Yatesville Lake

Big Sandy River Basin
Blaine Creek, Kentucky

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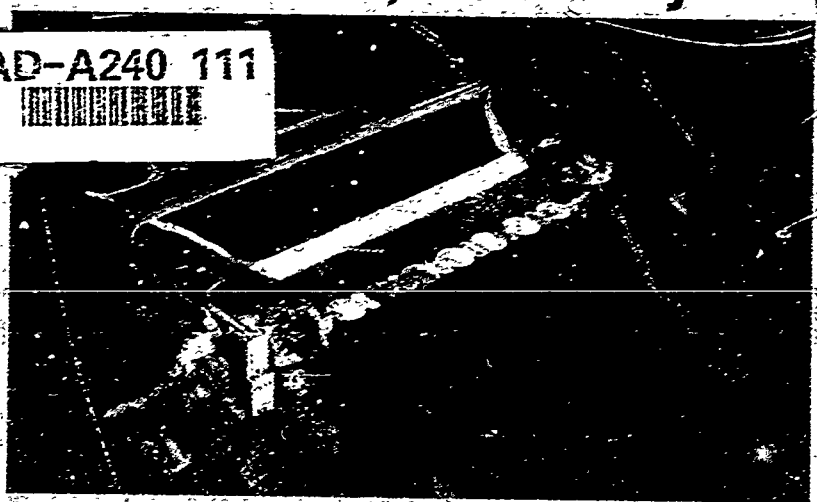

Foundation Report
Volume I

Construction of Dam and Appurtenant Works, Phase II
Contract Number DACW69-86-0039

September 1990

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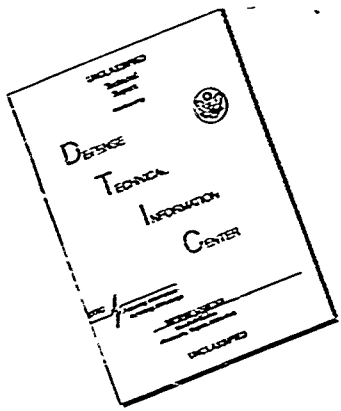

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REPLY TO
ATTENTION OF

CEORH-CD-I (1180)

SUBJECT: Foundation Report - Yatesville Lake, Kentucky
Construction of Dam, Contract No. DACW69-C-86-0039

DTIC/DA-2
Cameron Station
Alexandria, Virginia 22314

Dear Sir(s):

Forwarded in accordance with Paragraph 10b ER1110-1-1801, Change 2, dtd 1 Apr 83 is the subject report (2 vols).

Encl

JOSEPH R. TURNER, III
Acting Chief, Construction Division

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The geology of the Yatesville Lake Dam site and a discussion of how the engineered structures were adopted to the existing foundation conditions is the purpose of this report. Yatesville Dam is located in Eastern Kentucky, near the town of Louisa. Geologically, the area lies within the Cumberland Plateau Section of the Appalachian Plateau Physiographic province. The Pennsylvanian Age rocks are mostly sandstones, shales, coal, and siltstone. The principal features of this work are: a rock-fill dam with a central impervious core, a concrete intate structure, an uncontrolled spillway, a maintenance building, and a paved access road and parking area. The report describes in detail the procedures used to establish foundation grades, excavate and treat the foundation. Pertinent correspondence relating to foundation conditions along with one volume of typical foundation treatment photographs is included. Geologic cross-sections and boring logs are part of this report.

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FOUNDATION REPORT

VOLUME I

CONSTRUCTION OF DAM AND APPURTENANT WORKS, PHASE II

Contract No. DACW69-86-C-0039

Huntington District

U. S. Army Corps of Engineers

Huntington, West Virginia

SEPTEMBER 1990

Yatesville Lake, Phase II
Big Sandy River Basin
Blaine Creek, Kentucky

FOUNDATION REPORT
VOLUME I

(cont.) → Also included is information on the contractors and

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Yatesville Lake, Phase II
Big Sandy River Basin
Blaine Creek, Kentucky

FOUNDATION REPORT
VOLUME I

SECTION ONE -- INTRODUCTION

1. PURPOSE AND SCOPE

The purpose of this report is to ensure the preservation for the future use of the complete records of foundation conditions encountered during construction and the methods used to adapt structures to these conditions. The scope of this report covers the investigations, observations, and treatments involved in the establishment of sound foundations for the various structures at Yatesville Lake under Contract No. DACW69-86-C-0039.

2. PROJECT LOCATION AND DESCRIPTION

The Yatesville Lake Project is located on Blaine Creek, a tributary of the Big Sandy River. The Yatesville Dam is located 18.5 miles above the confluence of the stream with the Big Sandy and about 4 miles west of Louisa, Kentucky. The project consists of a rock-fill dam with a central impervious core, a concrete intake structure, an uncontrolled-type spillway, a maintenance building, and paved access road and a parking area. (See Appendix 12-01.A for statistical data concerning various features of the project.)

3. CONSTRUCTION AUTHORITY

The Yatesville Lake Project was authorized by the Flood Control Act of 1965, Public Law 89-298, 89th Congress, dated 27 October 1965. The authorized purposes of this project are for flood control, water-quality control, recreation, and fish and wildlife conservation.

4. PROJECT HISTORY

On 7 January 1977, a contract was awarded to EBY & Associates of Kentucky, a joint venture, for the construction of the Yatesville Dam and appurtenant works. Although mobilization was completed and excavation begun on the outlet portal and access road, this

work was halted and the contract terminated on 18 August 1977 by Presidential Order. The decision to separate Yatesville Dam and its appurtenant works into two separate contacts was approved in January 1981, with Phase I consisting of the outlet tunnel, stilling basin, outlet channel and intake structure foundation and Phase II consisting of the dam, intake structure, spillway, maintenance building, and access road. Re-evaluation of the original dam design resulted in several changes including: raising the top of dam from elevation 678 to 681 mean sea level (msl), redesign of the cofferdam from permanent earthfill to sheet-pile cells, and placing the dam foundation on top of rock rather than on overburden.

Construction of Dam and Appurtenant Works, Phase I, was awarded on 21 March 1984 to Cowin and Company, Incorporated, and was completed in March 1986. (For additional information see Foundation Report, Yatesville Dam, Phase I.) Construction of Dam and Appurtenant Works, Phase II, was awarded on 23 April 1986 to The Lane Construction Corporation. The dam embankment and 93 percent of the contract work were completed by September 1988. All physical work was accepted on 31 August 1989.

At the time of this report, contracts associated with the Yatesville Lake Project, although not directly related to the dam construction, include a clearing contract, two road relocation contracts, and three cemetery relocation contracts.

5. LOCATION OF STRUCTURES

The dam axis, with an alignment of N 87°32'W, intersects Blaine Creek at approximately 18.5 miles above its confluence with the Big Sandy River. The intake structure is located approximately 400 feet south of the dam on the left abutment. Connected to the intake structure is a preconstructed 975-foot tunnel and transition, a 112-foot stilling basin, and an outlet channel. Rock Borrow Area No. 1 and the maintenance building are located on the right abutment. The spillway is located approximately 1/2 mile east of the dam in a gap on the right valley wall. Elevations range from 518 msl on the dam foundation, after excavation, to 867 msl on top of the rock borrow area, before excavation.

6. CONTRACTORS

The prime contractor for the construction of the Yatesville Dam and Appurtenant Works, Phase II, was The Lane Construction Corporation, of Meriden, Connecticut. The contract was awarded on 29 April 1986. The work described in the contract included construction of

. a concrete intake structure, complete with 2 hydraulically operated main sluice gates, 2 emergency gates, 2 selective withdrawal outlet gates, 12 selective-withdrawal inlet gates, conduit liners, trash screens, 2 maintenance bulkheads, and a utilities system

. a rolled-random fill (earth and rock) dam (with impervious earth core) approximately 156 feet high, with a crest length of 855 feet

. a steel girder and concrete deck service bridge and spillway bridge

. an excavated spillway and inlet channel.

Other construction include a masonry-and-frame maintenance building with all appurtenant utilities and an asphalt-paved access road and parking area. Notice to Proceed was acknowledged on 15 May 1986 and the contract original completion date set on 19 April 1991, which gave 1,800 calendar days to complete the work. The final contract cost of the Phase II work was $27,604,765.

Major subcontractors included Boyles Brothers Drilling Company (exploratory drilling and foundation drilling and grouting); Richard Goettle, Incorporated (installation of steel sheet piles for the cellular cofferdam); McClelland Services, Incorporated (excavated the slurry cut-off walls); Stacon Corporation (installation of the dewatering system); and W.B. Fosson & Sons, Incorporated (construction of the maintenance building). (See Appendix 12-01.C for a partial list of contractor personnel and 12-01.G for a complete list of subcontractors.)

7. CONTRACT SUPERVISION

This contract was performed under a contractor-supervised Quality Control Program with quality assurance conducted through a Government Resident Office located on the construction site. This office was administered by a Resident Engineer acting as a legal representative of the Contracting Officer, the District Engineer. The Resident Engineer's staff number varied during the construction program depending on the workload during a particular phase of construction. (See Appendix 12-01.B for a partial list of Government personnel.)

SECTION TWO — FOUNDATION EXPLORATION

1. INVESTIGATION PRIOR TO CONSTRUCTION

Various exploratory programs were conducted at the Yatesville dam site between 1957 and the awarding of the Phase II contract in 1986. These investigations were performed to evaluate the foundation characteristics and to locate sources of suitable construction materials. These programs included not only investigations for work areas in this contract but for the outlet works as well, which was completed under a previous contract. Both rock and soil were investigated in the dam, outlet works, spillway and borrow areas. (For detailed information on pre-construction explorations, and field test and laboratory results see Design Memorandum No. 5, Volume II and Supplement to Volumes I and II)

The investigative procedures for overburden, at the dam and appurtenance sites, consisted of (1) drive sampling; (2) undisturbed sampling; and (3) excavation of test pits. Continuous drive samples were accomplished by 2-inch split spoon, using Standard Penetration Test (SPT) techniques; 4-inch and 6-inch hollow-stem auger; and churn-drilled samples. Fourteen undisturbed borings were completed at the dam site using a fixed piston sampler. Test pits were excavated by means of a backhoe in search of potential impervious borrow materials.

Various field and laboratory tests were performed on the collected samples from these soil investigations. Field tests performed during the soil investigation consisted of field pump-in test, recording blow counts, measuring the piezometric level where applicable, and visually classifying the sampled materials then sealing them for laboratory testing. Laboratory tests were performed on selected soil samples sent to the Ohio River Division Laboratories and included visual identification, moisture content, Atterburg limits, and gradation tests. Additional laboratory testing performed on select undisturbed and test pit samples included standard compaction, specific gravity, Q and R triaxial shear, S direct shear, consolidation, and permeability.

In addition to these Corps of Engineers investigations, A.C. Ackenheil and Associates Incorporated, of Charleston, West Virginia, performed a field investigation and laboratory testing program in 1968 under Contract Number DACW69-C-0012. This contract consisted of testing and evaluating the material from four tentatively designated borrow areas.

The rock investigation in the areas of the proposed structures and rock quarry was accomplished by drilling numerous NX size, 4-

inch and 15 6-inch diameter core borings using the standard double-tube-rotary core barrels with bottom-discharge bits. Thirty of the NX-size borings were drilled on a batter to determine joint spacing and orientation in the bedrock at the outlet portals, dam abutments, and spillway. All or part of selected NX-size borings were hydraulically pressure tested to determine the water tightness of the rock foundation. A select number of both the NX-size and 6-inch borings remained open after completion, to be used as observation holes so that seasonal ground-water levels would be recorded. Field tests performed by District geologists included core classification, pressure tests, and recording the piezometric level.

Various laboratory tests were performed on selected core borings. Select 6-inch core samples from the dam foundation were sent to Ohio River Division Laboratories for appropriate testing such as direct shear and sliding resistance, moisture content, and unit dry weight. Core samples from the rock borrow area were sent to the South Atlantic Division Laboratory (SADL), where tests were conducted for permeability, specific gravity, Los Angeles abrasion, weathering, gradation, 15-inch Q, R & S triaxial shear test, direct shear, and petrographic analysis. Additional testing on samples from the rock borrow area by SADL included vibrating-table relative density for sandstone members and standard compaction test for shale and siltstone members. (See Section 3-04 for additional information on rock testing.)

Investigations during the "Phase I" contract, awarded to Cowin and Company Inc., included the drilling of eight 4-inch core borings. These borings, located in the left abutment, were drilled by the subcontractor Stokley-Cheeks and Associates Incorporated. The information derived from these borings: four in the intake structure foundation, two in the service bridge foundation, and two in the right wing wall of the stilling basin, were used to supplement preconstruction exploratory information and to establish founding elevations for the excavation of the various structures. (See Yatesville Lake Foundation Report - Phase I.) Other exploratory drilling located in the outlet works included numerous preconstruction borings with laboratory tests being performed on selected samples.

The detailed results from the above rock and soil sample testing can be obtained from Design Memorandum No. 5, Volume II, Supplement to Volumes I & II, and A. C. Ackenheil & Associates, Incorporated, Borrow Area Investigation Report dated 29 November 1968.

2. INVESTIGATION DURING CONSTRUCTION

Investigations during construction can be divided into two headings: visual and physical. Visual investigations included the

continuous observation of conditions that were exposed during excavation so that conclusions derived fron interpretations of previous exploratory programs could be verified or revised. During this time, on-site inspections were conducted by personnel fron the District and Division geotechnical offices. The results of these respective items are discussed later in this report. Records of visual inspections of the final rock exposures and foundations include maps, documentation, and photographs. (See Appendix for records of visual inspections.)

Physical foundation investigation of rock was confined to exploratory borings. All exploratory drilling during construction was performed by the subcontractor Boyles Brothers Drilling Company with core logs made by a District geologist. These borings were drilled with a truck-mounted hydraulically-fed Longyear 44 rotary drill having a 4-inch-diameter standard bottom-discharge bit with diamond settings. Three separate investigations were made during construction, which included (1) spillway prior to excavation, (2) the dam foundation prior to foundation treatment, and (3) the dam foundation after foundation treatment. (See Appendix 12-06, Graphic Logs of Borings.)

Under Section 2F of the Contract Specifications, the Contractor was required to drill four 4-inch core borings in specified locations at the spillway prior to excavation. The information derived from these borings was used to supplement preconstruction exploratory information in order to establish founding elevations for the excavation of the spillway bridge foundation. These four borings were drilled in July 1986. Two of these borings, holes No. C-115 and C-116, were battered at 30^{0} into the designed inclined leg foundations of the spillway bridge. Holes number C-114 and C-117 were drilled vertically, located in the designed spillway bridge abutments. All four holes required casing in the top 5 to 10 feet due to severely weathered shale with drilled depths ranging from 45 to 65 feet. The average recovery of these borings was 93 percent, poor recovery was encountered within the top 20 feet, of these holes, due to severely weathered shales.

After overburden excavation was completed at the dam site, a conspicuous broken zone was discovered in the sandstone foundation at Station 5+85 from elevation 521 to 524. This broken zone required an exploratory drilling program to discover its extent, orientation, and severity. A series of 11 vertical 4-inch core holes were drilled (hole numbers EX-1 through 11), in September 1987, at various locations near the broken zone. During drilling a 6-inch-diameter roller bit was used for the first two feet to accommodate the length of the 4-inch ID core barrel. Depths of these exploratory holes varied from 11 to 22 feet with occasional core loss (0 - 60 percent loss) occurring in broken zones.

After drilling was completed, these 11 holes (hole numbers EX-1 through EX-11) were hydraulic-pressure tested then backfilled. The holes were hydraulic-pressure tested with a single air-expanding packer near the surface at 5 psi gauge pressure. If water take was encountered while testing near the surface, the hole would farther be tested at 5-foot increments. Eight holes (EX-4 through EX-11) exhibited high water takes (1.5 to 2.7 cfm) during testing. Upon completion, all holes were backfilled with a thick cement and water grout mixture and placed by tremie method. A conspicuously high grout take (454 bags of cement) was required to backfill these holes, in which the excess backfill is speculated to have been placed within the broken zones.

After the foundation drilling and grouting program was completed, an exploratory drilling operation was performed to determine the conditions of the dam foundation at locations of high grout takes and the effectiveness of the curtain grouting program. Seven 4-inch core holes (hole numbers CG-1 through CG-7) were drilled vertically to various depths (76 to 21 feet) within the valley bottom of the dam foundation during January and February 1987. No problems were encountered during drilling and a high recovery rate of 99% was achieved. After drilling was completed, the holes were pressure tested with a double-air-expanding packer at 5-foot increments and gauge pressures ranging from 5 to 24 psi. The formations tested "tight" with a range of 0.0 to 0.39 cfm. Upon completion, the holes were then backfilled with a thick cement and water mix and placed by tremie method.

An attempt to find an alternative impervious borrow area was initiated during placement of the dam embankment. A soil investigation was performed by a service contract with Mason-deVerteuil Geotechnical Services in June 1988. A series of overburden test pits and trenches were excavated, primarily located on the hillsides directly south and east of Spoil Area No. 1, between elevations 725 and 655. These pits and trenches were excavated by means of a John Deere 410 backhoe, with visual classifications and logs made in the field. The sampled material was tested in a lab for: gradation, moisture content, specific gravity, plasticity, and standard proctor curves. The results of this investigation failed to provide an improved source of impervious material of significant quantities.

SECTION THREE --- GEOLOGY

1. REGIONAL GEOLOGY

a. Physiography and Topography. The Blaine Creek drainage basin lies within the Cumberland Plateau Section of the Appalachian Plateau Physiographic Province. Within the project area, this section is characterized by a mature plateau with narrow drainage divides and a moderately wide flood plain, ranging from 300 to 600 feet wide, with a meandering stream. Blaine Creek has its source approximately 6 miles west of Martha, Lawrence County, Kentucky, at an approximate elevation of 1100 msl and flows in a general northeasterly direction discharging into the Big Sandy River at approximate elevation of 555 msl. Blaine Creek has a dendritic drainage pattern and flows on overburden throughout most of its course, except where it crosses the Lee Formation in the upper regions of the drainage basin. In several places, Blaine Creek has formed island-type knobs of bedrock within the alluvial flood plain caused by abandoned creek meanders.

b. Stratigraphy. The Blaine Creek basin was formed in sedimentary strata of the Pennsylvanian Age. Sedimentation took place on a broad subsiding basin, and a great thickness of alluvial sediments was accumulated with brief marine transgressions. The bedrock of the drainage basin in descending geologic order consists of the Monongahela, Conemaugh, Breathitt, and Lee formations.

The Monongahela Formation does not exist at full thickness in the basin area. This formation consists of siltstones, sandstones, and shales and is present at some of the higher elevations along the ridges toward the mouth of the drainage basin, below the dam site. Due to the lithologic similarity of the Monongahela and Conemaugh Formations and the thin and discontinuous nature of the Pittsburgh Coal horizon in this region, the lower boundary of the Monongahela must be projected from other stratigraphic beds.

The Conemaugh Formation is exposed in some of the higher elevations at the dam site and consists of sandstone, shale, siltstone, calcareous shale and siltstone, coal beds, Ames and Brush Creek limestone members, and a thin discontinuous limonite bed. This formation is located in the central and lower regions of the drainage basin. The Conemaugh Formation's lower boundary is defined as being placed at the top of the Princess Number 9 Coal Bed or, in the absence of this coal bed, on the base of a persistent mottled green and reddish shale member.

The Breathitt Formation is the predominant formation being exposed throughout the drainage basin. This formation is characterized by its numerous coal beds, many of which were exposed and mined from the Little Blaine Creek area. The lower Breathitt Formation is predominantly shale and siltstone with the upper Breathitt Formation consisting mostly of sandstone. In the mid-region of the basin massive sandstone members were deposited, some over 100-feet thick, as exposed at the dam site. The Breathitt also consists of flint-clay marker beds, claystones, and thin limestones such as the Magoffin Limestone and the Vanport Limestone members. The boundary for this formation is defined as having its lower contact placed at the top of the uppermost orthoquartzite member of the Lee Formation.

The Lee Formation is found only in limited exposures at lower elevations in the upper region of the drainage basin and does not outcrop at the construction site. The Lee Formation is the oldest unit found in the Blaine Creek drainage basin, with only the upper section of this formation being exposed. The Lee Formation is predominantly a medium grained quartzose sandstone with occasional conglomeratic or shale zones.

c. Structural Geology. Structurally, the region is part of the Appalachian Geosyncline, and the principal structural feature of the area is the Pittsburgh-Huntington Basin. This basin extends from southwestern Pennsylvania into Eastern Kentucky. Great thicknesses of shallow-water marine sediments were deposited in this basin. At the close of the Paleozoic Era, horizontal pressures originating from the Appalachian Mountain orogeny were exerted on the basin sediments and formed anticline-syncline folded topography generally trending from the northeast to the southwest. The folds are identified in the Blaine Creek basin and are located on Exhibit No. 4. Several structural domes have been defined in the basin and are also located on Exhibit No. 4. The regional dip of the rock strata is in a northerly direction at about 40 feet per mile.

Approximately 5 miles south of the dam site lies the Walbridge Fault. This is a "normal fault" that strikes in a general east-west direction, h ving a southern downthrown block with a displacement of about 150 feet. This fault is associated with the 38th Parallel Lineament, which is an east-west alignment of bedrock structural features from northeastern Virginia to south-central Missouri, with a probable Permian Age.

d. Seismic History. Research into the published records and statements by recognized geologists and geophysicists shows that the region of the Yatesville Dam project lies in a relatively inactive seismic area. In accordance with ETL 1110-2-

109, dated 21 October 1970, a seismic coefficient of 0.05g was recommended for the Yatesville dam site.

A seismic investigation of the dam site was performed in 1983, by a consultant, to evaluate the capability of nearby faults and the influence of recent events on the selection of design earthquakes. It was determined that none of the nearby faults were capable. The results of the design earthquakes were controlled by the Sharpsburg event, which was "floated" in the far-field because investigators have been unable to define a structural feature that was responsible for generating the earthquake. The selected far-field, hard-site motions for the design earthquakes at Yatesville Dam include (1) Operating - Basis Earthquake with a Richter Magnitude of 5.0, peak acceleration of 0.09g, peak velocity of 8 cm/sec and a bracketed duration of 2 seconds; (2) Maximum Credible Earthquake with a Richter Magnitude of 6.0, peak acceleration of 0.18g, peak velocity of 40 cm/sec and a bracketed duration of 30 seconds.

e. Economic Geology. Coal, gas, and oil have been produced from the Blaine Creek drainage basin. Most of the coal has been produced from the Breathitt Formation throughout the entire drainage basin with a concentration of past mining activity located in the area of the Left Fork and Right Fork of the Little Blaine Creek. Major coal beds within the Breathitt Formation that have been mined include the Princess Number 7, Richardson, Broas, Peach Orchard, Hazard, Whitesburg, and Van Lear coal beds. Both underground and strip methods of coal mining have been performed in the drainage basin. Underground mining consisted primarily of small household mines for domestic use, and strip mining consisted primarily of contour stripping in combination with augering.

Gas and oil have been produced from wells found throughout the drainage basin since the early 1900s. Of the gas and oil wells drilled to depths ranging from 500 to 4,000 feet, the major producing formations were the lower Mississippian "Wier" sandstone and Berea Sandstone, the Devonian Ohio Shale and "Corniferous" dolomite, and the Silurian "Big Six" sandstone. The largest oil and gas field is the Martha Pool with approximately 1700 wells, located in the upper region of the drainage basin. The major producing formation in this field is the "Wier" sandstone with oil traps being formed from the combination of structural domes and the presence of overlying impervious shales. Other, smaller, gas fields, which are located in the mid-region of the drainage basin, include the Cordell, Adams, Tarkin, and Daniels Creek School gas pools.

Clay and shales in the Breathitt Formation may be suitable for bricks, tile, pipe, or other building materials. Other possible resources include the sandstone members of the Breathitt

Formation for building stone, a thin discontinuous limonite member of the Conemaugh Formation for small amounts of iron ore, and quartzose members of the Lee Formation for glass sand.

2. SITE GEOLOGY

a. Physiography and Topography. The Yatesville dam site is located in a relatively narrow section of the Blaine Creek valley. The floodplain is approximately 450 to 500 feet wide along the axis of the dam. The floodplain, at the dam site, lies on the left side of the stream in the form of a terrace at about elevation 600 msl. The left valley wall rises on a moderately steep slope from the flood plain to the top of a hill at elevation 950 msl. On the right valley wall the slope rises non-uniformly from the stream to the ridge line. The valley wall contains large sandstone blocks which have weathered and separated from the outcropping Breathitt Sandstone. The Breathitt forms prominent sandstone cliffs, 5 to 25 feet high, throughout the entire construction site at elevations ranging from 625 to 675 msl. The sandstone blocks, found along the valley walls, have separated from these cliffs along high angled joints and have moved down slope. At the dam site, sandstone cliffs outcrop along both left and right valley walls from about elevation 650 to 675 msl with surface weathering forming overhangs and honeycombing.

b. Stratigraphy. The bedrock exposed during construction consisted almost entirely of sedimentary rocks of the Middle Pennsylvanian Breathitt Formation with limited amount of Conemaugh Formation being excavated from Rock Borrow Area No. 1. The members of the upper Breathitt Formation which were exposed at the construction site, in ascending geologic order, consist of the Upper Winifred Sandstone, Broas Coal Zone, a shale/sandstone member, Coalburg Sandstone, Richardson Coal Zone, Homewood Sandstone, Lower Kittanning Shale which includes the Princess Number 7 Coal Bed, and the East Lynn Sandstone.

The Breathitt Formation exposed during excavation of the dam foundation consists of 160 feet of bedrock from the Upper Winifred Sandstone to the Homewood Sandstone members. The Upper Winifred Sandstone Member was exposed in the base of the dam foundation from approximate elevation 520 to 535 msl and is described as being light gray, medium grained, moderately hard, and slightly micaceous. The Broas Coal Zone exposed in the dam foundation from elevation 535 to 545 msl consists of an underclay of variable thickness; a slightly pyritic, 1-foot-thick coal bed; a carbonaceous shale of variable thickness; and a thinner, discontinuous, upper coal bed. An interbedded shale/sandstone member was also exposed in the dam foundation from approximate

elevation 545 to 570 msl with a gray, fine-grained, sandstone and a dark gray, occasionally carbonaceous shale. The Coalburg and Homewood Sandstone Members, from elevation 570 to 680 msl, are lithologically similar and are indistinguishable at the dam site due to the absence of the Richardson Coal. These sandstone members are gray to brown, medium grained, slightly micaceous, massive sandstone with only occasional thin discontinuous shales and conglomerates.

The Breathitt Formation exposed during excavation other than the dam site include members from the Richardson Coal Zone to the East Lynn Sandstone. An extensive Richardson Coal Zone was found only in the spillway at approximate elevation 655 msl and consisted of two argillaceous coal beds, less than 1-foot thick, with a carbonaceous shale layer between them. The Homewood Sandstone Member, as described above, does not exist at the spillway but has various thicknesses elsewhere in the construction site. The Lower Kittanning Shale Member is present throughout the construction site between the Coalburg/Homewood Sandstone Members and the East Lynn Sandstone Member and was exposed during excavation of access and service roads, the spillway, and the rock borrow area. This member consists of shale with interbedded siltstone, claystone, sandstone, and coal beds. A major coal bed within this member is the Princess Number 7 Coal, which has been reported as being mined in the construction site, having a thickness of 1 to 2 feet. The uppermost member of the Breathitt Formation is the East Lynn Sandstone Member located throughout the construction site from approximate elevation 760 to 810 msl. This sandstone member is brown to gray, medium grained, and slightly to moderately weathered. The East Lynn Sandstone member was totally excavated from the right abutment, in Rock Borrow Area No. 1, for the placement in sandstone sections of dam embankment.

The Conemaugh Formation's lower boundary with the Breathitt Formation is defined at the construction site as being placed at the base of a mottled reddish- to purplish-brown and greenish-gray shale. Only the lower section of the Conemaugh Formation exists at the higher elevations in the construction site. This formation consists of a lower mottled shale and claystone, sandstone, shale, siltstone, calcareous shale and siltstone, and Bush Creek Limestone Member. The Conemaugh Formation in the right abutment was totally excavated from Rock Borrow Area No. 1 and was either placed in random rockfill of dam embankment or hauled to Spoil Area No. 4. The Bush Creek Limestone Member and associated calcareous sediments were not encountered during construction, but are reported to exist at approximate elevation 910 msl on the left abutment.

The depositional environment of the Breathitt Formation appears to be fluvially influenced. The exposed members above and below the Coalburg and Homewood Sandstone Members possibly represent a

meandering stream sequence. The sandstone in this sequence was deposited by an active stream channel with shales being floodplain deposits. The Broas, Richardson, and Princess Number 7 coal zones may represent regional swamp environments. The Coalburg Sandstone and Homewood Sandstone members are possibly a slightly braided or stacked meandering stream sequence. This sequence is characterized by massive sandstone being formed by active stream channels, thin conglomerates being erosional bases of these channels, and thin discontinuous shale lenses and coals representing abandoned stream channels. The lack of extensive shales in the 110-foot-thick Coalburg and Homewood Sandstone members could be due to the possible braided-type action of the stream, whereas the various directions of crossbedding indicate meandering-shaped stream channels. The stream flow in the upper Breathitt Formation was possibly in a northwesterly direction with sediment transported from the Appalachian highlands in the southeast.

The depositional environment of the lower Conemaugh Formation appears to be less swampy with the source material being from a more arid environment than the Breathitt Formation from evidence of change in shale color from gray to reddish brown and the lack of extensive coal beds. The deposition of this formation is reportedly placed in a deltaic plain with the Bush Creek Limestone Member representing a brief marine transgression. The stream flow during the Conemaugh age was probably in a northwest direction with the brief inundation of the sea from the west.

c. Structural Geology. The strata at the dam site and the area directly north of the dam dip to the northeast at the rate of 40 feet per mile. A small regional anticline has an alignment of N 70°E and is reportedly located approximately 0.3 mile south of the dam site. Approximately 5 miles south of the dam site lies the Walbridge Fault, a normal fault that strikes on a general east-west direction with the downthrown block to the south.

Most joints measured in the construction site had vertical to near vertical dips. These joints, some of which were either clay- or calcite-filled, were primarily found to be tight or slightly open and were commonly iron stained. Many vertical joints (59%) measured at the dam site have an alignment from N 10°W to N 15°E, which is the general direction of the valley. These joints, due to their strike and proximity to the original top of rock, are probably release joints occurring from valley stress relief resulting from unloading by erosion. In sections of the dam where a brittle stratum (sandstone) is interbedded with a more plastic stratum (shale), the sandstone would have a concentration of relief joints, some totally penetrating the sandstone members. A minor joint set, at the dam site, has

vertical dips with a stronger strike of N 30°E and a weaker strike of N 35°W.

Unique joint patterns, not found in other sections of the dam foundation, are associated with a series of near horizontal broken zones located in the valley bottom from station 5+30 to 6+30 within a sandstone member. One such pattern located in the vicinity of the broken zones consists of angled joints, occasionally coated, with a north-south strike and 60° to 30° dips to either the west or east. These angled joints can be interpreted as shear fractures occurring from the upward valley stress relief that had culminated in the valley bottom. Exposed within the broken zones are vertical joints with an east-west strike, representing extension joints resulting from slight elongation caused by valley stress relief.

Several near-horizonal broken zones, or faults, were found after overburden excavation and were investigated by means of exploratory drilling. These broken zones are located in the valley bottom from dam station 5+30 to 6+30. The uppermost zone was exposed, at the top of rock, perpendicular to the dam axis. The zones exist only within the Upper Winifred Sandstone Member between elevations 520 and 505 msl with thicknesses of 1 to 2 feet. These zones are slightly to severely broken with numerous discontinuous joints having a spacing of less than 1 foot. A black ferruginous coating was found within some broken zones on the bedding planes and joint surfaces with small stalactites forming in voids that were exposed at the surface. A sand-and-clay mylonite existed between the fist-sized blocks of sandstone within the broken zones although no brecciation had occurred with these sandstone blocks. There appears to be no rock movement along these broken zones or associated joints and little or no displacement of sandstone blocks within the broken zones although the presence of mylonite suggests some micromovement or compression in the sandstone. Iron-rich groundwater seepage was observed from the uppermost broken zone exposed at the surface from elevation 520 to 518 msl. The broken zones, or faults, appear to be the result of valley stress relief with the maximum stress occurring in the valley bottom where these zones are located.

A minor normal fault is located on the right spillway wall at station 4+40S through the Richardson Coal Zone. This fault has an alignment of N 75°W and a 45° dip to the south with a southern downthrown block and having a 4-foot displacement. This fault is not extensive, not being found in either the spillway sill excavation or the left spillway wall. Other features of structural geology include a small syncline located in the spillway and several minor slickensides within shale members throughout the construction site. Variable elevations for the Broas Coal Zone at the dam site and the top of the Coalburg/Homewood Sandstone members throughout the construction

site appear to be due to depositional rather than structural effects.

d. **Bedrock Weathering.** The topography of the Blaine Creek valley at the dam site is the result of differential weathering that caused the massive sandstone members to have slightly steeper slopes than shale members which form a more gentle relief. Differential weathering is prominent at the point of contact between the resistant Homewood Sandstone and soft Lower Kittanning Shale where vertical sandstone cliffs form. Surface weathering on these sandstone cliffs formed overhangs and "honeycombing" due to irregular cementation, ground water, and freeze/thaw cycles.

The dam foundation, for the most part, ranged from slight to moderate bedrock weathering with small pockets of severe weathering. The Upper Winifred Sandstone displayed only slight weathering at the original top of rock, which had drummy bedding planes and black ferruginous stained broken zones. The overlying shale/sandstone member had moderate weathering with iron stained sandstone joints and exposed weathered shale surfaces. This exposed weathered shale was removed to sound rock immediately prior to placing embankment. The Coalburg and Homewood sandstones had slight to moderate weathering with iron staining being common, and surface weathering of thin shale lenses. Severely weathered rock consisted of three, thin, poorly cemented, isolated pockets of sand within the sandstone members. (See Section 3-02.e for location of poorly cemented pockets.) The Lower Kittanning Shale from elevation 675 to 681 msl, at the surface, was severely weathered with discoloration and partial decomposition. This shale was excavated to sound rock before placing dam embankment.

The rock borrow area consisted partly of severely weathered shales and claystones in the Conemaugh Formation that were found to be unsuitable for dam embankment. The East Lynn Sandstone Member which is the dominant member in the rock borrow area, used in random and sandstone zones of dam embankment, had slight to moderate weathering and was commonly iron stained. The Lower Kittanning Shales, used partially in random rockfill, was slightly to moderately weathered.

In the vicinity of the spillway, the Lower Kittanning Shales are severely to moderately weathered. This is due in part to the soft nature of the rock and the narrow ridge through which the spillway is cut. The shale and claystone excavated above the spillway were severely weathered and became a factor in determining the founding elevations for the spillway bridge abutments. The bedrock in the spillway walls was moderately weathered with deterioration of shales on the exposed surfaces

causing differential weathering with thin interbedded sandstones.

e. Leaching and/or Solution Activity. The calcareous members of the Conemaugh Formation, in the higher elevations at the dam site, may have leached to produce the few calcite filled joints that were found. Solution activity formed black ferruginous coating and stalactites in voids and planes associated with broken zones, located in the valley bottom. Solution activity also formed the numerous iron-stained joints and sandstone beds at the dam site.

The leaching, or lack of cement, may have caused three thin isolated pockets of poorly cemented sandstone in the dam foundation. These sandstone pockets are iron-stained, discontinuous, approximately 1-foot thick, soft, and could be easily excavated with hand tools. These pockets of sandstone are located at: (1) sta. 5+07 to 5+20, 22 to 26 feet D/S; (2) sta. 5+70 to 5+80, 10 to 22 feet U/S, which was excavated and replaced with dental concrete; and (3) sta. 8+43 to 8+48, 40 feet U/S to 25 D/S, which was treated at the surface with dental concrete.

f. Ground Water. The ground water levels at the Yatesville Lake Project were determined during preconstruction subsurface exploration. It was established that the ground water level in the floodplain corresponds with the approximate stream elevation 572 msl and rises gradually in the abutments to approximate elevation 590 msl. Field observations have disclosed that there was ground-water movement within the Lower Kittanning Shales and along its contact with the Honewood Sandstone. Several small seeps and overburden slides occurred along this contact. These seeps, as exposed in the spillway walls, are indicative of a perched ground-water level and exhibit seasonal fluctuations.

Most of the ground water encountered at the construction site was during the excavation of overburden for the dam. Ground-water movement within the overburden was inhibited by the construction of two slurry cut-off walls. The ground water was then removed by means of a series of dewatering wells. The ground-water level was then monitored with piezometers. Staining and taste were evidence of the high iron content of this ground water. After overburden excavation at the dam site was completed, moderate ground-water seepage was evident in the valley bottom along an exposed near-horizontal broken zone at elevation 520 msl. This water had a high iron content and was controlled with the use of sump pumps. Minor ground-water seepage was found within an interbedded shale/sandstone member and the Broas Coal Zone at the dam site from elevation 535 to 570 msl. This negligible amount of ground water was controlled with the use of ditches and sump pumps. Various artesian ground-water zones were encountered at the valley bottom during foundation drilling and grouting. The

artesian pressures ranged from 0 to 10 psi and occurred below elevation 485 msl. The aquifers for most of the artesian flows were the Peach Orchard Coal and the Lower Winifred Sandstone Member.

g. Description of Overburden. The overburden at the dam site can be generally classified by the depositional nature of the material. These sections consist of (1) residual-colluvial material on the valley walls, (2) colluvial-alluvial material in the upper layer of the floodplain, (3) alluvial material in the lower layer of the floodplain. The overall thickness of the overburden in the floodplain ranges from 55 to 70 feet. Large glide blocks, derived from the valley walls, are occasionally found along the base of the valley walls but are rarely found within the floodplain.

The residual-colluvial material on the valley slopes was found to be relatively thin, 0 to 5 feet thick, consisting of mixtures of sand-, silt-, and clay-size particles derived from weathering of sandstone, siltstone, and shale.

The upper colluvium-alluvium layer consists primarily of interlensing deposits of clay, sands, and silts with some gravel- to boulder-size materials present. This layer is found throughout the top 10 to 25 feet of the floodplain and is characterized by its heterogeneity. Its deposition was influenced by either the hillside (colluvium) or the river (alluvium).

The lower alluvial layers in the floodplain consist of a soft clay layer, loose sand layers, and a foundation sand layer. The soft clay layer consists of a soft, bluish gray, sandy clay and was found to be continuous toward the left abutment under the upper colluvium-alluvium layer with a maximum thickness ranging from 10 to 30 feet. This clay layer may represent an abandoned stream channel filled with fine-grained flood deposits. The loose sand layers extend over the entire valley and underlie the clay layer towards the left abutment and the colluvium-alluvium layer toward the right abutment with an approximate thickness of 40 feet. This loose sand layer was found to have "loose" to "very loose" relative density during standard penetration tests. The bottom layer consists of foundation sands ranging from 10 to 30 feet thick with a "medium" relative density.

3. ENGINEERING CHARACTERISTICS OF OVERBURDEN

An extensive preconstruction exploration program was performed on the overburden at the dam site. Disturbed and undisturbed soil samples, collected from this program, were tested by the Ohio River Division Laboratories (ORDL) and the Waterways Experiment

Station. The results from these labs as well as field tests and observations can be found in Design Memorandum No. 5. The alluvial material at the dam site was divided into three classifications -- "soft clay," "loose sands," and "foundation sands." (See Section 3-02.07, Description Of Overburden.) This alluvium material was determined to be inadequate for the dam foundation, placed either totally or partially on overburden. After evaluating both field and laboratory data, deficiencies in the alluvial material were observed, including the following: (1) "soft clays" yielded an unacceptable safety factor during stability analysis for the end-of-construction condition; (2) "loose sands" during exploration were found to have conspicuously low blow counts (0-10 blows per foot) using Standard Penetration Test (SPT) techniques; and (3) "foundation sands" during liquefaction analysis were determined to be inadequate with respect to dynamic loading. Re-evaluation and analysis concluded that a dam founded on rock with the upstream shell partially founded on overburden would yield acceptable safety factors. (See Section 4-02 for design considerations of dam embankment.)

Soil samples from preconstruction exploration of potential borrow areas were tested by ORDL and A.C. Ackenhiel & Associates, Inc. Results from these tests can be found in Design Memorandum No. 5. Although two areas were determined to be suitable for borrow, only one was used during construction of the impervious core and diversion dikes. Impervious Borrow Area No. 1, below elevation 615 (msl), used during construction, was formed by an abandoned meander of Blaine Creek then filled with alluvial clay during flood periods. This alluvial clay was determined to exist in the top 10 feet of overburden and consisted primarily of silty clay.

During construction, continual tests were performed by the Government and contractor in field laboratories on the in-place materials of the impervious core. These materials were tested for correct classification (CL), moisture (-1% to +2% of optimum), and compaction requirements as specified in the contract. Also, as specified in the contract, undisturbed samples were taken at specific elevations during placement of the impervious core and were sent to ORDL for evaluation.

4 ENGINEERING CHARACTERISTICS OF ROCK

Representative rock samples from 6-inch borings were tested by Ohio River Division Laboratories (ORDL) and South Atlantic Division Laboratories. Results from these tests can be found in Design Memorandum No. 5. Two borings were tested, C-26 and C-77, to determine the engineering characteristics of the dam foundation. Sandstone and siltstone samples from boring C-26, located slightly upstream from the centerline of the dam near the center of the valley, were tested for direct shear and sliding resistance. Boring C-77 was drilled near the toe of the left

abutment just upstream from the dam centerline. From this boring a sample of clay with sandstone fragments (fault breccia) and zones of weaker sandstone was tested in direct shear with measurement of sliding friction. Selected samples from these holes were also tested for moisture content and unit dry weight. All or part of selected NX core holes, located at the dam site, were hydraulically pressure-tested to determine the water tightness of the various formations.

Ten borings, C-78 through C-87, were tested to determine the rock characteristics in Rock Borrow Area No. 1. From these borings petrographic and/or x-ray diffraction analysis was performed on 22 representative samples from various elevations. Sandstone members were found to be suitable for processed sandstone and sandstone rockfill zones of dam embankment. Both shale and sandstone members were suitable for random rockfill zones of dam embankment. The results of rock analysis of the borrow area and a summary of the various design-strength parameters and stability analysis of the dam embankment can be found in Design Memorandum No. 5.

Due to the lack of durability and/or sufficient quantities, the materials required for the drains, stone slope protection, and concrete aggregates were not available at the work site and had to be obtained from commercial sources. (See Appendix 12-01.M for a list of materials obtained from commercial sources.)

5. UNANTICIPATED GEOLOGIC CONDITIONS ENCOUNTERED

a. Dam Foundation. Several minor features were encountered in the dam foundation that were not anticipated. A prominent unanticipated feature was the presence of several near-horizontal broken zones located in the valley bottom. (See Section 3-02.c for description of broken zones.) These broken zones required additional excavation, dental concrete, dewatering, and foundation grouting. (See Section 4-05 for treatment of broken zones.)

Other unanticipated features in the dam foundation include small, isolated pockets of poorly cemented sandstone, which were removed and replaced with dental concrete. Soft shales and underclay below the Broas Coal, on the right abutment, required additional excavation and dental concrete. Although anticipated, the thickness of sandstone (110 feet) at the dam foundation is unusual for the Breathitt Formation.

b. Spillway. The characteristics of the shales in the spillway resulted, in part, to over excavation along the side walls and floor. This over excavation in the sidewalls affected

the concrete thicknesses in the inclined leg foundation of the spillway bridge. Over excavation in the spillway floor exposed portions of concrete in the sill and inclined leg foundation key that was designed to be founded in rock. This overexcavated rock along the spillway floor was replaced with compacted clay.

A detrimental condition occurring from the spillway shales is the differential weathering with a thin-bedded, moderately jointed sandstone which is undercut by the weathering shales. This undercutting may allow sandstone blocks to become dislodged, falling into the spillway floor. A normal fault located on the right spillway wall also enhances the surface weathering of the shales in its immediate area creating a slight undercutting effect. (For a description of normal fault see Section 3-02.c, Structural Geology.) These conditions of over excavation and weathering will be corrected with additional concrete in a later contract.

SECTION FOUR -- SPECIAL DESIGN CONSIDERATION

1. COFFERDAM

After termination of the 1977 contract for the construction of the Yatesville Dam, a re-evaluation of the original earthfill cofferdam design was required due to changes in design criteria. During the cofferdam re-evaluation, downstream flood profiles using the National Weather Service Dambreak Model indicated that the failure of a temporary embankment cofferdam at elevation 611 msl would constitute a significant hazard to life and property downstream. A design increase in height, to elevation 639, required relocation of the cofferdam which resulted in additional foundation exploration. This additional exploration determined that the foundation materials and strengths were significantly different than those derived from previous findings. Using this additional foundation information, the stability analysis of the permanent cofferdam design for the end-of-construction condition yielded an unacceptable safety factor.

Because of the inadequate safety factor for a permanent earthfill cofferdam, it was proposed that this structure be replaced by a permanent cofferdam consisting of sheet-pile cells with a crest elevation of 616 msl. This decrease in crest elevation, from 639 to 616, was required because of construction problems concerning the long sheets and the excessive diameters necessary for a higher crest, but was acceptable since a cellular structure can be safely overtopped. This cofferdam provided protection against a 5-year annual flooding frequency with 2 feet freeboard. This constructed cofferdam has a parallel alignment with the dam and is located 332.32 feet, center to center, upstream of the dam. The sheet-pile cells of the cofferdam consisted of seven 62.68-foot diameter cells with the sheets founded on top of rock or to the maximum depth at elevation 540 msl. The cells were filled with bottom ash and have a 12-inch concrete cap. Toward the left and right abutments of the cofferdam, concrete monoliths were placed to elevation 621 msl, and were later removed to elevation 616 msl after the completion of the dam embankment. Downstream of the cofferdam, 12-inch concrete slabs, with embedded drain pipes, were placed to protect the excavated slope from being undercut during periods of overtopping. These slabs were broken by a dozer, however, as the dam embankment was being placed. (See Section 7-01 for additional cofferdam information.)

2. DAM EMBANKMENT

The constructed dam embankment, which was founded on rock, is significantly different than the embankment design called for in the original 1977 contract, which was founded on overburden.

These design modifications were the result of changes in design criteria and additional foundation information, that varied from previous explorations. A change in hydrologic and hydraulic design criteria required that the dam crest be raised from elevation 678 msl to 681 msl (without camber). As a result of additional foundation exploration for the relocation of the cofferdam, it was concluded that extensive deposits of soft clays, silts, and loose silty sands were present not only in the vicinity of the cofferdam but also along the left abutment of the dam site. After incorporating this information with previously obtained results, the stability analysis of the dam embankment founded totally on overburden for the end-of-construction condition yielded an unacceptable safety factor below 1.0.

Analysis of a proposed embankment with the shell founded at elevation 555 msl on in situ foundation sands, which underlies the soft clays and loose sands, and its central impervious core founded on rock indicates that such an embankment is statically stable. Due to revised criteria for seismic design and recent earthquake epicenters, an additional seismic investigation was initiated. The results of this investigation increased the seismic coefficient from 0.05 g (previously recommended) to 0.18 g. Using these higher values in liquefaction studies for this proposed embankment indicated that the foundation is inadequate with respect to dynamic loading.

The constructed dam design is founded on rock with the exception of the upstream shell, which is partially founded on the downstream slope of the permanent cofferdam. Analysis of this design indicated that it is adequate for both static and dynamic loading. The embankment is approximately 855 feet long and has a crest elevation at 681 msl (without camber), which is 160 feet above the bedrock foundation at elevation 521 msl. The upstream embankment slope is 1V on 3H, with a 12-foot bench at elevation 635 msl, while the downstream slope is 1V on 2H. The embankment consists of processed sandstone, sandstone rockfill, and random rockfill zones upstream and downstream of an impervious clay core. An inclined and blanket drain, located downstream of the impervious core, will provide seepage control. The dam foundation treatment, which will also control seepage, included a foundation grout curtain, dental concrete, and dental grouting. (See Appendix 12-05 for cross section of dam embankment)

3. DEWATERING SYSTEM

A dewatering system for the overburden was required to accommodate the construction of the revised dam and cofferdam design, as mentioned above. This system allowed overburden excavation to be performed in the dry. The overburden excavation included the area of the cofferdam to elevation 570 msl, and total removal of overburden to the top of rock at and downstream

of the dam core. The dewatering system consisted of slurry cutoff trenches upstream and downstream of the excavation with a series of predrainage and dewatering wells within the excavated area. The slurry trench was constructed to the top of rock with a width of 3 feet and had a soil-bentonite backfill. The purpose of the slurry cutoff walls was to inhibit groundwater flow from the alluvial sands into the work area. These slurry cutoff walls significantly reduced dewatering requirements and pumping time for the numerous dewatering wells or systems that would have otherwise been necessary. (See Section 5-02 for description of dewatering provisions.)

4. INTAKE STRUCTURE

In the future, the intake structure and outlet works could be in contact with a chloride-dense water caused by petroleum production in the drainage basin. This problem will be mitigated by the enforcement of existing environmental laws. As a precaution to this corrosive water the design of the intake structure included several protective measures. The reinforcing steel, placed within the intake structure below elevation 635 msl, was covered with epoxy and the tie wire and ancillaries coated with nylon. The hydraulic pipes were required to be stainless steel below 645 msl. Most embedded and exposed ferrous surfaces below 635 msl were coated with two coats of epoxy zinc-rich paint and two coats of coal-tar epoxy. Other protected metals in the intake structure below elevation 635 msl include corrosive-resistant steel for screens exposed on the exterior, and a vinyl paint system for selective-withdrawal and main-sluice maintenance bulkheads.

The initial lift of the intake structure, above the base slab, required additional forming. This additional forming was due to a lower excavated rock elevation in the intake area than what indicated on the design drawings. (See Appendix 12-03, for modifications.)

5. FOUNDATION TREATMENT

Additional foundation treatment, beyond the designed plans and estimated quantities, was required during construction to treat the unanticipated broken zones in the dam foundation. (See Section 3-02.c for a description of broken zones.) The foundation treatments for these broken zones, found in the valley bottom, consisted of additional foundation curtain grouting, dental concrete, and rock excavation. Modifications to the foundation grout curtain were needed to prohibit groundwater movement through, and to consolidate, these horizontal broken zones. The modified design of the grout curtain called for two additional grout lines at a depth of 35 feet located at 37 feet

upstream and 20 feet downstream of centerline, from station 5+05 to 7+35 and 4+95 to 6+75 respectively. Dental concrete placed to isolate these broken zones from the impervious core totaled 585 cubic yards, which was greater than the total estimated quantities (300 cubic yards) cited in the contract. An additional 22 holes were drilled and grouted to seal the rock contact with this dental concrete. (See Section Nine for description of foundation treatment.) The rock excavation, needed to expose and treat these broken zones, totalled approximately 2,200 cubic yards and included pre-splitting and line drilling. (For additional information on foundation treatment see Appendix 12-01-H Dental Concrete, Appendix 12-02 Foundation Curtain Grouting, and Appendix 12-05 Exhibits.)

SECTION FIVE -- DEWATERING PROCEDURES

1. DEWATERING PROVISIONS

The contractor was required to provide sufficient dewatering equipment and to construct a dewatering system so that construction activities could be performed in the dry. The different aspects of the required dewatering system included stream diversion, surface-water control, dewatering overburden, and dewatering rock. The diversion of Blaine Creek was accomplished through the combined use of a diversion channel, ditches, and dikes; a cofferdam; and the dam outlet works. The contractor was required to design, install, operate, and maintain a system to control surface water and to unwater Blaine Creek between the diversion dikes. This requirement was satisfactorily fulfilled by the use of sand-bag dikes and strategically located sump pumps. Dewatering overburden required the contractor to install the designed minimum dewatering system. This dewatering system included dewatering and predrainage wells, piezometers, and slurry cutoff walls. Dewatering rock was partially accomplished by means of sump pumps and dental concrete.

2. DEWATERING OVERBURDEN

a. General. The excavation of the overburden to top of rock, in the valley floor of the dam foundation, required a dewatering system that would reduce and maintain the ground-water level to elevation 533 or lower. This system also required the ground-water level to be lowered to elevation 565 or lower in the sand formations underlying the excavation for driving the sheet piling for the cofferdam. The contract specifications and drawings set forth a minimum dewatering system consisting of slurry cutoff walls; dewatering and predrainage wells, pumps, and discharge header pipes; and monitoring systems, which include piezometers and flow-metering equipment. (See Appendix 12-01.0 for additional dewatering information.)

b. Slurry Cutoff Walls. Two slurry cutoff walls were constructed in order to inhibit ground-water movement through the overburden and into the dam-site excavation. The slurry cutoff walls were constructed by the subcontractor McClelland Services Inc., from 30 July to October 1986. These walls were excavated through the alluvial material to top of rock, with the length extending the entire width of the valley bottom. The installation of the slurry cutoff walls entailed excavating a 36-inch vertical slurry trench, backfilling the trench with a soil-bentonite mixture, capping it with a dry mix of bentonite and

crushed rock and covering it with a geotextile, and placing impervious fill over the fabric. The combined total area of slurry cutoff walls constructed is approximately 58,200 square yards.

The two slurry cutoff walls are located upstream and downstream of the dam-site excavation. The upstream wall is located 450 feet upstream of dam centerline, extending from station 2+86D to 8+37D. This upstream wall has a parallel alignment with the dam, except for a 14° downstream dogleg near the left abutment. The main wall of the "Y"-shaped downstream wall is located 470 feet downstream and has a parallel alignment with the dam centerline, from station 2+00D to 7+00D. The upstream leg of the "Y" intersects the main wall at station 4+88D and extends from the main wall 292 feet at 43° upstream toward the left abutment. (For slurry wall location see Appendix 12-05, Exhibits.) An approved Value Engineering (VE) proposal allowed the construction of the two sections of the downstream wall to be done in a single phase instead of the designed two-phase sequencing. (See Appendix 12-03, Modification.) The intersection of the upstream leg with the main downstream slurry wall was modified to be constructed at an angle instead of the designed curved intersection.

Excavation of the slurry cutoff walls began after the site preparation was completed and the slurry-wall alignments were marked. The trench excavation was completed by means of a Koehring 1266D backhoe with an extended boom and a 36-inch Adco rock bucket. The excavated trench ranged in depth from 0 to 62 feet. When large boulders were encountered, that could not be excavated solely by the backhoe, a crane and chiseled-point drop bar were used to break the boulders into excavatable pieces. During excavation, a bentonite slurry was added to the trench and the bentonite slurry level was maintained to within 1.5 feet of the working surface. The bentonite slurry consisted of a mixture of Sodium Bentonite, supplied by Federal Ore and Chemical Co, and creek water. The bentonite slurry was prepared by means of a "jet type" slurry mixer, pumps, header pipes, and settling ponds located approximately 550 feet upstream of the dam centerline. The slurry was mixed and tested to ensure that specified viscosity, specific gravity, and sand content requirements were met. (See Appendix 12-01-O Dewatering System for specified limits.) After a section or all of the trench had been excavated, and before backfilling operation had begun, the trench bottom was air lifted to remove any settled sand.

Backfilling of the slurry cutoff wall entailed filling the trench with a soil-bentonite backfill mixture to within 1-foot of the surface. The components of the backfill consist of in situ silty sands, coarse sand supplied by Standard Slag, dry Sodium Bentonite, and bentonite slurry. These components were combined by means of an Erie-Strayer concrete batch plant and mixed to meet specified gradation, 5 percent bentonite content,

slump, consistency, and density. (See Appendix 12-01-O Dewatering System for specified limits.) After the trench was backfilled, it was capped with a dry mixture consisting of half-inch and 1-inch crushed aggregate, sand, and 8 percent bentonite. The trenches were then covered with Mirafi 600X geotextile and a 3-foot-thick layer of impervious core material.

The upstream slurry cutoff wall was constructed from July to September 1986 with both excavation and backfilling proceeding from the right to left abutment. The backfilling operation entailed the batching of all backfill components by means of a batch plant, the mixing and placement of backfill material by means of concrete-mixing trucks, and pumping the displaced slurry into storage ponds for use either in the downstream wall or in the backfill mixture. The backfill for the upstream wall was placed with a high slump (4 to 6 inches) because of the difficulty encountered in removing the backfill material from the concrete mixing trucks. The backfill operation was limited while excavation was in progress, because of the low angle of repose (6 percent slope) of the placed backfill material and the slope of the rock abutment, for which clearance could not be maintained between the backfill and the toe of excavation. An approximate area of 23,700 square yards of slurry-wall construction was completed for the upstream wall.

After completion, a 2-foot surface settlement was noticed in the impervious fill located over the upstream slurry wall in November 1986. This settlement occurred after the dewatering system was completed and operational. The settlement may be due in part to the high slumped backfill material placed in the trench, which was then dewatered by nearby wells. The surface depression was subsequently backfilled with impervious material.

The downstream slurry cutoff wall was constructed from September to October 1986 with excavation proceeding from the left to right abutment and backfilling, after excavation was completed, from right to left abutment. The backfilling operation for the downstream slurry cutoff wall consisted of batching the dry components of the backfill by means of a concrete batch plant, hauling the dry material next to the trench by means of dump trucks, adding bentonite slurry from the trench to the dry backfill mixture, mixing backfill material and placing it in the trench, by means of a D-6 dozer, and pumping displaced excess bentonite slurry to a designated spoil area near the batch plant. The total area of the downstream slurry cutoff walls is approximately 34,500 square feet.

During a period of high water in November 1986, Blaine Creek had prematurely flooded into the diversion channel and damaged a section of the downstream slurry cutoff wall. The damage consisted of a notch being eroded where the wall crossed the channel, backfill material being lost, and a surface depression

near the diversion channel. Driving "Z" piling into the cutoff wall was required to prevent any additional loss of backfill material, and a geotextile and stone slope protection were added, as called for in the VE proposal, to prevent additional erosion during stream diversion.

c. **Dewatering Wells**. In order to lower the ground water at the dam site to specified levels, the contract provided for the installation of a minimum-designed dewatering well system. This system of wells was installed by a subcontractor, Stacon Corporation, during a 2-month period from 15 August to 6 October 1986. The dewatering well system consisted of 33 dewatering wells, power supply, and ground-water discharge systems. The dewatering wells were equipped with submersible pump, sand filter, wellscreen, and riser pipe. The ground water from these wells was pumped into a series of headers, valves, meters, and 4- to 8-inch steel pipes and was discharged into the diversion channel at two separate points. The electricity for the 220V single-phase submersible pumps was supplied by two temporary power poles and standby power supplied by a generator. The electricity was delivered by direct-bury cable to electrical panels equipped with disconnect switch, fuses, starter, and warning light. (For location and description of dewatering wells see Appendix 12-05, Exhibits.)

The dewatering wells were installed after partial overburden excavation was completed to approximate elevation 575 msl and Blaine Creek was temporarily diverted through the dam outlet works. Installation of the dewatering wells consisted of drilling the well; placing filter sand, wellscreen, and casing; developing the well; and completing the well. After their locations were surveyed, the 24-inch-diameter wells were drilled from the surface to top of rock using a Gus Peck "Super George" bucket auger. After drilling, the 8-inch-diameter riser pipe and wellscreen were assembled and installed along with the placement of the sand filter. The well was then developed, which consisted of: pumping well for 30 minutes, by means of a gas pump; surge well, 15 trips at a 2 ft/sec rate, using a wench and surge block; air lift bottom of well for 1 hour; test well capacity and the sand content using gas pump and a Rossum sand tester; repeat development if well tested with a sand content above 5 ppm. After development was completed, the filter sand was added to the specified level and the well disinfected. Primarily the wells were backfilled above the filter sand with in situ sands, although the wells upstream of the cofferdam were backfilled with a bentonite-cement mix. The well was completed after the Grunfos model SP6-6 submersible pump was installed and connected to the power supply and ground-water discharge system and a final sand-content test was performed.

Problems encountered during the various stages of dewatering well

installation were minor and did not affect the overall performance of the dewatering system. A problem that came about due to encountering boulders while drilling along the right abutment resulted in one well being relocated to a nearby location. Problems during development included a well, located toward the left abutment, having a low water yield and high sand content due to the fine-grained material in which it was placed. During backfilling operations, the PVC riser pipes were slightly deformed for some wells located upstream of the cofferdam. This deformation was caused by the high hydrating temperature of the backfill, due to the lack of specified sand in the mixture. The instrument panels for the wells located upstream of the cofferdam were later relocated to the top of the cofferdam to prevent damage during periods of flooding. The ground water encountered had a high iron content, which quickly discolored the transparent header section at each well.

The dewatering wells were successful in controlling the ground water so that overburden excavation could be performed in the dry. As the overburden excavation progressed, the wells located within the future fill area were systematically removed when they became inoperative until, finally, only the wells located directly upstream and downstream of the cofferdam remained in operation. At the completion of overburden excavation, ground-water seepage was noticed in the lower gravel layers at the downstream overburden slope located approximately at station 5+40 to 5+80, 300 feet downstream of the dam centerline. This seepage was controlled by means of a 30-inch diameter sump, which extended through the random rock fill and was later backfilled with rock when no longer needed.

d. Monitoring System. In order to determine the effectiveness of the overburden dewatering system at the dam site, a monitoring system was installed. The monitoring system consisted of piezometers, water meters, and inspection features at the individual dewatering wells. A series of 13 open-tube-type piezometers was installed in the area around the dewatering wells. (For piezometer locations see Appendix 12-05, Exhibits.) Water meters were installed at each of the two ground-water discharge points in the diversion channel. These meters measured the flow rate and total gallons discharged for the dewatering well system. Monitoring the individual dewatering wells was accomplished through the use of various inspection features at the well. These features included additional valves and tees to allow testing for flow rate and sand content, a 12-inch transparent header section to allow visual flow inspection, a well cap with a hole for sounding, and a warning light to indicate when the pump is off. The prime contractor read the monitoring system periodically and recorded the results.

The series of 13 piezometers was installed at the dam site from 3

September to 6 October 1986 by Triad Engineering Drilling and Services Co., a subcontractor of Stacon Corporation. The installation of these piezometers include: survey piezometer locations; set casing; install tip, riser pipe and filter sand; backfill and cap piezometer; and perform pump-in test. Piezometers were located in accordance with the contract drawings with the exception of piezometer "H" which was placed downstream of its designed location. The casing was set to rock by means of a Mobil drill and using augering and driving techniques in combination. The 5-foot plastic porous tip with riser pipe and filter sand was installed, with the casing being lifted as the filter sand was being added. The remaining hole was backfilled and capped according to specifications. The piezometer was then considered acceptable if the results of the pump-in test were 2 gpm or greater.

3. DEWATERING ROCK

After overburden excavation was completed at the dam site, ground water was observed seeping from the bedrock surface through joints and bedding planes. Since the overburden dewatering system was ineffective in controlling this type of water flow, additional dewatering measures were required. The measures to control this water flow consisted primarily of sumps, dental concrete, and foundation grouting. (See Section Nine for additional dental concrete and foundation grouting information.) These additional dewatering measures were required in the dam core area to prevent ground water from the rock foundation coming in contact with the impervious core material during and after placement. Rock features, within the dam core area, that produced ground water at the surface included a horizontal broken zone, located in the valley bottom; a shale seam, located in the valley bottom; and various bedding planes, located along the abutments.

The highest quantity of ground water encountered at the rock surface was emitted from a near-horizontal broken zone. This zone is located in the valley bottom, within the dam core, from station 5+40D to 6+00D, at elevation 521 to 518 msl. (See Section 3-02.c for description of broken zone.) In October 1987, after final rock excavation was completed, this ground water was controlled by embedding, in dental concrete, two 30-inch perforated metal pipes for sumps. These sumps were located outside the impervious-core limits, near areas of high water inflow, at station 5+78D, 57 feet U/S and at station 5+88D, 76 feet D/S. After foundation grouting was completed, the upstream sump failed to produce water, at which time it was backfilled with concrete. In March 1988 a third pipe was embedded in dental concrete to control this water, located at station 5+51D, 61 feet U/S. The two operating sumps were then pumped during embankment placement and were extended through the rockfill until the static

water level was exceeded. At that time the sumps were backfilled with concrete.

Other areas of ground water seepage from the bedrock, within the dam core area, included a shale/sandstone contact in the valley bottom and various bedding planes along the abutments. Very light ground water seepage and wetting was observed along various bedding planes within the thin interbedded shale, coal, and sandstone members along both abutments from elevations 535 to 565 msl. This seepage was not significant enough to warrant dewatering, although the curtain grouting partially sealed this water from the core area. A light ground-water seepage, < 1 gpm, was encountered at the lower contact of a 6-inch shale seam with sandstone near dam centerline at station 4+50D, elevation 527 msl. This ground water was initially controlled, in April 1988, by means of an 8-inch-diameter stand pipe with gravel packed around its base just prior to embankment placement. Later it was decided to further treat and isolate this water from the core. This additional treatment required removal of the overlying impervious core and entailed: further excavation of the shale seam, placing dental concrete, and embedding the 8-inch-diameter stand pipe in the concrete near the seepage. This pipe was then extended through the impervious core to its hydrostatic level and was backfilled with concrete and dry cement.

SECTION SIX -- EXCAVATION PROCEDURES

1. GENERAL

a. Construction Sequence And Stream Diversion. The contract specifications for construction of the Yatesville Dam, Phase 2, required a specific sequence, which was slightly modified during construction. The specified sequence was divided into two sections, Pre-diversion and Post-diversion, referring to the diversion of Blaine Creek through the outlet works. (See Appendix 12-01 P for Chronological Sequence of Construction.) The embankment season for this contract was specified as the period from 1 May to 1 December.

The major constructed pre-diversion sequence included (1) temporarily diverting Blaine Creek through the existing outlet tunnel, (2) excavating diversion channel, (3) partially excavating overburden and rock at the dam site, (4) constructing slurry cut-off walls, (5) installing dewatering wells, (6) constructing diversion dikes, (7) diverting Blaine Creek through the diversion channel, (8) completing cofferdam cells 1 through 6 and monoliths 1 through 4, (9) excavating the spillway, (10) continuing to excavate overburden at the dam site, (11) completing stage IV cofferdam berm, and (12) completing the intake structure to elevation 619.

The major constructed post-diversion sequence included (1) diverting Blaine Creek through the outlet works, (2) excavating the right diversion channel wall, (3) completing the cofferdam, (4) completing overburden and rock excavation at the dam site, (5) performing foundation treatment, (6) excavating borrow areas and placing the dam embankment, (7) completing the dam embankment, intake structure, access and service roads, and maintenance building.

b. Diversion Channel Excavation. The diversion channel was excavated through rock and overburden along the left dam abutment. The diversion channel permitted simultaneous construction of the intake structure to elevation 619 as well as cofferdam construction and overburden excavation at the dam site. Blaine Creek was diverted through the channel for a period of 9 months, from November 1986 to August 1987. The channel was approximately 1,000 feet in length and had a base width of 30 feet at elevation 574. The channel was founded primarily on rock although the downstream sections were partially excavated through overburden.

Rock excavation for the diversion channel began with systematic drilling and blasting in May 1986 and was completed in July 1986. (See Section 6-04 and Appendix 12-01.J for additional blasting information.) The 4V on 1H sloped faces of rock excavation in the upstream half were accomplished by means of the presplit method using 30-inch center-to-center spacing. The presplit walls varied in height with an approximate maximum of 70 feet along the left wall and 30 feet along the right wall. The excavation was benched at elevation 604 along the left upstream wall. The shot rock was excavated and hauled to a designated spoil area. The right wall of the diversion channel was excavated during post-diversion construction from August to September 1987 for cofferdam construction and dam excavation. The shot material from the right wall was used as 24-inch sandstone rockfill and placed downstream of the cofferdam.

Overburden excavation for the diversion channel consisted of stripping the residual soils on the left abutment, completed by means of dozers, and removing overburden along the downstream sections of the diversion channel, completed by means of backhoes. The excavated overburden material was removed to Spoil Area No. 4. Overburden exposed on the sidewalls of the diversion channel was excavated to an 1V on 2H, and stone slope protection was applied.

Rock encountered during excavation was of the Homewood and Coalburg sandstone members. Although no significant problems were encountered during rock excavation, minor rock breakage occurred in areas of high angled joints with alignments parallel to the presplit face. Overburden material consisted of a bluish-gray sandy clay and light brown silty sand. Significant ground water was not encountered, and run-off water and Blaine Creek were controlled by means of pumps and temporary dikes.

c. Cofferdam Excavation. Both rock and overburden excavation were required for construction of the cofferdam. The function of the cofferdam was to provide flood protection during dam construction and to serve as a partial foundation for the upstream dam embankment shell. The cofferdam is located upstream of and has a parallel alignment with the dam. The cofferdam consists of (1) sheet pile cells, (2) concrete monoliths, (3) and a downstream concrete slope. (For additional cofferdam description, see Section 4-01 and 7-01.)

Rock excavation for the cofferdam was limited to the foundations for concrete monoliths, located on the abutments, and the key for the downstream concrete slope. Along the right abutment, monoliths 1 through 4 and the closure areas were systematically drilled and blasted during July and August, 1986. Approximately 1,400 cubic yards of rock was excavated from these four monoliths and the cell No. 1 closure area. The vertical rock faces of

these monoliths, against which concrete was to be placed, was accomplished by means of the presplit method using 18-inch center-to-center spacing. After diverting Blaine Creek, the right wall of the diversion channel was excavated to permit the installation of cofferdam cell No. 7 and monoliths 5 and 6. The rock excavation of this diversion channel wall was accomplished by means of production drilling and blasting during August and September 1987. Concrete monoliths 5 and 6 were founded on the left diversion channel wall. (See Section 6-01.b for Diversion Channel Excavation.) A 2-foot-deep key into rock was required at the toe of the concrete slope located downstream of the cofferdam cells. This key was partially line-drilled, and approximately 92 cubic yards of structural excavation was performed in July 1987 by means of a Cat 245 backhoe and hand tools.

Overburden excavation at the cofferdam was for the most part accomplished by means of backhoes and hauled to Spoil Area 4. The overburden excavation began in May 1986 with the removal of material from the flood-plain surface to elevation 575. During September 1986, after the dewatering system in the cofferdam area was installed, the overburden was excavated to elevation 570 and the driving of sheet piling for the cells began. A limited amount of overburden excavation was needed in order to remove large boulders encountered during sheet-pile driving. After cofferdam cells 1 through 6 were completed, the overburden was excavated downstream of the cofferdam. This excavation consisted of a 1V on 2.5H slope from elevation 575 to top of rock, and was completed in June 1987.

The cofferdam's concrete monoliths were founded on massive sandstone of the Homewood and Coalburg Sandstone members. Most of the overburden encountered consisted of a light brown silty sand. No significant problems were encountered during overburden or rock excavation. The ground water was controlled during overburden excavation by means of dewatering wells and sump pumps.

d. Dam Site Excavation. Excavation at the dam site required the removal of overburden to the top of rock and to excavate the presplit rock slopes within the dam core area. The dam is located approximately 18.5 miles upstream of the stream's confluence and has an alignment of N 87°32'W. This dam consists of a central impervious core and outer rockfill zones. The area of dam-site excavation extended from dam station 1+20 to 9+75 and from elevation 518 to 681.

Rock excavation at the dam site was performed from June 1986 to November 1987 by systematic drilling and blasting methods. (For additional blasting information see Section 6-04 and Appendix 12-01-J.) An approximate total of 109,400 cubic yards of rock was excavated from the dam area, including rock excavation for the

diversion channel and excluding boulders encountered during overburden excavation. The presplit rock faces, within the central core area of the dam, were excavated on a 1V on 1H slope using 30-inch center-to-center spacing. The bench locations were established from information gathered from rock surface conditions, cross sections, and exploratory drill logs.

Presplit and production blasting began on the left abutment, at elevation 679 in May 1986, and was stopped at elevation 608 in June 1986. The remaining rock excavation at the left abutment, from elevation 608 to 526, was performed after stream diversion in August 1987 and was completed in October 1987. Eleven benches were excavated in the left abutment, located at approximate elevations 648, 630, 603, 590, 569, 563, 557, 545, 538, 534 and 526.

Blasting at the right abutment began from elevation 671 to 735 between July and September 1987. Rock excavation at the right abutment resumed in August 1987, from elevation 573 to 526, and was completed in September 1987. Eleven benches were excavated in the right abutment, located at approximate elevations 644, 620, 594, 573, 565, 558, 553, 545, 536, 532 and 526.

Additional rock excavation was required in areas where unusual or poor rock conditions had existed. A shale seam, located at the left abutment from elevation 612 to 615, was line drilled in August 1987 and later treated with dental concrete. Weathered sandstone cliffs and overhangs, located directly upstream of the dam on the right abutment, were presplit at a high angle from approximate elevation 670 to 645. Horizontal broken zones within a sandstone member, located in the valley bottom, required additional rock excavation. This excavation included presplit and production blasting from elevation 526 to 521, and line drilling and mechanical excavation from elevation 521 to 518. High angled open joints, located within the dam core area, with a north-south orientation, were discovered after preliminary drilling and blasting were completed in that area. Additional drilling and blasting were then required to remove these joints, located on the right abutment at elevation 567 to 573 and on the left abutment at elevation 535 to 538.

The bedrock encountered during dam-site rock excavation consisted of members of the Breathitt Formation, which includes, in descending order, (1) Homewood/Coalburg Sandstone members, (2) interbedded sandstone/shale member, (3) Broas Coal Zone, and (4) Upper Winifred Sandstone member. (For a description of rock, see Section 3-02.b, Stratigraphy.) The massive sandstone of the Homewood/Coalburg members was excavated with extensive slopes (10 to 30 feet, vertical height) and narrow benches (5 to 15 feet in width). The interbedded sandstone/shale member was excavated with snorter slopes (3 to 10 feet in height) and wider benches (10 to 30 feet in width). The Broas Coal beds were excavated in

the slope faces and later treated with dental concrete. The Upper Winifred Sandstone extended across the relatively flat valley bottom. (For cross section of dam, see Appendix 12-05, Exhibits.) The ground water encountered during rock excavation at the dam site was primarily controlled by means of sumps and pumps. (See Section 5-03 for Dewatering Rock)

Overburden excavation at the dam site consisted of removing soils on the abutments and overburden in the floodplain. The thickness of the soils on the abutments ranged from 0 to 5 feet and was excavated by means of dozers. The thickness of overburden in the floodplain ranged to a maximum of 65 feet. This material was excavated by means of backhoes assisted by dozers and front-end loaders and removed to Spoil Area 4. Approximately 621,700 cubic yards of primarily silty sands was excavated from the dam area. (See Section 3-02.g for Description of Overburden.)

Partial overburden excavation in the floodplain to approximate elevation 575 and the stripping of soils on the abutments began in May 1986. During this excavation, the topsoil was stockpiled for later use and a portion of the sands was stockpiled for use in the slurry-wall backfill. Overburden excavation resumed in May 1987, from elevation 575 to top of rock. This excavation proceeded from upstream to downstream with top of rock exposed in the valley bottom from 90 feet upstream to 300 feet downstream of the dam centerline. The upstream overburden slope was excavated to 2.5H on 1V, and the downstream slope to 1V on 2H. Occasional large boulders, totaling approximately 22,000 cubic yards, were encountered during overburden excavation, primarily toward the left abutment. Boulders too large to be loaded with backhoes were drilled and shot. Ground water during overburden excavation was controlled primarily by means of the dewatering wells. (See Section 5-02 for Dewatering Overburden.)

e. Spillway Excavation. Spillway excavation included stripping the overburden and then drilling and blasting the rock encountered. The spillway, an uncontrolled type, was cut through a natural low gap in a ridge located on the right valley wall approximately half a mile east of the dam. The finished spillway excavation is approximately 440 feet long by 114 feet wide, which is 4 feet wider than designed. The spillway crest, at elevation 645, is a 5-foot-wide by 3-foot-thick concrete sill anchored into bedrock. A steel-girder and concrete-deck access road bridge spans the spillway with its inclined legs founded on the spillway walls.

Rock excavation for the spillway began in August with systematic drilling and blasting from approximate elevation 675 to 645, and was completed in May 1987. The shot rock was excavated by means of backhoes, end loaders, and dozers, and was removed by end dump trucks to Spoil Area No. 1. An approximate total of 40,000 cubic

yards of rock was drilled and blasted in the spillway. The spillway walls were presplit on a 2V on 1H slope using 30-inch center-to-center spacing. The spillway walls were overexcavated by 2 feet at its base in places, widening the designed spillway of 110 feet to 114 feet. This overexcavation was due to misalignment of presplit drilling and the soft nature of the shales encountered. The spillway floor was mechanically overexcavated 1 to 2 feet below designed elevations as a result of the soft shales. This overexcavated area was replaced with compacted impervious fill to designed elevations and grade. Approximately 40,000 cubic yards of rock was excavated from the spillway.

Other areas of rock excavation in the spillway include the sill foundation and the inclined leg foundation. The spillway sill was line-drilled on 26 May 1987, and approximately 61 cubic yards of rock was mechanically excavated on 4 June 1987. Due to the overexcavation of the spillway floor, the sill was embedded only 1 to 2 feet into rock instead of the designed 3 feet, although the stability of the sill is enhanced by foundation anchors. Excavation for the spillway bridge inclined-leg foundation, located on the sidewalls, included presplitting on 18-inch center-to-center spacing and line-drilling the top keys, bottom keys, and pedestal keys. After presplitting was completed and production excavation permitted access, the various keys were line drilled during May and June 1987. Approximately 140 cubic yards of rock was mechanically excavated in the inclined leg keys. Overexcavation of the spillway walls, as mentioned above, increased the concrete thickness for the inclined-leg foundations at its base. (See Appendix 12-03, Modifications.)

The rock encountered during excavation included the Lower Kittanning shales member, and the Richardson coal zone. The bedrock in the spillway has a slight dip toward the upstream with a small syncline located on the left wall at station 3+60S and a normal fault located on the right wall at station 4+40S. The soft shales posed a problem with overexcavation in the sidewalls and floor of the spillway as well as differential weathering, which is severe in the area of the normal fault. (For geologic conditions encountered see Section 3-05.b) Ground water or surface water did not pose a significant problem during rock excavation, although ground-water seepage was encountered at the base of a thin sandstone bed at approximate elevation 670.

Overburden excavation in the spillway began in August 1986, after the clearing operation and exploratory drilling were completed. This material was excavated and removed to Spoil Area No. 1. Approximately 43,000 cubic yards of overburden material was excavated for the spillway. The overburden excavation extended from the surface to a thin sandstone bed at approximate elevation 675, where a 20-foot bench was excavated. The overburden above this bench was excavated to a 1V on 2H. Nearly 600 cubic yards

of overburden excavation was required to found the spillway bridge abutments on rock at the designed elevations. The overburden material encountered consisted primarily of residual soils and severely weathered shales. No significant problems were encountered during overburden excavation.

f. Borrow Area Excavation. Both rock-borrow and impervious-borrow excavation were required during the contract for dam embankment, diversion dikes, access and service roads, and various fill areas. Rock used for fill was excavated from Rock Borrow Area No. 1, located on the right dam abutment from elevation 870 to 755. Material for areas requiring an impervious fill was excavated from Impervious Borrow Area No. 1, located on the floodplain in an abandoned stream meander approximately 1/2 mile Southeast of the dam. Most of the materials excavated from these borrow areas were used during the placement of the dam embankment, from March to September of 1988.

Rock-borrow excavation began in September 1986, after clearing operations were completed and 71,100 cubic yards of overburden was removed, and was completed in September 1988. The rock borrow area was excavated by systematically drilling and blasting. The shot rock was mechanically excavated and was hauled to its designated area. The areas that required material from rock-borrow excavation include the dam embankment, access and service roads, and rock spall protection. Rockfill zones within the dam embankment include random rockfill, sandstone rockfill and processed sandstone. Excess material from the rock borrow area was hauled to Spoil Area No. 4. Approximately 929,700 cubic yards of rock was excavated from Rock Borrow Area No. 1.

The rock members that were excavated from Rock Borrow Area No. 1, in descending order, include the lower members of the Conemaugh Formation and the East Lynn Sandstone and Lower Kittanning Shales member of the Breathitt Formation. Most of the material from the Conemaugh Formation was hauled to Spoil Area No. 4, with a smaller quantity place in the downstream random rockfill area of the dam embankment. Most of the material excavated at the rock borrow area and used for fill was from the 50-foot-thick East Lynn Sandstone member. Approximately 5 to 10 feet of the upper section of the Lower Kittanning Shale member was excavated and used for random rockfill and random fill or was hauled to Spoil Area No. 4.

Impervious-borrow excavation began in July 1986 and was completed in September 1988. Most of this material was excavated and was used in the impervious core of the dam embankment from March 1988 to September 1988. The impervious-borrow excavation was preformed by scrapers with the surface being occasionally disked or broken by means of dozers or graders to obtain the optimum

moisture content. This material was then hauled to designated areas that required impervious material, including the impervious core of the dam embankment, the 3-foot impervious blanket placed upstream of the cofferdam, and the upstream and downstream diversion dikes. Approximately 345,800 cubic yards of material was excavated from Impervious Borrow Area No. 1. The excavated impervious-borrow material consisted primarily of silty clay and clay. This impervious material was tested after placement and compaction by contractor and Government personnel.

2. OVERBURDEN EXCAVATION

Overburden, or common, excavation was required at the dam-site, spillway, and rock-borrow area. The largest quantity of overburden excavation (80%) was performed in the dam-site area, which includes the dam foundation, cofferdam, and diversion-channel areas. The material encountered consisted primarily of residual soils at the spillway, rock-borrow area, and dam abutments; and alluvial material at the dam foundation. The overburden excavation in these areas began after clearing operations were completed. This overburden was primarily excavated and loaded with the use of Cat 245 backhoes or front-end loaders and was assisted by dozers along the abutments. This excavated material was either loaded onto Cat 773 end dump trucks and hauled to specified spoil areas or was stockpiled for alternative uses. A total of 787,182 cubic yards of overburden, or common, excavation was performed in these areas.

Overburden excavation was also required to remove impervious material to be used in the dam embankment and diversion dikes. This material was excavated from Impervious Borrow Area No. 1. The excavation was completed primarily by means of Cat 623 and 632 scrapers with the ground surface being disked with the use of dozers and graders. The material encountered consisted of silty clay from floodplain deposits. A total of 345,796 cubic yards of impervious excavation was preformed in Impervious Borrow Area No. 1.

3. ROCK EXCAVATION

Rock was defined in this contract as that material that would require removal by systematic drilling and blasting, loose boulders and rock one cubic yard or more in volume, and earthlike materials encountered below the top of rock. The rock excavation performed during this contract was divided into three categories: rock excavation, rock-borrow excavation, and structural excavation.

Rock excavation was required for various proposed structures to establish a sound unweathered foundation and to remove rock to

the proper line and grade as shown on the contract drawing or otherwise specified. The various structures addressed in this contract that required rock excavation include the dam foundation, spillway, cofferdam, and diversion channel. After mechanically removing overburden and severely weathered top of rock, the solid rock to be excavated was systematically drilled and blasted. The shot rock was excavated by backhoes and end loaders assisted by dozers. This material was then hauled by truck to specified spoil areas. A total of 173,323 cubic yards of rock was excavated for these various structures.

Rock-borrow excavation was defined as consisting of rock being excavated from designated rock-borrow areas. Rock borrow excavation during construction was limited to Rock Borrow Area No. 1. After clearing and overburden excavation were completed, this rock was systematically drilled and blasted. The shot rock was excavated by backhoe and end loaders assisted by dozers. This material was then hauled to be used in the various rockfill areas or placed in Spoil Area No. 4. A total of 929,669 cubic yards of rock was excavated from Rock Borrow Area No. 1.

Structural excavation is defined in this contract as rock excavation that requires hand excavation or additional care and control of mechanical excavation and blasting. This type of excavation was required for tight enclosed line-drilled foundations, which include the bottom spillway inclined leg keys, the spillway sill, the service-bridge abutment, and the downstream concrete cofferdam berm key. A total of 436 cubic yards of rock was excavated in this manner.

4. SYSTEMATIC DRILLING AND BLASTING

The bedrock foundations for various structures at the project required systematic drilling and blasting to facilitate excavation and obtain the specified line and grade. To obtain a smooth sloped surface of the proper dimensions, line drilling and pre-splitting methods were used. Production drilling and blasting methods were used to remove the inner rock mass from the preformed foundation slopes. The explosives used for blasting were manufactured by Atlas Powder Co., supplied by Eastern Kentucky Explosives, and stored in magazines at an isolated area of Spoil Area No. 1. These explosives were used in accordance with the manufacturer's specifications, and under the supervision of a licensed blaster. All blasts were monitored and recorded by means of a digital seismograph. (See Appendix 12-01 J., Explosives Data.)

Line drilling, under this contract, consisted of drilling vertical holes with air-track drills using 3-inch-diameter bits and 6-inch center-to-center spacing. Foundations that required line drilling include the top, bottom and pedestal keys for the

spillway inclined legs; the spillway sill; the service-bridge abutment; and the key trench for the downstream cofferdam concrete berm. A total of 2,221 square feet was drilled for these various foundations. Not included in this figure is the additional line drilling that was required for dental treatment in the dam core foundation. This additional line drilling was used for the treatment of a 3-foot shale seam on the left abutment and a 1- to 2-foot-thick horizontal broken zone in the valley bottom.

Pre-splitting was performed to develop the final rock surface of the dam core foundation, spillway sidewalls, cofferdam abutments, and sidewalls of the diversion channel. The final surfaces were cut on slopes that ranged from 1V on 1H to vertical. The pre-split holes were drilled with air-track drills using 3-inch diameter bits with a distance of either 30 inches from center to center or 18 inches, which was required in those areas where concrete would be in contact with the pre-split surface. These holes were loaded primarily with cartridges of "Kleen-Kut" explosive with the shot being initiated by a single electric blasting cap taped to one end of the detonating cord. An average pre-spilt powder factor of 0.11 pounds per square feet was produced for the job, and provided successful results.

After the rock excavation outline for the various foundations in the spillway and dam area had been inscribed by either the line-drill or pre-split method, the inner rock mass was removed to line and grade, where applicable, by production drilling and blasting. Production drilling in these areas was performed with air-track drills using 3-1/2-inch bits with patterns ranging from 4 feet by 4 feet to 8 feet by 8 feet at variable depths. These holes were loaded primarily with either bagged ANFO or "Apex" cartridges primed with "Atlas Power Primer". These holes were then shot using a variable delay system. The average production powder factor, for excavating approximately 150,000 cubic yards of rock from these areas, was 0.96 pounds per cubic yards.

Production drilling and blasting were required for the excavation of Rock Borrow Area No. 1. These production holes were primarily drilled vertically with air-track drills using 3-1/2-inch bits in 8 feet by 8 feet or 9 feet by 9 feet patterns at depths of 20 to 45 feet. These holes were loaded with bulk ANFO and were primed with one or two "Atlas Cast Boosters." The explosives were shot through a variable-delay electric blasting-cap system. A total of 930,000 pounds of explosives were used in Rock Borrow Area No. 1, which produced an average powder factor of 1.0 pounds per cubic yards.

5. FOUNDATION PREPARATION

The bedrock foundation preparation for the various structures was

performed in order to provide an adequate surface for the placement of the specified material. These materials included impervious core, rockfill, sand drains, and concrete. Foundation preparation began after rock or overburden excavation was completed, and consisted of obtaining an acceptable, sound foundation and performing cleanup operations. No separate payment was made for foundation preparation, with the cost being included in the price for the overlying excavation.

Extensive foundation preparation was performed in the dam core area, which includes foundations for the impervious core, processed sandstone, and an inclined drain. This preparation began with preliminary cleanup, using hand tools and compressed air, immediately after drilling and blasting were completed. This cleanup was necessary to inspect for detrimental rock conditions that may require further rock excavation and to create an adequate surface for foundation grouting. Prior to placing embankment, this foundation was cleaned again with water and/or compressed air. The foundation was then inspected to ensure that the rock was reasonably smooth, with an unweathered surface free from loose, drummy, porous, or shattered rock. Detrimental rock was then removed by means of hand tools and jack hammers. At this time any additional foundation treatment was performed on defects such as fractures, joints, or weathered bedding planes. Final cleaning with water and/or compressed air was performed on these foundations immediately before placing embankment. Foundation preparation for the dam foundation outside the pre-split core area consisted of mechanically cleaning overburden material from the top of rock. After preparation was completed, the dam foundation was photographed and mapped.

Foundation preparation for rock surfaces that would be in contact with concrete was performed after systematic drilling and blasting were completed. These foundations included cofferdam abutments and downstream concrete berm key; spillway inclined legs, abutments, and sill; and service-bridge abutment. This foundation preparation included meticulous cleaning of the rock surface and the removal of any loose, drummy, or detrimental rock by picking and barring. After preparation was completed, these foundations were photographed and mapped.

6. RECORD OF FOUNDATION APPROVAL

Foundation inspections were performed daily in regard to concrete and embankment placement on rock and rock excavation. This inspection entailed a visual check of structural and lithological aspects of the rock surface and assurance that the foundation was excavated to specified lines and grades and that the proper foundation treatment and preparation was applied. In addition to the rock surface, inspections were also made to ensure proper installation of [illegible]s, reinforcing steel, and concrete

forms in those specified areas. The contractor was then required to correct any detrimental conditions encountered during the inspection. After final foundation preparation and treatment were completed, the rock was measured, mapped, and photographed for permanent record. As a result of the inspections, the foundation was approved orally before embankment or concrete was placed.

Regularly scheduled inspections of foundation conditions were required by Engineering and Construction Division personnel. These inspections were made for approval and consultation on matters of crucial foundation conditions, unusual conditions, variations in specifications due to foundation work, and to ensure that proper construction and safety practices were observed. The observations were expressed orally and noted in the Memorandum for Records placed on file. (See Appendix 12-04, Correspondence.)

7. SAFETY

Safety precautions required during the construction program included (1) the installation of wire mesh on pre-split rock surfaces above the left cofferdam abutment; (2) the installation of scaffolding, safety lines, and tuggers for drills during foundation grouting; (3) the scaling of loose or unstable rock from excavated surfaces; (4) the excavation of overhanging rock on the right abutment of the dam to a smooth pre-split face; (5) the barricading of open excavation from traffic; (6) the excavation of cofferdam concrete abutments from elevation 621 to 616 to prevent a future water hazard after impoundment.

Other than the above special requirements, the applicable safety regulations as described in the Safety Manual EM 385-1-1 were followed throughout the construction program.

SECTION SEVEN — PILE DRIVING

1. COFFERDAM

Pile driving was required to construct the cellular sheet-pile cells for the cofferdam. The cellular cofferdam is located upstream from and is aligned parallel with the dam. The cofferdam consists of seven sheet-pile cells with connecting arcs, located in the valley, with the crest at elevation 616. (See Section 4-01 and Appendix 12-05 for location and description of cofferdam.) Each of these cells are 62.68 feet in diameter and consists of 120 sheets. This sheet piling included flat sheet piling; 30° wyes, used to attach the connecting arcs to the cells; and 90° tees, used at the concrete closures with bedrock. The connecting arcs have a 13.46-foot radius and consist of 25 sheets each. The piling was driven from elevation 570 to 540 or top of rock. All piles were high-strength PS 31 sheet piling manufactured by Bethlehem Steel Corporation. The 30° wyes were modified to reinforce the original design, as recommended by the manufacturer. (See Appendix 12-03, Modifications.) Quantities for steel piling used include 72,476.8 linear feet of sheet piling, 1,610.8 linear feet of 30° wyes, and 93 linear feet of 90° tees.

Pile driving for the cofferdam was performed by the subcontractor, Richard Goettle Inc. The sheet-pile cell construction began after dewatering and rock and overburden excavation were completed in that area. The template used was circular, single leveled, and was supported by rigid frames (tripods) on spud piles. After the template was properly aligned, four "key sheets" were placed at approximately 90° angles to help support the sheet piles until closure was made. The longer sheet piles were spliced to reduce driving and handling problems. The bottom sheets were 37 and 40 feet long and were driven to elevation 540 or top of rock. The varying lengths of the bottom sheets gave a staggered effect that allowed the top sheets to be spliced without the use of a template. The sheets were driven with a vibratory hammer until the penetration rate dropped to less than 1 foot per minute or when top of rock was encountered, at which time these piles were seated with an impact hammer, and the length and final blow count was recorded. The vibratory hammer used was a ICE 416 hydraulically-powered vibratory pile driver/extractor. The impact hammer used was either a Link Belt 440 or 105 diesel pile hammer. (See Appendix 12-01.P, Sheet Piling.)

After driving and splicing were completed, the sheets were trimmed to elevation 616. The cells were then backfilled with bottom ash from the nearby Kentucky Power Company's Big Sandy Plant. The cells were then completed by being capped with 1-

foot-thick wire reinforced concrete.

The pile-driving sequence for the cofferdam consisted of completing cells 1 through 6 prior to diverting Blaine Creek through the diversion channel, and cell number 7 after stream diversion through the outlet works. Construction of cofferdam cells 1 through 6 began in September 1986, and was completed in April 1987. The sequencing of these cells began with cell number 2, 3, 4, 5, 6, then 1. Pile driving for cell number 7 was performed in September 1987 after the completion of stream diversion, rock excavation of the right diversion channel, and placement of random rockfill in the area of the cells.

With the exception of those posed by boulders, few problems were encountered during pile driving of the cofferdam. Boulders created a problem during pile driving at cells 2 and 5. Excavation using a backhoe was required to remove these boulders which then allowed each of these sheets to be seated at its proper elevation. During a high-water event, in February 1989, after the completion of the dam embankment, water overtopped the cofferdam cells. This event caused additional settlement within the bottom ash backfill, which in turn slightly collapsed the concrete cap. There appeared to be no deformation of the sheet-pile cells during this event.

2. MISCELLANEOUS PILE DRIVING

During a period of high water in November 1986, Blaine Creek had eroded a notch in a section of the downstream slurry cutoff wall from which backfill was lost. To prevent any additional loss of the backfill material from the wall, five sheets of "Z" piling were driven into the slurry wall. This pile driving was performed by the subcontractor Richard Goettle Inc., using a vibratory hammer.

The relocation, in August 1986, of a temporary bridge across Blaine Creek was required to permit access to the intake structure during its construction. This bridge relocation required extraction and redriving of both "Z" and "H" piling used for the bridge abutments. This extraction and redriving was performed by the subcontractor Richard Goettle Inc., using a vibratory hammer.

SECTION EIGHT — FOUNDATION ANCHORS

1. INCLINED LEG FOUNDATION

Rock anchors were required for the "hang-on" concrete walls of the spillway bridge incline leg foundations and liners. The rock anchors were installed in May and June 1987, after drilling and blasting were completed. The installation of these anchors required drilling a 3-inch-diameter hole, approximately 11 feet deep, perpendicular to the designed concrete surface, using an air-track drill as excavation of the shot rock permitted access. After the drilling of all holes was completed, they were cleaned using water and compressed air. Immediately prior to installing the anchors, the holes were filled with a thick nonshrinking cement grout by tremie method using a Peroni grout pump. The anchor bars were placed in the hole, having a 4-inch clearance from the designed concrete surface and being held in place with wedges until the grout had set. The anchor bars consisted of a hook-shaped No. 9 rebar with a total length of 13 feet 9 inches. The rock anchors installed at the base of the liners had shorter embedded lengths into rock, due to overexcavation of the spillway sidewalls. A total of 130 rock anchors were installed in a pre-designed pattern in the spillway inclined leg foundation and liner. (See Appendix 12-01.K, Rock Anchors.)

2. SPILLWAY SILL

Fifteen rock anchors were installed in the spillway sill in June 1987, after the rock excavation was completed. The rock anchors are located, in line, at station 4+00S with variable spacing. The holes for the anchors were drilled vertically with air-track drills using a 3-inch-diameter bit to a depth of approximately 10 feet. Prior to placement of the anchor bars, the holes were cleaned with water and compressed air and filled with a thick nonshrinking cement grout using the tremie method. The rock anchors were then placed in the hole with the top of the anchor bars at elevation 644.4, and wedged with blocks to prevent movement. The rock anchors were, 13-foot, No. 10 rebar, with an "L" shape instead of the designed hooked shape.

3. TRASH BOOM

Three rock anchors were used to secure the temporary and permanent trash booms. After overburden was removed in April 1987, 3-inch-diameter holes were drilled for these anchors at 45° to a depth of 10 feet. The holes were cleaned and filled with a nonshrinking cement grout at which time the rock anchors were installed and wedged to prevent movement. The rock anchors

consisted of a 10-foot threaded No. 11 rebar with a spot-welded eye nut at the top. (See Appendix 12-01.K, Rock Anchors.) Due to the proximity of the top of rock to the ground surface, the designed deadman type anchor for the left-abutment trash-boom connection was deleted and replaced with the grouted rock-anchor type, as described above. (See Appendix 12-03, Modifications.)

SECTION MINE -- FOUNDATION TREATMENT

1. GENERAL

The foundation treatment for Phase II Construction of the Yatesville Dam consisted of (1) dental treating, with concrete or grout, the final dam foundation to correct rock deficiencies and provide an acceptable surface for embankment placement, (2) installing foundation grout curtains beneath the dam's impervious core to inhibit ground-water movement through the rock, (3) supplemental drilling and grouting of various features in the dam foundation, (4) drilling 3-inch-diameter drainage holes in the spillway concrete lining, and (5) compacting dam embankment.

2. DENTAL TREATMENT

Dental treatment was required to obtain a satisfactory surface on which to place impervious core material. Dental treatment consisted of excavating foundation defects and then treating these features with either dental concrete or grout. This treatment isolated the impervious core from these potentially harmful foundation features. These treated features include: open joints; bedding planes; fractures; lithologic contacts; soft, blocky, or incompetent rock; and faults or shear zones. The dental treatment was limited to features within the foundation for the impervious core and processed sandstone zones of the dam embankment. The rock preparation for the dental treatment entailed line drilling, hand and light mechanical excavation, and cleaning by means of air and water jet.

Dental concrete was used in areas of larger structural or lithological foundation defects. This concrete was a ready-mix, supplied by either the contractor's batch plant or Charlie's Concrete, located in Louisa, Kentucky. The concrete consisted of a 6 bag per cubic yard cement mix with fly ash added and a top aggregate size of 3/4-inch. The concrete surface, within the impervious core area, was either horizontal or 1V on 1H slope with forms or bulkheads being used as necessary. Of the 864 cubic yards of dental treatment performed during this contract; 590 cubic yards (68%) of dental concrete were required to treat the broken zones (faults) in the valley bottom, and 133 cubic yards (15%) were required to treat a coal seam and underclay located on the right abutment. Other foundation features that required dental concrete include shale and coal seams, pockets of poorly cemented sandstone, and vertical or overhanging rock surfaces. Placement of dental concrete began in October 1987 with partial treatment of the broken zones in the valley bottom, before curtain grouting in that area was performed. The remaining dental concrete was placed between February and July

1988, prior to placing embankment, as access permitted. (See Appendix 12-01.H, Dental Concrete.)

Dental grout was used to treat smaller foundation features such as joints, bedding planes, and fractures. Dental grout was mixed by hand and consisted of neat grout or sanded grout mixed at various thicknesses. A total of nearly 8 cubic yards of dental grout was placed on the dam's foundation within the impervious-core limits. Rock preparation for areas to be dental grouted entailed removing loose and drummy rock, notching the surface of joints and fractures, and cleaning with an air and water jet. The dental grout was then placed by trowled, broomed, or poured methods. Dental (contact) grouting was required to fill any voids at the rock contact with dental concrete placed to treat the broken zones in the valley bottom. (See Section 9-04, Supplemental Grouting.)

3. CURTAIN GROUTING

a. General. Foundation grout curtains were installed beneath the impervious core section of the dam to reduce ground-water leakage through the bedrock under the dam. These grout curtains were developed by drilling and grouting parallel lines of 1-7/8-inch-diameter holes having 20-foot horizontal spacing between primary holes, at various depths, using the split-spacing, stage-grouting method. The grout lines have a parallel alignment with the dam centerline and consist of two double-zoned grout lines that extend the length of the dam, and three single-zoned grout lines that only partially extend the dam's length. The five grout lines constructed during this project were designated as A,B,C,D, and E lines. The top zone (zone one) of the grout lines required both primary and secondary holes to be drilled with split spacing of higher order holes as necessary. The bottom zone (zone two), where required, consisted of only primary holes being drilled with additional split spacing of higher order holes as needed. (For additional grouting information and clarification see Appendix 12-02 Foundation Curtain Grouting and 12-05 Exhibits.)

The A Line is located 16 feet upstream of the dam centerline and extends the entire length of the dam, from station 1+35 to 9+96. This line has two zones: zone one extends from the top of rock to 20 feet below the surface, and zone two extends from 20 feet to 60 feet from the surface. The A Line holes are inclined 10° upstream and have, at the ends of the grout lines, fanned holes with a radiating pattern toward the abutments. The total area of the A Line was 61,699 square feet.

The B Line was an optional grout line with the hole spacing determined by grout takes of the A and C lines, and foundation

characteristics encountered. This grout line is located 8 feet upstream of the dam centerline with the holes drilled vertically to a single zone. Four 30-foot primary holes were drilled in this line on the right abutment to ensure that surface connections were sealed. Twentyfour 35-foot primary and secondary holes were drilled within the B Line, in the valley bottom from station 5+05 to 7+35, to ensure proper sealing and consolidation of the broken zones between the A and C Lines. The curtain area of the B Line was 9,847 square feet.

The C Line is located on the dam centerline and extends the entire length of the dam, from station 1+20 to 9+97. This line has two zones: zone one extends from the top of rock to 50 feet below the surface, and zone two extends from 50 feet to 75 feet from the surface. The C Line holes are inclined 30° toward the appropriate abutment with an overlapping area of opposing battered holes located in the valley bottom. At the ends of the grout lines, the holes were battered in a radiating pattern (fan) toward the abutments. A total grout curtain area for both zones of the C Line was 79,440 square feet.

Two additional grout lines, D and E, were installed to further treat the broken zones in the valley bottom. The holes for these lines were drilled vertically to a single zone with a depth of 35 feet. The D Line is located 20 feet downstream of the dam centerline from station 4+95 to 6+75. The E Line is located 37 feet upstream of the dam centerline from station 5+00 to 6+40. The curtain area of the D Line was 6,310 square feet, and 4,900 square feet for the E Line.

The curtain grouting program was performed by the subcontractor, Boyles Brothers Drilling Company, and was directed by Government personnel. This grouting program was completed in 6 months, between October 1987 and April 1988. The drilling and grouting were performed from the rock surface after final rock excavation was completed in the area. The drilling and grouting procedures entailed (1) locating the hole and installing nipples, (2) drilling 1-7/8-inch holes to various depths, (3) water-pressure test holes, (4) pressure grout holes if needed, and (5) backfill holes upon completion with grout.

The grout curtains were subdivided into sections of approximately 100 feet in length to facilitate the mobility of the contractor's drills and to comply with the contract specifications. The sequence of drilling and grouting within a given section included (1) A and C lines, zone 1; (2) A and C Lines, zone 2; (3) B Line, if required; (4) D and E Lines, if required; and (5) supplemental drilling and grouting of features not treated by the curtain grouting. The drilling and grouting sequence within a section of a grout line began with primary holes followed, where required, by secondary holes. Tertiary and then quaternary holes were added if split spacing was required.

Drilling and grouting operations began in the sections at the lower elevations in the valley bottom and proceeded upward toward the abutments. This general sequence consisted of (1) from the valley bottom at elevation 527 to 574 on the right abutment, station 4+80 to 3+00; (2) from the valley bottom at elevation 521 to 526 msl on the left abutment, station 4+80 to 8+00; (3) right abutment from elevation 574 to 678 msl, station 3+00 to 1+20; (4) left abutment from elevation 563 to 681 msl, station 8+00 to 10+00.

b. Drilling Procedures. Drilling 1-7/8-inch-diameter holes for the foundation grout curtain began after: final rock excavation was completed at the dam site; rock surface was cleaned in the grouting area; locations of holes were surveyed; and 3-inch-diameter nipples were embedded 18 inches into rock at the proper inclination. Drilling of the grout holes was accomplished by means of pneumatically powered CP 65 rotary drills mounted on air tracks. These drills were moved and stabilized on the rock slopes of the dam abutments by means of cables attached to an air powered tugger, which was anchored in rock at the top of the abutments. The most frequently used bit for drilling was the AW-size carbide-tipped plug type manufactured by Chrisdrill. Other bits used included AW sized diamond plug and drag-type bits.

The drilling procedures entailed: aligning drill to proper inclination through preset nipples; rotary drilling hole using water to remove cuttings; and cleaning hole at completion with water. When excessive artesian water flow or drill water loss was encountered during drilling, the hole was "staged" at that depth within the zone and grouted. The "staged" hole was then progressively deepened until the bottom of the designed zone was reached. Drill-water loss was occasionally encountered on the abutments, and zone 1 of the A Line on the valley bottom. Artesian water was commonly encountered in the valley bottom within both zones of the C Line, and zone 2 of the A Line. If a hole required to be deepened after grouting operations were completed, the subcontractor elected to redrill through the grout instead of removing the grout by washing.

Drill depths to the bottom of a designed zone ranged from 20.5 feet, in zone 1 of the A Line, to 98 feet, in zone 2 of the C Line. These depths were determined graphically from the surface location of the hole to a projected zone. The horizontal split spacing between holes varied, depending upon the type of hole: primary holes, 20-foot spacing; secondary holes, 10-foot spacing; tertiary holes, 5-foot spacing; and quaternary holes, 2.5-foot spacing. A total of 342 holes were drilled for the foundation grout curtains with a total of 19,326 linear feet of drilling performed.

c. Grouting Procedures. Stage-type grouting was used, where holes are progressively drilled and grouted from the surface downward to various stages and zones. The grouting procedures within a section of the grout curtain, began after drilling of all holes of a designated order was completed to the bottom of a stage or zone. These holes were then water pressure tested, pressure grouted (if required), and then backfilled upon completion. Both pressure testing and grouting were performed from the rock surface using expandable-air packers. Grouting was performed by injecting, into a hole, a neat grout (cement and water) under pressure ranging from gravity to 25 psi.

Water-pressure testing of the holes was used in order to perform additional cleaning, determine the hole "tightness," and provide information for determining grouting procedures. The pressure testing consisted of sealing the hole at the surface and measuring the flow of water being injected under pressure. Equipment used during pressure testing consisted of water pumps; water lines; air packers; and a header equipped with a pressure gauge, flow meter, and pressure relief valves. Each hole was pressure tested for at least 5 minutes, with flows measured in cubic feet per minute. When surface connections or connections between holes were encountered, pressure testing was continued until water became clear and the effect on the flow was determined as the connected hole was plugged. All results were recorded and connections noted to determine what grouting procedure, if any, was to be used.

For consistency, the same pressures and packer placements used during pressure testing a hole were also used during grouting. The packer setting was primarily between 1.5 and 2 feet from the surface with pressures ranging from 4 to 5 psi within zone 1 and 8 to 10 psi within zone 2, unless foundation conditions warranted a change. These foundation conditions consisted of artesian water flow in the valley bottom and severe surface connections on the abutments.

Pressure grouting was used to seal foundation features that would permit ground-water flow beneath the dam during impoundment. Pressure grouting consisted of mixing and injecting a cement and water grout under pressure into the hole. The grout was mixed primarily in a 30 cubic foot tub-type mixer located on a bench of the downstream concrete cofferdam berm, at elevation 575. While grouting the valley bottom the mixed grout was pumped to a separate intermediate 20 cubic foot agitator tub placed at the lower elevation. An additional 10 cubic foot colloidal-type mixer was used in the valley bottom for holes with smaller grout takes. The grout was delivered by progressive cavity pumps, through rigid and flexible grout lines. The grout flow into the hole was regulated by means of a header, equipped with pressure gauge (0 to 60 psi) and pressure-relief valve. The volume and rate of grout injected was measured at the mixing or agitating

tubs.

A hole was grouted if, during water-pressure testing, a flow of 0.2 cfm or greater was encountered. The initial injected grout mix was determined by pressure-testing results, typically a 3:1 water to cement ratio (by volume). If during grouting the injection rate failed to decrease, the grout mix would be progressively thickened. If premature blockage of grout flow or excessive mechanical downtime occurred, the hole was washed out and regrouted. If grout connections between holes existed, grouting was completed only after all connecting holes were properly grouted. Grouting was considered complete for a hole if 3/4 of the grouting pressure could be "held" within the hole. Split spacing was performed if the grout take of the highest required order hole would equal or exceed 5.0 cwt (5.3 cubic feet) of cement.

If a hole exhibited either surface connections or artesian water flow within the first zone, a form of stop grouting was used. If surface connections were evident during pressure testing of a hole, a packer was set below the connection and the lower portion of the hole was grouted with a thin mix (3:1). Upon completion of the lower section of these holes, the packer would be raised and a thicker mix (2:1 to 1:1) was used to treat the surface connection. To seal these surface connections, a series of low pressure/caulking cycles was implemented. In the valley bottom where artesian flow was encountered on the C Line, zone 1, a packer was placed at a 20-foot depth and 20 to 25 psi was used to overcome the artesian pressure and to prevent interference with grouting A Line, zone 1, which did not exhibit artesian water. After the artesian flow was stopped in these holes by grouting, the top 20 feet was then pressure tested and grouted. Packers were also placed at 20-foot depth and 20 to 25 psi pressure was used where artesian flow was encountered in zone 2, in both A and C Lines.

The mixed grout consisted of water (obtained from Blaine Creek) and cement (type I and II supplied by Kosmos Cement Company, Inc., in 94 lbs. bags). The grout mixes for foundation grouting ranged from 5:1 to .75:1 water to cement ratios. The most commonly used mixes were 3:1, 2:1, 1.5:1 and 1:1 with the 2:1 ratio consisting of 32 percent of cement mixed for grouting. A total of 3,717.9 cwt (3,955.2 cubic feet) of cement was injected into 19,326 linear feet of curtain grout holes, giving an average cement rate of 0.19 cwt/lin.ft. (0.20 cu.ft./lin.ft.). The cement rate significantly decreased as the split-spaced higher-order hole types were drilled within a section. (For cement rate per hole type see Appendix 12-02 page Q-30.) The highest concentration of grout takes (69%) was within the valley bottom, particularly zone 2 of the A Line. On the abutments, several holes within zone 1 of the C Line yielded high grout takes. A total of 430.9 hours were used to place foundation curtain grout,

which is well above the estimated 250 hours. This may partially be due to the time used to seal surface connections and to the cautious approach taken while grouting the valley bottom, due to premature blockage. A total of 4,949 cwt (5,264.9 cubic feet) of cement was mixed for grouting during the project, which included curtain grouting, supplemental grouting, backfilling grout holes, and wasted grout. (For grout takes per hole, see Appendix 12-02 and 12-05.)

After all grout holes were completed within a section to its final depth, the holes were backfilled. This backfill consisted of the thickest pumpable mixture of cement and water. The backfill mixture was applied in the grout holes by tremie method. Holes that produced a light artesian flow were backfilled and then dry packed with cement at the top 2 feet.

After the grouting program was completed in the valley bottom, seven 4-inch-diameter exploratory borings were drilled to determine the effectiveness of the grout program and type of foundation features grouted. These exploratory borings were located in areas of the broken zones and other high grout take areas within the valley bottom. Grout traces were occasionally recovered in open bedding plains, joints, and broken zones at various elevations. The pressure testing of these borings indicated "tight" holes.

4. SUPPLEMENTAL GROUTING

Supplemental foundation grouting was needed at the dam site to more extensively treat features not adequately covered by the designed parallel lines of the curtain grouting. The same drilling and grouting methods used during curtain grouting were also used for the supplemental grouting. The holes were drilled to shallow depths (5 to 10 feet), within a single zone, at various angles, with neither embedded nipples nor split spacing being required. Numerous surface connections were encountered while treating the foundation features that required cleaning during pressure testing, and sealing with grout using low-pressure/caulking cycles. The features that required supplemental grouting included open joints, dental concrete, and bedding planes. (For location and additional information, see Appendix 12-02.)

Four high-angled open joints required treatment by supplemental grouting within the impervious core limits of the dam. The joints that were exposed in foundation benches were vertically drilled directly over the joints. Joints exposed on the foundation slopes were drilled at 45° in order to intersect the joints. A 5- to 10-foot hole spacing was used along the length of the joints. These holes were water-pressure tested and then grouted to ensure maximum coverage. A total of 17.9 cwt (19

cubic feet) of cement was used to treat these joints.

Dental concrete, used to treat broken zones within the valley bottom of the dam foundation, required grouting between the concrete/rock contact. This "contact" grouting was used to seal any voids that would exist in contact areas with overhanging rock at the broken zone. These overhangs were located prior to dental concrete placement, and the grout holes were drilled later through the concrete to intersect the located overhangs. A total of 21 holes were drilled to a 5-foot depth and 30° inclination but were not pressure tested. Instead a 4:1 mix was initially used to determine "tightness," and was thickened as necessary. The concrete contact within the impervious core area was found to be "tight", although upstream and downstream of the impervious core, a total of 76.9 cwt (81.8 cubic feet) of cement was placed with surface connections being encountered. Partial payment was made under foundation grouting while the remaining quantities were attributed toward dental treatment.

To determine the "tightness" of a bedding plane in the valley bottom, a series of seven holes was drilled and pressure tested. These holes were drilled vertically, to a 9-foot depth, and pressure tested using 4 psi. During pressure testing, severe surface connections occurred at the bedding plane and a vertical open joint. It was determined, instead of grouting, to excavate the loose bedding plane to the area of the joint and to later dental treat the joint.

5. EMBANKMENT COMPACTION

After excavation and foundation preparation and treatment were completed within an area, placement and compaction of the dam embankment were initiated. The various types of embankment that required compaction included impervious core, inclined and blanket drains, type I and II graded filter, sandstone rockfill, processed sandstone, and random rockfill. Placement and compaction of embankment began with a portion of the downstream random rockfill area, from top of rock to approximate elevation 575, during the period of October to December 1987. The remaining dam embankment, which extended 160 feet in height from top of rock to elevation 681 (without camber), was placed from March to September 1988. An approximate total of 1,100,000 cubic yards of dam embankment was placed and compacted. (For embankment cross section, see Appendix 12-05, Exhibits.)

The equipment used during compaction included Ingersoll Rand SD-100D vibratory rollers, a sheep-foot roller with dozer, a 50-ton rubber-tire roller with dozer, and a D-8 dozer with disk attachment. The impervious material for embankment was excavated, hauled to, and placed within the dam core by means of 623E or 632 Cat scrapers. The other various types of embankment

were hauled to and placed at the dam by means of end dump trucks. The material for the embankment was obtained from various sources: (1) clay, from Impervious Borrow Area No. 1; (2) rock, from Rock Borrow Area No. 1, with limited amount of random rockfill from the dam rock excavation; (3) sand drains and graded filter type I, from Standard Slag at Haverhill, OH; (4) graded filter type II, from Beckley Stone Co. at Beckley, WV. These materials were tested during placement to ensure the proper gradation, compaction, moisture, and material type. (For specified requirements and test results see Embankment Report.)

For the most part compaction at the dam embankment was performed parallel to the dam centerline. The type of compaction effort was determined from test fill results. While placing dam embankment below elevation 590, the impervious core area was brought up slightly higher than the remaining fill areas, for drainage purposes. Above elevation 590 the level of the inclined drain was kept above the adjacent fill to prevent impervious-material and surface-water contamination within the drain.

In order to provide an impervious barrier for future lake impoundment, intensive field control was given during the placement and compaction of the impervious core material. Scrapers placed and partially spread the clay, with dozers maintaining an 8-inch loose-lift thickness. This lift of clay was then disked, which partially penetrated into the previous lift. The disked clay was then compacted with six passes of a sheeps-foot roller. At the bedrock/clay contact, the rock was moistened and the clay compacted with rubber-tire equipment, usually a front-end loader.

Horizontal laminations were observed within the compacted clay during the early stages of embankment placement. These laminations were removed and the clay recompacted. To eliminate any additional laminations, test fills were constructed of impervious material with various compaction efforts used. (For additional information see Embankment Report.) It was decided, from the results of the test fills, to; reduce sheep foot ballast from 100% to 25% - 50%, restrict the equipment traffic, and limit depth of disking to 10 inches. Damage by equipment that traversed the impervious core and inclined drain was controlled by designating a crossing point and "bridging" the inclined drain with timbers. These timbers and the impervious core at a crossing point were removed periodically, and the clay was replaced and recompacted, and the timbers relocated to a new crossing point.

The compaction effort for the sand drains and rockfill areas of embankment included; placing the material with an end dump truck, maintaining the specified loose-lift thickness with dozers, and compaction with four passes of an Ingersoll Rand SD-100D vibratory roller. In addition to this, the sand inclined and

blanket drains were "wetted" prior to compaction. The exception to this type of compaction was in the downstream Random-Rockfill area were the compaction effort consisted of two passes with a sheeps-foot roller and four passes with a 50-ton rubber-tire roller. (See Embankment Report for detailed information.)

6. DRAINAGE HOLES

Drainage holes required at the concrete spillway linings were drilled in April 1988 by the subcontractor, Boyles Bros. Drilling Co. A total of 26 3-inch-diameter holes (13 holes per lining) were drilled horizontally through 4-inch-diameter PVC pipe, which was embedded during concrete placement. These holes were drilled 20 feet, measured from the concrete surface, using a carbide-tipped core barrel and cleaned upon completion with drill water. The drills used were a C.P. 65 rotary air drill mounted either on an air track, used for holes at lower elevations, or a skid supported by a fork lift. A total of 468 linear feet were drilled through rock, primarily shales.

SECTION TEN — INSTRUMENTATION

1. GENERAL

Instrumentation for monitoring the performance of the dam was not addressed in this contract, although it was installed after completion of the dam embankment by Mason-deVerteuil Geotechnical, an A-E services contractor. At the time of this report, the installed instrumentation included surface-displacement monuments, survey monuments, and open-tube-type piezometers. This instrumentation was installed between November 1988 and July 1989. Planned additional instrumentation includes an automated data-acquisition system (ADAS) and a strong-motion accelerograph. (For additional instrumentation information see Appendix 12-01.N.)

2. SURFACE DISPLACEMENT MONUMENTS

Sixteen temporary surface-displacement monuments were installed prior to and near the location of the proposed permanent monuments. The permanent monuments were then installed after the service-road and guard-rail construction was completed at the dam crest After the data base was transferred to the permanent monument system the temporary monuments were abandoned. The surface-displacement monuments were constructed of concrete and were 6 inches in diameter, 5 feet long, reinforced with a No. 4 rebar, capped with a threaded brass insert, and set flush with the embankment. The location of these permanent monuments include: five pairs along the shoulders of the dam crest at stations 2+50, 4+00, 5+50, 7+50, and 8+50; and three pairs along the upstream and downstream mid-slope at stations 4+00, 5+50, and 7+00.

Horizontal and vertical measurement of the surface-displacement monuments will make it possible to detect movement in any direction at the dam's surface. The magnitude, direction, and rate of movement will be determined by maintaining and evaluating recorded observations. The observations, made at the time of this report, indicate that movements are as expected and not excessive for an earth-and-rockfill embankment. (See Periodic Inspection Reports for recorded movements.)

3. SURVEY MONUMENTS

To provide continuity of control for surface-displacement monument observations, a series of four pedestal-type survey monuments were installed. Two survey monuments were installed on each of the dam abutments. These survey monuments are a

permanent off-structure control-and-reference monument system, installed in stable original ground adjacent to the dam.

4. PIEZOMETERS

A total of 23 open-tube-type piezometers were installed within the dam embankment and foundation and downstream of the dam. These piezometers have a porous plastic tube, placed in a sand or gravel fill sensing zone, and a 3/4-inch-diameter plastic riser pipe, which is protected at the surface by a steel pipe fitted with a vented locking cap. The purpose of the piezometers is to monitor the seepage patterns and effectiveness of the seepage control measures at the dam. The locations of the piezometers were selected based partially on the actual foundation and embankment conditions observed during construction. (For instrumentation locations and typical installation details see Appendix 12-01.N.)

Because of the concern about possible seepage through laminations that may have developed in the impervious core during construction, all of the piezometers in the core have a longer than normal sensing zone. Two clusters of piezometers (station 4+50; P-6, 7, 8, and 9, and at station 5+90; P-13, 14, 15, and 16) were installed to provide continuity of sensing zone limits from 5 feet above top of rock to approximately 5 feet above the level of the blanket drain. The sensing zones within each cluster were installed at staggered depths to minimize the chance of interaction between piezometers.

Other piezometers were placed to monitor seepage at the foundation, internal drains, and at or downstream of the dam toe. The contact between the foundation and impervious core at various locations on the abutments will be monitored by piezometers P-1, 2, 20, 21, and 22. To monitor foundation seepage and gradient conditions in the bedrock at areas of dental concrete in the valley bottom, the piezometer tip was set into rock. These piezometers (P-3, 4, 5, 11, 12, and 17) were placed within the area of the two clusters of piezometers that will monitor the impervious-core laminations. Two piezometers (P-10 and P-18) were placed within the blanket drain to monitor the performance of the internal drainage system. Piezometer P-19 was installed to monitor underseepage at the toe of the dam. Piezometer P-23 was placed downstream of the slurry cutoff wall to monitor the ground-water level.

Primarily, the piezometers were installed from November 1988 to February 1989, by means of CME 55 and 75 drill rigs. Because of the unusually wet weather at that time, the downstream slope was too soft to permit safe positioning of the drill equipment. This delayed the installation of piezometers P-10, 17, and 18, which were not installed until July 1989. That same month (July 1989),

piezometer P-22 was replaced due to bentonite contamination of the sensing zone. Other problems encountered included a significant water loss while drilling in bedrock at piezometer P-12, located near the dental-treated broken zone at station 5+90. This piezometer also indicated a time-lag value of 12 minutes during a falling-head permeability test.

SECTION ELEVEN -- POSSIBLE FUTURE PROBLEMS

1. BROKEN ZONES

a. Potential Problems. Within the foundation for the dam's impervious core, horizontal broken zones (faults) were found in the Upper Winifred Sandstone Member, located in the valley bottom. These horizontal broken zones, approximately 1 foot thick, could provide avenues for ground-water movement under the impervious core or permit exposure of the ground water to the core material, promoting erosion. These broken zones were treated during construction to minimize potential problems. The foundation treatment for this feature included (1) extensive foundation curtain grouting to consolidate the rock and to inhibit ground-water movement, (2) additional rock excavation to expose the upper-most broken zone, (3) placement of dental concrete to isolate the impervious core from these zones, (4) temporary sumps to control ground water during placement of core material, (5) exploratory drilling to determine the severity and extent of these zones.

b. Recommended Observations. A cluster of piezometers, P-11 through P-19, was placed in the area of the broken zone at station 5+90. It is recommended that a continued emphasis be given to the monitoring of these piezometers. The relationship between those piezometers set into rock (P-11, 12, and 17) should be recorded and correlated. Observations should be made to the location, if any, of water flow through the blanket drain at the downstream toe of the dam.

2. MISCELLANEOUS DAM FOUNDATION FEATURES

a. Potential Problems. Other bedrock features within the dam impervious-core foundation that exhibit potential water seepage include coal beds, shale seams, open joints, and bedding planes. These features were properly treated during construction with dental concrete, dental grout, and curtain grouting. Light water seepage from the base of a thin shale seam in the valley bottom was observed during construction. Although this feature was properly treated, the additional hydrostatic pressure during impoundment could produce future seepage. Another area of potential seepage is at dam station 3+08, where a conspicuously high grout take (85.3 cwt) was encountered within 6 feet of the rock surface with only a light surface connection occurring at the lower shale/sandstone contact.

b. Recommended Observations. It is recommended that the miscellaneous foundation features on the abutments be monitored for possible water seepage by continued readings of piezometer numbers P-1, 2, 20, 21, and 22. It is also recommended that monitoring of the cluster of piezometers P-3 through P-10 be continued for possible water seepage from the thin shale seam at station 4+40 together with the recording of the relationship between those piezometers set in rock (P-3, 4, and 5).

3. SPILLWAY

a. Potential Problem. The spillway is an unprotected cut through the Lower Kittanning Shale Member of the Breathitt Formation. This shale, where exposed, is highly susceptible to deterioration by weathering. This deterioration had produced, in the sidewalls, undercutting beneath a thin sandstone bed and in the vicinity of a fault. This condition will probably result in a continual cleanup operation on the spillway floor and scaling along the sidewalls. This potential problem will be corrected with concrete sidewalls in a future contract.

b. Recommended Observations. The spillway sidewalls, where the weathered shale has undercut thin sandstone blocks, should be checked to determine if scaling is necessary. If the shale in the sidewalls exhibits excessive weathering, concrete liners may be required. The spillway floor should be inspected to determine if any obstructions to flow exist (fallen boulders for example) that require removal. Shale in the immediate area of the spillway sill should be periodically inspected for deterioration that would cause potential undercutting.

APPENDIXES

12-01. Foundation Related Statistical Data

12-02. Foundation Curtain Grouting

12-03. Modifications

12-04. Correspondence

12-05. Exhibits

12-06. Graphic Logs of Borings

12-01 FOUNDATION RELATED STATISTICAL DATA

Description	Page
(A) Yatesville Lake Pertinent Data	A-1 - A-5
(B) Government Personnel	B-1
(C) Contractor's Personnel	C-1
(D) Contractor's Equipment	D-1 - D-3
(E) Contract Quantities	E-1 - E-9
(F) Chronological Sequence of Construction	F-1 - F-7
(G) List of Subcontractors	G-1
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(I) Joint and Fault Directions	I-1 & I-2
(J) Explosives Data	J-1 - J-20
(K) Rock Anchors	K-1 - K-8
(L) Drainage Holes	L-1
(M) Materials Obtained From Commercial Sources	M-1 - M-2
(N) Instrumentation	N-1 - N-6
(O) Dewatering System	O-1 - O-24
(P) Sheet Piling	P-1 - P-12

12-01 A. YATESVILLE LAKE PERTINENT DATA

General.

Location of Project: The dam site is in Lawrence County, Kentucky, on Blaine Creek, a tributary of the Big Sandy River. The site is 18.5 miles from the mouth of Blaine Creek and approximately 4 miles west of Louisa, Kentucky. Blaine Creek enters the Big Sandy River at river mile 19.6.

Authorization: Flood Control Act of 1965 (PL 89-298)

Purposes Served: Flood reduction, recreation, water quality improvement and fish and wildlife conservation.

Reservoir Data.

Drainage Area Above Dam:..... 208 square miles

Streamflow:

maximum discharge..... 21,000 cfs
mean discharge..... 241 cfs
minimum discharge..... less than 1 cfs

Streambed Elevation at Dam:..... 573 msl

Reservoir Elevations:

Winter Pool..... 624.8 msl
Summer Pool..... 630.0 msl
Flood Pool..... 645.0 msl

Reservoir Area:

Winter Pool..... 1,745 acres
Summer Pool..... 2,242 acres
Flood Pool..... 3,805 acres

Reservoir Storage:

Winter Pool..... 26,200 acre-feet
Summer Pool..... 38,100 acre-feet
Flood Pool..... 83,300 acre-feet

Additional Summer Pool Data:

Maximum Depth..... 60'
Average Mean Depth..... 17.7'
Backwater Along Main Stream..... 20.6 miles
Shoreline..... 93.9 miles

12-01 A. YATESVILLE LAKE PERTINENT DATA (cont)

Dam.

Type:	rockfill w/ central impervious core, founded on rock
Location:	approx. stream mile 18.5
Top Elevation:	681 (w/out camber)
Max. Height Above Streambed:	108'
Crest Length:	855'
Crest Width:	32'

Cofferdam.

Type:	cellular sheetpile w/ concrete mono. @ abutments
Location:	332.34', center to center, U/S of dam
Crest Elevation @ Cells:	616.0 msl

Spillway.

Type:	Unlined, excavated through reservoir rim, uncontrolled broad-crested concrete sill
Location:	Approx. 1/2 mile southeast of dam
Crest Elevation:	645.0 msl
Width:	110.0'
Centerline Length:	430.0'

Outlet Works.

Type:..... concrete lined tunnel controlled U/S by intake structure and discharges D/S in stilling basin

Location:..... left abutment

Components:

Tunnel:

shape..... circular
finished diameter..... 13.0'
length..... 925.0'
transition length..... 59.23'

Intake Structure:

type..... wet well, with two gated 4' x 9' main sluices w/ invert el. 575 and a separate selective withdrawal system

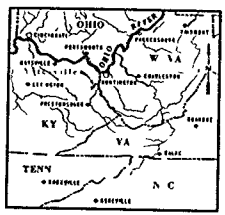
selective-withdrawal system... two wells, each well having two 4' x 4', three 4' x 3' and one 24" dia. gated inlets and two controlled outlets

Stilling Basin:

type..... hydraulic jump
length..... 112.0'
width..... 27.0'

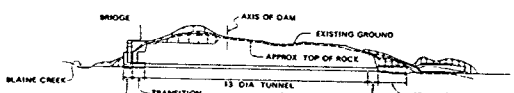
YATESVILLE F/C 84-A

PLAN

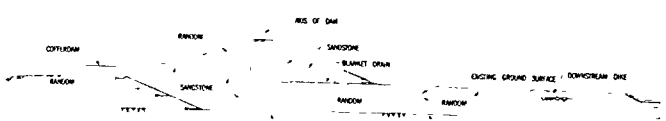


VICINITY MAP

NO WORK HAS BEEN INITIATED
WORK UNDER CONSTRUCTION
WORK COMPLETED

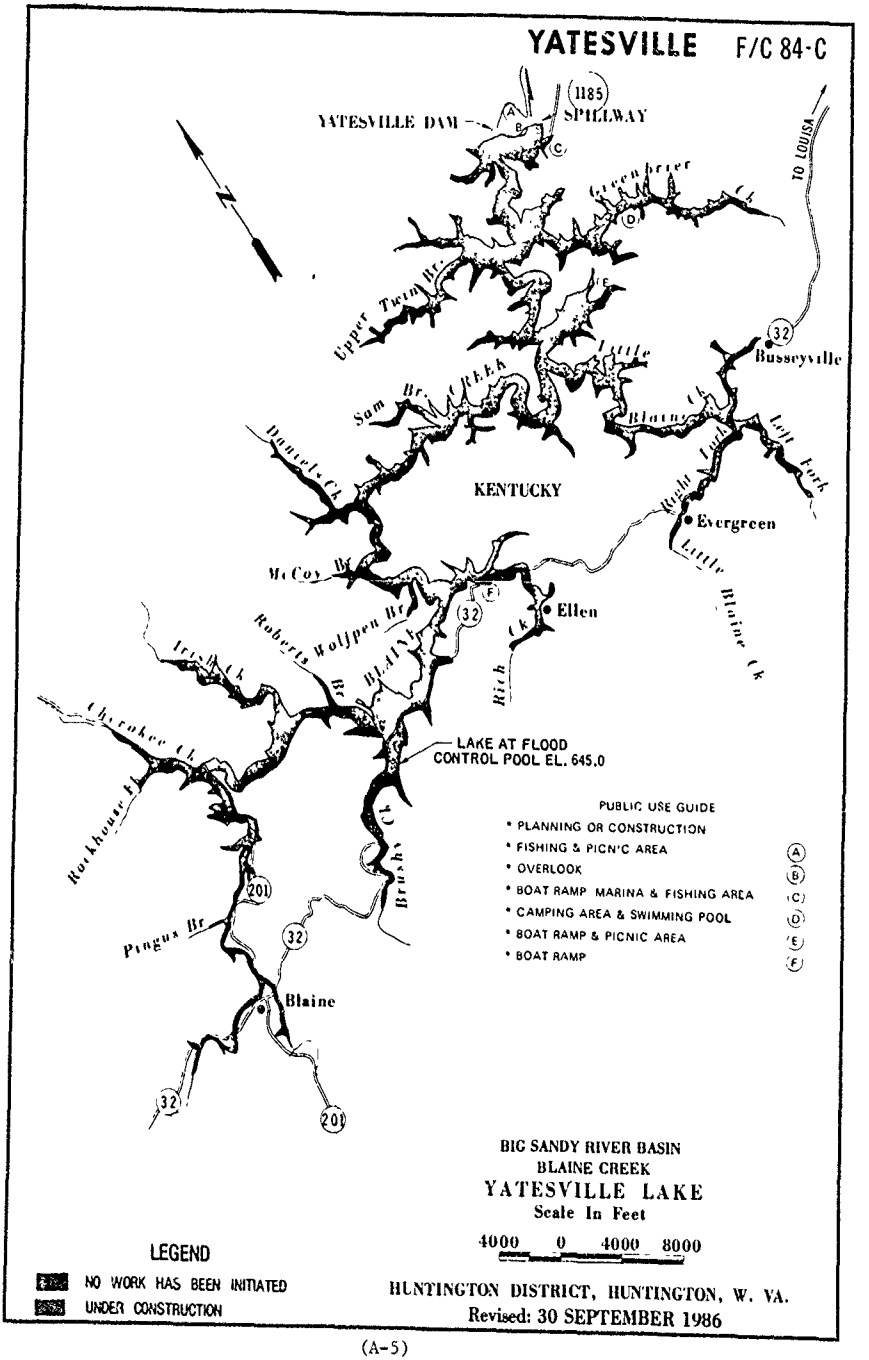


PROFILE ON CENTER LINE OF OUTLET WORKS

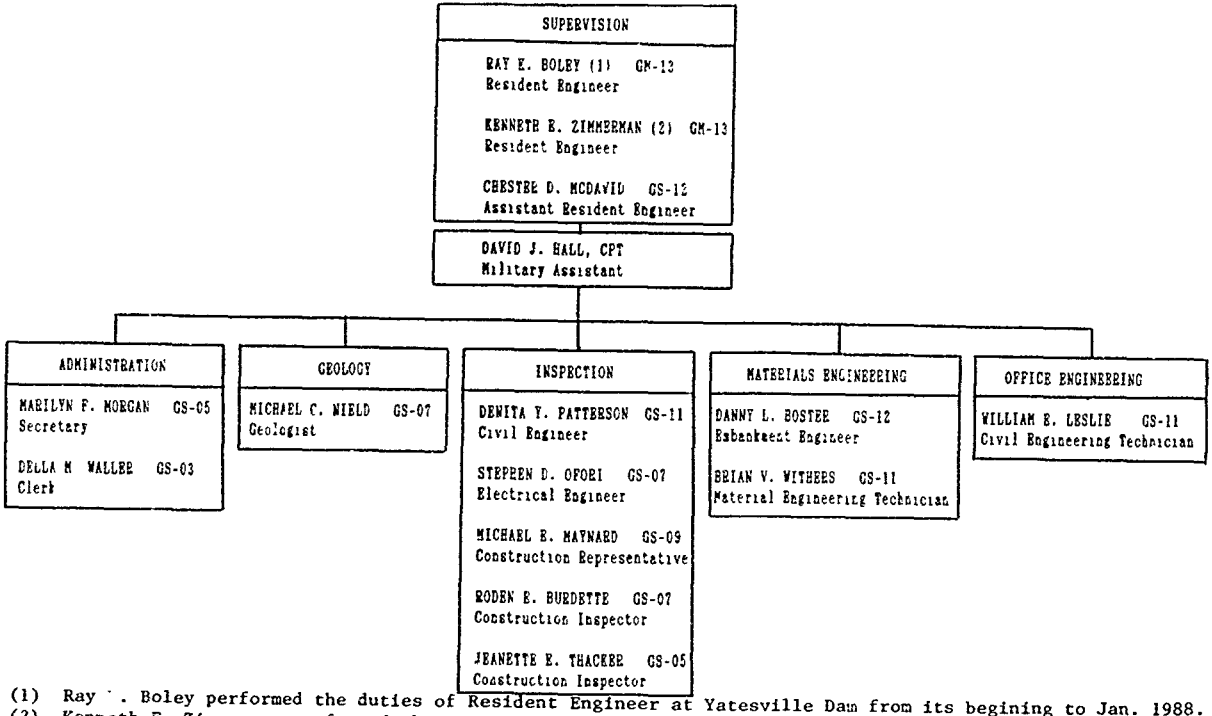


TYPICAL DAM SECTION

BLAINE CREEK
YATESVILLE LAKE
DAM AND SPILLWAY
PLAN AND SECTION
HUNTINGTON DISTRICT, HUNTINGTON W VA
Revised 30 SEPTEMBER 1986


YATESVILLE F/C 84-C
YATESVILLE DAM
SPILLWAY
1185
TO LOUISA
Busseyville
Upper Twin Br.
Sam Br.
Daniels Ck.
KENTUCKY
Evergreen
Little Blaine Ck
Right Fork
Left Fork
McCoy Br.
Roberts Br.
Wolfpen Br.
Ellen
Rich Ck.
Irish Ck.
Cherokee Ck.
Rockhouse Ck.
Pingus Br.
Brushy Ck.
Blaine
LAKE AT FLOOD CONTROL POOL EL. 645.0
PUBLIC USE GUIDE
* PLANNING OR CONSTRUCTION
* FISHING & PICNIC AREA
* OVERLOOK
* BOAT RAMP MARINA & FISHING AREA
* CAMPING AREA & SWIMMING POOL
* BOAT RAMP & PICNIC AREA
* BOAT RAMP
A
B
C
D
E
F
BIG SANDY RIVER BASIN
BLAINE CREEK
YATESVILLE LAKE
Scale In Feet
4000 0 4000 8000
LEGEND
NO WORK HAS BEEN INITIATED
UNDER CONSTRUCTION
HUNTINGTON DISTRICT, HUNTINGTON, W. VA.
Revised: 30 SEPTEMBER 1986

YATESVILLE RESIDENT OFFICE
Organizational Chart



(1) Ray . Boley performed the duties of Resident Engineer at Yatesville Dam from its begining to Jan. 1988.
(2) Kenneth E. Zimmerman performed the duties of Resident Engineer from Jan. 1988 to its completion.

12-01 C. CONTRACTOR'S PERSONNEL

The Lane Construction Corporation
965 East Main Street, Meriden CT 06450

Yatesville Lake Project

Project Manager	J. O. Hughes
Assistant Superintendent	J. N. Colvard
Office Manager	P. K. White
Job Engineer	R. A. Housel
Mechanical Supervisor	W. E. Slayers
Quality Control	W. H. Hamric M. P. Higgins
Excavation and Embankment Foremen	R. Teets M. Gula
Blasting Foremen	F. Paes Jr.
Structure Foremen	F. Glass E. Turner
Party Chief	E. E. Gray

(1) Kenneth E. Zimmerman performed the duties of Resident Engineer from Jan. 1988 to its completion.

12-01 D. CONTRACTOR'S EQUIPMENT

Lane Construction Corporation (prime contractor)

Dozers

1	D-9 Cat Dozer
5	D-8K Cat Dozers
1	D-8 Cat Dozer w/ Disk
1	D-8K Cat Dozer w/ Ripper
1	D-7 Cat Dozer
1	D-6 Cat Dozer
1	824 Cat Rubber Tire Dozer
1	D-31A Komatsu Dozer
1	450 John Deere Dozer

Trucks

11	Cat 773 End Dump Trucks
1	Cat 769 End Dump Trucks
4	Mack Conc. Agitator Trucks
3	Ford Water Trucks
1	Fuel Truck
1	Grease Truck
1	Welding Truck
1	Flat Bed Truck
1	ANFO Truck

Front End Loaders

1	922B Cat End Loader
1	988B Cat End Loader
1	977 Cat End Loader
1	966 Cat End Loader
1	922 Cat End Loader

Drills & Compressors

1	900 I. R. Air Compressor
1	750 I. R. Air Compressor
1	185 I. R. Air Compressor
1	750 Sullair Air Compressor
1	800 G. D. Air Compressor
1	750 G. D. Air Compressor
2	G. D. Air Track Drills
1	I. R. Air Track Drill

Cranes

1	3900 Manitowac Crane
1	74S Grove Crane
1	60S Grove Crane

Rollers

2	I. R. SD-100D Vib. Rollers
2	Sheep Foot Rollers
1	50 ton Roller

Graders

2	16 Cat Graders
1	120 Grader

Backhoes

2	245 Cat Excavators
1	410 John Deere Backhoe

Scrapers

3	623E Cat Scrapers
1	632 Cat Scraper

Miscellaneous

1	Erie Concrete Batch Plant
2	Maxie Light Plants
-	Various Trailers & Build.
1	Peroni grout plant

12-01 D. CONTRACTOR'S EQUIPMENT (cont)

Major Subcontractor's Equipment

Boyles Bros. Drilling Co.
(exploratory drilling and foundation drilling and grouting)

	Grout Plants
1	30 cu. ft. tub type mixer
1	10 cu. ft. colloidal type mixer
1	20 cu. ft. agitator tube
	Grout Pumps
3	Moyno 3L10 progressive cavity type pumps
1	Moyno 3L3 progressive cavity type pump
	Rotary Drill
5	C. P. 65 rotary air drills
2	Ingersoll-Rand air tracks
2	Longyear 44 truck mounted core drills
	Air Compressors
1	750 Ingersoll-Rand air compressor
1	750 Sullair air compressor
	Miscellaneous
1	227T Sellick fork lift
2	Garden Denver air powered water pumps
2	Ingersoll-Rand 4,000 lbs. air tuggers
1	Supply trailer
2	Ford F250 4X4 trucks
-	Various bits, water and air lines, etc.

McClelland Services Inc.
(slurry cutoff wall)

1	Erie batch plant
1	1266D Koehring backhoe
3	CCC concrete mixing trucks
1	Whiteman concrete pump
1	3900 Manitowic crane
1	W24B Case front end loader
1	550 John Deere dozer
1	Flat bed truck
1	Bentonite storage "pig"
1	D-6 Cat dozer
2	GMC end dump trucks
-	Various air compressors and water pumps

12-01 D. CONTRACTOR'S EQUIPMENT (cont)

Major Subcontractor's equipment (cont)

Richard Goettle Inc.
(sheet piling, cofferdam cells)

1	3900 Manitowic crane
1	LS-338 Link Belt crane
5	welding machines
1	416 ICE vibratory hammer
2	416 ICE power packs
1	440 Link Belt diesel pile hammer
1	105 Link Belt diesel pile hammer
-	various storage and office trailers

Stacon Corporation
(dewatering system)

1	Gus Peck "Super George" bucket auger drill
1	Mobil drill
1	air compressor
1	truck w/ wench
1	410 John Deere backhoe
1	storage trailer

MOUNTIAN ENTERPRISES INC.
(paving)

1	TD 25 International dozer with spreader box
1	12 Cat grader
1	3000 Ford tractor with broom
1	BW 172 Ingersoll-Rand vibratory roller
1	Huber maintainer
1	PF 172 paver
3	End dump trucks

12-91 E. CONTRACT QUANTITIES

Estimated Vs. Actual
(as of June, 1991)

ITEM NO.	DESCRIPTION	CONTRACT QUANTITY	UNIT PRICE	AMOUNT	TOTAL TO DATE QUANTITY	AMOUNT	UOF
1	Payment for Performance and Payment Bonds	1 JOB	130000.00	130,000.00	1 JOB	130,000.00	F
2	Environment Protection	1 JOB	135000.00	135,000.00	1 JOB	135,000.00	F
3	Clearing and Grubbing	1 JOB	800000.00	800,000.00	1 JOB	800,000.00	F
4	Trash Rack	1 JOB	100000.00	100,000.00	1 JOB	100,000.00	F
5	Removal of Trash Iron Rack; Intake; and Outlet Works	1 JOB	10000.00	10,000.00	.95 JOB	9,500.00	
6	Control of Groundwater and Surface Water	1 JOB	860000.00	860,000.00	1 JOB	860,000.00	F
7	Slurry Cutoff Walls	58000 S.F	18.00	900,000.00	58255.8 S.F	1,048,604.40	+ F
8	Drains in Foundation Rock	10 Ea.	5000.00	50,000.00	0 Ea.	0.00	F
9	Excavation, Common	471100 C.Y	5.00	2,355,500.00	727182 C.Y	3,935,910.00	+ F
10	Excavation; Rock Borrow	884600 C.Y	4.60	4,070,960.00	929668.85 C.Y	4,276,476.71	+F
11	Excavation, Rock	126900 C.Y	8.00	1,015,200.00	17332.7 C.Y	1,386,584.00	+ F
12	Line Drilling	2400 S.F	5.00	12,000.00	2692.56 S.F	13,462.80	+ F
13	Excavation, Impervious Borrow	492000 C.Y	5.00	1,206,000.00	345795.96 C.Y	1,037,387.88	+F
14	Exploratory Excavation	50 C.Y	150.00	7,500.00	0 C.Y	0.00	F
15a	Foundation Dental Treat. & Concrete, First 100 CY	100 C.Y	300.00	30,000.00	100 C.Y	30,000.00	F
15b	Foundation Dental Treat. & Concrete; All over 100 CY	200 C.Y	250.00	50,000.00	764.26 C.Y	191,065.00	+ F
16	Excavation, Structural	240 C.Y	80.00	19,200.00	436.4 C.Y	34,912.00	+F
17	Steel Sheet Piling - PS 31	73000 L.F	35.00	2,555,000.00	72476.8 L.F	2,536,688.00	F
18	30 Degree Wye - PS 31	1630 L.F	70.00	114,100.00	1610.8 L.F	112,756.00	F
19	90 Degree Tee - PS 31	100 L.F	100.00	10,000.00	93.0 L.F	9,300.00	F
20a	Exploratory Drilling - Mob & Demob	2 Ea	5000.00	10,000.00	2 Ea	10,000.00	F
20b	Core Drilling, 4-Inch Diameter Cores	669 L.F	30.00	24,000.00	575.5 L.F	17,265.00	F
20c	Core Hole Overburden Drilling without Sampling	60 L.F	30.00	1,800.00	68.9 L.F	2,067.00	+ F

12-01 E. CONTRACT QUANTITIES (cont.

Estimated Vs. Actual
(as of June, 1989)

ITEM NO.	DESCRIPTION	CONTRACT QUANTITY	UNIT PRICE	AMOUNT	TOTAL TO DATE QUANTITY	AMOUNT	UCF
20d	Exploratory Holes; Pressure Testing	95 Ea.	100.00	9,500.00	52 Ea.	5,200.00	F
2[illegible]	Sealing Holes with Cement	20 cwt	20.00	400.00	501.3 cwt	10,026.00	+ F
21a	Foundation Drilling & Grouting - Mob & Demob	1 Job	30000.00	30,000.00	1 Job	30,000.00	F
21b	Drilling 1-7/8 Inch Grout Holes	25000 L.F	10.00	230,000.00	19651.5 L.F	196,515.00	F
21c	Portland Cement in Grout	6500 cwt	6.00	39,000.00	4949.06 cwt	29,694.36	F
21d	Placing Grout	250 Hr.	100.00	25,000.00	430.86 Hr.	43,086.00	+ F
22	Impervious Core	157100 C.Y	1.50	235,650.00	166590.42 C.Y	249,885.63	++F
23	Embankment, Drain Material	38660 C Y	18.00	695,880.00	31535.51 C.Y	567,639.18	+F
24	Embankment, Type I Graded Filter	1820 C.Y	23.00	41,860.00	347.79 C.Y	7,999.17	F
25	Embankment; Type II Graded Filter	335 C Y	23.00	7,705.00	344.68 C.Y	7,927.64	+ F
26	Sandstone Rockfill; 6-Inch Lifts	4200 C Y	1.00	4,200 00	1523 C.Y	1,523.00	F
27	Sandstone Rockfill, 24-Inch Lifts	454400 C Y	0.65	295,360.00	462648.92 C.Y	300,721.80	++F
28	Processed Sandstone	174000 C Y	0.70	121,800.00	185797.74 C.Y	130,058.42	++F
29	Random Rockfill; 24-Inch Lifts	305700 C Y	0.70	213,990.00	276933.22 C Y	193,853.25	F
30	Sand and Gravel Cell Fill	48800 C.Y	20.00	976,000.00	47704.44 C.Y	954,088.80	F
31	Diversion Dikes	59800 C Y	2.50	99,500.00	48594.05 C.Y	121,485.13	+ F
32	Pervious Fill	1510 C Y	8 00	12,080.00	1386 C.Y	11,088.00	F
33	Random Fill	30600 C Y	2.25	68,850.00	56943 C.Y	128,121.75	+ F
34	Topsoil	84900 C Y	2.50	212,250 00	44742 C.Y	111,855.00	F
35	Additional Rolling for Compaction	500 Hr.	50.00	25,000.00	0 Hr.	0.00	F
36	DELETED			0 00		0.00	
37	Undisturbed Block Samples	6 Ea	200 00	1,200.00	6 Ea.	1,200.00	F
38	Test Pits in Embankment	10 Ea.	500.00	5,000.00	6 Ea.	3,000.00	F

12-01 E. CONTRACT QUANTITIES (cont)

Estimated Vs. Actual
(as of June, 1989)

ITEM NO.	DESCRIPTION	CONTRACT QUANTITY	UNIT PRICE	AMOUNT	TOTAL TO DATE QUANTITY	AMOUNT	UCF
39	Test Pits in Impervious Borrow	40 Hr.	40.00	1,600.00	14.5 Hr.	580.00	F
40	Remove - Reinstall Existing Guardrail	550 L.F	10.00	5,500.00	458.7 L.F	4,587.00	F
41	Remove Earth Shoulder on Existing Access Road	1 Job	1000.00	1,000.00	1 Job	1,000.00	F
42	Roadway Excavation	86000 C.Y	3.00	264,000.00	86407.88 C.Y	259,223.64	F
43	Select Rock Fill	4300 C.Y	3.00	12,900.00	10104 C.Y	30,312.00	+ F
44	Dense Graded Aggregate Base	8750 Ton	13.00	113,750.00	9841.45 Ton	127,938.85	+ F
45	Bituminous Material for Prime Coat	14 Ton	300.00	4,200.00	13.35 Ton	4,005.00	F
46	Bituminous Material for Tack Coat	10 Ton	300.00	3,000.00	5.28 Ton	1,584.00	F
47	Bituminous Concrete Base	1700 Ton	50.00	85,000.00	1676.1 Ton	83,805.00	F
48	Bituminous Concrete Surface	810 Ton	50.00	40,500.00	1075.48 Ton	53,774.00	+ F
49	Pipe for Subgrade Drainage (Underdrains)	60 L.F	15.00	900.00	49 L.F	735.00	F
50	Pipe Culvert, Size 24-Inch; 14-Gage BCCM	102 L.F	30.00	3,060.00	162 L.F	4,860.00	+ F
51	Headwall for 24-Inch Pipe	2 Ea.	1000.00	2,000 00	4 Ea.	4,000.00	+ F
52	Stone Dispersal Pad	8 C Y	50.00	400.00	9.6 C.Y	480.00	+ F
53	Drop Box Inlet at Sta 17+50A	1 Ea.	1000.00	1,000 00	1 Ea.	1,000.00	F
54	Drop Box Inlet at Sta 17+00B	1 Ea.	1000.00	1,000.00	1 Ea.	1,000.00	F
55	Rock Fill Bench Drainage Layer	965 C.Y	2.00	1,930.00	1636.56 C.Y	3,273.12	+ F
56	Guardrail, Single Face	5920 L.F	12.00	71,040 00	6033.7 L.F	72,404.40	+ F
57	Channel Lining; Class II	540 Ton	14.00	7,560 00	408.79 Ton	5,723.06	F
58	Slush-Grouted Stone Protection	335 S Y	15.00	5,025 00	450.4 S.Y	6,756.00	+ F
59	Pavement Marking	10650 L F	0.40	4,260.00	18782 L.F	7,512.80	+ F
60	Precast Concrete Parking Blocks	5 Ea.	100 00	500.00	5 Ea.	500.00	F
61	Number 57 Stone Base	5320 Ton	12 00	63,840 00	4366.7 Ton	52,400.40	F

12-01 E. CONTRACT QUANTITIES (cont)

Estimated Vs. Actual
(as of June, 1989)

ITEM NO.	DESCRIPTION	CONTRACT			TOTAL TO DATE		
		QUANTITY	UNIT PRICE	AMOUNT	QUANTITY	AMOUNT	OCF
62	Drilling and Grouting Holes for Anchor Bars	1600 L.F	10.00	16,000.00	1455 L.F	14,550.00	F
63	Drilling Drainage Holes	500 L.F	20.00	10,000.00	468 L.F	9,360.00	F
64	Stone Slope Protection; 24-Inch Thickness	15430 C.Y	23.00	354,890.00	16961.7 C.Y	390,119.10	+ F
65	Stone Slope Protection; 36-Inch Thickness	3660 C.Y	30.00	109,800.00	3631.93 C.Y	108,957.90	F
66	Bedding Material, Type I	920 C.Y	25.00	23,000 00	902.93 C.Y	22,573 25	F
67	Bedding Material; Type II	940 C Y	25.00	23,500.00	916.08 C.Y	22,902.00	F
68	Rock Spall Slope Protection	900 C.Y	4.00	3,600.00	705 C.Y	2,820.00	F
69	Filter Cloth	9200 S.Y	1.50	13,800 00	2525.71 S.Y	3,788.56	+F
70	Type I Gutter	770 L.F	70.00	53,900 00	1086 L.F	76,020 00	+ F
71	Type II Gutter	1970 L F	70.00	137,900.00	1966 L F	137,620.00	F
72	Type III Gutter	420 L.F	85.00	35,700.00	668 L F	56,780.00	+ F
73	Seeding	100 Ac.	1500.00	150,000.00	79.55 Ac.	119,325.00	+
74	Test Fills	1 JOB	50000.00	50,000 00	1 JOB	50,000.00	F
75	Concrete Sidewalk, Ramp and Apron	145 S.Y	30.00	4,350.00	112.12 S.Y	3,363.60	F
76	Chain Link Fence; 6-Foot	660 L.F	25.00	16,500.00	769 L.F	19,225.00	+ F
77	Concrete in Intake Structure	2500 C Y	350.00	875,000.00	2434.06 C Y	851,921.00	F
78	Concrete in Spillway & Service Bridge Abutments	280 C Y	250.00	70,000.00	287.77 C Y	71,942.50	+ F
79	Concrete in Spillway & Ser. Br. Approach Slabs	65 C.Y	175.00	11,375 00	59.47 C.Y	10,407.25	F
80	Concrete in Spillway Sill	60 C.Y	250.00	15,000 00	60.75 C.Y	15,187 50	+ F
81	Concrete in Inclined Leg Found. & Spillway Lining	524 C.Y	250.00	131,000.00	545.79 C.Y	136,447.50	+ F
82	Concrete in Cellular Cofferdam Cap and Bern	3100 C Y	200.00	620,000.00	5187 43 C.Y	1,037,486.00	+ F
83	Concrete in Cofferdam Closure Walls	1800 C.Y	250.00	450,000.00	1620.5 C.Y	405,125 00	F
84	Second Pour Concrete	80 C Y	500 00	40,000.00	90.44 C Y	45,220.00	+ F

Estimated Vs. Actual
(as of June, 1989)

ITEM NO.	DESCRIPTION	CONTRACT QUANTITY	UNIT PRICE	AMOUNT	TOTAL TO DATE QUANTITY	AMOUNT	UCF
85	Steel Reinforcement - Epoxy Coated	155000 Lb.	0.70	108,500.00	213967.96 Lb.	149,777.57	* F
86	Steel Reinforcement - Non-Coated	116700 Lb.	0.50	58,350.00	126159.38 Lb.	63,079.69	* F
87	Waterstops; Metal	660 L.F	6.00	3,960.00	641 5 L.F	3,849.00	F
88	Aluminum Doors for Intake Structure	1 JOB	5000.00	5,000.00	1 JOB	5,000.00	F
89	Maintenance Building	1 JOB	320000.00	320,000.00	.99 JOB	316,800.00	*
90	Metal Gage	1 JOB	3000.00	3,000.00	1 JOB	3,000.00	F
91	Waterproofing	1 JOB	1000 00	1,000.00	1 JOB	1,000.00	F
92	Letters, Numerals; and Insignia	1 JOB	6000.00	6,000.00	1 JOB	6,000.00	F
93	Grilles	1 JOB	1000.00	1,000 00	1 JOB	1,000.00	F
94	Concrete Hatch Covers	1 JOB	11000.00	11,000.00	98 JOB	10,780.00	
95	Maintenance Bulkheads	1 JOB	50000.00	50,000.00	1 JOB	50,000.00	F
96	Ventilation System	1 JOB	14000.00	14,000 00	1 JOB	14,000.00	F
97	Hand Hoist	1 JOB	3000.00	3,000 00	1 JOB	3,000.00	F
98	Puller Hoist	1 JOB	1000 00	1,000.00	1 JOB	1,000.00	F
99	Bulkhead Door	1 JOB	7000.00	7,000.00	1 JOB	7,000.00	F
100	Floor Drains and Drain Piping	1 JOB	4000.00	4,000.00	1 JOB	4,000 00	F
101	Grab Bars	1 JOB	500 00	500 00	1 JOB	500.00	F
102	Air Vent System	1 JOB	18000 00	18,000 00	1 JOB	18,000.00	F
103	Trash Screens	1 JOB	24000.00	24,000.00	1 JOB	24,000.00	F
104	Steel Ladders	1 JOB	5000.00	5,000 00	1 JOB	5,000.00	F
105	Aluminum Pipe Railing	1 JOB	19000.00	19,000 00	1 JOB	19,000.00	F
106	Aluminum Grating, Hatch Covers and Frames	1 JOB	14000.00	14,000 00	.95 JOB	13,300.00	
107	Miscellaneous Ferrous Metal Items	1 JOB	3000 00	3,000 00	1 JOB	3,000.00	F

12-01 E. CONTRACT QUANTITIES (cont)

Estimated Vs. Actual
(as of June, 1989)

ITEM NO.	DESCRIPTION	CONTRACT QUANTITY	UNIT PRICE	AMOUNT	TOTAL TO DATE QUANTITY	AMOUNT	OCF
108	Stainless Steel Angles	1 JOB	3000.00	3,000.00	1 JOB	3,000.00	F
11[illegible]	Gate for Intake Structure	1 JOB	1000.00	1,000.00	1 JOB	1,020.00	F
110	Project Signs	1 JOB	2000.00	2,000.00	1 JOB	2,000.00	F
111	Manhole Steps	1 JOB	500.00	500.00	1 JOB	500.00	F
112	Cast Iron Drainage Pipe; Size 4-Inch	75 L.F	12.00	900 00	76 L.F	912.00	+ F
113	Outlet Drainage Pipe, Size 18-Inch	250 L F	30.00	7,500.00	321 L.F	9,630.00	+ F
114	Drop Inlet No. 3	1 JOB	500 00	500 00	1 JOB	500.00	F
115	Drop Inlet No 4	1 JOB	500.00	500.00	1 JOB	500.00	F
116	Pipe Underdrains; Size 6-Inch	260 L F	8 00	2,080.00	360 L.F	2,880 00	+ F
117	Culvert Outfalls	35 C Y	24 00	840 00	57.4 C Y	1,377.60	+ F
118	Service Bridge Superstructure	1 JOB	80000.00	80,000.00	1 JOB	80,000.00	F
119	Spillway Bridge Superstructure	1 JOB	435000.00	435,000 00	1 JOB	435,000.00	F
120	Main Sluice Gates; Frames and Accessories	1 JOB	450000.00	450,000.00	1 JOB	450,000.00	*F
121	Selective Withdrawal Inlet Gates	1 JOB	180000.00	180,000 00	.99 JOB	178,200.00	
122	Selective Withdrawal Outlet Gates, Frames & Liners	1 JOB	230000 00	230,000.00	1 JOB	230,000.00	*F
123	Selective Withdrawal By-pass Valves & Conduit Piping	1 JOB	60000.00	60,000.00	1 JOB	60,000.00	F
124	Control Gates Operating System	1 JOB	90000.00	90,000.00	.99 JOB	89,100.00	
125	Floatwell System	1 JOB	30000.00	30,900.00	1 JOB	30,000.00	F
126	Raw Water Pumping System	1 JOB	14000.00	14,000 00	1 JOB	14,000.00	F
127	Sampling Piping	1 JOB	4000.00	4,000.00	1 JOB	4,000.00	F
128	Fuel Systems - Maintenance Building	1 JOB	20000.00	20,000 00	95 JOB	19,000.00	*
129	Electrical Work	1 JOB	350000.00	350,000.00	999 JOB	349,650 00	*
130	Diesel Electric Generator Set - Maint Bldg	1 JOB	25000.00	25,000 00	1 JOB	25,000.00	*F

12-01 E. CONTRACT QUANTITIES (cont)

Estimated Vs. Actual
(as of June, 1989)

ITEM NO.	DESCRIPTION	CONTRACT QUANTITY	UNIT PRICE	AMOUNT	TOTAL TO DATE QUANTITY	AMOUNT	OCF
131	Landscape Planting	1 JOB	75000.00	75,000.00	.85 JOB	63,750.00	
1	Portland Cement	32070.72 cwt	3.00	96,212.16	36043.26 cwt	108,129.78	+ F
132Ab	Pozzolan	5445.89 C F	2.00	10,891.78	7056.49 C F	14,112.98	+ F
133D	Bedding Material, Graded Filter Type 2	3960 C.Y	21.00	83,160.00	4087.8 C Y	85,843.80	+ F
P00002-1	Pipe Culvert; 36-inch; 10 gage BCCMP	170 L.F	114.00	19,380.00	170 L.F	19,380.00	F
P00002-2	Headwall-36 inch; 30 degree Skew	2 Ea.	3000.00	6,000 00	2 Ea.	6,000.00	F
P00002-3	Pipe Culvert; 72-inch, 8 gage BCCMP	78 L.F	244.00	19,032.00	78 L.F	19,032.00	F
P00002-4	Headwall-72 inch, 0 degree Skew	2 Ea.	7200.00	14,400 00	2 Ea.	14,400.00	F
P00003-1	V E. Change to Slurry Wall	1 JOB	-25900.00	-25,900 00	1 JOB	-25,900.00	F
P00003-2	V.E. Incentive Adjustment	1 JOB	14245.00	14,245.00	1 JOB	14,245.00	F
P00005-1	30 degree Wye Reinforcing	1630 L F	24.86	40,521 80	1630 L.F	40,521.80	F
P00006-1	Additional Foam for Trash Boom	1 JOB	6000 00	6,000.00	1 JOB	6,000 00	F
P00007-1	Relocate U/S Well Control Panels	1 JOB	6244.00	6,244.00	1 JOB	6,244.00	F
P00008-1	Intake Structure Base Formwork	1 JOB	7500.00	7,500.00	1 JOB	7,500.00	F
P00009-1	Grind Main Sluice Conduit Liners	1 JOB	1700.00	1,700.00	1 JOB	1,700.00	F
P00010-1	Delete Deadman Anchor	1 JOB	-3100.00	-3,100.00	1 JOB	-3,100.00	F
P00011-1	Locking Pin Material Substitution	1 JOB	172.00	172.00	1 JOB	172.00	F
P00012-1	Notch in Downstream Diversion Dike	1 JOB	6050.00	6,050.00	1 JOB	6,050.00	F
P00013-1	Sample Concrete Batches	1 JOB	13039 00	13,039.00	1 JOB	13,039.00	F
P0 -2	Alternate Mixing Water for Concrete	1 JOB	4726.00	4,726.00	1 JOB	4,726.00	F
P00014-1	Deletion of Power Cable	1 JOB	-2880.00	-2,880.00	1 JOB	-2,880.00	F
P00015-1	Test Fill	1 JOB	2405.41	2,405 41	1 JOB	2,405.41	F
P00015-2	Quarry Sample Test	2 Ea.	525.00	1,050 00	2 Ea.	1,050.00	F

12-01 E. CONTRACT QUANTITIES (cont)

Estimated Vs. Actual
(as of June, 1989)

ITEM NO.	DESCRIPTION	CONTRACT QUANTITY	CONTRACT UNIT PRICE	CONTRACT AMOUNT	TOTAL TO DATE QUANTITY	TOTAL TO DATE AMOUNT	OCF
P00015-3	Test Pits	10 Ea.	723.00	7,230.00	10 Ea.	7,230.00	F
P00016-1	Deletion of Fuel Storage and Dispensing System	1 JOB	-14700.00	-14,700.00	1 JOB	-14,700.00	F
P00017-1	Extend 36" Diameter Floatwell Pipe	1 JOB	1575.00	1,575.00	1 JOB	1,575.00	F
P00018-1	Modification to Masonry Walls	1 JOB	2017.00	2,017.00	1 JOB	2,017.00	F
P00019-1	Additional Inspection of Dam Foundation	1 JOB	7000.00	7,000.00	1 JOB	7,000.00	F
P00020-1	Remove & Replace Unsuitable Dam Core Material	1 JOB	57578.00	57,578.00	1 JOB	57,578.00	F
P00021-1	3" Waterline	1000 L.F	16.96	16,960.00	1000 L.F	16,960.00	F
P00021-2	2" Waterline	1830 L.F	16.05	29,371.50	2140 L.F	34,347.00	+ F
P00021-3	1-1/4" Waterline	300 L.F	16.01	4,803.00	176.5 L.F	2,825.77	F
P00021-4	4" Steel Casing	25 L.F	12.00	300.00	75 L.F	900.00	+ F
P00021-5	2" Gate Valve & Box	2 Ea	277.00	554.00	0 Ea.	0.00	F
P00021-6	1-1/4" Gate Valve & Box	1 Ea.	117.00	117.00	1 Ea.	117.00	F
P00022-1	Remove Top 5' of Upstream Cofferdam Cut-off Walls	1 JOB	5065.00	5,065.00	1 JOB	5,065.00	F
P00023-1	Suspension of Concrete Work on Intake Structure	1 JOB	59640.16	59,640.16	1 JOB	59,640.16	F
P00024-1	Preparation of Alternate Borrow Area	1 JOB	12214.00	12,214.00	1 JOB	12,214.00	F
P00026-1	Paint Embedded Metals in Intake Struct. Below El. 635	1 JOB	49950.00	49,950.00	1 JOB	49,950.00	F
P00027-1	Pressure Reducing Valves for Sel. With. Inlet Gates	1 JOB	6400.00	6,400.00	.75 JOB	4,800.00	+
P00028-1	Changes to meet Seismic Standards	1 JOB	16931.00	16,931.00	1 JOB	16,931.00	+F
P00028-2	Epoxy Floors in Toilet Areas	1 JOB	3655.00	3,655.00	1 JOB	3,655.00	F
P00028-3	Additional Framing for Soffit	1 JOB	1881.00	1,881.00	1 JOB	1,881.00	F
P00029-1	Thru Drilling of Connecting Collars on Gate Stems	1 JOB	6202.06	6,202.06	1 JOB	6,202.06	+F
P00029-2	Cover Plates over Floor Openings & Add Railings	1 JOB	6356.46	6,356.46	1 JOB	6,356.46	+F
P00029-3	Change Diameter of Gate Stem Collars and Wrenches	1 JOB	2832.89	2,832.89	1 JOB	2,832.89	+F

12-01 L. CONTRACT QUANTITIES (cont)

Estimated Vs. Actual
(as of June, 1989)

ITEM NO.	DESCRIPTION	CONTRACT QUANTITY	CONTRACT UNIT PRICE	CONTRACT AMOUNT	TOTAL TO DATE QUANTITY	TOTAL TO DATE AMOUNT	OCF
P00029-4	Additional threads for Hydraulic System Anchor Bolts	1 JOB	455.26	455 26	1 JOB	455.26	*F
				25,072,252.48		27,517,132.58	

(*) DENOTES OVERRUNS (*) DENOTES CHANGE (F) DENOTES FINAL QUANTITY

12-01 F. CHRONOLOGICAL SEQUENCE OF CONSTRUCTION

Date	Event
29 Apr 86	Contract was awarded to Lane Construction Corp.
15 May 86	Notice to Proceed
15 May 86	Began clearing and grubbing
15 May 86	Began common excavation at dam site
19 May 86	Preparatory meeting for rock excavation
20 May 86	Began drilling and blasting of diversion channel
21 May 86	Began common excavation of diversion channel
27 May 86	Began drilling and blasting of dam core
13 Jun 86	Constructed temporary dikes on Blaine Creek at dam
07 Jul 86	Began constructing U/S diversion dike
21 Jul 86	Began drilling and blasting of cofferdam monoliths
22 Jul 86	Began exploratory drilling at spillway bridge
23 Jul 86	Began excavation for service road
29 Jul 86	Began constructing D/S diversion dike
30 Jul 86	Began excavation of the U/S slurry cutoff wall
01 Aug 86	Completed exploratory drilling in spillway
12 Aug 86	Preparatory meeting for dewatering system
15 Aug 86	Began installing dewatering wells
27 Aug 86	Began drilling and blasting of spillway
08 Sep 86	Completed U/S slurry cutoff wall
09 Sep 86	Began excavation of the D/S slurry cutoff wall
16 Sep 86	Began common excavation at cofferdam el. 575 - 570
25 Sep 86	Completed common excavation at cofferdam
25 Sep 86	Began drilling and blasting of rock borrow area #1
06 Oct 86	Completed dewatering system
23 Oct 86	Completed the U/S diversion dike
23 Oct 86	Completed the D/S slurry cutoff wall
30 Oct 86	Began placing and driving sheet pile for cofferdam
03 Nov 86	Completed the D/S diversion dike
17 Nov 86	Diverted water through diversion channel
13 Jan 87	Began filling cofferdam cells with bottom ash
10 Feb 87	Completed driving piling for cofferdam cells 1 - 6
03 Mar 87	Completed filling cofferdam cells
05 Mar 87	Plugged Blaine Creek at intake channel
24 Mar 87	Placed concrete at the rock-cofferdam cell closure
09 Apr 87	Placed first lift concrete for cofferdam mono. 1&4
13 Apr 87	Placed first lift concrete for cofferdam mono. 1&3
15 Apr 87	Placed first lift concrete for cofferdam mono. 2
17 Apr 87	Completed cofferdam cells 1 - 6
27 Apr 87	Installed anchor bars for trash boom
01 May 87	Placed concrete for intake structure 570 - 575
05 May 87	Completed concrete for cofferdam mono. 1 - 4
11 May 87	Began line drilling spillway inclined legs & sill
12 May 87	Began concrete placements for spillway bridge abut
19 May 87	Began installing anchor bars for inclined leg
20 May 87	Placed concrete for intake structure 575 - 584
01 Jun 87	Completed line drilling spillway sill & incl. legs
04 Jun 87	Excavated spillway sill and incline leg keys
05 Jun 87	Completed installing anchor bars for inclined legs

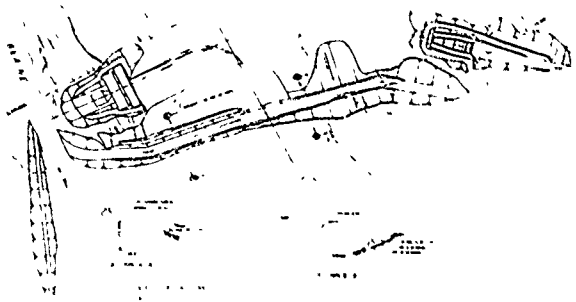
Date	Event
05 Jun 87	Began installing anchor bars in spillway sill
09 Jun 87	Began 10'-wide S.S. Rockfill D/S cofferdam berm
11 Jun 87	Began concrete placement of spillway inclined legs
11 Jun 87	Began concrete placement of spillway sill
16 Jun 87	Completed 10'-wide S.S. Rockfill D/S cofferdam
22 Jun 87	Completed concrete placement of spillway sill
03 Jul 87	Placed concrete for intake structure 584 - 593.5
17 Jul 87	Completed concrete cofferdam berm, stage IV
22 Jul 87	Placed concrete for intake structure 593.5 - 600.5
03 Aug 87	Placed concrete for intake structure 600.5 - 610.5
06 Aug 87	Began placing S.S. around intake channel & struct.
06 Aug 87	Diverted Blaine Creek through the intake structure
10 Aug 87	Began constructing plugs in diversion channel
12 Aug 87	Completed placing S.S. in intake area
17 Aug 87	Placed concrete for intake structure 610.5 - 619
20 Aug 87	Completed constructing plugs in diversion channel
20 Aug 87	Began drill & blast right diversion channel wall
24 Aug 87	Preparatory meeting for found. curtain grouting
25 Aug 87	Line drilled shale seam for dental concrete, dam
03 Sep 87	Began driving sheet pile for cofferdam cell #7
16 Sep 87	Placed first lift concrete for cofferdam mono #5
17 Sep 87	Completed driving sheet pile for cofferdam cell #7
23 Sep 87	Placed concrete for intake structure 619 - 627
24 Sep 87	Began exploratory drilling in dam foundation
30 Sep 87	Completed cofferdam cell #7 concrete cap
30 Sep 87	Completed exploratory drilling in dam foundation
01 Oct 87	Completed press. testing and sealing explor. holes
01 Oct 87	Completed concrete placements for cofferdam mono 5
02 Oct 87	Completed overburden excavation of dam site
02 Oct 87	Began dam embankment, 24" random rockfill, D/S
05 Oct 87	Placed first lift concrete for cofferdam mono #6
06 Oct 87	Began foundation drilling and grouting
06 Oct 87	Completed concrete for spillway inclined legs
06 Oct 87	Began const. of spillway bridge superstructure
10 Oct 87	Completed concrete for cofferdam monolith #6
16 Oct 87	Line drilled portions of broken zone to be treated
21 Oct 87	Placed concrete for intake structure 627 - 635
22 Oct 87	Began placing dental concrete, 277 yds @ bkn zone
23 Oct 87	Placed 246 yds dental concrete @ broken zone
28 Oct 87	Began line drilling for service bridge abutment
29 Oct 87	Completed drilling and blasting in dam foundation
29 Oct 87	Completed spillway bridge superstructure
05 Nov 87	Placed concrete for intake structure 635 - 644.25
16 Nov 87	Placed concrete for intake struct. 644.25 - 653.75
16 Nov 87	Began concrete placement for spillway bridge deck
20 Nov 87	Completed concrete for spillway bridge abutment
30 Nov 87	Began concrete for service bridge abutment
08 Dec 87	Placed concrete for intake struct. 653.75 - 663.25
22 Dec 87	Began concrete placement for service bridge abut.

12-01 F CHRONOLOGICAL SEQUENCE OF CONSTRUCTION (cont)

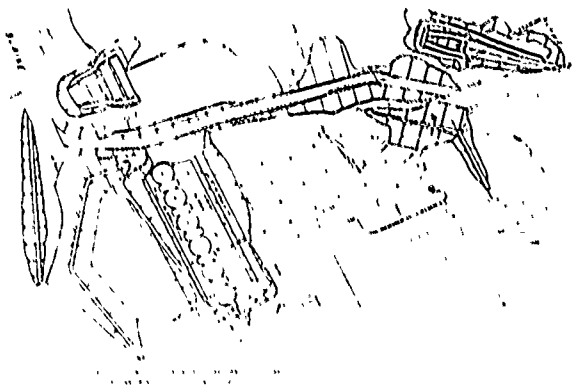
Date	Event
13 Jan 88	Placed concrete for intake struct. 663.25 - 677.5
28 Jan 88	Began post-grouting exploratory drilling, dam
04 Feb 88	Completed post-grouting exploratory drilling
15 Feb 88	Completed concrete for service bridge abutment
17 Feb 88	Placed concrete for intake struct. 677.5 - 687.5
26 Feb 88	Placed 17.5 cu. yds. dental concrete @ bkn. zone
29 Feb 88	Placed 12.0 cu. yds. dental concrete @ bkn. zone
01 Mar 88	Placed 8.0 cu. yds. dental concrete @ bkn. zone
02 Mar 88	Placed 16.0 cu. yds. dental concrete
07 Mar 88	Placed 22.5 cu. yds. dental concrete @ bkn. zone
07 Mar 88	Completed intake structure parapet walls
08 Mar 88	Placed 8.0 cu. yds. dental concrete @ bkn zone
22 Mar 88	Preparatory meeting for dam embankment
09 Mar 88	Began const. of service bridge superstructure
11 Mar 88	Placed 32.0 cu. yds. dental concrete @ coal seam
15 Mar 88	Placed 30.0 cu. yds. dental concrete @ coal seam
16 Mar 88	Placed 31.0 cu. yds. dental concrete @ coal seam
16 Mar 88	Completed service bridge superstructure
17 Mar 88	Placed 46.0 cu. yds. dental concrete
18 Mar 88	Placed 36.o cu. yds. dental concrtet @ coal seams
23 Mar 88	Began concrete for service bridge deck
28 Mar 88	Began placement of 12" processed s.s., dam
29 Mar 88	Began placement of impervious core of dam embank.
06 Apr 88	Completed foundation drilling and grouting
08 Apr 88	Began placement of 24" s.s. rockfill, dam
11 Apr 88	Completed concrete for spillway bridge deck
13 Apr 88	Began drilling drainage holes in spillway lining
13 Apr 88	Reworked portion of impervious core el. 530 - 528
14 Apr 88	Removed imperv. core to treat found., 4+90 - 4+20
15 Apr 88	Placed 3.0 cu. yds. dental concrete @ shale/s.s.
21 Apr 88	Placed 8.0 cu. yds. dental concrete @ coal seam
26 Apr 88	Placed 8.0 cu. yds. dental concrete @ coal seam
26 Apr 88	Completed drilling drainage holes in spillway
27 Apr 88	Excavated imperv. core, 545 - 541, 5+75 - 7+00
03 May 88	Placed 8.0 cu. yds. dental concrete @ coal seam
11 May 88	Placed 10.0 cu. yds. dental concrete @ shale/s.s.
13 May 88	Constructed impervious core test pad
17 May 88	Reworked imperv. core, 557 - 551, 3+50 - 7+00
27 May 88	Reworked portions of impervious core, 574 - 570
31 May 88	Reworked portions of impervious core, 574 - 570
02 Jun 88	Reworked imperv. core, 578 - 576, 3+25 - 4+50
06 Jun 88	Placed 6.0 cu. yds. dental concrete @ s.s.
10 Jun 88	Began placement of blanket drain @ 590, dam
23 Jun 86	Began placing Type I & II graded filter, dam
28 Jun 88	Began placing stone slope protection, dam
07 Jul 88	Placed 16.0 cu. yds. dental concrete @ shale seam
08 Jul 88	Completed dental concrete w/ 12 cu. yds. @ shale
13 Jul 88	Preparatory meeting for maintenance building
25 Jul 88	Began construction of maintenance building

12.01 F CHRONOLOGICAL SEQUENCE OF CONSTRUCTION (cont)

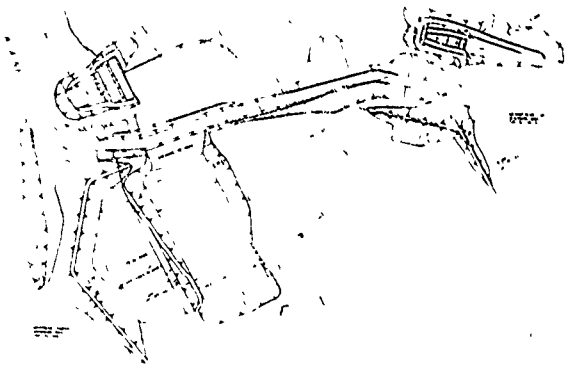
Date	Event
30 Aug 88	Completed placing 24" s.s. rockfill, dam
31 Aug 88	Completed placing 24" random rockfill, dam
09 Sep 88	Completed placing incline drain, dam
09 Sep 88	Completed placing 12" processed sandstone, dam
13 Sep 88	Completed placing impervious core, dam
13 Sep 88	Began placing 8" s.s. rockfill, dam
21 Sep 88	Completed dam embankment w/ 8" s.s. rockfill
03 Oct 88	Connected permanent trash boom
07 Oct 88	Removed concrete cofferdam mono. to el. 616
24 Oct 88	Preparatory meeting for paving
26 Oct 88	Began placing stone base for roads
15 Nov 88	Began paving service & access roads
17 Nov 88	Completed paving service & access roads
31 Aug 89	Acceptance of all physical work



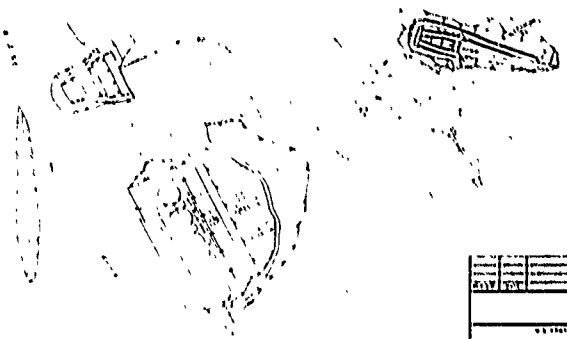
STAGE I



STAGE III

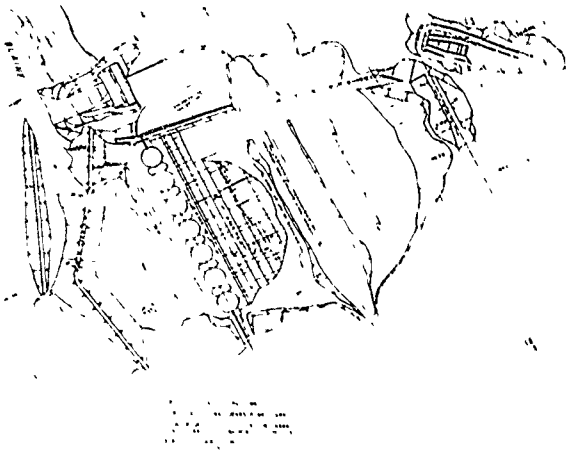


STAGE II

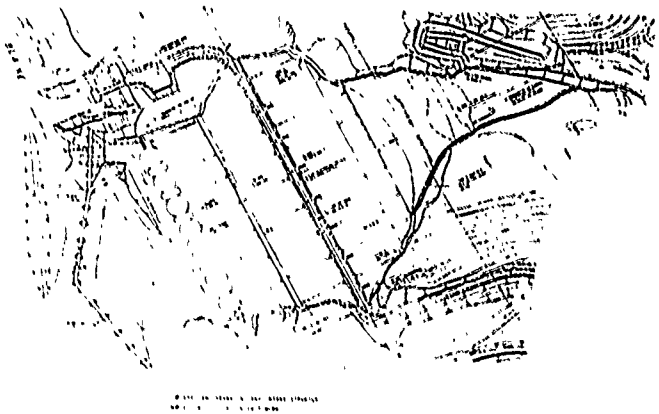


STAGE IV

YATESVILLE LAKE



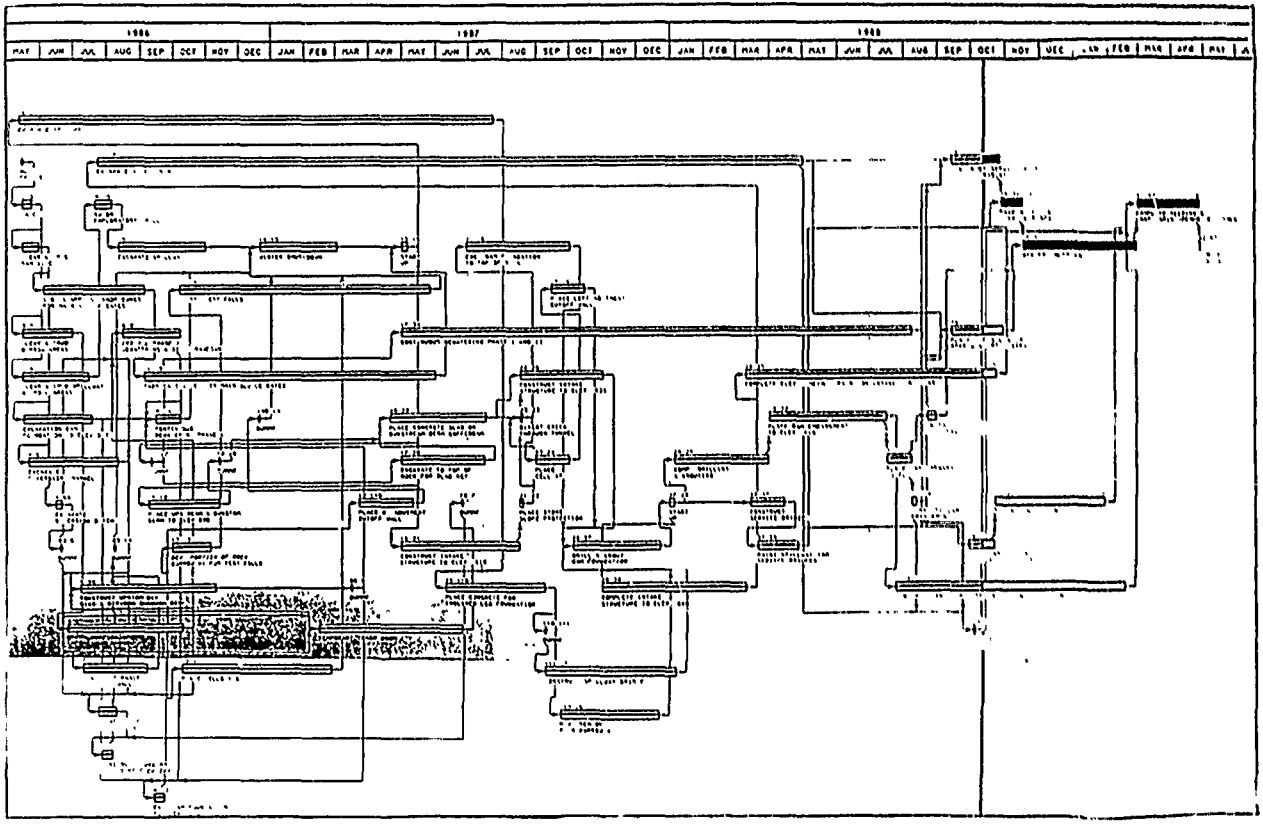
STAGE V



STAGE VI

YATESVILLE LAKE
DAM AND APPURTENANT FEATURES
CONTINUATION PROJECT
POST-DIVERSION

CHRONOLOGICAL SEQUENCE OF CONSTRUCTION



YATESVILLE LAKE DAM

YATESVILLE TIME-SCALED LOGIC DIAGRAM

Contractor: Lane Construction Corp.

12-01 G. LIST OF SUBCONTRACTORS

Name	Area of Responsibility
Ashland Acoustical	Subcontractor for W. B. Fosson & Sons Inc.
All State Contracting Co.	Sand blasting and painting
Boyles Bros. Drilling Co.	Exploratory drilling & foundation drilling and grouting
Bush Industries	Partial seeding and trash boom
Cabell Sheet Metal	Subcontractor for W. B. Fosson & Sons Inc.
Coalfield Contracting and Engineering Inc	Clearing and grubbing
W. B. Fosson & Sons Inc.	Maintenance Building
Richard Goettle Inc.	Sheet piling, cofferdam cells
High Tech Mechanical	Subcontractor for W. B. Fosson & Sons Inc.
J & H Reinforcing & Structrial Erectors	Subcontractor for W. B. Fosson & Sons Inc.
Manning Rebar Inc.	Reinforcing steel
McClelland Services Inc.	Slurry cutoff wall
Carmen W. Moon Masonry Contractors	Subcontractor for W. B. Fosson & Sons Inc.
Mountain Enterprises Inc.	Paving
Penn Line Services	Seeding and Landscaping
Ross Bros. Construction Co.	Bridge construction
Stacon Corp.	Dewatering system
Swanson & Nunn Electric Co.	Electrical work
Triad Engineering Drilling & Services	Subcontractor for Stacon Corp.
Varney Door Company Inc.	Subcontractor for W. B. Fosson & Sons Inc.

12-01.H DENTAL CONCRETE

Date	Quantity cu. yds.	Location	Elevation	Reason for treatment
10-22-87	277.0	5+64D - 5+96D, 68' U/S - 35' D/S	517 - 521	Broken zone in S.S.
10-23-87	246.0	5+48D - 5+96D, 35' D/S - 86' D/S	517 - 521	Broken zone in S.S.
02-26-88	18.5	5+21D - 6+00D, 60' U/S - 75' U/S	521 - 526	Broken zone in S.S.
02-29-88	7.0	5+21D - 5+27D, 26' U/S - 58' U/S	521 - 526	Broken zone in S.S.
02-29-88	5.0	5+95D - 6+01D, 46' U/S - 60' U/S	521 - 526	Broken zone in S.S
03-01-88	2.0	5+55D - 5+64D, 16' D/S - 38' D/S	521	Irr. surface w/ bd. pn.
03-01-88	3.0	4+70D - 5+02D, 10' D/S - 50' D/S	526 - 528	Irr. surface w/ vert. jt.
03-01-88	3.0	4+34D - 4+42D, 37' U/S - 1' U/S	529	S.S./shale contact
03-02-88	6.0	5+79D - 6+01D, 74' D/S - 83' D/S	522 - 526	Broken zone in S.S.
03-02-88	5.0	6+80D - 6+84D, 58' U/S - 40' D/S	531 - 534	Thin shale seam
03-02-88	5.0	6+89D - 7+01D, 62' U/S - 38' D/S	535 - 537	Thin shale seam
03-07-88	10.0	5+34D - 5+54D, 86' D/S - 104' D/S	521 - 525	Broken zone in S.S.
03-07-88	12.3	5+38D - 5+74D, 59' U/S - 40' U/S	521	Broken zone in S.S.
03-08-88	6.0	5+43D - 5+53D, 73' D/S - 91' D/S	521	Broken zone in S.S.
03-08-88	2.0	5+90D - 6+00D, 81' D/S - 82' D/S	526	Broken zone in S.S.
03-11-88	32.0	3+79D - 3+89D, C.L. - 25' U/S	536 - 545	Coal seam w/ shales

12-01 H. DENTAL CONCRETE (cont.)

Date	Quantity cu. yds.	Location	Elevation	Reason for treatment
03-15-88	30.0	3+79D - 3+89D, 25' D/S - 52' D/S	536 - 545	Coal seam w/ shales
03-16-88	31.0	3+79D - 3+89D, C.L. - 25' D/S,	536 - 545	Coal seam w/ shales
03-17-88	40.0	3+79D - 3+89D, 25' D/S - 63' D/S	536 - 545	Coal seam w/ shales
03-17-88	6.0	5+60D - 5+80D, 24'U/S - 50' U/S	521	Broken zone in S.S.
03-18-88	26.0	4+03D - 3+81D, 52' D/S - 76' D/S	536 - 543	Coal seam w/ shales
03-18-88	10.0	3+64D - 3+66D, 66' U/S - 60' D/S	546 - 548	Coal seam
04-15-88	3.0	4+37D - 4+71D, 2' U/S - 30' U/S	528	Shale/S.S. contact
04-21-88	8.0	7+37D - 7+40D, 45' U/S - 42' D/S	547 - 549	Coal seam
04-26-88	8.0	3+59D - 3+64D, 52' U/S - 4' D/S	551 - 548	Coal seam & shales
05-03-88	8.0	7+75D - 7+79D, 31' U/S - 32' D/S	558 - 560	Coal se. & S.S/sh cont.
05-11-88	10.0	3+19D - 3+39D, 29' U/S - 32' D/S	560 - 564	Irr. surface w/ S.S./sh
06-07-88	6.0	8+43D - 8+46D, 28' U/S - 28' D/S	585 - 587	Poorly cem. sandstone
07-07-88	16.0	8+84D - 8+86D, 28' U/S - 27' D/S	612 - 614	Shale seam
07-08-88	12.0	8+86D - 8+88D, 28' U/S - 27' D/S	614 - 616	Shale seam

12-C1.H DENTAL CONCRETE (cont)

- Dental concrete consisted of a 6 bags/cu.yd. cement mix with fly ash and having a top sized aggregate of 3/4".

- 8.3 cubic yards of neat and sanded grout was used throughout the dam foundation to treat joints, bedding planes and lithologic contacts. This grout was mixed with various cement/water ratios (0.5:1 to 2:1) and was applied using various methods (broomed, trowlled, etc.).

- All rock surfaces treated with dental concrete or grout were properly prepared, such as: cleaned, chipped, formed (if needed), and removal of loose and drummy rock.

DENTAL TREATMENT OF BROKEN ZONE
ORIGINAL ROCK
FINAL ROCK
DENTAL CONCRETE
50' U/S
62' U/S
5+00
5+50
6+00

DENTAL TREATMENT OF BROKEN ZONE
16' U/S
32' U/S
ORIGINAL ROCK
FINAL ROCK
DENTAL CONCRETE
5+00
5+50
6+00

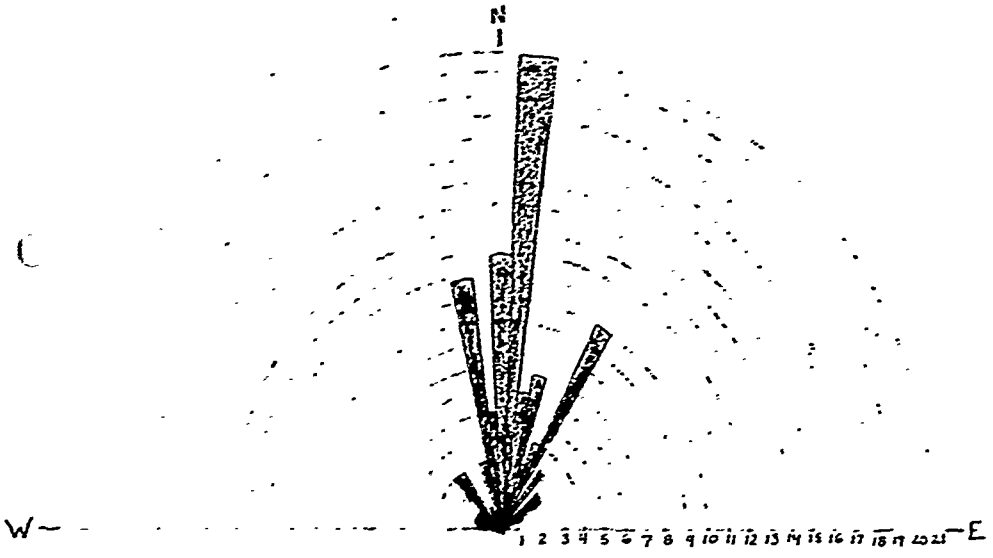
DENTAL TREATMENT OF BROKEN ZONE
5+00
5+50
6+00
CENTERLINE
ORIGINAL ROCK
FINAL ROCK
15' D/S
DENTAL CONCRETE

DENTAL TREATMENT OF BROKEN ZONE
ORIGINAL ROCK
FINAL ROCK
DENTAL CONCRETE
50' D/S
30' D/S
5+00
5+50
6+00

DENTAL TREATMENT OF BROKEN ZONE

12-01 I. JOINT AND FAULT DIRECTIONS

JOINT ROSETTE



MAJOR JOINTS		MINOR JOINTS	
(6) N 0°E	(4) N 10°W	(6) N 0°E	N 65°E
(11) N 5°E	N 15°W	(9) N 5°E	(4) N 5°W
(2) N 10°E	N 20°W	(4) N 10°E	(7) N 10°W
(3) N 15°E	N 30°W	(4) N 15°E	(2) N 15°W
N 25°E	(2) N 35°W	(3) N 20°E	N 20°W
(3) N 30°E	N 60°W	(3) N 25°E	(2) N 30°W
N 35°E		(7) N 30°E	N 35°W
N 40°E		(2) N 40°E	N 40°W
(2) N 45°E		(2) N 50°E	N 45°W
N 5°W		N 60°E	N 50°W
			N 55°W
			N 75°W

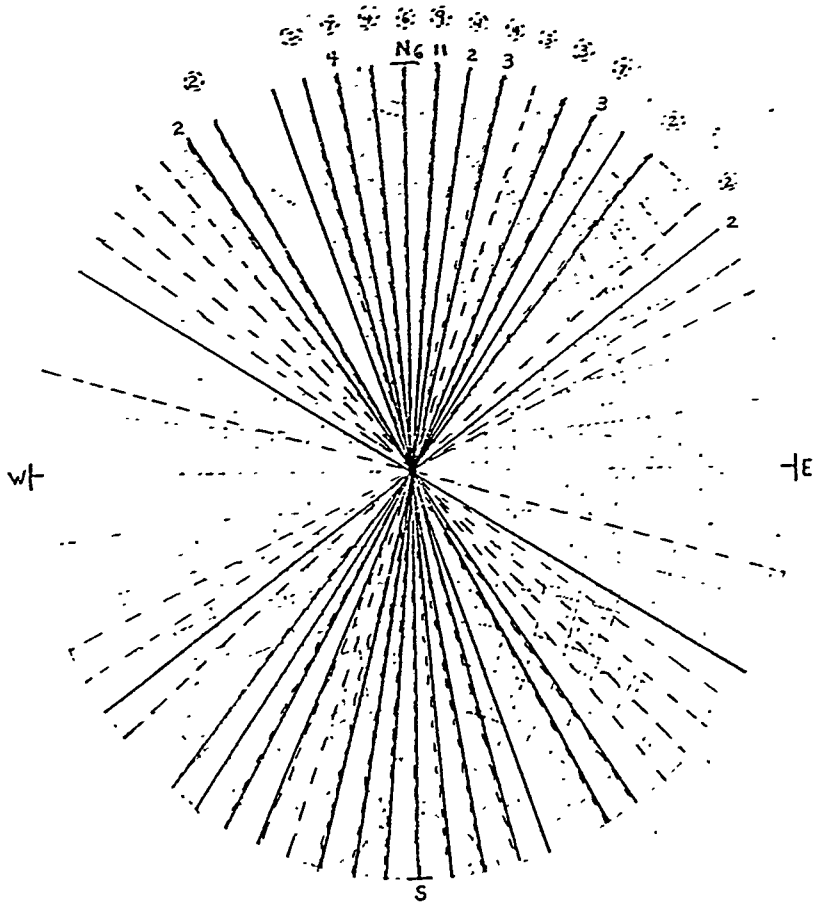
- Joints were measured from the pre-split core at the dam site
- Major joints are considered as those being in excess of 20 feet in length
- A total of 104 joints were measured: 41 major joints and 63 minor joints
- Joints were measured to the nearest fifth degree
- Most joints measured were vertical to near vertical with the following exceptions

Major Joints	Minor Joints
N 5°E, 50°E	N 5°W, 50°E
N 5°E, 60°E	N10°W, 30°E
N 35°E, 35°E	
(2) N 10°W, 60°E	

- No faults were located in the core of the dam, with the exception of the horizontal broken zones

12-01 I. JOINT AND FAULT DIRECTIONS

Joint Directions



——— Major Joints — — — — Minor Joints

* See Joint Rosette for further information

- No faults were located in the core of the dam, with the exception of the horizontal broken zones. One minor fault is located in the spillway with an alignment of N 75°E, 45°S. This is a normal type fault with a 4' displacement. (I-2)

12-01 J. EXPLOSIVES DATA

Contractor

The Lane Construction Corp.

Description

Pre-splitting drilling and blasting, production drilling and blasting, and line drilling.

Equipment

1	I. R. Air Track Drill
2	G. D. Air Track Drills
3	Air Compressors
1	Bulk ANFO Truck
1	Flat Bed Truck
2	Storage Magazines
1	Storage Trailer
1	Bulk ANFO Storage Tank

Materials

Supplier: Eastern Kentucky Explosives

Manufacturer: Atlas Powder Company

Types:

Blasting Agents.....	Bulk ANFO, Bagged ANFO, Apex
Other Explosives....	Kleen-Kut, Giant Gelatin
Primers.....	Power Primer, Atlas Cast Boosters
Other Accessories...	Electric Blasting Caps (Rockmaster), Detonating Cord, Blasting Machine, Safeguard Seismic Unit 1000D

Chronological Sequence

May 86		
	20	Began drilling and blasting diversion channel
	30	Began blasting left abutment of dam
Jun 86		
	24	Completed left abutment of dam from el 697 to 603
Jul 86		
	21	Began drilling and cofferdam monoliths 1 thru 4
	26	Began blasting right abutment of dam
	31	Completed blasting in diversion channel
Aug 86		
	27	Completed blasting for cofferdam mono. 1 thru 4
	27	Began drilling and blasting spillway
Sep 86		
	25	Began drilling and blasting Rock Borrow Area #1
	29	Completed blasting right abutment of dam 671 - 573

12-01 J. EXPLOSIVES DATA

Chronological Sequence (cont.)

May	87	
	4	Completed blasting spillway
	11-13	Line drilled incline leg foundation, spillway
	26	Line drilled spillway sill
	27	Began line drilling channel lining keys, spillway
Jun	87	
	1	Completed line drilling channel lining keys
	4	Mechanically excavated spillway sill and keys
Aug	87	
	12	Began blasting right abutment of dam el 573 - 526
	20	Began blasting right wall of diversion channel
	25	Line drilled shale seam in left abutment
	29	Began blasting left abutment of dam el 603 - 526
Sep	87	
	2	Completed blasting right wall of diversion channel
	11	Completed blasting right abutment of dam
Oct	87	
	2-3	Blasted valley section of dam el 526 - 521
	16	Line drilled broken zone in dam
	28-29	Line drilled service bridge abutment
	29	Completed blasting left abutment of dam
Sep	88	Completed drilling and blasting Rock Borrow Area

12-01 J. EXPLOSIVES DATA

DAM AND SPILLWAY

Line Drilling

Hole Diameter:..... 3"

Spacing:..... 6" center to center

Pre-splitting

Hole Diameter:..... 3"

Spacing:..... 30" center to center and
18" center to center

Average Powder Factor:... 0.11 lbs/sf

Production

Hole Diameter:..... 3 1/2"

Drill Pattern:..... 4' X 4' to 8' X 8'

Average Powder Factor:... 0.96 lbs/cy

ROCK BORROW AREA #1

Production

Hole Diameter:..... 3 1/2"

Drill Pattern:..... 8' X 8', 9' X 9'

Drill Depths:..... 20' to 45'

Average Powder Factor:... 1.0 lbs/cy

Total explosives:..... 930,000 lbs

ATLAS POWDER COMPANY

BLASTING DATA SHEET NO. 706

APEX®

HIGH-VELOCITY HIGH-ENERGY EMULSIONS

SERIES 200BA AND 300BA SERIES - BLASTING AGENTS

The APEX 200BA and 300BA Series are offered in a wide selection of grades to meet specific needs of quarries, construction and surface coal operations.

These high-energy emulsions are formulated for blasting agent classification, providing added savings in convenience and storage.

A blend of fuel and oxidizer, the water-in-oil emulsions have the oxidizer encapsulated as microscopic droplets by the fuel. Since each microcell has an oily exterior, the emulsions have excellent water resistance. All APEX grades withstand hydrostatic pressure up to 300 feet.

These extremely small microcells give APEX emulsions a high velocity and consequently, a highly efficient energy output

APEX 200BA Series and its cord-compatible counterpart, APEX 300BA, both feature a high detonation pressure which results in excellent fragmentation in dry or wet holes.

Packaged from 2"x16" to 9"x50 pounds, there is an APEX emulsion for just about every construction, quarry or coal stripping job.

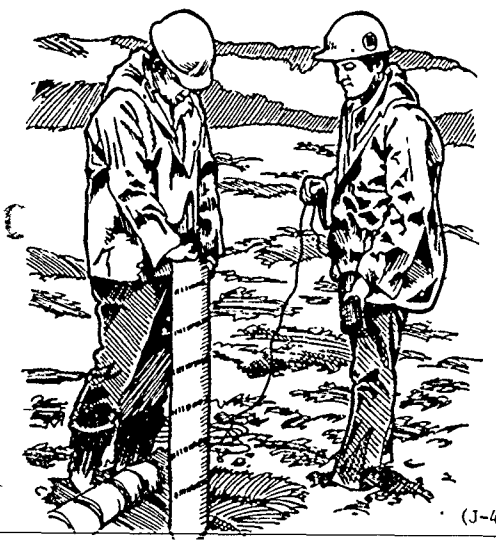
In coal stripping and quarry operations where water-filled holes predominate, these water resistant emulsions have been called "the best wet hole powder since dynamite."

And all APEX grades have excellent low temperature detonability.

Depending upon their diameter, the detonation velocity of these APEX explosives ranges from 15,000 to 19,000 fps, however, they carry a blasting agent classification and are relatively safe to store and handle.

In comparison with HD ANFO packed in a water resistant sleeve, APEX affords considerable cost/performance economies

In actual usage, blasters have said, "APEX sinks better and shoots better than high density ANFO You pay a little more for it, but it gets the job done."



PROPERTIES & SPECIFICATIONS

APEX	AWS cal/gr	ABS cal/cc	RBS*
220 or 320	680	840.	115
240 or 340	770	960	130
260 or 360	860	1070	145

(*ANFO = 100)

Density = 1.25 g/cc Detonation Pressure = 115 kilobars
Detonation Velocity = (3" dia.) 16-17,000 FPS
(5" dia.) 18-19,000 FPS

PRIMING

The 200BA and 300BA Series are blasting agents. As such, they require high explosive primers. Minimum priming requirements are.

- Products in 4 inch diameter and larger
  A minimum of a 4x5 lb Power Primer is recommended for severe water conditions Under less severe conditions, a 3x8" Power Primer or a 1-lb. Cast Primer may be used.
- Products in 2-3½ inch diameter
  Power Primer, 2x8; or equivalent

DETONATING CORD COMPATIBILITY

The use of detonating cord can reduce the effective energy released by an explosive. The degree to which this occurs is dependent on product, diameter of product and strength of detonating cord (see chart below)

CORD STRENGTH	PRODUCT DIAMETER 2" 2¼"	2½"-3½"	4"-6"*
4 grains/ft	Neither	300 Series	200/300 Series
7½ grains/ft	Neither	300 Series	300 Series
18 grains/ft	Neither	Neither	300 Series
25 grains/ft	Neither	Neither	300 Series

*If you desire to use the 200BA Series in larger diameters with the non electric delay systems, contact your Atlas Representative

Observe the following when using 40 or 50-grain detonating cord downlines or uplines

	Product Diameter	
	Less than 4 inch	4 inches or greater
APEX 200BA Series	Primer every 5 ft	Primer every 10 ft
APEX 300BA Series	Primer every 5 ft	Primer every 10 ft

PACKAGING

STYLE 59V - PLASTIC FILM
(Standard For 240 and 260 Only)

SIZE	ctg/60 lb.	Size	ctg/60 lb.
2"x16	28	3"x16	12
2¼"x16	21	3¼"x16	10
2½"x16	17	3½"x16	9
2¾"x16	14		

FOLLOWING PACKAGE STYLES
AVAILABLE IN ALL GRADES
(ALL WITH LOWERING TAPE OR LOOP)

STYLE 25-RIGID CARDBOARD CARTRIDGE

4"x20	6"x30
4½"x25	6½"x50
5"x30	7"x50
5½"x30	8"x50

STYLE 88T-POLYWOVEN BAG

4"x20	6"x30
4½"x25	7"x50
5"x30	8"x50
5"x15	9"x50

REGIONAL OFFICES

WESTERN
7332 South Alton Way
Suite A
Englewood CO 80112
(303) 779 1200

CENTRAL
1900 East Golf Road
Suite 510
Schaumburg IL 60195
(312) 843 8300

SOUTHEASTERN
Rivergate Park
Office Bldg #4
1994 Gallatin Rd N
Madison TN 37115
(615) 859 6270

EASTERN
3411 Silverside Road
#206 Webster Bldg
Wilmington DE 19810
(302) 478 6204

INTERNATIONAL
16201 SW 95th Ave
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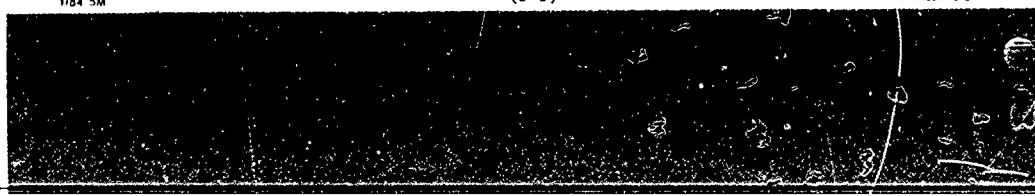


BLASTING DATA SHEET NO.651

KLEEN-KUT®

FOR OVERBREAK CONTROL

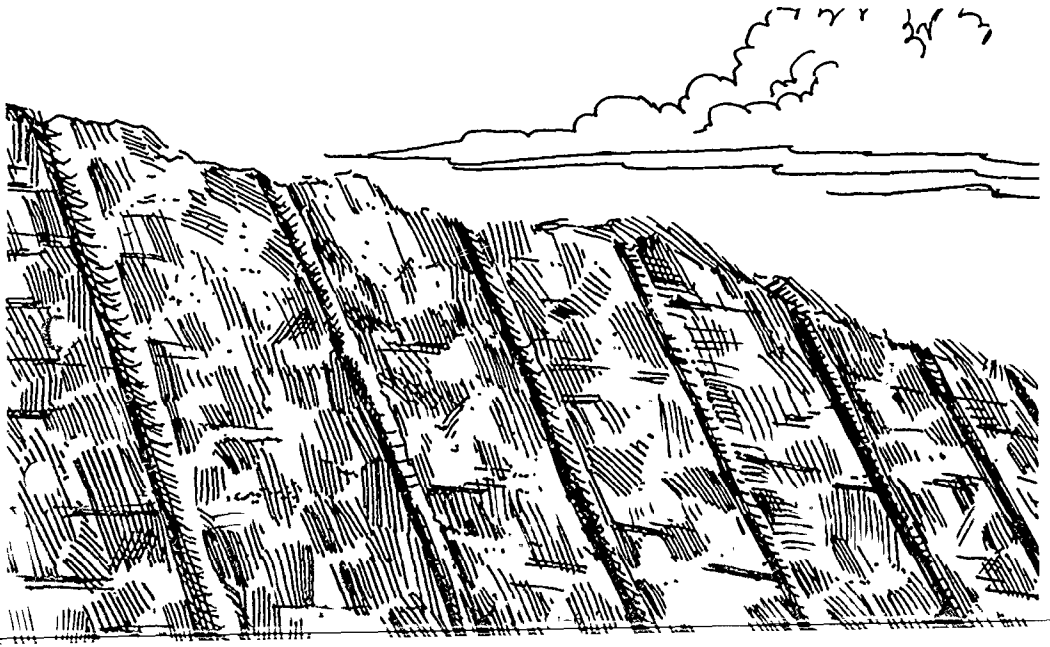
ATLAS POWDER COMPANY

CARTRIDGED FOR PRESPLITTING, SLOPE CONTROL, CUSHION BLASTING, SMOOTH BLASTING AND UNDERGROUND USE

Atlas Powder Company pioneered the concept of controlling overbreak in blasting to produce smooth walls in road cuts, quarries, building foundation sites, slope control in open pit mines, etc. To provide maximum application flexibility and lowest over-all cost, Atlas Powder manufactures three different grades in 36-inch lengths for use when employing overbreak control techniques—"Presplitting." "Slope Control," "Cushion Blasting" and "Smooth Blasting."

Some approximate application information based on experience is listed in tabular form on the other side of this sheet. However, it is not possible to be exact in such a table, since rock characteristics and local conditions play a major role in selection of the proper explosives for each job. For this reason, the data given should be considered only as a "rule-of-thumb" with the exact details to be worked out with an Atlas sales representative or distributor at the site.

Dynamite, the old Atlas workhorse, provides proven reliability.



ADVANTAGES

• Extra-long 36-inch cartridge reduces loading costs. • Continuous column produces better results. • Three grades meet a wide range of needs. • Package design permits varying explosive loads within the column.

KLEEN-KUT PROPERTIES AND SPECIFICATIONS

KLEEN KUT	BOREHOLE LOADING DENSITY (Lbs/Ft	DETONATION PRESSURE (Kilobars)	BOREHOLE PRESSURE (Kilobars)	RATED CARTRIDGE STRENGTH	RATED VELOCITY (confined fps)	RATED VELOCITY (open fps)	DIAMETER OF 36" CARTRIDGES (excluding coupler)	LINEAR FT PER 100 POUNDS ±3%	LBS PER CASE	FT PER CASE ±%
C	0.40	58	34	52%	14,000	10,000	1.13"	240	55	132
E	0.25	13	18	26%	9,200	7,500	1.13"	348	50	↕
U*	0.33	13	18	26%	9,200	7,500	1.13"	306	55	168

*Underground

APPROXIMATE APPLICATION INFORMATION

KLEEN-KUT	diameter of borehole to which usually applied	spacing for Presplitting	spacing for Slope Control	spacing (S) and burden (B) for Cushion Blasting	spacing (S) and burden (B) for Smooth Blasting
C	3" to 4"	24" to 42"	30" to 48"	S-48" B-72"	S-48" to 60" B-60" to 90"
E	2" to 3"	18" to 30"	24" to 36"	—	S-30" to 42" B-42" to 60"
U	2" to 3"	18" to 30"	—	—	—

Closely spaced smaller diameter relief holes are always drilled between boreholes along desired cleavage line when Cushion Blasting

PACKAGING

Kleen-Kut explosives are supplied in 36-inch cartridges Couplers are supplied on each cartridge to provide rigid column structure. Kleen-Kut U is especially formulated for underground use. However, C and E are not rated as Fume Class 1 and should not be used underground

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WESTERN
7332 South Alton Way
Suite A
Englewood CO 80112
(303) 779 1200

CENTRAL
1900 East Golf Road
Suite 510
Schaumburg, IL 60195
(312) 843 8300

SOUTHEASTERN
Rivergate Park
Office Bldg #4
1994 Gallatin Rd N
Madison TN 37115
(615) 859 6270

EASTERN
3411 Silverside Road
#206 Webster Bldg
Wilmington DE 19810
(302) 478 6204

INTERNATIONAL
16201 SW 95th Ave
Miami FL 33157
(305) 238 6632
Cable ATPOWCO
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*Must be handled and stored as a Class A explosive

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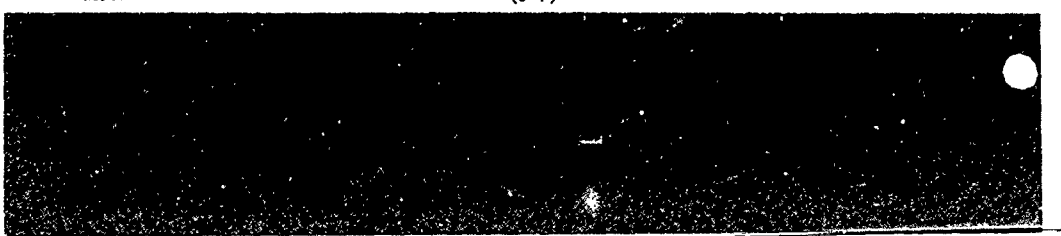


ATLAS POWDER COMPANY
Subsidiary of Tyler Corporation
Dallas, Texas 75251

BLASTING DATA SHEET NO.645

GIANT GELATIN

HIGH DENSITY HIGH VELOCITY

AN INDUSTRY STANDARD FOR OVERCOMING HARDROCK BLASTING PROBLEMS

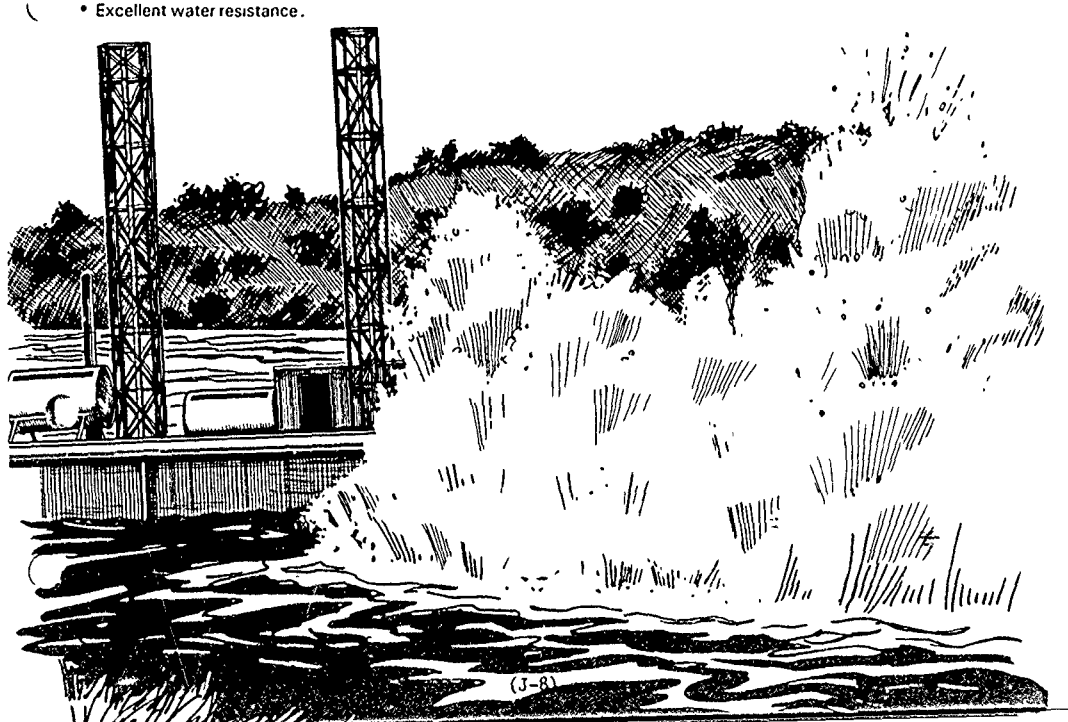
Atlas Giant Gelatin is widely used in river crossing, underwater ditching operations, in pipeline work, quarrying, mining and construction where high density and good detonation pressure must combine to overcome hardrock blasting problems

The high performance and good fume properties of Giant Gelatin also make it an excellent choice for underground mining and tunneling.

Dynamite, the old Atlas workhorse, provides proven reliability.

ADVANTAGES

- High density and high velocity under confinement result in high effective borehole pressure
- Excellent water resistance.
- Good detonation pressure results in excellent fragmentation
- Fume Class 1

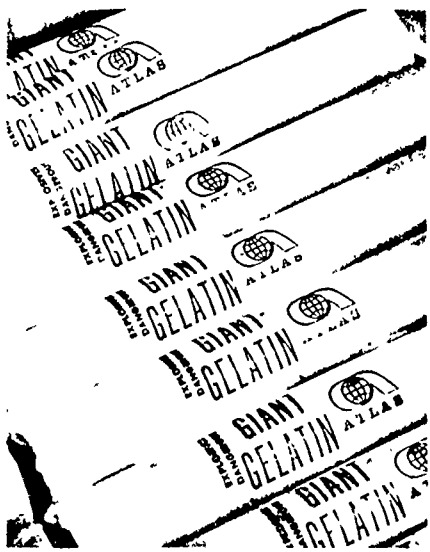


PROPERTIES AND SPECIFICATIONS

- Density - 1.48
- Velocity (confined) - 15,000 fps
- Absolute bulk strength - 1,256 cal/cc
- Relative bulk strength (ANFO = 100) - 170
- Detonation pressure - 75 kilobars

CARTRIDGES/50 POUNDS

CARTRIDGE SIZE	STICK COUNT
1"x8"	145-159
1⅛"x8"	117-128
1⅛"x16"	60-66
1¼"x8"	95-105
1½"x16"	34-36
2"x8"	36-40
2"x16"	18-19
2½"x16"	13
2½"x24"	8
3"x10 lbs.	5
3½"x10 lbs.	5



PACKAGING

ATLAS GIANT GELATIN is available in a complete range of sizes. Packaged in sprayed shells, with or without the Redi-Slit® feature. Redi-Slit cartridges when tamped fill the borehole more completely and make more efficient use of the power inherent in the explosive. Also supplied in bullet-nosed large diameter spiral-wound cartridges.

*Must be handled and stored as a Class A explosive.

REGIONAL OFFICES

WESTERN
7332 South Alton Way
Suite A
Englewood CO 80112
(303) 779 1200

CENTRAL
1900 East Golf Road
Suite 510
Schaumburg IL 60195
(312) 843 8300

SOUTHEASTERN
Rivergate Park
Office Bldg #4
1994 Gallatin Rd N
Madison TN 37115
(615) 859 6270

EASTERN
3411 Silverside Road
#206 Webster Bldg
Wilmington DE 19810
(302) 478 6204

INTERNATIONAL
16201 SW 95th Ave
Miami FL 33157
(305) 238 6632
Cable ATPOWCO
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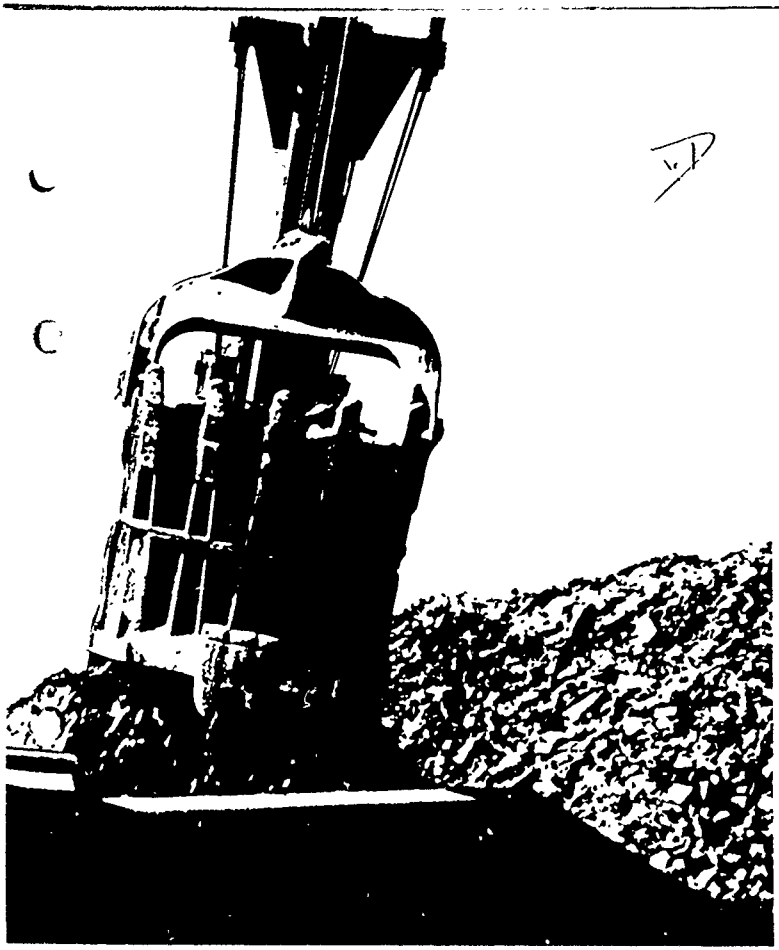
4/84 3M

Printed in U.S.A.

BLASTING DATA SHEET 642



Ammonia gelatin dynamite is specially formulated for use as a primer. In addition it is the most economical over-all explosive for bottom-load in quarries, mining and construction.

■ Lowest gelatin cost per foot of borehole ■ Lowest-cost high velocity primer ■ Extremely high detonation and borehole pressure ■ Detonates at high velocity only ■ Superior to 75% ammonia gelatin in performance ■ Better, more uniform breakage —less secondary blasting and mechanical handling.

ADVANTAGEOUS IN A VARIETY OF APPLICATIONS...

- ☐ As a primer for lower-strength explosives and blasting agents so that they are initiated at peak velocity.
- ☐ As up-the-column boosters to improve breakage or to break hard-rock strata.
- ☐ As a bottom-load to shear and move toes, producing better, more uniform breakage for easier digging.
- ☐ To permit greater borehole spacing and lower drilling costs.
- ☐ To reduce fumes in underground operations. (Employing full energy of Atlas Power Primer with blasting agents in underground operations will reduce fumes to a minimum, and also will show distinct improvement in rock movement and fragmentation.)

PROPERTIES OF ATLAS POWER PRIMER...

- Detonation pressure - 135 kilobars
- Borehole pressure - 55 kilobars
- Velocity (open)
  1¼"x8" - 17,000 fps
- Velocity (confined)
  1½"x8" - 18,000 fps
- Cal/cc - 1458
- Relative bulk strength (ANFO = 100) - 197
- Density - 1.36 gm/cc
- Good fume properties
- Excellent water resistance

ATLAS POWER PRIMER products are marked with distinctive red striping for easy identification. The dimensions and stick counts may vary slightly depending on the cartridge style. The lengths shown for 3" diameter and up are for tapered nose cartridge styles 26 or 23C.

CARTRIDGE SIZE (inches)	STICKS/50 LB. CASE
1 x 8	161-176
1⅛ x 8	127-139
1¼ x 8	105-115
1¼ x 16	52-57
1½ x 8	72-78
1½ x 16	36-39
1¾ x 8	54-59
1¾ x 16	27-29
2 x 8	41-45
2 x 16	20-22
2½ x 16	13-14
2½ x 24	9
2¾ x 16	11-12
3 x 8	18-20

CARTRIDGE SIZE (Diam./Weight)	LENGTH (inches)
2¾" x 6½ lbs.	23
3" x 5 lbs.	16
3" x 10 lbs	28
3½" x 10 lbs.	23
4" x 5 lbs.	9
4" x 16⅔ lbs.	27
5" x 25 lbs	27
5½" x 25 lbs.	23
6" x 33⅓ lbs.	26
7" x 50 lbs	27
8" x 50 lbs	21

REGIONAL OFFICES

WESTERN
Bldg. #40-D T.C.
7935 East Prentice Ave.
Englewood, CO 80111
(303) 779-1200

EASTERN
3411 Silverside Road
#205 Webster Bldg.
Wilmington, DE 19810
(302) 478-6204

CENTRAL
1111 Plaza Dr.
#530, Woodfield Office Plaza
Schaumburg, IL 60195
(312) 843-8300

APPALACHIAN
Colonial Green Village
4225 Colonial Ave. SW
Roanoke, Virginia 24018
(703) 989-3686

SOUTHEASTERN
Rivergate Park
Office Bldg. #4
1994 Gallatin Rd., North
Madison, TN 37115
(615) 859-6271

INTERNATIONAL
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(305) 238-6632
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Telex 80-3373

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In no event shall seller make any warranty or assume any liability

ATLAS CAST BOOSTERS

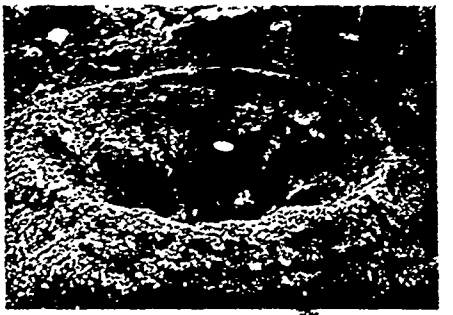
POWERFUL, DEPENDABLE AND ECONOMICAL

Atlas Cast Boosters have a high detonation velocity and unexcelled detonation pressure. This high detonation pressure ensures development of the full energy potential of blasting agents in a wide variety of borehole diameters.

Atlas Cast Boosters have a central channel for detonating cord which permits quick, easy loading when multiple primers are used for column loading or for decking.

Performance and sensitivity to initiation are unaffected under high heads of water and extended sleeping times.

Non-headache Atlas Cast Boosters combine safety and reliability with ease of handling, economy, superior water resistance, and excellent sinking densities. Atlas Cast Boosters are manufactured with the same dependability and high quality as all Atlas products



For use with electric detonators, detonating cord and/or non-electric delay systems

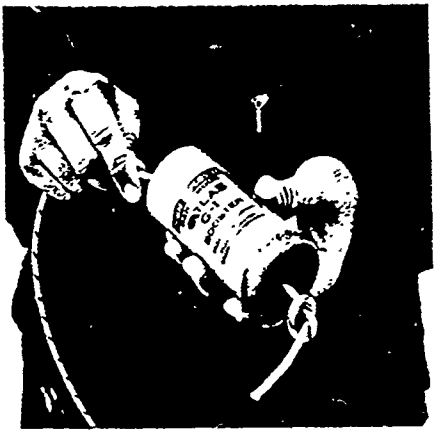
SPECIFICATIONS

- High Density ..... 1.6 g/cc
- High Velocity ..... 26,000 fps
- Detonation Pressure ..... 250 kilobars
  (Develops full energy potential of blasting agents.)
- Construction:

Weight	¾ Pound	1 Pound
Height	4⅜"	4¾"
Diameter	2"	2 3/16"
Packaging 50 lb case	80	60
Cord tunnel	Yes	Yes
Detonator well	Yes	Yes

(Other sizes available upon request)

- Shelf life ..... Excellent 2 years + under extreme conditions
- Minimum initiators ..... #8 strength detonator 40 grain detonating cord (Special order 25 grain)
- Water and oil resistance ..... Excellent
- Non-headache producing
- Ease of use: Incorporates detonator well and detonating cord tunnel that require no punching
- Temperature sensitivity ..... to −60°F
- DOT Classification ..... Class A



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Suite A
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3411 Silverside Road
#206 Webster Bldg
Wilmington, DE 19810
(302) 478-6204

CENTRAL
1900 East Golf Road
Suite 510
Schaumburg, IL 60195
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16201 SW 95th Ave
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BLASTING DATA SHEET NO. 644

ELECTRIC BLASTING CAPS

ROCKMASTER® TIMEMASTER® • KOLMASTER®

Atlas electric blasting caps are "masters" of the blasting industry.

Their exclusive design and quality-controlled construction guarantees excellent reliability and safety.

At Atlas, we utilize rigid statistical quality control to check each component of each cap, each step of the way in manufacture.

Atlas caps are designed for all blasting situations; quarries, underground and surface coal mines, metal mines and construction projects.

E.B. CAP SYSTEM ADVANTAGES

- Bottom hole initiation for optimum fragmentation and reduced toe.
- Easier control of noise and airblast to minimize complaints in congested areas.
- Most versatile system for delay deck shooting. Helps minimize vibration complaints.
- Most reliable, economical and overall safest initiation system.
- Electrical circuit permits checking of initiation system before firing of shot.

EXCLUSIVE DESIGN ASSURES PRECISELY CONTROLLED BLASTING

1 Plastic insulated wires are waterproof, ruggedly abrasion-resistant, have excellent low temperature properties, are easy to strip and handle.

2 Rubber plug double crimped to assure waterproof seal.

3 Match assembly insulated from shell to prevent grounding of electrical circuit.

4. Static and arc resistance feature (SF).

5 The match assembly is an exclusive Atlas design which helps provide the extremely high reliability of Atlas EB caps.

6 To assure accuracy, delay elements are tested by strict quality control methods.

7 The base charge is PETN

PACKAGING

(feet) Wire Length	Per Carton	Per Case
6-12	50	500
16	50	250
20-24	40	200
30	20	200
40	15	150
50-60	10	100
80-100	5	50
(spooled)		
120	5	50
150	5	40

Instantaneous For use where all holes are to be detonated simultaneously, or in the same series with any ROCKMASTER and TIMEMASTER E.B. caps.

Rockmaster® Millisecond Delays - Specially designed for highly controlled sequential blasting. Ideal for congested areas. Provides maximum production with minimum noise and vibration. Thirty (30) delay periods offer widest latitude in planning shot. (Orange & yellow leg wires)

Delay No.	Nominal Time (milliseconds)	Delay No.	Nominal Time (milliseconds)	Delay No.	Nominal Time (milliseconds)
1	8	11	300	21	1125
2	25	12	350	22	1250
3	50	13	400	23	1375
4	75	14	450	24	1500
5	100	15	500	25	1625
6	125	16	550	26	1750
7	150	17	650	27	1875
8	175	18	750	28	2000
9	200	19	875	29	2125
10	250	20	1000	30	2250

Timemaster® Delays - A series of 16 delay periods graduated in increments of 500 milliseconds. Generally used underground. Delay times provide sufficient time for rock movement out of cut. (Red & green leg wires)

Delay No.	Nominal Time (milliseconds)	Delay No.	Nominal Time (milliseconds)	Delay No.	Nominal Time (milliseconds)
0	8				
1	500	6	3000	11	5500
2	1000	7	3500	12	6000
3	1500	8	4000	13	6500
4	2000	9	4500	14	7000
5	2500	10	5000	15	7500

Kolmaster® Delays - A series of 9 delay periods developed for use in underground coal mining, normally provided with iron wires, with color coded insulation for easy identification.

Delay No.	Nominal Time (millisec)	Legwire Colors	Delay No.	Nominal Time (millisec.)	Legwire Colors
1	25	White	6	350	Gold
2	100	Lavender	7	400	Red
3	175	Blue	8	450	Light Green
4	250	Salmon	9	500	White/Lvndr
5	300	Dark Green			

ADVANTAGES OF ATLAS E.B. CAPS

- Greater reliability because every match is tested twice - both before and after assembly of the cap.
- Number 8 strength explosive output.
- Static and arcing protection built into the cap with the SF feature.
- More delay periods for greater versatility in planning and laying out blasts; compatible with sequential blasting machines.
- Identical firing characteristics for instantaneous and delay caps.
- Legwire insulation that is rugged yet easily stripped.

SPECIFICATIONS

Resistance of Atlas Copper Wire Electric Blasting Caps

Length, Feet	Ohms (average)	Length, Feet	Ohms (average)
4	1 5	30	2.2
6	1 6	40	2 3
8	1 7	50	2 6
10	1 8	60	2 8
12	1 8	80	3 3
16	1 9	100	3 8
20	2.1	120	4 4
24	2 3	150	5 1

RECOMMENDED FIRING CURRENT

Type Circuit	DC	AC
Single Cap	0 5 amp	0 5 amp
Single Series	1 5 amps	2 0 amps
Parallel Series	1 5 amps/series	2 0 amps/series
Parallel	1 0 amp/cap min 10 0 amps/cap max	1 0 amp/cap min 10 0 amps/cap max

REGIONAL OFFICES

WESTERN
7332 South Alton Way
Suite A
Englewood CO 80112
(303) 779 1200

CENTRAL
1900 East Golf Road
Suite 512
Schaumburg IL 60195
(312) 843 8300

SOUTHEASTERN
Rivergate Park
Office Bldg #4
1994 Gallatin Rd N
Madison, TN 37115
(615) 859-6270

EASTERN
3411 Silverside Road
#206 Webster Bldg
Wilmington DE 19810
(302) 478 6204

INTERNATIONAL
16201 SW 95th Ave
Miami FL 33157
(305) 238 6632
Cable ATPOWCO
Telex 80-3373
80-3364

"For innovation in explosives, ask Atlas!"

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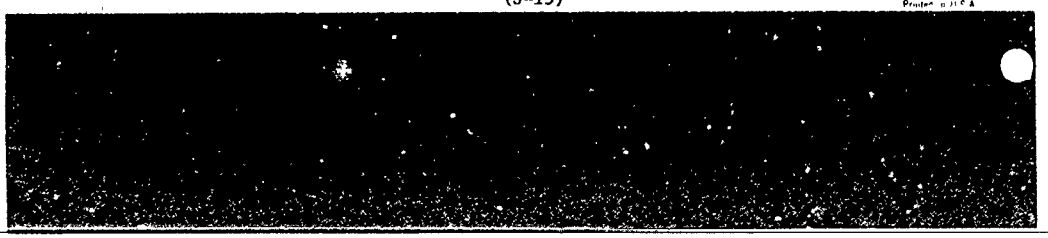
Printed in U.S.A.



ATLAS POWDER COMPANY

BLASTING DATA SHEET NO. 716

DETONATING CORD

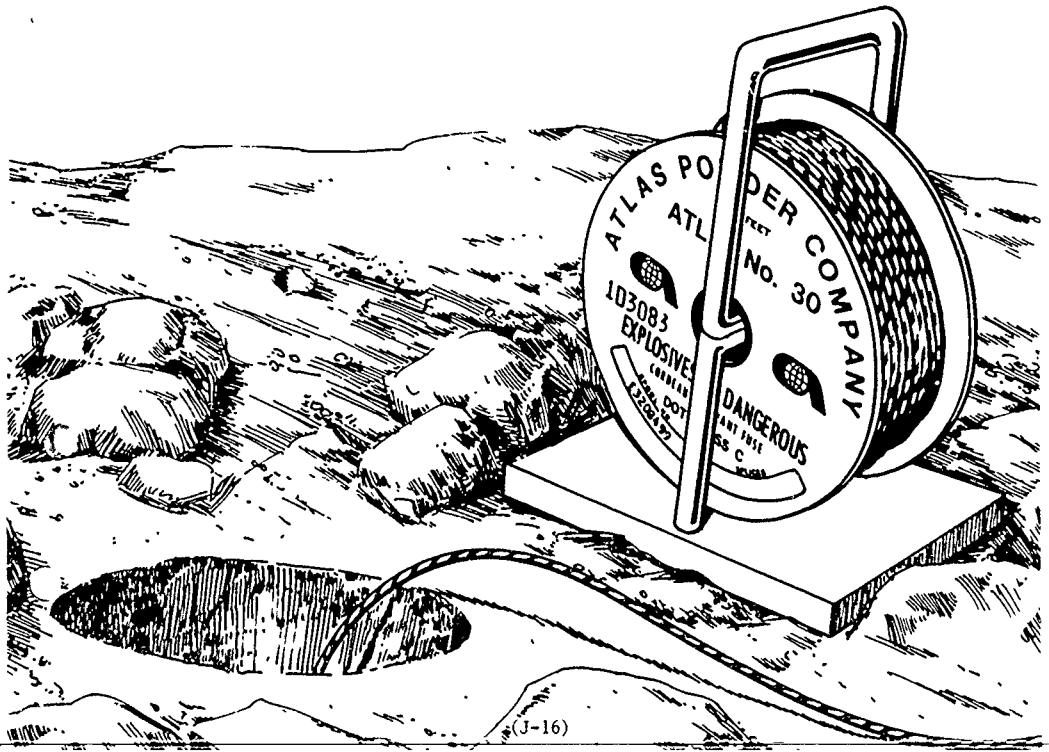
RUGGED AND DEPENDABLE

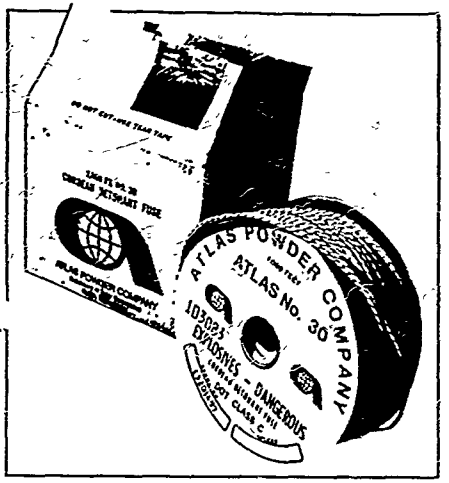
Atlas offers four strengths of detonating cord to satisfy blasting designs requiring trunklines, downlines, or uplines.

Atlas detonating cords have reliable tensile strength, water resistance, and abrasion resistance to satisfy nearly all blasthole conditions.

ADVANTAGES

- Flexible with good tensile strength.
- Color-coded for easy identification.
- Classified as "C" Explosive by D.O.T.
- Four cord load strengths to select.
- Relatively insensitive to shock, friction and heat.





DECKmaster HI-PRIME APPLICATIONS USING ATLAS DETONATING CORDS

ATLAS	HI-PRIME	STANDARD DECKmaster	DECKmaster 40
#18	NO	YES	NO
#30	YES	YES	NO
#40	YES	NO	YES
#50	YES	NO	NO

NOTE: When using cast primers consult manufacturer for proper cord core load strength recommendation.

ATLAS DETONATING CORD SPECIFICATIONS

CORE LOAD PER FT. (GRAINS)	OUTSIDE* DIAMETER (IN.)	APPROX. LOAD WT 1,000 FT. (LBS.)	TENSILE STRENGTH (LBS.)	SHIP WT. TWO 1,000 FT. SPOOLS (LBS.)
18	0.165	2.60	200	20
30	0.175	3.70	200	23
40	0.190	5.70	200	28
50	0.280	7.15	200	31

* ± 0.010

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(615) 859 6270

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3411 Silverside Road
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Telex 80 3373
80 3364

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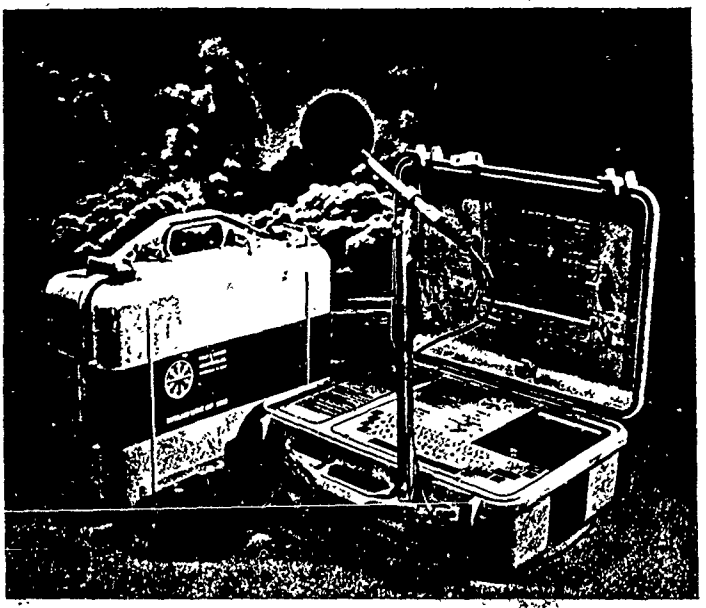
In no event shall either manufacturer or seller be liable for consequential damages or expenses.

SAFEGUARD SEISMIC UNIT 1000D

DIGITAL SEISMOGRAPH

Professionals in the explosives industry have long desired a seismograph that would produce immediate and on-site proof of legal compliance, yield accurate measurements to assist in the design of subsequent blast patterns, and provide convincing evidence in the event of damage claims or litigation. No such instrument existed. That is, UNTIL NOW!



The SAFEGUARD SEISMIC UNIT 1000D is a portable seismograph of advanced design which automatically records the ground motion and air concussion produced by blasting operations. It immediately produces a waveform record and a printout of peak particle velocity, the associated frequency, peak acceleration, and peak displacement for all three components of motion. Resultant peak particle velocity, maximum airblast, and pertinent recording data are also included in the printout. The operator enters the ...ter into the instrument's memory by using a typewriter keyboard to respond to printed questions. This information is then stored permanently and printed on each subsequent record unless changed by the operator. The SSU 1000D is battery operated. It may be left unattended to record and analyze up to 40 events over a two-week period without recharging. It may also be attached to a 12-volt battery should a longer period of unattended use be required.

Features of the SSU 1000D include

- Triggering by ground vibration or airblast
- Multiple record copies generated on demand
- Pause function to delay printout until requested
- Memory capability to store and reproduce last recording
- Variable graph length option for specialized recording (e.g. pile driving)
- Automatic selection of proper amplification or attenuation of printed graph
- Automatic dynamic calibration of seismic components

available in USA exclusively through

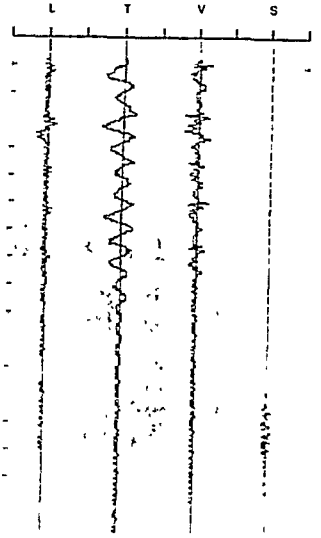
Philip R. Berger & Associates, Inc.
Box 779 / Warrendale PA 15095 / 412-776-3600
Massachusetts 617-371-1606
Connecticut 203-755-9376
North Carolina 919-851-5924
Florida 305-981-1230

...TE WAVEFORM RECORDIN... ANALYSIS

...ap... size reduced for reproduction purposes

** SAFEGUARD SEISMIC UNIT 1000-O **
OCT 14/85 11:16 31
INSTRUMENT # SSU 1122
EVENT #281
CLIENT ABC COAL COMPANY
OPERATION JONES PIT
SSU LOCATION L SMITH'S BACK YARD
DISTANCE TO BLAST (Ft) 875
OPERATOR. DENNIS EVANS
SEIS TRIG LVL (IPS) 15
SOUND TRIG LEVEL (dB)110
RECORD TIME (Sec) 5

GRAPHICAL RECORD
TIME = .33 SEC/IN
SOUND = .01 PSI/DIV
LTV. = .5 IPS/DIV



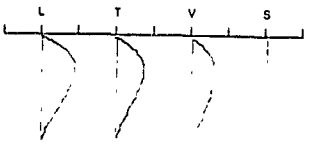
OCT 14/85 11 16 31

	L	T	V
PPV(in/s)	0.16	0.28	0.19
PPD (in)	0.00378	0.00872	0.00354
PPA (G)	0.17	0.17	0.25
F (Vel) Hz	3.8	8.8	13.8
RPPV (in/s)	0.29		

PEAK SOUND 117 DB, .00201 PSI
** A/D CALIBRATED OK **

...IBRATION GRAPH

TIME = 167 SEC/IN
LTV = 1 IPS/DIV



SHAKETABLE CALIBRATED ON OCT 10/85
BY PHILIP R BERGER & ASSOCIATES INC
BOX 779 WARRENDALE PA 15095
TEL 412 776 3600

SPECIFICATIONS

Seismic

Trigger Level:	Programmable in steps of .01 in/sec from .02 to 4.0 in/sec
Measuring Range:	±4.0 in/sec (5 auto-ranged scales)
Frequency Range:	2-256 Hz (+0dB - 3dB) (on 5 sec recording time)
Accuracy.	±3% of full scale at 160 Hz continuous sine wave input
Transducer.	Three perpendicular oriented electrodynamic, normalized
Calibration:	Dynamic calibration and electronic calibration after each event

Sound

Weighting Scale.	F (Flat)
Measuring Range.	110-140 dB sound pressure level (.0009-.0296 psi)
Frequency Range:	2-256 Hz (-3 dB at 2 Hz) on 5 sec recording time
Accuracy.	±0.7 dB at reference point (127 dB peak, 250 Hz continuous sine wave input)
Trigger Level:	110-140 dB in 1 dB steps
Calibration.	Electronic calibration check after each event

General

Recording:	Thermal printer, dot matrix, graphic capability and 40 columns with paper take-up
Recording Capacity.	40 events (approximately 80 ft. of paper)
Date Indication:	Month, day and year
Time Indication:	Hours, (24 hr clock), minutes and seconds
Time Stability:	Accurate to better than 1 minute /month
Recording Time & Sample Rates:	5 sec - 1024 samples/sec/channel 10 sec - 512 samples/sec/channel 15 sec - 256 samples/sec/channel
Shielding	Analog circuits shielded against interference
Operating Temperature Range	35° to 95° F 0° - 120° F (with diminished print clarity)
Graphical Printout	25, 5, 1.0, 2.0, and 4.0 in/second scales on seismic trace with automatic ranging, 0 to .0294 psi on sound

Power

Internal Battery	(1) 6V, 20AH gel-type, rechargeable
External Power	AC Adapter 9VDC at 500 MA Fast charge 20 VAC at 1A max 47-400 Hz

Ordering Information

SAFEGUARD SEISMIC UNIT 1000O

Philip R Berger & Associates, Inc
Box 779
Warrendale, PA 15095

(412) 776-3600

```
** BOMKSUM-G SEISMIC UNIT 1000-D **
JUN 10/87  12:09:48
INSTRUMENT # SSU 1210
EVENT # 865
COPY #  2
CLIENT:MINE-INST.
OPERATION YATESVILLE LAKE
SSU LOCATION:150-LT-STA-7-00-RD.-B
DISTANCE TO BLAST (Ft): 400
OPERATOR:TIM.HARRIS
SEIS TRIG LVL (IPS): .15
SOUND TRIG LEVEL (dB): N
RECORD TIME (Sec): 10
JUN 10/87  12:09:48

                T          R          V
PPV(IN/SEC) 0.34        0.27       0.27
PD(IN)    0.00691    0.00478    0.00353
PPA(G)    0.124      0.094      0.104
FR(HZ)    10.7       8.3        13.5
SPPV(IN/S)    0.34
PEAK SOUND  122 dB   0.00391 PSI

** A/D CALIB-ATED OK **

CALIBRATION GRAPH

          TIME = .384 SEC/IN
          SOUND= 0.020 PSI/DIV
          L.T.V= 1 IPS/DIV

          T          R          V          S

 MANUFACTURED CALIBRATED ON MAY 1,'86
BY:PHILIP R BERGER & ASSOCIATES,INC.
   BOX 279, WARRENDALE, PA. 15095
   TEL:412-776-3610
```

Typical Seismic Report

12-01 K. ROCK ANCHORS

Spillway - Inclined Leg Foundation & Lining (Description)

- Rock anchors for the spillway bridge inclined leg foundation and liner were installed in May and June 1987.

- Installation of the anchor bars included:

  (1) Complete drilling and blasting of spillway.

  (2) Drilled 3" dia. holes approximately 11' deep as excavation of the shot rock allowed accessibility to the drills. These holes were drilled perpendicular to the designed concrete surface.

  (3) The holes were then cleaned with water and compressed air.

  (4) Filled the holes with a thick cement grout by tremie method using a Peroni grout pump. This cement included Interplast-N, which is an expanding grout additive.

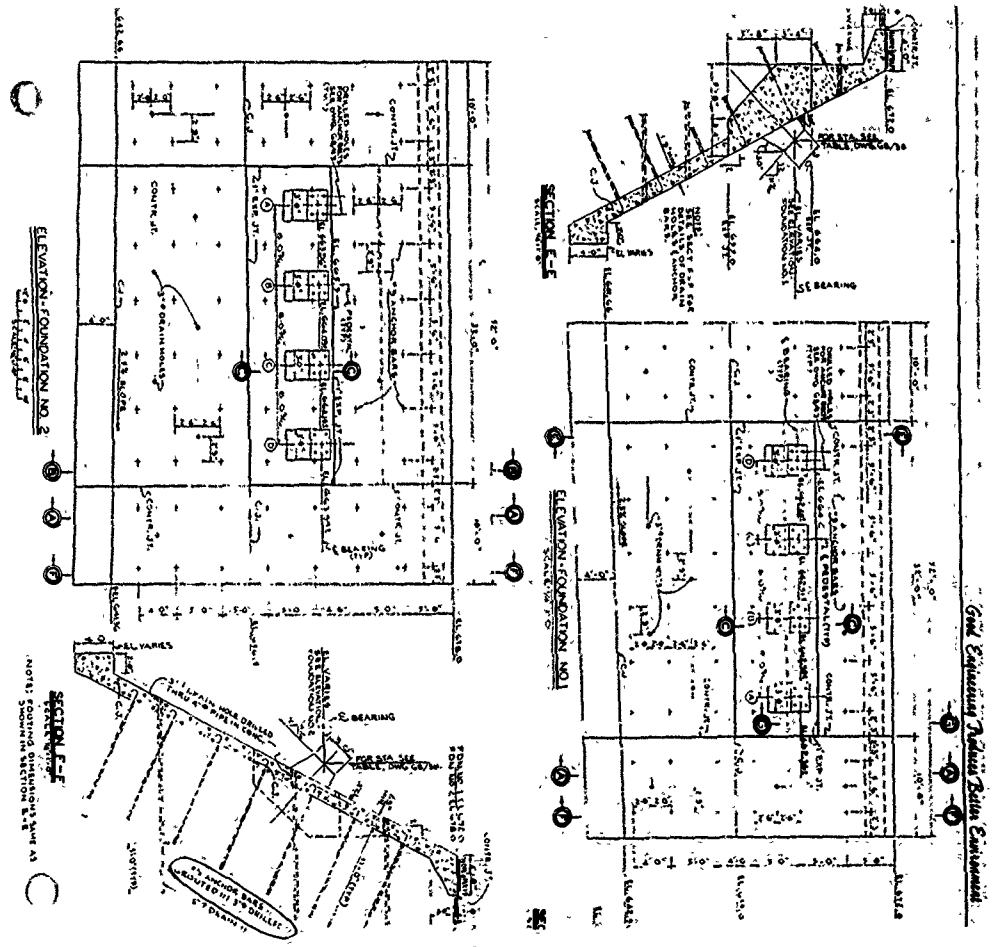
  (5) Placed the anchor bars in the holes, having a 4" clearance from the designed concrete surface. A smaller rebar was placed in the holes with the anchor bars to accommodate the placement of concrete reinforcing steel.
  The anchor bars were then wedged with blocks at the surface to prevent movement until grout had set.

- A total of 130 rock anchors were installed in the spillway bridge inclined leg foundation and lining.

- Rock anchors consisted of a #9 rebar with a total length of 13'-9" and having bending dimensions of "A" = 1'-3" and "B" = 12'-6".

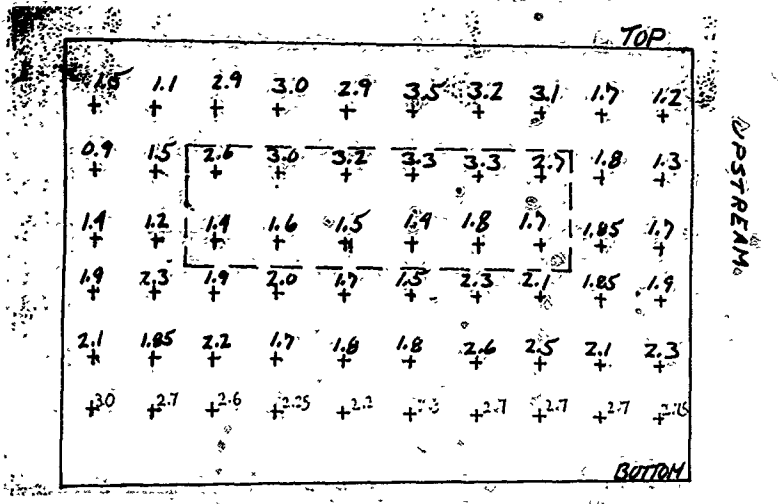
- See page K-2 for location of rock anchors in the incline leg foundation and lining.

Spillway - Inclined Leg Foundation & Lining
(Location)



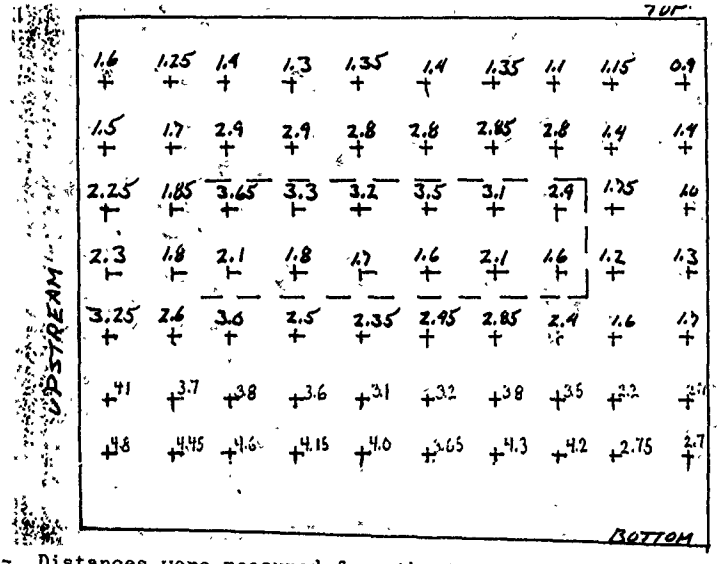
ELEVATION & SECTION VIEWS SHOWING LOCATION OF ROCK ANCHORS

Spillway - Inclined Leg Foundation & Lining
(Unembedded Lengths of Anchor Bars)



ABUTMENT NUMBER 1

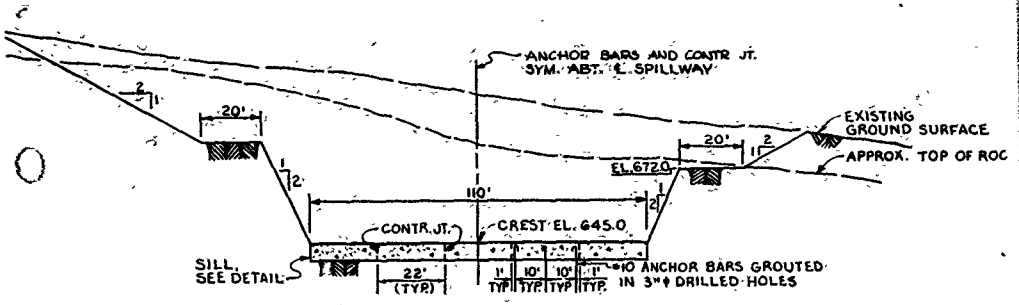
ABUTMENT NUMBER 2



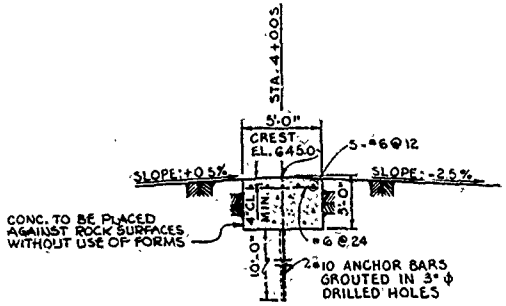
- Distances were measured from the top of the anchor bar to the rock surface.
- Distances were measured in feet.
- Anchor bars were installed having a 4" clearance from the designed exterior concrete surface.

12-01 K. ROCK ANCHORS (cont)

Spillway Sill
(Location and Description)



STA. 4+00S
SCALE: 1" = 20'



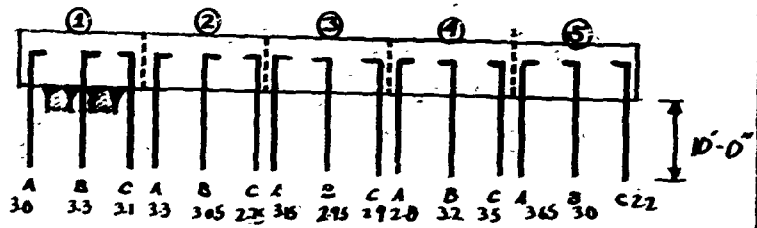
SILL DETAIL
SCALE: 1/4" = 1'-0"

- Rock anchors for the spillway sill were installed in June 1987.
- The as-built rock anchor's shaped differed from that of the designed rock anchors, having an "L" shape rather than a hooked shaped.
- Installation of the anchor bars consisted of:
  (1) Competed the line drilling and excavation of the sill.
  (2) Drilled vertical 3" dia. holes to approximately 10' depth.
  (3) Cleaned the hole with compressed air.
  (4) Grouted hole, by tremie method, with a thick cement grout having Interplast-N, an expanding grout additive.
  (5) Placed rock anchors in holes with the top of the anchor bars being at elevation 644.4, which allowed a 4" clearance with the concrete surface. The bars were then wedged with blocks at the surface to prevent movement.
- See page K-5 for unembedded lengths of the rock anchors in the spillway sill.

Spillway Sill
(Unembedded Lengths)

SPILLWAY SILL

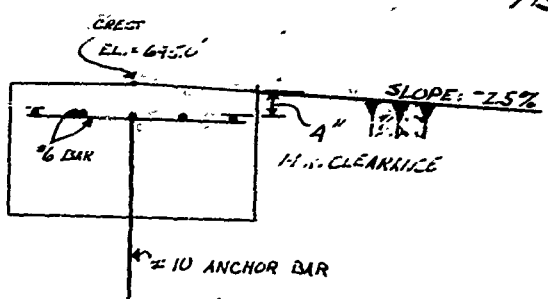
STA. 4+00S



UNEMBEDDED LENGTH

1A = 3.0	3A = 3.15	5A = 3.65
1B = 3.3	3B = 2.95	5B = 3.0
1C = 3.1	3C = 2.9	5C = 2.2
2A = 3.3	4A = 3.3	
2B = 3.05	4B = 3.2	
2C = 2.75	4C = 3.5	ANCHOR BAR = 13'

USED 14 BAGS CEMENT + 0.99 lbs SIKA/BAG



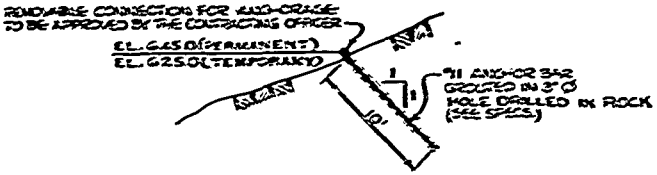
TOP OF #10 ANCHOR BAR ELEVATION = 645.0' − 0.333 (−2.5% SLOPE) − 0.333 (1" MIN. COVER) − 0.125 (2 #6 BARS)

= 644.42' (MAX. ELEV.)

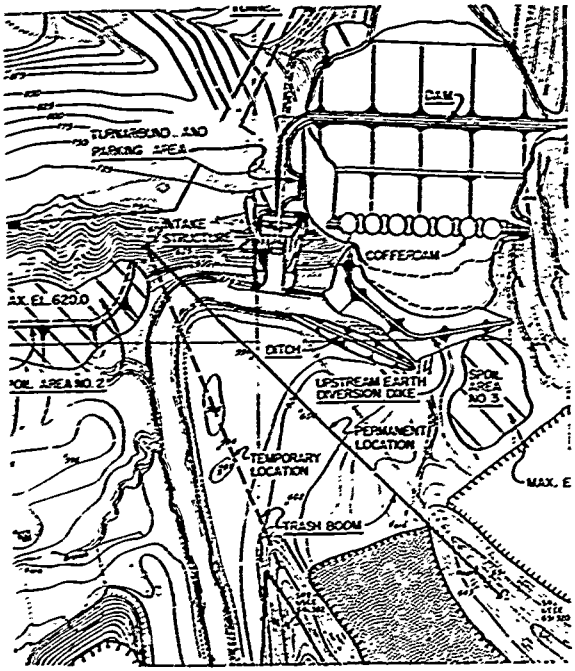
USE 644.4'

12-01 E. ROCK ANCHORS (cont)

Trash Boom Rock Anchors



TYPICAL ROCK ANCHOR DETAIL



LOCATION OF TRASH BOOM AND ROCK ANCHORS

- Rock anchors for the trash boom were installed in April 1987
- Instillation of rock anchors consisted of:
  - (1) Removal of all overburden in the area of the rock anchors.
  - (2) Drilling a 3" dia. hole approximately 10' deep at a 45° angle.
  - (3) Fill the hole, by tremie method, with a thick cement grout having Interplast-N expanding grout additive.
  - (4) Place the anchor bar in the hole. To prevent movement the bar was wedged with blocks at the surface.
- The anchor bars consisted of threaded # 11 rebar with a spot welded eye nut at the top. (K-6)

Intraplast-N expanding grouting aid

Technical Data

Description: Sikamix 110, Intraplast-N, is a grouting aid for portland cement. It increases fluidity, and produces a slow, controlled expansion prior to hardening.

Intraplast-N, a gray powder, is a balanced blend of expanding, fluidifying, and water-reducing agents. It does not contain calcium chloride, nitrates, or other chemicals potentially contributing to stress corrosion in prestressed steel.

Where to Use: It is used whenever a non-settling grout of superior quality is required. Common applications include grouting of prestressed tendons, machinery bases, and pre-placed aggregates.

Advantages:

- Fluidity: Intraplast-N grout is extremely fluid, workable, non-settling, and cohesive. There is little separation of cement paste when placed under water.
- Versatile: Use Intraplast-N with all types of grout incorporating Type I, II or III cements, with or without pozzolanic materials or fly ash, and with or without fine aggregate.
- Expansion: A gaseous expansion occurs within the grout before initial set and forces grout into close contact with the surrounding surfaces. Expansion ceases once grout hardens.

TYPICAL DATA*

Packaging: 50-lb bags.

Shelf Life: 6 mo if stored dry.

TRANS. 33-Dist
ITEM 1

HOW TO USE: Proportioning (by weight): The following suggested proportion serves only as a basis for trial mixes.

	SIZE OF OPENINGS			
Product	¼ in. or less		Larger than ¼ in.	
Cement[1]	2 parts	1 part	2 parts	1 part
Fly Ash[2]	1 part	none	1 part	none
Sand[3]	none	none	3 parts	1 part
Water[4]	4-5	4-5	4½-5½	4½-5½
Intraplast-N[5]	1%	1%	1%	1%

[1]ASTM,C-150-56; [2]ASTM,C350-57T; [3]100% passing an 8-mesh sieve; [4]Gallons per 100 lb cementitious material; [5]By weight of cementitious material

*All figures are from actual test results. Individual batches may vary somewhat. All values will vary with temperature and humidity.

Water requirements will be 5 to 10% lower than that of a plain mix of equal fluidity. Be sure your batches are so limited in size that placement can be completed within one hour so that as much of the expanding action as possible occurs after the grout is placed.

Mixing: Mixing should be in accordance with the Prestressed Concrete Institute's standards as follows:

a) Water should be added to the mixer first, followed by portland cement, fly ash, admixture, and sand as required.
b) Mixing should be of such duration as to obtain a uniform, thoroughly blended grout, without excessive temperature increase.
c) No water may be added to the grout to increase the flowability which has been decreased by delayed use of grout.
d) It is essential that the water content of the grout should be kept as low as possible. The water content should generally be less than 5½ gal/100 lb of cementitious material.

Form Work: Where areas to be grouted require form work, forms should be tight and well fitted. When using Intraplast-N grout, expansion of the grout should be restrained in order to produce highest possible density, bond, and strength. Top forms should be used where there are open areas. Unformed exposed surfaces will have a substantially lower strength for a limited depth.

Pumping: All pumps and hose fittings should be absolutely watertight to prevent loss of water and subsequent clogging.

Dosage: Add 1% by weight of cementitious material.

Note: For grouting of prestressed tendons, follow recommended practices of the Prestressed Concrete Institute. For grouting of rocks, fissures, pre-placed or natural aggregate, follow standard construction practices or consult SikaService for definite recommendations.

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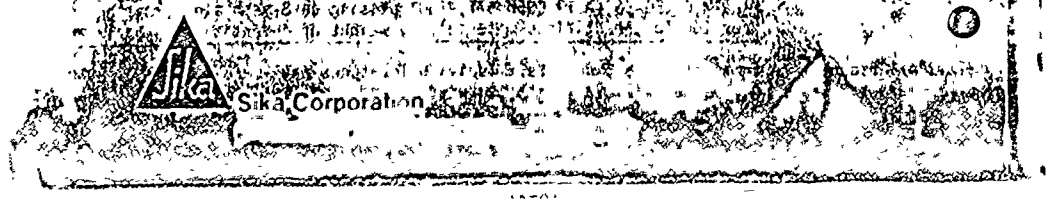
FL, Tampa.....813-879-9862	MS, Jackson.....601-362-6193	TX, Dallas.....214-661-3610	
GA, Atlanta.....404-761-7143	MT, Missoula.....406-543-3308	TX, Houston.....713-461-3010	
IL, Des Plaines...312-298-2810	NJ, Hackensack....201-933-8800	WI, Milwaukee.....414-272-3100	

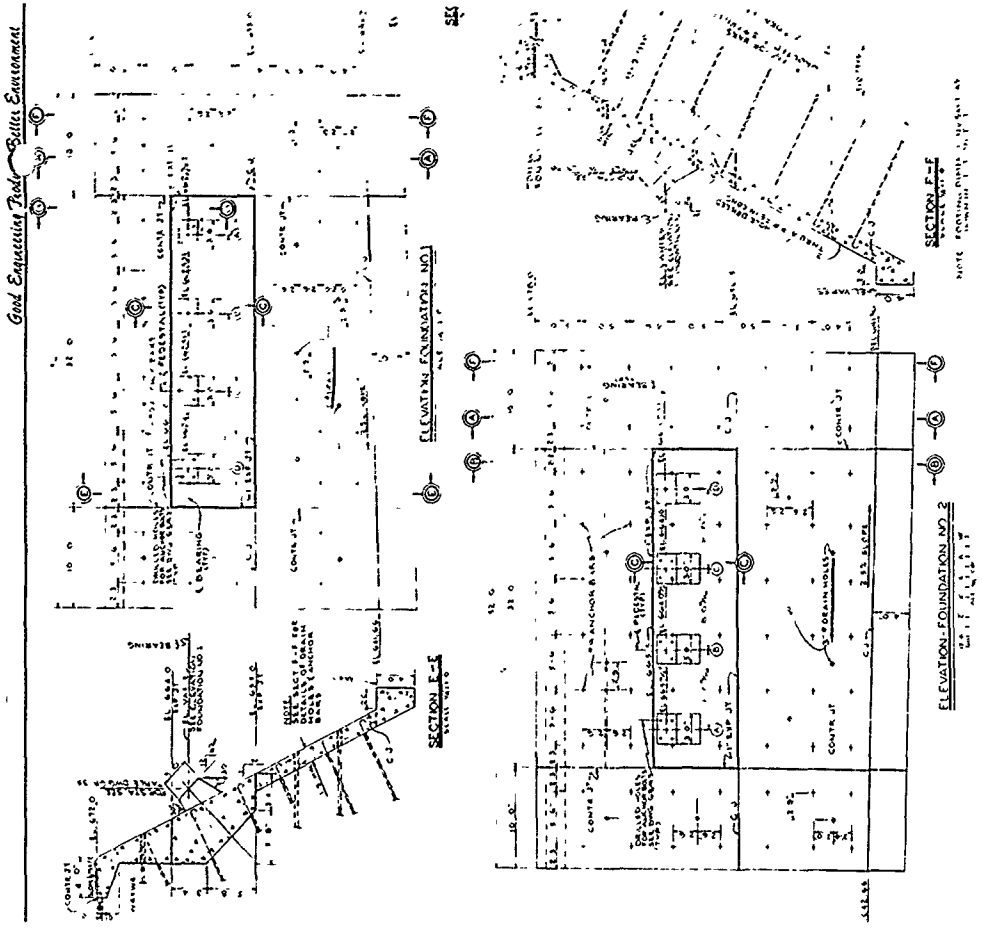
Executive Offices: Sika Corporation, P.O. 297, Lyndhurst, NJ 07071 . Tel. 201-933-8800 . TWX 710-989-0288



Drawer 257.Sika and Intraplast are registered trademarks.Made in USA.Printed in USA, June 21, 1984.

12-01 L. DRAINAGE HOLES

Spillway Lining



ELEVATION & SECTION VIEWS SHOWING LOCATION OF DRAINAGE HOLES

- Drainage holes were drilled in April 1988.
- Holes were drilled from embedded PVC pipe, placed during concrete placement.
- Holes were drilled with a C.P. 65 rotary air drill, mounted either on an air track drill or a skid supported by forklift.
- The 3" dia. drainage holes were cored 20' from the concrete surface on the horizontal.
- The holes were washed with water after the completion of drilling.

12-01.M MATERIALS OBTAINED FROM COMMERCIAL SOURCES

Description of Material		Source	Location of Source
Concrete:			
	Fly Ash	Ash Mgmt Co.	Amos Power Plant Winfield, WV
	Sand	Standard Slag	Cutlip Plant Piketon, OH
	Cement	Lonestar Cement Co.	Superior Plant Piketon, OH
	Aggregate	Ken-Mor Stone Co.	V-Quarry Olive Hill, KY
Graded Filter:			
	Type I	Standard Slag	Haverhill, OH
	Type II	Beckley Stone Co.	Beckley, WV
Slurry Cut-Off Wall:			
	Bentonite	Federal Ore and Chemical	Colony, WY
	Additional Sand	Standard Slag	Haverhill, OH
	Cap Aggregate	Ken-Mor Stone Co.	V-Quarry Olive Hill, KY
Road Aggregate:			
	#57 Stone	Acme Stone Co.	Olive Hill, KY
	DGA	Acme Stone Co.	Olive Hill, KY
Foundation Grouting:			
	Cement	Kosmos Cement Co.	Kosmosdale, KY
Dewatering Wells:			
	Well Filter	Parry Co.	Chillicothe, OH

12-01.M MATERIALS OBTAINED FROM COMMERCIAL SOURCES (cont)

Description of Material	Source	Location of Source
Dental Concrete:		
Ready Mixed	Charlie's Concrete Inc.	Louisa, KY
Dam Embankment:		
Sand Drains	Standard Slag	Haverhill, OH
Cofferdam:		
Fill Bottom Ash	Kentucky Power Co.	Big Sandy Plant Fallsburg, KY
Stone Slope Protection:		
Limestone	Ken-Mor Stone Co.	V-Quarry Olive Hill, KY

12-01 N. INSTRUMENTATION

Contractor

Mason - deVerteuil Geotechnical

Instrumentation Type

16 Surface Displacement Monuments
23 Open Tube Type Piezometers
Survey Monuments

Drill Rigs

CME 55 and CME 75

Chronological Sequence

Nov 88		
	11	Mobilization
	11 - 14	Placement of temporary surface displacement monuments
	22 - 29	Installation of piezometers: P-21 & P-22
Dec 88		
	9 - 29	Installation of piezometers: P-1, 2, 3, 5, 8, 12, 19, 20 & 23
	19	Established profile along dam axis
	19	Survey observation of displacement monuments
Jan 89		
	4 - 27	Installation of piezometers: P-4, 6, 7, 9, 13, 14, 15, & 16
	24	Survey observation of displacement monuments
Feb 89		
	9	Installation of piezometer P-11
	16 & 22	Survey observation of displacement monuments
	-	Installed permanent displacement monuments
Apr 89		
	5	Survey observation of displacement monuments
May 89		
	3	Survey observation of displacement monuments
Jul 89		
	3	Survey observation of displacement monuments
	-	Installation of piezometers: P-17, 18 & 10
	-	Replaced piezometer P-22

- Piezometer readings were taken approximately every month and daily during the involuntary impoundment in Feb 89.
- Falling Head Tests were performed on piezometers at various dates.

Planned Instrumentation

Automated Data Acquisition System (ADAS)
Strong Motion Accelerograph

12-01 N. INSTRUMENTATION

Surface Displacement Monument Data (Initial Placement) *

Monument Number	Station	Offset From CL	Elevation	Elev @ Top of Rock	Height Above Top of Rock
U-1	2+50	13.072	680.818	613	65
U-2	4+00	13.642	681.649	535	143
U-3	5+50	13.304	682.012	520	158
U-4	7+00	12.535	681.695	538	140
U-5	8+50	10.240	681.106	593	84
U-6	4+00	120.546	645.830	535	143
U-7	5+50	120.242	646.063	520	158
U-8	7+00	121.059	645.624	538	140
D-1	2+50	14.210	681.051	613	65
D-2	4+00	13.625	681.757	535	143
D-3	5+50	13.573	682.167	520	158
D-4	7+00	14.606	681.662	538	140
D-5	8+50	16.926	681.041	593	84
D-6	4+00	175.445	616.392	535	81
D-7	5+50	175.134	616.967	520	97
D-8	7+00	175.900	616.932	538	79

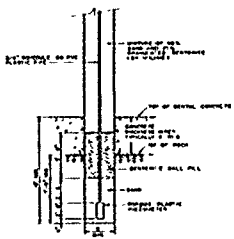
* Data base from the temporary monuments were transferred to the perminent monuments.

YATESVILLE LAKE - PIEZOMETER DATA					
Piez. No.	Location		Elevations		
	Station	Offset From Axis of Dam	Top of Riser	Top of Ground	Bottom of Tip
P-1	3+28	15'DS	682.6	681.3	559.1
P-2	3+95	15'DS	683.0	681.5	536.5
P-3	4+46	29'US	678.3	676.7	519.5
P-4	4+50	12'DS	683.1	681.7	519.3
P-5	4+40	17'DS	682.7	681.2	513.7
P-6	4+58	14'DS	683.1	681.6	531.2
P-7	4+65	15'DS	683.1	681.7	545.8
P-8	4+46	15'DS	683.0	681.5	559.6
P-9	4+58	14'DS	683.0	681.6	576.2
* P-10	4+50	75'DS	658.0	656.5	590.0
* P-11	5+90	60'US	679.0	677.5	525.8
P-12	5+90	23'US	678.8	677.2	516.8
P-13	5+85	14'DS	683.2	681.9	525.2
* P-14	5+95	13'DS	683.4	682.0	541.8
P-15	5+78	14'DS	683.4	682.0	558.9
* P-16	5+84	13'DS	683.4	682.0	575.6
* P-17	5+90	39'DS	676.0	674.5	507.0
* P-18	5+90	74'DS	659.0	657.5	590.0
P-19	5+91	249'DS	591.8	590.4	540.3
P-20	6+96	18'DS	682.9	581.4	536.1
P-21	7+62	17'DS	682.6	681.2	556.2
P-22	8+81	13'DS	682.2	680.8	608.0
P-23	5+89	550'DS	584.9	583.5	563.3

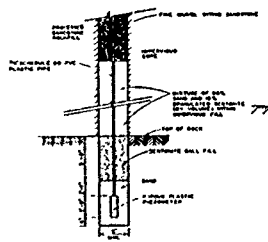
US - Upstream
DS - Downstream
* - Location and elevations are approximate.

Exhibit No. 7

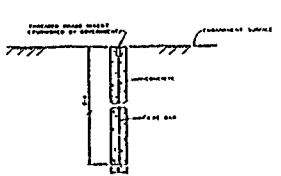
Good Engineering Produces Better Environment



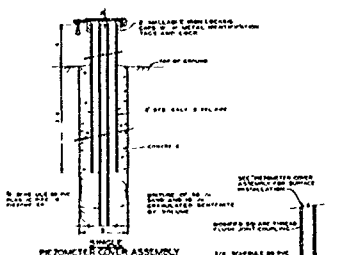
PIEZOMETER INSTALLATION DETAIL
ROCK W/ LOCATION OF APPLICATION OF DENTAL CONCRETE



PIEZOMETER INSTALLATION DETAIL
ROCK

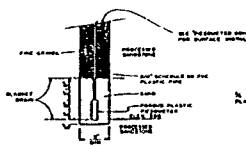


SURFACE DISPLACEMENT MONUMENT

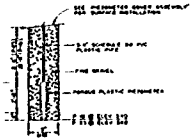


PIEZOMETER COVER ASSEMBLY

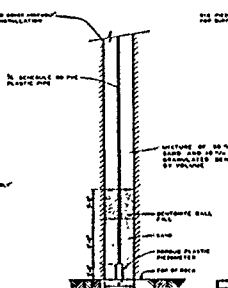
PIEZOMETER ASSEMBLY



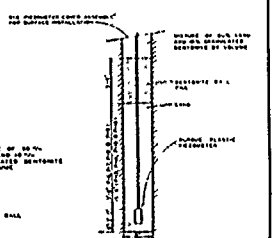
PIEZOMETER INSTALLATION DETAIL
BLANKET DRAIN



PIEZOMETER INSTALLATION DETAIL
RANDOM ROCKFILL



PIEZOMETER INSTALLATION DETAIL
TOP OF ROCK AND EMBANKMENT CONTACT



PIEZOMETER INSTALLATION DETAIL
IMPERVIOUS

NOTES
1. FOR INSTRUMENTATION PLAN SEE EXHIBIT NO. 3
2. FOR INSTRUMENTATION PROFILE AND SECTIONS, SEE EXHIBIT NO. 5.

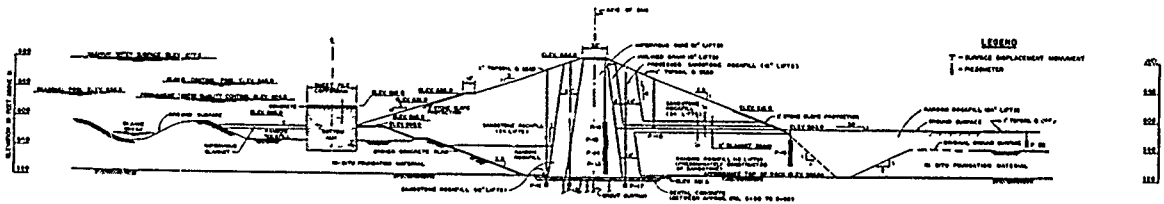
BLAINE CREEK, KENTUCKY
YATESVILLE LAKE
INSTRUMENTATION DETAILS

EXHIBIT NO. 4

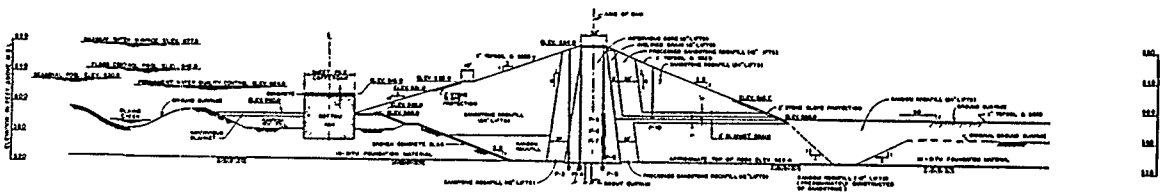
(N-4)

Grid Excavated Timber Butts Exposed
BLAINE
YATESVILLE LAKE
DAM
INSTRUMENTATION PLAN
LEGEND
CONST. NO.

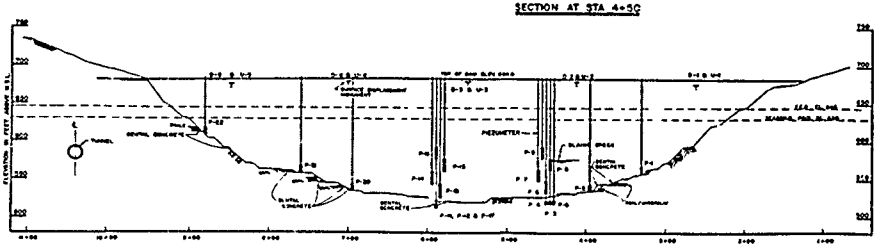
Good Engineering Produces Better Environment



SECTION AT STA 5+90



SECTION AT STA 4+50



PROFILE ALONG CENTERLINE OF DAM

BLAINE CREEK, KENTUCKY
YATESVILLE LAKE
INSTRUMENTATION
SECTIONS & PROFILE

EXHIBIT NO. 3

(G-N)

12-01 O. DEWATERING SYSTEM

Contractors

The Lane Construction Corp.: control surface water
Stacon Corporation: (subcontractor) dewatering wells
McClelland Services Inc.: (subcontractor) slurry cut-off wall

Description

Control Surface Water:..... Dikes, sand bags, sump pumps
Dewatering Wells:..... 33 dewatering & predrainage wells and 13 piezometers
Slurry Cut-Off Walls:..... Two 3' wide trenches excavated to top of rock, located up and downstream of the excavated area, extending across the valley.

Chronological Sequence

Jun 86
25 Began mobilization for McClelland Services Inc.
Jul 86
25 Began mixing slurry for cut-off walls
30 Began excavation of the U/S slurry cut-off wall
Aug 86
7 Began backfilling U/S slurry cut-off wall
12 Preparatory meeting for dewatering wells
13 Began mobilization for Stacon Corp.
15 Began installing dewatering wells
15 Completed excavation of U/S slurry cut-off wall
Sep 86
2 Completed backfilling U/S slurry cut-off wall
3 Began placing cap material on U/S slurry wall
3 Began installing piezometers
8 Completed placing cap and fabric on U/S wall
9 Began excavating the D/S slurry cut-off wall
24 Completed excavation of D/S slurry cut-off wall
29 Began backfilling D/S slurry cut-off wall
Oct 86
6 Completed well and piezometers installation
17 Began placing cap material on the D/S slurry wall
22 Completed backfilling the D/S slurry cut-off wall
23 Completed placing cap and fabric on D/S wall
Nov 86
7-10 Placed Z piling thru the D/S slurry cut-off wall
14 Placed fabric & SSP on notched section of D/S wall

- Measures to control surface water were taken throughout the length of the contract.

12-01 O. DEWATERING SYSTEM

Dewatering & Predrainage Wells and Piezometers

Subcontractor

Stacon Corporation: Dewatering and predrainage wells
Triad Engineering Drilling & Services: (subcontractor for Stacon Corp.) Piezometers

Well System

33 Dewatering and predrainage wells
13 Piezometers
- water pipes, meters, headers, electrical panels & cables, etc.

Equipment

1	Gus Peck "Super George" bucket auger
1	Mobil Drill (Triad Eng. Drilling & Serv.)
1	410 John Deere backhoe
1	Air compressor
1	Truck with wench
2	Diesel generators

Materials

Material	Supplier
Submersible pumps (1 H.P., 220 V, single phase)	Grundfos model SP6-6
Wellscreens & casings	Titan Industries
Sand filter material	Parry Company

- flow meters, water pipes, electrical panels & cables etc.

Installation Procedure

Dewatering & Predrainage Wells

- Survey well locations and align drill
- Drill holes with "Super George" bucket auger to top of rock.
- Disinfect well with calcium hypochlorite during drilling, as the filter sand is placed and upon completion.
- Assemble and install screen, riser pipe and sand filter.
- Develop well: (1) Pump well for 30 min. (2) Surge well (15 trips at a rate of 2 ft/sec) (3) Air lift for 30 min. (4) Pump well for 1 hr. and test for sand content using a Rossum sand tester (>5 ppm sand) (5) Repeat surging and air lift if high sand content.
- Backfill above filter sand: (1) Wells U/S of cofferdam with a cement-bentonite grout. (2) Wells D/S of cofferdam with filter sand or insitu sand.

12-01 0. DEWATERING SYSTEM

Dewatering & Predrainage Wells and Piezometers

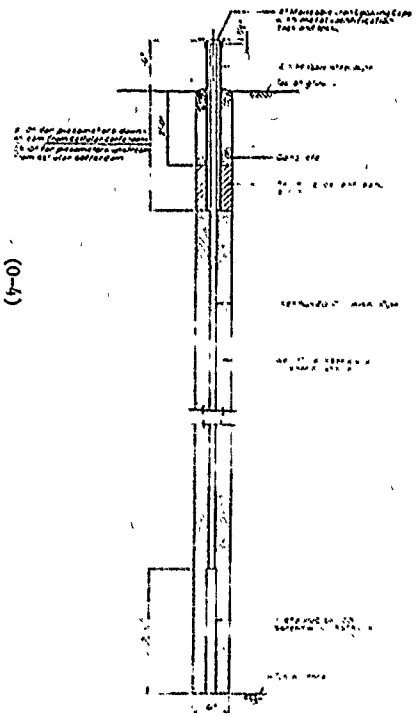
Installation Procedures (cont)

Dewatering & Predrainage Wells (cont)

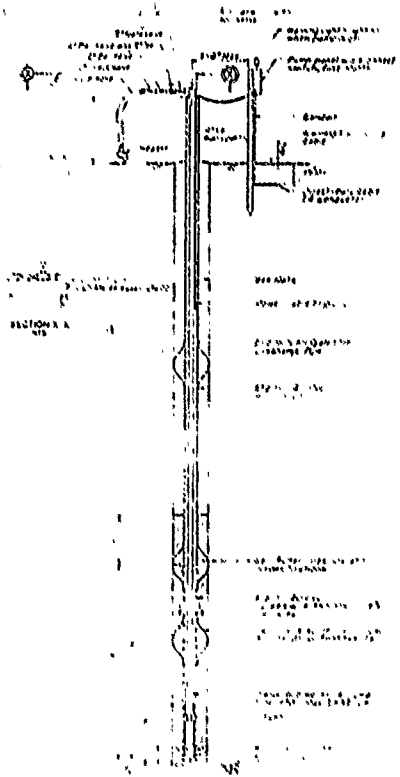
- Install submersible pump, pipes, valves, electrical box, etc.
- Perform final pump test.

Piezometers

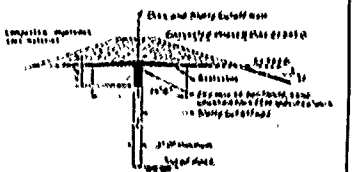
- Survey locations and align drill
- Drive casing and augured hole to top of rock with a Mobil drill.
- Install piezometer tip, riser pipe and filter sand.
- Backfill: (1) Piezometers D/S of cofferdam, 3' bentonite-cement-sand grout with 2' concrete at top. (2) Piezometers U/S of cofferdam, 23' bentonite-cement-sand grout with 2' concrete at top.
- Perform pump test (accepted rate at 2 gpm)



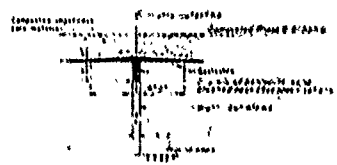
PIEZOMETER DETAIL
NTS



PHI DRAINAGE WELL DETAIL
NTS



TYPICAL SECTION OF SLURRY CUTOFF WALL IN DOWNSTREAM EMBANKMENT
NTS



TYPICAL SECTION OF SLURRY CUTOFF WALL UPSTREAM OF CELLULAR COFFERDAM
NTS

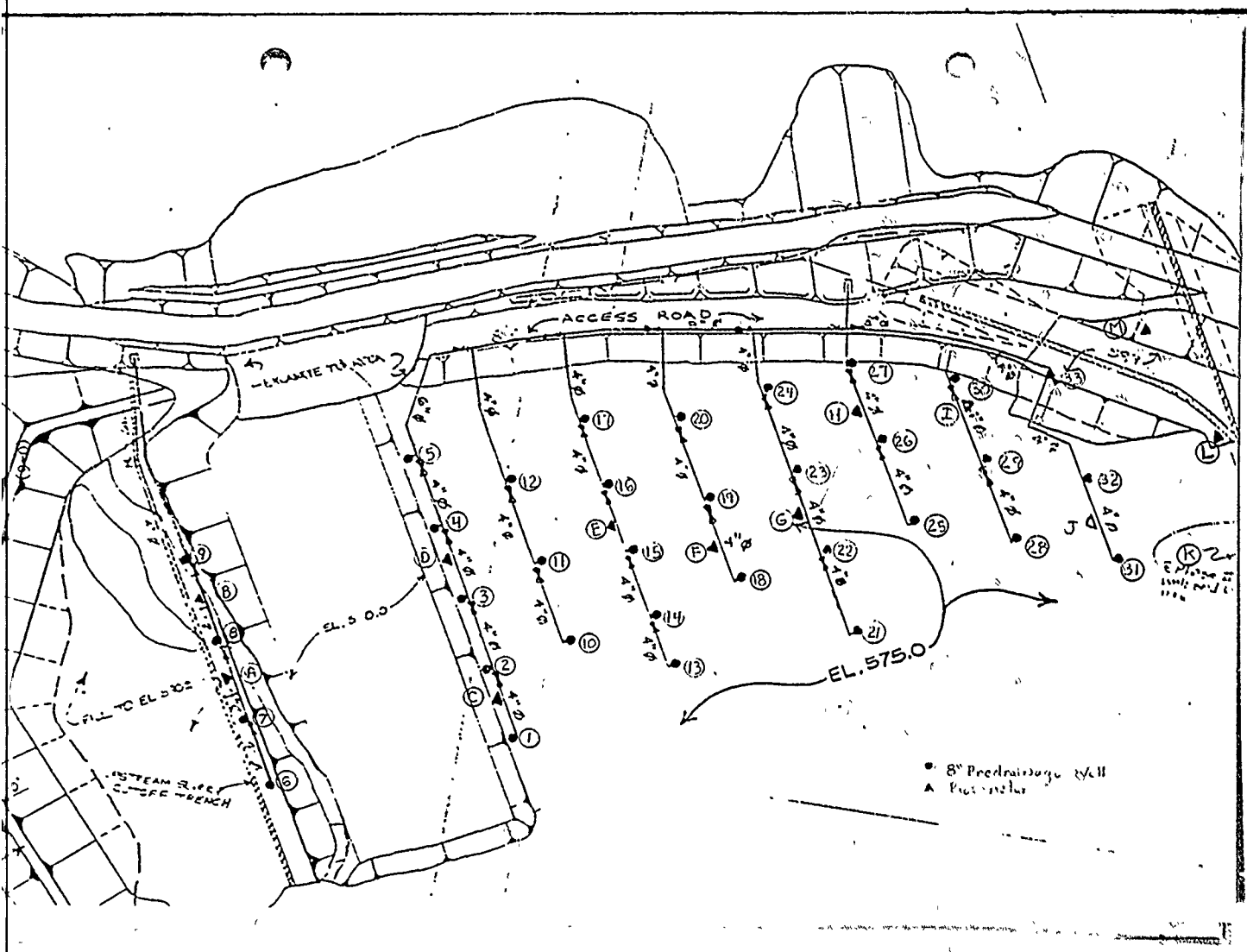
NOTE

PREPARED BY: GANNETT FLEMING, P.E.		
	BLAKE CREEK, PENTWAY	
	YATESVILLE LAKE	
	DAM AND APPURTENANT WORKS - PHASE II	
	DETAILS OF DEWATERING FEATURES	

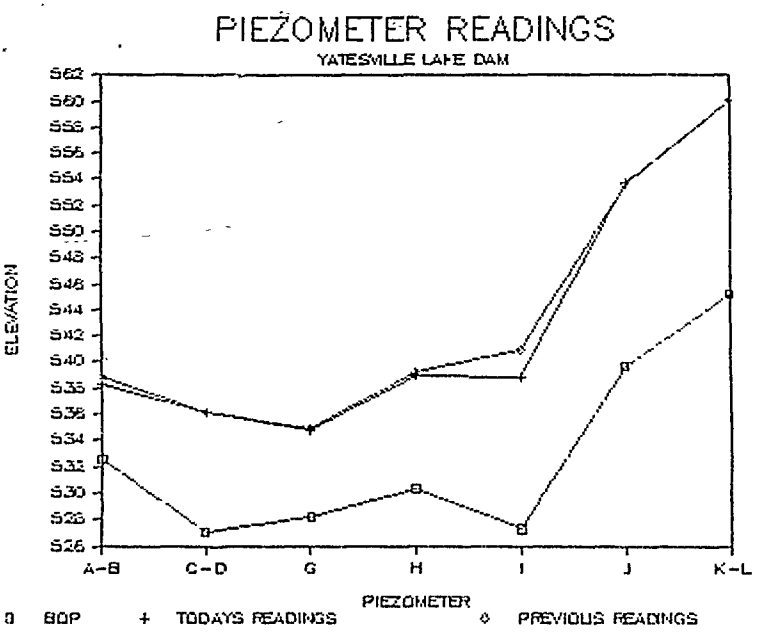
PIEZOMETER AND WELL LOCATIONS - DAM SITE

PIEZOMETER	DAM STATION	OFFSET	ELEV. @ TOP	ELEV. @ BOP
P-A	5 + 43.54-D	430.45 LT	591.60	529.60
P-B	6 + 17.22-D	430.38 LT	591.53	535.50
P-C	4 + 31.30-D	224.91 LT	577.12	526.50
P-D	5 + 70.46-D	226.50 LT	576.89	527.60
P-E	5 + 63.74-D	70.84 LT	576.87	525.90
P-F	5 + 11.70-D	7.33 RT	574.83	529.00
P-G	5 + 10.40-D	80.30 RT	573.82	528.20
P-H	5 + 91.29-D	179.31 RT	576.28	530.30
P-I	5 + 59.96-D	269.36 RT	576.58	527.90
P-J	4 + 17.57-D	357.41 RT	578.18	539.70
P-K	3 + 61.96-D	424.29 RT	590.75	555.80
P-L	4 + 60.71-D	429.76 RT	590.75	534.80
P-M	5 + 58.31-D	436.09 RT	590.25	530.70

WELL	DAM STATION	OFFSET	ELEV. @ TOP	ELEV. @ BOP
W-1	4 + 07.14-D	223.62 LT	578.00	528.30
W-2	4 + 72.87-D	223.77 LT	577.00	528.50
W-3	5 + 38.03-D	225.02 LT	576.20	527.30
W-4	6 + 06.65-D	225.99 LT	577.00	532.00
W-5	6 + 70.55-D	226.54 LT	577.00	535.00
W-6	4 + 36.36-D	429.16 LT	590.00	536.00
W-7	5 + 00.85-D	428.31 LT	590.00	527.00
W-8	5 + 76.21-D	427.64 LT	591.50	542.20
W-9	6 + 58.31-D	431.69 LT	591.90	539.50
W-10	4 + 66.15-D	149.70 LT	578.00	530.30
W-11	5 + 46.08-D	149.72 LT	577.00	527.00
W-12	6 + 26.09-D	150.50 LT	577.00	532.00
W-13	4 + 04.81-D	76.84 LT	570.65	545.75
W-14	4 + 66.12-D	69.85 LT	577.00	532.30
W-15	5 + 30.74-D	70.47 LT	577.50	525.80
W-16	5 + 95.78-D	71.65 LT	577.50	530.50
W-17	6 + 33.81-D	73.65 LT	576.00	542.00
W-18	4 + 70.60-D	8.96 RT	576.00	529.95
W-19	5 + 49.16-D	9.45 RT	575.40	527.90
W-20	6 + 27.80-D	1.06 RT	575.50	539.00
W-21	4 + 23.25-D	83.26 RT	573.90	538.30
W-22	4 + 71.21-D	81.04 RT	577.20	538.70
W-23	5 + 51.27-D	81.67 RT	574.75	526.50
W-24	6 + 02.33-D	81.77 RT	574.39	539.29
W-25	4 + 96.05-D	178.97 RT	575.00	531.50
W-26	5 + 51.52-D	180.00 RT	575.90	529.05
W-27	6 + 44.25-D	182.41 RT	598.40	546.40
W-28	4 + 25.52-D	270.16 RT	576.50	540.40
W-29	5 + 22.06-D	266.74 RT	574.40	527.50
W-30	6 + 02.39-D	265.03 RT	590.55	533.00
W-31	3 + 74.09-D	372.01 RT	595.50	558.50
W-32	4 + 52.83-D	355.91 RT	577.65	534.20
W-33	5 + 32.73-D	347.89 RT	589.10	528.85


ACCESS ROAD
EL. 575.0
EL. 5 0.0
FILL TO EL 5 10.5
STEAM BASE CUTOFF TRENCH
8" Predrainage Well
Piezometer

	BOTTOM OF PIPE	TODAYS READINGS	PREVIOUS READINGS	CHANGE	11-Jun-87
A-B	532.55	538.24	538.62	-0.38	
C-D	527.05	536.13	536.20	-0.07	
G	528.20	534.77	534.87	-0.10	
H	530.30	539.03	539.18	-0.15	
I	527.30	538.83	540.93	-2.10	
J	539.70	553.73	553.68	0.05	
K-L	545.30	560.08	560.05	0.03	
UPSTREAM GAGE READING		576.95	577.00	-0.05	



Typical Piezometer Reading

PIEZOMETER READINGS

DATE 11 JUNE 1987 TAKEN BY ESV

PIEZOMETER	ELEVATION OF PIEZOM. (FT)	DISTANCE TO WATER (FT)	WATER LEVEL (FT)	
A	591.60	54.55	537.05	538.24
B	591.53	52.10	539.43	
C	577.12	40.00	537.12	536.13
D	576.89	41.75	535.14	
G	573.82	39.05	534.77	
H	576.28	37.25	539.03	
I	576.58	[illegible]	538.83	
J	578.18	24.45	553.73	
K	590.75	23.45	567.30	560.08
L	590.75	37.90	552.85	

WATER GAGE: ELEVATION 576.95

WATER METER: 100 GPM

PUMPS RUNNING: NO.'S 7, 3, 4, 1, 2, 5

THE LANE CONSTRUCTION CORPORATION

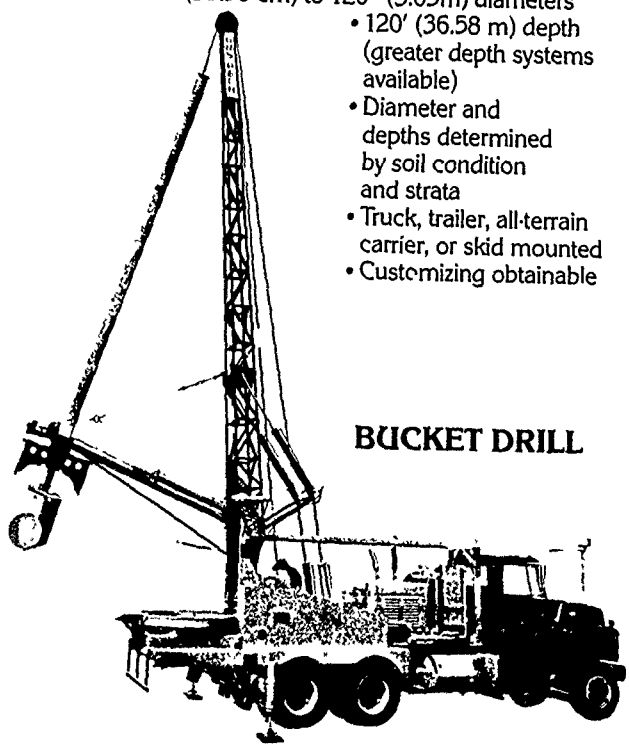
Typical Piezometer Report

EARTH DRI

WATER/DEWATERING WELLS • CAISSON • ELEVAT
• EXPLORATION • SOIL TESTING • CORING • SAM

★ "SUPER GEORGE"

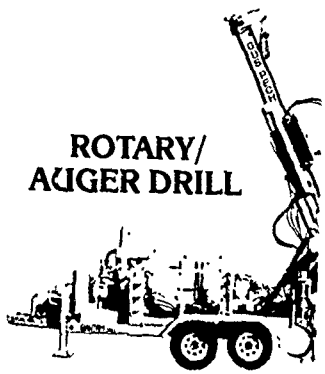
- 0-24 stepless rpm
- 373,080 inch lbs. (4299.75 kg·m) torque
- 14" (35.56 cm) to 120" (3.05m) diameters
- 120' (36.58 m) depth (greater depth systems available)
- Diameter and depths determined by soil condition and strata
- Truck, trailer, all-terrain carrier, or skid mounted
- Customizing obtainable



BUCKET DRILL

"BANTAM"

- 0-110 stepless rpm
- 60,000 inch lbs. (691.5 kg·m) torqu
- 3" (7.62 cm) to 24" (60.96 cm) diameters
- 800' (243.84 m) rotary depth
- 200' (60.96 m) auger depth
- Diameter and depths determined by soil condition and strata
- Truck, trailer, all-terrain carrier, or skid mounted
- Customizing obtainable



ROTARY/
AUGER DRILL

TELEPHONE 774-1320
Area Code 614

THE PARRY COMPANY
Producers of Quartz Products
219 CHURCH STREET
CHILLICOTHE, OHIO - 45601

JUL 16-86

Stang Hydronics
2935 North Toledo
Tulsa OK 74115

Attn: Mr Ron Peterson

Re: Quartz Well Pack Gravel

This letter is to confirm our February 19th quotation, $[redacted] per Ton for material in BULK, and $[redacted] Cwt full T/L hauling to Yatesville KY w/in 30 miles of Huntington, and to report two sieve analyses representative of the material we propose to supply, the same material mailed to you in February 20 labelled 1. Quartz Well Pack Gravel, Blended.

Sieve	Specified % Passing	FEB 20-86	JUL 16-86
4	100	100.00	100.00
6	85 - 100	99.91	100.00
8	65 - 100	91.82	87.10
10	45 - 92	75.35	71.48
14	15 - 75	43.32	45.33
16	8 - 62	30.32	31.91
20	0 - 25	11.29	16.20
30	0 - 12	1.66	3.60
40	0 - 2	-0-	.60

Thank you for your interest in our material.

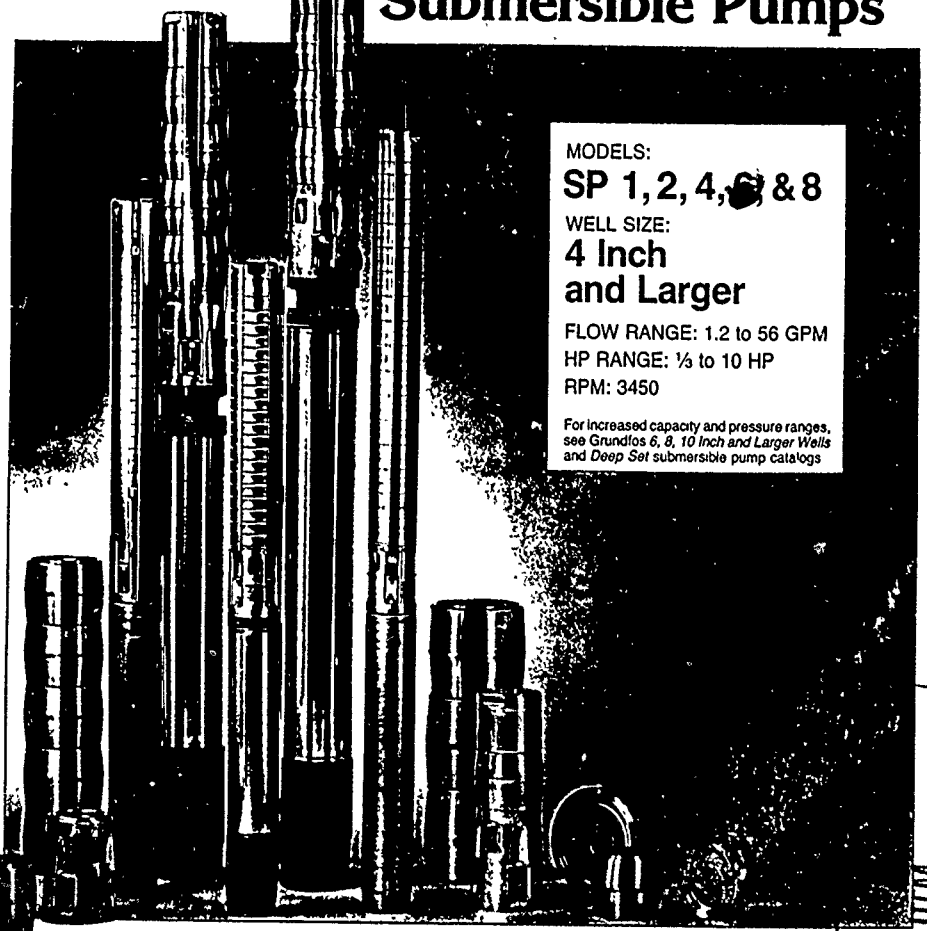
David Parry

Encl: 12 copies

4 Inch
and Larger Wells

RECEIPT ACKNOWLEDGED
Date: AUG 11 1988

Grundfos Stainless Steel Submersible Pumps



MODELS:
SP 1, 2, 4, 6 & 8
WELL SIZE:
4 Inch and Larger
FLOW RANGE: 1.2 to 56 GPM
HP RANGE: ⅓ to 10 HP
RPM: 3450

For increased capacity and pressure ranges, see Grundfos *6, 8, 10 Inch and Larger Wells* and *Deep Set* submersible pump catalogs

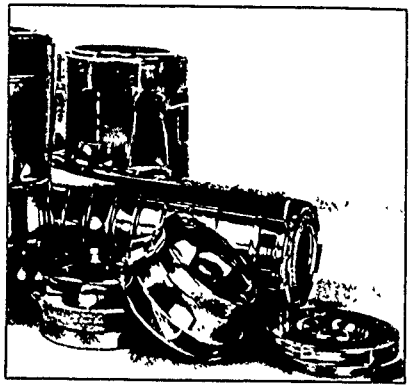
ITEM 3

GRUNDFOS

Grundfos Stainless Steel Submersible Pumps

Stainless Steel Quality

In the pump industry, stainless steel has come to mean Grundfos Pumps Unlike any other pump manufacturer, Grundfos uses high grade stainless steel for nearly every component. . impellers, diffusers, shafts, straps, check valves, couplings and cable guards Stainless steel construction plus advanced engineering designs make Grundfos the quality leader in today's submersible pump market.



Resistant to Wear, Corrosion and Abrasion

Stainless steel has long been recognized as the best material for pump construction Its resistance to wear, corrosion and abrasion ranks far above the ratings for commonly used plastic, bronze and cast iron materials

Competitively Priced

Only Grundfos has combined the superiority of stainless steel with advanced production and design techniques to produce stainless steel submersible pumps Mass production and standardized parts have yielded a superior product at a competitive price.

Wide Operating Ranges Available

Grundfos stainless steel submersibles range in size from 4" to 10" well diameters and from ½ to 100 HP with capacities up to 800 GPM and to depths of 1800 feet See the Grundfos catalog for the complete line of Grundfos stainless steel submersibles for 4 inch and larger, 6, 8, 10 inch and larger, and deep set water well applications

Stainless Steel Construction

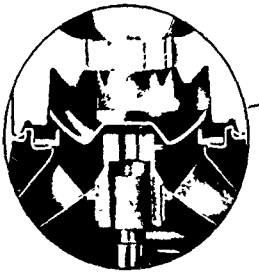
Grundfos uses high grade stainless steel (primarily 304 and 316) for nearly every component in their submersibles Stainless steel insures Grundfos quality with its strong, but lightweight properties, its resistance to corrosion and abrasion, and its ability to be precisely shaped and fabricated

Alternate construction pumps are also available for brackish, seawater and other harsh and corrosive environments For oil field applications, the Grundfos "SPO" units are especially designed to handle the rigors of shallow well oil field pumping

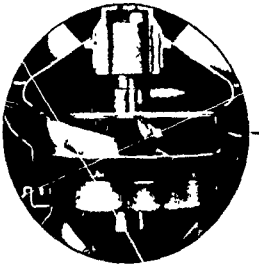
Pump Selection Guide

MODEL	MIN WELL SIZE	FLOW RANGE (GPM)	MAX. HEAD (FEET)	MAX. HEAD (PSI)
4 Inch & Larger Wells				
SP 1	4"	1 2-7	1055	457
SP 2	4"	5-14	930	403
SP 4	4"	11-28	900	390
SP 6	4"	20-40	510	221
SP 8	4" & 6"	22-56	765	331
6, 8, 10 Inch & Larger Wells				
SP 16	6"	48-110	845	366
SP 27	6"	75-200	835	361
SP 45	6"	150-290	680	294
SP 75	8"	230-500	310	134
SP 120	10"	350-800	420	182
Deep Set				
SP 1-DS	4" & 5"	1 2-7	1695	734
SP 2-DS	4" & 5"	5-14	1620	701
SP 4-DS	6"	11-28	1720	745
SP 8-DS	6"	22-56	1450	628
SP 16-DS	6" & 8"	48-110	1745	777
SP 27-DS	8"	75-200	1910	827
SP 45-DS	8"	150-290	1220	528
SP 75-DS	8"	230-500	1080	467
SP 120-DS	10"	350-800	590	255

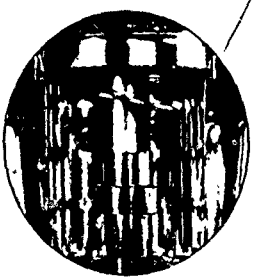
Exclusive Grundfos Designs



PATENTED, FAIL-SAFE CHECK VALVE DESIGN Grundfos stainless steel check valves are built into the top pump chamber to prevent loss of head and backflow These positive, non-clogging, non slamming valves are sized to meet the maximum pressures for each model



STAINLESS STEEL FABRICATION YIELDS MAXIMUM HYDRAULIC PERFORMANCE Grundfos fabrication techniques for stainless steel permit ideal shaping of impeller and diffuser vanes to maximize hydraulic design Combined with the inherent smoothness of stainless steel, the Grundfos design provides optimum performance and high operating efficiencies



EXCLUSIVE PRIMING INDUCER PROTECTS AGAINST DRY RUNNING The exclusive Grundfos priming inducer protects against damage due to dry running should water levels drop unexpectedly in the well Located inside the suction interconnector at pump intake this small axial flow screw provides enough water to lubricate the pump until the well has time to recover

Materials of Construction
(STANDARD PUMPS)

COMPONENT	SP1		SP2		SP4		SP6	SP8	SP16	SP27	SP45	SP75	SP120
	C	S	C	S	C	S	C	C	C	C	C	C	C
Check Valve Housing	2	2	2	2	2	2	2	2	2	2	2	2	9
Check Valve	2	2	2	2	2	2	2	2	2	2	2	2	2
Check Valve Seat	10/3	10/3	10/3	10/3	10/3	10/3	10/3	10/3	10/3	10/3	10/3	10/3	10/3
Diffuser Chamber	2	2	2	2	2	2	2	2	2	2	2	2	2
Top Bearing	10/3	NR	10/3	NR	10/3	NR	10/3	10/3	10/3	10/3	10/3	10/3	10/3
Impeller Seal Ring	10	10	10	10	10	10	10	10	10	10	10	10	10
Split Cone Nut	8	NR	8	NR	8	NR	2	2	2	2	2	2	8
Split Cone	2	NR	2	NR	2	NR	2	2	2	2	2	2	8
Impeller	2	2	2	2	2	2	2	2	2	2	2	2	2
Suction Interconnector	2	2	2	2	2	2	2	2	2	2	2	2	9
Inlet Screen	2	2	2	2	2	2	2	2	2	2	2	2	2
Pump Shaft	7	7	7	7	7	7	7	7	7	7	7	7	7
Coupling	4/6/7	4/6/7	4/6/7	4/6/7	4/6/7①	4/6/7	4/6/7	4/6/7①	5	5	5	5	5
Coupling Key	NR	NR	NR	NR	NR①	NR	NR	NR①	1/2	1/2	1/2	1/2	1/2
Straps	2	2	2	2	2	2	2	2	2	2	2	2	2
Cable Guard	2	2	2	2	2	2	2	2	2	2	2	3	3
Priming Inducer	3	3	3	3	3	3	3	3	2	2	2	NR	NR
Intermediate Bearings	2/8	10	2/8	10	2/8	10	10/3	10/3	10	10	10	10	10
Shaft Bearing Sleeve	NR	2	NR	2	NR	2	NR	NR	NR	NR	NR	NR	NR
8" Motor Adaptor Plate	NR	NR	NR	NR	NR	NR	NR	NR	9	9	9	NR	NR

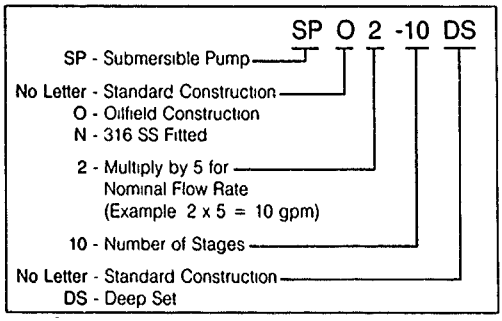
NOTES ① On 6" Motors For coupling refer to material code 5, For coupling key refer to material codes 1 and 2

NR Not Required C Cylindrical Shaft S Splined Shaft

Material Codes

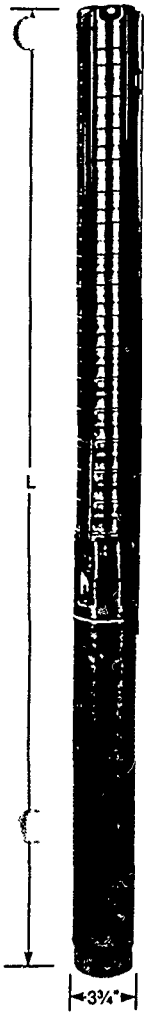
CODE NO.	MATERIAL
1	302 Stainless Steel
2	304 Stainless Steel
3	316 Stainless Steel
4	329 Stainless Steel
5	416 Stainless Steel
6	420 Stainless Steel
7	431 Stainless Steel
8	Zincless Bronze
9	Ni-Resist
10	NBR

SP Nomenclature

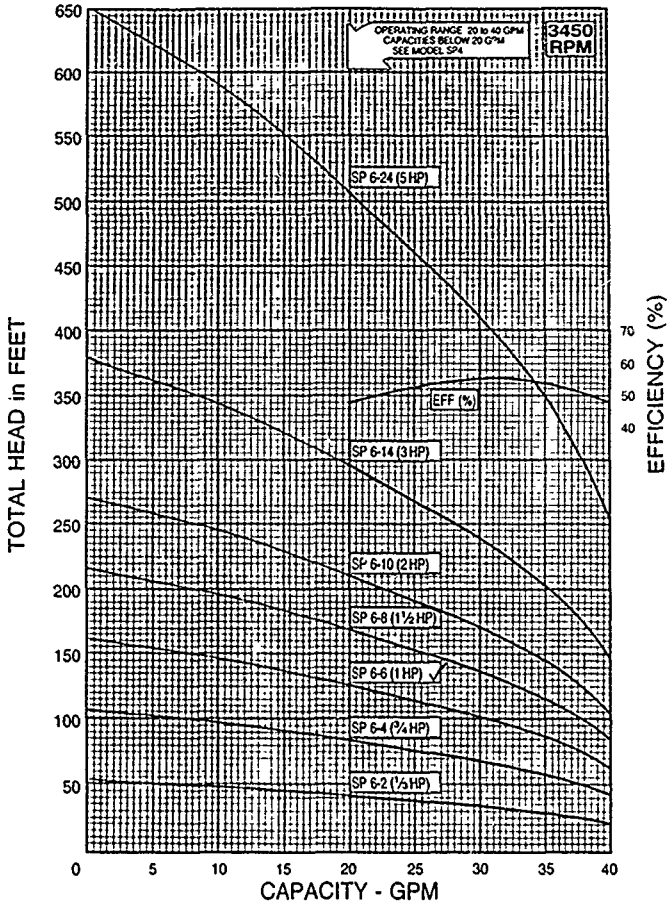


MODEL
SP 6

NOM. FLOW RATE
30 GPM
FLOW RANGE
20 to 40 GPM
PUMP OUTLET
2" NPT



Performance Curves



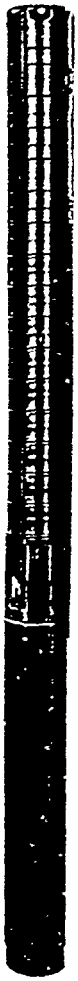
DIMENSIONS AND WEIGHTS

MODEL NO.	HP	LENGTH (L)	APPROX. UNIT SHIPPING WT. (LBS.)
SP 6-2	⅓	20¾"	26
SP 6-4	¾	24⅝"	34
SP 6-6	1	28½"	47
SP 6-8	1½	33⅜"	47
SP 6-10	2	38¾"	60
SP 6-14	3	50⅞"	79
SP6-24	5	78"	116

Specifications are subject to change without notice

MODEL
SP 6

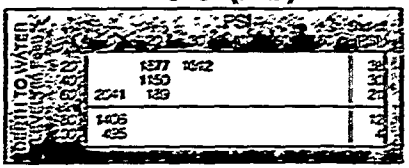
NOM. FLOW RATE
30 GPM
FLOW RANGE
20 to 40 GPM
PUMP OUTLET
2" NPT



SP 6 Selection Charts

RATINGS ARE IN GALLONS PER HOUR (GPH)

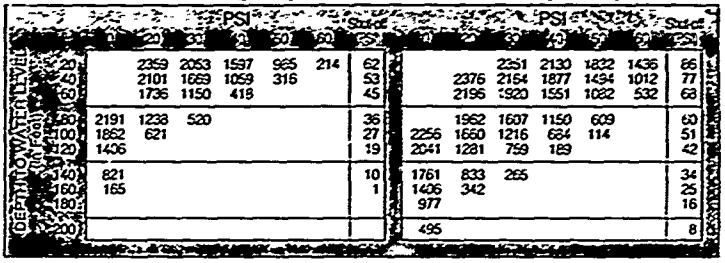
SP6-4 (¾HP)



Friction losses in discharge pipe and fittings are not included in tables.

SP6-6 (1 HP)

SP6-8 (1½HP)



Friction losses in discharge pipe and fittings are not included in tables.

12-01 O. DEWATERING SYSTEM

Slurry Cut-Off Walls

Subcontractor

McClelland Services Inc.

Slurry Cut-Off Walls

Description:.....	2 walls, one wall U/S of excavation and one "Y" shaped wall D/S of the excavation. The walls were constructed approximately parallel to the dam axis, extending from the left to right abutments.
Excavation:.....	3' wide trench excavated from surface to top of rock (0-65')
Slurry:.....	Sodium bentonite and water mixture.
Backfill:.....	Soil-bentonite mix design consisting of: on-site clayes, silts and sands; additional sand and gravel; dry bentonite and slurry.
Cap:.....	A dry mixture of aggregate, sand and dry bentonite covered with a geotextile and compacted impervious fill.

Equipment

1	Erie - Strayer concrete batch plant
1	1266D Koehring backhoe
1	3900 Manitowic crane
1	550 John Deere dozer
1	D-6 Cat dozer
3	CCC concrete mixing trucks
1	Whiteman concrete pump
1	W24B Case front end loader
1	4,000 cu.ft. storage pig
2	GMC end dump trucks
-	various air compressors and water pumps

Materials

Material	Supplier
Sodium Bentonite	Federal Ore and Chemical (Colony, WY) (Slurry Mud-90)
Backfill Sands	insitu sands and Standard Slag (Haverhill, OH)
Cap Aggregate	Ken-Mor Stone Co. (Olive Hill, KY)
Filter Fabric	Mirafi Inc. (Mirafi 600X)
Water	Blaine Creek

12-01 O. DEWATERING SYSTEM

Slurry Cut-Off Walls

Changes

- Constructed the D/S slurry cut-off wall within a single phase instead of two phases as indicated on the contract drawings.
- The upstream leg of the downstream slurry cut-off wall intersected the downstream leg in a strait line instead of a curved shape as indicated in the contract drawings.
- Mixed backfill material for the D/S slurry cut-off wall with a dozer near the trench.

Construction Procedure

- Level surface to proper elevation and survey alignment for trench excavation.
- Prepare slurry to specifications (viscosity 50-70, specific gravity >1.1, sand content <10%)
- Excavate trench with a Koehring 1266D backhoe using a 3' wide Adco rock bucket from surface to top of rock (0-65'). If boulders were encountered a chisel-point drop bar was used to break the boulders and were then excavated with a backhoe.
- Place and maintain bentonite slurry in trench to within 1.5' of surface.
- Clean bottom of trench by air lifting before placing backfill material.
- Batch soil-bentonite backfill to specified gradation with a minimum of 5% bentonite and a 3-6" slump.

Backfill gradation:

Sieve Size or Number (U.S. Standard)	Percent Passing by Wieght
2 inch	100
3/4 inch	90 - 100
3/8 inch	82 - 100
No. 4	74 - 100
No. 10	63 - 90
No. 30	45 - 73
No. 50	35 - 64
No. 200	20 - 45

Mixing Procedure:

U/S Wall: Batched total backfill mixture using an Erie Strayer concrete batch plant into concrete mixing trucks and then placing at the trench from the right to left abutment.

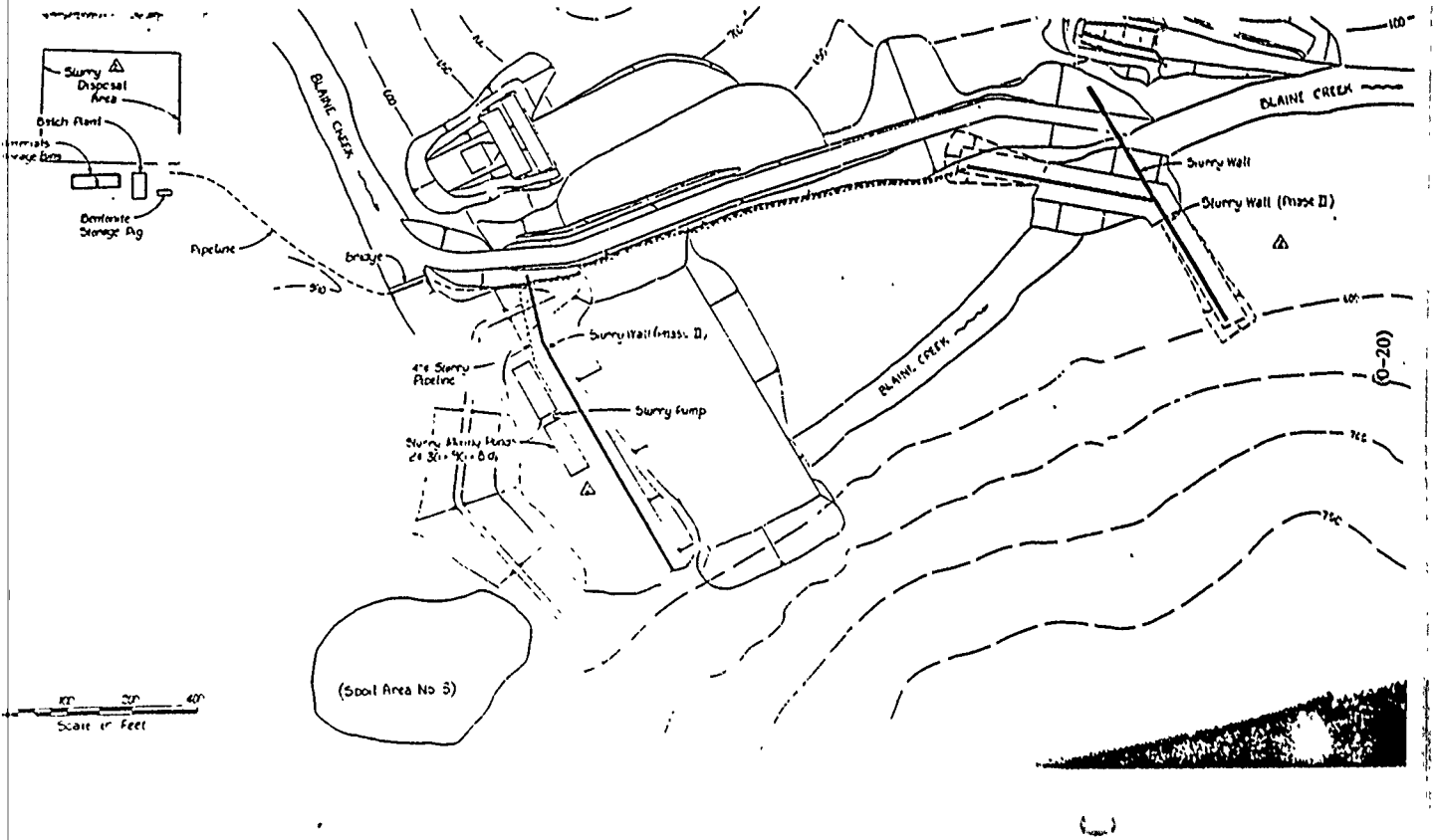
12-01 O. DEWATERING SYSTEM

Slurry Cut-Off Walls

Construction Procedure (Cont)

D/S Wall: Batched dry materials of backfill using an Erie Strayer concrete batch plant into dump trucks and was then placed on the ground, next to the trench, where the slurry was added. The backfill was then mixed and placed in the trench with a D-6 Cat dozer from the right to left abutment.

- Place soil-bentonite backfill in trench, maintaining a 100' distance between the toe of excavation.
- Removed the bentonite slurry from the trench as backfill material was added. This slurry was then used in the backfill mixture or was spoiled.
- Upon completion of backfilling operation a dry cap was placed, consisting of: bentonite 8%; sand - 1 part; 1/2 in. aggregate - 1 part; 1 in. aggregate - 2 parts). This mixture was batched using an Erie Strayer concrete batch plant, and was mixed and placed on the trench using concrete mixing trucks.
- Mirafi 600X geotextile was placed over capping material.
- Impervious fill was placed and compacted over the slurry cut-off wall after completion.


Slurry Disposal Area
Batch Plant
Bentonite Storage Pig
Pipeline
Bridge
BLAINE CREEK
Slurry Wall
Slurry Wall (Phase II)
Slurry Wall (Phase II)
4"ø Slurry Pipeline
Slurry Pump
(Spoil Area No 3)
(0-20)
Scale in Feet

Form ENG-1.01 (5/84)

COMPUTATIONS

Sheet No ____ Of ____

Job No 0536012A

By GRB Date 6/13/86

Chkd. By ____ Date ____

McClelland engineers

TRANS. 6A - Dist.

ITEM 3

LEGEND:

1 - Bentonite storage (4000-cu ft silo)
2 - Jet-type slurry mixer
3 - Gorman-Rupp 3x3x20-B pump (400 gpm @ 180 psi; 2200 rpm)
4 - Mixing box (4' x 4' x 5' deep)
5 - Recirculation pump
6 - Circulation pump
7 - Water supply pump
8 - Circulation pump and trench supply pump
* check valve
* Butterfly valve

SCHEMATIC OF SLURRY MIXING PLANT

Contract No.

Approved Distribution Copy

Date JUN 30 1986

Approval ... of the contract

U.S. ARMY ENGINEERS

Typical Bentonite Certification

FEDERAL BENTONITE

McClelland Engineers
P.O. Box 28232
St. Louis, MO 63132

Date: 9-12-86

REFERENCE: McClelland Project, T.B.S. Terminal, Charleston, WV

SUBJECT: Certification of Material Specification

TRUCK NUMBER/NAME: CNW 161141

Having reviewed Materials Specification, Section 13A, Eighth Edition, American Petroleum Institute, in its entirety, Federal Bentonite has conformed to all test data requirements for Slurry Mud® 90 sodium bentonite.

CHEMICAL ANALYSIS: A layered silicate mineral typically represented by the following formula:

$$(AL_{1.63}\ Fe_{.17}\ Mg_{.25})\ (AL_{.07}\ Si_{3.93})\ O_{10}\ (OH)_2\ (Na_{.24}\ \tfrac{Ca}{2}\ .04)$$

LABORATORY TEST RESULTS	TEST DATA
1. Fann 600 (Initial)	31
2. Fann 300 (Initial)	22
3. H_2O	7.2
4. Filtrate	*
5. Barrel Yield	Minimum - 90

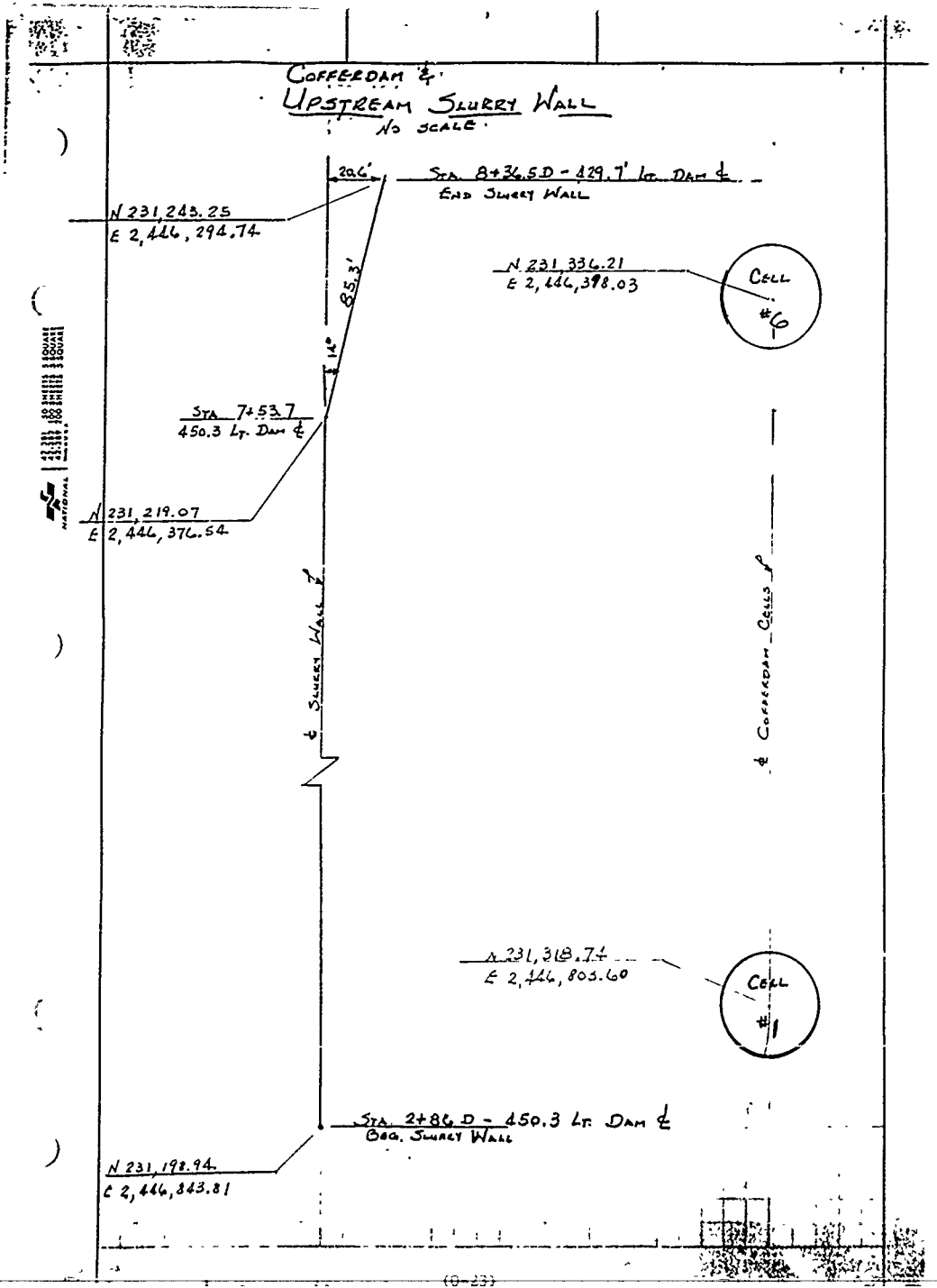
This information and data contained herein are believed correct when the recommended material is applied in accordance to the lines, grades, and cross sections as indicated and approved by the Design Engineer. We do not warrant by implication or expressly the accuracy thereof. In presenting uses for this product, no attempt has been made to discuss applicable limited warranties, expressed or implied.

Very truly yours,

Donald Hentz
Manager, Technical Services

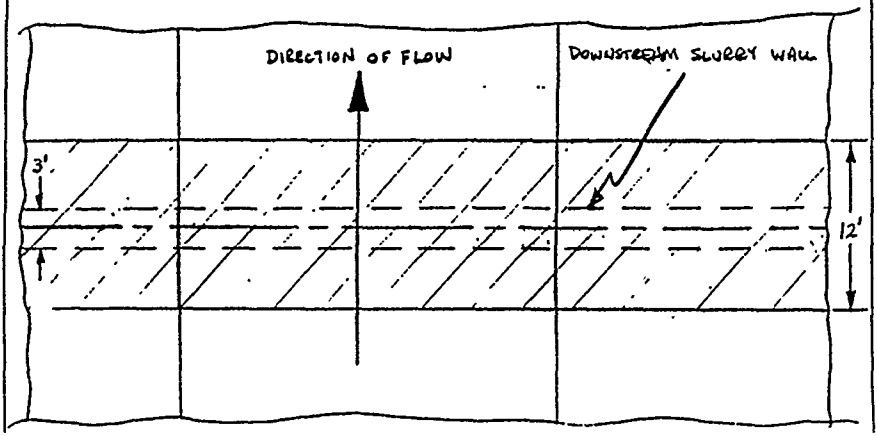
DH:MLJ/ra

* Filtrate Data will be given with aged results.

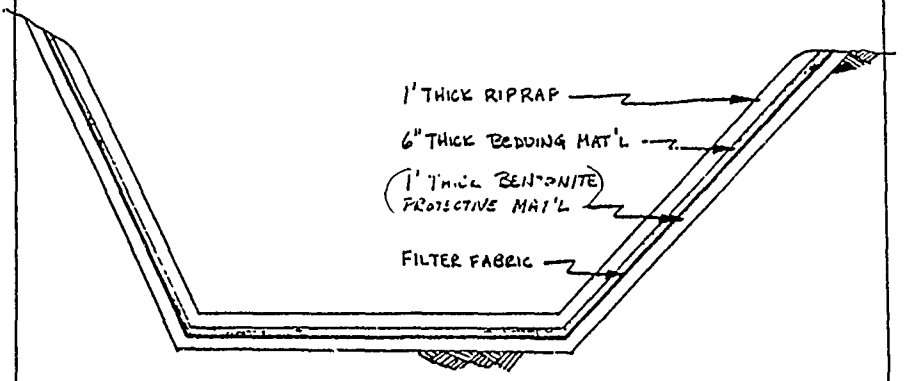

COFFERDAM &
UPSTREAM SLURRY WALL
NO SCALE
206'
STA. 8+36.5 D - 429.7' Lt. DAM ℄
END SLURRY WALL
N 231,243.25
E 2,446,294.74
N 231,336.21
E 2,446,398.03
CELL #6
85.3'
14°
STA 7+53.7
450.3 Lt. DAM ℄
N 231,219.07
E 2,446,376.54
℄ SLURRY WALL
℄ COFFERDAM CELLS
N 231,318.74
E 2,446,803.60
CELL #1
STA. 2+86 D - 450.3 Lt. DAM ℄
BEG. SLURRY WALL
N 231,198.94
E 2,446,343.81

* Modification to eliminate two separate phases of construction

PROPOSED DIVERSION CHANNEL PROTECTION OF DOWNSTREAM SLURRY WALL. PROTECTIVE LAYER COMPOSED OF THREE MATERIALS, TOTAL OF 2.5' THICK, 12' WIDE, CENTERED ON DOWNSTREAM SLURRY WALL.



PLAN



ELEVATION

SCALE: 1" = 10'

YATESVILLE LAKE DAM
CONTRACT: DACW69-86-C-0089

- "Z" piling was installed [illegible] from Notch [illegible] [illegible] [illegible]

12-01 P. SHEET PILING

Subcontractor

Richard Goettle Inc.

Types of Piling

- Temporary abutments for a access bridge across Blaine Creek ("Z" Piling)
- Temporary blockage of the downstream slurry cutoff wall ("Z" Piling)
- Cellular Cofferdam (Sheet Piling)

Cofferdam

Type:.....	Cellular sheet pile with concrete cell caps and concrete monoliths at the abutments.
Location:.....	Center line of cofferdam is 332.34' upstream of the dam centerline.
Number of Cells:....	Seven cells with connecting arcs.
Bottom Elevation:...	Sheets are driven to elev. 540 or top of rock.
Crest Elevation:....	Sheets are capped at elevation 616.

Equipment

1	3900 Manitowic crane
1	LS-338 Link Belt crane
5	Welding machines
1	416 ICE vibratory hammer
2	416 ICE power packs
1	440 Link Belt diesel pile hammer
1	105 Link Belt diesel pile hammer
-	Various storage and office trailers

Materials

Supplier:.....	Bethlehem Steel Corporation
Steel Sheet Piling PS 31:...	72476.8 LF
30 Degree Wye:.....	1610.8 LF
90 Degree Tee:.....	93.0 LF

Template

Single level template supported by rigid frames (tripods) on spud piles. Four "key sheets" (PS 31 welded to a H-pile) placed at 90 degree angles were placed to support sheet piles until closure was made.

12-01 P. SHEET PILING

Procedure

- Placement and alignment of template and drive "key sheets".
- Drive sheets with vibratory pile hammer until penetration rate drops to less than one foot per minute.
- Complete driving sheets with impact hammers with length and final blow count being recorded.
- Complete closure for cells or connecting arcs
- Splice additional sheet pile and trim to crest elevation 616.
- Fill cells and connecting arcs with fly ash and place 1' concrete cap.

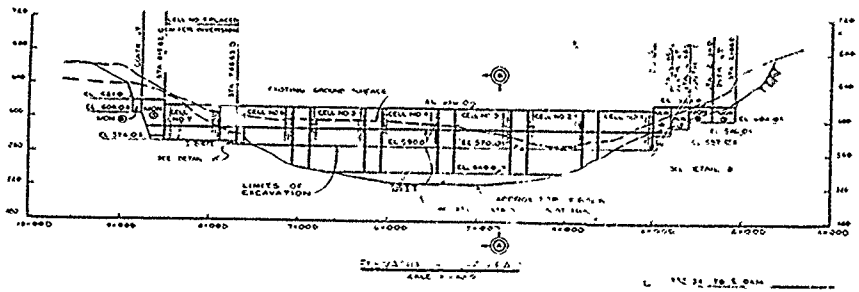
Chronological Sequence

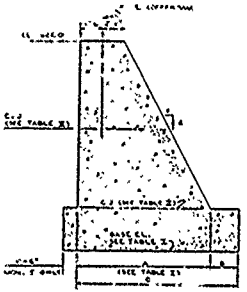
Sep 86		
	24	Began mobilization
	25	Began assembly of template
	25	Completed common excavation at cofferdam, elev. 570
Oct 86		
	30	Began placing sheet piling for cell #2
Nov 86		
	7-10	Placed "Z" piling for slurry cutoff wall
	14	Began placing sheet piling for cell #3
	19	Completed driving sheet piles for cell #2
	26	Completed driving sheet piles for cell #3
	26	Began placing sheet piling for cell #4
Dec 86		
	11	Began placing sheet piling for cell #5
	17	Completed driving sheet piling for cell #4
Jan 87		
	2	Began placing sheet piling for cell #6
	12	Completed driving sheet piling for cell #5
	13	Completed driving sheet piling for cell #6
	13	Began placing fill in cells
	26	Began placing sheet piling for cell #1
Feb 87		
	4	Completed driving sheet piling for cell #1
	18	Began trimming cells 1 - 6 to elevation 616
Mar 87		
	3	Completed trimming cells 1 - 6
	3	Completed filling cells 1 - 6
	26	Began placing concrete caps on cells 1 - 6
Apr 87		
	9	Began placing concrete monoliths on right abutment
	17	Completed placing concrete caps on cells 1 - 6
May 87		
	5	Completed placing concrete mono. on right abutment

Chronological Sequence (cont)

Sep 87		
	3	Began placing sheet piling for cell #7
	11	Completed driving sheet piling for cell #7
	16	Began placing concrete monoliths on left abutment
	30	Completed trimming, filling and capping cell #7
Oct 87		
	10	Completed placing concrete mono. on left abutment

Good Engineering Produces Better Environment

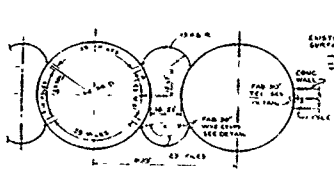




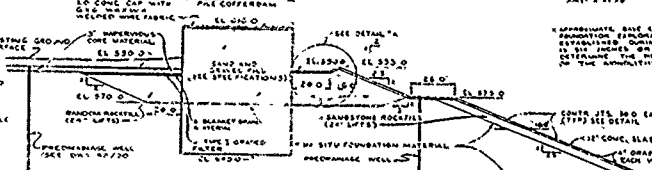
SECTION, CONCRETE WALL

TABLE II	
CONST. STG	MON. NO.
EL 5400	1,2,3,4,5
EL 5600	2,4,5
EL 5800	4,5
EL 5864.0	5
EL 5879.0	5

TABLE I			
MON. NO.	APPROX. BASE ELEVATION *	A	B	C
1	5405	10-6	—	10-6
2	5605	10-6	—	10-6
3	5855	13-0	3-6	17-6
4	6057	13-0	4-0	17-0
5	5772	25-0	5-0	30-0
6	6064	10-6	—	10-6

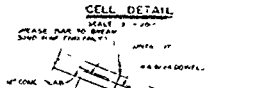


CELL DETAIL



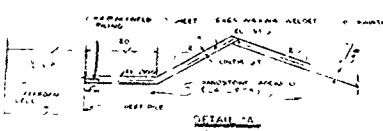
SECTION A-A

* APPROXIMATE BASE ELEVATIONS HAVE BEEN DETERMINED FROM FOUNDATION EXPLORATIONS. FINAL BASE ELEVATIONS WILL BE ESTABLISHED DURING CONSTRUCTION BY THE SUPERVISING OFFICER WHEN IN HIS OPINION, THE CONSTRUCTING OFFICER WILL DETERMINE THE NECESSITY FOR MODIFYING BASE WIDTHS OR THE ADMISSIBILITY INVOLVED



CELL DETAIL

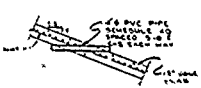
CONTR JT DETAIL



DETAIL 'A'

DETAIL 'B'

DETAIL 'C'



DRAIN DETAIL

KEY DETAIL

NOTES

Y FOR PLAN OF COFFERDAM, SEE DWG 52/10.

E CONCRETE SLAB WILL BE BANKED WITH A PAVEMENT BREAKER AS TAN IS PLACED SO THAT ENOUGHMENT IS PLACED ONLY AGAINST BROKEN CONCRETE. THIS NOTE APPLIES TO 1V ON 2OH SLOPES ONLY. EXCEPT TOP OF ROCK AND EL 5850. BREAKING ERODE THE ENCHMENT 6V AS WORK THEIN 6" VERTICALLY

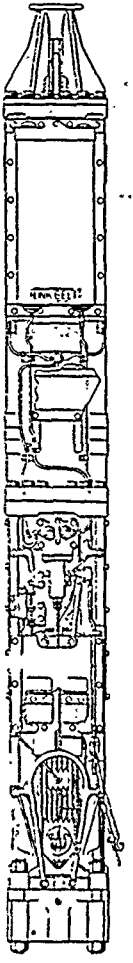
U.S. ARMY ENGINEER DISTRICT, HUNTINGTON
CORPS OF ENGINEERS
HUNTINGTON, W. VA.

BLAINE CREEK, KENTUCKY
YATESVILLE LAKE
DAM AND APPURTENANT WORKS-PHASE II
DAM
COFFERDAM DETAILS

DRAWING NO. 014-YBC-D-52/17

FMC

Link-Belt®
Model 440
Diesel Pile Hammer



Working Specifications

Rated equivalent WH energy	18,200 ft. lbs. (2,517 kgm)
Rated equivalent ram stroke	4' 8" (1.42 m)
Horsepower rating	49.6
Speed — blows per minute	88-92

Weights

Average hammer operating weight w/o driving head or filler	9,839 lbs. (4,463 kg)
Ram weight	4,000 lbs. (1,814 kg)
Anvil weight	705 lbs. (320 kg)
Recoil dampener adaptor assembly	520 lbs. (236 kg)

Capacities (Adequate for normal day)

Diesel fuel tank	13 gal. (49.21 liters)
Lube oil tank	1.8 gal. (6.81 liters)

Dimensions of Hammer

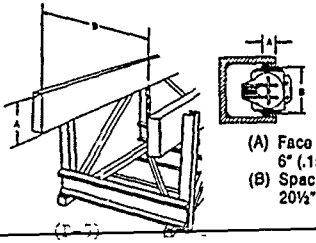
Width (side to side)	20" (.51 m)
Depth (does not include driving head)	34½" (.87 m)
Centerline to front	17 1/16" (.43 m)
Centerline to rear	17 1/16" (.43 m)
Hammer length only — with free fall starting device with "Y" hitch	13' 5¾" (4.11 m)
Average length of hammer, top of cylinder head to pile driving surface of driving head	13' 9¼" (4.20 m)
Average length of hammer, top of "Y" hitch lifting eye to driving surface of driving head (includes starting stroke)	19' 1" (5.82 m)
Hammer length only — with optional centerline lift starting device	14' 6¼" (4.43 m)
Average length of hammer, top of cylinder head to pile driving surface of driving head	15' 7½" (4.76 m) ①

① This dimension includes starting stroke if hoist line is attached directly to starting device. If starting and handling wire rope furnished with hammer is used, 14" (.36 m) must be added to hammer length and 37½" (.95 m) must be added for starting stroke.

Dimensions for Leads

Face width of guide rails (A)	6" (.15 m), 7" (.18 m), 8" (.20 m), or 9" (.23 m)
Distance between guide rails (B)	20½" (.52 m)

Note: Pads for wider leads, guide angles for other width rails, and guide clips for spud type leads are available.



(A) Face width of guide rails. 6" (.15 m) to 9" (.23 m)
(B) Space between guide rails. 20½" (.52 m)

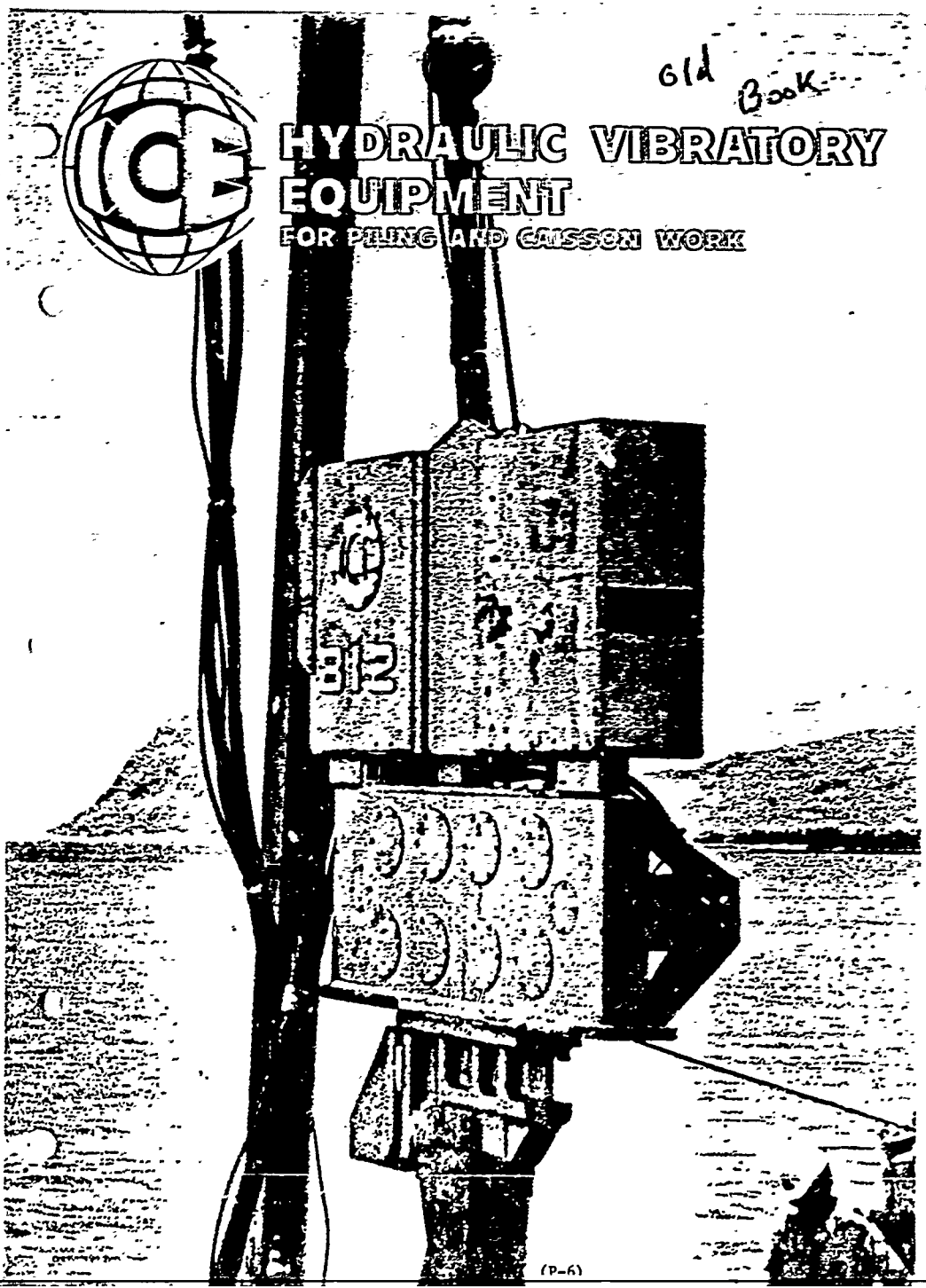
0025757.5
(Supersedes 440 D.P.H. Spec's CBS00831A-6-67 and CBS00831A-C-67)

Printed in U.S.A.

Old Book

HYDRAULIC VIBRATORY EQUIPMENT

FOR PILING AND CAISSON WORK



(P-6)

ICE'S COMPLETE RANGE OF HYDRAULICALLY-POWERED VIBRATORY PILE DRIVER/EXTRACTORS

- Three models
- Large eccentric moments
- Wide frequency ranges
- Reliable hydraulic power
- Advanced vibration suppressor
- Simple, rugged design
- Quiet

The ICE Model 215, 416 and 812 are hydraulically-powered, vibratory pile driver/extractors designed for maximum production and low maintenance and operating costs.

THREE MODELS. LARGE ECCENTRIC MOMENTS.

Three models allow the proper equipment to be selected for every job. The economical 216 is ideally suited to many less difficult jobs. The mid-size 416 is designed for average to hard pile driving and extracting work. The 812, the largest vibrator available, will handle the most difficult piling and caisson work. All three models have large eccentric moments for maximum driving and extracting force.

WIDE FREQUENCY RANGE.

All three models have variable frequencies to provide the most effective driving and extracting over the widest range of soil conditions.

HYDRAULICALLY POWERED.

Simple, reliable hydraulic power means low down-time and maintenance, high production, and low operating costs.

ADVANCED VIBRATION SUPPRESSOR.

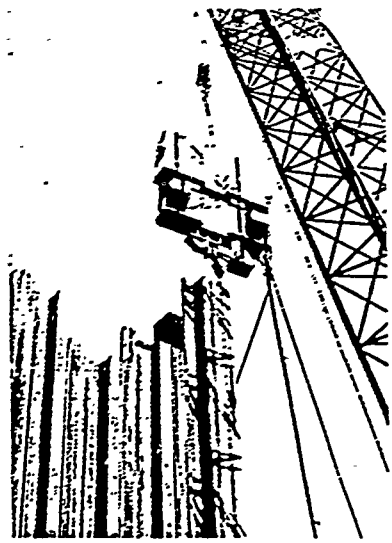
Transmission of vibration to the crane boom is virtually eliminated by the unique vibration suppressor. Rubber elastomers in a Z-pattern combine a high degree of vibration isolation with a 40-ton load capability for extraction.

DESIGNED FOR THE FIELD.

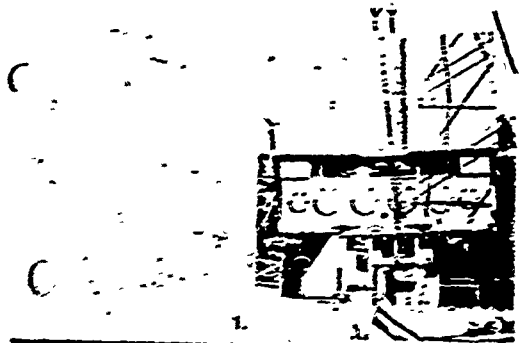
ICE vibratory drivers were designed by field-experienced foundation construction people. Vibrators and power packs feature simple, rugged designs to minimize field down-time and to speed repairs when trouble does occur. All parts for the unit are available in the United States. Ships with head attached for quick set-up.

LOW NOISE POLLUTION.

The vibratory drivers are virtually noiseless. The rubber elastomers in the vibration suppressor eliminate the spring-noise which sometimes occurs with other vibratory drivers. On the Models 416 and 812, the power pack is completely enclosed to reduce noise. Air intake and exhaust are both upward. An optional sound reduction package is available to further reduce noise.



ICE MODEL 812—350 HP—THE LARGEST VIBRATOR AVAILABLE TODAY



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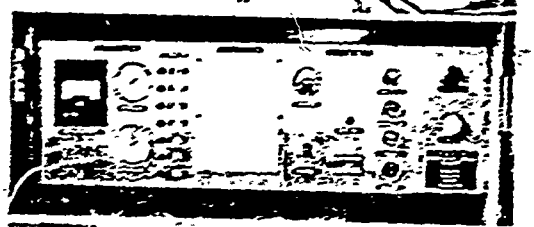

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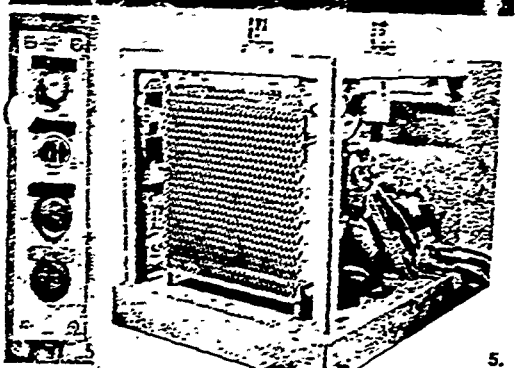

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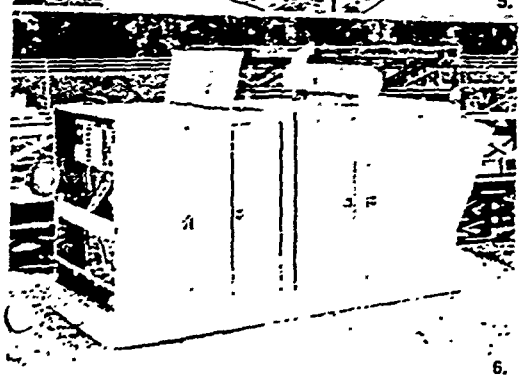


6.

1. The new Model 215 is the most economical vibratory pile driver/extractor available. And the 215 has all of the features of the larger 415 and 812—40-ton suppressor, variable frequency, remote-control pendant, replaceable gripping jaws, reliable hydraulic power.

2. The highly successful 415 is job proven from the cold of northern Canada to the heat of Nigeria and from 20-foot sheet piling to 65" diameter caissons.

3. On the 416 and 812, all controls and gages are located on a control panel at the rear of the power pack. In addition to the operating controls and gages, a trouble-shooting panel is provided to help locate and correct problems should they occur. Operating instructions are also located on the control panel to remind operators of proper operating and maintenance procedures. A large tool compartment is located beneath the control panel.

1. All vibrator functions are controlled from a remote-control pendant. A 50-foot cord allows operation from any position near the unit. Controls are provided to start and stop vibration and to close and open the hydraulic clamp in the driving head. A light indicates adequate clamping pressure to begin vibration.

5. The rugged, compact 216 power pack is protected by a heavy-duty steel frame. The combination subbase and fuel tank holds 110 gallons of fuel. The unit has a single-point lifting bail. Hose connections to the vibrator are made with quick-disconnect couplers. All operating controls are located on two side-by-side panels at the side of the unit.

6. The 416 and 812 power packs are totally enclosed in heavy-duty sheet metal. Air intake through the front door and air exhaust through a top door are both upward to reduce noise. The front door also protects the hydraulic oil cooler and engine radiator from damage and vandalism. A single-point lifting bail is provided. Hose connections to the vibrator are with quick-disconnect couplers.

COMPONENTS AND OPERATION

The ICE vibratory driver/extractor has five major operating components—vibration case, driving/extracting head, vibration suppressor, power pack, and remote-control pendant.

The eccentric weights in the vibration case are driven by hydraulic motors mounted on the vibration case. The motors and eccentrics are gear connected to maintain proper synchronization.

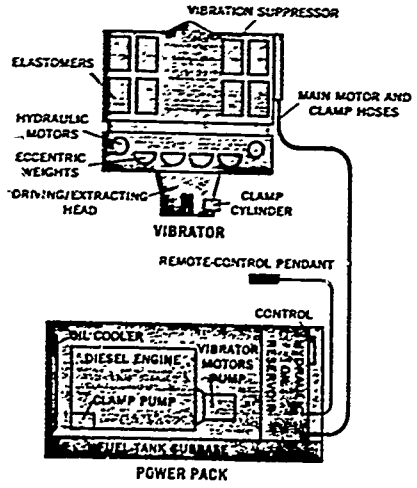
The driving/extracting head contains two gripping jaws—one stationary and one moveable. A large hydraulic cylinder operates the moveable jaw to grip the pile. Clamping and unclamping occurs in a few seconds.

The vibration suppressor is constructed with rubber elastomers to isolate the vibration case from the crane line. It is deigned for a maximum line pull of 40 tons during extraction.

The totally enclosed power pack is mounted on a skid type fuel tank sub-base. A control panel at the rear of the unit contains all operating gages and controls. A common reservoir supplies hydraulic fluid to separate hydraulic pumps—one for the main vibrator motors, one for the clamp in the driving/extracting head.

Three hydraulic hoses connect the power pack to the hydraulic motors in the vibrator. Separate hydraulic hoses run from the power pack to the driving/extracting head.

The hand-held, remote-control pendant has two push-buttons, a two-way switch, and an indicator light. The buttons start and stop vibration. The switch closes and opens the hydraulic clamp in the driving/extracting head. The light indicates that adequate clamping pressure exists for vibration to begin.

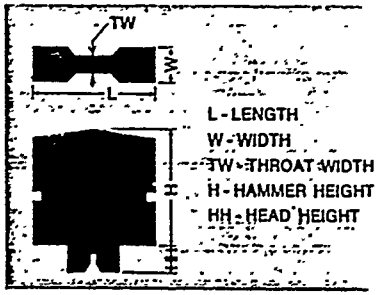


MODEL 812
DRIVING Z-PILING NEAR
ST. LOUIS, MISSOURI

SPECIFICATIONS

36.3 Tons | 65.4 Tons | I HAVE NOW! | 73.6 Tons.

	MODEL 216		MODEL 416		MODEL 812	
	English	Metric	English	Metric	English	Metric
VIBRATOR						
Type	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic
Eccentric moment	1000 in-lbs	1152 kg-cm	1800 in-lbs	2074 kg-cm	3600 in-lbs	4146 kg-cm
Frequency	800-1600 vpm	800-1600 vpm	480-1600 vpm	480-1600 vpm	750-1200 vpm	750-1200 vpm
Amplitude	¼-¾ inch	3-19 mm.	¼-1 inch	7-25 mm.	½-1 inch	12-25 mm.
Horsepower	115	115	220	220	350	350
Pile clamping force	50 tons	45 tonnes	100 tons	91 tonnes	100 tons	91 tonnes
Max. line pull for extraction	40 tons	36 tonnes	40 tons	36 tonnes	40 tons	36 tonnes
Suspended weight, with head	4500 lbs	2042 kg.	12,200 lbs	5445 kg.	14,700 lbs	6670 kg.
Length	47 in.	1194 mm.	96 in.	2440 mm.	96 in.	2440 mm.
Width	12 in.	305 mm.	22 in.	560 mm.	24 in.	610 mm.
Throat width	12 in.	305 mm.	12 in.	305 mm.	12 in.	305 mm.
Height with head	78 in.	1981 mm.	105 in.	2670 mm.	117 in.	2970 mm.
Height without head	68 in.	1727 mm.	76 in.	1930 mm.	88 in.	2235 mm.
POWER PACK						
Type	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic
Engine	CAT 3208	CAT 3208	AC 21000	AC 21000	AC 25000	AC 25000
Horsepower, max.	175	175	375	375	450	450
Weight	7500 lbs	3403 kg.	14,000 lbs	6355 kg.	15,500 lbs	7035 kg.
Length	96 in.	2458 mm.	154 in.	3910 mm.	154 in.	3910 mm.
Width	60 in.	1524 mm.	60 in.	1525 mm.	60 in.	1525 mm.
Height	68 in.	1727 mm.	90 in.	2290 mm.	90 in.	2290 mm.



Constant improvement and engineering progress make it necessary that we reserve the right to make specification, equipment and price changes without notice.

MODEL 216 SPECIFICATIONS

VIBRATION SUPPRESSOR—Forty ton line pull for extraction. Sixteen rubber elastomers isolate crane line from vibration case. Built-in safety stops. Single attach-point for crane line. Filter has replaceable element. Non-vibrating weight of 1850 lbs. assists driving.

VIBRATION CASE—Two eccentric weights mounted on parallel shafts. Shafts mounted in heavy-duty spherical roller bearings. Hydraulic motor mounted at end of vibration case. Motor and eccentric shafts connected by gear train to maintain synchronization. Splash lubricating system. Motor rated at 115 HP at 100 GPM and 2000 PSI. Vibration frequency 800 to 1600 vibrations per minute. Amplitude ¼-¾ inch.

DRIVING/EXTRACTING HEAD — Double-acting hydraulic cylinder (50 tons at 2000 PSI). Replaceable gripping jaws accept various types and sizes of piles. Cylinder guard protects hydraulic cylinder.

POWER-PACK—Protected by heavy-duty steel frame. 110 gallon fuel tank integral with square tubing subbase. Single point lifting attachment.

DIESEL ENGINE—CAT 3208 diesel. Eight cylinder O.H.V. Displacement 636 cu. in. Bore & stroke 4.5 x 5.0 inches. Horsepower 160 at 2400 RPM. Torque 400 ft. lbs. at 1400 RPM. Combustion system four cycle, normally aspirated.

HYDRAULIC SYSTEM

Type—Open Loop

Reservoir—270 gallon capacity. All steel welded construction with integral baffles. Clean-out access and exterior oil sight gage. Cavity for immersion heater. Fills by manual pump.

Filters—Return line, full flow, 25 micron replaceable cartridge with bypass protection and bypass indicator. Pick-up line strainer.

Pumps—Drive pump 100 GPM, 2000 PSI. Clamp pump 6½ GPM, 2000 PSI.

Control Valves—Precision two and four-way valves. Main and clamp circuit relief valves. Maximum operating pressure 2000 PSI.

Heat Exchanger—Full flow, fin and tube, oil and air.

Hoses—1¼ inch ID vibrator motor drive and return hoses. ⅜ inch ID clamp pressure and return hoses. ¾ inch motors case drain hose. All 100 feet long.

CONTROL PANEL INSTRUMENTATION—Tachometer. Engine water temperature gage. Engine oil pressure gage. Ammeter. Engine hour meter. Engine start switch. Drive pressure gage. Clamp pressure gage. Vibrator power-on switch.

CONTROL PENDANT—Hand held. 50-foot cable. 24 volt. Vibrator start-stop switch. Clamp close-open switch. Indicator light for adequate clamping pressure.

MODEL 416 SPECIFICATIONS

VIBRATION SUPPRESSOR—Forty ton line pull for extraction. Eight rubber elastomers isolate crane line from vibration case. Built-in safety stops. Single attach-point for crane line. Contains 85 gallon per minute 5000 psi filter on motors pressure line. Filter has replaceable elements. Manifold distributes hydraulic fluid to two motors and clamp. Non-vibrating weight of 4500 lbs. assists driving.

VIBRATION CASE—Four eccentric weights mounted on parallel shafts. Shafts mounted in heavy-duty spherical roller bearings. Two hydraulic motors mounted at end of vibration case. Motors and eccentric shafts connected by gear train to maintain synchronization. Splash lubricating system. Motors rated at 110 HP each at 80 GPM and 5000 PSI. Bolt pattern in bottom accepts standard driving heads. Vibration frequency 480 to 1600 vibrations per minute. Amplitude ¼-1 inch.

DRIVING/EXTRACTING HEAD — Double-acting hydraulic cylinder (100 ton at 4000 PSI, 125 ton at 5000 PSI). Replaceable gripping jaws accept various types and sizes of piles. Cylinder guard protects hydraulic cylinder. Removeable pile guard directs pile into gripping jaws.

POWER PACK—Totally enclosed in heavy-duty sheet metal. 135 gallon fuel tank integral with square tubing subbase. Air intake and exhaust upward for quiet operation. Single point lifting attachment. Sheet-metal door closes to protect engine radiator and hydraulic fluid heat exchanger.

DIESEL ENGINE—Allis-Chalmers 21000 diesel. Six cylinder O.H.V. Displacement 844 cu. inches. Bore and stroke 5¼ x 6½ inches. Horsepower (max.) 375 at 2100 RPM. Governed RPM 2000. Peak torque (net) 1048 Ft.-Lbs. @ 1400 RPM. Electrical system 12 volts, positive ground. Combustion system 4 cycle, turbocharged. Cooling system 16 gallons liquid. Batteries (2) 8D, Air Cleaner—dry type.

HYDRAULIC SYSTEM

Type—Open Loop

Reservoir—345 gallons capacity. All steel welded construction with integral baffles. Clean-out access and exterior oil sight gage. Cavity for immersion heater. Fills by manual pump.

Filters—Return line, full flow, 10 micron replaceable cartridge with bypass protection and filter bypass indicator. Pick-up line, full flow, 75 micron, replaceable cartridge with bypass protection and filter bypas indicator. Drive pressure line, full flow, 10 micron, replaceable cartridge with bypass protection and filter bypass indicator. Bypass on pick-up or return lines automatically shuts down diesel engine.

Pumps—Drive pump 85 GPM, 5000 PSI. Clamp pump 6½ GPM, 5000 PSI.

Control Valves—Precision two and four-way valves. Main and circuit relief valves. Maximum operating pressure 5000 PSI.

Heat Exchanger—Full flow, fin and tube, oil and air.

Hoses—1¼ inch ID vibrator motors drive and return hose. ⅜ inch ID clamp pressure hose. ¾ inch ID clamp return and motors case drain hose. All 150 feet long.

CONTROL PANEL INSTRUMENTATION — Hydraulic fluid monitor. Drive pressure gage. Clamp pressure gage. Shut-down indicator lights for engine overspeed, engine water overheating, engine oil pressure being low, oil return filter being clogged, pick-up filter clogged, high hydraulic fluid temperature. Engine tachometer. Main power switch. Engine start button. Shutdown reset switch. Engine oil pressure gage. Engine water temperature gage. Ammeter. Engine hour meter. Engine throttle. Engine stop knob.

CONTROL PENDANT—Hand held. 50-foot cable. 24 volt. Buttons to start and stop vibration. Switch to close and open driving/extracting head. Indicator light for adequate clamping pressure.

MODEL 812 SPECIFICATIONS

VIBRATION SUPPRESSOR—Forty ton line pull for extraction. Eight rubber elastomers isolate crane line from vibration case. Built-in safety stops. Single attach-point for crane line. Contains 125 gallon per minute 5000 PSI filter on motors pressure line. Filter has replaceable element. Manifold distributes hydraulic fluid to two motors and clamp. Non-vibrating weight of 4500 lbs. assists driving.

VIBRATION CASE—Eight eccentric weights mounted on parallel shafts. Shafts mounted in heavy-duty spherical roller bearings. Two hydraulic motors mounted on vibration case. Motors and eccentric shafts connected by gear train to maintain synchronization. Splash lubricating system. Motors rated at 175 HP each at 125 GPM and 5000 PSI. Bolt pattern in bottom accepts standard driving heads. Vibration frequency 750 to 1200 vibrations per minute. Amplitude ½-1 inch.

DRIVING/EXTRACTING HEAD — Double-acting hydraulic cylinder (100 ton at 4000 PSI, 125 ton at 5000 PSI). Replaceable gripping jaws accept various types and sizes of piles. Cylinder guard protects hydraulic cylinder. Removeable pile guide directs pile into gripping jaws.

POWER PACK—Totally enclosed in heavy-duty sheet metal. 135 gallon fuel tank integral with square tubing subbase. Air intake and exhaust upward for quiet operation. Single point lifting attachment. Sheet-metal door closes to protect engine radiator and hydraulic fluid heat exchanger.

DIESEL ENGINE—Allis-Chalmers 25000 diesel. Six cylinder O.H.V. Displacement 844 cu. inches. Bore & stroke 5¼ x 6½ inches. Horsepower (max.) 450 at 2100 RPM. Governed RPM 2000. Peak torque (net) 1248 ft.-lbs. @ 1500 RPM. Electrical system 12 volts, positive ground. Combustion system 4 cycle, turbocharged, intercooled. Cooling system 16 gallon liquid. Batteries (2) 8D. Air Cleaner—dry type.

HYDRAULIC SYSTEM

Type—Open Loop

Reservoir—345 gallons capacity. All steel welded construction with integral baffles. Clean-out access and exterior oil sight gage. Cavity for immersion heater. Fills by manual pump.

Filters—Return line, full flow, 10 micron replaceable cartridge with bypass protection and filter bypass indicator. Pick-up line, full flow, 75 micron, replaceable cartridge with bypass protection and filter bypass indicator. Drive pressure line, full flow, 10 micron, replaceable cartridge with bypass protection and filter bypass indicator. Bypass on pick-up or return lines automatically shuts down diesel engine.

Pumps—Drive pump 125 GPM, 5000 PSI. Clamp pump 6½ GPM, 5000 PSI.

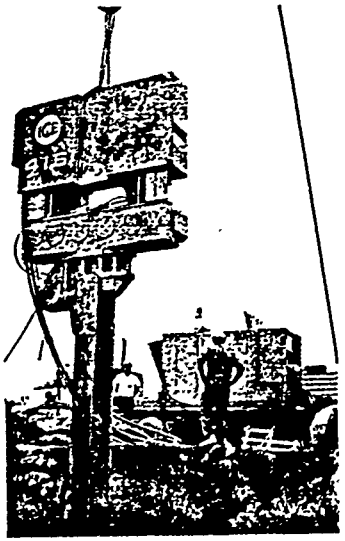
Control Valves — Precision two and four-way valves. Main and circuit relief valves. Maximum operating pressure 5000 PSI.

Heat Exchanger—Full flow, fin and tube, oil and air.

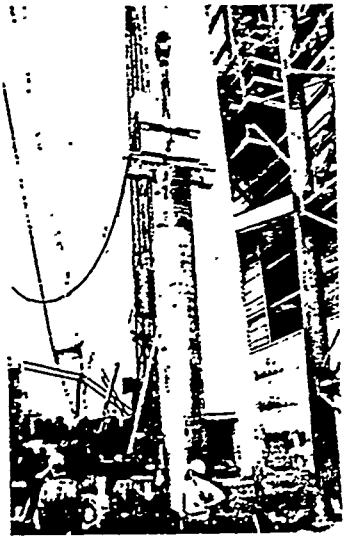
Hoses—1½ inch ID vibrator motors drive and return hose. ⅜ inch ID clamp pressure and return hoses. ¾ inch motors case drain hose. All 150 feet long.

CONTROL PANEL INSTRUMENTATION — Hydraulic fluid monitor. Drive pressure gage. Clamp pressure gage. Shutdown indicator lights for engine overspeed, engine water overheating, engine oil pressure being low, oil return filter being clogged, pick-up filter clogged, high hydraulic fluid temperature. Engine tachometer. Main power switch. Engine start button. Shutdown reset switch. Engine oil pressure gage. Engine water temperature gage. Ammeter. Engine hour meter. Engine throttle. Engine stop knob.

CONTROL PENDANT—Hand held. 50-foot cable. 24 volt. Buttons to start and stop vibration. Switch to close and open driving/extracting head. Indicator light for adequate clamping pressure.



MODEL 416 EXTRACTING 14" H-BEAMS IN WASHINGTON, D. C.



MODEL 812 INSTALLING 30-66" DIAMETER CAISSONS 85' LONG IN WEST VIRGINIA

12-02 FOUNDATION CURTAIN GROUTING

Description	Page
Location and Description	Q-1
Grouting Procedure	Q-6
Equipment	Q-9
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Statistical Data	
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12-02 FOUNDATION CURTAIN GROUTING

Location and Description

General

Location:	Impervious core section of dam foundation.
Surface:	Top of rock
Grout Lines:	2 to 5 parallel lines
Hole Spacing:	20' center to center spacing between primary holes.
Zones:	1 to 2

Drilling

Method:	Rotary drilling
Hole Diameter:	1-7/8 inch
Angles:	Vertical to 60°
Drill Depths:	20.5' to 98.0'

Pressure Testing

Connection:	Air packer, close to surface
Pressures:	5 psi to 20 psi
Minimum Time:	5 min

Grouting

Method:	Stage grouting - split spacing
Type:	Water & cement type I & II
Mix:	6:1 to 0.75:1
Connection:	Air packer, close to surface
Pressures:	4 psi to 25 psi
Hole Completion:	When hole "holds" 3/4 grouting pressure

Grout Lines

Line "A"

Location:	16' U/S of centerline, sta. 1+34 to 9+96
Angle:	10° upstream
Fans:	left and right abutments
Zones:	
1	0' to 20' vertical depth, primary and secondary holes required.
2	20' to 60' vertical depth, primary holes required.

12-02 FOUNDATION CURTAIN GROUTING

Location and Description (cont)

Grout Lines (cont)

Line "B"

Description:	Optional line determined on grout takes in lines "A" and "C".
Location:	8' upstream of centerline, sta. 7+35 to 5+05, and 3+75 to 3+15.
Angle:	Vertical
Zones:	one zone, 0' to 30' or 0' to 35'. Primary required with secondary holes being required between sta. 7+35 to 5+05.

Line "C"

Locatien:	Centerline, sta. 1+20 to 9+97.
Angle:	30° toward abutments with over lap area in valley bottom.
Fans:	Left and right abutments
Zones:	
1	0' to 50' vertical depth, primary and secondary holes required.
2	50' to 75' vertical depth, primary holes required.

Line "D"

Description:	This line was added to treat broken rock zones in the valley bottom.
Location:	20' downstream of centerline, sta. 6+75 to 4+95.
Angle:	Vertical
Zones:	One zone, 0' to 35' depth, primary and secondary holes required.

12-02 FOUNDATION CURTAIN GROUTING

Location and Description (cont)

Line "E"

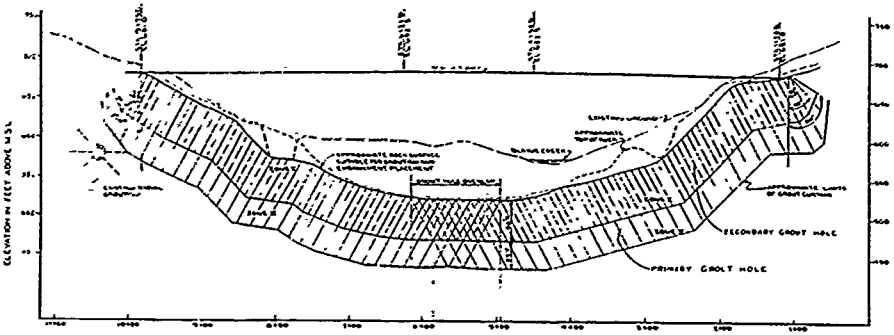
Description:.....	This line was added to treat broken rock zones in the valley bottom.
Location:.....	37' upstream of centerline, sta. 6+40 to 5+00.
Angle:.....	vertical
Zones:.....	One zone, 0' to 35' depth, primary and secondary holes required.

Other

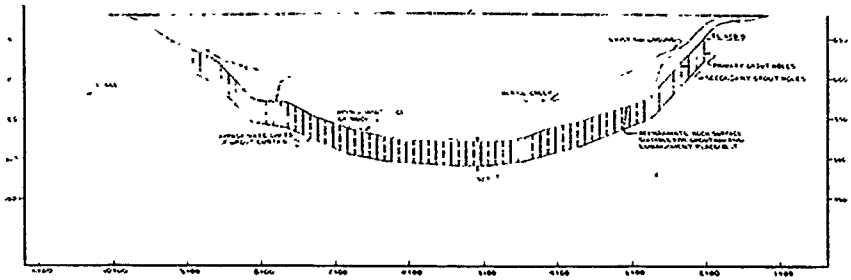
Description:.....	Various holes placed to treat joints, bedding planes and contact grouting that was not treated by foundation curtain grouting.
Location:.....	Various locations and arrangements within the impervious core section of the dam foundation.
Angle:.....	vertical to 30°
Zones:.....	one zone, various depths with a maximum of 10', secondary holes not required.

12-02 FOUNDATION CURTAIN GROUTING

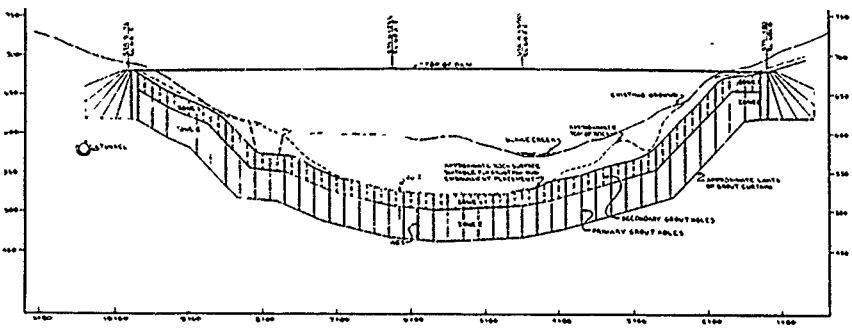
Location and Description



GROUT LINE 'C'-GROUT HOLES BATTERED TOWARD ABUTMENTS: ℄ DAM



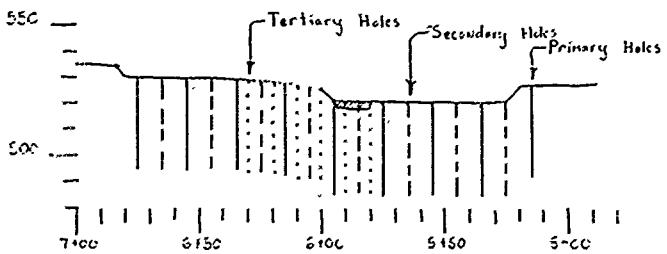
GROUT LINE 'B'-VERTICAL GROUT HOLES
8.0' UPSTREAM OF ℄ DAM



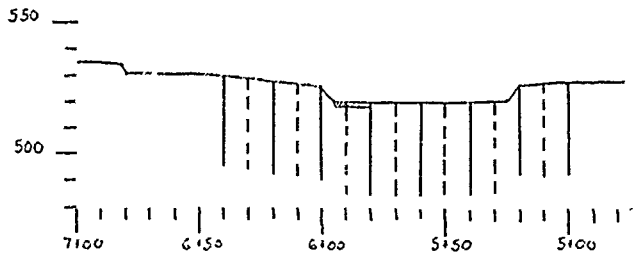
GROUT LINE 'A'-GROUT HOLES BATTERED 10° UPSTREAM
16.0' UPSTREAM OF ℄ DAM

12-02 FOUNDATION CURTAIN GROUTING

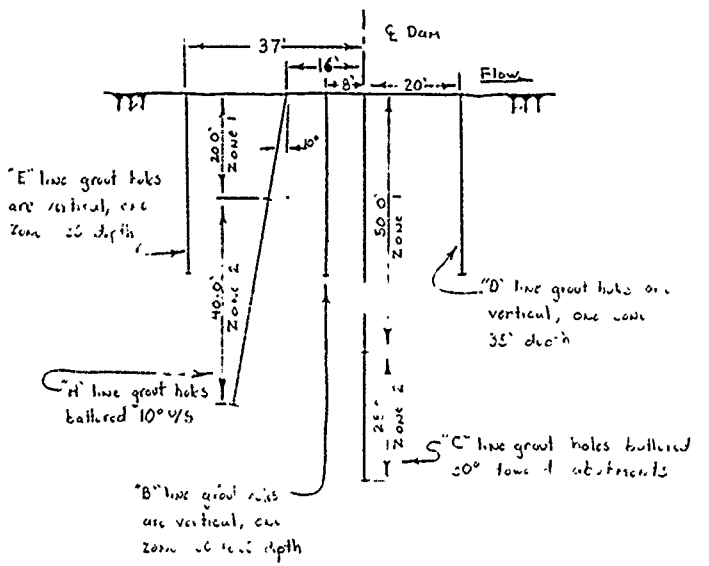
Location and Description



GROUT LINE "D" - VERTICAL - 20' D/S of ℄



GROUT LINE "E" - VERTICAL - 37' U/S of ℄



GROUTING DETAIL

12-02 FOUNDATION CURTAIN GROUTING

Grouting Procedure

Preparation

- Complete overburned and rock excavation to final grade.
- Survey proper locations for grout holes.
- Drill hole for nipple, 1.5' deep, at proper angle.
- Water test hole, if leakage occurs then gravity grout.
- Install 3" diameter nipple.

Drilling

- Align drill at proper angle and complete drilling to designed drill depth to bottom of zone.
- Equipment
  - Drill: CP-65 rotary drill mounted on a track drill, stabilized with cables attached to air powered tuggers located on the abutments.
  - Bits: 1 7/8 inch carbide tipped bits manufactured by Christensen Mining Products.
- If substantial drill water loss or artesian flow is encountered before completion of a zone, then the hole was "staged".
- The hole was washed after drilling was completed.

Pressure Testing

- After the completion of drilling a hole to the bottom of the stage or zone, the hole was then pressure tested with water at a minimum of 5 minutes.
- Equipment
  - Packer: Nitrogen inflated, installed at 2' depth
  - Header: Equip with a pressure gauge (psi), a flow meter (cu. ft.) and pressure relief valve.
- Pressures during testing was essentially 4 psi within zone 1, and 8 psi in zone 2.
- If surface connections or connections between holes were encountered, pressure testing would continue until water becomes clear and determine the effect on water flow as the connecting hole is plugged.
- If artesian flow is encountered the packer was placed at a 20' depth and 20 to 25 psi pressure was used to overcome the artesian pressure.

12-02 FOUNDATION CURTAIN GROUTING

- Grouting Procedure (cont)

Grouting

- A hole was grouted if a flow of 0.2 cu. ft. was encountered during pressure testing.
- Equipment
  - Grout Plants: 30 cu. ft. tub type mixer, 10 cu. ft. colloidal type mixer, and 20 cu. ft. agitator tank.
  - Header: Equip with a pressure gauge (0 to 60 psi) and a pressure relief valve.
- Holes were grouted by using the same pressures and packer placement as was used during the pressure testing.
- Grout mixes and volumes used was determined by the inspector from information gathered during pressure testing.
- If surface connections would occur, a series of grout circulation and caulking cycles would be performed.
- If premature blockage of grout flow, or excessive grout take, or excessive mechanical downtime would occur; the hole would be washed out and regrouted.
- Grouting was considered complete, for a hole, if 3/4 of the grouting pressure could be maintained during grout circulation.
- A hole would be "spilt spaced" if the grout take would equal or exceed 5.0 cwt cement.

- Sequence of drilling and grouting within a given 100' section would include:

  Primary, zone 1, lines "A" and "C"
  Secondary, zone 1, lines "A" and "C"
  Split space holes if needed; tertiary, quaternary, etc.

  Primary, zone 2, lines "A" and "C"
  Split space holes if needed; secondary, tertiary, etc.

  Primary, line "B"
  Secondary, line "B"
  Split spaced holes if needed

  Primary, lines "D" and "E"
  Secondary, lines "D" and "E"
  Split spaced holes if needed

  Additional grouting; joint treatment, contact grouting, and bedding planes.

12-02 FOUNDATION CURTAIN GROUTING

Grouting Procedure (cont)

Chronological Sequence of Drilling and Grouting (Boyles Bros. Drilling Co.)

21 Jul 86	Mobilization for exploratory drilling, spillway.
22 Jul 86	Began exploratory drilling, spillway bridge.
01 Aug 86	Completed exploratory drilling, spillway bridge.
05 Aug 86	Sealed exploratory holes in spillway.
05 Aug 86	Completed demobilization of drilling equipment.
24 Aug 87	Preparatory meeting for foundation grouting.
10 Sep 87	Began mobilization for foundation grouting.
23 Sep 87	Mobilized exploratory drilling equipment.
23 Sep 87	Began placing nipples for foundation grouting.
24 Sep 87	Began exploratory drilling: holes EX-1 thru EX-11.
30 Sep 87	Completed exploratory drilling: EX holes. *
30 Sep 87	Began pressure testing EX holes.
01 Oct 87	Completed pressure testing EX holes.
01 Oct 87	Began sealing EX holes.
02 Oct 87	Completed sealing EX holes.
06 Oct 87	Began found. drilling and grouting; 3+00 to 4+80.
22 Oct 87	Began grout lines A & C from sta. 4+80 to 8+00
29 Oct 87	Completed found. grouting from sta. 3+00 to 4+80.
17 Dec 87	Began grout lines B, D & E; sta. 4+80 to 8+00
18 Dec 87	Completed grout lines A & C; sta. 4+80 to 8+00.
20 Jan 88	Completed grout lines B, D & E; sta. 4+80 to 8+00.
21 Jan 88	Began contact grouting for dental concrete.
25 Jan 88	Completed contact grouting for dental concrete.
28 Jan 88	Began drilling exploratory holes CG-1 thru CG-9.
29 Jan 88	Began pressure testing CG exploratory holes.
01 Feb 88	Began foundation grouting; sta 1+20 to 3+00.
04 Feb 88	Completed drilling CG exploratory holes.
04 Feb 88	Completed pressure testing CG exploratory holes.
05 Feb 88	Sealed CG exploratory holes.
29 Feb 88	Completed found. grouting; sta. 1+20 to 3+00.
10 Mar 88	Began foundation grouting; sta. 8+00 to 10+00.
05 Apr 88	Completed found. grouting; sta. 8+00 to 10+00.
06 Apr 88	Completed foundation curtain grouting.
13 Apr 88	Began drilling drainage holes in spillway walls.
26 Apr 88	Completed drilling drainage holes in spillway.
28 Apr 88	Completed demobilizing equipment.

- All exploratory holes were 4-inch diameter EX and CG refers to the hole numbers.

12-02 FOUNDATION CURTAIN GROUTING

Equipment List
(Boyles Bros. Drilling Co.)

Grout Plants

1	30 cu. ft. tub type mixer, special made
1	10 cu. ft. Chemgrout colloidal type mixer
1	20 cu. ft. agitator tube, special made

Grout Pumps

3	Moyno 3L10 progressive cavity pumps
1	Moyno 3L3 progressive cavity pump

Rotary Drills

5	C. P. 65 air drills mounted on air tracks
2	Ingersoll-Rand air tracks
2	Longyear 44, truck mounted core drills

Bits

Drilling and Grouting

13	AW size Chrisdrill carbide plug type 20-387-445
1	AW size diamond plug type bit
1	AW size drag bit

Drain Holes

1	NXBW size Christensen core bit type 20-152-385
1	NX size Christensen concave plug type 20-186-052

Exploratory Drilling

1	7-inch tricone roller rock bit
1	4-inch diamond core bit

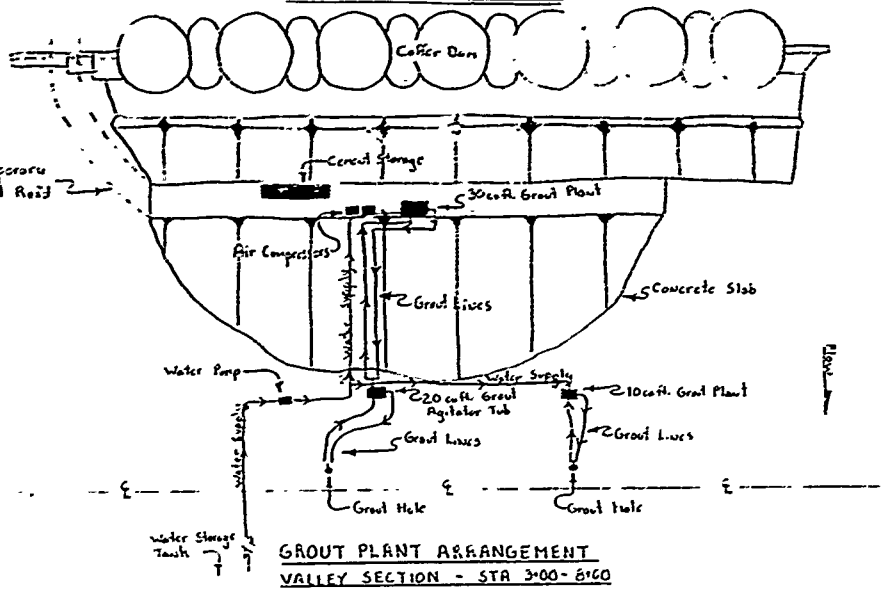
Air Compressors

1	750 Ingersoll-Rand air compressor
1	750 Sullair air compressor

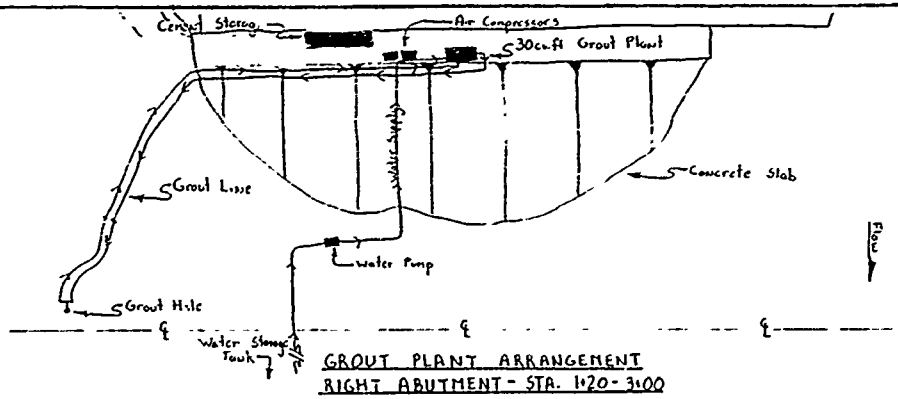
Miscellaneous

1	227T Sellick fork lift
2	Garden Denver air powered water pumps
1	Water supply tank
2	Ingersoll-Rand 4,000 lbs. air tugger
1	Supply trailer
2	F250 Ford 4X4 trucks
2	Light plants
-	Grout, water and air lines; gauges; meters; etc.
-	Cement: Kosmos type I and II, 94 lb. bags
-	Water source: Blaine Creek

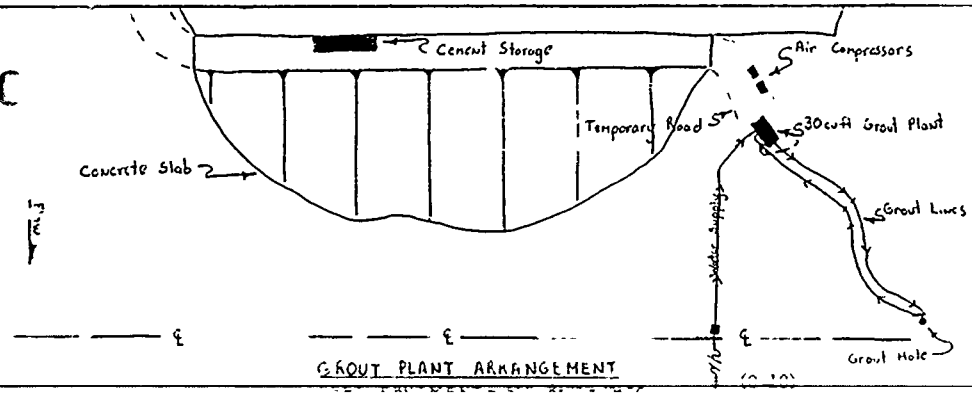
GROUTING EQUIPMENT



GROUT PLANT ARRANGEMENT
VALLEY SECTION - STA 3+00 - 6+60



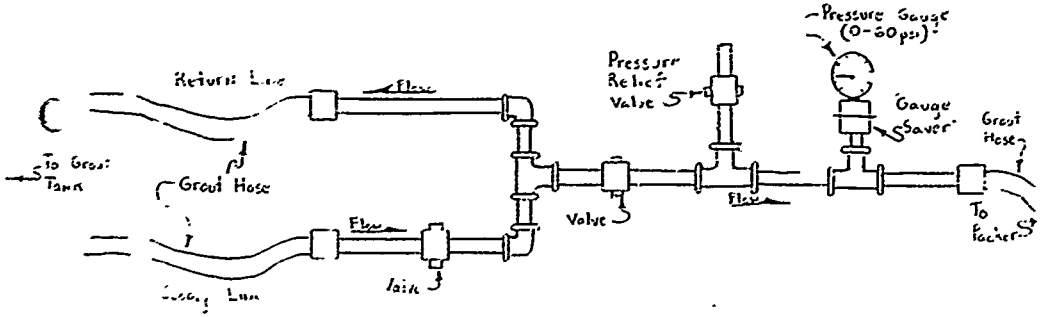
GROUT PLANT ARRANGEMENT
RIGHT ABUTMENT - STA. 1+20 - 3+00



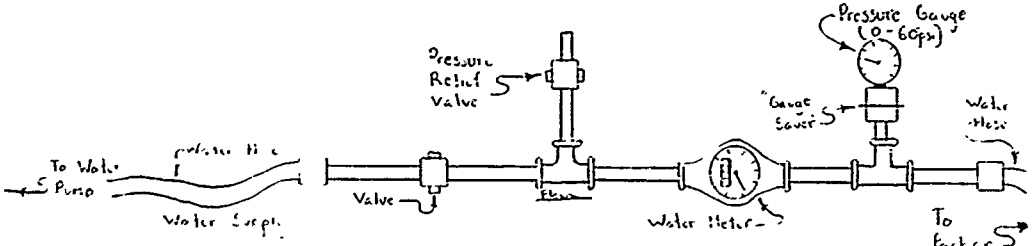
GROUT PLANT ARRANGEMENT

12-02 FOUNDATION CURTAIN GROUTING

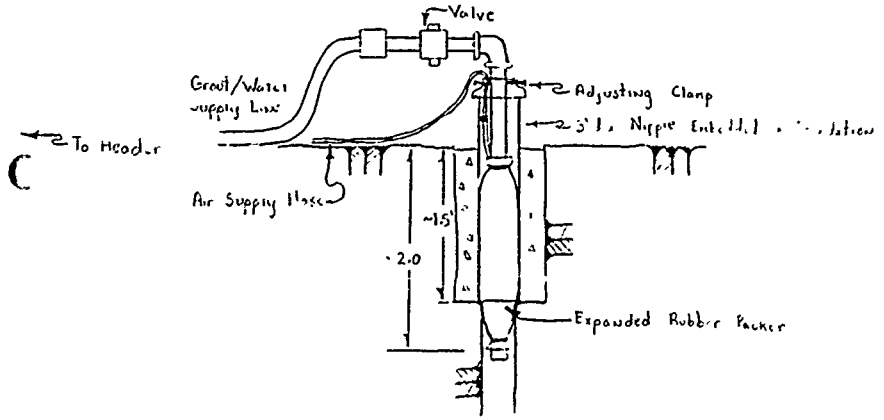
Equipment



GROUT HEADER
(NTS)



PRESSURE TEST HEADER
(NTS)



TYPICAL PACKER ASSEMBLY
(NTS)

Bovles Bros. DRILLING COMPANY Grout Plant & Delivery System

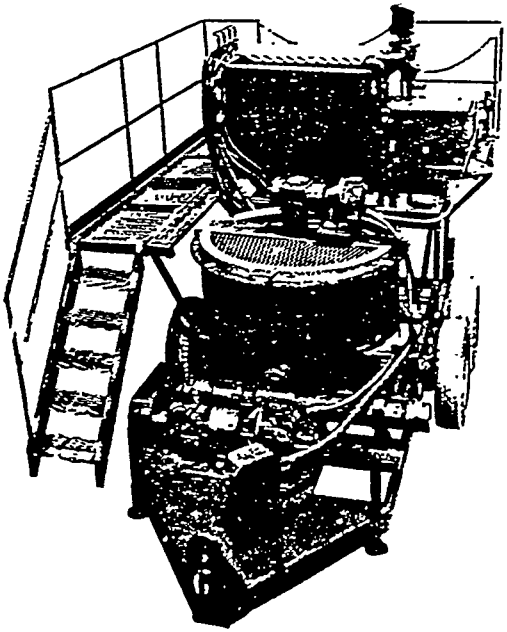
Bovles Bros. DRILLING COMPANY has developed this new self-contained performance proven grout mixing and delivery system with contractor inspired innovations including:

- Versatile mixing range
- Fast, mobile set-up
- Dependable performance
- Safe operation
- Self-Contained
- Rugged construction
- High volume capacity

Operator safety, convenience, and functional innovations provide efficient set-up and increased production. For rapid site to site set-up the entire grout plant is mounted on a dual axle trailer. A completely homogenous mix is assured with virtually any mix using our exclusive two mode system with a horizontal paddle agitator for complete mixing of heavy cement and sand grout and a high speed Vacseal pump circulation system for quick and thorough mixing of light and medium grout. Use of the Vacseal pump circulation mixing system eliminates the need for special auxillary mixing tanks and permits more rapid mixing and continuous grout delivery.

The holding tank or sump is mounted adjacent to the mixing tank and is equipped with a rapid agitation system to keep even the thickest mixes in suspension for high volume delivery to the hole.

Smooth, constant delivery of grout to the hole is assured with a Robins and Myers Moyno pump. This helical-screw, rotor-type pump maintains uniform flow without pulsation and allows a broad range of pump delivery rates. Whatever mix is desired, this highly efficient grout plant system is designed for uninterrupted high volume batch load delivery to the hole. This all adds up to the first broadspectrum, fully integrated grout plant.



Bovles Bros. DRILLING COMPANY
Mixing Services

Boyles Bros. DRILLING COMPANY

Grout Plant and Delivery System

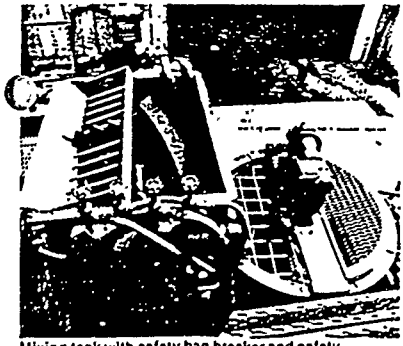
Water Meter
As each batch is prepared for primary mixing, a resetting digital water meter accurately determines water input to the mixing tank. This helps assure formulation of proper mix ratios.

intake. Return to tank.

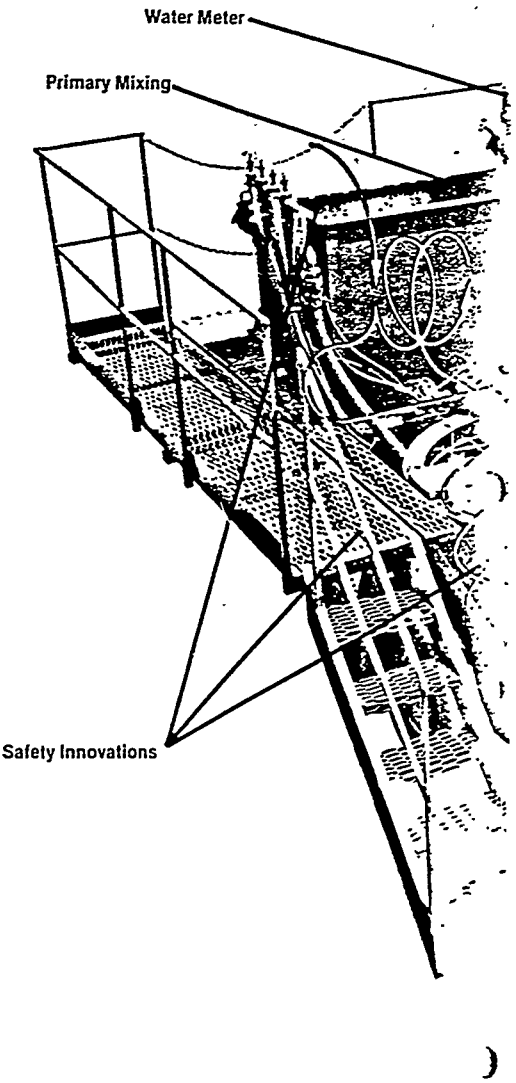
High speed Vacseal mixing pump.

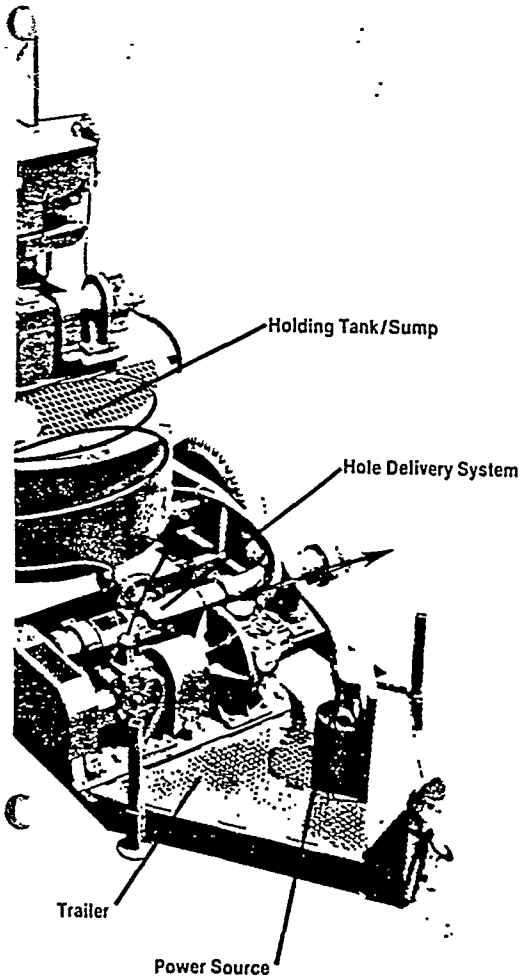
Primary Mixing
The 30-cubic foot mixing tank provides large capacity two-mode mixing. A horizontal paddle agitator assures complete mixing of heavy cement/sand grout with paddle speeds up to 62 r.p.m. Light and medium grout used in most applications is rapidly mixed by diagonal tank circulation through a Galigher Vacseal Pump for complete colloidal suspension of all grout particals using a high speed impeller rotating at 1700 r.p.m. Each agitation system provides a thoroughly mixed homogenous grout.

When heavy grout is being mixed the Vacseal pump circulation system can easily be bypassed.



Mixing tank with safety bag breaker and safety screening holding tank.





Holding Tank/Sump
Mixed grout can be quickly transferred from the mixing tank through a power activated 4-inch butterfly valve into the 30-cubic foot sump. A blade type agitator keeps the grout thoroughly mixed with a speed range of 0 - 30 r.p.m. The large capacity of the mixing and holding tank combination is designed to maintain continuous high volume delivery to the hole.

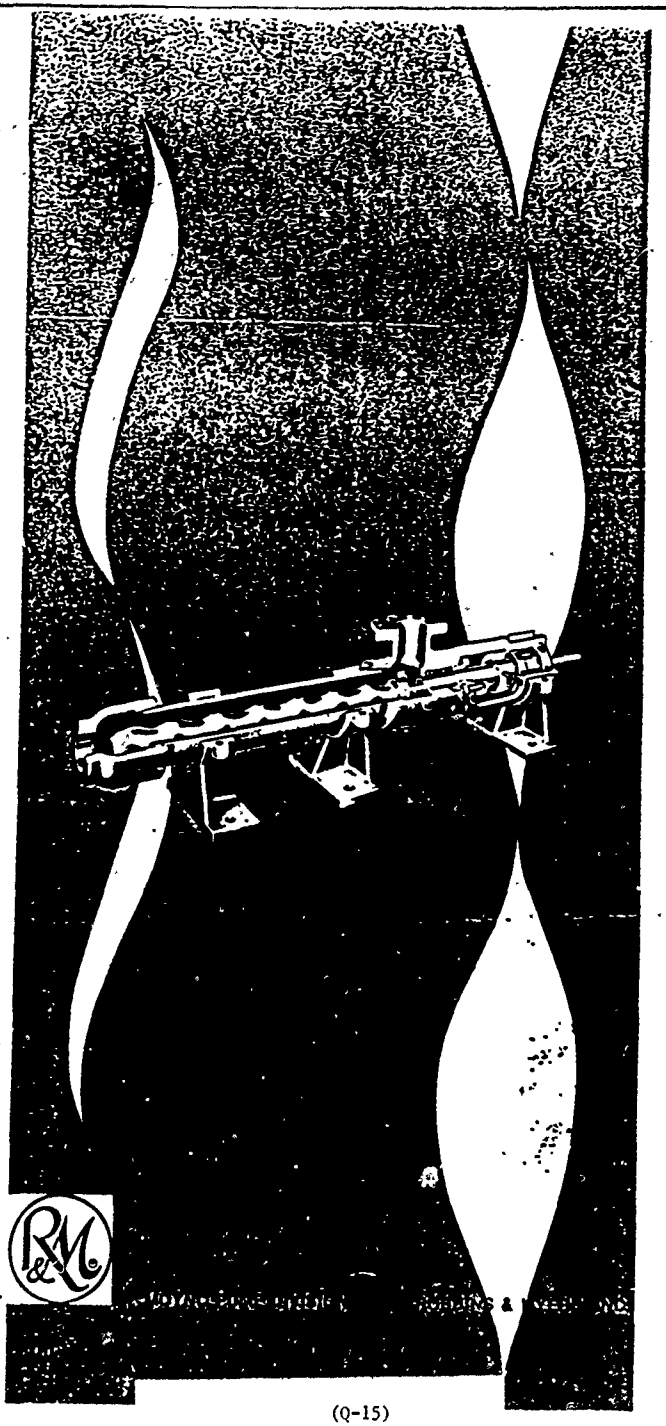
Hole Delivery System
A Robins and Myers Moyno 3L10 Pump delivery system transfers the prepared grout mix from the holding tank to the hole. This system assures constant uniform flow to the hole without pulsation, even when pumping heavy grout. High volume continuous delivery is possible up to 100 G P.M. and 300 P.S.I. Variable pump delivery is provided by a four speed Ford T-9 transmission. transmission.

Power Source
Mobil grout plants are available for either hydraulic or air powered operation. Both systems are self-contained and offer similar operational specifications. The hydraulic model utilizes Sunstrand hydraulic pumps and motors and is powered by a 353 Detroit Diesel engine. For air powered operation a 600 C.F.M. compressor is required to power the series 200 EIMCO Air Motors used on this model.

Trailer
Heavy duty three-tiered construction is used in the frame to support all system components. Twin axles assure long towing life. A pentle-towing eye is provided for quick hook-up for site to site and general towing. Four drop leg jacks stabilize the frame when the plant is operating and are easily retracted for travel.

Safety Innovations
Operator convenience and safety are important factors in achieving consistant high grouting performance. All powered moving parts are fully enclosed or screened to prevent accidental operator contact. A heavy duty bag breaker is provided on the mixing tank for operator convenience and safety. Solid work platforms provide efficient access to each work area and are safety-equipped with sturdy ladders, kickboards, chains and rails.

*Air powered model is shown.



BULLETIN

MOYNO.

PROGRESSING CAVITY

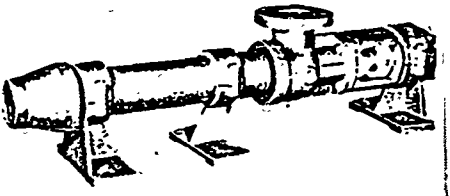
industrial pumps

...A TURN FOR THE BETTE

SPRINGFIELD, OHIO 45

FRAMES L, M and P

MOYNO pumps are most commonly specified in frame L designs. This is the standard frame construction suitable for the most frequently encountered pumping applications. Frames M and P are similar in design to frame L, but are equipped with heavy duty drive heads to accommodate greater horsepower for operation at higher pressures.



DIMENSIONS

PUMP SIZE	DIMENSIONS A*	B*	C	I*	L	WT. (Lbs.)	PUMP SIZE	DIMENSIONS A*	B*	C	I*	L	WT. (Lbs.)	PUMP SIZE	DIMENSIONS A*	B*	C	I*	L	WT. (Lbs.)
2M1	17	7¾	—	4	8½	22	1L4	30	13½	—	7½	15⅝	85	2L10	63½	32½	10½	9½	30	500
3M1	18⅝	9½	—	4¾	9⅝	23½	2L4	37½	20¼	—	8½	22	91	3L10	73½	42½	18	12½	30	545
6M1	24⅜	14½	—	4¾	15⅜	30	3L4	44⅛	27⅜	11	10½	15⅜	99	1L10H	58½	27½	—	15	30	424
1L2	17	7¾	—	4½	8½	22	6M4	71	49¾	25	17⅝	20	171	2L10H	73½	42½	18	12½	30	545
2L2	20½	10½	—	5¾	10½	25	1L8	38½	17¾	—	10⅝	20	141	4P10H	115⅝	75⅜	16½	11½	33½	1577
3L2	24¼	14¼	—	7¾	12	31	2L8	49¾	28⅜	12	9⅝	20	174	6P10	115⅝	75⅜	16½	11½	33½	1577
6M2	39½	26½	14	7¾	11½	55	3L8	60¾	39⅝	18	13¾	20	192	1L12	70	31	—	14½	37½	880
1L3	22⅝	10½	—	5⅝	11½	47	1L8	46	20⅝	—	9¾	27	303	2L12	85½	46½	20½	12	35	1075
2L3	28⅝	15⅜	—	9⅜	13	51	2L8	58¾	32½	14	10½	25	332	3L12	101½	62½	27	14½	42	1200
3L3	33⅜	20⅜	9	7⅜	11½	59	3L8	75⅝	45	24	12⅝	25	372	1L12H	77½	38½	—	17½	42	945
6M3	54⅜	38	22	10½	15½	105	1L10	53½	21¾	—	9¾	30	412	2L12H	101½	62½	27	14½	42	1205

PUMP SIZE	DIMENSIONS D**	E	F	G	H	J	K	M	N	O	P	Q	R	S	W	Z	Keyway
1L2, 2L2, 3L2, 2M1, 3M1, 6M1	3½	5½	3½	2	¾	¾	2	4¼	1½	¾	3¼	¾	4½	—	4	¾	¾ x ⅜
1L3, 2L3, 3L3, 6M2	4½	7⅝	4½	3	¾	¾	3	5	2½	¾	3¾	½	5⅝	—	5¾	¾	¾ x ⅜
1L4, 2L4, 3L4, 5M3	5½	9¾	5½	3½	⅝	⅝	3	7	3½	¾	5½	¾	7	—	7	⅝	½ x ⅜
1L8, 2L8, 3L8, 6M4	6½	11¼	7	4	1¼	1⅛	4	7½	4¾	¾	6	1⅛	8¾	—	8¾	⅞	½ x ⅜
1L8, 2L8, 3L8	8	14	9	5	1¾	⅞	5	9	4¾	½	7½	1½	9¼	—	11½	⅝	⅝ x ⅜
1L10, 2L10, 3L10, 1L10H, 2L10H	9½	16⅛	9	5	1¾	⅞	5	11	5¾	⅝	9½	1½	13½	—	11½	1	½ x ⅜
4P10H, 6P10	14	24	15⅜	6	2¾	1	6	13½	6	½	11¾	1½	19	18¾†	17½	1¼	½ x ¾
1L12, 2L12, 3L12, 1L12H, 2L12H	12½	21	12¾	6	2½	1	6	13½	6	½	11¾	1¼	18	—	14½	1¼	½ x ¾

Performance and Port Sizes – Frames L, M and P

PUMP FRAME	Cu. In./100 Rev	Port Sizes Vertical	Port Sizes Horiz	PUMP SPEED & DIFF. Press. PSI	300 RPM GPM	300 RPM Min. HP	450 RPM GPM	450 RPM Min. HP	600 RPM GPM	600 RPM Min. HP	900 RPM GPM	900 RPM Min. HP	1200 RPM GPM	1200 RPM Min. HP
2H1	.056	1"	¾"	0 60 120			22 20 15	½ ½ ½	29 26 22	½ ½ ½	43 41 37	½ ½ ½	58 55 51	½ ½ ½
3H1	.056	1"	¾"	0 90 180			22 20 15	½ ½ ½	29 26 22	½ ½ ½	43 41 37	½ ½ ½	58 55 51	½ ½ ½
6H1	.056	1"	¾"	0 180 360			22 19 15	½ ½ ½	29 26 22	½ ½ ½	43 41 37	½ ½ ½	58 56 51	½ ½ ½
1L2	.260	1"	¾"	0 30 60			11 .95	½ ½	15 13 9	½ ½ ½	22 21 17	½ ½ ½	30 28 23	½ ½ ½
2L2	.260	1"	¾"	0 60 120			11 .95	½ ½	15 13 9	½ ½ ½	22 21 17	½ ½ ½	30 28 23	½ ½ ½
3L2	.260	1"	¾"	0 90 180			11 .95	½ ½	15 13 9	½ ½ ½	22 21 17	½ ½ ½	30 28 23	½ ½ ½
6H2	.260	1¼"	¾"	0 180 360			11 .9	½ ½	15 13 9	½ ½ ½	22 21 17	½ ½ ½	30 28 24	1 1 1
1L3	.860	1¼"	1¼"	0 40 75			3.8 3.8	½ ½	5.1 4.8 2.7	½ ½ ½	7.5 6.8 5.8	½ ½ ½	10 9.3 7.7	½ ½ ½
2L3	.860	1¼"	1¼"	0 80 150			3.8 3.8	½ ½	5.1 4.8 2.7	½ ½ ½	7.5 6.8 5.8	½ 1 1	10 9.3 7.7	1 1 1½
3L3	.860	1¼"	1¼"	0 120 225			3.8 3.8	½ ½	5.1 4.8 2.7	½ 1 1	7.5 6.8 5.8	½ 1½ 1½	10 9.3 7.7	1 1½ 2
6H3	.860	2½"	1¼"	0 240 450			3.8 2.9	½ ½	5.1 4.3 2.7	1 1 1½	7.5 6.5 5.8	1½ 1½ 2	10.0 9.3 7.7	2 2 3
1L4	2.82	2½"	2"	0 40 75			6.8 6.7	½ ½	9.0 8.8 5.5	½ 1 1	13 12 11	1 1½ 1½	17 16 15	1 1½ 2
2L4	2.82	2½"	2"	0 80 150			6.8 6.7	½ ½	9.0 8.8 5.5	1 1½ 1½	13 12 11	1½ 2 2	17 16 15	2 2 3
3L4	2.82	2½"	2"	0 120 225			6.8 6.7	½ 1	9.0 8.8 5.5	1½ 2 2	13 12 11	2 3 3	17 16 15	3 3 4
6H4	2.82	3"	2½"	0 240 450			6.8 7.4	½ ½	9.0 9.7	2 2	13 12	3 3	17 16	4 4½
1L5	5.30	3"	2½"	0 40 75	15 11	1 1	20 19 13	1 1 1½	27 25 19	1½ 2 2	40 38 31	2 3 3		
2L5	5.30	3"	2½"	0 80 150	15 11	1 1	20 19 13	1½ 2 2	27 25 19	2 3 3	40 38 31	3 4 5		
3L5	5.30	3"	2½"	0 120 225	15 11	1 1½	20 19 13	2 3 3	27 25 19	3 4 5	40 38 31	5 5 7½		
1L6	11.7	4"	4"	0 40 75	35 27	2 2	46 38 26	3 3 3	62 52 36	4 5 5	93 78 54	7½ 7½ 7½		
2L6	11.7	4"	4"	0 80 150	35 27	3 3	46 38 26	5 5 7½	62 52 36	7½ 7½ 7½	93 78 54	10 10 10		
3L6	11.7	4"	4"	0 120 225	35 27	5 5	46 38 26	7½ 7½ 10	62 52 36	10 10 10	93 78 54	15 15 15		
1L10	18.8	6"	5"	0 40 75	46 46	3 3	62 62 53	5 5 5	84 84 74	7½ 7½ 7½	125 125 106	10 10 10		
2L10	18.8	6"	5"	0 80 150	46 46	5 5	62 62 53	7½ 7½ 10	84 84 74	10 10 15	125 125 106	15 15 20		
3L10	18.8	6"	5"	0 120 225	46 46	5 5	62 62 54	10 10 15	84 84 74	15 15 20	125 125 106	20 20 30		
1L10H	27.7	6"	5"	0 40 75	73 73	5 5	97 97 89	7½ 7½ 10	133 133 117	10 10 15				
2L10H	27.7	6"	5"	0 80 150	73 73	5 5	97 97 89	10 10 15	133 133 117	15 15 20				
4P10H	27.7	6"	5"	0 175 350	70 70	15 15	96 96 86	20 20 30	132 132 118	30 30 40				
6P10	18.8	6"	5"	0 250 500	46 46	15 15	62 62 52	20 20 30	84 84 72	30 30 40	125 125 104	40 40 50		
1L12	43.5	8"	6"	0 40 75	136 118 88	5 7½ 10	186 184 148	7½ 10 15	261 246 216	10 15 20				
2L12	43.5	8"	6"	0 80 150	136 118 88	10 10 15	186 184 148	15 15 20	261 246 216	20 20 30				
3L12	43.5	8"	6"	0 120 225	136 118 88	15 15 20	186 184 148	20 20 30	261 246 216	25 25 30				
1L12H	65.2	8"	6"	0 40 75	195 173 123	7½ 7½ 15	283 272 220	15 15 20	391 373 321	15 15 25				
2L12H	65.2	8"	6"	0 80 150	195 173 123	15 15 25	283 272 220	20 20 30	391 373 321	25 25 30				

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS
P.O. BOX 631
VICKSBURG, MISSISSIPPI 39180-0631

REPLY TO ATTENTION OF

March 2, 1987

Structures Laboratory
Cement and Pozzolan Unit

Mr. William J. Quinn
Chief Chemist
Kosmos Cement Company, Inc.
P. O. Box 72319
Louisville, Kentucky 40272

Dear Mr. Quinn:

The data and information submitted with your request of February 10, 1987 have been evaluated and found to comply with the requirements of Appendix A, Cement Quality Management System (CQMS), of ER 1110-1-2002, Engineering and Design, Cement, Pozzolan, and Slag Testing, dated April 5, 1985.

Effective March 1, 1987, the Kosmosdale, Kentucky, plant of Kosmos Cement Company, Inc. is designated as a qualified source of ASTM C 150, Type I and Type II cement under the CQMS.

The CQMS also requires that you send us:

a. A copy of each shipping document (weigh bill or bill of lading) semi-monthly for cement shipped to authorized Federal projects. Such a document shall contain the following information: (1) contract number, (2) consignee and destination, (3) specification and type, (4) producer, (5) silo or lot number, (6) quantity, (7) date shipped, and (8) carrier identification.

b. A copy of the test results for each lot of cement from which material is shipped under this system as required by the applicable specification, when we request such results.

c. Data on the most recent 20 pairs as described in paragraph 2b(3) of Appendix A every 6 months.

Sincerely,

Bryant Mather
Chief, Structures Laboratory

PORTLAND CEMENT

KOSMORTAR MASONRY CEMENT

KOSMOS CEMENT COMPANY, INC.

15301 DIXIE HIGHWAY
P.O. BOX 72319
LOUISVILLE, KY 40272

LABORATORY CERTIFICATE OF TESTS

Shipment of 11-1 19 87

THIS IS A RECORD OF TESTS ON BIN FROM WHICH SHIPMENTS SHOWN WERE MADE

Shipped to BOYLES BROTHERS DRILLING COMPANY

Shipped in BAG CWT Silo No. 15

Specifications ASTM C-150-85 II Product PORTLAND Sampled Tested 9-10-87

PHYSICAL TESTS			CHEMICAL ANALYSIS		
Compressive Strengths (p.s.i.)			Silicon Dioxide (SiO_2)	22.30	%
3 Days	7 Days		Aluminum Oxide (Al_2O_3)	4.33	%
Av. 3113	Av. 4018		Ferric Oxide (Fe_2O_3)	2.95	%
			Calcium Oxide (CaO)	62.91	%
			Magnesium Oxide (MgO)	2.83	%
Fineness 3918 cm^2/gm (Blaine)		(Wagner)	Sulfur Trioxide (SO_3)	2.35	%
Set (Gillmore) Init. 2:05 hrs.	Final 5:10	(Vicat)	Loss on Ignition	1.39	%
Autoclave	.031	%	Insoluble Residue	.28	%
Air Content	10.0	%	Tricalcium Silicate (C_3S)	45.5	%
			Tricalcium Aluminate (C_3A)	6.48	%
			Total Alkalies as (Na_2O)	.68	%

THE ABOVE RESULTS COMPLY WITH THE SPECIFICATIONS.

C

Respectfully submitted,

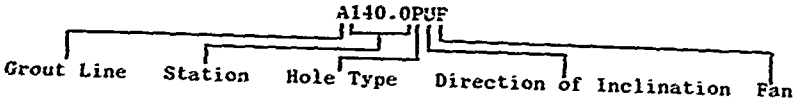
Kosmos Cement Company, Inc.

By William J. Quinn

12-02 FOUNDATION CURTAIN GROUTING

Nomenclature

The Hole numbering system is related to; the grout line, location, hole type, and the inclination direction of the grout hole. This system designates each hole a separate number and is compatible with the computer grouting program. Grout holes outside of the curtain grout lines were not designated a number and were not entered in the computer program.



Grout Line: This indicates which of the parallel grout lines that this hole is a member of.

"A" line: Located 16' upstream of centerline
"B" line: Located 8' upstream of centerline
"C" line: Located on the dam centerline
"D" line: Located 20' downstream of centerline
"E" line: Located 37' upstream of centerline

Station: This indicates the location of the hole in relation to dam stationing, from station 1+20 to 9+97.

Example: Station 1+40.0 will become 140.0

Hole Type: This indicates the type of hole in relation to the progression of grouting.

P = Primary holes (1st series of holes grouted)
S = Secondary holes (2nd series of holes)
T = Tertiary holes (3rd series of holes)
Q = Quaternary holes (4th series of holes)

Direction of Inclination:
This indicates the direction of the hole angle in which it was drilled. These holes range from 0° to 60°. This character was necessary in the overlap area of the "C" line in the valley bottom. The angle of the holes were essentially the same in each line, with the exception of the fans; C line = 30°, A line = 10°, B D and E lines are vertical.

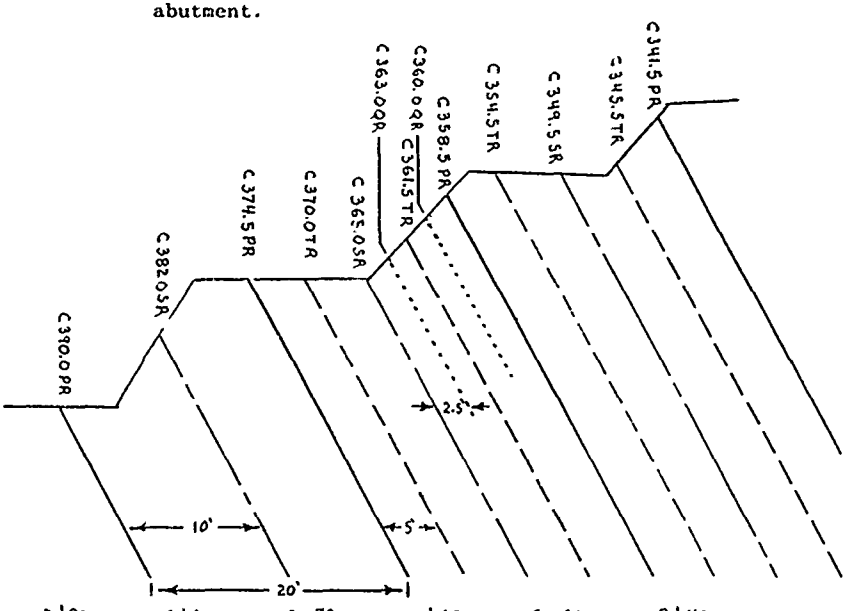
12-02 FOUNDATION CURTAIN GROUTING

Nomenclature (cont)

Direction of Inclination: (cont)

L = battered toward the left abutment
R = battered toward the right abutment
U = battered upstream, perpendicular to centerline
V = vertical

Fan: This is an optional character, indicating that the hole is a member of a fan. Only grout holes in a fan have this extra character, hole numbers other than fan holes will leave this entry blank. The fans exist at the termination points of A and C lines on the left and right abutments. The inclination of these holes is directed toward the abutment on with it is located. The angles of these holes vary depending on which line the fan located. The angle of the C line fan holes range from 30° to 60° toward the abutment. The angle of the A line fan holes range from 10° U/S and 0° toward the abutment to 10° U/S and 60° toward the abutment.



Typical numbering sequence: grout line "C"

12-02 FOUNDATION CURTAIN GROUTING

Computerized Grouting Records

INTRODUCTION:

Data obtained during the foundation curtain grouting operation was stored and utilized by computer. The computer program, "Microcomputer Grouting Data Package", is a data base package for storage, retrieval, and display of grouting data for geotechnical projects on a microcomputer. This data base package was developed by the US Army Engineer Waterways Experiment Station and is a project sponsored by the Office, Chief of Engineers, US Army. Criteria for a complete grouting data package were developed by a task force group of Corps of Engineers District and Division representatives with experience on actual projects. The criteria covered design, construction control, and post construction operation use. This package utilized a dBASE III Plus Version 1.1 (trademark of Ashton-Tate).

APPLICATION:

The grouting data base package is intended to provide a convenient means for storing data from field grouting operations that can be used as a rapid aid in the following areas.

a. Monitoring the status of drilling and water pressure testing.

b. Determining the need for grouting of stages and for split spacing of grout holes using project criteria.

c. Automatic calculation of estimated initial grout mixes and gage pressures when water pressure test data are entered.

d. Automatic calculation of sacks of cement used from grout mix and quantity values.

e. Monitoring the status of grouting and quick determination of permissible areas for drilling and pressure testing at the start of each shift.

f. Rapid display of summary tables and graphic display of pressure test water flow versus grout take for selected holes.

g. Automatic production of daily pay item summary table for comparison with contractor submitted quantities.

h. Display of progress, quantities, and costs for better assessment of likely overrun or potential problem areas.

Computerized Grouting Records (cont)

DATA ENTRY

Data entry makes use of the full screen editing feature of dBASE III that allows a form to be shown on the monitor screen and filled in. The field logs, used during the drilling and grouting operations, were similar to the forms shown on the computer monitor. These forms included: (1) Drilling Log, (2) Pressure Test Data, (3) Grouting Data (see page GR-21). For a new grout hole, the basic data must be entered first into the Drilling Log by hole number, zone and stage. Once the drilling record is entered, data for pressure testing and grouting can be entered in any order. Pay item quantities are entered from the field forms for each stage when other entries on the form are completed. The grout pay item quantities are stored in a separate file and can be viewed and edited separately. All data entered are stored in an appropriate file. A number of index files are used to keep the data ordered by hole number, zone, and stage or by date or other variable for rapid retrieval of data.

Data can be entered by using the selections 1 thru 5, shown on the main menu (page CG-22). After the information is entered in the drilling records (selection #2), the hole can be accessed for data entry with pressure test data (selection #3) or grouting data (selection #4) with grout pay quantities being stored separately (selection #5). After the initial data is entered it can be edited, printed, or deleted.

The following capabilities during data entry are included in the package.

a. The true vertical depth for slant holes is automatically calculated and stored in the drilling data records.

b. Pay item quantities are automatically updated in the hole data records by zone when pertinent data is entered.

c. A table of estimated grout mixes and grout pressures is printed out for the range of project criteria when a drilling record is entered. Project criteria are based on water flow rates (cfm) from water pressure tests.

d. When the water pressure record is entered for a hole stage, the initial mix and calculated grout gage pressure are printed out.

Computerized Grouting Records (cont)

DATA RETRIEVAL

Data retrieval and display are done automatically using the selections shown on the menus (page GR-22). Selections numbers 1 thru 5 on the main menu are used for entering new data, editing existing data, and reviewing and printing data on a single aspect of an individual hole (drilling, pressure testing, grouting, and grout pay quantities). Selection number 6 is used to estimate grout mixes and pressures for use in the field. Selections 7 and 8 on the main menu are used for statistical information and summaries for the individual grout hole or a given group of grout holes.

Selection number 7 on the main menu, "Print Hole Statistics", utilizes grout take information in relation to footage drilled. This selection has three options; summary of statistics for hole types (primary, secondary, etc.) within a given section, statistics for individual hole numbers within a given section, bar graph showing vertical drill depth and grout take.

Selection number 8 on the main menu, "Print Grouting Reports", consists of 7 separate selections as shown on the "Menu for Grouting Reports and Plot" (page CG-22) Options 1 thru 4, on the grouting reports menu, utilizes pressure testing and grouting information per stage within a given hole. Options 5 thru 7, on the grouting reports menu, summarizes pay quantities by hole numbers or dates.

Option 1, of selection number 8, is intended to provide all data for one hole by zone and stage for one or a range of hole numbers. Option 2 is intended to give the status for each hole in the desired range showing key results and date of drilling, pressure testing and grouting. Option 3 provides a list of water flow and grout take by hole number and stage for a desired range of hole numbers and depth interval to summarize this data for a horizontal interval. Option 4 displays water pressure flow and grout take per hole number for a desired range utilizing stick lines which represent the drilled hole on a scale of 1 in. = 10 ft. Options 5 and 6 produce a summary of pay quantities according to the project form for one date or for a desired range of dates. Option 7 provides a quick listing of all pay quantity data accumulated in the hole data file to the current date.

12-02 FOUNDATION CURTAIN GROUTING

Computerized Grouting Records

DATA ENTRY FORMS

```
                              DRILLING LOG
    PROJECT: Yatesville Lake              LOCATION: C/L, Center Section
    STATION: 5+90          ELEVATION:  521.00       HOLE NO: C590.0PR
    INCLINATION: 30 Lt  DIAMETER: 1-7/8"            DEPTH NIPPLE:1.5'
                        Bottom  [depth / elev.]      Bottom  [depth / elev.]
    DESIGN DEPTH TO  Zone  I:  58.0 /  470.77       Zone II:  87.0 /  445.66
                        Bottom  [depth / elev.]      Bottom  [depth / elev.]
    ACTUAL DEPTH TO  Zone  1:  58.0 /  470.77       Zone II:  87.0 /  445.66

    ZONE:  I        STAGE: 1              DEPTH INTERVAL:   1.5-58.0  FEET
    DATE: 11/02/87 DRILLER:                        INSPECTOR:  M. NIELD
DDDD
```

12-02 FOUNDATION CURTAIN GROUTING

Computerized Grouting Records

MAIN MENU

GROUTING DATA BASE FOR YATESVILLE DAM PROJECT

MAIN MENU TO ENTER NEW DATA OR REVIEW/EDIT EXISTING DATA	Selection
SUMMARY OF PROCEDURES	1
DRILLING RECORDS	2
PRESSURE TEST DATA	3
GROUTING DATA	4
GROUT PAY QUANTITIES FOR A GROUT STAGE	5
LIST OF GROUT MIXES & PRESSURES FOR RANGE OF HOLE NO'S.	6
PRINT HOLE STATISTICS	7
PRINT GROUTING REPORTS	8
RETURN TO OPERATING SYSTEM	9

Enter Selection.

MENU FOR GROUTING RECORDS
(options under selection #8 of the main menu)

VERSION OF GROUT DATA BASE FOR YATESVILLE DAM, KY

MENU FOR GROUTING REPORTS AND PLOT	Selection
FIELD RECORDS FOR ONE ENTIRE HOLE	1
DRILLING AND GROUTING SUMMARY FOR HOLE RANGE	2
WATER & GROUT TAKE TABLE FOR HOLE AND DEPTH INTERVAL	3
PLOT OF FLOW VS SACKS FOR HOLE RANGE (BY STATION)	4
DAILY PAY ITEM RECORD FOR SELECTED DATE	5
PAY ITEM RECORD SUMMARY FOR DATE RANGE	6
PAY QUANTITY SUMMARY FROM PROJECT/HOLE FILE	7
RETURN TO DATA ENTRY MENU	8
RETURN TO OPERATING SYSTEM	9

Enter Selection:

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Summary of Grouting Statistics

Contract Quantities

Description	Contract Estimated Quantity	Contract Unit Price	Contract Amount	Actual Quantity	Actual Amount
Mobilization & Demobilization	1 Job	$30000	$30000	1 Job	$30000
Drilling 1-7/8" Grout Holes	23000 LF	$10	$230000	19651.50 LF*	$196515
Portland Cement in Grout	6500 cwt	$6	$39000	4949.06 cwt+	$29694
Placing Grout	250 hrs	$100	$25000	430.86 hrs	$43086

- All quantities include; curtain grouting, additional foundation grouting in the dam foundation, and partial payment for contact grouting of dental concrete.

* This figure also includes redrill.

+ This figure also includes grout used for backfilling and wasted grout.

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Summary of Grouting Statistics

Total by Grout Lines

"A" Line

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	56	3,723	1,281.4	0.34
Secondary	47	1,827	115.7	0.06
Tertiary	10	455	5.9	0.01
Total	133	6,014	1,403.0	0.23

"B" Line

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	16	540	3.6	0.01
Secondary	12	420	5.7	0.01
Tertiary	1	10	0.0	0.00
Total	29	970	9.3	0.01

"C" Line
(left and right battered holes)

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	67	5,414	1,558.1	0.29
Secondary	63	3,880	324.2	0.08
Tertiary	28	1,618	21.0	0.01
Quaternary	2	30	0.0	0.00
Total	160	10,942	1,903.3	0.17

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Summary of Grouting Statistics

Total by Grout Lines

"D" Line

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	10	350	45.5	0.13
Secondary	9	315	162.6	0.52
Tertiary	6	210	2.6	0.01
Total	25	875	210.7	0.24

"E" Line

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	8	280	183.8	0.65
Secondary	7	245	7.8	0.03
Total	15	525	191.6	0.36

Total For Curtain Grouting

Grout Line	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
A line	133	6,014	1,403.0	0.23
B line	29	970	9.3	0.01
C line	160	10,942	1,903.3	0.17
D line	25	875	210.7	0.24
E line	15	525	191.6	0.36
Total	342	19,326	3,717.9	0.19

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Summary of Grouting Statistics

Total by Hole Type

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	157	10,316	3,072.4	0.30
Secondary	138	6,687	616.0	0.09
Tertiary	45	2,293	29.5	0.01
Quaternary	2	30	0.0	0.00
Total For Curtain Grouting	342	19,326*	3,717.9+	0.19
Additional Foundation Grouting	49	330	94.8	0.29
Total For All Foundation Grouting	391	19,659*	3,812.7+	0.19

* Figure does not include redrill

\+ Figure does not include cement used in backfilling or wasted grout.

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Summary of Grouting Statistics

Total by Grout Mixes
(cwt dry cement)

Grout Line	4:1	3:1	2:1	1.5:1	1:1	.75:1	Total
A	48.1	207.5	402.8	256.7	414.5	73.4	1403.0
B	0.0	3.8	0.0	0.0	5.5	0.0	9.3
C	46.2	412.7	639.0	415.4	382.3	7.7	1903.3
D	13.3	48.4	87.6	56.9	4.5	0.0	210.7
E	15.4	44.3	55.7	71.5	4.7	0.0	191.6
Total cwt Dry Cement	123.0	716.7	1185.1	800.5	811.5	81.1	3717.9
% of cwt Dry Cement	3.3%	19.3%	31.9%	21.5%	21.8%	2.2%	100%
Total cu ft Grout Mixed	553.5	2508.5	2962.8	1601.0	1217.3	101.4	8944.5
% of cu ft Grout Mixed	6.2%	28.1%	33.1%	17.9%	13.6%	1.1%	100%

- Figures are those used in curtain grouting and do not include grout use for backfilling and miscellaneous grouting, or wasted grout.
- Grout mixes (5:1, 2.5:1 and 1.75:1) that were placed in low quantities (combined total of 1% cwt of dry cement) were added to the closest frequently used grout mix.
- Figures for the volume of "grout mixed" (dry cement and water) are estimated.

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Summary of Grouting Statistics

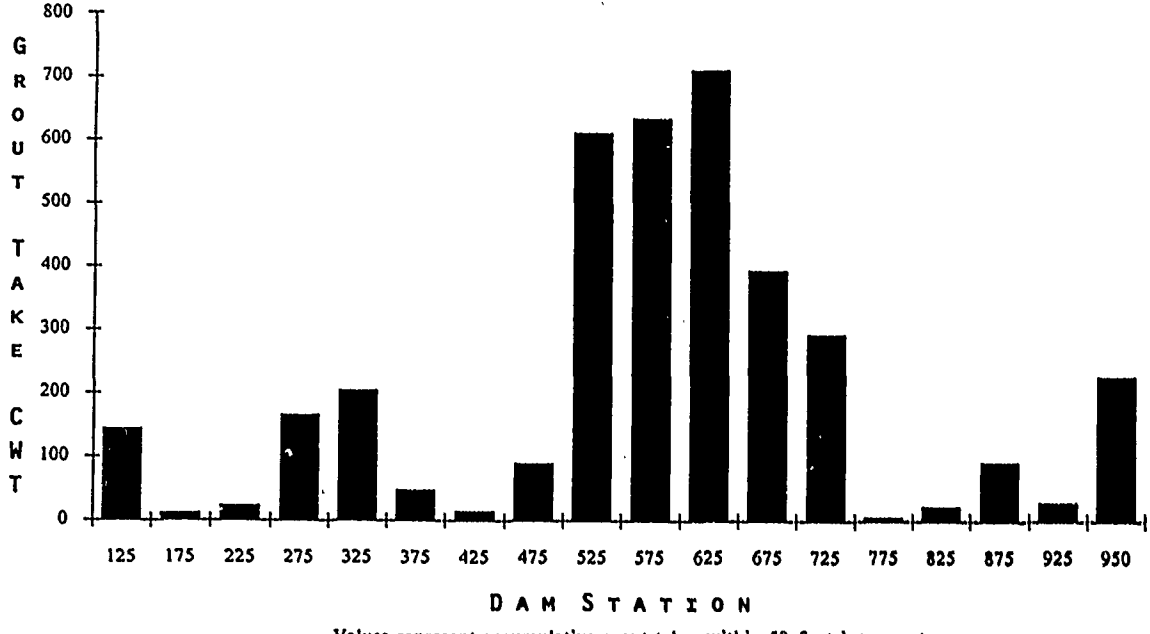
Total by Zones

Grout Line	Zone	Depth	Area of Curtain (SF)	Cement Placed (CWT)	Cement Rate (LBS/SF)
A Line	1	0-20'	19,749	211.5	1.1
A Line	2	20-60'	41,950	1,191.5	2.8
B Line	1	0-35'	9,847	9.3	0.1
C Line	1	0-50'	51,875	1,402.9	2.7
C Line	2	50-75'	24,565	500.4	1.8
D Line	1	0-35'	6,310	210.7	3.3
E Line	1	0-35'	4,900	191.6	3.9
Total			159,196	3,717.9	2.3

- Quantities do not include cement used in backfilling or wasted grout.
- Depth of zone is in feet from the rock surface and not necessarily drill depth.
- B Line depth is 0-30' on the right abutment.

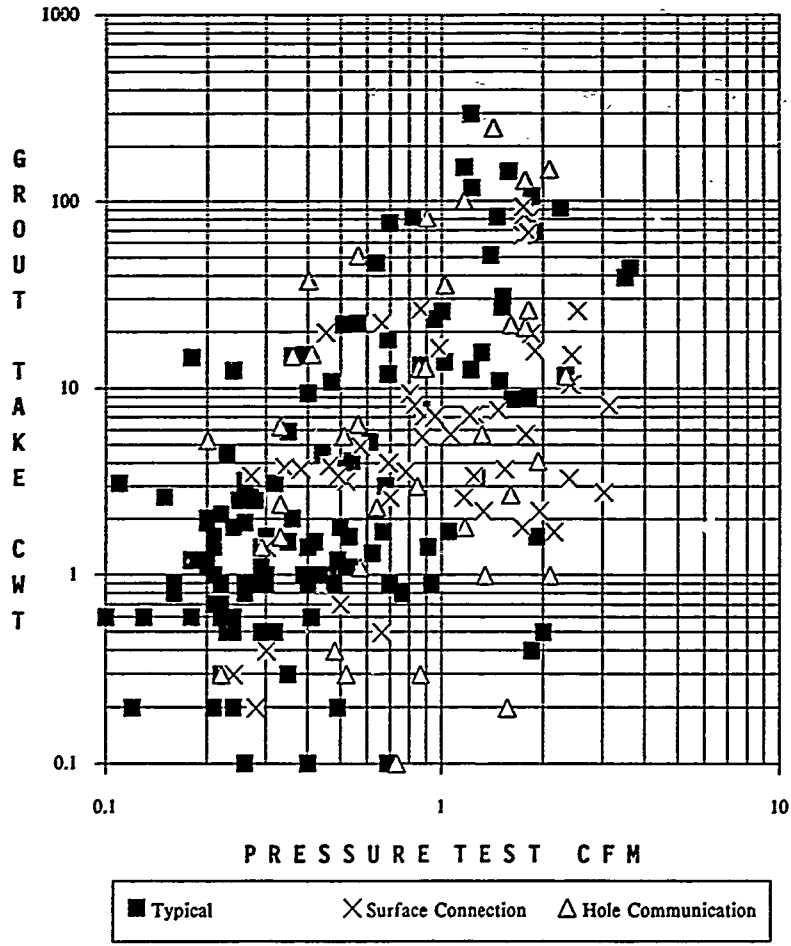
A, B, C, D, AND E LINES

(ZONES I & II)

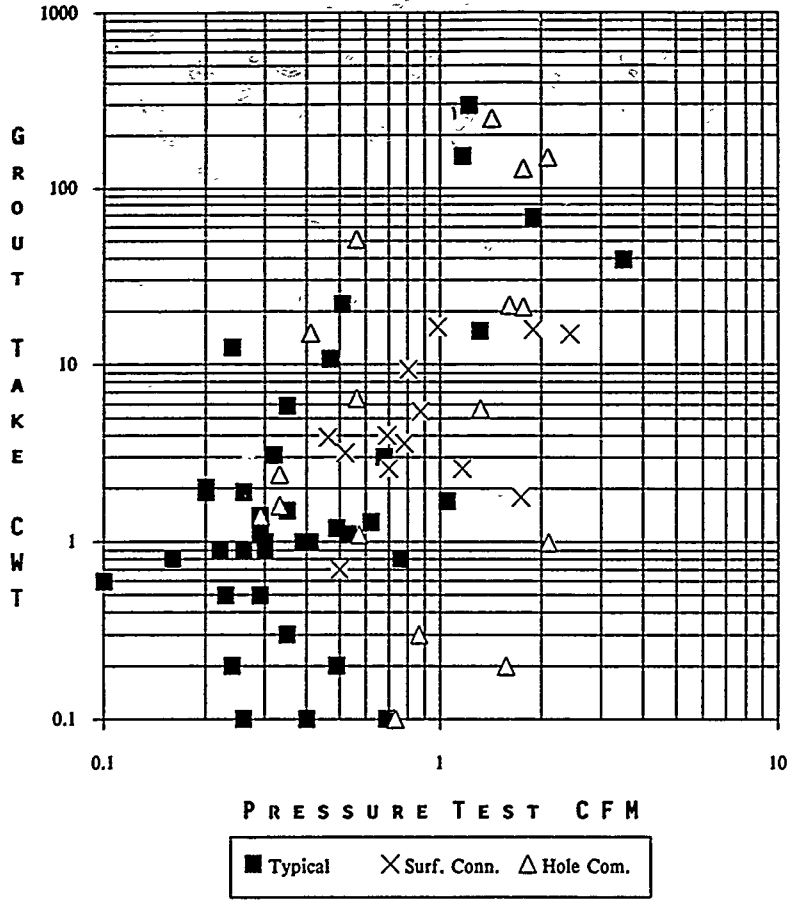


Values represent accumulative grout takes within 50-foot increments.

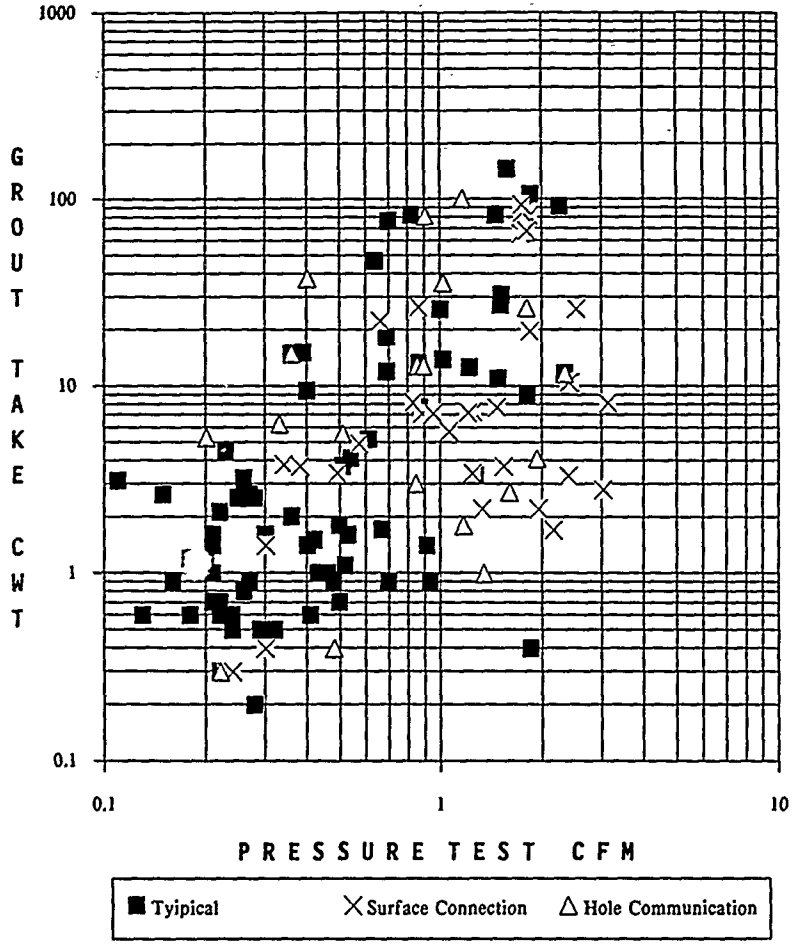
GROUT TAKE VS PRESSURE TEST



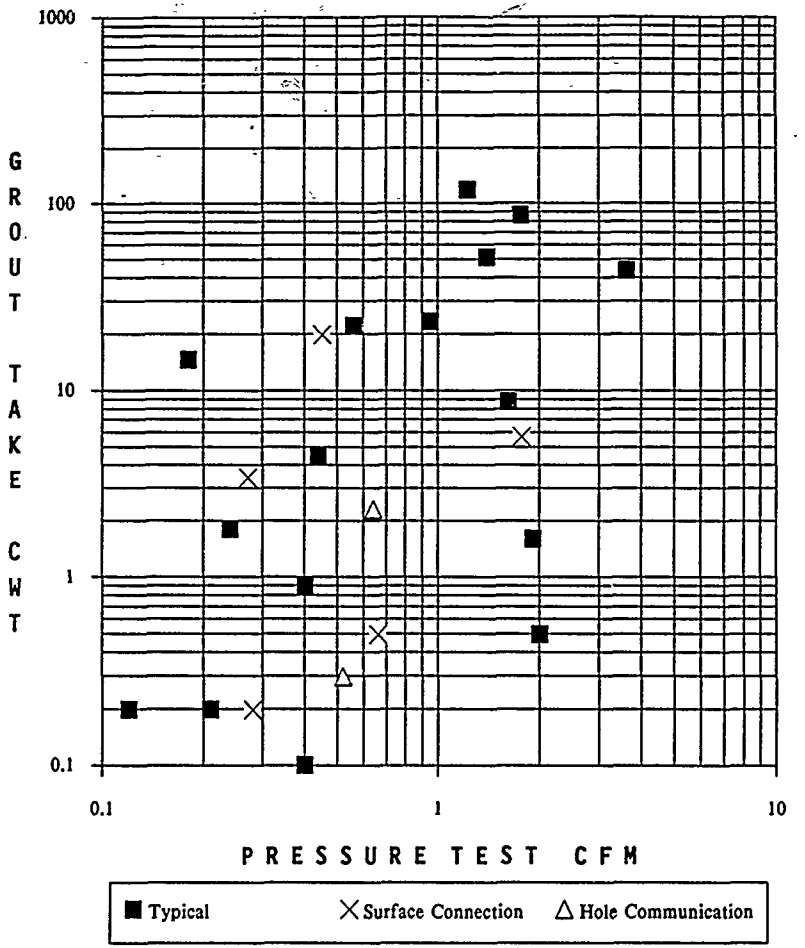
YATESVILLE DAM
A LINE - ZONE I & II



C Line - Zone I & II



B, D, AND E LINES



12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Right Abutment
(station 1+20 to 3+85)

Foundation Characteristics

Station 1+20 to 1+60

Surface Characteristics

Rock Type at Surface:..... Thin layer of shales and siltstone (Lower Kittaning Shale member)

Surface Elevations:..... 675 to 679 (low relief)

Grout Lines:..... A line: 9 holes (including fan)
C line: 9 holes (including fan)

Grouting Characteristics

Zone I

Grout Takes:..... Moderate

Connections:..... Numerous surface connections in shale 10' U/S of CL.

Other:..... Used plastic pvc pipe in holes to prevent cave-in.

Zone II

Grout Takes:..... Low

Connections:..... Numerous hole connections in the A line fan.

Station 1+60 to 3+00

Surface Characteristics

Rock Type at Surface:..... Massive sandstone (Homewood and Coalburg Sandstone members)

Surface Elevations:..... 574 to 675 (high relief)

Grout Lines:..... A line: 14 holes
B line: 23 holes

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Right Abutment
(station 1+20 to 3+85)

Foundation Characteristics

Station 1+60 to 3+00 (cont)

Grouting Characteristics

Zone I

Grout Take:..... Low

Connections:..... Few surface connections to bedding planes and joints.

Zone II

Grout Take:..... Very low

Connections:..... None

Station 3+00 to 3+85

Surface Characteristics

Rock Type at Surface:..... Thin interbedded sandstones, shales and coal members.

Surface Elevations:..... 536 to 574 (moderate relief)

Grout Lines:..... A line: 10 holes
B line: 4 holes
C line: 19 holes

Grouting Characteristics

Zone I

Grout Take:..... Moderate

Connections:..... Num. surface connections to bd. pns., frac., jts. and coal beds

Other:..... 8 additional holes were grouted to treat a hi. ang. jt.

Zone II:..... No grout takes or connections.

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Right Abutment
(station 1+20 to 3+85)

Holes With Cement Rates Higher Than 0.19 (cwt/lf)

Hole Number	Elev.	Angle	Zone/ Stage	Depth Interval	Cement Take CWT	Rate CWT / LF
C120.0PRF	678.5	60 rt	1/1	0 - 12	19.7	1.64
C128.0PR	678.5	30 rt	1/1	0 - 51	81.9	1.61
C148.0PR	677	30 rt	1/1	0 - 55	22.4	0.41
C148.0PR	677	30 rt	2/1	55 - 83	5.6	0.26
C201.2SR	645	30 rt	1/1	0 - 51	13.3	0.26
C264.6PR	598	30 rt	1/1	0 - 60	82.7	1.38
C281.5PR	592	30 rt	1/1	0 - 52	65.7	1.26
C308.7PR	568	30 rt	1/1	0 - 6.3	85.3	13.53
C323.0PR	560	30 rt	1/1	0 - 50	13.9	0.28
C332.5SR	559	30 rt	1/1	0 - 54	26.3	0.48
C341.5PR	558	30 rt	1/1	0 - 23	68.1	2.96
A350.0SU	553.5	10 us	1/1	0 - 22	15.6	0.71
C361.5TR	548.5	30 rt	1/1	0 - 51	12.8	0.25

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Right Abutment
(station 1+20 to 3+85)

A Line
(holes numbered A134.0PUF to A380.0PU)

Zone I

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	12	315.5	5.1	0.02
Secondary	12	296	18.7	0.06
Tertiary	2	48	0.0	0.00
Total	26	659.5	23.8	0.04

Zone II

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	19*	1,004.5*	8.6	0.01

A Line Total: Zone I & II

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	19	1,320	13.7	0.01
Secondary	12	296	18.7	0.06
Tertiary	2	48	0.0	0.00
Total	33	1,664	32.4	0.02

* Seven "A" line fan holes were drilled to full depth from top of rock to the bottom depth of zone II within a single stage.

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Right Abutment
(station 1+20 to 3+85)

C Line
right battered holes
(holes numbered C120.0PRF to C382.0SR)

Zone I

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	20	1,049.5	467.8	0.45
Secondary	19	990	70.7	0.07
Tertiary	10	522	15.3	0.03
Quaternary	2	30	0.0	0.00
Total	51	2,591.5	553.8	0.21

Zone II

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	20	504.5	6.7	0.01

C Line Total: Zones I & II

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	20	1,554	474.5	0.31
Secondary	19	990	70.7	0.07
Tertiary	10	522	15.3	0.03
Quaternary	2	30	0.0	0.00
Total	51	3,096	560.5	0.18

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Right Abutment
(station 1+20 to 3+85)

B Line
(holes numbered B575.0PV to B315.0PV)

Zone I

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	4	120	0.7	0.01

Total For Right Abutment

Line	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
A line	33	1,664	32.4	0.02
B line	4	120	0.7	0.01
C line	51	3,096	560.5	0.18
Total for Right Abutment	88	4,880	593.6	0.12

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Valley Section
(station 3+85 to 7+00)

Foundation Characteristics

Station 3+85 to 4+35

Surface Characteristics

Rock Type at Surface:..... F. to v.f.g. sandstone w/ occ. thin shale seams (Winifred Sandstone member)

Surface Elevations:..... 529 to 536 (low relief)

Grout Lines:..... A Line: 5 holes
C Line: 5 holes

Grouting Characteristics

Zone I

Grout Take:..... Low

Connections:..... Few surface connections to bedding planes.

Zone II

Grout Take:..... Very low

Connections:..... None

Station 4+35 to 5+60

Surface Characteristics

Rock Type at Surface:..... Lt. gr., m. to f.g., mod. h., occ. mic. (Winifred Sandstone member)

Surface Elevations:..... 521 to 529 (low relief)

Grout Lines:..... A Line: 15 holes
B Line: 6 holes
C Line: 22 holes
D Line: 7 holes
E Line: 7 holes

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Valley Section
(station 3+85 to 7+00)

Foundation Characteristics

Station 4+35 to 5+60 (cont)

Grouting Characteristics

Zone I

Grout Take:..... Very low, with the exception of hole number C550.0PR.

Connections:..... Occ. connections between holes.

Other:..... Seven additional holes were drilled and pressure tested to determine the tightness of foundation.

Zone II

Grout Take:..... High

Connections:..... Occ. connection between holes.

Other:..... Occ. heavy artesian flow was encountered. Deeper packers were used to increase grouting pressures.

Station 5+60 to 7+00

Surface Characteristics

Rock Type at Surface:..... Lt. gr., m. to f.g., mod. h., occ. mic., occ. hor. bkn. zones (Winifred Sandstone member)

Surface Elevations:..... 521 to 535 (low relief)

Grout Lines:..... A line: 21 holes
B line: 14 holes
C line: 32 holes
D line: 18 holes
E line: 8 holes

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Valley Section
(station 3+85 to 7+00)

Foundation Characteristics

Station 5+60 to 7+00 (cont)

Grouting Characteristics

Zone I

Grout Take:..... Moderate to high

Connections:..... Num. primary hole connections, occ. surface connections.

Other:..... A line: water loss during drilling was encountered within the top 15' (possibly within the broken zones).

B line: very low grout take due to grouting sequence.

C line: occ. artesian flow was encountered in bottom of zone. Deeper packers were used so grouting pressures could be increased.

Additional grouting consisted of: (1) 22 holes were drilled into dental concrete to perform contact grouting (2) 4 holes were grouted to treat a high angled joint.

Zone II

Grout Take:..... Moderate to high

Connections:..... Occ. hole connections.

Other:..... Occ. artesian flow was encountered in bottom of zone. Deeper packers were used so grouting pressures could be increased.

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Valley Section
(station 3+85 to 7+00)

Holes With Cement Rates Higher Than 0.19 (cwt / lf)

Hole Number	Elev.	Angle	Zone/ Stage	Depth Interval	Cement Take CWT	Cem. Rate CWT / LF
C490.0PR	526.5	30 rt	2/1	57.5 - 85	81.4	2.96
C510.0PR	526.5	30 rt	2/1	57 - 86	27.0	0.93
A520.0PU	526.5	10 us	2/1	26 - 66	250.6	6.27
C530.0PR	521	30 rt	2/1	52 - 81	18.3	0.63
A540.0PU	521	10 us	2/1	20.5 - 61	295.7	7.30
C550.0PR	521	30 rt	1/1	0 - 57	101.0	1.77
C550.0PR	521	30 rt	2/1	57 - 67	12.6	1.25
D555.0PV	521	vert	1/1	0 - 35	14.6	0.42
C560.0SR	521	30 rt	2/1	58 - 87	25.6	0.88
C570.0PR	521	30 rt	1/1	0 - 58	35.8	0.62
C570.0PR	521	30 rt	2/1	58 - 78	7.7	0.26
A580.0PU	521	10 us	1/1	0 - 20.5	16.5	0.80
A580.0PU	521	10 us	2/1	20.5 - 48	152.1	5.53
A580.0PU	521	10 us	2/2	48 - 61	130.2	10.02
C580.0SR	521	30 rt	2/1	58 - 87	37.7	1.30
D585.0PV	521	vert	1/1	0 - 35	23.4	0.67
C590.0PR	521	30 rt	1/1	0 - 58	30.9	0.53
D595.0PV	522	vert	1/1	0 - 35	8.7	0.25
C600.0SL*	526	30 lt	1/1	0 - 55	106.4	1.93

* Hole number C600.0SL was drilled and grouted in the wrong sequence.

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Valley Section
(station 3+85 to 7+00)

Holes With Cement Rates Higher Than 0.19 (cwt / lf)

Hole Number	Elev.	Angle	Zone/ Stage	Depth Interval	Cement Take CWT	Cem. Rate CWT / LF
C600.0SR	526	30 rt	1/1	0 - 65	12.8	0.20
E600.0PV	525	vert	1/1	0 - 10	43.9	4.39
E600.0PV	525	vert	1/2	10 - 35	118.5	4.74
D605.0SV	526	vert	1/1	0 - 20	87.0	4.35
C610.0PL	527	30 lt	1/1	0 - 55	15.1	0.27
D625.0SV	528	vert	1/1	0 - 17	51.5	3.03
C630.0PR	529	30 rt	1/1	0 - 66	144.1	2.19
C630.0PR	529	30 rt	2/1	66 - 96	10.9	0.36
C630.0PL	529	30 lt	2/1	55 - 84	6.3	0.22
A640.0PU	530	10 us	1/1	0 - 20.5	39.2	1.91
E640.0PV	529.5	vert	1/1	0 - 35	19.8	0.57
A650.0SU	531	10 us	2/1	20.5 - 61	22.8	0.56
C650.0PL	531	30 lt	1/1	0 - 57	14.9	0.26
C650.0PR	531	30 rt	1/1	0 - 17	11.6	0.68
C650.0PR	531	30 rt	2/1	62 - 78	91.4	5.71
D655.0PV	531	vert	1/1	0 - 35	22.1	0.63
A660.0PU	531	10 us	1/1	0 - 20.5	15.0	0.73
A660.0PU	531	10 us	2/1	20.5 - 61	150.6	3.72
A670.0SU	531	10 us	2/1	20.5 - 61	21.2	0.52
A680.0PU	531.5	10 us	1/1	0 - 12	5.7	0.48
A680.0PU	531.5	10 us	1/2	12 - 20.5	3.0	0.35

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Valley Section
(station 3+85 to 7+00)

Holes With Cement Rates Higher Than 0.19 (cwt / lf)

Holes Number	Elev.	Angle	Zone/ Stage	Depth Interval	Cement Take CWT	Cem. Rate CWT / LF
A700.0PU	535	10 us	1/1	0 - 13	68.4	5.26
A700.0PU	535	10 us	2/1	24 - 64	22.0	0.55

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Valley Section
(station 3+85 to 7+00)

A Line
(holes numbered A390.0SU to A700.0PU)

Zone I

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	16	337	149.5	0.44
Secondary	16	335.5	18.1	0.05
Tertiary	2	41	0.0	0.00
Total	34	713.5	167.6	0.23

Zone II

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	16	657	1,010.1	1.54
Secondary	11	410.5	68.7	0.17
Tertiary	6	366*	5.9	0.02
Total	33	1,433.5	1,084.7	0.75

A Line Total: Zone I & II

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	16	994	1,159.6	1.17
Secondary	16	746	86.8	0.12
Tertiary	8	407	5.9	0.01
Total	40	2,147	1,252.3	0.58

* Holes were drilled within a single stage from top of rock to bottom of zone II.

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Valley Section
(station 3+85 to 7+00)

B Line
(holes numbered B505.0PV to B685.0PV)

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	10	350	2.9	0.01
Secondary	10	350	0.0	0.00
Total	20	700	2.9	0.01

D Line
(holes numbered D495.0PV to D475.0PV)

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	10	350	45.5	0.13
Secondary	9	315	162.6	0.52
Tertiary	6	210	2.6	0.01
Total	25	875	210.7	0.24

E Line
(holes numbered E500.0PV to E640.0PV)

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	8	280	183.8	0.65
Secondary	7	245	78.0	0.03
Total	15	525	191.6	0.36

- All holes in B, D and E lines were drilled to one zone at 35' depth.

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Valley Section
(station 3+85 to 7+00)

C Line
right battered holes
(holes numbered C390.0PR to C650.0PR)

Zone I

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	14	812.5	348.1	0.43
Secondary	13	759	15.5	0.02
Tertiary	8	502	2.3	0.01
Total	35	2,073.5	365.9	0.17

Zone II

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	14	392.5	256.7	0.65
Secondary	10	282	77.0*	0.27
Tertiary	2	174+	3.4	0.02
Total	26	848.5	337.1	0.39

* 37.7 cwt of cement was placed within zone I at 15' depth while grouting zone II.

\+ Two tertiary holes were drilled in a single stage from the top of rock to bottom of zone II.

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Valley Section
(station 3+85 to 7+00)

C Line
left battered holes
(holes numbered C490.0PL to C698.2SL)

Zone I

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	11	636	46.2	0.07
Secondary	11	634	113.8*	0.18*
Tertiary	2	106	0.0	0.00
Total	24	1,376	160.0	0.11

Zone II

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	11	305	23.6	0.08
Secondary	3	83	3.0	0.04
Total	14	388	26.6	0.06

* Hole number C600.0SL, a secondary hole, was drilled and grouted in the wrong sequence. This hole was grouted into an area that was not previously grouted by primary holes. The grout take for this hole, within zone I, was 106.4 cwt of cement.

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Valley Section
(station 3+85 to 7+00)

C Line
left and right battered holes

Zone I

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	25	1,448.5	394.3	0.27
Secondary	24	1,393	129.3*	0.09
Tertiary	10	608	2.3	0.01
Total	59	3,449.5	525.9	0.15

Zone II

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	25	697.5	280.3	0.40
Secondary	13	365	80.0+	0.21
Tertiary	2	174#	3.4	0.02
Total	40	1,236.5	363.7	0.29

* Hole number C600.0SL was drilled and grouted in the wrong sequence.

\+ 37.7 cwt of cement was placed within the top 15' while grouting zone I.

\# Two holes were drilled within a single stage from top of rock to bottom of zone II.

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Valley Section
(station 3+85 to 7+00)

C line Total: Zones I & II
right battered holes

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	14	1,205	604.8	0.50
Secondary	13	1,041	92.5	0.09
Tertiary	10	676	5.7	0.01
Total	37	2,922	703.0	0.24

C line Total: Zone I & II
left battered holes

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	11	941	69.8	0.07
Secondary	11	717	116.8*	0.16
Tertiary	2	106	0.0	0.10
Total	24	1,764	186.6	0.10

C line Total: Zone I & II
left and right battered holes

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	25	2,146	674.6	0.31
Secondary	24	1,758	209.3	0.12
Tertiary	12	782	5.7	0.01
Total	61	4,686	889.6	0.19

* Hole number C600.0SL was drilled and grouted in the wrong sequence (106.4 cwt).

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Valley Section
(station 3+85 to 7+00)

Total For Valley Section

Zone I & II

Grout Line	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
A line	40	2,147	1,252.3	0.58
B line	20	700	2.9	0.01
C line	61	4,686	889.6	0.19
D line	25	875	210.7	0.24
E line	15	525	191.6	0.36
Total	161	8,933	2,547.1	0.28

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Left Abutment
(station 7+00 to 10+00)

Foundation Characteristics

Station 7+00 to 8+30

Surface Characteristics

Rock Type at Surface:..... Thin interbedded sandstone, shales and coal members.

Surface Elevations:..... 535 to 571 (moderate relief)

Grout Lines:..... A line: 13 holes
B line: 5 holes
C line: 17 holes

Grouting Characteristics

Zone I

Grout Take:..... Low

Connections:..... Occasional surface connections to shaley bedding planes.

Zone II

Grout Take:..... Very low

Connections:..... None

Station 8+30 to 9+60

Surface Characteristics

Rock Type at Surface:.....Massive sandstone (Homewood and Coalburg members)

Surface Elevations:..... 571 to 679 (high relief)

Grout Lines:..... A line: 13 holes
C line: 23 holes

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Left Abutment
(station 7+00 to 10+00)

Station 8+30 to 9+60 (cont)

Grouting Characteristics

Zone I

Grout Take:..... Low

Connections:..... Occasional surface connections with bd. pns. and hi. ang. jts.

Other:..... 8 additional holes were drill to treat two hi. ang. jts.

Zone II

Grout Take:..... Very low

Connections:..... None

Station 9+60 to 10+00

Surface Characteristics

Rock Type at Surface:..... Thin layer of sh. & sls. (Lower Kittaning member)

Surface Elevations:..... 679 to 681 (low relief)

Grout Lines..... A line: 10 holes (incl. fan)
C line: 7 holes (including fan)

Grouting Characteristics

Zone I

Grout Take:..... Moderate

Connections:..... Num. surf. conn. in sh. U/S of CL., occ. hole conn. in fan.

Zone II

Grout Take:..... Moderate

Connections:..... Occ. hole conn. in fan area.

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Left Abutment
(station 7+00 to 10+00)

Holes With Cement Rates Higher Than 0.19 (cwt/lf)

Hole Number	Elev.	Angle	Zone/ Stage	Depth Interval	Cement Take CWT	Cem. Rate CWT / LF
C705.9PL	539	30 lt	1/1	0 - 28	93.9	3.35
C705.9PL	539	30 lt	1/2	28 - 53	82.8	3.31
C712.8SL	544.5	30 lt	1/2	30 - 56	8.2	0.31
C855.0PL	592.5	30 lt	1/1	0 - 52	26.5	0.51
C884.0PL	611.5	30 lt	2/1	52 - 77	46.7	1.87
A920.0PU	643	10 us	2/1	29 - 81	12.5	0.24
C985.0PL	680	30 lt	1/1	0 - 54	26.0	0.48
A994.0PUF	681	40 lt	2/1	0 - 58	51.4	0.89
A990.0PUF	681	10 us	2/1	0 - 61	15.2	0.25
C997.0PLF	681	60 lt	2/1	48 - 73	76.2	3.05

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Left Abutment
(station 7+00 to 10+00)

A Line
(holes numbered A7+10.0PU to A996.0PUF)

Zone I

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	14	352	11.5	0.03
Secondary	14	340	8.6	0.03
Total	28	692	20.1	0.03

Zone II

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	21	1,066*	96.6	0.09
Secondary	8	445+	1.6	0.01
Total	29	1,511	98.2	0.06

A Line Total: Zone I & Zone II

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	21	1,418	108.1	0.08
Secondary	19	724	10.2	0.01
Total	40	2,142	118.3	0.06

* Seven fan holes were drilled in one stage from top of rock to bottom of zone II.

\+ Five fan holes were drilled in one stage from top of rock to bottom of zone II.

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Left Abutment
(station 7+00 to 10+00)

"C" Line
left battered holes
(holes numbered C705.9PL to C997.0PLF)

Zone I

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	22	1,151	279.0	0.24
Secondary	19	1,007	44.2	0.04
Tertiary	6	314	0.0	0.00
Total	47	2,472	323.2	0.13

Zone II

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	22	563	130.0	0.23
Secondary	3	*125	0.0	0.00
Total	25	688	130.0	0.18

C Line Total: Zone I & Zone II

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	22	1,714	409.0	0.24
Secondary	20	1,132	44.2	0.04
Tertiary	6	314	0.0	0.00
Total	48	3,160	453.2	0.14

* One fan hole was drilled in a single stage from top of rock to the bottom of zone II.

12-02 FOUNDATION CURTAIN GROUTING

Statistical Data

Left Abutment
(station 7+00 to 10+00)

B Line
(holes numbered B705.0PV to B735.0SV)

Zone I

Hole Type	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
Primary	2	70	0.0	0.00
Secondary	2	70	5.7	0.08
Tertiary	1	10	0.0	0.00
Total	5	150	5.7	0.04

Total For Left Abutment

Grout Line	Number of Holes	Drilling Rock (LF)	Cement Placed (CWT)	Cement Rate (CWT / LF)
A Line	40	2,142	118.3	0.06
B Line	5	150	5.7	0.04
C Line	48	3,160	453.2	0.14
Total for Left Abutment	93	5,452	577.2	0.11

A LINE ZONES I & II

Hole Number	Zone	Stage	Pressure Test CFM	Surface Connection	Hole Communication	Grout Take Per Mix 5:1	4:1	3:1	2.5:1	2:1	1.75:	1.5:1	1:1	0.75:1	Total CWT	Grout Time
A139.0PUF	2	1	1.56		TRUE					0.2					0.2	10m
A140.0PUF	2	1	0.56	TRUE	TRUE			4.8		1.7					6.5	1h 5m
A150.0SU	1	1	0.32	TRUE				0.9							0.9	45m
A220.0PU	2	1	0.26					0.9							0.9	30m
A240.0PU	2	1	0.39					1							1	30m
A250.0SU	1	1	0 5	TRUE				0.4				0.3			0.7	1h 55m
A270.0SU	1	1	0.62					1.3							1.3	1h 50m
A280.0PU	1	1	0.76					0.1				0.7			0.8	50m
A300.0PU	1	1	0.4					0.1							0.1	30m
A330.0SU	1	1	0.73		TRUE								0.1		0.1	15m
A340.0PU	1	1	0.35					0.3							0.3	30m
A350.0SU	1	1	1.31							9.3		6.3			15.6	2h 29m
A360.0PU	1	1	0.46	TRUE						3.9					3.9	2h 50m
A370.0SU	1	1	0.26					0.1							0.1	15m
A460.0PU	2	1	0.24					0.2							0.2	25m
A520.0PU	2	1	1.42		TRUE			17.1		20.3		58	155		250.6	6h 15m
A525.0TU	2	1	0.16					0.8							0.8	50m
A530.0SU	2	1	0.47				9.7	1.5							11.2	3h 0m
A535.0TU	2	1	0.26					1.9							1.9	1h 30m
A540.0PU	2	1	1.22					1.3		46.2		46.4	133	68.7	295.7	4h 45m
A550.0SU	2	1	0.29					1.1							1.1	1h 10m
A560.0PU	1	1	0.49					0.2							0.2	25m
A560.0PU	2	1	1.05					1.7							1.7	1h 25m
A570.0SU	1	1	1.88	TRUE				0.9		15					15.9	1h 56m
A570.0SU	2	1	0.33		TRUE			1.6							1.6	2h 15m
A580.0PU	1	1	0.98	TRUE						16.5					16.5	2h 33m
A580.0PU	2	1	1.17				11.6	33.2		45		49	13.3		152.1	5h 55m
A580 0PU	2	2	1.76		TRUE		16.1	33.3		41.5		24.1	15.2		130.2	6h 35m

A LINE ZONES I & II

Hole Number	Zone	Stage	Pressure Test CFM	Surface Connection	Hole Communication	Grout Take Per Mix									Total CWT	Grout Time
						5:1	4:1	3:1	2.5:1	2:1	1.75:	1.5:1	1:1	0.75:1		
A590.0SU	1	1	0.41					1							1	1h 10m
A590.0SU	2	1	0 2				1	1							2	1h 55m
A600.0PU	2	1	2.09		TRUE								0.1		0.1	23m
A610.0SU	1	1	0.53				1.1								1.1	50m
A610.0SU	2	1	0.2					1.9							1.9	2h 23m
A620.0PU	1	1	0.35					1.5							1.5	1h 25m
A620.0PU	2	1	0.35				4.7	1.2							5.9	2h 42m
A630.0SU	2	1	0.29					4.5							4.5	2h 4m
A640.0PU	1	1	3.5					1.3		37.8		0.1			39.2	3h 14m
A640.0PU	2	1	0.3					1							1	55m
A645.0TU	2	1	0.09					0.6							0.6	1h 21m
A650.0SU	2	1	1.6		TRUE			4.7		17.5		0.6			22.8	3h 45m
A655.0TU	2	1	0.24					0.9							0.9	1h 12m
A660.0PU	1	1	2.43	TRUE	TRUE					15					15	1h 4m
A660.0PU	2	1	2.08		TRUE			26.4		33.5		38.7	52		150.6	4h 21m
A665.0TU	2	1	0.29		TRUE			1.4							1.4	1h 38m
A670.0SU	1	1	0.69				0.1								0.1	21m
A670 0SU	2	1	1.76		TRUE							7.8	8.7	4.7	21.2	2h 30m
A675.0TU	2	1	0.86		TRUE			0.3							0.3	50m
A680.0PU	1	1	1.31		TRUE					5.7					5.7	45m
A680.0PU	1	2	0.68							3					3	1h 0m
A690.0SU	2	1	0.33		TRUE			2.4							2.4	52m
A700.0PU	1	1	1.89					24.4		44					68.4	4h 5m
A700.0PU	2	1	0.51					8.8		12.6		0.6			22	4h 0m
A780.0PU	1	1	0.78	TRUE						3.6					3.6	1h 20m
A820.0PU	1	1	1.73	TRUE								1.8			1.8	40m
A860.0PU	1	1	0.3						0.9						0.9	1h 20m
A870.0SU	1	1	0.52	TRUE						3.2					3.2	40m

A LINE ZONES I & II

Hole Number	Zone	Stage	Pressure Test CFM	Surface Connection	Hole Communication	Grout Take Per Mix									Total CWT	Grout Time
						5:1	4:1	3:1	2.5:1	2:1	1.75:	1.5:1	1:1	0.75:1		
A900.0PU	2	1	0.29				0.5								0.5	20m
A920.0PU	2	1	0.24				3.3	6.4		2.8					12.5	1h 55m
A930.0SU	1	1	0.69	TRUE						1.7			2.3		4	55m
A940.0PU	2	1	0.49					1.2							1.2	30m
A950.0SU	1	1	0.29						1.4						1.4	1h 0m
A960.0PU	1	1	0.7	TRUE									2.6		2.6	15m
A960.0PU	2	1	0.22					0.9							0.9	30m
A980.0PU	1	1	1.16	TRUE									2.6		2.6	15m
A990.0PUF	2	1	0.41		TRUE					14.6			0.6		15.2	3h 30m
A993.5SUF	2	1	0.42					1.1							1.1	30m
A994.0PUF	2	1	0.56		TRUE			4.4		10.9		22.3	13.8		51.4	5h 10m
A995.0PUF	2	1	0.8	TRUE	TRUE								9.4		9.4	15m
A995.5SUF	2	1	0.23					0.5							0.5	30m
A996.0PUF	2	1	0.87	TRUE	TRUE								5.5		5.5	10m

C LINE ZONES I & II

Hole Number	Zone	Stage	Pressure Test CFM	Surface Connection	Hole Communication	Grout Take Per Mix 5:1	4:1	3:1	2.5:1	2:1	1.75:1	1.5:1	1:1	0.75:1	Total CWT	Grout Time
C120.0PRF	1	1	1.84	TRUE					8.3	11.4					19.7	2h10m
C121.0PRF	1	1	1.85						0.4						0.4	20m
C122.0PRF	1	1	1.93	TRUE	TRUE					4.1					4.1	1h 50m
C128.0PR	1	1	1.83	TRUE				26.5		28.7		26.7			81.9	4h 30m
C138.0SR	1	1	0.49	TRUE				3.4							3.4	55m
C148.0PR	1	1	0.66	TRUE				11.3		8.8	2.3				22.4	2h 15m
C148.0PR	2	1	0.51	TRUE				5.6							5.6	2h 0m
C158.0SR	1	1	0.34	TRUE				3.8							3.8	50m
C174.3SR	1	1	1.27					3.3							3.3	40m
C181.0PR	2	1	0.2					1.1							1.1	1h 30m
C201.0SR	1	1	0.86					8.1	3.2	2					13.3	4h 10m
C238.0PR	1	1	1.25	TRUE						7.3					7.3	4h 10m
C264.6PR	1	1	1.46					25.9		42	10.3	4.5			82.7	4h 10m
C281.5PR	1	1	1.73	TRUE				37.4		28.3					65.7	4h 15m
C287.8SR	1	1	0.61						5.2						5.2	1h 30m
C294.2PR	1	1	1.81					4.3		4.5					8.8	1h 35m
C301.0SR	1	1	1.93	TRUE						1.1		1.1			2.2	1h 20m
C308.7PR	1	1	1.75	TRUE						12.2		17.4	55.7		85.3	3h 45m
C316.2SR	1	1	0.41							0.6					0.6	50m
C323.0PR	1	1	1.02					2.5		11.4					13.9	3h 23m
C332.5SR	1	1	1.8	TRUE	TRUE					3.6			22.7		26.3	3h 11m
C341.5PR	1	1	1.8	TRUE				1.1		19		27.9	20.1		68.1	3h 41m
C349.5SR	1	1	1.47	TRUE						4.5			3.2		7.7	2h 42m
C354.5TR	1	1	1.33	TRUE				0.4		1.8					2.2	1h 16m
C358.5PR	1	1	0.23	TRUE				0.3							0.3	40m
C361.5 TR	1	1	0 85	TRUE	TRUE			1.7		3.8			7.3		12.8	2h 6m
C365.0SR	1	1	0.57	TRUE				2.4		2		0.5			4.9	3h 14m
C370.0TR	1	1	0.24	TRUE				0.3							0.3	45m
C374.5PR	1	1	1.21	TRUE						4.8			2.4		7.2	2h 40m

C LINE ZONES I & II

Hole Number	Zone	Stage	Pressure Test CFM	Surface Connection	Hole Communication	Grout Take Per Mix									Total CWT	Grout Time
						5:1	4:1	3:1	2.5:1	2:1	1.75:1	1.5:1	1:1	0.75:1		
C410.0PR	1	1	3.02	TRUE						2.8					2.8	1h 50m
C430.0PR	1	1	2.42	TRUE				3		2.8		4.7			10.5	4h 30m
C430.0PR	2	1	#N/A										0.7		0.7	10m
C470.0PR	1	1	0.93		TRUE			0.9							0.9	1h 10m
C480.0SR	2	1	0.51							3.7					3.7	1h 10m
C490.0PR	1	1	1.6		TRUE			2.7							2.7	1h 30m
C490.0PR	2	1	0.9		TRUE			2.3		13.9			65.2		81.4	1h 40m
C510.0PL	2	1	0.26					2.6							2.6	2h 20m
C510.0PR	2	1	1.51							13.3			13.7		27	1h 18m
C530.0PL	2	1	0.46					1							1	50m
C530.0PR	2	1	0.69					15.2		3.1					18.3	5h 10m
C540.0SR	2	1	0.11				1.8	1.3							3.1	2h 25m
C550.0PR	1	1	1.16		TRUE			1.7		12.7		38.2	48.4		101	4h 6m
C550.0PR	2	1	1.22					2.7		9.9					12.6	1h 30m
C550.0PR	2	2	0.91					0.9		0.5					1.4	1h 20m
C550.0PL	1	1	1.34		TRUE							1			1	10m
C550.0PL	2	1	0.21					1							1	1h 5m
C555 0TR	2	1	0.21					1.4							1.4	1h 20m
C560.0SR	1	1	0.24					0.5							0.5	35m
C560.0SR	2	1	1					10.3		13.7		1.6			25.6	3h 17m
C565.0TR	2	1	0.36					2							2	1h 0m
C570.0PR	1	1	1.02		TRUE			2.7		32.3		0.8			35.8	3h 33m
C570.0PR	2	1	0.87			3.3		4.4							7.7	35m
C570.0PL	2	1	0.18					0.6							0.6	40m
C580.0SR	2	1	0.4		TRUE			11.8		9.2			16.7		37.7	4h 7m
C590.0PL	1	1	0.3					1.6							1.6	52m
C590 0PL	2	1	0.27					0.9							0.9	35m
C590.0PR	1	1	1.52		TRUE			1		12.6		17.3			30.9	2h 34m
C590.0PR	2	1	0.21				1.6								1.6	1h 10m

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C LINE ZONES I & II

Hole Number	Zone	Stage	Pressure Test CFM	Surface Connection	Hole Communication	Grout Take Per Mix									Total CWT	Grout Time
						5:1	4:1	3:1	2.5:1	2:1	1.75:1	1.5:1	1:1	0.75:1		
C600.0SL	1	1	1.85					11.5		38.8		49.9	6.2		106.4	3h 47m
C600.0SL	2	1	0.5					1.8							1.8	1h 0m
C600.0SR	1	1	0.89		TRUE			12.8							12.8	4h 54m
C610.0PL	1	1	0.39					8		4.8		2.3			15.1	4h 15m
C610.0PL	2	1	0.2		TRUE			3.1		2.2					5.3	2h 22m
C610.0PR	1	1	0 84		TRUE					3					3	54m
C610.0PR	2	1	0.26				3.1								3.1	49m
C620.0SL	2	1	0.13					0.6							0.6	40m
C620.0SR	1	1	0.48		TRUE					0.4					0.4	20m
C620.0SR	2	1	0.23				1.3	2.3	0.8						4.4	2h 0m
C625.0TR	1	1	0 2		TRUE		1.2								1.2	44m
C630.0PL	2	1	0.33		TRUE			3.5		2.8					6.3	2h 40m
C630.0PR	1	1	1.58					2.4		23.4		52.2	58.4	7.7	144:1	6h 58m
C630.0PR	2	1	1.49				10.9								10.9	2h 55m
C635.0TR	1	1	0.01		TRUE		0.2								0.2	25m
C640.0SL	2	1	0.23					0.6							0.6	40m
C640.0SR	1	1	1.17		TRUE					1.8					1.8	50m
C640.0SR	2	1	0.28					2.5							2.5	1h 30m
C645.0TR	1	1	0.16				0.9								0.9	1h 13m
C650.0PL	1	1	0.36		TRUE			11.3		3.6					14.9	2h 29m
C650.0PL	2	1	0.22		TRUE					0.3					0.3	20m
C650.0PR	1	1	2.33		TRUE			2.2		9.4					11.6	1h 30m
C650.0PR	1	2	0.54							4.1					4.1	1h 30m
C650.0PR	2	1	2.26				4	24.7		21.8		26.9	14		91.4	5h 54m
C650.0PR	2	2	0.18					1.2							1.2	30m
C660.0SL	1	1	0.27				2.6								2.6	55m
C670.0PL	1	2	0.69							11.9					11.9	1h 50m
C670.0PL	2	1	0.15				2.6								2.6	2h 24m
C680.0SL	1	1	0.53				1.6								1.6	1h 26m

(0-68)

C LINE ZONES I & II

Hole Number	Zone	Stage	Pressure Test CFM	Surface Connection	Hole Communication	Grout Take Per Mix 5:1	4:1	3:1	2.5:1	2:1	1.75:1	1.5:1	1:1	0.75:1	Total CWT	Grout Time
C688.3PL	1	1	2 15	TRUE				1.7							1.7	1h 30m
C688.3PL	2	1	0.22				2.1								2.1	1h 26m
C698.2SL	1	1	0.26				2.6	0.6							3.2	1h 37m
C705.9PL	1	1	1.74	TRUE				25.9		32.2		35.8			93.9	6h 55m
C705.9PL	1	2	0.82							36.1		46.7			82.8	3h 35m
C712.8SL	1	1	1.54	TRUE								3.7			3.7	32m
C712.8SL	1	2	0.83	TRUE			0.9	1.6		5			0.7		8.2	1h 27m
C722.0PL	1	1	0.88	TRUE				0.1		7					7.1	2h 20m
C732.0SL	1	1	0.52					1.1							1.1	38m
C740.5PL	1	1	0.5					0.7							0.7	40m
C755.0PL	1	1	0.28					0.2							0.2	20m
C791.8PL	1	1	0.46					1							1	55m
C811.8PL	1	1	0.95	TRUE						7.1					7.1	1h 20m
C818.1SL	1	1	0.3	TRUE						0.2		1.2			1.4	1h 15m
C827.6PL	1	1	0.25					2.5							2.5	1h 10m
C827.6PL	2	1	0.7					0.9							0.9	30m
C834.5SL	1	1	3.13	TRUE						5.7		2.4			8.1	1h 25m
C841.0PL	1	1	0.29					0.5							0.5	20m
C855.0PL	1	2	0.86	TRUE				8.3		6.1		12.1			26.5	3h 25m
C855.0PL	2	1	0.32					0.5							0.5	10m
C862.0SL	1	1	0.4					4.7		4.7					9.4	2h 40m
C868.5PL	1	1	0.67						1.7						1.7	45m
C878.0SL	1	1	0.24					0.6							0.6	35m
C884.0PL	1	1	0.48						0.9						0.9	30m
C884.0PL	2	1	0.64				4.6	12.2		29.9					46.7	2h 0m
C889.7SL	1	1	0.3	TRUE				0.4							0.4	25m
C896.0PL	2	1	0.22					0.6							0.6	30m
C911.0PL	2	1	0.43				1								1	25m
C917.3SL	1	1	0.4					1.2							1.2	40m

C LINE ZONES I & II

Hole Number	Zone	Stage	Pressure Test CFM	Surface Connection	Hole Communication	Grout Take Per Mix									Total CWT	Grout Time
						5:1	4:1	3:1	2.5:1	2:1	1.75:1	1.5:1	1:1	0.75:1		
C923.9PL	1	1	2.38	TRUE						3.3					3.3	45m
C937.5PL	1	1	1.24	TRUE				1.8				1.6			3.4	45m
C937.5PL	2	1	0.42					1.5							1.5	35m
C950.0PL	2	1	0.2					1.1							1.1	40m
C956.0SL	1	1	0.38	TRUE								3.7			3.7	1h 30m
C965.0PL	1	1	2.4	TRUE									10.5		10.5	1h 5m
C965.0PL	2	1	0.21					0.7							0.7	30m
C975.0SL	1	1	1.06	TRUE				5.7							5.7	1h 50m
C985.0PL	1	1	2.52	TRUE									26		26	2h 40m
C990.0SL	1	1	0.22					0.7							0.7	30m
C995.0PLF	1	1	#N/A										5.2		5.2	35m
C996.0PLF	1	1	#N/A										2.6		2.6	15m
C996.0PLF	2	1	0.26					0.8							0.8	45m
C997.0PLF	1	1	#N/A										2.6		2.6	15m
C997.0PLF	2	1	0.7					12.6		28.4		35.2			76.2	3h 40m

B, D, AND E LINES

Hole Number	Zone	Stage	Pressure Test CF	Surface Connection	Hole Communication	Grout Take Per Mix									Total CWT	Grout Time
						5:1	4:1	3:1	2.5:1	2:1	1.75:1	1.5:1	1:1	0.75:1		
B375.0PV	1	1	0.66	TRUE				0.5							0.5	1h 5m
B355.0PV	1	1	0.28	TRUE				0.2							0.2	50m
B565.0PV	1	1	0.12					0.2							0.2	20m
B585.0PV	1	1	0.24					1.8							1.8	1h 10m
B625.0PV	1	1	0.4					0.9							0.9	30m
B715.0SV	1	1	1.77	TRUE				0.2					5.5		5.7	2h 30m
															0	
D525.0SV	1	1	0.21					0.2							0.2	20m
D545.0SV	1	1	2.16					0.5							0.5	35m
D555.0PV	1	1	0.18					2.4		12.2					14.6	2h 5m
D575.0PV	1	1	0.4					0.1							0.1	30m
D585.0SV	1	1	0.95				2.1	6.3		5.7		9.3			23.4	5h 0m
D595.0PV	1	1	1.62					8.7							8.7	1h 50m
D600.0TV	1	1	0.52		TRUE			0.3							0.3	20m
D605.0SV	1	1	1.76				11.2	13		32.4		30.4			87	5h 5m
D610.0TV	1	1	0.64		TRUE			2.3							2.3	1h 15m
D625.0SV	1	1	1.4					3.7		30.6		12.7	4.5		51.5	3h 0m
D655.0PV	1	1	0.56					10.9		6.7		4.5			22.1	3h 50m
															0	
E600.0PV	1	1	3.62					20.2		18		5.7			43.9	7h 20m
E600.0PV	1	2	1.23				8.9	18.7		30.1		57.6	3.2		118.5	4h 10m
E610.0SV	1	1	0.27	TRUE				2		1.4					3.4	3h 20m
E620.0PV	1	1	1.91				1.6								1.6	1h 15m
E630.0SV	1	1	0.44					3.4		1					4.4	1h 55m
E640.0PV	1	1	0.45	TRUE			4.9			5.2		8.2	1.5		19.8	3h 0m

06/19/89

PRESSURE FLOW AND GROUT TAKE FOR HOLE AND DEPTH RANGE SHOWN

HOLE RANGE: A134.0PUF - A996.0PUF
DEPTH RANGE: 0.0- **.*

HOLE NO.	INTERVAL, FT	WATER CFM	TAKE, CWT	DATE PT	DATE GR
A134.0PUF	2.0-61.0	0.14	0.00	02/26/88	NOT REQ.
A135.0PUF	2.0-61.0	0.19	0.00	02/26/88	NOT REQ.
A136.0PUF	2.0-62.0	0.22	0.00	02/26/88	02/29/88
A137.0PUF	2.0-62.0	0.22	0.00	02/26/88	02/29/88
A138.0PUF	2.0-62.0	0.05	0.00	02/26/88	NOT REQ.
A139.0PUF	2.0-61.0	1.56	0.20	02/26/88	02/29/88
A140.0PUF	2.0-61.0	0.56	6.50	02/26/88	02/29/88
A150.0SU	2.0-21.0	0.32	0.90	02/17/88	02/19/88
A160.0PU	2.0-20.0	0.09	0.00	02/08/88	NOT REQ.
A170.0SU	2.0-29.0	0.04	0.00	02/17/88	NOT REQ.
A180.0PU	2.0-20.0	0.12	0.00	02/08/88	NOT REQ.
A180.0PU	29.5-77.0	0.04	0.00	02/26/88	NOT REQ.
A190.0SU	2.0-29.0	0.08	0.00	02/17/88	NOT REQ.
A200.0PU	2.0-20.5	0.05	0.00	02/05/88	NOT REQ.
A200.0PU	20.5-76.0	0.14	0.00	02/26/88	NOT REQ.
A210.0SU	2.0-29.5	0.01	0.00	02/15/88	NOT REQ.
A220.0PU	2.0-29.5	0.01	0.00	02/05/88	NOT REQ.
A220.0PU	29.5-78.0	0.26	0.90	02/25/88	02/29/88
A230.0SU	2.0-21.0	0.01	0.00	02/15/88	NOT REQ.
A240.0PU	2.0-26.5	0.01	0.00	02/05/88	NOT REQ.
A240.0PU	26.5-80.0	0.39	1.00	02/25/88	02/29/88
A250.0SU	2.0-29.5	0.50	0.70	02/15/88	02/18/88
A260.0PU	2.0-26.5	0.01	0.00	02/05/88	NOT REQ.
A260.0PU	2.0-75.0	0.07	0.00	02/25/88	NOT REQ.
A270.0SU	2.0-21.0	0.62	1.30	02/15/88	02/18/88
A280.0PU	2.0-29.5	0.76	0.80	02/05/88	02/08/88
A280.0PU	2.0-82.0	0.04	0.00	02/25/88	NOT REQ.
A290.0SU	2.0-29.5	0.03	0.00	02/15/88	NOT REQ.
A300.0PU	29 - 71	0.07	0.00	10/21/87	NOT REQ.
A310.0SU	1.5-23.0	0.00	0.00	10/13/87	NOT REQ.
A320.0PU	1.5-23.5	0.20	0.00	10/08/87	NOT REQ.
A320.0PU	23.5 - 65	0.05	0.00	10/21/87	NOT REQ.
A330.0SU	1.5-20.5	0.73	0.03	10/13/87	10/14/87
A340.0PU	1.5-25.5	0.35	0.03	10/08/87	10/08/87
A340.0PU	25.5-70	0.04	0.00	10/21/87	NOT REQ.
A345.0TU	1.5-20.0	0.01	0.00	10/16/87	NOT REQ.
A350.0SU	1.5-22	1.31	15.60	10/13/87	10/13/87
A355.0TU	1.5-20.0	0.00	0.00	10/07/87	NOT REQ.
A360.0PU	1.5-25.0	0.20	3.86	10/08/87	10/09/87
A360.0PU	1.5-20.0	0.00	0.00	10/22/87	NOT REQ.
A370.0SU	1.5-21.0	0.26	0.04	10/13/87	10/13/87
A380.0PU	1.5-28.5	0.01	0.00	10/08/87	NOT REQ.
A380.0PU	28.5-69	0.06	0.00	10/21/87	NOT REQ.
A390.0SU	1.5-20.5	0.02	0.00	10/12/87	NOT REQ.
A400.0PU	1.5-20.0	0.01	0.00	10/09/87	NOT REQ.
A400.0PU	20.5-64	0.04	0.00	10/15/87	NOT REQ.
A410.0SU	1.5-21.0	0.20	0.00	10/12/87	NOT REQ.
A420.0PU	1.5-20.5	0.13	0.00	10/07/87	NOT REQ.

A430.0SU	1.5-24.0	0.16	0.00	10/12/87 NOT REQ.
A440.0PU	1.5-20.5	0.01	0.00	10/07/87
A440.0PU	1.5-20.0	0.06	0.00	10/14/87 NOT REQ.
A450.0SU	2.0-20.5	0.00	0.00	10/12/87 NOT REQ.
A460.0PU	1.5-20.5	0.01	0.00	10/07/87 NOT REQ.
A460.0PU	20.5-61	0.24	0.22	10/14/87 10/15/87
A470.0SU	1.5-20.5	0.00	0.00	10/09/87 NOT REQ.
A480.0PU	1.5-20.5	0.00	0.00	10/07/97 NOT REQ.
A490.0SU	1.5-20.5	0.20	0.00	10/22/87 NOT REQ.
A500.0PU	1.5-20.5	0.20	0.00	10/22/87 NOT REQ.
A500.0PU	20.5-61	0.20	0.00	10/23/87 NOT REQ.
A510.0SU	1.5-20.5	0.02	0.00	11/02/87 NOT REQ.
A510.0SU	20.5-64.0	0.03	0.00	11/24/87 NOT REQ.
A520.0PU	1.5-26.0	0.20	0.00	10/27/87 NOT REQ.
A525.0TU	0-61.0	0.16	0.80	12/07/87 12/07/87
A530.0SU	1.5-20.5	0.20	0.00	11/02/87 NOT REQ.
A530.0SU	20.5-61	0.47	11.20	11/24/87 11/25/87
A535.0TU	0-61.0'	0.20	1.90	12/07/87 12/07/87
A540.0PU	1.5-20.5	0.02	0.00	10/27/87 NOT REQ.
A550.0SU	1.5-20.5	0.01	0.00	11/02/87 NOT REQ.
A550.0SU	20.5-61.0	0.29	1.10	12/01/87 12/01/87
A560.0PU	1.5-20.5	0.49	0.00	10/27/87 NO RECOR
A560.0SL	2.0-58.0	0.20	0.00	12/14/87 NOT REQ.
A565.0TU	2.0-20.5	0.08	0.00	11/09/87 NOT REQ.
A570.0SU	1.5-20.5	1.88	0.00	11/02/87 NO RECOR
A570.0SU	20.5-61.0	0.33	1.50	12/01/87 12/02/87
A575.0TU	2.0-20.5	0.20	0.00	11/09/87 NOT REQ.
A580.0PU	1.5-20.5	0.98	0.00	10/27/87 NO RECOR
A580.0PU	20.5-61.0	1.17	152.10	11/16/87 11/17/87
A590.0SU	1.5-20.5	0.41	0.00	11/13/87 NO RECOR
A590.0SU	20.5-61	0.20	1.98	12/01/87 12/02/87
A600.0PU	1.5-20.5	0.14	0.00	11/03/87 NOT REQ.
A610.0SU	0-20.5	0.53	0.00	11/16/87 NO RECOR
A610.0SU	20.5-64.0	0.20	1.86	12/01/87 12/02/87
A620.0PU	1.5-20.5	0.35	0.00	11/03/87 NO RECOR
A630.0SU	0-20.5	0.20	0.00	11/16/87 NOT REQ.
A630.0SU	20.5-61	0.29	0.00	12/15/87 NO RECOR
A640.0 PU	20.5-61.0	0.30	0.00	11/23/87 NO RECOR
A640.0PU	1.5-20.5	3.50	0.00	11/03/87 NO RECOR
A645.0TU	20'-61.0	0.20	0.56	12/07/87 12/08/87
A650.0SU	0-20.5	0.20	0.00	11/16/87 NOT REQ.
A650.0SU	20.5-61	1.60	22.80	12/01/87 12/02/87
A655.0TU	20.0-61.0	0.04	0.88	12/07/87 12/08/87
A660.0 PU	1.5-20.0	0.20	14.99	10/07/87 11/05/87
A670.0SU	0-20.5	0.69	0.00	11/16/87 NO RECOR
A670.0SU	20.5-61.0	1.78	21.20	12/01/87 12/02/87
A675.0TU	20'-61.0	0.03	0.26	12/07/87 12/08/87
A680.0PU	1.5-12.0	1.31	0.00	11/03/87 NO RECOR
A680.0PU	12-20.5	0.68	0.00	11/12/87 NO RECOR
A690.0SU	0.0-24.0	0.18	0.00	11/16/87 NOT REQ.
A690.0SU	24-64.0	0.33	2.37	12/10/87 12/11/87
A700.0PU	1.5-13.0	1.89	0.00	11/03/87 NO RECOR
A700.0PU	1.5-20.0	0.20	0.00	11/12/87 NOT REQ.
A700.0PU	24'-64.0'	0.51	0.00	12/08/87 NO RECOR
A710.0SU	0-29.0	0.00	0.00	11/18/87 NOT REQ.
A710.0SU	29-70.0	0.02	0.00	12/11/87 NOT REQ.
A720.0PU	1.5-20.0	0.20	0.00	10/07/87 NOT REQ.

A730.0SU	0-20.5	0.04	0.00	11/18/87	NOT REQ.
A740.0PU	1.5-22.0	0.20	0.00	11/12/87	NOT REQ.
A750.0SU	0.0-27.0	0.02	0.00	11/18/87	NOT REQ.
A760.0PU	1.5-20.5	0.20	0.00	11/13/87	NOT REQ.
A770.0SU	0-20.5	0.01	0.00	11/18/87	NOT REQ.
A780.0PU	1.5-23.0	0.20	3.62	10/12/87	11/13/87
A780.0PU 2	1.5-23.0	0.20	0.00	10/12/87	NOT REQ.
A790.0SU	0.0-20.5	0.06	0.00	11/18/87	NOT REQ.
A800.0PU	1.5-20.5	0.05	0.00	11/13/87	NOT REQ.
A810.0SU	2.0-20.5	0.07	0.00	03/22/88	NOT REQ.
A820.0PU	2.0-27.0	1.73	1.80	03/14/88	03/17/88
A830.0SU	2.0-21.0	0.20	0.00	03/22/88	NOT REQ.
A840.0PU	2.0-29.0	0.12	0.00	03/14/88	NOT REQ.
A850.0 SU	2.0-27.0	0.07	0.00	03/23/88	NOT REQ.
A860.0PU	2.0-27.0	0.30	0.90	03/16/88	03/17/88
A870.0 SU	2.0-26.0	0.52	3.20	03/23/88	03/23/88
A880.0PU	2.0-24.0	0.05	0.00	03/16/88	NOT REQ.
A890.0 SU	2.0-29.0	0.11	0.00	03/23/88	NOT REQ.
A900.0PU	2.0-29.0	0.02	0.00	03/17/88	NOT REQ.
A910.0 SU	2.0-24.0	0.06	0.00	03/23/88	NOT REQ.
A910.0 SU	24.0-80.0	0.16	0.00	04/04/88	NOT REQ.
A920.0PU	2.0-29.0	0.16	0.00	03/17/88	NOT REQ.
A930.0 SU	2.0-25.0	0.69	4.00	03/23/88	02/23/88
A930.0 SU	25.0-77.0	0.14	0.00	04/04/88	NOT REQ.
A940.0PU	2.0-29.0	0.09	0.00	03/17/88	NOT REQ.
A940.0PU	7.0-80.0	0.49	1.20	03/30/88	03/30/88
A950.0 SU	2.0-29.0	0.29	1.40	03/23/88	03/24/88
A960.0PU	2.0-28.0	0.70	2.60	03/18/88	03/18/88
A970.0 SU	2.0-20.0	0.13	0.00	03/23/88	NOT REQ.
A980.0PU	2.0-21.0	1.16	2.60	03/18/88	03/18/88
A985.0SU	7.0-61.0	0.05	0.00	04/05/88	NOT REQ.
A990.0PUF	7.0-61.0	0.40	15.20	03/30/88	03/30/88
A990.5SUF	7.0-61.0	0.10	0.00	04/05/88	NOT REQ.
A991.0PUF	7.0-61.0	0.51	0.00	03/30/88	NO RECOR
A992.0PUF	7.0-60.0	0.34	0.00	03/30/88	NO RECOR
A993.0PUF	1.5-20.0	0.57	0.00	10/07/87	NO RECOR
A993.5SUF	7.0-59.0	0.42	1.10	04/05/88	04/05/88
A994.0PUF	7.0-58.0	0.56	51.40	03/30/88	04/01/88
A994.5SUF	7.0-58.0	0.16	0.00	04/05/88	NOT REQ.
A995.0PUF	7.0-57.0	0.80	9.40	03/30/88	04/01/88
A995.5SUF	7.0-57.0	0.23	0.50	04/04/88	04/05/88
A996.0PUF	7.0-56.0	0.87	5.50	03/30/88	04/01/88

06/19/89

PRESSURE FLOW AND GROUT TAKE FOR HOLE AND DEPTH RANGE SHOWN

HOLE RANGE: B315.0 PV - B735.0 SV
DEPTH RANGE: 0.0- **.*

HOLE NO.	INTERVAL, FT	WATER CFM	TAKE, CWT	DATE PT	DATE GR
B315.0 PV	1.5-30.0	0.01	0.00	10/27/87	NOT REQ.
B355.0 PV	1.5-30.0	0.28	0.16	10/27/87	10/29/87
B375.0 PV	1.5-30.0	0.66	0.51	10/27/87	10/29/87
B505.0 PV	2.0-35.0	0.20	0.00	12/07/87	NOT REQ.
B515.0 SV	2.0-35.0	0.02	0.00	12/18/87	NOT REQ.
B525.0 PV	2.0-35.0	0.20	0.00	12/14/87	NOT REQ.
B545.0 PV	2.0-35.0	0.01	0.00	12/17/87	NOT REQ.
B555.0 SV	2.0-35.0	0.03	0.00	12/18/87	NOT REQ.
B565.0 PV	2.0-35.0	0.12	0.20	12/17/87	12/18/87
B575.0 SV	2.0-35.0	0.04	0.00	12/22/87	NOT REQ.
B585.0 PV	2.0-35.0	0.24	1.80	12/18/87	12/18/87
B595.0 SV	2.0-35.0	0.20	0.00	12/21/87	NOT REQ.
B605.0 PV	2.0-35.0	0.11	0.00	12/21/87	NOT REQ.
B615.0SV	2.0-35.0	0.10	0.00	01/04/88	NOT REQ.
B625.0 PV	2.0-35.0	0.40	0.09	12/27/87	12/21/87
B635.0SV	2.0-35.0	0.09	0.00	01/04/88	NOT REQ.
B645.0 PV	2.0-35.0	0.06	0.00	12/21/87	NOT REQ.
B655.0 SV	2.0-35.0	0.03	0.00	12/21/87	NOT REQ.
B665.0 PV	2.0-35.0	0.05	0.00	12/18/87	NOT REQ.
B675.0 SV	2.0-35.0	0.01	0.00	12/21/87	NOT REQ.
B685.0 PV	2.0-35.0	0.00	0.00	12/10/87	NOT REQ.
B705.0 PV	2.0-35.0	0.03	0.00	12/21/87	NOT REQ.
B715.0 SV	2.0-35.0	1.77	5.70	12/21/87	12/21/87
B720.0 TV	1.0-10.0	0.04	0.00	01/15/88	NOT REQ.
B725.0 PV	2.0-35.0	0.02	0.00	12/18/87	NOT REQ.
B735.0 SV	2.0-35.0	0.03	0.00	12/21/87	NOT REQ.

05/19/89

PRESSURE FLOW AND GROUT TAKE FOR HOLE AND DEPTH RANGE SHOWN

HOLE RANGE: C120.0PRF - C997.0PLF
DEPTH RANGE: 0.0- **.*

HOLE NO.	INTERVAL, FT	WATER CFM	TAKE, CWT	DATE PT	DATE GR
C120.0PRF	2.0-12.0	1.84	19.70	02/10/88	02/11/88
C120.0PRF	12.0-50.0	0.15	0.00	02/11/88	NOT REQ.
C120.5SRF	2.0-50.0	0.05	0.00	02/22/88	NOT REQ.
C121.0PRF	1.5-20.0	1.85	0.40	10/07/87	02/11/88
C121.0PRF	22.0-50.0	0.13	0.00	02/17/88	NOT REQ.
C122.0PRF	2.0-37.0	1.93	4.10	02/10/88	08/11/88
C122.0PRF	37.0-50.0	0.06	0.00	02/17/88	NOT REQ.
C125.0SR	2.0-50.0	0.09	0.00	02/22/88	NOT REQ.
C128.0PR	2.0-51.0	1.83	81.90	02/10/88	02/11/88
C138.0SR	2.0-53.0	0.49	3.40	02/17/88	02/19/88
C148.0PR	2.0-55.0	0.66	22.40	02/10/88	02/10/88
C158.0SR	2.0-55.0	0.34	3.80	02/17/88	02/19/88
C167.0PR	2.0-51.0	0.06	0.00	02/08/88	NOT REQ.
C167.0PR	51.0-81.0	0.18	0.00	02/26/88	NOT REQ.
C174.3SR	2.0-52.0	1.27	3.30	02/17/88	02/19/88
C181.0PR	2.0-50.0	0.02	0.00	02/08/88	NOT REQ.
C181.0PR	52.0-78.0	0.20	1.10	02/26/88	02/29/88
C187.3SR	2.0-52.0	0.08	0.00	02/17/88	NOT REQ.
C193.8PR	2.0-51.0	0.05	0.00	02/05/88	NOT REQ.
C193.8PR	51.0-76.0	0.13	0.00	02/26/88	NOT REQ.
C197.0TR	2.0-50.0	0.06	0.00	02/22/88	NOT REQ.
C201.2SR	2.0-51.0	1.76	13.30	02/16/88	02/19/88
C206.0TR	2.0-53.0	0.12	0.00	02/22/88	NOT REQ.
C210.3PR	2.0-53.0	0.05	0.00	02/05/88	NOT REQ.
C210.3PR	53.-79.0	0.17	0.00	02/26/88	NOT REQ.
C216.7SR	2.0-53.0	0.05	0.00	02/16/88	NOT REQ.
C223.0PR	2.0-52.0	0.04	0.00	02/05/88	NOT REQ.
C223.0PR	2.0-77.0	0.09	0.00	02/25/88	NOT REQ.
C229.3SR	2.0-53.0	0.06	0.00	02/16/88	NOT REQ.
C238.0PR	2.0-53.0	1.25	7.30	02/05/88	02/09/88
C238.0PR	2.0-78.0	0.09	0.00	02/25/88	NOT REQ.
C246.5SR	2.0-53.0	0.11	0.00	02/16/88	NOT REQ.
C252.0PR	2.0-52.0	0.09	0.00	02/05/88	NOT REQ.
C252.0PR	2.0-78.0	0.03	0.00	02/25/88	NOT REQ.
C258.4SR	2.0-53.0	0.10	0.00	02/16/88	NOT REQ.
C264.6PR	2.0-60.0	1.46	82.70	02/05/88	02/09/88
C273.5SR	2.0-53.0	0.04	0.00	02/17/88	NOT REQ.
C281.5PR	2.0-52.0	1.73	65.70	02/05/88	02/08/88
C281.5PR	2.0-78.0	0.10	0.00	02/25/88	NOT REQ.
C285.0TR	2.0-52.0	0.03	0.00	02/22/88	NOT REQ.
C287.8SR	2.0-52.0	0.61	5.20	02/15/88	02/18/87
C291.0TR	2.0-52.0	0.08	0.00	02/22/88	NOT REQ.
C294.2PR	2.0-52.0	1.81	8.80	02/05/88	02/08/88
C294.2PR	2.0-78.0	0.03	0.00	02/25/88	NOT REQ.
C301.0SR	1.0-15.0	1.95	2.20	02/15/88	02/18/88
C301.0SR	15.0-53.0	0.06	0.00	02/22/88	NOT REQ.
C308.7PR	1.5-6.3	1.75	85.31	10/08/87	10/10/87
C308.7PR	52-77	0.12	0.00	10/21/87	NOT REQ.

C316.2SR	1.5-54.0	0.41	0.62	10/13/87	10/14/87
C323.0PR	1.5-50.0	1.02	13.88	10/08/87	10/10/87
C323.0PR	50-75	0.20	0.00	10/21/87	NOT REQ.
C327.5TR	1.5-52.0	0.04	0.00	10/16/87	NOT REQ.
C332.5SR	1.5-54.0	1.80	26.27	10/13/87	10/14/87
C337.0TR	1.5-53.0	0.15	0.00	10/16/87	NOT REQ.
C341.5PR	1.5-20.0	0.02	0.00	10/12/87	NOT REQ.
C341.5PR	55-80	0.09	0.00	10/21/87	NOT REQ.
C345.5TR	1.5-51.0	0.01	0.00	10/16/87	NOT REQ.
C349.5SR	1.5-52.0	1.47	7.66	10/13/87	10/14/87
C354.5TR	1.5-54	1.33	2.20	10/16/87	10/19/87
C358.5PR	1.5-54.0	0.23	0.31	10/08/87	10/09/87
C358.5PR	54-79.0	0.20	0.00	10/21/87	NOT REQ.
C360.0QR	1.5-15.0	0.00	0.00	10/20/87	NOT REQ.
C361.5TR	1.5-51.0	0.85	0.00	10/16/87	10/19/87
C363.0QR	1.5-15.0	0.00	0.00	10/20/87	NOT REQ.
C365.0SR	1.5-50.0	0.57	4.09	10/13/87	10/13/87
C370.0TR	1.5-52.0	0.24	0.31	10/16/87	10/19/87
C374.5PR	1.5-54.5	1.21	7.15	10/08/87	10/08/87
C374.5PR	54.5-79	0.03	0.00	10/21/87	NOT REQ.
C382.0SR	1.5-53.0	0.12	0.00	10/13/87	NOT REQ.
C390.0PR	1.5-52.5	0.02	0.00	10/09/87	NOT REQ.
C390.0PR	52.5-77	0.04	0.00	10/15/87	NOT REQ.
C400.0SR	1.5-56.0	0.05	0.00	10/12/87	NOT REQ.
C410.0PR	1.5-55.3	3.02	0.00	10/07/87	10/08/87
C410.0PR	55.5-82.0	0.02	0.00	10/15/87	NOT REQ.
C420.0SR	1.5-54.0	0.20	0.00	10/12/87	NOT REQ.
C430.0PR	1.5-58.0	2.42	10.49	10/07/87	10/08/87
C430.0PR	57 - 82	0.00	0.07	10/15/87	10/15/87
C440.0SR	2.0-53.0	0.01	0.00	10/12/87	NOT REQ.
C440.0SR	53 - 81	0.20	0.00	10/19/87	NOT REQ.
C450.0PR	1.5-57.5	0.02	0.00	10/07/87	NOT REQ.
C450.0PR	1.5-20.0	0.07	0.00	10/14/87	10/15/87
C460.0SR	1.5-56.5	0.08	0.00	10/09/87	NOT REQ.
C460.0SR	56.5 - 85	0.20	0.00	10/19/87	NOT REQ.
C470.0PR	1.5-57.5	0.93	0.00	10/07/87	10/07/87
C470.0PR	56.5-85	0.28	0.00	10/14/87	10/15/87
C480.0SR	1.5-56.5	0.09	0.00	10/09/87	NOT REQ.
C480.0SR	56.5 - 85	0.51	3.73	10/19/87	10/19/87
C490.0PL	2.0-64.0	0.04	0.00	12/09/87	NOT REQ.
C490.0PR	1.5-57.5	1.80	3.73	10/07/87	10/07/87
C490.0PR	56.5 - 85	0.85	81.39	10/14/87	10/15/87
C500.0SL	2.0-64.0	0.01	0.00	12/09/87	NOT REQ.
C500.0SR	1.5-57.0	0.02	0.00	10/22/87	NOT REQ.
C500.0SR	57-85.0	0.06	0.00	11/24/87	NOT REQ.
C510.0PL	2.0-64.0	0.01	0.00	12/09/87	NOT REQ.
C510.0PR	1.5-57.0	0.05	0.00	10/22/87	NOT REQ.
C510.0PR	57.0-86.0	1.51	0.00	10/23/87	NO RECOR
C520.0SL	2.0-64.0	0.04	0.00	12/09/87	NOT REQ.
C520.0SR	1.5-57.0	0.01	0.00	11/02/87	NOT REQ.
C520.0SR	57-86.0	0.02	0.00	11/24/87	NOT REQ.
C530.0PL	2.0-58.0	0.20	0.00	12/09/87	NOT REQ.
C530.0PR	1.5-52.0	0.14	0.00	10/27/87	NOT REQ.
C540.0SL	2.0-58.0	0.02	0.00	12/14/87	NOT REQ.
C540.0SR	1.5-56.0	0.03	0.00	11/02/87	NOT REQ.
C540.0SR	56-81.0	0.11	3.10	12/01/87	12/01/87
C550.0PL	58-87.0	0.21	1.00	12/16/87	12/15/87

C550.0PR	80-84.0	0.20	0.00	11/16/87 NOT REQ.
C550.0PR 1	1.5-57.0	1.16	0.00	10/27/87 NO RECOR
C550.0PR 2	1.5-57.0	0.96	0.00	10/27/87 NO RECOR
C555.0TR	0-87.0	0.20	1.40	12/07/87 12/07/87
C550.0SR	1.5-58.0	0.24	0.00	11/02/87 NO RECOR
C565.0TR	20'-87.0	0.20	2.00	12/07/87 12/07/87
C570.0PL	58.0-84.0	0.18	0.60	12/16/87 12/16/87
C570.0PR	1.5-58.0	10.10	0.00	10/27/87 NO RECOR
C570.0PR 2	1.5-58.0	1.01	0.00	10/27/87 NO RECOR
C575.0 TR	0-58.0	0.00	0.00	12/07/87 NOT REQ.
C580.0 SR	58-87.0	0.40	37.68	12/01/87 12/02/87
C580.0SL	2.0-56.0	0.09	0.00	12/14/87 NOT REQ.
C580.0SR	1.5-58.0	0.12	0.00	11/13/87 NOT REQ.
C585.0 TR	0.0-58.0	0.20	0.00	12/07/87 NOT REQ.
C590.0PL	2.0-52.0	0.07	1.60	12/10/87 12/10/87
C590.0PR	1.5-58.0	1.52	0.00	11/02/87 NO RECOR
C590.0PR	58-87.0	0.21	1.60	11/23/87 11/23/87
C595.0TL	0.0-51.0	0.01	0.00	12/15/87 NOT REQ.
C595.0TR	0 - 59'	0.04	0.00	11/20/87 NOT REQ.
C600.0SL	0.0-55.0	0.04	0.00	11/16/87 NOT REQ.
C600.0SL	55.0-82.0	0.50	1.80	12/18/87 12/18/87
C600.0SL 1	0.0-05.0	1.85	0.00	11/16/87 NO RECOR
C600.0SL 2	0.0-55.0	1.62	0.00	11/16/87 NO RECOR
C600.0SL 3	2.0-55.0	0.04	0.00	11/19/87 NOT REQ.
C600.0SR	0-65	0.89	0.00	11/16/87 NO RECOR
C600.0SR 1	0-65'	0.89	12.80	11/16/87 11/18/87
C600.0SR 2	2-63.0'	0.02	0.00	11/19/87 NOT REQ.
C605.0TL	2.0-55.0	0.02	0.00	12/15/87 NOT REQ.
C605.0TR	2' - 64	0.06	0.00	11/20/87 NOT REQ.
C610.0PL	2.0-55.0	0.01	15.10	12/10/87 12/11/87
C610.0PR	1.5-64.0	0.69	0.00	11/03/87 NO RECOR
C610.0PR 1	1.5-64.0	0.84	0.00	11/03/87 NO RECOR
C610.0PR 2	1.5-64.0	0.69	0.00	11/03/87 NO RECOR
C615.0TR	2' - 65'	0.09	0.00	11/20/87 NOT REQ.
C620.0SL	2.0-55.0	0.20	0.00	12/15/87 NOT REQ.
C620.0SL	55.0-83.0	0.13	0.60	12/18/87 12/18/87
C620.0SR	2.0-65.0	0.48	0.00	11/19/87 NO RECOR
C620.0SR 1	2-65.0'	0.20	0.40	11/19/87 11/18/87
C620.0SR 2	0-65.0'	0.48	0.00	11/16/87 NO RECOR
C625.0 TR	2'-66.0	0.20	0.00	11/20/87 11/20/87
C630.0PL	2.0-55.0	0.02	0.00	12/10/87 NOT REQ.
C630.0PR	1.5-66.0	1.58	0.00	11/03/87 NO RECOR
C635.0 TR	2-67.0	0.01	0.20	11/20/87 11/20/87
C640.0 SR	66.0-97.0	0.28	0.00	12/07/87 NO RECOR
C640.0SL	2.0-56.0	0.01	0.60	12/15/87 12/18/87
C640.0SL	56.0-84.0	0.23	0.00	12/18/87 NO RECOR
C640.0SR	2.0-66.0	1.17	0.00	11/19/87 NO RECOR
C640.0SR 1	0 - 66.0	1.17	1.80	11/16/87 11/18/87
C640.0SR 2	2-66.0	0.01	0.00	11/19/87 NOT REQ.
C645.0 TR	2-65.0	0.16	0.90	11/20/87 11/20/87
C650.0PL	2.0-57.0	0.03	149.20	12/10/87 12/11/87
C650.0PR	1.5-17.0	2.33	0.00	11/03/87 NO RECOR
C650.0PR	17-62.0	0.54	0.00	11/12/87 NO RECOR
C660.0SL	0.0-57.0	0.27	0.00	11/16/87 NO RECOR
C670.0PL	1.5-15.0	3.05	0.00	11/03/87 NO RECOR
C680.0SL	0.0-57.0	0.42	0.00	11/16/87 NO RECOR
C680.0SL 1	0.0-57.0	0.53	0.00	11/16/87 NO RECOR

C680.0SL 2	0.0-57.0	0.42	0.00	11/16/87	NO RECOR
C688.3PL	1.5-13.0	2.15	0.00	11/03/87	NO RECOR
C698.2SL	0.0-54.0	0.26	0.00	11/16/87	NO RECOR
C705.9 PL	28-53.0	0.82	82.78	11/12/87	11/12/87
C705.9PL	1.5-28.0	1.74	0.00	11/03/87	NO RECOR
C705.9PL 1	1.5-28.0	1.45	0.00	11/03/87	NO RECOR
C705.9PL 2	1.5-28.0	1.74	0.00	11/07/87	NO RECOR
C709.0 TL	0-50.0	0.00	0.00	12/01/87	NOT REQ.
C712.8SL	2.0-30.0	1.54	8.20	11/16/87	11/20/87
C722.0PL	1.5-56.0	0.88	0.00	11/12/87	NO RECOR
C732.0SL	2.0-53.0	0.52	0.00	11/16/87	NO RECOR
C740.5PL	1.5-51.0	0.50	0.00	11/13/87	NO RECOR
C746.8 SL	0.0-54.0	0.10	0.00	11/18/87	NOT REQ.
C755.0PL	1.5-56.0	0.28	0.00	11/13/87	NO RECOR
C764.7 SL	2.0-54.0	0.02	0.00	11/18/87	NOT REQ.
C774.7PL	1.5-52.0	0.02	0.00	11/13/87	NOT REQ.
C782.5 SL	2.0-56.0	0.02	0.00	11/18/87	NOT REQ.
C791.8PL	1.5-57.0	0.46	0.00	11/13/87	NO RECOR
C801.6 SL	2.0-54.0	0.01	0.00	11/18/87	NOT REQ.
C811.8PL	50.0-75.0	0.11	0.00	12/03/87	NOT REQ.
C818.1SL	2.0-54.0	0.30	1.40	03/22/88	03/22/88
C827.6 PL	2.0-51.0	0.43	0.00	03/14/88	NO RECOR
C827.6PL	7.0-76.0	0.70	0.90	03/29/88	03/30/88
C831.5 TL	2.0-51.0	0.16	0.00	03/24/88	NOT REQ.
C834.5SL	2.0-51.0	3.13	8.10	03/22/88	03/22/88
C838.0 TL	2.0-52.0	0.03	0.00	03/24/88	NOT REQ.
C841.0PL	2.0-52.0	0.27	0.50	03/14/88	03/17/88
C847.1 SL	2.0-52.0	0.07	0.00	03/23/88	NOT REQ.
C855.0PL	2.0-52.0	0.86	26.50	03/16/88	03/17/88
C858.5 TL	2.0-51.0	0.13	0.00	03/24/88	NOT REQ.
C862.0 SL	2.0-52.0	0.40	9.40	03/23/88	03/23/88
C865.0 TL	2.0-52.0	0.15	0.00	03/24/88	NOT REQ.
C868.5PL	2.0-53.0	0.67	1.70	03/16/88	03/17/88
C878.0 SL	2.0-51.0	0.24	0.60	03/23/88	03/23/88
C878.0 SL	51.0-76.0	0.04	0.00	04/04/88	NOT REQ.
C884.0 PL	2.0-54.0	0.48	0.00	03/17/88	NO RECOR
C884.0PL	7.0-77.0	0.64	46.70	03/29/88	03/30/88
C889.7 SL	2.0-52.0	0.30	0.40	03/23/88	03/23/88
C889.7 SL	52.0-78.0	0.18	0.00	04/04/88	NOT REQ.
C896.0PL	2.0-52.0	0.07	0.00	03/17/88	NOT REQ.
C903.0 SL	2.0-52.0	0.04	0.00	03/23/88	NOT REQ.
C911.0PL	2.0-51.0	0.08	0.00	03/17/88	NOT REQ.
C917.3 SL	2.0-52.0	0.40	1.20	03/23/88	03/23/88
C923.9PL	2.0-52.0	2.38	3.30	03/17/88	03/18/88
C931.3 SL	2.0-51.0	0.04	0.00	03/23/88	NOT REQ.
C937.5PL	2.0-52.0	1.24	3.40	03/17/88	03/18/88
C943.7 SL	2.0-52.0	0.11	0.00	03/23/88	NOT REQ.
C950.0PL	2.0-52.0	0.18	0.00	03/17/88	NOT REQ.
C956.0 SL	2.0-53.0	0.38	3.70	03/23/88	03/23/88
C965.0PL	2.0-56.0	2.40	0.70	03/18/88	03/31/88
C975.0 SL	2.0-56.0	1.06	5.70	03/24/88	03/24/88
C985.0PL	2.0-54.0	2.52	26.00	03/18/88	03/18/88
C995.0PLF	25.0-50.0	0.16	0.00	03/21/88	NOT REQ.
C996.0PLF	7.0-74.0	0.26	0.80	03/30/88	03/31/88
C996.5SLF	2.0-74.0	0.19	0.00	04/04/88	NOT REQ.
C997.0PLF	7.0-73.0	0.70	76.20	03/30/88	03/31/88

06/19/89

PRESSURE FLOW AND GROUT TAKE FOR HOLE AND DEPTH RANGE SHOWN

HOLE RANGE: D495.0PV - D675.0PV
DEPTH RANGE: 0.0- **.*

HOLE NO.	INTERVAL, FT	WATER CFM	TAKE, CWT	DATE PT	DATE GR
D495.0PV	2.0-35.0	0.04	0.00	12/21/87	NOT REQ.
D505.0SV	2.0-35.0	0.18	0.00	12/22/87	01/12/88
D515.0PV	2.0-35.0	0.20	0.00	12/21/87	NOT REQ.
D525.0SV	1.5-35.0	0.09	0.20	12/22/87	01/12/88
D535.0PV	2.0-35.0	0.04	0.00	12/22/87	NOT REQ.
D545.0SV	1.5-35.0	2.00	0.50	12/22/87	01/12/88
D555.0PV	2.0-35.0	0.18	14.60	12/22/87	01/12/88
D565.0SV	2.0-35.0	0.20	0.00	01/14/88	NOT REQ.
D575.0PV	2.0-35.0	0.40	0.10	12/22/88	01/12/88
D580.0TV	2.0-35.0	0.20	0.00	01/18/88	NOT REQ.
D585.0SV	2.0-35.0	0.95	23.40	01/14/88	01/14/88
D590.0TV	2.0-35.0	0.04	0.00	01/18/88	NOT REQ.
D595.0PV	2.0-35.0	1.62	8.70	12/22/87	01/12/88
D600.0TV	2.0-35.0	0.31	0.30	01/18/88	01/19/88
D605.0SV	2.0-20.0	1.76	87.00	01/14/88	01/14/88
D605.0SV	20.0-35.0	0.05	0.00	01/18/88	NOT REQ.
D610.0TV	2.0-35.0	0.16	2.30	01/18/88	10/10/87
D615.0PV	2.0-35.0	0.11	0.00	01/04/88	NOT REQ.
D620.0TV	2.0-35.0	0.01	0.00	01/18/88	NOT REQ.
D625.0SV	2.0-17.0	1.40	51.50	01/04/88	01/11/88
D625.0SV	17.0-35.0	0.20	0.00	01/14/88	NOT REQ.
D630.0TV	2.0-35.0	0.03	0.00	01/18/88	NOT REQ.
D635.0PV	2.0-35.0	0.07	0.00	01/18/88	NOT REQ.
D645.0SV	2.0-35.0	0.12	0.00	01/20/88	NOT REQ.
D655.0PV	2.0-35.0	0.56	22.10	01/18/88	01/19/88
D665.0SV	2.0-35.0	0.08	0.00	01/20/88	NOT REQ.
D675.0PV	2.0-35.0	0.20	0.00	01/18/88	NOT REQ.

06/19/89

PRESSURE FLOW AND GROUT TAKE FOR HOLE AND DEPTH RANGE SHOWN

HOLE RANGE: E500.0PV - E640.0PV
DEPTH RANGE: 0.0- **.*

HOLE NO.	INTERVAL, FT	WATER CFM	TAKE, CWT	DATE PT	DATE GR
E500.0PV	2.0-35.0	0.06	0.00	12/22/87	NOT REQ.
E510.0SV	2.0-35.0	0.03	0.00	12/22/87	NOT REQ.
E520.0PV	2.0-35.0	0.01	0.00	12/22/87	NOT REQ.
E530.0SV	2.0-30.0	0.03	0.00	01/11/88	NOT REQ.
E540.0PV	2.0-35.0	0.02	0.00	01/05/88	NOT REQ.
E550.0SV	2.0-30.0	0.11	0.00	01/11/88	NOT REQ.
E560.0PV	2.0-35.0	0.14	0.00	01/05/88	NOT REQ.
E570.0SV	2.0-30.0	0.16	0.00	01/11/88	NOT REQ.
E580.0PV	2.0-35.0	0.16	0.00	01/05/88	NOT REQ.
E590.0SV	2.0-35.0	0.01	0.00	01/15/88	NOT REQ.
E600.0PV	2.0-10.0	3.62	43.90	01/05/88	01/06/88
E600.0PV	10.0-35.0	1.23	118.50	01/13/88	01/13/88
E610.0SV	2.0-35.00	0.27	3.40	01/15/88	01/15/88
E620.0PV	2.0-35.0	1.91	1.60	01/05/88	01/18/88
E630.0SV	2.0-35.0	0.44	4.40	01/13/88	01/13/88
E640.0PV	2.0-35.0	0.44	19.80	01/05/88	01/11/87

12-02 FOUNDATION CURTAIN GROUTING

Additional Foundation Grouting

GENERAL

Additional foundation grouting was needed in the dam site to more extensively treat features not adequately covered by the designed parallel lines of the curtain grouting. The features treated by these additional holes included joints, bedding planes and dental concrete. A description of the holes include: shallow drill depth (5' to 10'), single zoned, drilled at varying angles, embedded nipples not required, split spacing not required, low grouting pressure used (4 to 7 psi), numerous surface and hole connections, and grout/circulate/caulk cycles used to treat surface connections.

LOCATION AND DESCRIPTION

Contact Grouting:

- Feature:..... Contact grouting dental concrete.
- Description:..... Overhangs within a broken zone were marked and located before the placement of dental concrete, the grout holes were then drilled through the concrete to intersect these overhangs.
- Location:..... Station 6+00 to 5+80, elevation 522.
- Drilling:
  - Number:..... 21 holes
  - Depth:..... 5 feet
  - Angle:..... 30 degrees toward the rock slope
- Pressure Testing:..... None
- Grouting:
  - Date:..... 1-21-88, 1-22-88 and 1-25-88
  - Mix:..... 4:1, 3:1, 2:1, 1.5:1, 1:1
  - Pressure:..... 4 psi
  - Grout Take:..... Total of 76.9 cwt of cement

Pressure Tested Holes:

- Feature:..... An open bedding plane and a high angle, open, joint.
- Description:..... A series of holes were drilled to determine the water tightness of an open bedding plane. After the discovery of a high angle joint, excessive surface connections, and high water flow it was determined to remove this loose rock instead of attempting to grout.
- Location:..... Station 4+50 to 5+10, elevation 526 to 529.

12-02 FOUNDATION CURTAIN GROUTING

Additional Foundation Grouting

LOCATION AND DESCRIPTION (cont)

Pressure Tested Holes (cont)

Drilling:

Number:	7 holes
Depth:	9 feet
Angle:	Vertical
Location:	(1) sta. 4+50, 25' D/S (2) sta. 4+65, 30' D/S (3) sta. 4+80, 30' D/S (4) sta. 4+95, 35' D/S (5) sta. 5+10, 35' D/S (6) sta. 5+10, 50' D/S (7) sta. 5+10, 70' D/S

Pressure Testing:

Date:	11-19-87
Pressure:	4 psi
Water Flow:	(1) 0.05 cfm, (2) 0.47 cfm, (3) 1.01 cfm, (4) 1.40 cfm, (5) 1.18 cfm, (6) 0.08 cfm, (7) 0.07 cfm,
Grouting:	None

Left Abutment; Joint "A"

Feature:	High angle, iron stained, joint N 30° E
Description:	Holes were drilled on an angle to intercept joint due to the 45° sloped top of rock surface.
Location:	Sta. 8+90 to 9+00, elevation 612 to 630.

Drilling:

Number:	4 holes
Depth:	10 feet
Angle:	45 degrees
Location:	(1) 15' U/S, (2) 11' U/S, (3) 3' U/S, (4) 4' D/S.

Pressure Testing:

Date:	4-5-88
Pressure:	7 psi
Water Flow:	Washed holes, no measurements were taken.

Grouting:

Date:	4-5-88
Mix:	1:1
Pressure:	7 psi
Grout Take:	Total of 2.2 cwt of cement @ 1 hr 10 min.

12-02 FOUNDATION CURTAIN GROUTING

Additional Foundation Grouting

LOCATION AND DESCRIPTION (cont)

Left Abutment; Joint "B"

Feature:	High angled, iron stained, joint N 10° W to N 5° E
Description:	Holes were drilled at an angle to intercept the joint due to the sloped top of rock surface.
Location:	Sta. 8+30 to 8+50, elevation 573 to 585.
Drilling:	
Number:	4 holes
Depth:	10 feet
Angle:	45 degrees
Location:	(1) 20' U/S, (2) 15'U/S, (3) 3' U/S, (4) 3' D/S
Pressure Testing:	
Date:	4-6-88
Pressure:	7 psi
Water Flow:	(1) 0.0 cfm, (2) 0.01 cfm, (3) 1.66 cfm, (3) 2.51 cfm.
Grouting:	
Date:	4-6-88
Mix:	1.5:1 and 1:1
Pressure:	7 psi
Grout Take:	Total of holes (3) and (4) was 2.5 cwt of cement @ 2 hr 10 min.

Valley Section:

Feature:	High angled joint N 10° E
Description:	Holes were drilled directly on joint at rock surface.
Location:	Sta. 6+85 to 7+00, elevation 535
Drilling:	
Number:	4 holes
Depth:	10 feet
Angle:	Vertical
Location:	(1) 16' U/S, (2) 8' U/S, (3) centerline, (4) 9' D/S.
Pressure Testing:	
Date:	1-18-88
Pressure:	4 psi
Water Flow:	(1) 2.04 cfm, (2) 0.31 cfm (3) 1.02 cfm, (4) 0.29 cfm
Grouting:	
Date:	1-20-88
Mix:	2:1 and 1:1
Pressure:	4 psi
Grout Take:	2.0 cwt of cement @ 4 hr 20 min

12-02 FOUNDATION CURTAIN GROUTING

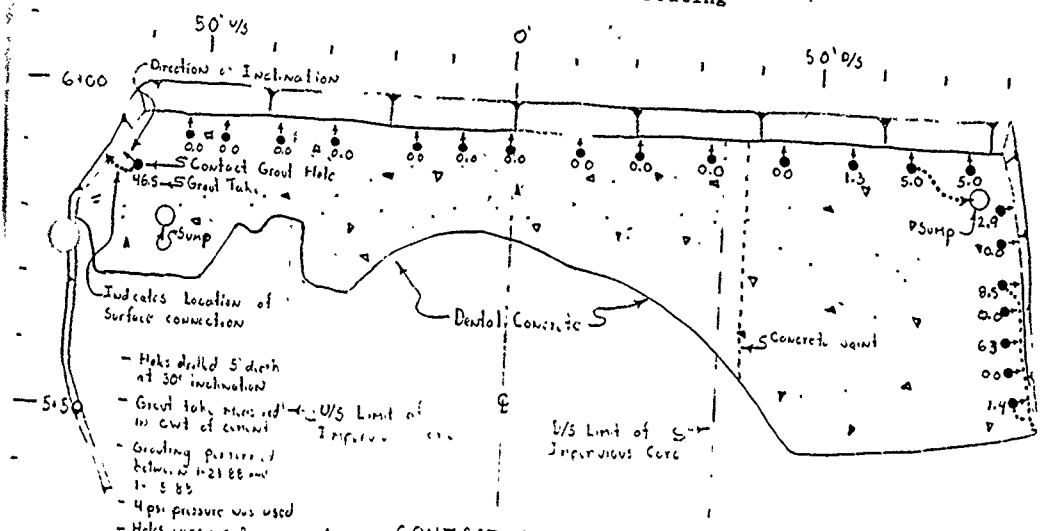
Additional Foundation Grouting

LOCATION AND DESCRIPTION (cont)

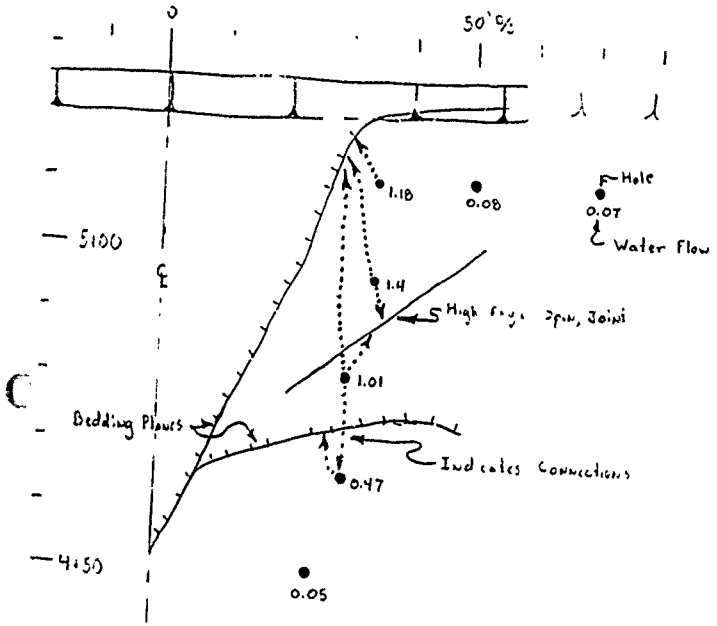
Right Abutment:

Feature:	High angled, occ. open, joint N 5° E
Description:	Holes were drilled directly on joint at rock surface.
Location:	Sta. 3+80 to 3+70, elevation 545
Drilling:	
Number:	8 holes
Depth:	5 feet
Angle:	Vertical
Pressure Testing:	Not required
Grouting:	
Date:	3-2-88
Mix:	3:1 and 1:1
Pressure:	4 psi
Grout Take:	Total of 11.2 cwt of cement @ 5 hr 20 min.

Additional Foundation Grouting



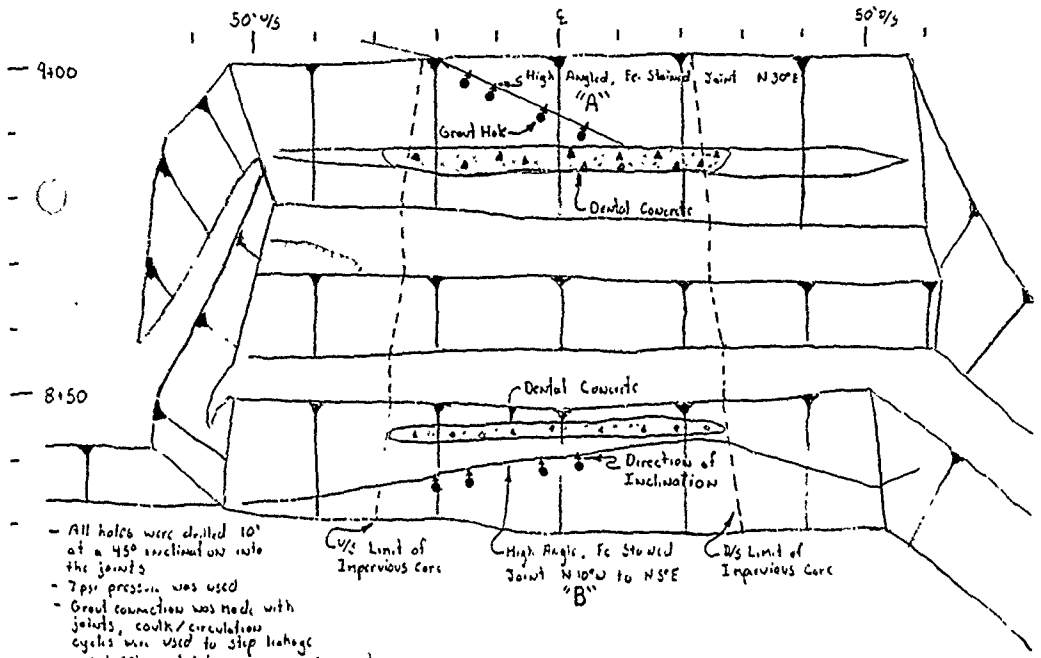
CONTACT GROUTING



PRESSURE TESTER HOLES

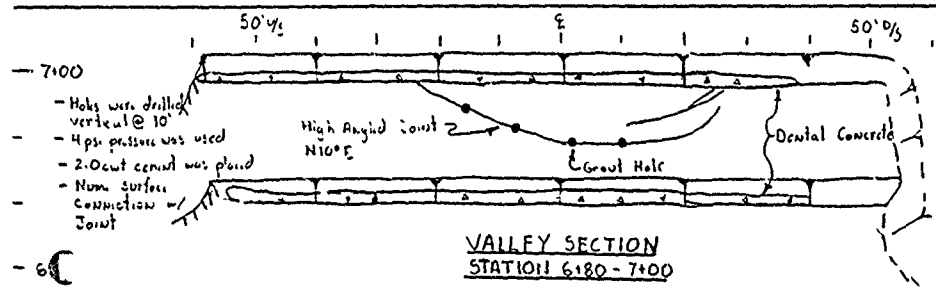
12-02 FOUNDATION CURTAIN GROUTING

Additional Foundation Grouting



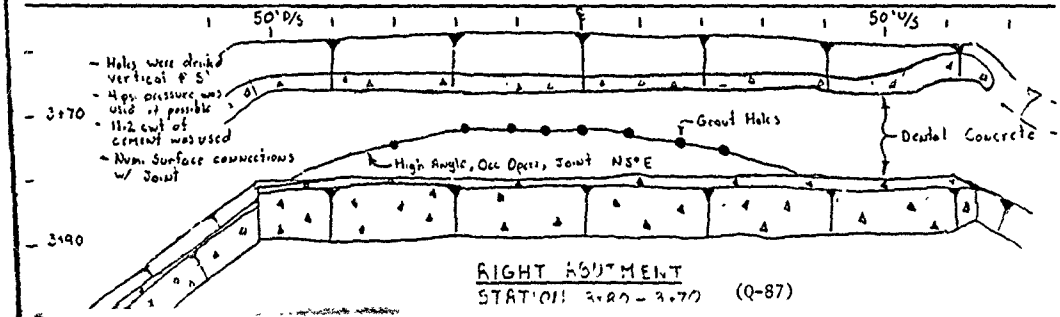
- All holes were drilled 10' at a 45° inclination into the joints
- 7psi pressure was used
- Grout connection was made with joints, caulk/circulation cycles were used to stop leakage
- Joint 'A' grout take was 2.2 cwt cement
- Joint 'C' grout take was 2.5 cwt cement

LEFT ABUTMENT
STATION A+30 - 9+00



- Holes were drilled vertical @ 10'
- 4psi pressure was used
- 2.0cwt cement was placed
- Num. surface connection w/ Joint

VALLEY SECTION
STATION 6+80 - 7+00



- Holes were drilled vertical @ 5'
- 4psi pressure was used at possible
- 11.2 cwt of cement was used
- Num. surface connections w/ Joint

RIGHT ABUTMENT
STATION 3+80 - 3+70

12-02 FOUNDATION CURTAIN GROUTING

Post Grouting Exploratory Borings

GENERAL

Exploratory drilling was performed in the valley sections of the dam foundation after the foundation grouting was completed in that area. These holes were drilled to determine the effectiveness of the foundation grouting by finding areas of grout take and the water tightness of the formations. The exploratory holes were located near grout holes which encountered large grout takes, these holes were then "logged" noting were grout traces were located within the core. At the completion of drilling the holes were then pressure tested with a single packer to determine the water tightness of the rock in that area. An area of concern during the grouting operation was the broken zones found within the top 20 feet of the valley sections. This area was then targeted for locations of exploratory holes, both upstream and downstream of centerline.

The exploratory holes were drilled with a Longyear 44 rotary drill between 28 Jan 88 and 4 Feb 88. The bit that was used during exploratory drilling, was a 4" dia. diamond core bit with a 5' barrel. During the exploratory drilling there was no excessive core or drill water loss encountered. The pressure testing was completed by the use of a single packer with the pressure being determined by depth of the packer (1psi/ft.).

LOCATION AND DESCRIPTION

Hole # CG-1

Location:..... Sta. 4+50, on centerline, elevation 527.6.

Purpose:..... Determine areas of grout flow from grout hole # C490.0PR, zone II, grout take = 81.4 cwt cement.

Depth:..... 75.9 feet

Grout Recovered:

Description	Elevation
grout hole fil. w/ grout	487.8 - 487.4
bd. pn. fil. w/ grout, 0.1' thick	458.5

Pressure Test:

Interval (ft.)	Pressure (psi)	Water Flow (cfm)
5.0 - 75.9	5	0.08
15.0 - 75.9	15	0.34

Post Grouting Exploratory Borings

LOCATION AND DESCRIPTION (cont)

Hole # CG-2

Location:..... Sta. 6+20, on centerline, elevation 527.4.

Purpose:..... ..... Determine grout flow along "C" line, grout holes #s C630.0PR (zone I, grout take = 144.8 cwt) and C600.0SL (zone I, grout take = 106.4 cwt).

Depth:..... 51.0 feet

Grout Recovered:..... No grout traces were logged

Pressure Tests:

Interval (ft)	Pressure (psi)	Water Flow (cfm)
5.2 - 11.8	5	0.0
11.8 - 18.4	11	0.39
18.4 - 25.0	18	0.24
24.0 - 51.0	24	0.0

Hole # CG-3

Location:..... Sta. 5+75, 17.5' U/S, elevation 520.9.

Purpose:..... Determine grout flows along curtain grout line "A", zone I.

Depth:..... 26.1 feet

Grout Recovered:

Description	Elevation
mod. bkn. mic. bd. pns. w/ tr. of grout:	517.4 - 517.3
bd. pn. fil. w/ grout, 0.02' thick	513.3
bkn. pn. w/ grout	513.0
bkn. pn. w/ grout trace	512.6
sli. bkn. bd. pn. fil. w/ grout	512.5 - 512.3
bkn. pn. w/ tr. of grout	510.5
bkn. bd. pn. w/ tr. of grout	509.2
hi. ang. jt. w/ tr. of grout	509.2 - 501.9
sh. coal w/ tr. of grout	506.3
ang. grout hole w/ grout backfill	504.3 - 501.9

LOCATION AND DESCRIPTION (cont)

Hole # CG-3 (cont)

Pressure Test:

Interval (ft)	Pressure (psi)	Water Flow (cfm)
5.0 - 26.1	5	0.0
18.0 - 26.1	18	0.0

Hole # CG-4

Location:..... Sta. 5+60, 38.1 D/S, elevation 520.8.

Purpose:..... Determine grout flow in broken zones downstream of grout lines, zone I.

Depth:..... 21.5 feet

Grout Recovered:

Description	Elevation
bd. pn. fil. w/ grout	510.9
bd. pn. fil. w/ grout, 0.01' thick	507.7
coal w/ tr. of grout	505.6 - 509.4

Pressure Test:

Interval (ft)	Pressure (psi)	Water Flow (cfm)
5.0 - 21.5	5	0.0
10.0 - 21.5	10	0.0

Hole # CG-5

Location:..... Sta. 6+05, 40' D/S, elevation 526.9.

Purpose:..... Determine grout flow in broken zones downstream of grout lines, zone I.

Depth:..... 22.5 feet

LOCATION AND DESCRIPTION (cont)

Hole # CG-5 (cont)

Grout Recovered:

Description	Elevation
void filled w/ grout	514.5 - 514.4
bkn. zone: sev. bkn., jts @ 45° ang., w/ sm. tr. of grout.	513.9 - 513.6
bd. pn. w/ tr. of grout	513.4
bd. pn. w/ tr. of grout	511.7
bd. pn. w/ tr. of grout	511.0

Pressure Test:

Interval (ft)	Pressure (psi)	Water Flow (cfm)
4.3 - 10.9	5	0.0
10.9 - 17.5	11	0.0
17.5 - 22.5	17	0.17

Hole = CG-6

Location:..... Sta. 5+10, 40' D/S

Purpose:..... To determine grout flows in broken zones downstream of grout lines, zone I.

Depth:..... 20.9 feet

Grout Recovered:..... No grout traces were logged.

Pressure Testing:

Interval (ft)	Pressure (psi)	Water Flow (cfm)
5.0 - 20.9	5	0.0

Hole # CG-7

Location:..... Sta. 6+25, 25' D/S, elevation 528.0

Purpose:..... Determine the direction of grout flow along line "D", grout hole # D625.0SV, grout take = 51.5 cwt.

Post Grouting Exploratory Borings

LOCATION AND DESCRIPTION (cont)

Hole # CG-7 (cont)

Depth:..... 21.1 feet

Grout Recovered:

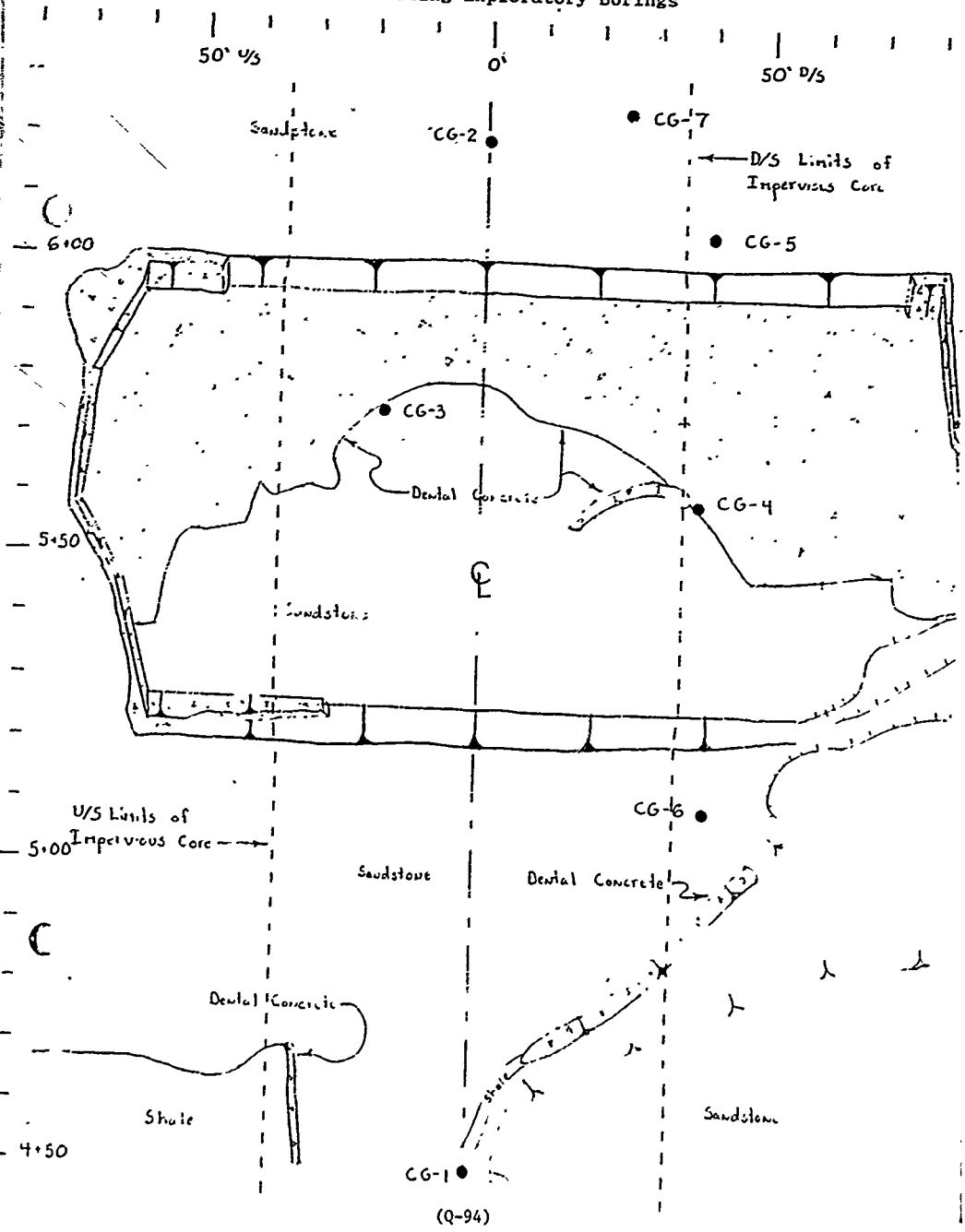
Description	Elevation
broken zone: sev. bkn., 0.1 loss, so. t. grout láys.	512.9 - 512.3

Pressure Test:

Interval (ft)	Pressure (psi)	Water Flow (cfm)
3.9 - 10.5	5	0.01
9.5 - 16.1	10	0.00
16.1 - 21.1	16	0.10

12-02 FOUNDATION CURTAIN GROUTING

Post Grouting Exploratory Borings



12-03 MODIFICATIONS

Mod. No.	Date	Description	Page
P00001	25 Aug 86	Fine aggregate for concrete.....	*
P00002	08 Dec 86	Pipe culverts in spoil area.....	*
P00003	09 Jan 87	Single phase const. of slurry wall...	R-1
P00004	05 May 87	Sheetpiling - 30^0 wye reinforcing....	R-3
P00006	20 Apr 87	Additional foam for trash boom.....	*
P00007	30 Jun 87	Relocate u/s dewater. well panels....	R-5
P00008	30 Jul 87	Intake structure form. el. 570 -575..	R-8
P00009	20 Aug 87	Mod. to main sluice conduit liners...	*
P00010	11 Aug 87	Delete deadmen anchor.....	R-12
P00011	26 Aug 87	Locking pin material substitution....	*
P00012	30 Oct 87	Notch in d/s diversion dike.....	R-15
P00013	04 Jan 88	Sample concrete batches.....	*
P00014	04 Jan 88	Deletion of power cable.....	*
P00015	04 Jan 88	Additional test fills and test pits..	R-17
P00016	04 Jan 88	Deletion of fuel storage system.....	*
P00017	10 Feb 88	Extend 36" dia. floatwell pipe.....	*
P00018	26 Apr 88	Modifications to masonry walls.....	*
P00019	23 May 88	Additional inspection of dam found...	R-21
P00020	09 Nov 88	Removal and replace imperv. core.....	R-23
P00021	03 Jan 89	Const. waterline to maint. build.....	*
P00022	11 Nov 88	Removal of 5' conc. cofferdam abut...	R-25
P00023	30 Nov 88	Suspension of conc. @ intake structure	*

* Modifications not related to this foundation report were not included

12-03 MODIFICATIONS (cont)

Mod. No.	Date	Description	Page
P00024	16 Dec 88	Preparation of alternate borrow area	R-27
P00025	18 Jan 89	6" concrete tolerance in spillway....	R-29
P00026	28 Feb 89	Paint embedded metals, intake struct.	R-31
P00027	27 Feb 89	Pressure reducing valves, inlet gates	*
P00028	27 Mar 89	Misc. changes to maintenance building	*

* Modifications not related to this foundation report were not included.

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT	1. CONTRACT ID CODE	PAGE OF PAGES
	J	1 2

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. (If applicable)
P00003	87 JAN 09		

6. ISSUED BY CODE

Department of the Army
Huntington District, Corps of Engineers
502 8th Street
Huntington, West Virginia 25701-2070

7. ADMINISTERED BY (If other than Item 6) CODE

8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code)

The Lane Construction Corp.
965 East Main St.
Meriden, CN 06450

(X) 9A. AMENDMENT OF SOLICITATION NO.

9B. DATED (SEE ITEM 11)

10A. MODIFICATION OF CONTRACT/ORDER NO.

X DACW69-86-C-0039

10B. DATED (SEE ITEM 13)

86 Feb 25

CODE FACILITY CODE

11 THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods

(a) By completing Items 8 and 15, and returning ____ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER If by virtue of this amendment you desire to change an offer already submitted such change may be made by telegram or letter provided each telegram or letter makes reference to the solicitation and this amendment and is received prior to the opening hour and date specified

12 ACCOUNTING AND APPROPRIATION DATA (If required)

FSN 96461 96X3122 CC, CE MR BF YBC 04.10C0 0000 0320 284

13 THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS, IT MODIFIES THE CONTRACT/ORDER NO AS DESCRIBED IN ITEM 14

(X) A. THIS CHANGE ORDER IS ISSUED PURSUANT TO (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.

B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).

C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:

X CC 58 "Changes" and CC-60 "Value Engineering - Construction"

D. OTHER (Specify type of modification and authority)

E. IMPORTANT. Contractor ☐ is not, ☒ is required to sign this document and return ____one copies to the issuing office

14 DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)

Reference is made to Contract Clause 58 "Changes" and Contract Clause 60 "Value Engineering - Construction" of the above numbered contract for "Construction of Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky."

Since an equitable adjustment to the contract price for the Value Engineering Change has been determined, it is necessary and in the best interest of the Government to modify the contract in certain particulars as follows:

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect

15A. NAME AND TITLE OF SIGNER (Type or print)		16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)	
		ROBERT D. BROWN III, COL, Corps of Engineers Contracting Officer	
15B. CONTRACTOR/OFFEROR	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA	16C. DATE SIGNED
(Signature of person authorized to sign)		BY (Signature of Contracting Officer)	9 Jan 87

The slurry walls constructed under this contract will be built completely in one construction sequence, as proposed in the Contractor's proposal, dated 29 July 1986, and approved by the Government on 13 August 1986.

Credit for all savings resulting from the V.E. change will be made at a new lump sum price for "V.E. Change to Slurry Wall."

Payment for the Contractor's portion of the savings will be made at a new lump sum price for "V.E. Incentive Adjustment."

The credit and payment will be made at the agreed lump sum prices hereby established by the addition of the two new items indicated below:

Item No.	Description	Estimated Quantity	Unit	Unit Price	Amount Increase	Amount Decrease
Mod P00003-1	V.E. Change to Slurry Wall	1	Job	Sum		$25,900.00
Mod P00003-2	V.E. Incentive Adjustment	1	Job	Sum	$14,245.00	

NET DECREASE IN CONTRACT PRICE (-) $11,655.00

The contract price is accordingly decreased by the amount of $11,655.00. The contract time is not changed by this modification.

It is understood and agreed that the adjustment constitutes compensation in full on behalf of the Contractor, his subcontractors and suppliers, for all costs and markup directly or indirectly attributable to the change ordered herein, for all unchanged work, for all delays related thereto, and for performance of the change within the time frame stated.

If the foregoing modification is acceptable, it is requested that you sign in Block 15B, complete blocks 15A and 15C of the form, and return the original to this office (ATTN: ORHSM).

CONTRACT MODIFICATION PROPOSAL AND ACCEPTANCE
(Modification of less than $50,000)
For use of this form, see ER 1180-1-1.

1. ISSUING OFFICE	2. CONTRACT NO.	3. MODIFICATION NO.
Resident Engineer, Yatesville Lake, P.O. Box 1101, Louisa, KY 41230-4101	DACW69-86-C-0039	P00005

4. TO (Contractor)	5. PROJECT LOCATION AND DESCRIPTION
The Lane Construction Corp. 965 East Main Street Meriden, CT 06450	Construction of Dam and Appurtenant Works Phase II, Yatesville Lake, KY

6. *A proposal is requested for making the hereinafter described change in accordance with specification and drawing revisions cited herein or listed in attachment hereto. Submit your proposal in space indicated on page 2, attach detailed breakdown of prime and subcontract costs. (See the clause of this contract entitled, "Modification Proposals - Price Breakdown") DO NOT start work under this proposed change until you receive a copy signed by the Contracting Officer or a directive to proceed.*

RAY K. BOLEY — Resident Engineer — Ray K. Boley
Date — *Typed Name and Title* — *Signature*

7. DESCRIPTION OF CHANGE: *Pursuant to the clause of this contract entitled, "Changes", the contractor shall furnish all plant, labor and material, and perform all work necessary to accomplish the following described work:*

a. Provide a reinforcing plate for the specified 30° wye piling in accordance with the revised and approved shop drawings for the piling.

b. All work shall be performed in accordance with the applicable provisions of the contract plans and specifications.

c. The above modification will result in the addition of one new item of work to the contract for which payment will be made at the agreed unit price hereby established as indicated below:

Item	Description	Quantity	Unit	Unit Price	Amount
P00005-1	30° wye reinforcing	1630	L.F.	$24.86	$40,521.80

d. The total contract price is increased in the amount of $40,521.80.

e. The contract completion date remains unchanged.

f. This adjustment constitutes compensation in full on behalf of the Contractor and its subcontractors and suppliers for all costs and markups directly or indirectly attributable to the change ordered herein, including impact, for all delays related thereto and for performance of the changes within the time frame stated.

Except as hereby Modified, all terms and conditions of said contract as heretofore Modified remain unchanged and in full force and effect.

The foregoing modification is hereby accepted:	*UNITED STATES OF AMERICA*
CONTRACTOR The Lane Construction Corporation	
By R D Stapleton *Signature*	Ray K. Boley *Signature*
R. D. Stapleton May 13,1987 — Executive Vice President *Date* — *Typed Name and Title*	RAY K. BOLEY Resident Engineer — 5 May 1987 *Date* — *Typed Name and Title*

CONTRACT MODIFICATION PROPOSAL AND ACCEPTANCE *(CONTRACTING OFFICER'S COPY)*

12 PROJECT	13 CONTRACT NO	14 MODIFICATION NO
Yatesville Lake	DACW69-86-C-0039	P00005

15 FUNDS PROGRAMMED FOR THIS CHANGE IN THE AMOUNT OF: $40,521.80 under under the appropriation FSN 96461, 96X3122 CG CE, MR BE YBC 04 10C0 0000 0320 284

16 NECESSITY FOR CHANGE AND REASON FOR OMISSION FROM PLANS AND SPECIFICATIONS

The original contract drawings did not show a reinforcing plate on the 30° sheetpiling wyes. The Contractor bid the job based on those drawings. The supplier, Bethlehem Steel, recommended the reinforcing plate as good practice. By DF dated 7 August 1986, ORHED agreed with Bethlehem and added the plate to the shop drawings. The Contractor, by letter dated 24 September 1986, explained his position that his bid did not include the reinforcing plate and would require additional costs to add the plate. By DF dated 30 October 1986, ORHCD explained the problem to ORHED and asked for concurrance on the extra cost for the reinforcing plate. By DF Comment 2 dated 10 December 1986, ORHED concurred.

17 RESUME OF NEGOTIATIONS OR RECOMMENDATIONS *(Government representative)*

By letter dated 24 February 1987, the Contractor submitted his proposed costs in the amount of $24.86 per L.F., for a total of $40,521.80. An independent Government Estimate was prepared on 23 January 1987 showing an estimated cost of $36.19 per L.F., for a total of $57,035.44. The Contractor's proposal was reviewed for technical accuracy and completeness. The subcontractor performing the installation of the sheetpiling did not ask for any additional mark-ups, he simply passed the material costs from the supplier directly to the prime contractor. The mark-ups that the Contractor then applied were within reasonable limits, since no previous mark-ups were proposed. The primary difference in costs between the Contractor's proposal and the Government Estimate was in the materials cost actually given to the Contractor and the pre-bid quotes obtained by the Government. Thus, the Contractor's proposal was accepted as being fair and reasonable. The contract price will therefore be increased in the amount of $40,521.80. The Contractor requested no additional time, and since the work was done in conjunction with other contract work, no adjustments to the contract time are needed.

DATE	TYPED NAME AND TITLE OF GOVERNMENT REPRESENTATIVE	SIGNATURE
5 May 1987	RAY K. BOLEY Resident Contracting Officer	Ray K. Boley

ENG FORM 3938-B
APR 1967

GPO 1967 OF—233 696

CONTRACT MODIFICATION PROPOSAL AND ACCEPTANCE

(Modification of less than $50,000)

For use of this form, see ER 1180-1-1.

1. ISSUING OFFICE	2. CONTRACT NO.	3. MODIFICATION NO.
Resident Engineer, Yatesville Lake, P.O. Box 1101, Louisa, KY 41230-4101	DACW69-86-C-0039	P00007

4. TO (Contractor)	5. PROJECT LOCATION AND DESCRIPTION
The Lane Construction Corp. 965 East Main Street Meriden, CT 06450	Construction of Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky

6. *A proposal is requested for making the hereinafter described change in accordance with specification and drawing revisions cited herein or listed in attachment hereto. Submit your proposal in space indicated on page 2, attach detailed breakdown of prime and subcontract costs. (See the clause of this contract entitled, "Modification Proposals - Price Breakdown") DO NOT start work under this proposed change until you receive a copy signed by the Contracting Officer or a directive to proceed.*

10 March 1987 — *Date*
RAY K. BOLEY, Resident Engineer — *Typed Name and Title*
Ray K. Boley — *Signature*

7. DESCRIPTION OF CHANGE: *Pursuant to the clause of this contract entitled, "Changes", the contractor shall furnish all plant, labor and material, and perform all work necessary to accomplish the following described work:*

It is necessary to move the upstream dewatering well control panels to the top of the cellular cofferdam so the wells can be pumped during high water events. Your proposal should include conduit from the present location over to the nearest arc to cell wye and up to the new location of the control panel, approximately 3' above the top of the cell. A safety line of 3/8" cable supported by 2" steel pipe posts set in sleeves inserted in the cell cap on about 50-foot centers should be included.

All work shall be in accordance with the applicable contract requirement and as directed by the Contracting Officer.

As a result of the change one (1) new lump sum item will be added to the contract as follows:

Item No.	Description	Quantity	Unit	Unit Price	Amount
P00007	Relocate u/s dewater. well control panel & install safety line.	1	Job	Sum	$6,244.00

The total contract price is increased in the amount of $6,244.00.

The contract completion date remains unchanged.

This adjustment consititues compensation in full on behalf of the contractor and its subcontractors and suppliers, for all costs and mark-ups directly or indirectly attributable to the change ordered herein, including impact, for all delays related thereto and for performance of the changes within the time frame stated.

Except as hereby Modified, all terms and conditions of said contract as heretofore Modified remain unchanged and in full force and effect.

The foregoing modification is hereby accepted.	*UNITED STATES OF AMERICA*
CONTRACTOR THE LANE CONSTRUCTION CORPORATION	
By R.O. Stapleton — *Signature*	Ray K. Boley — *Signature*
7/2/87 — *Date* R.O. Stapleton, Executive Vice Pr — *Typed Name and Title*	6/30/87 — *Date* RAY K. BOLEY Resident Engineer Resident Contracting Officer — *Typed Name and Title*

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Contract No. DACW69-86-C-0039
Modification No. P00007
Dam and Appurtenant Works, Phase II
Yatesville Lake, Kentucky
Continuation Sheet to ENG Form 3938
Block #7

If the foregoing is acceptable, it is requested that you sign and return the original to this office.

(CONTRACTING OFFICER'S COPY)

12 PROJECT	13 CONTRACT	14 MODIFICATION NO
Dam & Appurtenant Work [redacted] Phase II, Yatesville Lake, KY	DACW69-86-C-0039	P00007

15 FUNDS PROGRAMMED FOR THIS CHANGE IN THE AMOUNT OF: $6,244.00 - Increase

96X3122, CG FSN 96461
MR BE YBC 04 10C0 0000 0320 284

16 NECESSITY FOR CHANGE AND REASON FOR OMISSION FROM PLANS AND SPECIFICATIONS

The position of the upstream dewatering well control panels on the contract drawings did not allow use of the wells during high water. Relocation of the dewatering well control boxes above elevation 616.0 was necessary to utilize the upstream dewatering wells prior to potential flood waters cresting over the cellular cofferdam.

The safety line is necessary to protect personnel operating control boxes on top of the cellular cofferdam.

The upstream dewatering well control panels were relocated in accordance with MFR-Trip Report dated 27 Feb 87 from CEORH-ED-GG. The safety line was installed as per MFR-Trip Report dated 5 Mar 87 from CEORH-ED-GG.

17 RESUME OF NEGOTIATIONS OR RECOMMENDATIONS (Government representative)

The Contractor was issued ENG Form 3938 requesting a proposal to relocate the upstream dewatering wells to the top of the cofferdam cells on 10 Mar 87. The Contractor submitted a proposal on 15 May 87 with a price of $7,343.00. On 19 Jun 87 negotiations were conducted with Mr. Jim Hughes and Mr. Bob Housel of Lane Construction Corp. Mr. Hughes conceded during this meeting that the labor in the contractor's proposal was excessive. Mr. Hughes stated he would revise their labor costs. After this meeting the government estimate was also revised to allow additional welder time and equipment time to bury conduit. The revised government estimate dated 22 Jun 87 shows a cost of $6,686.94. On 23 Jun 87 Mr. Hughes returned with a revised cost proposal of $6,244.00, deleting $1,099.00 out of his labor. The revised proposal was $442.94 under the government estimate and is fair and reasonable. The $6,244.00 for the work was agreed upon in negotiations.

DATE	TYPED NAME AND TITLE OF GOVERNMENT REPRESENTATIVE	SIGNATURE
6/30/87	RAY K. BOLEY Resident Contracting Officer	Ray K. Boley

ENG FORM 3938-B
APR. 1967

GPO 1973 O - 484 254

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE	PAGE OF PAGES
	1 | 2

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. (If applicable)
P00003	30 JUL 87		

6. ISSUED BY	CODE	7. ADMINISTERED BY (If other than Item 6)	CODE
Department of the Army Huntington District Corps of Engineers 502 Eighth Street Huntington, West Virginia 25701-2070	AZ1068 BUYER/SYMBOL Mrs. Erwin/CECT-C PHONE: 304/529-5626		

8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code)	9A. AMENDMENT OF SOLICITATION NO.	9B. DATED (SEE ITEM 11)
The Lane Construction Corporation 65 East Main Street Meriden, CT 06450		
	X 10A. MODIFICATION OF CONTRACT/ORDER NO. DACW69-86-C-0039	10B. DATED (SEE ITEM 13) 86 FEB 25
CODE	FACILITY CODE	

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods: (a) By completing Items 8 and 15, and returning _____ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (If required)

FSN 96461 96X3122 CG HR BE YBC 04.10C0 0000 0320 284

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS. IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

A. ☐ THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.

B. ☐ THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation data, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).

C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:

X Contract Clause 58 "Changes" and Contract Clause 45 "Differing Site Conditions"

D. OTHER (Specify type of modification and authority)

E. IMPORTANT: Contractor ☐ is not, ☒ is required to sign this document and return one copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)

Reference is made to Contract Clause 58 "Changes," and Contract Clause 45 "Differing Site Conditions" of the above numbered contract for "Construction of Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky".

Since an equitable adjustment in the contract price for the differing site condition in the rock elevation at the intake structure has been determined, it is necessary and in the best interest of the Government to modify the contract in certain particulars as follows:

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER (Type or print)	16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)
	ROBERT D. BROWN III, COL, Corps of Engineers Contracting Officer
15B. CONTRACTOR/OFFEROR	15C. DATE SIGNED
(Signature of person authorized to sign)	
	16B. UNITED STATES OF AMERICA
	BY (Signature of Contracting Officer)
	16C. DATE SIGNED: 30 JUL 87

NSN 7540-01-152-8070
PREVIOUS EDITION UNUSABLE

30-105

STANDARD FORM 30 (REV. 10-83)
Prescribed by GSA
FAR (48 CFR) 53.243

(R-8)

Payment for all costs in connection with formwork required for the exterior intake structure walls from elevation 570.0 to elevation 575.0 will be made at a lump sum price for "Exterior Intake Structure Formwork from Elevation 570.0 to Elevation 575.0".

As a result of the Differing Site Condition, one contract item is hereby added to the contract at a lump sum price as set forth below:

Item No.	Description	Quantity Increase	Unit	Unit Price	Amount Increase
New (Mod P00008-1)	Exterior Intake Structure Formwork from Elevation 570.0 to Elevation 575.0	1 Job	Sum	$7,500.00	$7,500.00

The contract is increased in the amount of $7,500.00.

The time for completion remains unchanged.

It is understood and agreed that the adjustment provided herein constitutes compensation in full on behalf of the Contractor and its subcontractors and suppliers, for all costs and mark-up directly and indirectly attributable to the change ordered herein, for all unchanged work including impact, for all delays related thereto and for performance of the changes within the time frame stated.

If the foregoing modification is acceptable, it is requested that you sign in Block 15B, complete blocks 15A and 15C of the form, and return the original to this office (ATTN: CEORH-CT).

CEORH-CD-A 13 July 1987

FINDINGS OF FACT

SUBJECT: Findings of Fact in Support of Modification No. P00008, Contract No. DACW69-86-C-0039 (Construction of Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky

1. Necessity for Modification: The contract drawings for the intake structure indicate the top of rock at elevation 575.0 around the sides of the intake structure and an existing base slab placed to elevation 570.0. However, the rock adjacent to the intake structure had been removed previously, by another Contractor performing the tunnel excavation, to approximate elevation 570.0. Therefore, it became necessary for the Contractor to form the intake structure sides from elevation 570.0 to elevation 575.0 in lieu of placing concrete against rock as originally anticipated. In accordance with Contract Clause 45, "Differing Site Conditions," of the contract, the Contractor is entitled to an equitable adjusstment in the contract price for the additional costs he would incur as a result of the differing site condition.

2. Contract Provisions Under Which the Modification is Being Issued: Contract Clause 58, "Changes" and Contract Clause 45, "Differing Site Conditions."

3. Justification of Price: By letter dated April 15, 1987, and received April 17, 1987, the Contractor indicated that the intake tower base slab up to elevation 575.00 was to be placed against existing rock surfaces. However, the rock in this area was lower than indicated and the concrete would have to be formed. The Contractor requested compensation for the cost of forming the exterior concrete surfaces below elevation 575. By letter, dated April 24, 1987, the Resident Engineer acknowledged the lower rock elevation and requested the Contractor to submit a price proposal for forming the perimeter of the intake structure from top of rock to elevation 575. The Resident Engineer prepared an estimate on 29 April 1987 in the amount of $5,286.80 for the additional formwork. The Contractor submitted a hand written proposal to the Resident Engineer on 5 June 1987. The Contractor's proposal was reviewed and preliminary negotiations were held on 19 June 1987. As a result of these negotiations, both parties agreed to review their estimates, the Government's estimate was revised from $5,286.80 to $7,633.81 on 22 June 1987. The revision added stripping costs which had been omitted and included some rework resulting from high water before concrete was placed. The Contractor returned for negotiation on 24 June 1987 with a revised estimate in the amount of $8,227.00. As a result of these negotiations, the Contractor revised his estimate downward to $7,500.00 on 27 June 1987 which was considered to be fair and reasonable. The modification will result in an increase of $7,500.00 in the contract price as set forth below:

CEORH-CD-A

SUBJECT: Findings of Fact in Support of Modification No. P00008, Contract No. DACW69-86-C-0039 (Construction of Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky

Item No.	Description	Quantity Increase	Unit	Unit Price	Amount Increase
New (Mod P00008-1)	Exterior Intake Structure Forework from Elevation 570.0 to Elevation 575.0	1 Job	Sum	$7,500.00	$7,500.00

4. Justification of Time: Since the work will be performed concurrent with other contract work, additional contract time is not required.

5. Statement of Availability of Funds: Funds in the amount of $7,500.00 are available under the appropriation: FSN 96461 96X3122 CG,CE; HR BE YBC 04.10C0 0000 0320 284.

ROBERT D. BROWN III
Colonel, Corps of Engineers
Contracting Officer

CONTRACT MODIFICATION PROPOSAL AND ACCEPTANCE

(Modification of less than $50,000)

For use of this form, see ER 1180-1-1.

1. ISSUING OFFICE	2. CONTRACT NO.	3. MODIFICATION NO.
Resident Engineer, Yatesville Lake P.O. Box 1101, Louisa, KY 41230-4101	DACW69-86-C-0039	P00010

4. TO (Contractor)	5. PROJECT LOCATION AND DESCRIPTION
The Lane Construction Corporation 965 East Main Street Meriden, Connecticut 06450	Construction of Dam and Appurtenant Works Phase II Yatesville Lake, Kentucky 96x3122 CG CE FSN 96461 MR BE YBC 04 10C0 G000 0320 284

6. *A proposal is requested for making the hereinafter described change in accordance with specification and drawing revisions cited herein or listed in attachment hereto. Submit your proposal in space indicated on page 2, attach detailed breakdown of prime and subcontract costs. (See the clause of this contract entitled, "Modification Proposals - Price Breakdown") DO NOT start work under this proposed change until you receive a copy signed by the Contracting Officer or a directive to proceed.*

29 July 1987 — *Date*

RAY K. BOLEY Resident Engineer — *Typed Name and Title*

Ray K. Boley — *Signature*

7. DESCRIPTION OF CHANGE: *Pursuant to the clause of this contract entitled, "Changes", the contractor shall furnish all plant, labor and material, and perform all work necessary to accomplish the following described work:*

a. Delete deadman anchor for trash boom and substitute grouted anchor bar as directed in the field.

b. All work will be in accordance with contract plans and specifications and as directed by the Contracting Officer.

c. As a result of this change one lump sum item for a credit to the Government will be added to the contract as follows:

Item No.	Description	Est. Qty.	Unit	Unit Price	Est. Amount
P00010-1	Delete Deadman Anchor	1	Job	(-) $3,100.00	(-) $3,100.00

d. The contract time will remain unchanged.

e. It is understood and agreed that the adjustment provided herein constitutes compensation in full on behalf of the contractor, his subcontractors and suppliers, for all costs and markup directly or indirectly attributable to the change ordered, for all delays related thereto, and for performance of the change within the time frame stated.

f. If the foregoing modification is acceptable, it is requested that you sign the form and return the original to this office.

Except as hereby Modified, all terms and conditions of said contract as heretofore Modified remain unchanged and in full force and effect.

The foregoing modification is hereby accepted.	*UNITED STATES OF AMERICA*
CONTRACTOR THE LANE CONSTR. CORP'N	
BY N.W. Llewellyn *Signature*	Ray K. Boley RAY K. *Signature* BOLEY Resident Engineer
17 AUG 1987 N.W. LLEWELLYN PRES. *Date* *Typed Name and Title*	11 August 87 Resident Contracting Officer *Date* *Typed Name and Title*

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8. ISSUING OFFICE	9. CONTRACT NO	10. MODIFICATION NO.
Resident Engineer, Yatesville Lake P.O. Box 1101, Louisa, KY 41230-4101	DACW69-86-C-0039	P00010

11. **CONTRACTOR'S PROPOSAL—CHANGE IN CONTRACT PRICE**
(Detailed breakdown, attach additional sheets as necessary)

NOTE: *SIGN AND RETURN ORIGINAL AND COPIES; RETAIN ONE COPY FOR YOUR FILE*

NET INCREASE	NET DECREASE	CALENDAR DAYS INCREASE
$ 0	$ 3100.00	0 DAYS

(Proposed)

Credit for replacing concrete anchor with rock anchor for one end of trash boom

Proposed credit:

For concrete:

(6' x 7' x 8')/27 = 12.4 cy of concrete

12.4 cy x $250./cy = $3100.00

Total proposed credit = $3100.00

DATE	TYPED NAME AND TITLE	SIGNATURE
8-4-87	H.W. Reitz District Manager	H W. Reitz (JOH)

ENG FORM 3938
APR 87

CONTRACT MODIFICATION PROPOSAL AND ACCEPTANCE (CONTRACTING OFFICER'S COPY)

12. PROJECT	13. CONTRACT NO.	14. MODIFICATION NO
Construction of Dam and Appurtenant Works Phase II, Yatesville Lake, KY	DACW69-86-C-0039	P00010

15. FUNDS PROGRAMMED FOR THIS CHANGE IN THE AMOUNT OF: (-) $3,100.00 - Decrease

96x3122, CG CE FSN 96461
MR BE YBC 04 1000 0000 0320 284

16. NECESSITY FOR CHANGE AND REASON FOR OMISSION FROM PLANS AND SPECIFICATIONS

During the preparatory inspection for installation of the trash boom anchors, it was determined by field observations that a grouted rock anchor was more appropriate and would result in a partial savings to the government over the deadman anchor shown in the plans.

17. RESUME OF NEGOTIATIONS OR RECOMMENDATIONS (Government representative)

The Contractor was sent a request for proposal to delete one deadman anchor on 29 July 1987. The Contractor provided a proposed credit for the deletion, dated 4 August 1987, in the amount of (-)$3,100.00. The government's estimate dated 30 July 1987 proposed a credit of (-)$2,783.82. The Contractor's proposal resulted in a higher credit for the government. The Contractor's proposal is fair and reasonable and therefore was accepted. No additional time is necessary nor was granted for this modification.

DATE	TYPED NAME AND TITLE OF GOVERNMENT REPRESENTATIVE	SIGNATURE
5 Aug 87	RAY K. BOLEY, Resident Engineer	Ray K. Boley

ENG FORM 3933-B APR 1967

CONTRACT MODIFICATION PROPOSAL AND ACCEPTANCE
(Modification of less than $50,000)
For use of this form, see ER 1180-1-1.

1. ISSUING OFFICE	2. CONTRACT NO.	3. MODIFICATION NO.
Resident Engineer, Yatesville Lake P.O. Box 1101, Louisa, KY 41230-4101	DACW69-86-C-0039	P00012 Reason Code: C15

4. TO (Contractor)	5. PROJECT LOCATION AND DESCRIPTION
The Lane Construction Corporation 965 East Main Street Meriden, Connecticut 06450	Dam and Appurtenant Works Phase II Yatesville Lake, Kentucky FSN 96461; 96x3122 CG CE; MR BE YBC 04 10C0 0000-0320 284

6. *A proposal is requested for making the hereinafter described change in accordance with specification and drawing revisions cited herein or listed in attachment hereto. Submit your proposal in space indicated on page 2, attach detailed breakdown of prime and subcontract costs. (See the clause of this contract entitled, "Modification Proposals - Price Breakdown") DO NOT start work under this proposed change until you receive a copy signed by the Contracting Officer or a directive to proceed.*

10/7/87	RAY K. BOLEY, Resident Engineer	Ray K. Boley
Date	Typed Name and Title	Signature

7. DESCRIPTION OF CHANGE: *Pursuant to the clause of this contract entitled, "Changes", the contractor shall furnish all plant, labor and material, and perform all work necessary to accomplish the following described work:*

a. Change AU : Construct notch in downstream diversion dike as shown on drawings (enclosures 1 & 2) and as instructed in the field. All work will be in accordance with contract plans and specifications and as directed by the contracting officer.

b. As a result of this change one lump sum item will be added to the contract as follows:

Item No.	Description	Qty	Units	Unit Price	Amount
P00012-1	Notch in Downstream Diversion Dike	1	Job	Sum	$6050.00

c. The contract performance time is unchanged.

d. This adjustment constitutes compensation in full on behalf of the contractor for all costs and markup attributable to this change, for all unchanged work including impact, for all delays and for performance of the changes within the time frame stated.

Except as hereby Modified, all terms and conditions of said contract as heretofore Modified remain unchanged and in full force and effect.

The foregoing modification is hereby accepted.	*UNITED STATES OF AMERICA*
CONTRACTOR THE LANE CONSTRUCTION CORP.	
BY R.D. Stapleton *Signature*	Ray K. Boley *Signature*
10/28/87 *Date*	R. D. Stapleton, Executive Vice President *Typed Name and Title*
10/20/87 *Date*	RAY K. BOLEY Resident Engineer, RCO *Typed Name and Title*

☆U.S. GOVERNMENT PRINTING OFFICE 1982 - 383-458

CONTRACT MODIFICATION PROPOSAL AND ACCEPTANCE (CONTRACTING OFFICER'S COPY)

12. PROJECT	13. CONTRACT NO.	14. MODIFICATION NO
Dam and Appurtenant Works, PH II Yatesville Lake, Kentucky	DACW69-86-C-0039	P00012 Reason Code: C15

15. FUNDS PROGRAMMED FOR THIS CHANGE IN THE AMOUNT OF: $6050.00 - Increase

Chargeable to account number: FSN 96461; 96x3122 CG CE; MR BE YBC 04 10C0 0000 0320 284

16 NECESSITY FOR CHANGE AND REASON FOR OMISSION FROM PLANS AND SPECIFICATIONS

Change AU, Notch in Downstream Diversion Dike: Disposition form from CEORH-ED dated 16 Sep 87 requested contract DACW69-86-C-0039 be modified to provide a notch in the downstream diversion dike to better facilitate back flooding of the work area in case of a flood situation. Back flooding will provide additional protection to the cofferdam and minimize damage to the work area in case of high water overtopping the cofferdam.

17 RESUME OF NEGOTIATIONS OR RECOMMENDATIONS (Government representative)

Change AU, Notch in Downstream Diversion Dike: In response to a request for proposal dated 7 Oct 87, the Contractor proposed a price of $6050.00. The government estimate prepared 13 Oct 87 was $11,195.20. The Contractor's proposal was less than the government estimate and is acceptable. The Contractor's proposal was examined for labor, equipment, material, overhead and profit rates and is fair and reasonable. No additional time is required nor was allowed for this modification.

DATE	TYPED NAME AND TITLE OF GOVERNMENT REPRESENTATIVE	SIGNATURE
10/19/87	RAY K. BOLEY, Resident Engineer, RCO	Ray K. Boley

ENG FORM 3938-B APR 1967

CONTRACT MODIFICATION PROPOSAL AND ACCEPTANCE
(Modification of less than $50,000)
For use of this form, see ER 1180-1-1.

1. ISSUING OFFICE	2. CONTRACT NO.	3. MODIFICATION NO.
U.S. Army Engr District, Huntington Yatesville Lake Resident Office	DACW69-86-C-0039	P00015 Reason Code: C15

4. TO (Contractor)	5. PROJECT LOCATION AND DESCRIPTION
The Lane Construction Corporation 965 East Main Street Meriden, Connecticut 06450	Dam and Appurtenant Works, Ph. II, Yatesville Lake, KY FSN 96461 96x3122, CG CE MR BE YBC 04 10C0 0000 0320 284

6. *A proposal is requested for making the hereinafter described change in accordance with specification and drawing revisions cited herein or listed in attachment hereto. Submit your proposal in space indicated on page 2, attach detailed breakdown of prime and subcontract costs. (See the clause of this contract entitled, "Modification Proposals - Price Breakdown") DO NOT start work under this proposed change until you receive a copy signed by the Contracting Officer or a directive to proceed.*

12/3/87 — *Date*

RAY K. BOLEY, Resident Engineer — *Typed Name and Title*

Signature

7. DESCRIPTION OF CHANGE. *Pursuant to the clause of this contract entitled, "Changes", the contractor shall furnish all plant, labor and material, and perform all work necessary to accomplish the following described work:*

a. Change AY: (1) Construct a sandstone test fill with five one-foot lifts on top of the existing downstream random rock fill zone. Test fill will include five 30-feet wide lanes with compactive effort as indicated on attached sketch.

(2) Sample and perform gradations on two quarry samples at approximately 1/3 and 2/3 of the required volume necessary to construct the test fill.

(3) Perform approximately 10 rock fill test pits in accordance with applicable specifications except that a percolation test will not be required. Location will be as directed in the field.

b. All work shall be in accordance with applicable contract requirements and as directed in the field.

c. As a result of this change one lump sum and two unit price items will be added to the contract as follows:

Item No.	Description	Quantity	Unit	Unit Price	Amount
P00015-1	Test Fill	1	Job	Sum	$ 2405.41
P00015-2	Quarry Sample Test	2	Ea	$525.00	$ 1050.00
P00015-3	Test Pits	10	Ea	$723.00	$ 7230.00

Except as hereby Modified, all terms and conditions of said contract as heretofore Modified remain unchanged and in full force and effect.

The foregoing modification is hereby accepted.	*UNITED STATES OF AMERICA*
CONTRACTOR The Lane Construction Corporation	
BY *Signature*	*Signature*
1/8/88 — *Date* R.D. Stapleton, Vice President — *Typed Name and Title*	4 Jan 88 — *Date* RAY K. BOLEY Resident Engineer, RCO — *Typed Name and Title*

ENG FORM 3938, Jul 81 — EDITION OF JUN 77 IS OBSOLETE. — PAGE 1 OF 2 PAGES

GUS GOVERNMENT PRINTING OFFICE 1982 383-456

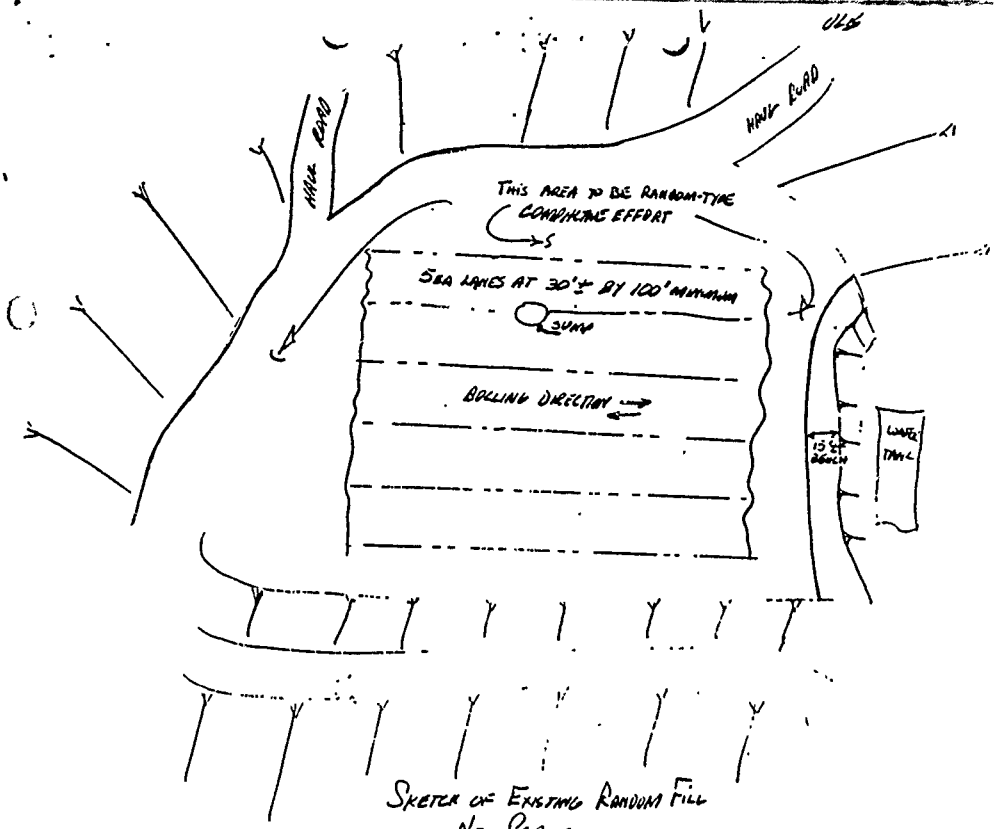
Contract No. DACW69-86-C-0039
Modification No. P00015
Dam and Appurtenant Works, Ph. II
Yatesville Lake, Kentucky
Continuation Sheet to ENG Form 3938
Block #7

d. The total contract is increased in the amount of $10,685.41.

e. The contractor completion date remains unchanged.

f. This adjustment constitutes compensation in full on behalf of the Contractor and its subcontractors and suppliers for all costs and markups directly or indirectly attributable to the change ordered herein, including impact, for all delays related thereto and for performance of the changes within the time frame stated.

g. If the foregoing is acceptable, it is requested that you sign and return the orginal to this office.



SKETCH OF EXISTING RANDOM FILL
NO SCALE

NOTES:
1. LOOSE LIFT THICKNESS = 12"
2. SANDSTONE MATERIAL SPECIFICATION - 12"
3. MINIMUM OF 4 LIFTS, MAXIMUM 5 LIFTS
4. COMPACTIVE EFFORT BY LANE AFTER SPREADING TO LOOSE LIFT OF 12":
   A. 2 COVERAGES TAMPING ROLLER FOLLOWED BY 4 COVERAGES VIBRATORY
   B. 4 COVERAGES VIBRATORY ONLY AS PER SPECIFICATIONS
   C. 6 COVERAGES VIBRATORY ONLY
   D. 4 COVERAGES TAMPING ROLLER ONLY
   E. "RANDOM-TYPE" AS SPECIFIED -- 2 COVERAGES TAMPING ROLLER FOLLOWED BY 4 COVERAGES (6 TRIPS) BY 50-TN DUMPER
5. 10 DUTEST PITS IN FILL AT LOCATIONS DIRECTED BY CONTRACTING OFFICER AND IN ACCORDANCE WITH ORIGINAL SPECS EXCEPT ACRE TEST NOT REQUIRED
6. 2 GRADATION TESTS FROM ROCK "AS SHOT" AT BORROW AREA.

CONTRACT MODIFICATION PROPOSAL AND ACCEPTANCE (CONTRACTING OFFICER'S COPY)

12. PROJECT	13. CONTRACT NO.	14. MODIFICATION NO.
Construction of Dam & Appurtenant Works, Phase II, Yatesville Lake, Kentucky	DACW69-86-C-0039	P00015

15. FUNDS PROGRAMMED FOR THIS CHANGE IN THE AMOUNT OF: $10,685.41 - Increased to Account Number: FSN 96461 96x3122, CC CE; MR BE YBC 04 1000 0000 0320 284

16. NECESSITY FOR CHANGE AND REASON FOR OMISSION FROM PLANS AND SPECIFICATIONS

Change AY: (1) Test Fill, (2) Quarry Sample Tests, (3) Tests Pits: Initial test pits resulted in gap graded material indicating compaction methods required by the specifications to be inadequate. In accordance with Memorandum for Record dated 23 November 1987 from CEORH-ED-G additional testing was initiated. On disposition form dated 9 December 1987, CEORH-ED requested modification to contract DACW69-86-C-0039. Reason Code: C15.

17. RESUME OF NEGOTIATIONS OR RECOMMENDATIONS (Government representative)

Change AY, (1) Test fill, (2) Quarry Sample Tests, (3) Tests Pits: In response to Request for Proposal dated 3 December 1987, the Contractor submitted a proposal dated 15 December 1987, for 10,685.41. The government estimate dated 9 December 1987 is $15,223.10. The Contractor's proposal was reviewed for technical accuracy, completeness and scope of work. The proposal was found to be acceptable. The Contractor's proposal is less than the government estimate and is fair and reasonable. The Contractor's proposal was accepted on 17 December 1987. No additional time is required nor allowed.

DATE	TYPED NAME AND TITLE OF GOVERNMENT REPRESENTATIVE	SIGNATURE
6 Jan 88	RAY K. BOLEY, Resident Engineeer, RCO	Ray K. Boley

ENG FORM 3938-B APR 1967

106

CONTRACT MODIFICATION PROPOSAL AND ACCEPTANCE
(Modification of less than $50,000)
For use of this form, see ER 1180-1-1.

1. ISSUING OFFICE	2. CONTRACT NO.	3. MODIFICATION NO.
U. S. Army Engr. Dist., Huntington Yatesville Lake Resident Office	DACW69-86-C-0039	P00019

4. TO (Contractor)	5. PROJECT LOCATION AND DESCRIPTION
The Lane Construction Corporation 955 East Main Street Meriden, Connecticut 06450	Dam and Appurtenant Works, Ph. II Yatesville Lake, Kentucky FSN 96461; 96x3122, CG CE; MR BE YBC 04 10C0 0000 0320 284

6. *A proposal is requested for making the herein after described change in accordance with specifications and drawing revisions cited herein or listed in attachment hereto. Submit your proposal in space indicated on page 2, attach detailed breakdown of prime and subcontract costs. (See the clause of this contract entitled, "Modification Proposals - Price Breakdown") DO NOT start work under this proposed change until you receive a copy signed by the Contracting Officer or a directive to proceed.*

Date	Typed Name and Title	Signature

7. DESCRIPTION OF CHANGE: *Pursuant to the clause of this contract entitled, "Changes", the contractor shall furnish all plant, labor and material, and perform all work necessary to accomplish the following described work:*

a. Change BG: Remove impervious material, repair water seepage in shale zone below impervious core, and replace impervious fill in accordance with Initial Order Number 1 and as directed in the field. All work will be in accordance with contract plans and specifications and as directed by the Contracting Officer.

b. As a result of this change one lump sum item will be added to the contract as follows:

Item No.	Description	Quantity	Unit	Unit Price	Amount
P00019-1	Additional Inspection of Dam Foundation	1	Job	Sum	$ 7,000.00

e. This adjustment constitutes compensation in full on behalf of the contractor and its subcontractors and suppliers for all costs and markups directly or indirectly attributable to this change, for all unchanged work including impact, for all delays related thereto and for performance of the work within the contract time which is unchanged.

Except as hereby Modified, all terms and conditions of said contract as heretofore Modified remain unchanged and in full force and effect.

The foregoing modification is hereby accepted.	*UNITED STATES OF AMERICA*
CONTRACTOR The Lane Construction Corporation	
BY R.D. Stapleton R.D.Stapleton, *Signature* Exec.Vice President	Kenneth E. Zimmerman *Signature* KENNETH E. ZIMMERMAN Resident Contracting Officer
May 26, 1988 *Date* *Typed Name and Title*	23 May 1988 *Date* *Typed Name and Title*

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CONTRACT MODIFICATION PROPOSAL AND ACCEPTANCE (CONTRACTING OFFICER'S COPY)

12. PROJECT	13. CONTRACT NO.	14. MODIFICATION NO.
Dam and Appurtenant Works, Phase II Yatesville Lake, Kentucky	DACW69-86-C-0039	P00019

15. FUNDS PROGRAMMED FOR THIS CHANGE IN THE AMOUNT OF:

$7,000.00 chargeable to account number: FSN 96461; 96X3122, CG, CE; MR BE YBC 04 10CO 0000 0320 284.

16. NECESSITY FOR CHANGE AND REASON FOR OMISSION FROM PLANS AND SPECIFICATIONS

Change BG, Additional Inspection of Dam Foundation:

See "Determination of Findings" dated 15 April 1988 attached.

Reason code: CL5.

17. RESUME OF NEGOTIATIONS OR RECOMMENDATIONS (Government representative)

Change BG, Additional Inspection of Dam Foundation:

In response to Request for Proposal, Initial Order No. 1 dated 18 April 1988, the contractor submitted a proposal of $7,000.00 dated 26 April 1988. The government estimate dated 18 April 1988 is $9,670.29. The contractor's proposal was reviewed for technical accuracy, completeness, and scope of work. The proposal was found to be acceptable. The contractor's proposal is less than the government estimate and is fair and reasonable. The contractor's proposal was accepted on 2 May 1988. No additional time is required nor allowed.

DATE	TYPED NAME AND TITLE OF GOVERNMENT REPRESENTATIVE	SIGNATURE
3 May 88	KENNETH E. ZIMMERMAN Resident Contracting Officer	Kenneth E. Zimmerman

ENG FORM 3938-B
APR. 1967

de/cal/5626

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE	PAGE OF PAGES
	1 | 1

AMENDMENT/MODIFICATION NO.	2. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. (If applicable)
P00020	09 Nov 88		

6. ISSUED BY	CODE	7. ADMINISTERED BY (If other than Item 6)	CODE
Huntington District Corps of Engineers 502 8th Street Huntington, West Virginia 25701-2070	A2706B BUYER/SYMBOL Mrs. Erwin/CEORH-CT-C 304-529-5626		

8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code)	(X)	9A. AMENDMENT OF SOLICITATION NO.
The Lane Construction Corporation 965 East Main Street Meriden, CN 06450		9B. DATED (SEE ITEM 11)
RECEIVED NOV 14 1988 LANE		10A. MODIFICATION OF CONTRACT/ORDER NO. DACW69-86-C-0039
		10B. DATED (SEE ITEM 13) 86 Feb 25

CODE	FACILITY CODE

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods:

(a) By completing Items 8 and 15, and returning _____ copies of the amendment. (b) By acknowledging receipt of this amendment on each copy of the offer submitted or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (If required)

FS: 96461 96X3122 CG, CE: MR BE YBC 04.10C0 0000 0320 284

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS, IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14

(X)	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation data, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).
	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
X	Contract Clause 58, "Changes"
	D. OTHER (Specify type of modification and authority)

E. IMPORTANT: Contractor ☐ is not, ☒ is required to sign this document and return one copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)

Reference is made to Contract Clause 58 "Changes" of the above numbered contract for "Construction of Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky.

Since an equitable adjustment in the contract price for the "Removal and Replacement of Unsuitable Impervious Fill Material in the Core of the Dam" has been determined, it is necessary and in the best interest of the Government to modify the contract in certain particulars as follows:

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER (Type or print)		16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)	
		THOMAS E. FAREWELL, COL, CE Contracting Officer	
15B. CONTRACTOR/OFFEROR	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA	16C. DATE SIGNED
(Signature of person authorized to sign)		BY Thomas E. Farewell (Signature of Contracting Officer)	09 Nov 88

NSN 7540-01-152-8070 30-105 STANDARD FORM 30 (REV. 10-83)

Payment for all costs in connection with removal and backfilling impervious core on April 13, (26) 27 and (28) 1988; Standby equipment cost on April 27 and April 28, 1988; Removal and backfilling impervious core material, building test fill, digging inspection trench, and standby equipment costs for May 11 thru May 17, 1988; Excavation and backfilling of impervious core at elev. 571-575 and right abutment at elevation 576 including standby costs from May 27 thru June 2, 1988; and excavation and backfilling impervious core at elevation 576 including standby costs on June 3, 1988.

As a result of the changes, one new contract item is hereby added to the contract at a lump sum price as set forth below:

Item No.	Description	Quantity Increase	Unit	Unit Price	Amount Increase
New Mod. P-00020-1	Removal and Replacement of Unsuitable Impervious Fill Material in the Core of the Dam	1 Job	Sum	$57,578.00	$57,578.00

The contract is increased in the amount of $57,578.00

The time for completion remains unchanged.

It is understood and agreed that the adjustment provided herein constitutes compensation in full on behalf of the Contractor and its subcontractors and suppliers, for all costs and mark-up directly and indirectly attributable to the change ordered herein, for all unchanged work including impact, for all delays related thereto and for performance of the changes within the time frame stated.

If the foregoing modification is acceptable, it is requested that you sign in Block 15B, complete Blocks 15A and 15C of the form, and return the original to this office with the completed SF-1415 (ATTN: CEORH-CT) after the consent of surety has been completed by you and your surety.

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT	1. CONTRACT ID CODE	PAGE OF PAGES
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2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. (If applicable)
P00022			

6. ISSUED BY	CODE	7. ADMINISTERED BY (If other than Item 6)	CODE
Huntington District Corps of Engineers 502 Eighth Street Huntington, West Virginia 25701-2070		YBC	

8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code)		9A. AMENDMENT OF SOLICITATION NO.
The Lane Construction Corporation 965 East Main Street Meriden, CN 06450		9B. DATED (SEE ITEM 11)
	X	10A. MODIFICATION OF CONTRACT/ORDER NO. DACW69-86-C-0039
		10B. DATED (SEE ITEM 13) 86 Feb 25
CODE / FACILITY CODE		

11 THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods.

(a) By completing Items 8 and 15 and returning _____ copies of the amendment (b) By acknowledging receipt of this amendment on each copy of the offer submitted or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER If by virtue of this amendment you desire to change an offer already submitted such change may be made by telegram or letter provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified

12 ACCOUNTING AND APPROPRIATION DATA (If required)

FSN 96461 96x3122 CG CE; MR BE YBC 04.10C0 0000 0320 284

13 THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS, IT MODIFIES THE CONTRACT/ORDER NO AS DESCRIBED IN ITEM 14

X	A THIS CHANGE ORDER IS ISSUED PURSUANT TO (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO IN ITEM 10A.
	B THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43 103(b)
	C THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
X	Contract Clause 58, "Changes"
	D OTHER (Specify type of modification and authority)

E IMPORTANT Contractor ☐ is not ☒ is required to sign this document and return one copies to the issuing office

14 DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)

Reference is made to Contract Clause 58 "Changes" of the above numbered contract for "Construction of Dam & Appurtenant Works, Phase II, Yatesville Lake, Kentucky".

Since an equitable adjustment in the contract price for "Removal of the top 5' of concrete abutments on each side of the cellular cofferdam" has been determined, it is necessary and in the best interest of the Government to modify the contract in certain particulars as follows:

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect

15A NAME AND TITLE OF SIGNER (Type or print)		16A NAME AND TITLE OF CONTRACTING OFFICER (Type or print)	
R. D. Stapleton, Executive Vice President		KENNETH E. ZIMMERMAN Resident Contracting Officer	
15B CONTRACTOR/OFFEROR R D Stapleton (Signature of person authorized to sign)	15C DATE SIGNED 11/8/88	16B. UNITED STATES OF AMERICA BY (Signature of Contracting Officer)	16C DATE SIGNED

PREVIOUS EDITION UNUSABLE

30-105-02

STANDARD FORM 30 (REV 10 83)
Prescribed by GSA
FAR (48 CFR) 53 243

Payment for all costs included in the removal of the top 5' of concrete from the cofferdam abutments in accordance with the approved blasting plan and distribution of the broken concrete in front of the cofferdam.

All work shall be in accordance with applicable provisions of the contract and as directed by the Contracting Officer Representative.

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
New Mod. P-00022-1	Removal of the top 5' of concrete abutments on each side of the cellular cofferdam.	1 Job	Sum	$5,065.00	$5,065.00

The contract is increased in the amount of $5,065.00.

The time for completion remains unchanged.

It is understood and agreed that the adjustment provided therein constitutes compensation in full on behalf of the contractor and its subcontractors and suppliers, for all costs and mark-up directly and indirectly attributable to the change ordered herein, for all unchanged work including impact, for all delays related thereto and for performance of the changes within the time frame stated.

If the foregoing modification is acceptable, it is requested that you sign in Block 15B, complete Blocks 15A and 15C of the form, and return the original to our Yatesville Field Office: ATTN: Kenneth E. Zimmerman.

4KC

Change Letters - "B"

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

CONTRACT ID CODE	PAGE OF PAGES
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2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. (If applicable)
P00024			

6. ISSUED BY CODE
Huntington District
Corps of Engineers
502 Eighth Street
Huntington, West Virginia 25701-2070

7. ADMINISTERED BY (If other than Item 6) CODE

8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code)
The Lane Construction Corporation
965 East Main Street
Meriden, CN 06450

CODE FACILITY CODE

(X) 9A. AMENDMENT OF SOLICITATION NO.

9B. DATED (SEE ITEM 11)

(X) 10A. MODIFICATION OF CONTRACT/ORDER NO.
DACW69-86-C-0039

10B. DATED (SEE ITEM 13)
86 Feb 25

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods: (a) By completing Items 8 and 15, and returning _____ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (If required)
FSN 96461 96X3122 CG CE; MR BE YBC 04.10C0 0000 0320 284

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS, IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14

(X) A. THIS CHANGE ORDER IS ISSUED PURSUANT TO (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.

B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).

(X) C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
Contract Clause 58, "Changes"

D. OTHER (Specify type of modification and authority)

E. IMPORTANT: Contractor ☐ is not, ☒ is required to sign this document and return one copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)

Reference is made to Contract Clause 58 "Changes" of the above numbered contract for "Construction of Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky".

Since an equitable adjustment in the contract price for "Preparation o Alternate Borrow Area" has been determined, it is necessary and in the best interest of the Government to modify the contract in certain particulars as follows:

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER (Type or print)	16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)
N W LLEWELLYN PRESIDENT THE LANE CONSTR CORP	KENNETH E. ZIMMERMAN Resident Contracting Officer
15B. CONTRACTOR/OFFEROR: N W Llewellyn (Signature of person authorized to sign)	15C. DATE SIGNED: 13 DEC '88
16B. UNITED STATES OF AMERICA BY: Kenneth E. Zimmerman (Signature of Contracting Officer)	16C. DATE SIGNED: 16 DEC 88

Payment for all costs included in the strip clearing of the alternate borrow area for taking cross sections, physically taking the cross sections, and restoring the areas disturbed by the contractors operations and the Corps of Engineer testing consultants operations.

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
New Mod. P-00024-1	Preparation of Alternate Borrow Area	1 Job	Sum	$12,214.00	$12,214.00

The contract is increased in the amount of $12,214.00

The time for completion remains unchanged.

It is understood and agreed that the adjustment provided therein constitutes compensation in full on behalf of the contractor and its subcontractors and suppliers, for all costs and mark-up directly and indirectly attributable to the change ordered herein, for all unchanged work including impact, for all delays related thereto and for performance of the changes within the time frame stated.

If the foregoing modification is acceptable, it is requested that you sign in Block 15B, complete Blocks 15A and 15C of the form and return the original to our Yatesville Field Office, ATTN: Kenneth E. Zimmerman

de/ca1/5620

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1 CONTRACT ID CODE	PAGE OF PAGES
J	1 | 2

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. (If applicable)
P00025	18 JAN 89		

6. ISSUED BY — CODE

Huntington District
Corps of Engineers
502 Eighth Street
Huntington, West Virginia 25701-2070

7. ADMINISTERED BY (If other than Item 6) — CODE

YBC

8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code)

(Lane Construction Corporation
965 East Main Street
Meriden, CN 06450

RECEIVED JAN 24 1989 LANE

CODE — FACILITY CODE

(X) 9A. AMENDMENT OF SOLICITATION NO.

9B. DATED (SEE ITEM 11)

10A. MODIFICATION OF CONTRACT/ORDER NO.

X DACW69-86-C-0039

10B. DATED (SEE ITEM 13)
86 Feb 25

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended by one of the following methods:

(a) By completing Items 8 and 15, and returning ____ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (If required)

FSN 96461 96X3122 CG CE; MR BE YBC 04.10C0 0000 0320 284

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS, IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

(X) A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.

☐ B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).

X C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
Contract Clause 58, "Changes"

☐ D. OTHER (Specify type of modification and authority)

E. IMPORTANT: Contractor ☐ is not, ☒ is required to sign this document and return one copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)

Reference is made to Contract Clause 58 "Changes" of the above numbered contract for "Construction of Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky".

Since an equitable adjustment in the contract price for "Payment of 6" Concrete Tolerance in Spillway" has been determined, it is necessary and in the best interest of the Government to modify the contract in certain particulars as follows:

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER (Type or print)	16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)
R. D. Stapleton, Executive Vice President	THOMAS E. FAREWELL Colonel, Contracting Officer

15B. CONTRACTOR/OFFEROR	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA	16C. DATE SIGNED
R V Stapleton (Signature of person authorized to sign)	1/26/89	BY Thomas E Farewell (Signature of Contracting Officer)	1/18/89

Payment for all costs included in the additional forming, furnishing and placing the additional 6 inches of concrete thickness for the spillway lining from the required minimum thickness of 1'-9" to the allowable limit of 2'-3" will result in increases in the quantities of Contract Items Nos. 81 and 132a and b for which payment will be made at contract unit prices.

As a result of the foregoing, the pay quantities for the three bid items are increased as set forth below:

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
81	Concrete in inclined leg foundation and spillway lining	64	CY	$250.00	$16,000.00
132	Portland Cement and Pozzalan				
	a. Portland Cement	270.72	CWT	3.00	812.16
	b. Pozzalan	45.89	CF	2.00	$ 91.78
					$16,903.94

The contract is increased in the amount of $16,903.94.

The time for completion remains unchanged.

It is understood and agreed that the adjustment provided herein constitutes compensation in full on behalf of the contractor and his subcontractors and suppliers, for all costs and mark-up directly and indirectly attributable to the change ordered herein, for all unchanged work including impact and for all delays related thereto as a result of the claim submitted by the contractor by letter dated July 7, 1988.

If the foregoing modification is acceptable, it is requested that you sign in Block 15B, complete Blocks 15A and 15C of the form and return the original to this office (ATTN: CEORH-CT).

AMENDMENT OF SOLICITATIO MODIFICATION OF CONTRACT J

1. CONTRACT ID CODE	PAGE OF PAGES
	1 | 2

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. (If applicable)
P00026	28 FEB 89		

6. ISSUED BY CODE

Huntington District
Corps of Engineers
502 Eighth Street
Huntington, West Virginia 25701-2070

7. ADMINISTERED BY (If other than Item 6) CODE

8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code)

The Lane Construction Corporat
5 East Main Street
riden, CN 06450

RECEIVED
MAR 3 - 1989
LANE

CODE FACILITY CODE

(X) 9A. AMENDMENT OF SOLICITATION NO.

9B. DATED (SEE ITEM 11)

10A. MODIFICATION OF CONTRACT/ORDER NO.

X DACW69-86-C-0039

10B. DATED (SEE ITEM 13)
86 Feb 25

11 THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods

(a) By completing Items 8 and 15 and returning _____ copies of the amendment (b) By acknowledging receipt of this amendment on each copy of the offer submitted, or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified

12 ACCOUNTING AND APPROPRIATION DATA (If required)

FSN 96461 96X3122 CG CE; MR BE YBC 04.10C0 0000 0320 284

13 THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS, IT MODIFIES THE CONTRACT/ORDER NO AS DESCRIBED IN ITEM 14

(X) A THIS CHANGE ORDER IS ISSUED PURSUANT TO (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.

B THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).

C THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:

X Contract Clause 58, "Changes"

D. OTHER (Specify type of modification and authority)

E. IMPORTANT: Contractor ☐ is not, ☒ is required to sign this document and return ~~one~~ copies to the issuing office

14 DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)

Reference is made to Contract Clause 58 "Changes" of the above numbered contract for "Construction of Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky".

Since an equitable adjustment in the contract price for "Painting Embedded Metals in the Intake Structure below Elevation 635" has been determined, it is necessary and in the best interest of the Government to modify the contract in certain particulars as follows:

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER (Type or print)	16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)
R. D. Stapleton, Executive Vice President	KENNETH E. ZIMMERMAN Resident Contracting Officer
15B. CONTRACTOR/OFFEROR: K D Stapleton (Signature of person authorized to sign)	15C. DATE SIGNED: 3/6/89
16B. UNITED STATES OF AMERICA: BY Kenneth E. Zimmerman (Signature of Contracting Officer)	16C. DATE SIGNED: 23 FEB 89

NSN 7540-01-152 8070
PREVIOUS EDITION UNUSABLE

30-105-02

STANDARD FORM 30 (REV. 10-83)
Prescribed by GSA
FAR (48 CFR) 53.243

(R-31)

Payment for all costs included in the cleaning and painting of all embedded ferrous metals excluding corrosion resistant steel or galvanized steel below Elevation 635 in the Intake Structure. The embedded surfaces are to be painted in accordance with paint system 6-A-Z, Coal Tar Epoxy.

As a result of this change, one new item will be established as set forth below:

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
New Mod. P-00026-1	Painting Embedded metals below Elevation 635 in the Intake Structure	1 Job	Sum	$49,950.00	$49,950.00

The contract is increased in the amount of $49,950.00.

The time for completion remains unchanged.

It is understood and agreed that the adjustment provided herein constitutes compensation in full on behalf of the contractor and his subcontractors and suppliers, for all costs and mark-up directly and indirectly attributable to the change ordered herein, for all unchanged work including impact, for all delays related thereto and for performance of the changes within the time frame stated. Also, it is understood and agreed that the adjustment provided herein constitutes full and total settlement of the Contractors Claim submitted by letter dated 16 June 1988.

If the foregoing modification is acceptable, it is requested that you sign in Block 15B, complete Blocks 15A and 15C of the form and return the original to our Yatesville Field Office, ATTN: Kenneth E. Zimmerman.

12-04 CORRESPONDENCE

LETTERS

Date	Subject	Page
05 May 86	Approval of seismic unit and specialists....	S-1
13 May 86	Notice to proceed.....	S-2
20 May 86	Excavation plan.....	S-3
04 Jun 86	Temporary creek diversion.....	S-5
09 Jun 86	Slurry wall backfill.....	S-7
25 Jun 86	Fill for slurry wall & sheetpile install....	S-9
25 Jun 86	Fill for slurry wall & sheetpile install....	S-10
25 Jun 86	Slurry wall backfill.....	S-11
25 Jun 86	Slurry wall.....	S-12
30 Jun 86	Approval of temporary creek diversion.....	S-17
07 Jul 86	Acceptance of cofferdam cell fill.....	S-18
09 Jul 86	One stage const. of D/S slurry wall "VE"....	S-20
21 Jul 86	Amendments to slurry wall "VE".....	S-26
31 Jul 86	Diversion of Blaine Creek.....	S-29
22 Aug 86	Bentonite for slurry wall.....	S-30
03 Feb 87	30 deg. wye piling.....	S-34
10 Feb 87	Remedial work on spillway walls.....	S-35
10 Mar 87	Boulders during cofferdam construction.....	S-36
06 Apr 87	Electrical panels for dewatering wells.....	S-38
13 Apr 87	Boulders during cofferdam construction.....	S-39
15 Apr 87	Rock elevation at intake structure.....	S-40
24 Apr 87	Rock elevation at intake structure.....	S-41
21 Jul 87	Diversion of Blaine Creek.....	S-42
16 Sep 87	Notch in D/S diversion dike.....	S-45
23 Nov 87	Additional D/S grout line & explor. borings.	S-48
02 Dec 87	Foundation curtain grouting.....	S-52
04 Apr 88	Embankment removal for foundation treatment.	S-53
18 Apr 88	Embankment removal for foundation treatment.	S-54
18 Apr 88	Embankment removal for foundation treatment.	S-56
02 Aug 88	Deterioration of spillway walls.....	S-58
19 Aug 88	Removal of top 5' conc. cofferdam abutments.	S-59
12 Dec 88	Add. conc. for spillway incline leg found...	S-60
31 Aug 89	Acceptance of physical work.....	S-63

MEMORANDUM FOR RECORD - TRIP REPORTS

Date	Subject	Date
07 Aug 86	Slurry cutoff wall.....	S-64
07 Aug 86	Rock excavation at dam foundation.....	S-65
11 Aug 86	Slurry trench & dam foundation treatment....	S-66
29 Aug 86	Dewatering wells, slurry wall & rock excav..	S-69
23 Oct 86	Rock test fills and pits.....	S-70

MEMORANDUM FOR RECORD - TRIP REPORTS (cont)

Date	Subject	Page
14 Nov 86	Slurry trench & sheetpiling	S-71
15 Dec 86	Slurry trench & cofferdam cell fill	S-73
27 Feb 86	Sheetpiling, dewater. well panels & slides	S-74
05 Mar 87	Slides, dewatering well electrical panels	S-75
05 Aug 87	Spillway abutments & dam foundation	S-76
21 Sep 87	Dam foundation	S-80
25 Sep 87	Dam foundation	S-81
29 Sep 87	Broken zone & exploratory drilling	S-82
29 Sep 87	Broken zone in dam foundation	S-83
01 Oct 87	Exploratory drilling in broken zone	S-84
05 Oct 87	Broken zone in dam foundation	S-85
06 Oct 87	Broken zone in dam foundation	S-86
20 Oct 87	Broken zone in dam foundation	S-87
28 Oct 87	Foundation curtain grouting & broken zone	S-88
28 Oct 87	Dam found., left abutment & bench el. 635	S-90
28 Oct 87	Broken zone in dam foundation	S-91
29 Oct 87	Dam foundation, left abutment	S-98
03 Nov 87	Foundation curtain grouting & dam found	S-100
04 Nov 87	Foundation curtain grouting	S-101
16 Nov 87	Foundation curtain grouting	S-102
18 Nov 87	Foundation curtain grouting	S-105
01 Dec 87	Foundation curtain grouting	S-106
04 Dec 87	Foundation curtain grouting	S-107
14 Dec 87	Foundation curtain grouting	S-108
18 Mar 88	Dental concrete	S-109
19 Apr 88	Foundation treatment of water seepage	S-110
06 Apr 88	Dam foundation	S-112
18 Apr 88	Removal & treatment of 8" standpipe & shale.	S-113
18 Apr 88	Foundation treatment of shale seam	S-116
21 Apr 88	Foundation treatment of shale seam	S-117

May 5, 1986

Construction Division
Yatesville Lake

SUBJECT: Contract No. DACW69-86-C-0039, Construction of Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky - Seismograph Submittal and Resumes for Seismic Specialists

The Lane Construction Corporation
P.O. Box 566
Louisa, Kentucky 41230

Gentlemen:

Reference your proposal dated May 1, 1986 requesting using the safeguard seismic unit 1000 and the resumes for the two seismic specialists. Both are approved subject to satisfactory performance.

Sincerely,

RAY K. BOLEY
Resident Engineer
Authorized Representative of
the Contracting Officer

CF:
ORHSU
ORHCD
ORHCD-YBC, wd

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
502 EIGHTH STREET
HUNTINGTON, WEST VIRGINIA 25701-2070
May 13, 1986

YBC

REPLY TO
ATTENTION OF:
Procurement and Supply Division

RECEIVED
MAY 15 1986
LANE

Subject: Contract No. DACW69-86-C-0039 for Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky

NOTICE TO PROCEED

IN DUPLICATE

Lane Construction Corporation
965 East Main Street
Meriden, Connecticut 06450

Gentlemen:

This is your notice to proceed with the work under the above referenced contract.

Work under this contract must start within ten (10) calendar days and be completed and ready for use not later than eighteen hundred (1800) calendar days after the date of receipt of this notice to proceed.

It is requested that you acknowledge receipt of this notice to proceed in the spaces provided below, retain a copy and return a copy to this office. The date of acknowledgment is to be the date the notice to proceed was actually delivered and received by you.

Sincerely,

Robert B. Wilson

ROBERT B. WILSON
Colonel, Corps of Engineers
Contracting Officer

Receipt is acknowledged this 15th day of May 1986 of Contract No. DACW69-86-C-0039, Notice to Proceed.

LANE CONSTRUCTION CORPORATION

By J. W. Llewellyn

Title Vice President

MAY 1986
RECEIVED
Resident Engineer
Yatesville Lake

The

LANE

CONSTRUCTION CORPORATION

GENERAL OFFICE: MERIDEN, CONN. 06450

FIELD OFFICE
P.O. Box 566, Louisa, KY 41230

DATE
May 20, 1986

Mr. Ray K. Boley, Resident Engineer
Yatesville Resident Office
P.O. Box 1101
Louisa, KY 41230

Re: Excavation Plan
Contract DACW 69-86-C-0039
Letter No. YD014

Gentlemen:

Attached is our excavation plan for the above referenced project.

If you should have any questions or comments please contact the writer of our field office.

Very truly yours,

THE LANE CONSTRUCTION CORPORATION

J.O. Hughes
Superintendent

Encl.

cc: Meriden
HWR
JOH
RAH
DCW
File

RECEIVED
MAY 1986
Resident Engineer
Yatesville Lake

(S-3)

EXCAVATION PLAN

THE EXCAVATION PLAN OF OPERATIONS SHALL COMPLY WITH PARAGRAPH 2D-3, 3.1 AND 3.2 OF THE TECHNICAL CONTRACT REQUIREMENTS.

THE FIRST PHASE OF EXCAVATION SHALL CONSIST OF THE DIVERSION CHANNEL, DIVERSION DITCH, EAST AND WEST ABUTMENTS, PORTION OF DAM FOUNDATION TO APPROXIMATE ELEVATION 575', AND PORTION OF ROCK AND IMPERVIOUS BORROW AREA 1 AS NECESSARY FOR THE DIVERSION OF WATER THROUGH THE DIVERSION CHANNEL AND OUTLET WORKS.

THE SECOND PHASE OF EXCAVATION SHALL CONSIST OF EXCAVATING THE REMAINDER OF THE DAM FOUNDATION AND PORTIONS OF ROCK AND IMPERVIOUS BORROW AREA 1 AS NECESSARY TO CONSTRUCT THE DAM EMBANKMENT.

IN ALL CASES, STRIPPING OF THE OVERBURDEN WILL BE HELD TO A MINIMUM FOR THE ROCK AND IMPERVIOUS BORROW AREAS. THE WORK SHALL BE COORDINATED BETWEEN EXCAVATION AND EMBANKMENT CONSTRUCTION TO PROVIDE FOR MAXIMUM RECOVERY OF SUITABLE MATERIAL FOR INCORPORATION INTO THE EMBANKMENT AT APPROPRIATE TIMES. BLADED DRAINAGE DITCHES SHALL BE CONSTRUCTED PRIOR TO EXCAVATION OPERATIONS.

The

LANE

CONSTRUCTION CORPORATION

GENERAL OFFICE: MERIDEN, CONN. 06450

FIELD OFFICE

P.O. Box 566, Louisa, KY 41230

DATE.

June 4, 1986

Mr. Ray K. Boley, Resident Engineer
Yatesville Resident Office
P.O. Box 1101
Louisa, KY 41230

Re: Temporary Diversion of Blaine Creek
Through Existing Conduit
Contract No. DACW69-86-C-0039
Yatesville Lake Dam
Letter No. YD-029

Gentlemen:

Reference our Letter No. YD-024 and your telephone conversation of June 4, 1986 with our Mr. H.W. Reitz concerning the temporary diversion of Blaine Creek through the existing conduit.

Attached please find a sketch showing the approximate location of the temporary diversion dike that we propose to install in order to divert Blaine Creek through the existing conduit. The dike will have a 15 foot wide berm to elevation 585, and will have upstream and downstream slopes of 2 horizontal to 1 vertical.

After the temporary dike is constructed and water diverted through the tunnel, the permanent dike will be built to EL. 588. Once the diversion channel has been excavated below El. 580, the permanent diversion dike will be constructed to EL. 602.

If you have any questions or require more information on this matter, please contract our field office.

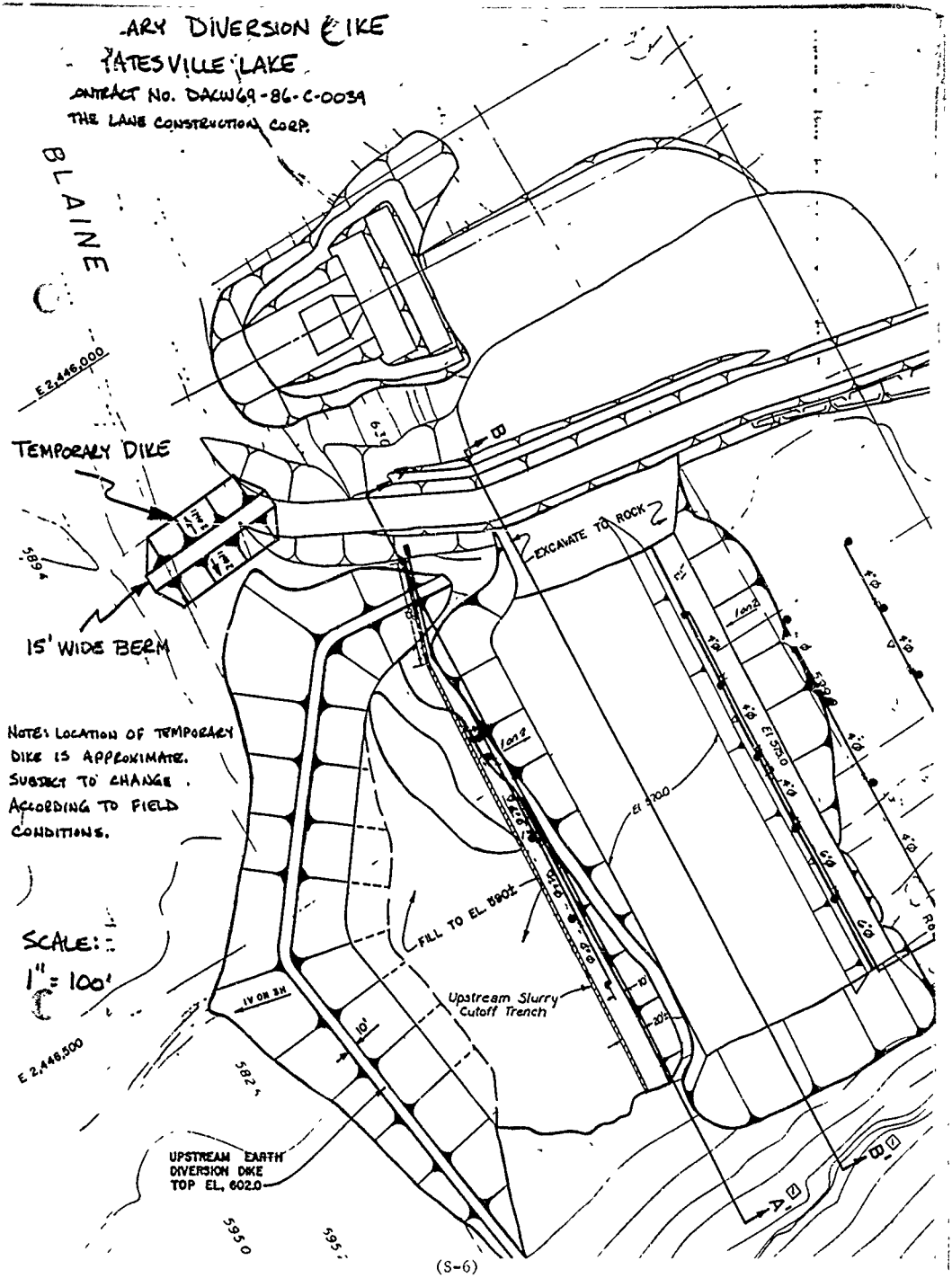
Very truly yours,

THE LANE CONSTRUCTION CORPORATION

J.O. Hughes
Superintendent

cc: Corps of Eng. (2)
Meriden
HWR
RAH
DCW
JOH
File

(S-5)


ARY DIVERSION DIKE
YATESVILLE LAKE
CONTRACT NO. DACW69-86-C-0039
THE LANE CONSTRUCTION CORP.
BLAINE
E 2,445,000
TEMPORARY DIKE
15' WIDE BERM
NOTE: LOCATION OF TEMPORARY DIKE IS APPROXIMATE. SUBJECT TO CHANGE ACCORDING TO FIELD CONDITIONS.
SCALE: 1" = 100'
E 2,446,200
EXCAVATE TO ROCK
EL 5750
EL 5700
FILL TO EL. 5802
Upstream Slurry Cutoff Trench
1V ON 3H
UPSTREAM EARTH DIVERSION DIKE TOP EL. 6020
5820
5950
5950

The

LANE

CONSTRUCTION CORPORATION

GENERAL OFFICE: MERIDEN, CONN. 06450

FIELD OFFICE

P.O. Box 566, Louisa, KY 41230

DATE

June 19, 1986

Mr. Ray K. Boley, Resident Engineer
Yatesville Resident Office
P.O. Box 1101
Louisa, KY 41230

RE: Coarse Material for
Slurry Wall Backfill
Contract No. DACW69-86-C-0039
Yatesville Lake Dam
Letter No. YD-040

Gentlemen:

Please find accompanying a sample of the coarse material that our subcontractors is proposing to use as part of the mixture for slurry wall backfill on the above referenced project for your approval.

Also attached is a gradation for the accompanying material, along with the material source.

If you require any more information or samples please contact our field office.

Very truly yours,

THE LANE CONSTRUCTION CORPORATION

J.O. Hughes

J.O. Hughes
Superintendent

cc: Meriden
HWR
RAH
JOH
File

RKB

McCLELLAND ENGINEERS, INC.
1744 Office Parkway
ST. LOUIS, MISSOURI 63141
(314) 569-0525

DATE 6/19/86	JOB NO.
PROJECT YATESVILLE DAM SLURRY WALLS	
LOCATION	
CONTRACTOR	OWNER
WEATHER	TEMP. °at AM °at PM
PRESENT AT SITE	

TO THE LANE CONST. CORP.
Route 1185, YATESVILLE LAKE DAM
LOUISA, KY. 41230

THE FOLLOWING WAS NOTED:

Attached is a bag of off-site material to be blended with on-site fines and bentonite to meet the required gradation band for the slurry trench backfill material.

the source of the material is: STANDARD SLAG
HAVER HILL PLANT, OHIO.

the gradation of the material, as tested by STANDARD SLAG at their HAVER HILL PLANT LAB is:

2" - 100%
3/4" - 100%
3/8" - 100%
#4 - 95%
#10 - 46%
#30 - 27%
#50 - 12%
#200 - 1.4%

If any additional information is required, please advise.

COPIES TO

FIELD REPORT

SIGNED

(S-8)

The

LANE

CONSTRUCTION CORPORATION

GENERAL OFFICE: MERIDEN, CONN. 06450

FIELD OFFICE

P.O. Box 566, Louisa, KY 41230

DATE

June 25, 1986

Mr. Ray K. Boley, Resident Engineer
Yatesville Resident Office
P.O. Box 1101
Louisa, KY 41230

Re: Embankment for Slurry Wall and
cofferdam installation
Contact No. DACW69-86-C-0039
Yatesville Lake Dam
Letter No. YD-046

Gentlemen:

Typical section A-A on sheet 52/17 of the contract drawings indicates methods for installation of the slurry wall and cellular cofferdam when excavation is required prior to commencing work. Typical sections on sheet 52/15 show similar details.

However, we have been unable to find the item of work and method of payment for the areas where embankment must be placed prior to the installation of the slurry wall or cellular cofferdam.

We suggest that either impervious or random fill be placed in these areas in order to accomodate the slurry wall and sheet piling installations.

Please advise.

Very truly yours,

THE LANE CONSTRUCTION CORPORATION

J.O. Hughes
Superintendent

cc: Meriden
HWR
RAH
WRH
JOH
File

June 25, 1986

Construction Division
Yatesville Lake

SUBJECT: Contract No. DACW69-86-C-0039, Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky - Classification of Fill Material

The Lane Construction Corporation
P.O. Box 566
Louisa, Kentucky 41230

Gentlemen:

As requested by your letter of June 25, 1986, classification of the fill material, not designated on the contract drawing, between the up stream diversion dike and the cellulor coffer dam is random backfill Item No. 33.

Sincerely,

RAY K. BOLEY
Resident Engineer
Authorized Representative
of the Contracting Officer

CF:
ORHSU
ORHCD
ORHCD-YBC,wd

ORHCD-YBC

25 June 1986

MEMORANDUM FOR RECORD

SUBJECT: Contract No. DACW69-86-C-0039, Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky - Slurry Wall Backfill

A sample of course material, submitted by the Contractor for use as a portion of the slurry wall backfill was examined and approved by Dan Boster, Jerry Phelps and Steve Hombeck, this date. Attached is a testing report on the material.

RAY K. BOLEY
Resident Engineer

Attach
as

CF:

ORHCD
ORHCD-YBC,wd

The

LANE

CONSTRUCTION CORPORATION

GENERAL OFFICE: MERIDEN, CONN. 06450

FIELD OFFICE: P.O. Box 566, Louisa, KY 41230

DATE: June 25, 1986

Mr. Ray K. Boley, Resident Engineer
Yatesville Resident Office
P.O. Box 1101
Louisa, KY 41230

RE: Slurry Cut-off Walls
Contract No. DACW69-86-C-0039
Yatesville Lake Dam
Letter No. YD-047

Gentlemen:

Reference your letter of June 24, and our meeting of June 25, 1986.

Attached you will find submittal information from our subcontractor, McClelland Services, Inc. for item 7, slurry cut-off walls on the above referenced contract.

If you have any questions on this matter please contact our field office.

Very truly yours,

THE LANE CONSTRUCTION CORPORATION

J.O. Hughes
Superintendent

cll

cc: Meriden
HWR
RAH
WRH
JOH
File

RECEIVED
JUN 1986
Resident Engineer
Yatesville Lake

SUBMITTALS FOR YATESVILLE DAM SLURRY CUTOFF WALLS

ITEM	SECTION	PAGE	SUBMITTAL
1	19.3	2C-27	Mr. Havis Dunn of Slurry Services International, Inc. (SSII) of Crossett, AR, will be the "Slurry Trench Specialist" while Pete Schuessler will be the "Mud Engineer" for this project. With their extensive experience and knowledge of slurry wall construction, Mr. Dunn and Mr. Schuessler will able to serve quite well in these capacities for a slurry wall project of this size. Mr. Dunn (see Attachment No. 1) has over 40 years of construction experience. He has specialized in slurry systems for groundwater control for the past 20 years. He is widely recognized in the construction and engineering professions as a pioneer and expert in the design and construction of slurry walls and cutoffs. Since 1975, Mr. Dunn has been President of SSII. Since he formed SSII the company has completed successfully about 25 projects ranging in size from $75,000 to $500,000. These projects included slurry cutoffs for temporary and permanent groundwater control forlocks, dams, pumping stations, hazardous waste confinements, and excavations for various structures. His involvement in these projects included estimating, planning, and in many cases direct supervision of construction. Attachment 1 is a list of slurry cutoff projects in which Mr. Dunn has participated as a consultant, construction supervisor, or contractor. Mr. Schuessler served as the "Mud Engineer" during construction of a slurry trench at Lock and Dam No. 13 on the Arkansas River.
2	21.1	2C-27	Sodium Bentonite for the slurry cutoff walls will be "Slurry Mud 90" supplied by Federal Ore & Chemicals, Inc. of Belle Fourche, SD. Attachment 2 is a sheet from the supplier showing its general properties. Test reports on the specific materials mined for this project will be shipped with the materials and will be furnished to the COE at that time.
3	21.2	2C-28	The slurry will be tested in compliance with the applicable parts of API Standard 13B.
4	21.4	2C-28	The soil-bentonite backfill will be mixed on site using the concrete batch plant currently on location. It will blend find materials from the site, coarse materials brought in and 5% bentonite mix such that the final mixture falls within the required gradation band.

SUBMITTALS FOR YATESVILLE DAM SLURRY CUTOFF WALLS

ITEM	SECTION	PAGE	SUBMITTAL
5	21.4	2C-29	Because the soil-bentonite backfill will be a mixture including on-site materials, we take exception to the requirement to furnish a 100-lb sample in advance. Gradation tests will be run on test batches to set up the concrete batch plant operation, and will be run at regular intervals thereafter (for each 500 cu ft of fill as specified in Sec 28.2.2/
6	22.1	2C-29	It is planned to excavate the slurry trenches using a large track-hoe, capable of full width and depth in a single pass.
7	22.5	2C-30	The slump of samples of the soil-bentonite backfill will be tested in general compliance with ASTM C143-78.
8	23.2	2C-30	Probing of the depth of the slurry trench will be accomplished with a 5-lb (or more) weight attached to the end of a 50-ft or 100-ft steel tape. The depth fo the slurry trench will be measured to within 0.1 ft, and will be translated to a known benchmark to obtain the elevation of the bottom of the slurry trench.
9	29.0	2C-33	At this time, Mirafi 600X is the intended geotextile to be used for treatment of the tip of the slurry cutoff walls.

SLURRY MUD 90

chemical name

Sodium Bentonite (Polymer Extended)

applications

Slurry Trench Cut-off Walls
Specific Industrial Application where a minimum 90 barrel yield material is required.

typical yield

Slurry Mud 90 will yield a minimum of 90 barrels of fluid to one ton of clay.

specifications

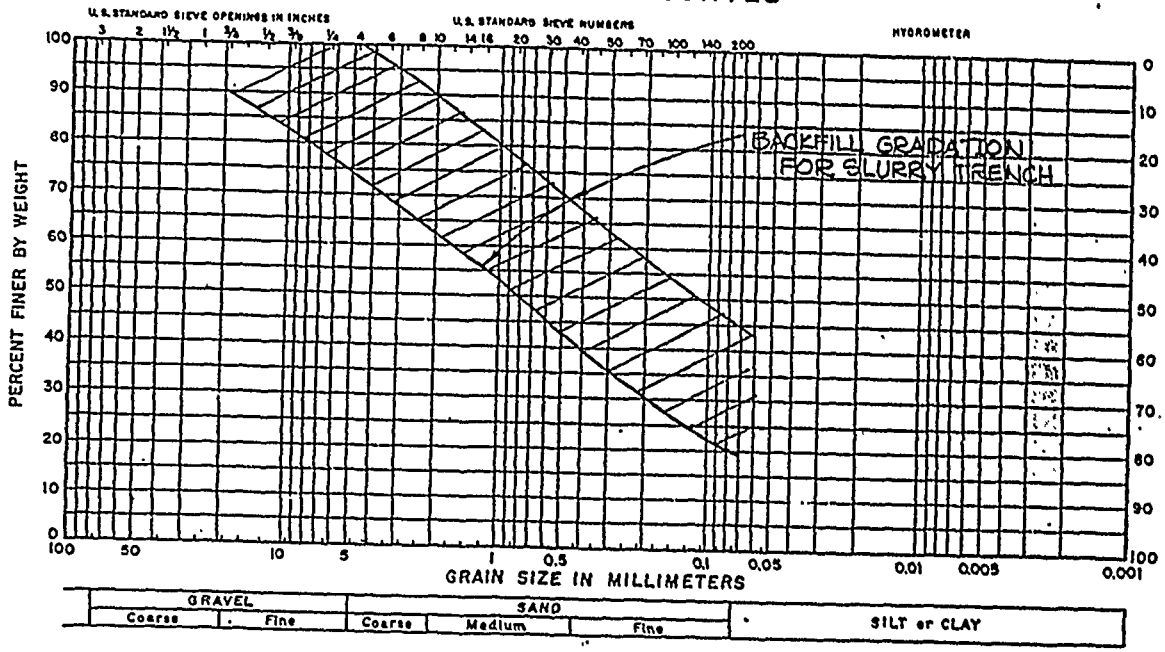
. Conforms to A.P.I. (American Petroleum Institute) specifications

	Typical Analysis	A.P.I. Specification
Fann 600 Reading	35.0 cps	30.0 cps min.
Fann 300 Reading	25.0 cps	
Plastic Viscosity	10.0 cps	
Yield Point (lb. per 100 sq. ft.)	15.0	3 × Plastic Vis. max.
Apparent Viscosity	17.5 cps	
Filtrate	13.5 ml.	15.0 ml., max.
Dry Screen Analysis (% Minus U.S. 200 Mesh)	80.0%	
Wet Screen Analysis (% Retained on U.S. 200 Mesh)	2.5–3.0%	4.0% max.
Moisture at time of shipment	7.0–9.0%	10.0% max.
pH	9.0–10.0	

To the best of our knowledge and belief, the above information is accurate. Because the conditions of handling and of use are beyond our control, we cannot guarantee results, and assume no liability for damages incurred in using our product. The above is not to be construed as a recommendation for use in violation of any patents or of applicable laws or regulations.

FEDERAL ORE & CHEMICALS, INC.
117 Fifth Avenue
Belle Fourche, SD 57717
A/C 605 892-2743

GRAIN SIZE CURVES



(S-16)

Attachment 4

SLURRY TRENCH BACKFILL GRADATION REQUIREMENTS

June 30, 1986

Construction Division
Yatesville Lake

SUBJECT: Contract No. DACW69-86-C-0039, Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky - Temporary Diversion of Blaine Creek

The Lane Construction Corporation
P.O. Box 566
Louisa, Kentucky 41230

Gentlemen:

This is to confirm verbal approval, given to Mr. Jim Hughes on June 17, 1986, of your plan to temporarily divert Blaine Creek through the outlet works. As agreed, after the diversion is complete the stilling basin will be dewatered, cleaned out, inspected, and repairs made, if necessary.

Sincerely,

RAY K. BOLEY
Resident Engineer
Authorized Representative of
the Contracting Officer

CF:
ORHSU
ORHCD
ORHCD-YBC,wd

July 7, 1986

Construction Division
Yatesville Lake

SUBJECT: Contract No. DACW69-86-C-0039, Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky - Bottom Ash

The Lane Construction Corporation
P.O. Box 566
Louisa, Kentucky 41230

Gentlemen:

The bottom ash, from Kentucky Power Company, you proposed for use as cell fill in your letter of May 16, 1986 and samples submitted with your letter of June 27, 1986 have been tested and is of acceptable quality.

The material is accepted as cell fill subject to the specified gradation requirements.

Sincerely,

RAY K. BOLEY
Resident Engineer
Authorized Representative of
the Contracting Officer

CF
ORHSU
ORHCD
✓ORHCD-YBC,wd

ORHED-DG (ORHCD-YBC/21 May 86) (32/COR-156)
SUBJECT: Contract No. DACW 69-86-C-0039, Dam & Appurtenant Works, Phase II, Yatesville Lake, KY - Proposed Source for Item 10 - Cell Fill

TO: ORHCD FROM: ORHED DATE: 24 Jun 86 CMT 3

Mr. Copher/law/5220 DD JWP

1. The material proposed for the cofferdam cells at Yatesville is a by-product of coal-fired generating plants and is known as "bottom ash." The material furnished to ORHED-GS and tested by ORDL was from the AEP facility near Louisa, Ky. The bottom ash sampled and tested appears to be predominantly glassy materials with a gradation approximating that of a "typical" concrete sand. The material tested was within gradation limits established by the specifications; however, data sheets furnished by Kentucky Electric Power for typical samples indicate variation in the -200 sieve size that extends outside the range allowed in the specifications. Consequently, in terms of gradation, the material may have to be processed or blended to meet the gradation requirements.

2. Because a "natural" material was considered when the specifications were being written and during the design phase, the rather low specific gravity of the bottom ash was of concern. The natural Gs would have been in the range of 2.7± but the proposed bottom ash has a Gs of approximately 2.2. Structural Section of Design Branch investigated the effect of this lower Gs on cell stability by using a cell-fill dry weight of 80 PCF. The assessment of the material with respect to this concern is that the weight of the material is not critical, provided it is within that range that would be expected for Gs = 2.2±, and further, that the angle of internal friction (Ø) remains at or above 30°.

3. In order to evaluate the angle of internal friction of this material, a direct-shear "s" test was performed at ORDL. The material was tested in a loose state to simulate the limited compaction as allowed in the specifications. Normal pressures were appropriate for a range of pressure from just below the material surface to approximately 60 feet of depth. The single s-test, consisting of three points, indicates that the Ø parameter is 37° and that the C parameter is 0 psi. This result appears consistent with the gradation and expected drainage characteristics and should be valid for the loading conditions expected.

4. It is therefore concluded that this type material is acceptable as long as the specified gradation is maintained.

CHARLES E. VANDEVELDE
Chief, Engineering Division

The
LANE
CONSTRUCTION CORPORATION
965 EAST MAIN STREET
MERIDEN, CT 06450 203-235-3351
DISTRICT MANAGERS D M. CROSS D E EDFORS J P GENTILE F A HEALY D L. KENTZEL D A. McCRAE H W REITZ T M. RUSH

July 9, 1986

Mr. Ray K. Boley, Resident Engineer
Yatesville Resident Office
P.O. Box 1101
Louisa, KY 41230

Re: Value Engineering Contracting Proposal
Yatesville Lake Dam
Contract No. DACW69-86-C-0039
Letter No. YD-055

Gentlemen:

Attached is a proposal from McClellan Services, Inc. to install the slurry wall in one stage construction on the referenced contract.

In addition to McClellan's proposal we propose to cap the slurry trench in the diversion channel side and bottom slope with stone slope protection 12 ft. wide by 2 ft. deep to prevent erosion and possible damage to the integrity of the slurry wall, while Blaine Creek flows through the diversion channel. Prior to placement of the impervious material in the diversion dike the slope protection will be removed.

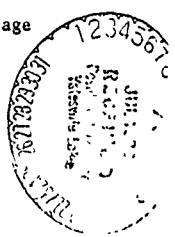
In accordance with FAR 52.248-3 we request your approval of the technical aspects of the proposal, even though an agreement on price reduction has not been reached, by issuing a notice to proceed with the change.

You can be assured that:

1. The government will not incur any additional costs because of implementation of this approval.

2. The government will realize a reduction in the contract price by an instant contract savings.

3. The government may realize "Collateral Savings" by one stage construction of the slurry wall.



We request your response to this proposal prior to 25 August 1986. Also this proposal was previously alluded to in our Letter No. YD-032 dated June 9, 1986. However per your letter of 24 June 1986 the phasing changes from the specified procedures are being submitted separately.

Your favorable response to this proposal will be appreciated.

Very truly yours,

THE LANE CONSTRUCTION CORPORATION

H.W. Reitz
District Manager

cll

Attach: McClellan 7/3/86

cc: Meriden
McClellan
HWR
RAH
JOH
File

McClelland services, inc.
GEOTECHNICAL CONSTRUCTION SERVICES
1601 Dielman Road, P. O Box 28232
St. Louis, Missouri 63132, (314) 993-1463

July 3, 1986

CC. MERIDEN
AWR
RAN
JOH

The Lane Construction Corporation
Post Office Box 566
Louisa, Kentucky 41230

Attention: Mr Jim Hughes, Project Superintendent

Subject: Value Engineering Change Proposal
Yatesville Dam Slurry Cutoff Walls
Contract No. DACW69-86-C-0039

Gentlemen:

This value engineering change proposal is being submitted for evaluation of its technical acceptability. We will submit a cost estimate separately.

The existing contract, with reference to the construction of the slurry cutoff walls, requires the following general construction sequence on Drawings 019C-YBC-9-52/6 and -52/7.

STAGE I

1. Excavate diversion channel.

2. Excavate diversion ditch.

STAGE II

1. Divert Blaine Creek through diversion channel.

2. Place upstream fill to El 590, construct upstream slurry cutoff wall, and construct a segment of the downstream slurry cutoff wall.

STAGE IV

1. Construct intake structure to El 619 (min) and place stone slope protection.

STAGE V

1. Divert Blaine Creek through diversion tunnel.

2. Construct the remaining segment of the downstream slurry cutoff wall.

RECEIVED
JUL 7 1986
YATESVILLE

The proposed contract revisions will allow construction of the slurry cutoff walls in plan as specified with the following modification to the general construction sequence relative to the slurry cutoff wall installation shown on Drawings 019C-YBC-9-52/6 and -52/7:

STAGE I

1. Construct intake structure to El 619 (min) and place stone slope protection.

2. Excavate the diversion channel and ditch as shown, leaving a plug of natural materials in the downstream end, similar to the downstream plug to be placed later. A smaller dike will be left or placed in the upstream end of the channel such that the flow in Blaine Creek will be diverted through the diversion tunnel.

STAGE II

1. Place upstream fill to El 590, construct the upstream slurry cutoff wall, then construct all segments of the downstream slurry cutoff wall.

2. Excavate the downstream plug to the depth and lines shown for the diversion channel, thus excavating with the plug a portion of the downstream slurry cutoff wall. The upstream dike will then be removed such that the creek flow is diverted through the diversion channel as planned.

STAGE V

1. After the Stage V downstream dike has been installed in the diversion channel, that portion of the slurry wall which was excavated out of the channel in Stage II will be reinstalled in a manner similar to that previously utilized. Caution will be exercised during the installation to insure that the old and new slurry wall segments overlap sufficiently to form an adequate seal.

The proposed construction sequence revisions will eliminate a significant part of the remobilization which would have been required to install the Stage V segment of the downstream slurry cutoff wall, and will result in a reduction in cost to the Government. The sequence changes will impose some additional risks to the contractor, in that if a major flood occurs while the diversion channel is temporarily plugged such that the diversion tunnel will not pass the flow, the upstream plug will be breached, and the Stage V branch of the slurry cutoff wall will have to be repaired.

RECEIVED
JUL 7 1986
YATESVILLE

The proposed modification of the general construction sequence relative to the slurry cutoff wall installation will require the previously noted revisions as well as those listed below:

1. Drawing No. 019C-YBC-9-52/6

   STAGE I - The drawing should be changed to show temporary upstream and downstream plugs in the diversion channel and an upstream plug in Blaine Creek.

   STAGE II - The drawing should be changed to show the temporary upstream and downstream plugs in the diversion channel as in Stage I above; and the branch of the downstream slurry wall, which had originally been scheduled for installation during Stage V, should be displayed in the Stage II drawing.

   STAGE III - The drawing should be changed to show all of the segments of the downstream slurry wall completed.

   STAGE IV - Same changes as in Stage III.

2. Drawing No. 019C-YBC-9-52/20

   a. The words "centerline Phase V cutoff dike and slurry wall, top El 589.0" should be change to read "centerline branch of downstream slurry wall and Phase V cutoff dike, top El 589.0".

   b. The words "branch of Phase II slurry wall (to tie into Phase V slurry wall)" should be changed to read "Branch of downstream slurry wall".

   c. The words "centerline Phase II slurry wall and diversion dike" should be changed to read "centerline downstream slurry wall and diversion dike".

3. Drawing No. 019C-YBC-9-10/74

   a. The words "end of Phase I slurry wall" should be changed to read "end of downstream slurry wall".

   b. The words "0+00 continuation of Phase I slurry wall = beginning of branch of Phase II slurry wall at 4+30" should be changed to read "0+00 continuation of downstream slurry wall = beginning of branch of downstrean slurry wall at 4+30".

RECEIVED
JUL 7 1986
YATESVILLE

4. Drawing No. 019C-YBC-9-10/75

   a. The words "end of Phase V cutoff dike and Phase II slurry wall" should be changed to read "end of branch of downstrean slurry wall and Phase V cutoff dike".

   b. The words "end of branch of phase II slurry wall - begin cutoff dike - begin Phase II slurry wall" should be changed to read "begin cutoff dike".

   c. The words "begin branch of Phase II slurry wall" should be changed to read "begin branch of downstream slurry wall".

   d. The words "begin Phase I and II slurry wall" should be changed to read "begin downstream slurry wall".

Implementation of this VECP will result in no additional costs incurred by the Government for such items as test and evaluation costs and operating and support costs. Additionally, the Government's collateral costs will not be affected. A contract modification accepting this VECP should be issued as soon as possible to allow the immediate implementation of this proposal by the contractor, who is scheduled to begin the slurry wall installation on or about July 21, 1986. Should delays be encountered in implementing this proposal, the cost reduction to the Government could be lost since the slurry wall construction phase is expected to last only 6 weeks. Acceptance of this proposal will not lengthen the contract completion time.

Sincerely,

McCLELLAND SEVICES, INC

G Richard Bird, PE
President

SAM:GRB:klg

McClelland services, inc.

GEOTECHNICAL CONSTRUCTION SERVICES
1601 Dielman Road, P. O. Box 28232
St. Louis, Missouri 63132, (314) 993-1463

JULY 21, 1986

THE LANE CONSTRUCTION CORPORATION
POST OFFICE BOX 566
LOUISA, KENTUCKY 41230

ATTENTION: MR. JIM HUGHES, PROJECT SUPERINTENDENT

SUBJECT: AMENDMENTS TO VALUE ENGINEERING CHANGE PROPOSAL
YATESVILLE DAM SLURRY CUTOFF WALLS
CONTRACT No. DACW69-86-C-0039

GENTLEMEN:

LISTED BELOW ARE AMENDMENTS TO OUR VALUE ENGINEERING CHANGE PROPOSAL. ATTACHED IS A COPY OF OUR ORIGINAL V.E.C.P. DATED JULY 3, 1986.

PAGE 1

— DELETE: STAGE IV 1. CONSTRUCT INTAKE... PROTECTION.

PAGE 2

— DELETE FROM STAGE I : 1. CONSTRUCT INTAKE... PROTECTION.

— CHANGE THE STAGE I ITEM No. 2 TO ITEM No. 1.

— DELETE FROM STAGE V 1. AFTER THE... ADEQUATE SEAL.

AND INSERT:

JUST BEFORE THE STAGE V DOWNSTREAM DIKE IS TO BE INSTALLED IN THE DIVERSION CHANNEL, THE SURFACE OF THAT PORTION OF THE SLURRY WALL WHICH WAS EXCAVATED OUT OF THE CHANNEL IN STAGE II WILL BE CLEANED OUT TO FULLY EXPOSE THE SLURRY WALL BACKFILL IN THE DIVERSION CHANNEL. THAT PORTION OF THE SLURRY WALL WILL THEN BE CAPPED WITH THE MIXTURE OF BENTONITE, SAND, AND CRUSHED ROCK STIPULATED ON PAGE 2C-33, SECTION 29 OF THE TECHNICAL SPECIFICATIONS. CAUTION SHALL BE EXERCISED TO INSURE THAT CONTINUOUS SEALS ARE FORMED WITH THE EXISTING SLURRY WALL CAPS ON EITHER SIDE OF THE DIVERSION CHANNEL. THE IMPERVIOUS DOWNSTREAM DIKE WILL THEN BE CONSTRUCTED ON TOP OF THE SLURRY WALL IN THAT AREA.

— IN THE FIRST SENTENCE OF THE PARAGRAPH FOLLOWING STAGE V, DELETE THE WORDS...A SIGNIFICANT PART OF...

McClelland services, inc.

ACCEPTANCE OF THE AMENDED VALUE ENGINEERING CHANGE PROPOSAL WILL RESULT IN THE INSTANT CONTRACT SAVINGS DETAILED BELOW:

MOBILIZATION — DEMOBILIZATION

KOEHRING 1266 EXCAVATOR		
DISASSEMBLE AND ASSEMBLE	(TWICE)	= $11,400
HAULING	(TWICE)	= 12,000
CRANES FOR ASSEMBLY AND DISASSEMBLY	(TWICE)	= 12,000
MISC. HAULING (PUMPS, PARTS, ETC.) ST. LOUIS TO JOB		
$1.00/MILE/LOAD × 450 MILES × 2 LOADS	(TWICE)	= 1,800
SET UP AND DISASSEMBLE EQUIPMENT		
3 MEN × 3 DAYS × $175/MAN/DAY	(TWICE)	= 3,150
EQUIPMENT: 3 DAYS × $250/DAY	(TWICE)	= 1,500
INSTANT CONTRACT SAVINGS		= $41,850

IF YOU HAVE ANY QUESTIONS REGARDING THIS AMENDED V.E.C.P., PLEASE DO NOT HESITATE TO CALL.

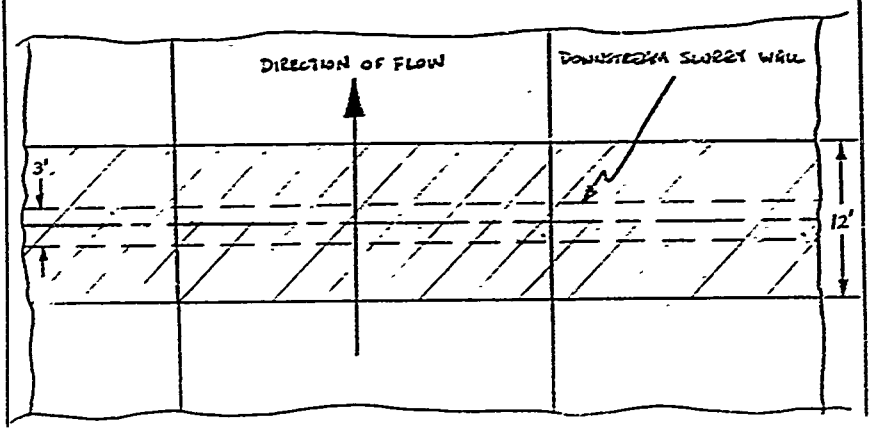
VERY TRULY YOURS,

McCLELLAND SERVICES, INC.

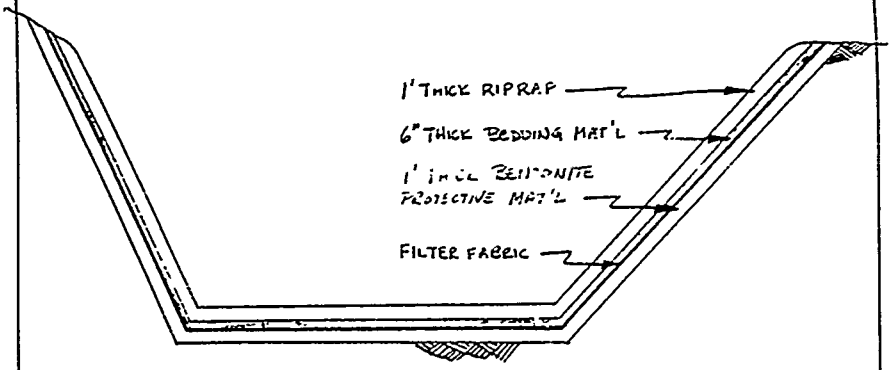
Scott A. Matthews

FOR G. RICHARD BIRD, PE
PRESIDENT

PROPOSED DIVERSION CHANNEL PROTECTION OF DOWNSTREAM SLURRY WALL. PROTECTIVE LAYER COMPOSED OF THREE MATERIALS, TOTAL OF 2.5' THICK, 12' WIDE, CENTERED ON DOWNSTREAM SLURRY WALL.



PLAN



ELEVATION

SCALE: 1" = 10'

YATESVILLE LAKE DAM
CONTRACT: DACW69-86-C-0059

THE LANE CONSTRUCTION CORP.

DISPOSITION FORM

For use of this form, see AR 340-15; the proponent agency is TAGO.

REFERENCE OR OFFICE SYMBOL	SUBJECT
02ECD-YBC	Contract No. DACW69-86-C-0039, Dam & Appurtenant Works, Phase II Yatesville Lake, KY - Revised Contractor Value Engineering Proposal

TO: 02ECD | FROM: 02ECD-YBC | DATE: 31 July 1986 | CMT 1

Boley/mva

1. Attached is the Contractor's revised Value Engineering Proposal for performing the slurry trench work in one mobilization.

2. The Contractor proposes while Blaine Creek is diverted thru the outlet works to construct all slurry walls shown on the drawings. After the Stage V Section is installed the Contractor proposes to excavate the plug from the diversion channel and protect the slurry wall exposed in the channel in accordance with his sketch. After the intake is completed to elevation 619 and Blaine Creek is diverted thru the outlet works the slurry wall would be exposed and the inpervious dike would be constructed across the channel.

Ray K. Boley

RAY K. BOLEY
Resident Engineer

Attach
as

(S-29)

DA FORM AUG 80 2496 PREVIOUS EDITIONS WILL BE USED

The

LANE

CONSTRUCTION CORPORATION

GENERAL OFFICE: MERIDEN, CONN. 06450

FIELD OFFICE: P.O. Box 566, Louisa, KY 41230

DATE: August 22, 1986

Mr. Ray K. Boley, Resident Engineer
Yatesville Resident Office
P.O. Box 1101
Louisa, KY 41230

Re: Bontonite Certifications
Contract No: DACW69-86-C-0039
Yatesville Lake Dam
Letter No. YD-078

Gentlemen:

Attached you will find four copies each of the laboratory test results and supplier's certification for bentonite that will be used in construction of the slurry cut-off walls on the above referenced project.

We hope this meets with your approval.

Very truly yours,

THE LANE CONSTRUCTION CORPORATION

J.O. Hughes
Superintendent

clb

cc: MERIDEN
HWR
RAH
WHH
JOH
FILE

AUG 1986

LETTER OF TRANSMITTAL

McClelland services, inc.

RECEIVED AUG 2 1986

TO: The Lane Construction Corporation
Post Office Box 566
Louisa, Kentucky 41230

FROM: McClelland Services, Inc.
1601 Dielman Road
P.O. Box 28232
St. Louis, Missouri 63132
(314) 993-1463

ATTENTION: Mr Jim Hughes, Project Superintendent

Re: Yatesville Dam Slurry Walls

Date: August 19, 1986
Your Job No.: DACW69-86-C-0039
Our Job No.: 03860224

We are sending you, ☒ herewith ☐ separately, via _____ the following items: ☐ _____

☐ Reports ☐ Prints ☐ Boring Logs ☐ Specifications ☐ Calculations ☐ Copy of Letter

Copies	Date or Number	Description
4		Bentonite Certification and laboratory analysis for Rail Car CNW 169071

These are transmitted:

☐ As Requested
☐ As Requested By: _____
☐ For Your Information and Use
☐ For Your Action
☐ For Your Files
☐ For Approval
☐ For Review and Comment
☐ As a Correction to Our Report, Dated _____
☐ Resubmit _____ Copies for Approval
☐ Submit _____ Copies for Distribution
☐ _____
☐ Returned After Loan to Us
☐ Please Return

cc: Scott Matthees
Project Supervisor

Remarks:

Signed G. Richard Bird, President

☐ Reply Requested

FEDERAL ORE & CHEMICALS, INC.

117 Fifth Avenue
Belle Fourche, SD 57717
A/C 605 892-2743

LABORATORY ANALYSIS

DATE TESTED: 8-12-86

SOLD TO: McClelland

SHIP TO: Charleston, WV

SHIP DATE	RAIL CAR OR TRUCK NUMBER	PLANT OF ORIGIN	TYPE OF MATERIAL
8-12-86	CNW 169071	Colony	7.27.(

NOTE: Our data for the above shipment shows the following test results:

LABORATORY TEST RESULTS		LABORATORY TEST RESULTS	
1 Fann 600	41	7	
2 Fann 300	28	8	
3 H_2O	50	9	
4 Filtrate	13.8	10	
5 Barrel Yield	103	FEDERAL BENTONITE	
6		SIGNED	Bud Fagel

Should you have any questions or require additional information please let us know.

CUSTOMER COPY

FEDERAL BENTONITE

McClelland Engineers
P.O. Box 28232
St. Louis, MO 63132

Date: 8-12-86

REFERENCE: McClelland Project, T.B.S. Terminal, Charleston, WV

SUBJECT: Certification of Material Specification

TRUCK NUMBER/NAME: CNW 161071

Having reviewed Materials Specification, Section 13A, Eighth Edition, American Petroleum Institute, in its entirety, Federal Bentonite has conformed to all test data requirements for Slurry Mud® 90 sodium bentonite.

CHEMICAL ANALYSIS: A layered silicate mineral typically represented by the following formula:

$$(Al_{1.63}\ Fe_{.17}\ Mg_{.25})\ (Al_{.07}\ Si_{3.93})\ O_{10}\ (OH)_2\ (Na_{.24}\ Ca_{\frac{2}{2}}\ .04)$$

LABORATORY TEST RESULTS

		TEST DATA
1.	Fann 600 (Initial)	40
2.	Fann 300 (Initial)	24
3.	H_2O	10
4.	Filtrate	*
5.	Barrel Yield	Minimum - 90

This information and data contained herein are believed correct when the recommended material is applied in accordance to the lines, grades, and cross sections as indicated and approved by the Design Engineer. We do not warrant by implication or expressly the accuracy thereof. In presenting uses for this product, no attempt has been made to discuss applicable limited warranties, expressed or implied.

Very truly yours,

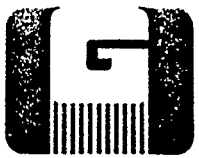
Donald Hentz

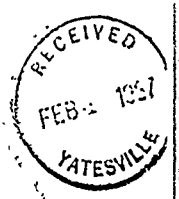
Manager, Technical Services

DH:MLJ/ra

* Filtrate Data will be given with aged results.

(S-33)





February 3, 1987

LANE CONSTRUCTION CORPORATION
Yatesville Dam Field Office
P.O. Box 566
Louisa, Kentucky 41230

Attn: Mr. Bob Housel

RE: Yatesville Lake Dam
Contract DACW69-86-C-0039
Sheet Pile Cofferdams

Gentlemen:

This letter replaces our letter dated July 28, 1986 concerning the extra plate on the sheet pile Wyes.

Our shop drawing number 8632-1 was returned to us with a note to add a 1/2" x 14" plate to the back of the 30 Deg. Wyes. We made this change and resubmitted our shop drawing per your request.

This plate is not shown on the contract drawings and therefore we did not include its cost in our bid. We feel this plate should be an extra to our contract.

This plate adds 38,794 lbs. at an average unit cost to us of $82.57/CWT for the lengths ordered, for a total cost increase of $32,032.00. This is the price we must pay Bethlehem Steel and includes the plate material, cutting and drilling the plate, welding the plate to the sheet piles, and freight to the job site.

We hereby request an extra to our contract of $32,032.00 to cover the cost of this extra plate.

Your attention to this matter is greatly appreciated. If you have any questions, please contact the writer.

Very truly yours,

RICHARD GOETTLE, INC.

William S. Heckman

William S. Heckman
Project Manager

WSh/rw

cc: MERIDEN
NWR
TOH
RAH

February 10, 1989

Construction Division
Yatesville Lake

SUBJECT: DACW69-86-C-0039, Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky

The Lane Construction Corporation
Post Office Box 566
Louisa, Kentucky 41230

Gentlemen:

Reference is made to my letter dated September 23, 1988, requesting a proposal for performing remedial work on the Spillway Walls and your proposal dated October 12, 1988 for this work.

It has been determined that this work will not be prosecuted at this time; therefore no negotiation for this work will be conducted.

Your participation in the submittal of a cost proposal for the proposed work is appreciated.

Sincerely,

Kenneth E. Zimmerman
Resident Engineer
Authorized Representative of
the Contracting Officer

Copy Furnished:

The Lane Construction Corporation
965 East Main Street
Meriden, Connecticut 06450
CEORH-CT
CEORH-CD
CEORH-CD-YBC, wd

March 10, 1987

Construction Division
Yatesville Lake

SUBJECT: Contract No. DACW69-86-C-0039, Construction Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky - Boulders or Rocks Encountered in Pile Driving Operations

Lane Construction Corporation
P.O. Box 566
Louisa, Kentucky 41230

Gentlemen:

In regard to your letter number YD-119 claiming Differing Site Conditions for large rock encountered in driving piling for cellular cofferdam, the following is referenced.

1. Specifications - Division 2, Section 2C, Paragraph 2.2.1.1 "The existence of some gravel, cobbles, boulders, and float rock must be anticipated and reckoned with in constructing the slurry cutoff walls, installing the dewatering and predrainage wells and driving the sheet piling for the cellular cofferdam."

2. Specification - Division 2, Section 2E, Paragraph 11.2.1 "should obstructions restrict driving a piling to the specified penetration, they should be removed or penetrated with a chisel beam. If the Contractor demonstrates that removal or penetration is impractical, he shall make such changes in design alignment of the piling structure as directed by the Contracting Officer to insure adequacy and stability of the structure."

The Specifications indicate the existence of cobbles and boulders and also indicated procedures for when they are encountered in the pile driving operation. These procedures were actually used in the installation procedure.

I therefore, deny any entitlement to additional costs, but you may appeal this decision by a request to the Contracting Officer for his decision.

Sincerely,

RAY K. BOLEY
Resident Engineer
Authorized Representative of
the Contracting Officer

CF:
ORHCT
ORHCD
ORHCD-YBC, wd

dcc

DISPOSITION FORM

ORHED-DG

SUBJECT: Modification of Contract No. DACW69-86-C-0039, Construction of Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky

TO ORHCD FROM ORHED DATE 6 Apr 87 CMT 1
Mr. Copher/5220

1. It is requested that the subject contract be modified to raise the elevations of the electrical panels for the dewatering wells upstream of the cofferdam. These electrical panels should be located at or above elevation 619. This should be accomplished by running a buried cable to the nearest intersection of cofferdam cell and connecting arc. The cable should then be housed in a conduit and run to the top of the cofferdam. The electrical panel should be placed on a 2-inch steel post at a convenient height for reading. The post should be put in a sleeve in the concrete for easy removal during overflow. All cable and electrical connections should be waterproof.

A safety cable should be constructed to the panels by placing similarly removable steel posts in sleeves in the concrete with a 1/2-inch cable connecting the posts. The posts should be spaced on 50' centers.

2. This modification is a result of the 6 November 1986 Safety Meeting held at the job site and is necessary in order to provide continuous operation of the dewatering wells during flood events in Construction Stages IV and V. In the event of overtopping of the cofferdam, the panels and safety cable can be removed to prevent collection of drift.

3. Any contract drawings affected by this change should be corrected on "As Constructed" Drawings.

CHARLES E. VANDEVELDE, P.E.
Chief, Engineering Division

CF:
ORHED-B
ORHED-GS

WADDELL ED-D
Everson DC
NIDA GU
PAVIK PB
RIDDLE ED-B
VANDEVELDE ED

April 13, 1987

Construction Division
Yatesville Lake

SUBJECT: Contract No. DACW69-86-C-0039, Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky - Sheet Piling

The Lane Construction Corporation
Post Office Box 566
Louisa, Kentucky 41230

Gentlemen:

In response to your letter number YD-119-2, dated April 2, 1987 the following is referenced:

Specification Section 2E, Paragraph 11.2.1 states: "Should obstructions restrict driving a piling to the specified penetration, they should be removed or penetrated with a chisel beam. If the Contractor demonstrates that removal or penetration is impractical, he shall make such changes in design alignment of the piling structure as directed by the Contracting Officer to insure the adequacy and stability of the structure."

The restrictions encountered were actually removed from the piling alignment by excavating as indicated in the above specification.

The excavation referred to in your letter is the excavation referred to in the Specification, Section 2E, Paragraph 3., which covers the excavation to planned line and grades.

Therefore, my decision issued in my letter dated March 10, 1987 (copy attached) is unchanged.

The
LANE
CONSTRUCTION CORPORATION
965 EAST MAIN STREET
MERIDEN, CT 06450 203 235 3351

DISTRICT MANAGERS D. M. CROSS D. E. EDFORS J. P. GENTILE F. A. HEALY D. L. KENTZEL D. A. McCRAE H. W. REITZ T. M. RUSH

April 15, 1987

Mr. Ray K. Boley Resident Engineer
Yatesville Resident Office
P.O. Box 1101
Louisa, KY 41230

Re: Intake structure base slab exterior formwork
Contract No. DACW69-86-C-0039
Yatesville Lake Dam
Letter No. YD-150

Gentlemen:

Contract Drawings - YBC-9-5261/34 and 35 indicate that the intake tower base slab up to elevation 575.00 is to be placed against existing rock surfaces.

Since the rock lines shown on the drawings do not exist in the field, we request that a modification be prepared to compensate The Lane Construction Corporation for the cost of forming the exterior surface below elevation 575.

Please advise.

Very truly yours,

THE LANE CONSTRUCTION CORPORATION

H.W. Reitz
District Manager

clb

cc: MERIDEN
HWR
JOH
RAH
WHH
FILE

EQUAL OPPORTUNITY EMPLOYER

April 24, 1987

Construction Division
Yatesville Lake

SUBJECT: Contract No. DACW69-86-C-0039, Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky - Intake Structure Base Slab Exterior Formwork

The Lane Construction Corporation
Post Office Box 566
Louisa, Kentucky 41230

Gentlemen:

As requested by your letter number YD-150 dated April 15, 1987, a review of the rock elevation for the intake structure lift from elevation 570 to 575 is lower than indicated in the contract drawings and will require forming.

Request that you submit a price proposal for forming the perimeter from the top of rock to elevation 575. Your proposal for the work should be submitted in accordance with applicable contract requirements by May 8, 1987.

Sincerely,

RAY K. BOLEY
Resident Engineer
Authorized Representative of
the Contracting Officer

CF:
ORHCT
ORHCD
ORHCD-A (Sheldon)
ORHCD-YBC, wd

The

LANE

CONSTRUCTION CORPORATION

GENERAL OFFICE: MERIDEN, CONN. 06450

FIELD OFFICE: P.O. Box 566, Louisa, KY 41230

DATE: July 21, 1987

Mr. Ray K. Boley, Resident Engineer
Yatesville Resident Office
P.O. Box 1101
Louisa, KY 41230

Re: Diversion Sequence Schedule
Contract No. DACW69-86-C-0039
Yatesville Lake Dam
Letter No. YD-181

Gentlemen:

As per your conversation with the writer on Thursday, July 16, 1987, attached is the sequence of operations and dated bar chart for the diversion of Blaine Creek through the intake structure and tunnel on the above referenced job for your approval.

If you have any questions concerning this schedule, please contact our field office.

Very truly yours,

THE LANE CONSTRUCTION CORPORATION

J.O. Hughes
Superintendent

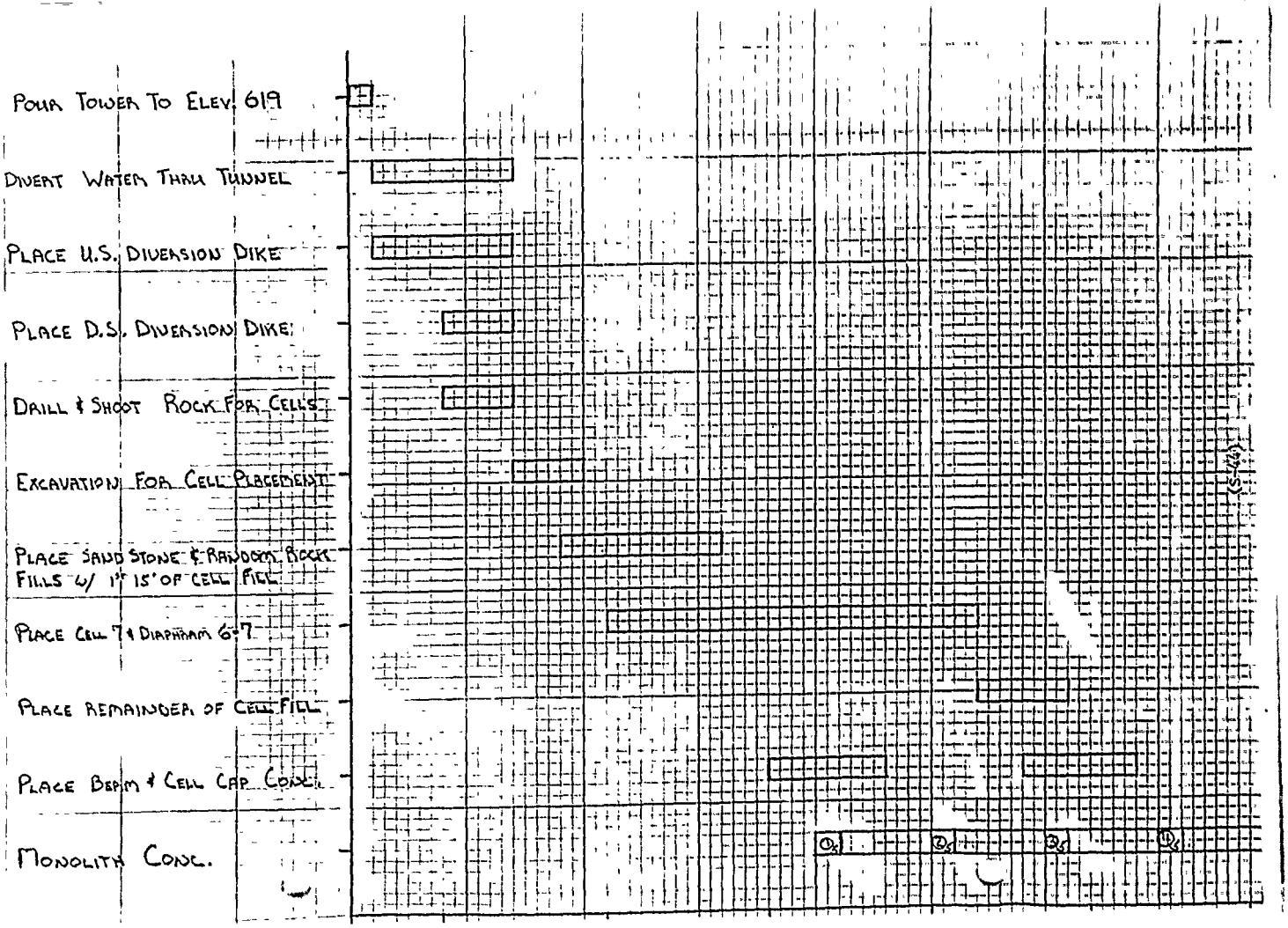
clb

cc: MERIDEN
HWR
JOH
RAH
FILE

Sequence of Work

1. Pour tower to elev. 619
2. Divert water through outlet works
3. Place upstream and downstream diversion dikes
4. While placing diversion dikes drill rock for cell placement
5. After upstream dike is placed to elev. 602 and downstream dike is placed to 589, shoot rock drilled in Step 4
6. Excavate rock and earth in area of cell placement to elev. 574
7. Place sandstone, random rock and cell fill to elev. 589 in appropriate areas.
8. Install cell 7 and diaphram 6-7 through 15' of cell fill previously placed
9. Place downstream slope berm on all areas except those that tie to cells while cells are being installed
10. After cell 7 has been installed and seated start monoliths on bottom 15 feet which already has backfill material in it
11. After cell 7 and diaphram 6-7 are installed complete cell fill
12. Continue monolith placement as cells are filled
13. Place cell cap concrete and remainder of berm concrete

The above work shall be completed using extended work day, 6 days a week and a double shift where necessary.


POUR TOWER TO ELEV. 619
DIVERT WATER THRU TUNNEL
PLACE U.S. DIVERSION DIKE
PLACE D.S. DIVERSION DIKE
DRILL & SHOOT ROCK FOR CELLS
EXCAVATION FOR CELL PLACEMENT
PLACE SAND STONE & RANDOM ROCK FILLS W/ 1' IS' OF CELL FILL
PLACE CELL 7 & DIAPHRAM 6-7
PLACE REMAINDER OF CELL FILL
PLACE BEAM & CELL CAP CONC.
MONOLITH CONC.

DISPOSITION FORM

For use of this form, see AR 340-15; the proponent agency is TAGO.

REFERENCE OR OFFICE SYMBOL	SUBJECT
CEORH-ED-DG	Modification of Contract No. DACW69-86-C-0039 Construction of Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky

TO CEORH-CD FROM CEORH-ED DATE 16 Sept 1987 CMT 1

Mr. Copher/bh/5220

1. In order to better facilitate back flooding of the work area prior to an overtopping of the cellular cofferdam, it is requested that the subject contract be modified to include provisions for a notch in the downstream diversion dike. This modification will provide additional protection to the cellular cofferdam and minimize damage to the work area during a flood event that overtops the cofferdam.

2. A notch with a bottom width of 30' at El. 580.0 should be cut through the existing downstream diversion dike as shown on Enclosure No. 1. The cut slopes should be 1V on 2H. The proposed notch should be filled with sandstone with a top size of 24" and have a 4' horizontal layer of impervious material on the tailwater side. The crest of the cofferdam will be raised from El. 585, with 2' of sandbags to El. 587. This section should be as shown on Enclosure No. 2.

3. The contractor should be required to have a large backhoe and operator available near the downstream diversion dike, at all times, during flooding conditions. The contractor should also be required to have lights and gasoline generators on each abutment of the cellular cofferdam, if requested, during flooding. These lights should be sufficient to light the downstream side of the cellular cofferdam and all of the concrete pad on the berm.

4. A one-foot thick layer of rock should be placed on top of the downstream diversion dike for access. The width should be 6' on each side of the center line.

5. Information on elevations and conditions for breaching the downstream diversion dike will be supplied by Engineering Division.

6. All contract drawings affected by this change should be corrected on "As Constructed Drawings."

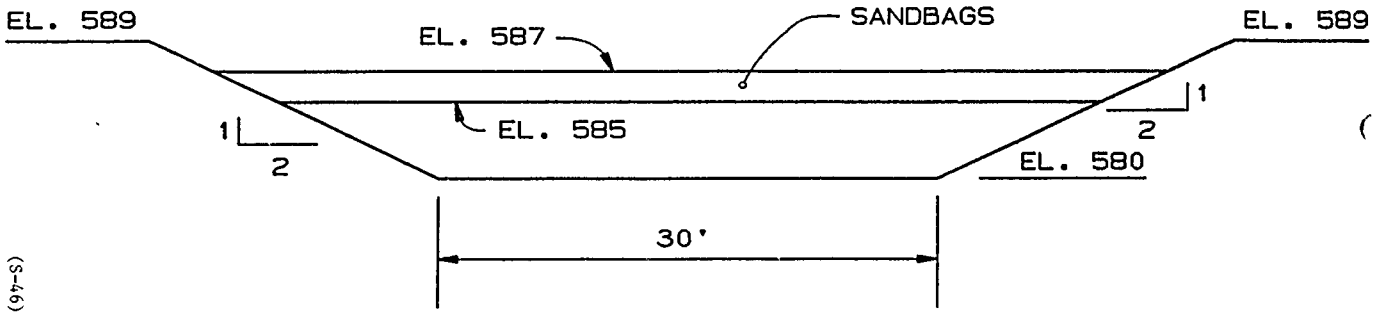
CHARLES E. VANDEVELDE
Chief, Engineering Division

2 Encl
as

WADDELL ED-D
COFFMAN ED-G
HARMAN ED-H
YOST OC
TUCKER
PAVIK PB
RIDDLE ED-B
VANDEVELDE

(S-45)

DA FORM AUG 60 2496 PREVIOUS EDITIONS WILL BE USED

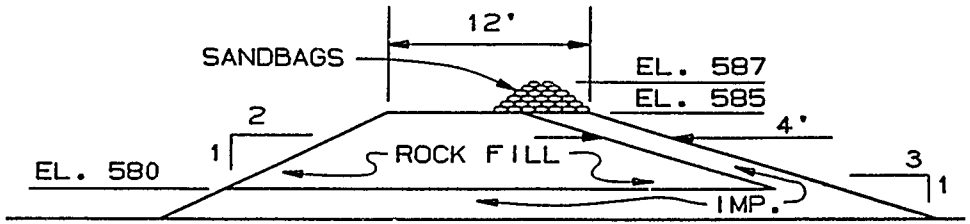


(S-46)

PROFILE

YATESVILLE DOWNSTREAM DIVERSION DIKE NOTCH

INCL. 1



TAILWATER

(S-47)

TYPICAL SECTION

YATESVILLE DOWNSTREAM DIVERSION DIKE NOTCH

INCL. 2

CEORH-ED-G 23 November 1987

MEMORANDUM FOR RECORD

SUBJECT: Potential Modifications to Yatesville Dam Phase II Contract

1. On 20 November 1987 a meeting was held in the Geotechnical Branch conference room on the above subject. Those in attendance were:

Dave Hammer	CEORD-ED-G	Don Copher	CEORH-ED-DG
Russ Fondelier	CEORD-ED-G	Leno Bird	CEORH-ED-DT
David Deeds	CEORH-CD	James A. Coffman,Jr.	CEORH-ED-G
Ray K. Boley	CEORH-CD-YBC	Jerry W. Phelps	CEORH-ED-GS
Pat Oshel	CEORH-CD	Stephen T. Hornbeck	CEORH-ED-GG
Danny Boster	CEORH-CD-YBC	Jim Owen	CEORH-ED-GS

2. Mr. Phelps opened the meeting and discussed the present design and history of the filter design for the project. It was then noted that based on the test pit data shown in enclosure 1, the 12" processed sandstone and the 24" sandstone were both "gap graded" materials. Both materials appear to be gap graded after being shot and placed in the test fills. This tends to indicate that the compaction required in the specifications may be inadequate or that the method of processing is inadequate. This type of gradation would tend to indicate the potential for piping of the impervious core material into the filter.

3. It was agreed by the Geotechnical personnel that some type of filter material will be required at the rock foundation contact surface and that the filter should extend up each abutment to at least elevation 590. Three alternatives were discussed. The first alternative, as shown on enclosure 2, would modify the design by extending the inclined drain down to top of rock. The second alternative, as shown on enclosure 3, would modify the design by placing a 3-foot wide by 10-feet high layer of inclined drain material in the foundation trench and processed sandstone zone. This layer would extend up each abutment to elevation 590. The third alternative, as shown on enclosure 4, would be to reevaluate and resolve the problem of the gap graded processed sandstone if possible by means of a processed sandstone fill on the existing random rock fill.

5. Mr. Boley then indicated that if we elect to use commercial material, Route 1185 may be closed to the Contractor during the winter months. If this occurs it could affect the contract time.

6. A brief discussion ensued as to the cost of adding the inclined drain to top of rock. The estimated cost was $250,000.00 as a minimum. It was noted that if the Contractor could demonstrate that he had lost a construction season the change could run well in excess of $1,000,000.00.

7. Mr. Deeds then indicated that he was not in favor of the Contractor placing any more embankment this year. Mr. Boley stated that the Contractor couldn't place fill this year because of the status of the grouting. Mr. Deeds also indicated that we may want to require the Contractor to process the on-site materials to a specified gradation during the winter months for placement in the processed sandstone zone during the next construction season. Specific gradations to meet geotechnical requirements may necessitate the use of a grizzley. It was noted that gradations specified during processing may not provide the required in-place gradations. It was then generally agreed that the most economical method would be to place the processed sandstone on top of the existing random rock fill and compact the processed sandstone fill with various compaction efforts. The results of these tests will determine if alternate 3 will be acceptable.

8. Mr. Boley indicated for the record that the remainder of rock borrow area to be shot was not known at this time.

9. In summary, because of the cost for extending the inclined drain to rock, the potential closure of Route 1185 to the Contractor during the winter months, and the potential claim for delay of the contract by the Contractor, it was agreed that alternate 3 would be investigated at this time. Investigation of alternate 3 will consist of the following:

a. Placing 4 - 12" lifts of processed sandstone
b. Obtaining 2 - gradations representative of the shot material
c. Obtaining 2 - in-place gradations per compaction type.

The 12" lifts of processed sandstone will require test pits. The density of the material will be required, but the percolation test will not be required. Compaction of the 12" processed sandstone will require the following equipment and number of passes:

a. 2 passes of a tamping roller towed by a D-8 with cleats, and 4 passes of a 50 ton rubber tired roller
b. 4 passes of a vibratory roller (control, same as specifications)
c. 6 passes of a vibratory roller
d. 2 passes of a tamping roller towed by a D-8 with cleats, and 4 passes of a vibratory roller
e. 4 passes of a tamping roller towed by a D-8 with cleats

Fill work on the processed sandstone will commence on or about 30 November 1987.

11. The addition of the processed sandstone to elevation 579 will not create a problem for Hydraulics.

12. Mr. Deeds then discussed the need for additional construction personnel required during the grouting operations. Mr. Deeds indicated that during grouting of the valley bottom, there will be two geologists on duty. The additional geologist will be either John Lusher or Dave Nugent.

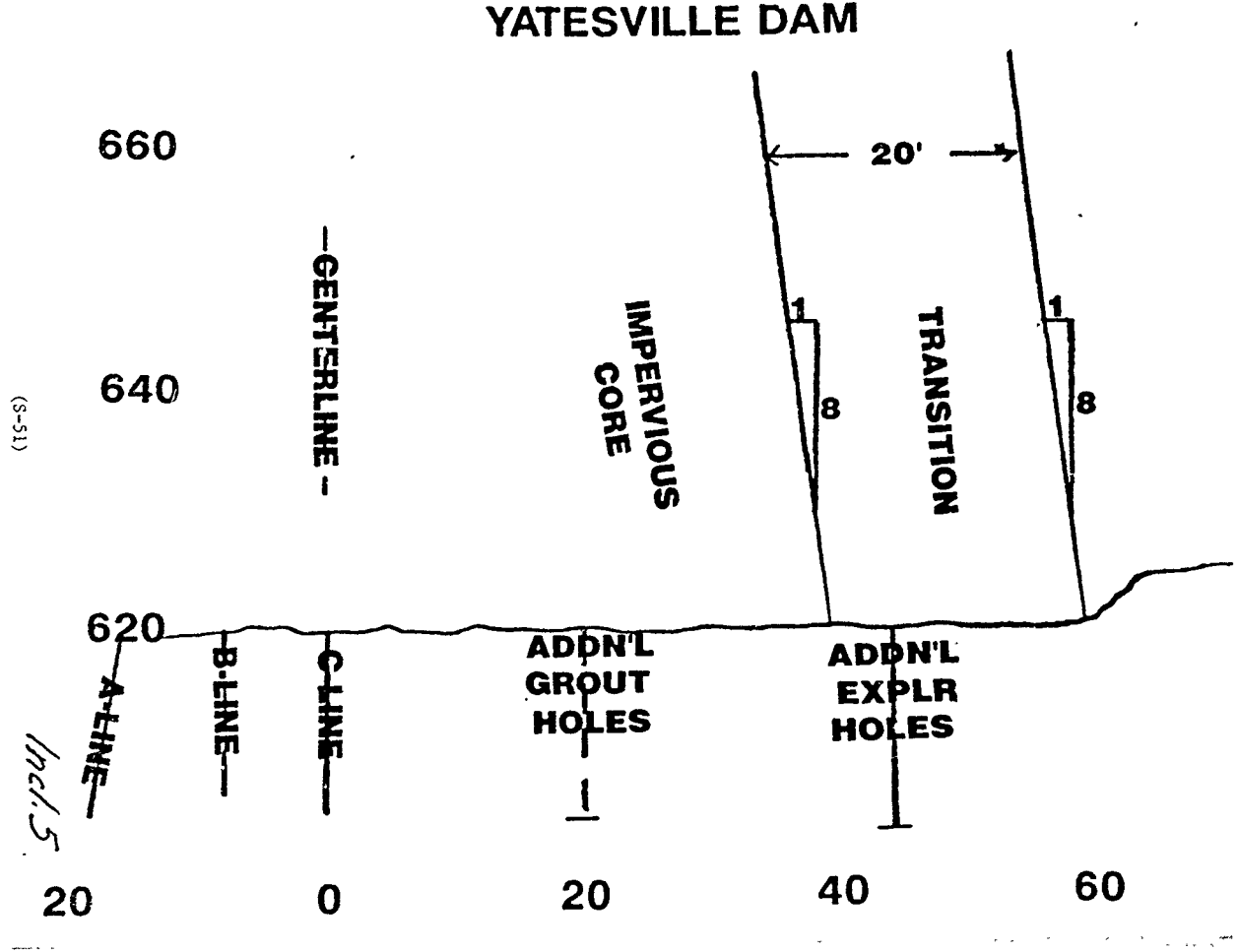
13. The location of an additional downstream grout line was finalized at 20 feet downstream of the centerline of the dam as shown on enclosure 5. The location of an additional upstream grout line was previously agreed upon. Additional exploratory holes are intended approximately 45 feet downstream of the centerline. The additional grouting and exploratory holes are intended to ensure that voids are not present into which impervious material could pipe.

James V. Owen FOR
Civil Engineer
Soils Section

Stephen T. Hornbeck
Geologist
Geology Section

Encls: 5 as stated

CF:
CEORH-ED
CEORH-ED-D
CEORH-ED-H
CEORH-ED-B
CEORD-ED-G
CEORH-CD


YATESVILLE DAM
660
640
620
20'
1
8
1
8
CENTERLINE
IMPERVIOUS CORE
TRANSITION
A-LINE
B-LINE
C-LINE
ADDN'L GROUT HOLES
ADDN'L EXPLR HOLES
20
0
20
40
60

(S-51)

Incl. 5

December 2, 1987

Construction Division
Yatesville Lake

SUBJECT: Contract No. DACW69-86-C-0039, Construction of Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky - Grouting

The Lane Construction Corporation
Post Office Box 566
Louisa, Kentucky 41230

Gentlemen:

This is to confirm verbal instructions given to perform "B" line grouting between approximate Station 5+00± to Station 7+25± in the foundation. Also due to foundation conditions, it is necessary to install an additional upstream grout line at the middle of the upstream transition zone and a downstream grout line 20-feet down stream of the center line. These lines will consist of vertical primary and secondary holes to approximate elevation 500 between approximate Station 5+00± to Station 6+40±.

If there are any questions concerning this, please contact the field office.

Sincerely,

Ray K. Boley
Resident Engineer
Authorized Representative of
the Contracting Officer

CF:

CEORH-CT
CEORH-CD
CEORH-CD-YBC, wd

DF

CEORH-ED-G YATESVILLE DAM PHASE II CONSTRUCTION

CEORH-CD CEORH-ED 4 APRIL 1988
Hornbeck, 5234

1. Based upon our telephone conversation of this date I wish to confirm to you my request that a portion of the dam embankment be removed. The embankment removal is necessitated by the seepage for which a sump pipe was installed near centerline in the impervious core on the right side of the embankment. We are concerned with the source of the seepage, and the potential for the transmission of full reservoir head to the exit point of the seepage which is approximately 5 feet upstream of the centerline of the dam. The removal of this material will allow the excavation of the Shale material under which the seepage appears to be moving. The removal of this shale material will then allow an assessment to be made concerning the source and path of the seepage as well as the potential for transmission of full reservoir head into the central part of the core.

2. My technical staff will assist you and your staff in any way possible to reduce the influence of this request upon the ongoing work.

CHARLES E. VANDEVELDE
Chief, Engineering Division

CF:
CEORH-ED
CEORH-ED-B
CEORH-ED-G
CEORH-ED-D

CERTIFIED MAIL - RETURN RECRIPT REQUESTED

April 18, 1988

Construction Division
Contract Administration Branch

SUBJECT: Contract No. DACW69-86-C-00 onstruction of Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky, Initial Order No. 1, Change Order "BG"

The Lane Construction Corporation
966 East Main Street
Meriden, Connecticut 06450

Gentlemen:

Confirming the verbal notification and instructions given by the Resident Engineer on April 14 and 15, 1988, you are directed to proceed with the below described work. Modification to the contract providing for adjustments as a result of this directive is being initiated.

It is proposed to modify the contract in certain particulars as described below:

1. Cease placement of the impervious embankment materials in the vicinity of Stations 4+20 to 4+90.

2. Remove the embankment materials exposing the shale seam which is producing water.

3. Clean and remove the shale to expose a fresh surface.

4. Place a vertical riser pipe in the location as designated.

5. Plug the small water leaks in the shale with oakum and place dental concrete approximately 8 inches in thickness over the exposed shale.

6. Backfill the excavation with impervious embankment.

7. The riser pipe shall be extended through the embankment until the hydraulic head is equalized. With the head equalized, the pipe shall be grouted full to seal the hole.

All work shall be accomplished in accordance with applicable contract documents and as directed by the Resident Engineer.

You are hereby directed to proceed with this work immediately. This work is considered to be of an urgent nature and should be given priority effort.

You are requested to submit your cost proposal in accordance with Contract Clause 70, to the Resident Engineer by April 28, 1988. In the event your proposal cannot be submitted by the date indicated, you should advise the Resident Engineer, in writing, stating the reason for the delay and request additional time for submission.

This directive constitutes Initial Order No. 1. Upon submittal of your proposal and completion of the subsequent negotiations, a formal contract modification covering the additional work will be issued.

Sincerely,

Robert D. Brown III
Colonel, Corps of Engineers
Contracting Officer

CF:
CEORH-CD-A
CEORH-CD-YBC ✓
CEORH-CT
CEORD-CO-C

SHELDON	CD-A
DEEDS	CD
TUCKER	CT
EVERSOLE	OC
VANDEVELDE	ED
MATTHEWS	EA
BROWN	DE

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

DETERMINATION OF FINDINGS

April 18, 1988

AUTHORITY TO ISSUE NOTICE TO PROCEED FOR CHANGE ORDER

Upon the basis of the following Findings and Determination, a Notice to Proceed to Contract No. DACW69-86-C-0039, "Construction of Dam and Appurtenan. Works, Phase II, Yatesville Lake, KY" may be issued.

FINDINGS

1. Description of the Change: The Contract provides for the installation of a impervious material within the dam. The impervious material will be placed upon the foundation rock of the dam. During that placing, ground water began infiltrating from under the shale layer. This led to a concern about the source of the water and the potential that the shale conceals fractured bedrock. Therefore, it was determined that this layer of shale must be removed. Impervious material, which had already been placed, must be removed prior to removal of the shale leayer. The cleaned shale surface shall have the small water bearing seams sealed with oakum and the entire area covered iwth dental concrete. A vertical riser pipe shall be set at the area with maximum flow to relieve the hydrostatic head. The impervious embankment shall be replaced and the riser pipe extended through the embankment until the flow is equalized. When the flow is equalized and the embankment is at the same approximate level, the riser shall be grouted full to seal the pipe and hole.

2. Effect if the Notice to Proceed is Not Issued: The Contractor is currently placing impervious material. The shale must be removed and the groundwater controlled before additional impervious material can be placed. If the Notice to Proceed is not issued, the Contractor will be delayed by the Government, incurring additional costs for which the Government will be responsible. Thus, it is necessary and in the best interest of the Government to issue a Notice to Proceed to avoid unnecessary delays and resultant costs.

3. Estimated Cost: It is estimated that the final costs for the additional work will be approximately $25,000.00. This amount is subject to adjustment due to the Contractor's proposal being not yet received, the exact amount of excavation to be done, pending negotiations, and other adjustments or changes. Sufficient funds for this Notice to Proceed, in the amount of $25,000.00 are available under the appropriation FSN 96461 96X3123 CG MR BE YBC 04 10C0 0000 0320 284.

4. Status of Negotiations: The negotiations will commence immediately upon receipt of the Contractor's proposal.

DETERMINATION

Based upon the findings noted above, it is necessary and in the best interest of the Government to issue the Notice to Proceed without prior agreement in price.

ROBERT D. BROWN III
Colonel, Corps of Engineers
Contracting Officer

D-4

DISPOSITION FORM

For use of this form, see AR 340-15; the proponent agency is TAGO.

REFERENCE OR OFFICE SYMBOL	SUBJECT
CEORH-CD (1180)	Yatesville - Erosion of Spillway Side Slopes at Bridge Abutments, Contract No. DACW69-86-C-0039

TO	FROM	DATE	CMT 1
CEORH-ED	CEORH-CD	2 August 88	

1. During visit to the subject project since my arrival in the Huntington District, I have observed what appears to be increased deterioration of the spillway sideslopes adjacent to the bridge abutments.

2. After discussions with Mr. Zimmerman, Yatesville Resident Engineer, and conducting a cursory review of our files, I discussed the situation with Mr. Don Copher to obtain additional information. Mr. Copher informed me that corrective plans will be finalized in August 1988.

3. The Lane Construction Company is making rapid progress and is expected to be near completion of the embankment by Mid October 1988. It is anticipated that the contractor will demobilize the majority of his heavy equipment including the batch plant at that time. Therefore if action is anticipated by Engineering Division to request corrective action in the spillway through contract modification it is necessary that that information be provided this office as soon as possible and no later than 1 September 1988.

4. In view of the potential for severe erosion during flows of less than PMF magnatude it is my opinion that corrective action should be taken.

Lawrence R Brockman

LAWRENCE R. BROCKMAN
Assistent Chief, Construction Division

CF:
CEORH-CD
CEORH-CD-YBC

(S-58)

CEORH-ED-DG Modification of Contract No. DACW69 -86-C-0039 Construction of Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky

TO: CEORH-CD FROM: CEORH-ED DATE: 19 Aug 1988 CMT 1
Copher 5220/C. Vandevelde

1. It is requested that the subject contract be modified to include removal of the top 5' of concrete abutments, on each side of the cellular cofferdam.

2. The top of the abutments should be removed so no part extends above Elevation 616.0. Removal should be accomplished by drilling and blasting. A drilling and blasting plan should be submitted to CEORH-ED for approval before this work is started.

3. This modification is necessary in the interest of safety.

4. All contract drawings affected by this modification should be corrected on the "As Constructed Drawings".

David J. Vandevelde
FOR CHARLES E. VANDEVELDE P.E.
Chief, Engineering Division

FOR Waudell RPW ED
Eversole OC
Tucker CT
Ryder RPB
Warren SO
Riddle ED-B
FOR Vandevelde ED

SEP 1988
RECEIVED
Resident Engineer
Yatesville Lake

DISPOSITION FORM

For use of this form, see AR 340-15; the proponent agency is TAGO.

REFERENCE OR OFFICE SYMBOL	SUBJECT
CEORH-CD-YBC (1180)	Contract No. DACW69-86-C-0039, Dam & Appurtenant Works, Phase II, Yatesville Lake, Kentucky -Change No. BT, Mod. No. P00025

TO	FROM	DATE	CMT 1
CEORH-CD	CEORH-CD-YBC	12 Dec 88	Zimmerman/mm/686-2424

1. During the prosecution of the work of the contract agreement could not be reached for the method of measurement for Pay Item No. 81. Concrete in Inclined Leg Foundations and Spillway Lining. The sequence of events were:

10 May 1988 - Contractor requested additional pay by letter for Item Nos. 81, 132A, and 132B

19 May 1988 - Contractor's request denied by letter

16 Jun 1988 - Contractor briefly states his reasons for additional pay for concrete

20 Jun 1988 - DF regarding the Contractor's request for payment

6 Jul 1988 - Contractor's request again denied and told he could request a Contracting Officer's Decision

7 Jul 1988 - Contractor requested a Contracting Officer's Decision

7 Nov 1988 - A meeting was held with the Contracting Officer.

Documents listed above are attached as Enclosure No. 1.

2. The meeting with the Contracting Officer was attended by the following:

Corps of Engineers	Lane Construction Corp.
David J. Deeds	James Hughes
Tony Tomlinson	Bob Housel
Kenneth E. Zimmerman	Don Kentzel
Ray K. Boley	
Leno Bird	
Ed Eversole	
Col. Thomas E. Farewell	

3. The points of the Contractor's plea for payment were:

a. The Specifications indicates that payment will be made for all concrete placed within the forms.

b. The Specifications give tolerance for excavated rock surfaces.

DA FORM AUG 80 2496 PREVIOUS EDITIONS WILL BE USED (S-60)

c. The drilling for the excavation was difficult, but care was taken to try to prevent over excavation.

d. The bid price did not include any contingency for placing concrete in quantities greater than the amount listed in the bidding schedule.

4. The consensus after the Contractor's presentation was that the Contractor was entitled to an equitable adjustment for the spillway concrete.

5. The following documentation is submitted as the basis for the issuance of a contract modification to accomplish the intent of paragraph 4 above.

6. Since this action is the result of a claim submitted by the Contractor, there was no request for proposal sent to the Contractor.

7. The Contractor's Letter No. YD-282 dated 7 July 1988 (Enclosure No. 2) serves as the Contractor's proposal. This correspondence submitted a cost of $31,075.00.

8. An estimate for an equitable adjustment was prepared and is included as Enclosure No. 3.

9. A Technical/Cost Analysis was prepared and is attached as Enclosure No. 4.

10. Prenegotiation Objectives were established and are attached as Enclosure No. 5.

11. Attached is the Record of Negotiations (Enclosure No. 6).

12. By a letter dated 12 December 1988 (Enclosure No. 7) the Contractor has confirmed the agreement reached during the negotiations of 8 December 1988.

13. It is requested that the contents of this DF be used as the basis for issuing a contract modification to make the following changes:

Item No.	Description	Quantity	Unit	Unit Price	Amount Increase
81	Concrete in Inclined Leg Foundation and Spillway Lining	64	CY	$250.00	$16,000.00
132	Portland Cement and Pozzalan				
	a. Portland Cement	271	CWT	3.00	813.00
	b. Pozzalan	46	CU. FT.	2.00	96.00

Kenneth E. Zimmerman
KENNETH E. ZIMMERMAN
Resident Engineer

Enclosures

CF:

CEORH-CD
CEORH-CD-YBC, wd

SMITH/jks/5011

August 31, 1989

Construction Division
Contract Administration Branch

SUBJECT: Contract No. DACW69-86-C-0039 for Dam and Appurtenant Works, Phase II, Yatesville Lake, Kentucky

Lane Construction Company
965 East Main Street
Meriden, Connecticut 06450

Gentlemen:

All physical work under the referenced contract was found to be completed in accordance with the plans and specifications and is accepted as of August 16, 1989.

Acceptance of the physical work does not relieve you of the responsibility to comply with all the requirements of the contract. Final payment will be made only when all administrative requirements of the contract have been met.

Sincerely,

Thomas E. Farewell
Colonel, Corps of Engineers
Contracting Officer

CF:
CEORH-CD
CEORH-CD-A
CEORH-CD-YBC
CEORH-OP
CEORH-RM-F
CEORH-ED
CEORD-RM-F
CEORH-CT

EPLING CD-A
SHELDON CD-A
TURNER CD
EVERSOLE OC
TUCKER CT
DEEDS DD-P
MATTHEWS EA
REYNOLDS DO
FAREWELL DE

ORHED-GS

7 AUGUST 86

MEMORANDUM FOR RECORD-TRIP REPORT

SUBJECT: YATESVILLE DAM PHASE II CONSTRUCTION

1. ON 31 July 86 Messrs. Hammer, Canning, Boster, Hornbeck, Hawley, and Owen visited the subject project.

2. The slurry trench operation was in progress. At the time of the inspection approximately 50 feet of slurry trench had been excavated from the right abutment. Excavation for the gravity cut-off walls associated with the coffer dam had begun, and excavation of the diversion channel continued. During the inspection it was agreed that the left abutment would not require further notching into rock for the impervious core and transition zones.

3. Mr. Hammer indicated that the project was in good shape and that he felt the District made the right decision in placing the embankment on rock. ORD will visit the site each four to six weeks.

4. No safety violations were noted.

James V. Owen JVO
James V. Owen
Civil Engineer, Soils Section

CF:
ORHED
ORHED-D
ORHED-B
ORHED-GG

(S-64)

ORHED-GG

7 AUGUST 86

MEMORANDUM FOR RECORD-TRIP REPORT

SUBJECT: YATESVILLE DAM PHASE II CONSTRUCTION

1. On 6 August 86 Messrs. Owen, Merritt, and Hornbeck visited the Yatesville site. Construction of the diversion channel, upstream slurry trench, and the right abutment core trench was continuing. All portions of the work were being performed in a neat and professional manner and all work appeared to be within specification limits. No safety violations were noted.

2. The rock surface on the right abutment appears to less irregular than originally anticipated, and the slope of the abutment rock toward the valley center appears to flatter than originally anticipated during the design stages of the project (reference drawing 52/12, centerline profile). The primary reason for this appears to be an inaccurate top of ground elevation for boring C-27 (approximate elevations, 598 shown versus 620 actual) which resulted in an inaccurate top of rock elevation. As a result, the core trench excavation was started approximately 10 feet deeper into the abutment than was necessary. Additionally, the slope of the top of rock surface is flatter than 1 vertical on 1 horizontal and as the core trench is excavated to a 1 vertical on 1 horizontal average slope, the core trench excavation progresses deeper into the abutment. While this condition per se is not cause for concern, it would result in a more costly excavation and could result in a sharp change in foundation conditions as the excavation reaches the valley bottom. As the slope of the rock surface flattens out in the valley bottom it would also become necessary to use production blasting to shape the core trench since presplitting is impractical at slopes less than 1 vertical on 1 horizontal. As a result of these considerations it has been determined that the 5 foot maximum bench width specified in paragraph 2D-14.4 must be revised to allow for bench widths of ten feet currently and possibly 15 feet if considered necessary in the future. Consideration will be given to whether the front edge of the benches will require chamfering (removal of the outside corner) to reduce the potential for cracking of the embankment. No contract modification is currently planned to effect this change but the decrease in excavation quantities may fall outside the plus or minus 15% variations in estimated quantities clause of the contract.

Stephen T. Hornbeck
Geologist, Geology Section

CF:
ORHED
ORHED-GS
ORHED-D
ORHED-B

(S-65)

Yatesville Resident Office

ORDED-G

11 August 1986

MEMORANDUM FOR RECORD

SUBJECT: Trip Report, (1) Meeting with District Geotechnical Personnel on the R.D. Bailey Embankment Criteria Report, and (2) Inspection of Construction at Yatesville Dam

1. On 27 July 1986, Division inspection team met with Huntington Geotechnical personnel to discuss stability analysis methods to be included in the embankment criteria report and to inspect construction of Yatesville Dam on 28 July 1986.

2. Purpose. The purpose of the trip was twofold: (1) to discuss and agree on the type of slope stability analyses to be included in the R.D. Bailey Embankment Criteria Report and (2) to inspect the construction of Yatesville Dam.

3. Attendees.

Steven Hornbeck	Geologist	ORHED-GG
Dan Boster	Soils Engineer	ORHED-GS
Jim Owens	Soils Engineer	ORHED-GS
Bill Hawley	Design Engineer	ORHED-T
Ray Boley	Resident Engineer	Yatesville Dam
Chester McDavid	Asst Resident Engineer	Yatesville Dam
Cpt. David Hall	Military Assignment	Yatesville Dam
David Hammer	Chief, Geotech Branch	ORDED-G
Charlie Canning	Division Geologist	ORDED-G

4. Background.

a. R.D. Bailey Embankment Criteria and Performance Report: Regulations require that an embankment criteria report be submitted after completion of reservoir filling. The report is to include slope stability analyses that confirm stability of the structure as designed. In the case of R.D. Bailey whose design was changed after the FDM was approved, no analyses on the new section were performed. Analyses must now be performed to go in the Embankment Criteria Report.

b. Yatesville Dam: The embankment was originally to be founded on overburden. However, additional subsurface investigations revealed areas of marginally acceptable material which caused serious concerns with embankment stability and possible construction problems during excavation. Another potential problem of liquefaction was surfaced during the seismic study.

Taking the above factors into consideration, it was decided that the embankment should be founded on rock. In order to excavate the soft saturated material an elaborate method for dewatering was required (deep wells and slurry trenches).

5. Observations. On 28 July 1986, personnel from the Huntington District and Ohio River Division met with Yatesville Dam Resident personnel and were briefed on the on-going work. The contractor had begun the upstream slurry trench excavation, excavated upper elevations of the right and left abutments and had most of the diversion channel excavated. A temporary drainage ditch and two sump wells had been installed to drain the upper overburden to provide a working surface for upper embankment excavation and installation of dewatering wells. Presently the river has been diverted through the tunnel by constructing a temporary dike. Once the diversion channel excavation has been completed the river will be routed through the channel by completion of the upstream earth diversion dike (see Attachment No. 1). The contractor has proposed to dike-off the intake structure area and to start constructing the concrete structure, thus reducing the project completion date by approximately six months to one year (see Attachment No. 1). A second proposal is to construct both branches of the downstream slurry trench to save remobilization costs when the cofferdam branch is scheduled for construction. The contractor has submitted a V.E. proposal to the Resident Office for an early start on the intake structure and for construction of both branches of the slurry trench. The contractor has been made aware that the slurry trench must be protected from damage during operation of the diversion channel (see Attachment No. 1).

The inspection party first visited the upstream slurry trench excavation. The contractor started excavation the first of the week and was still refining his operation techniques (see Photographs 1, 2, 3, 4, and 5). During the trench inspection the rock excavation for the right abutment coffercell tie-in was examined (see Photographs 6 and 7). Next the party inspected the diversion channel and top elevations of the left abutment (see Photographs 8, 9, 10, 11, 12 and 13). The contractor had excavated a temporary drainage ditch running parallel to the diversion channel and had installed several well sumps to facilitate preliminary embankment excavation. The trench gave the party an opportunity to examine the soft silty materials and the large boulders that had been indicated by the contract borings (see Photographs 14, 15, 16, 17, 18, and 19). After inspecting the trench we observed placement and compaction of material in the area of the downstream diversion dike. We then inspected the on-going right abutment excavation (see Photographs 20, 21 and 22).

6. Discussion. After the inspection an exit briefing was conducted in the resident office. The group discussed the condition of the abutment and proposed treatments of some sheared shale layers. It was the feeling of the group that if the left abutment rock remained as good as what has been exposed so far, further notching in the rock for embankment tie-in would not be necessary. The right abutment excavation revealed some thin horizontally bedded layers (1/2 - 1 inch thick) which will be removed. We discussed the need for exercising caution to avoid jacking these horizontal beds during curtain grouting. The grouting will require close inspection by experienced

personnel. The resident offices agreed; however they pointed out that due to manpower restraints the close grouting inspection may be difficult to achieve.

7. Conclusions.

a. R.D. Bailey Embankment Criteria Report. It was mutually agreed by all that the District would initially perform an analysis of the critical case to determine what strengths of the select sandstone would be required to yield an acceptable factor of safety. Knowing this value we would then be in a better position to make a decision on which would be the best way to go as far as the overall analyses themselves are concerned.

b. Yatesville Dam. The project is progressing extremely well. Resident personnel are well aware of the various on-going operations. The contractor appears at this stage to have planned his work well and is accomplishing it without the confusion that generally is associated with the initial phase of construction. The soft silty material uncovered by the temporary drainage ditch has reconfirmed the need to found the embankment on rock and the necessity for the installation of a system of slurry trenches and dewatering wells. The district should be prepared to have experienced personnel to fully cover the grouting on a 24 hour basis. If in-house personnel cannot be made available the district should explore the use of an AE contract.

8. The undersigned wish to express their appreciation and thanks to the district and resident office personnel for their cooperation in this very informative site visit.

DAVID P. HAMMER, P.E
Chief, Geotechnical Branch

CHARLES G. CANNING
Division Geologist

CF: ORDCO
ORDED-T
ORHED-G
ORHED
ORHCO
ORDCO-Yatesville

ORHED-GG 29 AUGUST 86

MEMORANDUM FOR RECORD-TRIP REPORT

SUBJECT: YATESVILLE DAM PHASE II CONSTRUCTION

1. On 27 August 86 Messrs. Boster and Hornbeck of Geotechnical Branch visited the project site to observe the construction activities and progress. The Contractor was backfilling the upstream slurry trench but the backhoe was inoperative and was not excavating for the downstream slurry trench. Installation of the dewatering wells was progressing in preparation for lowering the groundwater to elevation 565 in order to start the upstream cellular cofferdam. Excavation for the right abutment cut-off wall of the cofferdam was continuing. Excavation in the spillway had been initiated to provide random rock for the cofferdam.

2. The project activities were performed in a neat and orderly fashion and no safety violations were noted.

Stephen T. Hornbeck
Geologist, Geology Section

CF:
ORHED
ORHED-D
ORHED-G
ORHED-GS
ORHED-B

ORHED-G 23 October 1986

MEMORANDUM FOR RECORD

SUBJECT: Trip Report - Yatesville Lake Project, Kentucky, Site Visit

1. On 23 October 1986, Messrs. Jim Owen and Jerry Phelps of Soils Section, Geotechnical Branch, visited the subject project. Significant observations are as follows.

2. The top surface of the completed 24-inch Sandstone rockfill testfill was observed. The 5'X5'X3' deep test pit was excavated and the percolation test was ready to begin. The Sandstone material observed is extremely degraded after compaction and has an appearance of sand sizes filling all voids of the matrix. The 12-inch Sandstone and 12-inch random rockfill testfills will be constructed in the near future.

3. A small sample of random rock was recovered from the rock borrow area. Ray Boley questioned the weathered condition of the random rock and requested guidance on the overburden stripping. Mr. Boley was advised that weathered rock is acceptable as a source of random rockfill. It was also noted that we should be careful to prevent overstripping by the Contractor, which would ultimately result in unnecessary quantity overruns.

4. Other areas observed include construction of the sheetpile cell template, capping the downstream slurry trenches with a filter cloth and gravel/bentonite cap to allow cross traffic, and discharge from the dewatering system.

5. Mr. Boley indicated he would talk to the Contractor concerning the erosion repair along the right bank of the diversion channel haul road.

Jerry W. Phelps

JERRY W. PHELPS
Chief, Soils Section
Geotechnical Branch
Engineering Division

CF:
ORHCD
ORHED
ORHED-D
ORHED-B
ORHED-H
ORHED-G
ORHED-GS
ORHED-GG

GRHED-G 14 November 1986

MEMORANDUM FOR RECORD-TRIP REPORT

SUBJECT: YATESVILLE DAM PHASE II CONSTRUCTION

1. On 13 November 1986 Messrs. Owen and Hornbeck of Geotechnical Branch and Mr. Honaker of Design Branch visited the site.

2. A portion of the first row of sheets for cell #2 had been driven as far as possible. It appears that a boulder was encountered beneath cell #2 on the left upstream face near the interlock between cell #2 and #3. Mr. Honaker is to review the design considerations based on the cell data to be furnished by Construction Division. The Contractor was in the process of moving the template to cell #3.

3. On 8 November 1986 flood conditions at the project caused overtopping of the diversion channel plugs. As a result of the high water the downstream diversion channel plug was removed back to the "Z" piles used to retain the downstream slurry wall. Prior to flooding a depression was noted near the center of the valley along the centerline of the upstream slurry trench. Shortly after the flood, the small depression had extended over about 50 feet and the cap over the upstream slurry trench had settled about 18 inches. Mr. Boster of Geotechnical Branch inspected the site on 12 November 1986 along with Construction Division personnel. It is believed that settlement may have been caused by the placement procedure used by the Contractor. The settlement area had been repaired prior to our visit. Construction Division personnel were cautioned that continued settlement of the slurry wall could endanger the integrity of the upstream impervious blanket, and that the implications of this were uncertain.

4. Construction Division personnel indicated that Mr. Hawley had been requested to check and see if anyone else desired to inspect the test fills prior to removal.

5. Construction Division personnel indicated that one of two samples from the primary impervious borrow area consisted of "CH" material. The location and depth of the samples were not known at the time of the visit but Mr. Owen indicated that he would talk to Mr. Phelps as to the extent of the CH material in the impervious borrow since pans are proposed to be used by the Contractor for excavation of the impervious material.

6. A review of the contract drawings and the field conditions indicate that a "Z" pile wall will be required for the "upstream" y-section of the downstream slurry wall prior to Stage 5 construction. The use of such a wall should prevent the loss of the slurry into the excavation and settlement of the downstream diversion dike.

7. Concern was expressed about the need for breaching the downstream diversion dike and slurry trench during Stage 5 construction. Based on the present field conditions it would appear that if a breach of the downstream diversion dike is required it would be desirable to accomplish the breach in the fill plug placed in the diversion channel and the right bank of the diversion channel. Several schemes were then discussed as to the method of breaching. One method would be to place a pipe with "flap valves" and the other method would be the use of a "fuse plug" of erodible material to facilitate the breaching. It would appear that the buried pipe method would permit a more controlled release if a closure structure could be designed.

8. A review of the drawings 52/7 Stage 5, 52/15 Section C-C, and 52/21 indicates the downstream diversion dike at elevation 597 will be removed to elevation 589 during Stage 5 construction. Removal of the dike to elevation 589 as shown on the drawings will remove the slurry trench cap which was not the intent of the designer. Also it was noted that removal of the downstream diversion dike from elevation 589 to the finished grade of the random fill will require removal and replacement of the slurry trench cap at elevation 589. Although only a 6" cap is required on drawing 52/21 at least a two foot cap will be required over the random fill at finished grade since this area will be used by the public.

9. A request was made to furnish test fill and sheet pile data to ORHED-GS and ORHED-D.

10. It appears that several items require further consideration by the Yatesville Design Team. It is further recommended that a thorough review of the Diversion, Construction, and Flooding Sequences be undertaken by the design team to ensure that no unanticipated conditions arise during Stages 5 and 6 when downstream populations are at risk (for example, what procedures or options are available when flood debris results in partial blockage of the intake-transition area and the reduced capacity of the diversion tunnel leads to unexpected rates of rise in the upstream pool).

James V. Owen
Civil Engineer
Geotechnical Branch

Stephen T. Hornbeck
Geologist
Geotechnical Branch

CF:
ORHED
ORHED-D
ORHED-GG
ORHED-GS
ORHED-B
ORHED-H

ORHED-GG

15 December 1986
JWP

MEMORANDUM FOR RECORD-TRIP REPORT

SUBJECT: YATESVILLE DAM PHASE II CONSTRUCTION

1. On 12 December 1986 Messrs. Phelps and Owen visited the project to inspect the bottom ash stockpile area. The reason for the inspection was to inspect the amount of material stockpiled and the distance from the slurry trench. Since settlement of the trench cap had occurred in the past, it was believed that a surcharge from the bottom ash may be part of the cause. The site was inspected and Mr. Phelps indicated he did not feel there was a problem or need to restrict the amount of fill.

2. It was however noted that the bottom ash material was above elevation 602. Because of the bottom ash fill location between the upstream cofferdam and slurry trench, the bottom ash has in affect increased the upstream cofferdam height. In order to prevent potential damages downstream of the project, the bottom ash material above elevation 602 should be either spread to elevation 602 or placed in the cells as soon as possible. All future stockpiling should be below elevation 602.

James V. Owen
Civil Engineer
Geotechnical Branch

CF:
ORHED
ORHED-D
ORHED-G
ORHED-GS
ORHED-B
ORHED-H

ORHED-GG 27 February 87

MEMORANDUM FOR RECORD-TRIP REPORT

SUBJECT: YATESVILLE DAM PHASE II CONSTRUCTION

1. On 25 February 1987 Messrs. Owen and Hornbeck of Geotechnical Branch visited the subject site. All cells and arcs had been driven, spliced, and welded; and the Contractor was in the process of filling the cells with the bottom ash backfill. The cells were exhibiting some bulging indicating that the interlocks were going into tension as the backfilling progressed

2. As part of the visit it was noted that the electrical panels for the dewatering system upstream of the cells was below elevation 616 and was therefore subject to flooding. Since the system was designed to continue operating until just prior to overtopping, the electrical panel should be relocated.

3. A series of small slides was observed in the overburden on the right abutment at elevations above the top of the future dam, and somewhat to either side of the center line of dam. None of the slides were currently of major significance in terms of either volume or influence on the work site. One slide which was located approximately 75 feet upstream of the center line has the potential to influence the work site in that if it continues it may involve larger and larger areas and volumes of material. The slides were obviously triggered by the influence of water, but the source of the water was uncertain at the time of the visit. Observations of the slides will continue and remedial measures implemented when required.

Stephen T. Hornbeck
Geologist, Geology Section

CF:
ORHED
ORHED-D
ORHED-G
ORHED-GS
ORHED-B

ORHED-GG 5 March 1987

MEMORANDUM FOR RECORD-TRIP REPORT

SUBJECT: YATESVILLE DAM PHASE II CONSTRUCTION

1. On 4 March 1987 Messrs. Owen and Hornbeck visited the project site.

2. The slide at the top of the right abutment had moved somewhat during the weekend rains but remained essentially the same.

3. The compaction equipment to be used on the random rock fill upstream of the coffer dam was questioned by the project staff. The specified equipment (Sheepsfoot and 50 Ton) cannot be used adjacent to the arcs because of space constraints. Vibratory rollers were discussed, and will probably be used.

4. On the upstream side of the coffer dam the Contractor had placed some random fill which was scheduled for removal due to inadequate placement and compaction. This was unrelated to paragraph 3, above.

5. Removal of the bottom ash that remains on the upstream impervious blanket will be required in order to effectively tie in the remaining portion of the impervious blanket.

6. The project staff called Charles Mansur concerning the need to provide electrical panels above elevation 616 for the "B-Line" of wells downstream of the coffer dam. It was determined that this was not required.

7. The project staff indicated that hand railing would be required across the top of the coffer dam for safety. The need for quick removal of the hand rail during flood conditions was discussed.

8. The project staff continues to need guidance concerning when to breach, the elevation of the upstream and downstream pools at time of breaching, and other information as noted in the ORHED-G MFR dated 14 November 1986.

James V. Owen
Soils Engineer

Stephen T. Hornbeck
Geologist

CF:
ORHED
ORHED-D
ORHED-G
ORHED-GS
ORHED-H
ORHED-H

CEORH-CD-I

5 August 1987
Woodburn/js/5371

MEMORANDUM FOR RECORD:

SUBJECT: Trip report - Yatesville Dam, Contract No. DACW69-86-C-0039

1. On 4 August 1987 H. P. Oshel and W. F. Woodburn visited the subject project. The purpose of the visit was to inspect the work in progress and the shale seam exposed by the last shot on the right abutment.

2. The intake structure has been placed to elevation 610.5 and the forms were being raised to elevation 619.0.

3. Steve Hornbeck, Jim Owens, Don Copher, Bob Honaker, and Coy Miller from ED were on site to discuss their concerns wi... the spillway bridge abutments and to agree on a proposal to correct the situation. (See Attached Sketch). The existing situation is that the concrete lining protrudes out past the rock face by approximately 2 feet. Their concern is that if the maximum design flow elevation 659 is ever reached this situation will cause severe erosion of the rock behind the concrete lining thus causing failure of the pier foundations. Their proposed modification as shown on the sketch was agreed upon by all with the following changes: (1) The rock excavation line will be changed as shown by the dotted line. This was changed so that the excavation could be done with a large hydraulic hoe. (2) The excavation and concrete be stopped at elevation 661.0 (Two foot above maximum design flow.)

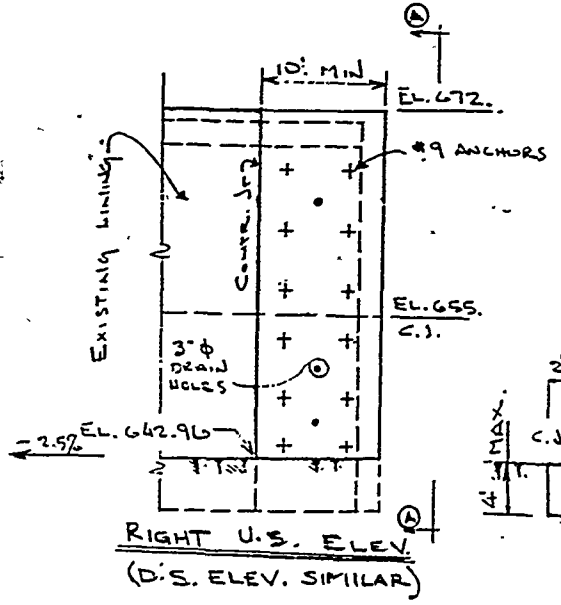
4. The contractor had recently shot and removed rock in the right abutment core trench down to elevation 564. A major joint in the sandstone bench at elevation 575 was inspected. This stained joint was oriented parallel to the valley and extended completly across the core trench. Due to the nature of the joint it was decided to drill a presplit line behind the joint and remove the jointed rock down to the underlying dark gray shale. Two other areas in this same area will require dental treatment. One is a shaley zone which is seeping water and the other is a carbonaceous shale and coal layer, 1-foot ± thick, at bench elevation 564.

5. No safety violations were noted.

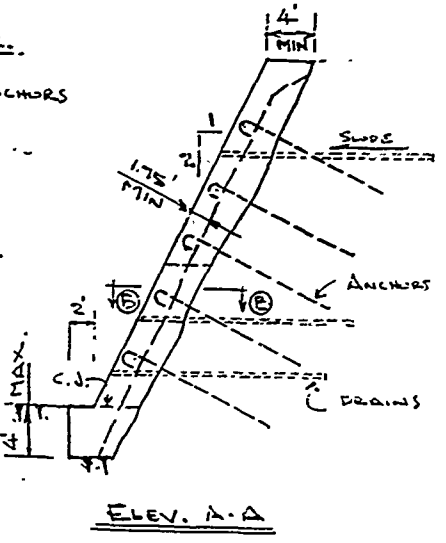
H. P. OSHEL
Geologist

W. F. WOODBURN
Civil Engineer

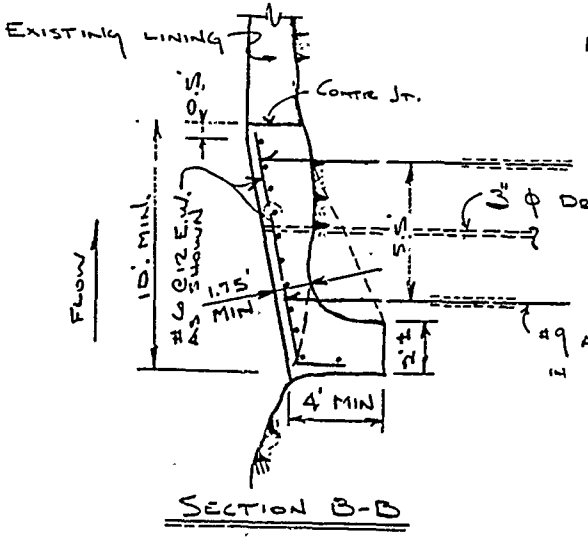
CF:
CEORH-CD-I
CEORH-CD
CEORH-YBC



RIGHT U.S. ELEV.
(D.S. ELEV. SIMILAR)



ELEV. A-A



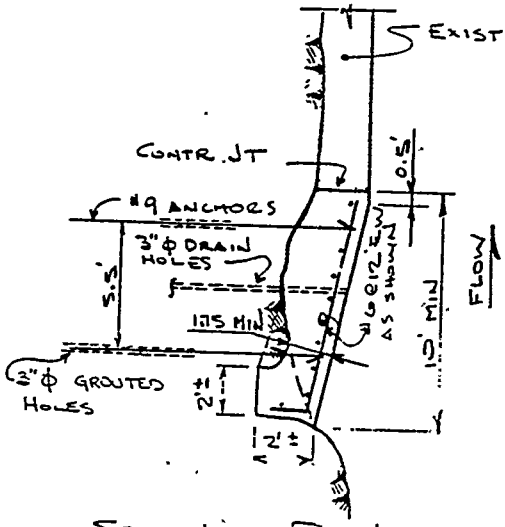
NOTE: RE-STEEL, ANCHOR BARS AND DRAINS SIMILAR TO EXISTING CONC. LINING

SECTION B-B

ORD Form 427
1 APR 83

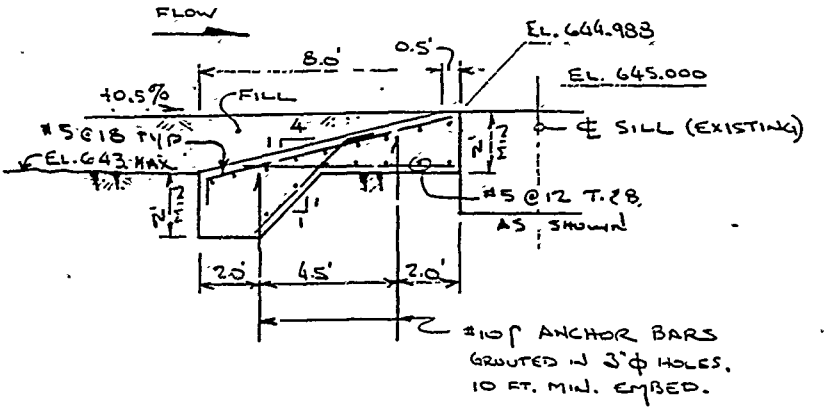
☆U.S. GOVERNMENT PRINTING OFFICE: 1985-560-803

YATESVILLE LAKE
SPILLWAY LINING - MOD.



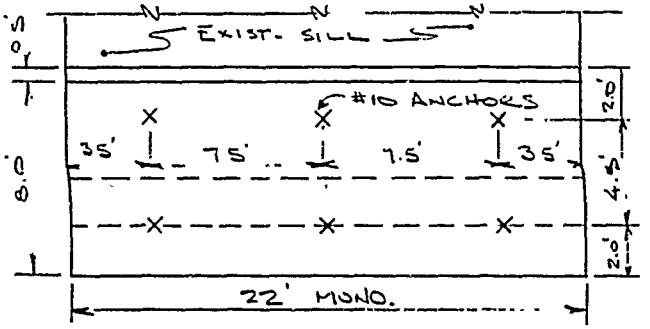
SECTIONAL PLAN
LEFT SIDE - U.S.

NOTE: RE-STEEL, ANCHOR BARS AND DRAINS SIMILAR TO EXISTING CONC. LINING.



SECTION

D.S. EXTENSION SLAB SIMILAR



ANCHOR BAR LAYOUT

CEORH-CD-I 21 September 1987

MEMORANDUM FOR RECORD:

SUBJECT: Trip Report - Yatesville Lake Project Contract No. DACW69-86-C-0039

1. On 1 Sept 87 H. P. Oshel visited the referenced project to observe overburden excavation in the valley bottom and inspect the rock along the right abutment.

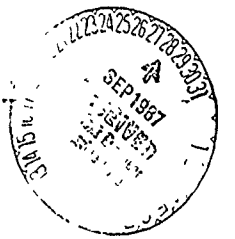
2. The contractor was excavating the overburden in the left half of the valley using front end loaders, dump trucks and dozers. The material was being hauled to the spoil area. The material was dry and there were no apparent problems with excavation.

3. Overburden excavation has exposed the entire right abutment and the contractor has presplit and excavated the core trench to the valley floor. A coal seam about 8-10 inches thick is present near the base of the slope and will have to be dental treated as well as one exposed eariler about 8-9 feet higher. Considerable clean up remains in the bottom before any inspection can be made.

4. No safety violations were noted.

H. P. OSHEL
Geologist

CF:
CEORH-CD
CEORH-CD-I
CEORH-CD-YBC



CEORH-CD-I 25 September 1987

MEMORANDUM FOR RECORD:

SUBJECT: Yatesville Lake Project, Contract No. DACW69-86-C-0039

1. On 21 Sept 1987 H. P. Oshel visited the subject project. I was accompanied by Bill Stromb, WES and Dave Nugen, SWJ. The purpose of the visit was to inspect the valley bottom and discuss and coordinate the computerized record keeping of the grouting program. We were met at the site by Steve Hornbeck, Geology Section and Charles Canning, ORD.

2. The valley bottom was inspected with the exception of an approximate 30'± strip about the center which was covered by water. It was reported that there is a large joint or some other feature containing broken rock under the water. The contractor was pumping the water out but progress was very slow and we will have to wait until much later to see the bottom. It was agreed that from the water up the right abutment, the rock looks very good. The two exposed coal seams will have to be dental treated. There is some rock removal yet to be done on the left side and the bench elevations need to be determined. Generally, the group throught the bottom looked good. The isolated areas of drummy rock will be removed during final clean-up. The area under water will be inspected when the contractor completes the clean-up.

3. Bill Stromb set up and coordinated the grout record keeping computer program with Mike Neild and Captain Hall. We need to furnish Mr. Stromb a couple of more items and he will complete the program for us.

4. The grouting sub-contractor, Boyles Bros. were setting up their grout plant and we have given the ok to set grout pipes up the right abutment.

5. Concrete placing had resumed and a placement was in progress on the spillway.

6. No safety violations were noted.

H. P. OSHEL
Geologist

CF:

CEORH-CD
CEORH-CD-I
CEORH-CD-YBC

CEORH-CD-I 29 Sept 87

MEMORANDUM FOR RECORD:

SUBJECT: Trip Report - Yatesville Lake Project
DACW69-86-C-0039

1. On 25 Sept 87, H. P. Oshel visited the referenced project. The purpose of the visit was to meet with representatives of Engineering Division and discuss and inspect the foundation in the valley bottom.

2. Background. Upon removal of the overburden in the valley bottom, an area of broken rock, along with some sandy, clayey seams, mineralization along bedding contacts and several seams of water were observed flowing from this area. A trench about 5 feet below the general rock surface, running almost parallel (going slightly to the right side at approximately 10 degrees) and the full distance of the exposed valley bottom. The general elevation at the valley floor is 526+ and the lowest part of the trench is about 521.3. During the clean-up operations some of the loose, broken rock was removed from the trench.

3. On the visit of 24 Sept we layed out a boring program to determine the extent of this area. There is a contract pay item for exploratory drilling. The sub-contractor, Boyles Bros., had drilled one hole near center line on the right side of the trench about sta 5+53 along with holes at the upper and lower ends of the impervious-transition sections and had moved to the left side of the trench and drilled one hole about 10-foot from the trench near center line. The core from these holes indicates no broken zone or mineralization to the extent of what we observe on the left side of the trench. Small, 0.1 - 0.2, broken zones are present and may represent a thinning of the area toward the right abutment. Logs and a boring plan will be included in a later trip report after they are completed.

4. We decided that 4 additional holes were necessary to better delineated the broken zone on the left side. One hole was located in the trench and three others to the left of the trench. These holes should also be presure tested.

5. Representatives from ORD will visit the project on 28 Sept to review the borings, inspect the foundation and offer recommendations for treatment.

6. Overburden excavation is continuing on the downstream slope. Ground water springs have been encountered which is causing erosion and sloughing of the slope. One of the larger areas was backfilled with rock to help prevent further erosion.

7. No safety violations were noted.

H. P. Oshel

H. P. OSHEL
Geologist

CF: CEORH-CD-I, CEORH-CD-YBC

CEORH-CD-I 29 Sept 87

MEMORANDUM FOR RECORD:

SUBJECT: Trip Report - Yatesville Lake Project Contract No. DACW69-86-C-0039

1. On 28 Sept 87 H. P. Oshel visited the subject project. The purpose of the visit was to inspect the core borings drilled to date, observe and discuss foundation treatment in the valley bottom with ORD and ED. Representing ORD were Charlie Canning, Geologist and Russ Poundlier, Soils Engineer and Engineering Division by Steve Hornbeck, Geologist and Jim Owen, Soils Engineer. Dan Boster, Mike Neild and Chester McDavid of the project were also present.

2. Of the four additional core holes we designated on 25 Sept., the one in the trench had been completed and he was drilling the hole on centerline. A detailed inspection of all the borings and the rock surface was made. The hole in the trench revealed the broken area (0.2±) present at about elevation 521.3 and the centerline hole indicated the broken zone at a lower elevation which indicates the zone may dip steeply along a strong joint that is present about 3 feet to the left of the trench face. Geologic sections, mapping and a boring plan will be worked up on 29 Sept 87.

3. Recommendations. It was agreed that on the right side we would go back about 30 feet toward the abutment, from the edge of the trench, drill a 1 on 1 pre-split line and excavate the rock to the open bedding plane we can see in the trench at elevation 621. The amount of dental treatment, if required, will be determined at a later date. There is a strong joint that runs approximately parallel to the trench and forms the back limit of the excavation. This joint seems to form the extent of the slabby, drummy rock that is present on the right side. Most of the excavation will be in the range of 3-5 feet. The slabby, drummy rock is not groutable and would have to be removed prior to embankment placing. This would leave only about 2 feet, more or less, over the open bedding plane and there is the possibility that the rock would be lifted while grouting. It was realized that some competent rock would have to be removed but all felt it was necessary. The decision on the left side will be made when the core borings are completed and the sections worked up. These will be send to ORD and we will discuss treatment methods on a conference call with CD, ED and ORD.

4. Excavation is continuing on the downstream slope and the ground water problem still persists.

5. No safety violations were noted.

H. P. Oshel

H. P. OSHEL
Geologist

CF:
CEORH-CD-YBC
CEORH-CD-I

CEORH-CD-I 01 October 1987

MEMORANDUM FOR RECORD:

SUBJECT: Trip Report - Yatesville Lake Project, Contract No. DACW69-86-C-0039

1. On 30 Sept 87 H. P. Oshel visited the subject project for the purpose of inspecting the core borings being drilled to investigate the foundation problems. I was met at the project by Steve Hornbeck and Jim Owen, ED. Chester McDavid, Dan Boster, Mike Neild of the project were also present.

2. Background. Reference is made to Trip Report of 25 and 28 Sept. The contractor is completing drilling the holes referred to in the trip reports.

3. To date the core borings have indicated that the broken zone on the left side occurs generally in the range of elevation 514. Some holes show another broken zone about elevation 510. Right side excavation was established earlier. A coal seam is present and is consistant about elevation 507, dipping slightly toward the right abutment. Mike Neild is drawing up sections and logs and will deliver them to the District Office on 1 Oct. At that time Steve Hornbeck and I will call Charlie Canning, ORD, discuss the foundation conditions and propose a method of treatment. Also on 1 Oct the contractor will clean off the rock surface to the left of the trench and we will inspect and map the surface and recommend treatment on 2 Oct. At the present time it appears that left side excavation will extend to about elevation 514. The contractor will pressure test and backfill all holes tomorrow. The problem may be how to transition from the 621 elevation on the right side to the 614 on the left.

4. Overburden excavation was still in progress on the downstream slope.

5. No safety violations were noted.

H. P. OSHEL
Geologist

CF:
CEORH-CD-I
CEORH-CD-YBC

CEORH-CD-I 5 October 1987

MEMORANDUM FOR RECORD:

SUBJECT: Trip Report: Yatesville Lake Project, Contract No. DACW69-86-C-0039

1. On 2 Oct 1987 H. P. Oshel visited the subject project. I was met at the site by Steve Hornbeck and Jim Owen, both ED-G. The purpose of the visit was to establish the excavation limits for the broken zone on the left side of the trench which runs up and downstream through the valley bottom.

2. The geologic sections were reviewed and the rock surface on the left side was closely inspected. There were no continuous joints or open planes on this side. There were a few drummy thin bedded layers that will have to be removed prior to placing embankment. It was decided to step back from the left face of the trench about 8-10 feet, just back of core hole No. 4, drill a pre-split line and remove the rock to approximate elevation 521. Depending on where the broken zone is in the area of the excavation dental concrete or same additional excavation may be required to treat this feature. Hornbeck and Oshel then called Charlie Canning, ORDED-G and presented the planned excavation program to him. Canning agreed with the plan and will visit the job next week to inspect the excavation.

3. On the right side of the trench the previously determined excavation was in progress. Rock was being excavated between the pre-split line and the trench using a back-hoe and dumps. The excavated rock was being placed in the downstream random section and consisted of a moderately hard, grey sandstone. Not enough material had been excavated so the bottom could be seen. It should be cleaned up in a couple of days.

4. No safety violations were noted.

H. P. OSHEL
Geologist

CF:
CEORH-CD-I
CEORH-CD-YBC

OCT 1987
RECEIVED
Resident Engineer
Yatesville Lake

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MEMORANDUM FOR RECORD

SUBJECT: Trip Report - Yatesville Lake Project Contract No. DACW69-86-C-0039

1. On 6 October H. P. Oshel visited the subject project. The purpose of the visit was to inspect the foundation excavation of the broken zone in the valley bottom and decide when ORD Geotech Rep should visit the job. I was met at the project by Steve Hornbeck and Jim Owen both ED-G.

2. The contractor had drilled, shot and excavated the broken zone on the left side of the valley. The pre-split lines are good but the bottom was covered with water and mud and could not be observed. It will be washed down and cleaned by 9 Oct. We could observe a good flow of water coming from the bottom. There was a joint or bedding plane near the toe of the left side pre-split line, which meandered more towards the center of the excavation as you look downstream, that was making most of the water. Where this plane could be observed I was able to run the ends of my fingers in it. Coal fragments and sand were being washed out of the opening.

3. Steve and I called Charlie Canning, ORD-G, and decided that the best time for him to come to the job would be Friday. We will meet him at the project, at which time a close inspection of the bottom will be made and treatment, if any, will be decided.

4. Grout hole drilling had been initiated on the right side and to date 5 holes have been drilled.

5. Placement of random rock fill in the downstream section was still in progress and about 3-5 feet had been placed.

6. No safety violations were noted.

H. P. OSHEL
Geologist

20 Oct 87

CEORH-CD-I

MEMORANDUM FOR RECORD:

SUBJECT: Trip Report - Construction of Dam - Yatesville Lake, Kentucky, Contract No. DACW-69-86-C-0039

1. On 9 Oct 87, H. P. Oshel visited the subject project. The purpose of the visit was to inspect the valley bottom where the broken rock zone had been excavated. I was met at the site by Steve Hornbeck, Jim Owen and Jerry Phelps, ORHED-G and Charlie Canning and Russ Fondalier, ORDED-G.

2. We were informed by Ray Boley, RE, that progress had been slow on clean-up in the bottom and that he talked with the contractor about this. When we viewed the bottom, it was still about 80 percent covered with mud and water and nothing could be seen. The portion from the toe of the left abutment to the trench had been washed down and we were able to inspect it. With the exception of a good bit of drummy rock, the surface looked good. Several joints were present which may have to be treated. We decided to return on 15 Oct to inspect the bottom. Water was observed running through joints or open bedding planes in the bottom.

3. Jerry Phelps expressed some concern that we were not removing all the overburden from the valley walls prior to placing random embankment. Ray Boley stated that all the random had been placed against rock abutments. The area in reference was just above where the embankment was being placed and was a small overburden slide on the bedrock. All the abutments will be stripped to rock. There was also some confusion about the amount of a random embankment we had placed. Some thought it would only be about 50 feet wide from the downstream slope whereas it's about 50 feet downstream from the transition. After the lift, we will bench and step back about 35 feet and bring it up to the agreed elevation of 570. Ray Boley explained the planned embankment placing to the group and it's my understanding that all are aware of what's being done and why and are in agreement.

4. No safety violations were noted.

HOMER P. OSHEL, Geologist
Construction Division
S&I/Q Branch

CF:

CEORH-CD-I, (Oshel), wd
CEORH-YBC, wd

OCT 1987

CEORH-CD-I 28 October 1987

MEMORANDUM FOR RECORD

SUBJECT: Trip Report, Yatesville Lake Project, Ky. Contract No. DACW69-86-C-0039

1. On 23 October 1987, H. P. Oshel visited the subject project. The purpose of the visit was to inspect the excavated area of the broken zone that had not been covered by concrete and discuss the grouting with Mike Neild and Ray Boley.

2. The grouting program is being accomplished as follows: drilling and grouting the upstream and downstream lines at the same time, doing all holes and completing Zone I; we will complete all the right angles holes in the bottom before drilling the left angled holes; the planned 3 lines of grout holes will be completed prior to drilling/grouting the added consolidation holes; Pressure applied 4 psi, Zone I, 5 psi, Zone II; the center line of holes, where required, will be done after completing the up and downstream lines; the program was started with sections, sta 3+00 to 4+90 but due to the limited space, the alternating sections couldn't be maintained, but the required distances and time were followed; the water pressure test is being done on holes near the drilling operation. Mike Neild is keeping a good sectional plan of the grout holes and takes.

3. During the past 4 days, the excavation we required in the broken zone (MFR dtd 22 Oct 87) was accomplished and approximately 2/3 or more of the area was backfilled with concrete. A total of 277 cy was placed on 22 October. The downstream part, about 40 feet long, will be backfilled on 23 October. The rock was being cleaned while I was on site and the cleaned area looked very good. At the base of the excavation, ele 515±, a thin section of the broken zone could be seen and looking across the downstream face of the excavation from left to right and going up in elevation, the broken zone widened to an area about 20 - 30 inches wide. Large areas of grout could be observed in the broken zone. This grout apparently came from core hole no. 6 when it was backfilled, which means the grout moved about 30 - 35 feet. In several places, water was coming out of the broken zone. These areas are being referenced and, if necessary, grout pipes can be set at a later time.

4. The downstream random fill will be up to elevation 570 today. This is the highest elevation we will place to this season. Concrete had also been placed in the intake structure to elevation 635 and was covered and heated when necessary.

5. No safety violations were noted.

6. Photos were taken and are on file.

H. P. OSHEL
Geologist

Yatesville

CEORH-CD-I 28 October 1987

MEMORANDUM FOR RECORD

SUBJECT: Trip Report, Yatesville Lake, Contract No. DACW69-86-C-0039

1. On 27 October 1987, H. P. Oshel visited the subject project. I was accompanied by Gene Weekly, LTC. of the EPA Branch. The purpose of the visit was to inspect and coordinate the grouting program and inspect a rock cut bench on the left abutment.

2. The contractor was drilling grout holes in the valley bottom about sta 6+40. While we were on the site, a downstream Zone I hole was completed to 54 feet. A large artesian flow was encountered at approximately 53 feet. No grouting was in progress while we were on site.

3. A bench on the left abutment at approximate ele 635 was inspected. After the rock was cleaned, several joints in the rock were present. The joints run in an up and downstream manner and are in sandstone. The sandstone at this bench elevation is 2 - 3 feet thick with shale underlying. The joints appear to stop at the base of the sandstone. One major joint runs the complete width of the core trench and is a fairly strong joint. It has also been somewhat loosened by blasting as several shattered rock zones from the production shot can be observed. This joint is located about midway between the toe and outer edge of the bench. Three other open joints are present in this outer part of the bench. It was my recommendation that we step behind the strong joint that crosses the core trench, line drill and remove the rock down to the underlying shale. Representatives of ED-G will inspect this area tomorrow.

4. In a discussion of the grouting program in the RE office, we discussed a recommendation by Charles Canning, Division Geologist, that we increase grout pressures in Zone II from 5 psi to 10-15 psi. By setting a packer down at least 5 feet, we feel that the increased pressure can be safely applied.

5. All the broken zone rock excavation and replacement with dental concrete is complete. A total of 523 cy of dental concrete and grout were used. Pipes for contact grouting were set.

6. No safety violations were noted.

H. P. OSHEL
Geologist

CEORD-ED-G 28 October 1987

MEMORANDUM FOR RECORD

SUBJECT: Trip Report, Yatesville Dam, Inspections of the Broken Zone Dental Excavation

1. Dates. This report is a composite of five trips made between 21 September 1987 and 22 October 1987.

2. Purpose. The purpose of the trips was to consult with district geotechnical and construction personnel on various investigations and treatments for the broken zone.

3. Attendees. For attendees, see list, attachment 1.

4. Background. During the week of 14 September 1987, Mr. Steve Hornbeck (CEORH-ED-GG) telephoned Mr. Charlie Canning (CEORD-ED-G) and informed him that the contractor would have the foundation for Yatesville Dam uncovered by the end of the week. A site visit was scheduled for 21 September 1987 to inspect the foundation. Mr. Canning met with district and resident personnel on the morning of 21 September 1987. A broken zone extending upstream and downstream near centerline station 5+80 ± had been uncovered prior to the visit (see photos 1 through 4). A detailed inspection of the zone was not possible at this time as the area had flooded during the weekend due to a pump failure. The group met in the resident's office and agreed that exploratory core borings should be taken on each side of the zone to determine the type and extent of treatment required (see figure 1 for locations of borings).

On 25 September 1987 the district informed CEORD-ED-G that most of the core borings would be completed and a meeting would be held at the site on Monday, 28 September 1987. Mr. Fondelier and Mr. Canning met with district and resident personnel on this date to examine the core samples (see photos 5 through 10). After the inspection the group met in the resident office and agreed to excavate back from the broken zone to a distance where there would be a minimum of 5 feet of sound rock over the zone as shown in figure 1.

Mr. Hornbeck informed division personnel that the contractor had completed the excavation and would have the site ready for inspection on or about 9 October 1987. Mr. Fondelier and Mr. Canning met with district and resident personnel on this date. However, the contractor had not completed clean-up and sections of the broken zone were flooded. Therefore, the final inspection of the broken zone was delayed until 15 October 1987.

On 15 October 1987, division personnel met with district and resident office personnel to inspect the broken zone and determine the method of treatment to be used. The group mutually agreed that the bottom of the broken zone should be lowered an additional 3 to 4 feet or to sound rock, whichever came first, and backfilled with concrete (see photos 11 and 12). Additional excavation in the downstream area would also be required due to an open joint and broken

Yatesville Lake

rock along a bedding plane (see photos 13 through 15). Once excavation in the area (shown in photo 15) was completed, the team would make a final inspection before placing backfill concrete. During the inspection the group also discussed the treatment for the right side presplit slope face. In the upstream area the partially open bedding plane as shown in photo 17 would be treated with concrete. A second open bedding plane (shown in photo 18) located downstream would be excavated back toward the right abutment and treated with concrete.

Mr. Hornbeck informed division personnel on 20 October 1987 that the contractor had completed the additional excavation requested by the team on 15 October 1987 and the broken zone would be ready for inspection on or about 22 October 1987. Division personnel traveled to the site on 22 October 1987 and met with district and resident personnel.

5. Observations made during the 22 October 1987 visit. The contractor had completed the excavation and clean-up in preparation for placing backfill concrete. The bottom of the broken zone had been excavated to an average elevation of 518±. It was evident in some areas that the zone extended below the present surface and a highly broken zone remained in the left face of the excavation (see photos 21 through 24). The rock in the bottom and the broken zone in the slope face did tighten up in the area starting approximately 20 feet upstream of the concrete form which was set just downstream of the impervious core placement surface (see photos 24 through 27 and 29 through 33). The remaining broken zone downstream of the form had not been cleaned; therefore, final inspection was not possible (see photos 32 and 33). However, the additional excavation recommended during the 15 October 1987 site visit removed the zone of the open joint downstream from the impervious core and transition placement surface (see photos 13 and 14) and a large section of the near horizontal broken zone (see photos 14 and 15).

6. Recommendations. Upon completion of the inspection, the group discussed treatment of the zone and recommended the following:

a. Concrete should be placed approximately 2 feet above the broken zone along the left slope as shown in photos 21 through 27. To prevent a feather edge the concrete should be placed horizontally for 3 to 4 feet toward the right side before sloping down to the right face as shown in figure 2.

b. The bottom of the excavation should be covered with a sand grout mix and broomed into cracks and joints.

c. Grout pipes should be installed near the upstream end of the excavation over open joints as shown in photo 28.

d. Grout hole locations should be marked along the left slope and mapped for future drilling and grouting. These locations are noted on photos 23 through 27.

e. Grout holes in the broken zone should be grouted upon completion of the grout curtain.

f. The upstream face of the broken zone excavation should be treated with concrete (see photos 36 and 37).

g. The open bedding planes on the right face of the excavation should be treated with concrete. This area is shown in photos 17 and 18.

7. Conclusions. Based on the lithology and the configuration of the broken zone, the group agreed that little would be gained to take the excavation any deeper due to a coal seam and associated soft indurated clay zones as shown in photos 7 and 8. It was the opinion of the group that concrete fill and additional grouting will form a satisfactory protective barrier for the impervious core.

8. Future Actions.

a. The district should keep CEORD-ED-G informed of the progress of the grouting and foundation treatment and the scheduling of site visits to inspect and review critical phases of construction.

b. The district should notify division personnel prior to grouting the broken zone.

c. Since the danger of jacking up the horizontal beds is great, Construction should have a person highly experienced in pressure grouting assisting the project geologist at all times.

d. During several of these visits there were informal discussions regarding the adequacy of the 12-inch maximum size processed sandstone to provide filter against the insitu rock faces at the upstream and downstream ends of the core trench. No decisions were made on this issue as these faces had not yet been totally cleaned and it was anticipated that fill placement would not begin until next construction season. The weather has been excellent and the contractor is now progressing with foundation cleanup and treatment to such an extent that he may be in a position to place some fill before winter shutdown. It is therefore imperative that an evaluation of the materials to be placed in the core trench between the impervious core and the upstream and downstream excavation faces be made expeditiously. The district should advise the division on the results of this evaluation.

CEORD-ED-G
SUBJECT: Trip Report, Yatesville Dam, Inspections of the Broken Zone Dental Excavation

28 October 1987

e. Division should schedule regular visits to the site during grouting and foundation preparation, and should make a final inspection of the foundation prior to fill placement.

9. The undersigned wish to thank district and resident personnel for their cooperation in keeping the division informed of the foundation problems and for the joint effort by everyone involved in solving these problems.

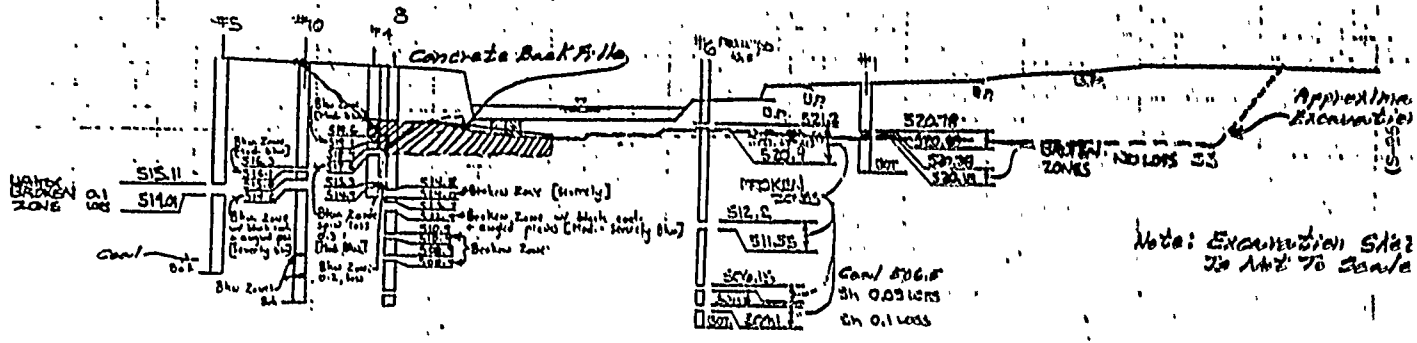
CHARLES G. CANNING, SR.
Division Geologist

RUSS FONDELIER
Division Soils Engineer

CF: CEORD-CO
CEORH-CD
CEORH-ED-GG
CEORH-ED-GS
Yatesville Project Office

YATESVILLE DAM MEETINGS
LIST OF ATTENDEES

		21 Sep	28 Sep	9 Oct	15 Oct	22 Oct
Charles Canning	CEORD-ED-G	X	X	X	X	X
Russ Fondelier	CEORD-ED-G		X	X	X	X
Jerry Phelps	CEORH-ED-G		X	X	X	
Steve Hornbeck	CEORH-ED-GG	X	X	X	X	X
Jim Owen	CEORH-ED-GG	X	X	X	X	X
John Bertram	CEORH-ED-GG				X	
Pat Oshel	CEORH-CD-I	X	X	X	X	
Dave Nugen	CEORH-CD-SWJ			X	X	X
Chester McDavid	CEORH-CD-YBC	X	X	X	X	X
Dan Boster	CEORH-CD-YBC	X	X	X	X	X
Mike Neild	CEORH-CD-YBC	X	X	X	X	X
Ray Boley	CEORH-CD-YBC	X	X	X	X	


#5
#10
8
#4
Concrete Backfill
#6
#1
Approximate Excavation Line
Broken Zone (Slightly)
Broken Zone of Slight seal + angled plane (Mod. Severely Blu)
Broken Zone
Blue Zone
Blue Zone of Slight seal (Severely Blu)
Blue Zone (Mod. Blue)
Blue Zone (Slightly Blu)
Blue Zone (Slightly Blu)
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PROPOSED ACCESS ROAD
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CEORH-ED-GG 29 October 1987

MEMORANDUM FOR RECORD - TRIP REPORT

SUBJECT: YATESVILLE DAM - PHASE II CONSTRUCTION

1. On 28 October 1987 Messrs. Owen and Hornbeck visited the subject site with Messrs. McDavid and Boster of the Resident's staff.

2. An inspection was made of the latest excavation on the left abutment near the inflection point at the bottom of the abutment. The bench above the inflection point had a number of fractures trending across the bench in an upstream to downstream direction which were either caused by or aggravated by blast holes drilled slightly below the grade to which the bench broke. The fractures necessitate the removal of approximately four feet of rock to a small shale seam which was apparent on the excavated face in front of the bench. The second bench above the inflection point appeared satisfactory, while the third bench above the inflection point was concealed by an access road.

3. The impervious blanket upstream of cell #7 has been completed and tied into the blanket for cells 1 thru 6.

4. The revisions to the downstream diversion dike have been completed, except for the placement of the sand bags.

5. Mr. Boster indicated that the Contractor wants to place some impervious core material this year. Prior to placing additional embankment, the foundation for the impervious core, processed sandstone, and sandstone and random rockfills will require the following:

A. Concrete treatment of the end zones of the foundation trench will be required.

B. Completion of drilling and grouting.

C. Completion of dental treatment.

D. Excavation of existing random fill back 20 feet from the existing slope to remove oversize material and to remove the zone of reduced compaction at the edge of the fill.

E. Final cleaning of the abutments.

F. Cleaning and foundation preparation for the impervious core and processed sandstone zone.

G. The limits of the processed sandstone and impervious core should be permanently marked on the abutments.

6. It is noted for the record that if placement of the main embankment begins this year, that portion of the concrete slab on the coffer dam berm which is broken prior to placement (up to four vertical feet ahead of the placement of the fill) would remain exposed throughout the coming flood season.

7. At the present time the Contractor is in the process of placing formwork for the spillway bridge deck

James V. Owen
Civil Engineer
Soils Section

Stephen T. Hornbeck
Geologist
Geology Section

CF:
CEORH-ED
CEORH-ED-D
CEORH-ED-H
CEORH-ED-G
——>CEORH-CD
CEORH-ED-B

1- GRT
2- Deeds
Sam O. cy
YBC

CEORH-CD-I

3 Nov 87

MEMORANDUM FOR RECORD

SUBJECT: Trip Report, Yatesville Lake Project Ky, Contract No. DACW69-86-C-0039

1. On 30 Oct 87, H. P. Oshel visited the subject project. The purpose of the visit was an inspection of the grouting operation and rock on the left abutment at about elevation 630+. Steve Hornbeck and Jim Owen, ED-G were also present.

2. No grouting was in progress on this date. The contractor was setting grout pipes up the right abutment. The grout hole with the large artesian flow referred to in the trip report of 27 Oct had been grouted, taking about 80-90 bags. During our field inspection, the contractor was given permission to drill and grout starting up the left abutment.

3. The 635 bench with the open joint that was discussed in the 27 Oct trip report had been shot out as directed and was pretty well cleaned up. Two joints are still present and although they are open at the surface, the group felt that they could be treated, i.e. grouted and dental treated. Several isolated pieces of loose rock will have to be removed prior to embankment placing.

4. No safety violations were noted.

H. P. OSHEL
Geologist

CEORH-CD-I

4 Nov 87

MEMORANDUM FOR RECORD

SUBJECT: Trip Report, Yatesville Lake Project Ky, Contract No. DACW69-86-C-0039

1. On 3 Nov 87, H. P. Oshel visited the subject project. The purpose of the visit was an ongoing inspection of the foundation grouting program.

2. Grouting was in progress in the valley bottom at about sta 5+60 on the upstream grout line. At the time I left, about 20 bags had been pumped in this hole. Mike Neild, Dan Boster and myself discussed the program. We agreed that the consolidation grout holes would be on 10 foot centers. They are located along the centerline of the up and downstream transitions. These grout holes along with the 'B' line holes will be done after the A and C lines are completed. All grouting is complete from sta. 4+90 to 3+00. The contractor was setting grout pipes up the left abutment. The contractor has ample room in which to drill and grout. It is my understanding that the prime is restricting all his work to the valley bottom.

3. No safety violations were noted.

H. P. OSHEL
Geologist

CEORH-CD-I 16 Nov 87

MEMORANDUM FOR RECORD

SUBJECT: Trip Report, Yatesville Lake Project Ky, Contract No. DACW69-C-0039

1. On 12 Nov 87, H. P. Oshel visited the subject project. The purpose of the visit was to meet with representatives of Engineering Division and ORD Geotech representatives to discuss the grouting program and proposed changes in the embankment section. A list of attendees is attached.

2. After a brief office discussion of the grouting progress to date, the group inspected the work area. Grouting was in progress in the valley bottom. While we were on site, one hole was completed and another started with very little grout take on either. The contractor has set nipples and initiated hole drilling up the left abutment. Grout takes of up to 300 bags have occurred in deeper holes, ie-50-70 feet, where heavy artesian flow has occurred. There have been very few connections to adjacent holes. A discussion was held concerning bench at elevation 631-2 on the left side. This is the bench discussed in my trip report of 30 Oct. After inspection, the group agreed that the open joints referred to could be treated by cleaning and grouting with some additional shallow holes. It was observed that we had some grout leakage along a shale seam at the base of this bench. In my opinion, this indicated effective grouting. The remainder of the valley bottom was inspected. Brief discussions ensued concerning jacking the foundation and various treatment prior to embankment placing. Charlie Canning, ORDED-G insisted that CD needed an experienced grout inspector. Ray Boley and I stated that we felt Mike Neild was doing a good job and we were monitoring the grouting and had no problems with his work. Mr. Canning felt that some situations could arise which an experienced person could help out, specifically, jacking the foundation. He also reminded us that he had a commitment from CD to have an experienced person on the job. We told him we would consider his request and could detail John Lusher to the job.

3. The meeting continued in the RE's office. Russ Foundlier, ORDED-G felt that a change in the embankment section was needed. He felt that the rock fill against the

downstream impervious was gap graded and the fines in the impervious could be piped into the rock fill. He felt that we needed a sand drain from the foundation up. This would be 8 feet wide. Jerry Phelps said a slightly dirty concrete sand would do. Engineering Division will issue a request for a modification. ED-GS had also worked up some gradiation curves and sections which are attached. Dan Boster pointed out that the curves for the random rockfill embankment are not gap graded. Our present concrete sand has about 0.7% passing a No. 200 seive. It was stated that if we believe the random embankments test fill gradiations, we could eliminate the drains, but we will put them in anyway. Treatment of the upstream area was discussed and ED would like to hold off on this for awhile, i.e. they are not ready to propose a mod at this time, although we did discuss a sand drain to some extent. A rough sketch is attached.

4. We discussed the location of the additional grout lines in the trench portion of the valley bottom. As reported in my MFR of 3 Nov, we had planned to complete the 2 required lines prior to doing the optional B line along with the consolidation holes and the contact holes. As suggested in a previous meeting with ORD representatives, the consolidation holes would be located in the center of the up and downstream transitions. Some concern now exists as to the location of the downstream line, as this could allow water to build up between the grout lines and possibly exit to the downstream under pressure, like a nozzel effect. Some thought it was better to let the water dissapate and have no downstream grout line or move it near the downstream toe of the core. It was also pointed out that the downstream consolidation program could just be gravity grouted to fill any voids encountered. As I understand it, ED will propose to CD in writing this additional work. Charlie Canning said the holes we are going to drill near the upstream sump should go through the dental concrete and about 10 feet into rock.

4. No safety violations were noted.

H. P. Oshel
Geologist

attachment

CF
CEORH CD YBC

12 Nov 87

Yatesville Attendees

Charlie Canning	CEORD
Russ Foundalier	CEORD
Jerry Phelps	CEORH-ED-G
Jim Owen	CEORH-ED-G
Steve Hornbeck	CEORH-ED-G
Pat Oshel	CEORH-CD
Ray Boley	CEORH-CD-YBC
Dan Boster	CEORH-CD-YBC
Chet McDavid	CEORH-CD-YBC

CEORH-CD 18 Nov 87

MEMORANDUM FOR RECORD

SUBJECT: Trip Report, Yatesville Lake Project, Ky. Contract No. DACW69-86-C-0039

1. On 17 Nov 87, H. P. Oshel visited the subject project. The purpose of the visit was an inspection of the on going grouting program.

2. Grouting was in progress in the trench portion of the valley bottom. Considerable grout was being placed between a 3 to 1 and 5 to 1 mix. It was found that a heavy mix such as 1:1 would plug off the hole. The contractor has set up 2 grout plants in the bottom and plans work both. Drilling was also in progress on the left abutment. John Lusher is now on the job working with Mike Neild. The way I see it, drilling and grouting in the valley bottom will probably take another three weeks.

3. Two concrete placements were made on the spillway bridge deck yesterday, 16 Nov 87. Heavy rains delayed work today.

4. No safety violations were noted.

H. P. OSHEL
Geologist

CEORH-CD-I 1 December 1987

MEMORANDUM FOR RECORD

SUBJECT: Trip Report, Yatesville Lake Project Kentucky, Contract No. DACW69-86-C-0039

1. On 30 Nov 87 H. P. Oshel visited the subject project. The purpose of the visit was to discuss and inspect the foundation grouting program and the initiation of the test fill program.

2. Grouting is continuing in the valley bottom. Work is still in progress on the A and C lines, with quite a few Zone II holes remaining. The B-line along with the added up and downstream lines have not been started. We anticipate about 3 more weeks work in the valley bottom.

3. The first lift was being placed for the test fill. All lifts are 1-foot with various compactive efforts as decided in a joint ORD-ORHCD-ED meeting. The fill is being placed on the downstream random section. The compaction requirements are painted on the left abutment rock and the zones are clearly staked. The operation looked very satisfactory.

4. A severe erosion problem was noted near the spillway bridge at sta 17+50 access road, where the 24-inch pipe daylights on the fill section. There is a deep (12-18") ditch from the scour pad to the bottom of the slope. We will put a stone lined ditch to the bottom of slope. This will be paid for under the roadwork pay items.

5. No safety violations were noted.

H.P. OSHEL
Geologist

Yatesw DL

CEORH-CD-I 4 Dec 1987

MEMORANDUM FOR RECORD

SUBJECT: Trip Report, Yatesville Lake Project, Ky.
Contract No. DACW69-86-C-0039

1. On 3 Dec 1987, H. P. Oshel visited the subject project. The purpose of the visit was to meet with representatives of CEORD-ED-G and CEORD-ED-G and inspect the test fill operations and discuss progress to date. The ongoing grouting operation was also inspected. A list of attendees is attached.

2. The contractor is in the process of placing the third one-foot lift on the test fill. The sandstone appears well graded. The D-7 dozer working the fill would break down any rock that would not fit in a 12-inch lift. The material is all sandstone from the rockborrow area. Fill elevation is about 573. The fill is divided into 4 zones, each receiving different compaction requirements. We observed complete cycles of dumping, spreading and compacting. Two small holes were dug (approximately 12x12 inches) to visually look at compaction and voids. No voids were observed and compaction appeared good, checking with penetration of a pocket knife although to the eye the section compacted with the vibratory roller appeared tighter. The fills should be completed in about 3 days depending on the weather, at which time we will start the test pits.

3. Grouting. The contractor was backfilling the completed grout holes and drilling on the left side. All available holes were grouted yesterday. He worked until 10:00 p.m. last night. Pipes had been set for the B-line and the pipes were being set for the additional up and downtream lines. The left slanting holes on the C-line remain to be completed after which he will start on the B-line holes.

4. A discussion of the field inspection ensued in the RE's office. ORD would like to look at the test pits late next week. It was noted that the test fills look good. The rock is breaking and the compaction equipment doesn't make much difference other than the sheepsfoot. We prefer the vibratory. The inplace moisture on the rock is 2 to 3% and the density of the previous test pits were 132 to 133 lbs. which was the design assumption. The added downstream line of grout holes should either be gravity grouted or very low pressure grouted.

5. No safety violations were noted.

H. P. OSHEL
Geologist

CEORH-CD-I 14 December 1987

MEMORANDUM FOR RECORD

SUBJECT: Yatesville Lake Project, Kentucky,
Contract No. DACW69-86-C-0039

1. On 10 Dec 87, H. P. Oshel visited the subject project. The purpose of the visit was to meet with representation of Engineering Division and ORD Geotech. Present from ORHED-G were Steve Hornbeck and Jim Owens and ORDED-G, Russ Foundalier and Charlie Canning. Ray Boley and Dan Boster CD-YBC were also present.

2. The contractor has completed the test fill and is in the process of digging the required 4x4x4 test pits. Of the initially required 4 pits, one has been completed and one was underway. The pits should be completed by Dec 15th. The test pits looked very good, no voids were noted in the walls and the rock appeared well graded. Gradiation results will be furnished to us by the contractor.

3. Grouting operations were still continuing in the valley bottom. Grout pipes have been set for the B-line holes along with the two additional up and down stream lines. Pressure testing and drilling were in progress while we were on site. Charlie Canning seemed to be satisfied with the work. Both John Lusher and Mike Nield were on the job. Artesian water is still being encountered drilling some Zone II holes in the bottom.

4. The erosion problem at access road sta. 17+50 as noted in my MFR of 1 Dec 87 has been corrected. A Type 2 stone ditch has been placed down the entire slope. Grading was in progress at the base of the slope and should be completed today.

5. No safety violations were noted.

H. P. OSHEL
Geologist

CEORH-CD 18 March 1988

MEMORANDUM FOR RECORD

SUBJECT: Trip Report, Yatesville Lake Project, Contract No. DACW69-88-C-0039

1. On 16 Mar 88, H. P. Oshel visited the subject project. The purpose of the visit was to inspect the ongoing dental concrete and the cleaning operations in the valley bottom. I was met at the site by Steve Hornbeck and Jim Owen, ED-G.

2. The dental concrete work is progressing well. The coal and shaley area on the right abutment is completed and the contractor is stripping the forms. All dental work in the lowered section of the valley is essentially complete.

3. Water was seeping into the foundation through fractures in the rock near the upstream center of the lowered area. This seep, which is in a lower area of the foundation, is directly related to the amount of water being pumped from the sump which is about 20 feet upstream. When the pump is running, the flow stops. We decided to pump the water down, clean and remove drummy rock, pack the fractures with oakum and dental concrete the area. Pumping would be in progress during this time.

4. Drilling for grout holes was in progress on the left abutment. It is expected that all drilling will be complete in 2-3 weeks.

5. No safety violations were noted.

PAT OSHEL
Geologist

CF:
CEORH-CD-YBC✓

CEORH-CD (1180) 19 April 1988

MEMORANDUM FOR RECORD

SUBJECT: Trip Report, Yatesville Lake Project, KY, Contract No. DACW69-86-C-0039

1. On 13 April 1988, H. P. Oshel visited the subject project. The purpose of the visit was to observe embankment placing operations and meet with representatives of Engineering Division, Steve Hornbeck, Jim Owen and Larry Franks, ED-G.

2. Concern had been expressed by ED over the movement and cracking of the impervious material under rubber tired equipment. The above mentioned, myself, Ken Zimmerman and Dan Boster of the project observed the embankment placing. The material, which is a very silty clay, was pumping and showing some surface cracking under the movement of scraper tires. We had been informed by Brian Withers that all compaction tests met our requirements and all but one moisture test had passed. It was over by 0.5%. The pumping and cracking is due to the silty nature of the fill material. After discussing the issue, it was decided to have a scraper cut a 3-foot deep trench, about 15-20 feet long across the impervious near the upstream edge, just right of the drain. We also decided to cut a block sample, these are pay items in the spec's, from this area and ship to ORDL for testing. The block sample will be taken just upstream from center line about sta 5+75. After the scraper had cut the trench, we observed no cracking in the fill other than a couple in the uncompacted top lift. The fill was so tight that it was difficult to shove a knife blade into the fill. Engineering Division was satisfied with the embankment placement operation. The block sample will be cut tomorrow. CD personnel were concerned about the effects of the movement of the scrapers over the fill and the shearing effect they have on the compacted fill during the excavation of the trench. The embankment will have to be disced and recompacted prior to resuming embankment placing operations. We also ran a loaded scraper close to the edge of the trench to see if cracking occurred, none was observed.

3. ED also had concerns over the removal and placement of material from the upstream haul road in the upstream sandstone rockfill. ED feels this material should be removed or placed in downstream random zone.

4. In the vicinity of sta 4+25 to 4+50, ±, a shale seam about 4-6 inches thick was present. This was in the form of a lobe with sandstone underlying the shale. At the time this area was to be covered with impervious, a small water seep between the shale and sandstone was detected. A small

CEORH-CD
SUBJECT: Trip Report, Yatesville Lake Project, KY,
Contract No. DACW69-86-C-0039

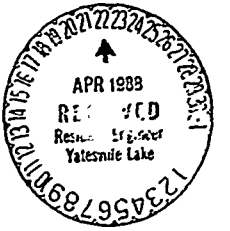
depression was cut in the sandstone very near this seep and a 8-inch riser pipe set with rock spalls and small rock placed around the base to allow the water to seep into the pipe. After this was done, embankment was placed and hand compacted around the pipe. The contractor set a pump at the pipe and would pump when water would build up. Engineering people did not like this pipe and thought it should have been concreted in rather than having stone around it. They felt that water could seep int the embankment. We discussed methods of backfilling the pipe. It was decided to grout the bottom portion, place 2 feet of bentonite and concrete up the remainder.

5. The contractor was also breaking up the concrete slab on the upstream slope. This was being done with a single tooth ripper on a D-8 dozer. The concrete was being cut completely through on 10-foot centers. ED-G would prefer that we rip across the concrete on 10-foot centers so as to produce a block effect.

6. No safety violations were noted.

PAT OSHEL
Geologist

CF:
CEORH-CD-YBC



CEORH-CD (1180) 6 April 1988

MEMORANDUM FOR RECORD

SUBJECT: Trip Report, Yatesville Lake Project, Kentucky
Contract No. DACW69-86-C-0039

1. On 25 Mar 88, H. P. Oshel visited the subject project. The purpose of the visit was to inspect the foundation prior to the contractor initiating embankment placement operations. Others present were Jim Owen and Steve Hornbeck, ED-G, Russ Foundilier and Wayne Swartz CEORD-ED-G along with the Resident Engineer.

2. The valley bottom area of the foundation was inspected in detail. Loose and drummy rock was marked for removal. Joints that needed cleaned out and grouted were also noted. Generally, the foundation clean-up and preparation looked very good. The contractor plans to work over the week-end to complete the cleaning so that fill placement can start Monday, 28 March.

3. After the inspection, a meeting was held in the RE's office to discuss the inspection and placement procedures. The group agreed that clean-up and foundation preparation was proceeding very well. A lengthy discussion followed on the method of placing the initial lifts of material in the valley bottom. Much concern was expressed by ED and CEORD-ED representatives about running equipment across the rock in order to make the first lift. It was decided to end-dump the sandstone rockfill at the upstream toe, shove it into the lower most foundation area and then shove the impervious ahead so that traffic over the foundation rock would be held to a minimum. The first lift of impervious will be compacted with wheeled equipment. We went back to the job site to make sure all were in agreement about what we would do and where.

4. Project geologist, Mike Nield, is mapping the foundation on a 1 to 10 scale map. Photo's are being taken.

5. No safety violations were noted.

Pat Oshel
Geologist

CF:CEORH-CD-YBC

CEORH-ED-GS
MEMORANDUM FOR RECORD

SUBJECT: YATESVILLE DAM, PHASE II CONSTRUCTION 18 April 1988

1. On 12 April 1988, Messers Hornbeck and Owen visited the site and reviewed the work in progress.

2. At this time, placement of the impervious core, and the upstream and downstream processed sandstone zones were at approximately elevation 534.0, and ripping of the slab was in progress and appeared satisfactory. During observation of the impervious core material placement, it was noted that the scrapers and end-dumps were causing what appeared to be excessive rutting and heaving of the impervious core material. It was also observed that an 8"ϕ standpipe had been installed 5 feet upstream of centerline in the impervious core at about station 4+90± to top rock. The 8"ϕ standpipe was reportedly installed to contain the seepage in the foundation in order to place the impervious core. It is understood that the standpipe was placed on top of rock with pea gravel around the base of the pipe prior to placeing the impervious material. The standpipe was apparently not encased in concrete at the base. The fill height around the pipe at this point was approximately 4 to 5 feet.

3. A meeting of CEORH-ED-G personnel was held on 12 April 1988 to determine if there was a need for revising the specifications or the remedial measures required. Based on QA tests, it appears that most of the impervious core material in place will meet the specifications. Of the approximately one dozen compaction tests performed so far, all of the tests except one were within the limits of the specifications. One test was 1/2 percent over or 2 1/2 persent above optimum. Because of the pumping action of the impervious core, it was decided that a scraper would be used to excavate a test trench to observe if damage to the impervious core material due to traffic loading conditions was occurring.

4. On 13 April 1988, Messers Franks, Hornbeck and Owen returned to the site, and specified the limits of the test trench. The test trench was located on the upstream side of the impervious core at about station 5+00±. A visual inspection of the trench indicated no apparent cracks or separations along lifts in the base or walls of the trench. The scraper was then loaded and directed to make several passes within 1 to 3 feet of the trench wall. Although the trench wall would heave and pump, no visible sign of cracking appeared. During this test, however, some disturbance was done to the

in place core material due to the turning of the equipment. In these areas, it was agreed that the fill would be recompacted. Although it was apparent that the trench walls were not damaged due to the compaction effort, it was also apparent that the trench may not have been deep enough to penetrate the zone of core material that was causing the pumping. It is believed that pumping of the material is primarily due to the type of material (silty clay), an increase in pore pressure, the material being too wet of opitmum although meeting the specifications, possible foundation seepage outside of the core limits that are not being pumped by the two main standpipes, and surface water ponding between the core and the concrete slab in the processed sandstone. It would appear that the pumping action will continue until the material in the problem area is either bridged or removed. It was agreed that block samples would be taken on 14 April 1988 and sent to ORD as soon as possible to evaluate existing conditions with design values.

5. On 14 April 1988, Messers Coffman, Fondelier, Hornbeck and Owen discussed the pumping problem of the core, the use of haul road fill material as fresh 24" sandstone, the location of the 8"ϕ standpipe and the preparation of the random fill face downstream of the centerline of the dam. It was generally agreed that the results of the impervious block samples would determine if removal of a portion of the impervious fill at the center of the valley would be required. It was also agreed by those in attendance and Wayne Swartz, Geologist (CEORD-G), that the existing impervious material around the 8"ϕ standpipe and the shale seams that required the standpipe should be removed. Removal of the shale seam, and exposure of the foundation would then permit proper evaluation of the source of seepage and provide for proper treatment. The use of haul road fill in place of 24" sandstone was then discussed. Although the haul road was constructed from sandstone from the rock borrow area, the material has been subject to severe breakdown and contamination from hauling equipment and weathering. A visual inspection of the material would indicate the material should be used as random or spoiled. During placement of the haul road material some pumping was noted. Because of the severe weathering and breakdown of this material, and the concern with the pumping action, it is believed that the haul road material should not be placed in or be used as 24" sandstone material.

6. As a result of the above discussions within Engineering Division and those with ORD, the following should be revised.

   a. The 8"ϕ standpipe within the impervious core should be removed along with the required core material down to top of rock as agreed to by phone. The foundation will

then be inspected and the remedial actions taken to ensure that seepage will not be in direct contact with with core material.

b. A block sample of the impervious core material will be taken, in the area that pumps the most and sent to ORD for testing.

c. The haul road material will be spoiled as agreed to by phone.

d. The outer face of the random fill will be removed as agreed to previously.

Steven T. Hornbeck
Geologist
Geology Section

James V. Owen
Civil Engineer
Soils Section

CF:
CEORH-ED
CEORH-ED-D
CEORH-ED-G
CEORH-ED-GG
CEORH-ED-GS
CEORH-ED-GM
CEORH-CD
CEORD-G

CEORH-ED-GS
MEMORANDUM FOR RECORD

SUBJECT: YATESVILLE DAM, PHASE II CONSTRUCTION 18 April 1988

JWP

1. On 15 April 1988, Messers Deeds, Turner, Oshel, Zimmerman, McDavid, Boster and Hill of CEORH-CD met with Messers Phelps, Hornbeck, Owen and Meadows of CEORH-ED-G, at the project site. The main purpose of the meeting was to inspect the area of the 8"ϕ standpipe.

2. The foundation in the area of the standpipe indicated two small leaks in the area where the weathered shale had been. One leak appeared to be exiting from a clay seam approximately 10' upstream of the previous location of the 8"ϕ standpipe and the other leak was at the upstream side of the trench near the contact zone between the processed sandstone and the core. It was agreed that the area closest to the centerline would require dental treatment and the area of seepage at 10' upstream of the centerline would require a standpipe. The standpipe will be placed directly over the seepage and anchored into rock with concrete.

3. Use of the haul road material was then discussed. In general, it was agreed that the existing 8' of haul road material would remain in place between the concrete slab and the processed sandstone. It was also agreed that the remaining outer surface of the haul road fill, however, will be spoiled and only the unweathered sandstone remaining will be used as 24" sandstone.

4. Cleaning of the random fill face was in progress at the time of the inspection.

Stephen T. Hornbeck
Geologist
Geology Section

James V. Owen
Civil Engineer
Soils Section

CF:
CEORH-ED
CEORH-ED-D
CEORH-ED-G
CEORH-ED-GG
CEORH-ED-GM
CEORH-ED-GS
CEORH-CD
CEORD-ED-G

CEORH-CD-I (1180) 21 April 1988

MEMORANDUM FOR RECORD

SUBJECT: Trip Report, Yatesville Lake Project, KY,
Contract NO. DACW69-86-C-0039

1. On 15 April 1988, H. P. Oshel visited the subject project. David Deeds, Joe Turner, CEORH-CD, Steve Hornbeck, Jerry Phelps and Jim Owen, ED-G were also present. The purpose of the visit was to inspect and discuss the excavation to rock and to assess the water problem referred to in my trip report of 13 Apr 88.

2. The contractor had excavated through about 8 feet of impervious embankment down to foundation rock and removed the shale seam. The cuts through the impervious were vertical. The excavation was approximately 15' x 15' or slightly larger. Water was seeping in through the sandstone-shale contact along the upstream face of cut, parallel to the ℄ of the dam and at 2 places along the cut face running up and downstream. The larger of these seeps was producing about 1/2 pint of water per minute. The original stand pipe was about a foot or so from the larger seep, and set into a shallow depression with rock around the base of the pipe.

3. At a meeting in the RE's office, it was decided to set the 8 inch pipe over the larger seep place dental concrete around the pipe and the shale cut face. ED wants to isolate the impervious from the seeps. Perhaps the most critical item is replacing the impervious embankment so that we have a tight, uniform fill. This was discussed and decided to cut the impervious section back at no flatter than 1 on 1. The right side is on rock and the upstream face is on the transition contact which should not be disturbed and this cut will be left near vertical and the material tied into the existing fill.

4. The placement of fill from the upstream haul road to the sandstone fill was discussed. Some felt that the haul road material did not classify as rock fill. We will remove some of the material, place some in the downstream random section and what is appropriate in the upstream sandstone fill. place

5. No safety violations were noted.

PAT OSHEL
Geologist

CF:
CEORH-CD-YBC

APR 1988
RECEIVED
Resident Engineer
Yatesville Lake

CEORH-ED-GS

MEMORANDUM FOR RECORD
Subject: Yatesville Lake, Right Abutment Slide

27 February 1989
Mr. Owen/5231
JWP

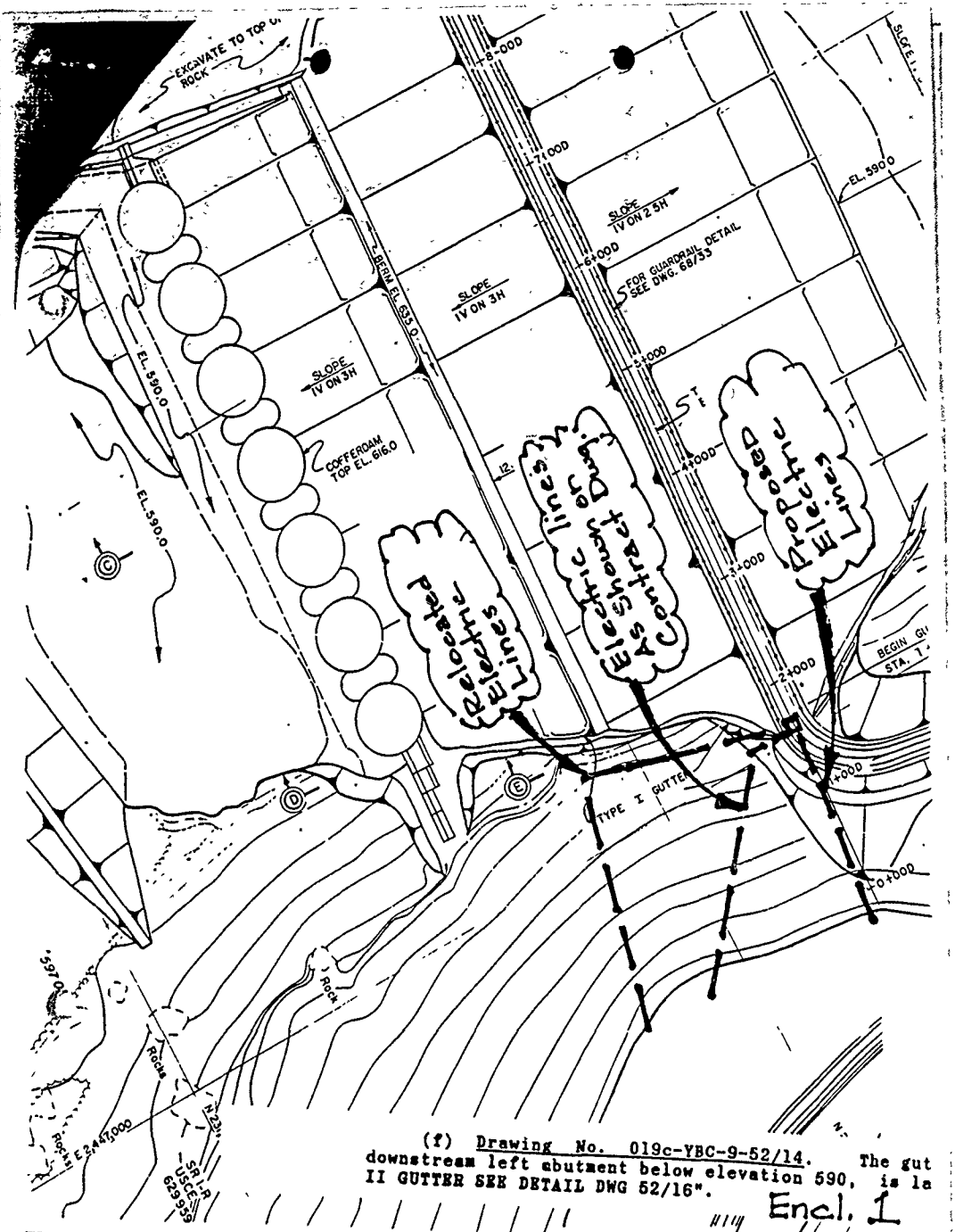
1. On 23 February 1989, Messrs. Copher and Porter of CEORH-ED-D and Phelps, Owen, and Hornbeck of CEORH-ED-G, met with Zimmerman, Mc David and Boster at the site to discuss the above subject.

2. The slide area in question is located on the right abutment upstream from the centerline of the dam. The primary and secondary power supply lines for the intake structure presently passes through the toe of the slide. Based on current field conditions it would appear that the slide is moving along the top of rock and if the slide should continue it may block the rock paved gutter on the right abutment. A small slide was noted in this area during construction of the embankment and the surface of the slide area was reworked in an attempt to prevent further sliding. Based on contract drawings , the original alignment for the power supply lines for the intake structure would have been through the initial slide area, however, CEORH-CD relocated the power supply lines upstream of the initial slide area in an effort to prevent possible damage to the lines. Because of saturation of the overburden slope on 16 February 1989, the limits of the original slide area has expanded and the power supply alignment is now endangered.

3. A review of the site conditions indicated that the best possible alignment for the electric lines would be as shown on enclosure 1. This alignment would require the proposed power line be placed below rock and encased in concrete. Excavation into overburden may require shoring. Because of this alignment change at least one new manhole would be required and the power supply lines will probably have to be spliced.

James V. Owen
Civil Engineer
Soils Section

CF
CEORH-OR
CEORH-ED-D
CEORH-ED-G
CEORH-ED-B
→CEORH-CD-YBC



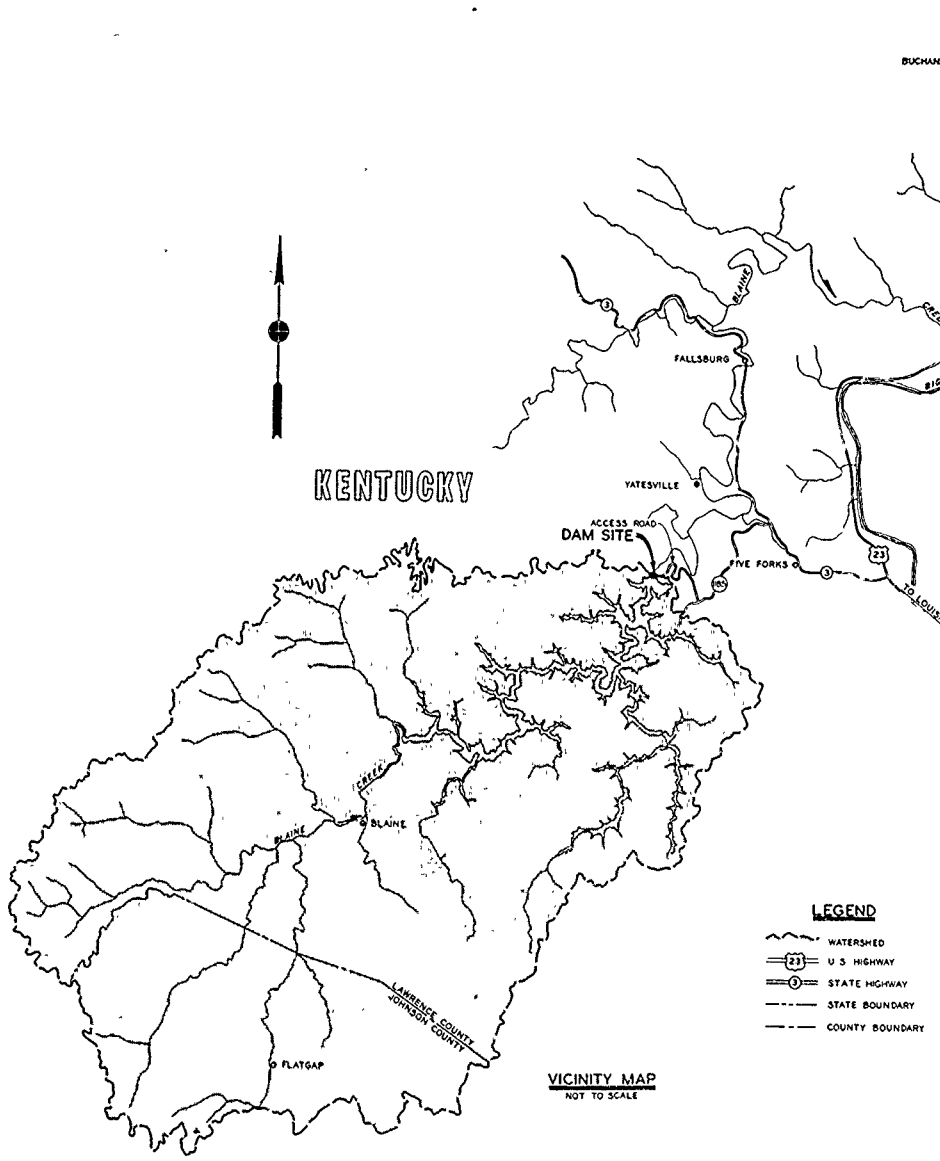
(f) Drawing No. 019c-YBC-9-52/14. The gut
downstream left abutment below elevation 590, is la
II GUTTER SEE DETAIL DWG 52/16".

Encl. 1

12-05 EXHIBITS

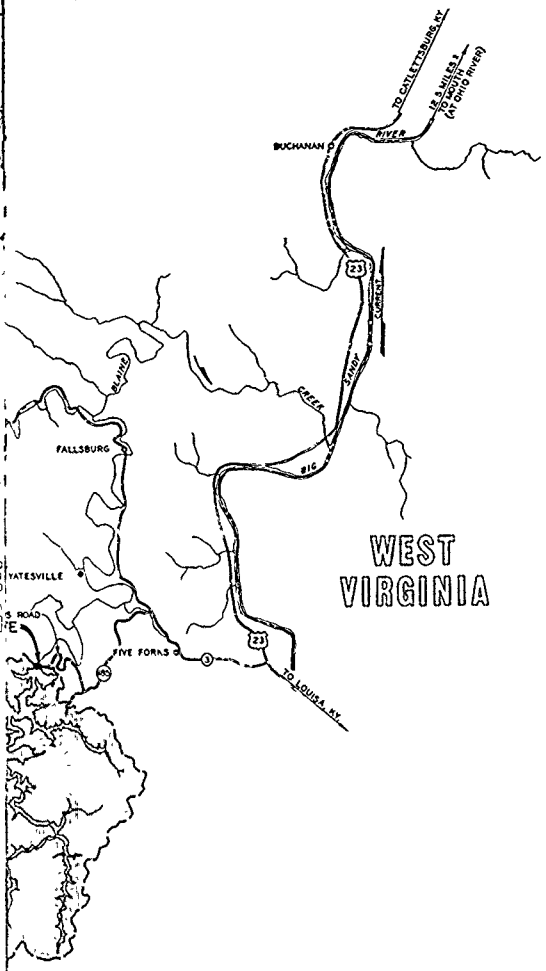
Exhibit Number	Title
1	Site and Vicinity Map
2	General Site Plan
3	Structures - Sections and Profiles
4	Regional Geology Map - Lithology
5	Regional Geology Map - Structural
6	Generalized Geologic Column
7	Geologic Map of Dam - Upstream of Core
8	Geologic Map of Dam - Downstream of Core
9	Geologic Map and Section - Dam Core
10	Geologic Map of Dam Core - Sta. 1+20 to 3+85
11	Geologic Map of Dam Core - Sta. 3+85 to 7+00
12	Geologic Map of Dam Core - Sta. 7+00 to 10+00
13	Geologic Maps - Miscellaneous
14	Curtain Grouting - General
15	Curtain Grouting - A Line - Sta. 1+20 to 3+85
16	Curtain Grouting - C Line - Sta. 1+20 to 3+85
17	Curtain Grouting - A & C Lines - Sta. 3+85 to 7+00
18	Curtain Grouting - A Line - Sta. 7+00 to 10+00
19	Curtain Grouting - C Line - Sta. 7+00 to 10+00
20	Curtain Grouting - B, D, and E Lines
21	Dewatering System
22	Slurry Cut-off Walls

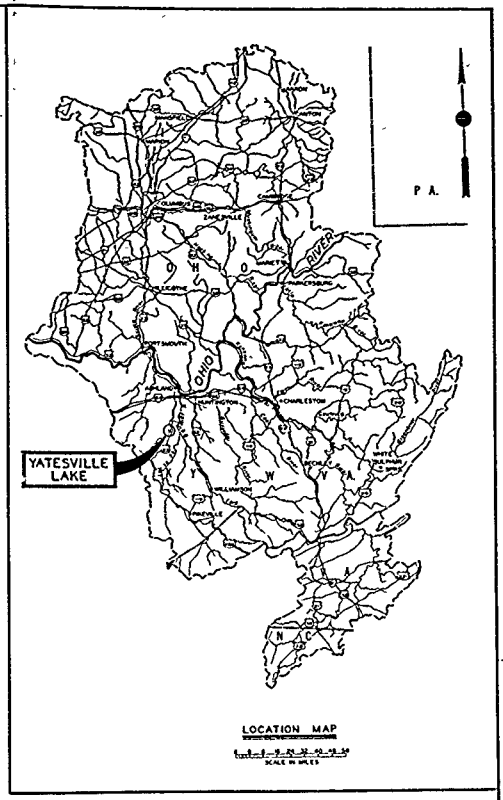
Good Engineering Produces Better Environment



VICINITY MAP
NOT TO SCALE

Good Engineering Produces Better Environment





LEGEND

- WATERSHED
- 23 U S HIGHWAY
- 3 STATE HIGHWAY
- STATE BOUNDARY
- COUNTY BOUNDARY

MAP
LAKE

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT

BLAINE CREEK, KENTUCKY

YATESVILLE LAKE

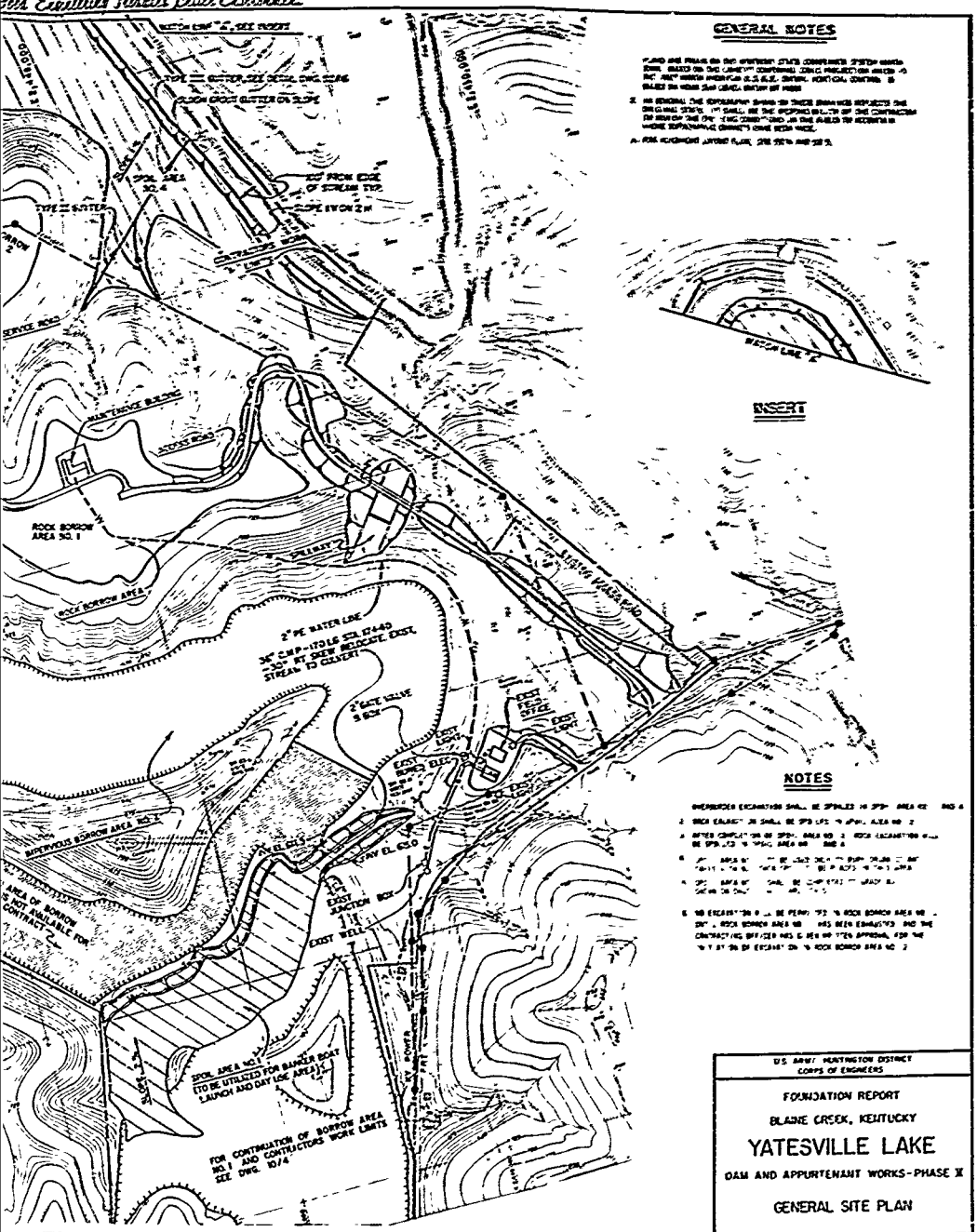
DAM AND APPURTENANT WORKS - PHASE II

SITE AND VICINITY MAP

EXHIBIT NO 1

MATCH LINE "A", SEE INSERT
TYPE III GUTTER, SEE DETAIL DWG 52/16
SLUSH GROUT GUTTER ON SLOPE
SPOIL AREA NO 4
TYPE II GUTTER
ROCK BORROW AREA NO 2
CONTRACTORS WORK LIMITS
SERVICE ROAD
EXIST STILLING BASIN
EXIST TUNNEL
DAM
MAINTENANCE BUILDING
ACCESS ROAD
ROCK BORROW AREA NO 1
SPILLWAY
TURNAROUND AND PARKING AREA
INTAKE STRUCTURE
COFFERDAM
ROCK BORROW AREA
DITCH
SPOIL AREA NO 3
UPSTREAM EARTH DIVERSION DIKE
PERMANENT LOCATION
TEMPORARY LOCATION
TRASH BOOM
MAX EL 6200
SPOIL AREA NO 2
PREVIOUS BORROW AREA NO 2
THE SHADED AREA OF BORROW AREA NO 1 IS NOT AVAILABLE FOR USE IN THIS CONTRACT
PREVIOUS BORROW AREA NO 1
CONTRACTORS WORK LIMITS
SPOIL AREA NO 1 (TO BE UTILIZED FOR BARGE BOAT LAUNCH AND DAY USE AREA)
FOR CONTINUATION OF BORROW NO 1 AND CONTRACTORS WORK SEE DWG 10/4
N 233,000
N 232,000
N 231,000
N 230,000
N 229,000

Good Engineering Produces Better Environment



U.S. ARMY HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT

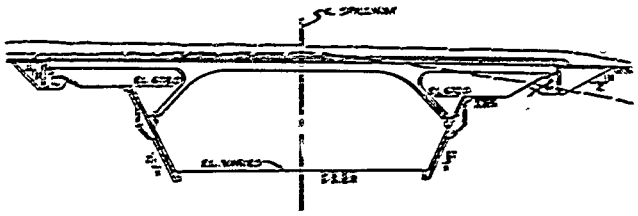
BLAINE CREEK, KENTUCKY

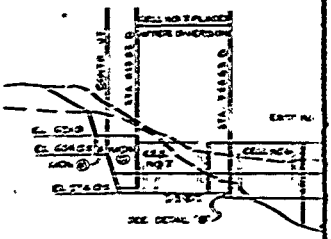
YATESVILLE LAKE

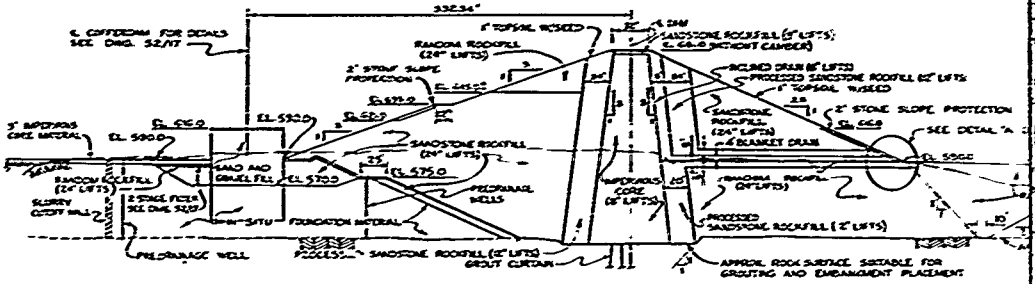
DAM AND APPURTENANT WORKS - PHASE X

GENERAL SITE PLAN

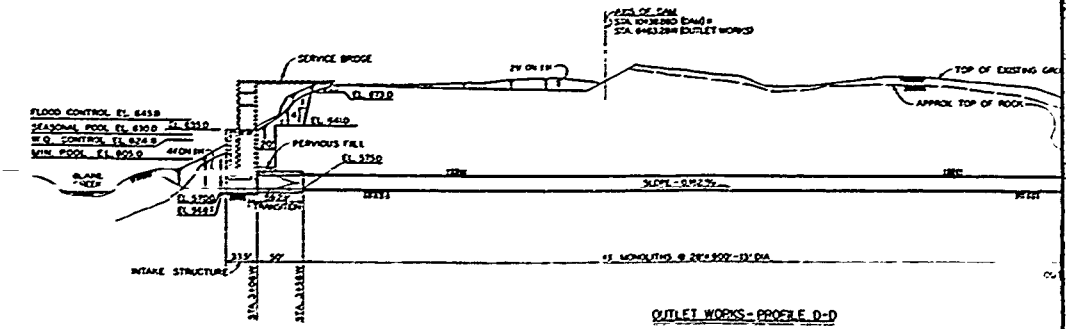
EXHIBIT NO 2



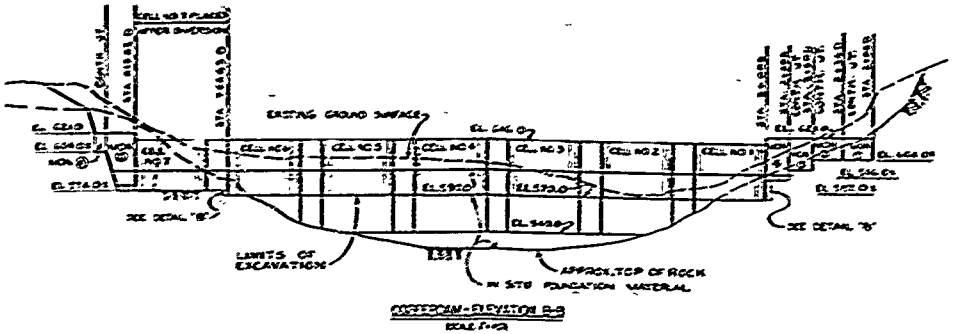




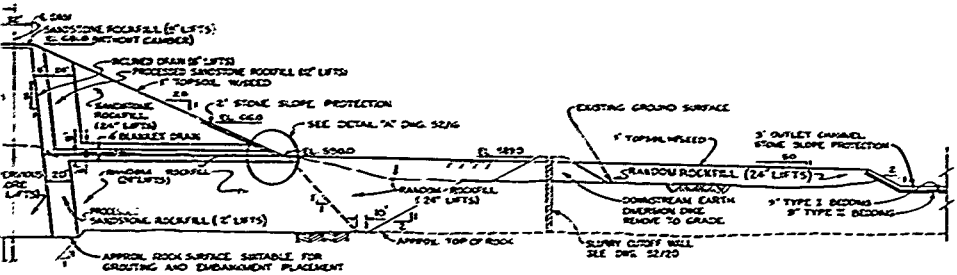
DAM EMBANKMENT – SECTION C-C



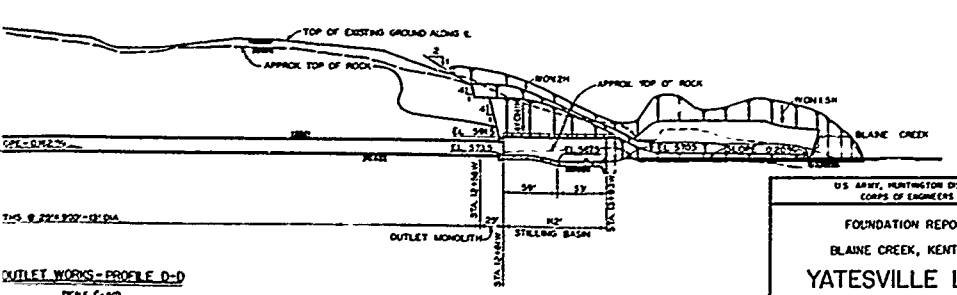
OUTLET WORKS – PROFILE D-D



CUTOFF WALL - ELEVATION B-B
SCALE 1"=40'



DAM EMBANKMENT - SECTION C-C
SCALE 1"=40'



OUTLET WORKS - PROFILE D-D
SCALE 1"=50'

US ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT

BLAINE CREEK, KENTUCKY

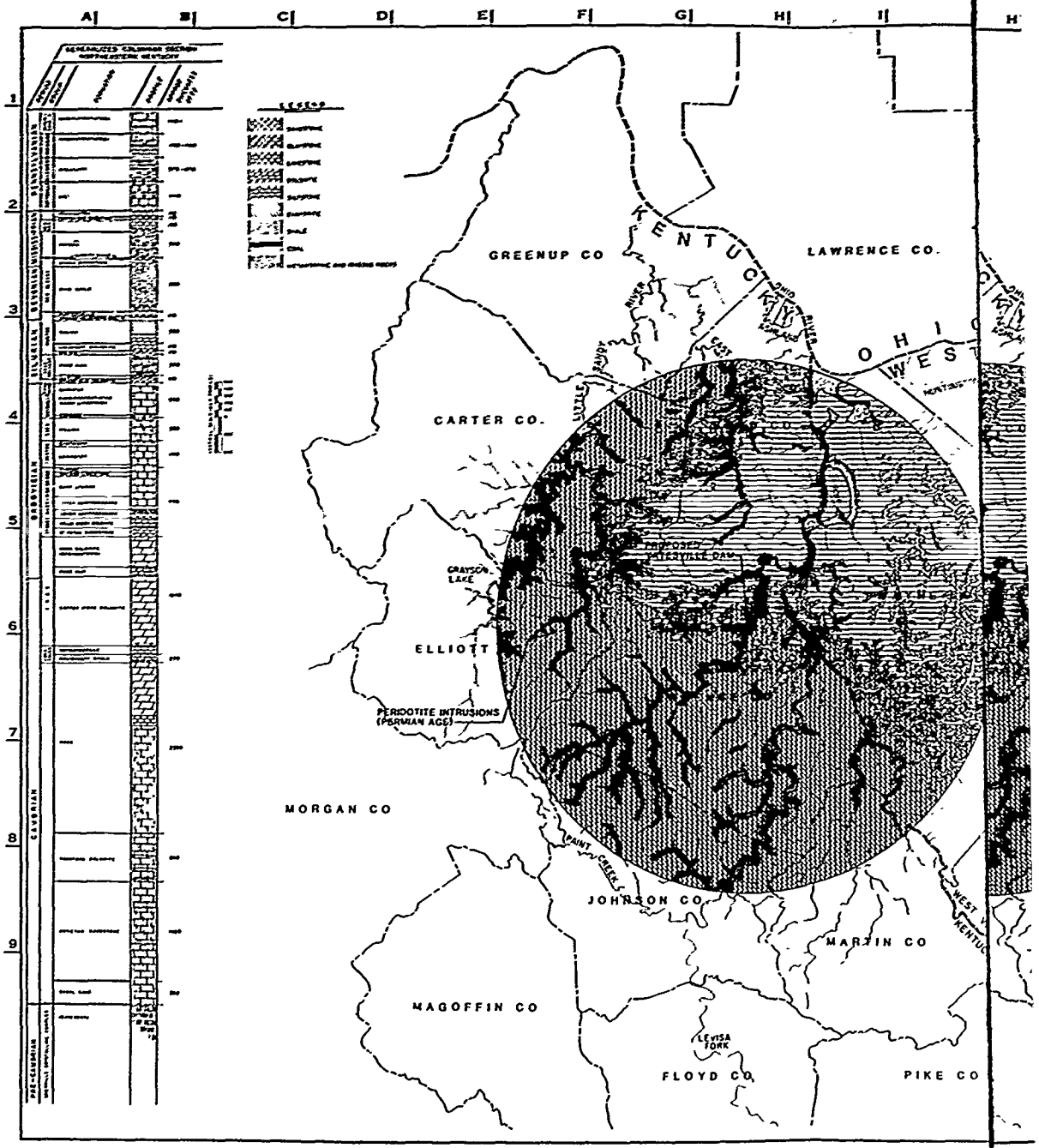
YATESVILLE LAKE

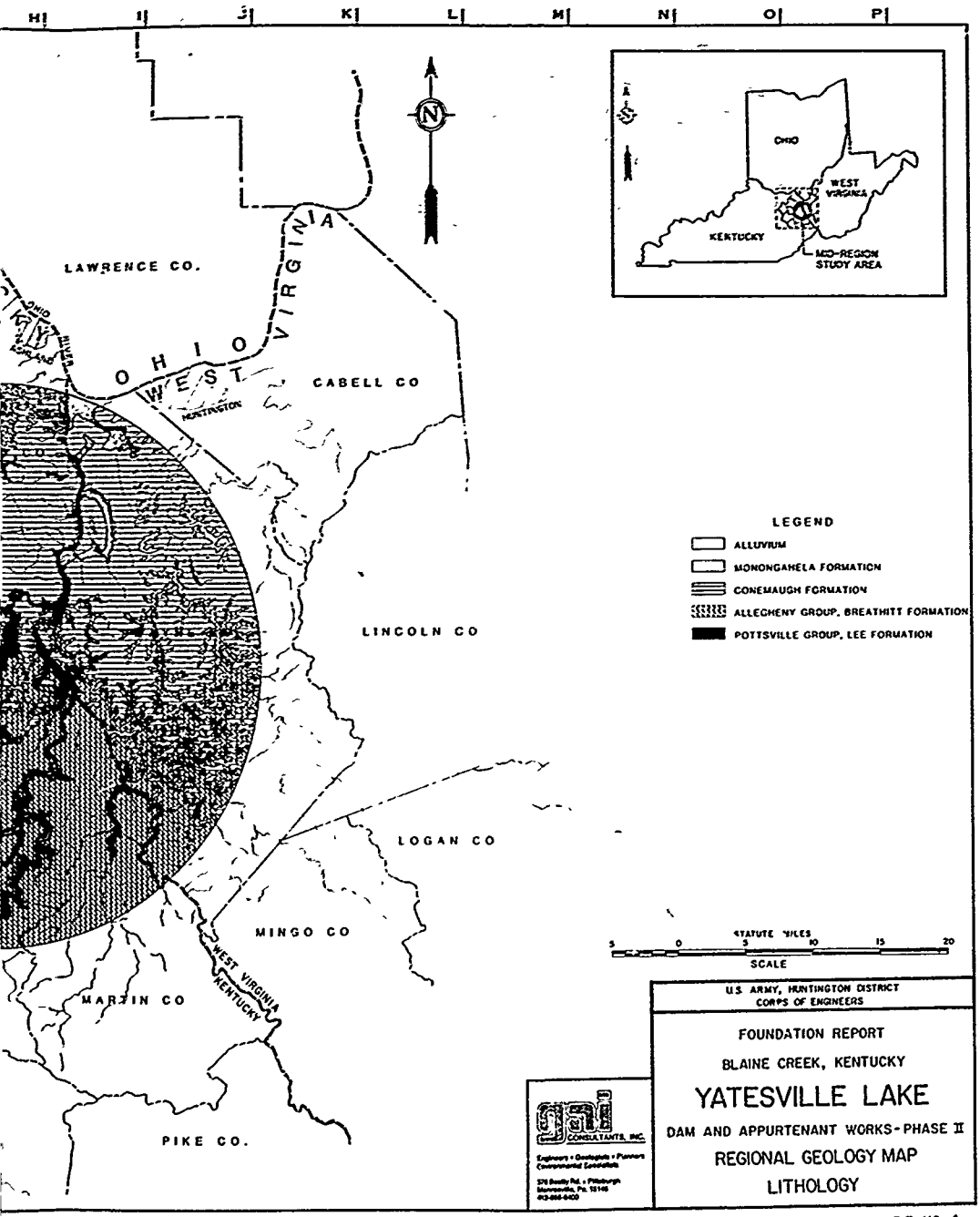
DAM AND APPURTENANT WORKS - PHASE II

STRUCTURES

SECTIONS AND PROFILES

EXHIBIT NO 3


A
B
C
D
E
F
G
H
I
1
2
3
4
5
6
7
8
9
GREENUP CO
LAWRENCE CO.
KENTUCKY
OHIO
WEST
CARTER CO.
GRAYSON LAKE
ELLIOTT
PERIDOTITE INTRUSIONS (PERMIAN AGE)
MORGAN CO
JOHNSON CO
MARTIN CO
MAGOFFIN CO
FLOYD CO.
PIKE CO
LEVISA FORK
PAINT CREEK



U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT

BLAINE CREEK, KENTUCKY

YATESVILLE LAKE

DAM AND APPURTENANT WORKS - PHASE II

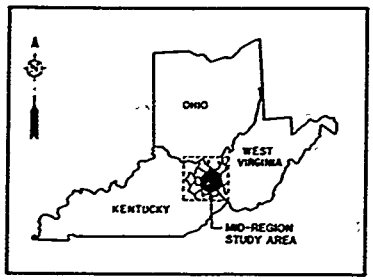
REGIONAL GEOLOGY MAP

LITHOLOGY

CONSULTANTS, INC.

Engineers • Geologists • Planners
Environmental Consultants

EXHIBIT NO. 4



GREENUP CO.

LAWRENCE CO

MID-REGION STUDY AREA

CARTER CO.

ROWAN CO.

BOYD CO.

GRAYSON LAKE

PERIDOTITE INTRUSIONS (PERMIAN AGE)

PROPOSED YATESVILLE DAM

WAYNE CO

ELLIOTT CO.

MORGAN CO.

JOHNSON CO.

MARTIN CO

MAGOFFIN CO

FLOYD CO.

PIKE C

NORTHERN BOUNDARY OF ROME TROUGH

KENTUCKY RIVER FAULT ZONE

LITTLE SANDY FAULT

ROSS CHAPEL MONOCLINE

MAYKY MONOCLINE

WALBRIDGE FAULT

BLAINE CREEK FAULT SYSTEM

LAUREL CREEK DOME

IRVINE-PAINT CREEK FAULT

PAINT CREEK UPLIFT

SOUTHERN BOUNDARY OF ROME TROUGH

LEGEND

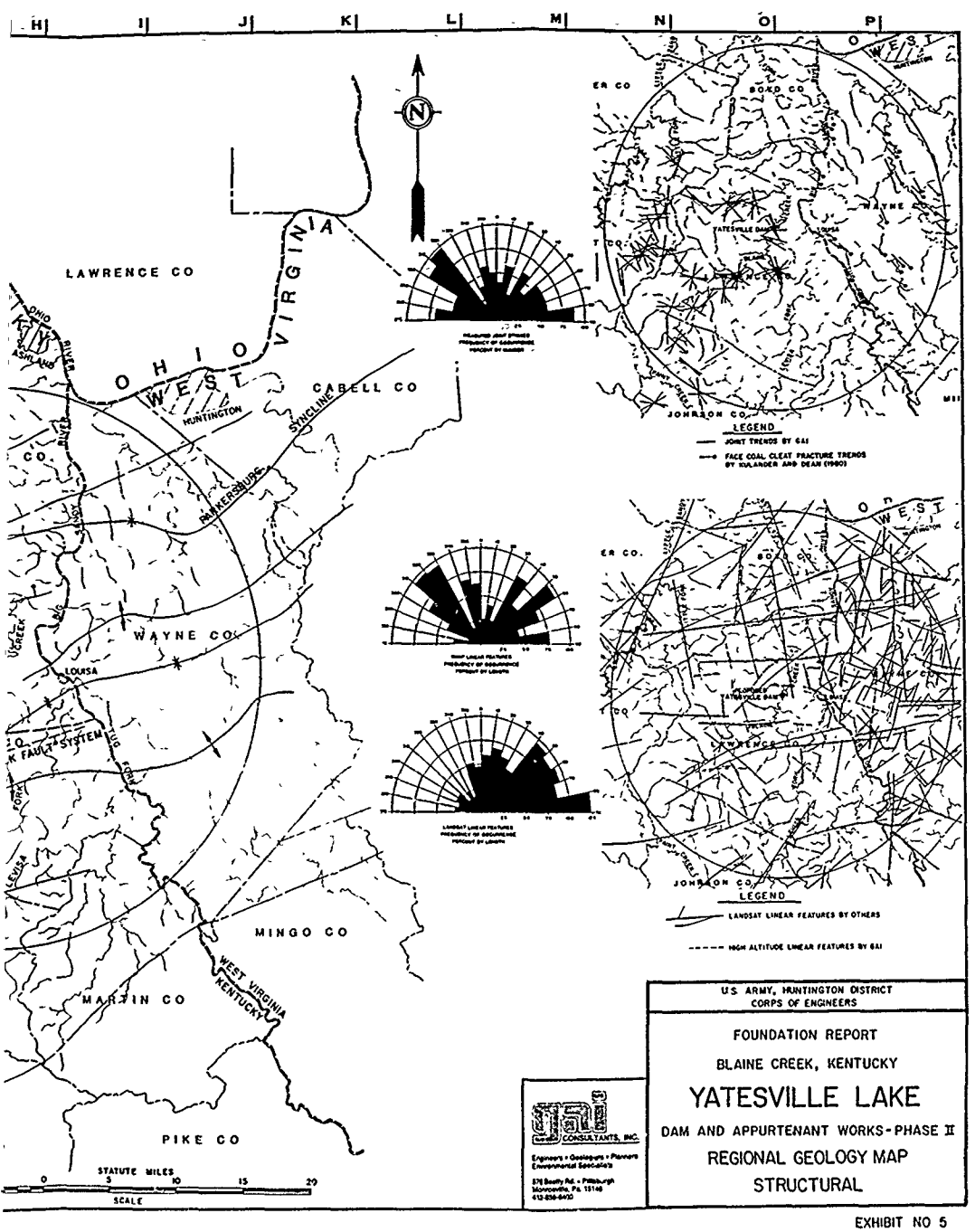
- ANTICLINAL AXIS
- SYNCLINAL AXIS
- NORMAL FAULT, BALL AND BAR ON DOWNTHROWN SIDE
- STRUCTURAL DOME
- BOUNDARY OF ROME TROUGH
- CONCEALED FAULT

REFERENCES.

1. GEOLOGIC MAP OF KENTUCKY, SHEET 3 OF 4 McDOWELL, R C., GRABOWSKI, JR., G J., AND HOGAN, S L., 1981
2. GEOLOGIC MAP OF WEST VIRGINIA REST SHEET, WEST VIRGINIA GEOLOGICAL AND ECONOMIC SURVEY, 1968
3. GEOLOGIC MAP OF SOUTH CARTER, ELLIOTT, GREENUP, JOHNSON, LAWRENCE, LEE, MENIFEE, MORGAN, AND WOLFE COUNTIES, KENTUCKY, PRICE, JR., J F., RICHARD, C. AND WELL, R. S., HYDROLOGIC INVESTIGATIONS ATLAS HA-37, SHEET 1 OF 3, 1962
4. STRUCTURE CONTOUR MAP ON THE BASE OF THE OHIO SHALE IN EASTERN KENTUCKY, RICHARD, S. D., AND ETTENSOHN, F. R., 1980

STATUTE MILES

SCALE



U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT

BLAINE CREEK, KENTUCKY

YATESVILLE LAKE

DAM AND APPURTENANT WORKS - PHASE II

REGIONAL GEOLOGY MAP

STRUCTURAL

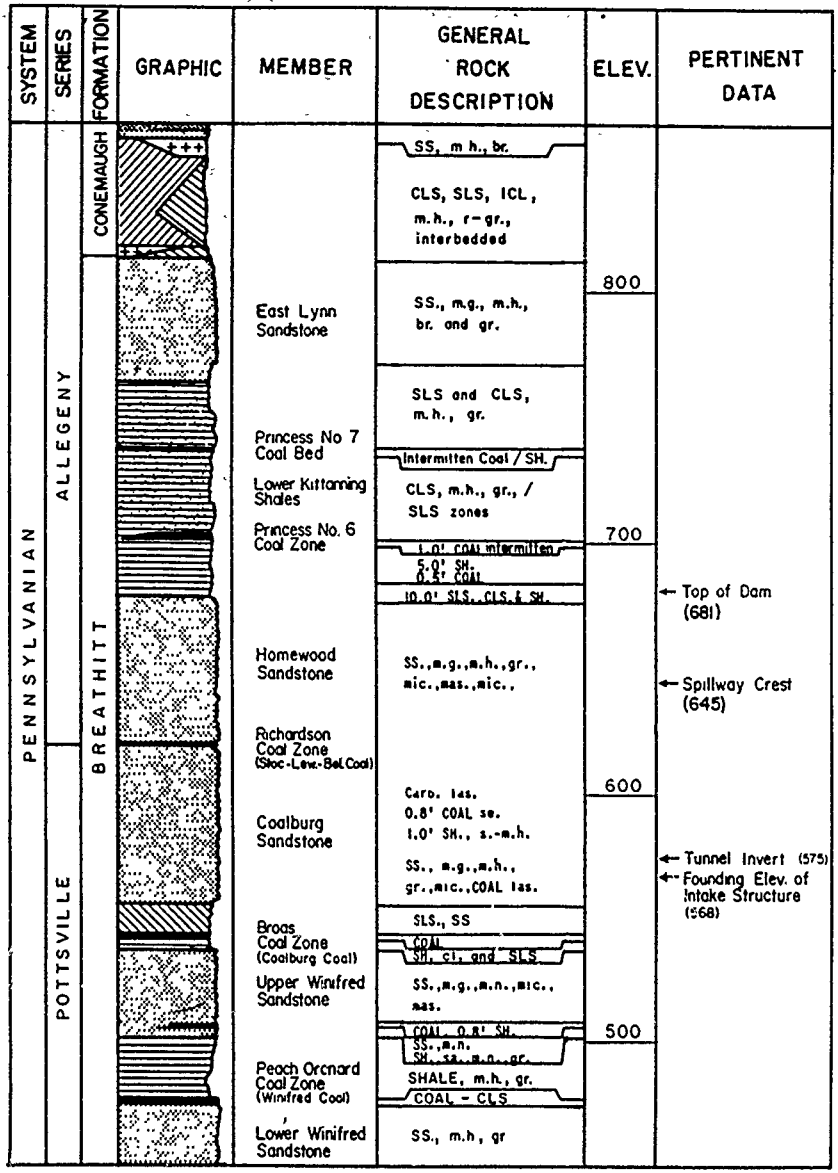
GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists
570 Beatty Rd. • Pittsburgh
Monroeville, Pa. 15146
412-856-6400

EXHIBIT NO 5

YATESVILLE RESERVOIR PROJECT

GENERALIZED GEOLOGIC COLUMN

SCALE 1" = 50'



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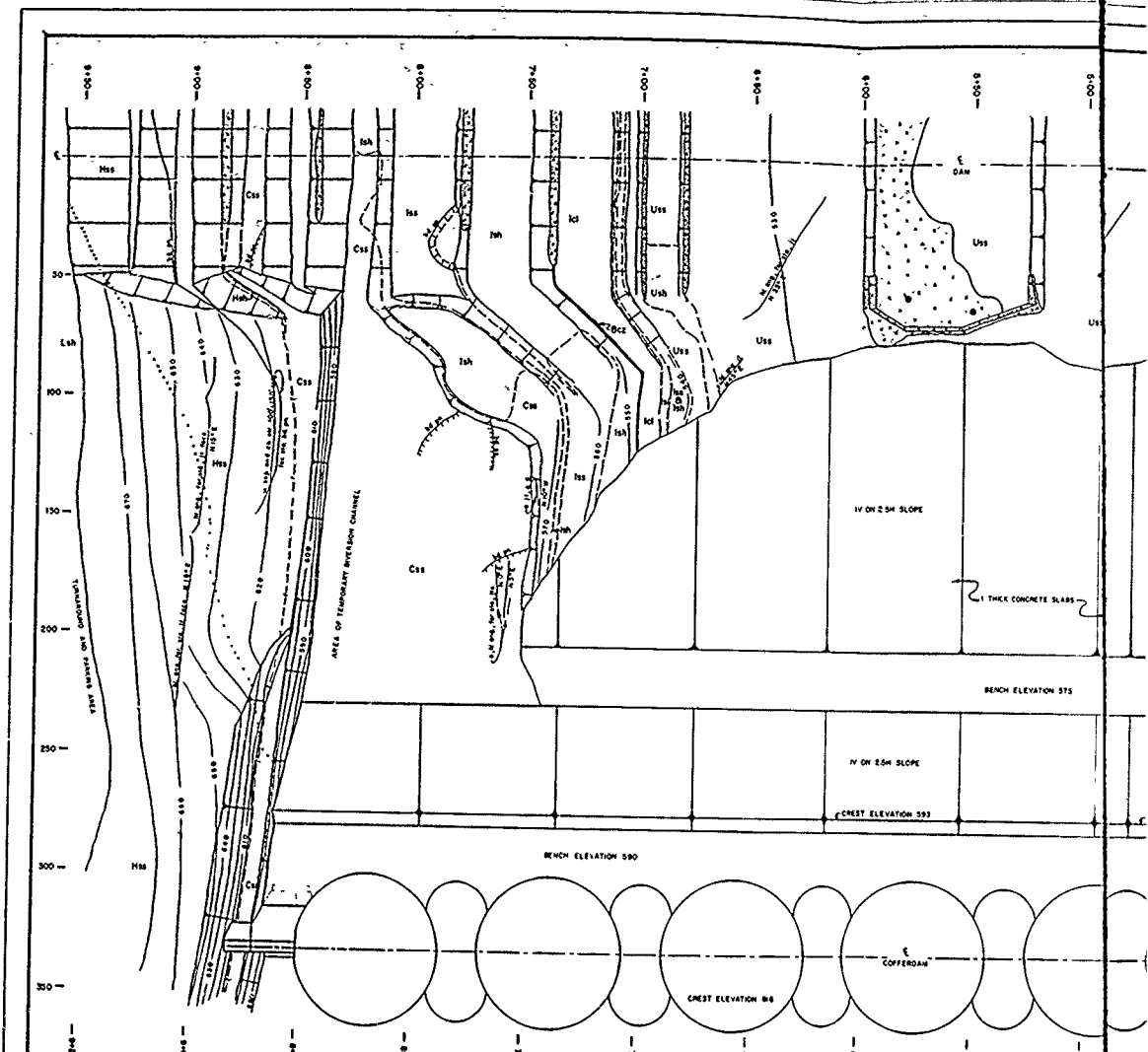


LEGEND

Lsh — **SHALE** with thin interbeds of sandstone, siltstone and coal. Soft to moderately hard, grey, silty, moderately weathered and jointed. (Lower Kittanning Shale Member)

Hss — **SANDSTONE** Moderately hard, medium to fine grained, grey to light brown, micaceous, slightly weathered, massive, occasional ferruginous stained zones, cliff forming at elevation 640 to 675. (Homewood Sandstone Member)

Hsh — **SHALE** Soft, dark grey, slightly carbonaceous, occasional thin coal stringers, lens shaped, discontinuous. (Homewood Sandstone Member)

Css — **SANDSTONE** Moderately hard, medium to fine grained, light grey to light brown, micaceous, slightly to moderately weathered, massive, occasional ferruginous stained zones. (Cranberry Sandstone Member)

Ish — **SHALE** Soft, grey to dark grey, slightly carbonaceous, moderately weathered, variable thickness 2'-10' (Interbedded Member)

Iss — **SANDSTONE** Moderately hard, medium to fine grained, light grey to light brown, fine occasional thin conglomerate beds, occasional plant fossils, slightly to moderately weathered, variable thickness (Interbedded Member)

Bcc — **COAL** Moderately hard, black, blocky, occasionally pyritic, occasionally shaley, approximately 1' thick. (Brush Coal Zone)

Isl — **SILTSTONE** Moderately hard, 5Y4/1 grey, siliceous silt, occasional plant fossils, weathers when exposed, 1'-2' thick, underclay (Interbedded Member)

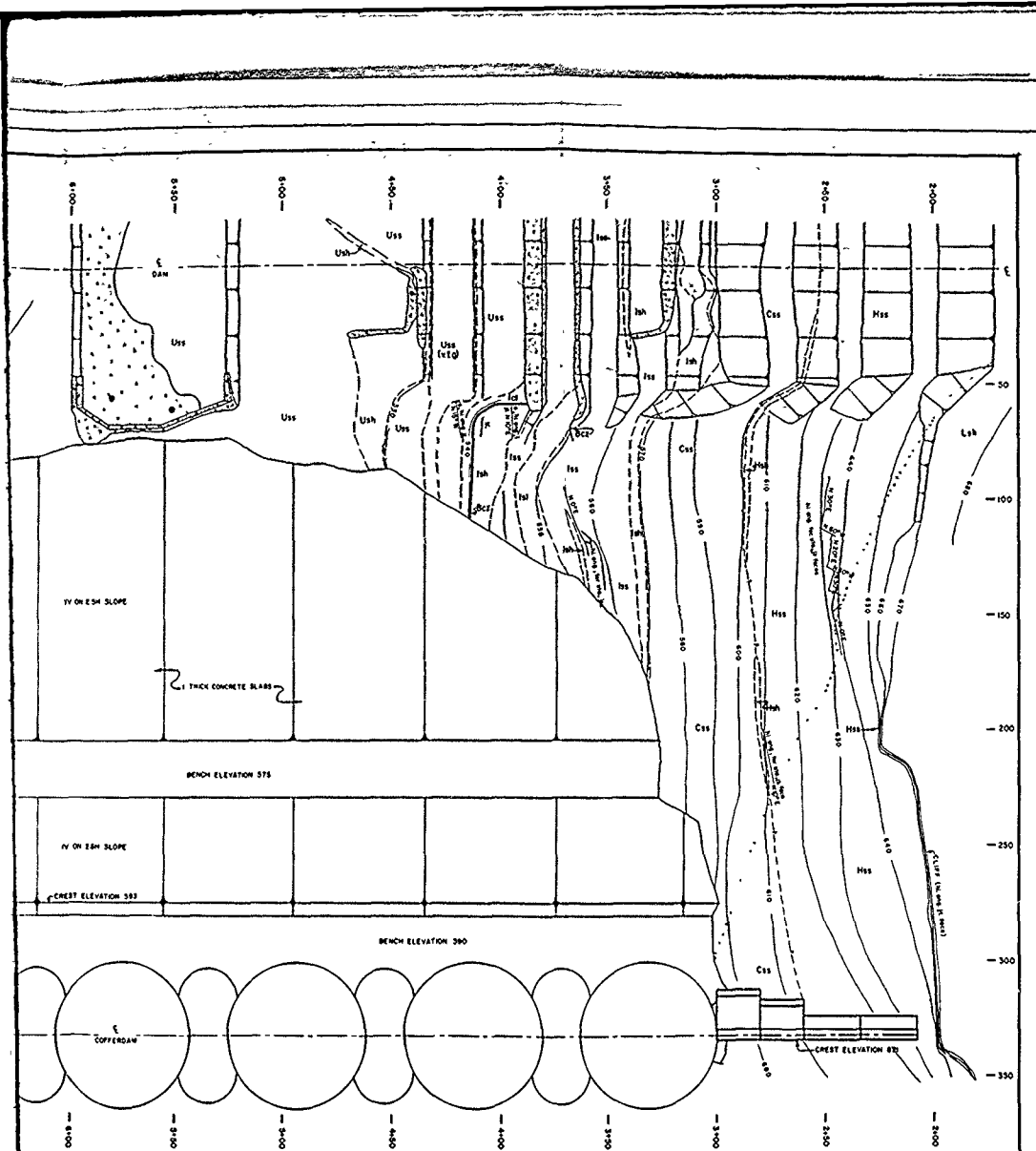
Icl — **CLAYSTONE** Soft, light brown, shaley, numerous plant fossils, 1' 2' thick, weathers when exposed, underclay (Interbedded Member)

Ush — **SHALE** Soft, grey to greenish grey, silty, thin-0.5' (Upper Washington Sandstone Member)

Uss — **SANDSTONE** Moderately hard, medium to fine grained, light grey, siliceous, slightly weathered, massive, occasionally cross bedded, broken zones below elevation 525. (Upper Washington Sandstone Member)

a.	Artesian
ang	Angled
bd.	Bedding
co.	Coal
f.	Fine
fer.	Ferruginous
fl.	Flow
g.	Grained
h.	High
j.	Joint
o.	Open
pl.	Plane
sep.	Seepage
stn.	Stained
str.	Stringers
v.	Very
w.	Water

Geologic contact
Inferred geologic contact
Centerline
Dam embankment
Bedding plane 3-1 thick
Joint with orientation
Coal
Dental concrete
Sump



Artesian
Angled
Bedding
Coal
Fine
Formginous
Fine
Grained
High
Joint
Open
Plane
Seepage
Stained
Stringers
Very
Water

Geologic contact
Inferred geologic contact
Centerline
Dam embankment
Bedding plane >1' thick
Joint with orientation
Coal
Dental concrete
Sump

N

20 0 20 40 60
Scale 1"=20'
Datum is mean sea level
Contour interval 10 feet

NOTES

(1) ALL LITHOLOGIC MEMBERS ARE OF THE MIDDLE PENNSYLVANIAN BREATHITT FORMATION.

(2) THE COFFERDAM CONCRETE MONOLITHS, LOCATED ON THE ABUTMENTS, WERE LATER EXCAVATED TO ELEVATION 611.

(3) THE DOWNSTREAM CONCRETE SLABS WERE BROKEN PRIOR TO PLACEMENT OF EMBANKMENT.

(4) FOR GEOLOGIC MAP DOWNSTREAM OF CORE SEE EXHIBIT NUMBER 8.

(5) FOR GEOLOGIC MAP AND SECTION OF DAM CORE SEE EXHIBIT NUMBER 9

(6) THE DAM AND COFFERDAM HAVE AN ALIGNMENT OF N 87° 36' W

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT

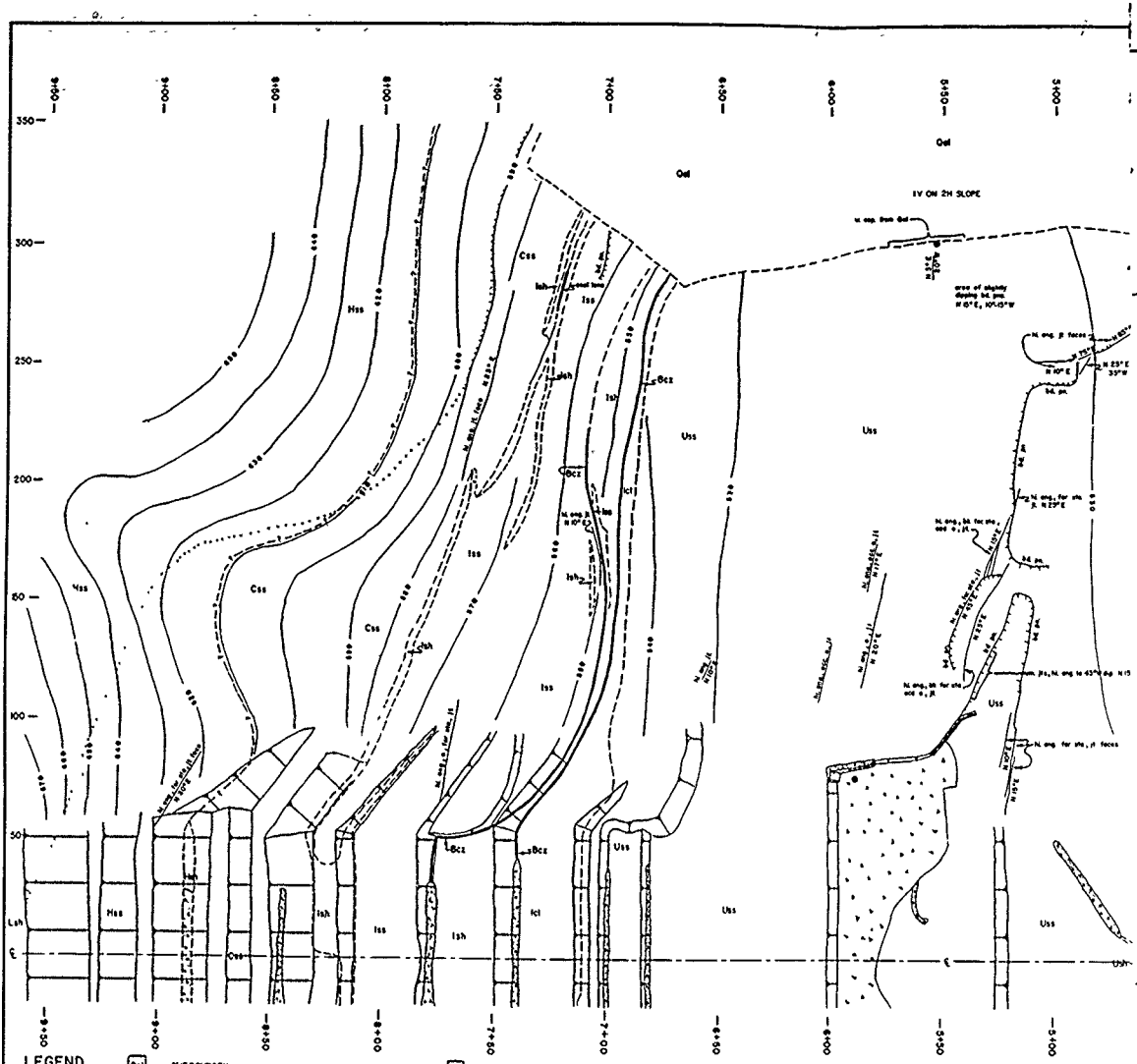
BLAINE CREEK, KENTUCKY

YATESVILLE LAKE

DAM AND APPURTENANT WORKS - PHASE II

GEOLOGIC MAP OF DAM
UPSTREAM OF CORE

EXHIBIT NO 7



LEGEND

Qal — OVERBURDEN Grey to brown, stream deposited, silty sand, gravel and sand layer at base; blotch grey sandy-silty-clay, occasionally soft, located toward left abutment. (Quaternary, alluvium)

Lsh — SHALE with thin interbeds of sandstone siltstone and coal. Soft to moderately hard, grey, silty, moderately weathered and jointed (Lower Kittanning Shale Member)

Hss — SANDSTONE Moderately hard, medium to fine grained, grey to light brown, micaceous, slightly weathered, massive, occasional ferruginous stained zones, cliff forming at elevation 640 to 675 (Homewood Sandstone Member)

Hsh — SHALE Soft, dark grey, slightly carbonaceous, occasional thin coal stringers, lens shaped, discontinuous. (Homewood Sandstone Member)

Css — SANDSTONE Moderately hard, medium to fine grained, light grey to light brown, micaceous, slightly to moderately weathered, massive, occasional ferruginous stained zones. (Cowberg Sandstone Member)

Ish — SHALE Soft, grey to dark grey, slightly carbonaceous, moderately weathered, variable thickness 2' to (Interbedded Member)

Iss — SANDSTONE Moderately hard medium to fine grained, light grey to light brown, few occasional thin conglomerate beds, occasional plant fossils, slightly to moderately weathered sensible thicknesses (Interbedded Member)

Bcz — COAL Moderately hard, black, blocky, occasionally pyritic, occasionally shaley approximately 1' thick (Brush Coal Zone)

Ist — SILTSTONE Moderately hard, light grey, siliceous silt, occasional plant fossils, weathers when exposed, 1' 2" thick, underclay (Interbedded Member)

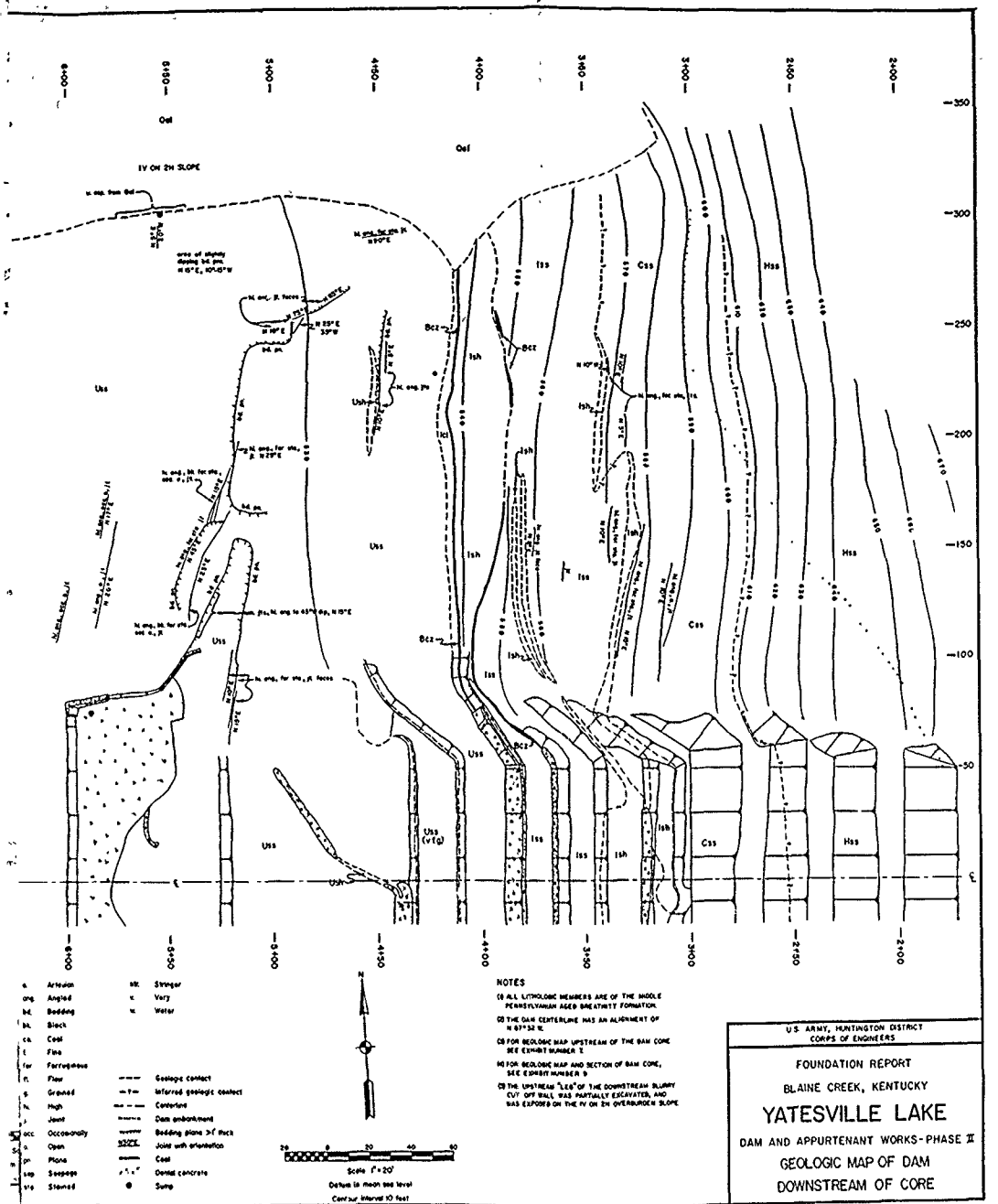
Ict — CLAYSTONE Soft, light brown, shaley, numerous plant fossils, 1' 2" thick, weathers when exposed underclay (Interbedded Member)

Ush — SHALE Soft, grey to greenish grey, silty, thin-0.5' (Upper Winifred Sandstone Member)

Use — SANDSTONE Moderately hard, medium to fine grained, light grey, micaceous, slightly weathered massive, occasionally cross bedded, broken zones below elevation 520. (Upper Winifred Sandstone Member)

a. Artesian	str. Stringer
ang. Angled	v. Very
bd. Bedding	w. Water
blk. Black	
co. Coal	
f. Fine	
fer. Ferruginous	
fl. Flow	Geologic contact
g. Grained	Inferred geologic contact
h. High	Centerline
j. Joint	Dam embankment
occ. Occasionally	Bedding plane >1 thick
o. Open	Joint with orientation
pl. Plane	Coal
sep. Seepage	Dental concrete
stn. Stained	Sump

20 0 20 40 60 Datum



a.	Artesian	str.	Stringer
ang.	Angled	v.	Very
bd.	Bedding	w.	Water
bl.	Black		
ca.	Coal		
f.	Fine		
for.	Ferruginous		
fl.	Flow	———	Geologic contact
g.	Grained	—?—	Inferred geologic contact
h.	High	— — —	Centerline
j.	Joint	———	Dam embankment
occ.	Occasionally	———	Bedding plane >1' thick
o.	Open	———	Joint with orientation
pl.	Plane	———	Coal
sep.	Seepage	———	Dental concrete
st'd.	Stained	●	Sump

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

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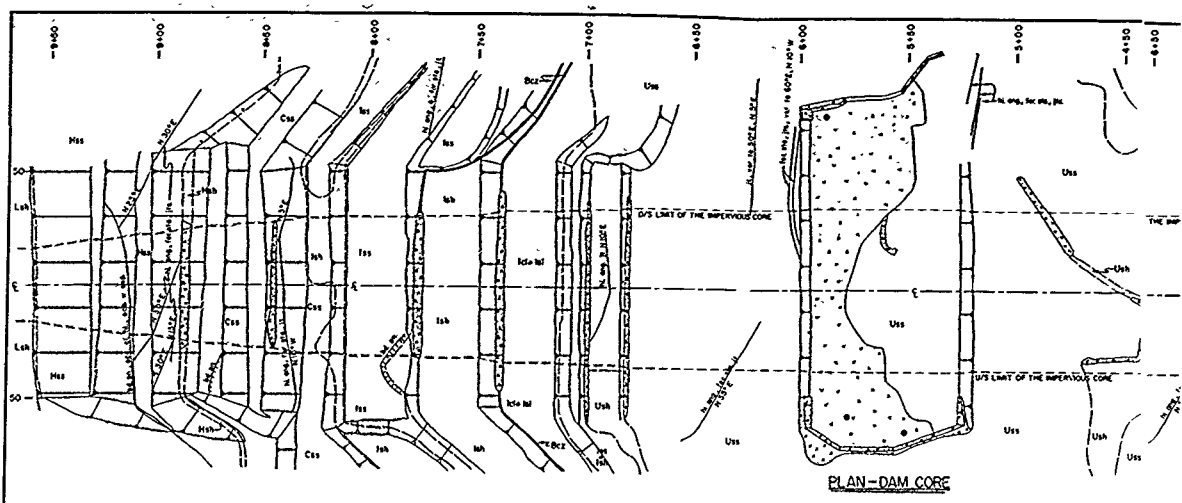
BLAINE CREEK, KENTUCKY

YATESVILLE LAKE

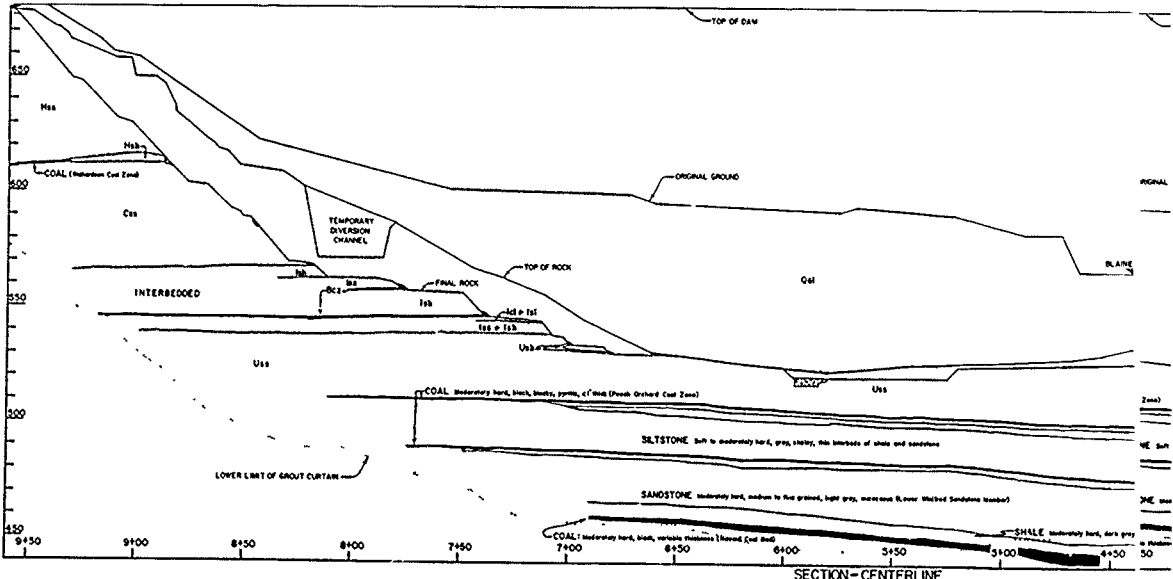
DAM AND APPURTENANT WORKS - PHASE II

GEOLOGIC MAP OF DAM
DOWNSTREAM OF CORE

EXHIBIT NO 8



PLAN - DAM CORE



SECTION - CENTERLINE

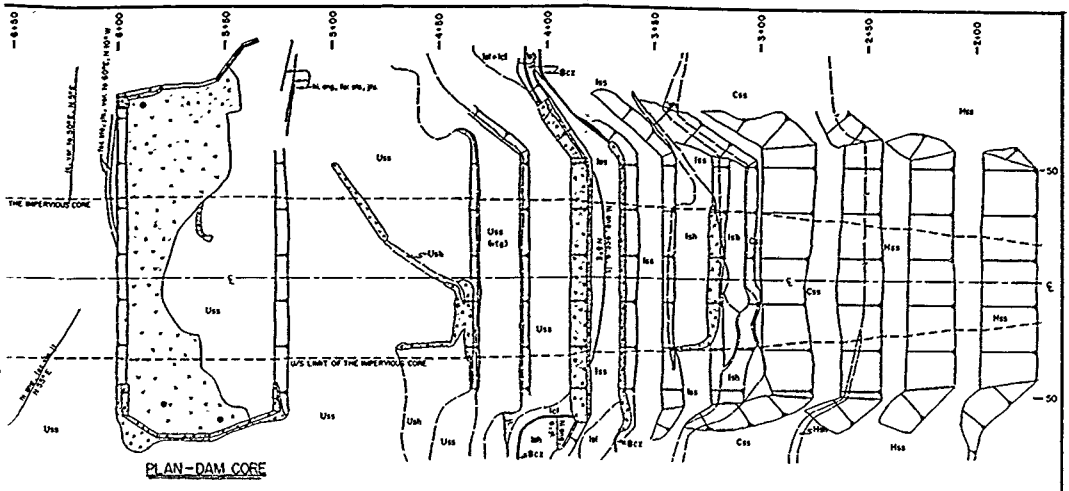
LEGEND

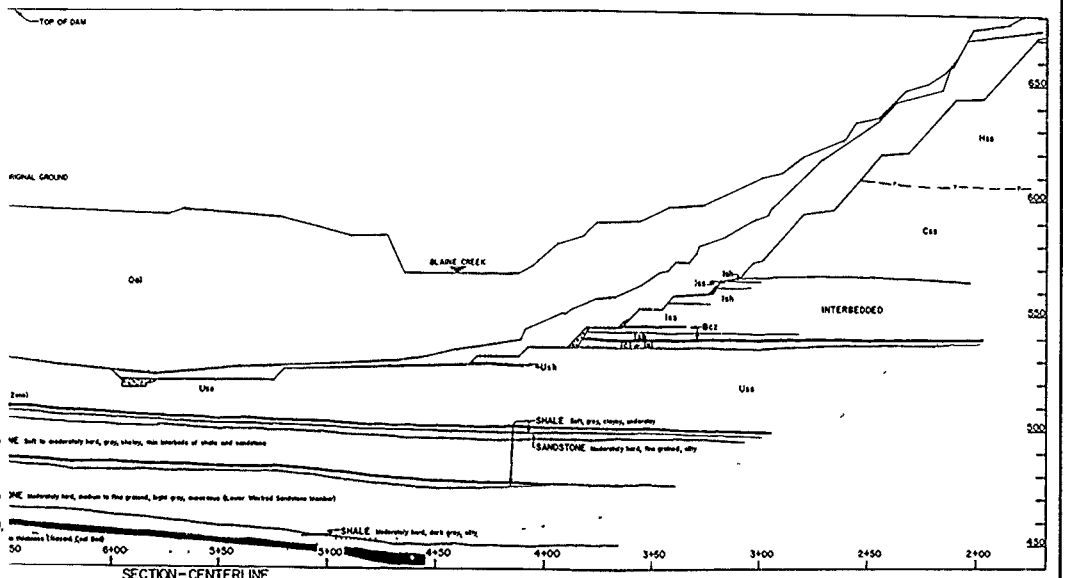
- Qal — OVERBURDEN: Gray to brown, stream deposited, silty sand, gravel and sand layer at base; thumb gray sandy-silty-clay, occasionally boldly bedded toward left abutment. (Quaternary, alluvium)
- Lsh — SHALE: with thin interbeds of sandstone, siltstone and coal. Soft to moderately hard, gray, silty, moderately weathered and jointed (Lower Kittanning Shale Member)
- Kss — SANDSTONE: Moderately hard, medium to fine grained, gray to light brown, massive, slightly weathered, massive occasional ferruginous stained zones, cliff forming at elevation 640 to 675. (Homewood Sandstone Member)
- Mah — SHALE: Soft, dark gray, slightly carbonaceous, occasional thin coal stringers, fine bedded, discontinuous (Mahoning Sandstone Member)
- Csc — SANDSTONE: Moderately hard, medium to fine grained, light gray to light brown, massive, slightly to moderately weathered, massive, occasional ferruginous stained zones. (Castleburg Sandstone Member)
- Ish — SHALE: Soft, gray to dark gray, slightly carbonaceous, moderately weathered, variable thickness 2' to (Interbedded Member)
- Hss — SANDSTONE: Moderately hard, medium to fine grained, light gray to light brown, few occasional thin conglomerate beds, occasional plant fossils, slightly to moderately weathered, variable thicknesses (Interbedded Member)
- Bcz — COAL: Moderately hard, black, blocky, occasional, pyrite, occasionally shaley, approximately 1' thick. (Brazil Coal Zone)
- Isl — SILTSTONE: Moderately hard, light gray, shaleous silt, occasional plant fossils, weathers when exposed, 1' 2' thick, undercuts. (Interbedded Member)
- Icl — CLAYSTONE: Soft light brown, shaley, numerous plant fossils, 1' 6' thick, weathers when exposed, undercuts (Interbedded Member)
- Ush — SHALE: Soft, gray to greenish gray, silty, thin-6.5' (Upper Washed Sandstone Member)
- Uss — SANDSTONE: Moderately hard, medium to fine grained, light gray, occasional, slightly weathered, massive, occasionally brown banded brown zone below elevation 320. (Upper Washed Sandstone Member)

a.	Artesian	str.	Stringer
ang.	Angled	v.	Very
bd.	Bedding	w	Water
bk.	Black		
co.	Coal		
f.	Fine		
fer	Ferruginous		
fl.	Flow		
g.	Grained	———	Geologic contact
h.	High	—?—	Inferred geologic contact
j.	Joint	— — —	Centerline
occ.	Occasionally	~~~~	Bedding plane >1' thick
o.	Open	30°/E	Joint with orientation
pn.	Plane	═══	Coal
seep.	Seepage	▱▱▱	Cantal concrete
stn.	Stained	●	Sump

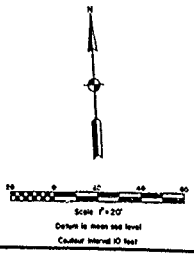
Scale 0 ft.

Datum is ft. above





a	Artesian	str.	Stronger
ang	Angled	v.	Very
bd.	Bedding	w.	Water
bk.	Black		
ca.	Coal		
f.	Fine		
fer	Ferruginous		
fl.	Flow		
g.	Grained		Geologic contact
h.	High		Inferred geologic contact
j.	Joint		Centerline
occ.	Occasionally		Bedding plane >1' thick
o.	Open		Joint with orientation
pl.	Plane		Coal
seg.	Seamage		Dental concrete
sto.	Stained		Sump



NOTES
(4) ALL LITHOLOGIC MEMBERS ARE OF THE MIDDLE PENNSYLVANIAN ABER BREATHITT FORMATION
(5) THE DAM CENTERLINE HAS AN ALIGNMENT OF N 67° 30' W
(6) FOR GEOLOGIC MAP OF DAM CORE, STATION 1+86 TO 3 80 SEE EXHIBIT NUMBER 10.
(7) FOR GEOLOGIC MAP OF DAM CORE, STATION 3+86 TO 7+00, SEE EXHIBIT NUMBER 11.
(8) FOR GEOLOGIC MAP OF DAM CORE, STATION 7+00 TO 10+00, SEE EXHIBIT NUMBER 12

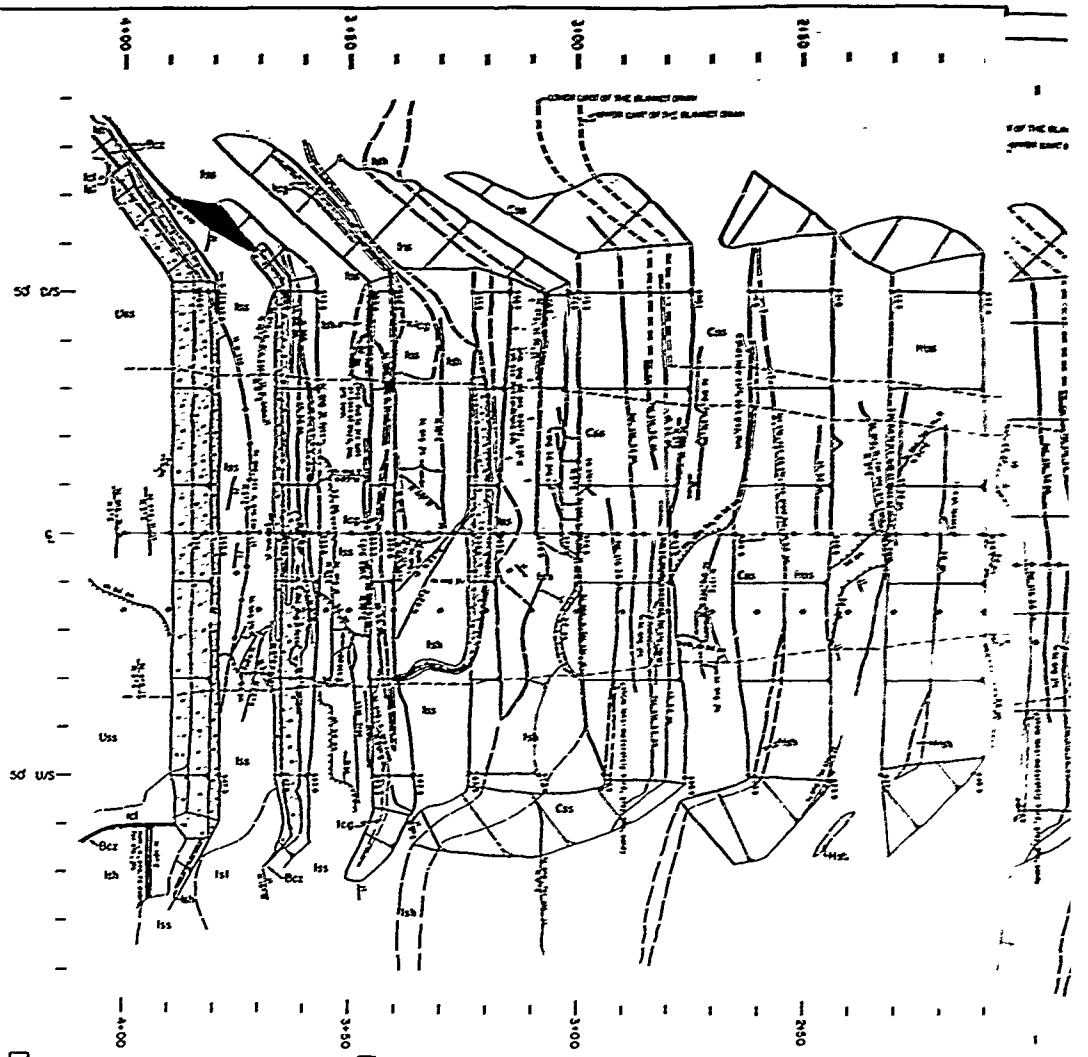
U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT
BLAINE CREEK, KENTUCKY

YATESVILLE LAKE

DAM AND APPURTENANT WORKS - PHASE II
GEOLOGIC MAP AND SECTION
DAM CORE

EXHIBIT NO 9

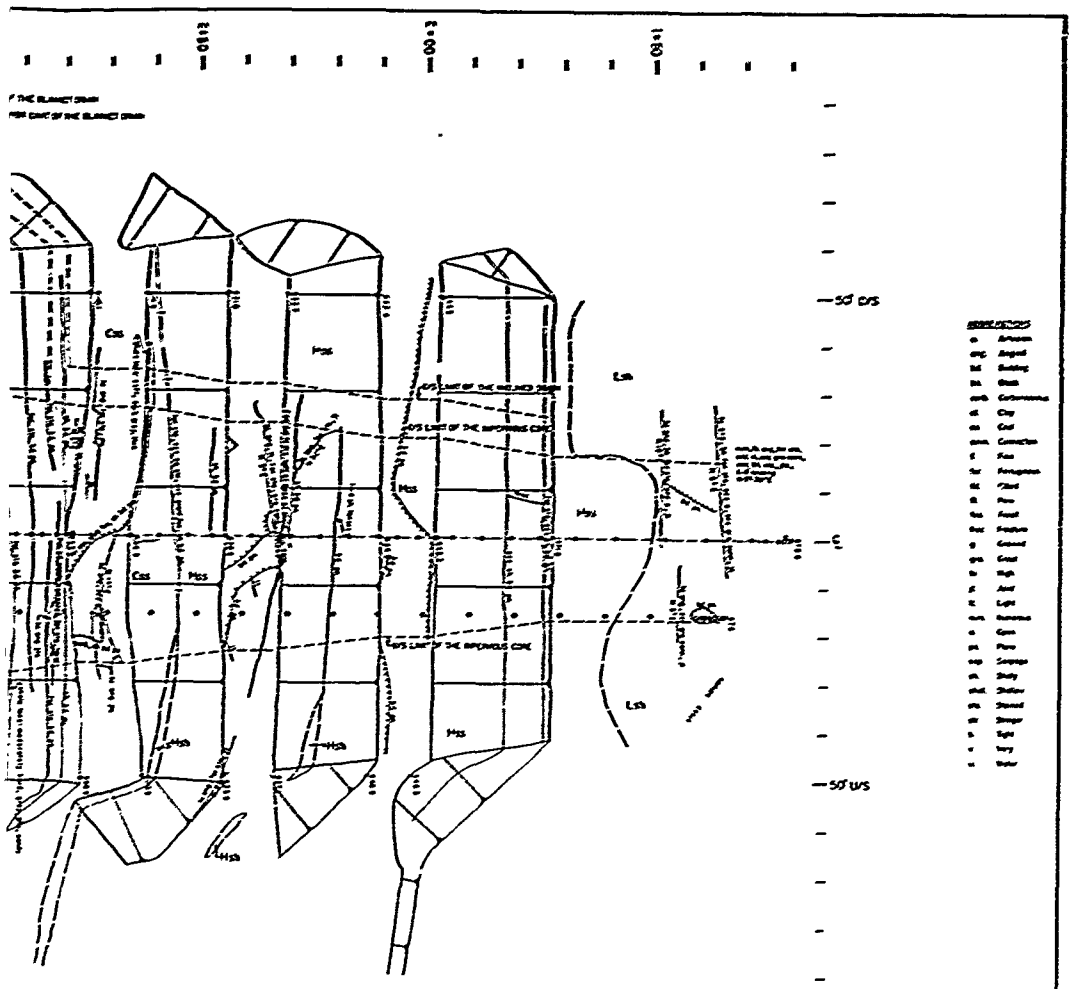


LEGEND

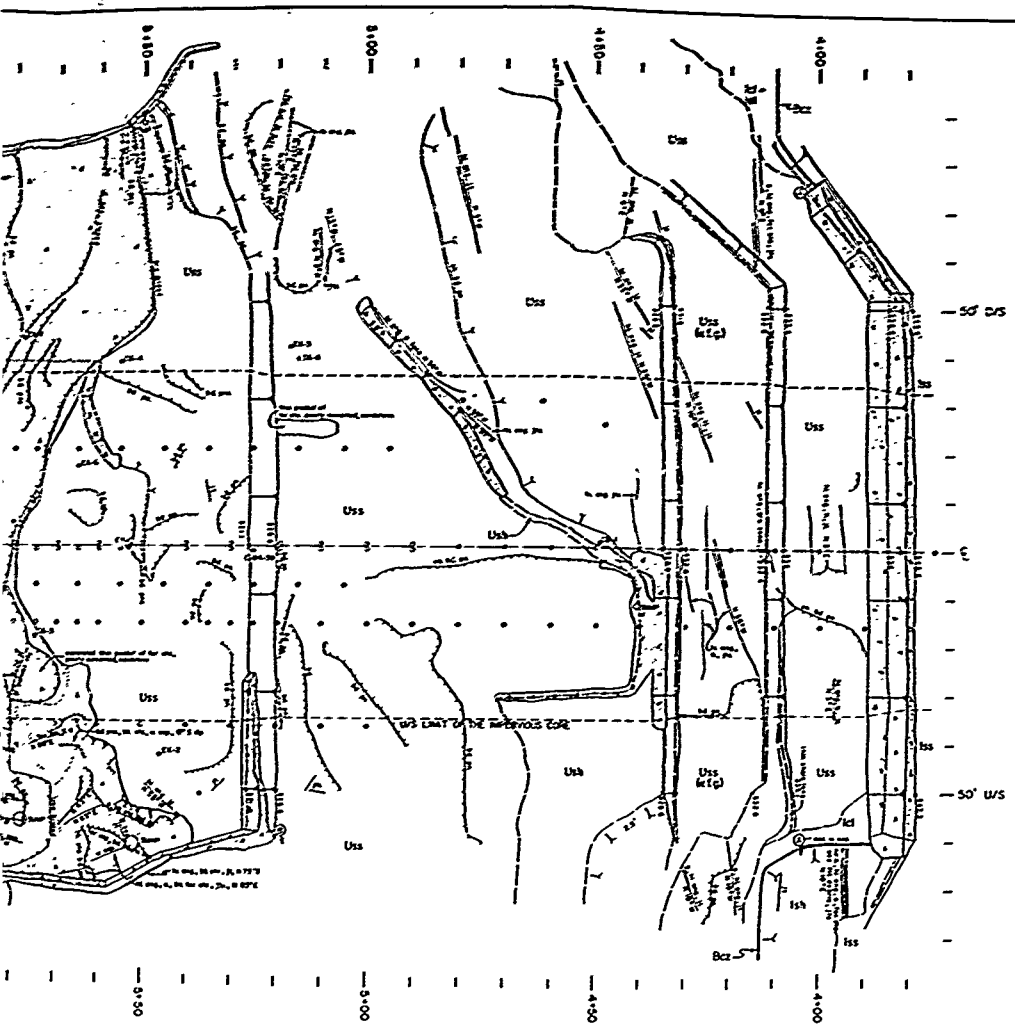
- Ish — SHALE with thin interbeds of sandstone, siltstone and coal. Soft to moderately hard, grey, 10% moderately weathered and jointed. (Lower Inferno Joint Member)
- Isz — SANDSTONE: Moderately hard, medium to fine grained, grey to light brown, interbedded, slightly weathered, moderately, occasionally fine-grained, thinned joints, 20% fracturing of intervals 0.05 to 0.1% (Intermediate Sandstone Member)
- Ish — SHALE: Soft, dark grey, slightly carbonaceous, interbedded fine sand stringers, less frequently, siltstone/coal. (Intermediate Sandstone Member)
- Css — SANDSTONE: Moderately hard, medium to fine grained, light grey to light brown, micaceous, slightly to moderately weathered, massive, occasional fine-grained, inclined zones (Castlebay Sandstone Member)
- Ish — SHALE: Soft, grey to dark grey, slightly carbonaceous, moderately weathered, variable thickness (Lost Intermediate Member)
- Isz — SANDSTONE: Moderately hard, medium to fine grained, dark grey to light brown, fine occasional thin carbonaceous bands, or coaloid plant fossils, slightly to moderately weathered, variable thicknesses (Intermediate Member)
- Icg — CONGLOMERATE: Moderately hard, grain sized to coarse grained sand, grey, fine grained matrix, quartz pebbles, sandstone fragments, and stringers of mudstone/silt and coal, thin and discontinuous. (Intermediate Member)
- Bcz — COAL: Moderately hard, brown, blocky, occasionally pyritic, occasionally shaley, approximately 1' thick. (Brown Coal Zone)
- Ist — SILTSTONE: Moderately hard, light grey, micaceous silt, occasional plant fossils, mudstone zones dispersed, 1' 2' thick, moderately fractured (Member)
- Ccl — CLAYSTONE: Soft, light brown, shaley, numerous plant fossils, 1-2 thick, mudstone zones dispersed, unfractured. (Intermediate Member)
- Uss — SANDSTONE: Moderately hard, medium to fine grained, light grey, micaceous, slightly weathered, massive, occasionally cross bedded, broken zones below elevation 520 (Upper Washed Sandstone Member)

- Geologic contact
- Inferred geologic contact
- Centreline
- Core embankment
- Bedding plane
- Joint with orientation
- Coal
- Diorite concrete
- Spring
- Grout hole
- Exploratory hole
- Survey point

Scale


1+50
2+00
2+50
50' D/S
50' U/S
Qs
Mss
Mss
Mss

LEGEND
SHALE
SANDSTONE
COAL
SILTSTONE
CLAYSTONE
SHALE
SANDSTONE
Geologic contact
Inferred geologic contact
Concretion
Concretion joint
Bedding plane
Coal with orientation
Coal
Dome concretion
Jump
Drill hole
Exploratory hole
Survey point
Artesian
Angled
Boring
Black
Carbonaceous
Clay
Coal
Concretion
Fine
Ferruginous
Filled
Flow
Fossil
Fracture
Ground
Uss
Ush
Usm
Usc
Ucl
Ucs
Lss
Lsm
50' D/S
50' U/S
D/S LIMIT OF THE IMPERVIOUS CORE
7+00
8+00
9+00
10+00
11+00



NOTES

(1) ALL LITHOLOGIC MEMBERS ARE OF THE MIDDLE PENNSYLVANIAN ANES BREATHITT FORMATION.

(2) MOST FEATURES MAPPED WITHIN THE IMPERVIOUS CORE WERE TEXTAL THEATER.

(3) GROUT CONNECTIONS (grn. cons.) REFERS TO FOUNDATION DRILLING AND GROUTING.

(4) THE DAM CENTERLINE HAS AN ALIGNMENT OF N 69° 30' E

(5) FOR ELEVATION VIEW OF A-A, B-B, C-C, AND D-D SEE EXHIBIT NUMBER 10.

(6) FOR CROSS SECTION SEE EXHIBIT NUMBER 9.

(7) FOR GEOLOGIC MAP OF DAM CORE, STATION 1+20-3+85 AND 7+00-10+00, SEE EXHIBITS NO 10 AND 12.

Scale 1"=10'

Datum is mean sea level

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT

BLAINE CREEK, KENTUCKY

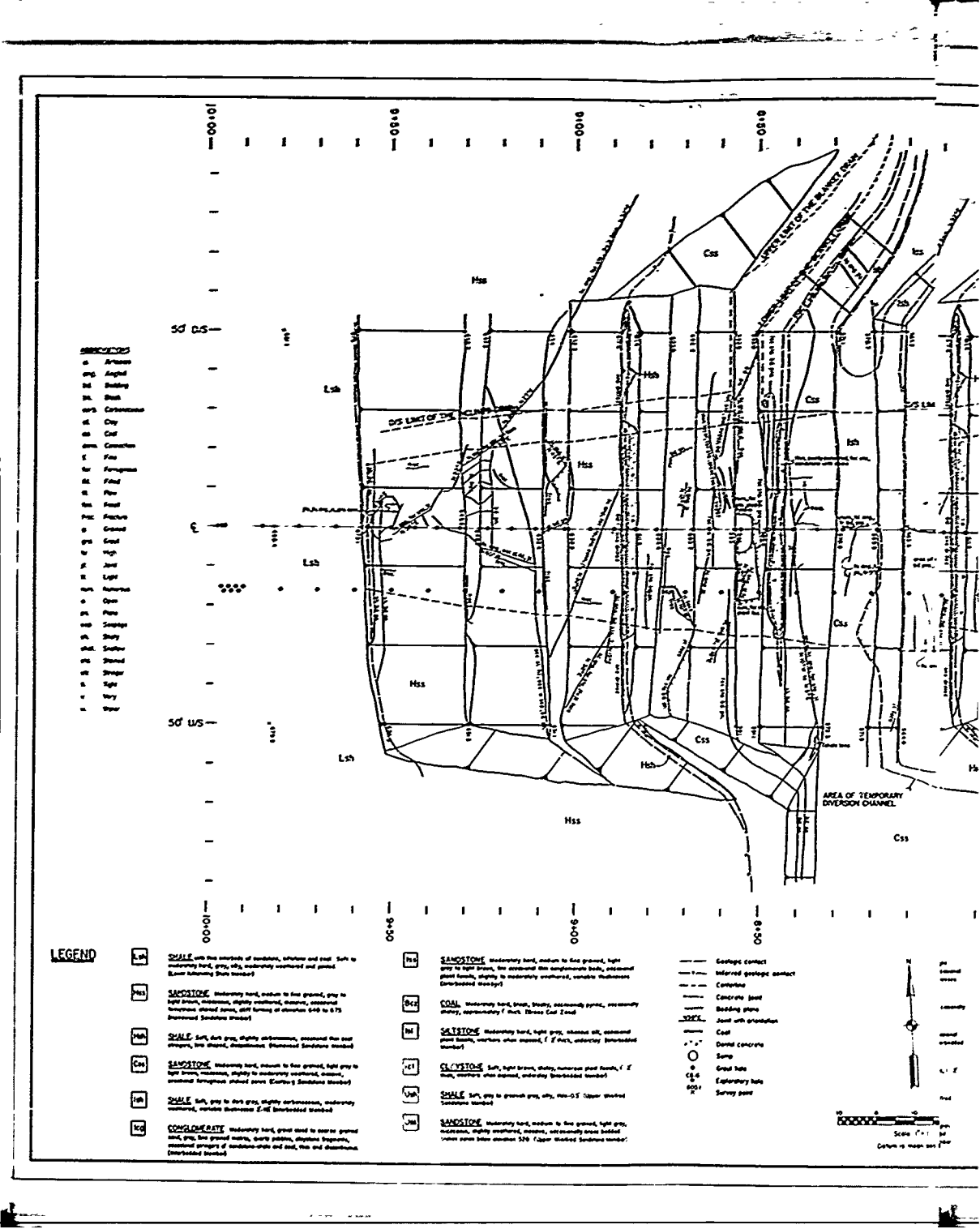
YATESVILLE LAKE

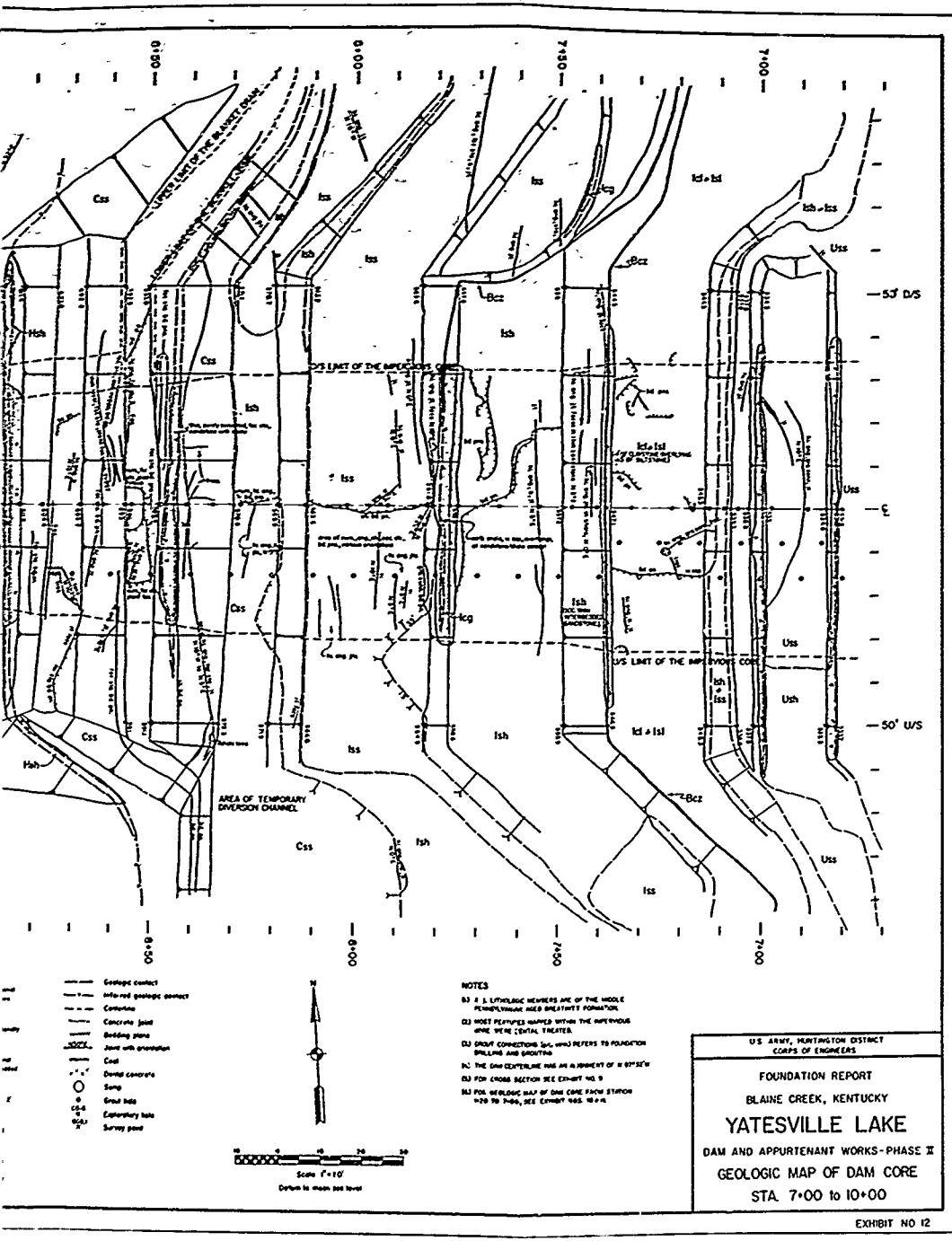
DAM AND APPURTENANT WORKS - PHASE II

GEOLOGIC MAP OF DAM CORE

STA 3+85 to 7+00

EXHIBIT NO. 8


LEGEND
SHALE with thin interbeds of sandstone, siltstone and coal. Soft to moderately hard, grey, silty, moderately weathered and jointed. (Lower Subsidiary Strata Member)
SANDSTONE: Moderately hard, medium to fine grained, grey to light brown, interbedded, slightly weathered, massive, occasional fossiliferous sandstone beds, cliff forming at elevation 640 to 670. (Intermediate Sandstone Member)
SHALE: Soft, dark grey, slightly carbonaceous, occasional thin coal stringers, thin bedded, disaggregated. (Intermediate Sandstone Member)
SANDSTONE: Moderately hard, medium to fine grained, light grey to light brown, interbedded, slightly to moderately weathered, massive, occasional fossiliferous pebbled zones. (Kentucky Sandstone Member)
SHALE: Soft, grey to dark grey, slightly carbonaceous, moderately weathered, contains thin lenses 2-4" (Interbedded Member)
CONGLOMERATE: Moderately hard, gravel sized to coarse grained sand, grey, fine grained matrix, quartz pebbles, siltstone fragments, occasional pockets of sandstone-shale and coal, thin and discontinuous. (Interbedded Member)
SANDSTONE: Moderately hard, medium to fine grained, light grey to light brown, fine occasional thin conglomeratic beds, occasional plant fossils, slightly to moderately weathered, variable thicknesses. (Interbedded Member)
COAL: Moderately hard, brown, blocky, occasionally pyritic, occasionally shaley, approximately 1' thick. (Illinois Coal Zone)
SILTSTONE: Moderately hard, light grey, siliceous silt, occasional plant fossils, medium when exposed, 1' 2" thick, underclay. (Interbedded Member)
CLAYSTONE: Soft, light brown, shaley, numerous plant fossils, 1' 6" thick, weathers when exposed, underclay. (Interbedded Member)
SHALE: Soft, grey to greenish grey, silty, thin-0.5' (Upper Weakley Sandstone Member)
SANDSTONE: Moderately hard, medium to fine grained, light grey, micaceous, slightly weathered, massive, occasionally cross bedded. (Upper Weakley Sandstone Member)
Geologic contact
Inferred geologic contact
Centerline
Concrete joint
Bedding plane
Joint with orientation
Coal
Dental concrete
Sump
Grout hole
Exploratory hole
Survey point
AREA OF TEMPORARY DIVERSION CHANNEL
Hss
Lss
Css
Bcz
Sd
Hsh
Lsh
Bs
Ss
Ls
Cs
Hs
50' D/S
50' U/S
D/S LIMIT OF DAM
UPPER LIMIT OF THE BLANKET DRAIN
Scale 1"=1'
Datum is mean sea level



NOTES

(1) A, B, LITHOLOGIC MEMBERS ARE OF THE MIDDLE PENNSYLVANIAN AGED BREATHITT FORMATION.

(2) MOST PERTYPES MAPPED WITHIN THE IMPERVIOUS CORE WERE CENTRALLY TREATED.

(3) GROUT CONNECTIONS (GC, WHICH REFERS TO FOUNDATION DRILLING AND GROUTING.

(4) THE DAM CENTERLINE HAS AN ALIGNMENT OF N 87°32'W

(5) FOR CROSS SECTION SEE EXHIBIT NO. 9

(6) FOR GEOLOGIC MAP OF DAM CORE FROM STATION 1+20 TO 7+00, SEE EXHIBIT NOS. 10 & 11

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT

BLAINE CREEK, KENTUCKY

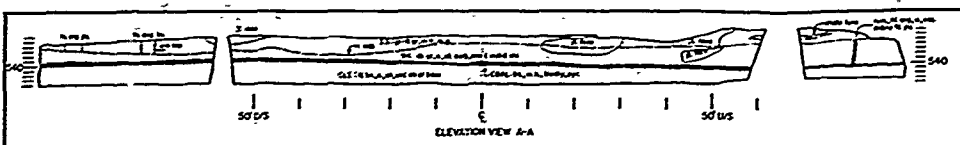
YATESVILLE LAKE

DAM AND APPURTENANT WORKS - PHASE II

GEOLOGIC MAP OF DAM CORE

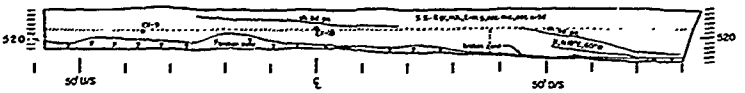
STA. 7+00 to 10+00

EXHIBIT NO 12

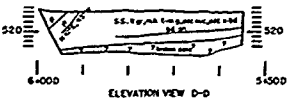


ELEVATION VIEW A-A

ELEVATION VIEW B-B

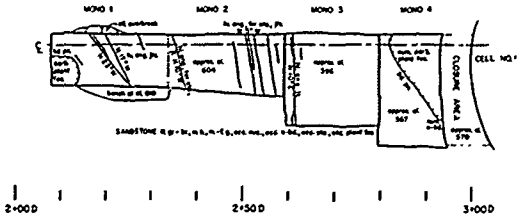


ELEVATION VIEW C-C

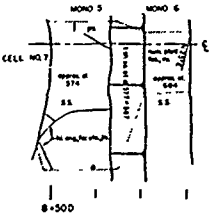


ELEVATION VIEW D-D

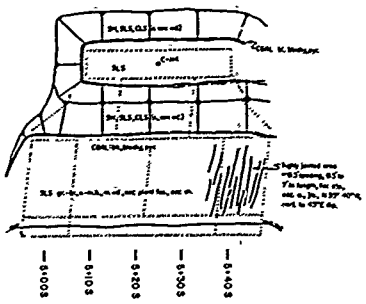
DAM



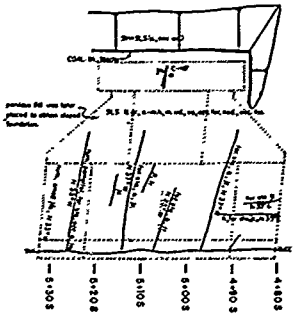
PLAN VIEW - CONCRETE MONOLITHS



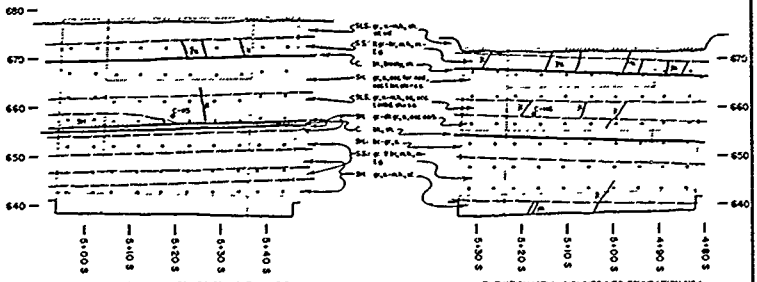
COFFERDAM



PLAN VIEW-ABUTMENT NO. 2



PLAN VIEW-ABUTMENT NO. 1



ELEVATION VIEW-INCLINED LEG FOUNDATION NO. 2

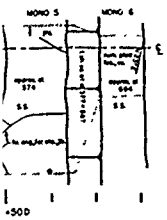
ELEVATION VIEW-INCLINED LEG FOUNDATION NO. 1

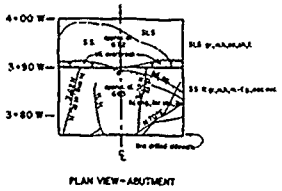
SPILLWAY BRIDGE

LEGEND

- Geologic contact
- Inferred geologic contact
- Centerline
- Concrete joint
- Bedding plane
- Joint with orientation
- Coal
- Dental concrete
- Sump
- Grout hole
- Exploratory hole
- Rock anchor

Scale 1" = 10'





PLAN VIEW-ABUTMENT

SERVICE BRIDGE

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT

BLAINE CREEK, KENTUCKY

YATESVILLE LAKE

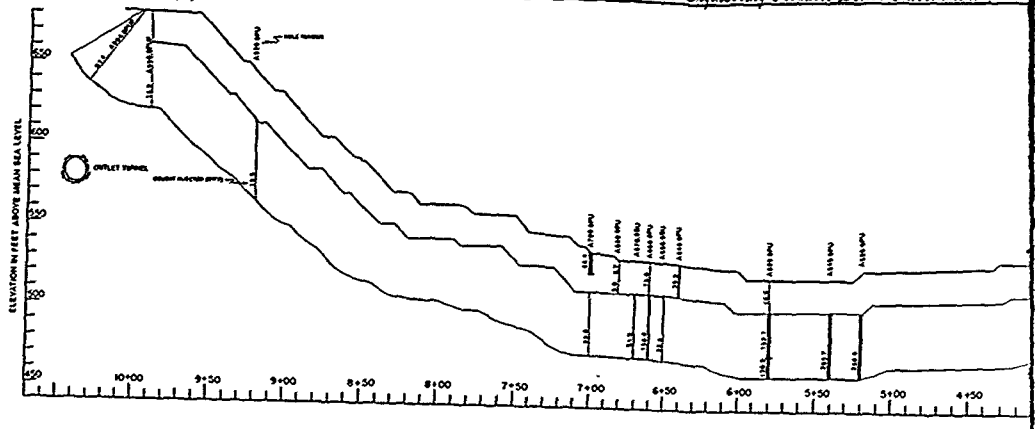
DAM AND APPURTENANT WORKS - PHASE II

GEOLOGIC MAPS

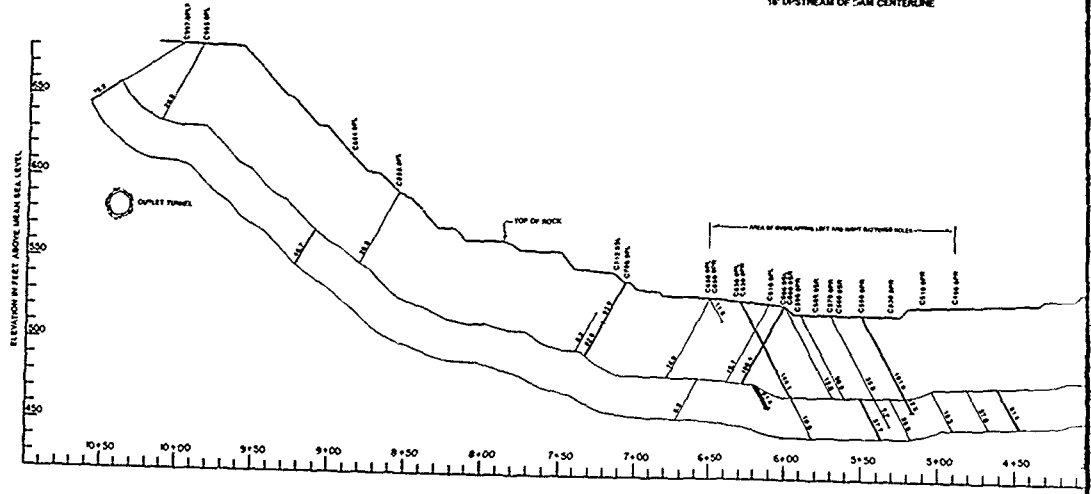
MISCELLANEOUS

EXHIBIT NO 13

Good Engineering Produces Better Environment !

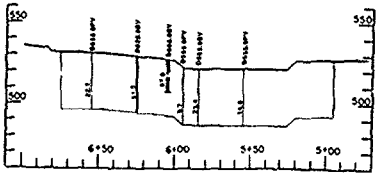


SECTION - A LINE
16' UPSTREAM OF DAM CENTERLINE

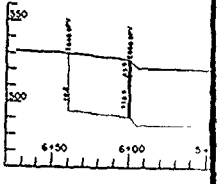


SECTION - C LINE
DAM CENTERLINE

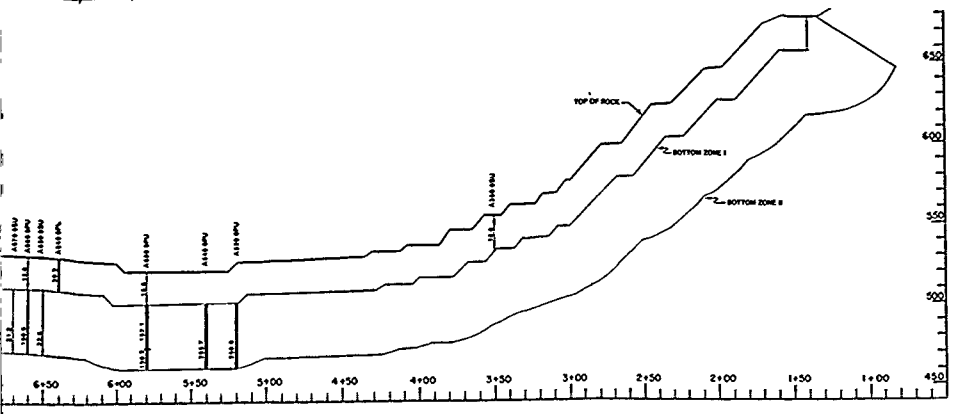
SECTION - B LINE
8' UPSTREAM OF DAM CENTERLINE



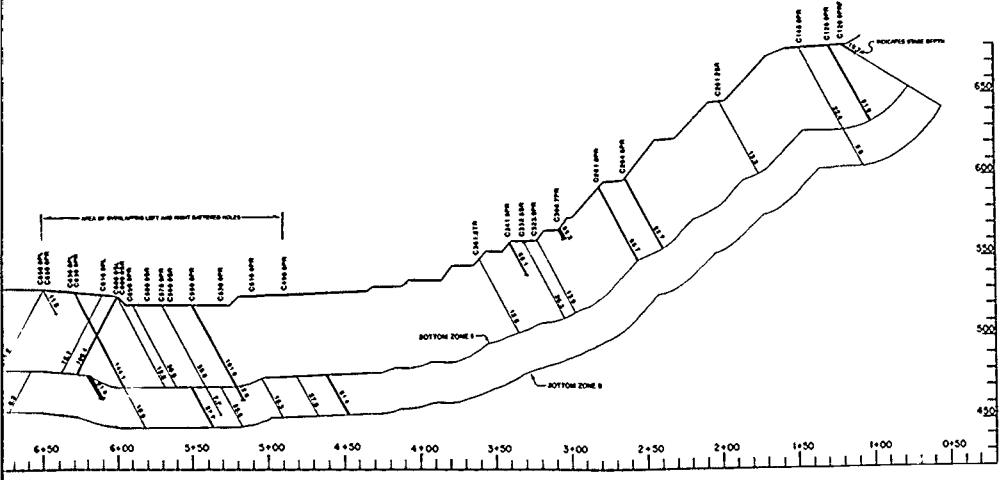
SECTION - D LINE
20' DOWNSTREAM OF DAM CENTERLINE



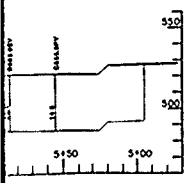
SECTION - E L
37' UPSTREAM OF DAM CE



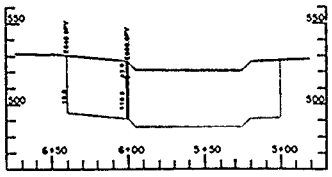
SECTION - A LINE
16' UPSTREAM OF DAM CENTERLINE



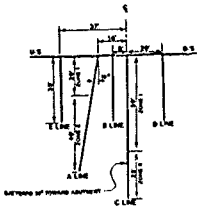
SECTION - C LINE
DAM CENTERLINE



- D LINE
DAM CENTERLINE



SECTION - E LINE
37' UPSTREAM OF DAM CENTERLINE



GROUTING DETAIL
(NTS)

MAJOR GROUT TAKES PER LINEAR FOOT

US ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT

BLAINE CREEK, KENTUCKY

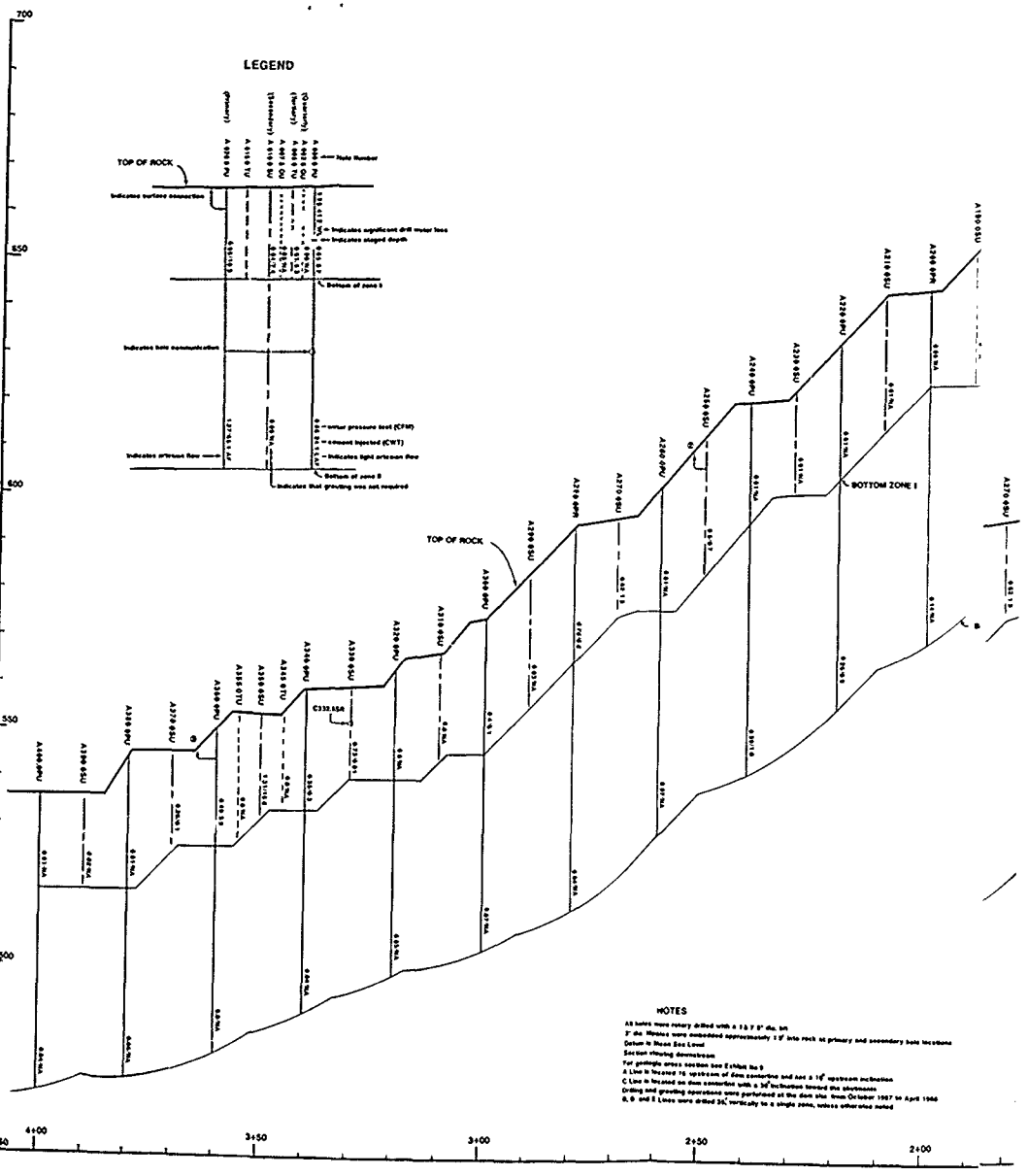
YATESVILLE LAKE

DAM AND APPURTENANT WORKS - PHASE II

CURTAIN GROUTING

GENERAL

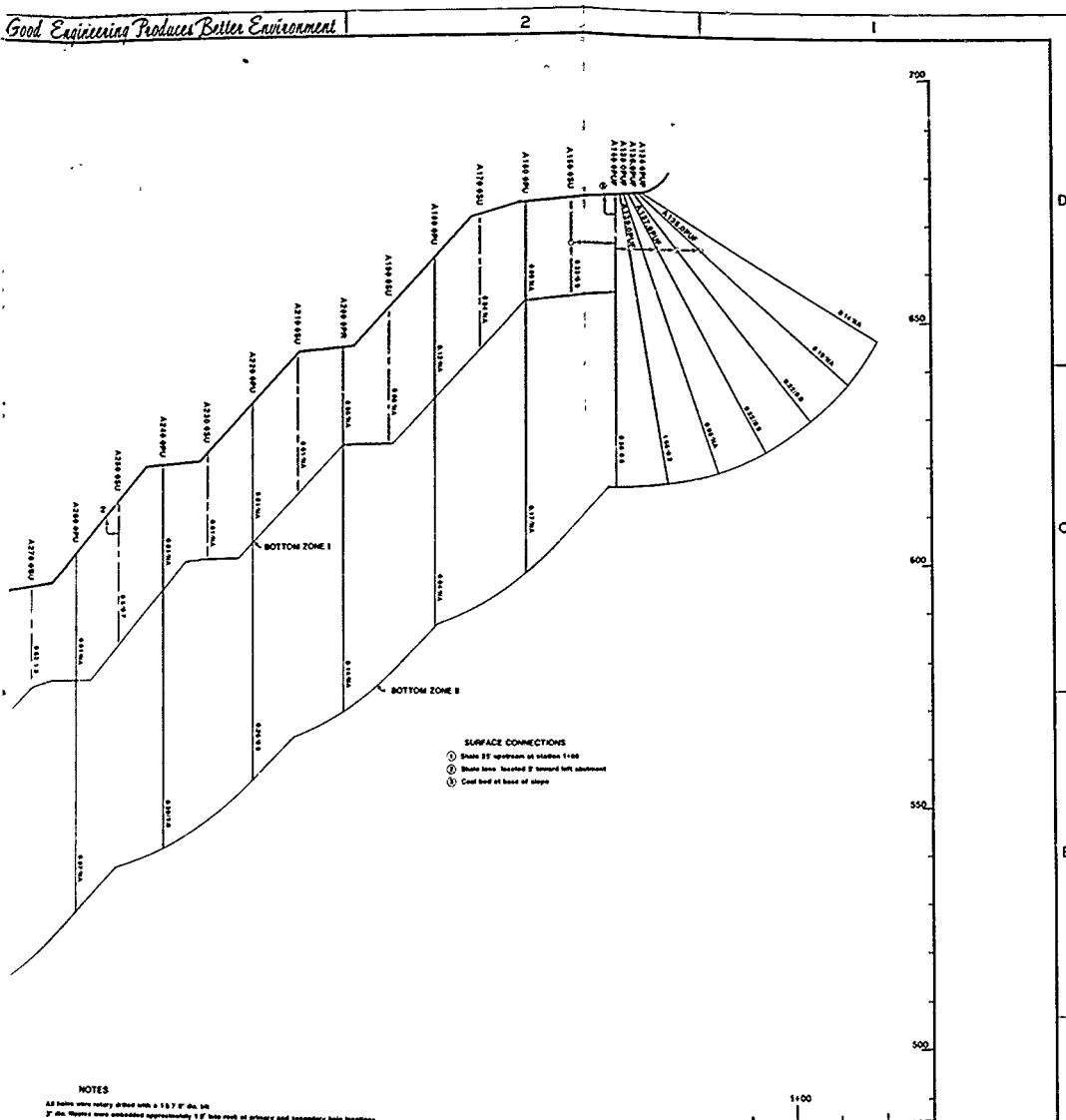
EXHIBIT NO 14



NOTES

All holes were rotary drilled with a 15 7 8" dia. bit
7" dia. Nipples were embedded approximately 1 0' into rock at primary and secondary hole locations
Datum is Mean Sea Level
Section viewing downstream
For grouting areas section see Exhibit No 9
A Line is located 15 upstream of dam centerline and has a 10° upstream inclination
C Line is located on dam centerline with a 30° inclination toward the upstream
Drilling and grouting operations were performed at the dam site from October 1967 to April 1968
B, D and E Lines were drilled 30° vertically in a single zone, unless otherwise noted

SCALE. 1" = 10'



NOTES

All holes were rotary drilled with a 15/7 8" dia. bit.
3" dia. Wasks were embedded approximately 1.0' into rock at primary and secondary hole locations
Datum is Mean Sea Level
Sea look viewing downstream
For geologic cross section see Exhibit No 9
A Line is located 16 upstream of dam centerline and has a 10° upstream inclination
C Line is located on dam, centerline with a 30° inclination toward the abutments
Drilling and grouting operations were performed on the dam site, from October 1957 to April 1958.
B, D and E Lines were drilled 24' vertically to a single zone, unless otherwise noted

SCALE 1" = 10'

U.S. ARMY HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT

BLAINE CREEK, KENTUCKY

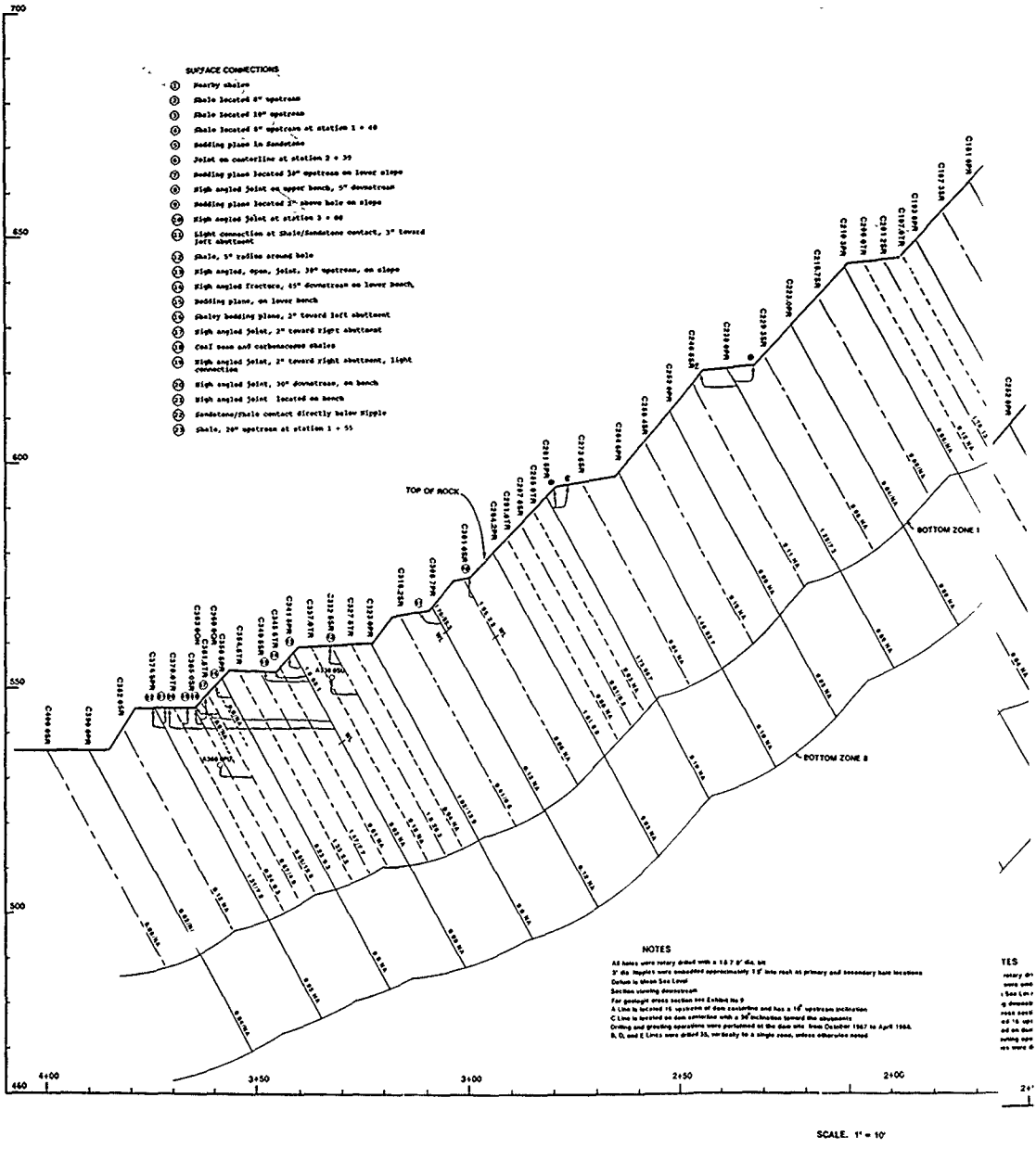
YATESVILLE LAKE

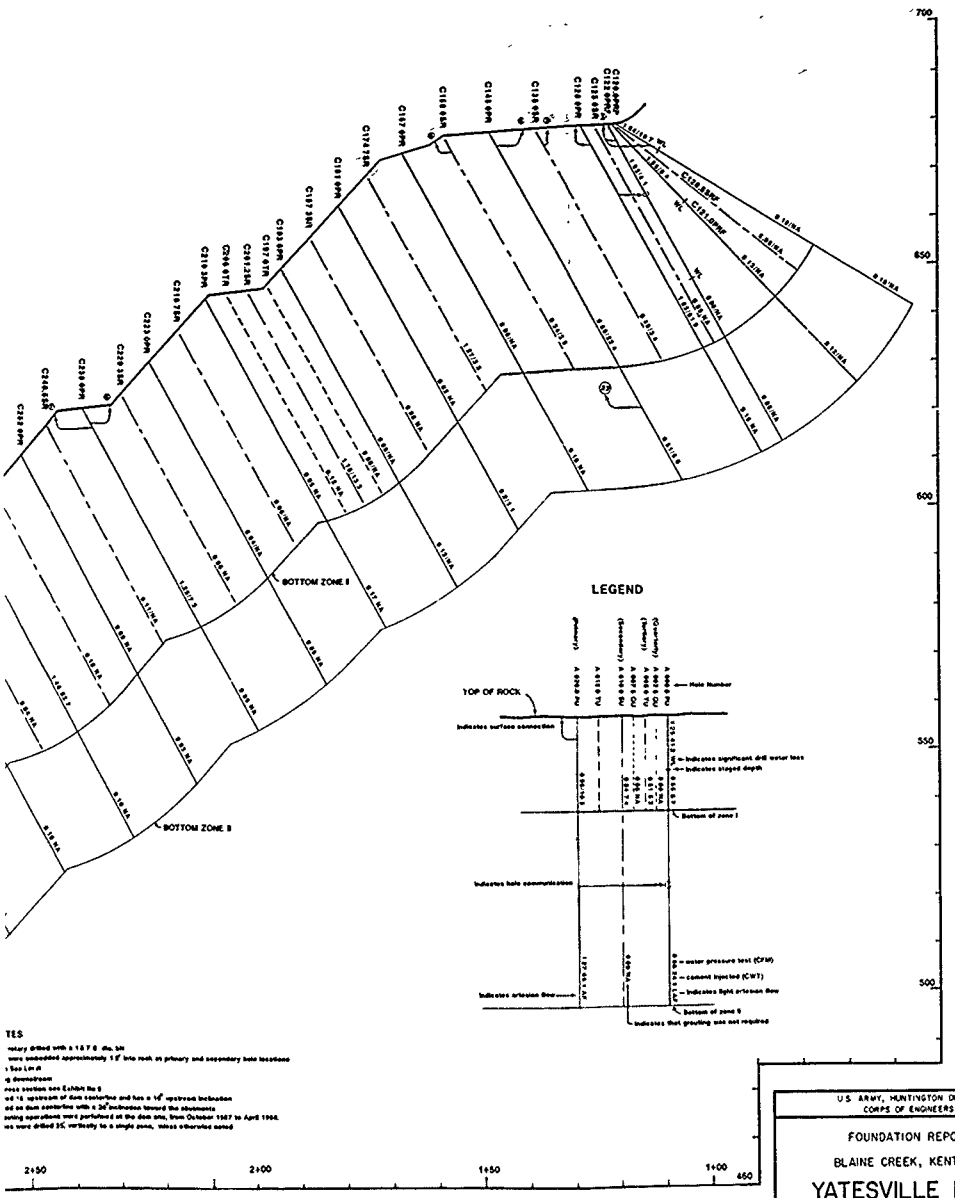
DAM AND APPURTENANT WORKS - PHASE II

CURTAIN GROUTING

A LINE - STA 1+20 TO 3+85

EXHIBIT NO 15


SURFACE CONNECTIONS
1 Nearby shales
2 Shale located 8" upstream
3 Shale located 10" upstream
4 Shale located 8" upstream at station 1 + 40
5 Bedding plane in Sandstone
6 Joint on centerline at station 2 + 39
7 Bedding plane located 36" upstream on lower slope
8 High angled joint on upper bench, 5" downstream
9 Bedding plane located 3" above hole on slope
10 High angled joint at station 3 + 66
11 Light connection at Shale/Sandstone contact, 3" toward left abutment
12 Shale, 5" radius around hole
13 High angled, open, joint, 38" upstream, on slope
14 High angled fracture, 45" downstream on lower bench
15 Bedding plane, on lower bench
16 Shaley bedding plane, 2" toward left abutment
17 High angled joint, 2" toward right abutment
18 Coal seam and carbonaceous shales
19 High angled joint, 2" toward right abutment, light connection
20 High angled joint, 30" downstream, on bench
21 High angled joint located on bench
22 Sandstone/Shale contact directly below Ripple
23 Shale, 20" upstream at station 1 + 55
TOP OF ROCK
BOTTOM ZONE I
BOTTOM ZONE II
700
650
600
550
500
460
4+00
3+50
3+00
2+50
2+00
NOTES
All holes were rotary drilled with a 16 7/8" dia. bit
3" dia. Ripples were embedded approximately 15' into rock at primary and secondary hole locations
Datum is Mean Sea Level
Section viewing downstream
For geologic cross section see Exhibit No 9
A Line is located 15 upstream of dam centerline and has a 16° upstream inclination
C Line is located on dam centerline with a 36° inclination toward the abutments
Drilling and grouting operations were performed at the dam site from October 1967 to April 1968.
B, D, and E Lines were drilled 30, vertically to a single zone, unless otherwise noted
SCALE. 1" = 10'



LEGEND

TES

rotary drilled with a 1.87 6 dia. bit
were embedded approximately 1'-0" into rock at primary and secondary hole locations
1 See Line #
g downstream
ross section see Exhibit No 8
ed 15 upstream of dam centerline and has a 14° upstream inclination
ed on dam centerline with a 30° inclination toward the abutments
outing operations were performed at the dam site, from October 1967 to April 1968.
es were drilled 3C vertically to a single zone, unless otherwise noted

SCALE, 1" = 10'

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT

BLAINE CREEK, KENTUCKY

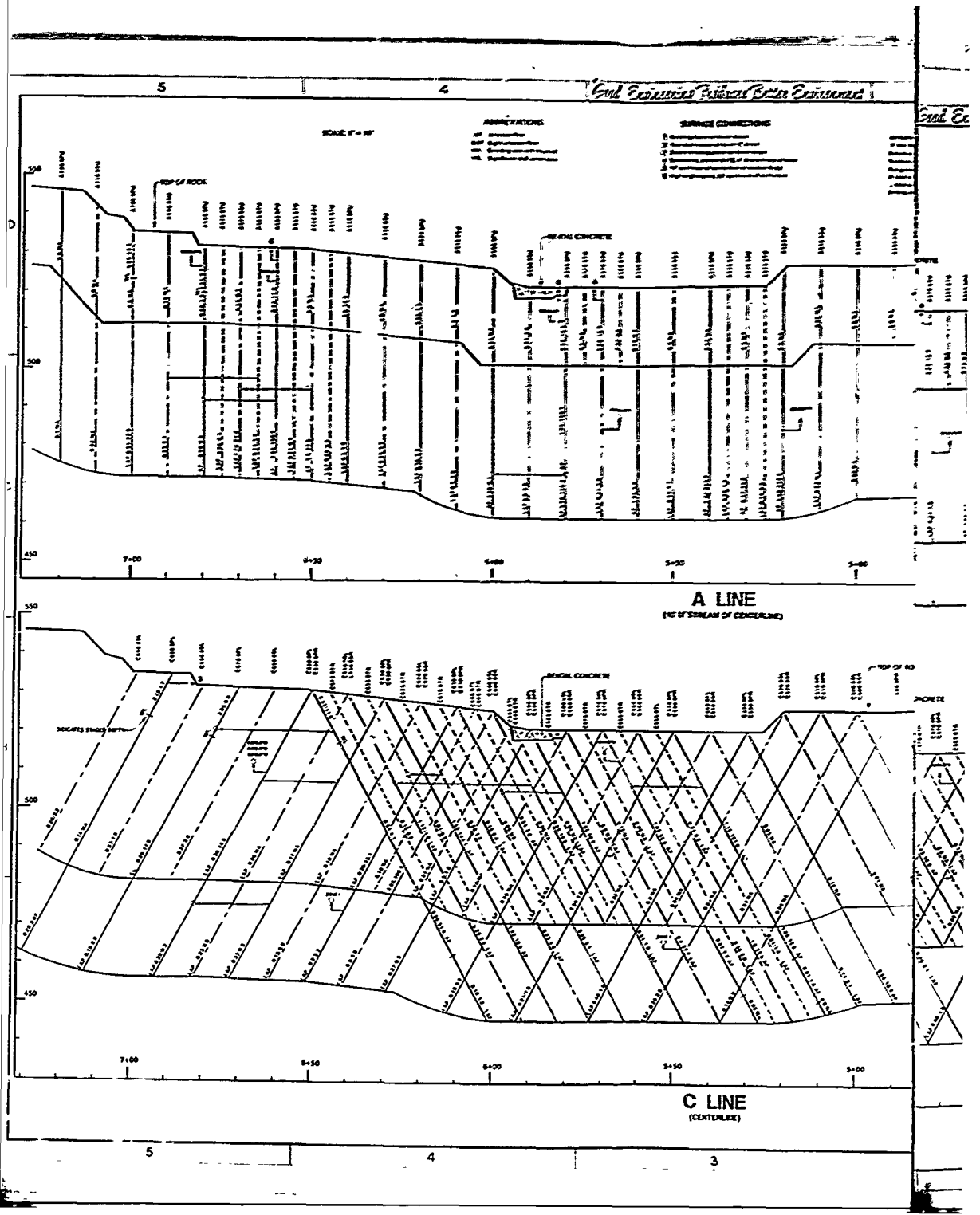
YATESVILLE LAKE

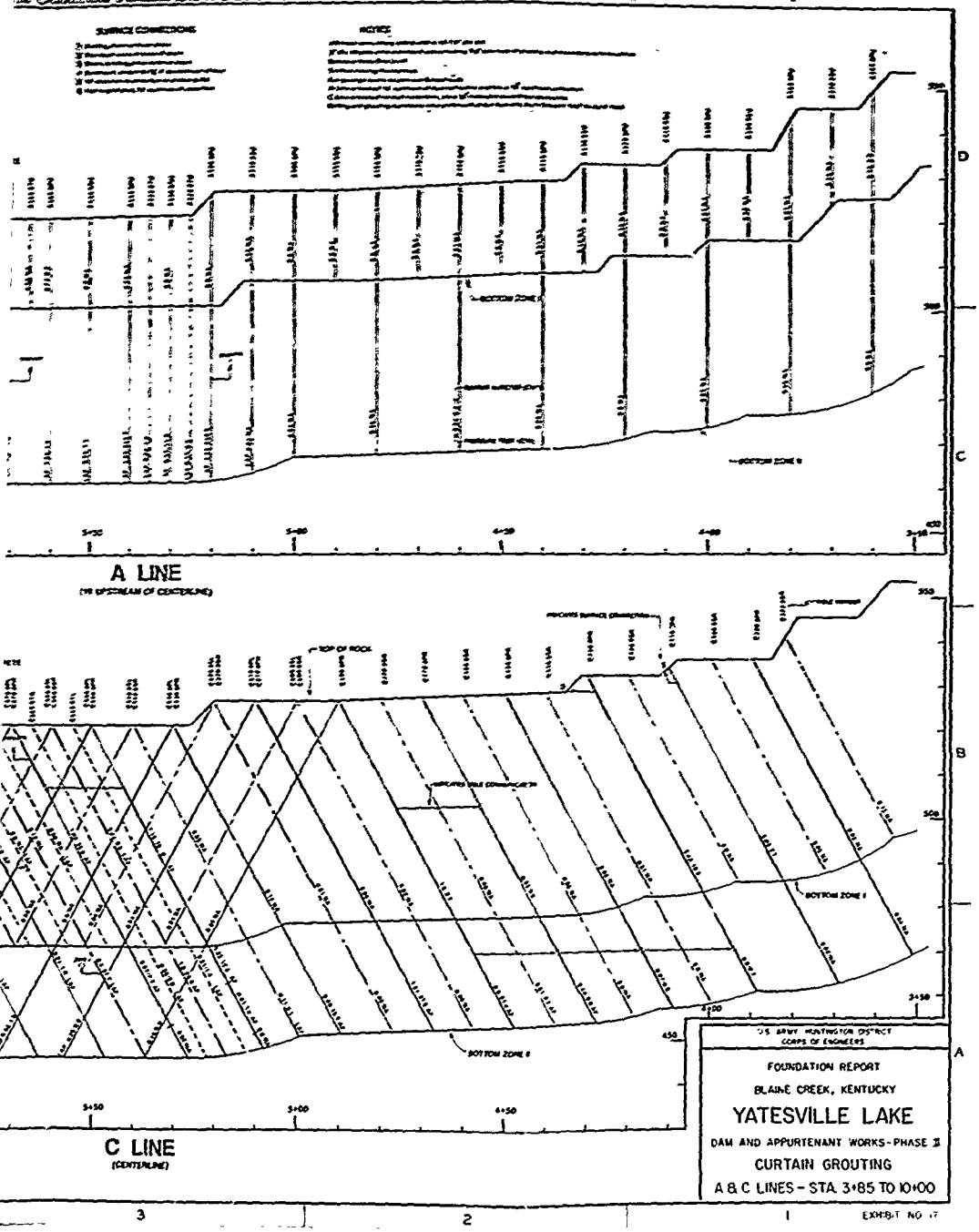
DAM AND APPURTENANT WORKS - PHASE II

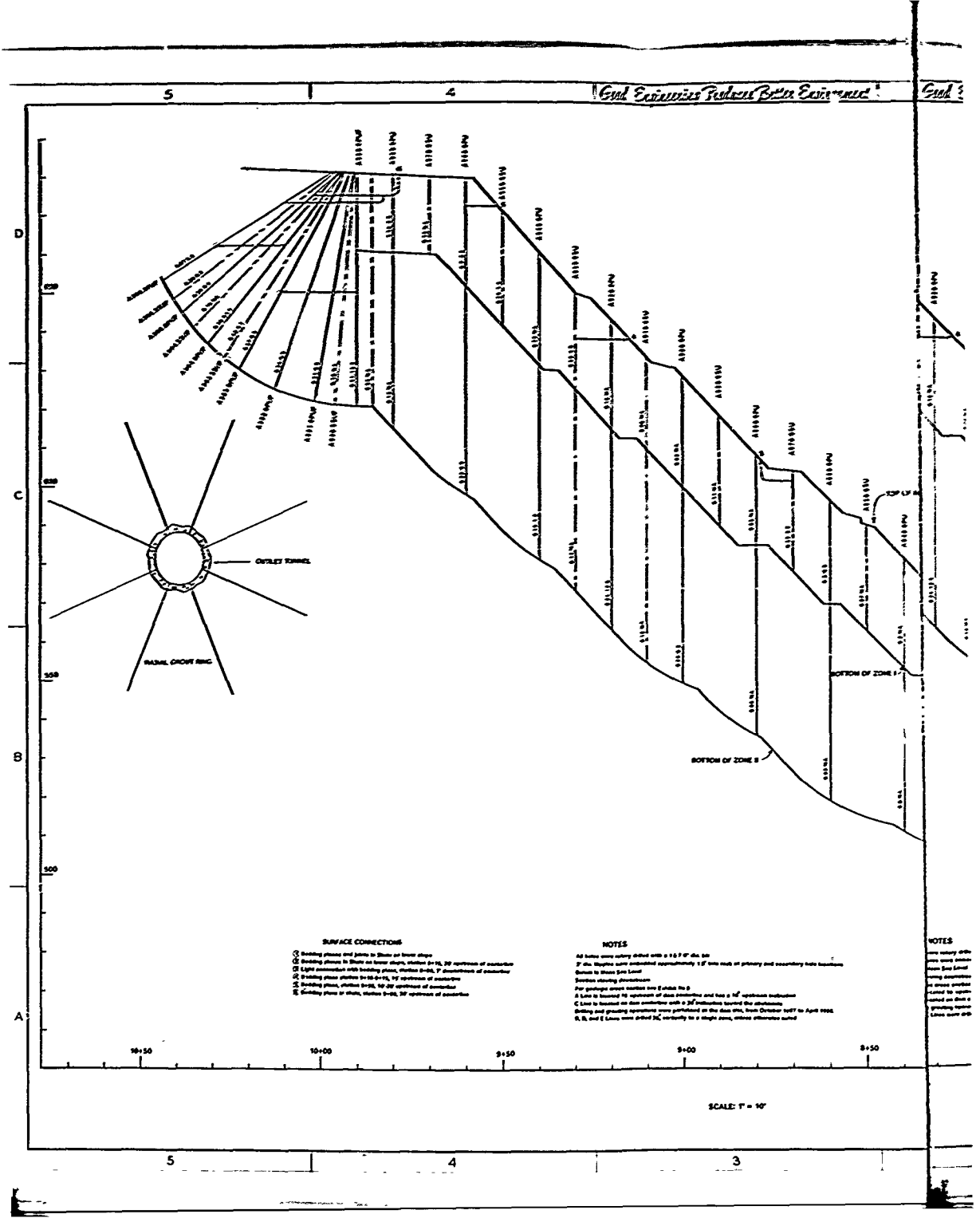
CURTAIN GROUTING

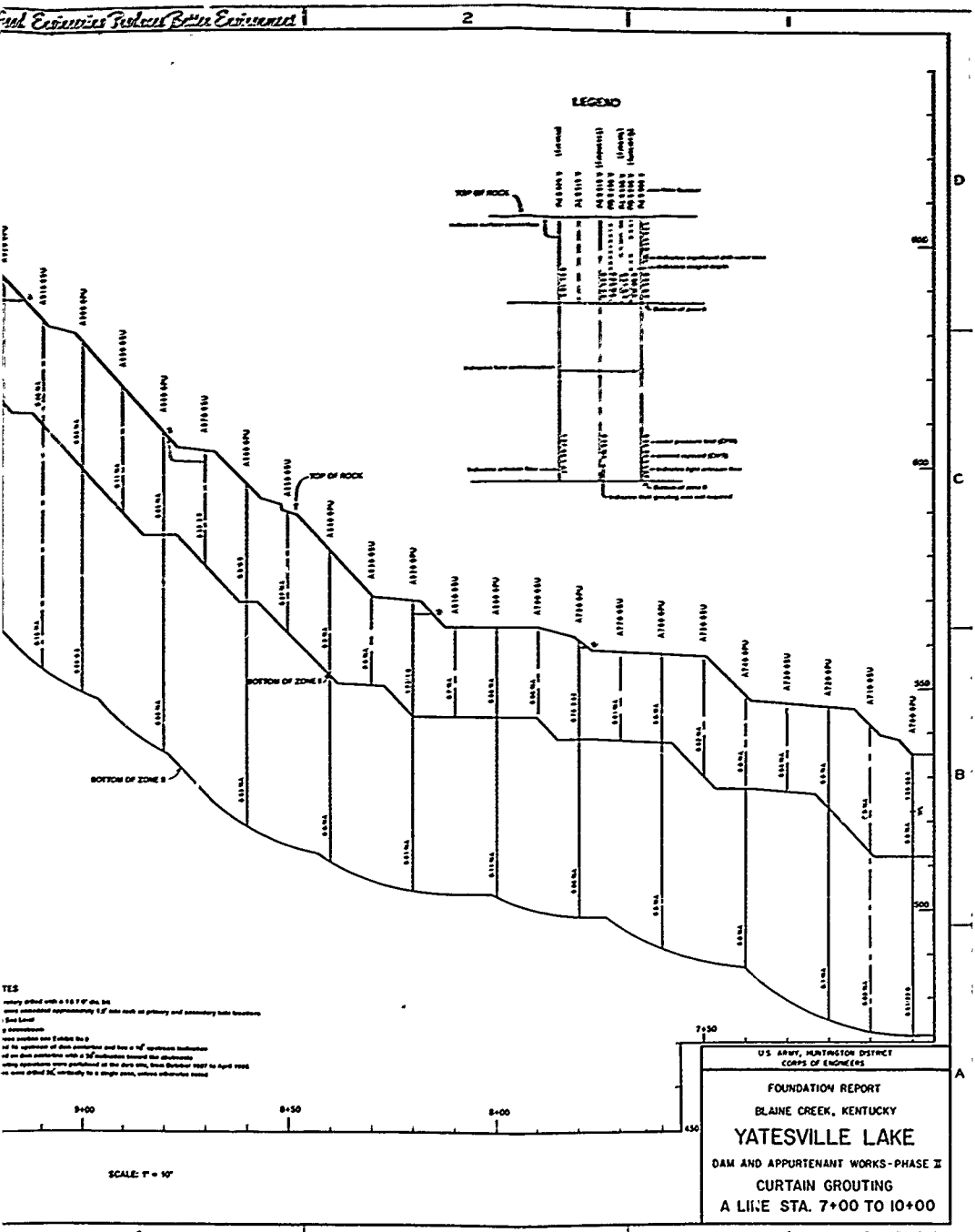
C LINE STA. 1+20 TO 3+85

EXHIBIT NO 16


A LINE
C LINE
(CENTERLINE)


A LINE
C LINE
(CENTERLINE)
TOP OF ROCK
BOTTOM ZONE II
BOTTOM ZONE I
US ARMY HUNTINGTON DISTRICT
CORPS OF ENGINEERS
FOUNDATION REPORT
BLAINE CREEK, KENTUCKY
YATESVILLE LAKE
DAM AND APPURTENANT WORKS - PHASE II
CURTAIN GROUTING
A & C LINES - STA 3+85 TO 10+00
EXHIBIT NO 17


5
4
Grand Excavation Profile Below Excavation
Grand
D
C
B
A
OUTLET TUNNEL
RADIAL CROWN RING
TOP OF
BOTTOM OF ZONE II
BOTTOM OF ZONE II
SURFACE CONNECTIONS
NOTES
NOTES
10+50
10+00
9+50
9+00
8+50
SCALE: 1" = 10'
5
4
3



U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT

BLAINE CREEK, KENTUCKY

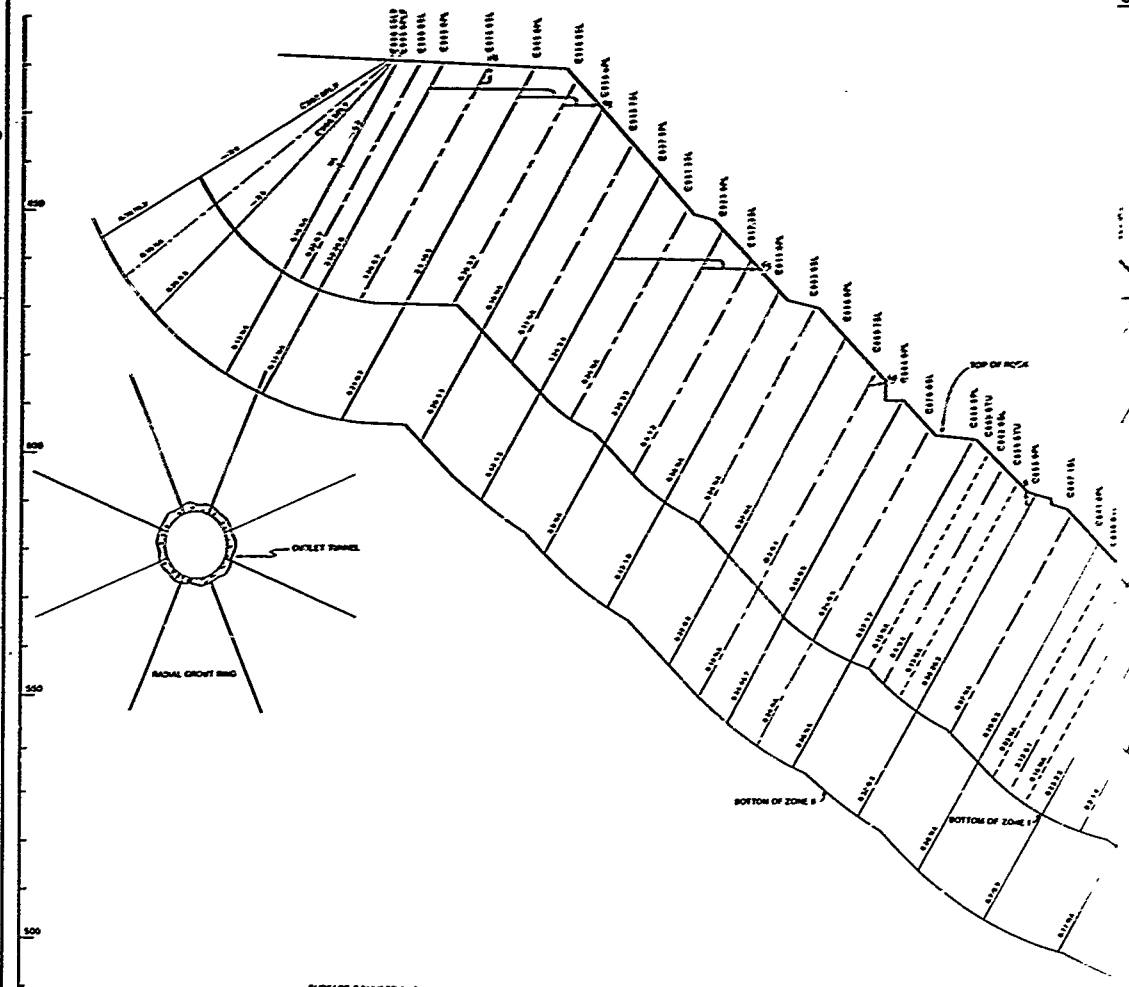
YATESVILLE LAKE

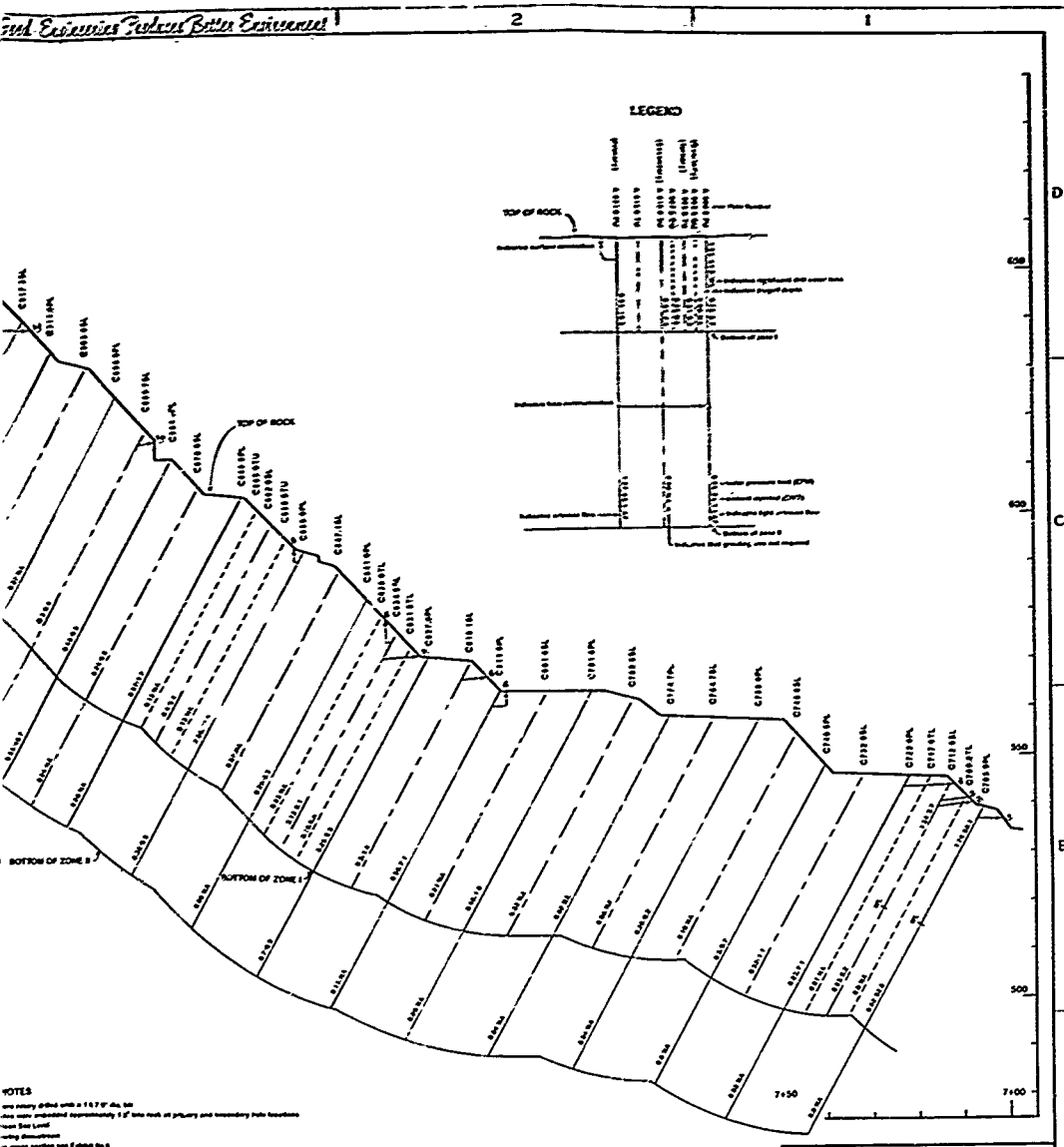
DAM AND APPURTENANT WORKS - PHASE II

CURTAIN GROUTING

A LINE STA. 7+00 TO 10+00

EXHIBIT NO 18


OUTLET TUNNEL
RADIAL GROUT RING
TOP OF ROCK
BOTTOM OF ZONE II
BOTTOM OF ZONE I
SURFACE CONNECTIONS
NOTES
SCALE: 1" = 10'



NOTES

SCALE: 1" = 10'

US ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT

BLAINE CREEK, KENTUCKY

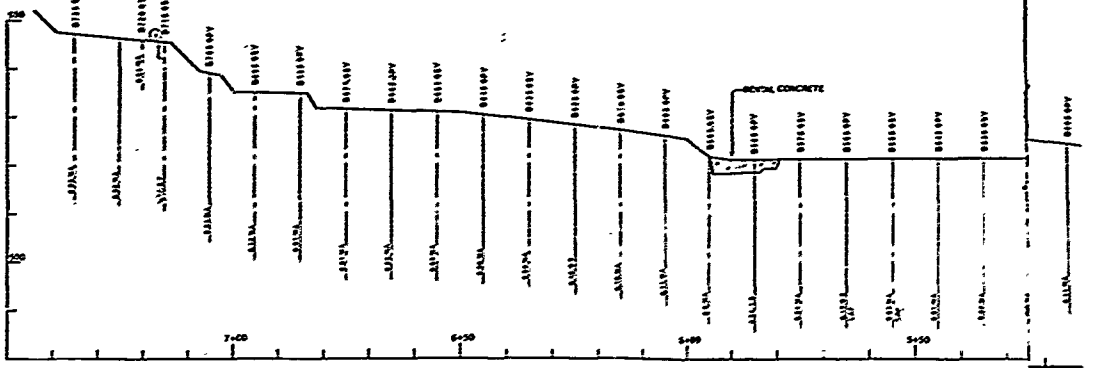
YATESVILLE LAKE

DAM AND APPURTENANT WORKS - PHASE II

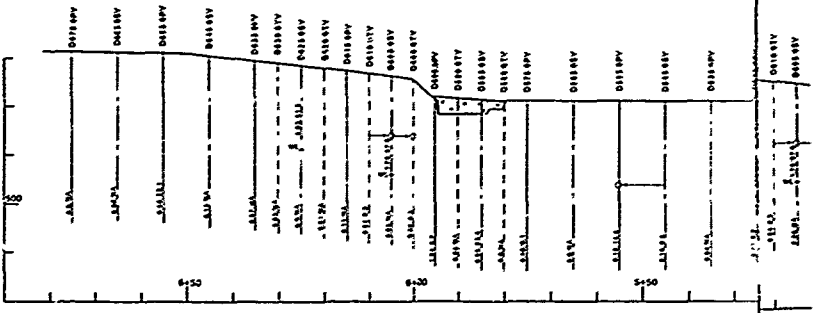
CURTAIN GROUTING

C LINE STA. 7+00 TO 10+00

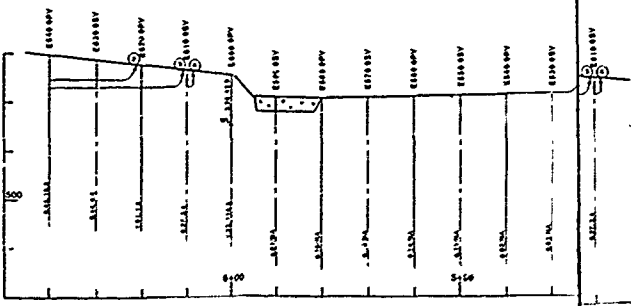
EXHIBIT NO. 9



B LINE
8' UPSTREAM OF DAM CENTERLINE



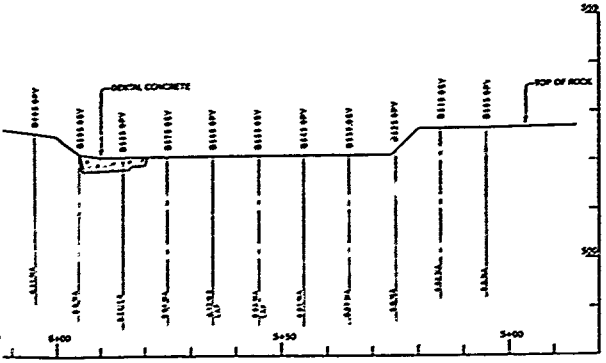
D LINE
20' DOWNSTREAM OF DAM CENTERLINE



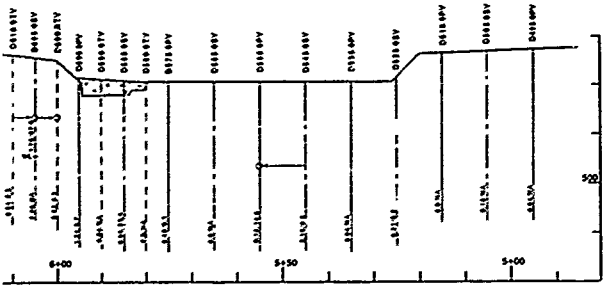
E LINE
37' UPSTREAM OF DAM CENTERLINE

SURFACE CONFECTIONS

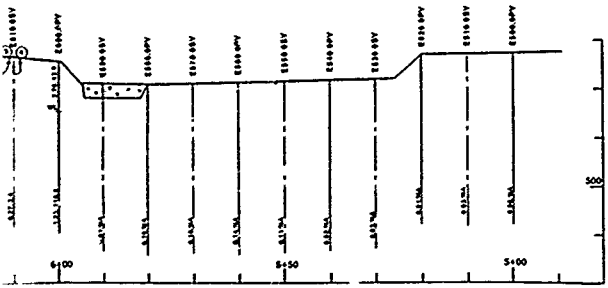
SCALE 1" = 10'



E
CENTERLINE



D LINE
20' DOWNSTREAM OF DAM CENTERLINE

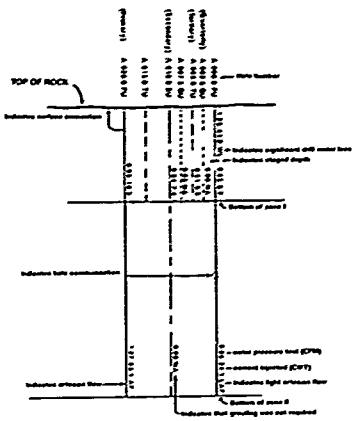


E LINE
37' UPSTREAM OF DAM CENTERLINE

SCALE 1" = 10'

ADDITIONAL B LINE HOLES

LEGEND



NOTES

All holes were rotary drilled with a 10 7/8" dia. bit.
3" dia. Nipples were embedded approximately 1.5' into rock at primary and secondary hole locations.
Return to Mouse See Lowell
Section showing dimensions
For geologic cross sections see Exhibit No 5
A Line is located 16' upstream of dam centerline and has a 16" upstream inclination.
C Line is located on dam centerline with a 24" inclination toward the abutments.
Drilling and grouting operations were completed at this dam site, from October 1967 to April 1968.
B, D, and E Lines were drilled 24' vertically in a single zone, unless otherwise noted.

US ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT

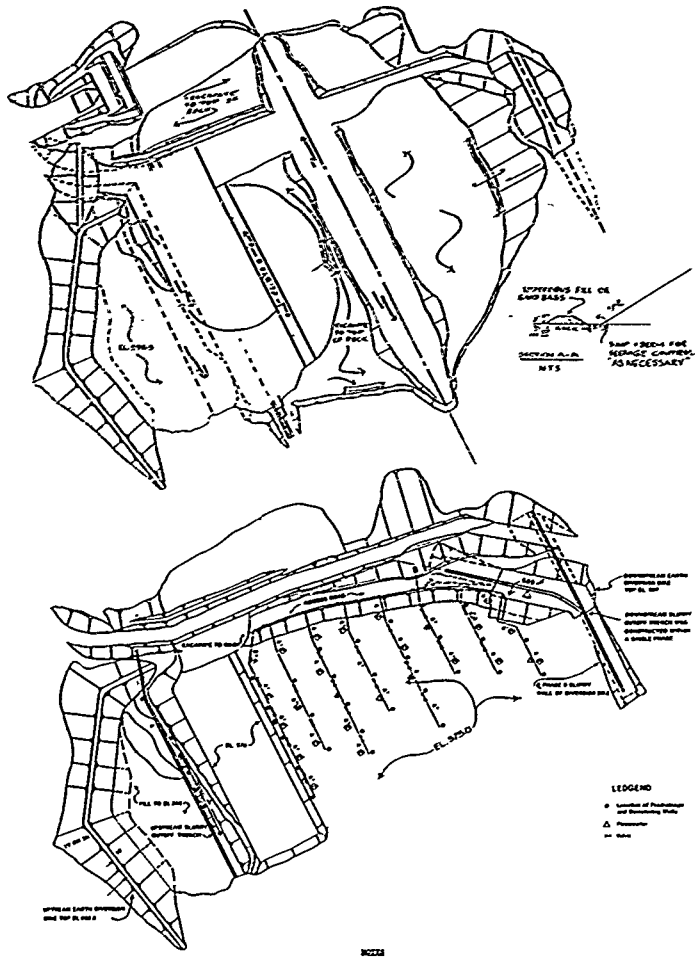
BLAINE CREEK, KENTUCKY

YATESVILLE LAKE

DAM AND APPURTENANT WORKS - PHASE II

CURTAIN GROUTING
B, D, AND E LINES

EXHIBIT NO 20



NOTES

1. Dewatering and Predrainage Wells to be installed at locations indicated

2 Well and Piezometer construction materials to be in accordance with the specifications

3 Berms and sumps for seepage control are to be constructed by the General Contractor Pumps supplied for the sumps will be Prosser Model No 9-26112, 20 F single phase, 230 volt pumps or similar as required Discharge from sumps to be vinyl hose and/or PVC as required to diversion channel

4 6" dia discharge manifold shown on access road for clarity Actual location to be on the 3:1 slope away from running surface Road crossings to be encased in 12" dia Steel pipe buried a minimum of 1 ft

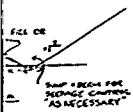
5 All final well discharge points to be fitted with flow meters as specified

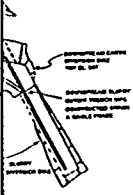
6 Well discharge manifolds to be extended to tunnel entrance and exit points when final diversion through the tunnel is accomplished

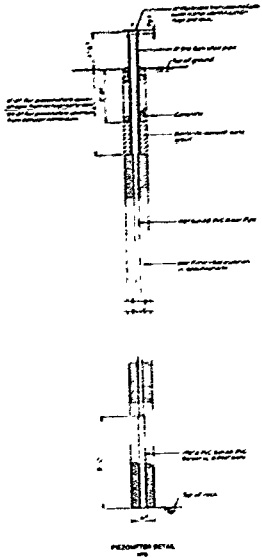
7 Wells will be developed in accordance with the specifications and as directed by the Contracting Officer

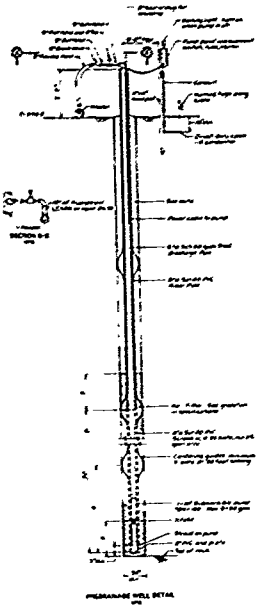
8 Wells discharge rates and piezometers will be monitored by the General Contractor in accordance with the specifications and as directed by the Contracting Officer

Good Engineering Produces Better Environment



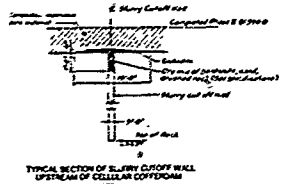




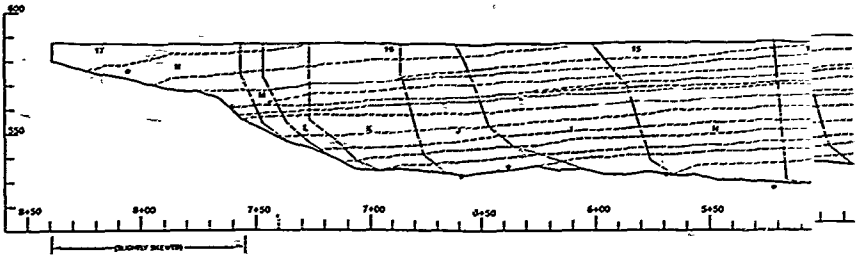


LEGEND

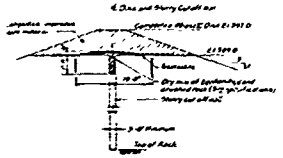
- Location of Piezometer and Observation Wells
- Piezometer or Well



TYPICAL SECTION OF SLURRY CUTOFF WALL
UPSTREAM OF CELLULAR COFFERDAM



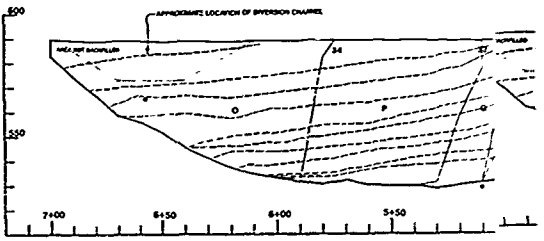
PROFILE A-A
UPSTREAM SLURRY CUT-OFF WALL



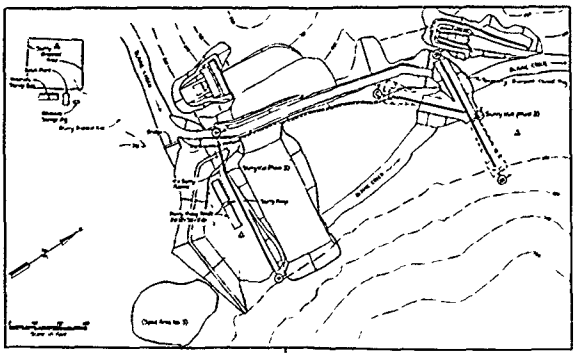
TYPICAL SECTION OF SLURRY CUTOFF
WALL IN DOWNSTREAM DIVERSION DIKE

EXCAVATION		
	DATE EXCAVATED	AREA (Sq Ft)
A	07-30-84	700
B	07-31-84	2,348
C	08-01-84	567
D	08-02-84	2,861
E	08-04-84	1,987
F	08-06-84	748
G	08-07-84	1,379
H	08-08-84	2,553
I	08-09-84	2,716
J	08-10-84	2,112
K	08-12-84	2,838
L	08-13-84	757
M	08-14-84	481
N	08-15-84	1,919
O	08-20-84	1,367
P	08-19-84	2,898
Q	08-11-84	885
QQ	08-11-84	2,261
R	08-12-84	1,951
S	08-13-84	1,795
T	08-16-84	2,867
U	08-17-84	2,748
V	08-20-84	3,235
VV	08-20-84	116
W	08-22-84	675
WW	08-22-84	3,799
X	08-23-84	3,679
Y	08-24-84	1,946

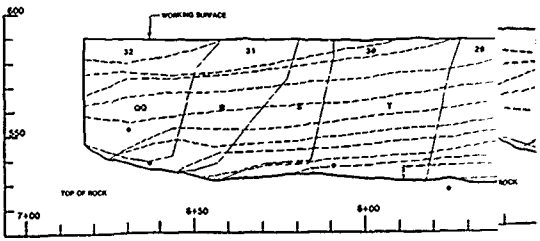
BACKFILL		
	DATE BACKFILLED	AREA (Sq Ft)
1	08-07-84	344
2	08-08-84	1,142
3	08-11-84	1,376
4	08-13-84	1,431
5	08-15-84	1,868
6	08-16-84	1,242
7	08-16-84	1,836
8	08-19-84	2,243
9	08-21-84	1,844
10	08-22-84	756
11	08-23-84	1,974
12	08-25-84	1,474
13	08-30-84	1,535
14	08-27-84	886
15	08-29-84	1,516
16	08-29-84	1,537
17	09-06-84	734
18	09-27-84	675
19	09-28-84	2,843
20	09-10-84	1,895
21	10-01-84	2,751
22	10-02-84	2,847
23	10-03-84	2,561
24	10-04-84	2,748
25	10-09-84	2,293
26	10-08-84	2,261
27	10-08-84	2,346
28	10-09-84	2,175
29	10-10-84	1,799
30	10-11-84	—
31	10-16-84	1,348
32	10-15-84	2,412
33	10-21-84	—
34	10-22-84	—



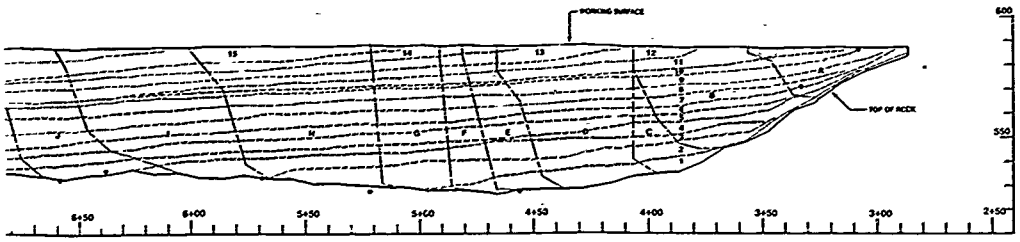
DOWNS



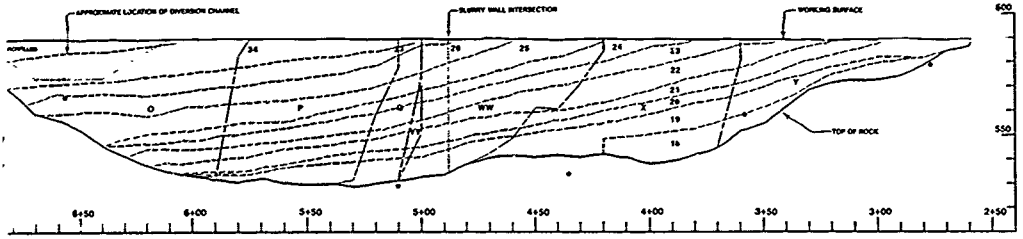
PLAN VIEW



PROFILE C-C
DOWNSTREAM SLURRY CUT-OFF WALL LEG D



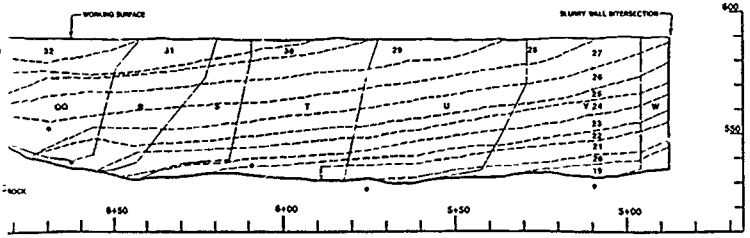
PROFILE A-A
UPSTREAM SLURRY CUT-OFF WALL



PROFILE B-B
DOWNSTREAM SLURRY CUT-OFF WALL

LEGEND

- EARLY BACKFILL SOUNDINGS
- EARLY EXCAVATION SOUNDINGS
- TOP OF ROCK, PROJECTED FROM NEAR-BY BORINGS



PROFILE C-C
DOWNSTREAM SLURRY CUT-OFF WALL LEG (SKEWED)

SCALE: 1"=50'

NOTES

- CONSTRUCTION OF THE SLURRY CUT-OFF WALLS WAS PERFORMED BY THE SUBCONTRACTOR McCLELLAND SERVICES INC. FROM JULY TO OCTOBER 1966
- EXCAVATION WAS PERFORMED WITH THE USE OF A 10000 SOIDFING BACKHOE
- THE SLURRY WAS A BOOKIE BENTONITE AND WATER MIXTURE (VISCOSITY 30 - 70, SPECIFIC GRAVITY 1.1, AND SAND CONTENT <10%)
- BACKFILL WAS A SOIL BENTONITE MIXTURE OF 5' SLUMP 5% BENTONITE, AND SPECIFIED SOIL GRADATION
- THE BACKFILL MATERIALS WERE BATCHED WITH THE USE OF AN ERIE-STRAYER CONCRETE BATCH PLANT
- THE BACKFILL MATERIALS FOR THE UPSTREAM WALL WERE MIXED WITH THE USE OF DOWER, 45 MIXING TRUCKS
- THE BACKFILL MATERIALS FOR THE DOWNSTREAM WALLS WERE MIXED ON THE GROUND WITH A D-6 DOZER.
- SLURRY CUT OFF WALL C-C WAS PARTIALLY REMOVED DURING OVERBURDEN EXCAVATION.

U.S. ARMY, HUNTINGTON DISTRICT
CORPS OF ENGINEERS

FOUNDATION REPORT

BLAINE CREEK, KENTUCKY

YATESVILLE LAKE

DAM AND APPURTENANT WORKS - PHASE II

SLURRY CUT-OFF WALLS

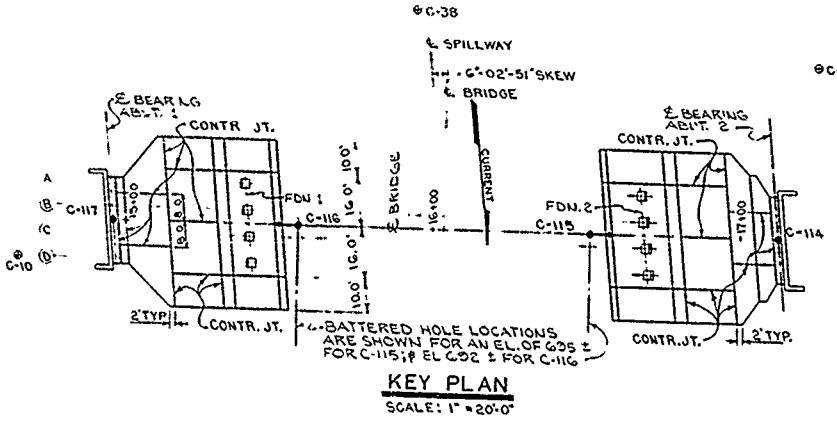
EXHIBIT NO 22

12-06. GRAPHIC LOGS OF BORINGS

Hole No.	Purpose
C-114	Establishing founding elevation for spillway bridge abutment, foundation #2.
C-115	Establishing founding elevation for spillway bridge inclined leg foundation #2.
C-116	Establishing founding elevation for spillway bridge inclined leg foundation #1.
C-117	Establishing founding elevation for spillway bridge abutment, foundation #1.
EX-1	Determine the extent, orientation and severity of broken zones discovered in the dam foundation.
EX-2	" "
EX-3	" "
EX-4	" "
EX-5	" "
EX-6	" "
EX-7	" "
EX-8	" "
EX-9	" "
EX-10	" "
EX-11	" "
CG-1	Determine areas and formations of grout takes, and the effectiveness of the foundation grout curtain.
CG-2	" "
CG-3	" "
CG-4	" "
CG-5	" "
CG-6	" "
CG-7	" "

12-06. GRAPHIC LOGS OF BORINGS (cont)

Location of Exploratory Holes
C-114 thru C-117
(spillway bridge foundation)



KEY PLAN
SCALE: 1" = 20'-0"

C-37

SCHEDULE OF DRILLING

HOLE NO.	APPROX TOP OF HOLE ELEV	APPROX TOP OF ROCK ELEV.	BOTTOM ELEV.
C-114	697	695	650
C-115 *	695	690	640
C-116 *	692	685	640
C-117	690	675	650

ALL BORINGS 4-INCH SIZE

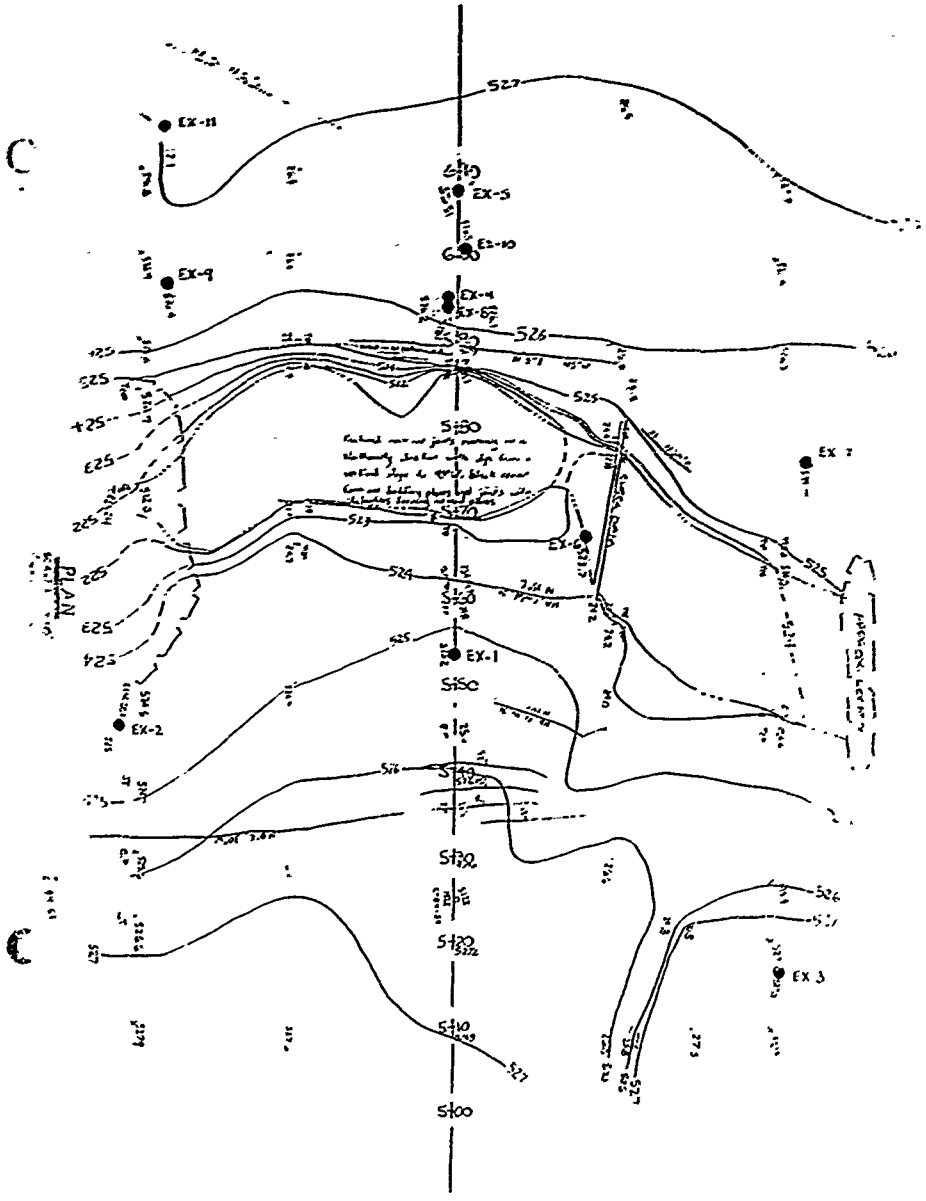
* ANGLE HOLE BATTERED 30° IN THE DIRECTION SHOWN.

LEGEND

- EXPLORATORY CORE BORINGS REQUIRED TO BE DRILLED UNDER THIS CONTRACT.
- EXISTING CORE BORINGS-SEE DWG 10/2

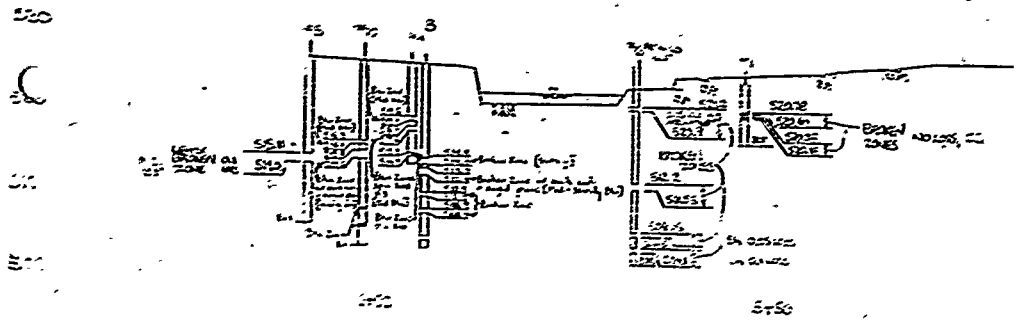
12-06. GRAPHIC LOGS OF BORINGS (cont)

Location of Exploratory Holes
EX-1 thru EX-11
(broken zones in dam foundation)

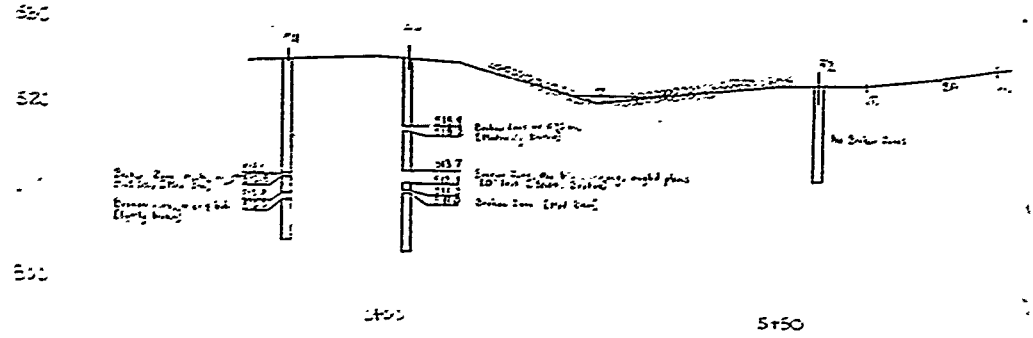


12-06. GRAPHIC LOGS OF BORINGS (cont)

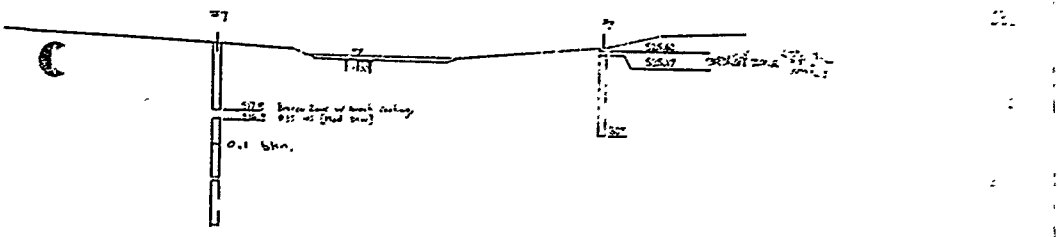
Sections of Exploratory Holes
EX-1 thru EX-11
(broken zones in dam foundation)



PROFILE - 2 DAM

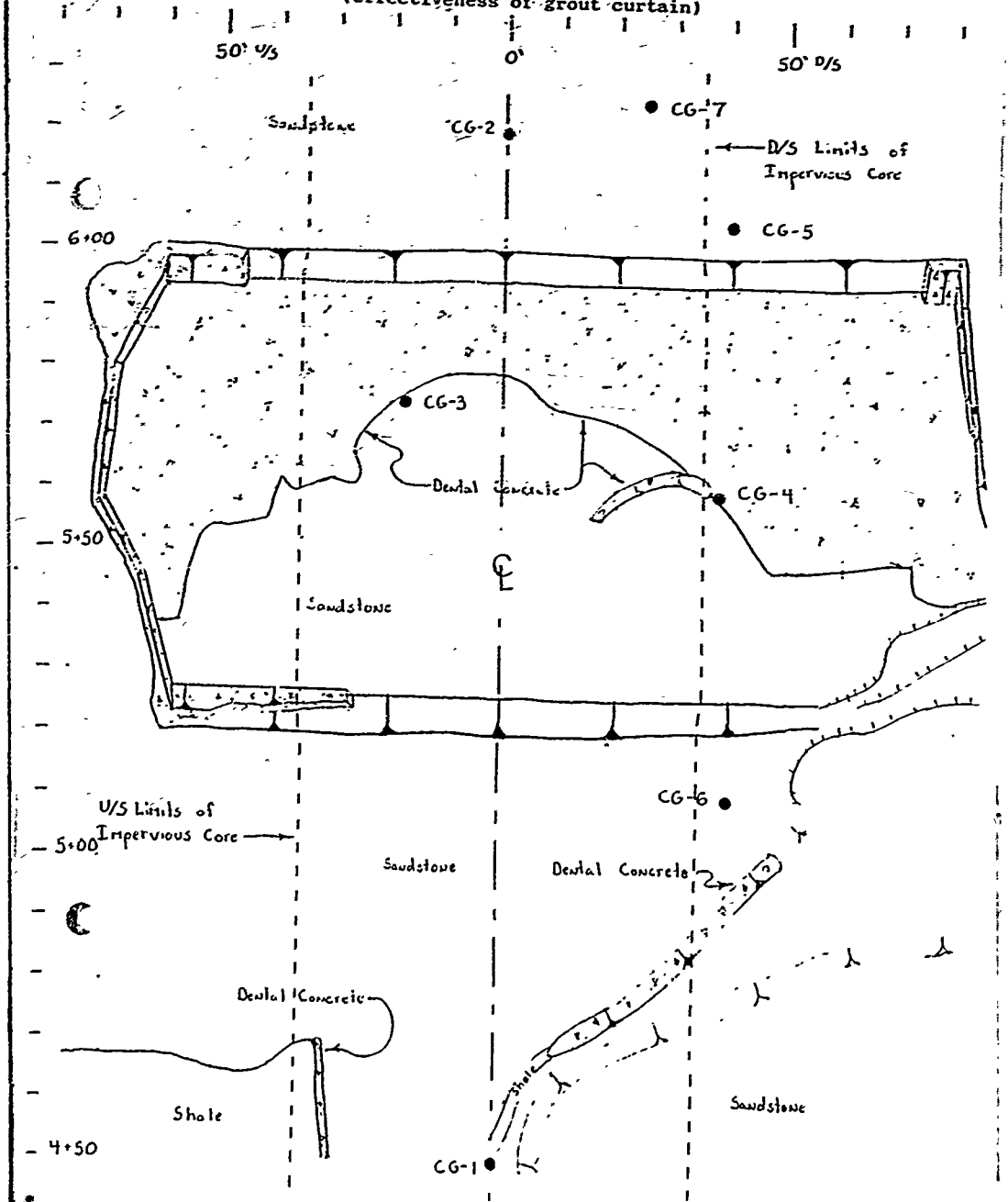


PROFILE - 40' LEFT



PROFILE - 40 RT (downstream)

Location of Exploratory Holes
CG-1 thru CG-7
(effectiveness of grout curtain)



Hole No. C-114

DRILLING LOG	DIVISION: Huntington District	INSTALLATION:	SHEET 1 OF 1 SHEETS
1. PROJECT: Yatesville Lake, Ky. Phase II		10. SIZE AND TYPE OF BIT: 4" Diamond Core Bit	
2. LOCATION (Coordinates or Station): Spillway, Sta. 17+11.7		11. DATUM FOR ELEVATION SHOWN (MSL or USC&GS): MSL	
3. DRILLING AGENCY: Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: Longyear 44	
4. HOLE NO. (As shown on drawing title) and file number: C-114		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER: Bob Lawson		14. TOTAL NUMBER CORE BOXES: 11	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: 680.2'	
7. THICKNESS OF OVERBURDEN: 6.5' not sampled		16. DATE HOLE: STARTED 22 July 1986; COMPLETED 23 July 1986	
8. DEPTH DRILLED INTO ROCK: 38.9'		17. ELEVATION TOP OF HOLE: 694.4'	
9. TOTAL DEPTH OF HOLE: 45.4'		18. TOTAL CORE RECOVERY FOR BORING: 97 %	
		19. SIGNATURE OF INSPECTOR: M. L. C. Neal	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
694.4	0		NOT SAMPLED			
687.9	5					
			687.9-685.4 SILTSTONE, m. hard, gray, clay filled ver. fr. @ 687.9-685.7. m. wd.		1	
	10		685.4-682.7 SHALE, soft, gray m. wd., bkn. @ 684.7-682.7	100		
682.7			682.7-881.8 SHALE, s., dk.gr. carb.,plant fos., bkn.	80	2	water prob.
680.7			681.8-680.2 CLAYSTONE, s.,r. br.to gr., wd., bkn.			
	15		680.2-679.5 SHALE, s.,dk.gr.		3	
			679.5-678.7 SILTSTONE, m.h.,gr.			
676.4			678.7-678.5 CLAYSTONE,s.,br. wd. 678.5-677.8 COAL, bk., shaly	93		
	20		677.8-674.3 SILTSTONE, m.h., gr. sandy		4	
			674.3-674.6 COAL, bk.,shaly			
			674.6-669.9 SANDSTONE, m.h., lt.gr., f. to m. grained, x-bd., mic. bd. pns. at bottom	100	5	
671.2	25		669.9-669.6 COAL, bk.,shaly			
			669.6-663.3 SHALE,s., gr. intbd. siltstone @ 668.3-668.6 668.9-669.3	100	6	
666.0	30				7	
			663.3-656.3 SANDSTONE, m.h., f.-m. g., x-bd., carb. partings, gradational w/ m. g. at bottom and f. g. at top. fer. stained @ 657.1-656.8 intbd. shale @ 660.9-661.2	100	8	10% water loss
661.2	35					
656.3			656.3-655.6 COAL, bk., blocky	94	9	
	40		655.6-654.4 SHALE, s.,dk.g., carb.. coal stringers.			
			654.4-648.2 SANDSTONE, m.h., lt. gr., f.-c. grained, occ. x-bd., carb. partings. ver. jt. @ 654.1-651.9 intbd. siltstone @ 654.4-654	98	10	
651.1						
649.0	45		648.2-649.0 SILTSTONE, m.h., lt.gr., fer. nod. @ 648.4 BOTTOM OF HOLE	100	11	

Depth	Pen	Rec	Time	Other
11.7	5.2	5.2	:35	
13.7	2.0	1.6	:40	
18.0	4.3	4.0	:45	
23.2	5.2	5.2	:30	
28.4	5.2	5.2	:50	
33.2	4.8	4.8	:30	
38.1	4.9	4.6	:40	
43.3	5.2	5.1	:45	
45.4	2.1	2.1	:20	

Hole No. C-115

DRILLING LOG	DIVISION HUNTINGTON DISTRICT	INSTALLATION	SHEET 1 OF 2 SHEETS
1. PROJECT: Yatesville Lake, Ky., Phase II		10. SIZE AND TYPE OF BIT: 4" Diamond Bit	
2. LOCATION (Coordinates or Station): Spillway @ Sta. 16+51.7		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: Longyear, 44 Truck Mounted	
4. HOLE NO. (As shown on drawing title) and Sht number): C-115		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED S/A; UNDISTURBED S/A	
5. NAME OF DRILLER: Bob Lawson		14. TOTAL NUMBER CORE BOXES: 16	
6. DIRECTION OF HOLE: ☐ VERTICAL ☒ INCLINED 30° DEG. FROM VERT.		15. ELEVATION GROUND WATER: 679.3	
7. THICKNESS OF OVERBURDEN: 9.8' (w. rock)		16. DATE HOLE: STARTED 25 July 1986; COMPLETED 29 July 1986	
8. DEPTH DRILLED INTO ROCK: 55.0'		17. ELEVATION TOP OF HOLE: 694.7	
9. TOTAL DEPTH OF HOLE: 64.8'		18. TOTAL CORE RECOVERY FOR BORING: 98 %	
		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
694.7						
	5					
686.2	10		686.2-679.5 SHALE, s., br., wd. vuggy @ 685.8 & 682.8 bkn. @ 685.6-680.7 hi. ang. fer. stained jts. @ 683.1 (N 45° W) @ 682.9-681.9 (N 45° W) @ 680.9-683.4 (N 45° W) coal @ 683.5 & 679.9 clayey @ 679.8-679.7 carb. @ 681.1-679.5		1	
681.9	15			86	2	Depth 14.8, Pen 5.0, Rec 4.3, Time 1:10
677.7	20		679.5-678.7 COAL, blocky, pyr. 678.7-674.5 SILTSTONE, m.h.-s., gr. carb. @ 678.7-677.5 shaley @ 674.0-674.5	98	3 4	Depth 19.6, Pen 4.8, Rec 4.7, Time 1:15
673.2	25		674.5-671.0 SANDSTONE, m.h., m.-f. grained, lt. gr., mic. num. mic. bd. pns. @ 672.1-671.0 increasing w/ depth 671.0-670.9 COAL, shaley	100	5	Depth 24.8, Pen 5.2, Rec 5.2, Time 1:00
668.9	30		670.9-663.3 SHALE, s.-m.h., gr. silty @ 669.0-668.4	100	6	Depth 29.8, Pen 5.0, Rec 5.0, Time 0:35
665.3	35			100	7	Depth 33.9, Pen 4.1, Rec 4.1, Time 0:50
			663.3-657.5 SANDSTONE, m.h., f.-v.f. grained, lt.gr., mic. bd. pns.		8	
660.5	40			100	9	Depth 39.5, Pen 5.6, Rec 5.6, Time 0:45
			657.5-656.0 SHALE, s., dk. gr., carb. coal @ 657.3-657.1 & 656.7-656.5 & 656.2-656.0 656.0-654.8 SHALE, s. gr.			90% w. loss @ 42.8
656.0	45			100	10	Depth 44.7, Pen 5.2, Rec 5.2, Time 0:35
			654.8-651.0 SANDSTONE, m.h., lt.gr., f.-m. g., gradation Coal w/ coal stringers @ 652.1-651.0	100	11	Depth 49.8, Pen 5.1, Rec 5.1, Time 0:35
651.6						

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PROJECT Yatesville Lake

HOLE NO C-115

C-115

DRILLING LOG | DIVISION HUNTINGTON DISTRICT | INSTALLATION | Hole No. C-115 | SHEET 2 OF 2 SHEETS

1. PROJECT: Yatesville Lake, Ky. , Phase II
2. LOCATION (Coordinates or Station): Spillway @ Sta. 10+51.7
3. DRILLING AGENCY: Boyles Bros. Drilling Co.
4. HOLE NO. (As shown on drawing title and file number): C-115
5. NAME OF DRILLER: Bob Lawson
6. DIRECTION OF HOLE: ☐ VERTICAL ☒ INCLINED 30° DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 9.8 (w. rock)
8. DEPTH DRILLED INTO ROCK: 55.0
9. TOTAL DEPTH OF HOLE: 64.8
10. SIZE AND TYPE OF BIT: 4" Diamond Core Bit
11. DATUM FOR ELEVATION SHOWN (MSL or USGS): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: Longyear 44 truck Mounted
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A
14. TOTAL NUMBER CORE BOXES: 16
15. ELEVATION GROUND WATER: 679.3
16. DATE HOLE: STARTED 25 July 1986; COMPLETED 29 July 1986
17. ELEVATION TOP OF HOLE: 694.7
18. TOTAL CORE RECOVERY FOR BORING: 98 %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g				
						Depth	Pen	Rec	Time	Other
	50		SANDSTONE, (cont.)							
			651.0-649.4 SHALE, s., gr., fer. nods. @ 650.9		12					40% w. loss
			silty w/ fer. sta. @ 649.5							
647.3	55		649.4-647.4 SANDSTONE, m.h. lr. gr., m.-fw. mic.,	94	13	54.7	4.9	4.6	:55	
			647.4-638.6 SHALE, s., gr., silty @ 645.0-642.7 fer. nods. @ 646.1-645.3 & 641.4-640.6		14					
643.3	60			100		59.4	4.7	4.7	1:00	
					15					
638.6	65		BOTTOM OF HOLE	100	16	64.8	5.4	5.4	1:00	

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PROJECT Yatesville Lake, Phase II | HOLE NO. C-115

C-116

Hole No. C -116

DRILLING LOG	DIVISION HUNTINGTON DISTRICT	INSTALLATION	SHEET 1 OF 2 SHEETS
1. PROJECT: Yatesville Lake, Ky. Phase II		11. SIZE AND TYPE OF BIT: 4" Diamond Core Bit	
2. LOCATION (Coordinates or Station): Spillway Sta. 15+55.7		11. DATUM FOR ELEVATION SHOWN (USGS or ASCS): MSL	
3. DRILLING AGENCY: Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: Longyear 44 Truck Mounted	
4. HOLE NO. (As shown on drawing title and file number): C-116		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER: Bob Lawson		14. TOTAL NUMBER CORE BOXES: 13	
6. DIRECTION OF HOLE: ☐ VERTICAL ☒ INCLINED 20° DEG. FROM VERT.		15. ELEVATION GROUND WATER: 679.3'	
7. THICKNESS OF OVERBURDEN: 9.5' (poor roc		16. DATE HOLE: STARTED 30 July 1986; COMPLETED 31 July 1986	
8. DEPTH DRILLED INTO ROCK: 51.2'		17. ELEVATION TOP OF HOLE: 692.3'	
9. TOTAL DEPTH OF HOLE: 60.7'		18. TOTAL CORE RECOVERY FOR BORING: 89 %	
		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			NOT SAMPLED			
684.0	10		684.0-675.3 SHALE, s., br.-gr., wd. vuggy @ 682.5 broken @ 683.4-682.8 679.7-675.4 clayey @ 679.7-679.5	84	1	Depth Pen Rec Time Other 14.5 5.0 4.2 1:00
679.7	15				2	
675.4	20		675.3-675.1 COAL, bk., blocky	44		19.5 5.0 2.2 :40 70% w. los
			675.1-672.9 SILTSTONE, s., gr., mic., plant fos. w/ occ. pyr. stained bd. pn. @ 675.0		3	
671.1	25		hi. ang. jt. N0°E @ 673.9-672.5	80		24.5 5.0 4.0 :35
			672.9-669.8 SHALE, s., gr.		4	
666.7	30		669.8-666.3 SANDSTONE, m.h. lt.gr., medium grained, mic mic. bd. pns. @ bottom	100		29.5 5.0 5.0 :35
			666.3-666.1 COAL, bk., shaly		5	
663.2	35		666.1-659.7 SHALE, s., gr., fer. nod. @ 662.7 clayey @ 661.0	100	6	33.6 4.1 4.1 :30
660.0				97	7	37.3 3.7 3.6 1:00
	40		659.7-656.8 SILTSTONE, m.h. lt. gr., sa., occ. sandstone lenses		8	
655.7			656.8-654.0 SHALE, s.-m.h., gr.-br., scat. fer. fil. trace fos., sandy @ 656.2-655.6	100		42.3 5.0 5.0 :45
			654.0-653.8 COAL, shaly		9	
	45		653.8-653.3 SHALE, s., carb			
651.3			653.3-653.3 COAL, bkn.,occ. pyr. 653.0-647.7 SHALE, s., dk. gr.-br., cl. carb. @ 653.0-652.8	78	10	47.3 5.0 3 9 :45
	50				11	

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PROJECT Yatesville Lake

HOLE NO C-116

C-116 —

Hole No. C-116

DRILLING LOG	DIVISION: HUNTINGTON DISTRICT	INSTALLATION	SHEET 2 OF 2 SHEETS
1. PROJECT: Yatesville Lake , Ky., Phase II		10. SIZE AND TYPE OF BIT: 4" Diamond Bit	
2. LOCATION (Coordinates or Station): Spillway @ Sta. 15+55.7		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: Longyear 44 Truck Mounted	
4. HOLE NO. (As shown on drawing title and File number): C-116		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER: Bob Lawson		14. TOTAL NUMBER CORE BOXES: 13	
6. DIRECTION OF HOLE: ☐ VERTICAL ☒ INCLINED 30 DEG. FROM VERT.		15. ELEVATION GROUND WATER: 679.3	
7. THICKNESS OF OVERBURDEN: 9.5' (poor rock)		16. DATE HOLE: STARTED 30 July 1986; COMPLETED 31 July 1986	
8. DEPTH DRILLED INTO ROCK: 51.2'		17. ELEVATION TOP OF HOLE: 692.3'	
9. TOTAL DEPTH OF HOLE: 60.7'		18. TOTAL CORE RECOVERY FOR BORING: 89 %	
		19. SIGNATURE OF INSPECTOR: M.S.L.	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) Depth	Pen.	Rec.	Time	Other
647.7			SHALE (cont.)	100	11	51.5	4.2	4.2	:45	
			647.7-639.7 SANDSTONE, m.h., lt.gr., m.-f. grained.							
			vuggy @ 641.0		12					
			hi. ang. fer. stained jt.							
643.3			N 45° W @ 641.0-640.0	100		56.6	5.1	5.1	:30	
			fer. nod. @ 641.4		13					
639.7				100		60.7	4.1	4.1	:45	
			BOTTOM OF HOLE							

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PROJECT: Yatesville Lake, Ky Phase II

HOLE NO: C-116

C-117

Hole No. C-117

DRILLING LOG	DIVISION HUNTINGTON DISTRICT	INSTALLATION	SHEET 1 OF 1 SHEETS
1. PROJECT: Yatesville Lake, Ky., Phase II		10. SIZE AND TYPE OF BIT: 4" Diamond Core Bit	
2. LOCATION (Coordinates or Station): Spillway; Sta. 17+11.7		11. DATUM FOR ELEVATION SHOWN (GS or MSL): MSL	
3. DRILLING AGENCY: Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: Longyear 44 Truck Mounted	
4. HOLE NO. (As shown on drawing title and file number): C-117		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER: Bob Lawson		14. TOTAL NUMBER CORE BOXES: 8	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG FROM VERT		15. ELEVATION GROUND WATER: 671.3'	
7. THICKNESS OF OVERBURDEN: 9.5 (poor rock)		16. DATE HOLE: STARTED 1 August 1986; COMPLETED 1 August 1986	
8. DEPTH DRILLED INTO ROCK: 31.5'		17. ELEVATION TOP OF HOLE: 689.3'	
9. TOTAL DEPTH OF HOLE: 41.0'		18. TOTAL CORE RECOVERY FOR BORING: 89 %	
		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
689.3			NOT SAMPLED			
679.8	10		679.8-679.3 SHALE, s., gr., wd.			
			679.3-675.0 SILTSTONE, s., gr., cl., wd., bkn.		1	
675.0	15		675.0-674.1 SHALE, s., dk.gr., carb., wd., bkn., cl.	60		
			674.1-669.5 SILTSTONE, s.-m.h., lt.gr., very f. sand, sli. wd., fer. stained jt. @ 673.4		2	
670.6	20		669.5-668.4 SHALE, s., gr., cl. @ 668.8-668.5	75		
			668.4-664.2 SANDSTONE, m.h. f.-m. grained, mic., num. mic. partings at bottom.		3	
665.6	25		664.2-664.0 COAL, bk., shaly	100		
			664.0-658.3 SHALE, s., gr.-dk.gr. sandstone lenses @ 660.8 & 658.8		4	
660.8	30			94	5	
			658.3-652.2 SILTSTONE, m.h. dk.gr.-gr., mic., t. intbd. sandstone (f.-m.g., m.h., x-bd.) @ 654.3-652.2		6	
655.6	35			98	7	
			652.2-652.4 COAL, bkn., shaly			
650.7			652.4-651.4 SHALE, s., dk.gr. carb.	98	8	
	40		651.4-650.7 COAL, bk. shaly			
648.3			650.7-650.2 SHALE, s., dk.gr. carb.	100		
			650.2-648.3 SHALE, s., gr.			
			BOTTOM OF HOLE			

Depth	Pen.	Rec.	Time	Other
14.3	4.8	2.9	.45	
18.7	4.4	3.3	:30	
23.7	5.0	5.0	:30	
28.5	4.8	4.5	:30	
33.7	5.2	5.1	.35	
38.6	4.9	4.8	:35	
41.0	2.4	2.4		

Hole No. EX-1

DRILLING LOG	DIVISION: Ohio River Division	INSTALLATION: Huntington District	SHEET 1 OF 1 SHEETS
1. PROJECT: Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT: 4" diamond core	
2. LOCATION (Coordinates or Station): Sta. 5+53.4, at center line		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): TBM	
3. DRILLING AGENCY: Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title and file number): EX-1		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER: Cody Niendorf		14. TOTAL NUMBER CORE BOXES: 2	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG FROM VERT.		15. ELEVATION GROUND WATER: 522.4	
7. THICKNESS OF OVERBURDEN: 2.0 rock not sampled		16. DATE HOLE: STARTED 9-24-87; COMPLETED 9-24-87	
8. DEPTH DRILLED INTO ROCK: 5.4		17. ELEVATION TOP OF HOLE: 525.2	
9. TOTAL DEPTH OF HOLE: 7.4		18. TOTAL CORE RECOVERY FOR BORING: 100%	
		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
525.2	0					
	1		Rock not sampled			- Roller bit was used from top of rock to 2'.
523.2	2		Sandstone: moderately hard, light gray, medium grained, occ. mic., occ. X-bd. micaceous bedding plane			
522.8						
	3				Box #1	
	4		broken plane			Run #1 Tape depth.... 7.4 Run length.... 7.4 Recovered..... 7.4 Loss..... 0.0
520.8						
520.7			broken zone (mod. bkn.)			
520.4						
520.2	5		broken zone (mod. bkn.)			- water return: lt. gray 100%
	6				Box #2	
	7					
517.8			Bottom of Hole	100%		
	8					Pressure Test Data 521.2 - 517.8: 0.27 cfm - gauge pressure at surface 5 psi
	9					

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PROJECT: Yatesville Lake, Phase II | HOLE NO. EX-1

Hole No. EX-2

DRILLING LOG	DIVISION	INSTALLATION	SHEET
	Ohio River Division	Huntington District	1 OF 2 SHEETS

1. PROJECT: Yatesville Lake, Phase II	10. SIZE AND TYPE OF BIT: 4" diamond core
2. LOCATION (Coordinates or Station): sta. 5+44.9, 42.4' upstream of centerline	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): TBM
3. DRILLING AGENCY: Boyles Bros. Drilling Co.	12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44
4. HOLE NO. (As shown on drawing title and file number): EX-2	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A
5. NAME OF DRILLER: Cody Niendorf	14. TOTAL NUMBER CORE BOXES: 3
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG FROM VERT.	15. ELEVATION GROUND WATER: 522.3
7. THICKNESS OF OVERBURDEN: 2.0 rock not sampled	16. DATE HOLE: STARTED 9-24-87; COMPLETED 9-24-87
8. DEPTH DRILLED INTO ROCK: 9.9	17. ELEVATION TOP OF HOLE: 525.1
9. TOTAL DEPTH OF HOLE: 11.9	18. TOTAL CORE RECOVERY FOR BORING: 100 %
	19. SIGNATURE OF INSPECTOR: [illegible]

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
525.1	0					
	1		Rock not sampled			Roller bit was used from the top of rock to 2.0' depth.
523.1	2		Sandstone: moderately hard, light gray, medium grained, occ. micaceous, occ. cross bedded.			
	3					
521.8			bedding plane, bk. coated			
	4				Box #1	Run #1 Tape depth...6.9 Run length...4.9 Recovered....4.9 Loss.....0.0
	5					water return was lt. gray @ 100%
	6					
	7				Box #2	
518.2			mech. broken	100%		
517.2	8		micaceous bedding plane			
	9					
515.4			micaceous bedding plane		Box #3	
515.1	10					

ROIB No. EA-2

DRILLING LOG	DIVISION: Ohio River Diversion	INSTALLATION: Huntington District	SHEET 2 OF 2 SHEETS
1. PROJECT: Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT: 4" diamond core	
2. LOCATION (Coordinates or Station): sta. 5+44.9; 42.4' upstream of centerline		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): TBM	
3. DRILLING AGENCY: Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title and file number): EX-2		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER: Cody Niendorf		14. TOTAL NUMBER CORE BOXES: 3	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: 522.3	
7. THICKNESS OF OVERBURDEN: 2.0 rock not sampled		16. DATE HOLE: STARTED 9-24-87; COMPLETED 9-24-87	
8. DEPTH DRILLED INTO ROCK: 9.9		17. ELEVATION TOP OF HOLE: 525.1	
9. TOTAL DEPTH OF HOLE: 11.9		18. TOTAL CORE RECOVERY FOR BORING: 100 %	
		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
525.1	10		Sandstone: (cont)			Run #2 Tape depth...11.9 Run length....5.0 Recovered.....5.0 Loss.....0.0
514.2	11		broken bedding plane		Box #3	
513.8			broken bedding plane			
513.2	12		Bottom of Hole	100%		
	13					Pressure Test Data Interval (el) — flow (cfs) 518.2 - 513.2 — 0.0 520.1 - 513.2 — 0.0 gauge pressure at surface was 5 psi

DRILLING LOG	DIVISION: Ohio River Division	INSTALLATION: Huntington District	SHEET 1 OF 2 SHEETS
1. PROJECT: Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT: 4" CLINTON CORE	
2. LOCATION (Coordinates or Station): Sta. 5+16.7, 40.9' downstream of center li		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): TBM	
3. DRILLING AGENCY: Zoyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title) and Sheet number: EX-3		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER: Cody Nicodorf		14. TOTAL NUMBER CORE BOXES: 3	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: 525.5	
7. THICKNESS OF OVERBURDEN: 2.0 rock not sampled		16. DATE HOLE: STARTED 9-24-87; COMPLETED 9-25-87	
8. DEPTH DRILLED INTO ROCK: 10.3		17. ELEVATION TOP OF HOLE: 527.8	
9. TOTAL DEPTH OF HOLE: 12.3		18. TOTAL CORE RECOVERY FOR BORING: 100 %	
		19. SIGNATURE OF INSPECTOR: [illegible]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Descriptions)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
523.8	0	c	d	e	f	g
	1		Rock not sampled			- Roller bit was used from the top to rock to 2' depth.
525.6	2					
528.6			Sandstone: moderately hard, medium grained, light gray to greenish gray, occ. mic., occ. cross bedded, broken zone (lightly bkn. with 10% surface area covered with a black coating)			
525.2	3				Box #1	Run #1 Tape depth.... 7.3 Run length.... 5.3 Recovered..... 5.3 loss..... 0.0
	4					
	5					- water return: lt. gray 100%
	6					
	7					
520.5			mech broken	100%	Box #2	
	8					
	9					
517.8	10					

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PROJECT: Yatesville Lake, Phase II

HOLE NO: EX-3

Hole No. EX-3

DRILLING LOG | Division: Ohio River Division | Installation: Eisenhower Reservoir | Sheet 2 of 2 sheets

1. Project: Yatesville Lake, Phase II
2. Location (Coordinates or Stating): 5416.7 - 40.9' downstream of center line
3. Drilling Agency: Boyles Bros. Drilling Co.
4. Hole No. (As shown on drawing title) and Sky number: EX-3
5. Name of Driller: Cody Stendorf
6. Direction of Hole: ☒ Vertical ☐ Inclined ____ deg. from vert.
7. Thickness of Overburden: 2.0 rock not sampled
8. Depth Drilled Into Rock: 10.3
9. Total Depth of Hole: 12.3
10. Date and Type of Bit: 6" diamond core
11. Datum for Elevation Shown (MSL or Other): TEN
12. Manufacturer's Designation of Drill: truck mounted Longyear 44
13. Total No. of Overburden Samples Taken: Disturbed N/A; Undisturbed N/A
14. Total Number Core Boxes: 3
15. Elevation Ground Water: 525.5
16. Date Hole: Started 9-24-87; Completed 9-25-87
17. Elevation Top of Hole: 527.8
18. Total Core Recovery for Boring: 100
19. Signature of Inspector: [signature]

Elevation	Depth	Legend	Classification of Materials (Description)	% Core Recovery	Box or Sample No.	Remarks
517.8	10		Sandstone: (cont)			
	11					Run #2 Tape depth.... 12.3 Run length.... 5.0 Recovered..... 5.0 Loss..... 0.0
					Box #3	
515.6	12		Bottom of Hole	100%		- water return: lt. gray 100%
	13					Pressure Test Data 523.8 - 515.6: 0.01 c gauge pressure at surface was 5psi

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PROJECT: Yatesville Lake, Phase II | HOLE NO: EX-3

Page No. —

DRILLING LOG	DIVISION Ohio River Division	INSTALLATION Huntington District	SHEET 1 OF 2 SHEETS
1. PROJECT Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT 4" CLUBBED CORE	
2. LOCATION (Coordinates or Station) Sta. 3+95.2 1.5' upstream of center line		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL Truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title) EX-4		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER Cody Wiendorf		14. TOTAL NUMBER CORE BOXES 3	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 522.5	
7. THICKNESS OF OVERBURDEN 2.0 rock not sampled		16. DATE HOLE: STARTED 9-25-87; COMPLETED 9-25-87	
8. DEPTH DRILLED INTO ROCK 10.1		17. ELEVATION TOP OF HOLE 526.2	
9. TOTAL DEPTH OF HOLE 12.1		18. TOTAL CORE RECOVERY FOR BORING 95 %	
		19. SIGNATURE OF INSPECTOR	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
526.2	0					
	1		Rock not sampled			- Roller bit was used from the top of rock to 2' depth.
524.2	2			N/A	N/A	
			Sandstone: moderately hard, medium grained, light gray to greenish gray, occ. micaceous, occ. cross bedded.			
523.0	3		broken bedding plane			
	4				Box #1	Run #1 Tape depth.... 6.8' Run legth..... 4.8' Recovery..... 4.8' Loss..... 0.0' Water return: lt. gray @ 100%
520.5	5		micaceous bedding plane			
519.6	6					
519.1	7		Sandstone: moderately hard to soft, medium grained, brownish gray, poorly cemented.	100%		Bottom of run #1
			broken (poss. mech., mod. bkn.)		Box #2	
518.4	8		Sandstone: moderately hard, medium grained, light gray to greenish gray, occ. micaceous, occ. cross bedded.			
517.9			broken zone (0.3' mech. spin loss, mod bkn.)			
517.6	9		micaceous bedding plane			
516.2	10					

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(TRANSLUCENT)

PROJECT Yatesville Lake, Phase II | HOLE NO EX-4

DRILLING LOG	Division: Ohio River Division	Installation: Huntington District	Sheet 4 of 2 sheets
1. Project: Yatesville Lake, Phase II		10. Size and type of bit: 4" diamond core	
2. Location (Coordinates or Station): Sta. 5495.2 1.3' upstream of center line		11. Datum for elevation shown (GS or MSL): MSL	
3. Drilling agency: Boyles Bros. Drilling Co.		12. Manufacturer's designation of drill: truck-mounted Longyear 44	
4. Hole No. (As shown on drawing title) and EM number: EX-4		13. Total no. of overburden samples taken: Disturbed N/A; Undisturbed N/A	
5. Name of driller: Cody Kiendorf		14. Total number core boxes: 3	
6. Direction of hole: ☒ Vertical ☐ Inclined ____ deg. from vert.		15. Elevation ground water: 522.6	
7. Thickness of overburden: 2.0 rock not sampled		16. Date hole: Started 9-25-87; Completed 9-25-87	
8. Depth drilled into rock: 10.1		17. Elevation top of hole: 526.2	
9. Total depth of hole: 12.1		18. Total core recovery for boring: 95 %	
		19. Signature of inspector: Will E Eiker	

Elevation	Depth	Legend	Classification of Materials (Description)	% Core Recovery	Box or Sample No.	Remarks (Drilling time, water loss, depth of weathering, etc., if significant)
516.2	10		Sandstone: (cont)			Run #2 Tape depth....12.1 Run length.....5.3 Recovered.....4.8 Loss.....0.5
513.3	11		broken zone (0.2' loss)		Box #3	- Occ. drill chatter during run #2
514.9						- lost 100% of return water at approx. 12'
514.1	12		Bottom of Hole	91%		
	13					Pressure Test Data 522.2 - 514.1: 2.4cfm 519.2 - 514.1: 2.1 cfm - gauge pressure at surface 5 psi

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Project: Yatesville Lake, Phase II | Hole No: EX-4

Plate No. E1-5

DRILLING LOG	DIVISION: Ohio River Division	INSTALLATION: Huntington District	SHEET 1 OF 2 SHEETS
1. PROJECT: Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT: 4" diamond core	
2. LOCATION (Coordinates or Station): sta. 6+07.9 at centerline		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): TBM	
3. DRILLING AGENCY: Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title) and title number): EX-5		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER: Cody Sleadorf		14. TOTAL NUMBER CORE BOXES: 5	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: 522.7	
7. THICKNESS OF OVERBURDEN: 2.0 rock not sampled		16. DATE HOLE: STARTED 9-25-87; COMPLETED 9-25-87	
8. DEPTH DRILLED INTO ROCK: 17.7		17. ELEVATION TOP OF HOLE: 526.5	
9. TOTAL DEPTH OF HOLE: 19.7		18. TOTAL CORE RECOVERY FOR BORING: 99 %	
		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
526.5	0					
	1		Rock not sampled			Roller bit was used from top of rock to 2.0' depth.
524.5	2					
	3		Sandstone: moderately hard, medium grained, light gray to greenish gray, occ. micaceous, occ. cross bedded			Run #1 Tape depth...7.1 Run length...5.1 Recovered....5.1 Loss.....0.0
	4				Box #1	water return was light gray at 100%
	5					Pressure Test Data Interval (el) — flow (cfm) 522.5 - 506.8 — 2.2 519.5 - 506.8 — 2.3 514.5 - 506.8 — 2.2 509.5 - 506.8 — 0.1
	6					gauge pressure at surface was 5 psi
519.4	7			100%		
	8		(solid)		Box #2	
	9					
516.5	10					

Hole No. EX-5

DRILLING LOG	DIVISION Ohio River Division	INSTALLATION Huntington District	SHEET 2 OF 2 SHEETS
1. PROJECT Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT 4" diamond core	
2. LOCATION (Coordinates or Station) sta. 6407.9 at centerline		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) TBM	
3. DRILLING AGENCY Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title and title number)		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER Cody Siesdorf		14. TOTAL NUMBER CORE BOXES 5	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 522.7	
7. THICKNESS OF OVERBURDEN 2.0 rock not sampled		16. DATE HOLE STARTED 9-25-87 COMPLETED 9-25-87	
8. DEPTH DRILLED INTO ROCK 17.7		17. ELEVATION TOP OF HOLE 526.5	
9. TOTAL DEPTH OF HOLE 19.7		18. TOTAL CORE RECOVERY FOR BORING 99 %	
		19. SIGNATURE OF INSPECTOR Mike Ford	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
516.5	10		Sandstone: (cont)			
515.9						
515.6	11		micaceous bedding planes		Box #3	Run #2 Tape depth...12.5 Run length....5.4 Recovered.....5.3 Loss.....0.1
515.11			broken zone (lightly broken with 0.1 loss)			water return: light gray @ 100%
514.0	12			98%		
513.7	13		bedding plane			
513.2			low angle joint			
512.5	14		broken plane		Box #4	
511.5	15		broken plane			Run #3 Tape depth...17.9 Run length....5.4 Recovered.....5.3 Loss.....0.1
511.3			bedding plane			
511.0			bedding plane			
510.4	16		bedding plane			drill chatter @ 14' depth and occ. through out run.
510.2			mech. broken w/ 0.1 loss			
509.6	17		num. micaceous bedding planes Conglomerate: moderately hard, brown siltstone rock fragments with gray medium grained sand matrix, Occ. coal stringers.			water return @ 100%
508.6	18			98%	Box #5	
508.3			Coal: moderately hard, black, blocky, broken			Run #4 Tape depth...19.7 Run length....1.8 Recovered.....1.8 Loss.....0.0
507.6	19		Shale: soft, light brown, clayey, broken.			100% water return occ. black water return
506.8			Bottom of Hole	100%		
	20					

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PROJECT Yatesville Lake, Phase II | HOLE NO EX-5

DRILLING LOG

DIVISION: Ohio River Division

INSTALLATION: Buffalo District Office

SHEET 1 OF 2 SHEETS

1. PROJECT: Yatesville Lake, Phase II

2. LOCATION (Coordinates or Station): sta. 5467.3, 16.3' downstream of centerline

3. DRILLING AGENCY: Boyles Bros. Drilling Co.

4. HOLE NO. (As shown on drawing title and hole number): EX-6

5. NAME OF DRILLER: Cody Niemdorf

6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.

7. THICKNESS OF OVERBURDEN: 1.0 rock not sampled

8. DEPTH DRILLED INTO ROCK: 19.7

9. TOTAL DEPTH OF HOLE: 20.7

10. SIZE AND TYPE OF BIT: 4" diamond core

11. DATUM FOR ELEVATION SHOWN (TBM or MSL): TBM

12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44

13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A

14. TOTAL NUMBER CORE BOXES: 6

15. ELEVATION GROUND WATER: 522.5

16. DATE HOLE: STARTED 9-26-87; COMPLETED 9-26-87

17. ELEVATION TOP OF HOLE: 523.4

18. TOTAL CORE RECOVERY FOR BORING: 99 %

19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
523.4	0					
			Rock not sampled			Roller bit was used from top of rock to 1' depth.
522.4	1					
			Sandstone: moderately hard, medium grained, light gray to greenish gray, occ. micaceous, occ. cross bedded			
521.7			bedding plane, iron stained			
	2					
521.2						
			broken zone (moderately broken with carb. coating)			
520.9						
						Run #1
	3				Box #1	Tape depth...4.5
						Run length...3.5
						Recovered....3.5
						Loss.....0.0
519.7						
519.5			bedding planes			water return was lt. gr @ 100%
	4					
518.9				100%		
	5					
	6					
			(solid)		Box #2	
	7					Run #2
						Tape depth...9.7
						Run length...5.3
						Recovered....5.3
						Loss.....0.0
	8					water return, lt. gray, @100%
	9					
513.7				100%		
513.4	10					

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PROJECT: Yatesville Lake, Phase II

HOLE NO: EX-6

Hole No. EX-6

DRILLING LOG	Division: Ohio River Division	Installation: Huntington District	Sheet 2 of 2 Sheets

1. PROJECT: Yatesville Lake, Phase II
2. LOCATION (Coordinates or Station): sta. 5467.3, 16.3' downstream of centerline
3. DRILLING AGENCY: Boyles Bros. Drilling Co.
4. HOLE NO. (As shown on drawing title and hole number): EX-6
5. NAME OF DRILLER: Cody Niendorf
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 1.0 rock not sampled
8. DEPTH DRILLED INTO ROCK: 19.7
9. TOTAL DEPTH OF HOLE: 20.7
10. SIZE AND TYPE OF BIT: 4" diamond core
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): TBM
12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A
14. TOTAL NUMBER CORE BOXES: 6
15. ELEVATION GROUND WATER: 522.5
16. DATE HOLE: STARTED 9-26-87; COMPLETED 9-26-87
17. ELEVATION TOP OF HOLE: 523.4
18. TOTAL CORE RECOVERY FOR BORING: 99 %
19. SIGNATURE OF INSPECTOR: Mike Reed

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
513.4	10					
			Sandstone: (cont)			
	11					
512.2					Box #3	
			broken zone (moderately broken)			
511.6						
511.3	12		spin loss			Run #3 Tape depth...15.1 Run length....5.4 Recovered.....5.4 Loss.....0.0 100% water loss between 11' and 12' depth, water seepage at surface.
511.0			broken plane			
	13					
509.7			micaceous bedding plane		Box #4	
509.5			broken plane			
	14					
509.0						
508.9			micaceous bedding plane			
508.6						
508.3	15			100%		
507.7						
507.6			Coal: mod. h., bk., blocky			
	16		Conglomerate: mod. h., br. siltstone rock frag., gr. med. g. sa. matrix, occ. coal stringers.			
507.0						
506.9			Coal: mod. h., bk., pyr.			
506.7			Sandstone: mod. h., med. g., gr.			
	17		Coal: mod. h., bk., blocky, shaley at top.		Box #5	Run #4 Tape depth...20.7 Run length....5.7 Recovered.....5.5 Loss.....0.2
506.2			Shale: s., dk. gr., rb., broken with 0.1' loss			
505.8			Shale: soft, light gray to brown, clayey.			
	18					
504.5						
	19		broken with 0.1 loss			
504.1						
			Siltstone: soft to moderately hard, light gray, thin interbeds of shale and sandstone			
503.4	20					

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PROJECT: Yatesville Lake, Phase II — HOLE NO: EX-6

Hole No. EX-6

DRILLING LOG	DIVISION: Ohio River Division	INSTALLATION: Huntington District	SHEET 3 of 3 SHEETS
1. PROJECT: Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT: 4" diamond core	
2. LOCATION (Coordinates or Stations): sta. 5+67.3, 16.3' downstream of centerline		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): TBM	
3. DRILLING AGENCY: Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title and file number): EX-6		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER: Cody Niendorf		14. TOTAL NUMBER CORE BOXES: 6	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG FROM VERT.		15. ELEVATION GROUND WATER: 522.5	
7. THICKNESS OF OVERBURDEN: 1.0 rock not sampled		16. DATE HOLE: STARTED 9-26-87; COMPLETED 9-26-87	
8. DEPTH DRILLED INTO ROCK: 19.7		17. ELEVATION TOP OF HOLE: 523.4	
9. TOTAL DEPTH OF HOLE: 20.7		18. TOTAL CORE RECOVERY FOR BORING: 99 %	
		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
503.4	20		Siltstone: (cont)		Box #6	
502.8						
502.7			Sandstone: god, hd, sce, k,	97%		
			Bottom of hole			
	21					Pressure Test Data interval (el) — flow (cfm) 520.4 - 502.7 — 1.51 515.4 - 502.7 — 1.91 510.4 - 502.7 — 1.95 505.4 - 502.7 — 0.0 gauge pressure at surface was 5 psi
	22					
	23					

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(TRANSMITTAL)

PROJECT: Yatesville Lake, Phase II

HOLE NO: EX-6

Hole No. EX-7

DRILLING LOG	DIVISION: Ohio River Division	INSTALLATION: Huntington District	SHEET 1 OF 3 SHEETS
1. PROJECT: Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT: 4" diamond core	
2. LOCATION (Coordinates or Station): sta. 5+76.3, 44' downstream of centerline		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): TBM	
3. DRILLING AGENCY: Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title) and file number: EX-7		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER: Cody Niendorf		14. TOTAL NUMBER CORE BOXES: 6	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: 522.5	
7. THICKNESS OF OVERBURDEN: 2.1 rock not sampled		16. DATE HOLE: STARTED 9-28-87; COMPLETED 9-28-87	
8. DEPTH DRILLED INTO ROCK: 19.6		17. ELEVATION TOP OF HOLE: 525.8	
9. TOTAL DEPTH OF HOLE: 21.7		18. TOTAL CORE RECOVERY FOR BORING: 95 %	
		19. SIGNATURE OF INSPECTOR: Bill L. Caudill	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
525.8	0					
	1		Rock not sampled			roller bit was used from top of rock to 2.1' depth.
523.7	2					
523.5			Sandstone: moderately hard, medium grained, light gray to greenish gray, occ. micaceous, occ. cross bedded			
523.2	3		bedding plane			
			poorly cemented and vuggy sandstone with 0.1' loss due to mechanical breakage		Box #1	Run #1 Tape depth...6.8 Run length...4.7 Recovered....4.6 Loss..... .0.1 100% water loss @ 6.7' water seepage at surface
	4		iron stained bedding plane			
	5					
	6					
519.0	7			97%		
518.5			broken plane			
					Box #2	
517.8	8		bedding plane, iron stained broken zone (moderately broken, scat. bk. coating, with 0.3' loss)			Run #2 Tape depth...12.3 Run length....5.5 Recovered.....5.2 Loss..... ..0.3
516.9	9					
515.9			broken plane			
515.8						

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PROJECT: Yatesville Lake, Phase II | HOLE NO: EX-7

HOLE NO. EX-7

DRILLING LOG	DIVISION: Ohio River Division	INSTALLATION: Huntington District	SHEET 2 OF 3 SHEETS

1. PROJECT: Yatesville Lake, Phase II
2. LOCATION (Coordinates or Station): sta. 5+76.3, 44' downstream of centerline
3. DRILLING AGENCY: Boyles Bros. Drilling Co.
4. HOLE NO. (As shown on drawing title and file number): EX-7
5. NAME OF DRILLER: Cody Niendorf
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG FROM VERT.
7. THICKNESS OF OVERBURDEN: 2.1 rock not sampled
8. DEPTH DRILLED INTO ROCK: 19.6
9. TOTAL DEPTH OF HOLE: 21.7
10. SIZE AND TYPE OF BIT: 4" diamond core
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): TBM
12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A
14. TOTAL NUMBER CORE BOXES: 6
15. ELEVATION GROUND WATER: 522.5
16. DATE HOLE: STARTED 9-28-87; COMPLETED 9-28-87
17. ELEVATION TOP OF HOLE: 525.8
18. TOTAL CORE RECOVERY FOR BORING: 95 %
19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
515.8	10					
515.5			Sandstone: (cont) bedding plane w/ bk. coating			
515.1			micaceous bedding plane			
	11					
514.3			low angle joint		Box #3	
513.8	12		low angle joint			
513.5				94%		
513.4			mod. broken			
	13					
						Run #3 Tape depth...17.5 Run length....5.2 Recovered.....5.2 Loss.....0.0
511.6	14		bedding plane			
	15				Box #4	
510.2			broken plane			
509.9						
509.7	16		broken zone (lightly to mod. bkn. w/ carb. bd. pn.			
509.4			carbonaceous bedding plane			
508.8	17					
508.3			Conglomerate: mod. h., br siltstone rock frag., gr. med. sa. matrix, occ. coal stringers, mod. bkn. 0.3 loss	100%		
	18		med. g. sandstone: 508.3 to 508.1			
506.8					Box #5	Run #4 Tape depth...21.7 Run length....4.9 Recovered.....3.5 Loss.....1.4
	19		Coal: mod. h., bk., shaley at top, bkn. at top w/ 0.1' loss			
506.1			Shale: soft, light brown, clayey w/ occ. clay seams, severely broken w/ 1.0' loss.			
505.8	20					

Hole No. EX-7

DRILLING LOG	DIVISION Ohio River Division	INSTALLATION Huntington District	SHEET 3 OF 3 SHEETS

1. PROJECT Yatesville Lake, Phase II	10. SIZE AND TYPE OF BIT 4" diamond core
2. LOCATION (Coordinates or Station) sta. 5476.3, 44' downstream of centerline	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) TBM
3. DRILLING AGENCY Boyles Bros. Drilling Co.	12. MANUFACTURER'S DESIGNATION OF DRILL truck mounted Longyear 44
4. HOLE NO (As shown on drawing title and file number) EX-7	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A
5. NAME OF DRILLER Cody Niendorf	14. TOTAL NUMBER CORE BOXES 6
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.	15. ELEVATION GROUND WATER 522.5
7. THICKNESS OF OVERBURDEN 2.1 rock not sampled	16. DATE HOLE STARTED 9-28-87 COMPLETED 9-28-87
8. DEPTH DRILLED INTO ROCK 19.6	17. ELEVATION TOP OF HOLE 525.8
9. TOTAL DEPTH OF HOLE 21.7	18. TOTAL CORE RECOVERY FOR BORING 95 %
	19. SIGNATURE OF INSPECTOR W.F. Cook

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
505.8	20	c	d	e	f	g
			Shale: (cont)			
					Box #6	
	21					
504.1			Bottom of Hole	72%		
	22					
						Pressure Test Data Interval (ft) / flow (cfm) 521.7 - 504.1 / 1.74 518.7 - 504.1 / 2.0 513.7 - 504.1 / 2.3 508.7 - 504.1 / 1.75 gauge pressure at surface was 5 psi
	23					

Hole No. EX-8

DRILLING LOG	DIVISION Ohio River Division	INSTALLATION Huntington District	SHEET 1 OF 3 SHEETS

1. PROJECT	Yatesville Lake, Phase II	10. SIZE AND TYPE OF BIT	4" diamond core
2. LOCATION (Coordinates or Station)	sta. 5494.2, 1.3' upstream of centerline	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	TBM
3. DRILLING AGENCY	Boyles Bros. Drilling Co.	12. MANUFACTURER'S DESIGNATION OF DRILL	truck mounted Longyear 44
4. HOLE NO. (As shown on drawing title) and file number	EX-8	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED	N/A / N/A
5. NAME OF DRILLER	Cody Niendorf	14. TOTAL NUMBER CORE BOXES	6
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.	15. ELEVATION GROUND WATER	522.5
		16. DATE HOLE STARTED / COMPLETED	9-28-87 / 9-28-87
7. THICKNESS OF OVERBURDEN	2.0 rock not sampled	17. ELEVATION TOP OF HOLE	526.1
8. DEPTH DRILLED INTO ROCK	20.0	18. TOTAL CORE RECOVERY FOR BORING	100 %
9. TOTAL DEPTH OF HOLE	22.0	19. SIGNATURE OF INSPECTOR	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO	REMARKS (Drilling time, water loss, depth of weathering, etc.; if significant)
526±1	0					
	1		Rock not sampled			Roller bit was used from top of rock to 2' depth.
524.1	2		Sandstone: moderately hard, medium grained, light gray to greenish gray, occ. micaceous, occ. cross bedded			
523.8						
523.1	3		bedding planes			
	4				Box #1	
521.8			bedding plane			Run #1 Tape depth...7.1 Run length...5.1 Recovery.....5.1 Loss.....0.0
	5					
	6					
519.4			bedding plane			
519.0	7			100%		
	8				Box #2	
517.3			broken plane			
	9					
516.2			broken plane			
516.1	10					

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PROJECT Yatesville Lake, Phase II | HOLE NO EX-8

DRILLING LOG	DIVISION	Hole No. EX-8
	Ohio River Division	

1. PROJECT: Yatesville Lake, Phase II	INSTALLATION: Huntington District; SHEET 2 OF 3 SHEETS
2. LOCATION (Coordinates or Station): sta. 5494.2, 1.3' upstream of centerline	10. SIZE AND TYPE OF BIT: 4" diamond core
3. DRILLING AGENCY: Boyles Bros. Drilling Co.	11. DATUM FOR ELEVATION SHOWN (USGS or USCS): TBM
4. HOLE NO. (As shown on drawing title and file number): EX-8	12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44
5. NAME OF DRILLER: Cody Niendorf	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	14. TOTAL NUMBER CORE BOXES: 6
7. THICKNESS OF OVERBURDEN: 2.0 rock not sampled	15. ELEVATION GROUND WATER: 522.5
8. DEPTH DRILLED INTO ROCK: 20.0	16. DATE HOLE: STARTED 9-28-87; COMPLETED 9-28-97
9. TOTAL DEPTH OF HOLE: 22.0	17. ELEVATION TOP OF HOLE: 526.1
	18. TOTAL CORE RECOVERY FOR BORING: 100 %
	19. SIGNATURE OF INSPECTOR:

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
516.1	10		Sandstone: (cont)			
515.5						
515.4			broken planes			
515.2	11					Run #2
						Tape depth...12.4
514.8						Run length....5.3
					Box #3	Recovery.....5.3
			broken zone (severly broken)			Loss.....0.0
514.1	12					- 100% water loss @ 9'
513.7						
				100%		
			broken zone (mod. to sev. broken, occ. bk. coated, few angled planes)			
512.9	13					
512.1						
512.0	14		micaceous bedding planes (lightly broken)			Run #3
					Box #4	Tape depth...17.2
511.4						Run length....4.8
511.3			broken zone (lightly broken, with angled planes)			Recovered.....5.0
	15					Loss.....0.0
510.9						
			broken zone (severely broken with angled planes)			
510.4						
510.2			broken plane			
	16					
509.9						
509.8			broken zone (lightly broken with angled planes)			
509.2	17		bedding plane			
508.9				100%		
			Broken zone (moderately broken, poss. mechanical)			
508.4						
508.2	18		bedding plane			
508.1					Box #5	
508.0			Conglomerate: moderately hard, brown siltstone rock fragments, gr. med. g. sa. matrix, occ. coal stringers.			
507.3	19		broken plane			
506.9						
			Coal: moderately hard, black, blocky, shaley @ top.			
506.4						
506.1	20		Shale:			

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PROJECT: Yatesville Lake, Phase II; HOLE NO: EX-8

Hole No. FX-8

DRILLING LOG | Division: Ohio River Division | Installation: Huntington District | Sheet 3 of 3 Sheets

1. Project: Yatesville Lake, Phase II
2. Location (Coordinates or Station): sta. 5454.2, 1.5' upstream of centerline
3. Drilling Agency: Boyles Bros. Drilling Co.
4. Hole No. (As shown on drawing title and file number): FX-8
5. Name of Driller: Cody Standard
6. Direction of Hole: ☒ Vertical ☐ Inclined ____ Deg. From Vert.
7. Thickness of Overburden: 2.0 rock not sampled
8. Depth Drilled into Rock: 20.0
9. Total Depth of Hole: 22.0
10. Size and Type of Bit: 4" diamond core
11. Datum for Elevation Shown (MSL or Assumed): MSL
12. Manufacturer's Designation of Drill: truck mounted Longyear 44
13. Total No. of Overburden Samples Taken: Undisturbed N/A; Disturbed N/A
14. Total Number Core Boxes: 6
15. Elevation Ground Water: 522.5
16. Date Hole: Started 9-28-87; Completed 9-28-87
17. Elevation Top of Hole: 526.1
18. Total Core Recovery for Boring: 100 %
19. Signature of Inspector: [signature]

Elevation	Depth	Legend	Classification of Materials (Description)	% Core Recovery	Box or Sample No.	Remarks
506.1	20	c	d	e	f	g
			Shale: soft, light brown, interbedded clayey layers.			Run #1 Tape depth....22.0 Run length....4.8 Recovered.....4.8 Loss.....0.0
505.5						
	21		mech. broken zone		Box #6	
505.1						
504.8			Siltstone: soft to moderately hard, light gray, shaley seams.			
504.6						
504.5			bedding planes			
504.1	22		Bottom of Hole	100%		
	23					Pressure Test Data Interval (el) / Flow (cfm) 524.0 - 504.0 / 2.2 519.0 - 504.0 / 2.1 514.0 - 504.0 / 1.9 509.0 - 504.0 / 1.8 - gauge pressure at the surface was 5 psi

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Project: Yatesville Lake, Phase II | Hole No: FX-8

Hole No. EX-9

DRILLING LOG	Division: Ohio River Division	Installation: Huntington District	Sheet 1 of 3 Sheets
1. Project: Yatesville Lake, Phase II		10. Size and Type of Bit: 4" Diamond Core	
2. Location (Coordinates or Station): Sta. 5+56.5, 35.7' upstream of center line		11. Datum for Elevation Shown (TBM or MSL): TBM	
3. Drilling Agency: Boyles Bros. Drilling Co.		12. Manufacturer's Designation of Drill: truck mounted Longyear 44	
4. Hole No. (As shown on drawing title and file number): EX-9		13. Total No. of Overburden & Bedrock Samples Taken: Undisturbed: N/A; Disturbed: N/A	
5. Name of Driller: Cody Stendorf		14. Total Number Core Boxes: 6	
6. Direction of Hole: ☒ Vertical ☐ Inclined ____ Deg. From Vert.		15. Elevation Ground Water: 522.3	
7. Thickness of Overburden: 2.0 rock not sampled		16. Date Hole: Started 9-25-87; Completed 9-25-87	
8. Depth Drilled Into Rock: 20.0		17. Elevation Top of Hole: 526.4	
9. Total Depth of Hole: 22.0		18. Total Core Recovery for Boring: 91 %	
		19. Signature of Inspector: [signature]	

Elevation	Depth	Legend	Classification of Materials (Description)	% Core Recovery	Box or Sample No.	Remarks (Drilling time, water loss, depth of weathering, etc., if significant)
526.4	0					
	1		Rock not sampled			- Roller bit was used from top of rock to 2' depth.
524.4	2					
	3		Sandstone: moderately hard medium grained, light gray to greenish gray, occ. micaceous, occ. cross bedded			
	4				Box #1	Run #1 Tape depth.... 6.8 Run length.... 4.8 Recovered..... 4.8 Loss..... 0.0 - water return: lt. gray 100%
	5					
521.2			bedding plane			
520.6	6		bedding plane			
519.7			bedding plane	100%		
519.6						
519.5			bedding plane			
	7				Box #2	
518.9						
			broken zone (moderately broken with 0.4 loss @ bot.)			
	8					
518.2						
517.8			bedding plane			
	9					
517.3			bedding plane			
516.8			bedding plane			
516.7			micaceous bedding plane			
516.4	10					

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Project: Yatesville Lake, Phase II — Hole No: EX-9

Hole No. EX-9

DRILLING LOG	Division: Ohio River Division	Installation: Huntington District	Sheet 4 of 3 sheets
1. Project: Yatesville Lake, Phase II		10. Size and type of bit: 4" diamond core	
2. Location (Coordinates or Station): Sta. 5456.6, 35.7' upstream of center line		11. Datum for elevation shown (TBM or MSL): TBM	
3. Drilling Agency: Boyles Bros. Drilling Co.		12. Manufacturer's Designation of Drill: truck mounted Longyear 44	
4. Hole No. (As shown on drawing title and file number): EX-9		13. Total No. of Overburden Samples Taken: Disturbed N/A; Undisturbed N/A	
5. Name of Driller: Cody Wiendorf		14. Total Number Core Boxes: 6	
6. Direction of Hole: ☒ Vertical ☐ Inclined ____ Deg. from Vert.		15. Elevation Ground Water: 522.3	
7. Thickness of Overburden: 2.0 rock not sampled		16. Date Hole: Started 9-29-87; Completed 9-29-87	
8. Depth Drilled into Rock: 20.0		17. Elevation Top of Hole: 526.4	
9. Total Depth of Hole: 22.0		18. Total Core Recovery for Boring: 91 %	
		19. Signature of Inspector: [signature]	

Elevation	Depth	Legend	Classification of Materials (Description)	% Core Recovery	Box or Sample No.	Remarks (Drilling time, water loss, depth of weathering, etc., if significant)
516.6	10		Sandstone: (cont)			
	11				Box #3	Run #2 Tape depth... 11.9 Run length... 5.1 Recovered.... 4.7 Loss..... 0.4 - water return: lt. gray 100% water loss @ 10'
514.5	12		Mech. cracked area	93%		
513.7	13					
	14		broken zone (severely bkn. poorly cem., partly coated black, occ. ang. pns.)			Run #3 Tape depth... 16.5 Run length... 4.6 Recovered.... 3.6 Loss..... 1.0
512.1						
511.7			bedding plane		Box #4	
511.3	15					
511.0			broken zone (mod. broken)			
510.9			broken plane			
510.5			broken plane (angled)			
	16					
509.9				78%		
509.3	17		high angled joint (509.9 to 508.8) bedding plane			
508.8			micaceous bedding plane			
508.5			bedding plane			
	18					
508.2			carbonaceous bedding plane		Box #5	
507.8			broken plane			
507.7			micaceous bedding plane			
507.6						
507.4	19		Conglomerate: mod. h., pr., SLS frags., med. g. sa. mtx.			
			Coal: mod. h., bk., blocky, sev. bkn. w/ 0.5 loss			
506.9			Shale: s., lt. br., cl. se., poss. loss			
506.4	20					

ENG FORM 1836 MAR 71 — Previous editions are obsolete (TRANSFERRED)

Project: Yatesville Lake, Phase II — Hole No. EX-9

Hole No. EX-9

DRILLING LOG	DIVISION: Ohio River Division	INSTALLATION: Huntington District	SHEET 3 OF 3 SHEETS
1. PROJECT: Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT: 4" diamond core	
2. LOCATION (Coordinates or Station): 5496.6, 36.7' upstream of center line		11. DATUM FOR ELEVATION SHOWN (USM or NGS): TBM	
3. DRILLING AGENCY: Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title and file number): EX-9		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER: Cody Niendorf		14. TOTAL NUMBER CORE BOXES: 6	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: 522.3	
7. THICKNESS OF OVERBURDEN: 2.0 rock not sampled		16. DATE HOLE: STARTED 9-29-87; COMPLETED 9-29-87	
8. DEPTH DRILLED INTO ROCK: 20.0		17. ELEVATION TOP OF HOLE: 526.4	
9. TOTAL DEPTH OF HOLE: 22.0		18. TOTAL CORE RECOVERY FOR BORING: 91 %	
		19. SIGNATURE OF INSPECTOR: Wilbert E. Hall	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
506.4	20		Shale: (cont)			
			broken clayey seams at el. 506.2, 506.0, 505.6			Run #4 Tape Depth... 22.0 Run length... 5.6 Recovered.... 5.1 Loss..... 0.5
	21				Box #6	
505.0			Sandstone: moderately hard, medium grained, lt. gray, gradational w/ fine @ top			
504.4	22		Bottom of Hole	91%		
	23					Pressure Test Data Interval (el.) — flow (cfs) 522.4 - 504.4 — 2.4 519.4 - 504.0 — 2.5 514.4 - 504.4 — 2.2 509.4 - 504.4 — 2.1 504.4 - 504.4 — 1.8 gauge pressure @ surface was 5 psi

Hole No. EX-10

DRILLING LOG	DIVISION: Ohio River Division	INSTALLATION: Huntington District	SHEET 1 OF 3 SHEETS
1. PROJECT: Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT: 4" diamond core	
2. LOCATION (Coordinates or Station): sta. 6+01, 1' downstream of centerline		11. DATUM FOR ELEVATION SHOWN (USM or NGS): TEN	
3. DRILLING AGENCY: Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title and file number): EX-10		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER: Cody Niendorf		14. TOTAL NUMBER CORE BOXES: 6	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: 522.4	
7. THICKNESS OF OVERBURDEN: 2.0 rock not sampled		16. DATE HOLE: STARTED 9-29-87; COMPLETED 9-29-87	
8. DEPTH DRILLED INTO ROCK: 20.1		17. ELEVATION TOP OF HOLE: 526.2	
9. TOTAL DEPTH OF HOLE: 22.1		18. TOTAL CORE RECOVERY FOR BORING: 97 %	
		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
526.2	0					
	1		Rock not sampled			Roller bit used from top of rock to 2'
524.2	2		Sandstone: moderately hard, medium grained, light gray to greenish gray, occ. micaceous, occ. cross bedded			
	3					
	4				Box #1	Run #1 Tape depth...6.7 Run length...4.7 Recovered....4.7 Loss.....0.0 - water recovery 100%
521.3	5		bedding plane			
	6					
519.5	7			100%		
	8				Box #2	Run #2 Tape depth...12.1 Run length... 5.4 Recovered.....5.1 Loss.....0.3
517.6			bedding plane			
	9					
516.9			bedding plane			
			high angled joint			
516.3			broken (moderately broken)			
516.2						

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PROJECT: Yatesville Lake, Phase II | HOLE NO: EX-10

Hole No. EX-10

DRILLING LOG	DIVISION Ohio River Division	INSTALLATION Huntington District	SHEET 2 OF 3 SHEETS
1. PROJECT Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT 4" diamond core	
2. LOCATION (Coordinates or Station) sta. 6+01, 1' downstream of centerline		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) TBM	
3. DRILLING AGENCY Bowles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title and file number) EX-10		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER Cody Niendorf		14. TOTAL NUMBER CORE BOXES 6	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 522.4	
7. THICKNESS OF OVERBURDEN 2.0 rock not sampled		16. DATE HOLE: STARTED 9-29-87; COMPLETED 9-29-87	
8. DEPTH DRILLED INTO ROCK 20.1		17. ELEVATION TOP OF HOLE 526.2	
9. TOTAL DEPTH OF HOLE 22.1		18. TOTAL CORE RECOVERY FOR BORING 97 %	
		19. SIGNATURE OF INSPECTOR [signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
516.2	10		Sandstone: (cont)			
515.8			broken zone (severely broken, occ. black coating, occ. angled planes, loss 0.3'		Box #3	
514.6	11					
514.3			bedding plane			
514.1	12			94%		
513.2	13		bedding planes			
513.0						
512.8						
	14				Box #4	Run #3 Tape depth...17.2 Run length....5.1 Recovered.....5.1 Loss.....0.0
	15					
510.1	16					
509.7			bedding planes			
509.3						
509.2	17					
509.0			Conglomerate: moderately hard, br. siltstone rock fragments, lt. gr. med. sand matrix, occ. coal stringers	100%		
508.9						
508.6						
508.4			broken zone (mech., mod. bkn.)		Box #5	
	18					
507.8			Coal: Moderately hard, black, blocky, broken.			
507.4			Shale: soft, light brown, clayey, carbonaceous at top with 0.2 loss.			
	19					
506.8						
506.6			broken zone (severely broken, with 0.1 loss.)			
506.2	20					

Hole No. EX-10

DRILLING LOG	DIVISION Ohio River Division	INSTALLATION Huntington District	SHEET 3 of 3 SHEETS
1. PROJECT Yatesville Lake, Phase II		10. SIZE AND TYPE OF B.T 4" diamond core	
2. LOCATION (Coordinates or Station) sta. 6+01, 1' downstream of centerline		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) TBM	
3. DRILLING AGENCY Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title and file number) EX-10		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER Cody Niendorf		14. TOTAL NUMBER CORE BOXES 6	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 522.4	
		16. DATE HOLE: STARTED 9-29-87; COMPLETED 9-29-87	
7. THICKNESS OF OVERBURDEN 2.0 rock not sampled		17. ELEVATION TOP OF HOLE 526.2	
8. DEPTH DRILLED INTO ROCK 20.1		18. TOTAL CORE RECOVERY FOR BORING 97 %	
9. TOTAL DEPTH OF HOLE 22.1		19. SIGNATURE OF INSPECTOR	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
505.2	20					
506.0			Shale: (cont)			
			Siltstone: soft to moderately hard, light brown, clay filled fractures.		Box #6	Run #4 Tape depth...22.1 Run length....4.9 Recovered.....4.6 Loss.....0.3
504.8	21					
			Sandstone: moderately hard, light gray, medium grained.			
504.1	22		Bottom of Hole	94%		
	23					Pressure Test Data Interval (el) / Flow (cfm) 522.2 - 504.1 / 2.2 519.2 - 504.1 / 2.1 514.2 - 504.1 / 2.0 509.2 - 504.1 / 1.9 - gauge pressure at surface 5 psi
	24					

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PROJECT Yatesville Lake, Phase II | HOLE NO EX-10

Hole No. EX-11

DRILLING LOG	DIVISION: Ohio River Division	INSTALLATION: Huntington District	SHEET 1 OF 3 SHEETS

1. PROJECT: Yatesville Lake, Phase II	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station): sta. 6+11.6, 37' upstream of centerline	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): TBM
3. DRILLING AGENCY: Boyles Bros. Drilling Co.	12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear-44
4. HOLE NO. (As shown on drawing title and file number): EX-11	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A
5. NAME OF DRILLER: Cody Niendorf	14. TOTAL NUMBER CORE BOXES: 6
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: 522.3
7. THICKNESS OF OVERBURDEN: 2.0 rock not sampled	16. DATE HOLE: STARTED 9-30-87; COMPLETED 9-30-87
8. DEPTH DRILLED INTO ROCK: 19.8	17. ELEVATION TOP OF HOLE: 527.1
9. TOTAL DEPTH OF HOLE: 21.8	18. TOTAL CORE RECOVERY FOR BORING: 98 %
	19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
527.1	0					
	1		Rock not sampled			- Roller bit was used from top of rock to 2' depth.
525.1	2					
	3		Sandstone: moderately hard, medium grained, light gray to greenish gray, occ. micaceous, occ. cross bedded		Box #1	Run #1 Tape depth...6.7 Run length...4.7 Recovered....4.7 Loss.....0.0 -water return 100%
	4					
	5		(solid)			
	6					
520.4				100%		
	7				Box #2	
519.7			broken planes (low angle)			
519.6						
	8					Run #2 Tape depth...11 1 Run length....4.4 Recovery.....4.4 Loss.....0.0
	9					
517.6			bedding plane			
517.1	10					

Hole No. EX-11

DRILLING LOG	DIVISION Ohio River Division	INSTALLATION Huntington District	SHEET 2 of 3 SHEETS
1. PROJECT Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT 4" diamond core	
2. LOCATION (Coordinates or Station) sta. 6+11.1, 37' upstream of centerline		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) TBM	
3. DRILLING AGENCY Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL truck mounted Longyear 44	
4. HOLE NO (As shown on drawing title and file number) EX-11		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER Cody Niendorf		14. TOTAL NUMBER CORE BOXES 6	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG FROM VERT.		15. ELEVATION GROUND WATER 522.3	
7. THICKNESS OF OVERBURDEN 2.0 rock not sampled		16. DATE HOLE STARTED 9-30-87; COMPLETED 9-30-87	
8. DEPTH DRILLED INTO ROCK 19.8		17. ELEVATION TOP OF HOLE 527.1	
9. TOTAL DEPTH OF HOLE 21.8		18. TOTAL CORE RECOVERY FOR BORING 98 %	
		19. SIGNATURE OF INSPECTOR [signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
513.1	10	c	4	e	f	g
			Sandstone: (cont)			
					Box #3	
516.0	11			100%		
	12					
514.9			broken planes			
514.8						
						Run #3
514.2			bedding plane			Tape depth...16.9
	13					Run length....5.8
513.9			broken plane			Recovery.....5.6
513.7			micaceous bedding plane			Loss.....0.2
513.6			bedding plane			
513.2			bedding plane		Box #4	
513.0	14					
512.8			broken zone (moderately broken, mechanical, 0.2 loss)			
	15					
	16					
510.9						
			broken zone (slightly bkn to severely broken @ bottom mechanical)	97%		
510.3						
510.1	17					
509.7			bedding plane			
509.5			bedding plane			
	18					
					Box #5	
508.7			carb. bedding plane			
508.6			Coal: moderately hard, black, blocky, shaley @ top broken with 0.2 loss.			
507.9						
507.7			Shale: soft, brown, clayey, carb. @ top, occ. iron noduals. broken plane			
507.1	20					

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PROJECT Yatesville Lake, Phase II | HOLE NO EX-11

DRILLING LOG — Division: Ohio River Division — Installation: Huntington District — Hole No. EX-11 — Sheet 3 of 3 sheets

1. Project: Yatesville Lake, Phase II
2. Location (Coordinates or Station): sta. 6+11.1, 37' upstream of centerline
3. Drilling Agency: Boyles Bros. Drilling Co.
4. Hole No. (As shown on drawing title and file number): EX-11
5. Name of Driller: Cody Miendorf
6. Direction of Hole: [X] Vertical [ ] Inclined ____ deg. from vert.
7. Thickness of Overburden: 2.0 rock not sampled
8. Depth Drilled into Rock: 19.8
9. Total Depth of Hole: 21.8
10. Size and Type of Bit: 6" diamond bit
11. Datum for Elevation Shown (TBM or MSL): TBM
12. Manufacturer's Designation of Drill: truck mounted Longyear 44
13. Total No. of Overburden Samples Taken: Disturbed N/A; Undisturbed N/A
14. Total Number Core Boxes: 6
15. Elevation Ground Water: 522.3
16. Date Hole: Started 9-30-87; Completed 9-30-87
17. Elevation Top of Hole: 527.1
18. Total Core Recovery for Boring: 98 %
19. Signature of Inspector: [signature]

Elevation	Depth	Legend	Classification of Materials (Description)	% Core Recovery	Box or Sample No.	Remarks (Drilling time, water loss, depth of weathering, etc., if significant)
507.1	20					
506.8			Shale: (cont)			Run #4 Tape depth...21.8 Run Length....5.0 Recovered.....4.7 Loss.....0.3
506.5			broken zone (severly broken, mechanical, 0.1 loss.			
506.2	21					
505.9			Siltstone: soft to mod. h., lt. br., gradational.			
505.7			Sandstone: mod. h., med. g., lt. br.			
505.3			broken plane (low angled)	94%		
	22		Bottom of Hole			
	23					

Pressure Test Data

Interval (el)	Flow (gpm)
523.1 - 505.3	2.4
520.1 - 505.3	2.7
515.1 - 505.3	2.1
510.1 - 505.3	2.3

- gauge pressure at surface was 5psi

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Project: Yatesville Lake, Phase II | Hole No. EX-11

Hole No. CG-1

DRILLING LOG	DIVISION: Ohio River Division	INSTALLATION: Huntington District	SHEET 1 OF 4 SHEETS
1. PROJECT: Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT: 4" diamond core	
2. LOCATION (Coordinates or Station): sta. 4450, centerline		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): TBM	
3. DRILLING AGENCY: Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title and file number): CG-1		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER: Bill Womack		14. TOTAL NUMBER CORE BOXES: 22	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN: 0.8 rock not sampled		16. DATE HOLE: STARTED 2-2-88; COMPLETED 2-4-88	
8. DEPTH DRILLED INTO ROCK: 75.1		17. ELEVATION TOP OF HOLE: 527.6	
9. TOTAL DEPTH OF HOLE: 75.9		18. TOTAL CORE RECOVERY FOR BORING: 99 %	
		19. SIGNATURE OF INSPECTOR: Wilbur C Wickel	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc.; if significant)
527.6	0					
526.8			Rock not sampled			Roller bit was used from top of rock to 0.8
526.4	1		Shale: soft, gray			
			Sandstone: moderately hard medium to fine grained, light gray, micaceous, occ. cross bedded, occ. iron stained		Box #1	Run #1 Tape depth...4.9 Loss.....0.0 Drill time...:15
	2					
	3					
	4		broken plane: 524.2			100% water return
	5			100%		
	6				Box #2	Run #2 Tape depth...10.0 Loss.....0.0 Drill time....:15
	7					
	8					100% water return
	9				Box #3	
	10		(solid)	100%		
	11					
	12					Run #3 Tape depth...15.1 Loss.....0.1 Drill time....:15
	13				Box #4	100% water return
	14					
	15		mech. broken: 512.4	98%		
	16					
	17		broken plane: 510.1		Box #5	Run #4 Tape depth...19.1 Loss.....0.0 Drill time.....20
	18					100% water return
	19			100%		
507.6	20					

Hole No CG-1

DRILLING LOG	DIVISION Ohio River Division	INSTALLATION Huntington District	SHEET 2 OF 4 SHEETS
1. PROJECT Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT 4" diamond core	
2. LOCATION (Coordinates or Station) Sta. 4450, centerline		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) TBM	
3. DRILLING AGENCY Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title and file number) CG-1		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN DISTURBED N/A UNDISTURBED N/A	
5. NAME OF DRILLER Bill Womack		14. TOTAL NUMBER CORE BOXES 22	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE STARTED 2-2-88 COMPLETED 2-2-88	
7. THICKNESS OF OVERBURDEN 0.8 rock not sampled		17. ELEVATION TOP OF HOLE 527.6	
8. DEPTH DRILLED INTO ROCK 75.1		18. TOTAL CORE RECOVERY FOR BORING 99 %	
9. TOTAL DEPTH OF HOLE 75.9		19. SIGNATURE OF INSPECTOR M. C. Gill	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
507.6	20					
	21		micaceous bedding pn.: 506.3			Run #5 Tape depth...24.1 Loss.....0.0 Drill time....:20
	22					
	23		micaceous bedding pn.: 504.3		Box #7	100% water return
503.7	24		Sandstone: moderately hard coarse to fine grained, light gray, conglomeratic w/ num. br. siltstone rock fragments, occ. coal stringers.	100%		Run #6 Tape depth...26.6 Loss.....0.0 Drill time....:15
	25					
501.4	26		Shale: s., bk., carb., slk. 503.1 - 502.8	100%	Box #8	100% water return
500.8			Coal: mod. h., bk., blocky,			
500.6	27		pyr. @ top, sh. @ mid.			
500.0			Shale: s., dk. gr., mod. broken w/ 0.1 loss			Run #7 Tape depth...30.3 Loss.....0.1 Drill time... :25
	28		Claystone: s., br., sli. carb.			
	29		Siltstone: soft to moderately hard, light brown, num. coal stringers, thin intbd. sandstone layers, occ. sandstone rock frags. clayey @ 497.5 - 496.7			100% water return
	30			97%	Box #9	
496.7	31		Shale: s. to mod. h., gr, sli. carb., occ. plant fos., thin intbd. greenish gr. sandstone, occ. br. siltstone rock frags., thin intbd of siltstone.			Run #8 Tape depth...33.3 Loss.....0.0 Drill time....:20
	32					
	33		broken bd pn.: 496.6 broken plane: 494.4 mech. broken 494.0	100%	Box #10	100% water return
	34					Run #9 Tape depth. .38.7 Loss.....0.0 Drill time.....25
	35					
	36					100% water return
	37		broken plane.490.4		Box #11	
	38					
	39		mech. bkn. 0.1 loss. 488.9	100%		
487.6	40		foundation grout hole filled w/ grout: 487.8 - 487.4			

Hole No. CG-1

DRILLING LOG	DIVISION: Ohio River Division	INSTALLATION: Huntington District	SHEET 3 OF 4 SHEETS
1. PROJECT: Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT: 4" diamond core	
2. LOCATION (Coordinates or Station): sta. 4+50 centerline		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): TBM	
3. DRILLING AGENCY: Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title and file number): CG-1		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER: Bill Womack		14. TOTAL NUMBER CORE BOXES: 22	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN: 0.8 rock not sampled		16. DATE HOLE: STARTED 2-2-88; COMPLETED 2-4-88	
8. DEPTH DRILLED INTO ROCK: 75.1		17. ELEVATION TOP OF HOLE: 527.6	
9. TOTAL DEPTH OF HOLE: 75.9		18. TOTAL CORE RECOVERY FOR BORING: 99 %	
		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
487.6	40		Shale: (cont)			
	41				Box #12	Run #10 Tape depth...44.0 Loss.....0.1 Drill time.....30 water return 100%
	42					
	43					
	44			98%	Box #13	
	45					Run #11 Tape depth...49.3 Loss.....0.0 Drill time....:25 water return 100%
	46					
	47					
	48		broken bedding plane: 481.6		Box #14	
478.3	49			100%		
477.5	50		Coal: mod. h., bk., pyr. @ top, blocky, cl. so. @ 477.7			
	51		Claystone: s., greenish gr. above 476.7, dk. br. slt. carb. below 476.7. broken pns.: 477.2, 477.0		Box #15	Run #12 Tape depth...54.5 Loss.....0.0 Drill time....:30 water return 100%
	52		476.7 and 475.6 broken zone: 476.3 - 476.0			
475.3			Siltstone: soft to moderately hard, light gray, occ. carbonaceous stringers.			
	53				Box #16	
	54		sandy: 473.9 - 473.6, 473.1 - 472.9			
	55		shaley: 473.5 - 473.4, 473.1 - 472.9	100%		
471.9						
471.7	56		Shale: s., lt. gr., cl., broken w/ 0.1 loss			Run #13 Tape depth...60.0 Loss.....0.0 Drill time....:30
	57		Sandstone: moderately hard, medium to fine grained, light gray to greenish gray, occ. cross bedded, micaceous.		Box #17	water return 100%
	58					
	59					
467.6	60			100%		

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PROJECT: Yatesville Lake, Phase II | HOLE NO: CG-1

Hole No. CG-1

DRILLING LOG	DIVISION: Ohio River Division	INSTALLATION: Huntington District	SHEET 4 OF 4 SHEETS
1. PROJECT: Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT: 4" diamond core	
2. LOCATION (Coordinates or Station): sta. 4+50, centerline		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): TBM	
3. DRILLING AGENCY: Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title and file number): CG-1		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED: N/A ; UNDISTURBED: N/A	
5. NAME OF DRILLER: Bill Womack		14. TOTAL NUMBER CORE BOXES: 22	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER:	
7. THICKNESS OF OVERBURDEN: 0.8 rock not sampled		16. DATE HOLE: STARTED 2-2-88 ; COMPLETED 2-4-88	
8. DEPTH DRILLED INTO ROCK: 75.1		17. ELEVATION TOP OF HOLE: 527.6	
9. TOTAL DEPTH OF HOLE: 75.9		18. TOTAL CORE RECOVERY FOR BORING: 99 %	
		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
467.6	60		Sandstone: (cont)			
	61				Box #18	
	62					Run # 14 Tape depth...65.4 Loss.....0.0 Drill time....:30
			shaley seam: s., gr., 0.05 thick @ 465.1			
	63					water return 100%
	64				Box #19	
	65			100%		
	66		mic. bd. pn.: 461.6			
	67		mic. bd. pn.: 460.6			Run #15 Tape depth...70.7 Loss.....0.0 Drill time....:45
	68				Box #20	
	69		mic. bd. pn.: 458.6 bd. vn. fil. w/ grout 0.1' thick: 458.5			water return 100%
	70		broken zone: sev.,mech. @ 458.1 - 457.3	100%		
	71				Box #21	
	72					
	73					Run #16 Tape depth...75.9 Loss.....0.0 Drill time....:30
	74					water return 100%
	75				Box #22	
			mic. bd. pn.: 452.4			
451.7	76		Bottom of Hole	100%		
	77					Pressure Test Data gauge Interval press. flow (cfm) 5.0 - 75.9 5.0 0.08 15.0 - 75.9 15.0 0.34
	78					

Hole No. CC-2

DRILLING LOG	DIVISION: Ohio River Division	INSTALLATION: Huntington District	SHEET 1 OF 2 SHEETS
1. PROJECT: Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT: 4" diameter core	
2. LOCATION (Coordinates or Station): 414 4629 centerline		11. DATUM FOR ELEVATION SHOWN (GS or MSL): TSW	
3. DRILLING AGENCY: Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: Truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title) and (or) number: CC-2		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: UNDISTURBED: 3/4; DISTURBED: 3/4	
5. NAME OF DRILLER: C. Raney, B. Womack		14. TOTAL NUMBER CORE BOXES: 12	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN: 1.7 rock not sampled		16. DATE HOLE: STARTED 1-29-88; COMPLETED 2-1-88	
8. DEPTH DRILLED INTO ROCK: 49.3		17. ELEVATION TOP OF HOLE: 527.4	
9. TOTAL DEPTH OF HOLE: 51.0		18. TOTAL CORE RECOVERY FOR BORING: 100 %	
		19. SIGNATURE OF INSPECTOR: John Tucker	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
527.4	0		Rock not sampled			Roller bit was used
525.7	1.7		Sandstone: fine grain, mod. hard, gray, fer stained, open bd. pa.:8.1			Began coring mechanically broken: 1.7 - 1.9
	5.2	5	very soft, gray, silty clay seam with interbedded sandstone fragments:15.3 - 15.4	100	1	
			conglomeratic: 18.0 - 18.2 scattered very thin coal			
	10.3	10	stringers: 18.3 - 18.8	100	2	
	12.8			100	3	
		15				mechanically broken: 16.0 - 16.2
	17.7			100	4	
508.6	18.8					
507.9	19.5		Coal: seam, solid			
507.6	19.8	20	Clay Seam: mod. h., sl., gr., slt. wd.,19.5 - 19.8			
505.9	21.5		Siltstone: cl., s., gr., 19.8 - 21.5	100	5	
	22.9		Sandstone: fine grained, hard, gray, 21.5 - 24.4			
503.0	24.4	25	Siltstone: mod. h., gr., we., v. s., gr, cl. fil. @ 24.7 - 25.5 & 25.2 - 25.3	100	6	
501.1	26.3		Shale: silty, mod. hard, gray, calcareous nodules scattered @ 36.4 - 36.8, scattered thin gray sandstone stringers @ 38.7 - 41.9, carbonaceous @ 41.0 - 41.9			
	27.2			100	7	
	31.3	30				
	34.3			100	8	mechanically broken: 34.3 - 35.5
		35				
	39.3			100	9	
		40				
485.5	41.9					
485.0	42.4		Coal: solid	100	10	
			Claystone: silty mod. hard, weathered @ 42.4 - 43.6, slk. hi. ang. 42.5 - 42.7 slk. low ang. 43.5 - 43.7			
482.0	45.4	45	Siltstone: mod. h., gr., cl. @ 46.7 - 46.9, low ang. o. jt. @ 46.8 - 46.9 shale se. mod. h. gr. @ 47.4 - 47.6			
479.8	47.6			100	11	
		50	Sandstone:			

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PROJECT

HOLE NO

Hole No. CC-2

DRILLING LOG | DIVISION: Ohio River Division | INSTALLATION: Huntington District | SHEET 2 OF 4 SHEETS

1. PROJECT: Yatesville Lake, Phase II
2. LOCATION (Coordinates or Station): sta. 6429, centerline
3. DRILLING AGENCY: Hayles Tress. Drilling Co.
4. HOLE NO. (As shown on drawing title) and type number: CC-2
5. NAME OF DRILLER: C. Brent B. Wesley
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 1.7 rock not sampled
8. DEPTH DRILLED INTO ROCK: 49.3
9. TOTAL DEPTH OF HOLE: 51.0
10. SIZE AND TYPE OF BIT: 6" AX diamond core
11. DATUM FOR ELEVATION SHOWN (USC or MSL): TSM
12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A
14. TOTAL NUMBER CORE BOXES: 16
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED 1-20-88; COMPLETED 2-1-88
17. ELEVATION TOP OF HOLE: 527.4
18. TOTAL CORE RECOVERY FOR BORING: 100 %
19. SIGNATURE OF INSPECTOR: John Lasher

ELEVATION a	DEPTH (ft.) b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. (Rock) e	CORE OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
476.4	51.0		Sandstone: b., gr., sli. carb., low ang. o. jt. @ 50.2 - 50.3, broken w/ f. sz. gr. cl. infilling @ 50.2 - 50.4, solid 50.5 - 51.0. Bottom of Hole	100	12	

Pressure Test Data

Interval (ft.)	gauge press. (psi)	flow (cfm)
2 - 11.8	5	0.0
1.8 - 18.4	11	0.39
8.4 - 25.0	18	0.22
5.0 - 51.0	24	0.00

Hole No. CC-3

DRILLING LOG	Division: Ohio River Division	Installation: Huntington District	Sheet 1 of 2 Sheets
1. Project: Yatesville Lake, Phase II		10. Size and type of bit: 4" diamond core	
2. Location (Coordinates or Station): sta. 5475, 17.5' upstream of centerline		11. Datum for elevation shown (TBM or Msl): TBM	
3. Drilling Agency: Boyles Bros. Drilling Co.		12. Manufacturer's designation of drill: truck mounted Longyear 44	
4. Hole No. (As shown on drawing title) and Sheet number: CC-3		13. Total No. of Overburden Samples Taken: Disturbed N/A; Undisturbed N/A	
5. Name of Driller: Bill Womack		14. Total Number Core Boxes: 7	
6. Direction of Hole: ☒ Vertical ☐ Inclined ____ Deg. From Vert.		15. Elevation Ground Water	
7. Thickness of Overburden: 2.0 rock not sampled		16. Date Hole: Started 2-1-83; Completed 2-1-83	
8. Depth Drilled Into Rock: 24.1		17. Elevation Top of Hole: 520.9	
9. Total Depth of Hole: 26.1		18. Total Core Recovery for Boring: 100 %	
		19. Signature of Inspector: Bill Womack	

Elevation	Depth	Legend	Classification of Materials (Description)	% Core Recovery	Box or Sample No.	Remarks (Drilling time, water loss, depth of weathering, etc., if significant)
520.9	0					
	1		Rock not sampled			Roller bit was used from top of rock to 2.0' depth
512.9	2		Sandstone: mod. h., med. - f. g., lt. gr., mic., occ. x-bd., occ. fer. sta.			
	3		mic. bd. pn.: 518.8			
			jt. 45°: 518.7 - 518.5	100%	Box #1	Run #1
	4		mod. broken mic. bd. pns. w/ traces of grout: 517.4			Tape depth...6.6
			517.3			Loss.....0.0
	5		bd. pn.: 516.8			Drill time...:20
						water return 100%
	6					
	7					
			-bd. pn. fil. w/ grout 0.02' thick: 513.3		Box #2	
	8		bkn. pn. w/ grout: 513.0			
			bkn. pn. w/ grout tr.:512.6			Run #2
			sil. bkn. bd. pns. fil. w/ grout: 520.5 - 512.3	100%		Tape depth...11.7
	9		mic. bd. pn.: 511.5 & 511.4			Loss.....0.0
						Drill time....:15
	10		mic. bd. pn.: 510.9			water return 100%
			bkn. pn. w/ tr. of grout: 510.5			
	11				Box #3	
			bkn. bd. pn. w/ tr. grout: 509.2			
	12		hi. ang. jt. w/ grout: 509.2 - 509.1			
	13		mic. bd. pn.: 507.8 & 507.6			Run #3
506.8	14		mic. bd. pn.: 507.1 & 507.0		Box #4	Tape depth...16.2
506.5			Sandstone: mod. h., med. - f. g., cong., claystone	100%		Loss.....0.0
505.9	15		rock frags., coal stringers @ bottom.			Drill time....:30
			Coal: mod. h., bk., blocky, sh. @ top w/ tr. of grout			water return 100%
	16		Claystone: s., br., carb @top, occ. s.s. nod.,			
503.9	17		gradational sa. @ bottom. bkn: 505.8, 505.7, 505.6		Box #5	
			505.2 & 504.2			Run #4
	18		Sandstone: mod. h., med. - f. g., lt. gr., mic.			Tape depth...20.7
	19		bkn. pn.: 502.7	100%		Loss.....0.0
			ang. grout hole w/ backfill: 504.3 - 501.9			Drill time. ...20
501.1	20		Siltstone			water return 100%

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Project: Yatesville Lake, Phase II (CC-3)

Hole No.

Hole No. CC-3

DRILLING LOG	DIVISION: Ohio River Division	INSTALLATION: Huntington District	SHEET 2 OF 2 SHEETS
1. PROJECT: Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT: 4" diamond core	
2. LOCATION (Coordinates or Station): sta. 5475, 17.5' upstream of centerline		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): TBM	
3. DRILLING AGENCY: Bowles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title and title number): CC-3		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER: Bill Womack		14. TOTAL NUMBER CORE BOXES: 7	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE: STARTED 2-1-88; COMPLETED 2-1-88	
7. THICKNESS OF OVERBURDEN: 2.0 rock not sampled		17. ELEVATION TOP OF HOLE: 520.9	
8. DEPTH DRILLED INTO ROCK: 24.1		18. TOTAL CORE RECOVERY FOR BORING: 100 %	
9. TOTAL DEPTH OF HOLE: 26.1		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
500.9	20	c	d	e	f	g
500.2	21		Siltstone: mod. h. - s., gr., gradational w/ sa. @ top & sh. @ bottom cl. se.: 501.0, 500.9 & 500.5		Box #6	
	22		Shale: soft, dark gray, num. sandstone stringers, occ. coal stringers, bkn. pns.: 498.5, 498.0 496.6	100%		Run #5 Tape depth...26.1 Loss.....0.0 Drill time....:20
	23					
	24				Box #7	water return 100%
	25					
494.8	26		Bottom of Hole			
	27					Pressure Test Data
	28					interval (ft) / gauge press. (psi) / flow (cfm) 5.0 - 26.1 / 5 / 0.0 18.0 - 26.1 / 18 / 0.0

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PROJECT: Yatesville Lake, Phase II | HOLE NO: CC-3

Hole No. CG-4

DRILLING LOG	DIVISION Ohio River Division	INSTALLATION Huntington District	SHEET 1 OF 2 SHEETS
1. PROJECT Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT 4" diamond core	
2. LOCATION (Coordinates or Station) sta. 5+60, 38.1' downstream of centerline		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) TBM	
3. DRILLING AGENCY Bowles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title and file number) CG-4		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER Bill Womack		14. TOTAL NUMBER CORE BOXES 6	
6. DIRECTION OF HOLE ☑ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE: STARTED 2-2-88; COMPLETED 2-2-88	
7. THICKNESS OF OVERBURDEN 2.2 rock not sampled		17. ELEVATION TOP OF HOLE 520.8	
8. DEPTH DRILLED INTO ROCK 19.3		18. TOTAL CORE RECOVERY FOR BORING 99 %	
9. TOTAL DEPTH OF HOLE 21.5		19. SIGNATURE OF INSPECTOR [signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
520.8	0					
	1		Rock not sampled			Roller bit was used from top of rock to 2.2' depth.
518.6	2					
	3		Sandstone: mod. hard, medium to fine grained, light gray, mic., occ. x-bd., occ. fer. sta.			
	4				Box #1	Run #1 Tape depth....7.3 Loss.....0.0 Drill time....:15 water return 100%
	5					
	6					
	7			100%	Box #2	
	8					
	9					Run #2 Tape depth...12.6 Loss.....0.0 Drill time....:15 water return 100%
	10		bd. pn. fil. w/ grout: 510.9 low ang. jt. 30°: 510.8 - 510.7			
	11		bd. pns.: 510.5 & 510.3		Box #3	
	12		bd. pn.: 509.1			
	13		bd.pn. fil. w/ grout 0.01' thick: 507.7	100%		
507.4			bd. pn.: 507.6			
506.9	14		Conglomerate: mod. h., br., claystone rock frags., med. g. lt. gr. sa. matrix.		Box #4	Run #3 Tape depth...16.9 Loss.....0.0 Drill time....:15 water return 100%
			Sandstone: mod. h., med. -			
505.6	15		f. g., lt. gr., mm. coal stringers.			
			coal: 506.2 - 506.1			
504.9	16		Coal: mod. h., bk., blocky tr. of grout.			
			clay seam @ 505.4	100%		
	17		Claystone: s., lt. br., carb. @ top.			
503.4			bkn. pn.: 504.2		Box #5	
502.5	18		Siltstone: mod. h., lt. gr., gradational w/ coarser @ bot.			Run #4 Tape depth....21.5 Loss.....0.1 Drill time....:15 water return 100%
	19		Sandstone: mod. h., med. - f. g., mic., occ. x-bd. shaley below: 499.8			
500.8	20			98%		

DRILLING LOG	DIVISION Ohio River Division	INSTALLATION Huntington District	Hole No. CG-4 SHEET 2 OF 2 SHEETS
1. PROJECT Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT 4" diamond core	
2. LOCATION (Coordinates or Station) sta. 5+60, 38.1 downstream of centerline		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) TBM	
3. DRILLING AGENCY Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title and file number) CG-4		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER Bill Womack		14. TOTAL NUMBER CORE BOXES 6	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN 2.2 rock not sampled		16. DATE HOLE STARTED 2-2-88 COMPLETED 2-2-88	
8. DEPTH DRILLED INTO ROCK 19.3		17. ELEVATION TOP OF HOLE 520.8	
9. TOTAL DEPTH OF HOLE 21.5		18. TOTAL CORE RECOVERY FOR BORING 99 %	
		19. SIGNATURE OF INSPECTOR [signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
500.8	20		Sandstone: (cont)		Box #6	
	21					
499.3			Bottom of Hole			
	22					
	23					

Pressure Test Data

interval (ft)	gauge press. (psi)	flo (cf
5.0 - 21.4	5.0	0.0
10.0 - 21.5	10.0	0.0

Hole No. CC-5

DRILLING LOG	DIVISION: Ohio River Division	INSTALLATION: Huntington District	SHEET 1 OF 2 SHEETS
1. PROJECT: Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT: 4" diamond core	
2. LOCATION (Coordinates or Station): sta. 6+05, 40' downstream of centerline		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): TBM	
3. DRILLING AGENCY: Bowles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear '44	
4. HOLE NO. (As shown on drawing title and file number): CC-5		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER: Chad Ramey		14. TOTAL NUMBER CORE BOXES: 6	
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN: 1.3 rock not sampled		16. DATE HOLE: STARTED 1-28-88; COMPLETED 1-28-88	
8. DEPTH DRILLED INTO ROCK: 20.7		17. ELEVATION TOP OF HOLE: 526.9	
9. TOTAL DEPTH OF HOLE: 22.5		18. TOTAL CORE RECOVERY FOR BORING: 100 %	
		19. SIGNATURE OF INSPECTOR: W. L. C. Hall	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
526.9	0					
	1		Rock not sampled			Roller bit was used from top of rock to 1.8' depth
525.1	2		Sandstone: mod. h., med.-f. g., lt. gr., mic., occ. fer. sta., occ. x-bd.			
	3				Box #1	Run #1 Tape depth....7.1 Loss.....0.0 Drill time.....15
	4					water return 100%
	5		fer. sta. jt. 45°: 522.5 - 522.2			
	6					
	7			100%	Box #2	
	8					
	9					Run #2 Tape depth...12.4 Loss.....0.0 Drill time....:25
	10		mic. bd. pn.: 517.4		Box #3	water return 100%
	11					
	12					
	13		void filled w/ grout: 514.5 - 514.4 broken zone; sev. bkn., jt. @ 45°, sm. tr. of grout: 513.9 - 513.6 bd. pn. w/ grout tr.: 513.4 bd. pn.: 513.3 mic. bd. pn.: 512.5 bd. pn. w/ grout tr.: 511.7 broken pn.: 511.5 bd. pn. w/ grout tr.: 511.0	100%	Box #4	Run #3 Tape depth...17.9 Loss.....0.0 Drill time.....15 water return 100%
	14					
	15					
	16					
510.7	17		Conglomerate: mod. h., br claystone rock frags., lt gr. med. g. sa matrix, occ. coal stringers		Box #5	
508.6	18		bkn. pns.: 509.6 & 509.4	100%		
508.0	19		Coal: mod. h., bk., blocky, sh. @ top. Claystone: s., br., cl., carb. @ top			
506.9	20		cl. se.: 507.6, 507.5, 506.8, 506.3			

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PROJECT: Yatesville Lake, Phase II | HOLE NO: CC-5

Hole No. CG-5

DRILLING LOG	DIVISION: Ohio River Division	INSTALLATION: Huntington District	SHEET 2 OF 2 SHEETS

1. PROJECT: Yatesville Lake, Phase II
2. LOCATION (Coordinates or Station): sta. 6+05, 40' downstream of centerline
3. DRILLING AGENCY: Boyles Bros. Drilling Co.
4. HOLE NO. (As shown on drawing title and file number): CG-5
5. NAME OF DRILLER: Chad Raney
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED _____ DEG FROM VERT.
7. THICKNESS OF OVERBURDEN: 1.8 rock not sampled
8. DEPTH DRILLED INTO ROCK: 20.7
9. TOTAL DEPTH OF HOLE: 22.5
10. SIZE AND TYPE OF BIT: 4" diamond core
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): TBM
12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A
14. TOTAL NUMBER CORE BOXES: 6
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED 1-28-88; COMPLETED 1-28-88
17. ELEVATION TOP OF HOLE: 526.9
18. TOTAL CORE RECOVERY FOR BORING: 100 %
19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
506.9	20	c	d	e	f	g
			Claystone: (cont)			Run #4
506.2						Tape depth...22.5
	21		Siltstone: s., lt. br., gradational w/ c. @ bottom		Box #6	Loss.....0.0
505.2			cl. se.: 505.3			Drill time....:15
	22		Sandstone: mod. h., med. - f. g., lt. gr., mic.	100%		water return 100%
504.4			Bottom of Hole			
	23					
	24					
	25					

Pressure Test Data

interval (ft)	gauge press. (psi)	flow (cfm)
4.3 - 10.9	5	0.0
10.9 - 17.5	11	0.0
17.5 - 22.5	17	0.1

Hole No. CG-6

DRILLING LOG	DIVISION: Ohio River Division	INSTALLATION: Huntington District	SHEET 1 OF 1 SHEETS

1. PROJECT: Yatesville Lake, Phase II	10. SIZE AND TYPE OF BIT: 4" diamond core
2. LOCATION (Coordinates or Station): sta. 5+10, 40' downstream of centerline	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): TBM
3. DRILLING AGENCY: Boyles Bros. Drilling Co.	12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44
4. HOLE NO. (As shown on drawing title and file number): CG-6	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A
5. NAME OF DRILLER: B. Womack	14. TOTAL NUMBER CORE BOXES: 6
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN: 2.1 rock not sampled	16. DATE HOLE: STARTED 2-4-88; COMPLETED 2-4-88
8. DEPTH DRILLED INTO ROCK: 18.8	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE: 20.9	18. TOTAL CORE RECOVERY FOR BORING: 100 %
	19. SIGNATURE OF INSPECTOR: John Lusher

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
	2.1		Rock not sampled			Roller bit was used
	2.3		Sandstone: fine grained, hard, massive bedding, gray, sli. carbonaceous, sli. micaceous, solid 2.1 - 7.3 & 7.3 - 12.5, thin bedded with carb. coated bedding planes 10.1 - 12.5, solid 12.5 - 17.1, shaley bedded with carb. coated bd. planes 17.1 - 17.3, separated micaceous bd. plane 17.25, conglomeritic 19.2 - 19.7, shale seam, soft gray 19.7 - 19.9, broken shale seam, mod. hard 19.9 - 20.0, indurated clay seam gray 20.0 - 20.5, numberous 0.01 thin coal stringers 20.5 - 20.9, cast fossil 20.9.	100	1	
	12.5			100	2	
	17.5			100	3	
	20.9			100	4	
			Bottom of Hole			

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PROJECT: Yatesville Lake, Phase II | HOLE NO: CG-6

Hole No. CG-7

DRILLING LOG	DIVISION: Ohio River Division	INSTALLATION: Huntington District	SHEET 1 OF 2 SHEETS
1. PROJECT: Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT: 4" diamond core	
2. LOCATION (Coordinates or Station): sta. 6+25, 25' downstream of centerline		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): TBM	
3. DRILLING AGENCY: Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title and file number): CG-7		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER: C. Ramey		14. TOTAL NUMBER CORE BOXES: 6	
6. DIRECTION OF HOLE: (X) VERTICAL ( ) INCLINED ____ DEG FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN: 1.9 rock not sampled		16. DATE HOLE: STARTED 1-28-88; COMPLETED 1-28-88	
8. DEPTH DRILLED INTO ROCK: 19.2		17. ELEVATION TOP OF HOLE: 528.0	
9. TOTAL DEPTH OF HOLE: 21.1		18. TOTAL CORE RECOVERY FOR BORING: 97 %	
		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
528.0	0					
	1		Rock not sampled			Roller bit was used from top of rock to 1.9' depth.
526.1	2					
	3		Sandstone: mod. h., med. - f. g., lt. gr., mic., occ. x-bd., occ. fer. sta.			
	4				Box #1	Run #1 Tape depth....6.3 Loss.....0.1 Drill time....:25 water return 100%
	5					
	6			98%		
	7		jt. w/ 45° ang.: 521.9 - 521.7 mech. broken: 520.7		Box #2	
	8					Run #2 Tape depth...10.7 Loss.....0.0 Drill time.....22 water return 100%
	9					
	10			100%	Box #3	
	11					
	12					Run #3 Tape depth...16.0 Loss.....0.1 Drill time....:20
	13		mech. broken: 517.3			
	14		mech. broken: 515.1		Box #4	water return 100%
	15		broken zone; sev. bkn., 0.1 loss, so. t. grout lays.: 512.9 - 512 3			
	16			98%		
511.1	17		Conglomerate: mod. h., br. claystone rock frags., med. g. lt gr. sa. matrix, coal stringers @ bottom. bkn w/ 0.3: 510.2 - 509.8		Box #5	Run #' Tape depth...21.1 Loss.....0.3 Drill time....:20
509.3	18					
509.0	19		Coal: mod. h., bk., blocky Claystone: s., cl., gradational w/ coarser with depth			water return 100%
508.0	20			94%		

Hole No. CG-7

DRILLING LOG	DIVISION: Ohio River Division	INSTALLATION: Huntington District	SHEET 2 OF 2 SHEETS
1. PROJECT: Yatesville Lake, Phase II		10. SIZE AND TYPE OF BIT: 4" diamond core	
2. LOCATION (Coordinates or Station): sta. 6+25, 25' downstream of centerline		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): TBM	
3. DRILLING AGENCY: Boyles Bros. Drilling Co.		12. MANUFACTURER'S DESIGNATION OF DRILL: truck mounted Longyear 44	
4. HOLE NO. (As shown on drawing title and file number): CG-7		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A	
5. NAME OF DRILLER: C. Ramey		14. TOTAL NUMBER CORE BOXES: 6	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN: 1.9 rock not sampled		16. DATE HOLE: STARTED 1-28-88; COMPLETED 1-28-88	
8. DEPTH DRILLED INTO ROCK: 19.2		17. ELEVATION TOP OF HOLE: 528.0	
9. TOTAL DEPTH OF HOLE: 21.1		18. TOTAL CORE RECOVERY FOR BORING: 97 %	
		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
508.0	20		Claystone: (cont)		Box #6	
507.3						
506.9	21		Sandstone: mod. h., med. - f. g., lt. gr., mic.			
			Bottom of Hole			
	22					
	23					
	24					

Pressure Test Data

interval (ft)	gauge press. (psi)	flow (cfm)
3.9 - 10.5	5	0.0
9.5 - 16.1	10	0.0
16.1 - 21.1	16	0.1