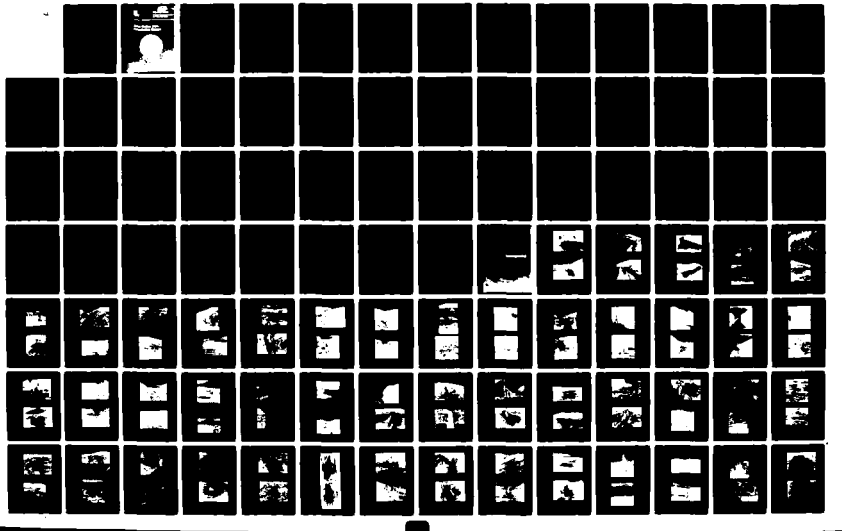
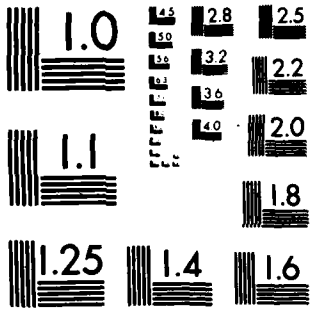
AD-A137 732 CAVE BUTTES DAM FOUNDATION REPORT GILA RIVER BASIN: 1/3
PHOENIX ARIZONA AND VICINITY (INCLUDING NEW RIVER)(U)
ARMY ENGINEER DISTRICT LOS ANGELES CA AUG 83

UNCLASSIFIED F/G 13/13 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: 015	2. GOVT ACCESSION NO.: AD-A127 732
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)*: CAVE BUTTES DAM FOUNDATION REPORT GILA RIVER BASIN: PHOENIX, ARIZONA AND VICINITY (INCLUDING NEW RIVER)	5. TYPE OF REPORT & PERIOD COVERED: Final Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Geology Section, Geotechnical Branch	8. CONTRACT OR GRANT NUMBER(s): DACW-77-C-0058
9. PERFORMING ORGANIZATION NAME AND ADDRESS: U.S. Army Corps of Engineers, P.O. Box 2711, Los Angeles, CA 90053	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS	12. REPORT DATE: August 1983
	13. NUMBER OF PAGES: 81
14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*: Office, Chief, of Engineers, U.S. Army, Washington, D.C. 20314	15. SECURITY CLASS. *(of this report)*: Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

Available in limited quantities from performing organization.

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Foundation
Geology
Construction
Foundation treatment
Grouting

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

A summation of the foundation exploration and subsequent foundation treatment and grouting program during construction of Cave Buttes Dam near Phoenix, Arizona. Includes 94 photos and 58 plates.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

GILA RIVER BASIN

NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

MARICOPA COUNTY, ARIZONA

CAVE BUTTES DAM

FOUNDATION REPORT

U.S. ARMY, CORPS OF ENGINEERS

LOS ANGELES DISTRICT

AUGUST 1983

CONTENTS

CONTENTS (Cont'd)

CONTENTS (Cont'd)

PHOTOS

CONTENTS (Cont'd)

CONTENTS (Cont'd

CONTENTS (Cont'd)

CONTENTS (Cont'd)

CONTENTS (Cont'd)

CONTENTS (Cont'd)

CONTENTS (Cont'd)

PLATES

AS-BUILT PLATES

AS-BUILT PLATES (Cont'd)

FOUNDATION GEOLOGY PLATES

FOUNDATION GEOLOGY PLATES (Cont'd)

ATTACHMENTS

I. INTRODUCTION

LOCATION

1.01 Cave Buttes Dam is located in Maricopa County, Arizona, approximately 19 miles north of downtown Phoenix. The dam is on Cave Creek about 0.7 miles downstream (south) of the historical Cave Creek Dam. The new dam controls a drainage area of 191 square miles and is a portion of the New River and Phoenix City Streams, Arizona Flood Control Project. Major elements of the project are: the main embankment, outlet works, spillway, three dikes and the bypass channel. The bypass channel forms a spillway within the reservoir to pass water around Cave Creek Dam and prevent the flow of water over the top of the old concrete dam. Plate 1 shows the project location.

PROJECT DESCRIPTION

1.02 Main Embankment. The dam is a rolled earthfill structure, zoned with three classes of material to provide an exterior pervious shell and an impervious core which extends to bedrock. Crest length of the dam is 2,260 feet at elevation 1,679 feet above M.S.L. Maximum height above streambed is 109 feet. At maximum water surface elevation (1,674.1 feet) the total storage is 86,056 acre feet. During a maximum probable flood the peak inflow would be 172,000 cfs, and the peak outflow would be 100,600 cfs. Plate 2 shows the general plan and location of Cave Buttes and appurtenant structures.

1.03 Outlet Works. The outlet works are located on bedrock at the left abutment of the dam. They consist of an approach channel, intake tower, a circular 3.75-foot diameter conduit 528.75 feet long, a reinforced concrete energy dissipator and an unlined channel that discharges into the main stream channel. See Plates 5, 20 and 21.

1.04 Spillway. The spillway is in a natural saddle approximately 1,600 feet northwest of the main embankment. The crest elevation of 1,657.1 feet and width of 510 feet fit the natural terrain. The spillway was excavated in rock and is unlined. The crest is protected from erosion by a 5-foot thick concrete sill 3 feet wide at the bottom and 5.5 feet wide at the crest elevation. The sill extends completely across the spillway crest and continues up each side wall as a 2-foot thick slab to an elevation of 1,670 feet. The detached broad-crested spillway is trapezoidal in cross section with side slopes cut 2 vertical on 1 horizontal. Benches 12 feet wide were cut at elevation 1,680 feet to control erosion of excavated slopes. See Plates 5, 16, 17 and 18.

1.05 Dikes. Three dikes were required to elevation 1,679.1 feet in order to confine the maximum water surface and maintain a 5-foot freeboard.

1.05.01 Dike No. 1 is located in a saddle about 90 feet northwest of the main embankment. At crest elevation (1,679.1 feet) it is approximately 930 feet long. Maximum height is 39 feet. See Plates 5, 11, 12 and 13.

1.05.02 Dike No. 2 is approximately 6,000 feet northeast of the main embankment. The west end of Dike No. 2 abuts on rock and the east end feathers out onto the plain east of Cave Creek Road. At crest elevation it is about 9,035 feet long. Maximum height is 55 feet above the original ground elevation. See Plates 5 and 15.

1.05.03 Dike No. 3 is located about two miles northwest of the dam. The length is approximately 3,245 feet at the crest elevation. The height is a maximum of ten feet above the original ground surface.

1.06 Bypass Channel. The bypass channel is 400 feet wide with invert elevations of 1,628 feet at the channel crest, 1,620 feet at the upstream end and 1,613 feet at the downstream end. Two channels, which drain into the reservoir upstream of the old concrete dam, cross the upstream end of the bypass channel. The downstream end is in a natural channel leading directly into the reservoir of Cave Buttes Dam. The bypass channel is unlined and the crest is not protected from erosion. Erosion of the invert or walls of the bypass could only result in more rapid equalization of water levels on upstream and downstream sides of the old dam. Plates 22 and 23 show the plan, profile, and sections of the bypass channel.

CONSTRUCTION AUTHORIZATION

1.07 The New River and Phoenix City Streams Flood Control Project, also known as the Phoenix, Arizona and Vicinity (including New River) Project, was authorized by the Flood Control Act of 1965 (Public Law 89-298, 89th Congress) which states, in part, under Section 204 that "The project for flood protection at Phoenix, Arizona and vicinity, is hereby authorized substantially, in accordance with the recommendation of the Chief of Engineers In-house Document Numbered 216, Eighty-ninth Congress at an estimated cost of $58,310,000." Cave Buttes Dam is a part of that project. Final contract quantities and costs are listed in Attachment 1.

PURPOSE AND SCOPE.

1.08 This report assembles information detailing the foundation conditions and materials encountered, and any treatment or adaptations required by them at Cave Buttes Dam and appurtenances. The project was

completed in December 1979. The purpose is to document in a concise foundation report complete geologic records for convenient reference, should an occasion arise at some future date which requires use of these records. Data presented include information from geologic studies and exploration made prior to and during construction, as well as specific details of conditions encountered and construction operations related to foundations. The text, plates and photographs describe the foundation conditions, foundation treatment and construction features of the dam, outlet works, dikes, spillway and bypass channel. Complete engineering characteristics of overburden materials, conditions of foundations composed of overburden materials, data on excavation and placement of embankment materials and instrumentation are presented in Phase II, Part 1 of the General Design Memorandum (GDM), Cave Buttes Dam dated July 1976. Other pertinent data concerning the project can be found in Design Memorandum No. 3, Cave Buttes Dam, Phase II, July, 1976.

CONTRACTORS AND CONTRACT SUPERVISION

1.09 The project was constructed by Washington Construction Co., P.O. Box 8989 Missoula, Montana, under government contract No. DACW-77-C-0058. The total amount of the bid for construction was $9,769,353. The work started in September 1977 and was completed in December 1979. Contract Supervision was by the U.S. Army Engineer District, Los Angeles. Veryl Cox was Project Engineer and Filmore Turner was Project Geologist.

II. FOUNDATION EXPLORATION

INVESTIGATIONS PRIOR TO CONSTRUCTION

2.01 General. Subsurface investigations were made at Cave Buttes Dam in the foundation areas of the dam, dikes, outlet works, spillway and the bypass channel. The subsurface investigations were started in March 1970 and were completed in October 1975. Field exploration consisted of site reconnaissance, deep and shallow seismic refraction surveys, diamond core drilling, bucket-type power auger drilling, and excavating trenches with a dozer and Gradall. Soils exploration data and results of tests on soils from trenches and bucket auger holes are presented in the GDM. General plan of geologic exploration is indicated on Plate 3. General site geology, plan of geologic exploration, and geologic sections are shown on Plates 4 and 5.

2.02 Embankment Foundation. Subsurface exploration in the streambed consisted of drilling 6 diamond core holes to depths ranging from 60 to 100.6 feet and excavating 4 test trenches (TT 70-20 through 22 and 36) to depths ranging from 16 to 32 feet. The materials encountered during the diamond drilling and the results of the water pressure tests are described in the logs of the holes. Plate 6 shows logs of holes D-4u, D-6u and D-20u. Logs of D-5u, D-15u and D-16u are on Plate 7. Location of each hole is shown on Plate 3. Test trench locations and results of the moisture content and in-place density tests and the classification of the material are presented in the GDM. Plans, profile and sections of the main embankment are shown on Plates 11, 12, 13, and 14. Both deep and shallow seismic refractive surveys gave information on seismic velocities in the embankment foundation. Location of seismic lines are shown on Plate 8. Sections and Time-Distance graphs are shown on Plate 9.

2.03 Dam Abutments. Four diamond core holes penetrated the abutments: D-3u and D-19u on the right abutment to depths of 75 and 101.3 feet, respectively, and D-7u and D-26u to depths of 75 and 30 feet, respectively, on the left abutment. Investigation on the left abutment along the alinement of the outlet conduit is discussed in paragraph 2.07. See Plate 3 for locations and Plates 6 and 7 for logs of the diamond core holes.

2.04 Dike No. 1. Diamond core holes D-9u and D-10u were each drilled 25 feet to investigate subsurface conditions at Dike No. 1. Test trench 70-38 was excavated to a depth of four feet. A log of the trench indicated an average of one foot of overburden covering bedrock consisting of red, gray and green schist which was hard at a depth of three feet. Logs of the holes are on Plate 6. Plates 11, 12 and 13 show the plan, profile and sections of Dike No. 1. Log and location of TT-70-30 is presented in the GDM. Shallow seismic refractive surveys gave information on seismic velocities in the dike foundation. Location of seismic lines are shown on Plate 8. Sections and Time-Distance graphs are shown on Plate 10.

2.05 Dike No. 2. Two diamond core holes were drilled at Dike No. 2. Hole D-11u in the right abutment penetrated 51.2 feet, encountering 4.6 feet of older alluvium overlying greenschist. Hole D-12u, approximately 900 feet east along the dike axis and at an elevation 32 feet lower than D-12u, encountered both Recent and older alluvium without reaching bedrock when the hole was completed at a depth of 60 feet. Additional investigation was done

by bucket auger holes, undisturbed samples and various soils investigation tests, giving results presented in the GDM. Shallow seismic refractive surveys gave information on seismic velocities in the dike foundation. Location of seismic lines are shown on Plate 8. Sections and Time-Distance graphs are shown on Plate 10.

2.06 Dike No. 3. The dike foundation was investigated by bucket auger holes. An analysis of the data secured is discussed in the GDM. Shallow seismic refractive surveys gave information on seismic velocities in the dike foundation. Location of seismic lines are shown on Plate 8. Sections and Time-Distance graphs are shown on Plate 10.

2.07 Outlet Works. Foundation investigation for the outlet works also provided additional information on the left abutment of the main embankment. Five diamond core holes were drilled, ranging in depth from 40 to 100.3 feet, and three test trenches were excavated. Test trench 75-1, 75-2 and 75-19 at depths of 19.5, 27.5 and 27.0, respectively, each exposed bedrock at points along the centerline of the outlet. Logs of holes D-8u and D-21u are on Plate 6 and logs of holes D-17u, D-18u, D-27u, as well as of TT-75-1, TT-75-2 and TT-75-19 are on Plate 7. Location of all outlet works exploration is shown on Plate 3.

2.08 Spillway. The investigation for the spillway, located approximately 1,600 feet northwest from the dam site, included drilling six diamond core holes ranging in depth from 25.2 to 60.3 feet and excavating one test trench, TT-70-25, to a depth of 25 feet. A Caterpillar D-8 dozer with hydraulic blade and rippers was used to excavate the trench and to determine the rippability, breakdown properties of the rock, and possible size gradation of the excavated

material. Locations of the holes are shown on Plate 3. Logs of holes D-1u and D-2u are shown on Plate 6, and logs of holes D-22u, 23u, 24u and 25u are shown on Plate 7. Four shallow seismic probes provide a section along the spillway crest with information on seismic velocities. Location of seismic probes are shown on Plate 8. Sections and Time-Distance graphs are shown on Plate 10.

2.09 Bypass Channel. Investigation for the bypass channel consisted of geologic inspection, mapping and a seismic refractive survey. Results are shown on Plate 22. Plate 23 shows the bypass channel plan, profile and sections.

2.10 Riprap Investigation. Potential locations which could supply facing stone were evaluated to identify possible economical sources of riprap. Stockpiles of cobbles and boulders at commercial plants processing alluvium were also inspected. Processing of alluvium from the pervious borrow areas was considered. An exposure of bedrock approximately one mile southwest of the dam site was explored by drilling six diamond core holes ranging in depth from 37.5 to 101.1 feet. Locations of holes (D-28u through D-33u) are shown on Plate 4. The Contractor selected not to open a quarry or process material from the pervious borrow areas as he could supply cobbles for facing stone from stockpiles at the United Metro Plant located downstream from Cave Buttes Dam.

2.11 Refractive Seismic Surveys. Seismic surveys were conducted during March and April 1970 to determine seismic velocities of subsurface material. The March 1970 survey utilized two lines, each approximately 900 feet long, located along the dam axis in the stream bottom. The measured velocities showed a distinct zoning of materials in the alluvium. From the ground

surface to a depth of approximately 35 feet, the seismic velocities ranged from 4,000 to 10,000 feet per second and from 35 to 150 feet, the velocities ranged from 10,000 to 16,700 feet per second.

2.12 In April 1970, shallow seismic surveys were conducted between test holes where additional information was required. Ten seismic lines were run across the streambed obtaining velocities of the various types of sediments to a maximum depth of approximately 35 feet and the velocity at the alluvium-bedrock contact. The velocities in the streambed alluvium ranged from 1,000 to 5,300 feet per second. The velocity in the rock ranged from 8,000 to 14,000 feet per second with an anomaly of 20,000 feet per second indicated in some runs. Four seismic lines were run along the spillway crest. The velocity in the bedrock from ground surface to 10 feet, varied from 3,900 to 5,000 feet per second and below 10 feet the velocities ranged from 6,600 to 14,000 feet per second.

2.13 Four seismic lines were run along the alinement of Dike No. 1. The material from ground surface to approximately 10 feet have seismic velocities varying from 1,600 to 3,500 feet per second; from 10 to 20 feet deep, the velocities increased to 5,500 feet per second and below 20 feet the velocities increased to 12,000 feet per second. Eight seismic lines were run along the alinement of Dike No. 2. The seismic profile shows quite a large reduction in velocities at locations away from the right abutment and a consistent increase in velocity with increased depth into the flood plain. Near the toe of the right abutment, from ground surface to 7 feet, the velocities varied from 800 to 1,000 feet per second; from 7 to 16 feet, the velocities ranged from 2,700 to 5,100 feet per second; and from 16 to 45 feet, the velocities ranged from

10,000 to 14,000 feet per second, reflecting bedrock at that depth. In the flood plain, the seismic velocities varied erratically from 1,500 to 12,000 feet per second. Below the surficial layer to a maximum depth of 15 feet, the velocities ranged from 1,800 to 3,100 feet per second. A third layer showed velocities from 5,500 to 6,500 feet per second. The higher velocities probably reflect highly consolidated alluvium.

2.14 Five seismic probes were taken along Dike No. 3 at depths of 30 feet. From the ground surface to a maximum of 15 feet the velocities varied from 1,000 to 1,500 feet per second. Below this layer, the velocities varied from 2,900 to 4,700 feet per second. For the seismic line locations and Time-Distance graphs and sections, see Plates 8, 9 and 10.

INVESTIGATIONS DURING CONSTRUCTION

2.15 General. Investigations made during construction included three NX size holes drilled to check distribution of grout take. These holes were located at Sta. 13+27.6 in the right abutment, Sta. 23+13.1 in the cutoff trench and Sta. 30+18.3 in the left abutment. The drilling indicated that the rock was tight and no cavities or voids existed. Although not treated as part of the formal investigation, all dental excavations were checked to determine the adequacy of the rock as a foundation and to insure that any unsatisfactory conditions were corrected. A Gradall backhoe was used during stripping and scaling to investigate and remove apparently unsuitable material. Near Sta. 50+00 of the outlet works, material up to 15 feet below the proposed foundation grade was removed and replaced with concrete to provide suitable foundation.

III. GEOLOGY

REGIONAL GEOLOGY

3.01 The rock types encountered in the mountainous areas of the surrounding region are very similar. The basement complex is composed predominately of Precambrian schistose and massive metaigneous rocks with lesser amounts of associated gneiss and quartzite. These are covered and intruded by Tertiary igneous rocks. The igneous rocks consist of granite, rhyolite, andesite, vesicular basalt flows, tuff and tuffaceous agglomerate. The trend of foliation in the rock formations is in a southwest-northeast direction, and is generally steeply dipping. Alluvium fills the valleys and covers the slopes of the hills and mountains. Older alluvium, which consists of moderately to well consolidated residual soil and talus debris, is generally found along the side slopes of the valleys and underlies the Recent alluvium. In the valleys, the older alluvium is mostly sand and silty sand containing varying amounts of caliche. Recent alluvium, which consists of unconsolidated silt, sand, gravel, cobbles and boulders, is found in the valley areas in the stream channels and the flood plain washes. Rocks similar to those of the nearby hills and mountains probably underlie the alluvial deposits. The deep dissection of the mountains, and the great extent and depth of the alluvial fans suggest that the Phoenix area has undergone a long, stable geologic history.

SITE GEOLOGY

3.02 General. Cave Buttes Dam is located approximately 19 miles north of Phoenix, Arizona and about 0.7 miles south of the existing Cave Creek concrete multiple-arch dam. The dam at streambed elevation (1,570 feet) spans Cave Creek between two rock ridges that parallel the valley. A thin veneer of older alluvium (talus material) covers the upper slopes of the ridges and becomes much thicker on the east side of the valley near the base of the slope. The materials in the valley are Recent and older alluvium, which consists of various combinations of sand, gravel, cobbles and some boulders extending to a depth of approximately 35 feet. Bedrock forming the ridges and underlying the stream bottom is a metaigneous rock, consisting of moderately hard green schist, greenstone and granite. There is evidence of ancient folding and some faulting in the rock formations in the vicinity of the proposed Cave Buttes Dam. Site geology is shown on Plate 4.

3.03 Physiography. Cave Creek rises in the New River Mountains and flows generally southwest through Paradise Valley as an intermittent stream for about 48 miles and through Phoenix to the Salt River; its drainage area at the Salt River is 311 square miles. The gradient in the vicinity of the existing Cave Creek Dam is 50 feet per mile. The portion of the river below the Arizona Canal flows along poorly defined water courses. Cave Creek, at the dam, is an ephemeral stream on alluvial fill with a course which passes through gently sloping desert terrain with low hills rising about 500 feet above the surrounding alluvial slope of Paradise Valley. The dam is located within a cluster of these hills as shown on Plates and 2 and 4.

3.04 Overburden Materials. Except for the residual soil and mantle rock of the upper portions of the hills, overburden consists of Recent and older alluvium.

3.04.01 Recent alluvium, the youngest unit, is material currently being deposited in active stream channels and within the reservoir behind the historical Cave Creek Dam. This material was deposited or has been reworked by floods and lesser flows recently enough to be clearly distinguishable from the older unit. Grain sizes represented in Recent alluvial deposits range from clay through silt, sand, cobbles and boulders. Small amounts of clay binder occur in the stream channel deposits, especially close to bedrock. Reservoir deposits are rich in silt and clay as shown by the plastic nature of material behind Cave Creek Dam. Recent alluvium is directly over bedrock at some locations and lies on older alluvium where bedrock is more deeply buried. Plate 4 indicates the general distribution of deposits of Recent alluvium.

3.04.02 Older alluvium consists of valley fill deposits, talus debris, slope wash and residual materials which have not been reworked by the present drainage system. Silty sand, some clay, angular gravel, sandy gravel and cobbles form this deposit. Most rock fragments are 6 inches in diameter or less, consisting of angular or subangular greenstone or other basement complex rock. Well-cemented material and loosely consolidated portions are both present in the unit. Older alluvium is found on slopes of the hills at the site and underlies the Recent alluvium of the deeply filled valleys. Plate 4 indicates the general distribution of surface exposures of older alluvium.

3.05 Bedrock. Bedrock types encountered in the vicinity of Cave Buttes Dam consists of younger bedrock, older granite and the basement complex.

3.05.01 Younger bedrock types are not common in the project area. Basalt forms a cap on several hills south of the dam. Tuffaceous agglomerate, consisting of greenstone fragments cemented in a tuffaceous matrix, occurs as a veneer at a few locations. Younger granite is locally prominent, generally as irregular intrusions, dikes and lenses or pods a few feet to a few tens of feet in maximum diameter. Alinement of the intrusions parallel with structural elements of the older rock is most common. Only a few small dikes of other instrusive rocks were seen.

3.05.02 Older granite, believed to be Precambrian, is exposed a mile or less west of the dam, and extends westward as a mass with dimensions of several thousand feet.

3.03.03 The basement complex of Precambrian schistose and massive metaigneous rock is the principal bedrock of the project area. Greenstone is the term commonly applied. It is moderately hard to hard, light to dark green, and fine to medium grained. Fracturing occurs mostly along older recemented fractures. Schistose intervals are light to brownish green, moderately hard to soft, platy and chlorititic. There are occasional zones of talc and clay. Serpentinization was observed at several locations. Alteration producing iron oxides gives some areas of greenstone a brilliant red or yellow coloration due to the presence of limonite and related minerals.

3.06 Bedrock Weathering or Alteration. Occasional intervals of soft schist occur in the greenstone, especially near granite intrusions. Some of the schist is talc-like in character as on the west (right) side of the spillway. Lenses of granite on the right abutment of the dam were weathered to a yellow rust color. The greenstone near the granite was altered to a red color. Throughout the foundation of the dam, alteration producing limonite and associated iron oxides is common, resulting in greenstone which is red or sometimes rusty yellow. Occasional development of serpentine is seen at various locations. Some of the varieties of altered greenstone are soft and punky. Some locations required dental excavation and replacement with concrete. See Plates 25 through 56.

3.07 Leaching or Solution Activity. No evidence of leaching or solution activity resulting in the formation of voids was found throughout the investigation and construction of Cave Buttes Dam and appurtenant structures.

GEOLOGIC STRUCTURE

3.08 General. Very complex detail was seen in the strip of bedrock cleaned by compressed air to allow careful inspection of the foundation for the impervious core of the dam. Fractures, shears, alteration zones, metamorphism and igneous intrusions are marks left by the forces applied throughout the long existence of the material which is now greenstone of the Precambrian complex. See Plates 25 through 45 for detailed mapping of the foundation for the dam embankment, Dike No. 1 and Dike No. 2.

3.09 Distinctive shear zones. Three shear zones, or faults, cross the foundation area. At Sta. 14+70 a zone of sheared and brecciated greenstone 8 to 11 feet thick forms a band of platy and blocky material with associated gouge. The zone, which is shown on Plate 27, is nearly vertical and crosses almost directly northward. Near Sta. 20+00 a shear zone 26 feet wide at the south edge of the cutoff trench and 3 feet wide at the north edge was present. See Plate 31. Platy and blocky material with gouge forms this zone. The east side of the zone crosses the cutoff trench almost directly northward. Dips range from 40 to 60° eastward. The west side goes northward about 30 feet and then tapers to the northeast until it is only 3 feet from the east side of the shear zone at the north edge of the cutoff trench. Dips measured on the west side and central part were from 80°E, through vertical to 80°W, 70°SE and 40°E. Near Sta. 28+80 the third shear zone extends northward across the foundation. This zone is 10 feet wide on the south edge of the strip and 3 feet wide on the north edge. Sheared greenstone and gouge are dominant. See Plate 36.

3.10 Complexity of Structure. The complex combination of a large shear zone, thrust faults, thinner shears and igneous intrusions shown on Plate 35 near Sta. 27+30 helps in understanding some of the complex detail throughout the foundation. The large shear zone is 18 feet wide on the south edge of the cleaned area and it extends to 40 feet northward. At that point the shear is 10 feet wide. The shear zone splays out into about seven branches. The branches are thrust faults and have associated shear zones less than a foot wide. Several granite dikes are present in the area. One dike is one foot wide and extends 42 feet to the northeast. A semicircular thrust fault exposure shows dips of 40°, 30°, and 40° directly toward the dike, suggesting

the thrust fault is in the shape of a plunging syncline with the dike along its axis. Granite dikes, lenses or pods occur at various places along the foundation, such as Sta. 9+80 (Plate 25) and 13+00 (Plate 26) where lenses trend N30°, nearly parallel with much of the jointing. Other occurrences of granite are scattered sparsely throughout the foundation area. All of the granite in the dam foundation is referred to as the "younger granite" in contrast to the Precambrian granite just west of the project area. No specific age dates are available, and mode of occurrence is the basis for separating the two types of granite. The very complex detail of shearing and jointing shown on the foundation geology plates 25 through 45 may be related to forces associated with emplacement of the younger granite.

3.11 Structural trends.

3.11.01 Dam. The general structural trend of the rock of the right abutment (Sta. 9+80 to 13+50 shown on Plates 25 and 26) is northeast. More than fifty granite dikes, lenses or pods fit into this pattern. Cross joints are common but are less persistent than the joints with a northeast strike. The dip of the joints is variable in both direction and strike, resulting in a bedrock which is platy to blocky in character. The trend changes to due north at Sta. 13+40, where two shears less than a foot thick extend northward across the foundation with minor warping and branching. East of the shear zone at Sta. 14+70, described earlier, the northward trend is less distinct. The trend is replaced by a series of warped, branching and intersecting shears less than a foot thick which trend northeast and northwest in a complex manner while maintaining a general northward trend. Dips are mostly between 90° and 50°. At Sta. 22+00, complexities increase and include shear zones less than a

foot thick which curve, branch, rejoin and have short sections which become thrust faults. This trend ends at the shear zone near Sta. 28+80, which was described earlier. The left abutment eastward from the outlet conduit is characterized by shears less than one foot thick which branch and curve but maintain a general northwest trend. A northeast trend is supperimposed east of Sta. 31+00. See Plates 25 through 38.

3.11.02 Dike No. 1. This dike starts less than 100 feet due east of the main dam, where it extends east a short distance before curving to the northeast. The foundation is primarily fractured and sheared greenstone. Three shear zones thicker than 3 feet cross the foundation of the dike. At Sta. 33+65 a shear zone with 3 to 5 feet of gouge shows a strike of N5°W and dip of 45°W. At Sta. 37+40 a shear zone 10 to 25 feet wide was mapped. A strike of N80°W and dip of 40°S was observed. At Sta. 38+65 a shear zone 3 to 5 feet wide had a strike of N15°E and dip of 70°E. Thinner shears with gouge and joints are present throughout the cleaned strip. The shears intersect, branch, rejoin, splay out and show wide variation in dip and strike. See Plates 39 through 43.

3.11.03 Dike No. 2. This dike is located about 6,000 feet northeast of the dam embankment. The basic foundation of the right abutment, Sta. 50+09 to Sta. 53+55 is sheared and jointed greenstone, however, a veneer of tuffaceous agglomerate is present where it was not removed by abutment excavation. The foundation northeast of Sta. 53+35 is older alluvium and is further described in the GDM. Two shear zones are persistent and thick enough to be described. The first, at Sta. 50+60, trends N48°E, dipping 80-85°

southeast, and the second, at Sta. 51+40, is 2 to 3 feet wide and was traced across the foundation. The strike is N58°E and the dip is 60° southeast. Dips of fractures range from 85 to 25°. See Plates 44 and 45.

3.11.04 Dike No. 3. This dike is located about 2 miles northwest from the main embankment. Alluvial slopes forming the divide between New River drainage area and Apache Wash, tributary to Cave Creek Dam, form the foundation of Dike No. 3. The foundation materials consist of surficial layers of sandy clay over-lying a highly cemented sandy silt or clayey sand. (Exploration and conditions at Dike No. 3 are considered in the GDM).

3.12 Ground Water. The headwaters of Cave Creek are located above the town of Cave Creek. The creek crosses six miles of alluvial plain before it bends northeast at a point one mile north of Cave Buttes Dam. The plain slopes 25 miles southeast to the Salt River and comprises Paradise Valley. A well penetrated 1,136 feet of alluvial valley fill near the center of the six mile reach of Cave Creek. The deep alluvium of Paradise Valley continues to the Salt River, past the city of Scottsdale. Any water absorbed by the alluvium crossed by Cave Creek in upper Paradise Valley would continue as groundwater recharge of the valley. Surplus water during periods of substantial flow would travel down Cave Creek and be controlled by Cave Buttes Dam. Ground water in the vicinity of the dam was at elevation 1,538 feet prior to construction. This represented a local water table maintained by only about 35 feet of alluvium over the bedrock and extensive ponds from local gravel operations which were filled during times of heavy rainfall. During excavation for the cutoff trench, seepage occurred along the sides of the cutoff trench where the contact of the rock and alluvium was at lower elevations. After the heavy March 1978 rains, considerable seepage, about 300

gallons per minute, occurred along the rock on both sides of the cutoff trench throughout much of its length, due to the ponding of water in the gravel pits. By July 1978, the ponds had dried up and only a slight seepage was occurring. Seepage through rock continued along the base of the left abutment and near Stas. 14+00 and 27+00 near the base of the right abutment in areas of close jointing and complex shear zones. These seeps were sealed by grouting.

IV. DIVERSION AND CONTROL OF WATER

4.01 The control of surface flows and shallow ground water during the rainy season was a problem to the contractor in his operations in both the construction site for the dam embankment and the upstream impervious borrow area. The historical Cave Creek Dam was very beneficial to the contractor in the control of water during the two major flood periods that occurred in February-March 1978. Through the close control of floodwaters by the combined efforts of the Maricopa County Flood Control District, the Corps of Engineers personnel and the contractor's men and equipment, a great amount of damage was avoided when flow was curtailed by controlled release of water through the outlet works of the existing Cave Creek Dam. The Contractor's dewatering plan consisted of constructing a diversion levee and channel from the outlet of Cave Creek Dam extending along the base of the right (west) abutment through the construction site to control surface flow. The excess flow was discharged downstream from the dam site into the natural drainage channels of Cave Creek. The levee and channel were kept in good operating condition until the embankment was high enough to divert runoff through the new outlet works. A considerable amount of maintenance of the levee was required to contain the high discharge in the channel during the periods of high run off when erosion was taking place along the levee.

4.02 While the alluvial materials in the streambed were being excavated to bedrock and during grouting and treatment of the foundation rock, the contractor had to control the water flowing in along the bedrock contact and the seepage from surface fractures in the rock. The source of the water was from gravel pit ponds both upstream and downstream of the excavation. The Contractor excavated a small trench in the rock along the upstream and downstream toe of the cutoff excavation to collect water seeping into the construction area. The water was collected in sumps and pumped to discharge downstream of the excavation and into the diversion channel. At the time the core material was placed, seeps from the fractured rock had been grouted off and the minor amount of seepage along the upstream and downstream toe was controlled by sump pumps so that placement of the core material on the rock surface was accomplished with a dry foundation. See Photos 1 through 12.

V. FOUNDATION PREPARATION

5.01 General. The preparation of the foundation included stripping the overburden material and removing loose rock from the abutments of the dam and of Dikes No. 1 and 2. The preparation also included the stripping of the alluvial materials under the outer zones of the dam embankment in the streambed to elevation 1,558 feet and the excavation of the cutoff trench to bedrock. After excavation of the overburden or alluvium, the bedrock was cleaned several times by air blasting along with a considerable amount of handwork to remove all loose rock within the area of the core trench and 12 feet upstream and downstream of the core contact.

5.02 Stripping and Scaling. After removal of the overburden, approximately 1 to 2 feet of material was excavated from both abutments of the dam and from the streambed using a D-9 dozer followed by a rubber-tired backhoe. Approximately 6 inches to 1 foot of residual soil and weathered bedrock were removed from the abutments and foundation of Dike No. 1 and the right abutment of Dike No. 2. The bedrock surfaces were first cleaned with high pressure air and handwork by laborers prior to geologic mapping and grouting. Scaling was not required on the left abutment of the main embankment or for Dikes Nos. 1 and 2. The lower portion of the right abutment for the main embankment from elevation 1,584 to 1,558 feet, was scaled to the following slopes: from centerline to 10 feet downstream of centerline, the slope was cut 1V on 1H; from 10 to 95 feet downstream of centerline, the slope was cut on a 1.25V on 1H and from 95 feet to 168 feet downstream of centerline, the slope was cut of 1.5V on 1H. The scaling was accomplished by drilling on 2-1/2 foot centers and blasting with 40 percent gelatin. After the scaling, there remained no near-vertical faces greater than 3 feet high. See Photo 13.

5.03 Excavation.

5.03.01 Dam, Right Abutment. The right abutment consisted of a reddish brown highly fractured schistose greenstone with occasional dikes of highly weathered light colored granite. After removal of 6 to 8 inches of residual soil, the foundation area for the core zone was cleaned with air and prepared for grouting. The combination of fracturing and weathering left a somewhat irregular foundation surface, with local relief varying from 6 to 12 inches. Although some higher slopes in the rock surfaces were present,

usually along infrequent shear zones, a minimal amount of excavation was necessary. After the overburden was removed to suitable bedrock, the surface was cleaned with high pressure air to prepare the surface for grouting. See Photos 14 through 18 for views of material exposed by the right abutment excavation.

5.03.02 Dam, Left Abutment. The left abutment consisted of highly fractured schistose greenstone with a few small dikes of intrusive rocks. Remnants of Tertiary volcanic breccia were plastered on portions of the greenstone bedrock. This material was removed by hand labor using picks and jack hammers or treated with mortar or dental concrete as necessary before any fill material was placed. The materials removed from the abutments to elevation 1,558 feet were classified as abutment excavation. Again the bedrock surface was cleaned with high pressure air to prepare the surface for grouting. See Photos 19 through 25 for views of material exposed by the left abutment excavation.

5.03.03 Cutoff Trench. The material excavated below elevation 1,558 feet was classified as cutoff trench excavation. The cutoff excavation consisted of excavating alluvial streambed material. Suitable excavation materials were placed in zone III, the pervious zone of the embankment. The bedrock surface exposed by the excavation was an undulating surface, with some areas having 2 to 4 feet of soft weathered material. The bedrock consisted of highly fractured blocky schistose greenstone with a few small intrusive dikes. These materials are very similar to the abutments but are highly sheared and brecciated. Most of the jointing and foliation trends in a north to northeast direction. Heavy equipment used in the excavation of the cutoff

trench and the weathered condition of the bedrock resulted in some over-excavation resulting in a relatively uneven surface. In depressions where densification by rolling of core material was not possible, the areas were filled with dental concrete. Heavy rains that occurred during and after the excavation of the cutoff trench caused ponding of water in the excavation. Water from ponding and local seepage was removed by sumping and pumping until the foundation could be cleaned by blowing off all the loose material with high pressure air and removing the loose material with rubber-tired front end loaders. This operation was required more than once in some areas when after cleaning, the area became wet again or was submerged for several days. Repeated cleaning was necessary to prepare the surface for grouting. One high rock knob, at Sta. 28+25, was drilled and blasted. This was the only drilling and blasting required in the cutoff trench. See Photos 26 through 28 for views of foundation rock exposed in the cutoff trench.

5.04 Outlet Works. The excavation of the outlet works near the toe of the left abutment and dam Sta. 29+25 commenced after the core and transition zones were stripped of overburden to streambed elevation 1,558 feet. See Photos 29 through 40.

5.04.01 Intake Tower. The intake structure and retaining wall are located at Sta. 53+92 on the upstream portion of the outlet works. The east side of the retaining wall was notched into the bedrock. The notch was excavated by controlled drilling and blasting, however, because of the joint pattern of the rock, there was a slight overbreak. After the retaining wall was constructed, the space between the rock and conduit was backfilled with selected silty sand and compacted by hand held power tampers. See Photos 30 and 31.

5.04.02 Outlet Conduit. The outlet structure was constructed on fractured greenstone from Sta. 53+92 to 50+85. During the excavation from Sta. 50+85 to 48+10, alluvium and highly weathered and sheared greenstone were encountered which had been eroded deeper than the invert for the structure. These materials were overexcavated to remove compressible material from the base of the outlet conduit structure. The area overexcavated was approximately 275 feet long with a maximum depth of overexcavation of approximately 15 feet. The area overexcavated was cleaned and backfilled with concrete to form an incompressible and impervious foundation for the outlet works conduit. At Sta. 47+41, a cutoff for the energy dissipator was line drilled to 3 feet, trimmed with air hammers and backfilled with concrete. A section of the outlet works east wall, between Sta. 50+50 and 52+00 was line drilled on 12 inch centers to 8 foot depths; every other hole was loaded with 40 percent gelatin. The results of the blasting provided a relatively smooth sound wall. See Photos 29 through 40. A D-9 dozer and Gradall was used for removal of material in the excavation for the outlet conduit. See Plates 19 through 21 and 46 through 49.

5.05 Dike No. 1. After removing the top few feet of soil, the exposed bedrock consisted of highly fractured reddish brown to a drab green schistose greenstone. No scaling was necessary to flatten the slopes before any surface treatment was done. After the soil and approximately 2 feet of weathered bedrock was removed, the surface was blown off with high pressure air to prepare the surface for grouting. See Photos 41 through 44.

5.06 Dike No. 2. After removing the top few feet of soil and weathered bedrock on the right abutment, the exposed bedrock was highly fractured and was similar to that of Dike No. 1. No further excavation was required. The surface was blown off with high pressure air to prepare the surface for grouting. See Photos 45 and 46.

5.07 Spillway. The spillway was excavated through steeply dipping thinly bedded schist, blocky greenstone and occasional hard lenses of quartzite. The material excavated was not suitable for fill in the embankment and it was wasted. The excavated materials were placed upstream of the spillway, extending the approach apron. Most of the foliated bedrock trended about 30° northeast with dips between 70-90° to the north. The right (west) wall of spillway between Sta. 19+70 and 22+50 started slaking soon after exposure to the air and was cut back on a somewhat flatter slope. The excavation of the left (east) wall stood up well at a 2V on 1H slope. A relatively trapazoidal, 510 foot long trench at least 5 feet wide on top and approximately 3 feet wide at the base by approximately 5 feet deep was excavated for construction of the sill across the spillway crest at Sta. 18+00. The excavation of the trench was accomplished by line drilling with holes on 1-foot centers along the centerline of the sill. Every other hole was loaded with 2 to 1-1/2 inch by 3 inch long sections of 40 percent gelatin, with stemming material separating these sections. After shooting, the broken rock was removed with a backhoe and trimmed with air hammers. The excavation for the sill provided a satisfactory surface for placing concrete. The sill controls erosion of the spillway invert and sides. The notch on the right (west) wall was excavated with a Gradall for the right sill wall. The much harder rock on the left wall had to be drilled and blasted. The cut did not break out well because of the

complex joint pattern. The excavation was formed and backfilled with concrete. The sides of the sill were constructed to a 13-foot height. See Photos 47 through 56. See Plates 16, 17, 18 and 50 through 56.

5.08 Bypass Spillway Channel. The excavation of the bypass spillway channel was routinely accomplished using a heavy duty dozer and a rubber tired backhoe. Occasional blasting was required. See Photos 57 and 58 and Plates 22 and 23.

VI. FOUNDATION TREATMENT

EMBANKMENT

6.01 General. After each segment of the foundation of the dam was excavated, the bedrock surface within zone 1 and an additional 12 feet upstream and downstream of zone 1 was cleaned of loose material using high pressure air hoses. Geologic features of the bedrock surface were then mapped, and a concurrent foundation drilling and grouting program started. The specified grouting program, which consisted of a 40-foot spacing of holes, was fundamentally a foundation proofing program or an extension of the design investigation to assure that no pervious zones or voids crossed the foundation. In general, foundation conditions that were exposed and as drilled for grouting were essentially as anticipated during design. All excavations inspected showed rock of adequate quality and competence for the foundation of a dam of the size and purpose of Cave Buttes Dam. The grouting commenced 23 January and was completed 15 August 1978. There was a delay of nearly a month due to a period of high rainfall. At total of 222 grout holes were drilled and grouted near the center of the core zone, forming a single

line curtain with numerous additional grout holes drilled off the line. The holes ranged in depth from 8 to 75 feet, and were EX size with the exception of 3 NX size exploratory grout holes. See Plates 57 and 58.

6.02 Right Abutment. The foundation treatment on the right abutment between Stas. 10+00 and 13+50 consisted of drilling and grouting 13 EX holes and a NX exploratory hole for a total of 507 feet. Eleven holes were drilled on 40 foot centers along the centerline of zone I core material, with hole No. 53 bracketed about 10 feet on each side because of the amount of grout used. Total grout take in hole No. 53 was 4-3/4 sacks of cement at mixtures of 3:1 and 2:1 at a pressure of 10 psi. The average grout take for all holes in the right abutment was 0.06 sacks per linear foot of hole. The rock within the core zone was then mapped, see Plates 25, 26, 57 and 58. All loose rock material, grasses and roots that had accumulated since the grouting were removed. Shear zones and open joints were treated with a sand-cement mortar mixture. Overhangs were removed and larger depressions were filled with dental concrete. The core zone of the right abutment above elevation 1,558 feet was closely inspected, mapped and photographed at each five foot increment, before and after foundation treatment. No embankment material was placed before each increment was approved for adequacy of treatment by the project geologist. When required, the abutment was again air cleaned prior to placing embankment material. See Photos 59 through 62.

6.03 Cutoff Trench (core trench). The foundation treatment of the cutoff trench between Sta. 13+50 and 29+00 consisted of drilling and grouting 150 EX holes and one NX exploratory grout hole; a total of 5,905 feet of drilling. Of this drilling, 106 holes were drilled along the centerline of zone I, core material. The line of grout curved downstream approaching the abutments.

Distance from the centerline of the dam was approximately 42 feet across the mid-portion of the valley. Forty-five additional holes were drilled to insure sealing of potential problem areas where surface fractures were more frequent, especially in the vicinity of fault gouge, breccia and surface seeps. Where required, the spacing of the grout holes within the cutoff trench was reduced to 20 foot centers after pressure tests on some of the holes indicated an anomalous water versus grout take. There were no significant changes in grout take and it was, therefore, concluded that the foundation was tight. The average grout take for all holes in the cutoff trench was 0.05 sacks per foot of hole. After the grouting was completed the area was mapped, see Plates 27 through 35, 57 and 58. The area was again cleaned by blowing off the loose earth and rock with air. Larger depressions, where the densification of the core material with rubber tired rollers was not possible, were filled with dental concrete. Smaller areas and open joints were filled with mortar. This treatment consists of filling small depressions or surface irregularities to prevent seepage between the rock formation and the zone I, impervious material. Then rolling with the rubber tired equipment would fill voids and small cracks with the clayey, plastic material and achieve the desired compaction required of the initial fill. The initial fill placed was wet of optimum. See Photos 63 through 77.

6.04 Left Abutment. The foundation treatment on the left abutment between Stas. 29+00 and 32+50 consisted of drilling and grouting 15 EX holes and one NX exploratory grout hole for a total of 670 feet. Fourteen holes were drilled on 40 foot centers along the center line of zone I, core material, with hole No. 32 bracketed about 10 feet on each side, because this 40-foot hole took 30-1/3 sacks of cement. The rock foundation was tight, as

the take of the other holes ranged from 0 to 4-1/4 sacks or an average of 0.08 sacks per foot of hole. The 60 foot exploratory NX grout hole, D-36, took 1-2/3 sacks. After the grouting was completed the area was mapped. See Plates 36, 37, 38, 57 and 58. Final preparation of the abutment included removing all material that was loose or, in the opinion of the project geologist, could break down when wet. All vegetation that had grown on the surface since the grouting operation was removed. Where necessary, irregular surfaces were cut back, shear zones and open joints were cleaned and filled with a sand-cement mortar and larger depressions were backfilled with dental concrete. As for the right abutment, the core zone of the left abutment was closely examined, mapped and approved for each five foot increment and photographed for record of the foundation treatment. This was all completed before any embankment material was placed on the rock surface. See Photos 78 through 83.

OUTLET WORKS

6.05 The foundation treatment of the Outlet Works consisted of drilling and grouting 8 EX holes, 4 holes 10 feet apart on both sides of the conduit, measured both upstream and downstream of the centerline of the core zone. The purpose of this drilling and grouting was to prevent possible seepage paths developing between the rock and the concrete backfill of the conduit. The area was tight, as it took only 4-1/4 sacks of cement for a total of 175 feet of drilling. See Photos 84 and 85. See Plates 19 through 21 and 46 through 49.

DIKE NO. 1

6.06 The foundation treatment for Dike No. 1, between Stas. 33+60 and 42+40, consisted of drilling and grouting 25 EX grout holes, a total of 584 feet. Twenty-three holes were drilled on 40 foot centers along the centerline of Dike No. 1 and two additional holes bracketed hole No. 2, approximately 10 feet on each side. These extra grout holes were drilled because of the 6-2/3 sacks of cement used in the 25 feet of hole No. 2. The average grout take for all grout holes was 0.04 sacks per foot of hole. The rock foundation was tight. The only problem encountered, was the surface seeps, caused by the fractured rock formation and the near surface caving conditions in most of the holes. This condition was resolved by puddling grout at the surface to seal the surface fractures. The holes were filled to the ground surface by hand and the pipe above ground surface was cut before embankment fill was placed. The relief of the rock surface was so gentle, that only one small area on the right side of the dike (Sta. 35+50) required treatment with dental concrete. See Photos 86 and 87. See Plates 11, 12, 13 and 39 through 43, 57 and 58.

DIKE NO. 2

6.07 The foundation treatment for Dike No. 2, between Stas. 51+00 and 53+30, consisted of drilling and grouting 7 EX holes for a total of 175 feet. These holes were drilled on the right abutment of the dike and spaced 40 feet apart using a total of 4 sacks of cement for an average take of 0.03 sacks per foot of hole. This indicated that the formation was very tight. No further surface treatment was necessary other than recleaning the surface with high pressure air prior to placing embankment material. See Photos 88 and 89. See Plates 15, 44, 45, 57 and 58.

Spillway

6.08 The trench excavated for the control sill provided a satisfactory rock foundation for placing reinforcing steel and concrete. The sill with the side extensions at each end are expected to maintain the cross section required. See Photos 90 through 94. See Plates 16 through 18 and 50 through 58.

Bypass Channel.

6.09 No foundation treatment was required for the bypass channel.

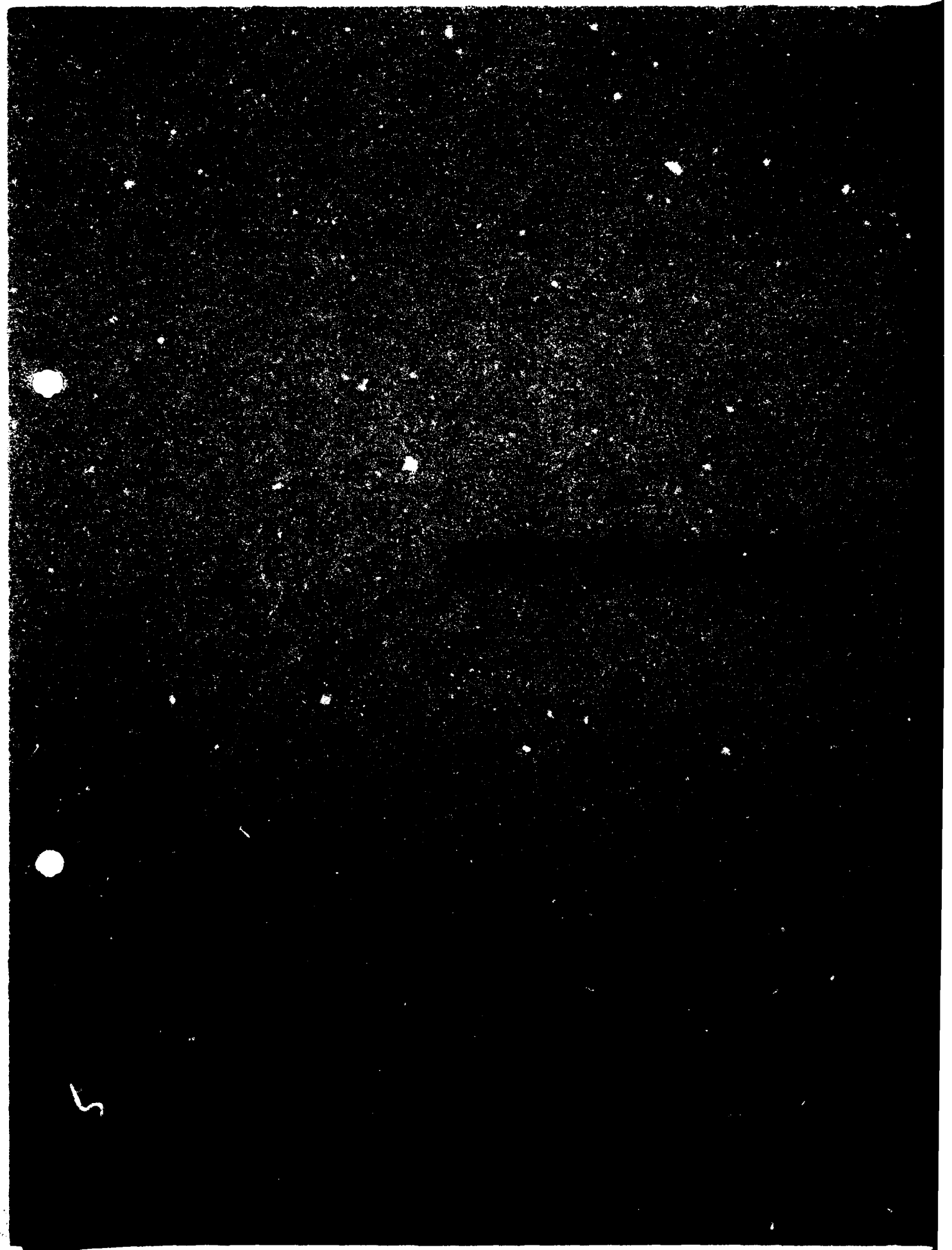


Photo 1 Center outlet of Cave Creek Dam. Lake elevation is 1,627 feet; release of 500 cfs.

1 Mar 78

Photo 2 Outlet Works centerline, upstream from centerline of dam. Ponds from recent rain.

1 Mar 78

Photo 3 Diversion of water through construction, toe of right abutment, upstream of centerline of dam.

17 Jan 78

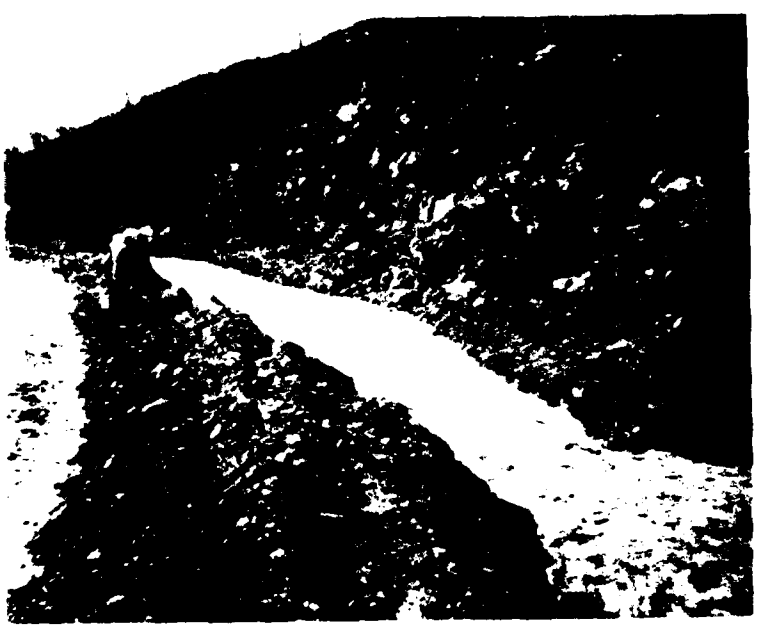


Photo 4 Diversion of water through construction, toe of right abutment, downstream of centerline of dam.

17 Jan 78

Photo 5 Diversion of 1500 cfs along toe of right abutment. View is up channel to the north. 2 Mar 78

Photo 6 Diversion of 1500 cfs along toe of right abutment. View is down channel to the south.

2 Mar 78

Photo 7

Core trench. Looking east from top of diversion dike. Contractor trving to remove water from trench.

21 Mar 78

Photo 8

Core trench. Looking west. Contractor trying to drain water accumulated from rain and seepage.

21 Mar 78

Photo 9 Slight seep at elevation 1,538± in downstream part of cutoff trench, near right abutment.
19 Oct 78

Photo 10

Seep in bottom of cutoff trench at rock knob, Sta. 27+50.
12 July 78

Photo 11

Downstream side of cutoff trench, Sta. 21+05. Salt cedar growth along seepage at top of bedrock.
19 July 78

Photo 12

Cutoff trench. Drainage ditch along downstream toe of trench.
6 Apr 78

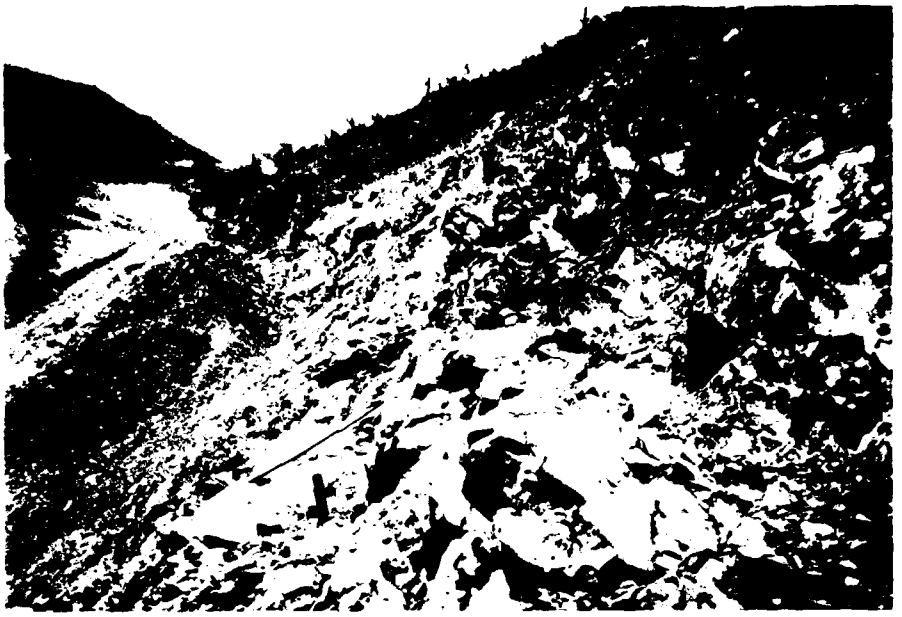


Photo 13 Right Abutment. View downstream of toe along diversion ditch. Scaling is completed; 1V on 1H in core zone and 1.5V on 1H in downstream zone II.

4 May 78

Photo 14 Cave Buttes Dam, right (west) abutment.

16 Jan 78

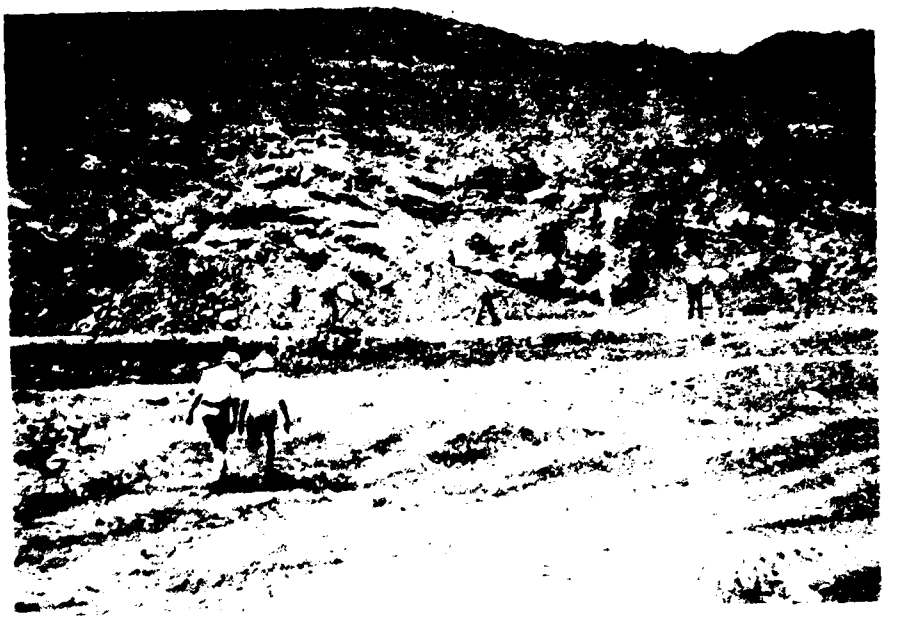


Photo 15 Cave Buttes Dam, right (west) abutment area of downstream zone II.

16 Jan 78

Photo 16

Right abutment. Drilling holes on 2½ foot centers for scaling.

25 Jan 78

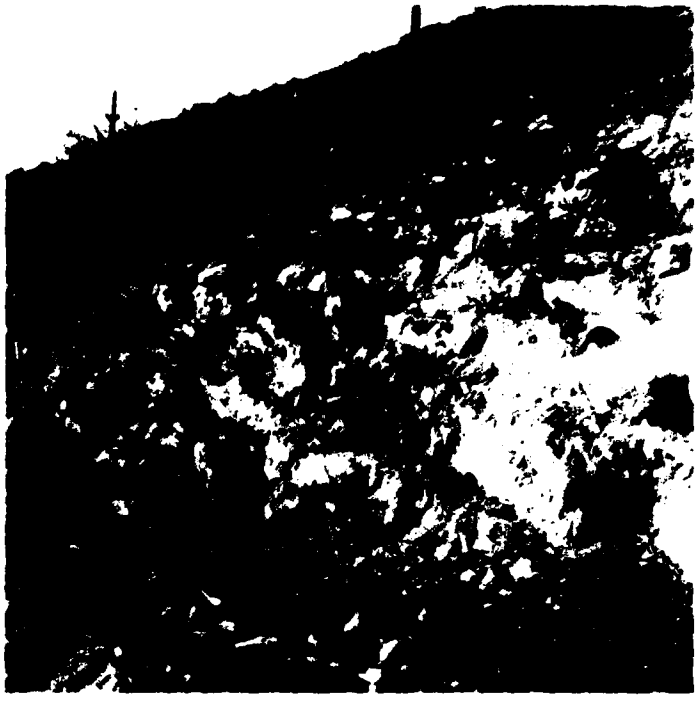


Photo 17

Right abutment. Holes drilled on 2½ foot centers for scaling using 40% gel. Downstream zone II, elev. 1,5670±.
25 Jan 78

Photo 18 Right abutment. View looking west during early stage of cleaning operations.
17 Jan 78

Photo 19 Left abutment. Approximate centerline of zone I foundation from near top of dam.
20 Dec 77

Photo 20 Left abutment. Contact between zone I and zone II foundations. Dental clean up between elevations 1,565 and 1,570.

31 Oct 78

Photo 21 Left abutment. Upstream side of zone I foundation, elevation 1,575 to 1, 585; removal of fragmented rock in well-cemented sandy matrix.

31 Oct 78

Photo 22

Left abutment. Cleaning completed in upper part, center of zone I foundation.

16 Jan 78

Photo 23

Left abutment. Cleaning completed in upper part, center of zone I foundation.
16 Jan 78

Photo 24

Left abutment. View east along centerline of dam. Presplit holes can be seen in hard rock of outlet.
21 Mar 78

Photo 25

Left abutment to distant right abutment. View of cutoff trench. Grouting in center at Sta. 23+20.

4 May 78

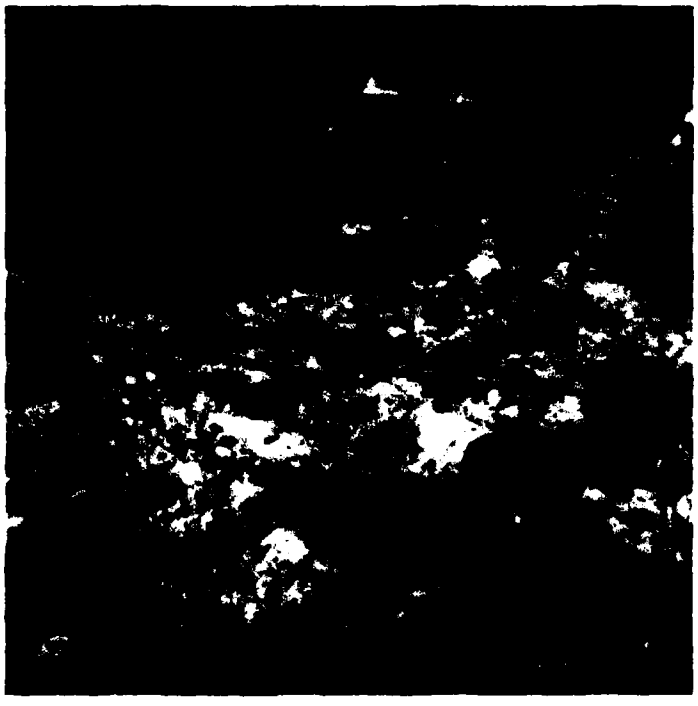


Photo 26

Cutoff trench. Cleaning by high pressure air before grouting.

24 Apr 78

Photo 27

Cutoff trench. Cleaning by high pressure air before grouting.
24 Apr 78

Photo 28

Cutoff trench near base of right abutment. Mr. Hadsall standing on last grout hole drilled, 3 more left to drill.
12 July 78

Photo 29

Outlet Works.
View north from
downstream of energy
dissipator site.
21 Mar 78

Photo 30

Outlet Works.
Centerline view
upstream toward
intake site.
15 Feb 78

Photo 31

Outlet Works.
Sta. 54+00, cut for retaining wall of intake.
15 Feb 78

Photo 32

Outlet Works.
Intake retaining wall and conduit, Sta. 53+92.5.
4 June 78

Photo 33

Outlet Works, downstream of centerline of dam. Stakes are on outlet centerline. Drilling is for presplitting along side wall.

15 Feb 78

Photo 34

Outlet Works.
Base for conduit.
View downstream
from Sta. 51+50.

21 Mar 78

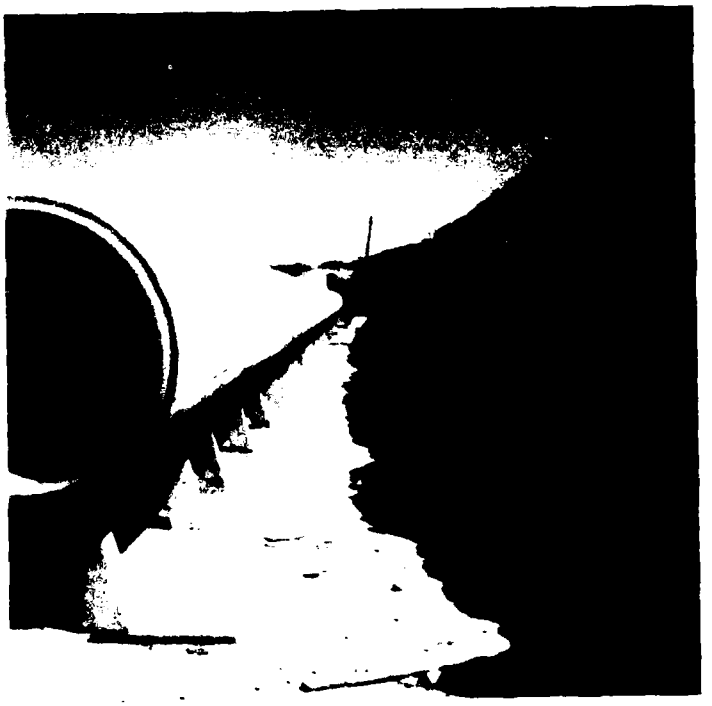


Photo 35

Outlet Works.
Setting conduit,
view upstream from
outlet Sta. 51+50.
6 Apr 78

Photo 36

Outlet Works.
Same as photo 35
except view is along
the west side.
6 Apr 78

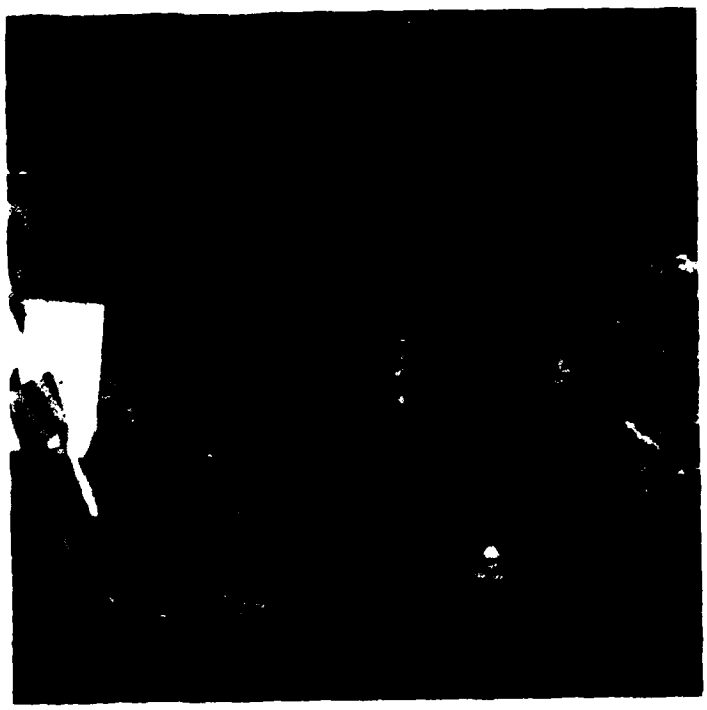


Photo 37

Outlet Works.
Sta. 50+00 after cleaning and before setting forms for backfilling with lean concrete.
24 Apr 78

Photo 38

Outlet Works.
Excavation for outlet wall, downstream of energy dissipator.
21 Mar 78

Photo 39 Outlet Works. Portion of concrete backfill near Sta. 50+00 to restore proposed foundation grade.
4 May 78

Photo 40 Outlet Works. Downstream portal and excavation for outlet channel.

1 Nov 78

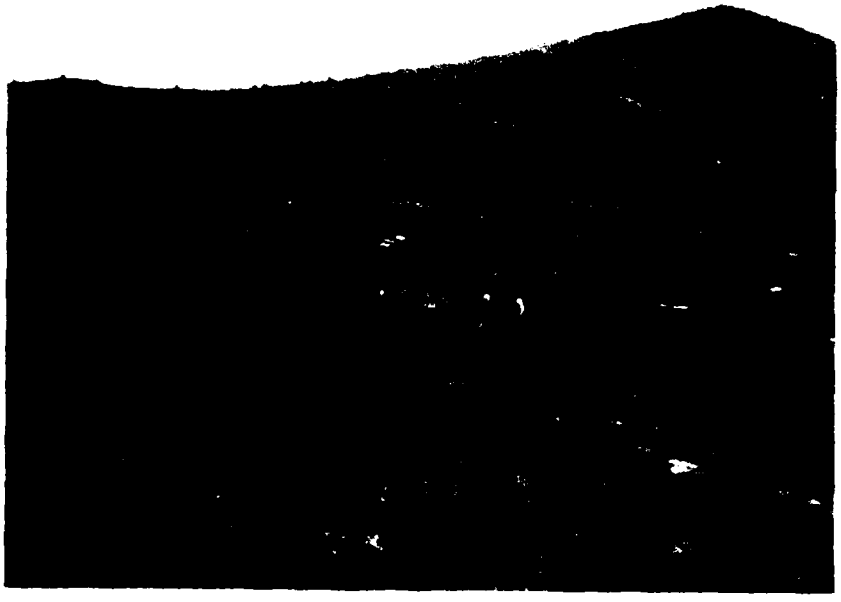


Photo 41 Dike No. 1, looking east.

16 Jan 78

Photo 42 Dike No. 1, looking east.

16 Jan 78

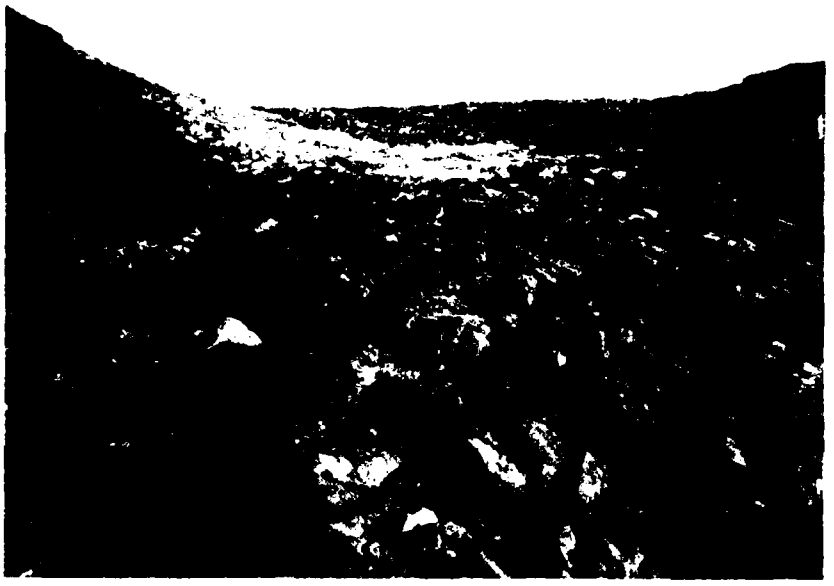


Photo 43 Dike No. 1, right side.

16 Jan 78

Photo 44 Dike No. 2, right abutment.

16 Jan 78

Photo 45

Dike No. 2.
Right abutment,
view west from
Sta. 54+00.
21 Mar 78

Photo 46

Dike No. 2.
Right side after
excavation half
way up abutment.
4 May 78

Photo 47 Spillway. Upstream right (west) side. Excavation by ripping with localized blasting.

4 May 78

Photo 48 Spillway. Upstream right side, approximately 15 to 18 foot cut in center area.

4 May 78

Photo 49

Spillway.
Ripping to
excavate schist
bedrock.
6 Apr 78

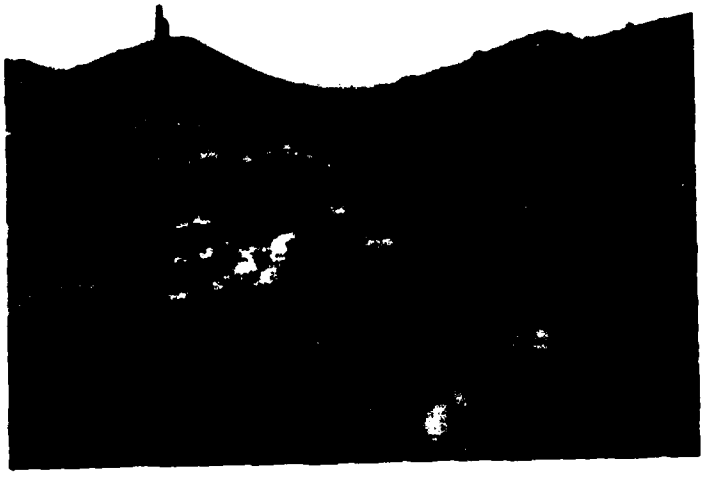


Photo 50

Spillway.
View downstream,
CP drill working
on blast hole.
6 Apr 78

Photo 51

Spillway. Final cut. Split spacing drilled on 1-foot centers.

7 Apr 78

Photo 52 Spillway crest, excavation for sill. View looking west.

16 Mar 79

Photo 53 Spillway crest. Left (east) wall after cleaning to remove loose rock; overbreak is at notch for vertical extension of sill.

1 Mar 79

Photo 54 Spillway crest. Right (west) wall, excavation for end of sill and the vertical extension.

7 Mar 79

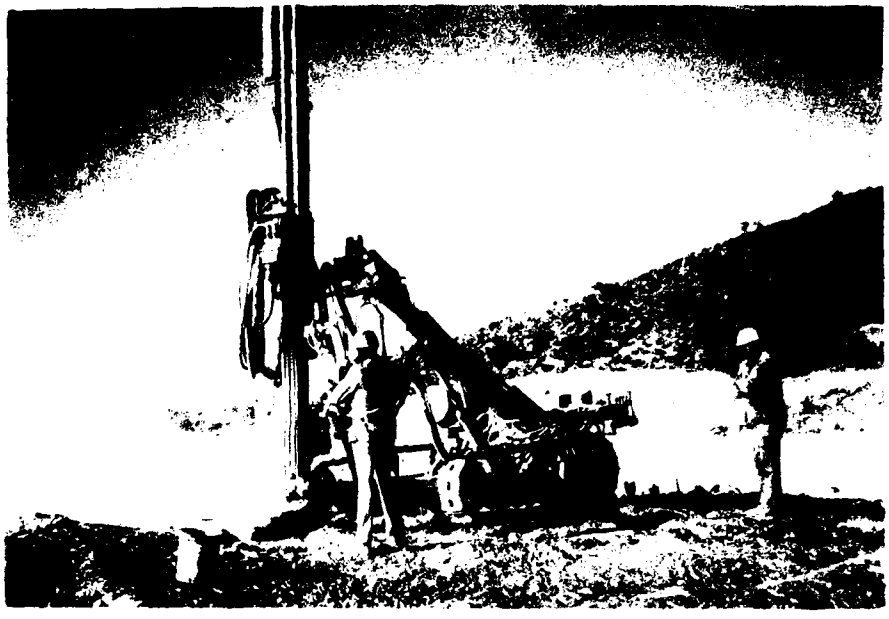


Photo 55 Spillway crest, Sta. 18+00. Drilling holes 5 feet deep on 1-foot centers for controlled blasting of sill trench.

8 Dec 78

Photo 56 Spillway crest. Controlled blasting for sill trench. Charges are set in alternate holes which are line drilled on 1-foot centers to 5 foot depths.

8 Dec 78

Photo 57 Bypass channel. View looking upstream.

13 July 79

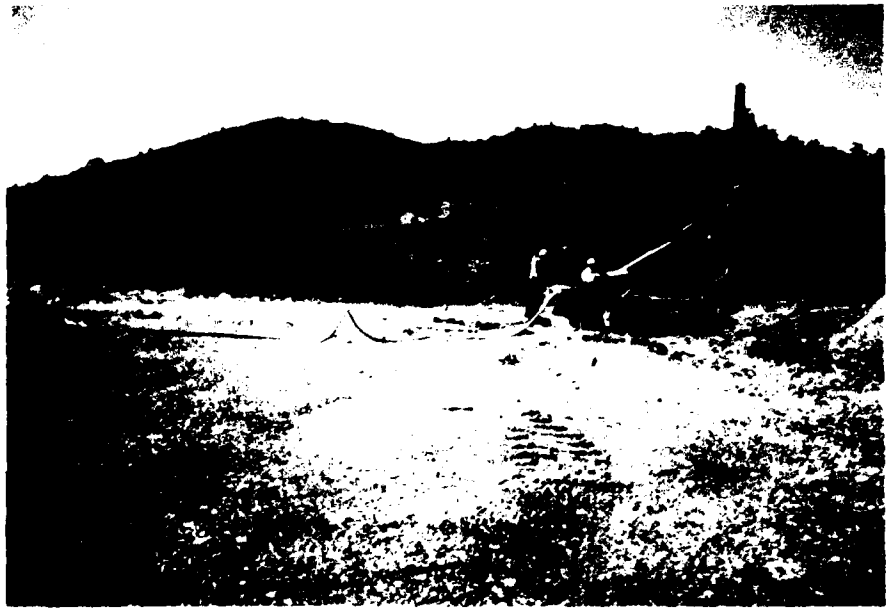


Photo 58 Bypass channel. Looking west along crest. Drilling for blast holes.

13 July 79

Photo 59 Right (west) abutment. View upstream of foundation treatment between elevations 1,540 to 1,550.
27 Oct 78

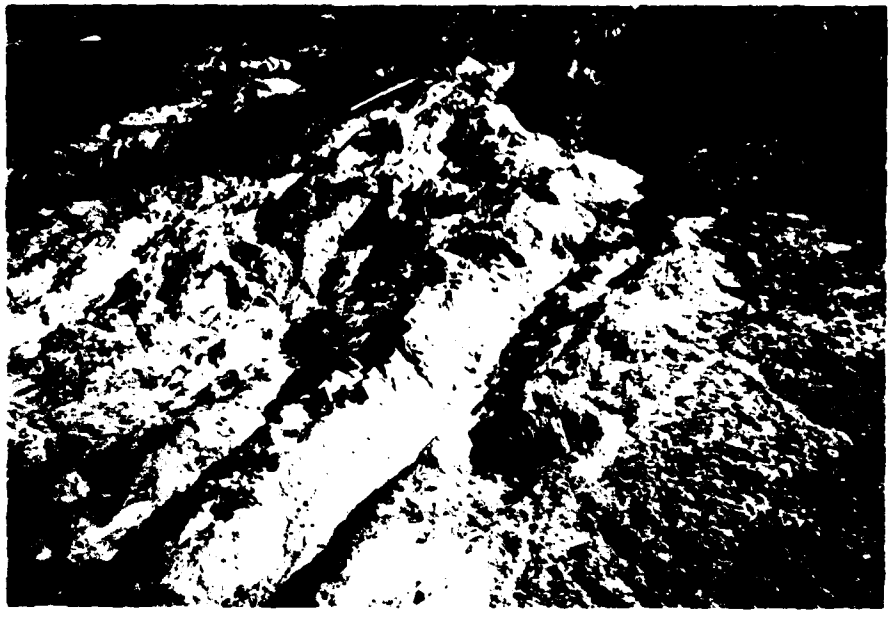


Photo 60 Right abutment. Detail of dental and mortar treatment between elevations 1,540 to 1,550.
27 Oct 78

Photo 61 Right abutment, foundation treatment. Dental concrete and sand-cement slurry grout. Looking downstream, elevation 1,550.

1 Nov 78

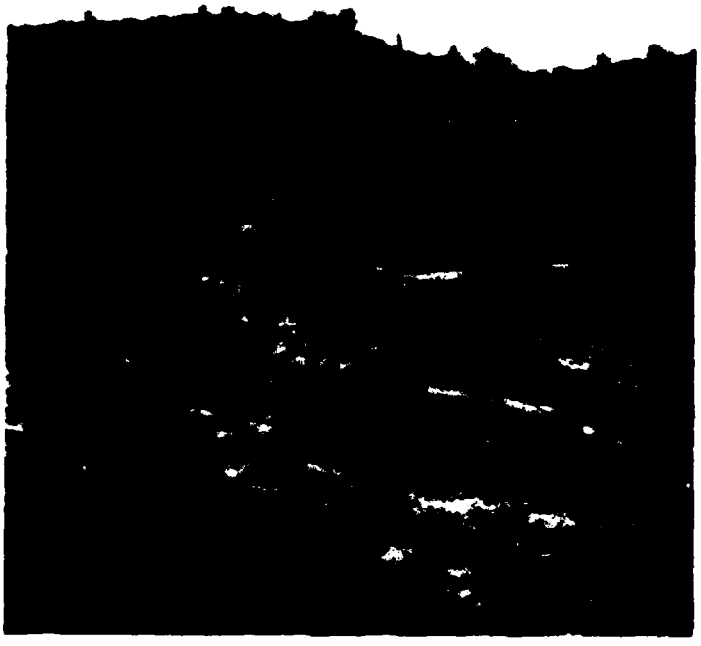


Photo 62

Right abutment. Drilling grout holes.

12 Apr 78

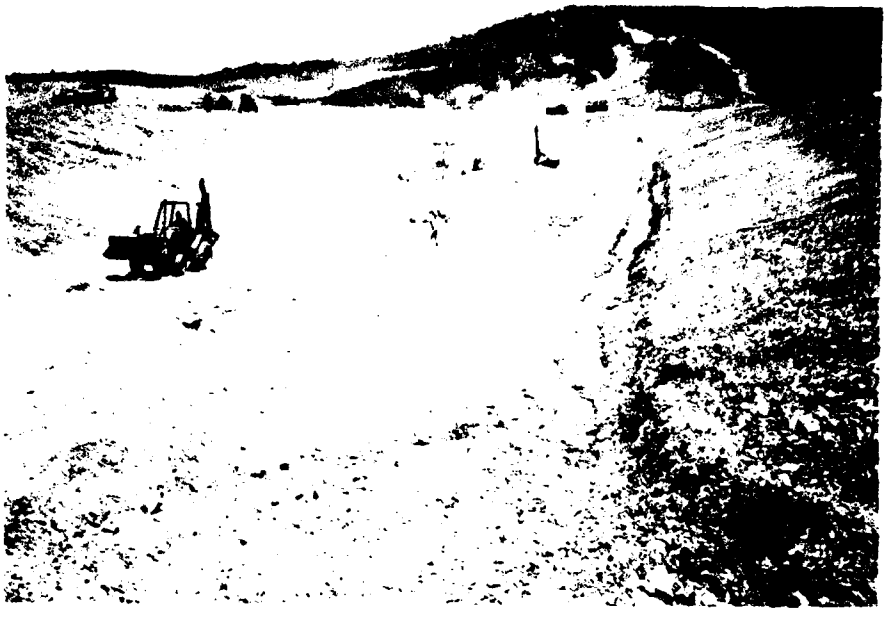


Photo 63 Cutoff trench. View east toward left abutment. Clean up and grouting in bottom of trench.
4 May 78

Photo 64

Cutoff trench.
Drilling grout hole.
Water puddle is from drilling operations.
4 May 78

Photo 65

Cutoff trench, west side. CP drill on grout hole location.
14 June 78

Photo 66

Cutoff trench. Dental concrete at Sta. 14+50.
19 July 78

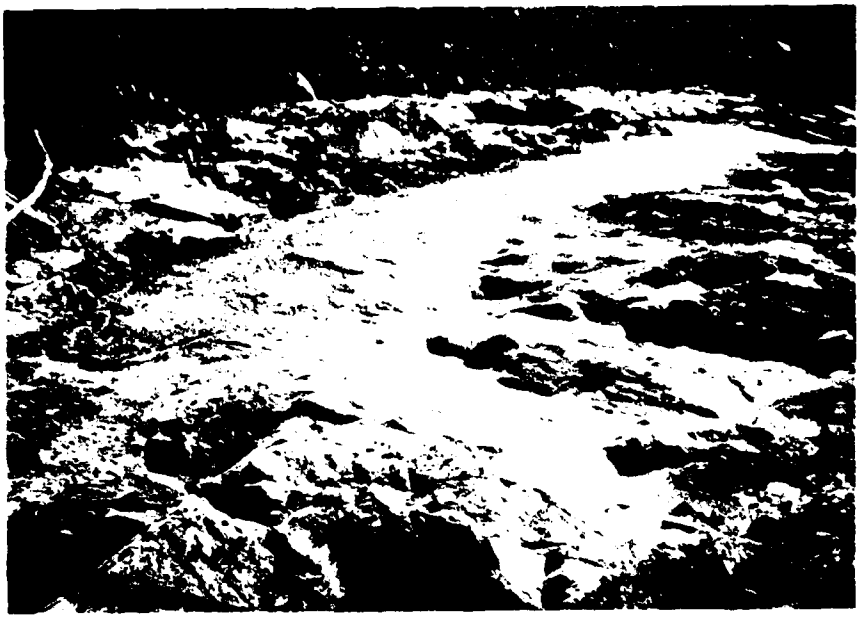


Photo 67 Cutoff trench. Dental concrete on upstream side between Stas. 18+50 and 20+00.

8 Aug 78

Photo 68

Cutoff trench. Dental concrete at Sta. 24+82, downstream from grout curtain.

12 July 78

Photo 69 Cutoff trench. Grouting to cut off seepage at Sta. 28+50.

8 Aug 78

Photo 70

Cutoff trench. Placing dental concrete.

19 July 78

Photo 71

Cutoff trench.
Placing dental
concrete.
19 July 78

Photo 72

Cutoff trench.
Dental concrete
and slurry grout
near Sta. 27+00.
Start of core mat-
erial placement.
8 Aug 78

Photo 73

Cutoff trench.
Slurry grout and
dental concrete.
19 July 78

Photo 74 Cutoff trench. Foundation treatment at elevation 1,550 to 1,560, below outlet works.
28 Oct 78

Photo 75 Cutoff trench. Foundation treatment at elevation 1,550 to 1,560, below outlet works. View is to the immediate right of photo 74.

28 Oct 78

Photo 76 Cutoff trench. Rock surface near right abutment. Water seep found during cleaning before grouting.

22 June 78

Photo 77 Cutoff trench. Panoramic view of left abutment (elevation 1,545 to 1,565) after foundation treatment. Top of outlet concrete is at elevation 1,565.

23 Oct 78

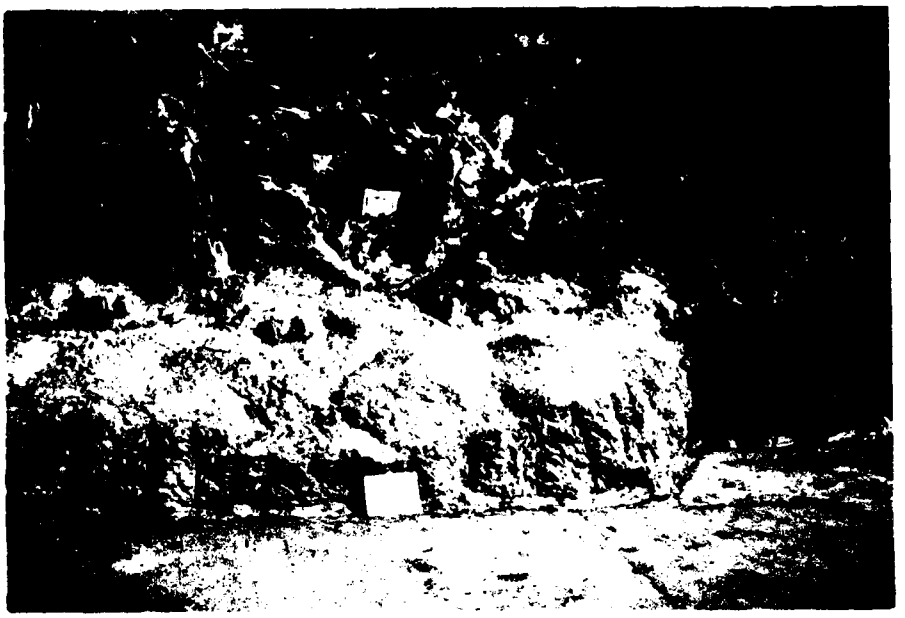


Photo 78 Left abutment, foundation treatment. Elevation 1,565 to 1,570; downstream edge of zone I foundation in near right edge of photo.

31 Oct 78

Photo 79 Left abutment between elevation 1,550 to 1,555. Foreman and crew mixing mortar and pea gravel concrete from dry pre-mixed bags for use as slurry grout to fill holes and deep fractures.

23 Oct 78

Photo 80 Left abutment. Foundation treatment in core zone between elevations 1,550 and 1,560.

23 Oct 78

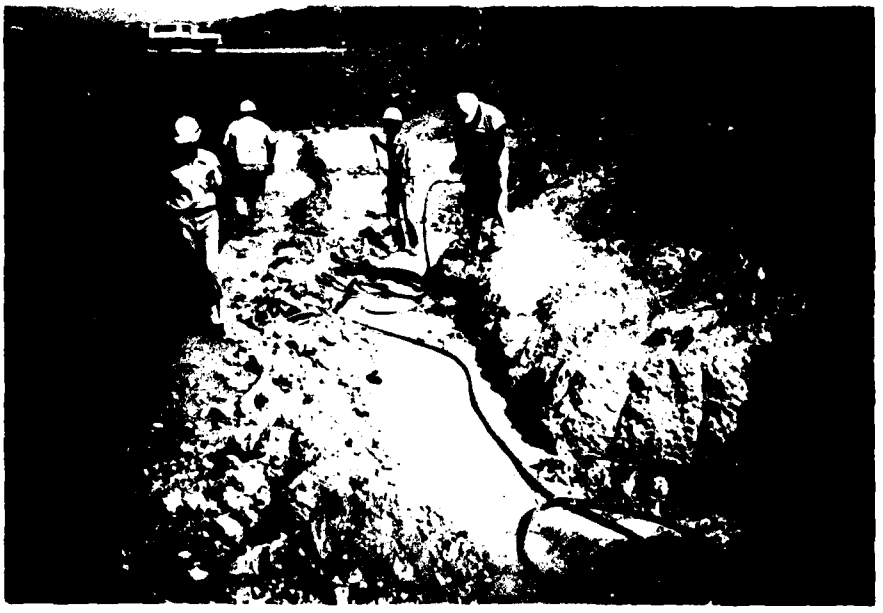


Photo 81 Left abutment. Dental concrete above outlet at elevation 1,565. View is upstream at zone I - zone II contact.

18 Oct 78

Photo 82 Left abutment. Grout hole No. 6-63 at Sta. 29+09. Material is well cemented gravels and cobbles.
8 Aug 78

Photo 83 Left abutment after cleaning and during grouting.
8 Aug 78

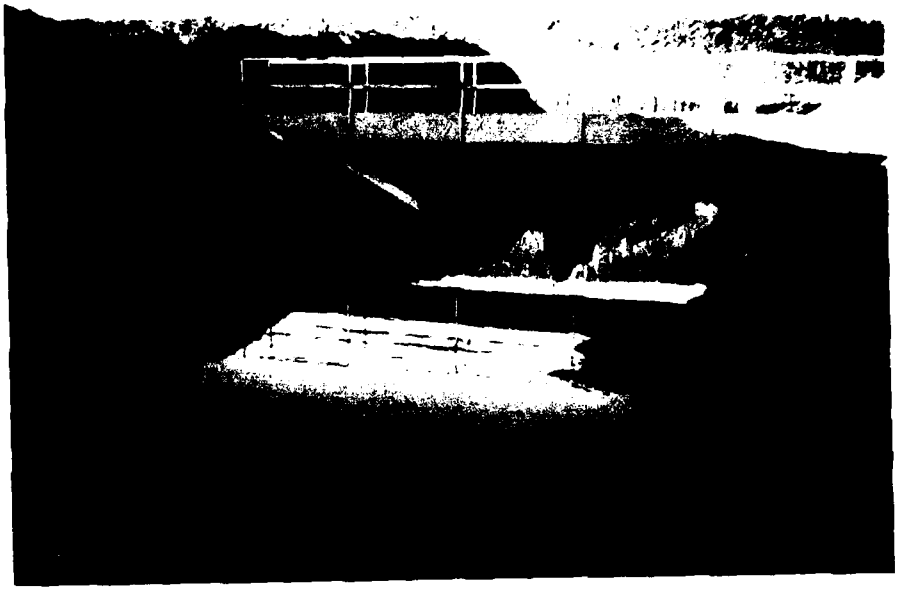


Photo 84 Outlet channel. View upstream toward beginning of of channel. Footbridge, energy dissipator and skyline of embankment at elevation 1,595.

11 Dec 78

Photo 85 Outlet channel. View downstream toward end of conduit, energy dissipator, bridge and beginning of channel. Camera point is on embankment at elevation 1,595.

12 Dec 78

Photo 86

Dike No. 1. CP drill setting pipe for grout holes in the zone II area.
25 Jan 78

Photo 87

Dike No. 1. Pressure grouting with neat cement grout.
3 Feb 78

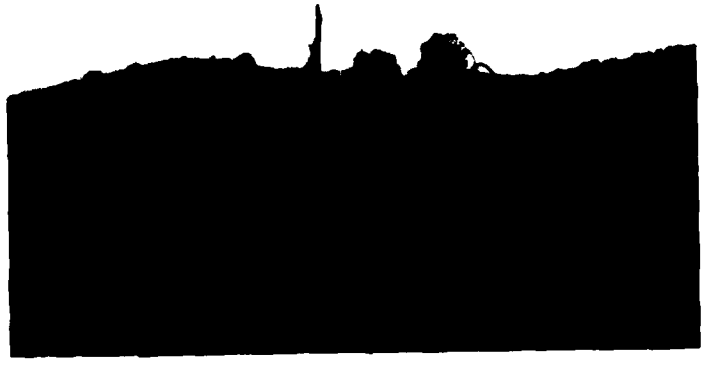


Photo 88 Dike No. 2. Elevation 1,650, west abutment. View looking east.

7 May 79

Photo 89 Dike No. 2. Elevation 1,650, west abutment. View looking east.

7 May 79

Photo 90

Spillway crest.
Setting steel in
trench for sill.
28 Mar 79

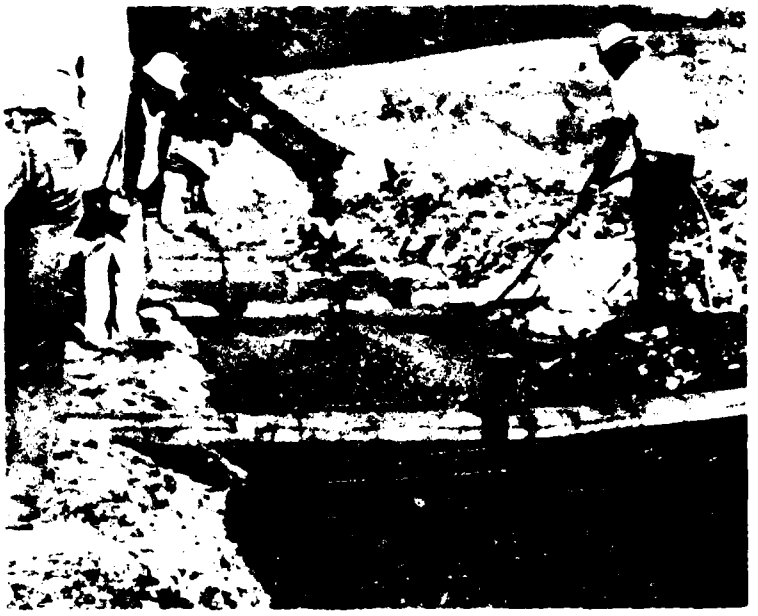


Photo 91 Spillway crest. Placing concrete in sill.
9 Apr 79

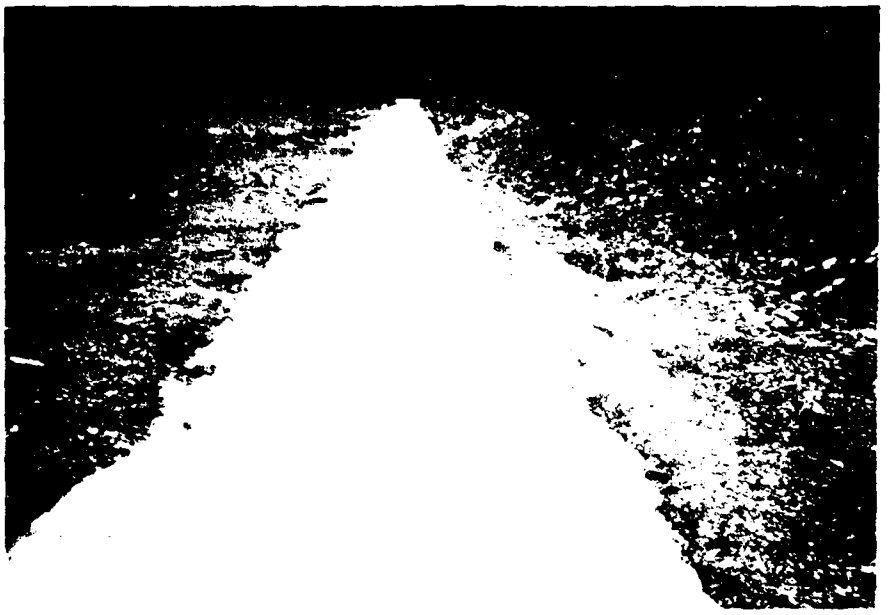


Photo 92 Spillway crest. Concrete in place along sill. View looking west.

10 Apr 79

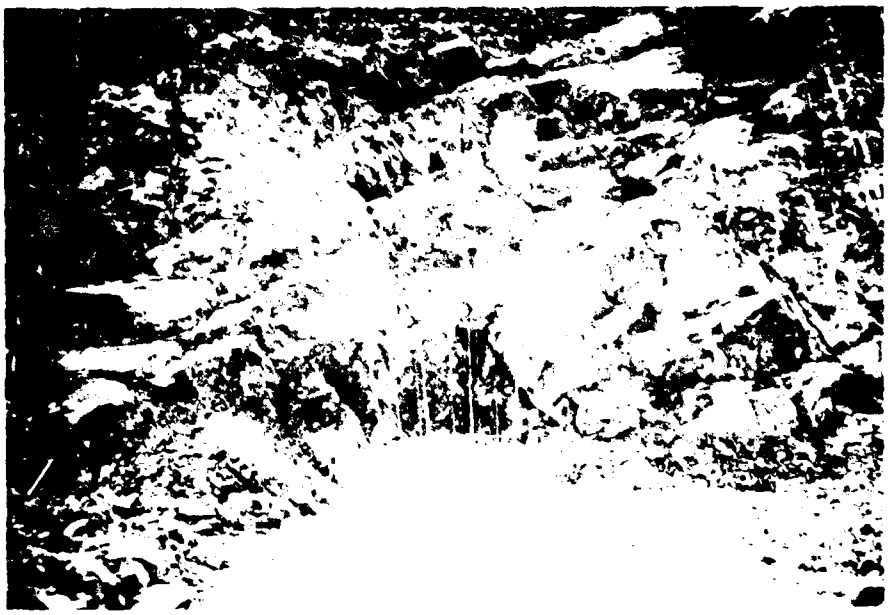
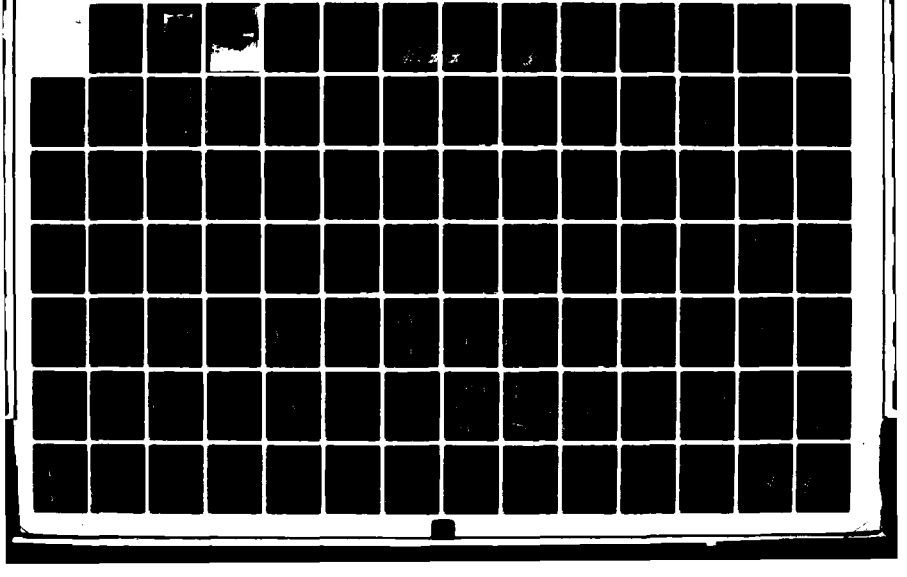


Photo 93 Spillway crest. East end of sill, some steel for upright extention but no forms through overbreak.

10 Apr 79

AD-A137 732 CAVE BUTTES DAM FOUNDATION REPORT GILA RIVER BASIN: PHOENIX ARIZONA AND VICINITY (INCLUDING NEW RIVER)(U) ARMY ENGINEER DISTRICT LOS ANGELES CA AUG 83 2/3

UNCLASSIFIED F/G 13/13 NL



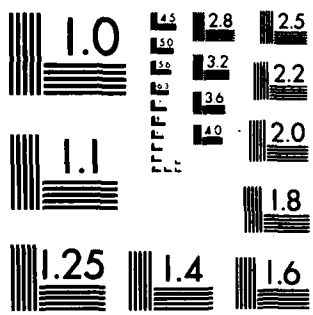
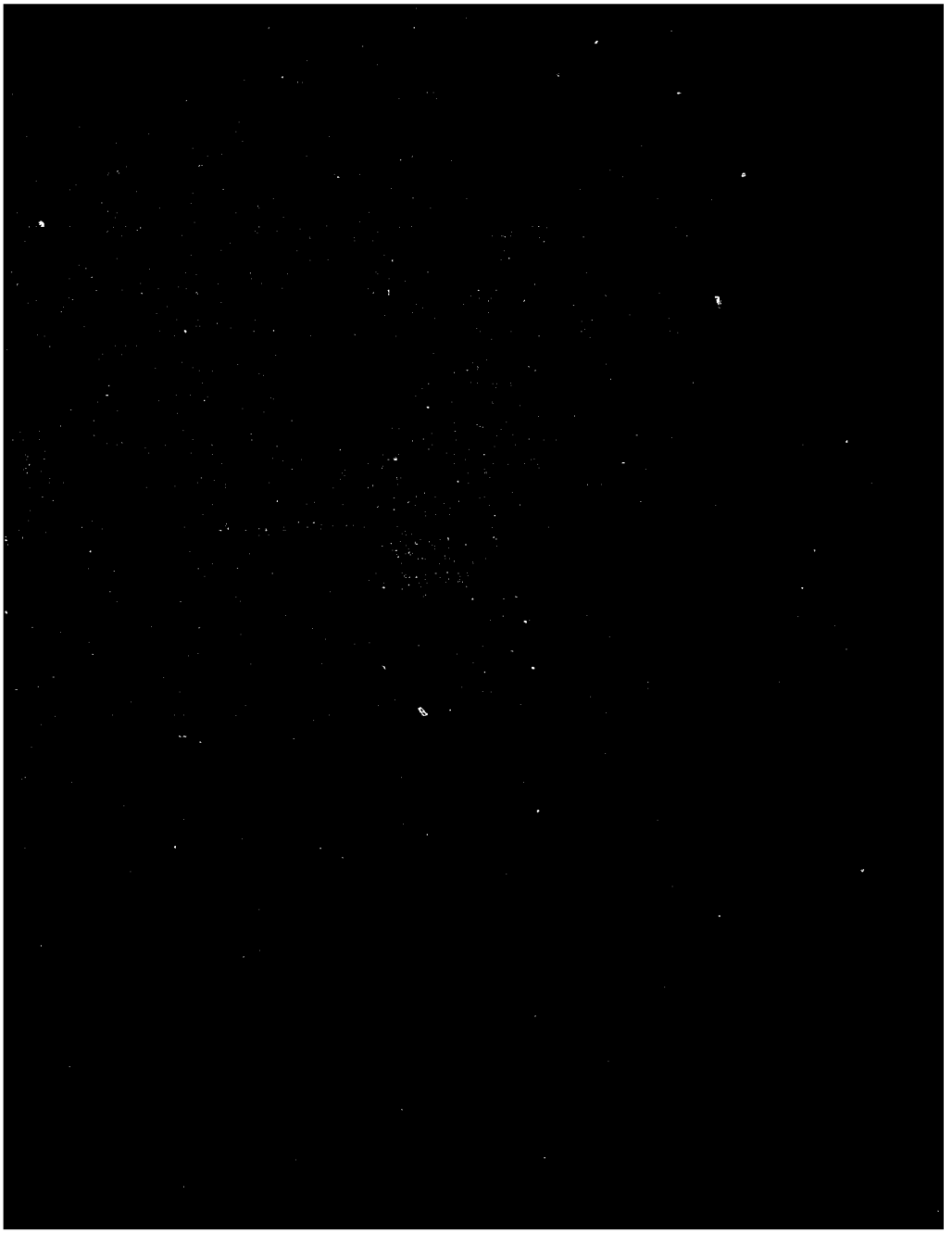
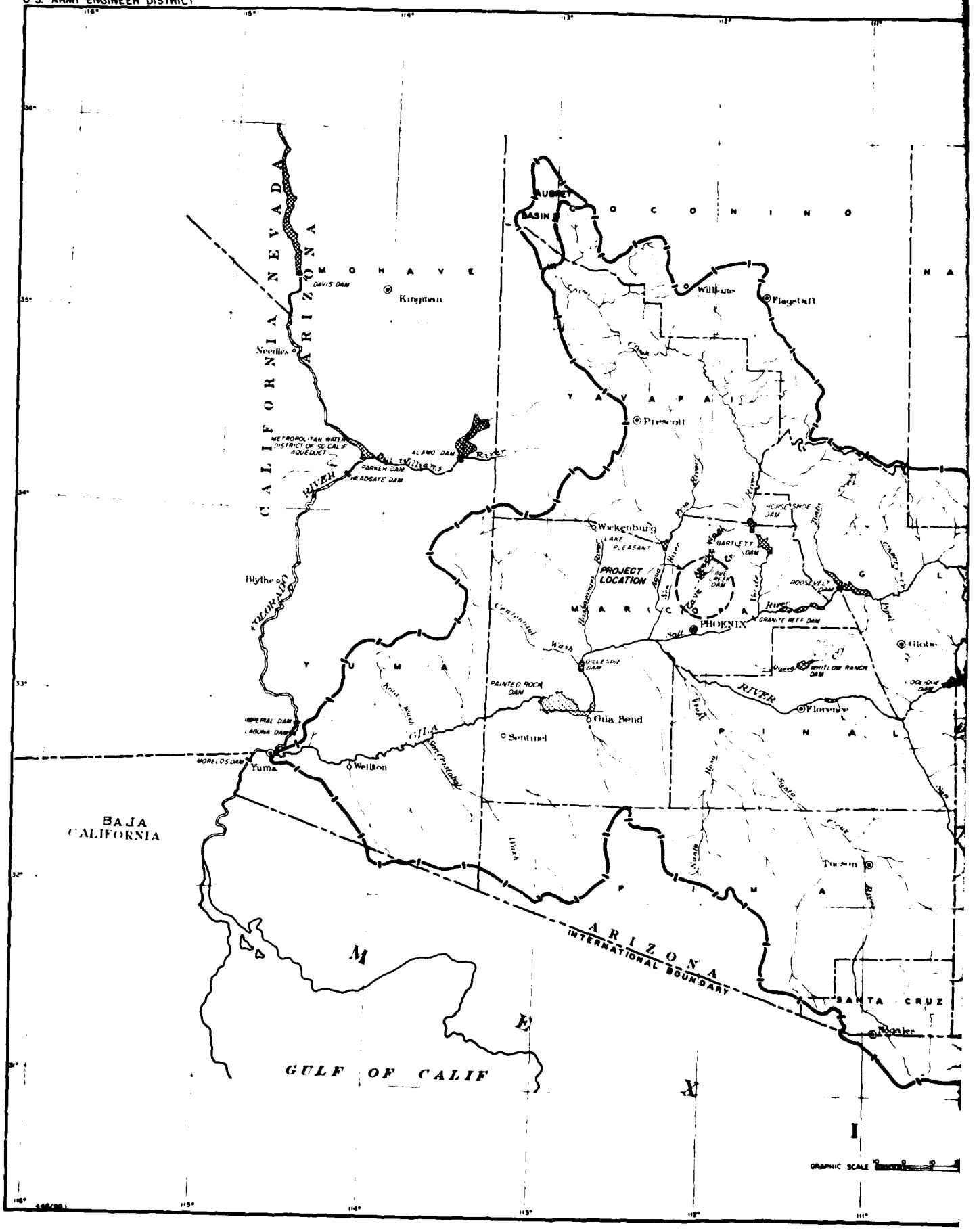


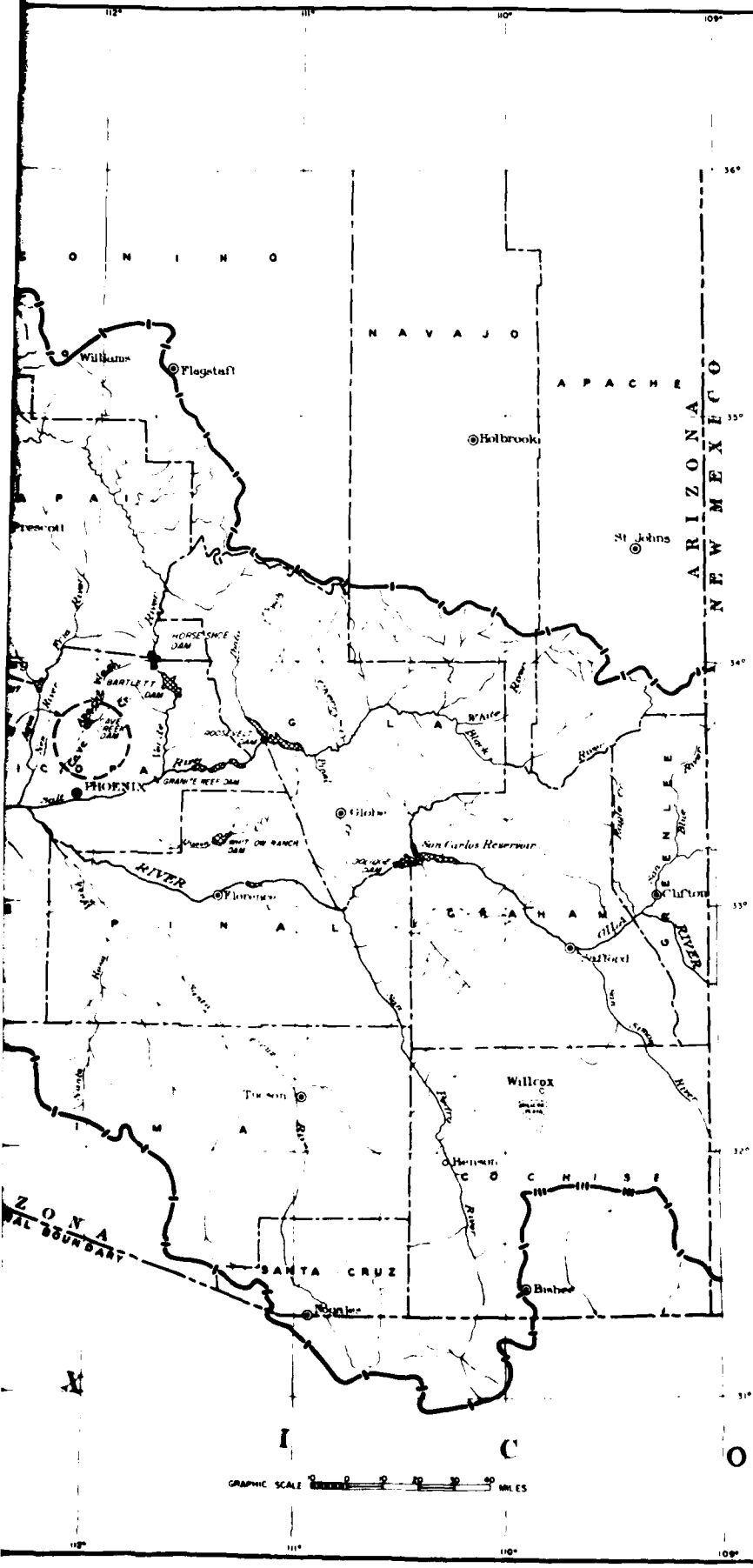
Photo 94 Spillway crest. Steel set for upright extension of sill.

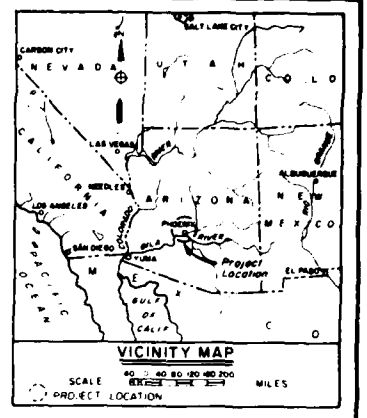
10 Apr 79



U.S. ARMY ENGINEER DISTRICT







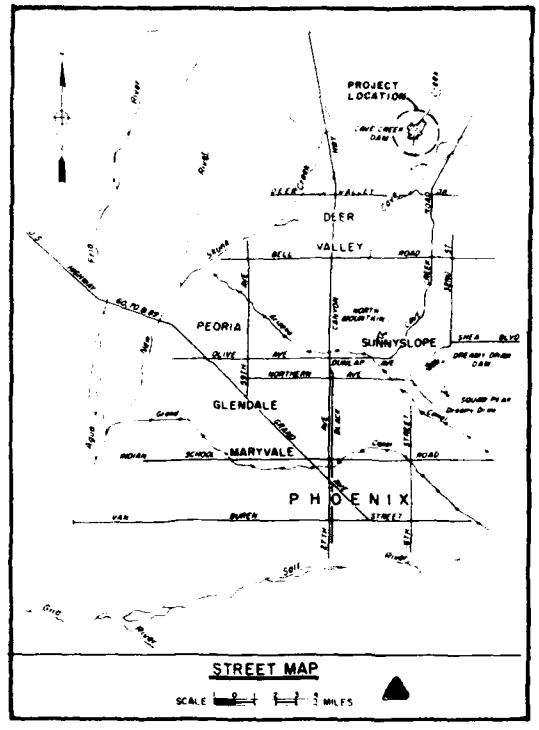
N

LEGEND

BOUNDARY OF GILA RIVER DRAINAGE AREA

BOUNDARY OF NEFFECTIVE AREA

EXISTING DAM AND RESERVOIR



SYMBOL	DESCRIPTIONS	DATE	APPROVAL
▲	Added street map	5 Aug 77	

REVISIONS

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY: R.R.K.
DRAWN BY:
CHECKED BY: R.R.K.

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM

PROJECT LOCATION

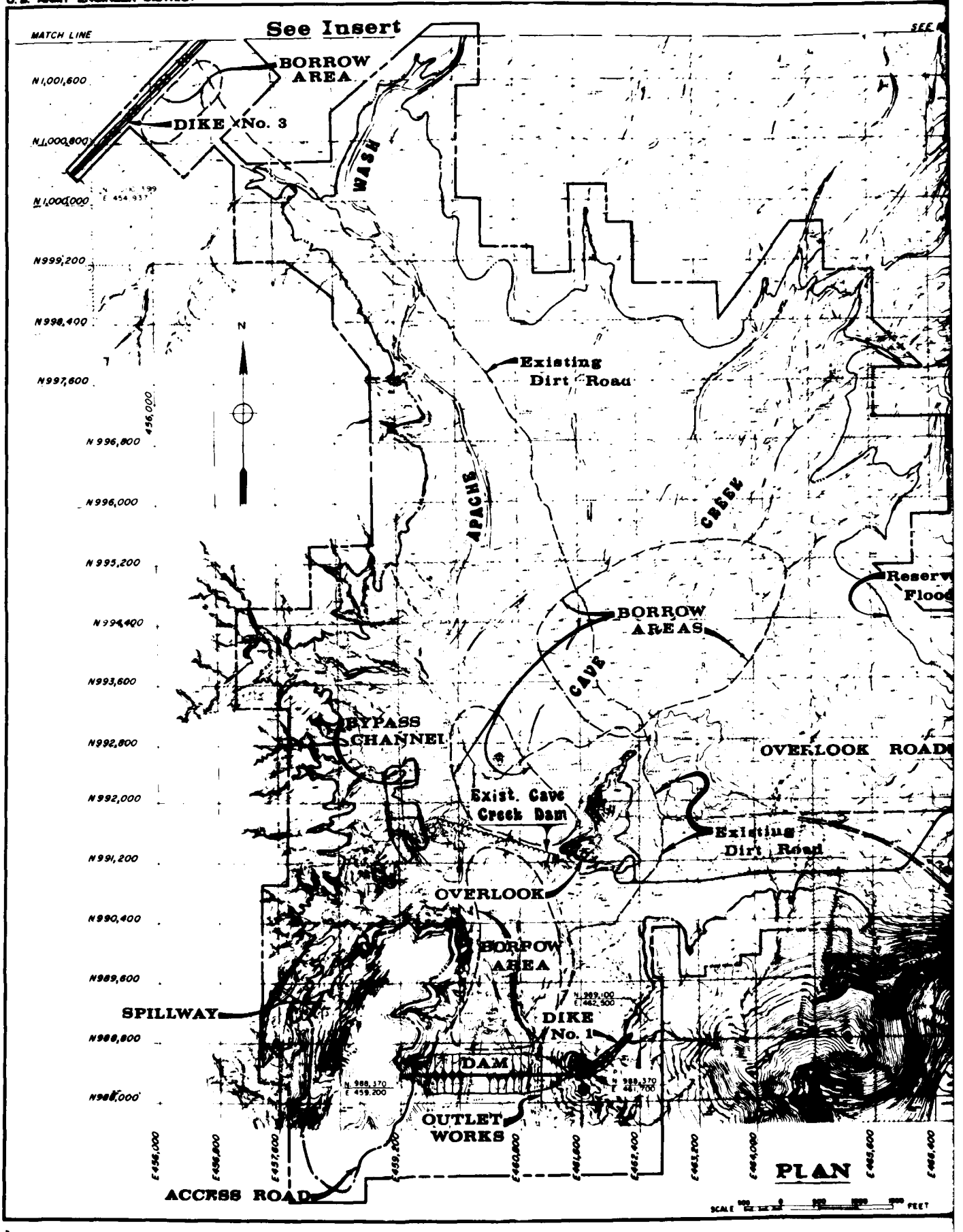
SUBMITTED BY:
APPROVAL RECOMMENDED:
APPROVED:
SPEC. NO. DACW09-77-B-0021
DISTRICT FILE NO. 244/2 REV "A"

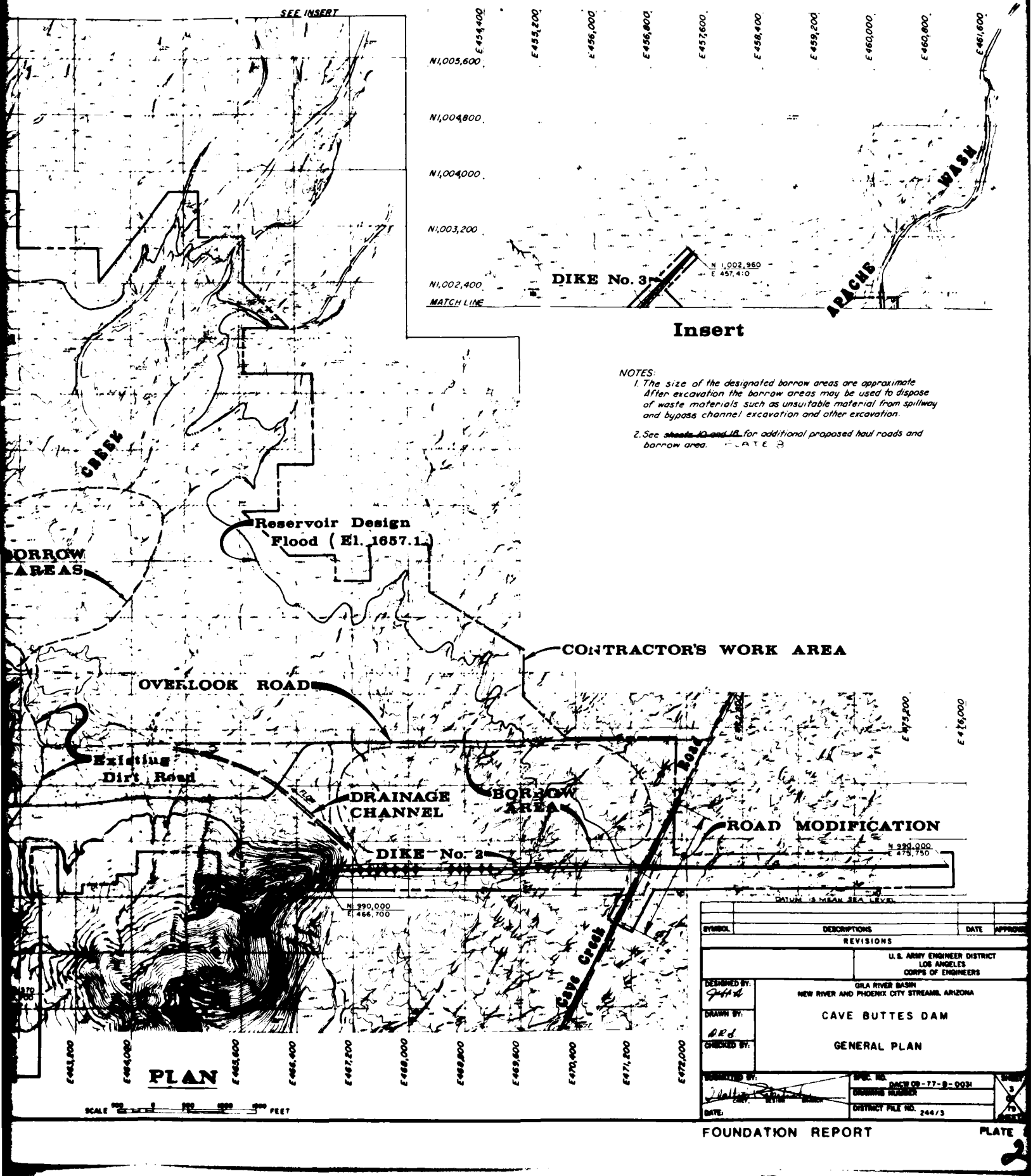
SHEET 2 OF 9 SHEETS

FOUNDATION REPORT

PLATE

U.S. ARMY ENGINEER DISTRICT





DATUM IS MEAN SEA LEVEL

SYMBOL	DESCRIPTIONS	DATE	APPROVED
	REVISIONS		

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY: Jeff M
DRAWN BY: ARd
CHECKED BY:

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM

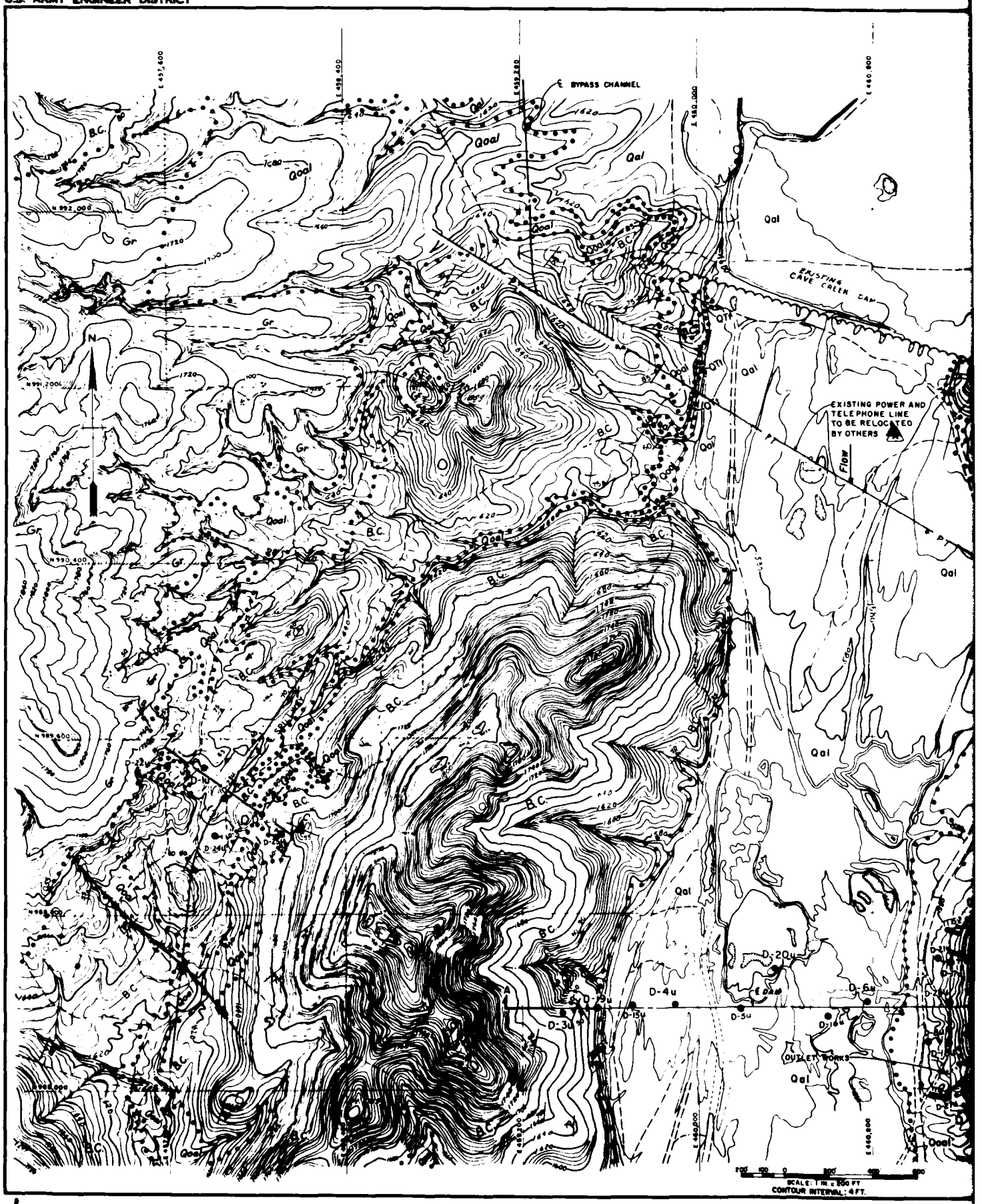
GENERAL PLAN

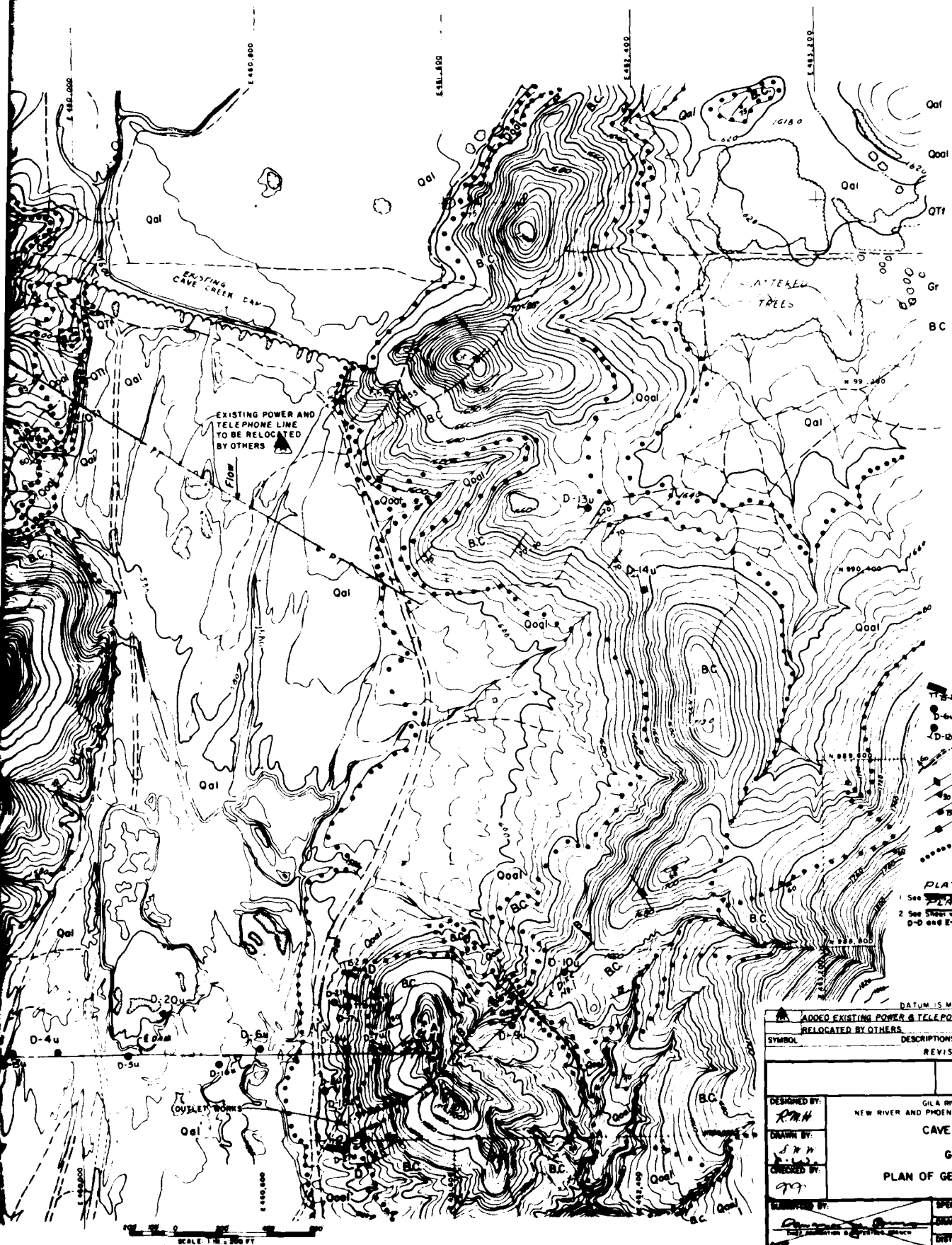
SUBMITTED BY: CHIEF, ENGINEERING DIVISION
DATE:

SPEC. NO. DACW09-77-B-0031
DRAWING NUMBER
DISTRICT FILE NO. 244/3

SHEET 9 OF 18 SHEETS

U.S. ARMY ENGINEER DISTRICT





LEGEND

Qal QUATERNARY RECENT ALLUVIUM. Streamped and flood-plain deposits, clay, silt, sand, gravel, cobbles, and boulders, unconsolidated

Qoal QUATERNARY OLDER ALLUVIUM Slope wash, residual soil, and talus debris, silt, sand, gravel and cobbles, occasional lenses of cemented materials

QTf QUATERNARY OR TERTIARY TUFFACEOUS AGGLOMERATE Buff to light brown, subangular to angular rock fragments well cemented in a tuffaceous matrix, rock fragments are generally green metamorphosed basement complex rocks which go to cobble size

Gr PRECAMBRIAN GRANITE Light brown to pink, moderately hard to hard, medium to coarse grained, closely fractured at surface

BC PRECAMBRIAN BASEMENT COMPLEX Green metamorphosed rock, greenstone is moderately hard to hard, light dark green, fine to medium grained, fracturing occurs mostly along older, recemented fractures, schistose intervals are light to brownish green, moderately hard to soft, platy and chloritic, slightly weathered near surface, occasional altered zones of talc and clay, foliation dips 45 to 90°, but mostly 60 to 90°

LEGEND

- Test trench
- Diamond drill hole, vertical
- Diamond drill hole, inclined
- Fault (showing dip) dashed where approximately located, dotted where existence uncertain Long arrows indicate direction of relative movement
- Strike of vertical foliation
- Strike and dip of inclined foliation
- Strike and dip of inclined joint
- Strike of vertical joint
- Contact between alluvium and bedrock, or between various types of bedrock

GENERAL NOTES

PLATES 6 AND 7

1. See PLATE 5 for logs of diamond drill holes
2. See Sheet 6 for geologic sections A-A through D-D and E-E along ℄ of Dike No. 2.

DATUM IS MEAN SEA LEVEL

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		
1	ADDED EXISTING POWER & TELEPONE LINE TO BE RELOCATED BY OTHERS	17 AUG 77	

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY: R.W.H.
DRAWN BY: S.W.M.
CHECKED BY:

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM

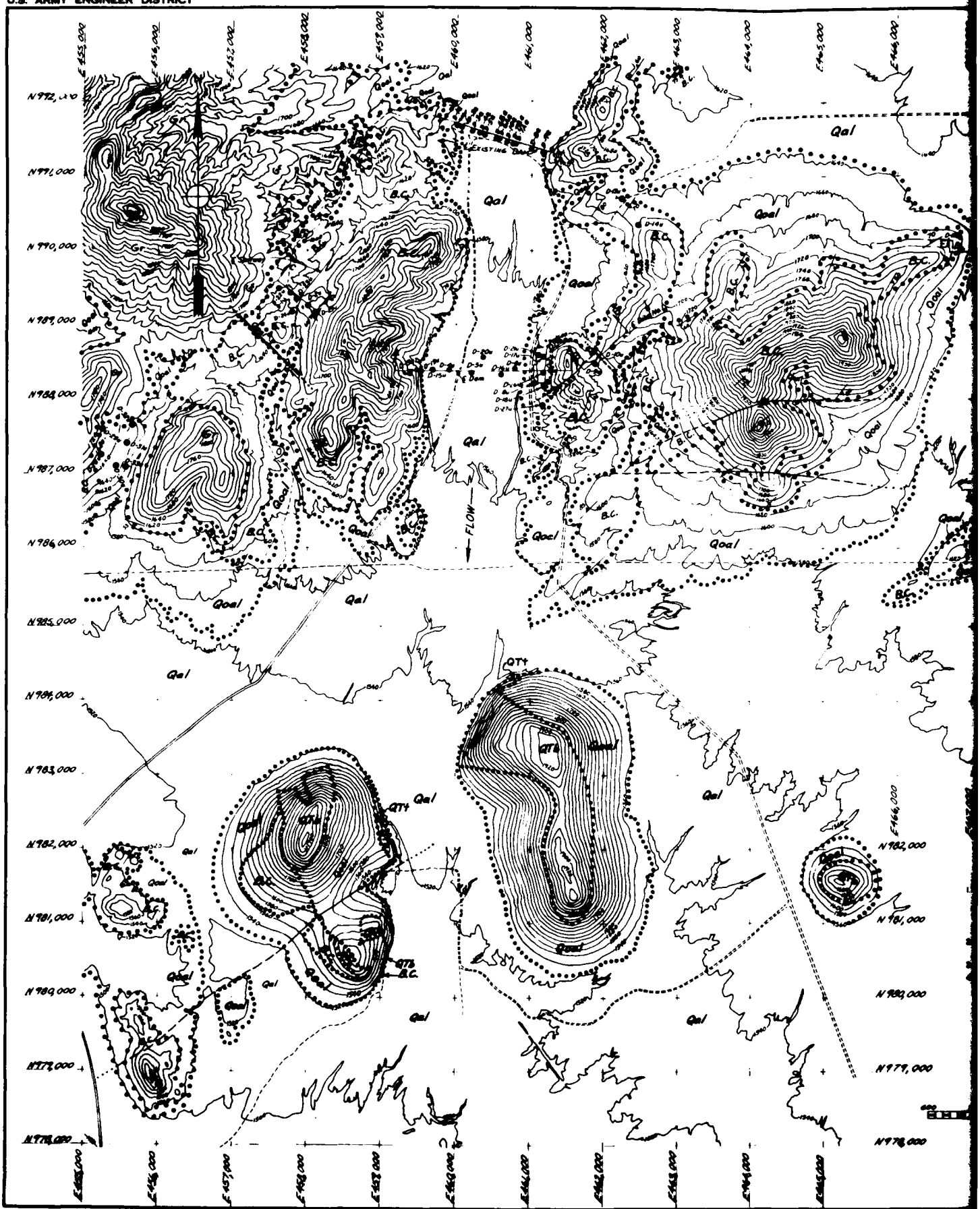
GENERAL

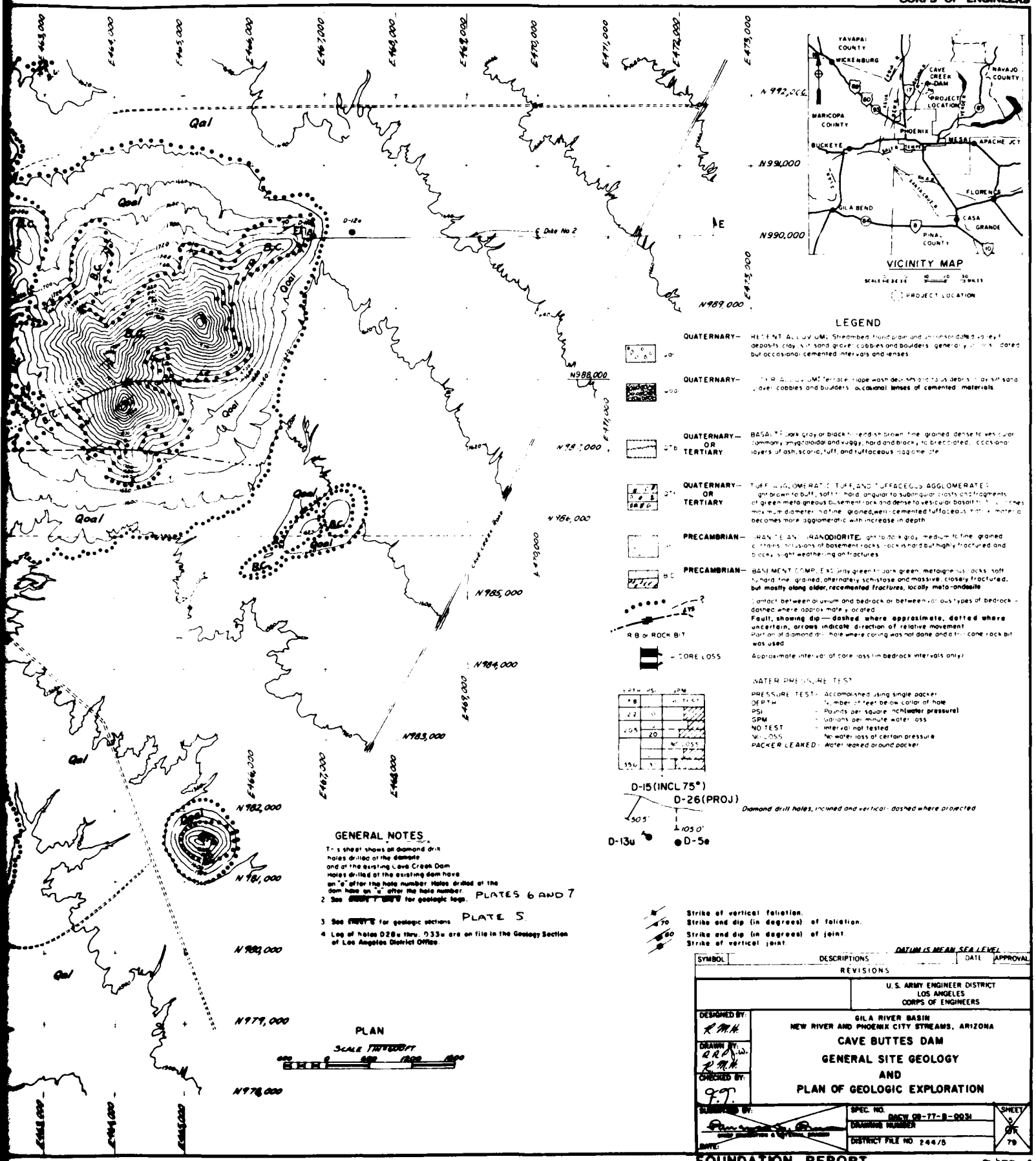
PLAN OF GEOLOGIC EXPLORATION

SUBMITTED BY: Chief, Foundation & Materials Branch
DATE:

SPEC. NO. DACW09-77-B-0031
DRAWING NUMBER
DISTRICT FILE NO. 244/4 REV. "A"
SHEET 7 OF 79

FOUNDATION REPORT 2 PLATE 3


E 455,000
E 456,000
E 457,000
E 458,000
E 459,000
E 460,000
E 461,000
E 462,000
E 463,000
E 464,000
E 465,000
E 466,000
N 992,000
N 991,000
N 990,000
N 989,000
N 988,000
N 987,000
N 986,000
N 985,000
N 984,000
N 983,000
N 982,000
N 981,000
N 980,000
N 979,000
N 978,000
Qal
Qoal
B.C.
QTf
QTb
FLOW
EXISTING



PLAN

SCALE 1"=1000FT

VICINITY MAP

LEGEND

QUATERNARY— RECENT ALLUVIUM: Streambed fluvial plain and unconsolidated valley deposits clay, silt sand gravel cobbles and boulders generally unconsolidated but occasional cemented intervals and lenses

QUATERNARY— OLD ALLUVIUM: Terrace slope wash debris and talus deposits clay silt sand gravel cobbles and boulders occasional lenses of cemented materials

QUATERNARY— OR TERTIARY — BASALT: Dark gray or black to reddish brown fine grained dense to vesicular commonly amygdaloidal and vuggy, hard and blocky, to brecciated, occasional layers of ash, scoria, tuff, and tuffaceous agglomerate

QUATERNARY— OR TERTIARY — TUFF, AGGLOMERATIC TUFF, AND TUFFACEOUS AGGLOMERATE: Light brown to buff, soft to hard, angular to subangular clasts and fragments of green metamorphic basement rock and dense to vesicular basalt to 12 inches maximum diameter, matrix fine grained, well-cemented tuffaceous material becomes more agglomeratic with increase in depth

PRECAMBRIAN— GRANITE AND GRANODIORITE: Light to dark gray, medium to fine grained contains inclusions of basement rocks rock is hard but highly fractured and blocky, slight weathering on fractures

PRECAMBRIAN— BASEMENT COMPLEX: Gray green to dark green, metaigneous rocks soft to hard fine grained, alternately schistose and massive, closely fractured, but mostly along older, recemented fractures, locally meta-andesite

Contact between alluvium and bedrock or between various types of bedrock — dashed where approximately located

Fault, showing dip — dashed where approximate, dotted where uncertain, arrows indicate direction of relative movement

Part of diamond drill hole where coring was not done and tricone rock bit was used

RB or ROCK BIT

= CORE LOSS — Approximate interval of core loss (in bedrock intervals only)

WATER PRESSURE TEST

PRESSURE TEST - Accomplished using single packer
DEPTH - Number of feet below collar of hole
PSI - Pounds per square inch (water pressure)
GPM - Gallons per minute water loss
NO TEST - Interval not tested
NO LOSS - No water loss at certain pressure
PACKER LEAKED - Water leaked around packer

Diamond drill holes, inclined and vertical - dashed where projected

Strike of vertical foliation.
70 Strike and dip (in degrees) of foliation.
60 Strike and dip (in degrees) of joint.
Strike of vertical joint.

GENERAL NOTES

1. This sheet shows all diamond drill holes drilled at the damsite and at the existing Cave Creek Dam. Holes drilled at the existing dam have an "a" after the hole number. Holes drilled at the dam have an "u" after the hole number.
2. See PLATES 6 AND 7 for geologic logs.
3. See PLATE 5 for geologic sections.
4. Log of holes D28u thru. D33u are on file in the Geology Section of Los Angeles District Office.

DATUM IS MEAN SEA LEVEL

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY: R.M.H.
DRAWN BY: G.R.P. R.M.H.
CHECKED BY: G.T.

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM
GENERAL SITE GEOLOGY AND PLAN OF GEOLOGIC EXPLORATION

SUBMITTED BY:
DATE:

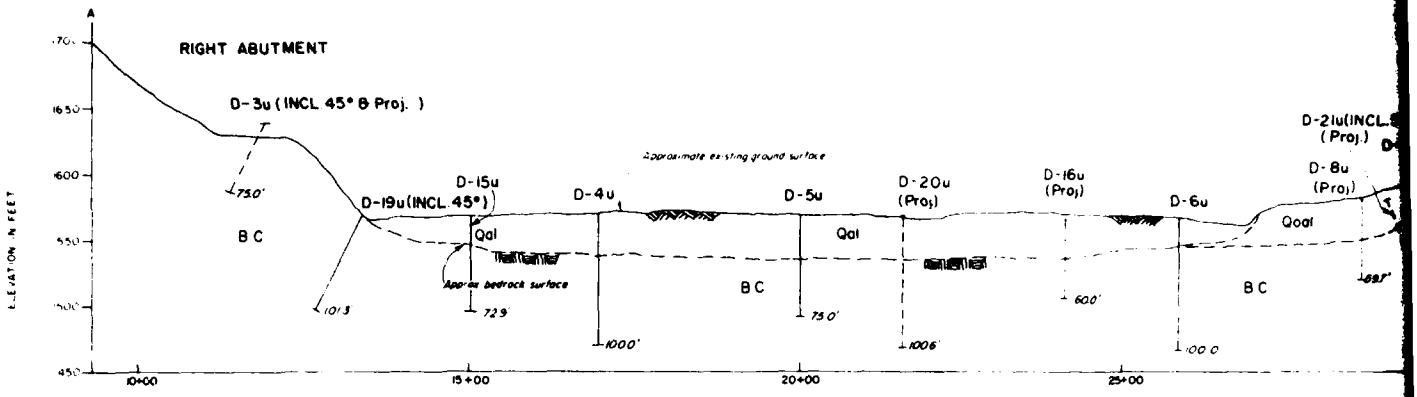
SPEC. NO. DACW 09-77-B-0034
DRAWING NUMBER
DISTRICT FILE NO. 244/5

SHEET 5 OF 79

FOUNDATION REPORT

PLATE 4

2



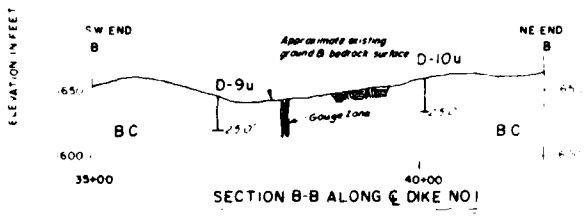
SECTION A-A ALONG ℄ DAM

VERTICAL SCALE 1IN=50FT

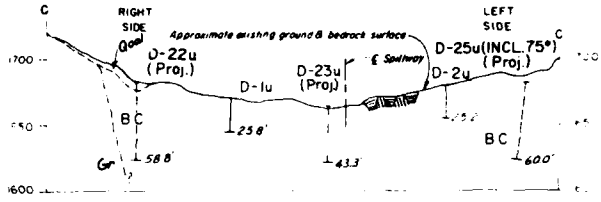
50 0 50 100 150

HORIZONTAL SCALE 1IN=100FT

100 0 100 200 300



SECTION B-B ALONG ℄ DIKE NO I



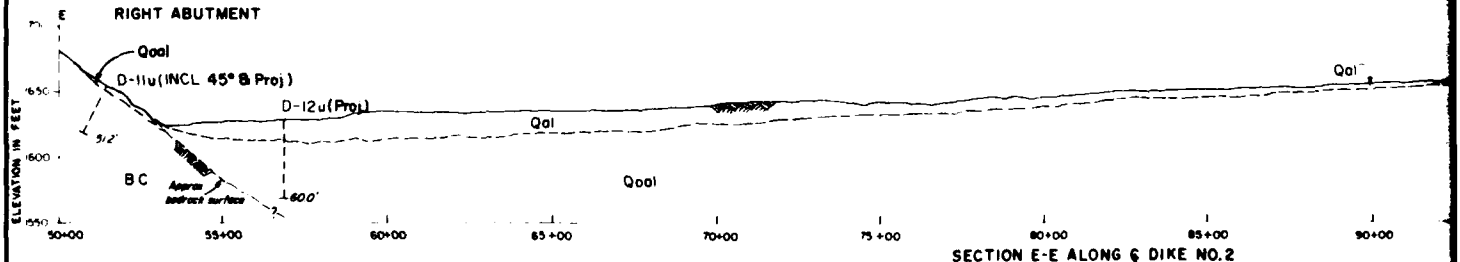
SECTION C-C ALONG CREST OF SPILLWAY

VERTICAL SCALE 1IN=50FT

50 0 50 100 150

HORIZONTAL SCALE 1IN=100FT

100 0 100 200 300



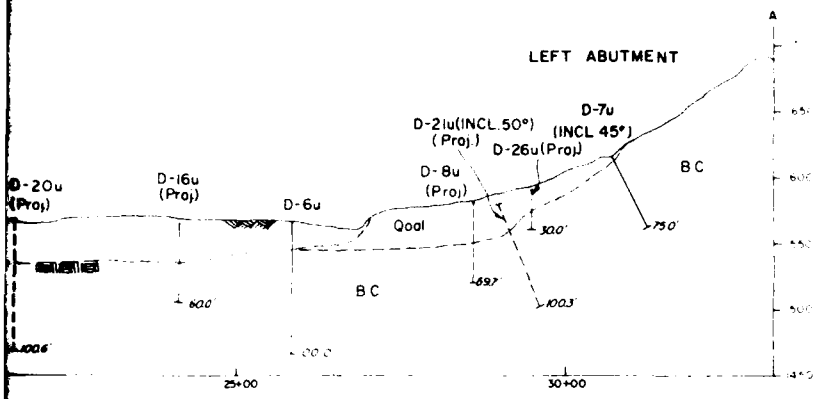
SECTION E-E ALONG ℄ DIKE NO. 2

VERTICAL SCALE 1IN=50FT

50 0 50 100 150

HORIZONTAL SCALE 1IN=200FT

200 0 200 400 600



ALONG ℄ DAM

SCALE 1IN=50FT

SCALE 1IN=100FT

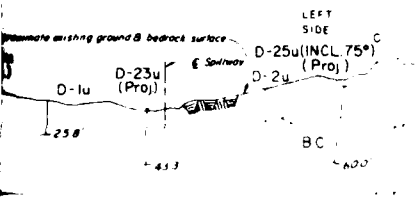
GENERAL NOTES

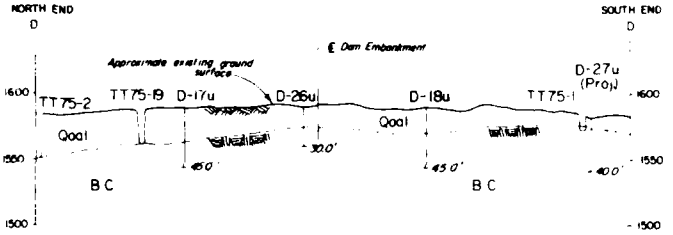
1. See Sheet 4 for legend and location of sections A & through E E
2. See Sheets 7 and 8 for geologic logs of diamond drill holes
3. Diamond drill holes drilled for NX size core
4. Sections drawn looking upstream
5. See Sheet 3 for location of section E E

→ PLATE 4

→ PLATES 6 AND 7

→ PLATE 8



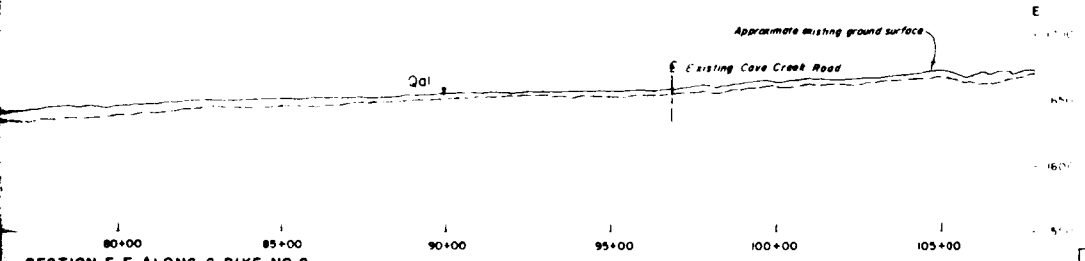


SECTION C-C ALONG CREST OF SPILLWAY

VERTICAL SCALE 1IN=50FT

HORIZONTAL SCALE 1IN=100FT

SECTION D-D ALONG OUTLET WORKS



SECTION E-E ALONG ℄ DIKE NO.2

VERTICAL SCALE 1IN=50FT

HORIZONTAL SCALE 1IN=200FT

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY: R.M.H.
DRAWN BY: J.W.
CHECKED BY: 991

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM
GEOLOGIC SECTIONS
DAM, DIKES NO 1 AND NO 2, SPILLWAY, AND OUTLET WORKS

SUBMITTED: Chief, Foundation & Materials Branch

APPROVED: Chief, Engineering Division

APPROVAL RECOMMENDED: Chief Engineering Division

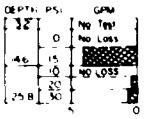
SPEC. NO. DACW09-[illegible]-6-0031

DISTRICT FILE NO. 244/6

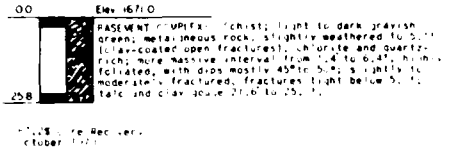
SHEET 5 OF 10 SHEETS

FOUNDATION REPORT 2

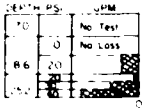
PLATE 5



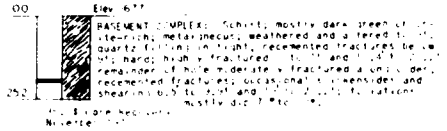
D-1U



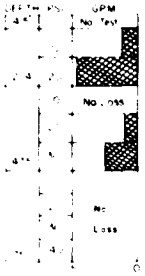
[illegible] Rec very
October 1970



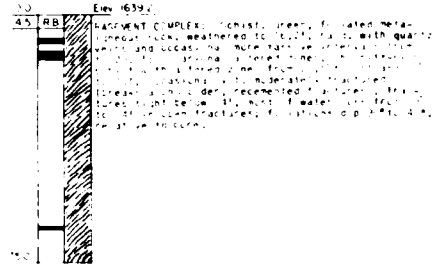
D-2U



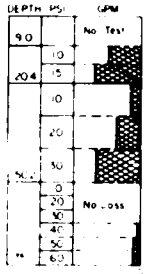
[illegible] core recovery
Nov[illegible] 1970



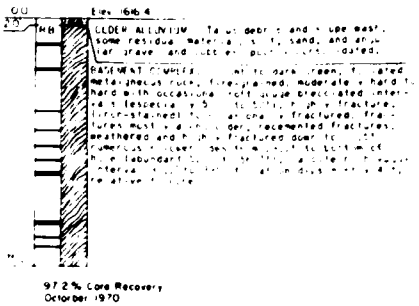
D-3U (INCL 45°)



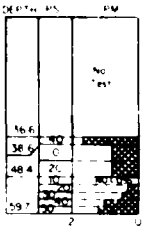
94.0% Core Recovery
[illegible] 1970



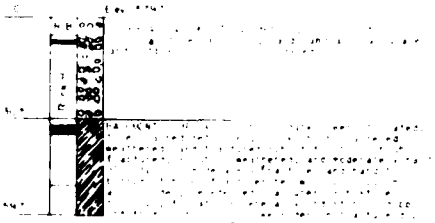
D-7U (INCL 45°)



97.2% Core Recovery
October 1970

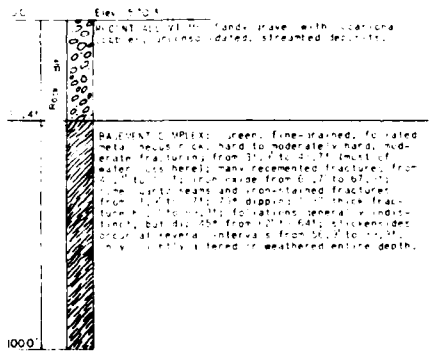


D-8U

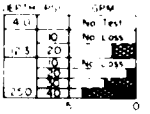


89.3% Core Recovery
October 1970

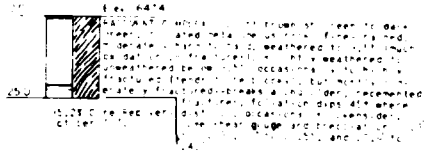
D-4U



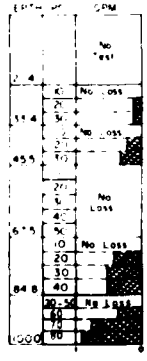
[illegible] core Rec very
[illegible] 1970



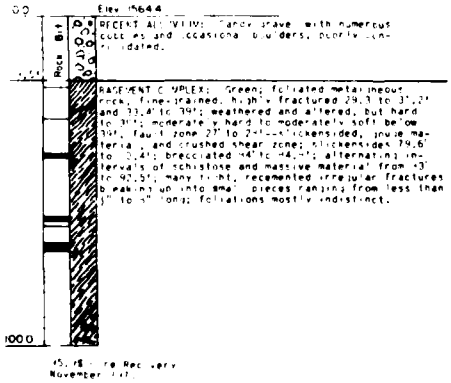
D-9U



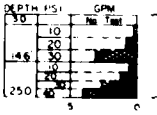
[illegible] 25 Rec very
[illegible] 1970



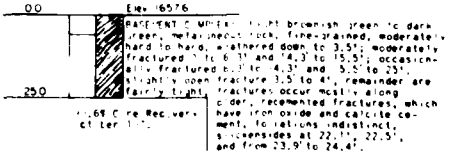
D-6U



[illegible] 5.1[illegible] re Rec very
November 1[illegible]



D-10U



[illegible] 6% Core Rec very
[illegible] 1970

SCALE [illegible] FT
10 0 10 20 30 40 50

D-7U (INCL 45°)

Elev 1616.4

OLDER ALLUVIUM: Talus debris and slope wash, some residual material, silt, sand, and angular gravel and cobbles, unconsolidated.

BASEMENT COMPLEX: Light to dark green, foliated metaigneous rock; fine-grained, moderately hard to hard with occasional soft gouge brecciated intervals (especially 5...' to 52'); highly fractured (iron-stained) to occasionally fractured; fractures mostly along older, recemented fractures, weathered and highly fractured down to ...; numerous slickensides from ... to bottom of hole (abundant 52.5' to 56.5'); calcite-rich vuggy interval 3...' to 34'; foliation dips mostly 47° relative to core.

97.2% Core Recovery
October 1970

D-8U

Elev 579...

OLDER ALLUVIUM: Talus debris ... and angular gravel and cobbles ...

BASEMENT COMPLEX: ... green, foliated, fine-grained metaigneous rock ... weathered, and fractured ... fractured ... weathered, and moderately hard ... fractures and ... older, recemented fractures ...

...3% Core Recovery
...ober 1970

D-9U

Elev 6474

BASEMENT COMPLEX: Light brown to green to dark green; foliated metaigneous rock, fine-grained, moderately hard to hard, weathered to soft (much oxidation on fractures), ... unweathered below ...; occasionally to highly fractured (trends ...) ... moderately fractured; breaks along older, recemented fractures; foliation dips 45° where distinct; occasional ... slickensides; some shear gouge ... and ...

...% Core Recovery
...tober ...

D-10U

Elev 1657.6

BASEMENT COMPLEX: Light brownish green to dark green; metaigneous rock, fine-grained, moderately hard to hard, weathered down to 3.5'; moderately fractured 3' to 6.3' and 14.3' to 15.5'; occasionally fractured 6.3' to 14.3' and 15.5' to 25'; slightly open fracture 3.5' to 4', remainder are fairly tight. Fractures occur mostly along older, recemented fractures, which have iron oxide and calcite cement; foliations indistinct; slickensides at 22..., 22.5', and from 23.9' to 24.4'.

...% Core Recovery
...ber 1...

D-11U (INCL 45°)

Elev 16...

DEPTH	PSI	GPM
9		No Test
19.3	10 / 15	
29.3	20 / 30	
41.7	20 / 30 / 40	
51...	30 / 20 / 10	

OLDER ALLUVIUM: Talus debris ... residual material.

BASEMENT COMPLEX: Green, foliated metaigneous rock; fine-grained, weathered ... moderately fractured, with ... occasionally to moderately fractured ... fractures occur along older, recemented fractures; foliation generally indistinct ... from 35° to 6... relative to core ... calcite crystal-lined fractures ... 37.5' to 41'; brecciated ...

96.8% Core Recovery
November 1970

D-12U

Elev ...

No pressure tests made - used drilling mud and rock bit

RECENT ALLUVIUM: Streambed deposits, ... granitic ... sand, gravel ... unconsolidated.

OLDER ALLUVIUM: Sandy gravel with ... cobbles ... moderately consolidated ... greenstone and basalt gravel and cobbles.

RB, RB, RB, RB, RB — 600

...% Core Recovery
November ...

D-13U (INCL 45°)

Elev ...

DEPTH	PSI	GPM
8.4		No Test
9.8		No Loss
15.3		

OLDER ALLUVIUM: Talus debris and slope wash ... residual material ... fragments.

BASEMENT COMPLEX: Green ... metaigneous rock, fine-grained ... recemented fractures ... 40° relative to core ... 18 ... 18.9 ...

...% Core Recovery
October 1970

D-14U

Elev 6...

DEPTH	PSI	GPM
8.6		No Test
20.0		No Loss
21.0	30 / 20	

BASEMENT COMPLEX: Green, foliated metaigneous rock, fine-grained, moderately hard to hard ... weathering ... moderately fractured ... fractured metaigneous ... 18' ... interval.

81.1% Core Recovery
October 1970

D-19U (INCL 45°)

Elev 568...

DEPTH	PSI	GPM
4.2		No Test
	10	No Loss
	20	
25.7	30	
32.0		No Test
	10	
	20	
58.0	10	
	30	
75.3	10	
	20	No Loss
	30	
101.3	40	

BASEMENT COMPLEX: Green, fine-grained, highly foliated metaigneous rock, moderately weathered to ... very little weathering below ...; occasionally to moderately fractured, with iron oxide and calcite lining fractures, moderately hard to soft (soft in shear zones from 52.0' to 53.5' and 58' to 61'); most of water loss 5... to 53.5'; open fracture 58' to 6...; foliations dip 3... to 5... relative to core.

...% Core Recovery
April 1970

D-20U

Elev ...

OLDER ALLUVIUM: Cemented debris ... unconsolidated.

BASEMENT COMPLEX: Green, fine-grained, foliated metaigneous rock, highly fractured ... fracture surfaces ... recemented fractures.

...% Core Recovery
March ...

D-21U (INCL 50°)

Elev 580.6

OLDER ALLUVIUM: ... sand and ... gravel ... greenstone ... some carbonate ... unconsolidated.

BASEMENT COMPLEX: Green, fine-grained, foliated metaigneous rock, moderately soft to hard, moderately to highly fractured, weathered and altered ... fractures are coated ... calcite; fractures ... altered zone ...

55.8% Core Recovery
April 1970

GENERAL NOTES

1. See ~~sheet~~ for legend. → PLATE 4
2. See ~~sheet~~ for plan of exploration.
3. Drill holes ... are ... from horizontal.
4. ... classifications on this sheet are visual.
5. Dip of foliations and joints, fractures, and faults measured from horizontal (except in inclined holes, where measured relative to core).
6. RB - Designates rock bit.

DATUM IS MEAN SEA LEVEL

Scale ... FT: 0, 10, 20, 30

SYMBOL	DESCRIPTION	DATE	APPROVAL

REVISIONS

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM

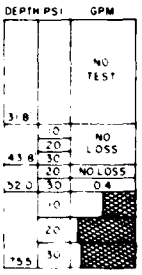
GEOLOGIC LOGS - SHEET 1

DESIGNED BY: RMH
DRAWN BY: ...
CHECKED BY: ...

SPEC. NO. DACW09-...
DISTRICT FILE NO. 244/7

SHEET 7 OF ...

D-5U



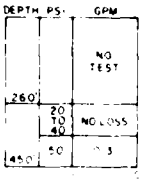
Elev 1567.1

0.0 — ROCK BIT — 31.5 — 75.0

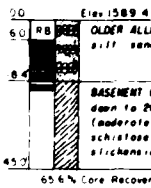
RECENT ALLUVIUM Streambed deposits, silt, sand, gravel, cobbles, and occasional boulders, unconsolidated

BASEMENT COMPLEX Green, fine-grained metaigneous rock, chlorite-rich, occasionally to highly fractured along older, recemented fractures, unweathered, fault gouge 32.5' to 32.7' and 43.5' to 43.8', occasional slickensides from 43' to 70.5', brecciated from 36.2' to 41.5' and 62.1' to 63.2', occasional quartz-rich intervals, moderately hard to hard, large water loss from 31.5' to 31.8' to 31.8' (around casing), most of water loss 52' to 66'

70.6% Core Recovery
September 1974



D-18U



Elev 1589.4

0.0 — RB — 6.0 — 8.4 — 45.3

OLDER ALLUVIUM Slope wash, with residual [illegible] silt, sand, and gravel, cemented material [illegible]

BASEMENT COMPLEX Green metaigneous rock; down to 20.2', then becomes highly fractured (moderately hard to hard) to 26.7', platey schistose interval 39.4' to 40.5' (foliation slickensides from 26' to 43', moderately to fractured 26.7' to 45', broken to 28.7' and 35.8' to 36.2'

65.6% Core Recovery
October 1974

D-15U

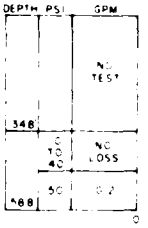
Elev 1569.2

0.0 — ROCK BIT — 26 — 72.9

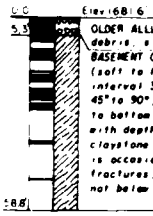
RECENT ALLUVIUM Streambed deposits, silt, sand, gravel, cobbles, and occasional boulders, silt-rich 0 to 3', slightly consolidated 8.5' to 26.1'

BASEMENT COMPLEX Green, fine grained metaigneous rock and pink medium-grained granitic rock, extensive breccia intervals, rock is moderately hard to hard with numerous, scattered soft gouge zones weathered 26.1 to 31', green rock (greenstone) to 39', greenstone breccia and granitic rock in alternating intervals from 39' to bottom of hole, numerous gouge intervals associated with the granite breccia contacts, these gouge intervals small faults generally dip 40° to 50° and go to 1" thick, occasionally fractured 31' to 67' and 68' to 72.9', moderately fractured 27' to 28', highly fractured 26.1 to 31' and 67' to 68', the reddish brown iron-oxide cemented breccia has many healed fractures, barely distinct 40° dip in breccia

98.2% Core Recovery
October 1974



D-22U



Elev 1681.6

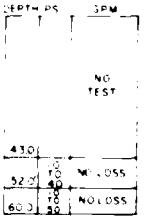
0.0 — 5.3 — 58.8

OLDER ALLUVIUM Slope wash, with residual debris, silt, sand, and gravel

BASEMENT COMPLEX Green metaigneous rock, (soft to hard) from 5.3' to 33' and 42.4' to interval 33' to 42.4', weathered down to 6.8 45° to 90°, but mostly 45° down to 15', and to bottom of hole, schist is soft to 29.5', with depth, occasional intervals of talc claystone 20' to 27.8', the massive metaigneous is occasionally to highly fractured along fractures, numerous slickensides occur also not below 46.5'

66.8% Core Recovery
October 1974

D-16U



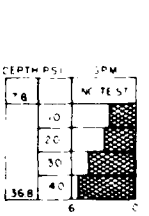
Elev 1563.6

0.0 — ROCK BIT — 29.8 — 60.0

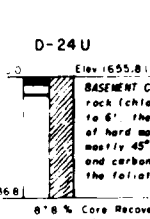
RECENT ALLUVIUM Streambed deposits, sand, gravel, cobbles and occasional boulders, uncemented, especially in top 2', continuous cobbles 15' to 24.2', caliche cemented metaigneous rock fragments 25.7' to 27.4' (fragments are angular and up to 3" maximum diameter)

BASEMENT COMPLEX Green, fine grained metaigneous rock, highly fractured along older, recemented fractures, moderately hard to hard, slightly weathered 29.8' to 38', schistose interval (25° dip on foliations) from 40' to 41.3', occasional slickensides from 30' to 57.5', thin gouge interval at 48.1', gouge and clay like material 49' to 52'

76.7% Core Recovery
September 1974



D-23U



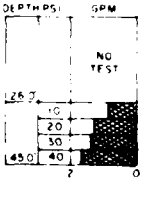
Elev 1664.5

0.0 — 43.5

BASEMENT COMPLEX Green foliated metaigneous schist), foliation dips 40° to 90°, but mostly 90° dip occurs 30' to 43.3', slickensides co rock soft to moderately hard, becomes harder weathered down to 6.7', breccia from 11' to fragments in light reddish brown carbonate filling between foliations, talc schist inte 25.8', red claystone 30.6' to 31.3', talc/cl 31.3' to 36.5', hard, massive green metaigneous 37.5' to 38.2'

84.5% Core Recovery
October 1974

D-17U



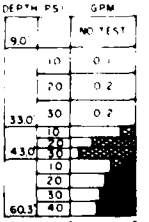
Elev 1589.2

0.0 — ROCK BIT — 7.4 — RB — 25.7 — 45.0

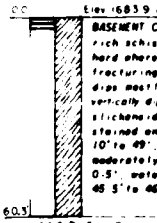
OLDER ALLUVIUM Slope wash, with residual soil and talus debris, slightly consolidated, angular to subrounded metaigneous rock fragments to 3" maximum diameter, well-cemented material from 7.4' to 10.7', less indurated from 10.7' to 25.7', with fragments of basalt, greenstone, and quartzite

BASEMENT COMPLEX Green metaigneous rock, quartz rich, moderately fractured 25.7' to 29.3', 30.5' to 34.5', and 40' to 41.5', highly fractured 29.3' to 30.5' and 41.5' to 45', occasionally fractured 34.5' to 40', relatively unweathered, secondary filling mostly calcite, rock is blocky and moderately hard to hard down to 43', softer (chlorite-rich, below 43', becomes mottled below 40' with more iron oxide and calcite coating the 60° dipping fractures

68.4% Core Recovery
October 1974



D-24U



Elev 1655.8 (INCL 69.5*)

0.0 — 36.8

BASEMENT COMPLEX Pale to dark green, foliated rock (chlorite-rich schist) soft to hard, to 6' then slightly weathered to 7', occasio of hard massive rock (greenstone) or quartzi mostly 45° to 55° relative to hole, alternat and carbonate-rich layers, slickensides occur the foliations, talc schist interval 32.2' to

8.8% Core Recovery
October 1974

D-25U

Elev 1683.9 (INCL 75*)

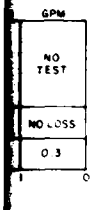
0.0 — 60.5

BASEMENT COMPLEX Green foliated metaigneous rich schist), fine grained, moderately soft hard where schist grades into massive interval fracturing occurs along older recemented fra dips mostly 70° to 80° relative to hole, foliation vertically dipping, rock occasionally to moderately slickensides common along foliations most fo stained and occur along foliations occasion 10' to 49', highly fractured from 0 to 5' and moderately fractured from 9.4' to 10.2', slig 0.5', water loss mostly in slightly open frac 45.5' to 46.5', and 50' to 51'

96.3% Core Recovery
October 1974

SCALE 1 IN = 30 FT
10 0 10 20 30 40 50

D-18U



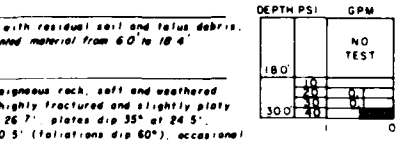
0.0 Elev 1589.4

6.0 RB — OLDER ALLUVIUM Slope wash with residual soil and talus debris, silt sand and gravel, cemented material from 6.0' to 18.4'

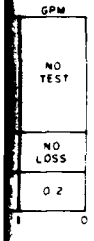
18.4 — BASEMENT COMPLEX Green metaigneous rock, soft and weathered down to 20.2', then becomes highly fractured and slightly platy (moderately hard to hard) to 26.7', plates dip 35° at 24.5', schistose interval 39.4 to 40.5' (foliations dip 60°), occasional slickensides from 26' to 43', moderately to occasionally fractured 26.7' to 45', brecciated interval 28.3' to 28.7' and 35.8' to 36.2'

43.4 M

65.6 % Core Recovery
October 1974



D-22U



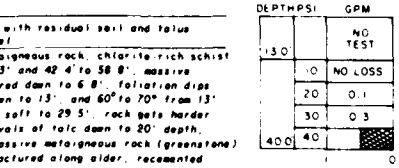
0.0 Elev 681.6

5.3 — OLDER ALLUVIUM Slope wash, with residual soil and talus debris silt sand, and gravel

BASEMENT COMPLEX Green metaigneous rock, chlorite-rich schist (soft to hard) from 5.3' to 33' and 42.4' to 58.8', massive interval 33' to 42.4', weathered down to 6.8', foliation dips 45° to 90° but mostly 45° down to 13', and 60° to 70° from 13' to bottom of hole, schist is soft to 29.5', rock gets harder with depth, occasional intervals of talc down to 20' depth, claystone 20' to 27.8', the massive metaigneous rock (greenstone) is occasionally to highly fractured along older, recemented fractures numerous slickensides occur along foliations, but not below 46.5'

58.8

66.8 % Core Recovery
October 1974



D-23U

0.0 Elev 664.5

BASEMENT COMPLEX Green foliated metaigneous rock (chlorite rich schist) foliation dips 40° to 90° but mostly 45° to 60°, the 70° to 90° dip occurs 30' to 43.3', slickensides common along foliations rock soft to moderately hard becomes harder with depth, highly weathered down to 6.7', breccia from 11' to 13' — greenstone fragments in light reddish brown carbonate matrix, much iron oxide filling between foliations, talc schist interval from 23.4' to 25.8', red claystone 30.6' to 31.3', talc limonite rich schist 31.3' to 36.5', hard massive green metaigneous rock (greenstone) 37.5' to 38.2'

43.3

84.5 % Core Recovery
October 1974

D-24U

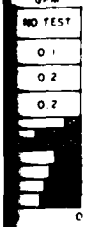
0.0 Elev 655.8 (NGL 69.5')

BASEMENT COMPLEX Pale to dark green, foliated metaigneous rock (chlorite rich schist) soft to hard, highly weathered to 6', then slightly weathered to 7', occasional intervals of hard massive rock (greenstone) or quartzite foliation dips mostly 45° to 55° relative to hole alternating chlorite-rich and carbonate rich layers, slickensides occur occasionally along the foliations, talc schist interval 32.2' to 32.8'

36.8

87.8 % Core Recovery
October 1974

D-25U



0.0 Elev 1683.9 (NGL 75')

BASEMENT COMPLEX Green, foliated metaigneous rock (chlorite-rich schist), fine grained, moderately soft to moderately hard, hard where schist grades into massive interval (greenstone), fracturing occurs along older recemented fractures, foliation dips mostly 70° to 80° relative to hole, foliation of ground surface is vertically dipping, rock occasionally to moderately fractured, slickensides common along foliations, most fractures are iron-stained and occur along foliations, occasional slickensides from 10' to 49', highly fractured from 0 to 5' and 12.7' to 13.2', moderately fractured from 9.4' to 10.2', slightly weathered 0.5', water loss mostly in slightly open fractures from 34' to 36', 45.5' to 46.5', and 50' to 51'

60.3

96.3 % Core Recovery
October 1974

SCALE 1"=50' FT
10 0 10 20 30 40 50

D-26U

0.0 Elev 1590.2

15.5 — OLDER ALLUVIUM Slope wash residual soil and talus debris, cemented material from 5 to 8' depth, cobbles encountered 11' to 15.5'

30.0 — BASEMENT COMPLEX Green, non-foliated metaigneous rock, occasionally to highly fractured along older recemented fractures, very soft to hard, numerous slickensides from 21.5' to 27', occasionally to moderately fractured from 15.5' to 20' and 26.8' to 30', gouge interval 23.7' to 24', coarser grained 27' to 30', fractures coated with iron oxide, highly weathered 15.5' to 17.8'

84.1 % Core Recovery
October 1974

D-27U

0.0 Elev 1580.9

7.0 — OLDER ALLUVIUM Slope wash residual soil and talus debris Cemented material from 5.5-7.0'

BASEMENT COMPLEX Green metaigneous rock, moderately soft to hard, occasionally to highly fractured along older recemented fractures, slightly weathered 7' to 8.5', epidote-rich and platy (moderately soft 12.8' to 14.8', banded hard metaigneous rock (greenstone) 14.8' to 34', foliated from 14' to 40', foliations dip mostly 45°, occasional slickensides from 11' to 34', usually along foliations, occasional gouge intervals, highly fractured 20.1' to 22.5', 25.7' to 27.6', and 35.2' to 36', occasionally fractured from 22.5' to 25.7' and 36' to 40', moderately fractured 7' to 20.1' and 27.6' to 35.2', platy schistose intervals from 28.4' to 29.6' and 30.4' to 35.2'

40.0

82.5 % Core Recovery
October 1974

T.T. 75-1

0.0 Elev. 577.6

19.5 — OLDER ALLUVIUM Slope wash and residual material, silt, sand and gravel, some caliche between 1.5-4.5', thin lenses of cemented materials from 4.5-7.5' and below 7.5' coarse unconsolidated materials including some cobbles and occasional boulders 2.5' maximum diameter

BASEMENT COMPLEX Green, platy schist, cryptocrystalline, moderately hard to hard foliations dip 60°-85°

July 1975

T.T. 75-2

0.0 Elev. 581.4

27.5 — OLDER ALLUVIUM Slope wash and residual material, silt, sand and gravel, unconsolidated some lenses of well cemented material from 3.0' to 9.0', loosely consolidated coarse material below 9.0' some cobbles and occasional boulders 2' maximum diameter

BASEMENT COMPLEX Green, platy schist cryptocrystalline, moderately hard to hard foliations dip 50° to 70°

July 1975

T.T. 75-19

0.0 Elev. 587.6

27.0 — OLDER ALLUVIUM Slope wash and residual material silt, sand and gravel unconsolidated well cemented material from 5.0-13.0', loosely consolidated coarse material below 13.0' including cobbles and occasional boulders 2' maximum diameter

BASEMENT COMPLEX Green, platy schist, cryptocrystalline, moderately hard to hard foliations dip 60°-85°

August 1975

GENERAL NOTES

1 SEE SHEET 5 FOR LEGEND PLATE 4
2 SEE SHEET 3A FOR PLAN OF EXPLORATION SHOWING LOCATION OF DIAMOND DRILL HOLES AND GEOLOGY PLATE 3
3 DRILL HOLE INCLINATIONS ARE MEASURED FROM HORIZONTAL
4 SOIL CLASSIFICATIONS ON THIS SHEET ARE VISUAL
5 DIP OF FOLIATIONS AND JOINTS, FRACTURES, AND FAULTS MEASURED FROM HORIZONTAL (EXCEPT IN INCLINED HOLES WHERE IT IS MEASURED RELATIVE TO CORE).
6 TERM "GREENSTONE" REPRESENTS THE GREEN, MASSIVE METAIGNEOUS ROCK

DATUM IS MEAN SEA LEVEL

SYMBOL	DESCRIPTION	DATE	APPROVAL
	REVISIONS		

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY R.M.H.
DRAWN BY D.Y.
CHECKED BY R.P.

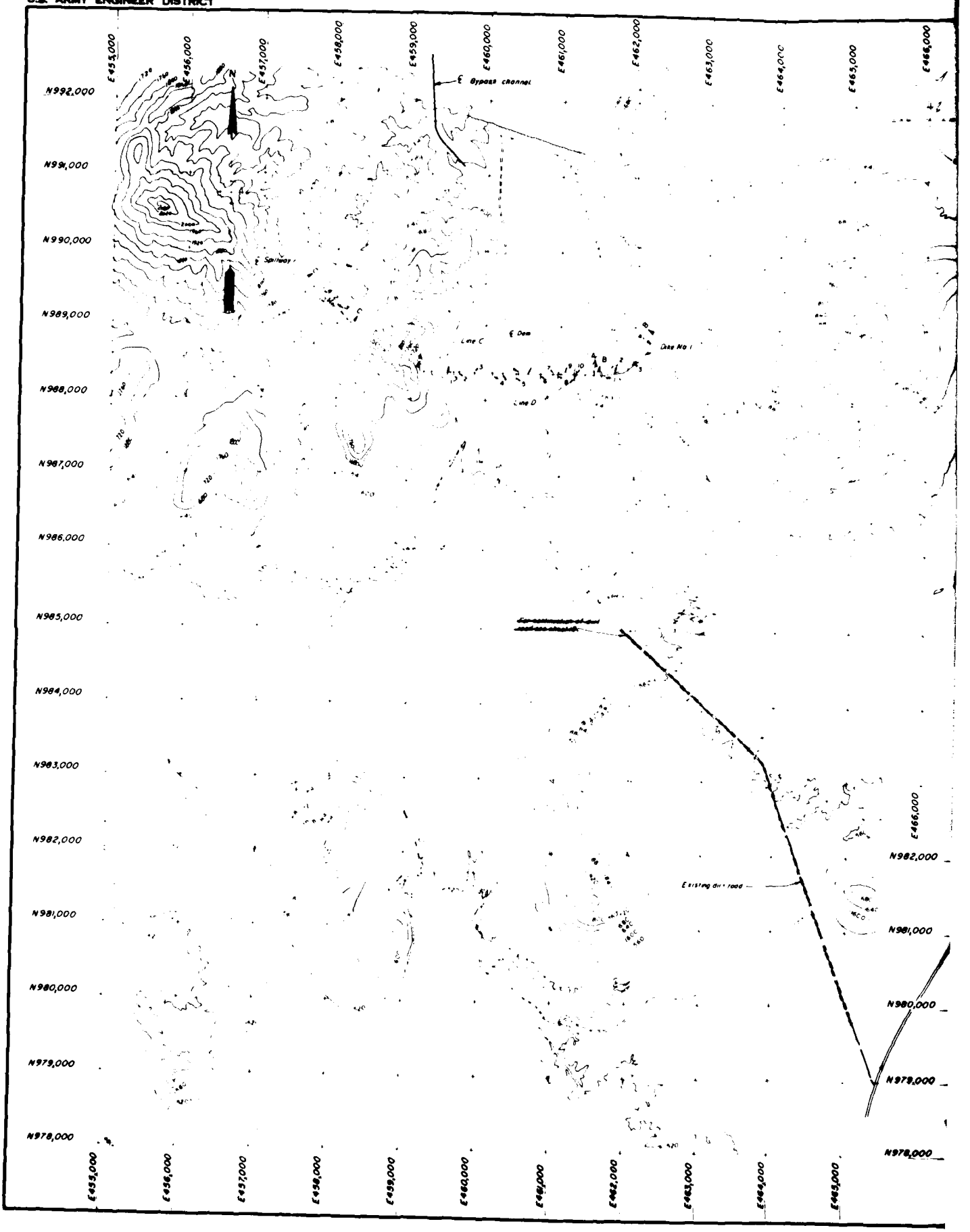
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

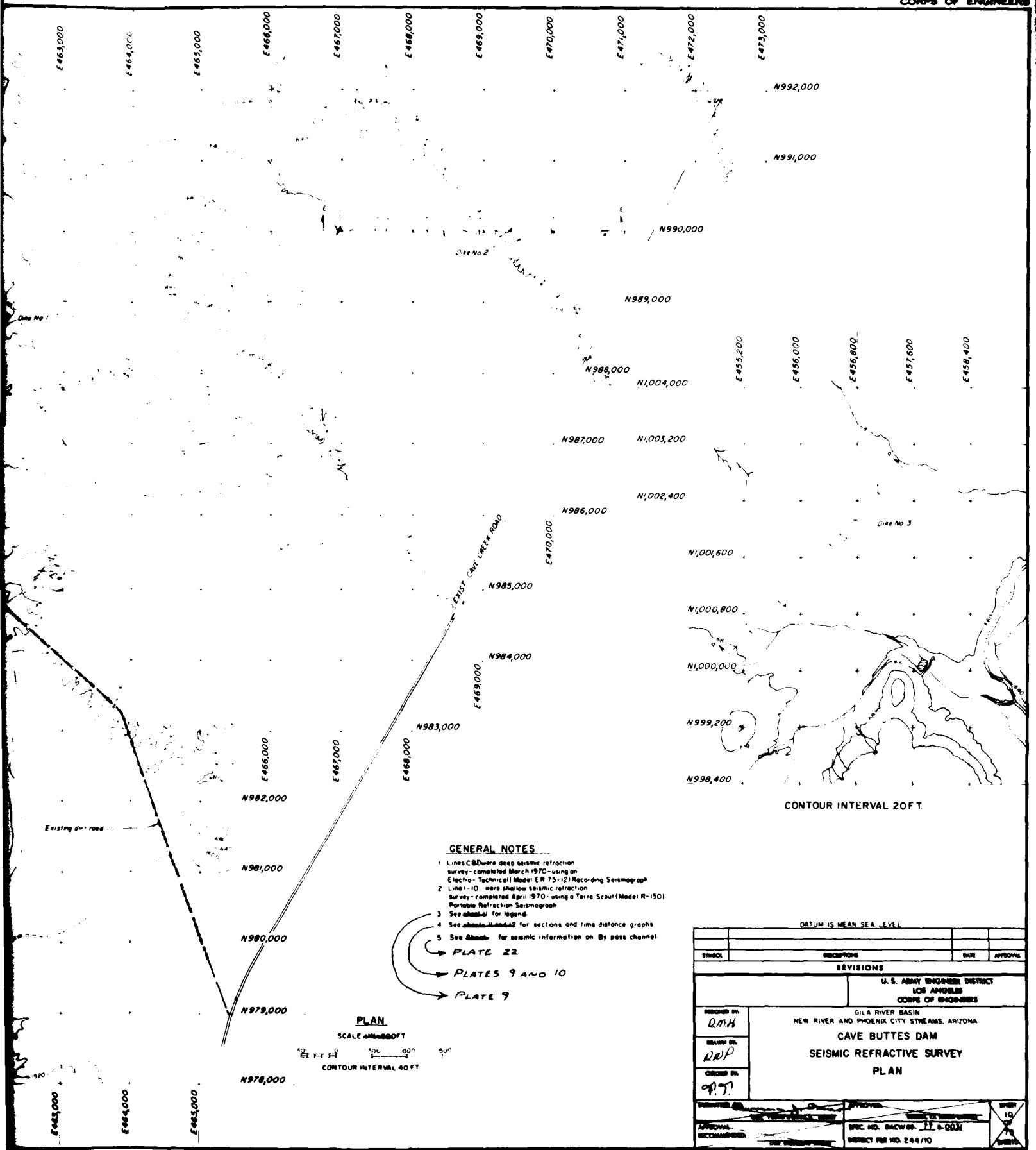
CAVE BUTTES DAM

GEOLOGIC LOGS - SHEET II

APPROVED
RECOMMENDED
SPEC. NO. DACW09-72-B-0031
DISTRICT FILE NO. 244/8
SHEET 2 OF 4 SHEETS

FOUNDATION REPORT 2 PLATE 7


U.S. ARMY ENGINEER DISTRICT
E455,000
E456,000
E457,000
E458,000
E459,000
E460,000
E461,000
E462,000
E463,000
E464,000
E465,000
E466,000
N992,000
N991,000
N990,000
N989,000
N988,000
N987,000
N986,000
N985,000
N984,000
N983,000
N982,000
N981,000
N980,000
N979,000
N978,000
N
℄ Bypass channel
℄ Spillway
℄ Dam
Line C
Line D
Dike No. 1
Existing dirt road



GENERAL NOTES

1. Lines C&D were deep seismic refraction survey - completed March 1970 - using an Electro - Technical (Model ER 75-12) Recording Seismograph
2. Line 1-10 were shallow seismic refraction survey - completed April 1970 - using a Terra Scout (Model R-150) Portable Refraction Seismograph
3. See sheet-4 for legend.
4. See sheets 41 and 42 for sections and time distance graphs
5. See Sheets for seismic information on By pass channel

→ PLATE 22
→ PLATES 9 AND 10
→ PLATE 9

PLAN

SCALE 1"=800FT

0 400 800

CONTOUR INTERVAL 40 FT

DATUM IS MEAN SEA LEVEL

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY: R.M.H.
DRAWN BY: D.W.P.
CHECKED BY: A.T.

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

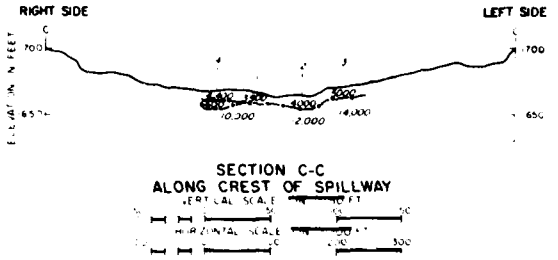
CAVE BUTTES DAM
SEISMIC REFRACTIVE SURVEY
PLAN

APPROVED: [illegible]
RECOMMENDED: [illegible]

SPEC. NO. DACW09-71-B-0034
DISTRICT FILE NO. 244/10

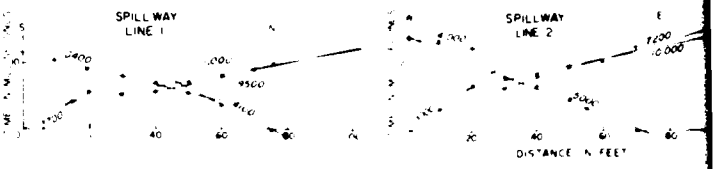
SHEET 10 OF 71 SHEETS

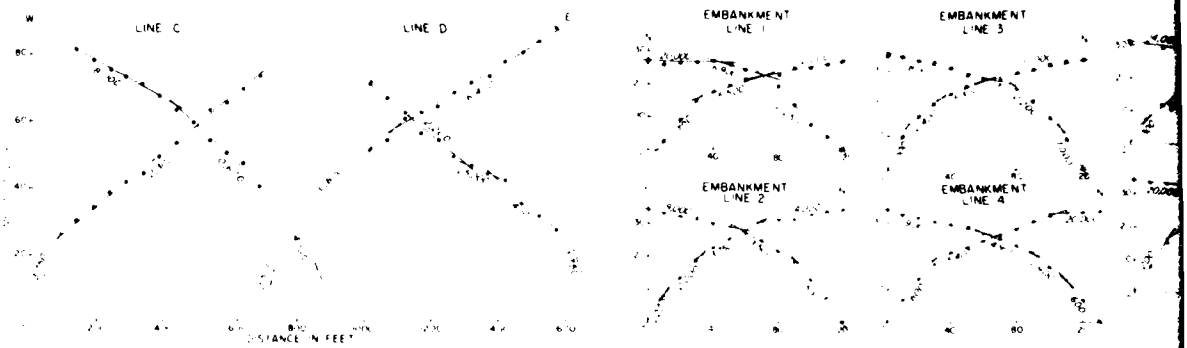
FOUNDATION REPORT 2 PLATE 8

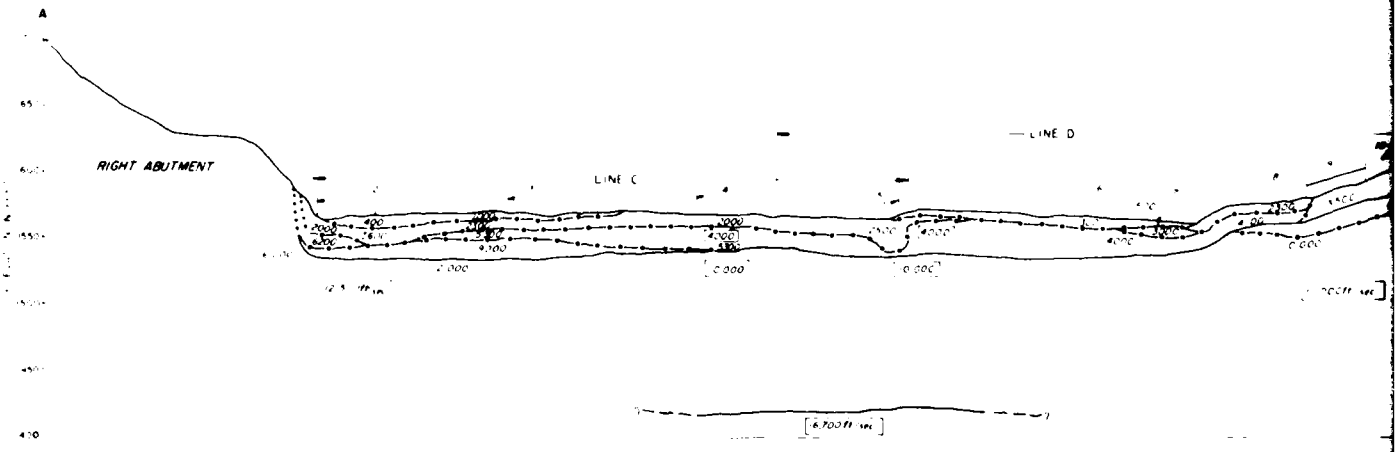


SECTION C-C
ALONG CREST OF SPILLWAY

VERTICAL SCALE
HORIZONTAL SCALE







SECTION A-A
ALONG ℄ DAM

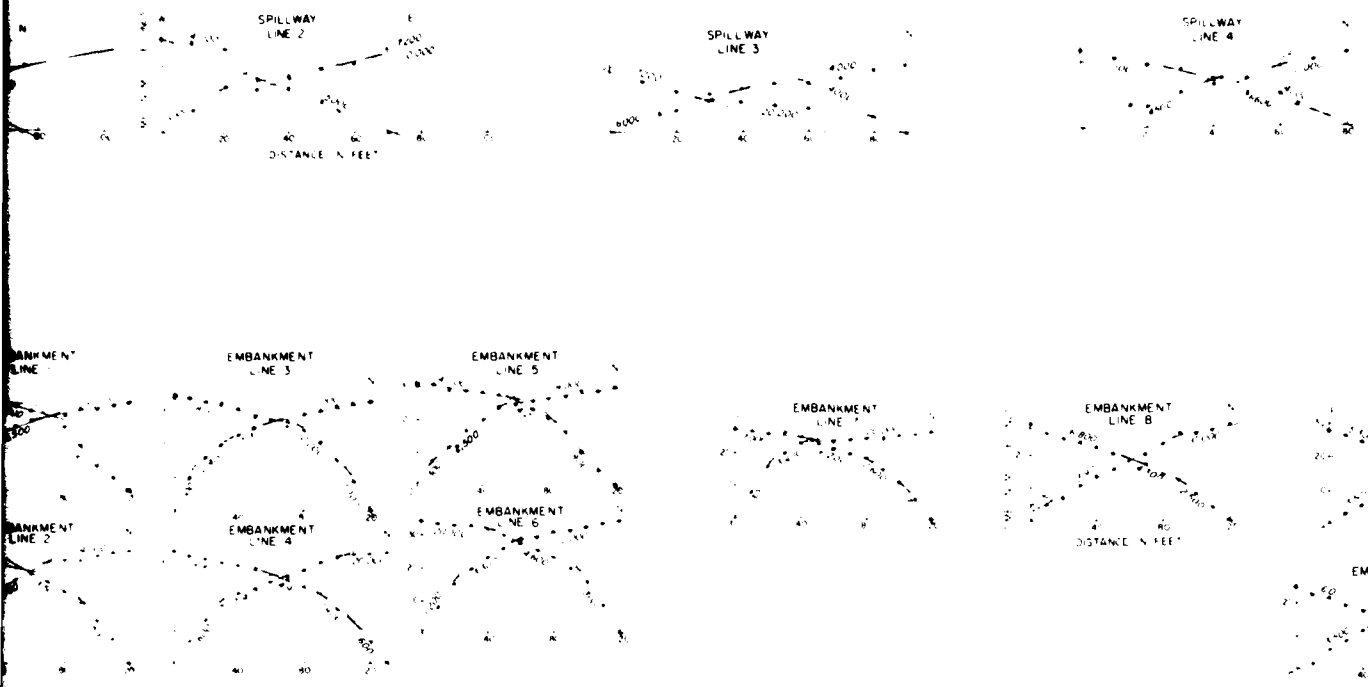
VERTICAL SCALE
HORIZONTAL SCALE

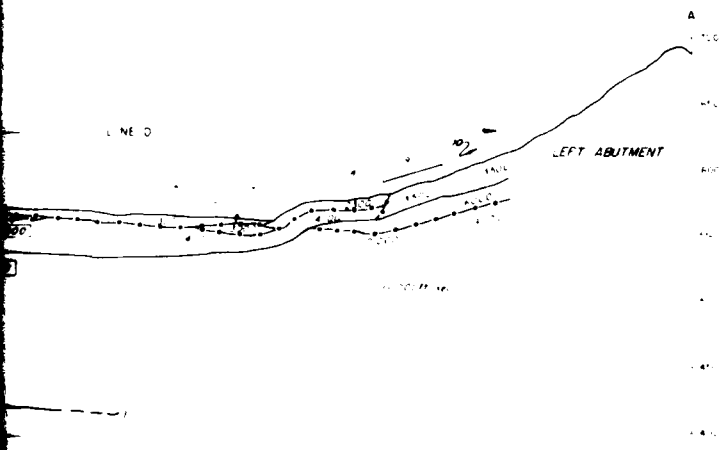
1. SEE [illegible] FOR L

2. NUMBERED LINES A
REFRACTION SEISM
LABORATORIES, PHI

3. LINES C AND D ARE
MODEL ER75-12 RE
BY HENRICHS GEOP

4. TIME-DISTANCE GRA





LEGEND

- LINE C — SEISMIC PROBE LINE PARALLEL OR NEARLY PARALLEL TO SECTION
- SEISMIC PROBE LINE PERPENDICULAR TO OR AT AN ANGLE TO SECTION
- SHALLOW SEISMIC VELOCITY BOUNDARY-DOTTED WHERE INFERRED OR INTERPOLATED
- DEEP (MULTI-CHANNEL) SEISMIC VELOCITY BOUNDARY
- 2000 / 2900 ft/sec — AVERAGE SEISMIC VELOCITY (FEET/SECOND)-BOX AROUND FIGURE INDICATES VELOCITY AS FIGURED FROM MULTI-CHANNEL SEISMIC

GENERAL NOTES

1. SEE [illegible] FOR LOCATION OF SEISMIC PROBE LINES PLATE 8.
2. NUMBERED LINES ARE SHALLOW SEISMIC PROBES DONE WITH A TERRASCOUT PORTABLE REFRACTION SEISMOGRAPH DURING APRIL 1970 WORK WAS DONE BY ARIZONA TESTING LABORATORIES, PHOENIX, ARIZONA
3. LINES C AND D ARE DEEP SEISMIC (MULTI-CHANNEL) DONE WITH AN ELECTRO-TECHNICAL MODEL ER 75-12 RECORDING SEISMOGRAPH DURING 17-18 MARCH 1970 WORK WAS DONE BY HEINRICHS GEOEXPLORATION COMPANY, TUSCON, ARIZONA
4. TIME-DISTANCE GRAPHS FROM CONTRACTORS RECORDS

DATUM IS MEAN SEA LEVEL

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
REVISIONS			

U S ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

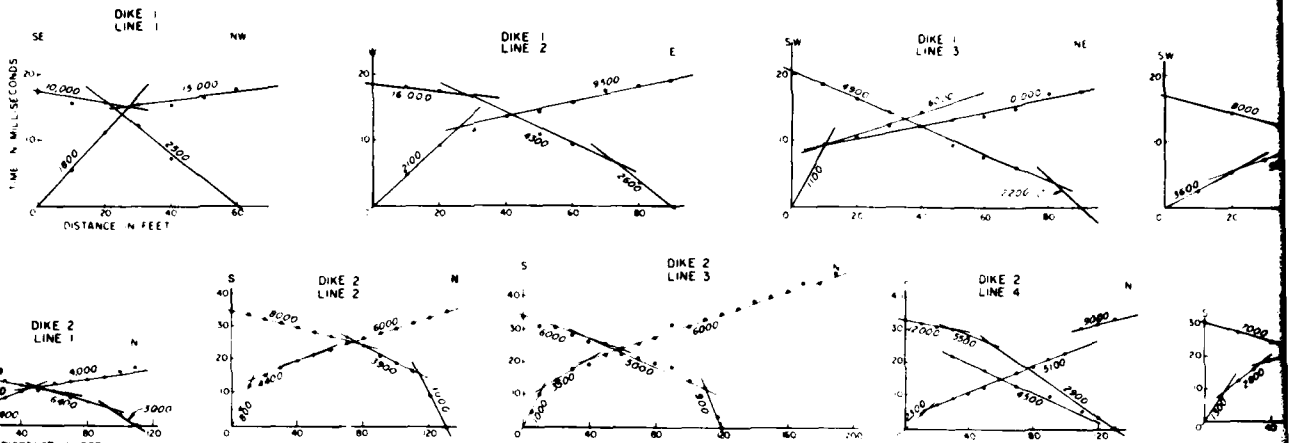
DESIGNED BY E.M.H.
DRAWN BY
CHECKED BY T.P.

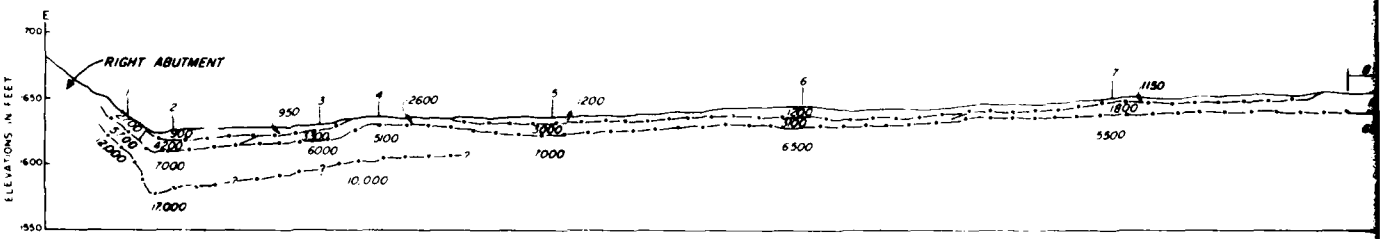
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM
SEISMIC REFRACTIVE SURVEY
SECTIONS AND TIME-DISTANCE GRAPHS
SHEET I

SUBMITTED BY [illegible]
APPROVED [illegible]
APPROVAL RECOMMENDED [illegible]
SPEC NO. DACW09-77-B-0031
DISTRICT FILE NO. 244/11
SHEET 11 OF 78 SHEETS

FOUNDATION REPORT 2 PLATE 9

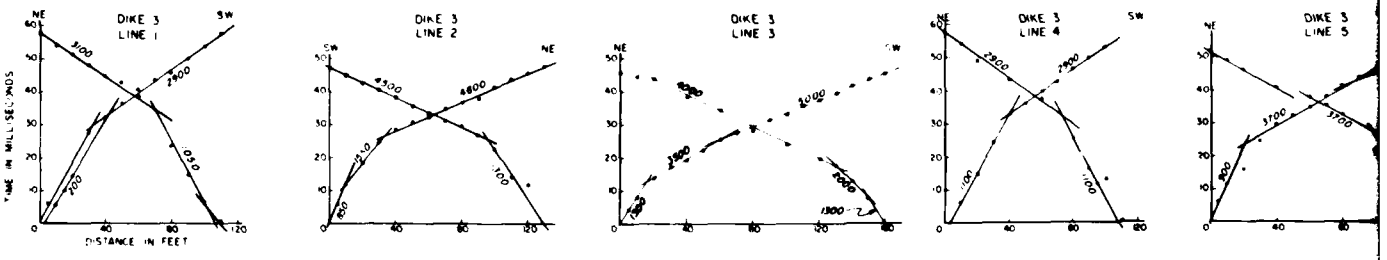


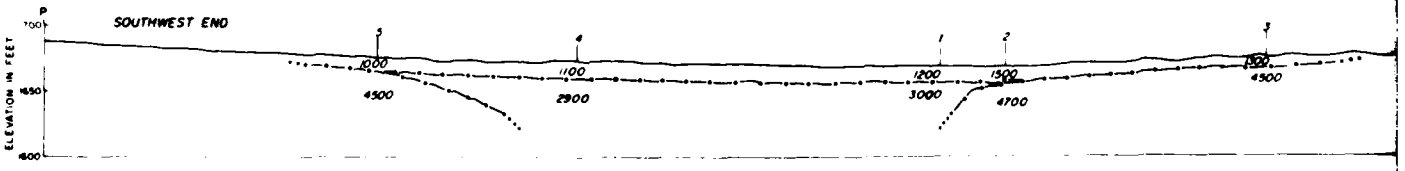


SECTION E-E
ALONG ℄ DIKE 2

VERTICAL SCALE 1 IN = 50 FT

HORIZONTAL SCALE 1 IN = 200 FT

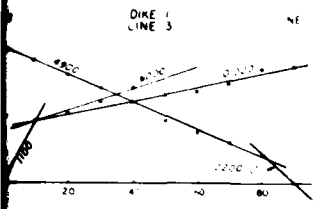


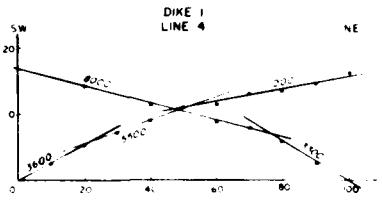


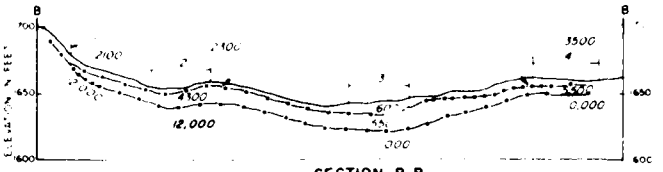
SECTION P-P
ALONG ℄ DIKE 3

VERTICAL SCALE 1 IN = 50 FT

HORIZONTAL SCALE 1 IN = 200 FT

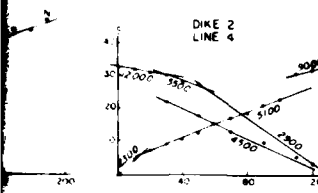


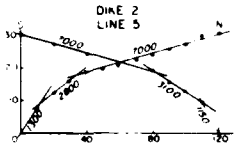


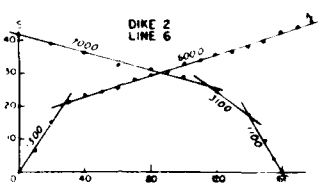


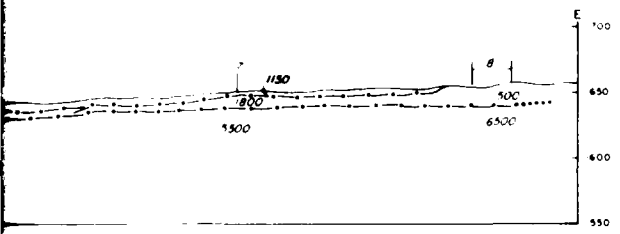
SECTION B-B
ALONG ℄ DIKE 1

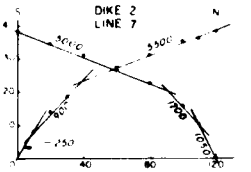
VERTICAL SCALE 1" = 50 FEET
HORIZONTAL SCALE 1" = 100 FEET

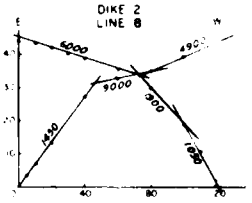






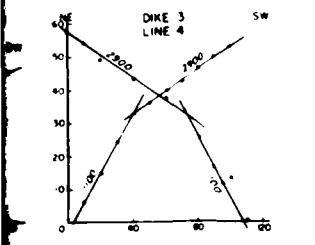


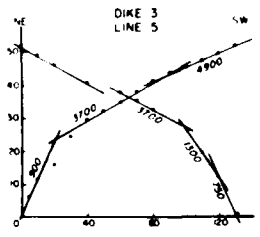


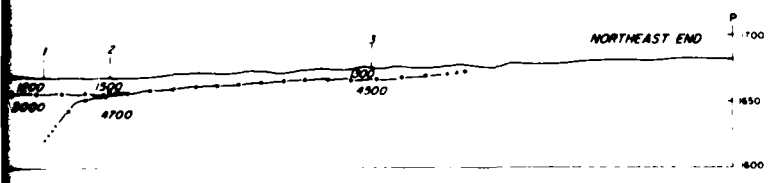


GENERAL NOTES

1. See sheet 10 for location of seismic probe lines. PLATE B
2. Numbered lines are shallow seismic probes done with a "Terrascout" portable refraction seismograph during April 1970. Work was done by Arizona Testing Laboratories, Phoenix, Arizona.
3. See sheet 11 for legend PLATE 9







DATUM IS MEAN SEA LEVEL

SYMBOL	DESCRIPTION	DATE	APPROVAL
	REVISIONS		

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY R.M.H.
DRAWN BY JPW
CHECKED BY FM

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM

SEISMIC REFRACTIVE SURVEY
SECTIONS AND TIME-DISTANCE GRAPHS
SHEET II

SUBMITTED
RECOMMENDED
APPROVED

SPEC. NO. DACW09-72-C-0008
DISTRICT FILE NO. 244/12

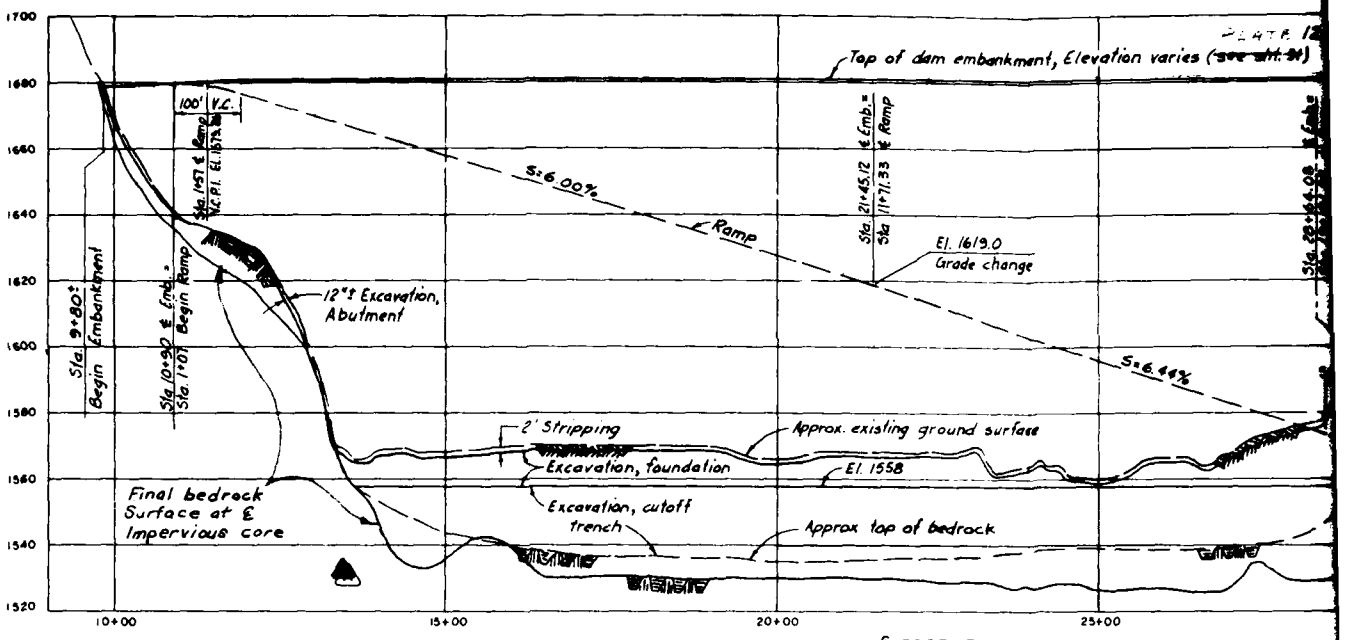
SHEET 12 OF 79 SHEETS

FOUNDATION REPORT

PLATE 10

2

PLATE 12



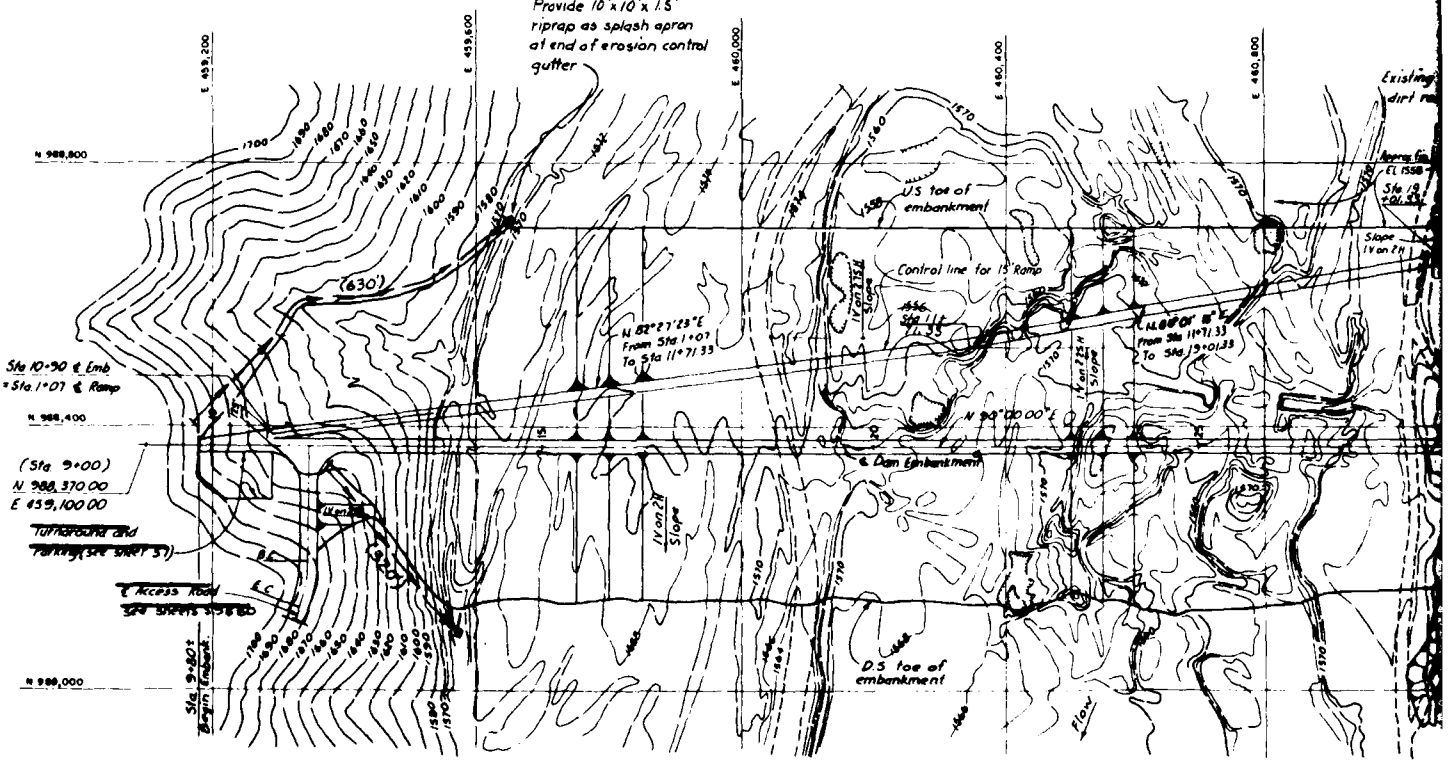
℄ PROFILE

HORIZONAL SCALE 1"=100 FT

100 0 100 200

VERTICAL SCALE 1"=20 FT

10 0 10 20 30 40 50



PLAN

SCALE 1"=100 FT

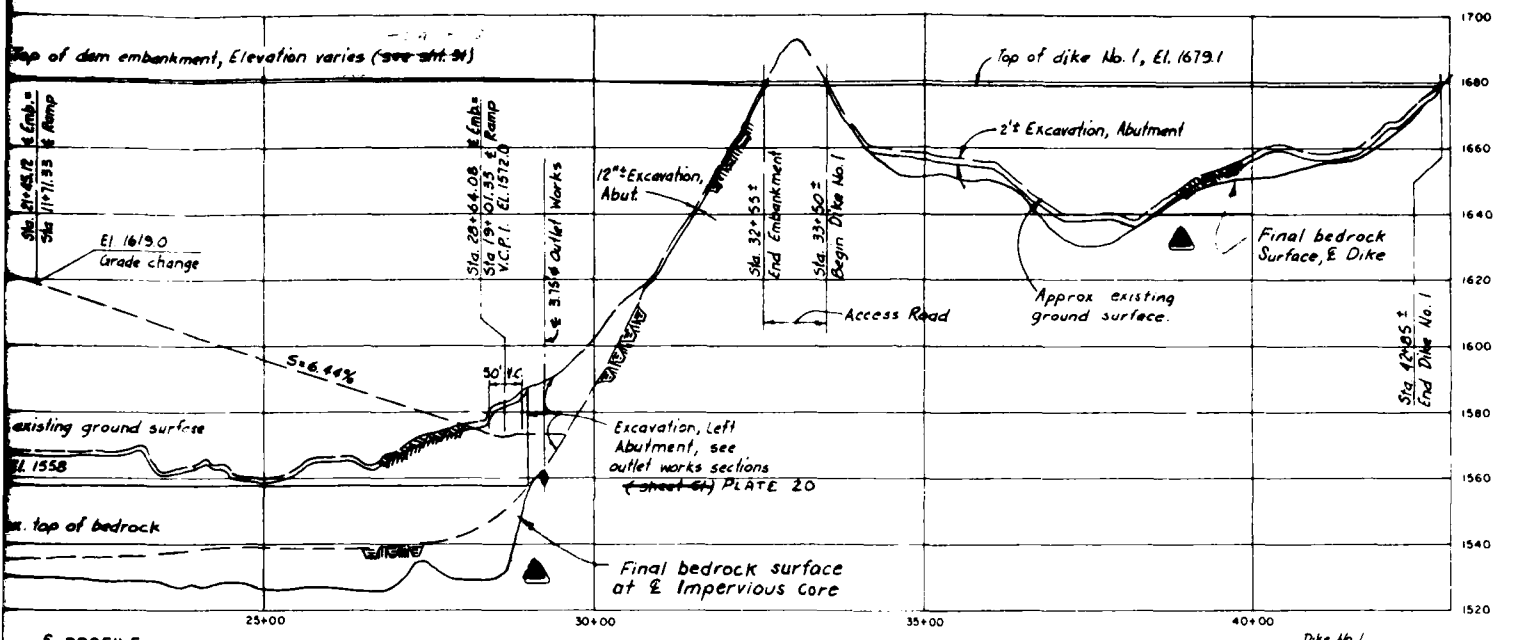
100 0 100 200

LEGEND

- 1610 — Existing contour lines, with elevations shown.
- (300') → Location of erosion control gutter, with horizontal length indicated. see sheet 33 for details.
- → ⊡ Provide 10'x10'x1.5' riprap as splash apron at end of erosion control gutter.
- Approximate existing ground surface
- Approximate bedrock surface

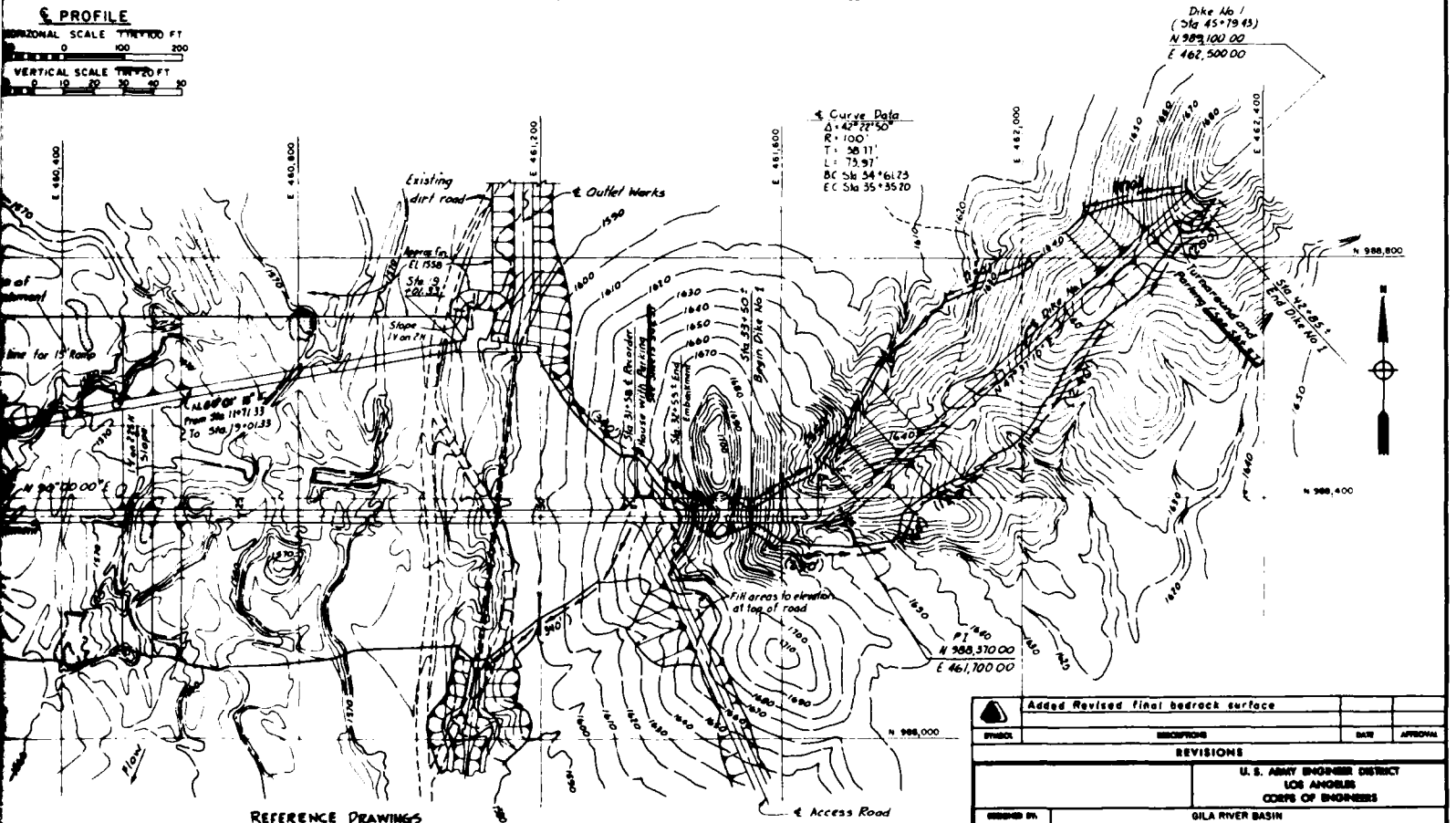
REFERENCE DRAWINGS

1. For cross sections, see sheets 6
2. For instrumentation, see sheets
3. For foundation, abutments and trench excavation, see sheet 6
4. For access roads, see sheets
5. For Outlet Works Plan & Profile, sheets 49 & 50, PLATE 14.
6. For esthetic treatment of embankment, see sheets 44 & 45.



℄ PROFILE

HORIZONAL SCALE 1"=100 FT
0 100 200
VERTICAL SCALE 1"=20 FT
0 10 20 30 40 50



PLAN

SCALE 1"=100 FT
0 100 200

REFERENCE DRAWINGS

1. For cross sections, see ~~sheets 81-92~~ PLATES 12 AND 13.
2. ~~For instrumentation, see sheets 84,85,86.~~
3. For foundation, abutments and cutoff trench excavation, see ~~sheet 88~~ PLATE 19.
4. ~~For Access Roads, see sheets 89-92.~~
5. For Outlet Works Plan & Profile, see ~~sheets 93-96~~ PLATE 19.
6. ~~For esthetic treatment of embankment, see sheets 97-98.~~

REFERENCES:

1. TOPOGRAPHY BY PHOTOGRAMMETRIC METHOD BY AERIAL MAPPING CO SURVEY OF OCTOBER 1974 CONTOUR INTERVAL AS SHOWN.
2. HORIZONTAL CONTROL IS BASED ON NATIONAL GEODETIC SURVEY DATUM. VERTICAL CONTROL IS BASED ON 1929 MSL DATUM.

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	Added Revised final bedrock surface		

REVISIONS

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY: J.M.H.
DRAWN BY: J.W.S.
CHECKED BY: M

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

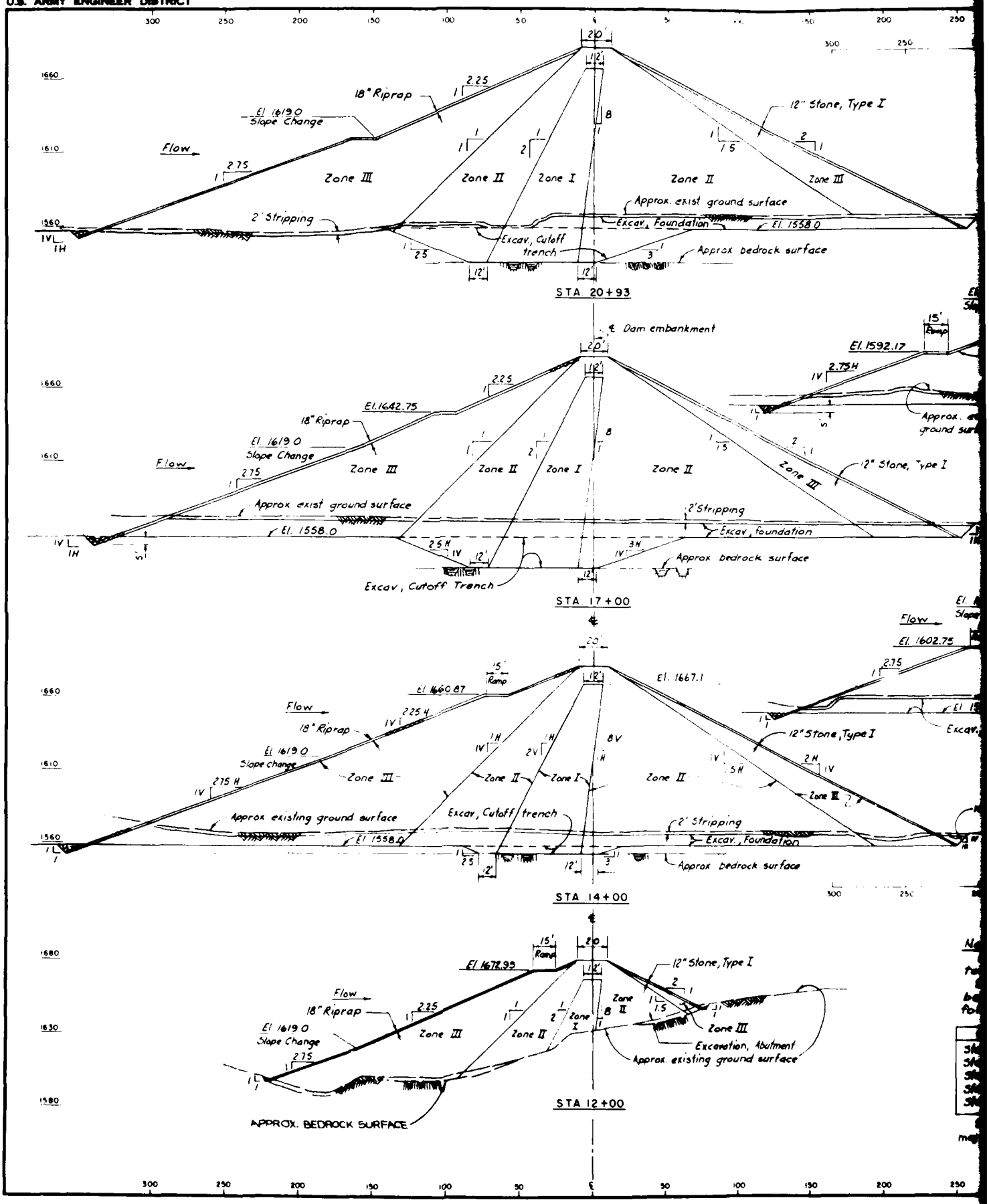
CAVE BUTTES DAM

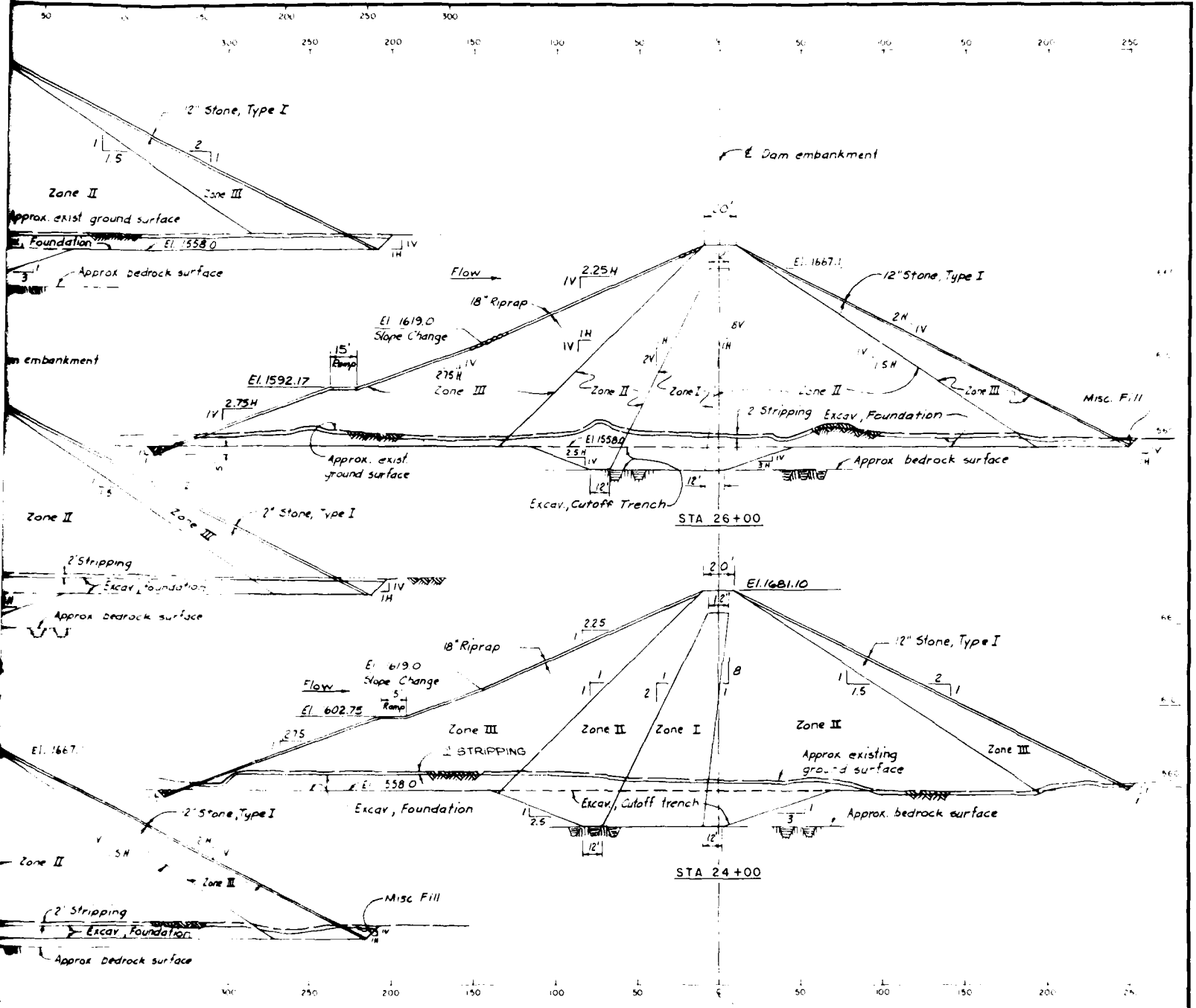
DAM AND DIKE NO. 1 EMBANKMENTS
PLAN AND PROFILE

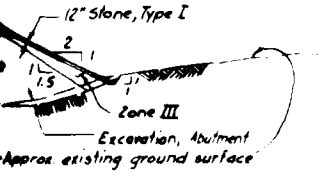
SUBMITTED BY: [signature] APPROVED: [signature]
APPROVAL RECOMMENDED: [signature]
SPEC. NO. DACW09- 77 B-0111
DISTRICT FILE NO. 244/30
SHEET 30 OF 71 SHEETS

FOUNDATION REPORT 2 PLATE 11

U.S. ARMY ENGINEER DISTRICT







Notes

1. For typical section, details of crown, toe, erosion control gutter, and ramp, see ~~SHT 32~~ PLATE 13
2. Crest elevation of dam shall vary uniformly between stations in accordance with the following table:

CREST ELEVATION, DAM	
Sta 9+80	El. 1679.10
Sta. 12+00	El. 1680.10
Sta 14+00	El. 1681.10
Sta. 28+00	El. 1681.10
Sta. 32+55	El. 1679.10

3. Downstream Zone III material above El. 1657 may be replaced with Zone II material.

DATUM IS MEAN SEA LEVEL

SYMBOL	DESCRIPTION	DATE	APPROVAL
	REVISIONS		

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY: J.H.B.
DRAWN BY: JWS B.E.V.
CHECKED BY:

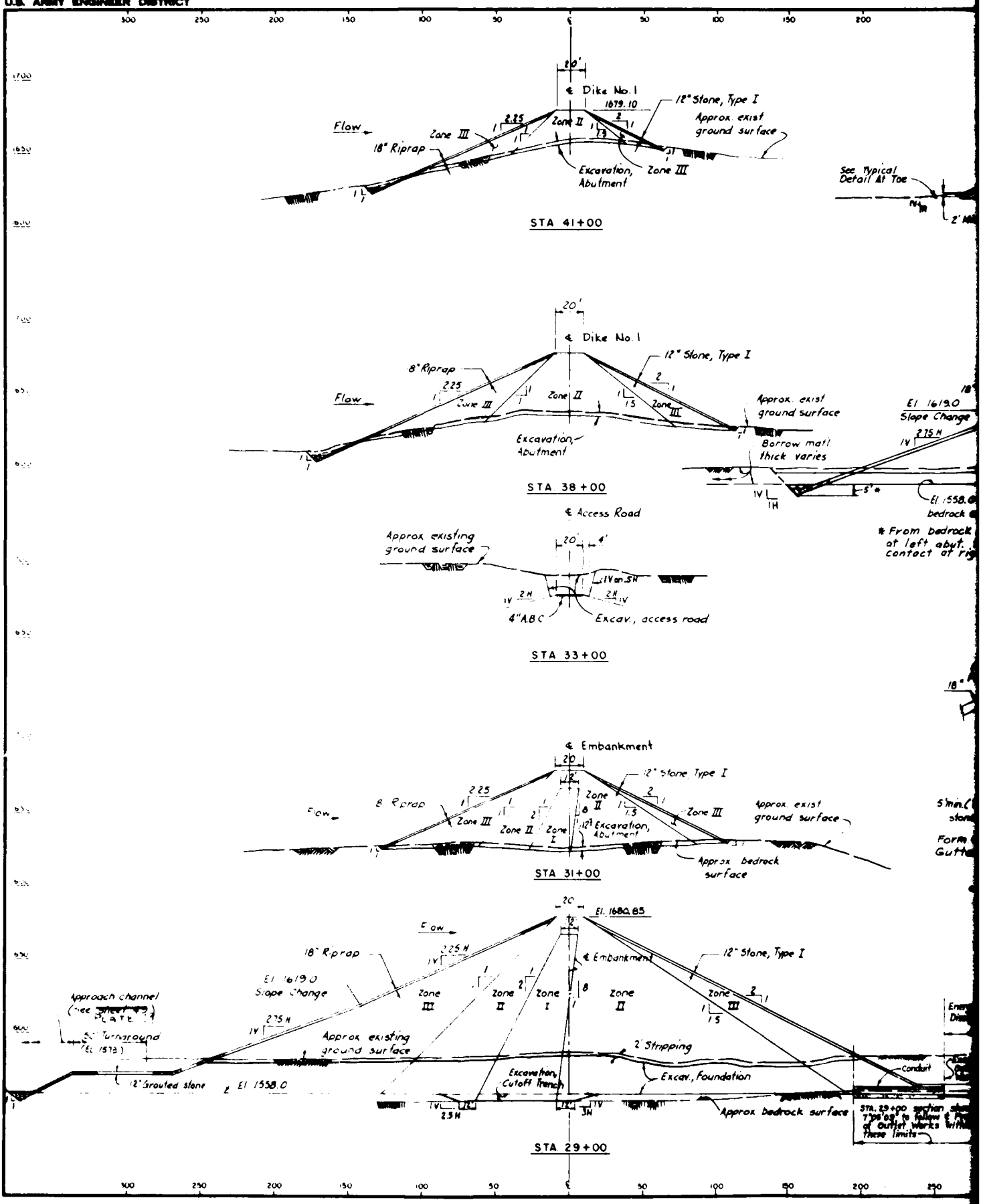
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM

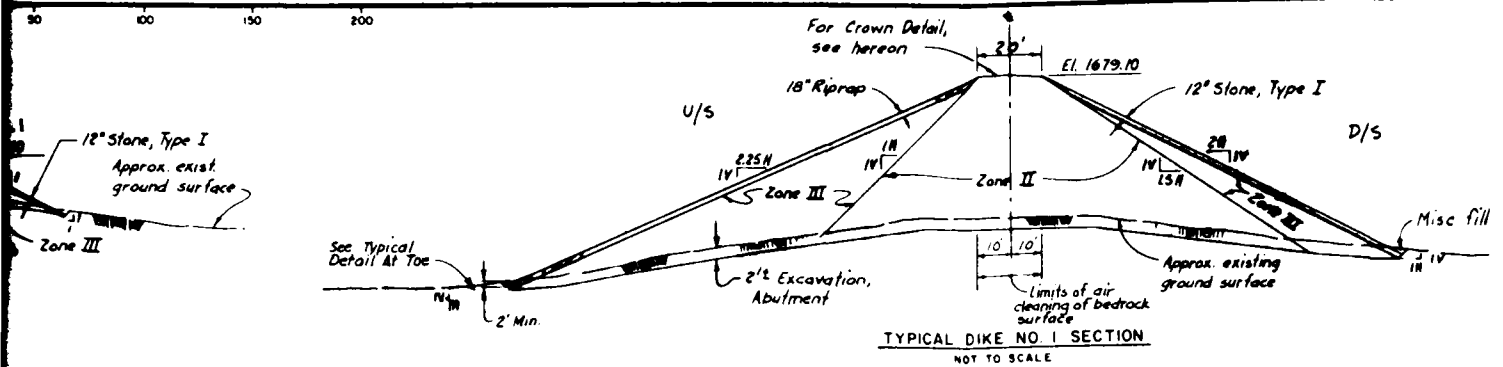
DAM AND DIKE NO I EMBANKMENTS
CROSS SECTIONS SHEET I

SUBMITTED BY: Walter Robertson
APPROVED:
APPROVAL RECOMMENDED:
SPEC. NO. DACW09-72-B-0031
DISTRICT FILE NO. 244/31
SHEET 31 OF 75 SHEETS

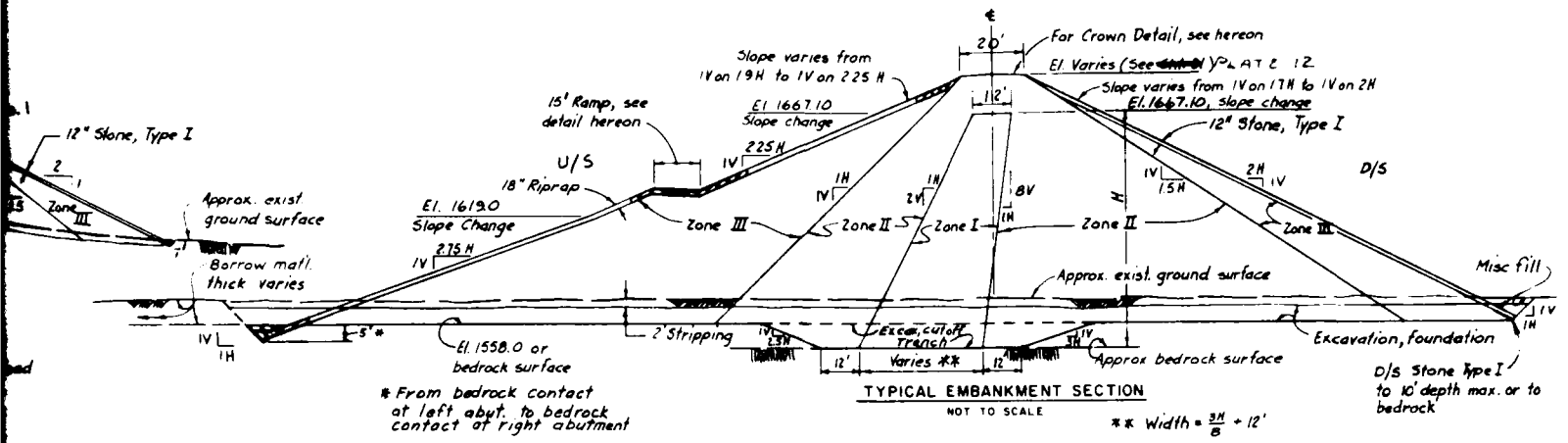
U.S. ARMY ENGINEER DISTRICT



CORPS OF ENGINEERS



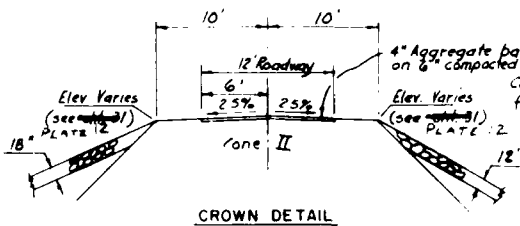
TYPICAL DIKE NO. 1 SECTION
NOT TO SCALE



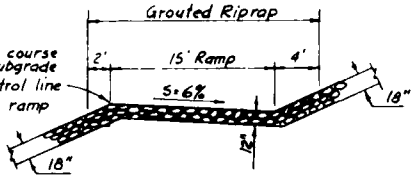
* From bedrock contact at left abut. to bedrock contact at right abutment

TYPICAL EMBANKMENT SECTION
NOT TO SCALE

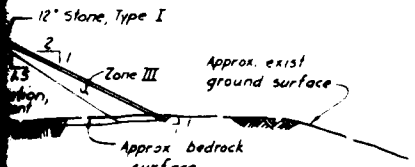
** Width = $\frac{3H}{8}$ + 12'

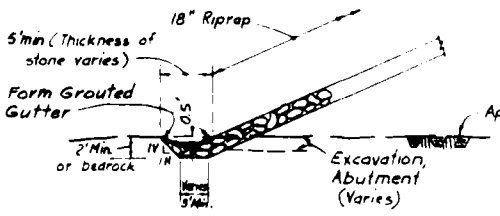


CROWN DETAIL
NTS

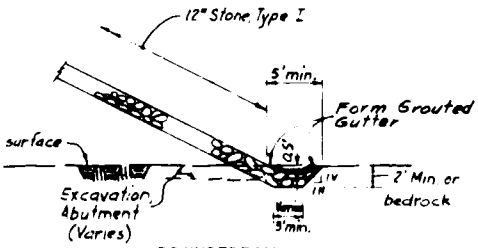


RAMP DETAIL
NTS



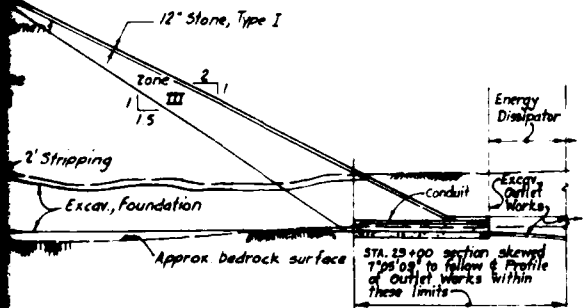


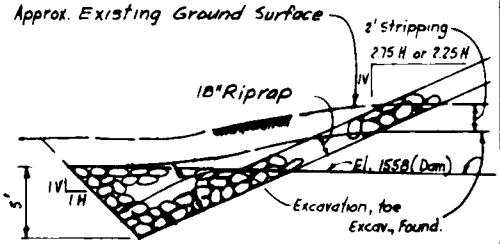
UPSTREAM
NTS



DOWNSTREAM
NTS

DETAIL OF EROSION CONTROL GUTTER ON SLOPE OF EMBANKMENT
NTS





TYPICAL DETAIL AT UPSTREAM TOE
(BETWEEN STA. 14+00 & STA. 29+00, STA 37+35.4 STA. 38+75 AND STA. 40+12 & STA 41+38)
NOT TO SCALE

DATUM IS MEAN SEA LEVEL

SYMBOL	DESCRIPTION	DATE	APPROVAL
	REVISIONS		

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY: [illegible]
DRAWN BY: W.S.
CHECKED BY: [illegible]

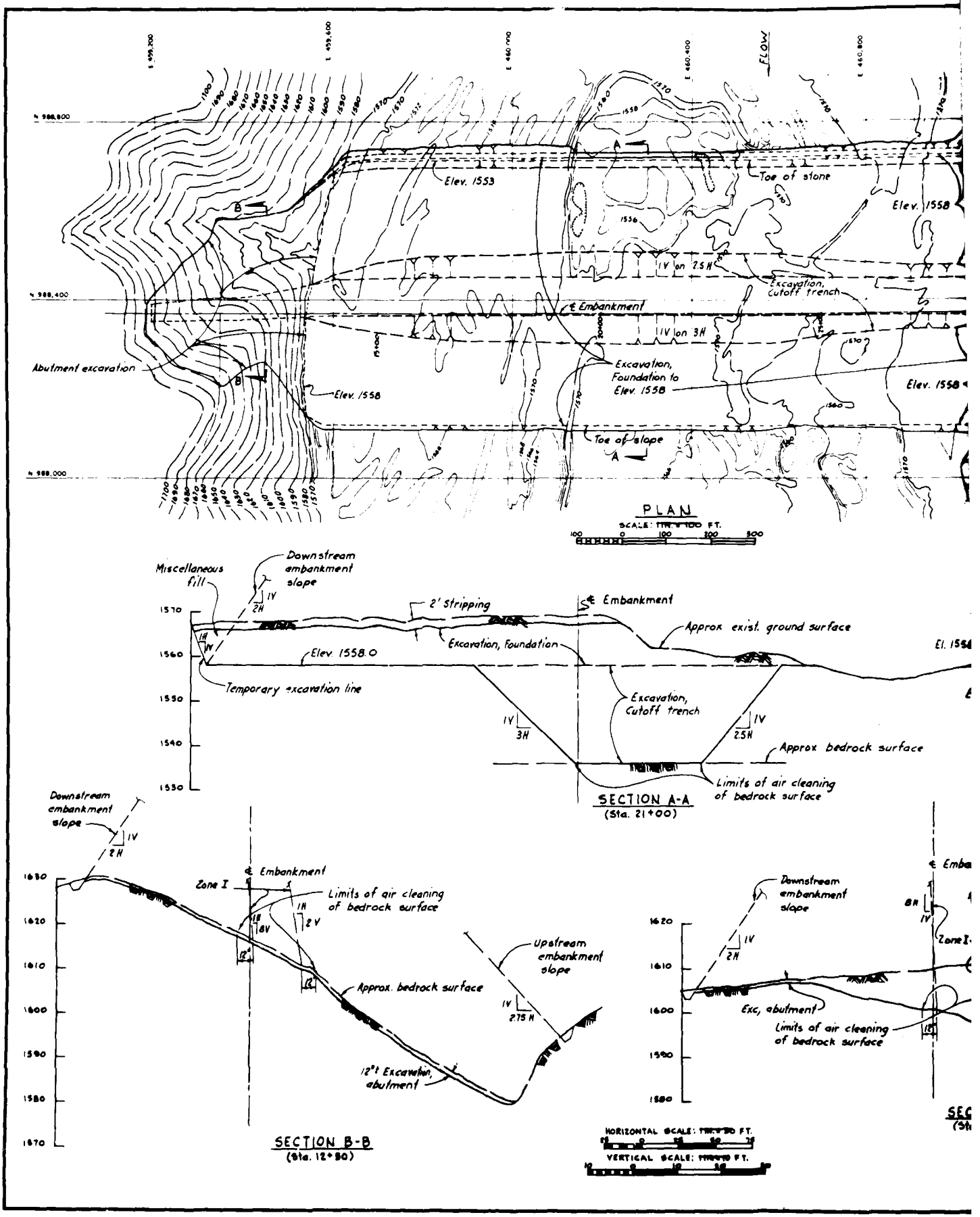
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

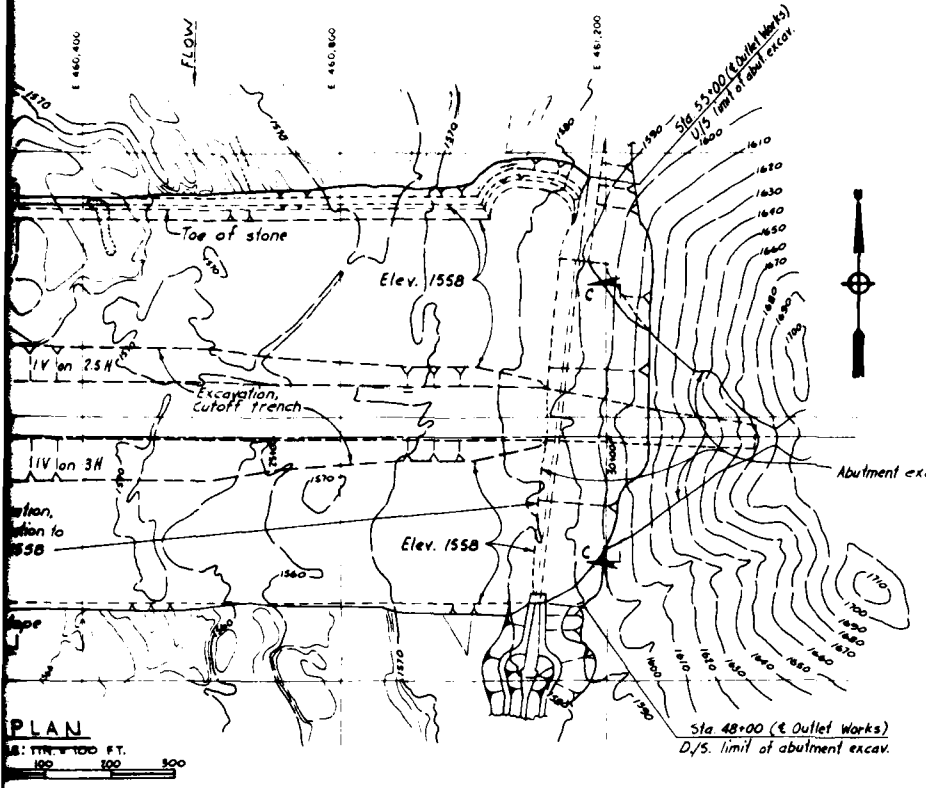
CAVE BUTTES DAM

DAM AND DIKE NO 1 EMBANKMENTS
CROSS SECTIONS SHEET II

SUBMITTED BY: [illegible]
APPROVAL RECOMMENDED: [illegible]
APPROVED: [illegible]
SPEC. NO. DACW09-77-B-0031
DISTRICT FILE NO. 244/32

FOUNDATION REPORT
2
PLATE 13


E 459,200
E 459,600
E 460,000
E 460,400
E 460,800
FLOW
N 988,800
N 988,400
N 988,000
Elev. 1553
Toe of stone
Elev. 1558
1V on 2.5H
Excavation, cutoff trench
℄ Embankment
1V on 3H
Abutment excavation
Excavation, Foundation to Elev. 1558
Elev. 1558
Toe of slope
PLAN
SCALE: 1"=100 FT.
Miscellaneous fill
Downstream embankment slope
2' Stripping
℄ Embankment
Approx exist. ground surface
Excavation, Foundation
Elev. 1558.0
Temporary excavation line
Excavation, Cutoff trench
Approx bedrock surface
Limits of air cleaning of bedrock surface
SECTION A-A
(Sta. 21+00)
Zone I
Upstream embankment slope
Approx. bedrock surface
12" Excavation, abutment
Exc, abutment
SECTION B-B
(Sta. 12+80)
HORIZONTAL SCALE: 1"=50 FT.
VERTICAL SCALE: 1"=10 FT.

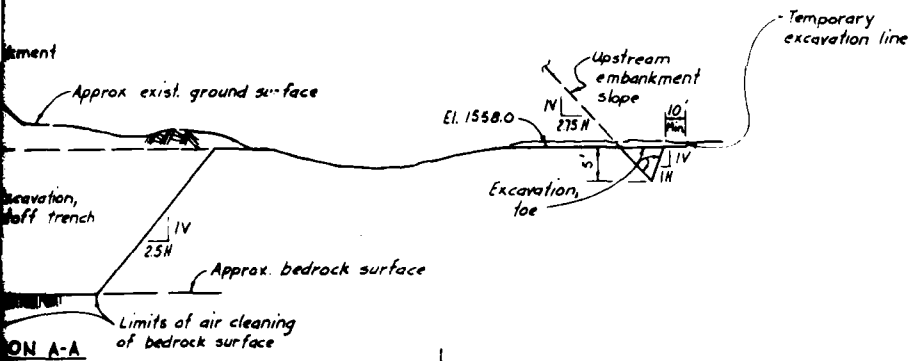


PLAN

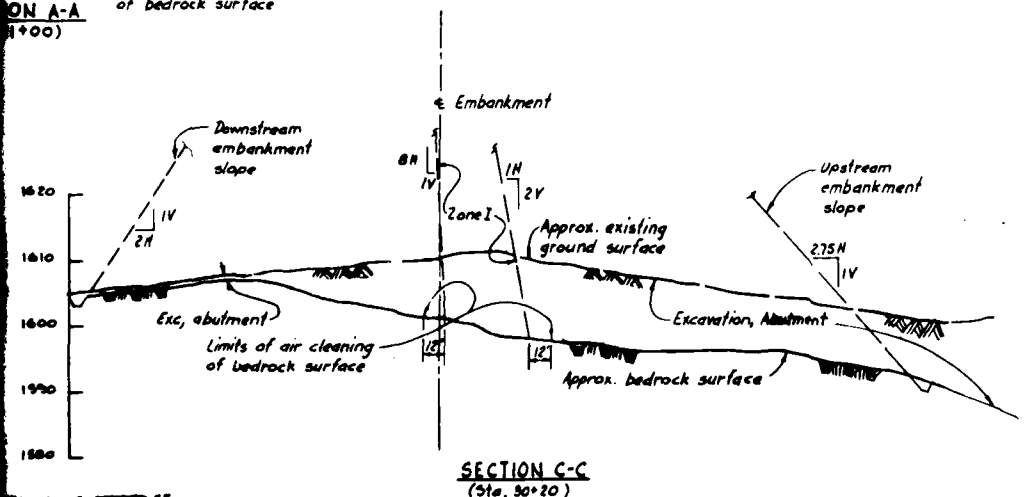
SCALE: 1"=100 FT.

Note:

1. For details of outlet works excavation, see ~~sheets 49-52~~ PLATES 19 AND 21



ON A-A
(1+00)



SECTION C-C
(Sta. 50+20)

REFERENCES

1. Topography by photogrammetric method by Aerial Mapping Co. Survey of October 1974. Contour interval as shown.
2. Horizontal control is based on National Geodetic Survey Datum. Vertical is based on 1929 MSL Datum.

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM
DAM EMBANKMENT-FOUNDATION, ABUTMENTS AND CUTOFF TRENCH EXCAVATION
PLAN AND SECTIONS

DESIGNED BY: J.H.M.
DRAWN BY: J.W.S.
CHECKED BY: M.K.

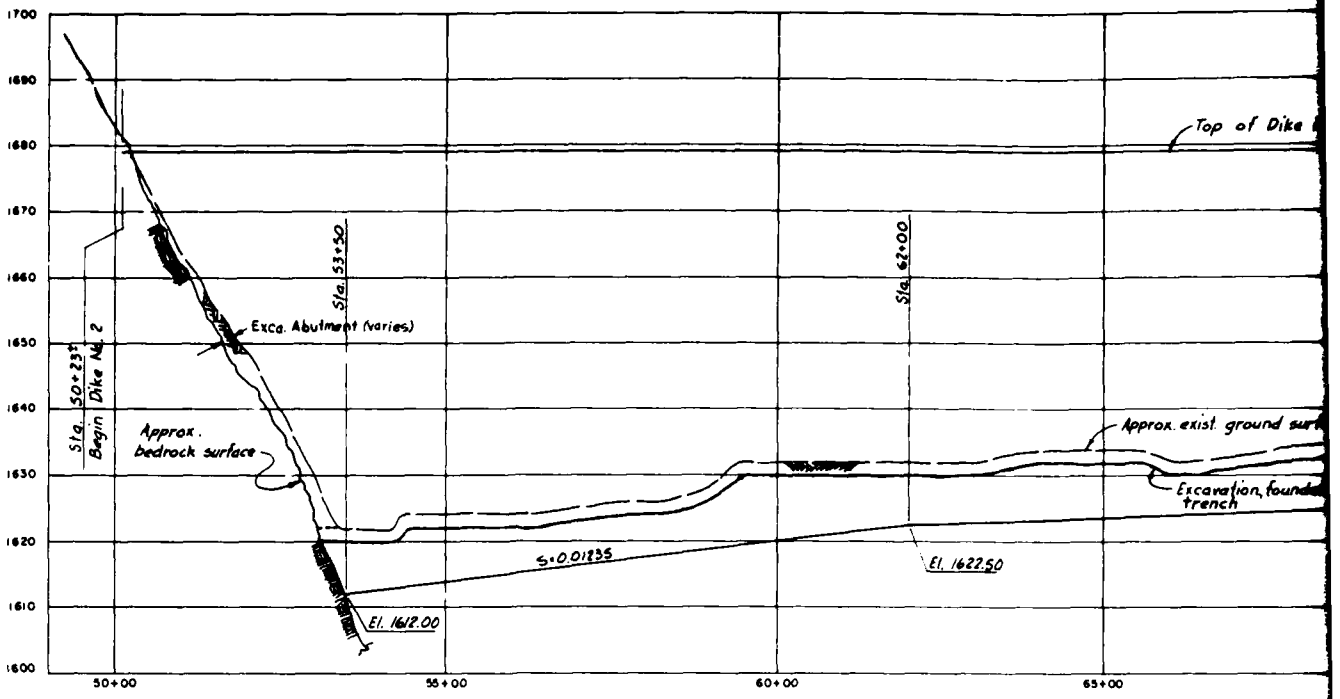
SUBMITTED BY:
APPROVED:
APPROVAL RECOMMENDED:

SPEC. NO. DACW09-77-B-0031
DISTRICT FILE NO. 244/33
DATE:

SHEET 33 OF 71 SHEETS

FOUNDATION REPORT 2

U.S. ARMY ENGINEER DISTRICT



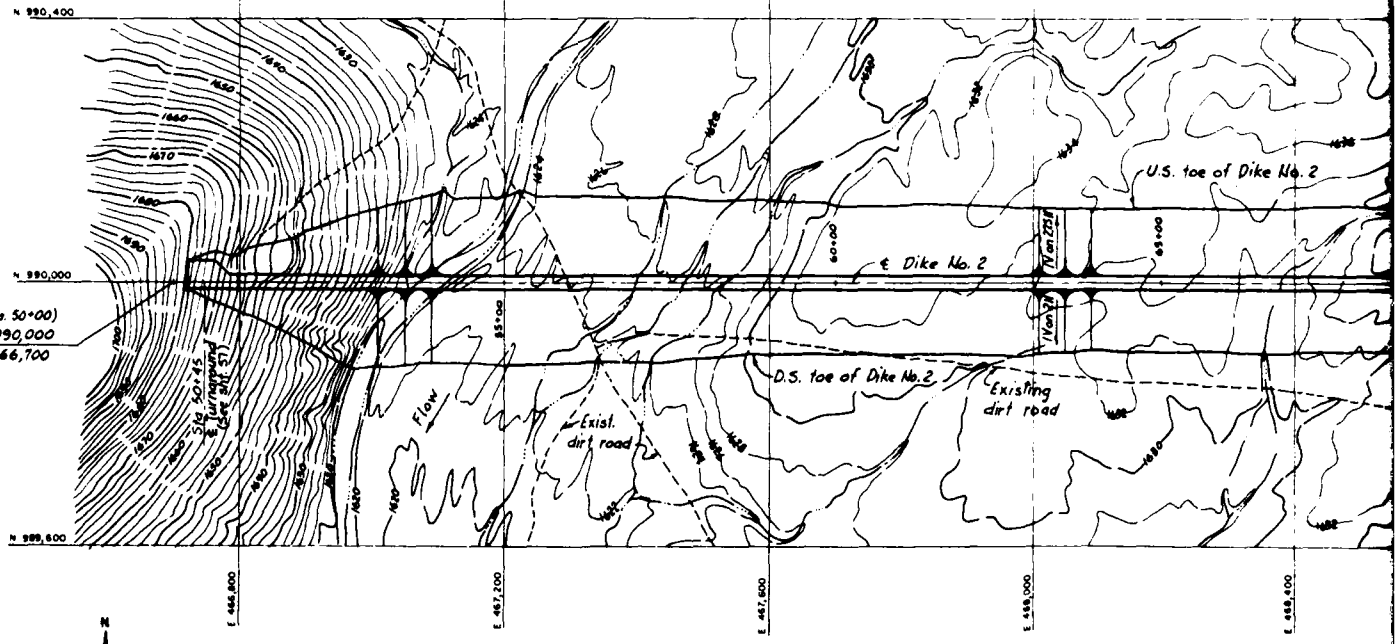
℄ PROFILE

HORIZONTAL SCALE 1"=100 FT

100 0 100 200

10 0 10 20

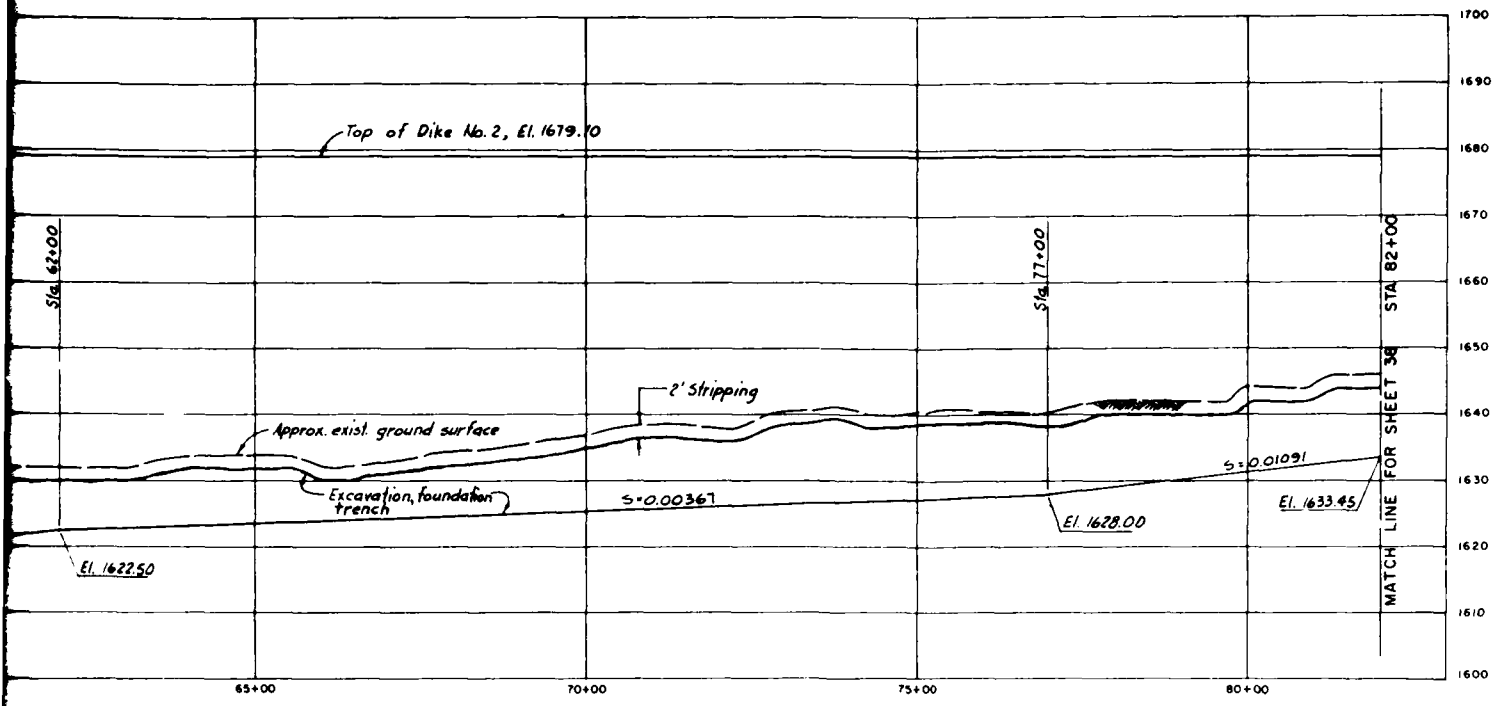
VERTICAL SCALE 1"=10 FT



PLAN

SCALE 1"=100 FT

100 0 100 200



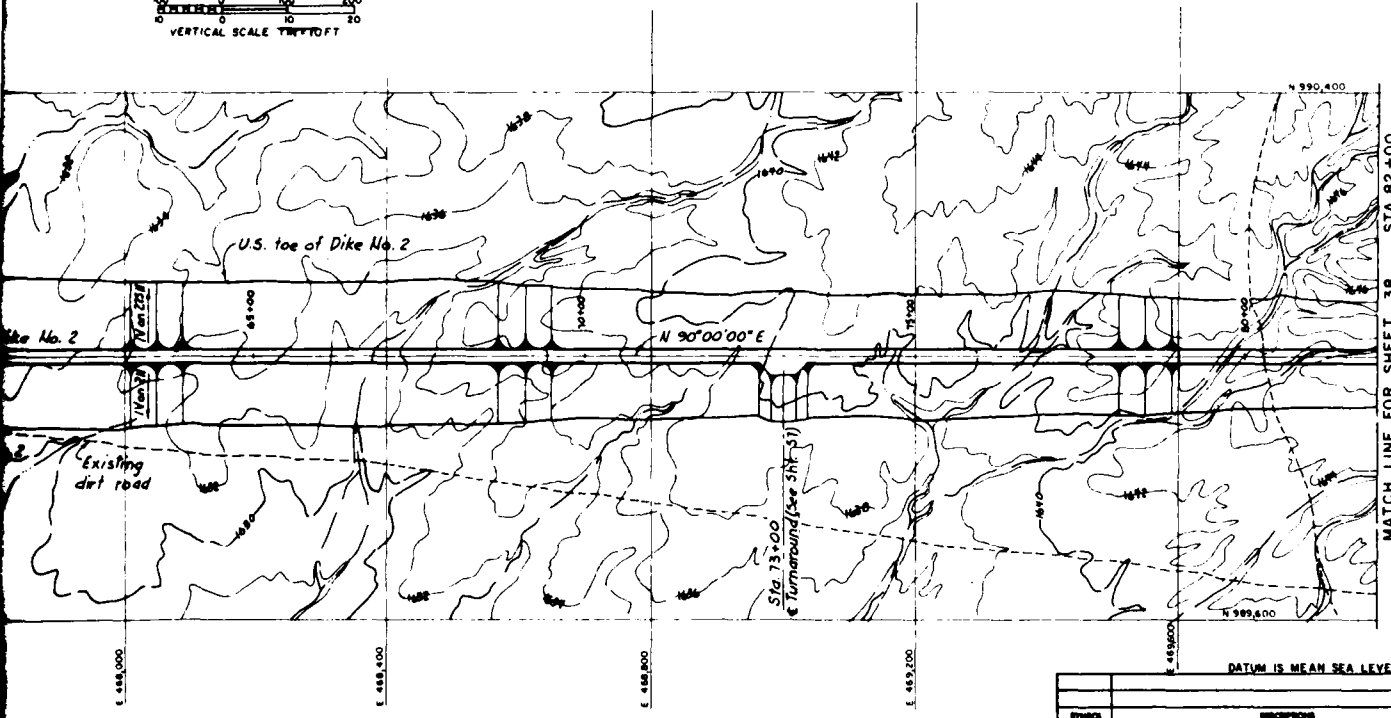
℄ PROFILE

HORIZONAL SCALE 1"=100 FT

100 0 100 200

10 0 10 20

VERTICAL SCALE 1"=10 FT



PLAN

SCALE 1"=100 FT

100 0 100 200

DATUM IS MEAN SEA LEVEL

REFERENCE DRAWINGS

~~1 FOR CROSS SECTIONS, SEE SHEETS 40 AND 41~~
~~2 FOR INSTRUMENTATION, SEE SHEETS 42, 43 AND 44~~
~~3 FOR ESTHETIC TREATMENT, SEE SHEETS 72 & 73~~

REFERENCES:

1. TOPOGRAPHY BY PHOTOGRAMMETRIC METHOD BY AERIAL MAPPING CO SURVEYS OF OCTOBER 1974 CONTOUR INTERVAL IS 2 FEET
2. HORIZONTAL CONTROL IS BASED ON NATIONAL GEODETIC SURVEY DATUM VERTICAL CONTROL IS BASED ON 1929 MSL DATUM.

SYMBOL	DESCRIPTION	DATE	APPROVAL
	REVISIONS		

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

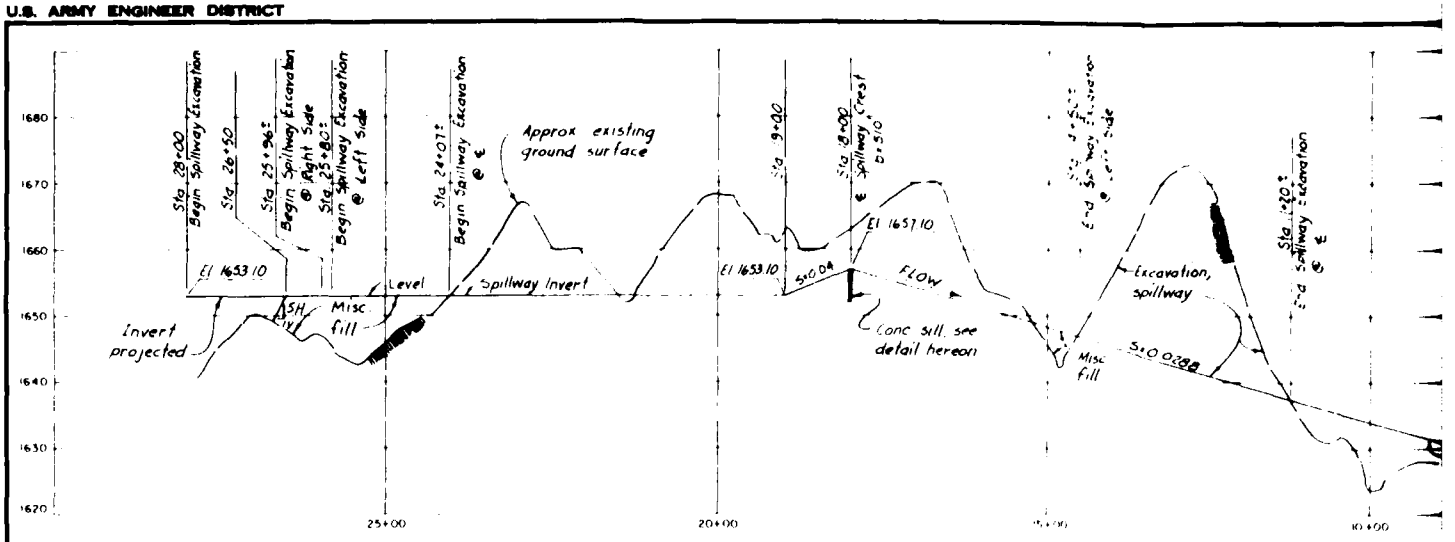
DESIGNED BY: [illegible]
DRAWN BY: J.W.S.
CHECKED BY: [illegible]

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM
DIKE NO. 2
PLAN AND PROFILE
STA. 50+23 TO 82+00

SUBMITTED BY: [illegible] APPROVED: [illegible]
APPROVAL RECOMMENDED: [illegible]
SHEET 37 OF 75 SHEETS
SPEC. NO. DACW09-77-B-0031
DISTRICT FILE NO. 244/37

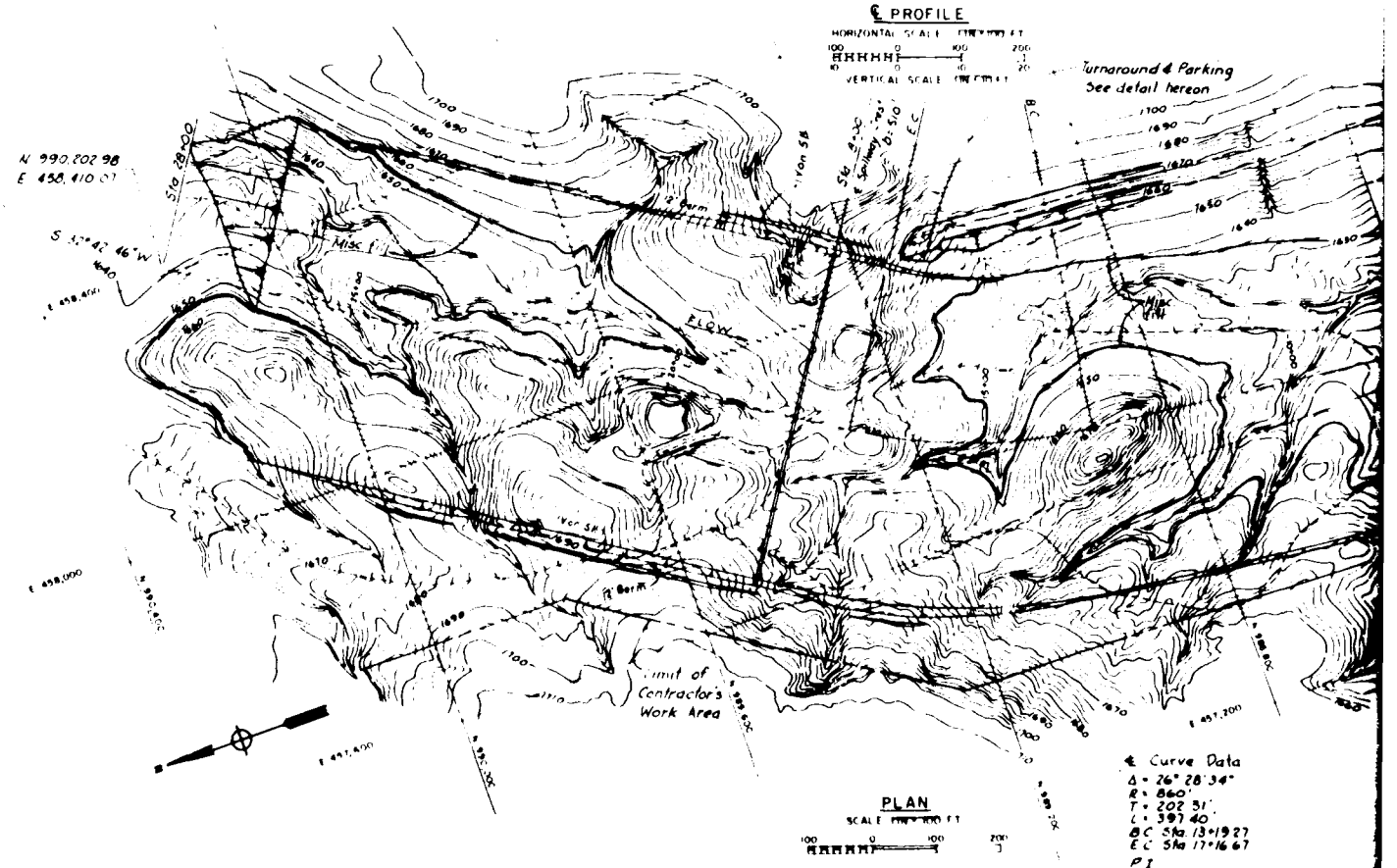
U.S. ARMY ENGINEER DISTRICT



℄ PROFILE

HORIZONTAL SCALE 1 IN = 100 FT

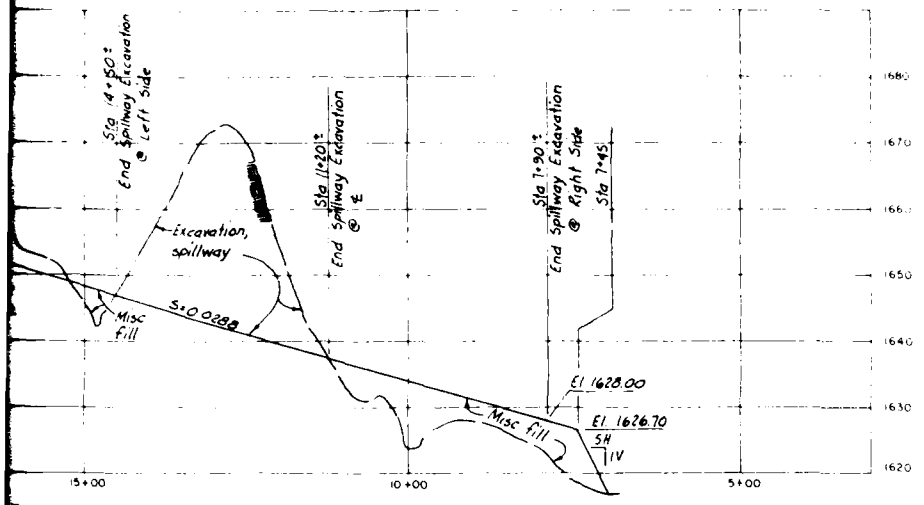
VERTICAL SCALE 1 IN = 10 FT

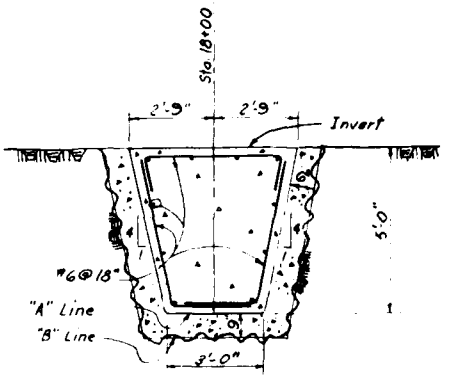


PLAN

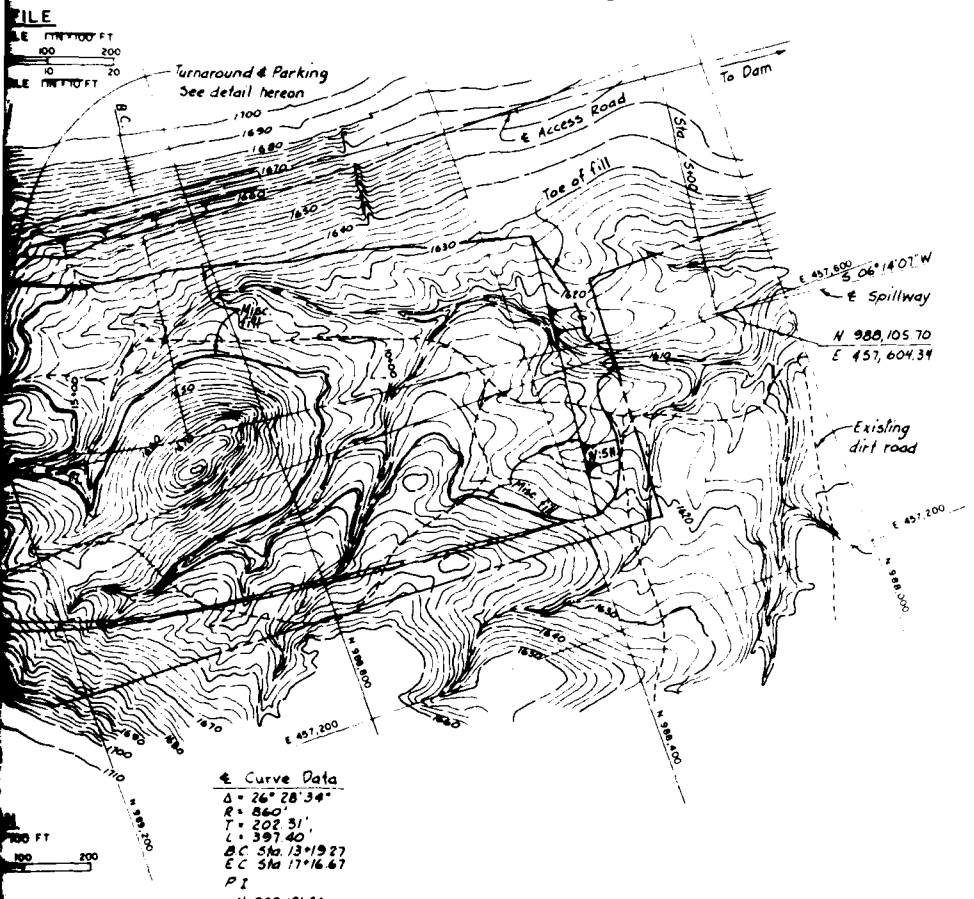
SCALE 1 IN = 100 FT

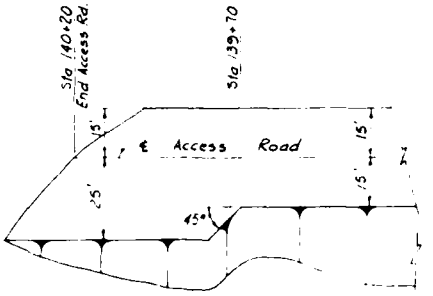
℄ Curve Data
Δ = 26° 28' 34"
R = 860'
T = 202.31'
L = 397.40'
℄C Sta 13+19.27
E.C. Sta 17+16.67
P.I.
N 989,121.24
E 457,715.30





CONCRETE SILL
AT SPILLWAY CREST
NOT TO SCALE





TURNAROUND & PARKING AREA AT SPILLWAY
NOT TO SCALE

℄ Curve Data
Δ = 26° 28' 34"
R = 860'
T = 202.31'
L = 397.40
BC Sta 13+19.27
EC Sta 17+16.67
PI
N 989,121.24
E 457,715.30

NOTES.
1 FOR LOCATION OF WASTE AREA FOR EXCAVATED SPILLWAY MATERIALS, SEE ~~SHEET 8~~ PLATE 2.

REFERENCES:
1. Topography by Photogrammetric Method by Aerial Mapping Co. Survey of October 1974. Contour interval as shown.
2. Horizontal control is based on National Geodetic Survey Datum Vertical control is based on 1929 MSL Datum.

DATUM IS MEAN SEA LEVEL

SYMBOL	DESCRIPTION	DATE	APPROVAL
	REVISIONS		

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

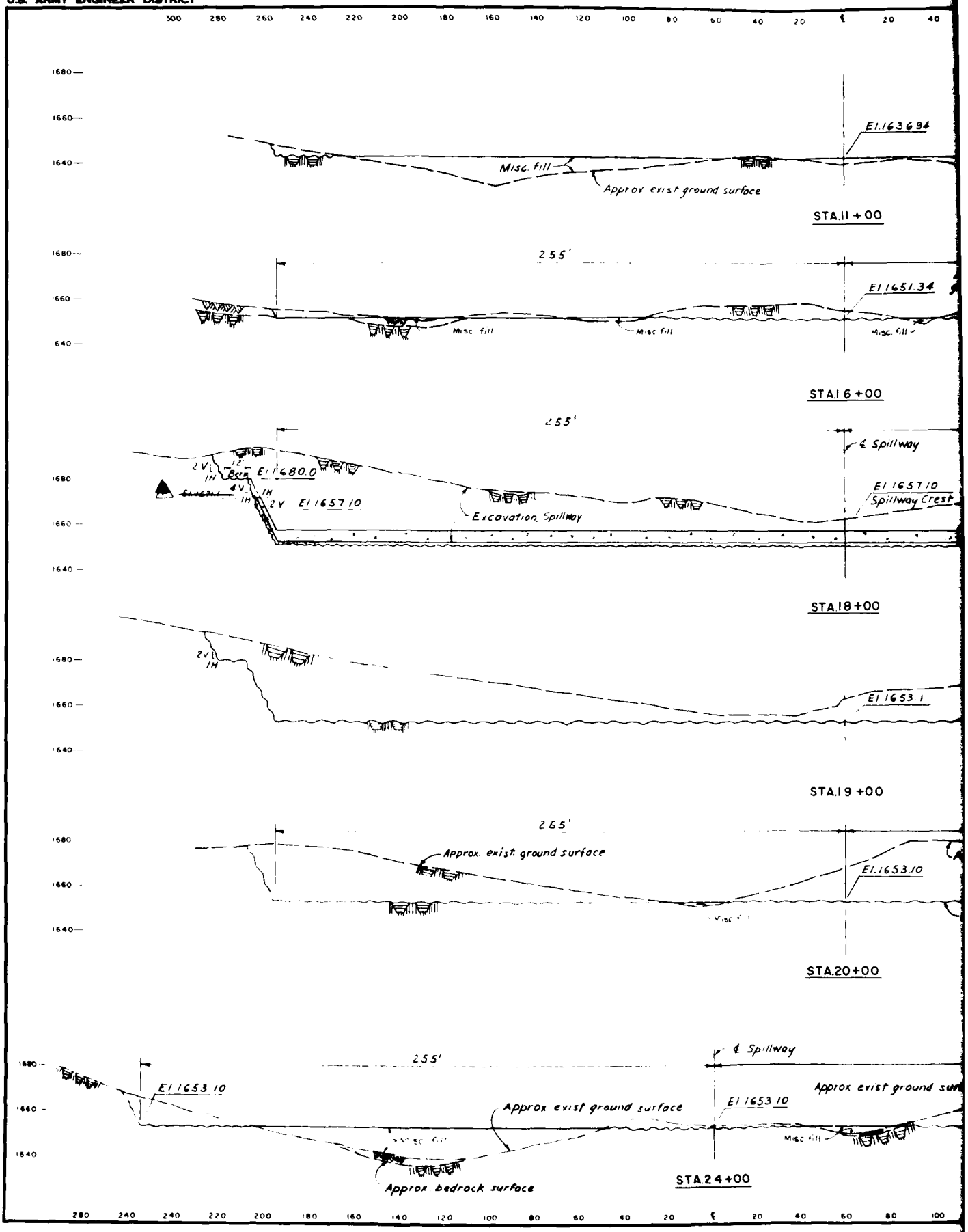
DESIGNED BY:
DRAWN BY: J.W.S.
CHECKED BY:

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

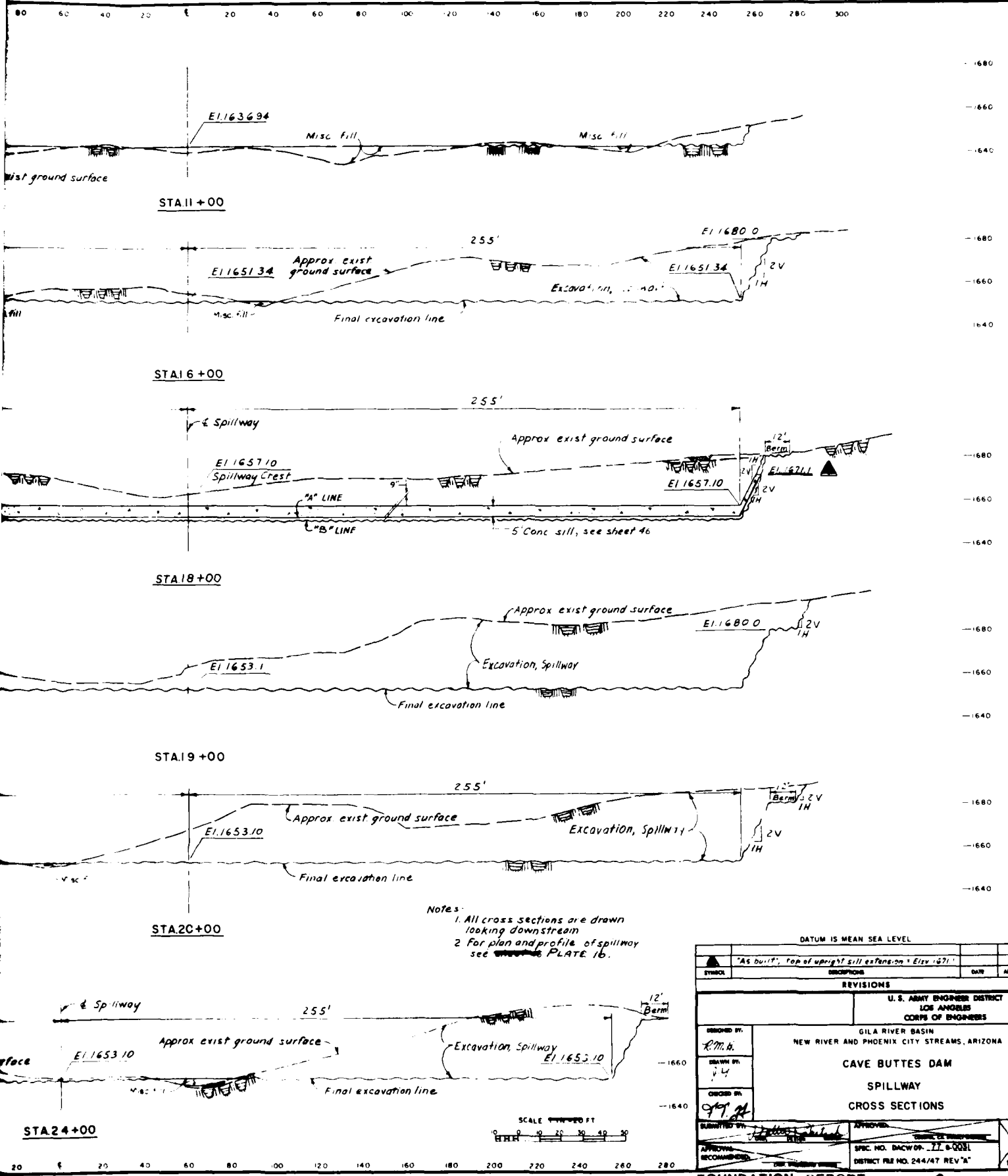
CAVE BUTTES DAM
SPILLWAY
PLAN AND PROFILE

SUBMITTED:
APPROVED:
APPROVAL RECOMMENDED:
SPEC. NO. DACW09-77-B-0003
DISTRICT FILE NO. 244/46
SHEET 46 OF 71 SHEETS

U.S. ARMY ENGINEER DISTRICT



CORPS OF ENGINEERS



DATUM IS MEAN SEA LEVEL

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
▲	"As built": Top of upright sill extension = Elev. 1671.1		

REVISIONS

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY: R.M.H.
DRAWN BY: J.K.
CHECKED BY: R.M.H.

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM

SPILLWAY

CROSS SECTIONS

SUBMITTED BY: Chief, Engineering Division
APPROVED: Chief, Engineering Division
RECOMMENDED: Chief, Engineering Division
APPROVED: Colonel, Corps of Engineers

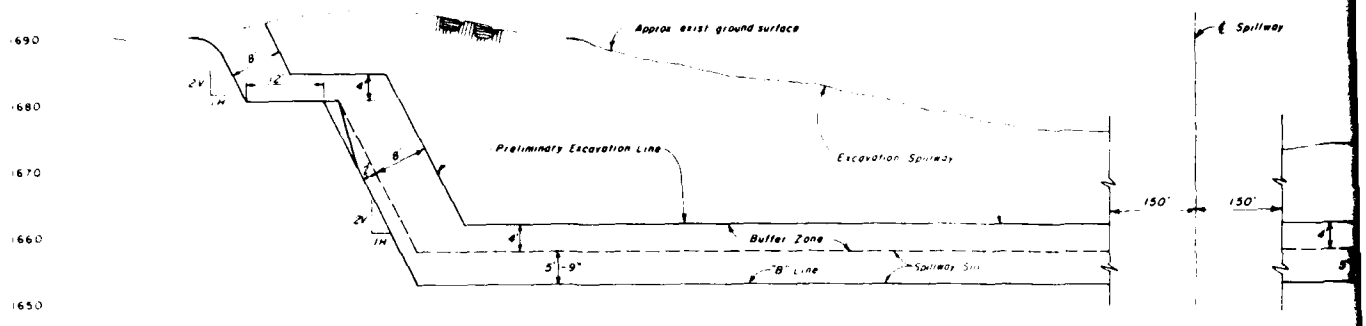
SPEC. NO. DACW09-77-B-0031
DISTRICT FILE NO. 244/47 REV "A"

SHEET 47 OF 71 SHEETS

FOUNDATION REPORT

2

PLATE 17



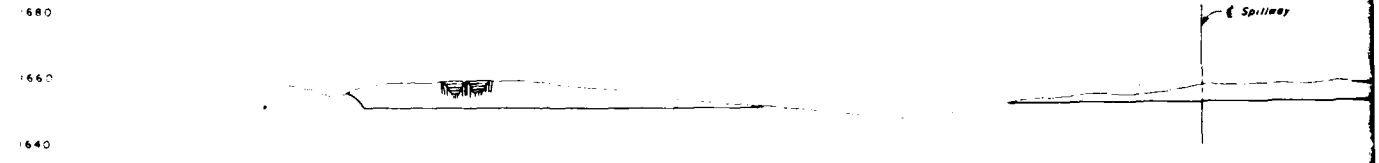
SPILLWAY CREST - STA 18+00

SCALE 1"=10 FT

A

STA 13+00

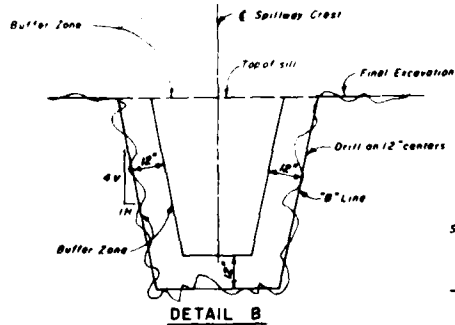
STA 19+00



STA 21+00

SCALE 1"=20 FT

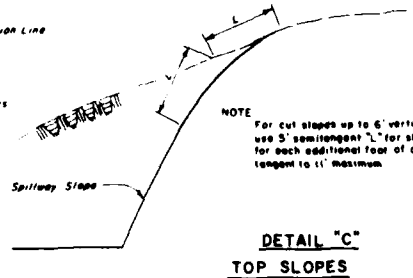
B



DETAIL B

TYPICAL SECTION SPILLWAY SILL

SCALE 1"=2 FT C



NOTE

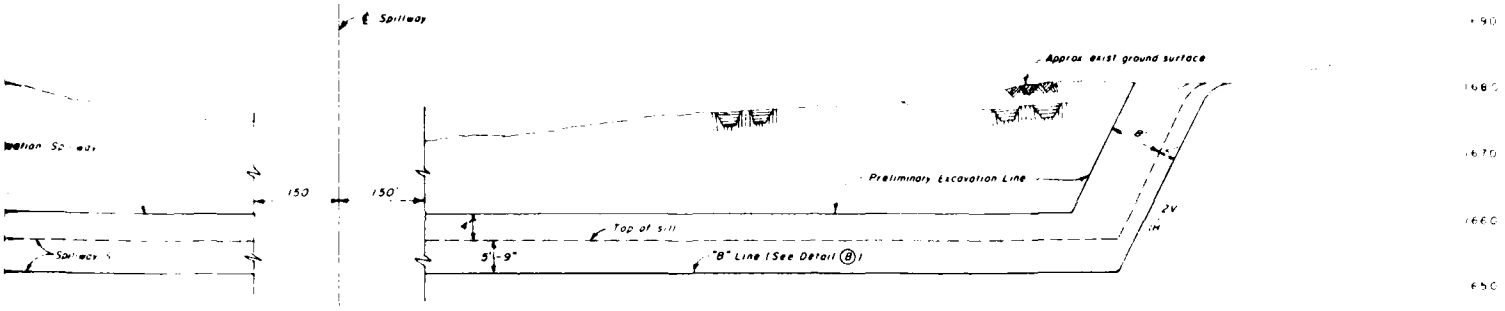
For cut slopes up to 6' vertical heights use 3' semitangent "L" for slope rounding for each additional foot of cut add 1' semi-tangent to 11' maximum

DETAIL "C"

TOP SLOPES

SCALE 1"=10 FT

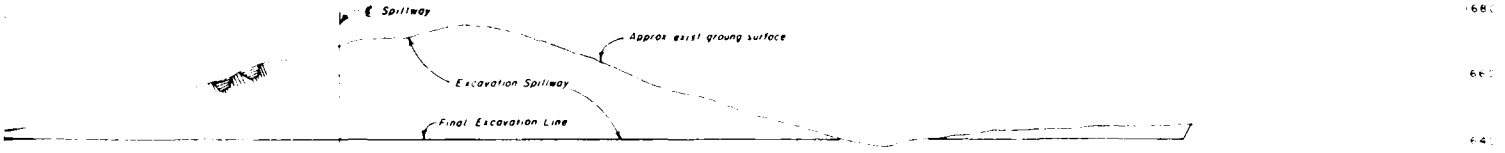
A



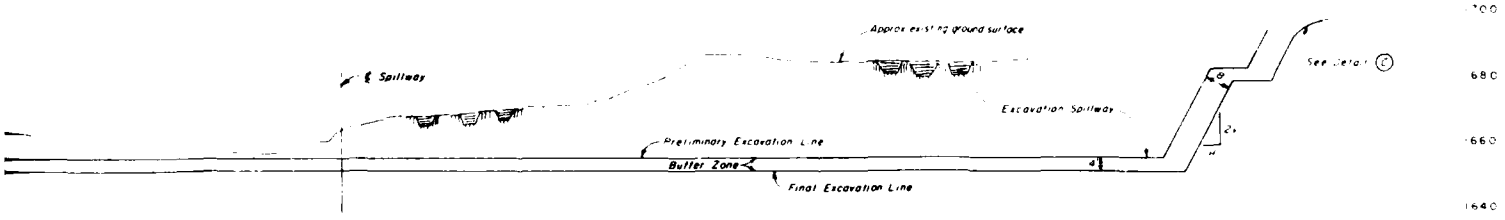
SPILLWAY CREST - STA. 18+00

SCALE 1 IN = 10 FT

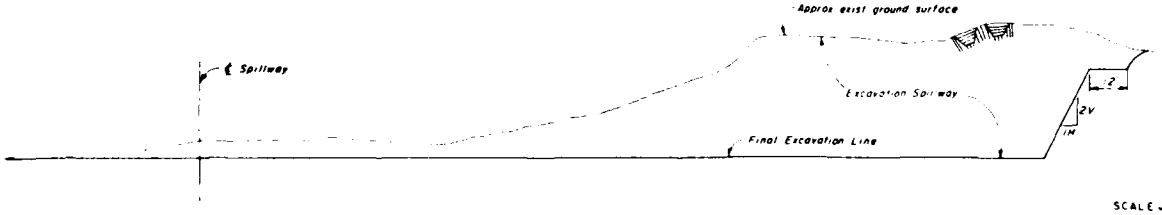
4



STA. 13+00



STA. 19+00



STA. 21+00

SCALE 1 IN = 30 FT

B

SCALE 1 IN = 10 FT A

SCALE 1 IN = 20 FT B

SCALE 1 IN = 2 FT C

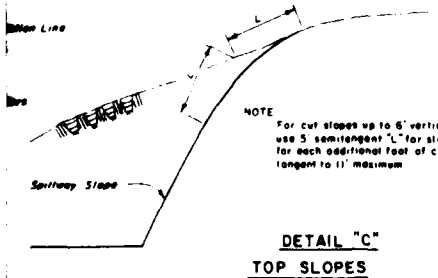
GENERAL NOTES

1 ALL SECTIONS ARE LOOKING DOWNSTREAM (DOWNSTATION)

2 IN THE AREA BETWEEN STATION 17+00 AND 19+00 ON EITHER SIDE OF THE SPILLWAY CREST, WHERE RIPPING WOULD DAMAGE THE ROCK NEAR THE PRELIMINARY EXCAVATION LINE, SOUND WALL BLASTING METHODS WILL BE USED TO REMOVE THE BUFFER ZONES ACCORDING TO PRESCRIBED METHODS UNDER BLASTING

3 CONTRACTOR SHALL SUBMIT PLANS FOR EXCAVATIONS BY BLASTING

4 SEE SHEET A6 FOR PLAN VIEW
PLATE 16



NOTE
For cut slopes up to 6' vertical heights use 5' semitangent "L" for slope rounding, for each additional foot of cut add 1' semi-tangent to 11' maximum

DETAIL "C"

TOP SLOPES

SCALE 1 IN = 10 FT

A

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY: RMH & DMP
DRAWN BY: DY
CHECKED BY: RMH

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM

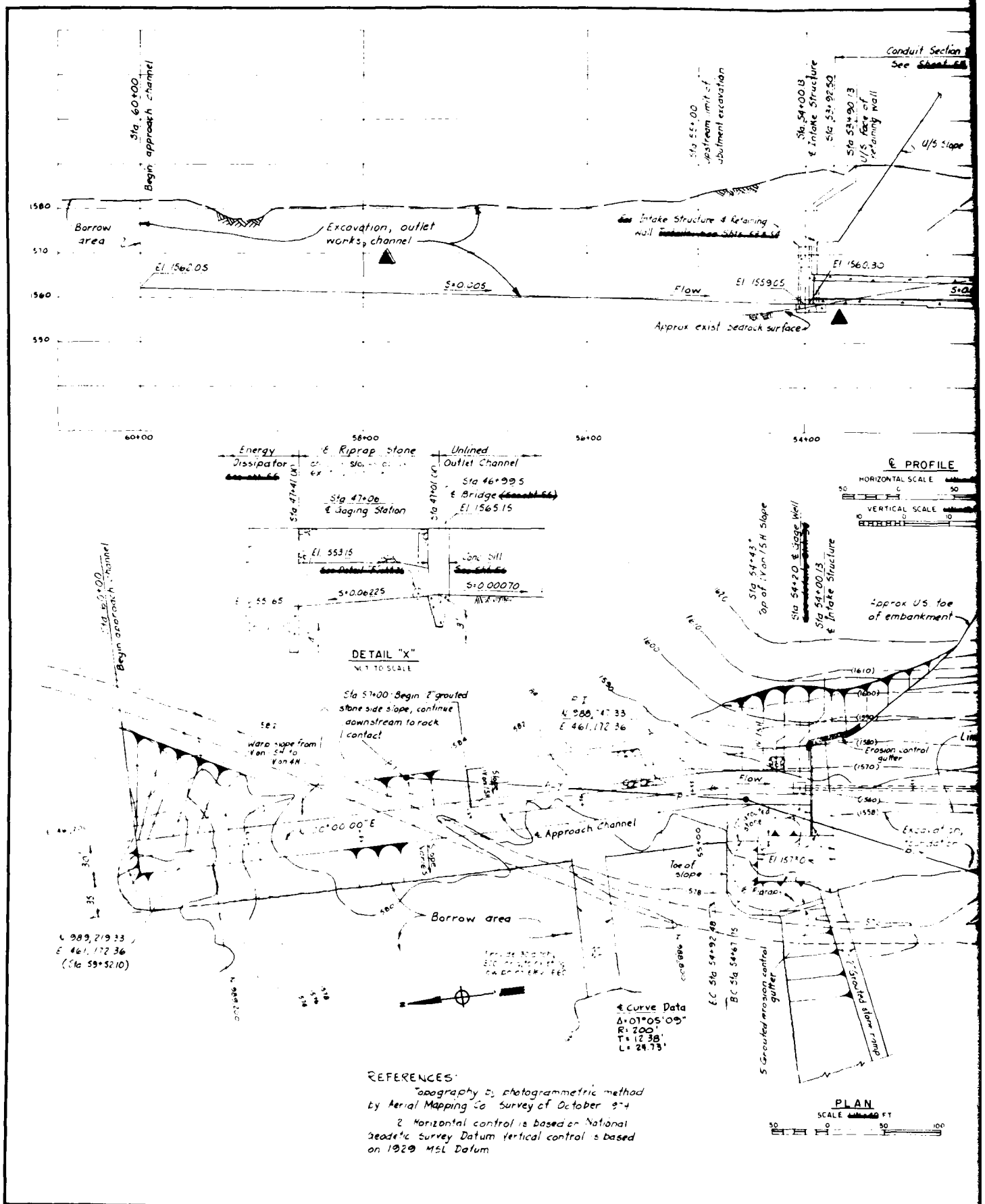
SPILLWAY

ROCK EXCAVATION DETAILS

SUBMITTED BY: [signature]
APPROVED: [signature]
APPROVAL RECOMMENDED: [signature]

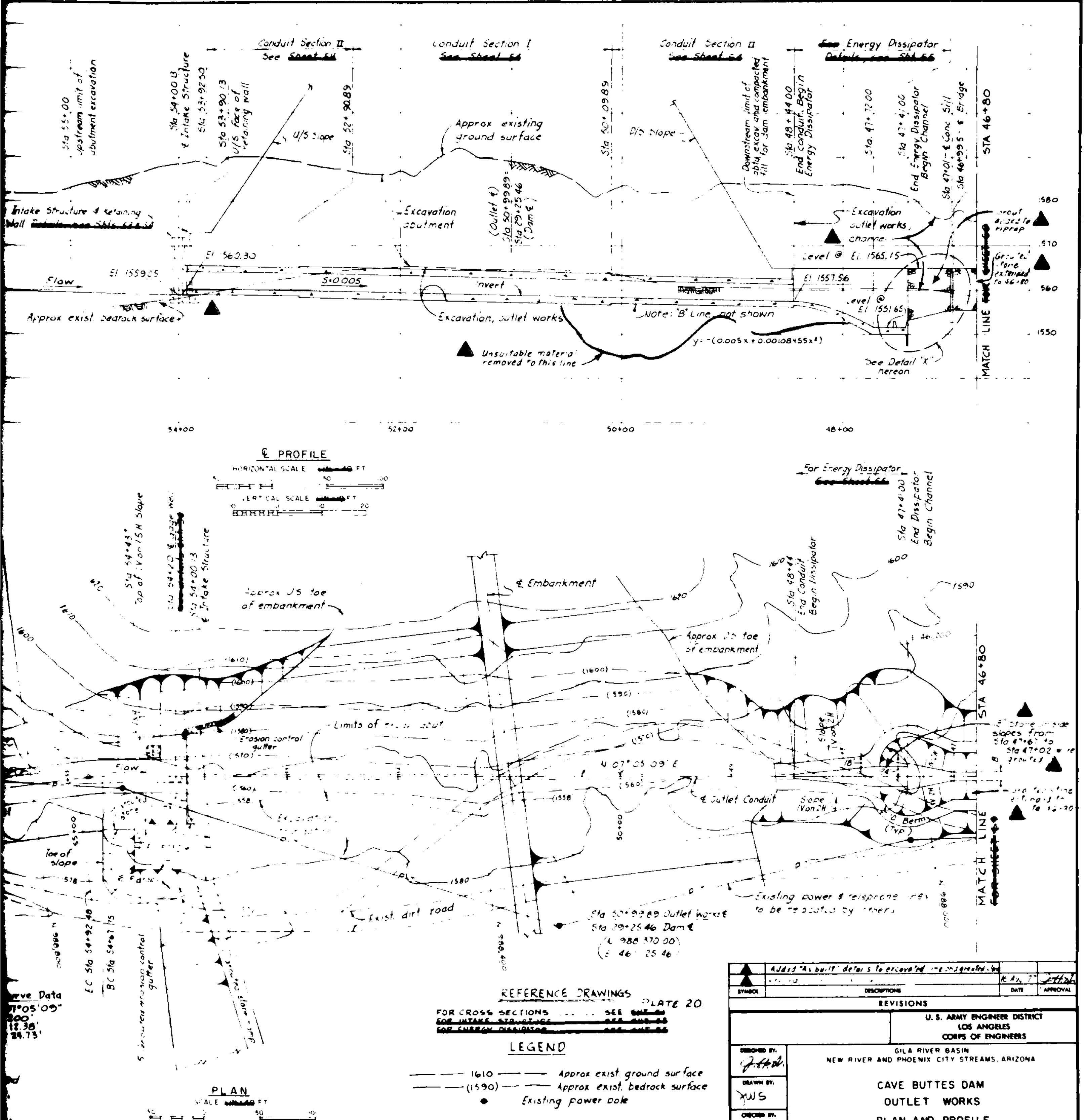
SPEC. NO. DACW09-77-B-0091
DISTRICT FILE NO. 244/48
DATE:

SHEET 48 OF SHEETS



REFERENCES:

1. Topography by photogrammetric method by Aerial Mapping Co. Survey of October 9-4
2. Horizontal control is based on National Geodetic Survey Datum Vertical control is based on 1929 MSL Datum



REFERENCE DRAWINGS

PLATE 20

FOR CROSS SECTIONS ... ... SEE

LEGEND

— — 1610 — — Approx exist. ground surface

— — (1590) — — Approx exist. bedrock surface

● Existing power pole

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
▲	Added "As built" details to excavated line & grouted		

REVISIONS

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM
OUTLET WORKS
PLAN AND PROFILE
STA 60+00 TO STA 46+80

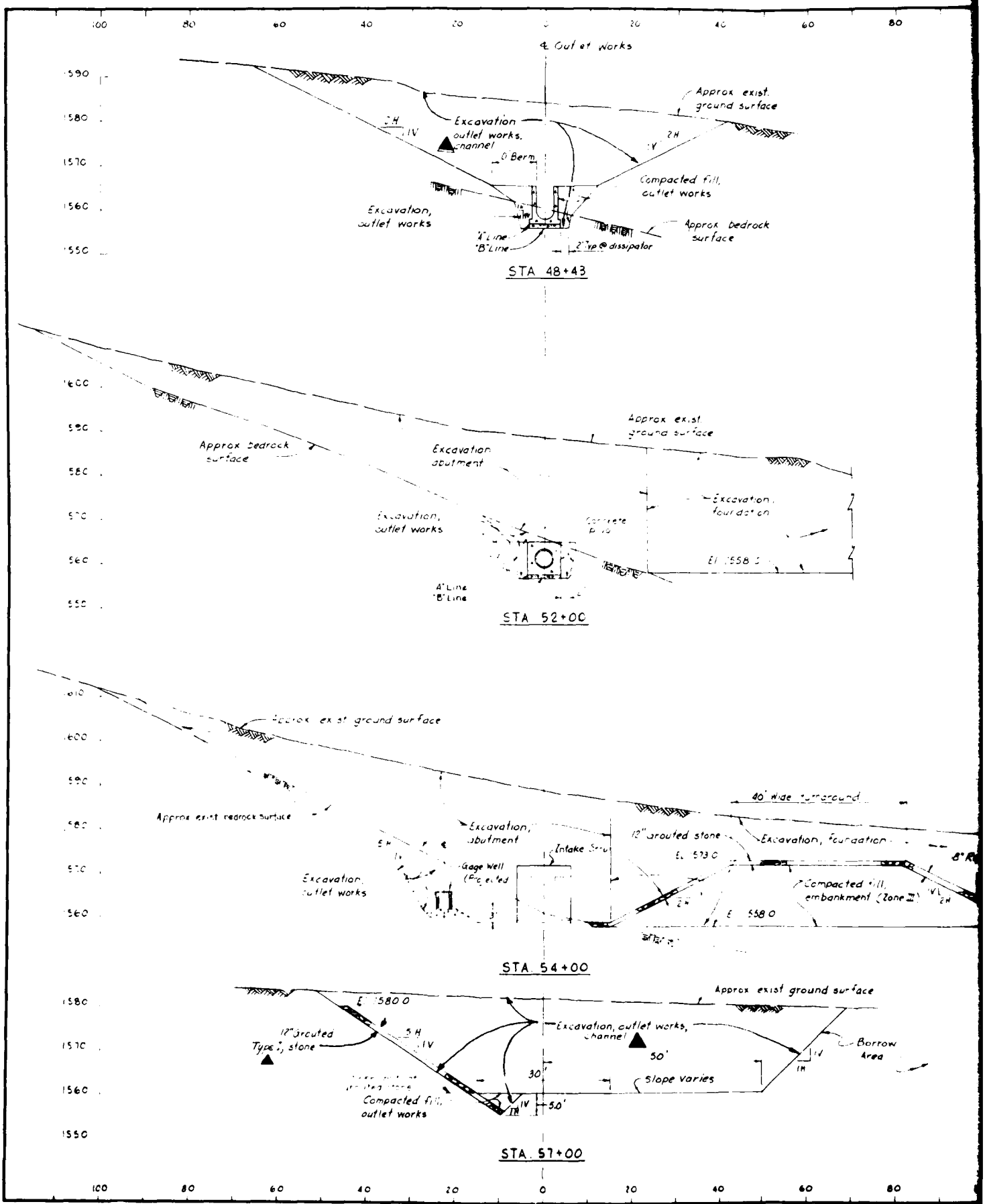
DESIGNED BY: DRAWN BY: XWS CHECKED BY: SUBMITTED BY: APPROVAL RECOMMENDED: APPROVED:

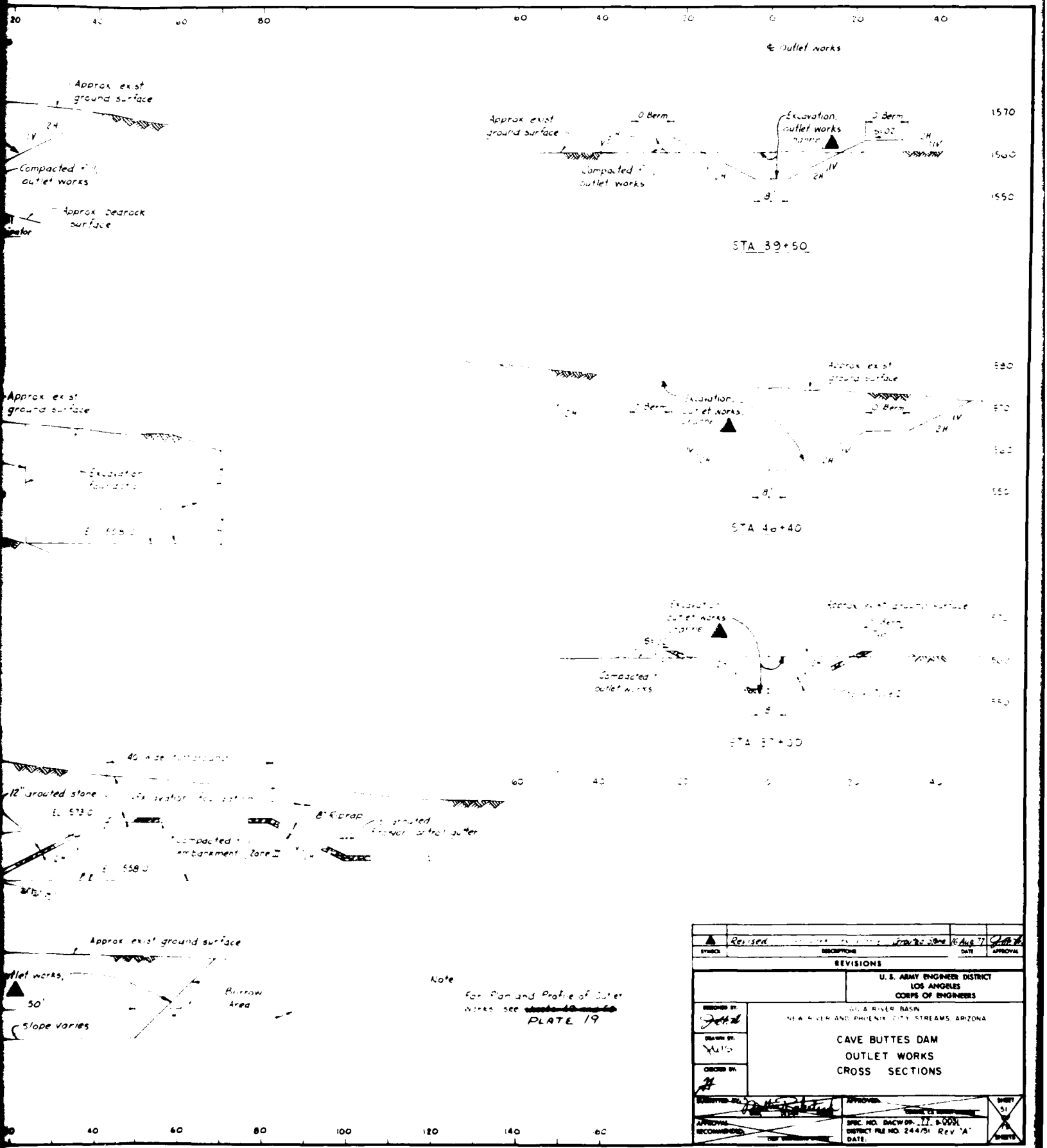
SPEC. NO. DACW09-77-B-0031
DISTRICT FILE NO. 244/49 REV "A"
DATE:

SHEET 49 OF 79 SHEETS

FOUNDATION REPORT

PLATE 19


℄ Out et works
Approx exist. ground surface
Excavation outlet works. channel
Berm
Compacted fill, outlet works
Excavation, outlet works
Approx bedrock surface
"A" Line
"B" Line
STA 48+43
Approx exist ground surface
Approx bedrock surface
Excavation abutment
Excavation, outlet works
Excavation, foundation
STA 52+00
Bedrock exist ground surface
Approx exist bedrock surface
40' Wide turnaround
Excavation, abutment
Intake
Gage Well
Excavation outlet works
12" grouted stone
Excavation, foundation
Compacted fill, embankment (Zone
STA 54+00
Approx exist ground surface
Excavation, outlet works, channel
12" grouted Type , stone
Borrow Area
Slope varies
Compacted fill, outlet works
STA 57+00



Note

For Plan and Profile of Outlet Works see ~~sheets 49 and 50~~ PLATE 19

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
1	Revised [illegible] Zone II	16 Aug 71	

REVISIONS

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY:
DRAWN BY:
CHECKED BY:

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM
OUTLET WORKS
CROSS SECTIONS

SUBMITTED BY:
APPROVED:
APPROVAL RECOMMENDED:

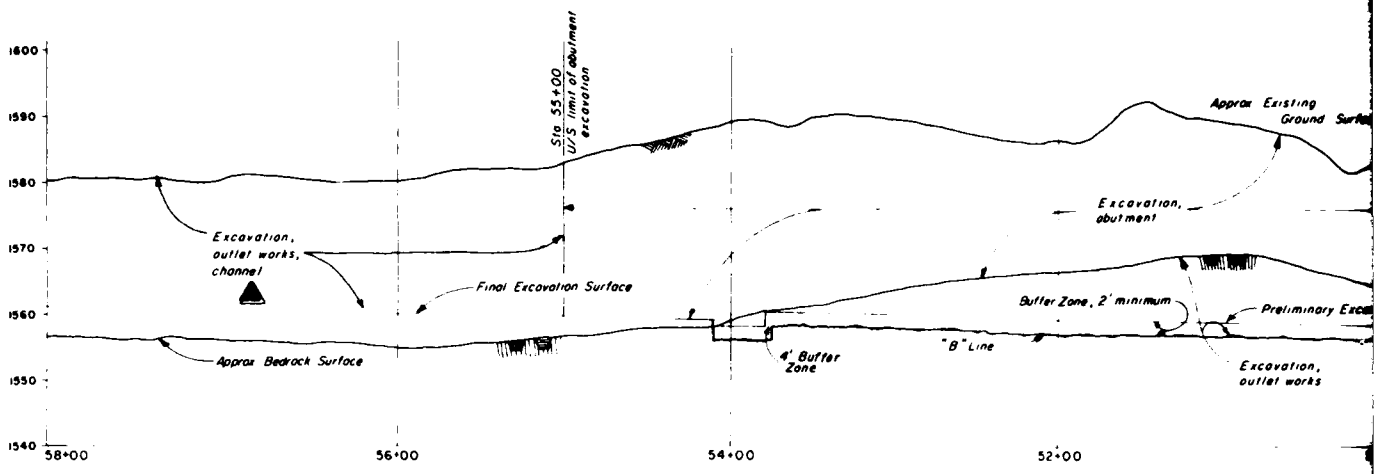
SPEC. NO. DACW09-[illegible]-B-0051
DISTRICT FILE NO. 244/51 Rev "A"
DATE:

SHEET 51 OF [illegible] SHEETS

FOUNDATION REPORT

PLATE 20

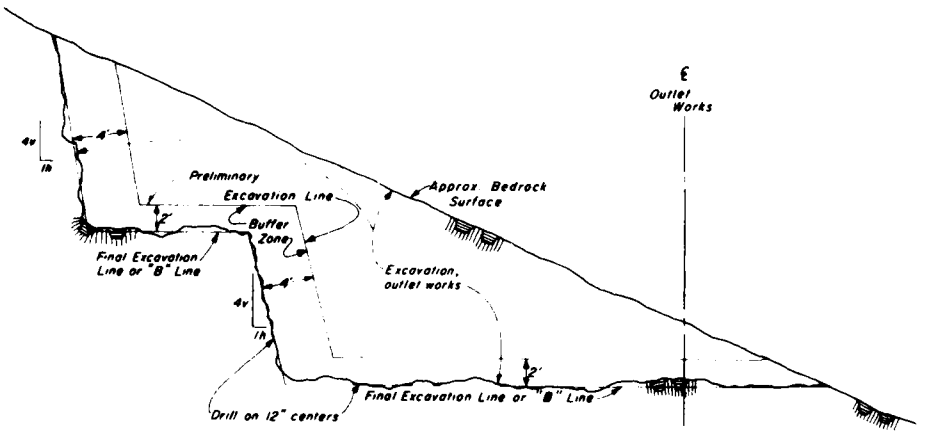
2



PROFILE ALONG ℄ OUTLET WO

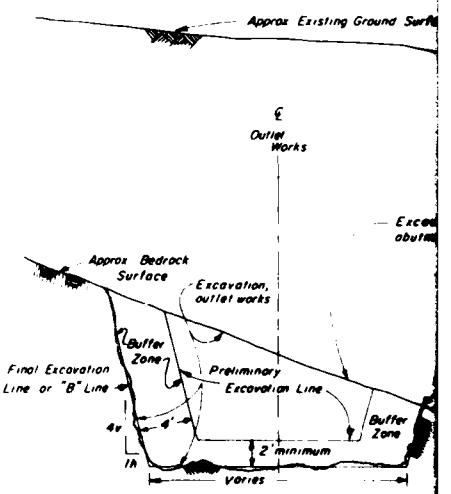
HORIZONTAL SCALE
40 20 0 40 80 120

VERTICAL SCALE
10 5 0 10 20 30



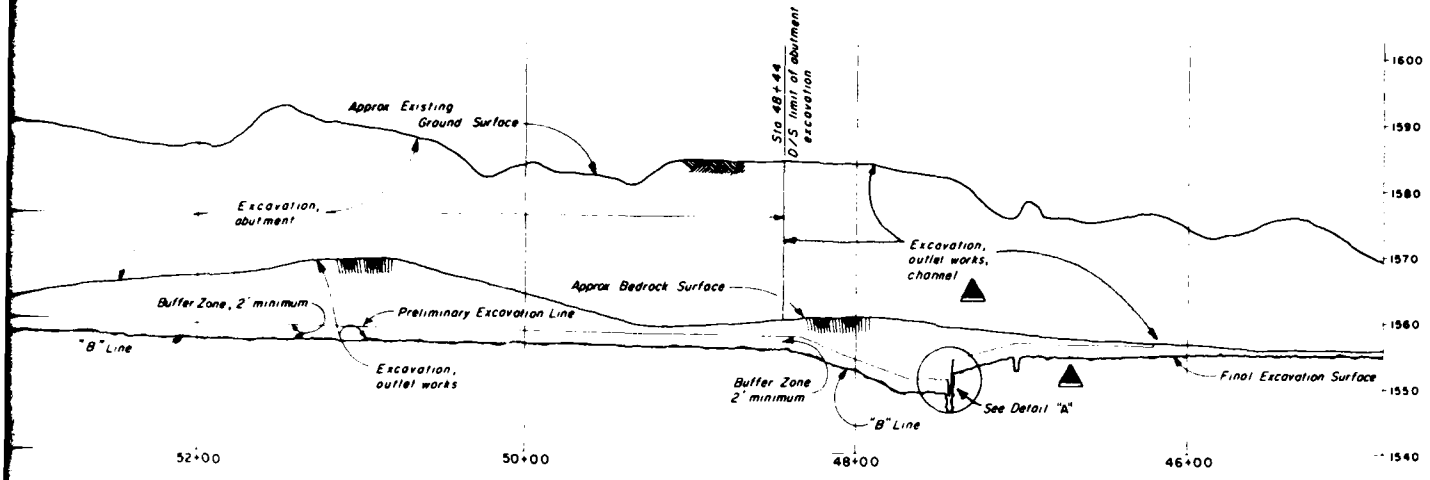
TYPICAL SECTION AT RETAINING WALL

SCALE



TYPICAL SECTION OUTLET CO

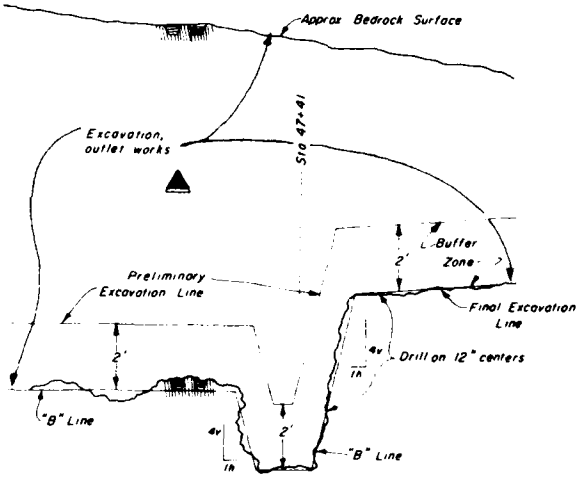
SCALE
5 4 3 2 1 0 5 10 FEET



PROFILE ALONG ℄ OUTLET WORKS

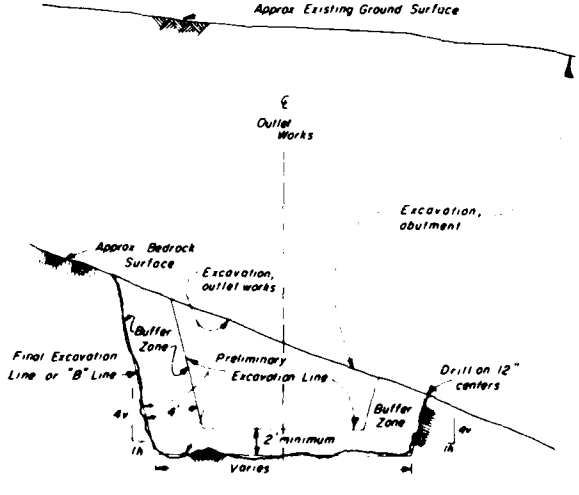
HORIZONTAL SCALE
40 20 0 40 80 120 160 FEET

VERTICAL SCALE
10 5 0 10 20 30 40 FEET



DETAIL A

SCALE
2 1 0 2 4 FEET



TYPICAL SECTION OUTLET CONDUIT

SCALE
5 4 3 2 1 0 5 10 FEET

GENERAL NOTES

1. IN THE AREA BETWEEN STATION 53+87 AND 46+00 ALONG THE OUTLET WORKS WHERE RIPPING WOULD DAMAGE THE ROCK FACE NEAR THE PRELIMINARY EXCAVATION LINE, SOUND WALL BLASTING METHODS WILL BE USED TO REMOVE THE BUFFER ZONES ACCORDING TO PRESCRIBED METHODS UNDER BLASTING
2. CONTRACTOR SHALL SUBMIT PLANS FOR EXCAVATIONS BY BLASTING
3. SEE [illegible] FOR PLAN VIEW
   PLATE 19

DATUM IS MEAN SEA LEVEL

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	Revised notes and limits of excavation for outlet works	16 Aug '71	[illegible]

REVISIONS

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY: DWL
DRAWN BY:
CHECKED BY:
TRACED BY:

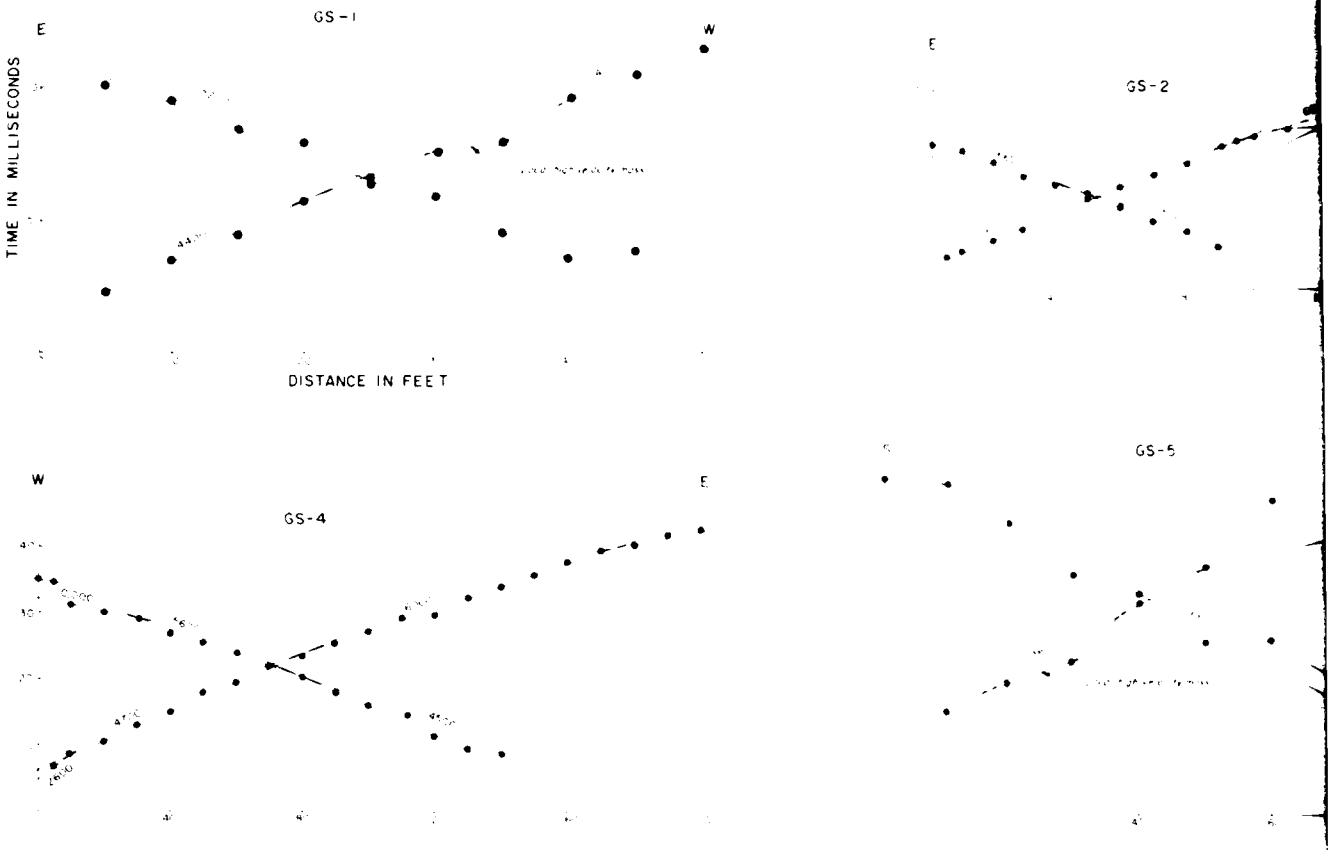
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

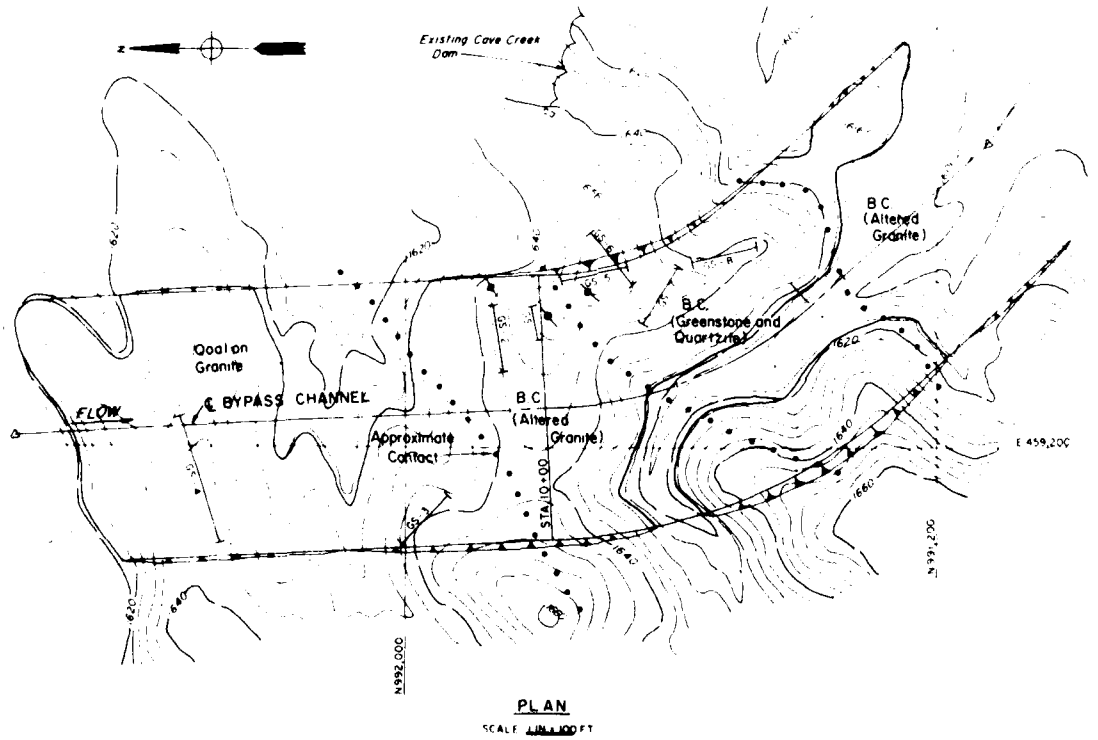
CAVE BUTTES DAM
OUTLET WORKS
ROCK EXCAVATION DETAILS

RECOMMENDED: [illegible]
APPROVED: [illegible]
APPROVAL RECOMMENDED: [illegible]
SPEC. NO. DACW09-[illegible]-B-0035
DISTRICT FILE NO. 244/82 REV "A"
DATE:
SHEET 52 OF 79 SHEETS

FOUNDATION REPORT 2

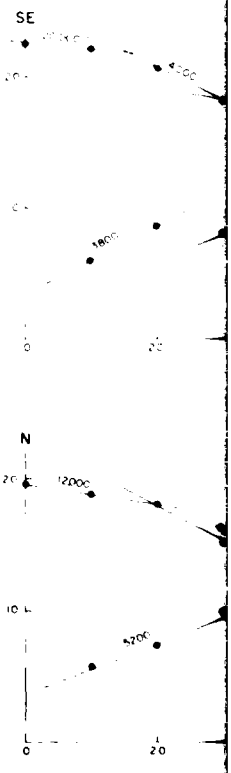
PLATE 21

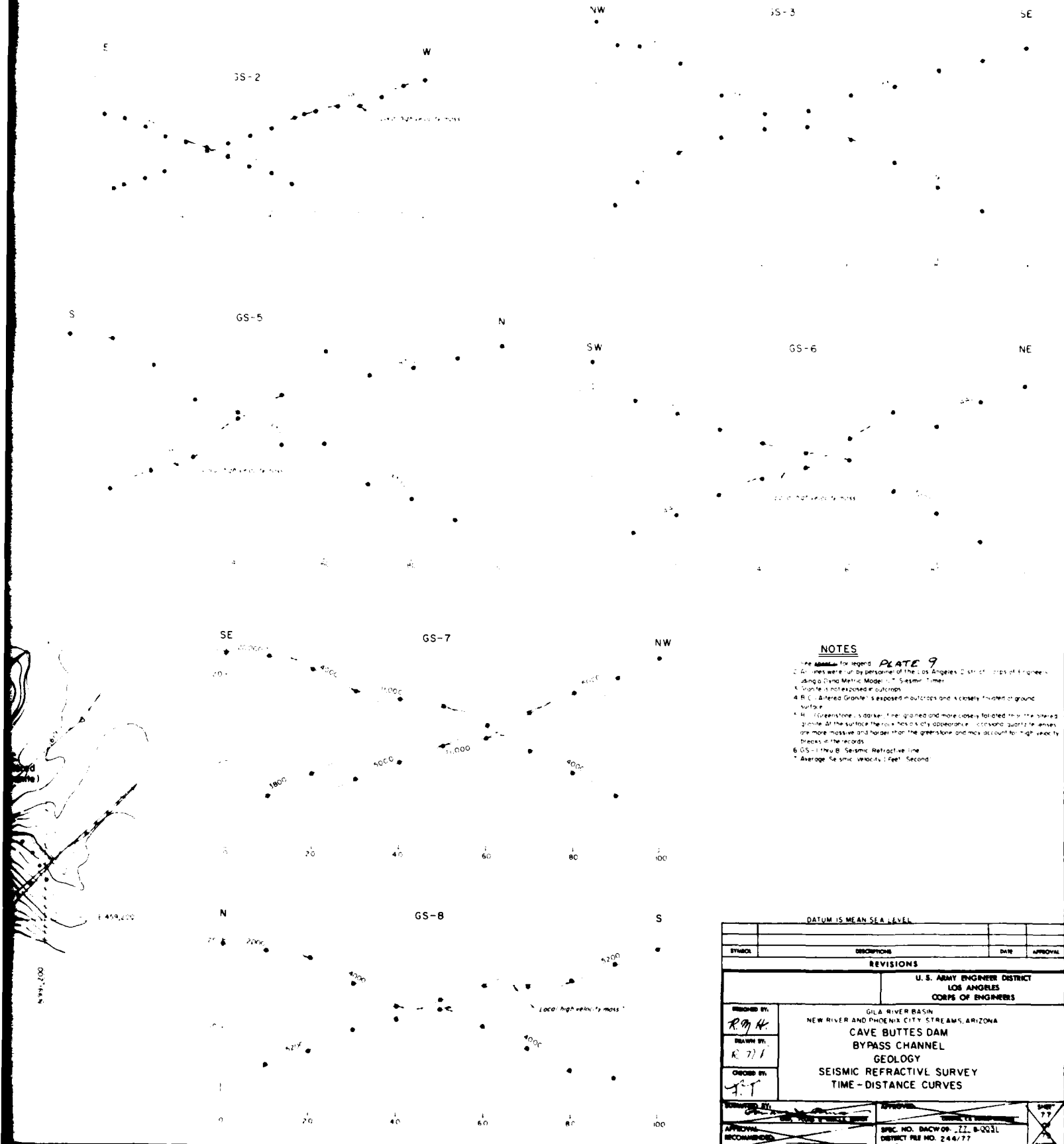




PLAN

SCALE 1IN=100FT





NOTES

1. See [illegible] for legend. PLATE 9
2. All lines were run by personnel of the Los Angeles District, Corps of Engineers using a Dyna Metric Model [illegible] Seismic Timer.
3. Granite is not exposed in outcrops.
4. B, C, Altered Granite is exposed in outcrops and is closely fractured at ground surface.
5. H, Greenstone is darker, fine grained and more closely foliated than the altered granite. At the surface the rock has a city appearance. Occasional quartz lenses are more massive and harder than the greenstone and may account for high velocity blocks in the records.
6. GS-1 thru 8, Seismic Refractive line.
7. Average Seismic Velocity (Feet/Second).

DATUM IS MEAN SEA LEVEL

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

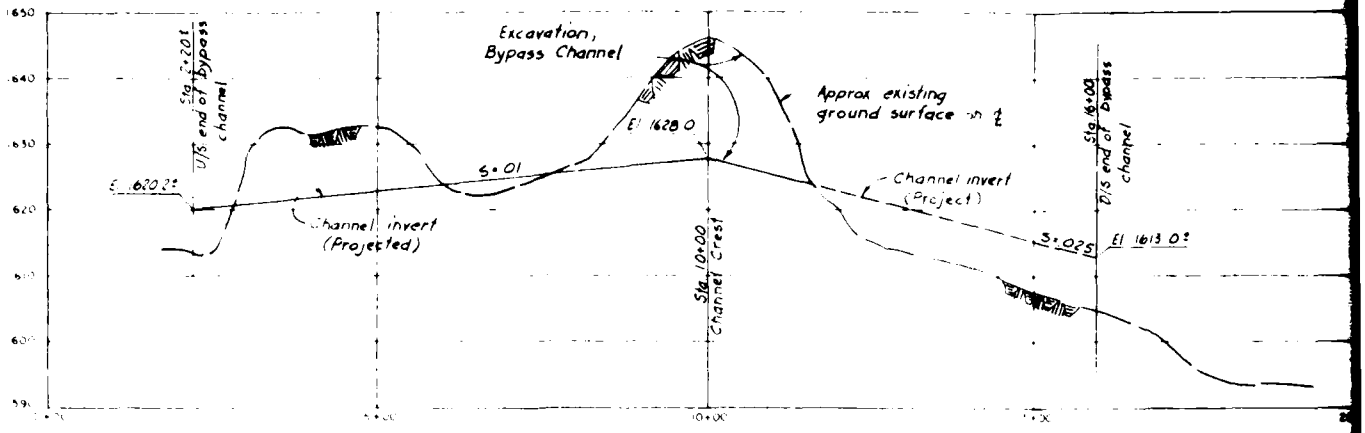
DESIGNED BY: R.M.H.
DRAWN BY: R.T.I.
CHECKED BY: T.F.T.

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA
CAVE BUTTES DAM
BYPASS CHANNEL
GEOLOGY
SEISMIC REFRACTIVE SURVEY
TIME - DISTANCE CURVES

SUBMITTED BY: [illegible]
APPROVED: [illegible]
APPROVAL RECOMMENDED: [illegible]
SPEC. NO. DACW09-77-B-0031
DISTRICT FILE NO. 244/77
DATE:
SHEET 77 OF 78 SHEETS

FOUNDATION REPORT 2

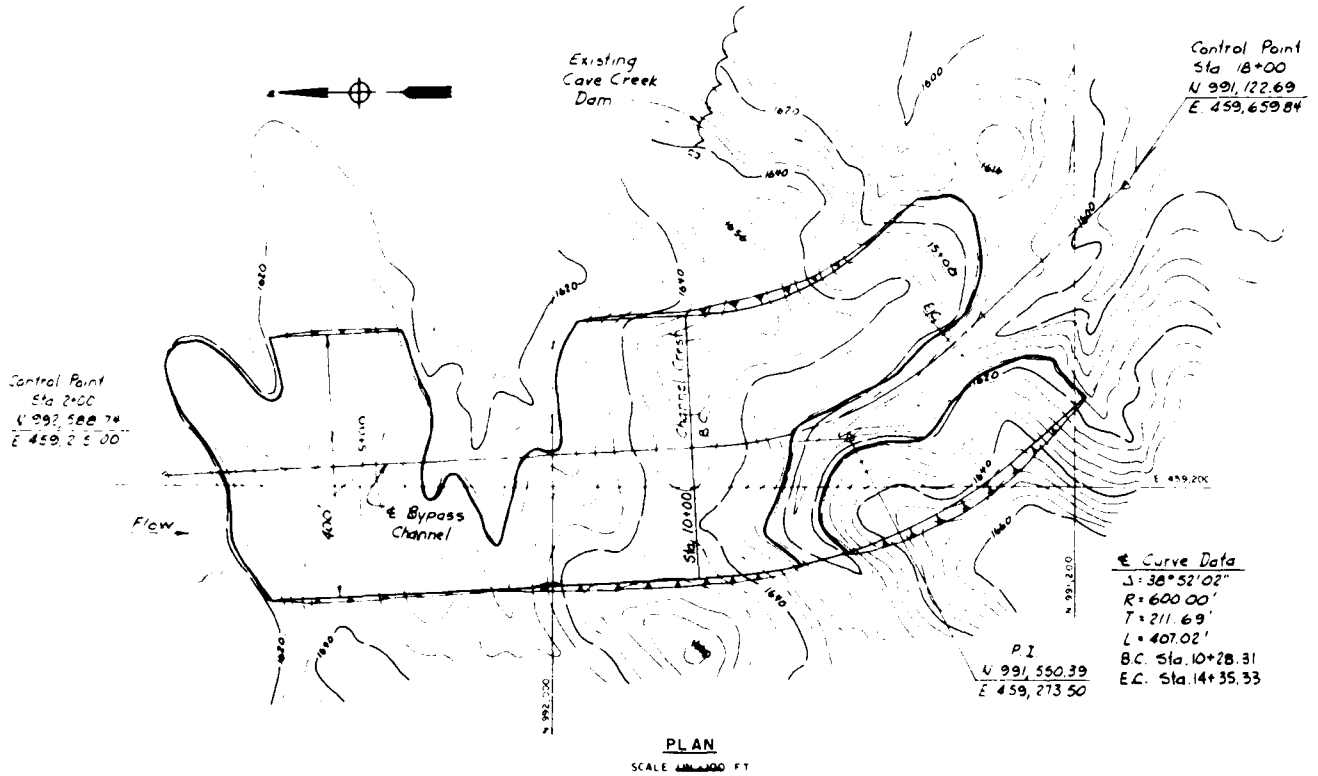
PLATE 22



℄ PROFILE

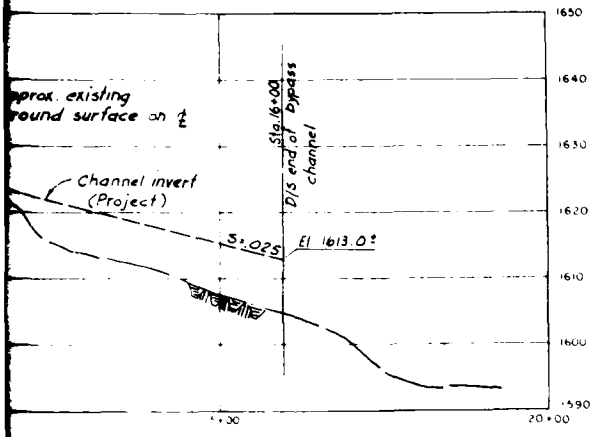
HORIZONTAL SCALE 1" = 100 FT

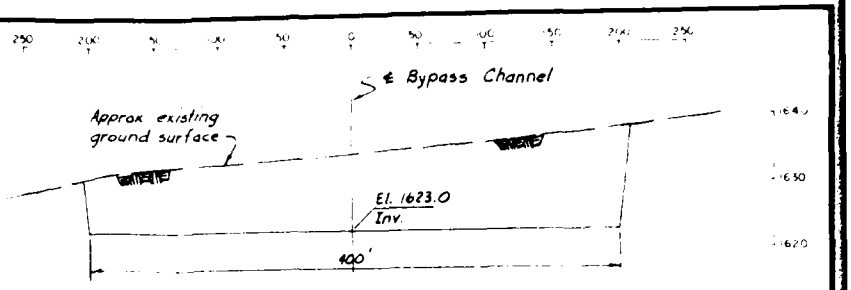
VERTICAL SCALE 1" = 10 FT



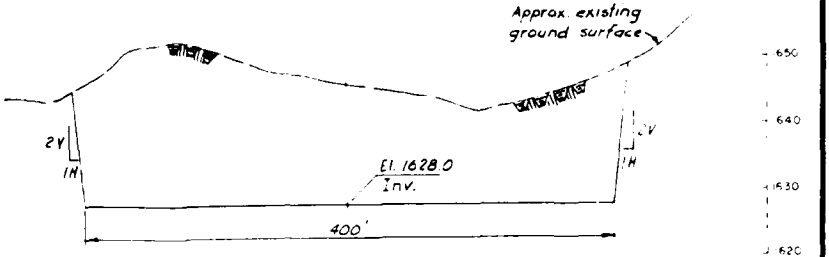
PLAN

SCALE 1" = 100 FT

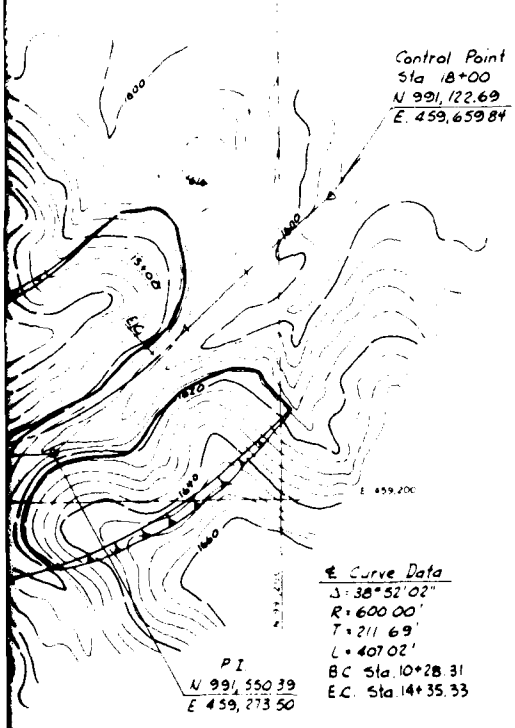


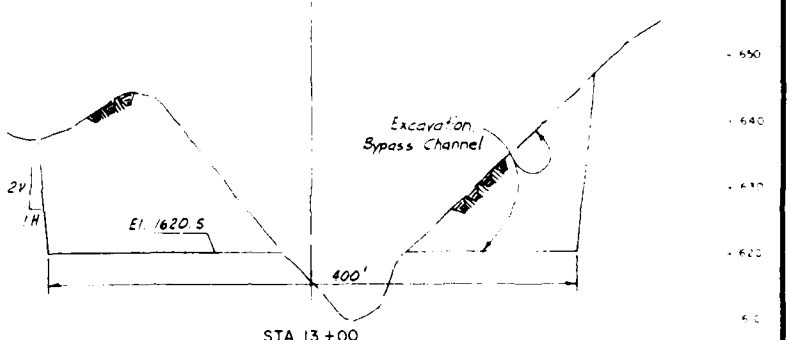


STA 5+00

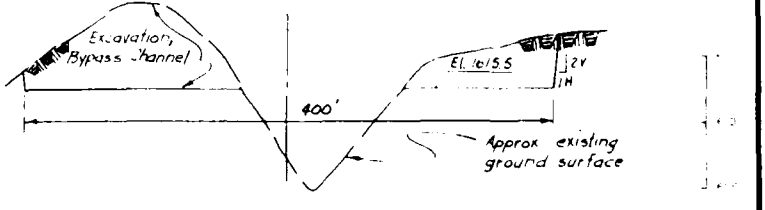


STA 10+00





STA 13+00



STA 15+00

HORIZONTAL SCALE 50 FT
VERTICAL SCALE FT

Note Cross Sections are drawn looking downstream

REFERENCES:

1. Topography by Photogrammetric Method by Pafford and Associates Survey of July 1969.
2. Horizontal control is based on National Geodetic Survey Datum. Vertical control is based on 1929 MSL Datum.

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY: JHH
DRAWN BY: gws
CHECKED BY: JH

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM

BYPASS CHANNEL

PLAN, PROFILE AND SECTIONS

SUBMITTED: [signature]
APPROVED:
APPROVED: RECOMMENDED:
SPEC. NO. DACW09-72-B-0031
DISTRICT FILE NO. 244/78
DATE:
SHEET 78 OF 78 SHEETS

US ARMY ENGINEER DISTRICT

LEGEND

Qal Quaternary – Recent Alluvium: Streambed, flood plain and unconsolidated valley fill deposits; clay, silt, sand, gravel, cobbles and boulders, generally unconsolidated but occasional cemented intervals and lenses.

Qoal Quaternary – Older Alluvium: Terrace, slope wash deposits and talus debris, clay, silt, sand, gravel, cobbles and boulders; partly consolidated valley fill with consolidated intervals and lense of cemented materials

Qtb Quaternary or Tertiary – Basalt: dark gray or black to reddish brown, fine grained, dense to vesicular; commonly vesicular and vuggy, hard and blocky to brecciated, occasional layers of ash, scria, tuff and tuffaceous agglomerate.

QTt Quaternary or Tertiary – Tuff, Agglomertic tuff and tuffaceous agglomerate: Light brown to buff, soft to hard, angular to subangular clasts of green metaigneous rock and dense to vesicular basalt to 3½ inches maximum diameter in a fine grained, well cemented tuffaceous matrix, material becomes more agglomeratic with increase in depth.

gr porphyry felsite

QTi Quaternary or Tertiary intrusive rocks: Includes pods, lenses and dikes of "younger" granite and a few dikes of various intrusive rocks. They are identified individually on the plates using a scale of 1 inch=10 feet No specific age dates are available for any rock in this group.

Gr Precambrian – Granite and granoclíorite: medium to fine grained, contains inclusions of basement rocks. hard but highly fractured and blocky, partly weathered on fractures.

gst

B.C. Precambrian – Basement Complex: gray green to dark green. metaigneous rock, soft to hard fine grained alternately schistose and massive, closely fractured, but mostly along older recemented fractures, locally meta-andesite, gst=greenstone.

60°

Fault, showing dip, dashed where approximate, dotted where existance is uncertain. Long arrows show relative movement.

60

Foliation, srike and dip (in degrees), vertical, strike shown.

75

Joints, strike and dip (in degrees), vertical, strike shown.

Contact be

G-91 G-93

D-26U D-36

R.B. or rockbit

core loss

5.8		no test
12.2	10	
	10	
20.5	20	
	10	no loss
	20	
35.0	30	

4

505'

1105.0'

D-13u

D-5e

Large s

40°

? ≠ 1-8" gεb (r F 9)

50

40

2-8" (5")

SLURRY GROUT

DENT

LEGEND (Cont.)

ontact between alluvium and bedrock types (Plates 3 and 4)

G-93 Grout holes, vertical, inclined, EX size plug bit used.

Length of grout and core holes are horizontal projection of the true length (Plates using 1"=10' scale.)

-36

Diamond core holes, vertical and inclined, NX size.

ockbit Portion of core hole not cored (used tri-cone rockbit)

e loss Approximate interval of core loss (inbedrock intervals only)

Water Pressure Test

	no test
0	
0	
0	
0	no loss
0	
0	

O

Pressure test, accomplished using single packer
Depth, number of feet below collar of hole.
PSI, Pounds per square inch (water pressure)
GPM, gallons per minute water loss
No test, interval not tested
No loss, no water loss at pressure shown
Packer leaked, water leaked around packer.

Diamond core drill holes (shown on small scale section) inclined and vertical, dashed where projected.

105.0'
D-5e Diamond core holes, inclined and vertical (on small scale plan)

Large scale items used on Plates with 1"=10' scale

Contact between alluvium and bedrock or types of each, hachured where gradational.

0°
Fault or shear zone, dashed = approximate location, dotted concealed, ? = existance uncertain, 1-8"=range of thickness, g¢b=gouge and breccia, (r¢g=color is red and green, (brwn)=brown (y)=yellow, etc.

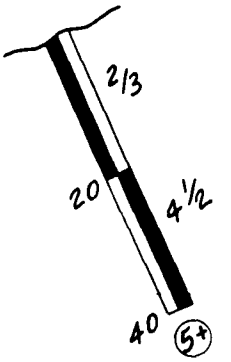
4b (rFg)
40
Joints (strike and 50°dip), (strike and vertical) (sheeted, strike, 40°dip, spaced 2-8" apart, average spacing 5 inches)

Point of surface leakage of grout

DENTAL Location of surface treatment with slurry grout or dental concrete.

gr Granite dikes lenses or pods.

LEGE



Grout hole detail
collar of the hol
number is number
left side number
the stage was gro
of cement placed

GENE

1. Grout header
pipe, holes dri
number of discontinuities to place a m
spaced grout hole locations, inclinati
in field, mix ratios (water to cement)
only during surface leaks or large ta

2. Grout hole lengths shown in
true length. Apparant dip of grout ho
by stereonet. See Plates 57 and 58 f

3. Geology for Plates 25-56 ma
January through August 1978. Geology
of 1970 through 1975.

4. For location of all diamond
See Plate 4. See Plates 6 and 7 for
location of profiles or sections A-A
See Plate 5 for geologic sections.

5. See Plates 25-56 for plan sh
geology mapped in 1978.

6. The term "greenstone" repres
rock, even when brilliant red or yellow
are seen.

7. Soil classification on geologi

8. Data on engineering characteri
condition of foundations composed of
emplacement of embankments, overburde
are presented in Phase II, Part I of t

F

)

(Plates 3 and 4)

size plug bit used.

e horizontal
ates using 1"=10' scale.)

nclined, NX size.

d (used tri-cone rockbit)

(inbedrock intervals only)

t

ng single packer
lar of hole.
ter pressure)
oss

ure shown
und packer.

n on small
rtical, dashed

d vertical (on small scale plan)

"= 10' scale

d bedrock or types of each,

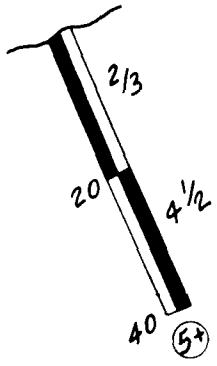
= approximate location,
nce uncertain,
gouge and breccia,
, (brwn) = brown (y) = yellow, etc.
, (strike and vertical) (sheeted,
part, average spacing 5 inches)

e of grout

atment with slurry
te.

ses or pods.

LEGEND (Cont.)



Grout hole detail ground surface and collar of the hole at top, right side number is number of sack placed in the stage, left side number is drilled depth of hole when the stage was grouted, circle shows total sacks of cement placed in the hole as neat cement grout.

GENERAL NOTES

1. Grout header was connected directly to the grout pipe, holes drilled at angles to intersect maximum number of discontinuities to place a more effective grout curtain, split spaced grout hole locations, inclinations and direction were determined in field, mix ratios (water to cement) were thin (5.1 to 7.1), thickened only during surface leaks or large takes.

2. Grout hole lengths shown in plan are horizontal projections of the true length. Apparent dip of grout holes on profiles or sections determined by stereonet. See Plates 57 and 58 for grouting data.

3. Geology for Plates 25-56 mapped summer 1978, grouting was done January through August 1978. Geology on Plates 3-23 from investigations of 1970 through 1975.

4. For location of all diamond core holes of 1970 through 1975, See Plate 4. See Plates 6 and 7 for geologic logs. See Plate 3 for location of profiles or sections A-A through D-D, of section E-E See Plate 4. See Plate 5 for geologic sections.

5. See Plates 25-56 for plan showing grout hole locations and geology mapped in 1978.

6. The term "greenstone" represents the green massive metaigneous rock, even when brilliant red or yellow shades resulting from iron oxides are seen.

7. Soil classification on geologic logs are visual.

8. Data on engineering characteristics of overburden materials, condition of foundations composed of overburden materials, data on emplacement of embankments, overburden excavation and instrumentation are presented in Phase II, Part I of the G.D.M.

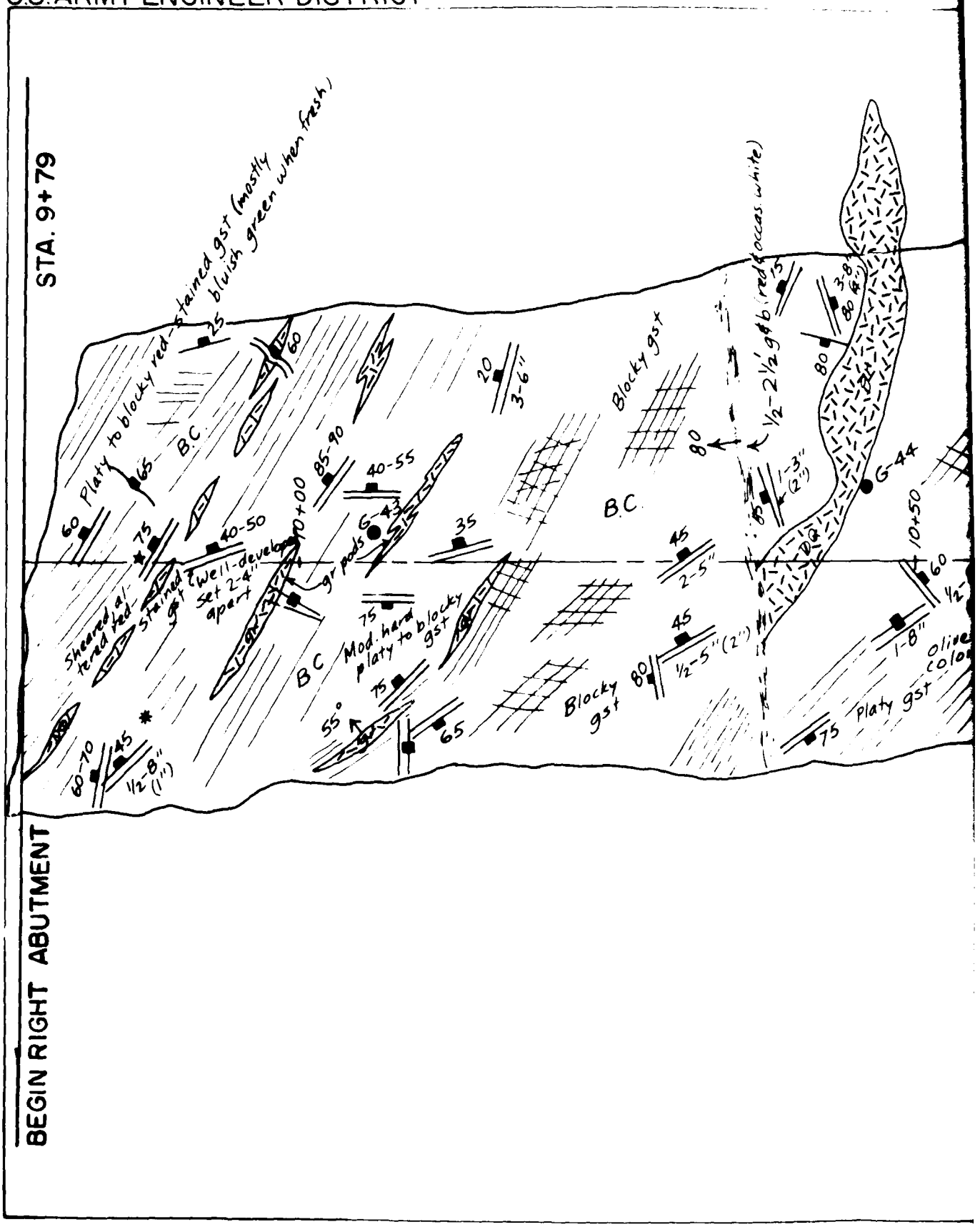
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

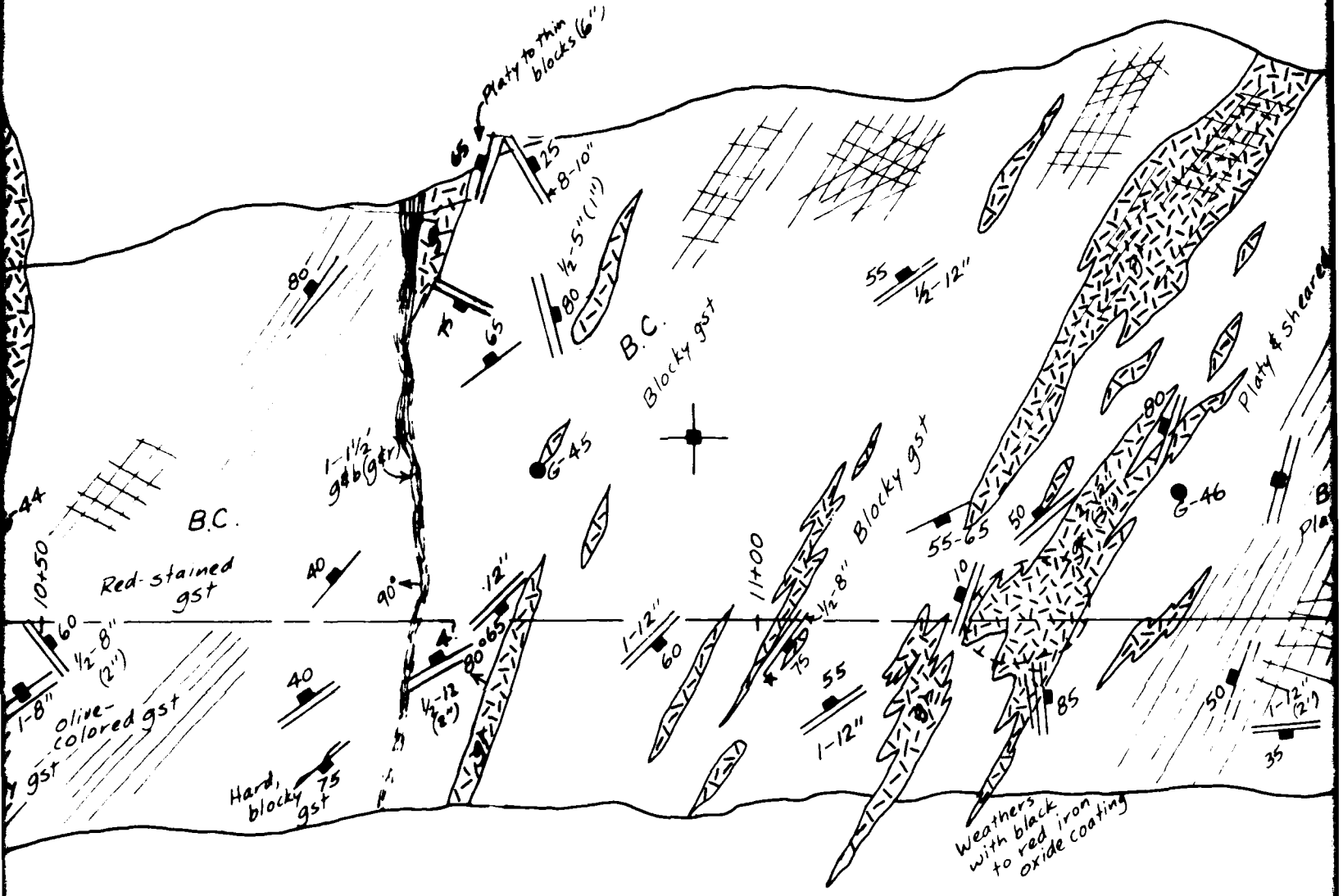
CAVE BUTTES DAM

LEGEND AND GENERAL NOTES

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

U.S. ARMY ENGINEER DISTRICT

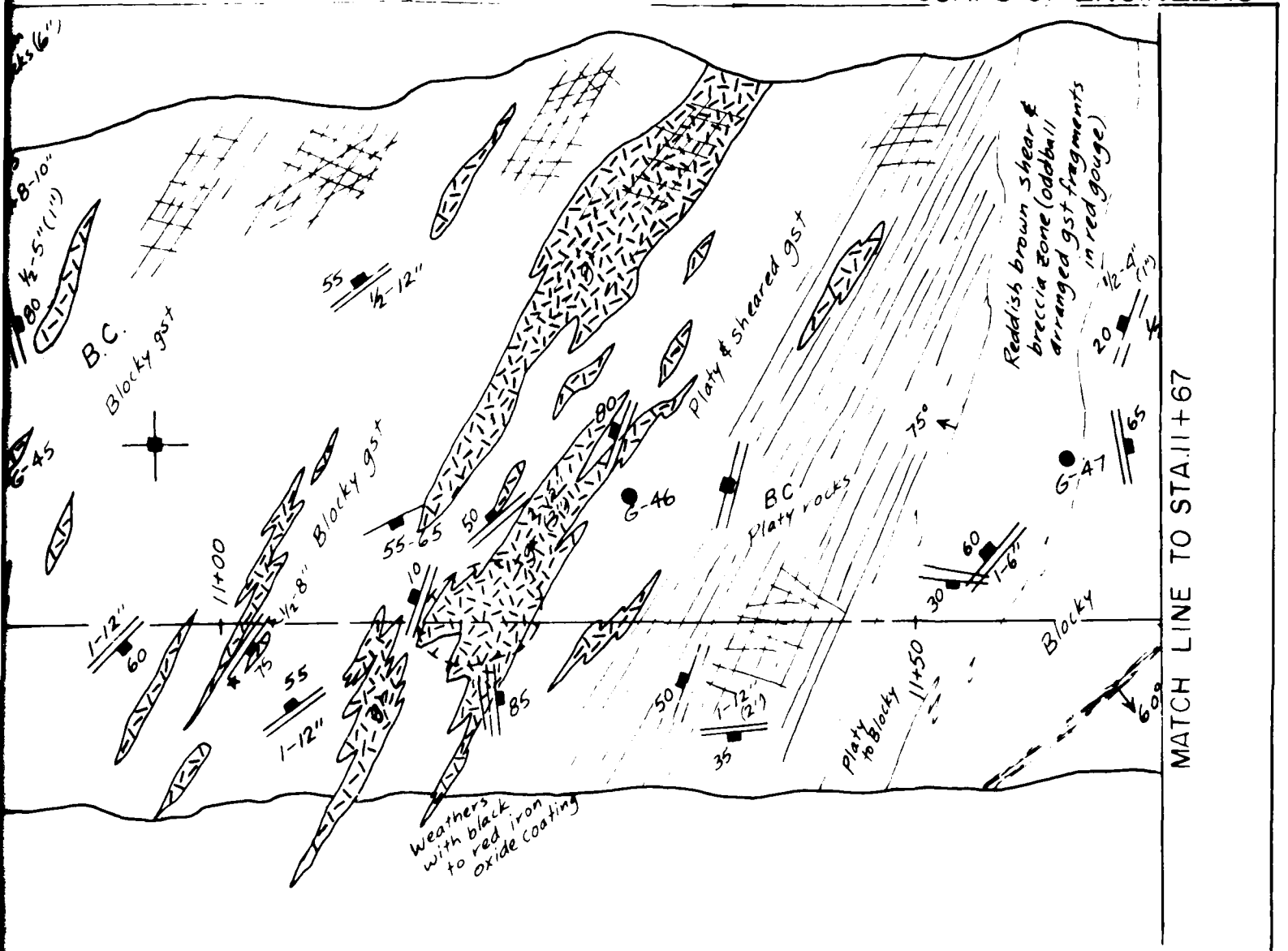




NOTE:

Refer to Plate 24 for Rock descriptions and explanation of symbols.

CORPS OF ENGINEERS



1 IN = 10 FT

SCALE 10 0 10 FEET

NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols.

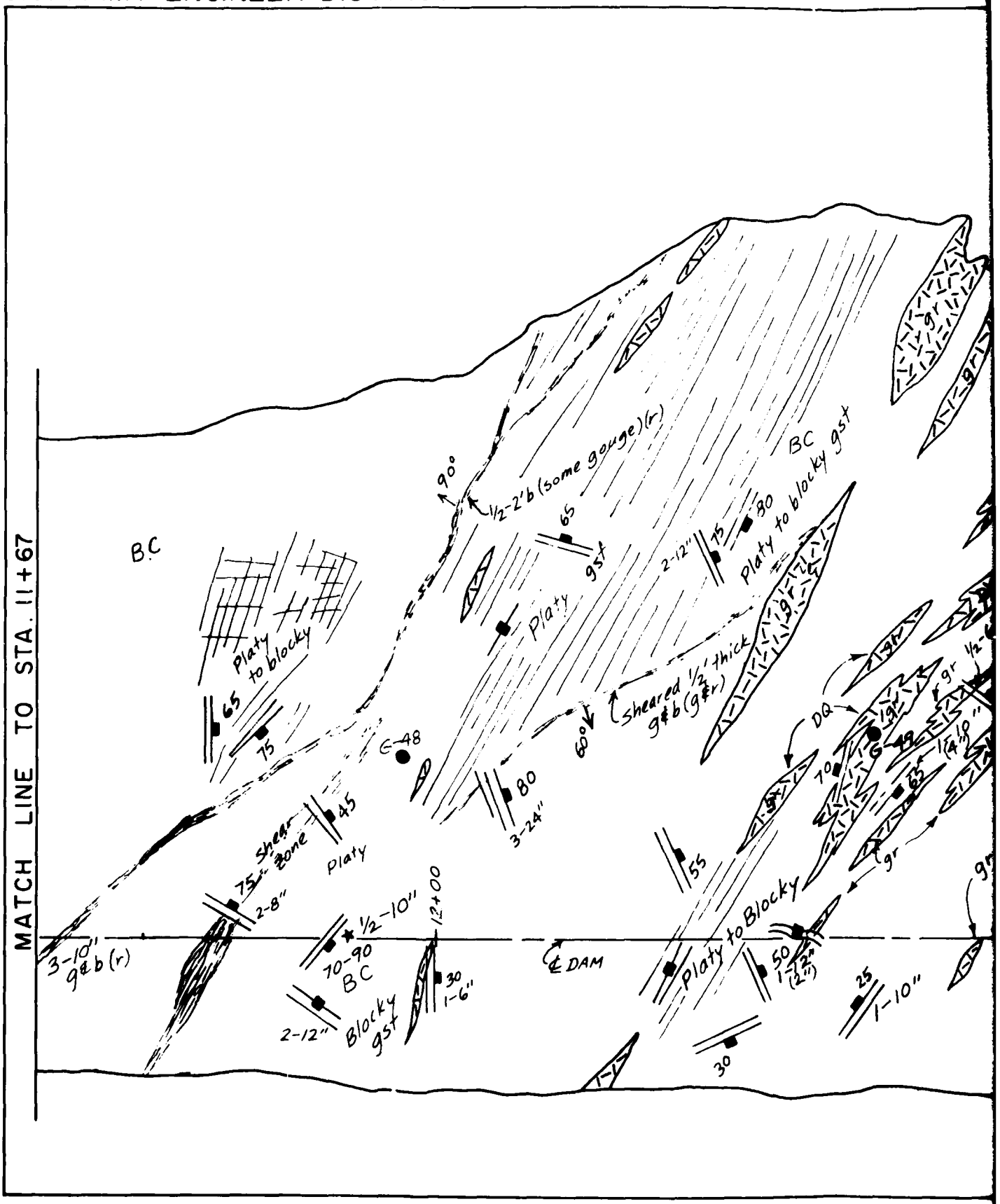
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS ARIZONA

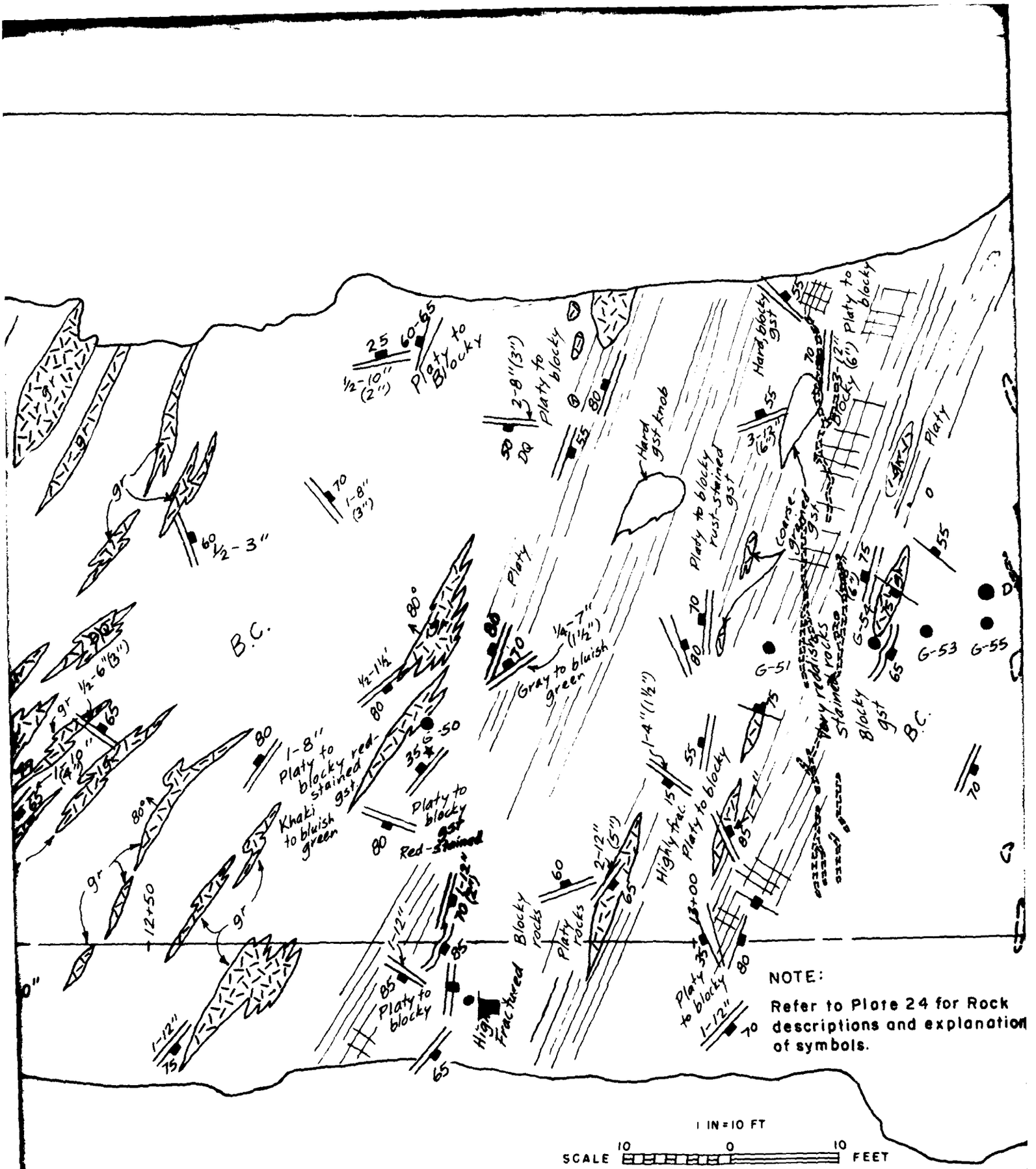
CAVE BUTTES DAM
FOUNDATION GEOLOGY
RIGHT ABUTMENT
STA. 9+79 to STA. 11+67

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

FOUNDATION REPORT PLATE 25

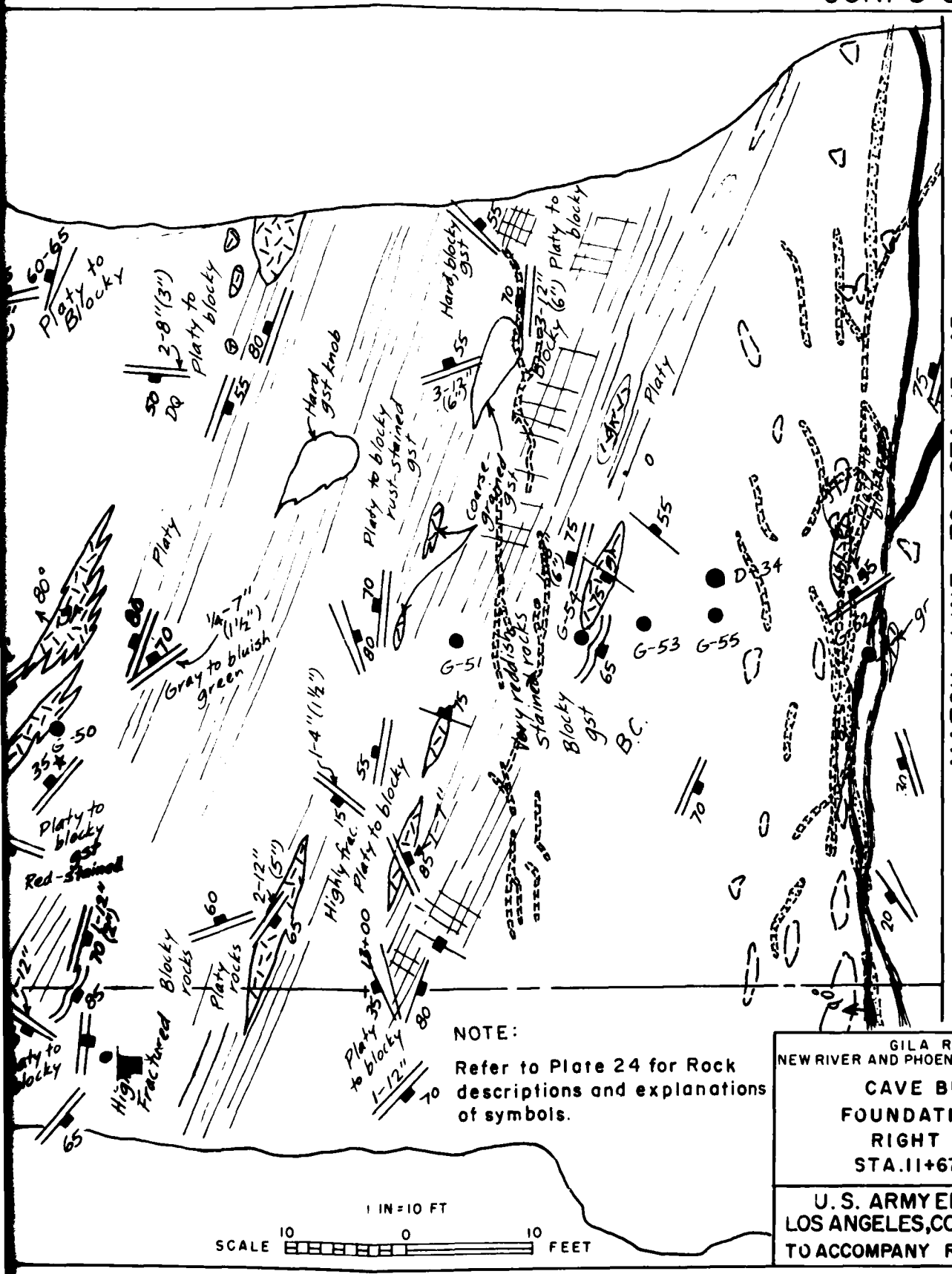
U.S. ARMY ENGINEER DISTRICT




B.C.
B.C.
G-50
G-51
G-52
G-53
G-55
12+50
13+00
Platy to blocky
Khaki to bluish green
Red-stained gst
Gray to bluish green
Platy to blocky rust-stained gst
Hard gst knob
Hard, blocky gst
Coarse-grained gst
Blocky gst
Blocky rocks
Platy rocks
Highly frac. Platy to blocky
Platy to blocky
Platy
NOTE:
Refer to Plate 24 for Rock descriptions and explanation of symbols.
1 IN = 10 FT
SCALE 10 0 10 FEET

2

CORPS OF ENGINEERS



NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols.

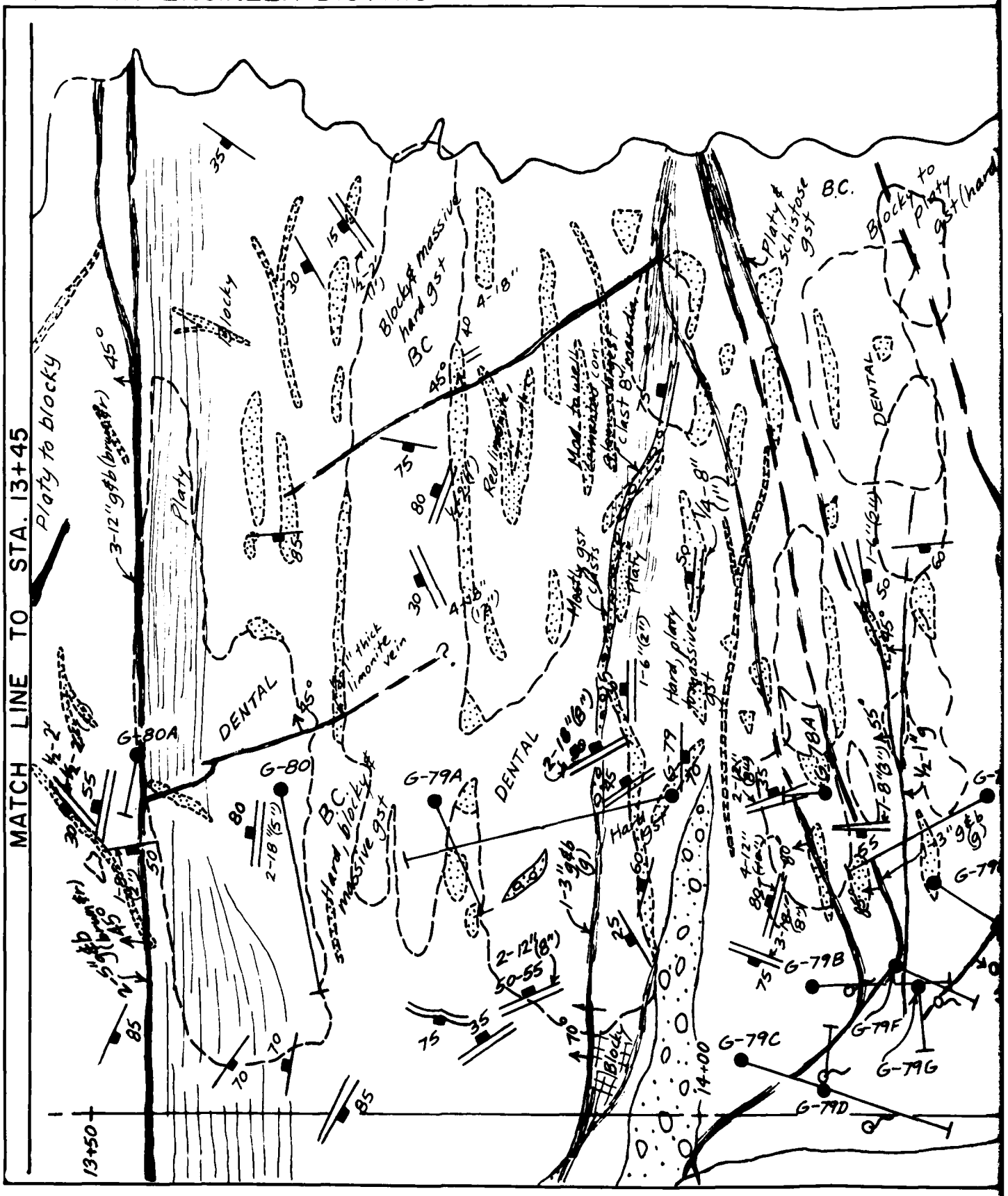
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

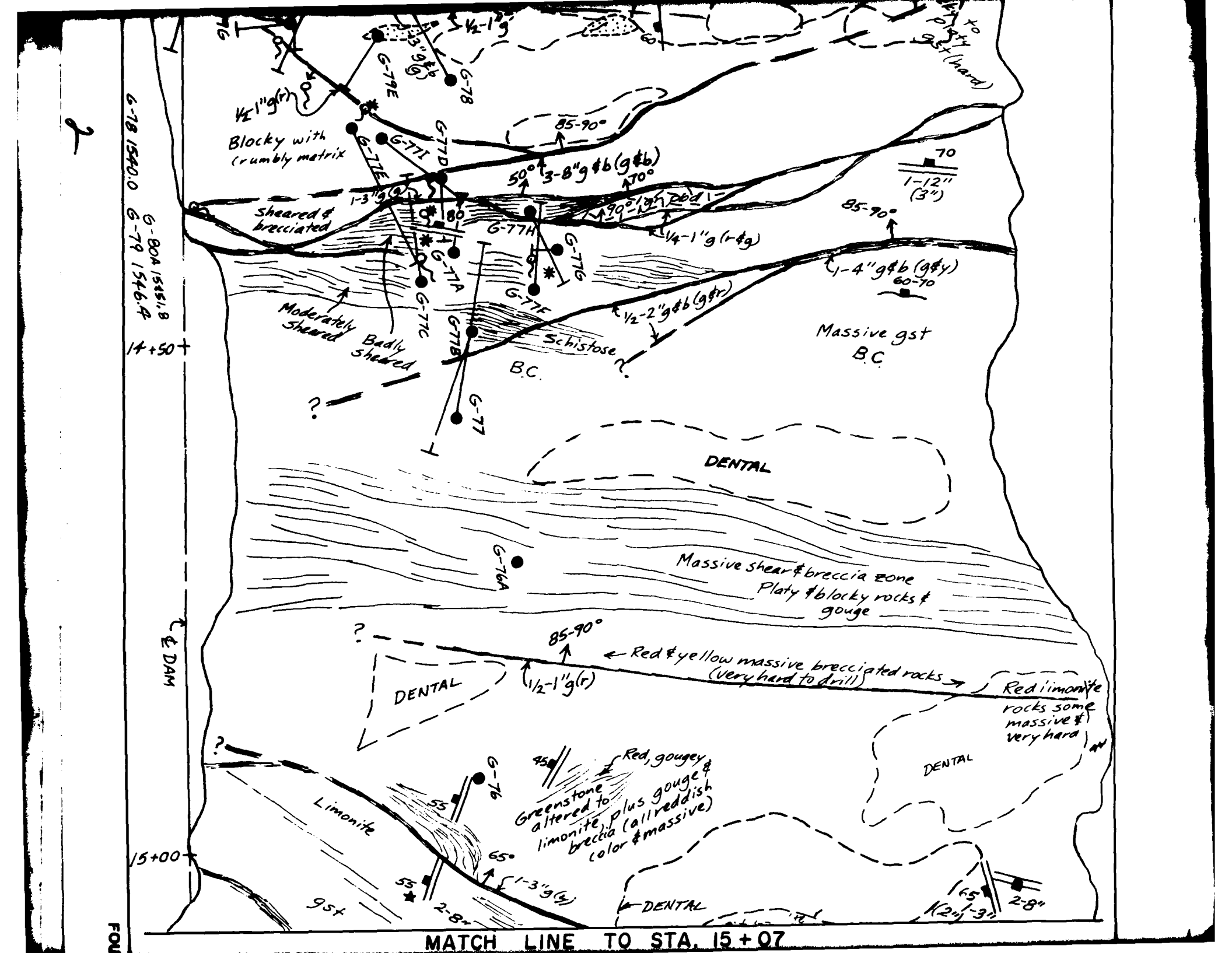
CAVE BUTTES DAM
FOUNDATION GEOLOGY
RIGHT ABUTMENT
STA. 11+67 to STA. 13+45

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

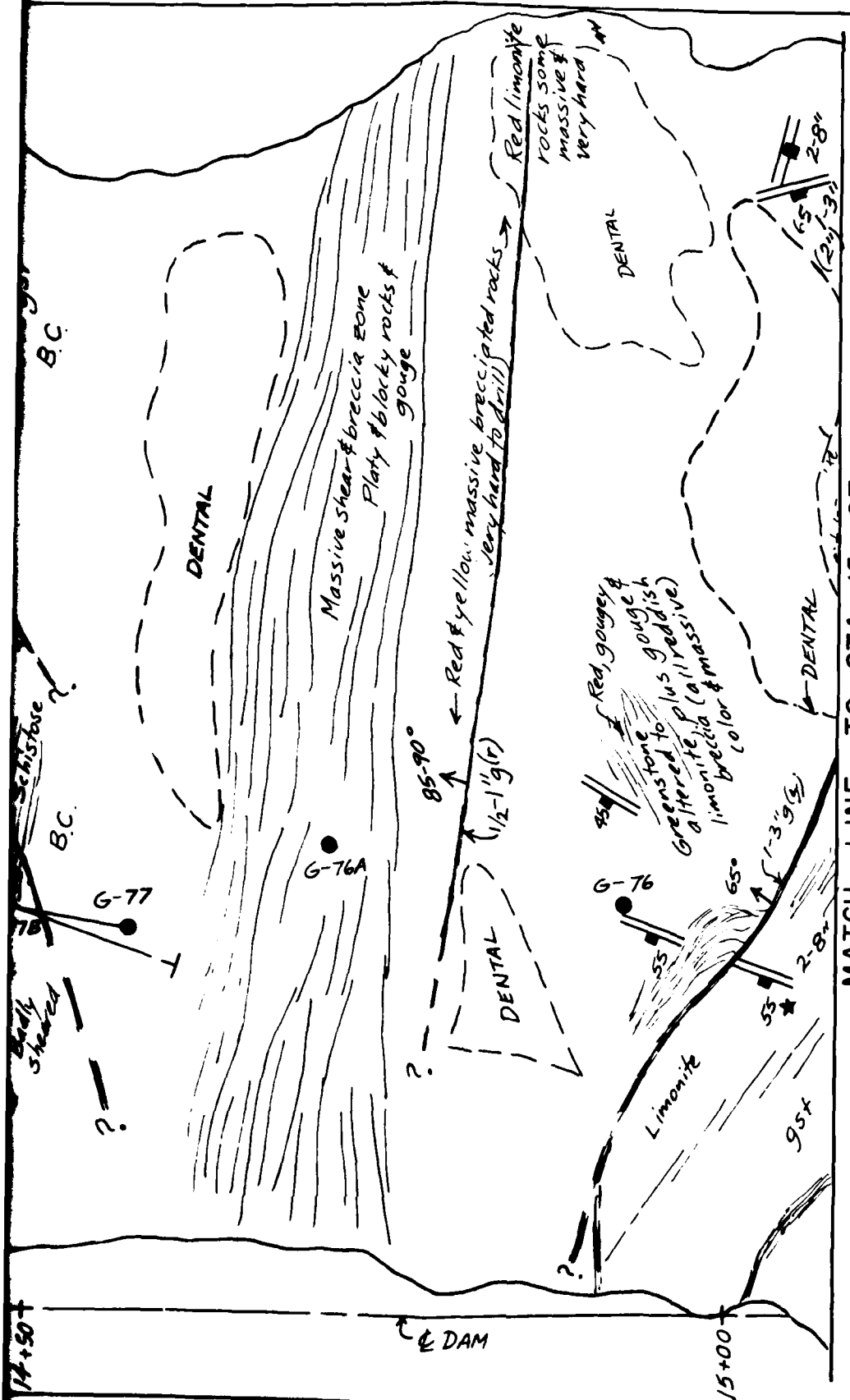
FOUNDATION REPORT PLATE 26

U.S. ARMY ENGINEER DISTRICT




G-78 1540.0
G-79 1546.4
G-80A 1545.8
14+50
15+00
℄ DAM
G-79E
G-78
G-77I
G-77D
G-77E
G-77H
G-77G
G-77A
G-77C
G-77B
G-77
G-76A
G-76
Blocky with crumbly matrix
Sheared & brecciated
Moderately Sheared
Badly Sheared
Schistose
B.C.
Massive gst
B.C.
DENTAL
Massive shear & breccia zone
Platy & blocky rocks & gouge
Red & yellow massive brecciated rocks (very hard to drill)
Red limonite rocks some massive & very hard
Greenstone altered to limonite plus gouge & breccia (all reddish color & massive)
Limonite
gst
MATCH LINE TO STA. 15+07

CORPS OF ENGINEERS



NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols.

1 IN = 10 FT

SCALE 10 0 10 FEET

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

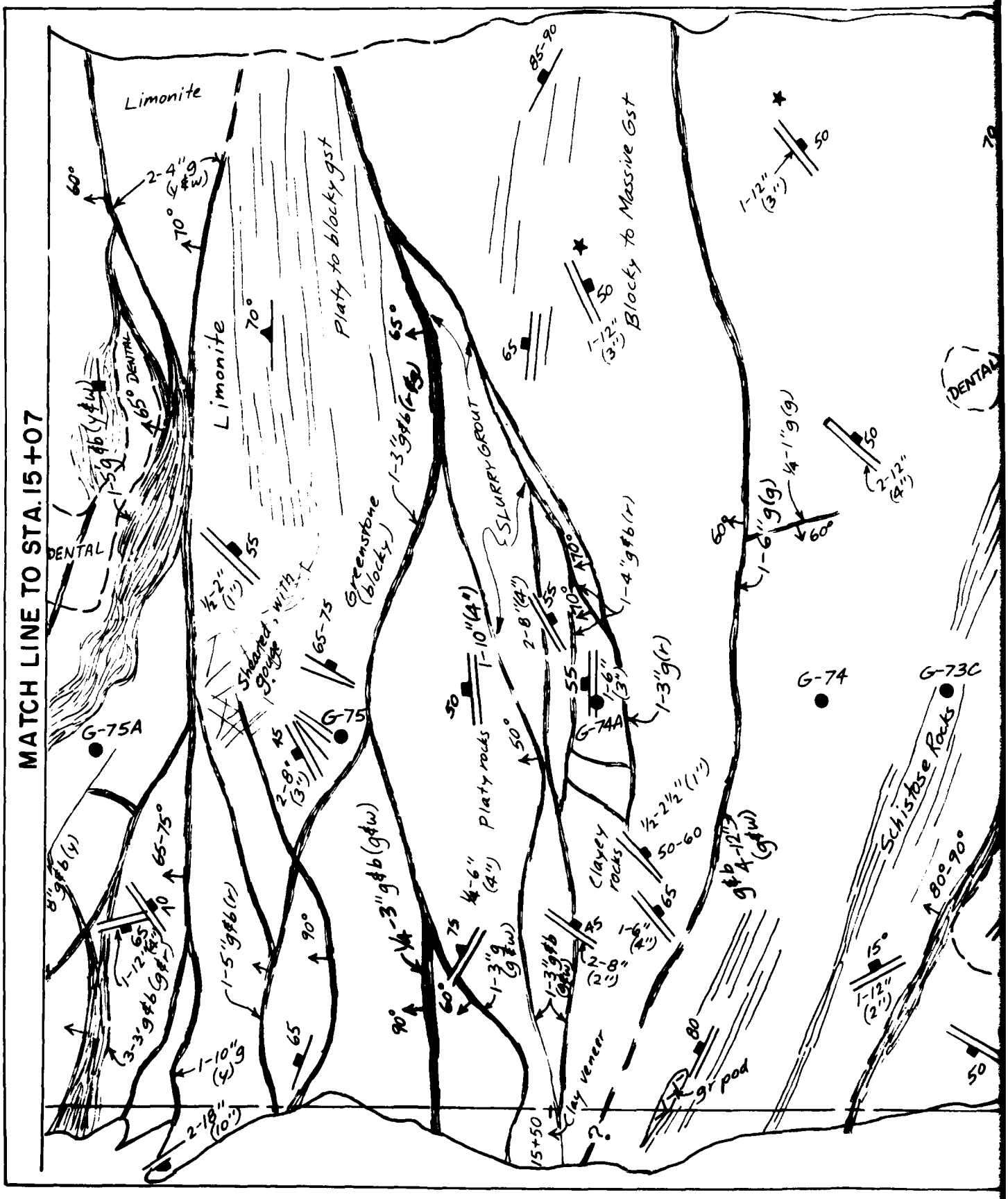
CAVE BUTTES DAM
FOUNDATION GEOLOGY
CUTOFF TRENCH
STA. 13+45 to STA. 15+07

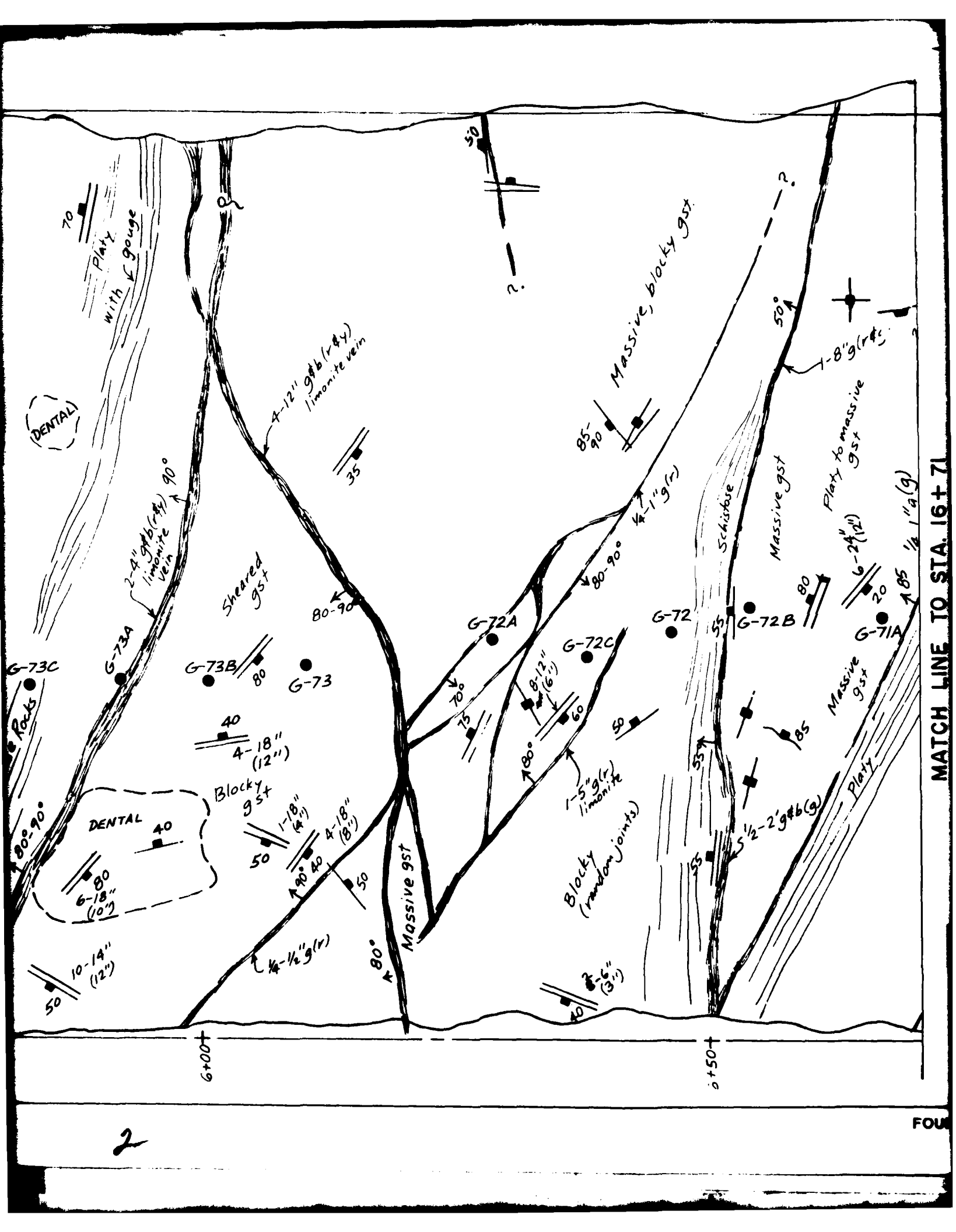
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS

TO ACCOMPANY REPORT DATED:

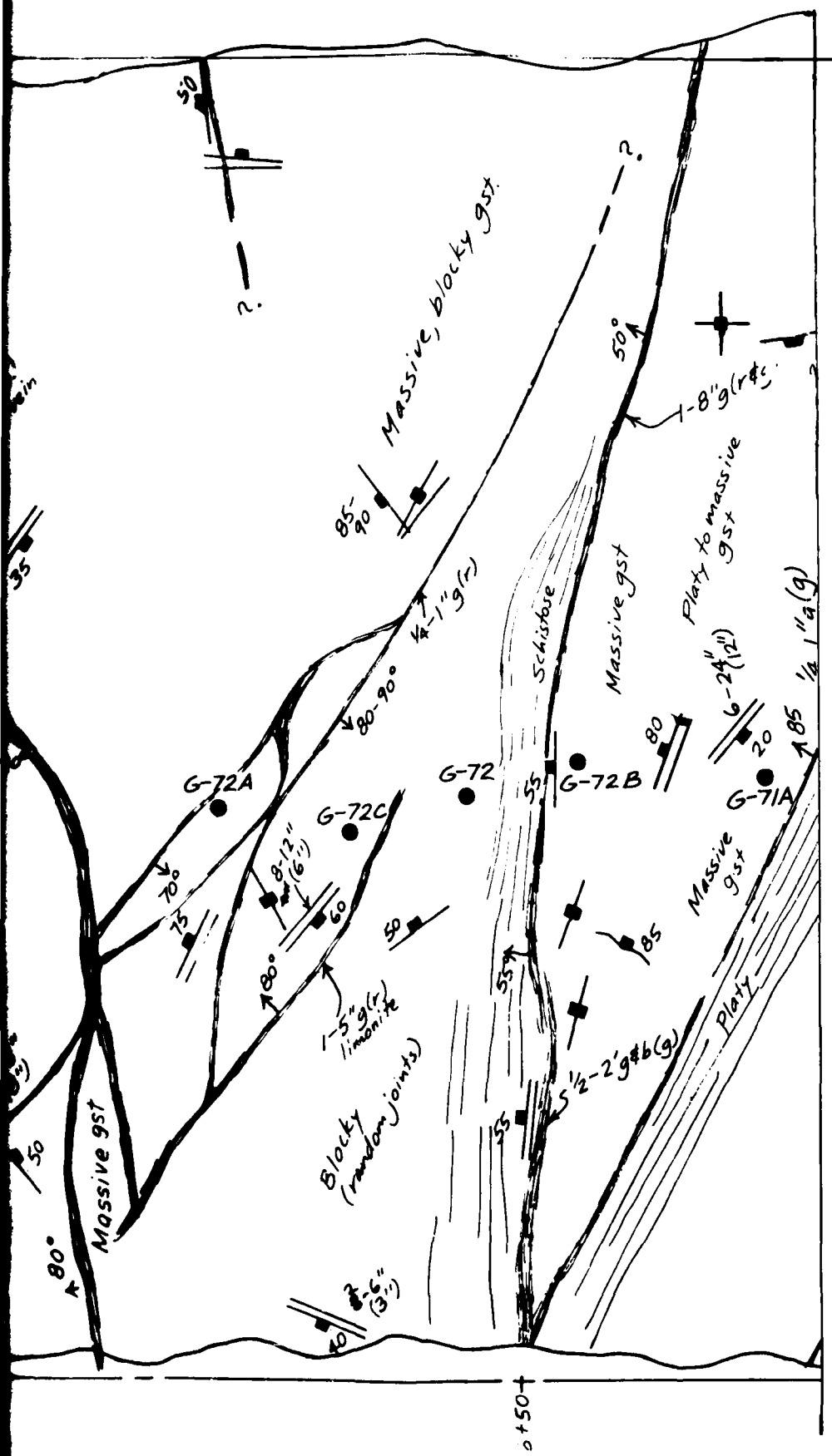
FOUNDATION REPORT PLATE 27

U.S. ARMY ENGINEER DISTRICT




MATCH LINE TO STA. 16+71
Platy with gouge
(DENTAL)
4-12" g#b (r#y) limonite vein
2-4" g#b (r#y) limonite vein
Sheared gst
Massive, blocky gst
Schistose
Massive gst
Platy to massive gst
Platy
Blocky gst
Blocky (random joints)
Massive gst
Rocks
DENTAL
G-73C
G-73A
G-73B
G-73
G-72A
G-72C
G-72
G-72B
G-71A
4-18" (12")
6-18" (10")
1-18" (4")
4-18" (8")
10-14" (12")
8-12" (6")
1-5" g(r) limonite
5½-2' g#b(g)
6-24" (12")
6+00
5+50
2

CORPS OF ENGINEERS



MATCH LINE TO STA. 16+71

NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols.

1 IN = 10 FT

SCALE 10 0 10 FEET

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

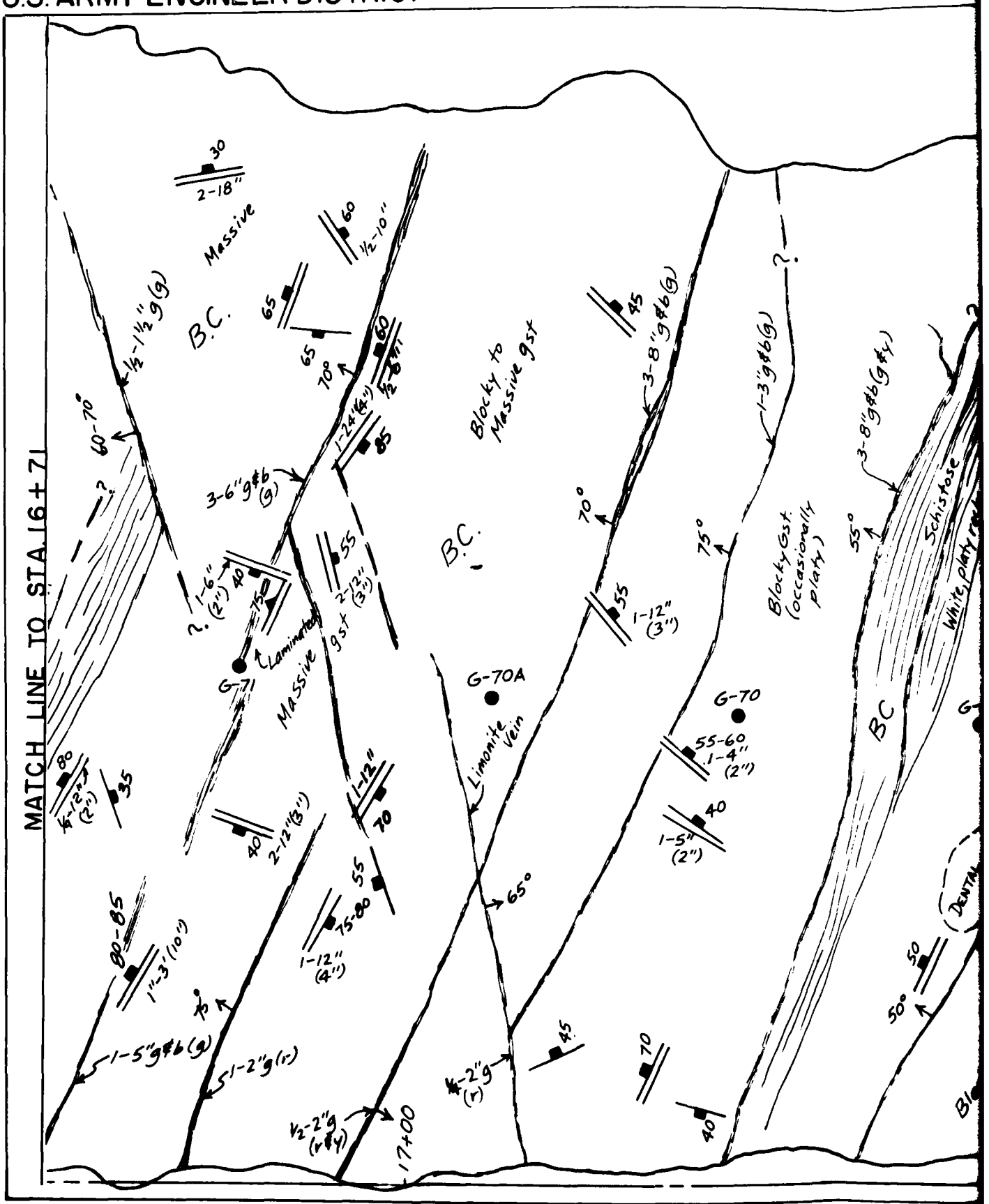
CAVE BUTTES DAM
FOUNDATION GEOLOGY
CUTOFF TRENCH
STA. 15+07 to STA. 16+71

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS

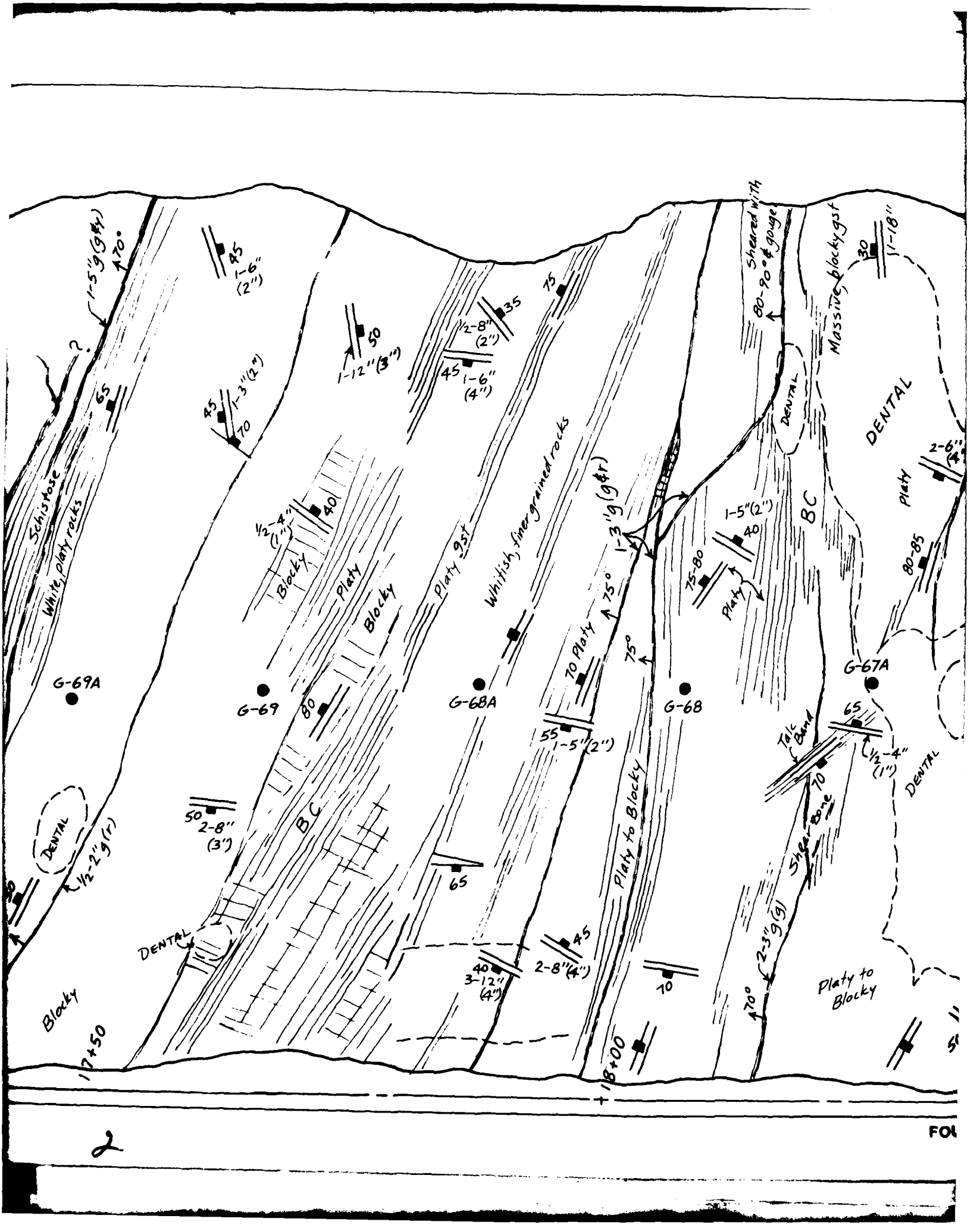
TO ACCOMPANY REPORT DATED:

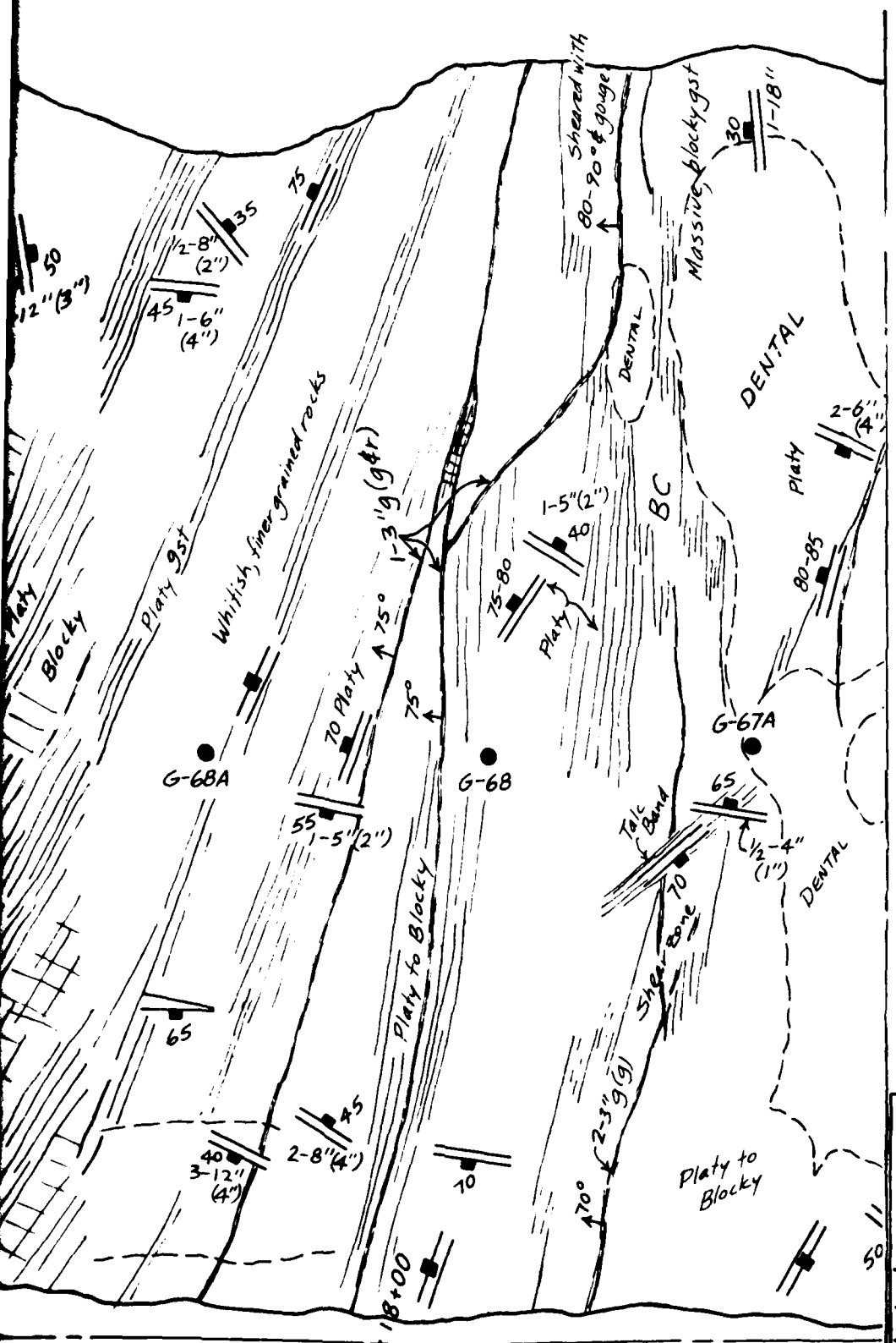
FOUNDATION REPORT PLATE 28

U.S. ARMY ENGINEER DISTRICT



1


Schistose
White, platy rocks
1-5"g(gtr)
70°
45
1-6"
(2")
65
45
1-3"(2")
70
50
1-12"(3")
½-8"
(2")
35
45
1-6"
(4")
75
Whitish, fine grained rocks
Platy gst
½-4"
(1")
40
Blocky
Platy
Blocky
G-69A
G-69
80
G-68A
70 Platy
75°
1-3"g(gtr)
55
1-5"(2")
Platy to Blocky
75°
G-68
Sheared with
80-90° ∉ gouge
DENTAL
BC
1-5"(2")
40
75-80
Platy
Massive, blocky gst
30
1'-18"
DENTAL
Platy
2-6"
80-85
G-67A
65
Talc Band
½-4"
(1")
70
DENTAL
Shear zone
2-3"g(g)
70°
Platy to
Blocky
50
2-8"
(3")
BC
DENTAL
½-2"g(r)
65
DENTAL
40
3-12"
(4")
45
2-8"(4")
70
Blocky
17+50
18+00
2
FOU



NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols.

1 IN = 10 FT

10 0 10

E FEET

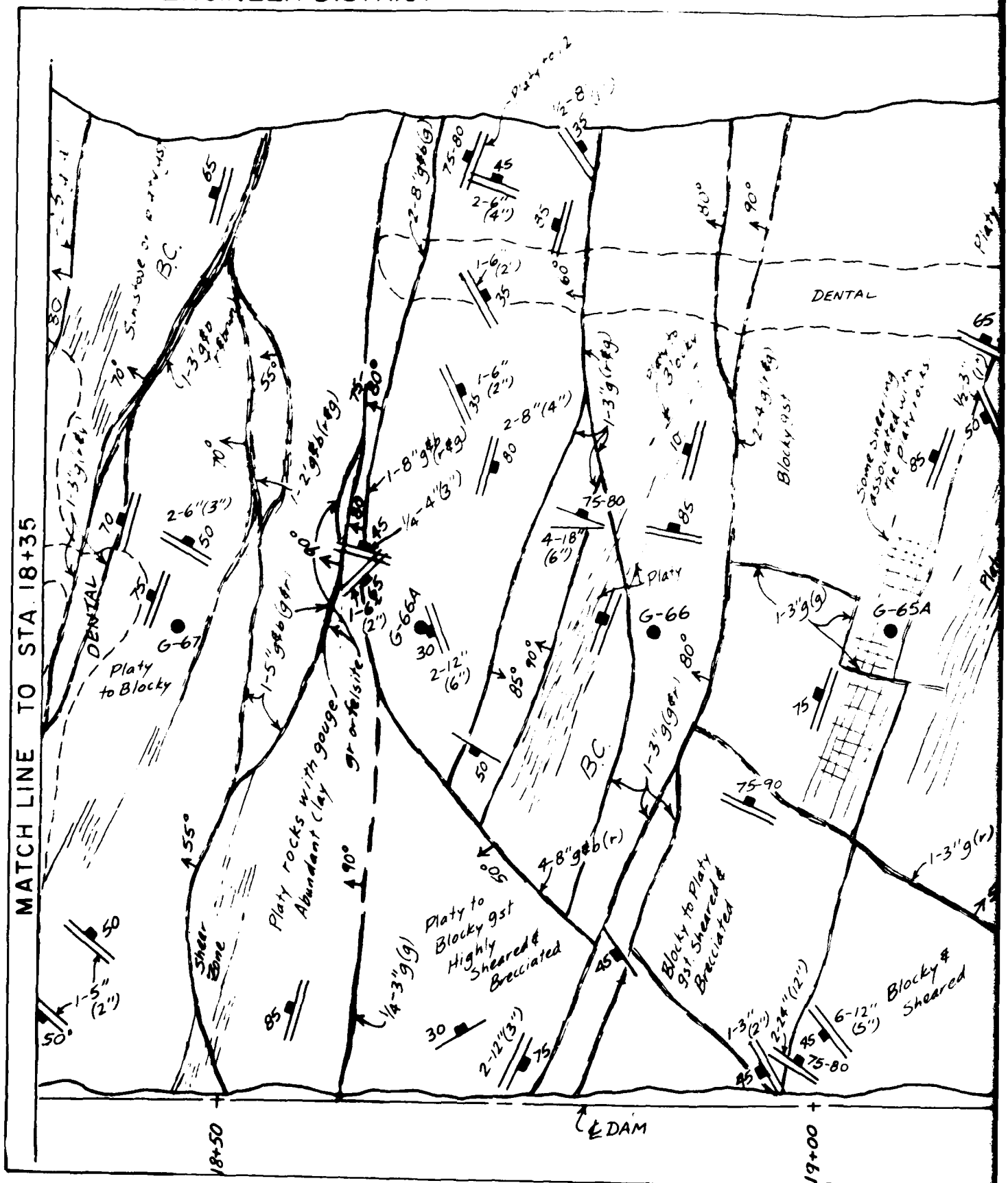
GILA RIVER BASIN
RIVER AND PHOENIX CITY STREAMS, ARIZONA

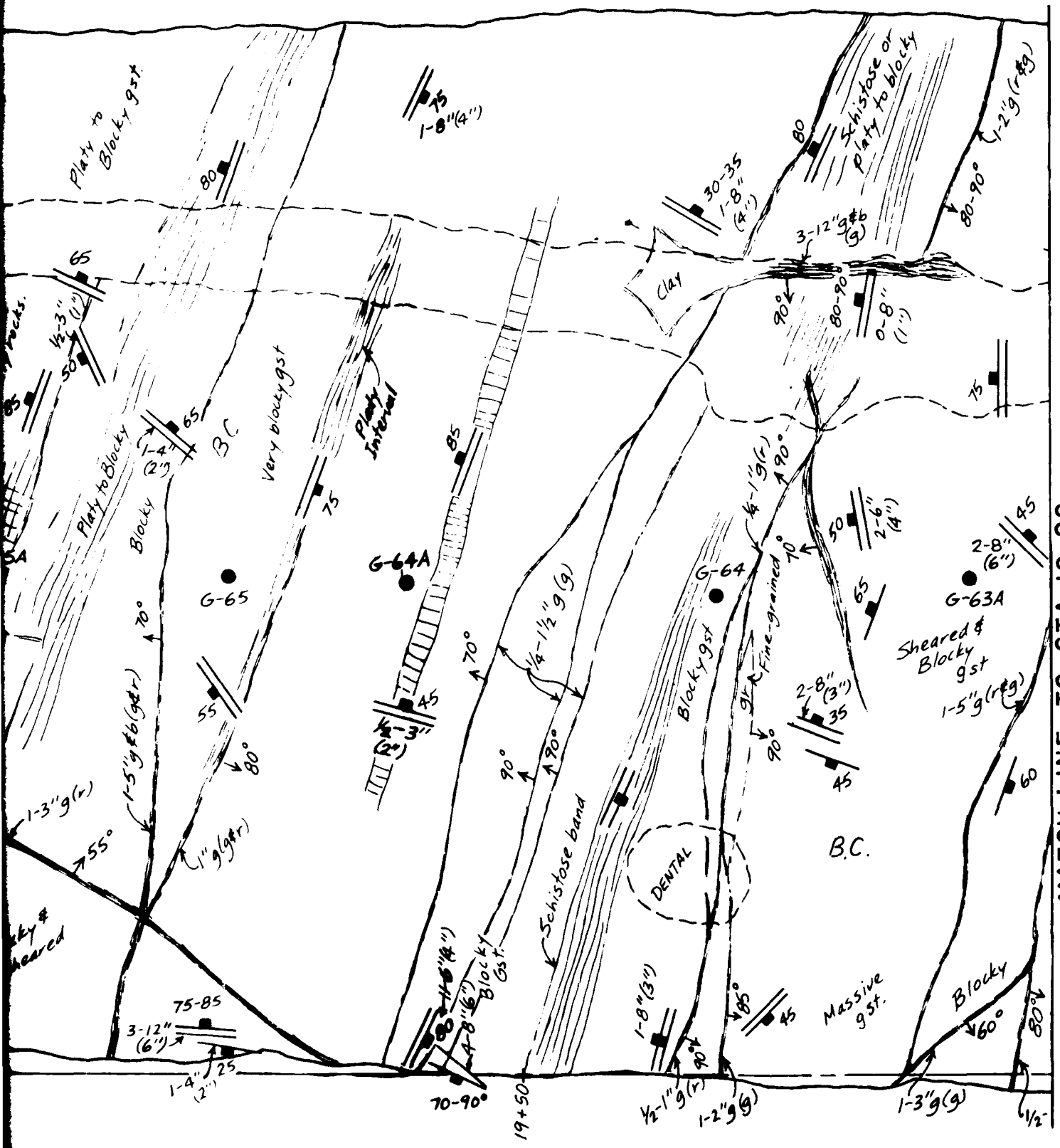
CAVE BUTTES DAM
FOUNDATION GEOLOGY
CUTOFF TRENCH
STA. 16+71 to STA. 18+35

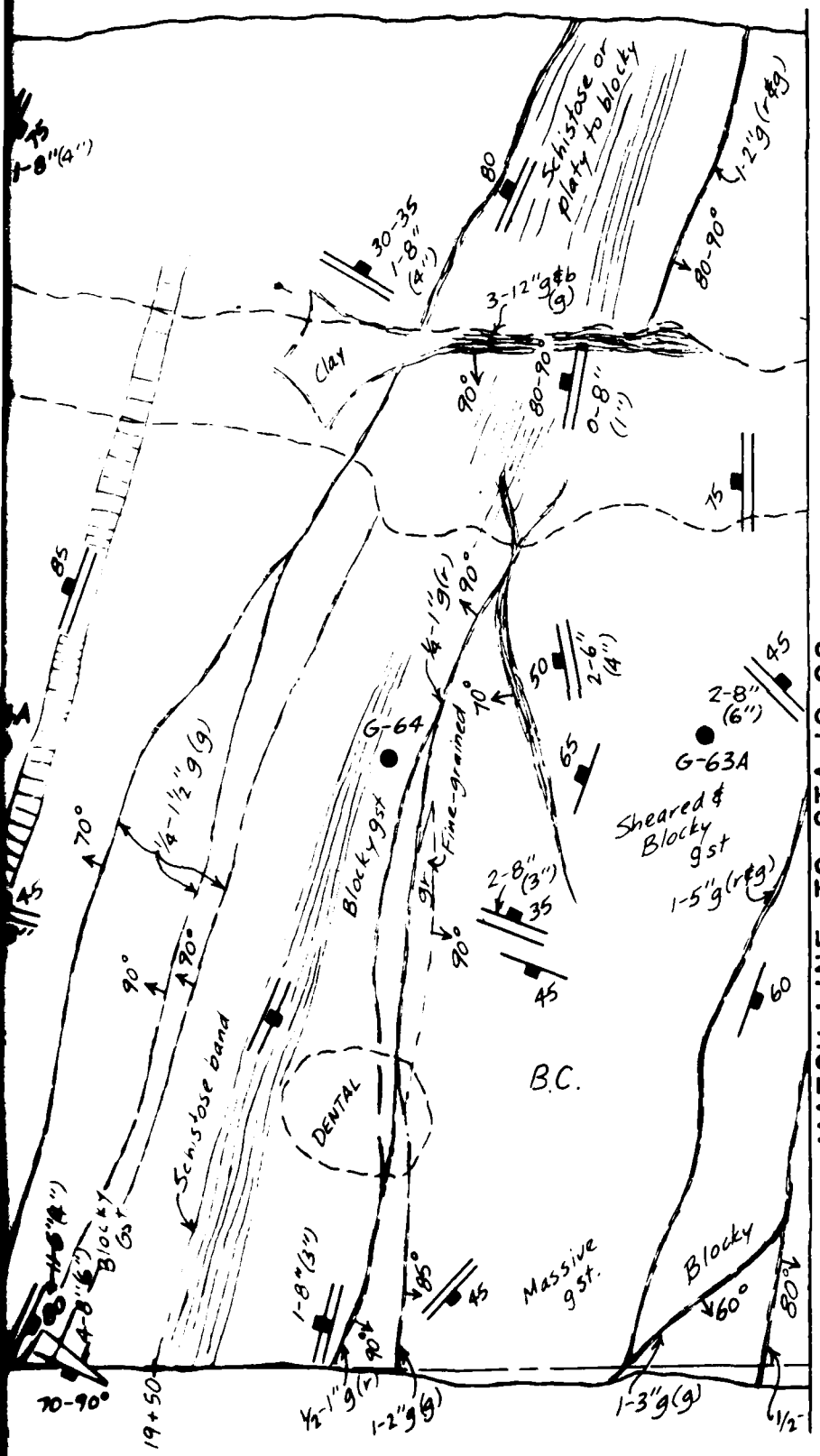
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

FOUNDATION REPORT PLATE 29

U.S. ARMY ENGINEER DISTRICT




Platy to Blocky gst.
Very blocky gst
Platy to Blocky
Blocky
Platy Interval
Schistose or platy to blocky
Clay
Schistose band
DENTAL
B.C.
Blocky gst
Fine-grained
Sheared & Blocky gst
Massive gst.
Blocky
G-65
G-64A
G-64
G-63A
MATCH LINE TO STA. 19+92
19+50



NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols.

1 IN = 10 FT

SCALE 10 0 10 FEET

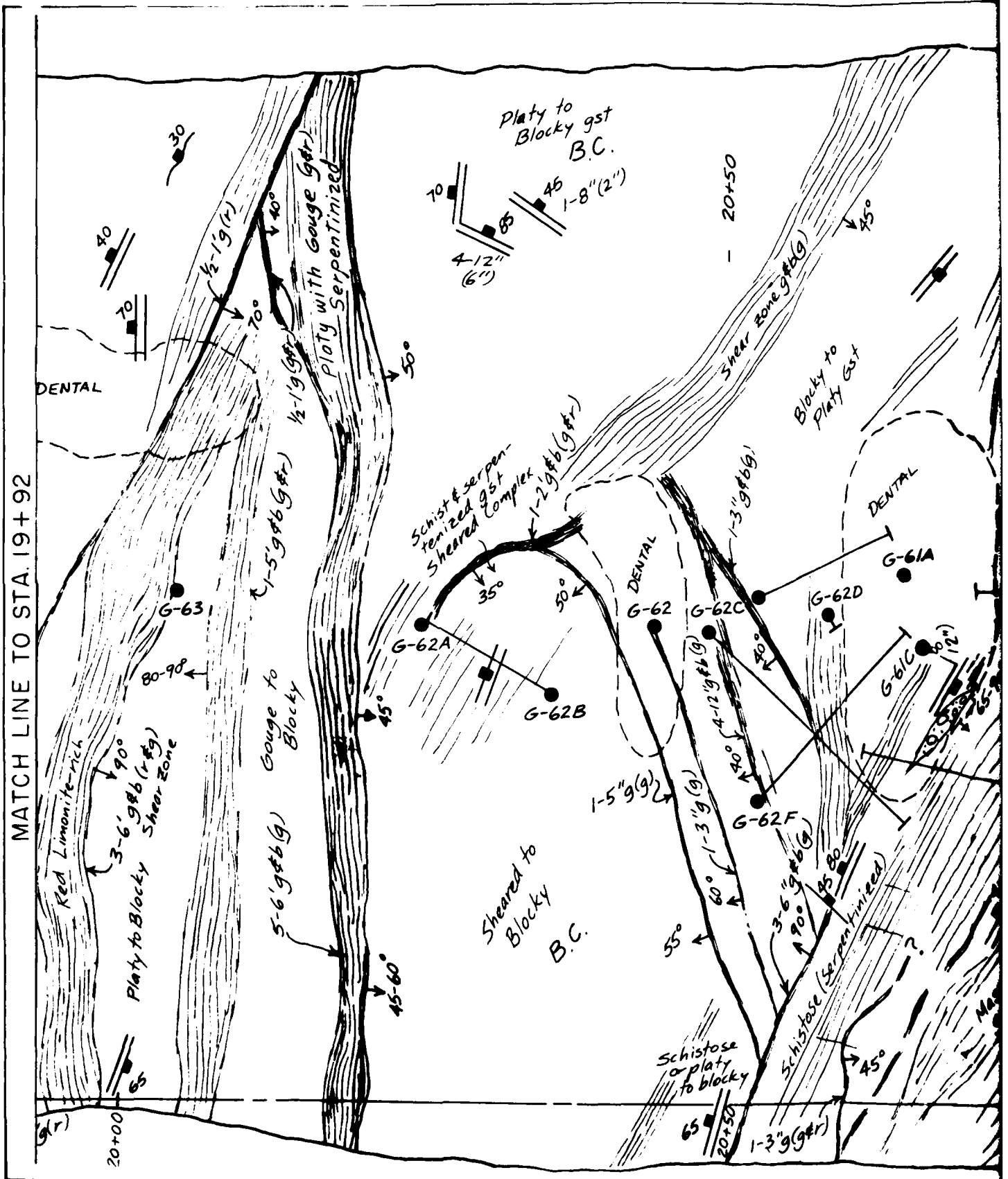
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

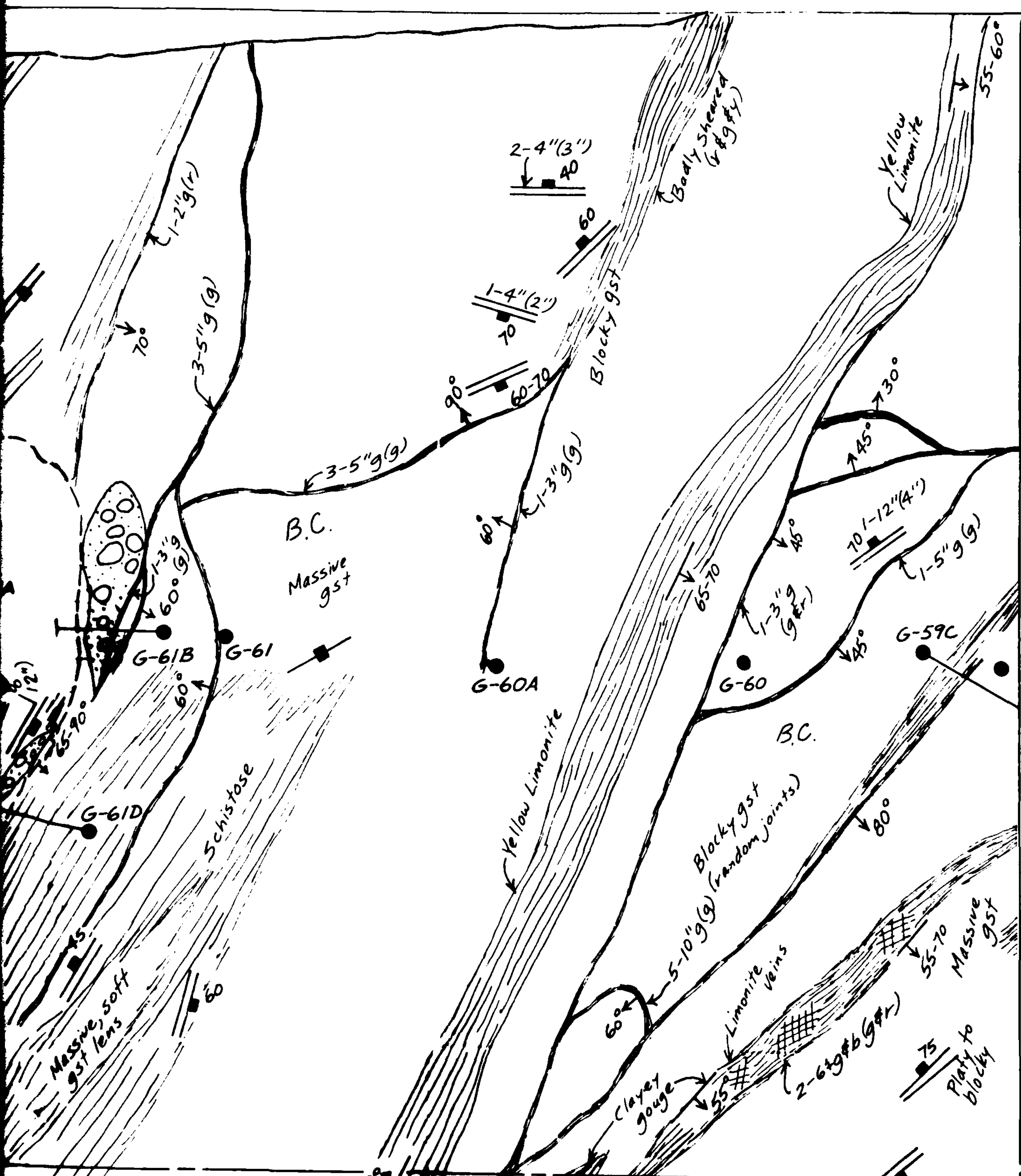
CAVE BUTTES DAM
FOUNDATION GEOLOGY
CUTOFF TRENCH
STA. 18+35 to STA. 19+92

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

FOUNDATION REPORT PLATE 30

U.S. ARMY ENGINEER DISTRICT

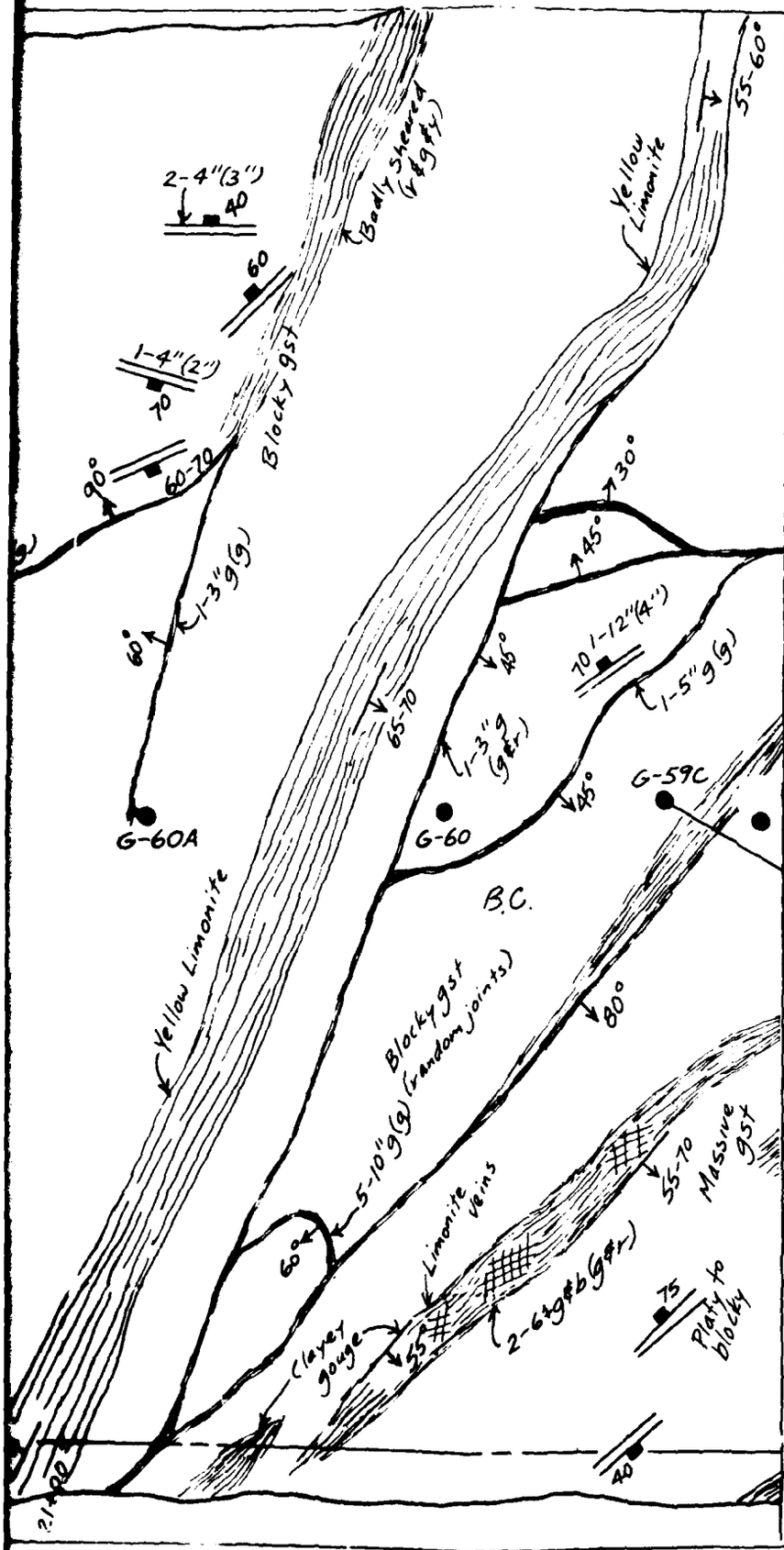




2-4"(3")
40
60
1-4"(2")
70
90°
60-70
Badly Sheared (r & g & y)
Blocky gst
Yellow Limonite
55-60°
1-2"g(r)
3-5"g(g)
70°
3-5"g(g)
1-3"g(g)
60°
B.C.
Massive gst
1-3"g
60°(g)
G-61B
G-61
G-60A
G-60
G-59C
G-61D
60°
12"
65-90°
Schistose
Massive, soft gst lens
45
60
Yellow Limonite
65-70
45°
30°
45°
70 1-12"(4")
1-5"g(g)
1-3"g (g&r)
45°
B.C.
Blocky gst (random joints)
80°
5-10"g(g)
60°
Limonite veins
Clayey gouge
55°
2-6"g&b(g&r)
55-70
Massive gst
75
Platy to blocky
40
90°
21+00
MATCH LINE TO STA. 21+47

2

CORPS OF ENGINEERS



NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols.

1 IN = 10 FT

SCALE 10 0 10 FEET

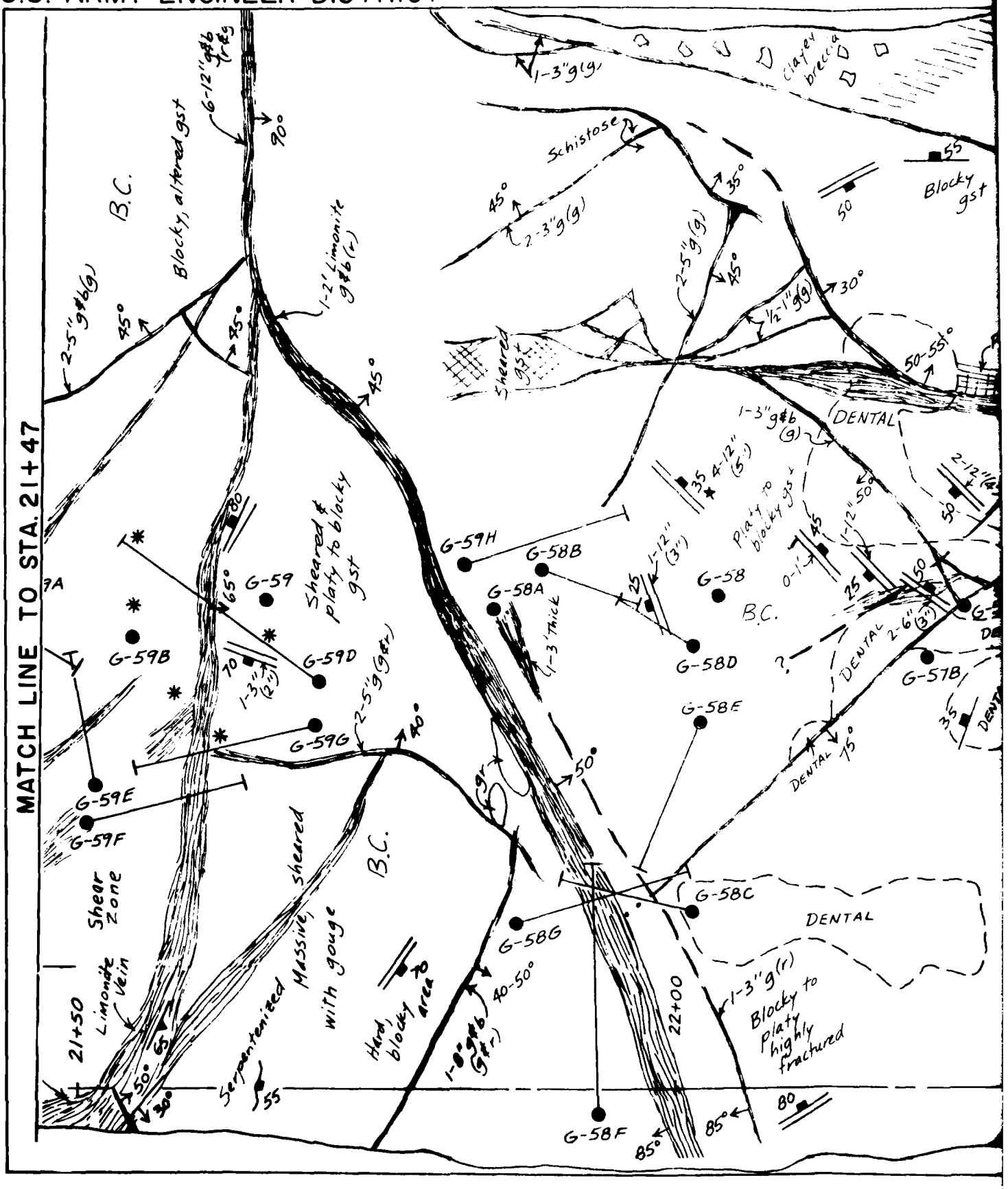
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

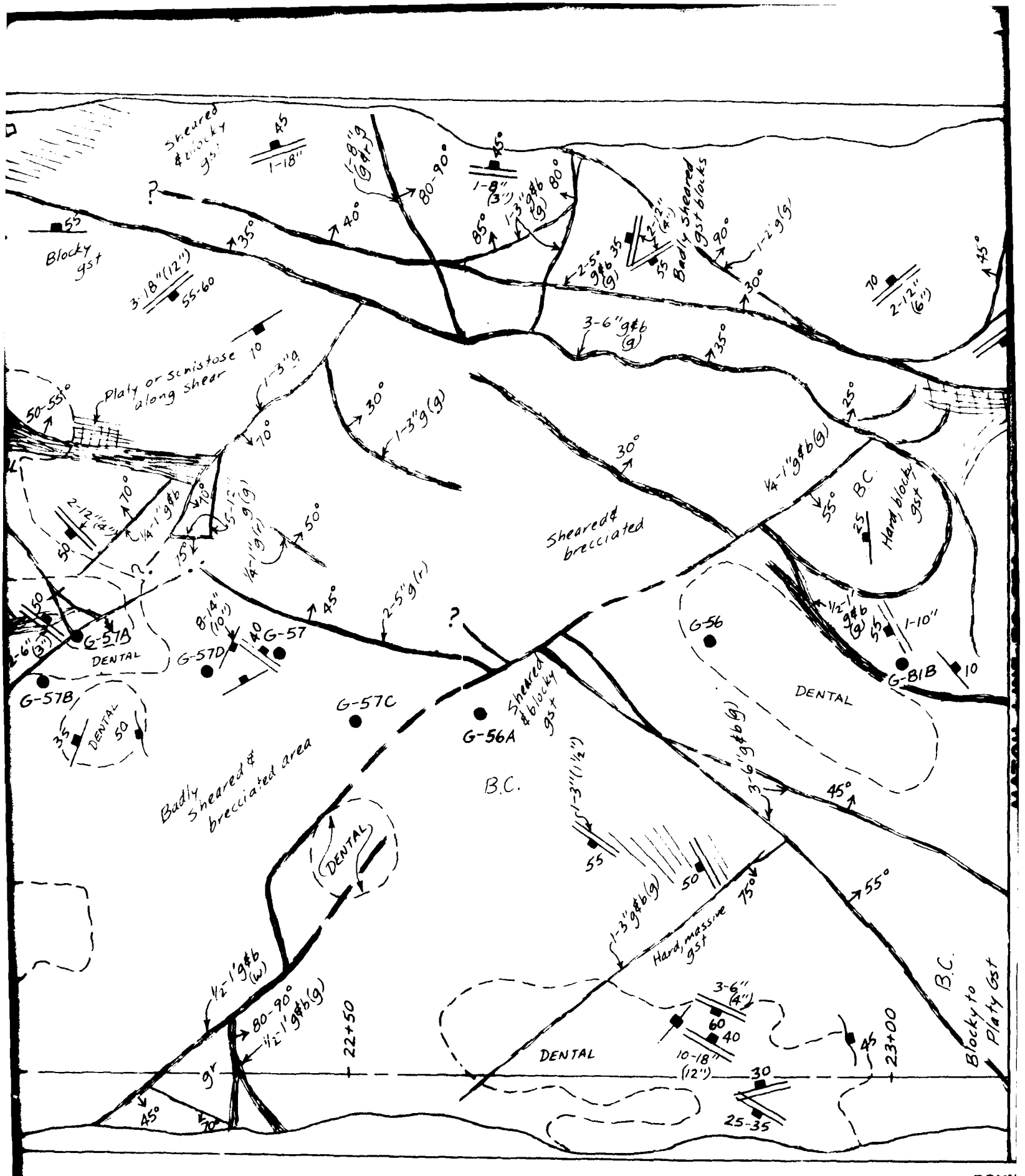
CAVE BUTTES DAM
FOUNDATION GEOLOGY
CUTOFF TRENCH
STA. 19+92 to STA. 21+47

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

FOUNDATION REPORT PLATE 31

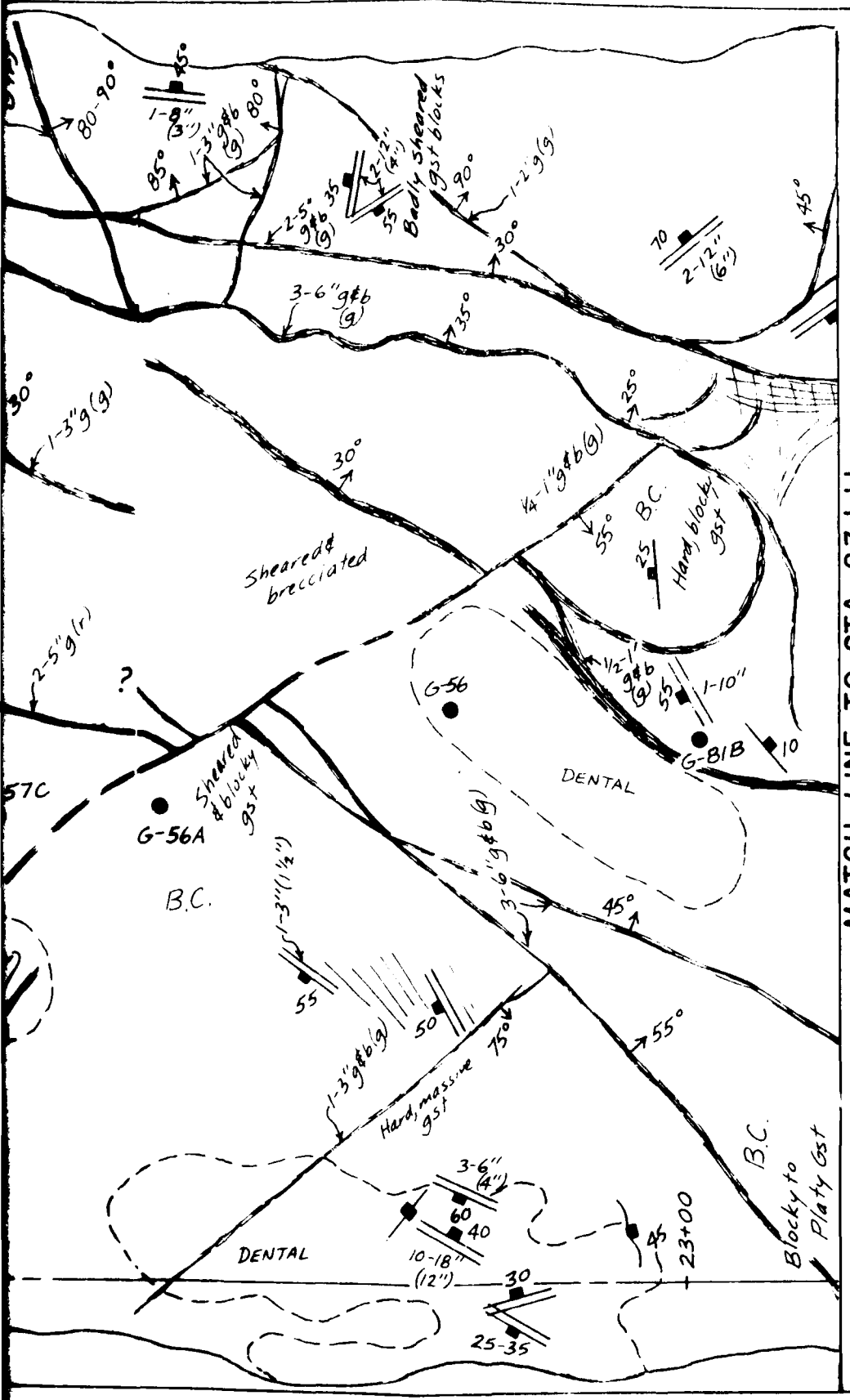
U.S. ARMY ENGINEER DISTRICT




Sheared & blocky gst
Blocky gst
Platy or schistose along shear
Sheared & brecciated
Badly sheared & brecciated area
Hard, blocky gst
Hard, massive gst
Badly sheared gst + blocks
Blocky to platy gst
DENTAL
B.C.
G-57A
G-57B
G-57C
G-57D
G-56
G-56A
G-81B
22+50
23+00

2

FOUN



MATCH LINE TO STA. 23+11

NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols.

1 IN = 10 FT

10 0 10

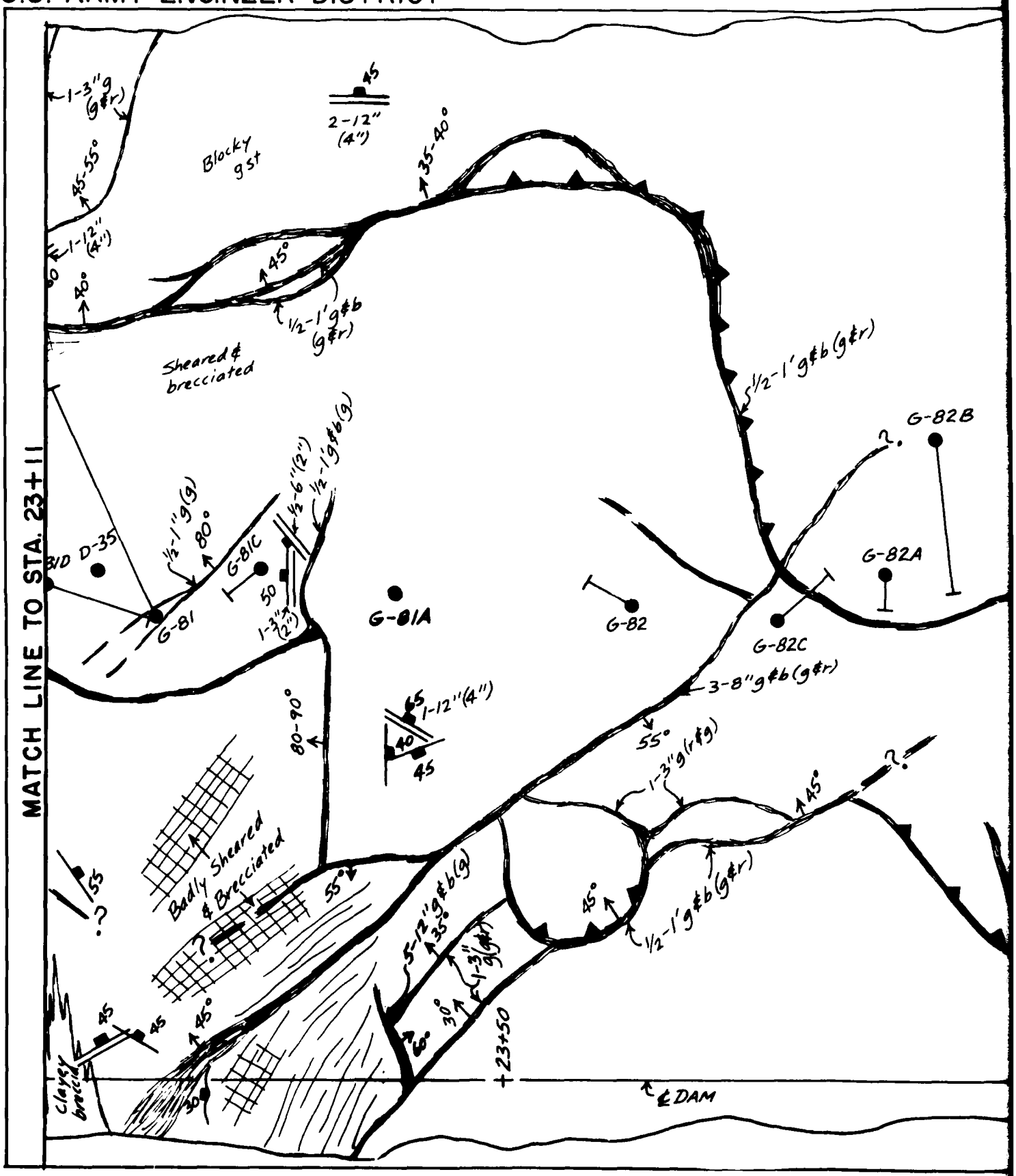
E FEET

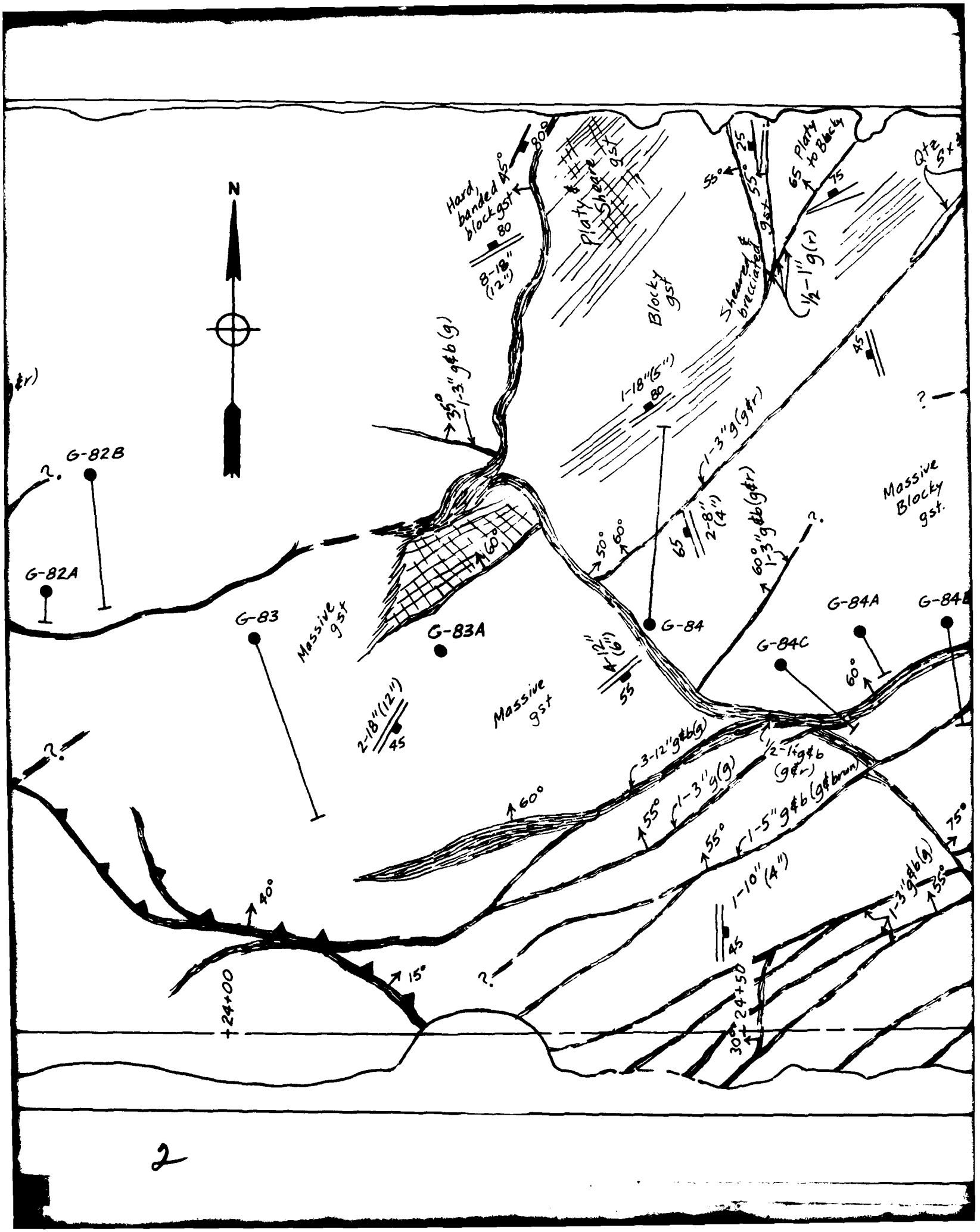
GILA RIVER BASIN
RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM
FOUNDATION GEOLOGY
CUTOFF TRENCH
STA. 21+47 to STA. 23+11

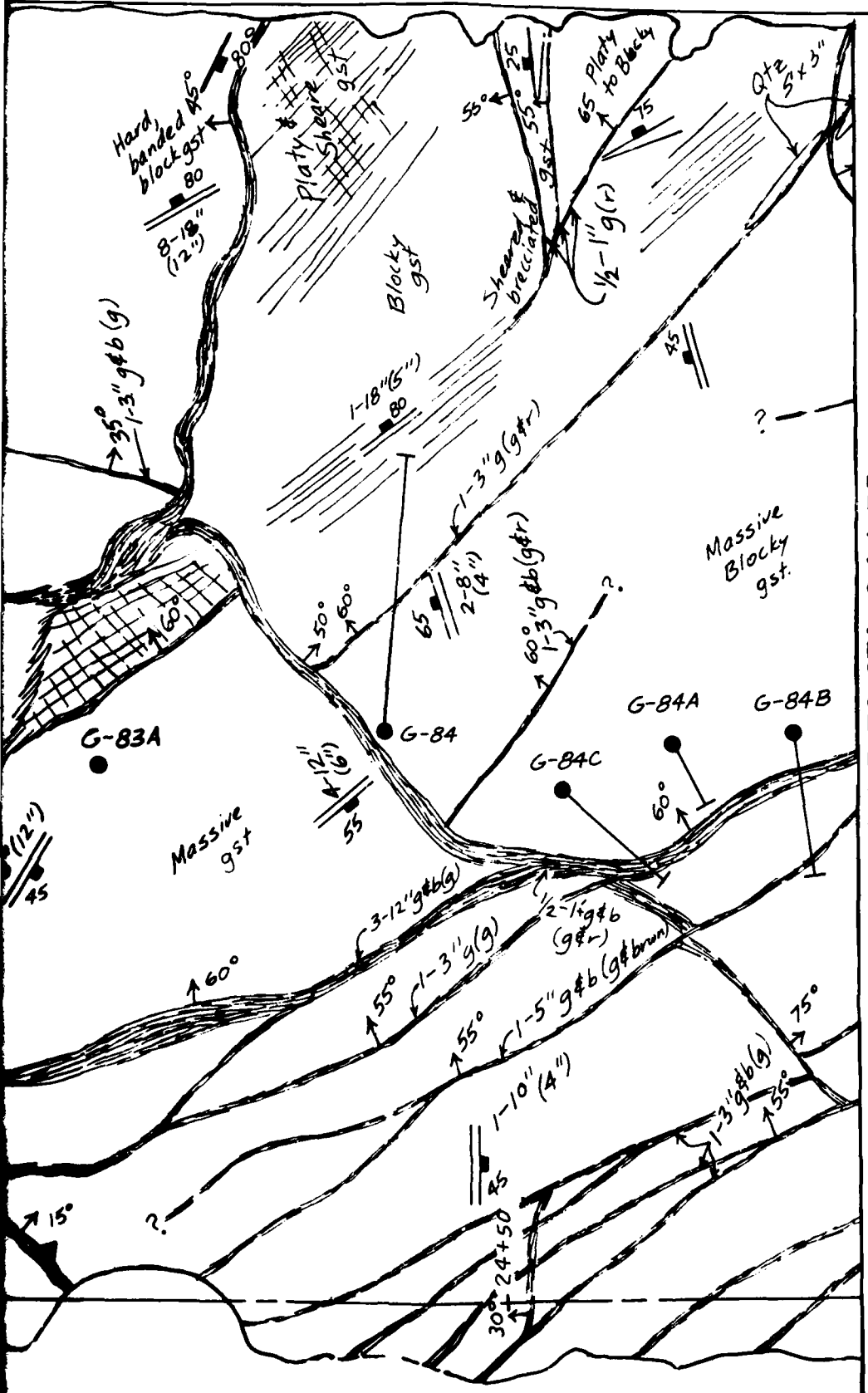
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

U.S. ARMY ENGINEER DISTRICT




N
G-82B
G-82A
G-83
G-83A
G-84
G-84A
G-84B
G-84C
Hard, banded blockgst
80
8-18" (12")
Platy Shear gst
Blocky gst
Sheared & brecciated gst
65 Platy to Blocky
75
Qtz
1-3"g(qtr)
1-18"(5")
2-8"(4")
Massive Blocky gst.
Massive gst
2-18"(12")
45
4-12"(1')
55
3-12"g¢b(g)
1-3"g(g)
1-5"g¢b(g¢brwn)
1-10"(4")
+24+00
+24+50
2

CORPS OF ENGINEERS



MATCH LINE TO STA. 24+75

NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols.

1 IN = 10 FT

10 0 10 FEET

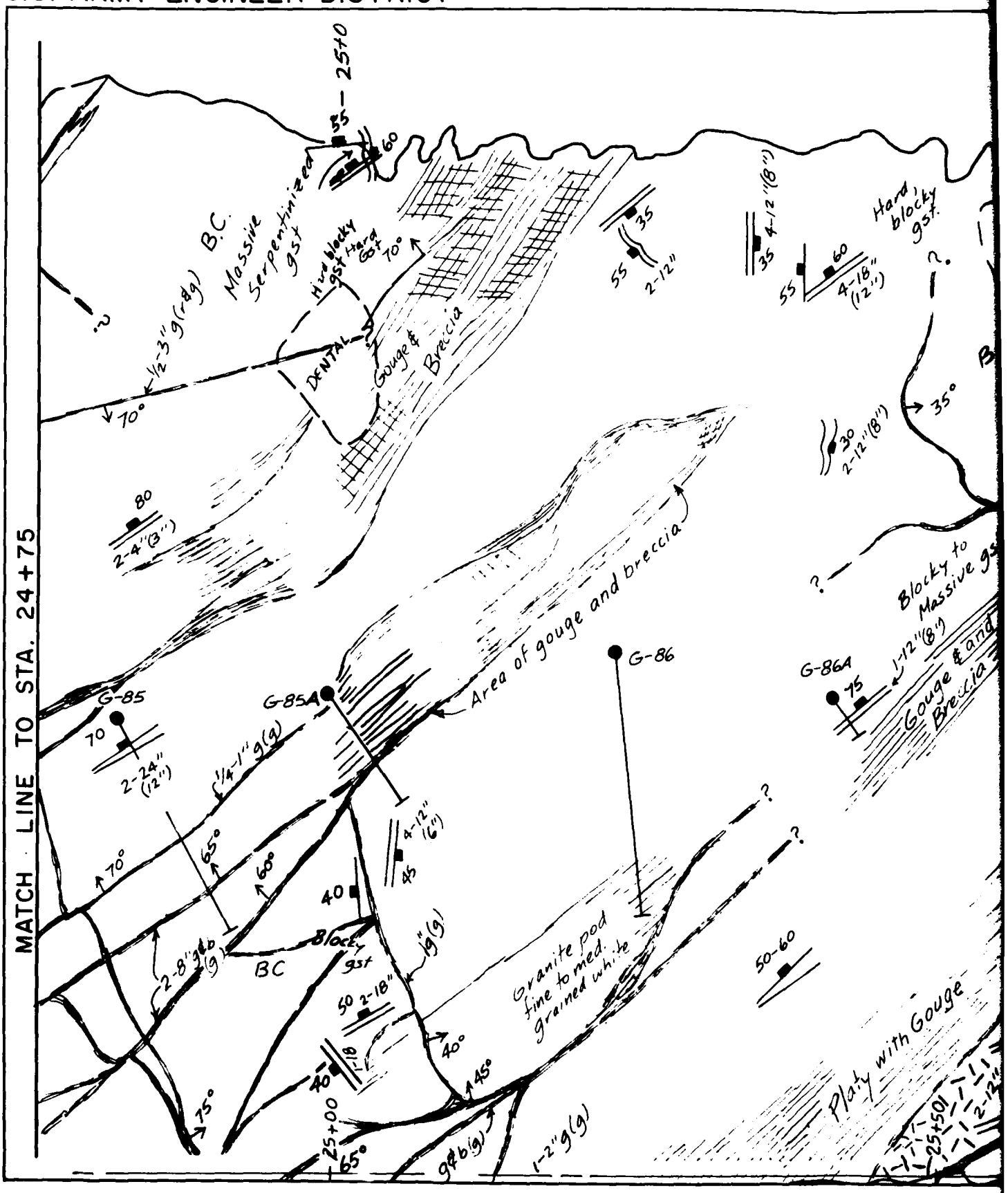
GILA RIVER BASIN
N RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM
FOUNDATION GEOLOGY
CUTOFF TRENCH
STA. 23+11 to STA. 24+75

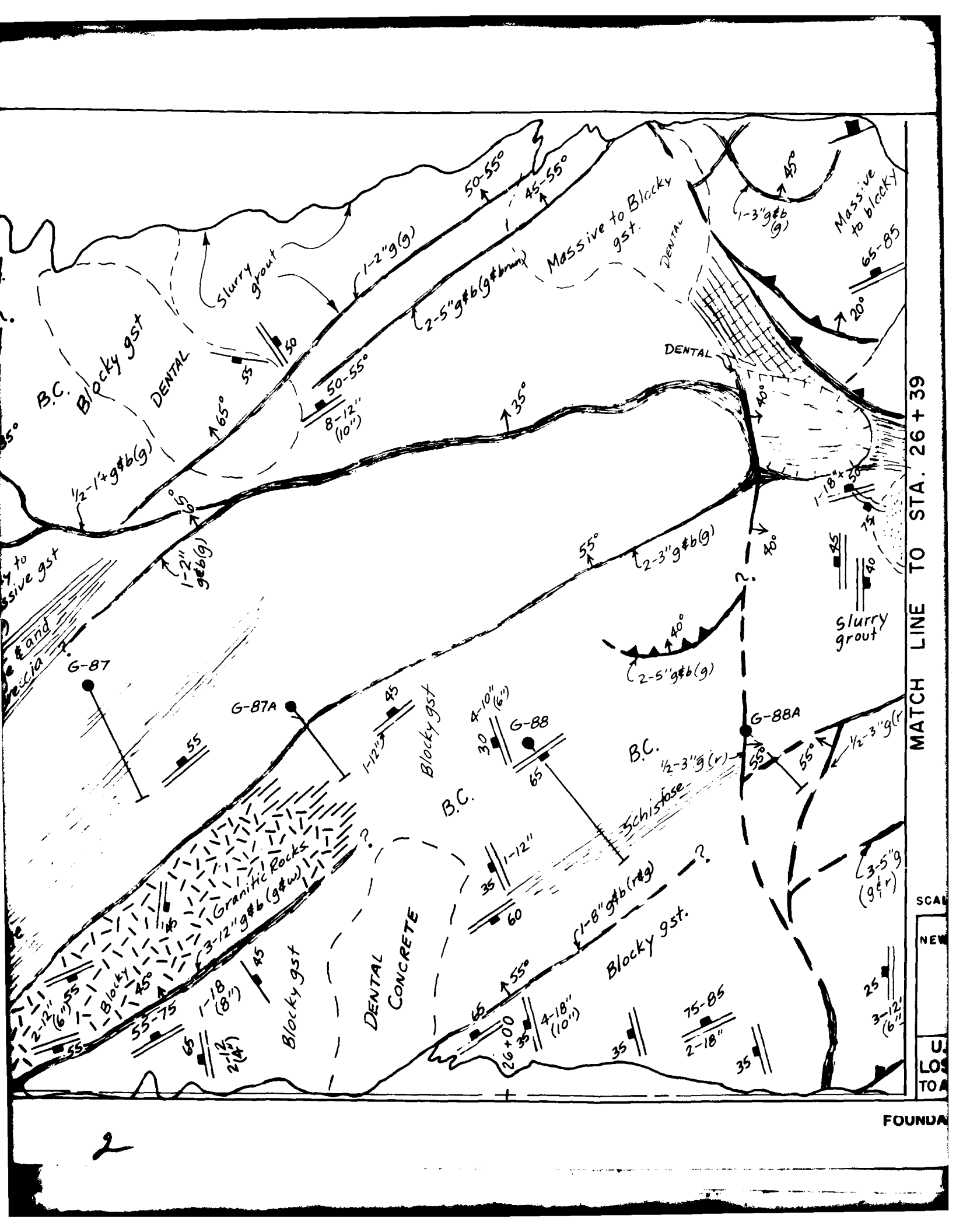
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

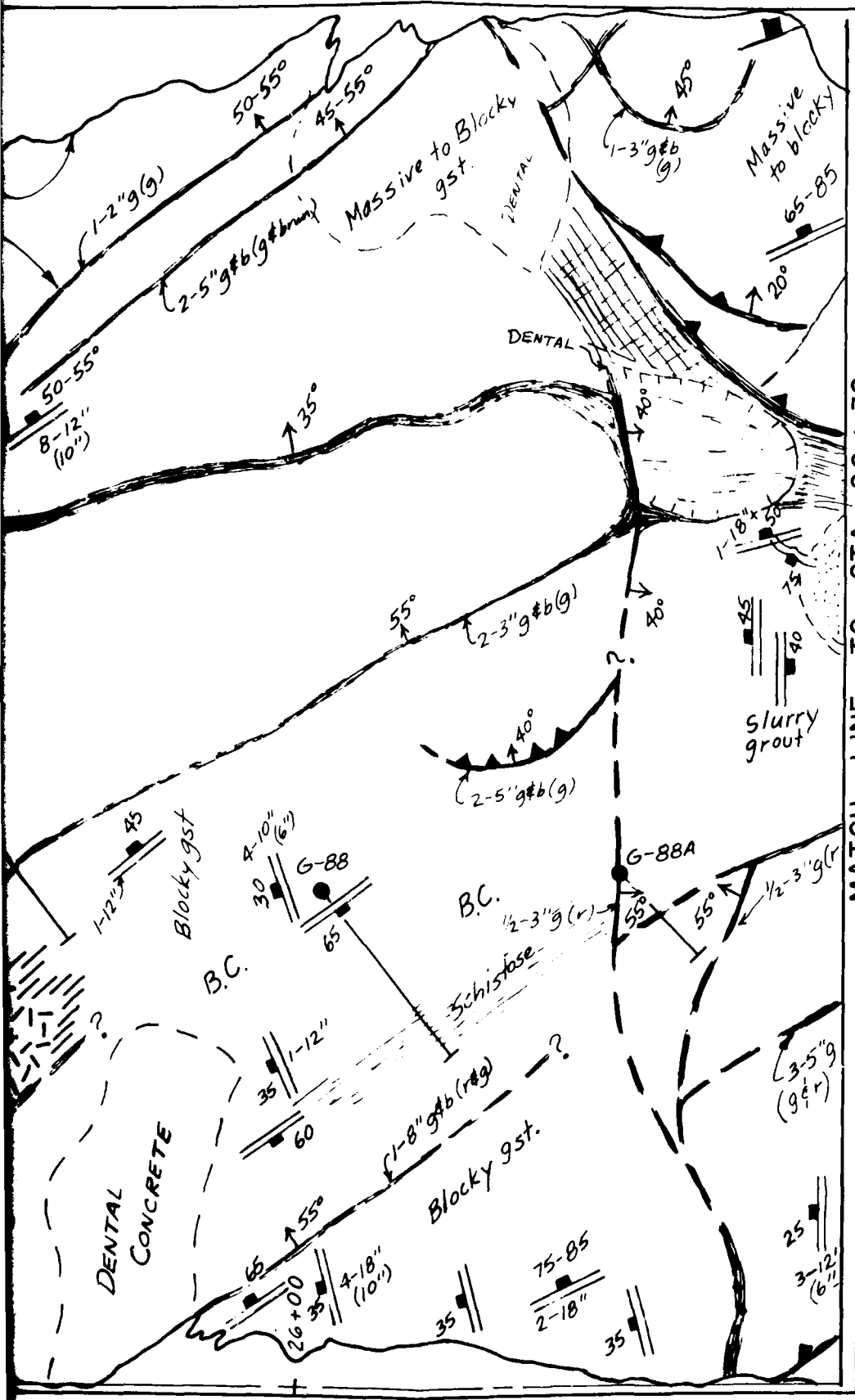
FOUNDATION REPORT PLATE 33

U.S. ARMY ENGINEER DISTRICT



1


MATCH LINE TO STA. 26 + 39
Massive to Blocky gst.
Slurry grout
B.C.
Blocky gst
DENTAL
G-87
G-87A
G-88
G-88A
Granitic Rocks
Schistose
DENTAL CONCRETE
Blocky gst.
Slurry grout
50-55°
45-55°
55°
65°
35°
40°
45°
20°
1-2" g(g)
2-5" g¢b(g¢brown)
1½-1+ g¢b(g)
1-2" g¢b(g)
2-3" g¢b(g)
1-3" g¢b (g)
1-18" x 50
1-8" g¢b(r¢g)
3-12" g¢b (g¢w)
4-18" (10")
8-12" (10")
4-10" (6")
1-12"
1-18 (8")
2-12" (6")
2-12" (12")
75-85
2-18"
3-12" (6")
3-5" g (g¢r)
½-3" g(r)
26+00
SCALE
NEW
FOUNDA



NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols.

1 IN = 10 FT

SCALE .0 0 10 FEET

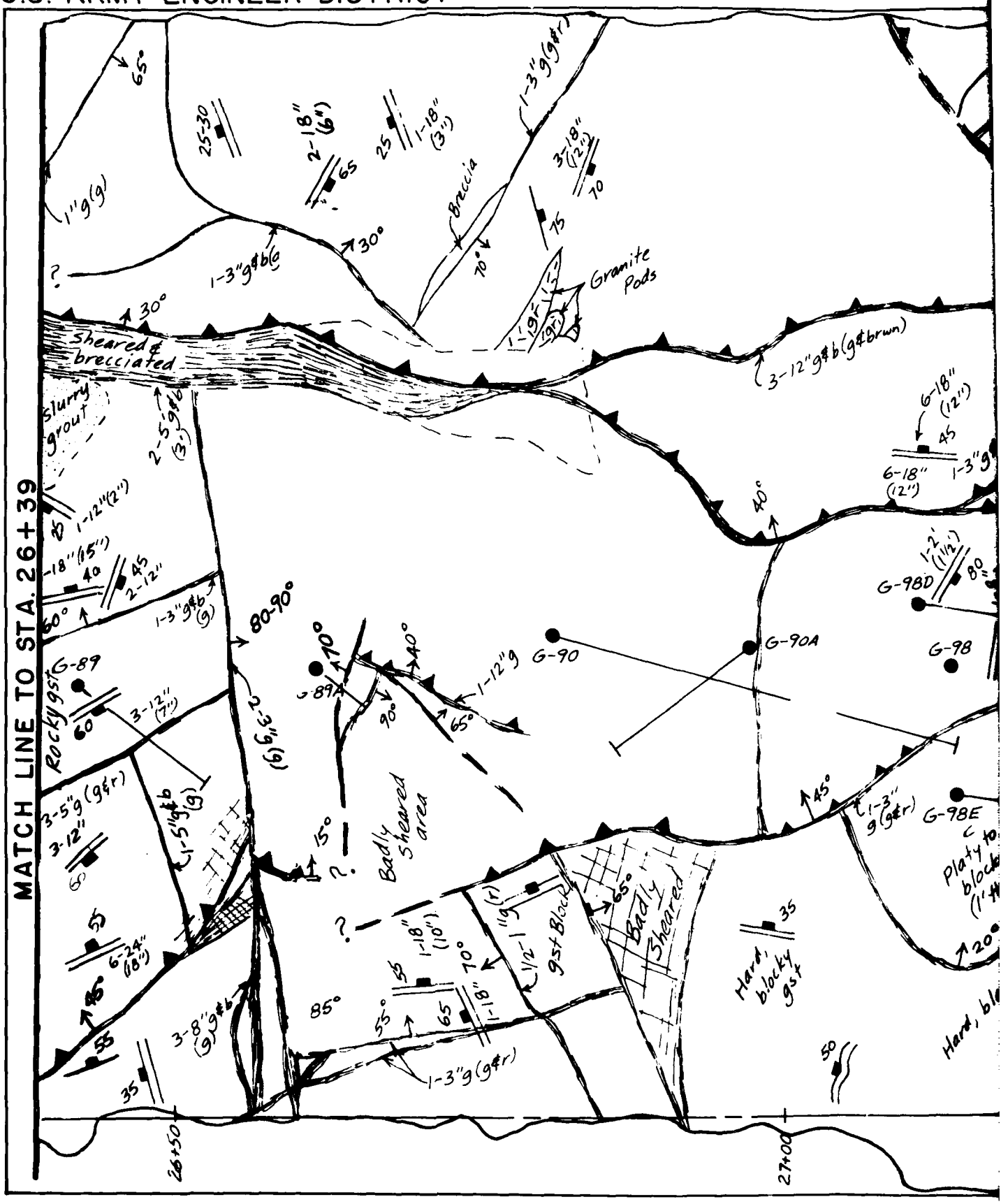
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA
CAVE BUTTES DAM
FOUNDATION GEOLOGY
CUTOFF TRENCH
STA. 24+75 to STA. 26+39

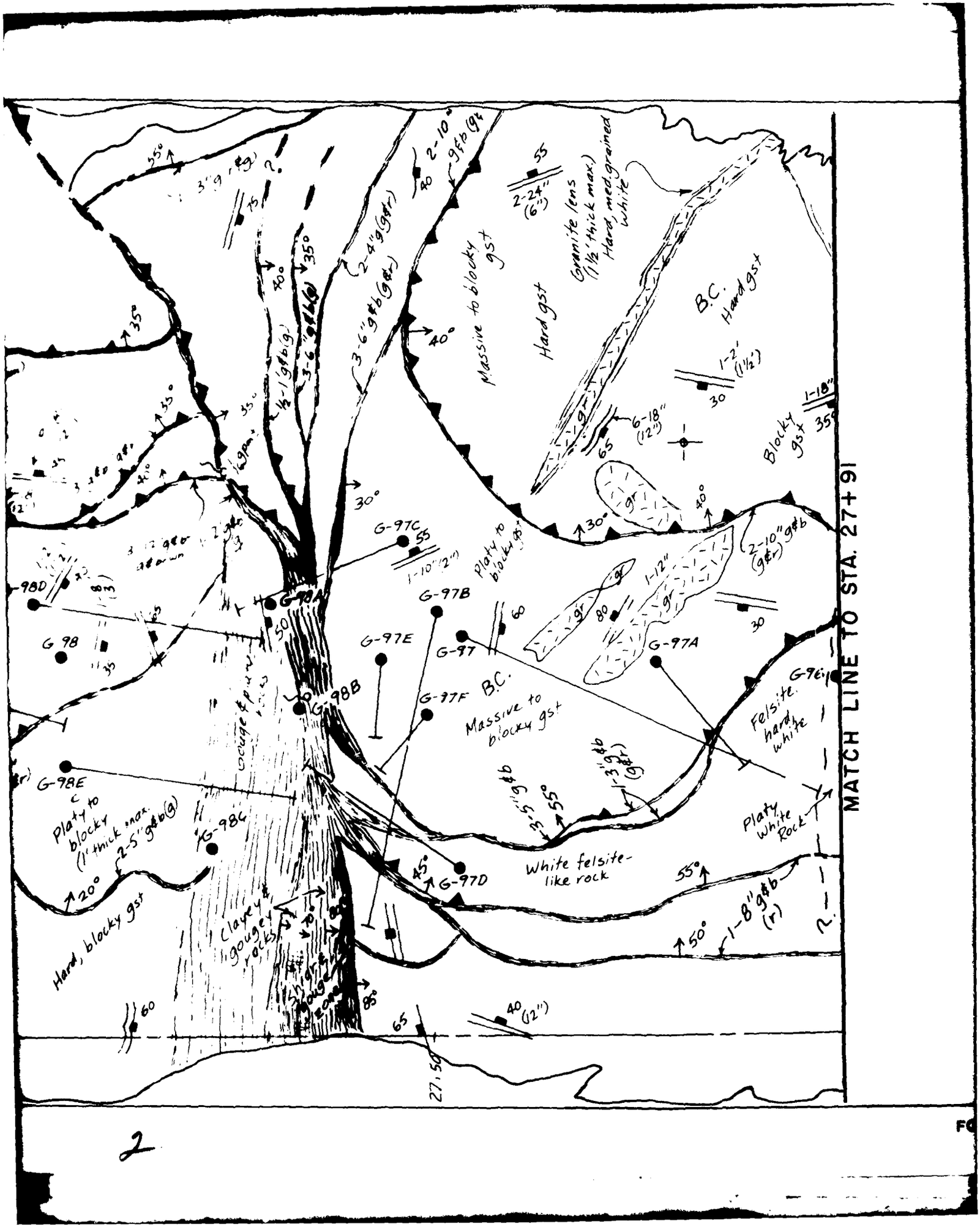
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

FOUNDATION REPORT PLATE 34

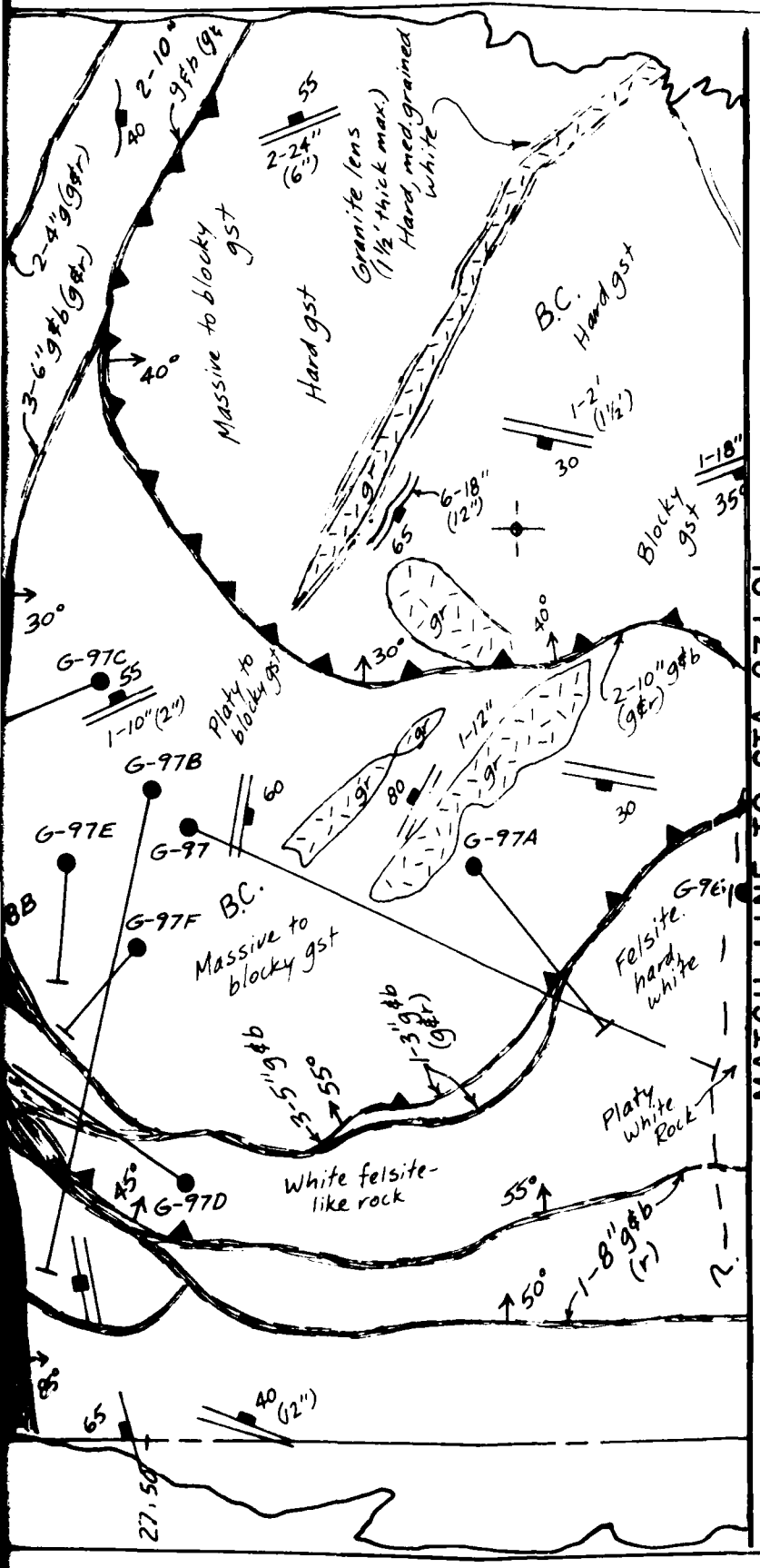
3

U.S. ARMY ENGINEER DISTRICT




MATCH LINE TO STA. 27+91
G-98D
G-98
G-98E
G-98C
G-98B
G-98A
G-97C
G-97B
G-97E
G-97F
G-97
G-97A
G-97D
G-97E
B.C.
Massive to blocky gst
Hard gst
Granite lens (1½' thick max.) Hard, med. grained white
Platy to blocky (1" thick max.)
Hard, blocky gst
Clayey gouge & rocks
Shear zone
White felsite-like rock
Felsite, hard white
Platy, white Rock
Blocky gst
27,50

2



NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols.

1 IN = 10 FT

SCALE 10 0 10 FEET

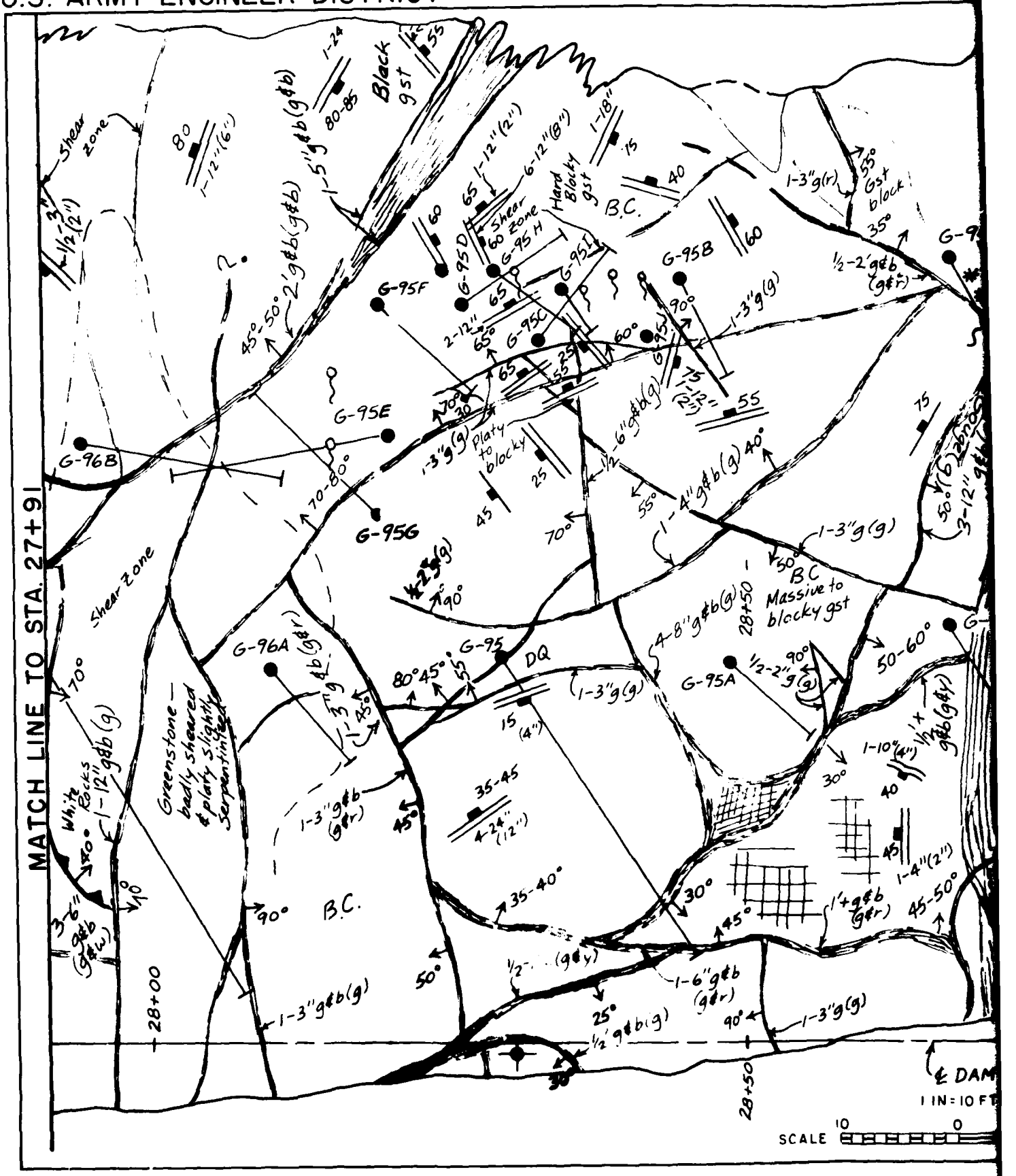
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

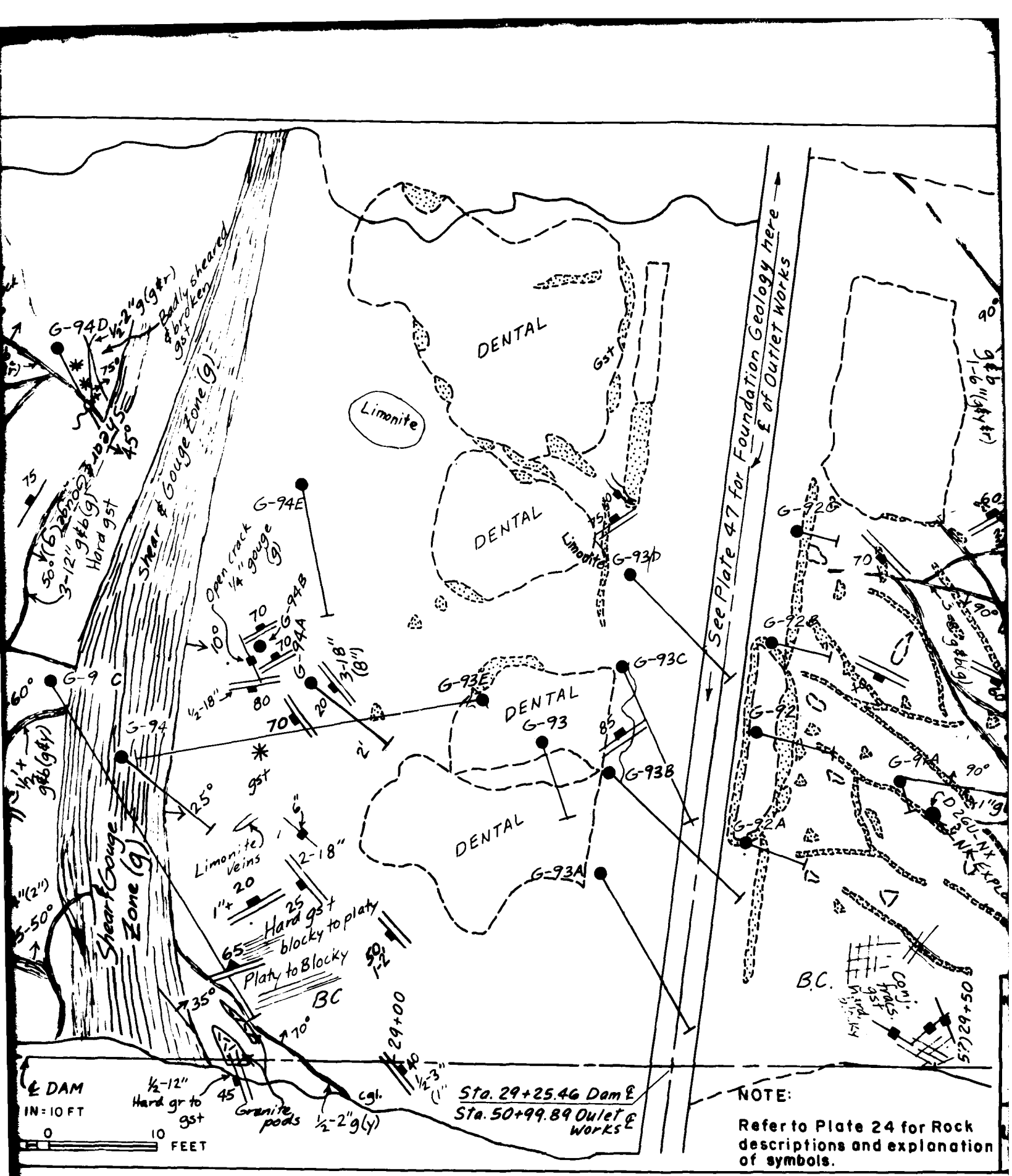
CAVE BUTTES DAM
FOUNDATION GEOLOGY
CUTOFF TRENCH
STA. 26+39 to STA. 27+91

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS

TO ACCOMPANY REPORT DATED:

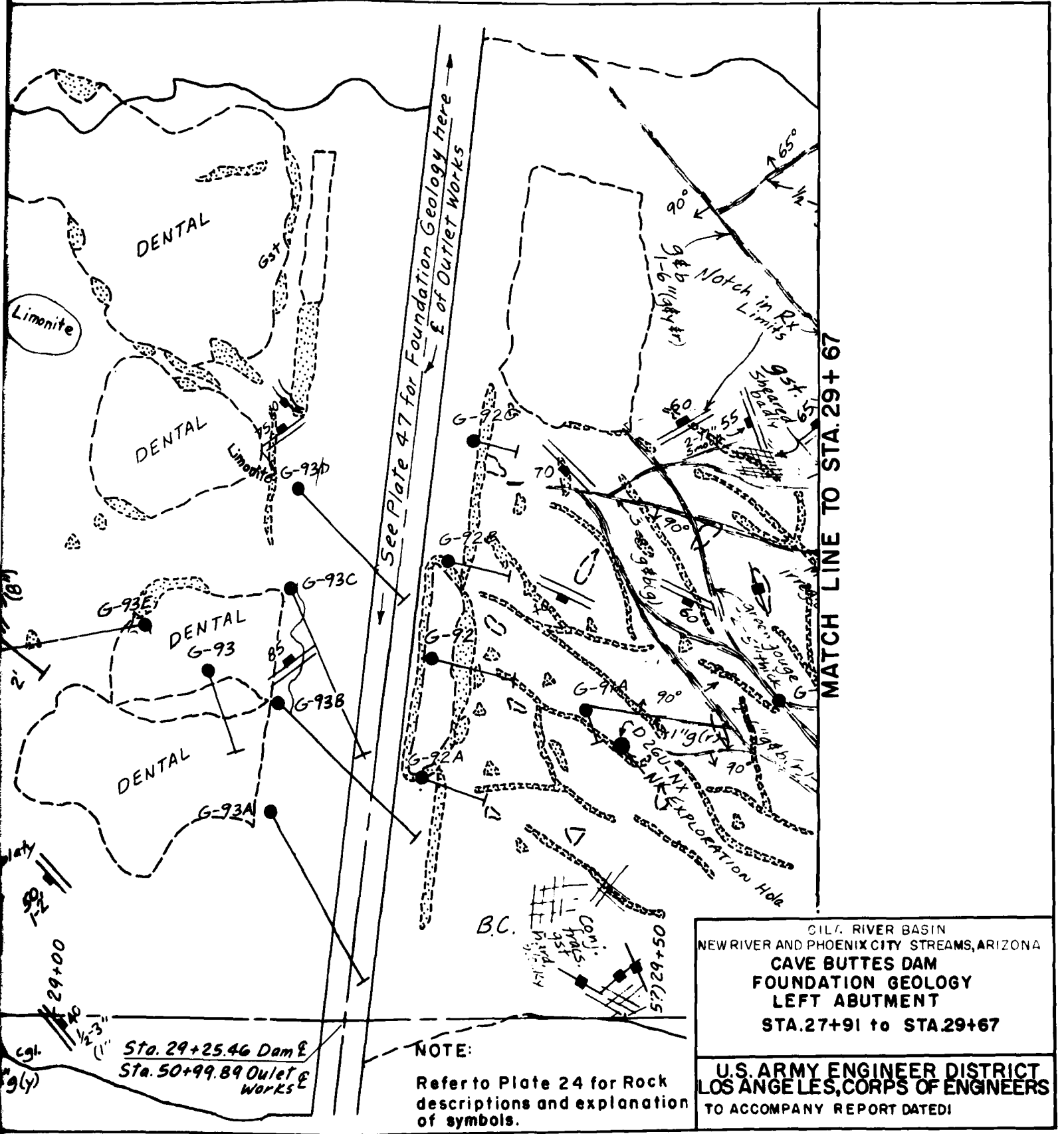
U.S. ARMY ENGINEER DISTRICT





NOTE:

Refer to Plate 24 for Rock descriptions and explanation of symbols.



NOTE:

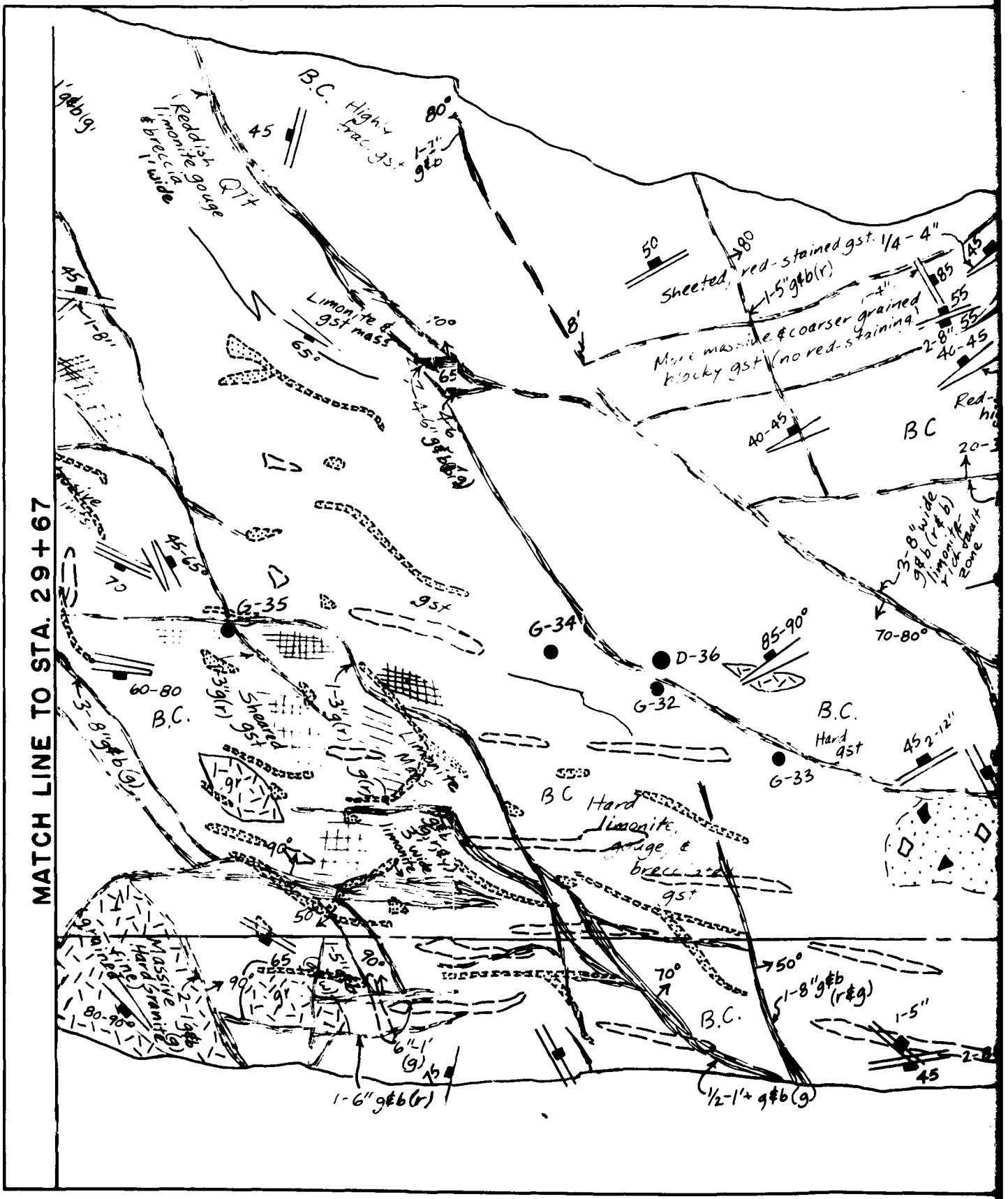
Refer to Plate 24 for Rock descriptions and explanation of symbols.

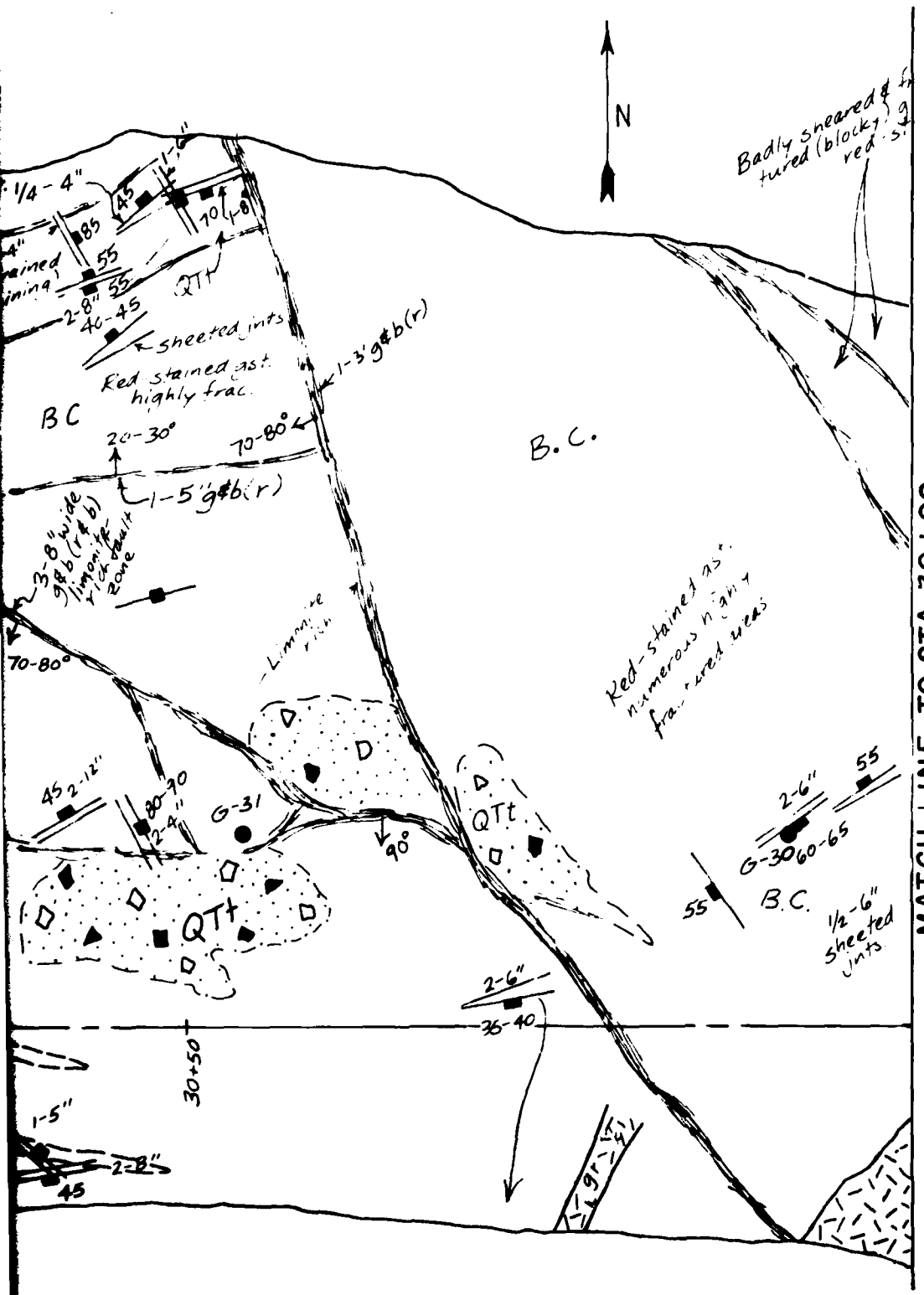
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA
CAVE BUTTES DAM
FOUNDATION GEOLOGY
LEFT ABUTMENT
STA. 27+91 to STA. 29+67

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED!

PLATE 36

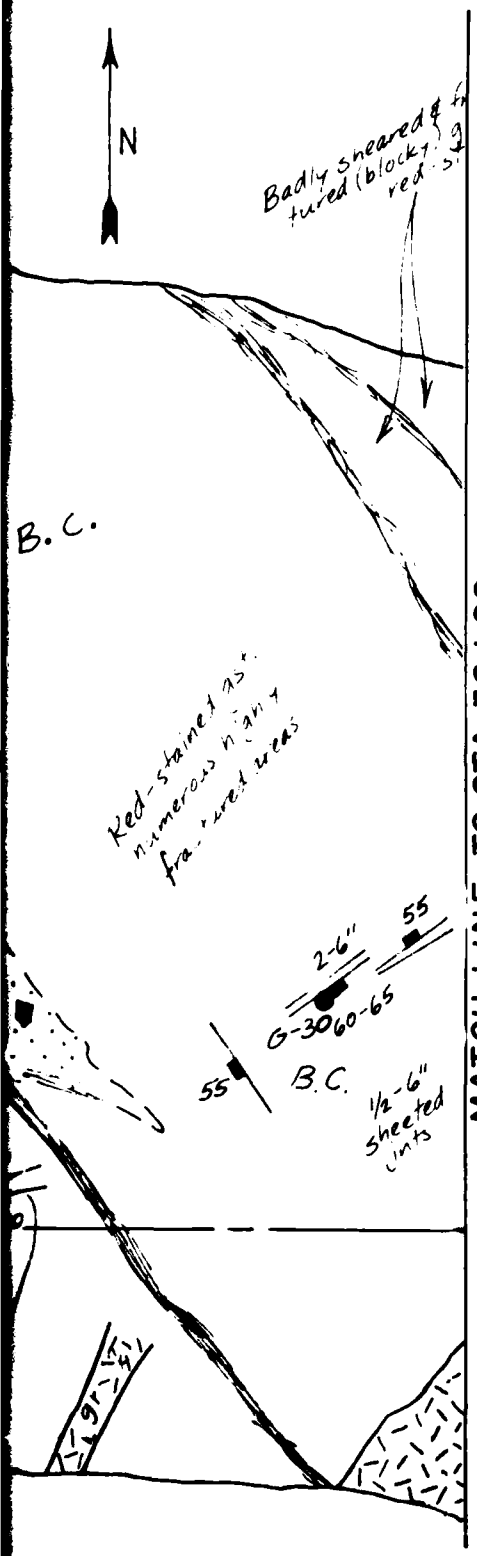
U.S. ARMY ENGINEER DISTRICT





NOTE:

Refer to Plate 24 for Rock descriptions and explanatio of symbols.



1 IN = 10 FT

SCALE 10 0 10 FEET

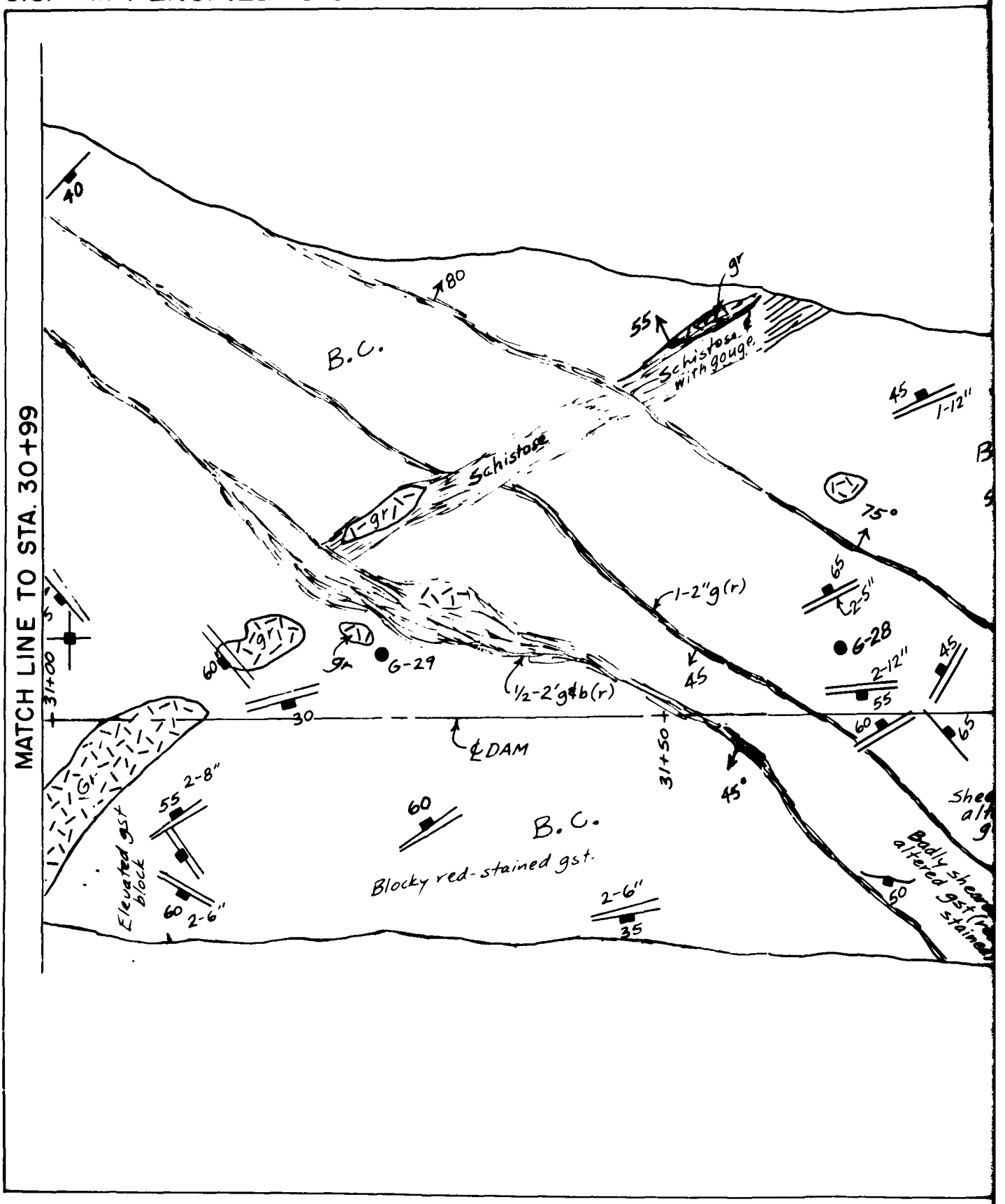
NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols.

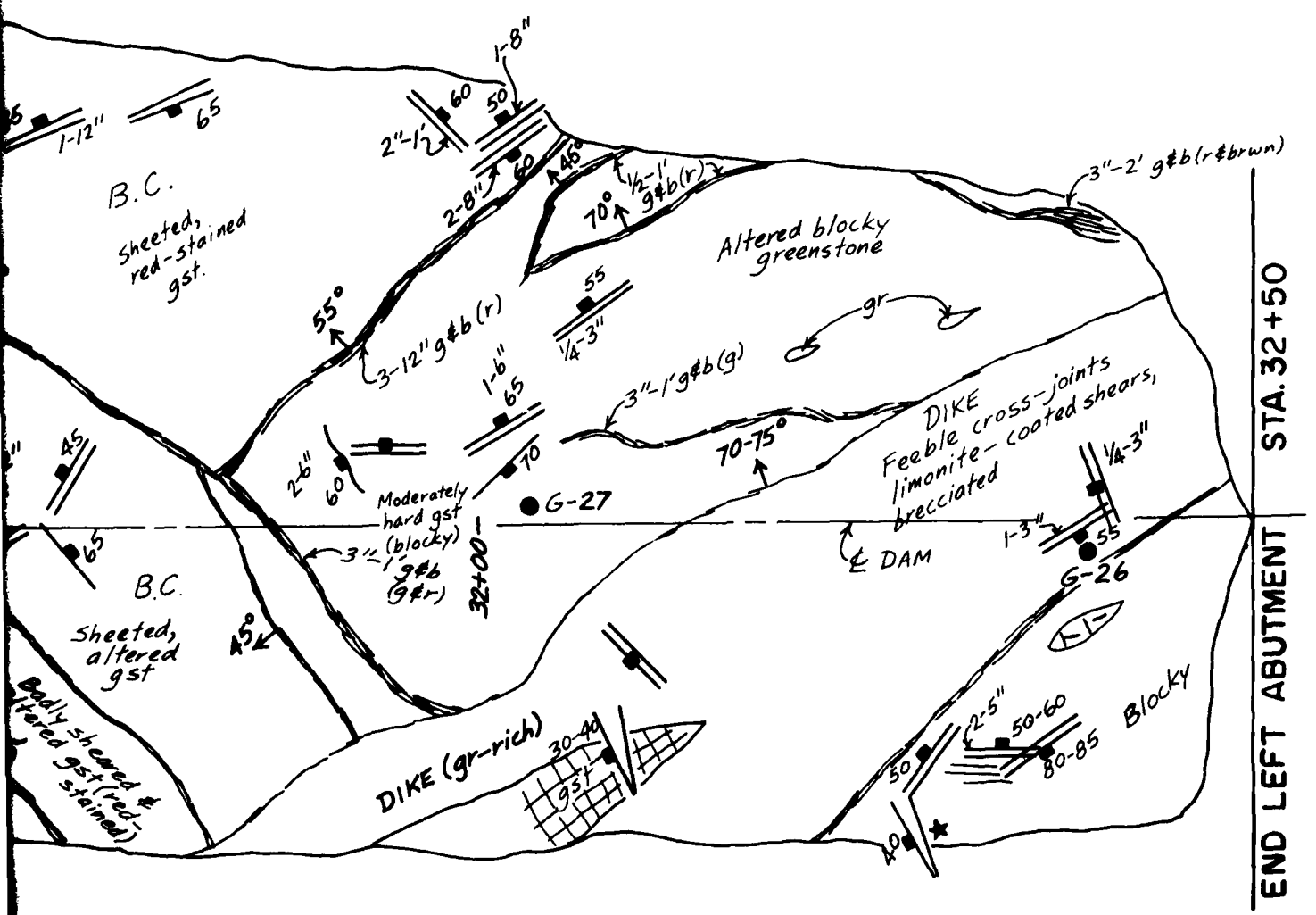
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA
CAVE BUTTES DAM
FOUNDATION GEOLOGY
LEFT ABUTMENT
STA. 29+67 to STA. 30+99

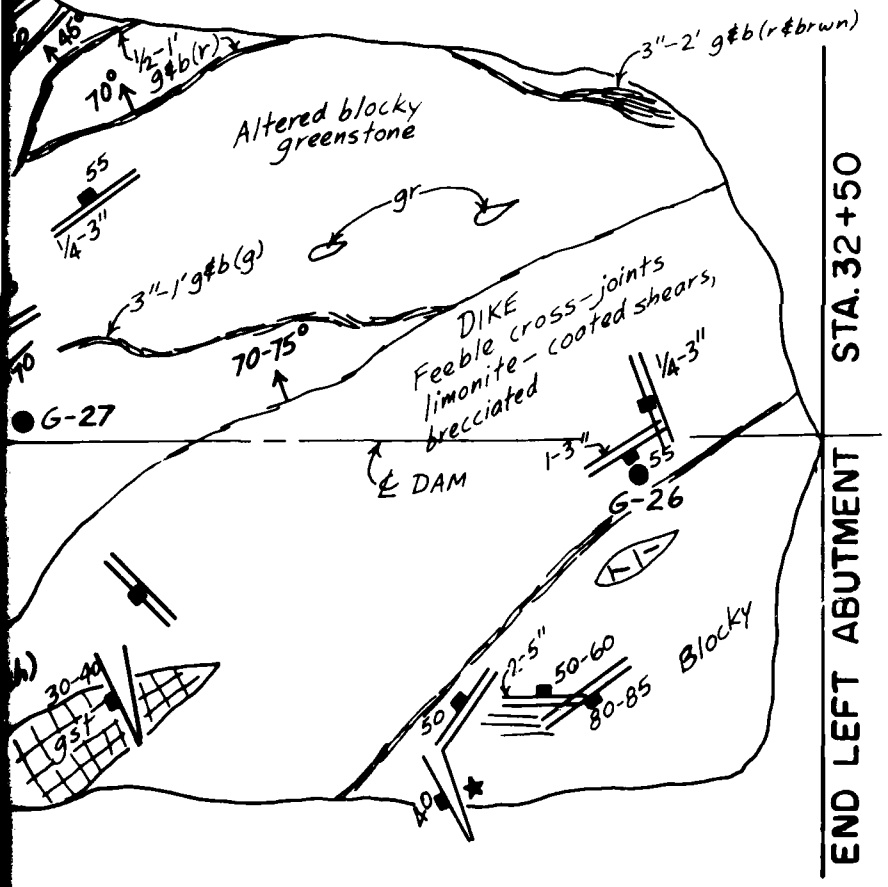
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

U.S. ARMY ENGINEER DISTRICT



1


1-8"
1-12"
65
60
50
2"-1½"
2-8"
45°
70°
½-1' g&b(r)
3"-2' g&b(r&brwn)
B.C.
Sheeted, red-stained gst.
Altered blocky greenstone
55°
3-12" g&b(r)
55
¼-3"
gr
1-6"
65
3"-1' g&b(g)
DIKE
Feeble cross-joints limonite-coated shears, brecciated
70-75°
2-6"
60
70
Moderately hard gst (blocky) g&b (g&r)
G-27
¼-3"
1-3"
55
DAM
G-26
32+00
STA. 32+50
END LEFT ABUTMENT
B.C.
Sheeted, altered gst
45°
Badly sheared & altered gst (red-stained)
DIKE (gr-rich)
30-40
gst
2-5"
50-60
80-85
Blocky
50
40



NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols.

1 IN = 10 FT

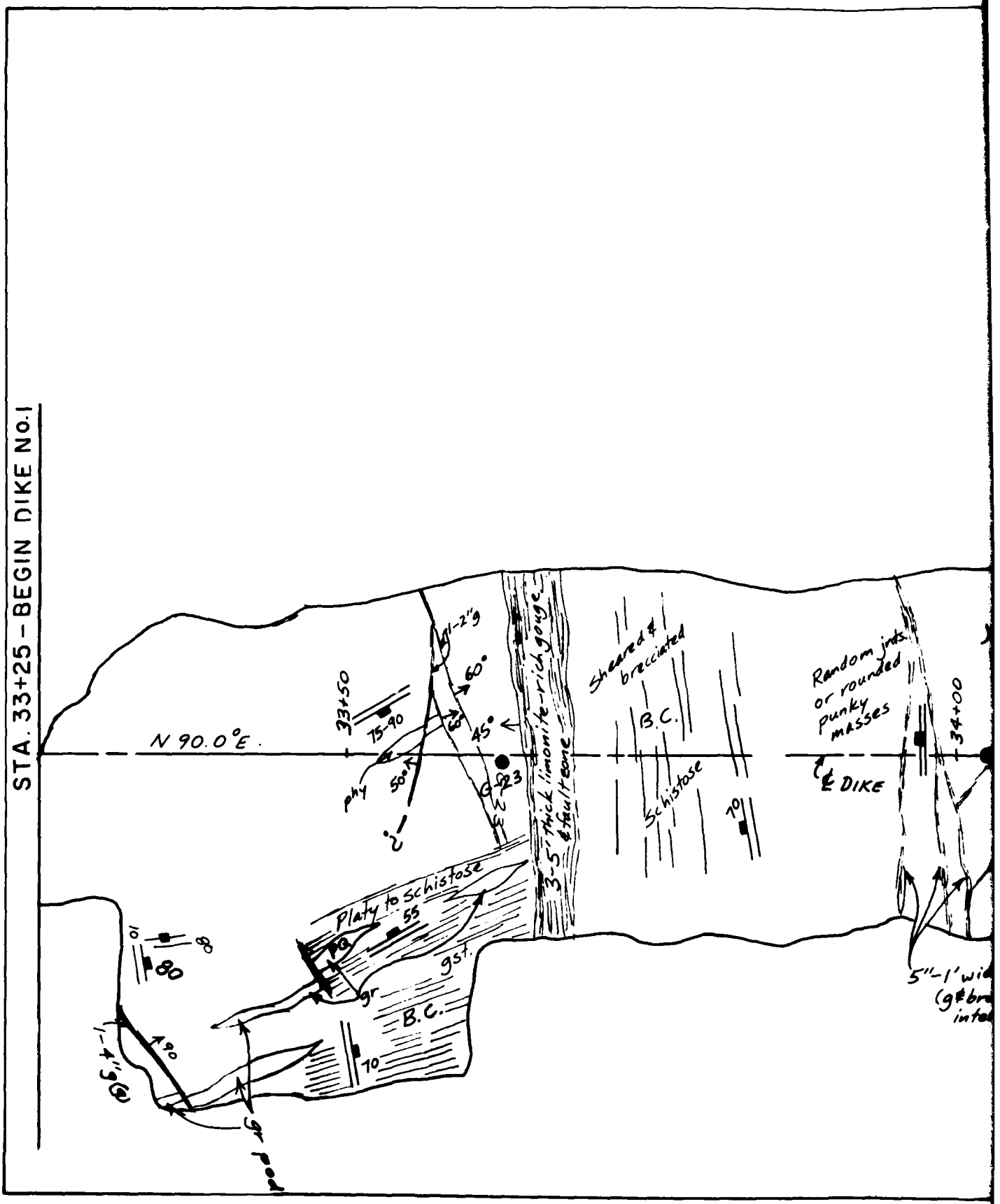
SCALE 10 0 10 FEET

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

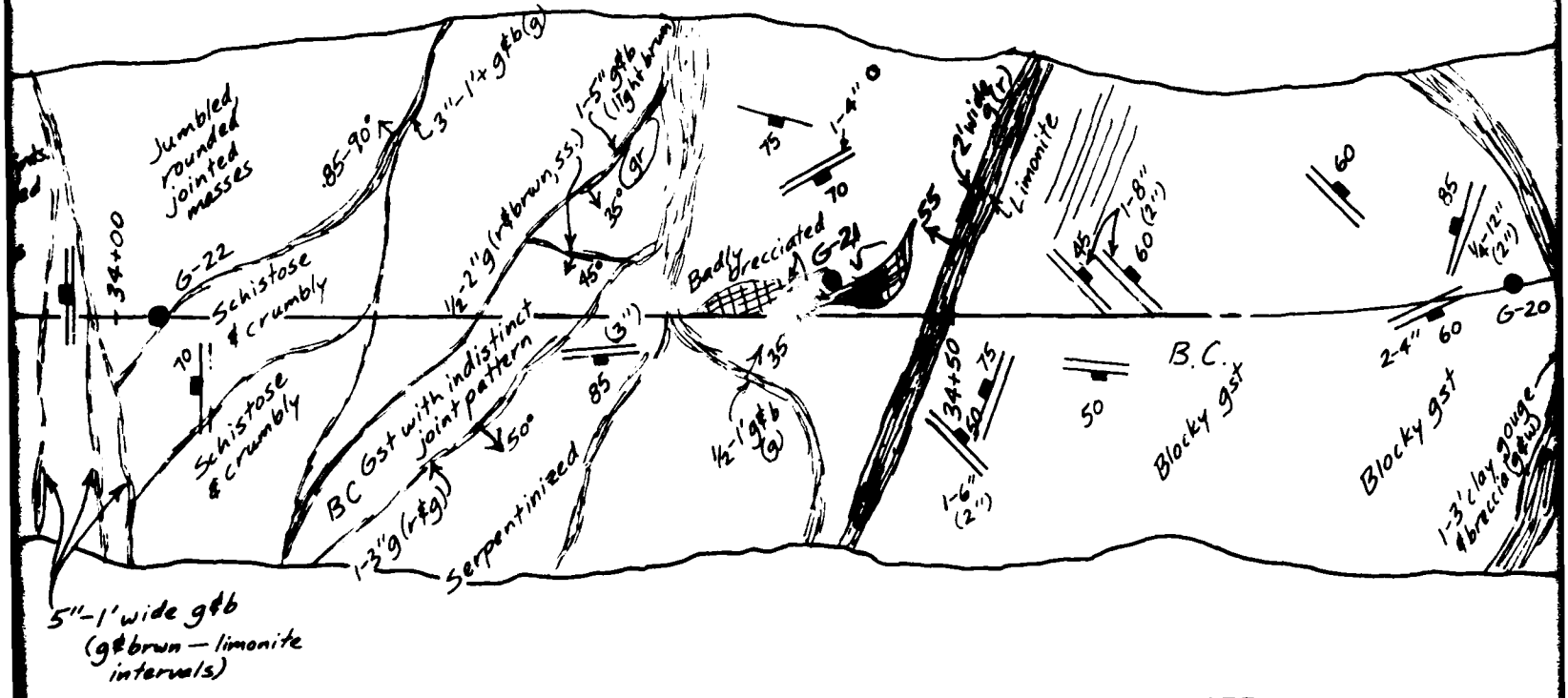
CAVE BUTTES DAM
FOUNDATION GEOLOGY
LEFT ABUTMENT
STA. 30+99 to STA. 32+50

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

U.S. ARMY ENGINEER DISTRICT



1

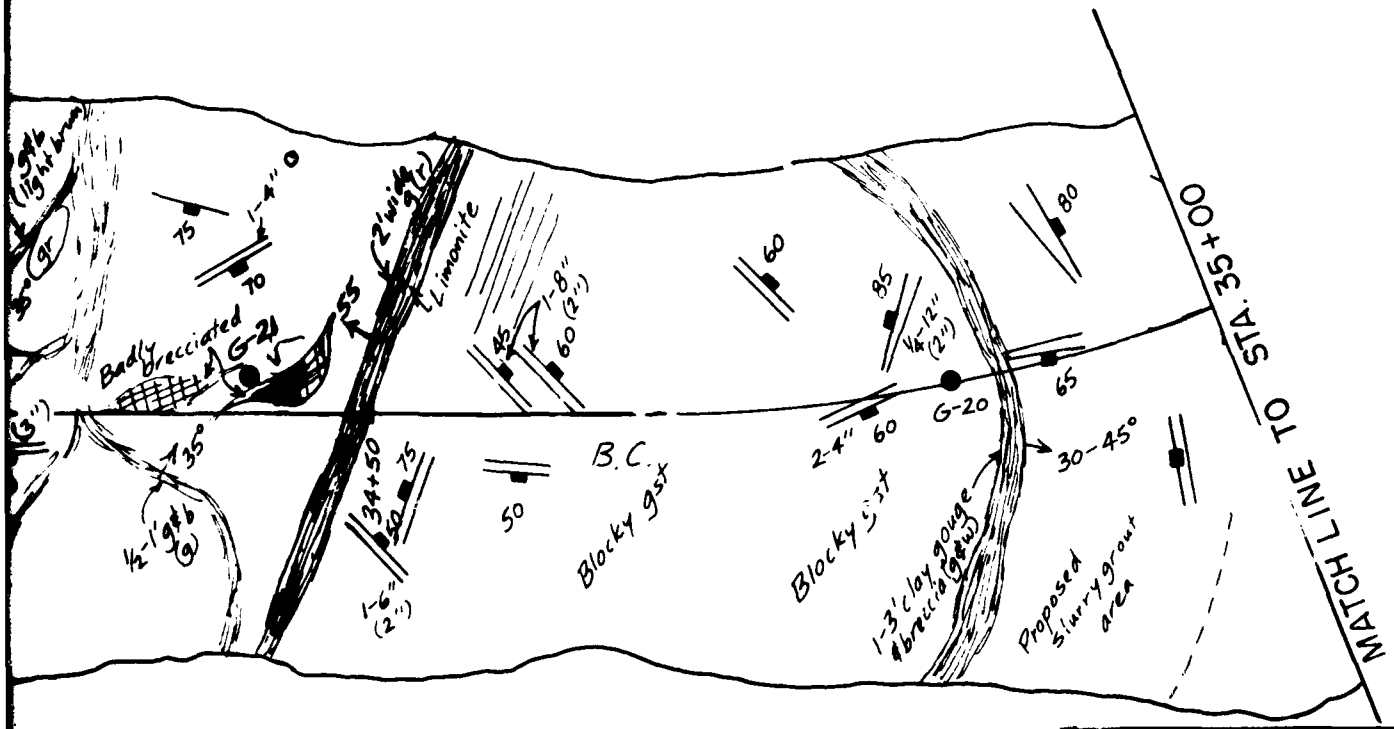


NOTE:

Refer to Plate 24 for Rock descriptions and explanatio of symbols.

1 IN = 10 FT

SCALE 10 0 10



NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols.

1 IN = 10 FT

SCALE 10 0 10 FEET

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM
FOUNDATION GEOLOGY
DIKE No. 1
STA. 33+25 to STA. 35+00

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS

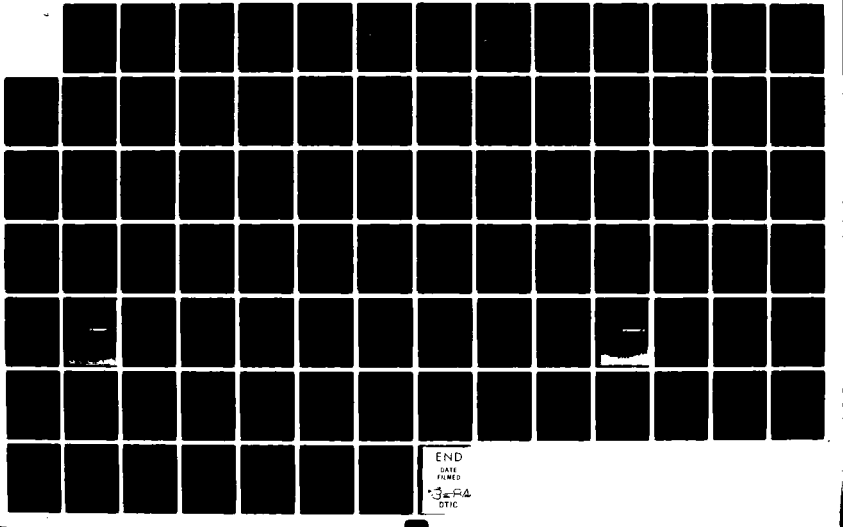
TO ACCOMPANY REPORT DATED:

FOUNDATION REPORT PLATE 39

AD-A137 732 CAVE BUTTES DAM FOUNDATION REPORT GILA RIVER BASIN: PHOENIX ARIZONA AND VICINITY (INCLUDING NEW RIVER)(U) ARMY ENGINEER DISTRICT LOS ANGELES CA AUG 83

3/3

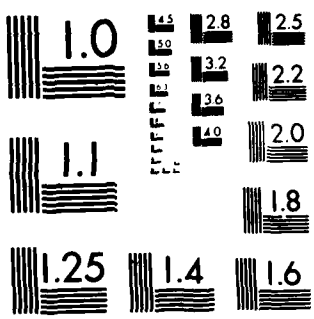
UNCLASSIFIED F/G 13/13 NL



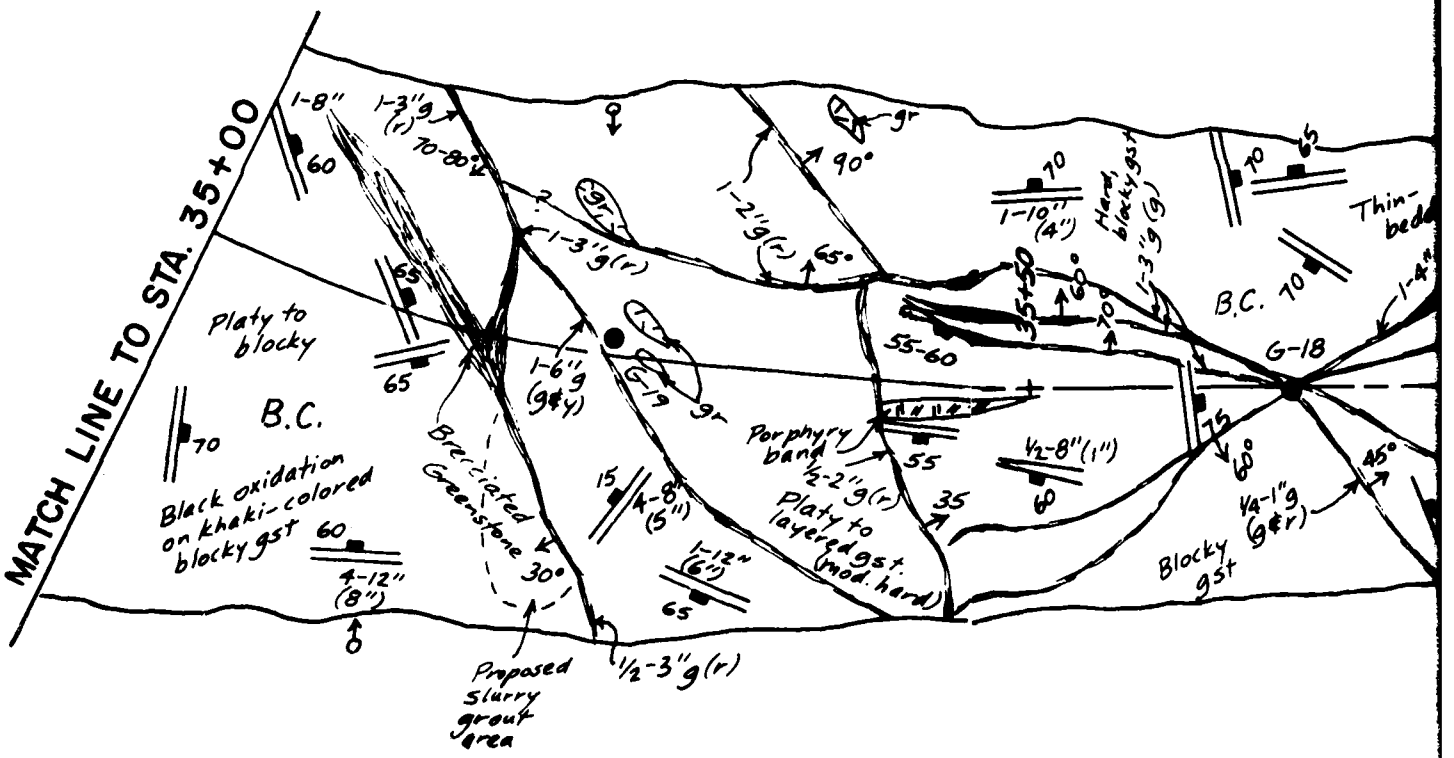
END

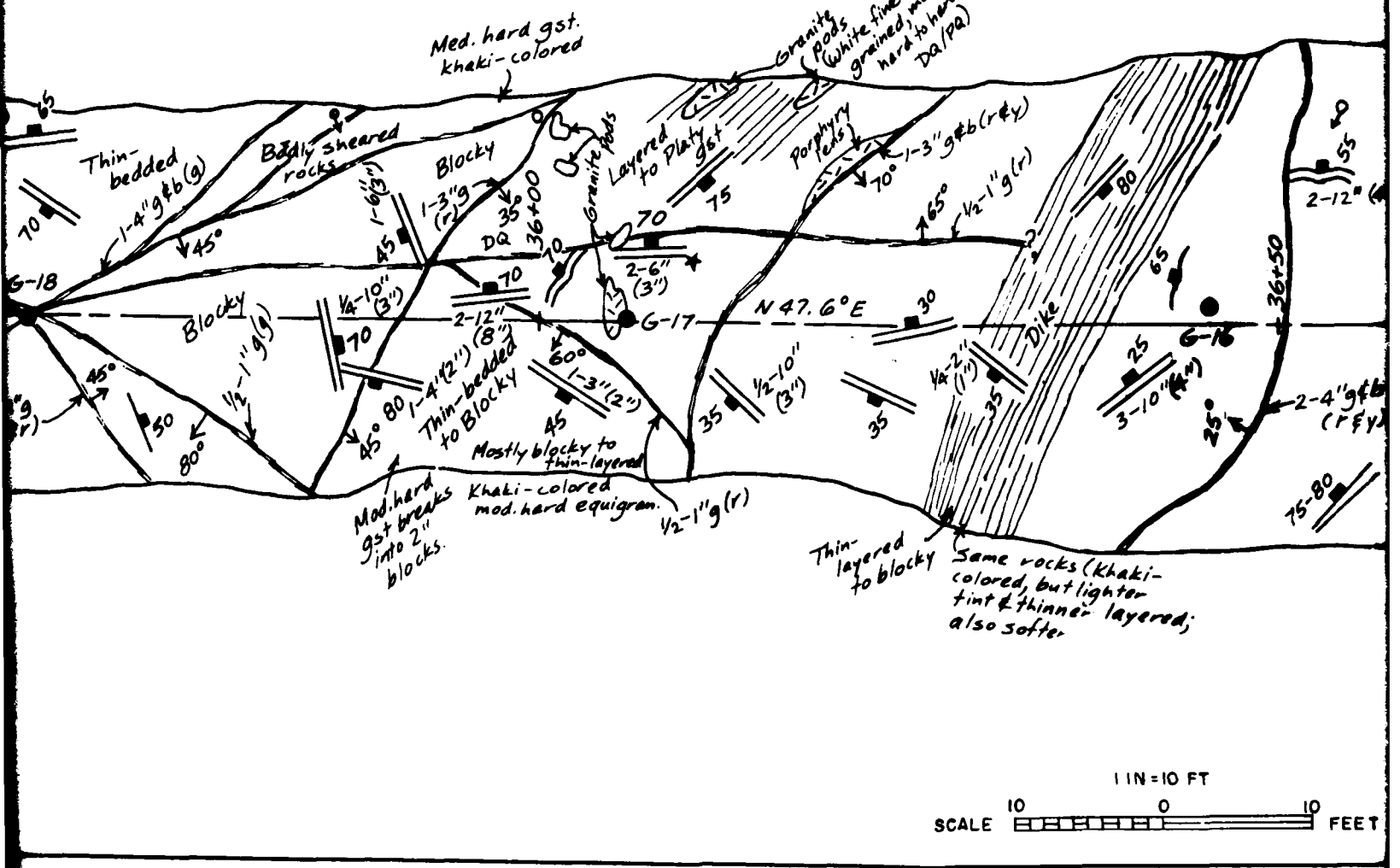
DATE FILMED

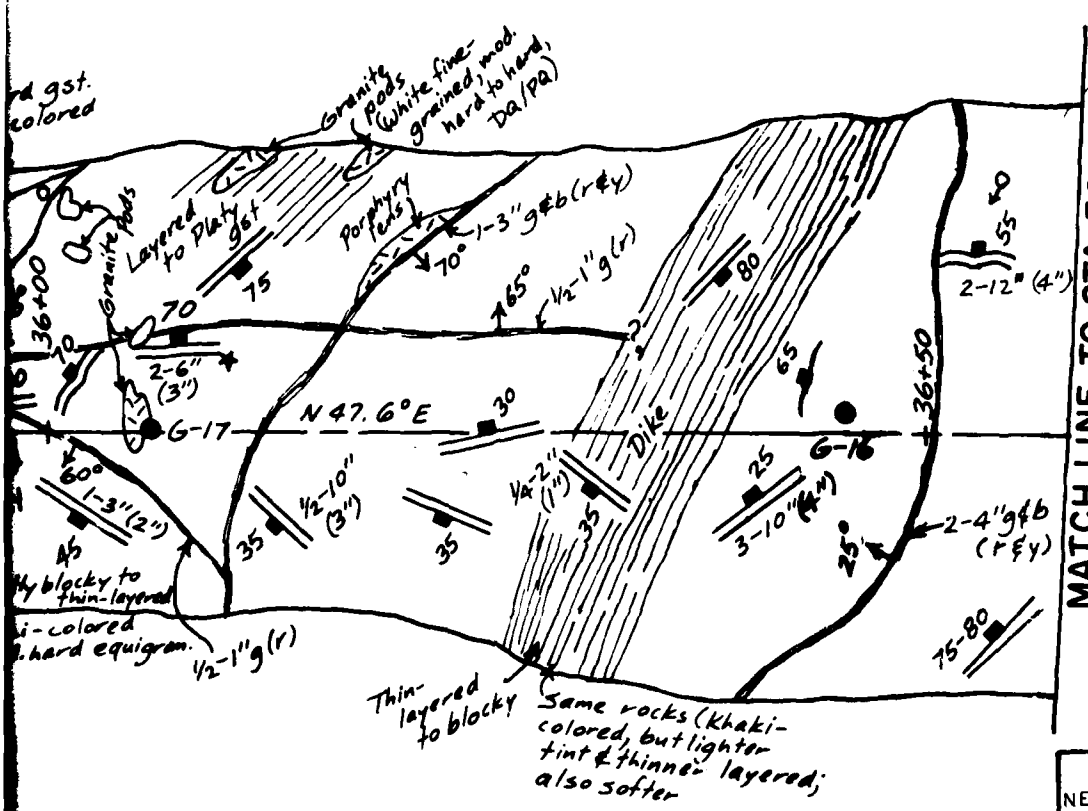
DTIC



U.S. ARMY ENGINEER DISTRICT




Med. hard gst. khaki-colored
Granite (pods, white fine-grained, mod. hard to hard, DQ/PQ)
Thin-bedded 1-4" gtb(g)
Badly sheared rocks
Blocky 1-3" g (r)
1-6" (3")
Granite pods
Layered to Platy gst
Porphyry dikes
1-3" gtb(r&y)
1/2-1" g(r)
2-12" (8")
2-6" (3")
1/4-10" (3")
1-4" (2") Thin-bedded to Blocky
1-3" (2")
Blocky 1/2-1" g(g)
N 47.6° E
G-17
G-18
G-16
Dike
1/2-10" (3")
1/4-2" (1")
3-10" (4")
2-4" gtb (r&y)
2-12"
36+00
36+50
Mostly blocky to thin-layered
Khaki-colored mod. hard equigran.
Mod. hard gst breaks into 2" blocks.
Thin-layered to blocky
Same rocks (khaki-colored, but lighter tint & thinner layered; also softer
1 IN = 10 FT
SCALE 10 0 10 FEET



NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols.

1 IN = 10 FT

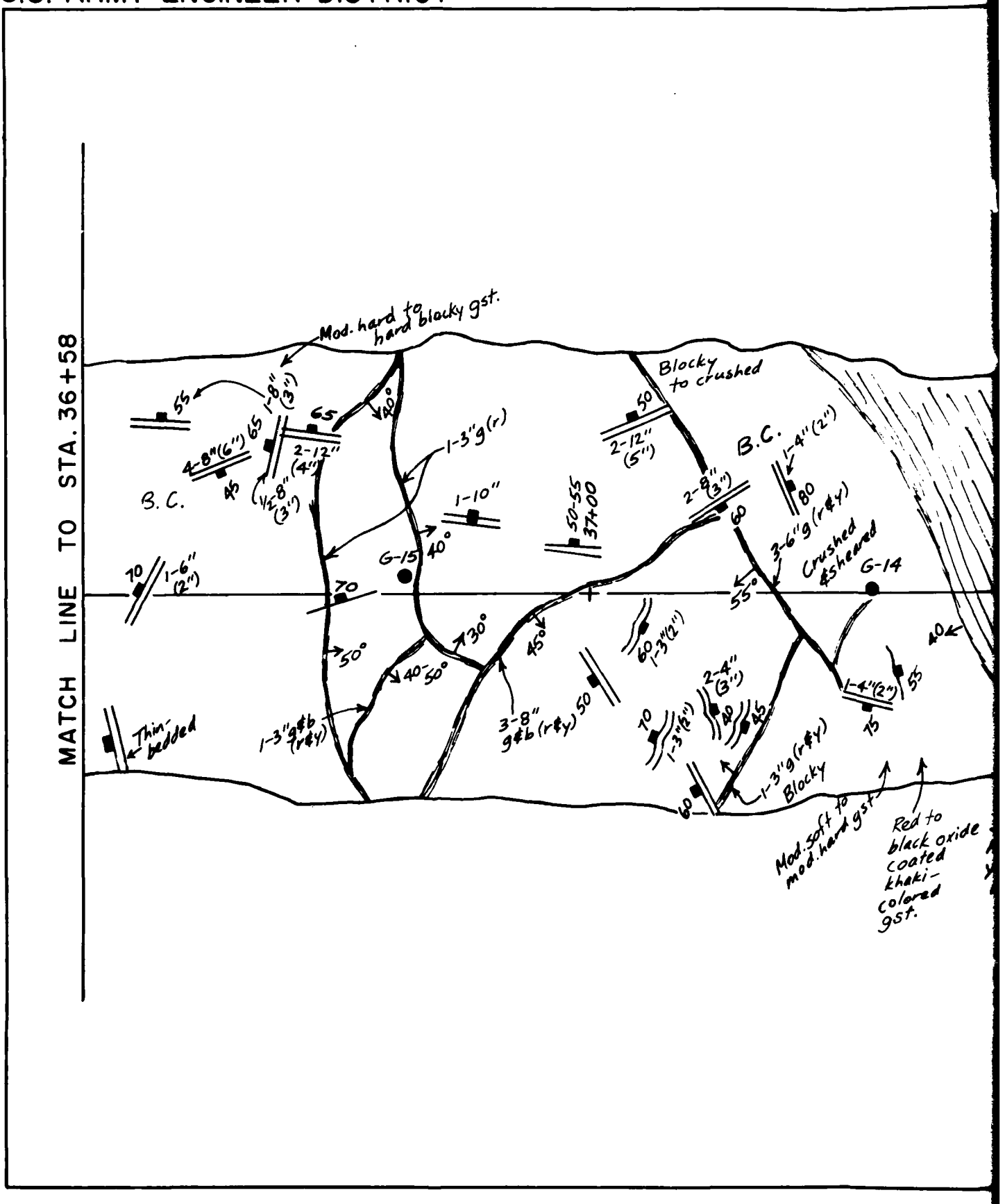
SCALE 10 0 10 FEET

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA
CAVE BUTTES DAM
FOUNDATION GEOLOGY
DIKE No. 1
STA. 35+00 to STA. 36+58

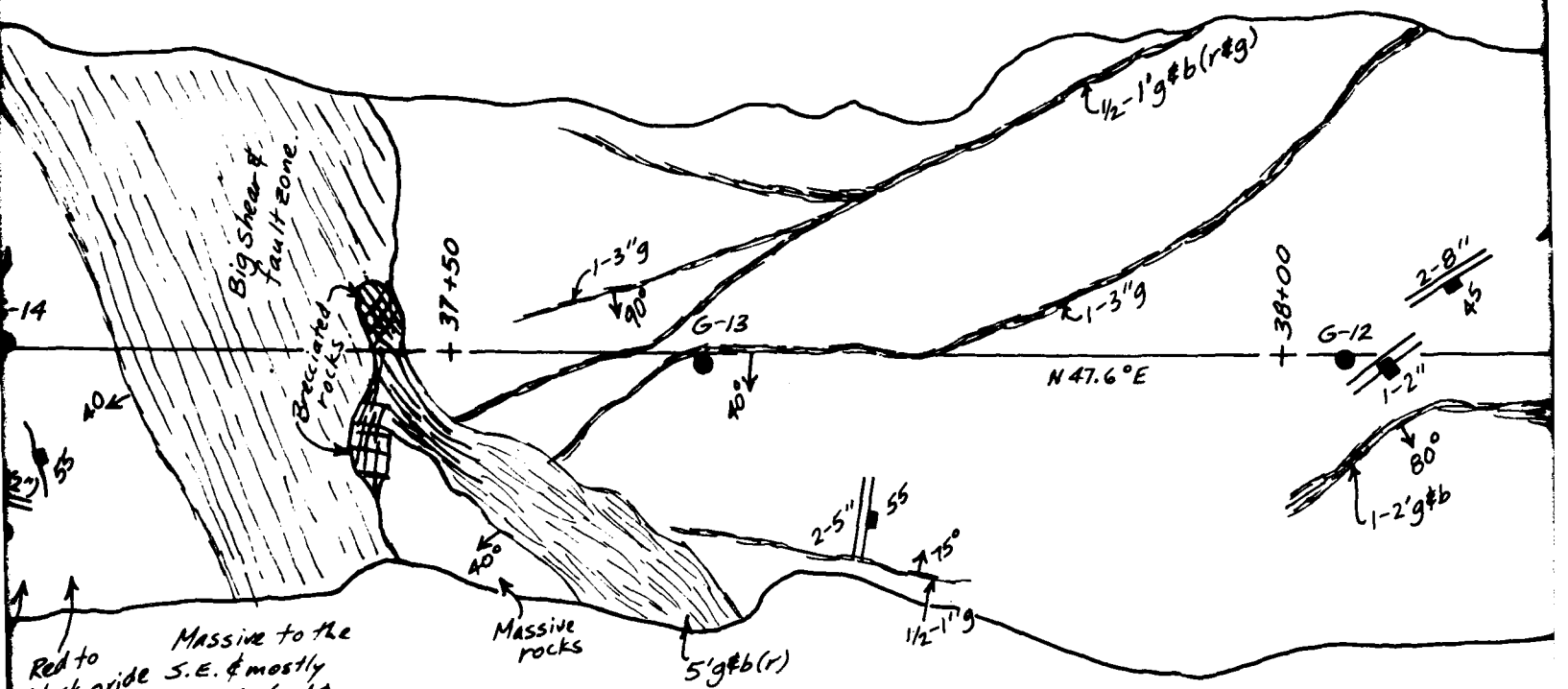
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

FOUNDATION REPORT PLATE 40

U.S. ARMY ENGINEER DISTRICT

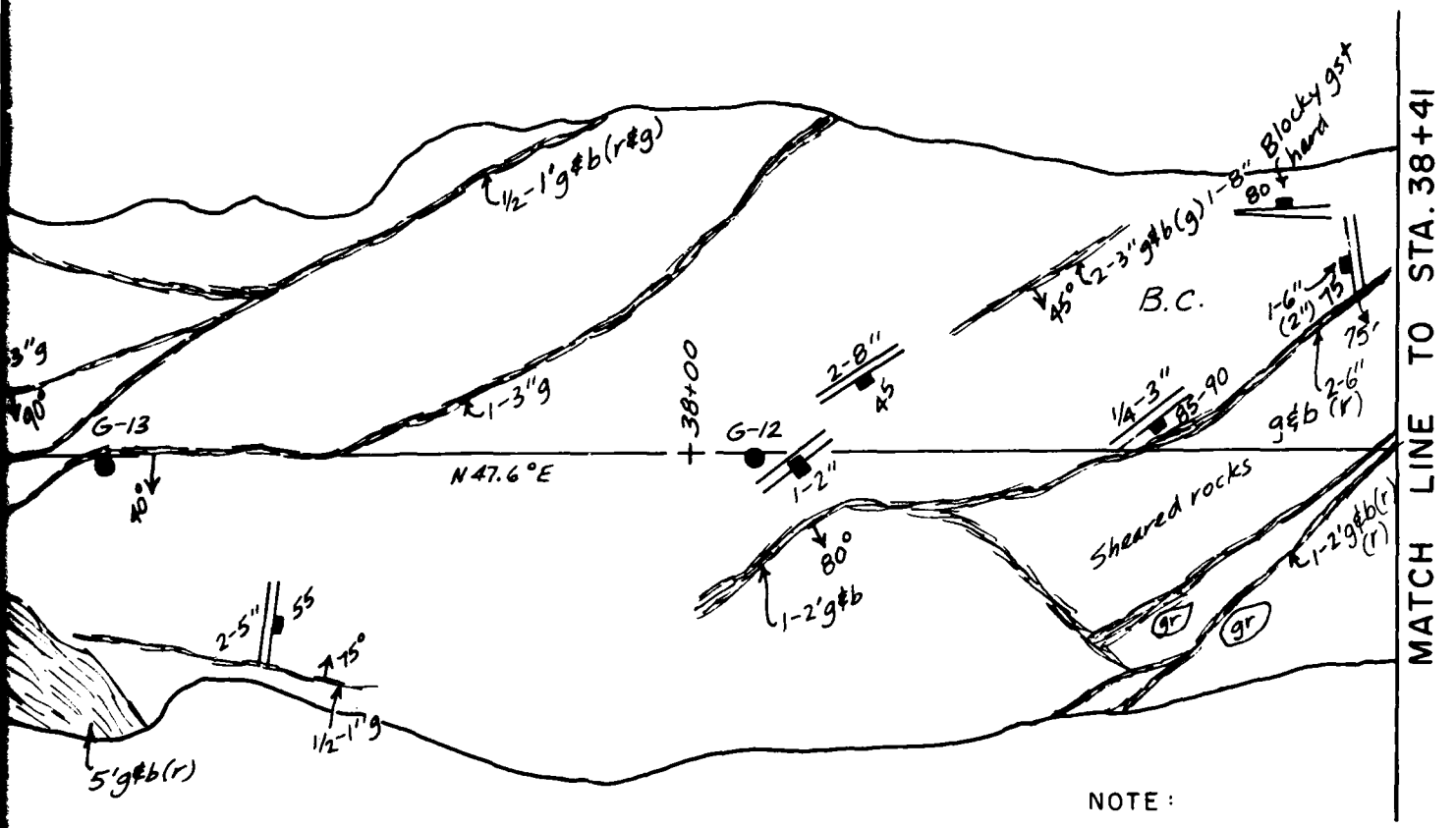


1



1 IN = 10 FT

SCALE 10 0 10 F



NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols.

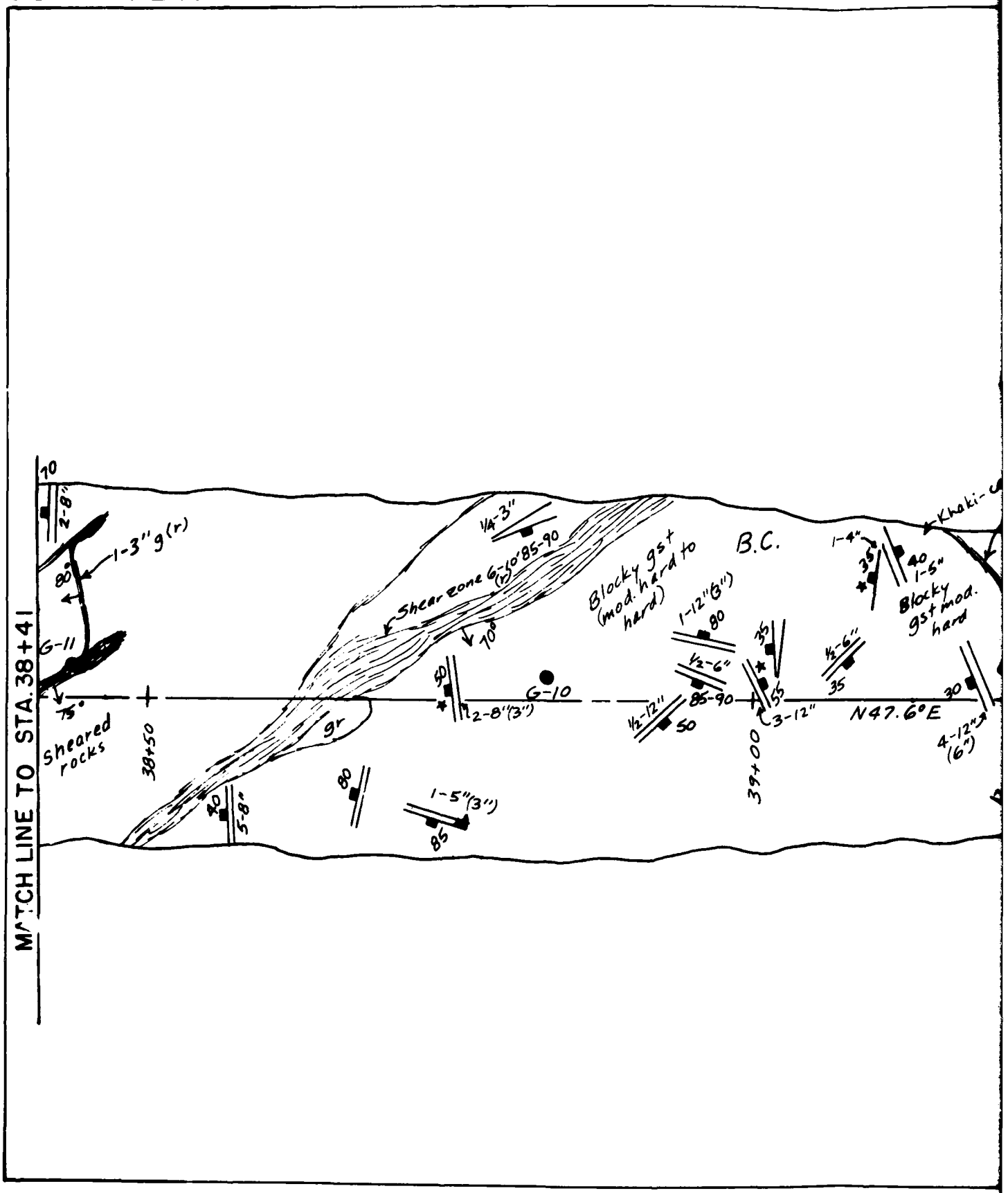
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA
CAVE BUTTES DAM
FOUNDATION GEOLOGY
DIKE No. 1
STA. 36+58 to STA. 38+41

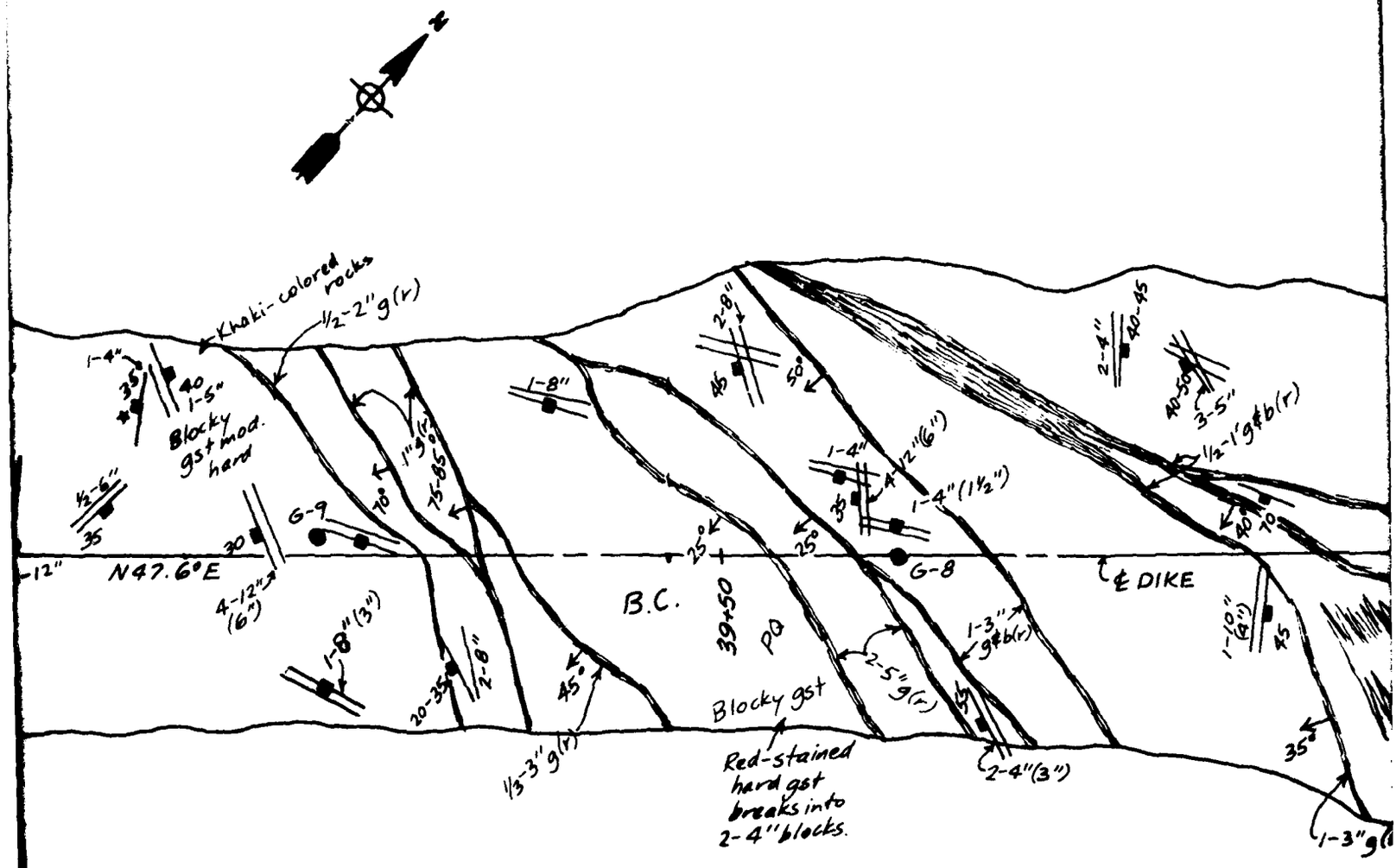
SCALE 1 IN = 10 FT
10 0 10 FEET

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

FOUNDATION REPORT PLATE 41

U.S. ARMY ENGINEER DISTRICT



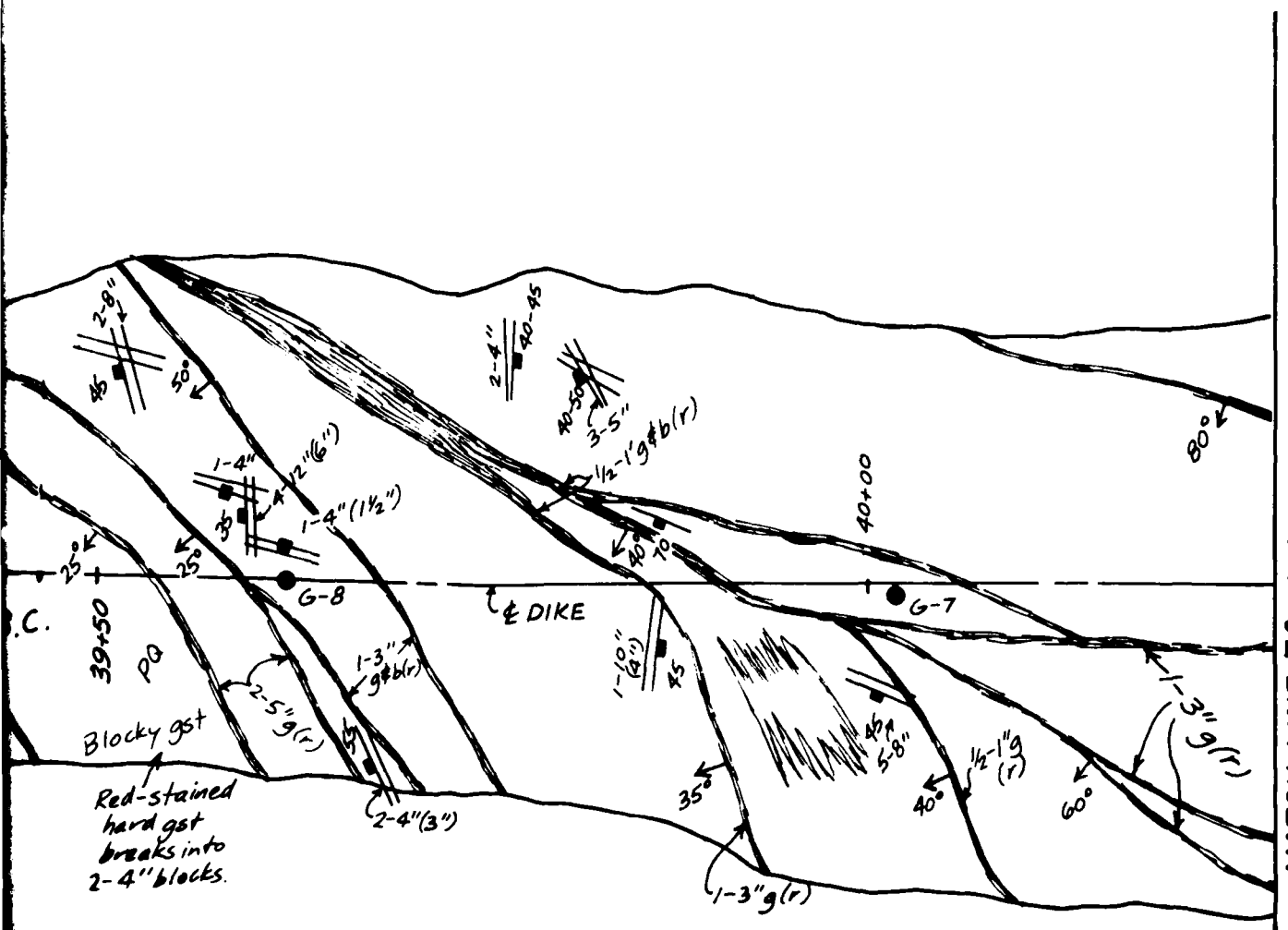


NOTE:

Refer to Plate 24 descriptions and e of symbols.

1 IN = 10 FT

SCALE 10 0



NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols.

1 IN = 10 FT

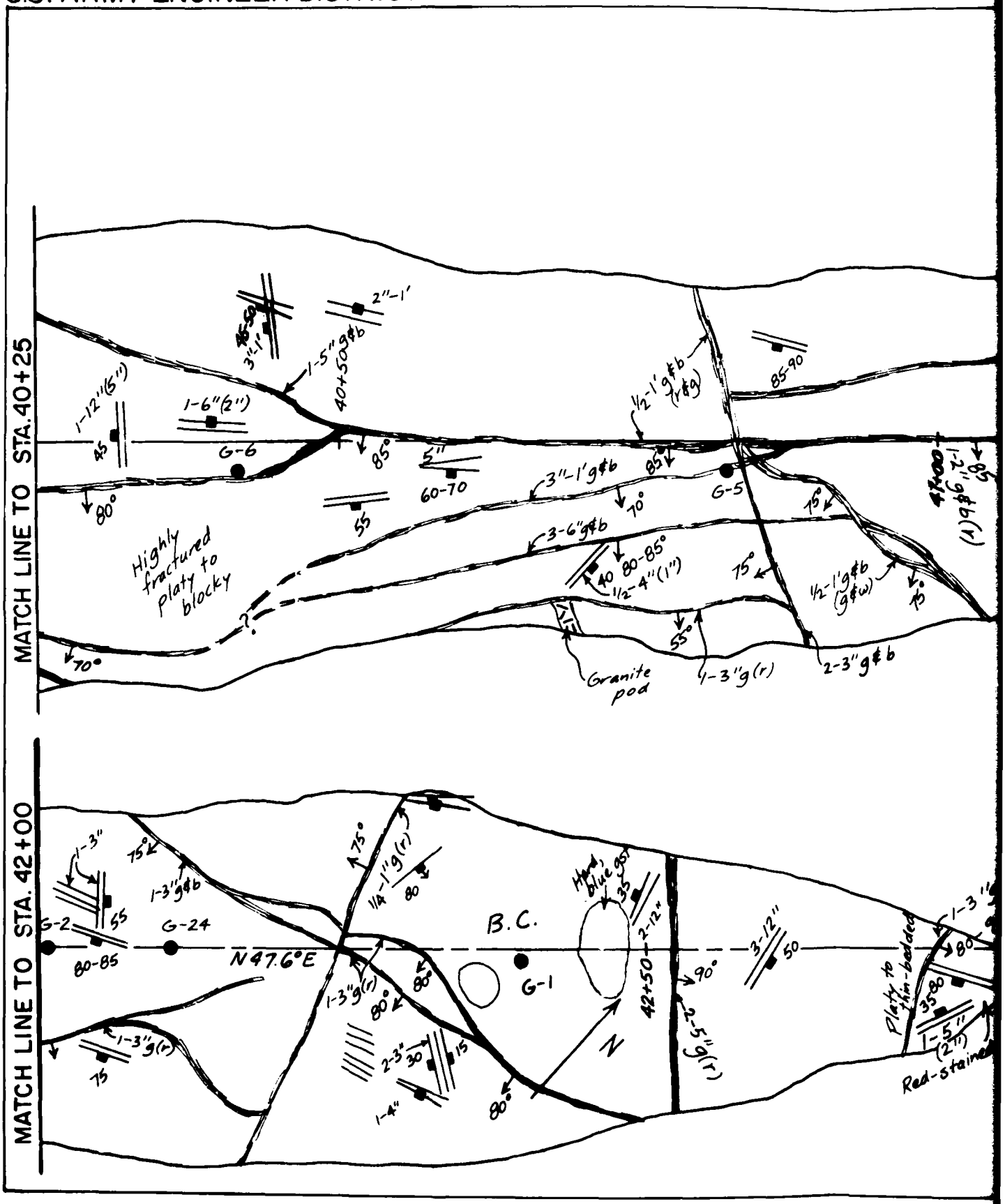
SCALE 10 0 10 FEET

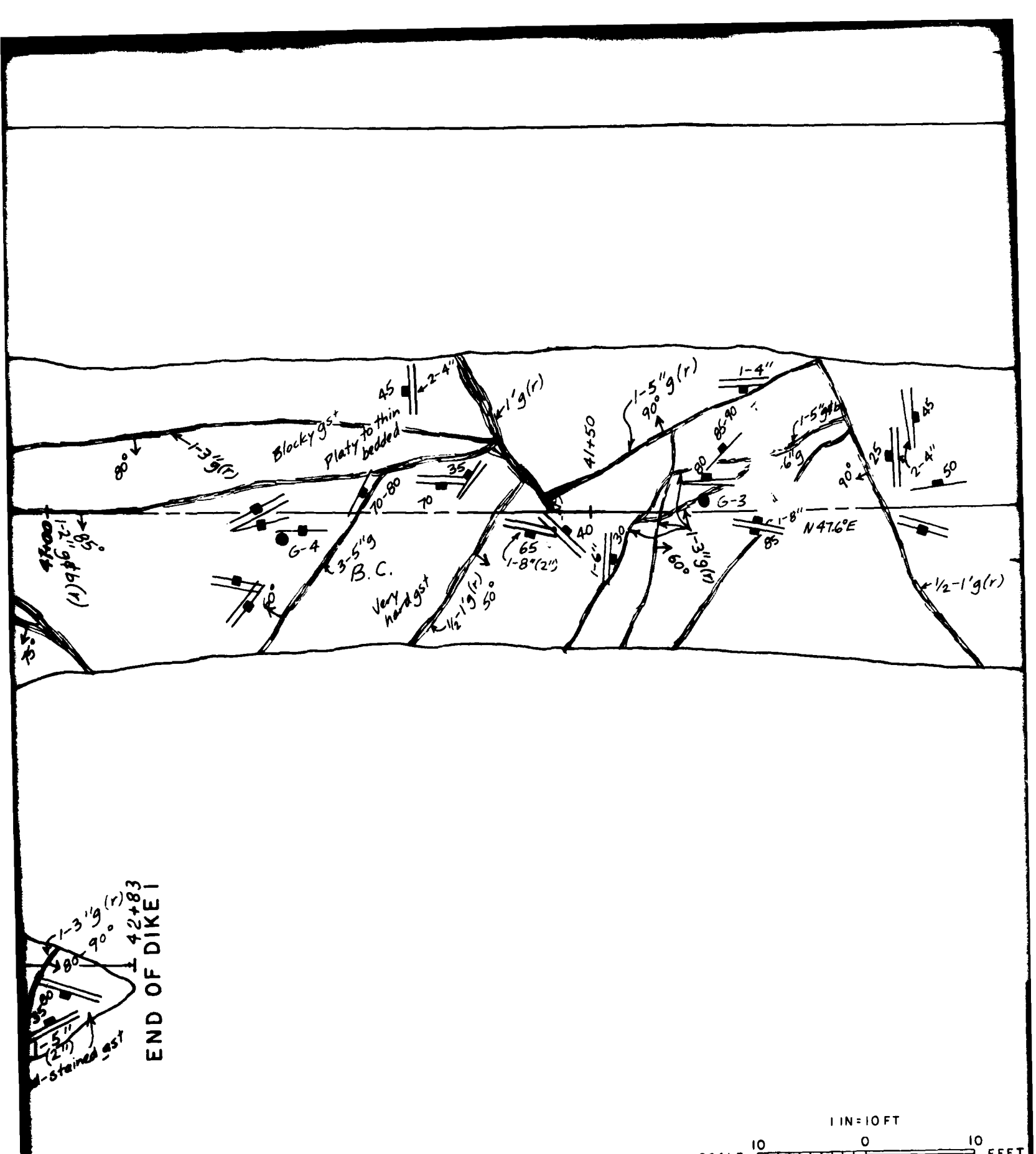
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM
FOUNDATION GEOLOGY
DIKE No. 1
STA. 38+41 to STA. 40+25

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

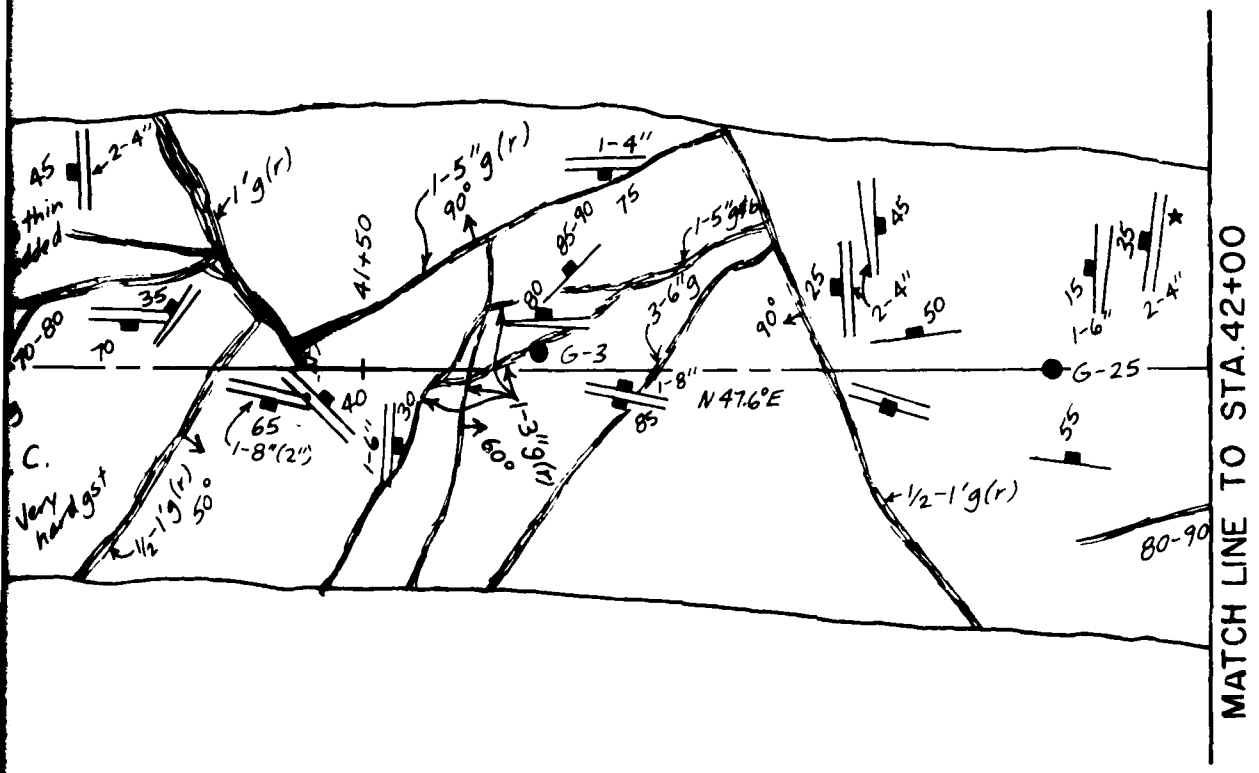
U.S. ARMY ENGINEER DISTRICT




Blocky gst
Platy to thin bedded
1-3"g(r)
80°
45
2-4"
1'g(r)
1-5"g(r)
90°
1-4"
41+50
85-90
1-5"g(r)
1-6"g
90°
25
45
2-4"
50
80
G-3
35
10-80
70
G-4
3-5"g
B.C.
1-2"g
85°
1-8"
N47.6°E
40
65
1-8"(2")
1-6"
30
60°
1-3"g(r)
85
Very hard gst
1½-1'g(r) 50°
½-1'g(r)
1-3"g(r)
90°
42+83
END OF DIKE I
80
80
1-5"
(2")
1-stained gst
1 IN = 10 FT
SCALE 10 0 10 FEET

FOU

2



NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols.

1 IN = 10 FT

SCALE 10 0 10 FEET

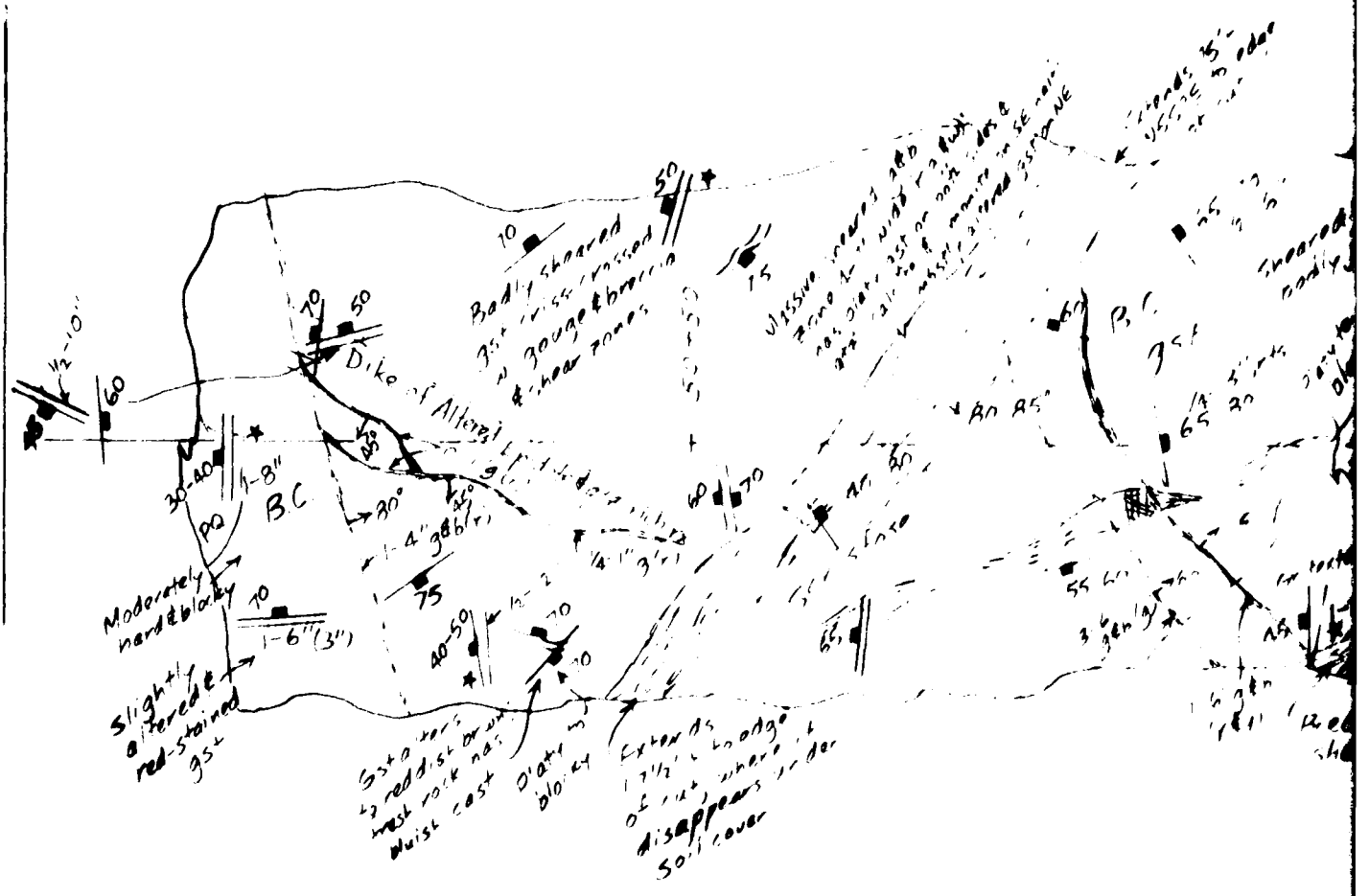
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA
CAVE BUTTES DAM
FOUNDATION GEOLOGY
DIKE No. 1
STA. 40+25 to STA. 42+83

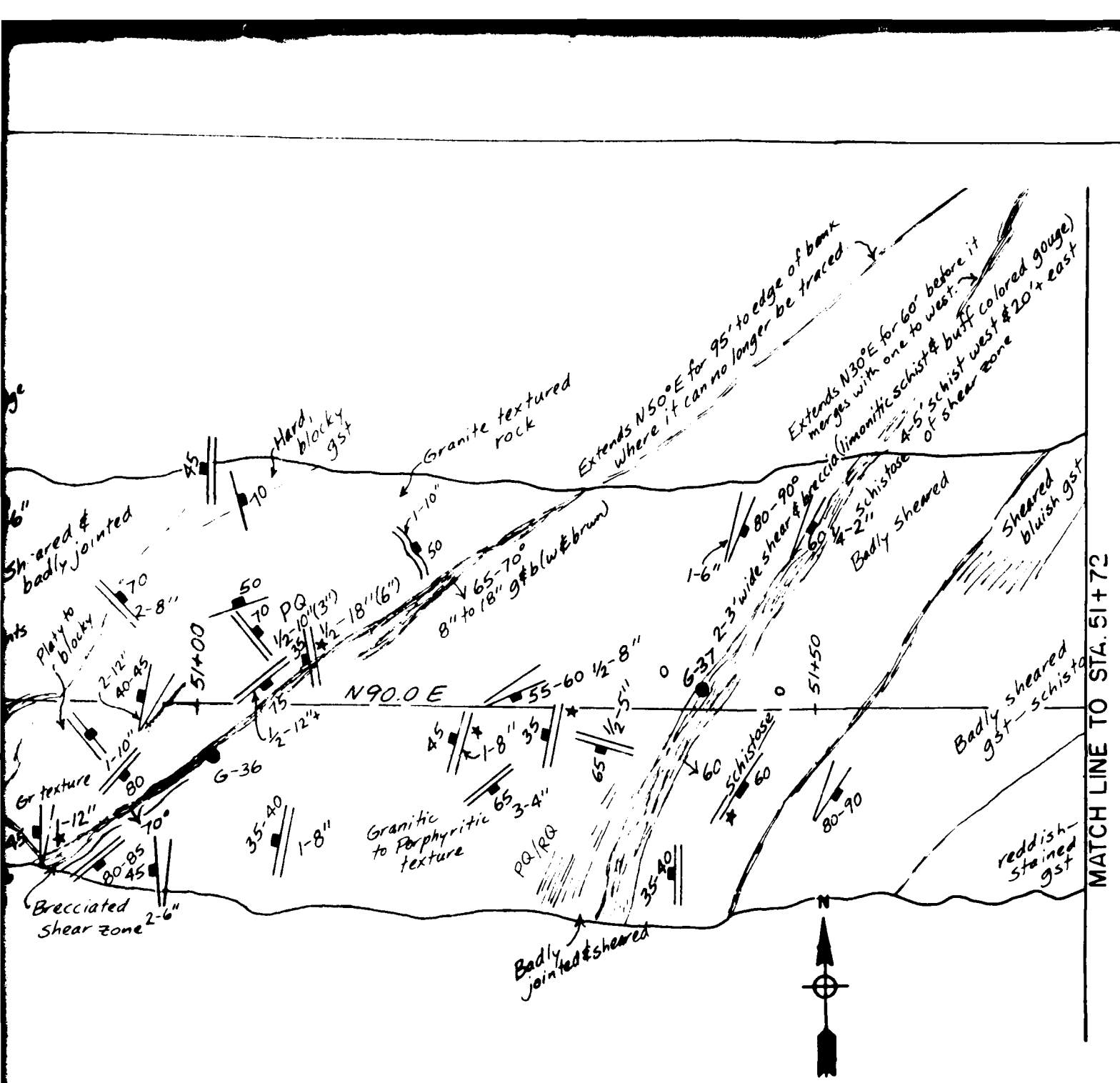
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

FOUNDATION REPORT **PLATE 43**

U.S. ARMY ENGINEER DISTRICT

STA. 50+09 - BEGIN DIKE No. 2



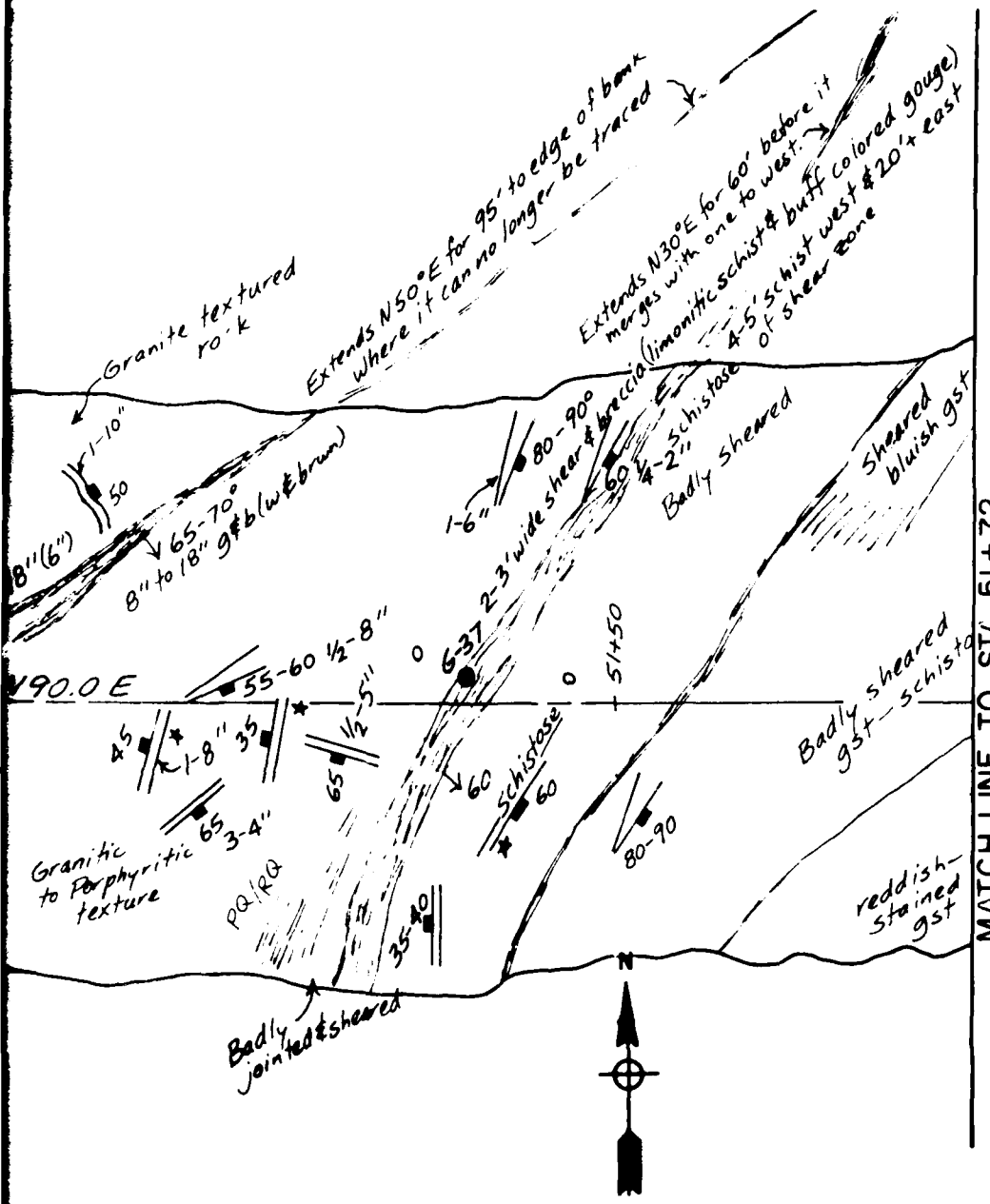


NEW

U.S.
LOS
TO A

FOUNDAT

2



NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols.

1 IN = 10 FT

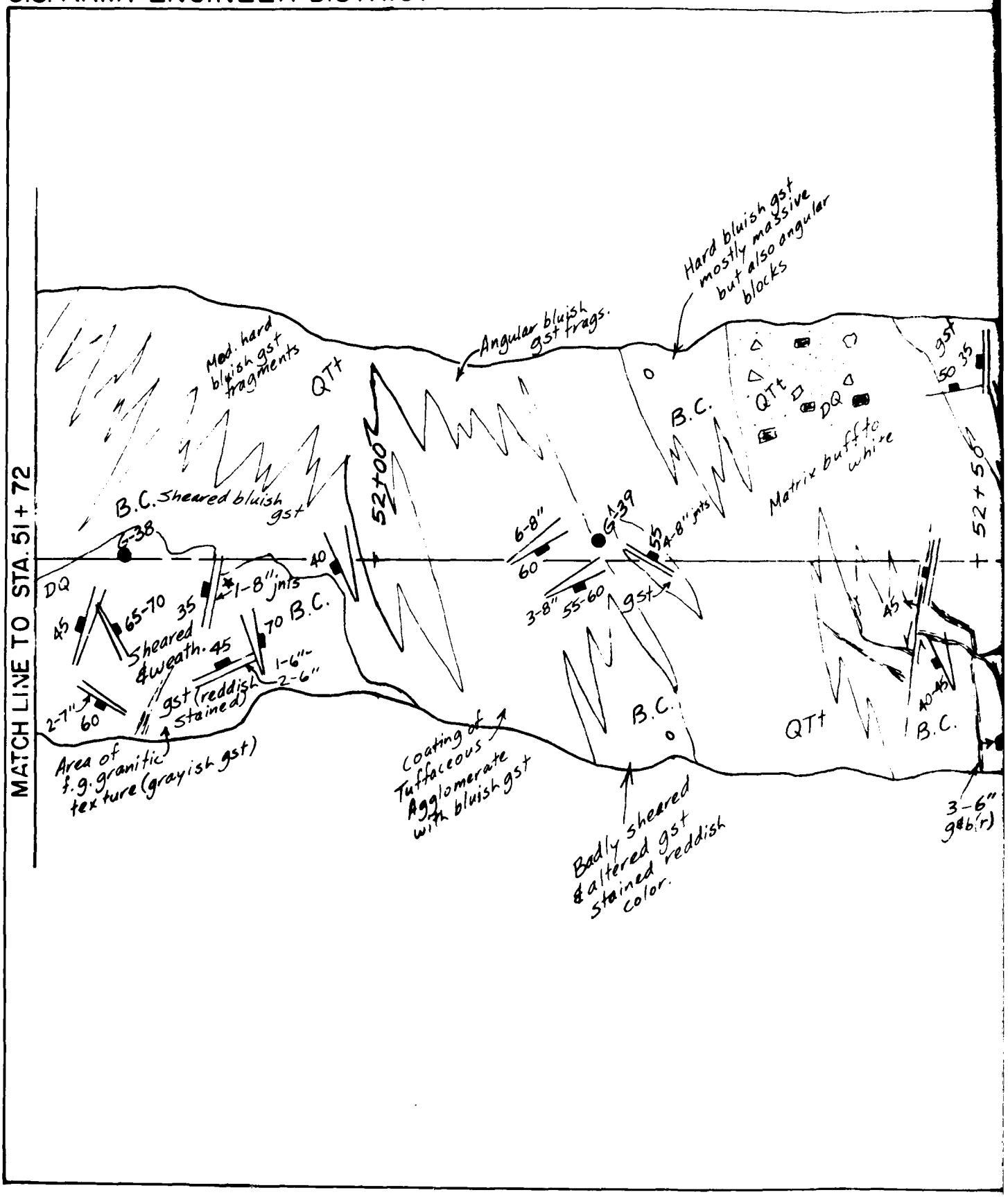
SCALE 10 0 10 FEET

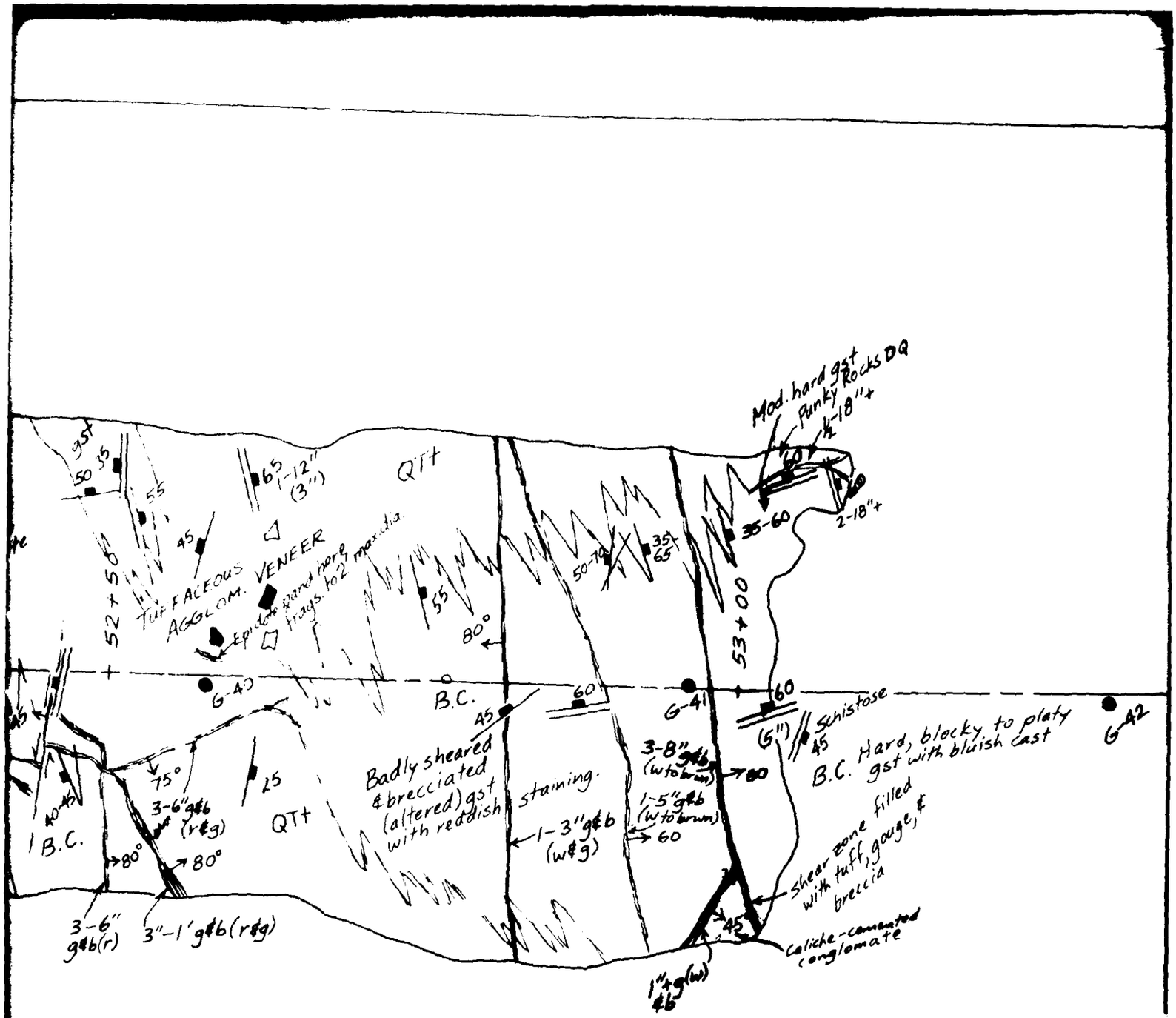
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA
CAVE BUTTES DAM
FOUNDATION GEOLOGY
DIKE No. 2
STA. 50+09 to STA. 51+72

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

FOUNDATION REPORT **PLATE 44**

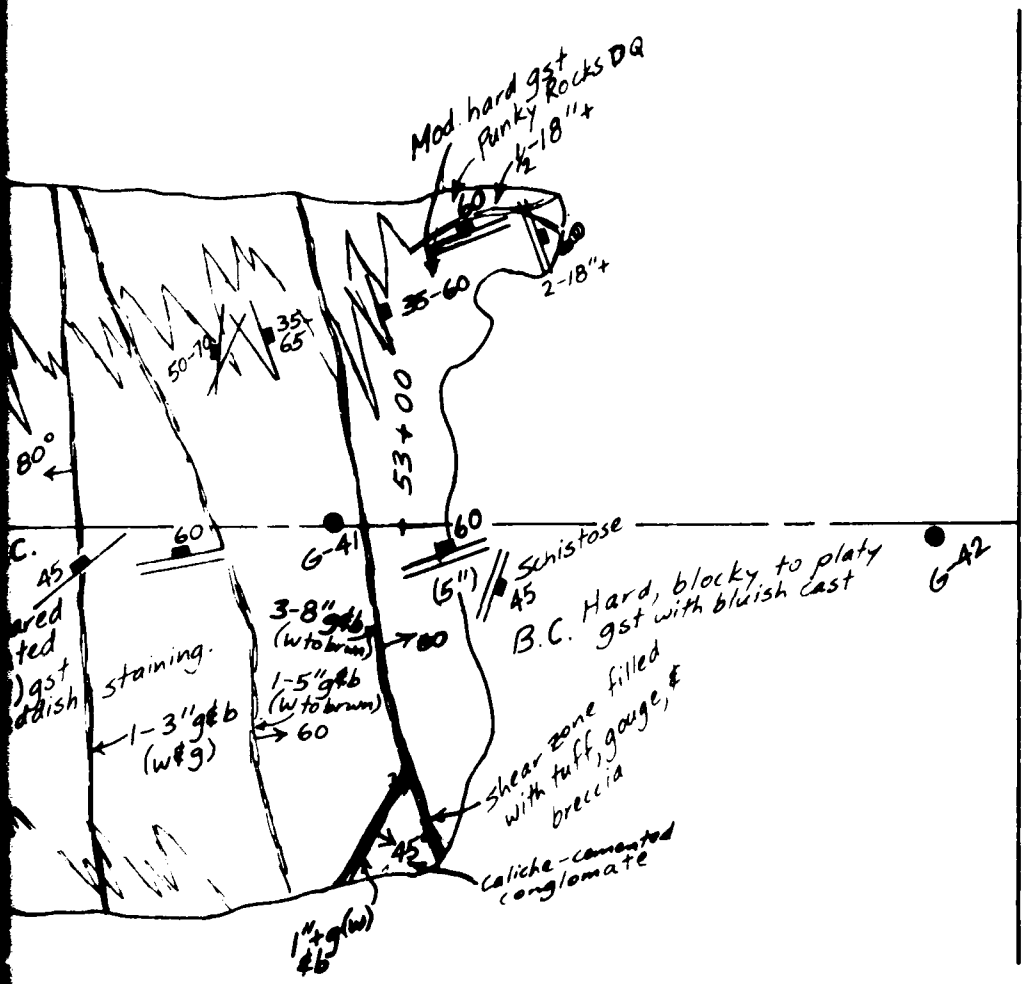
U.S. ARMY ENGINEER DISTRICT




gst
50
35
55
65
1-12" (3")
QTf
45
52+50
TUFFACEOUS AGGLOM. VENEER
Epidote grand more frags. to 2 max. dia.
55
80°
G-40
B.C.
60
45
50-70
35-65
53+00
35-60
Mod. hard gst Punky Rocks DQ
½-18"+
2-18"+
G-41
60
(6")
Schistose
45
B.C. Hard, blocky to platy gst with bluish cast
G-42
B.C.
40-45
75°
3-6" g&b (r&g)
25
QTf
Badly sheared & brecciated (altered) gst with reddish staining.
1-3" g&b (w&g)
3-8" g&b (w to brn)
80
1-5" g&b (w to brn)
60
Shear zone filled with tuff, gouge, & breccia
45
Caliche-cemented conglomerate
80°
80°
3-6" g&b(r)
3"-1' g&b(r&g)
1"+g(w) &b
1 IN = 10 FT
10
0
10
SCALE
FEE

2

FO



NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols.

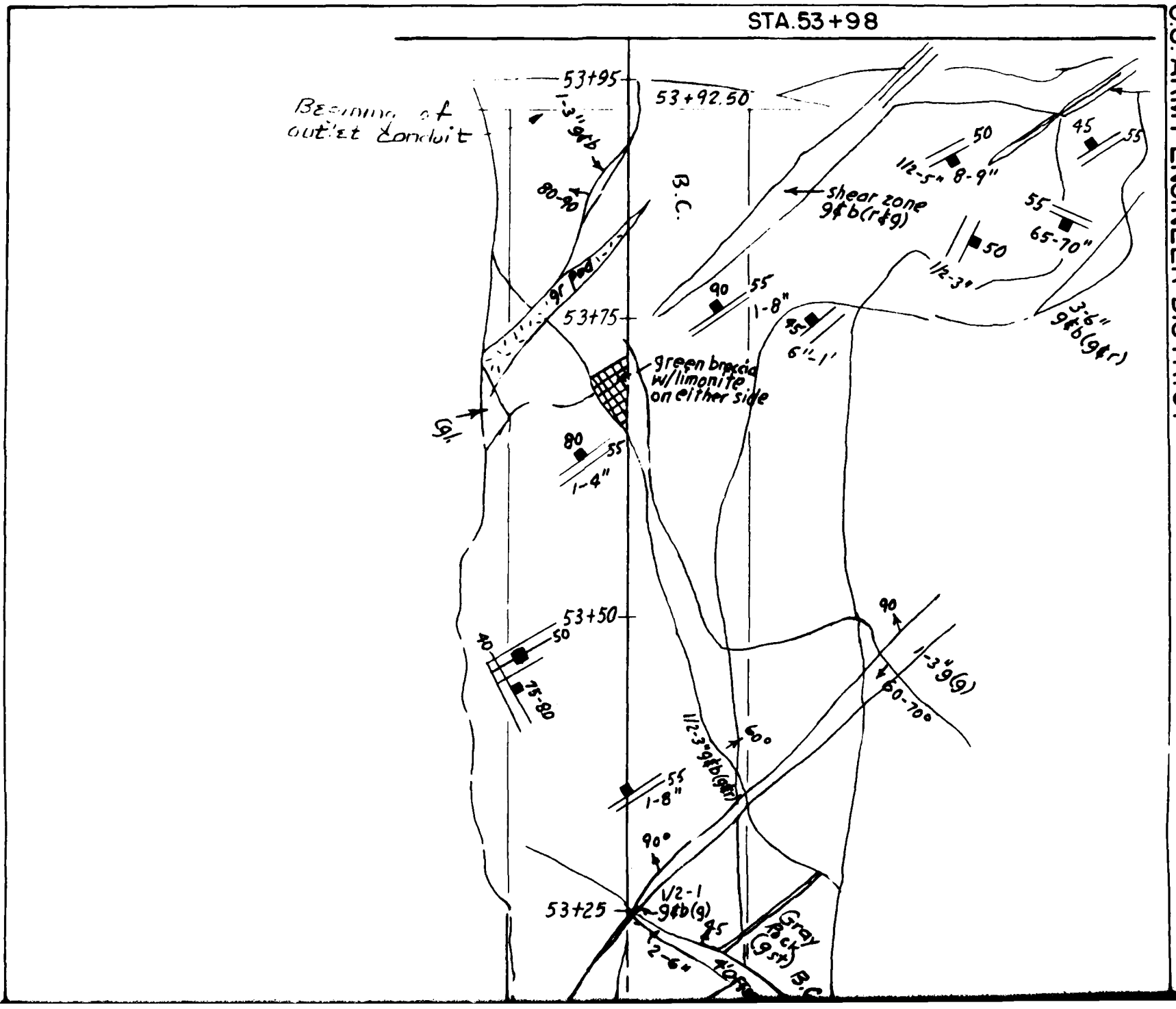
1 IN = 10 FT

SCALE 10 0 10 FEET

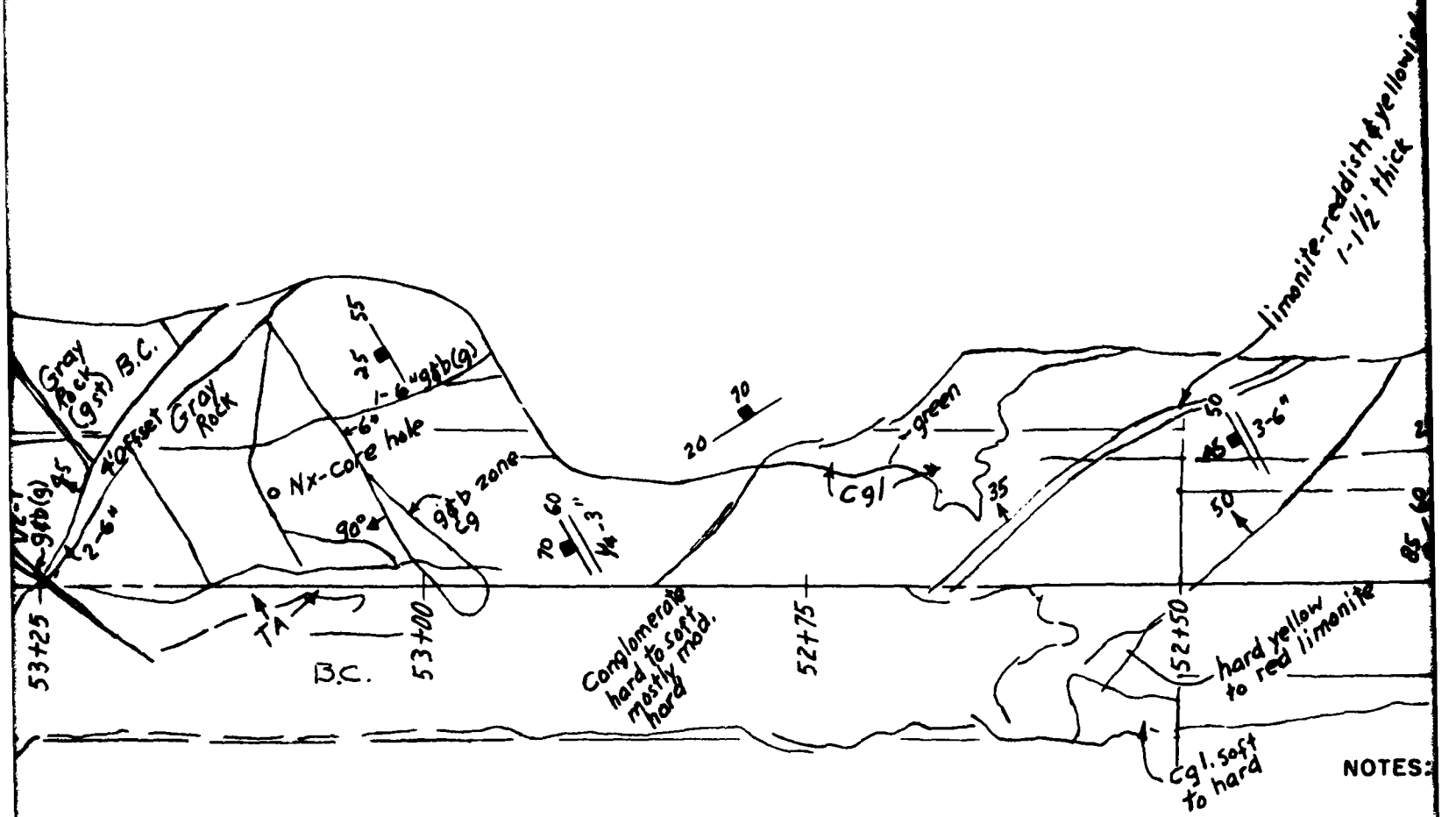
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA
CAVE BUTTES DAM
FOUNDATION GEOLOGY
DIKE No. 2
STA. 51+72 to STA. 53+35

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

FOUNDATION REPORT PLATE 45



U.S. ARMY ENGINEER DISTRICT



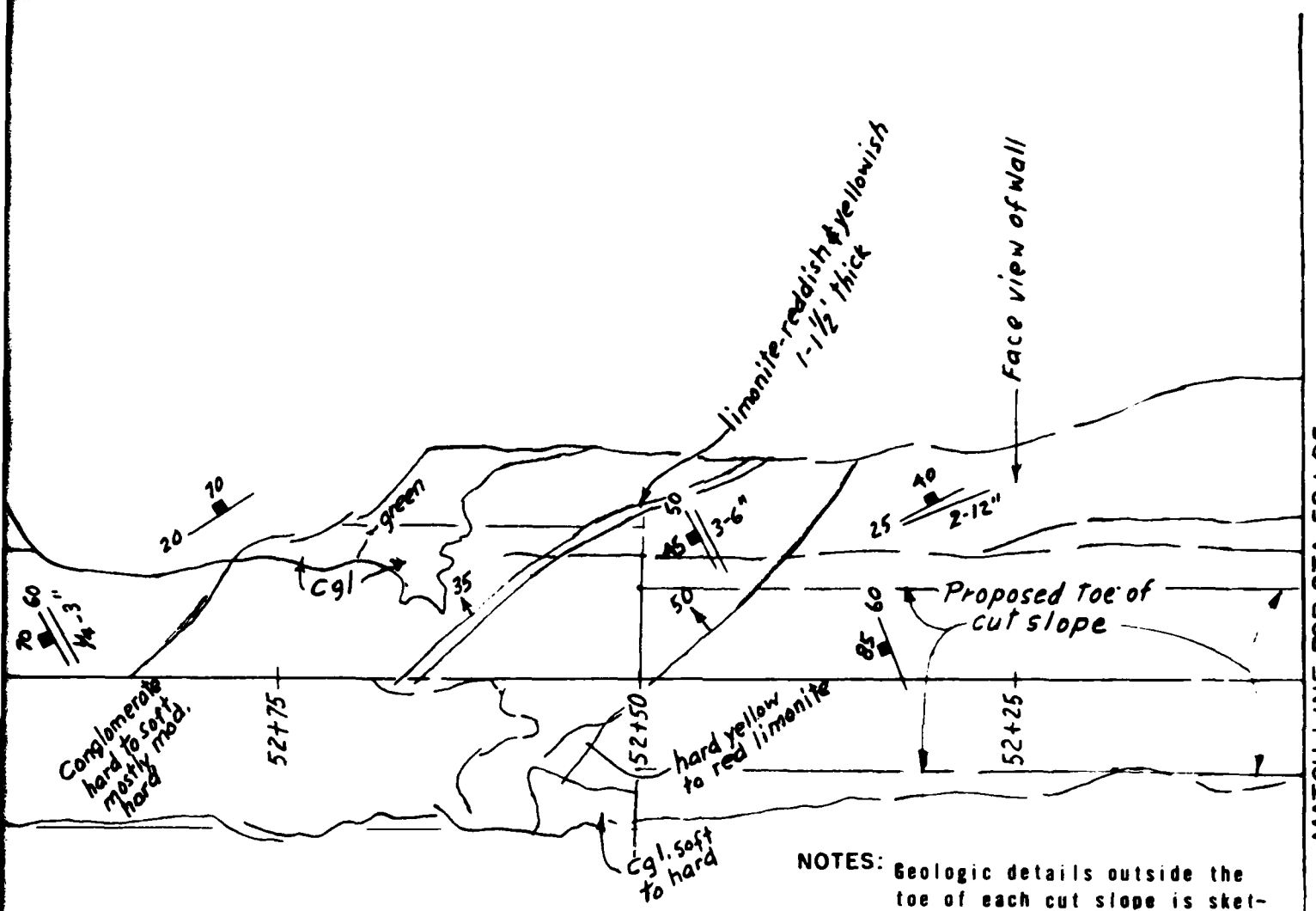
NOTES:

1 IN = 10 FT

SCALE 10 0 10 FEET

FO

2



NOTES: Geologic details outside the toe of each cut slope is sketched as a face view of the cut slope. Other data, including grout hole locations and geology at foundation grade between the cut slopes are shown in Plan.

Refer to Plate 24 for Rock descriptions and explanations of symbols

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

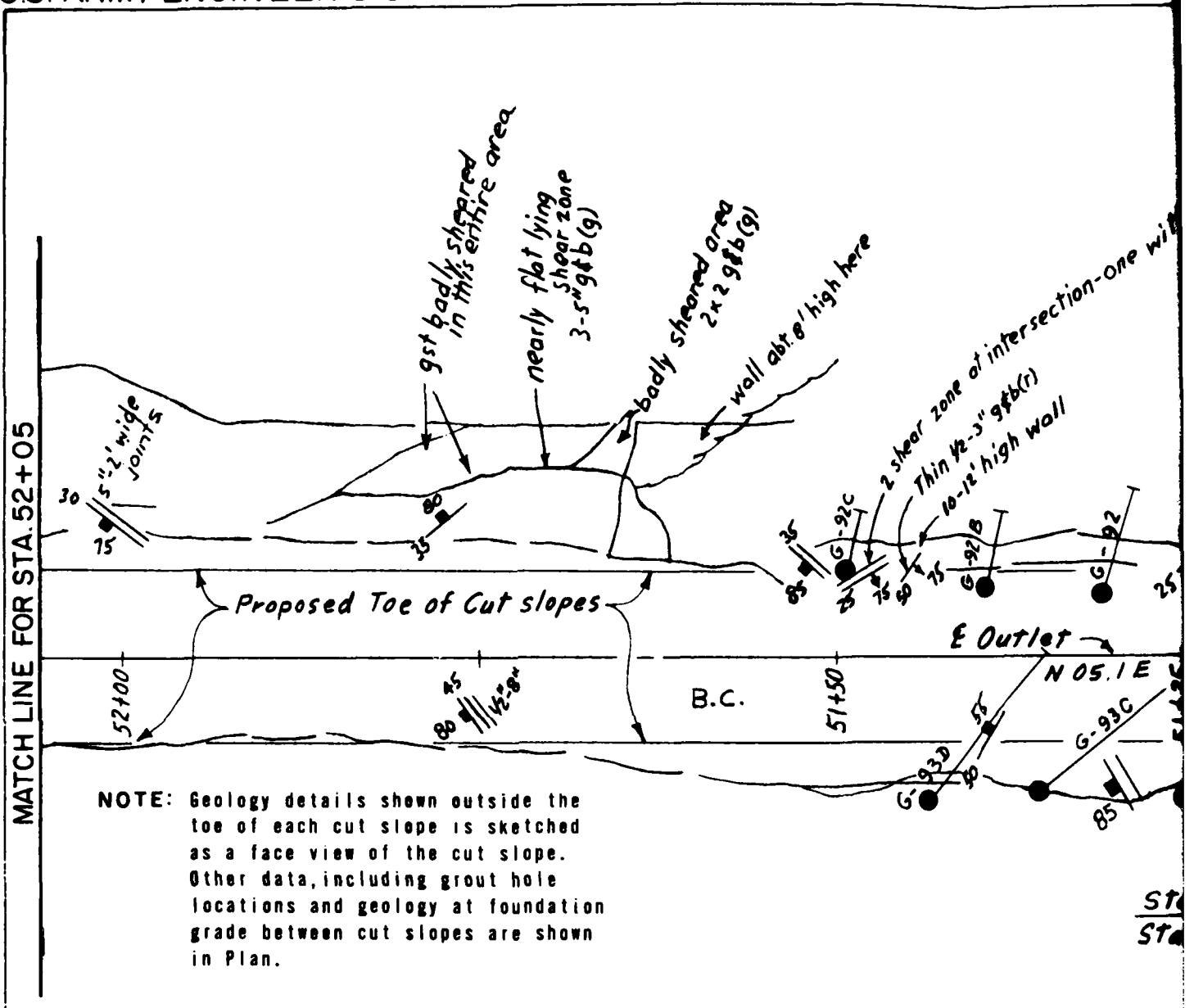
CAVE BUTTES DAM
FOUNDATION GEOLOGY
OUTLET WORKS
STA. 53+98 to STA. 52+05

1 IN = 10 FT
SCALE 10 0 10 FEET

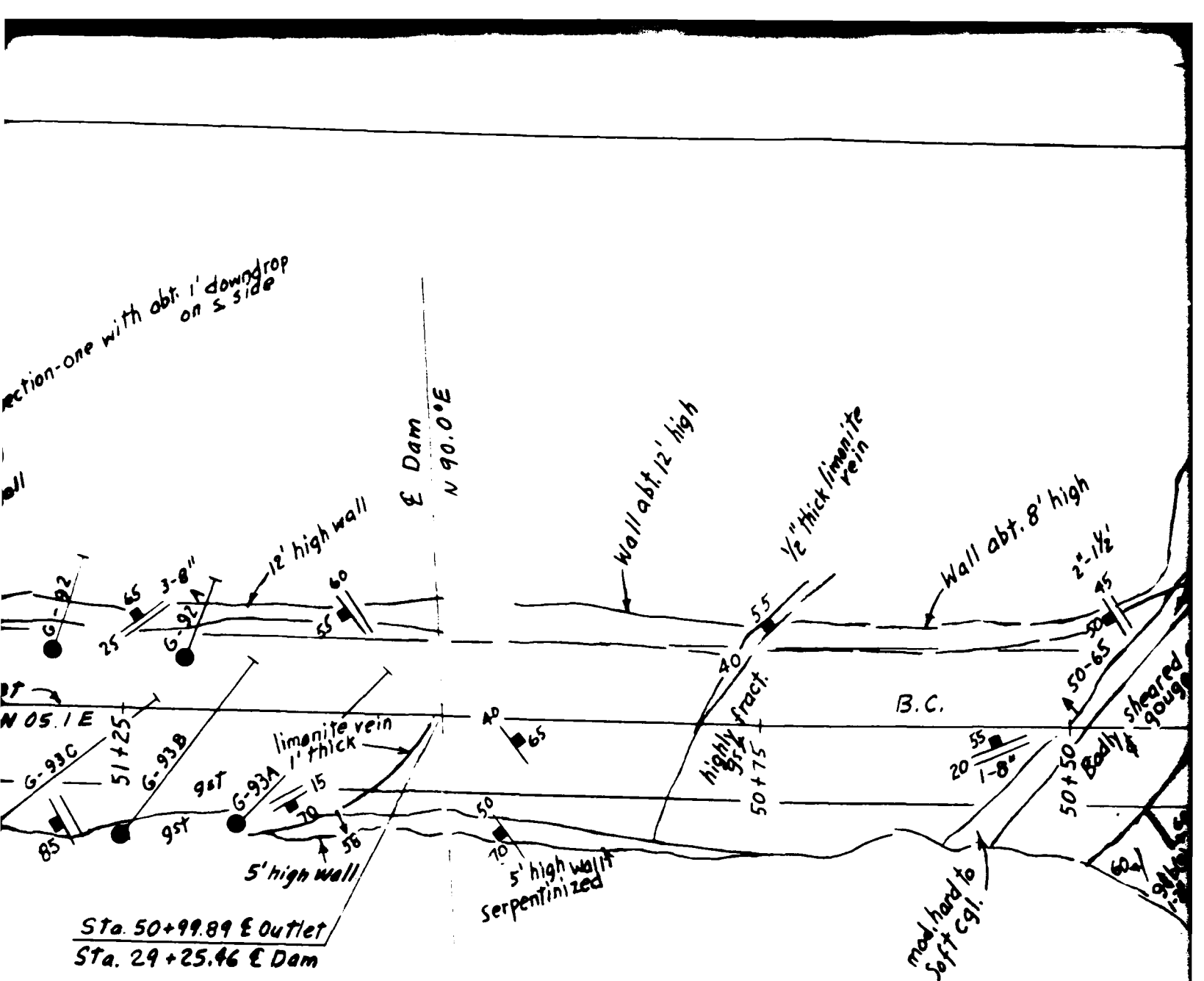
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

FOUNDATION REPORT PLATE 46

U.S. ARMY ENGINEER DISTRICT

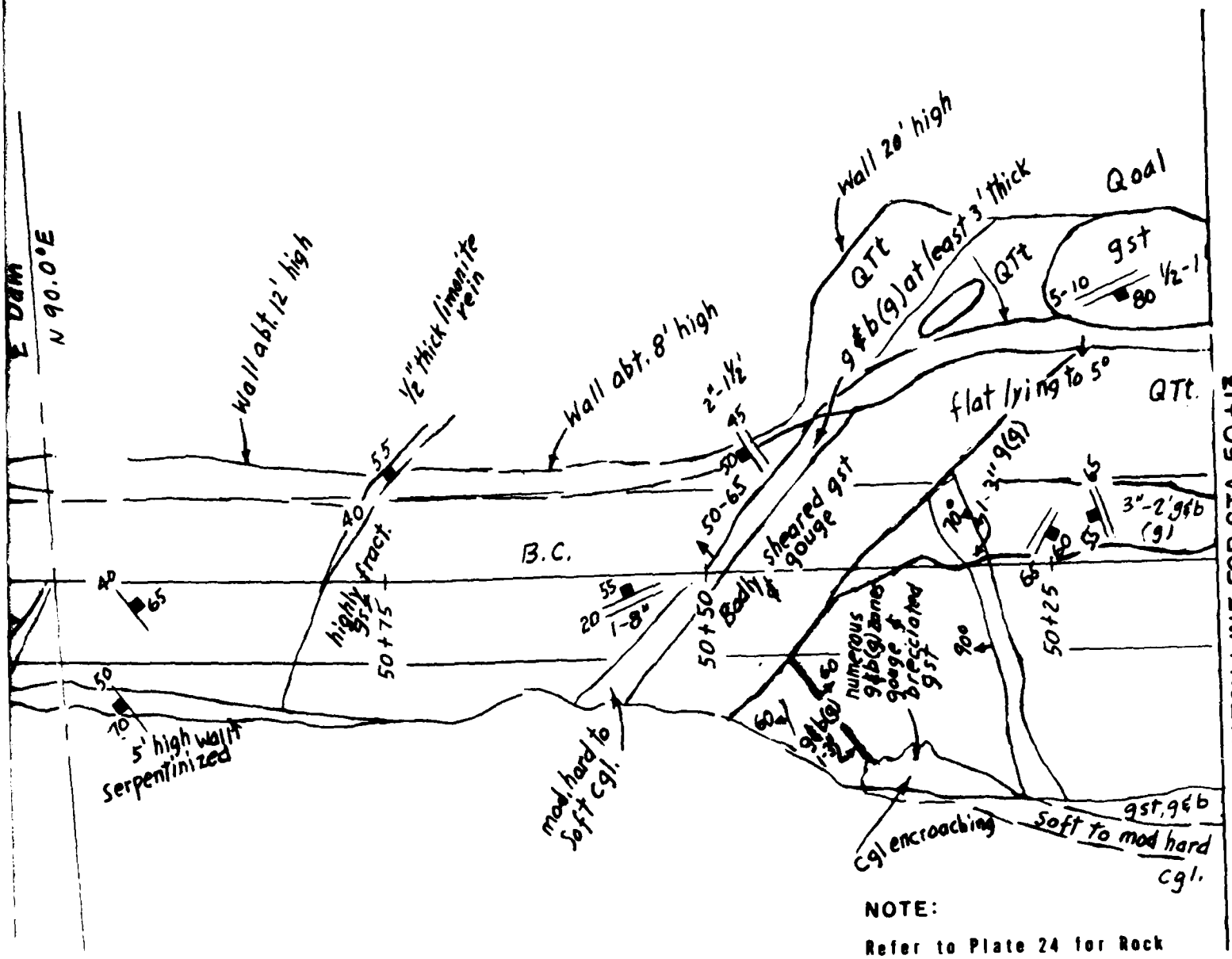


NOTE: Geology details shown outside the toe of each cut slope is sketched as a face view of the cut slope. Other data, including grout hole locations and geology at foundation grade between cut slopes are shown in Plan.


rection-one with abt. 1' downdrop on S side
all
℄ Dam N 90.0°E
Wall abt. 12' high
½" thick limonite vein
Wall abt. 8' high
2"-1½"
12' high wall
G-92
G-92A
3-8"
25
65
60
55
55
40
45
50
50-65
B.C.
N 05. 1 E
G-93C
51+25
G-93B
G-93A
limonite vein 1" thick
15
70
50
56
85
95T
highly fract.
50+75
50+50
Badly sheared gouge
20
55
1-8"
5' high wall
5' high wall serpentinized
mod. hard to soft cgl.
Sta. 50+99.89 ℄ Outlet
Sta. 29+25.46 ℄ Dam
1 IN = 10 FT
SCALE 10 0 10 FEET

2

CORPS OF ENGINEERS



NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols

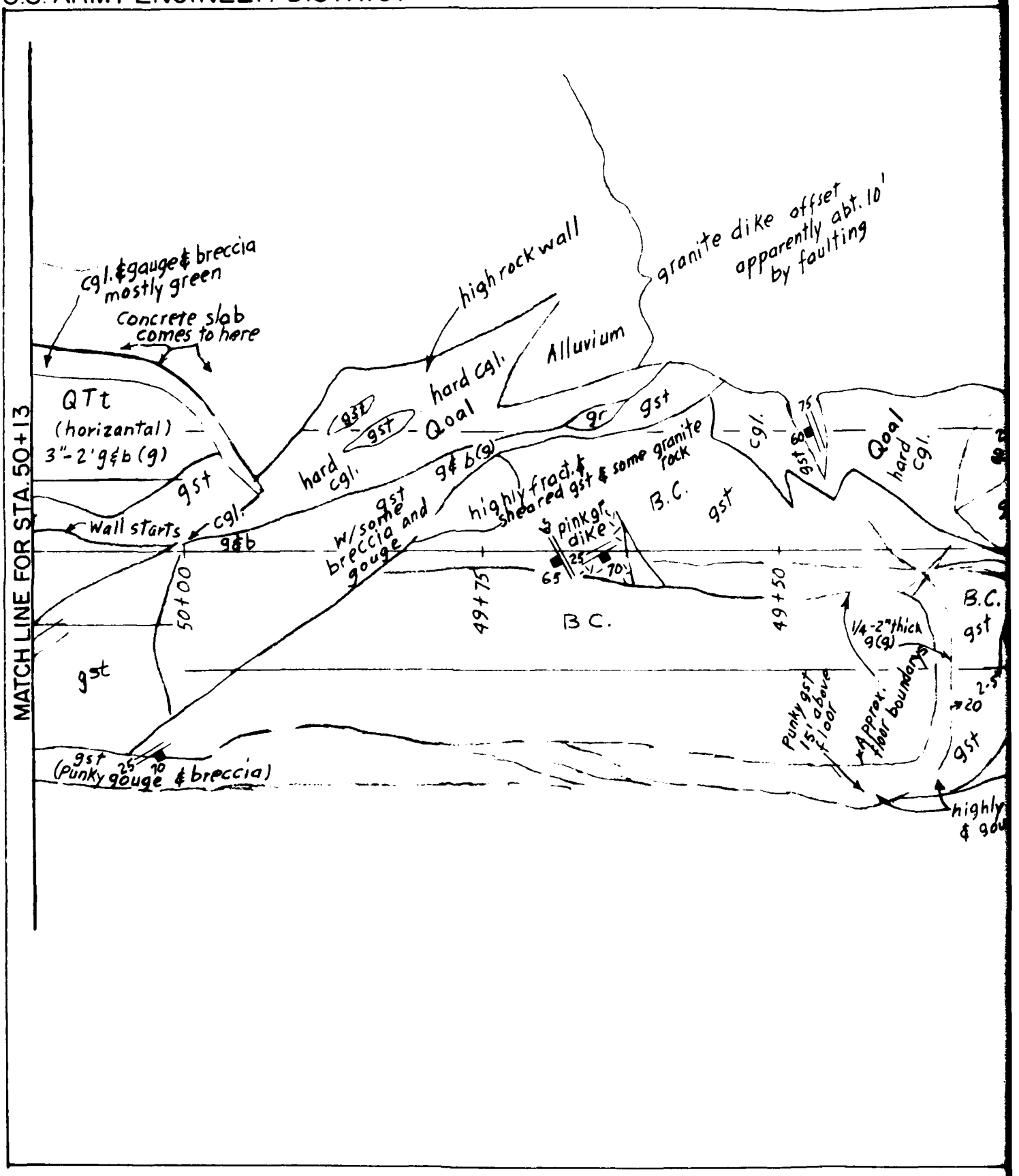
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA
CAVE BUTTES DAM
FOUNDATION GEOLOGY
OUTLET WORKS
STA. 52+05 to STA. 50+13

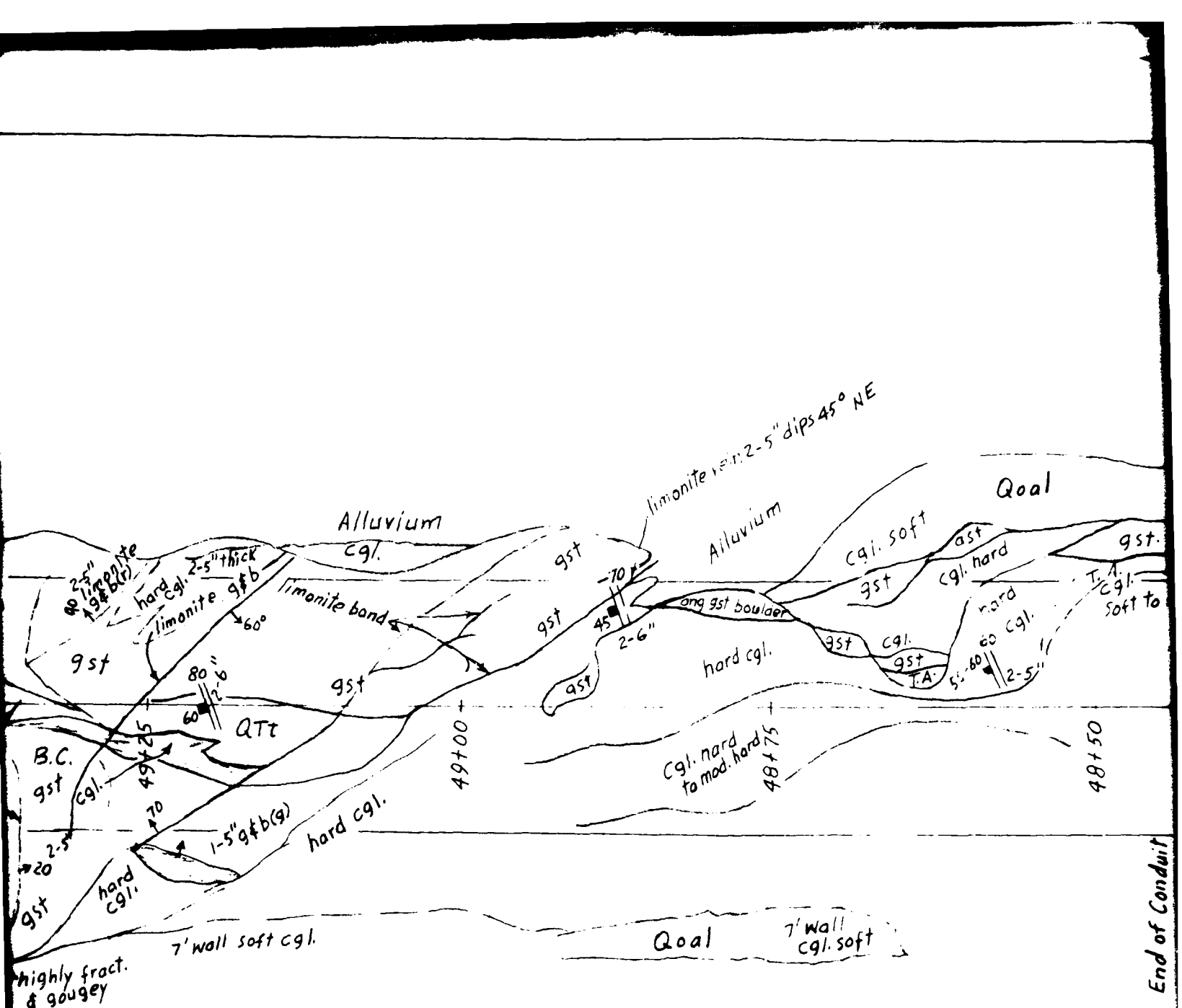
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

1 IN = 10 FT
SCALE 10 0 10 FEET

FOUNDATION REPORT PLATE 47

U.S. ARMY ENGINEER DISTRICT





NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols

1 IN = 10 FT

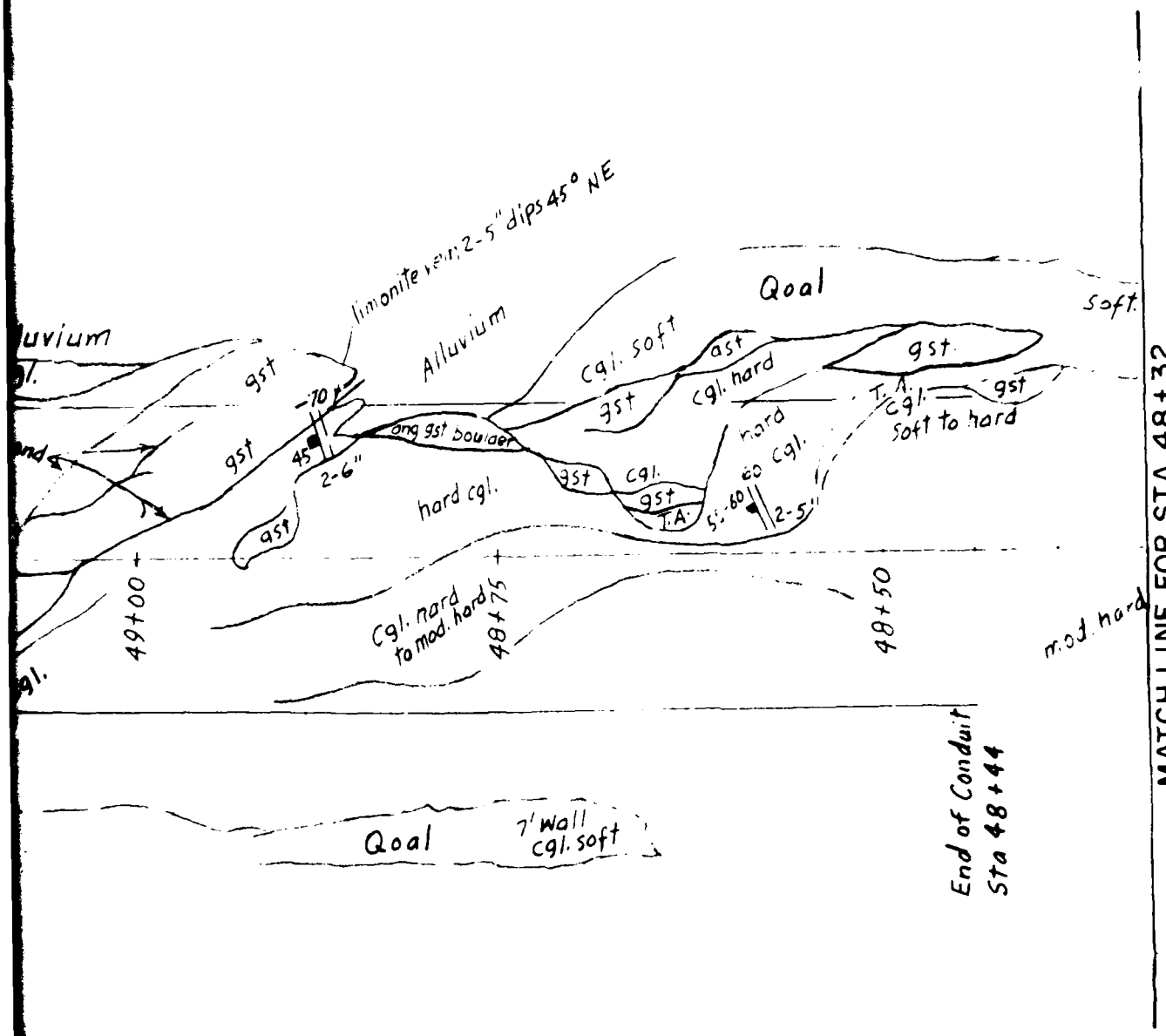
SCALE 10 0 10 FEET

NEW R

U.S.
LOS A
TO ACC

FOUNDATIO

2.



NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols

1 IN = 10 FT

SCALE 10 0 10 FEET

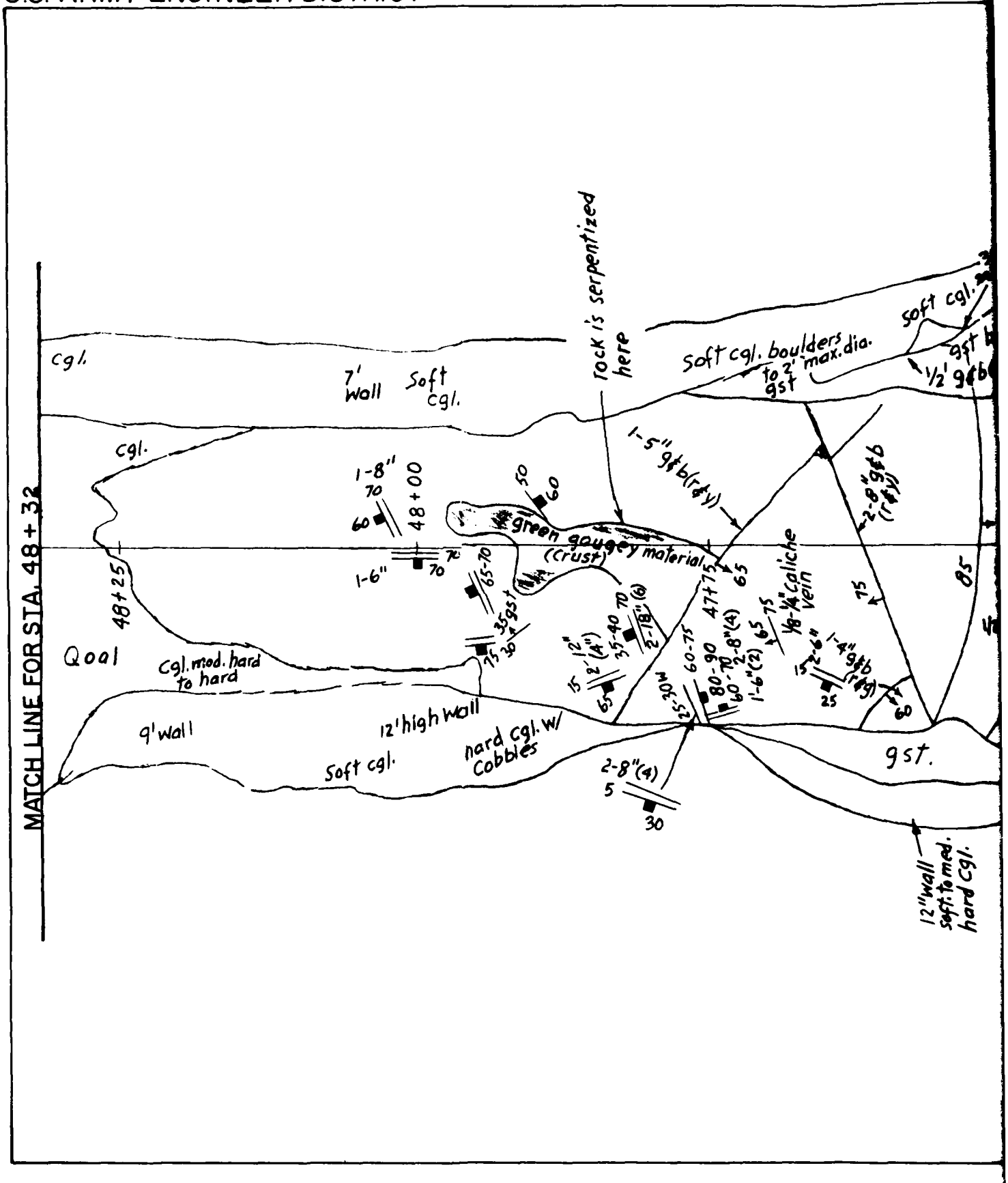
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM
FOUNDATION GEOLOGY
OUTLET WORKS
STA. 50+13 to STA. 48+32

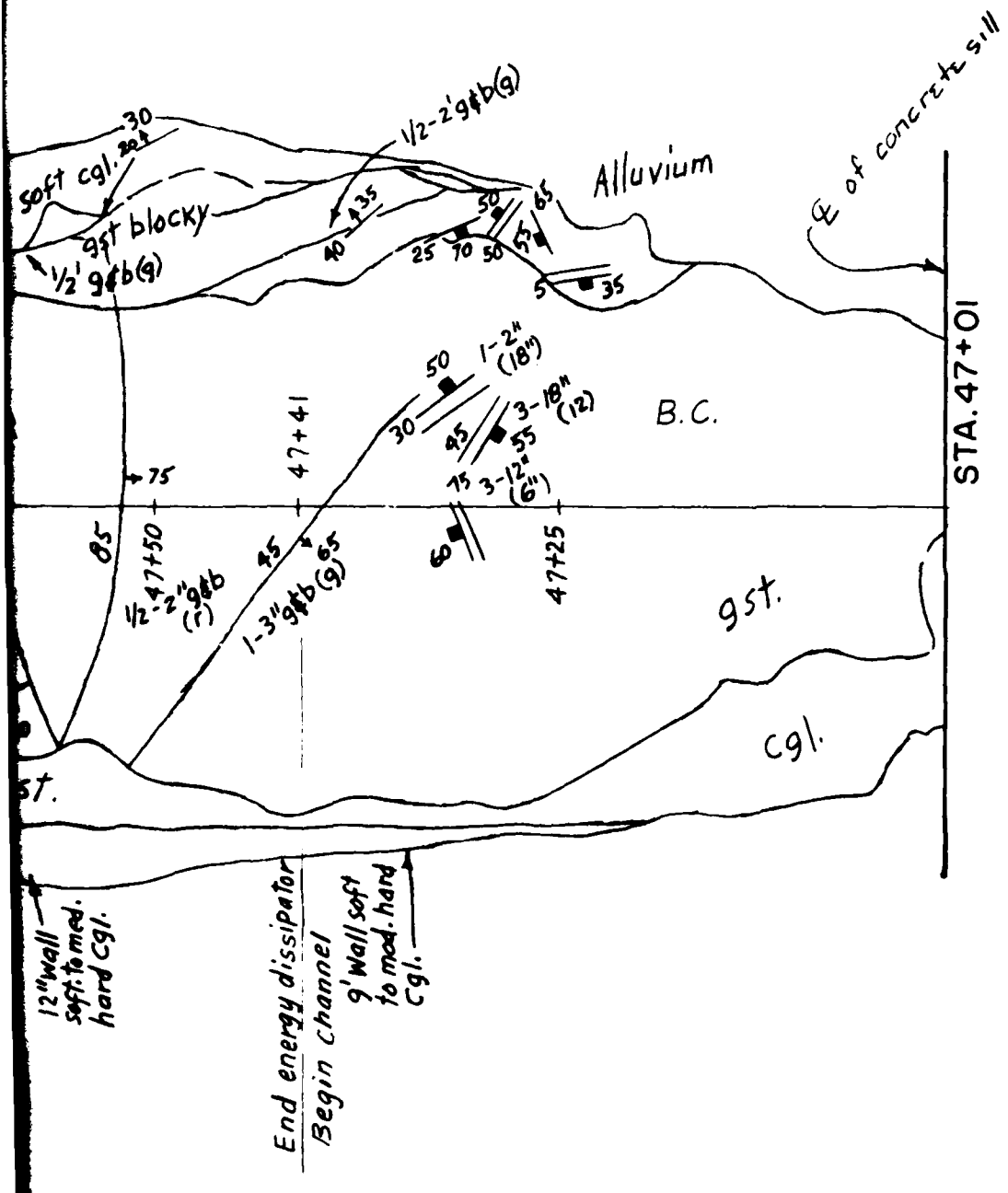
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

FOUNDATION REPORT **PLATE 48**

U.S. ARMY ENGINEER DISTRICT



1

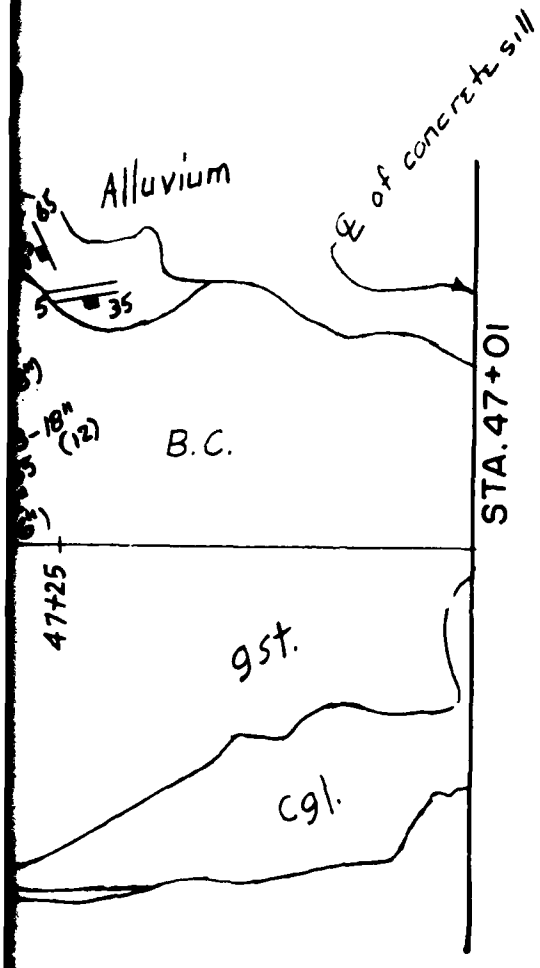


1 IN = 10 FT

SCALE 10 0 10 FEET

FOU

2



NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols

1 IN=10 FT

SCALE 10 0 10 FEET

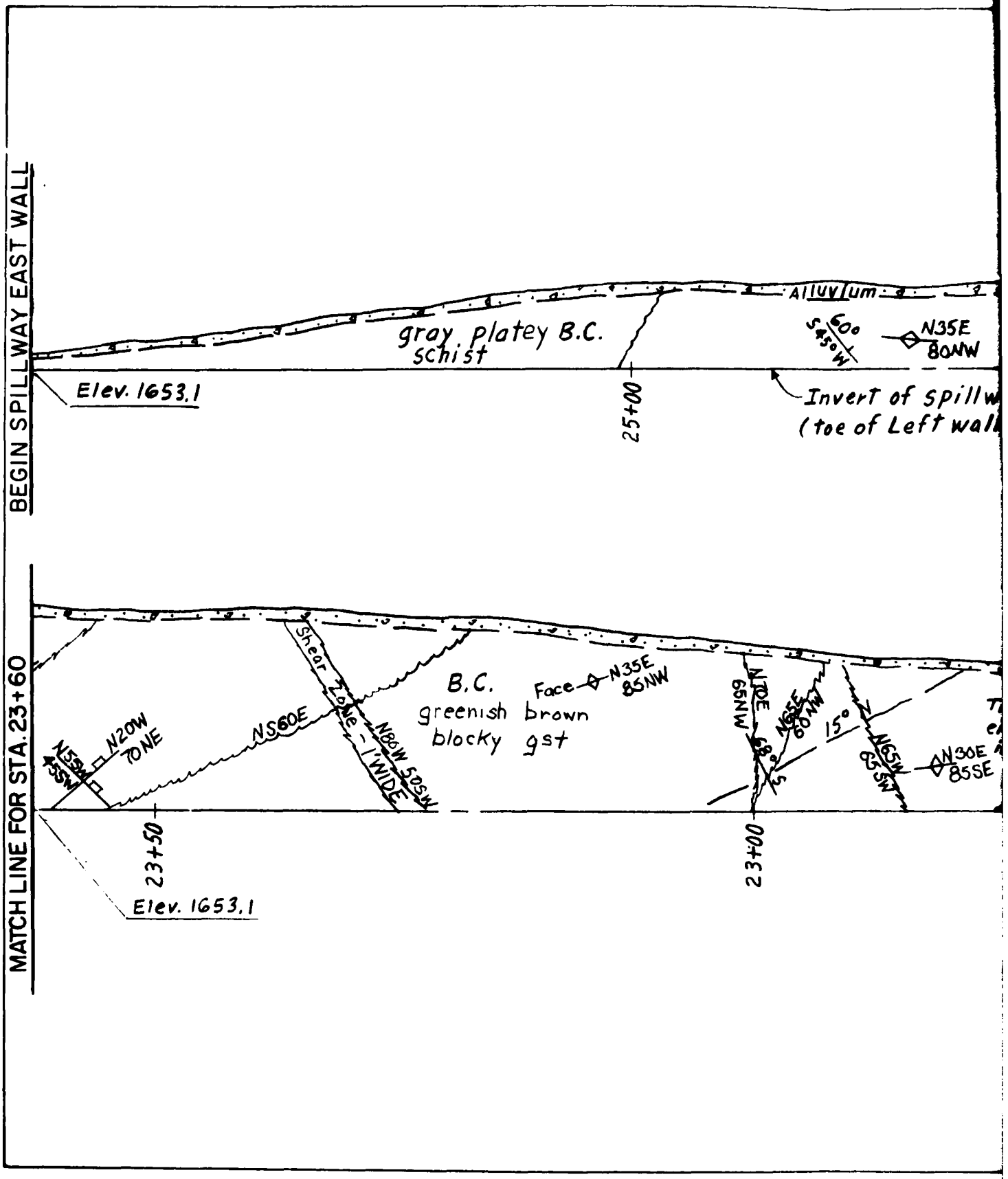
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

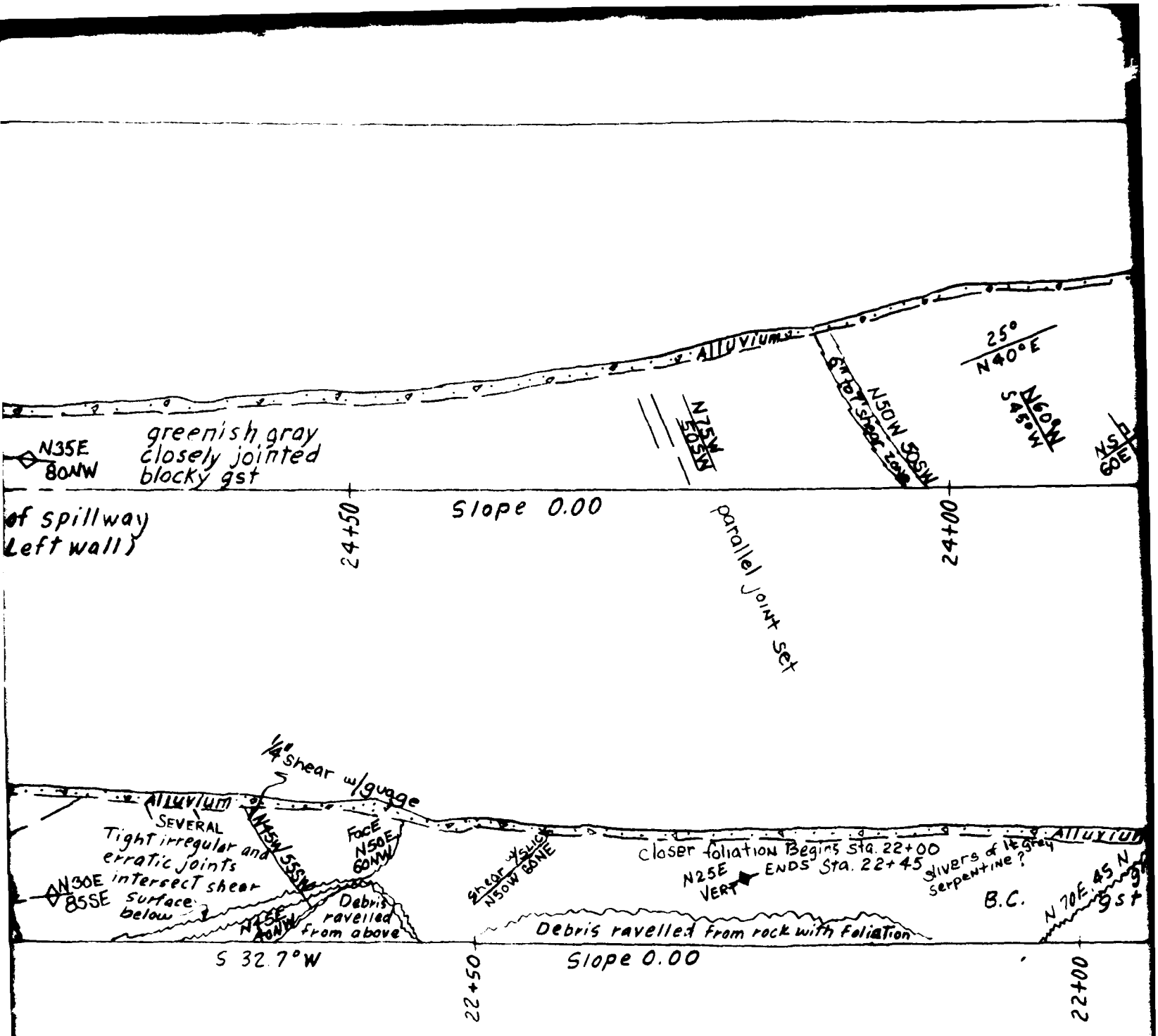
CAVE BUTTES DAM
FOUNDATION GEOLOGY
OUTLET WORKS
STA. 48+32 to STA. 47+01

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

FOUNDATION REPORT PLATE 49

U.S. ARMY ENGINEER DISTRICT





NOTE:

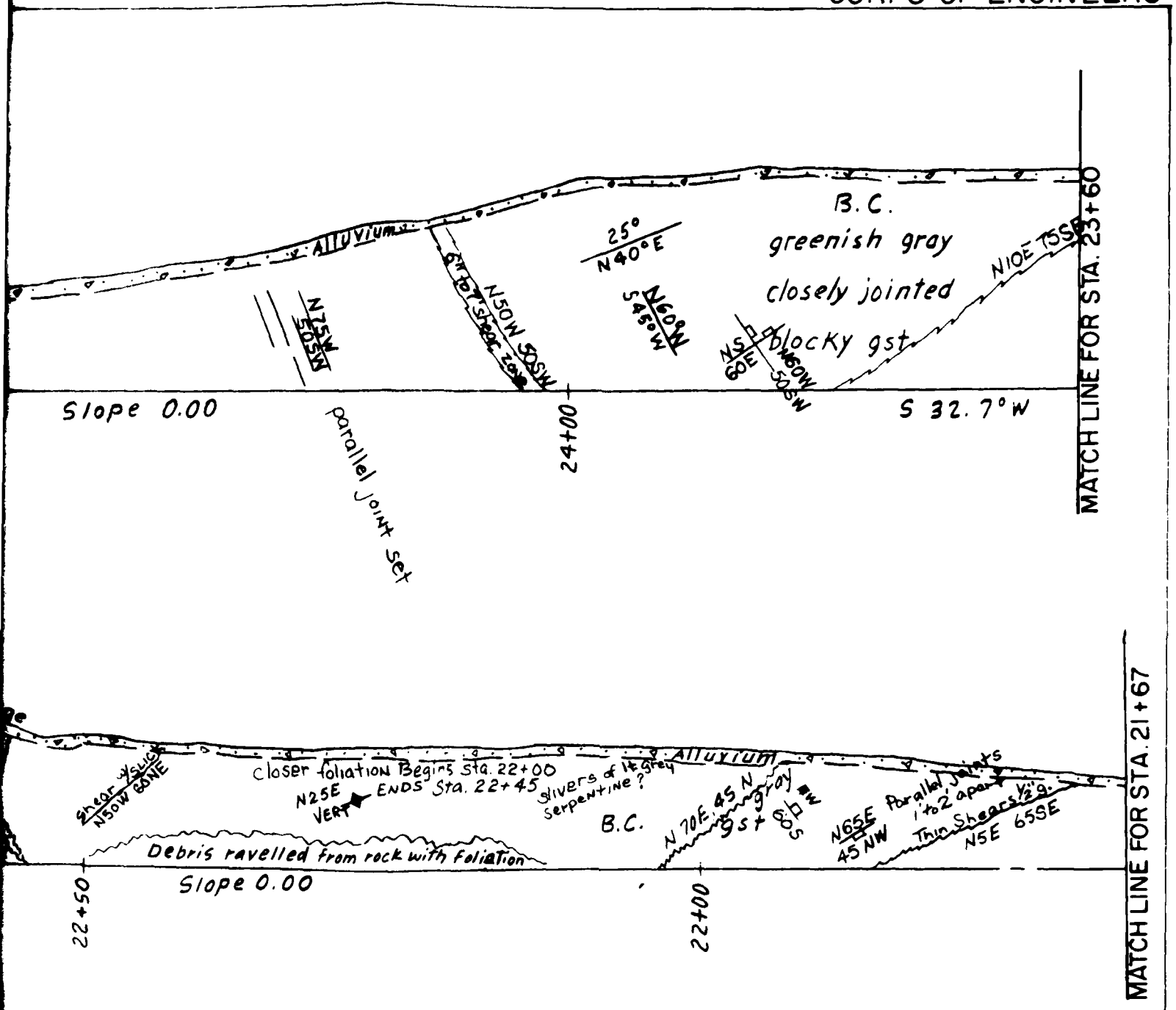
Refer to Plate 24 for Rock descriptions and explanations of symbols

1 IN = 10 FT

SCALE 10 0 10 FEET

2

FOU



NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols

1 IN : 10 FT

SCALE 10 0 10 FEET

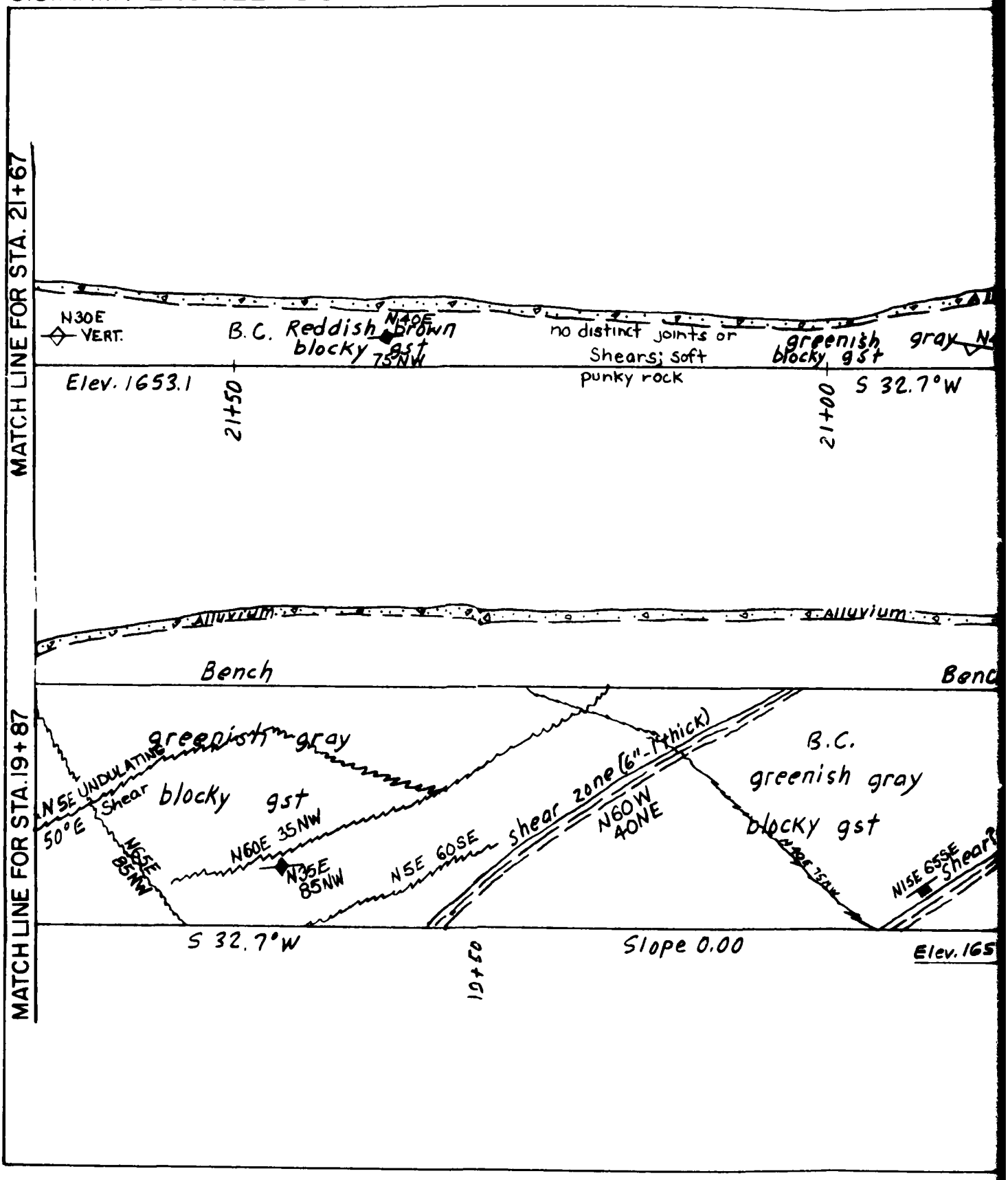
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

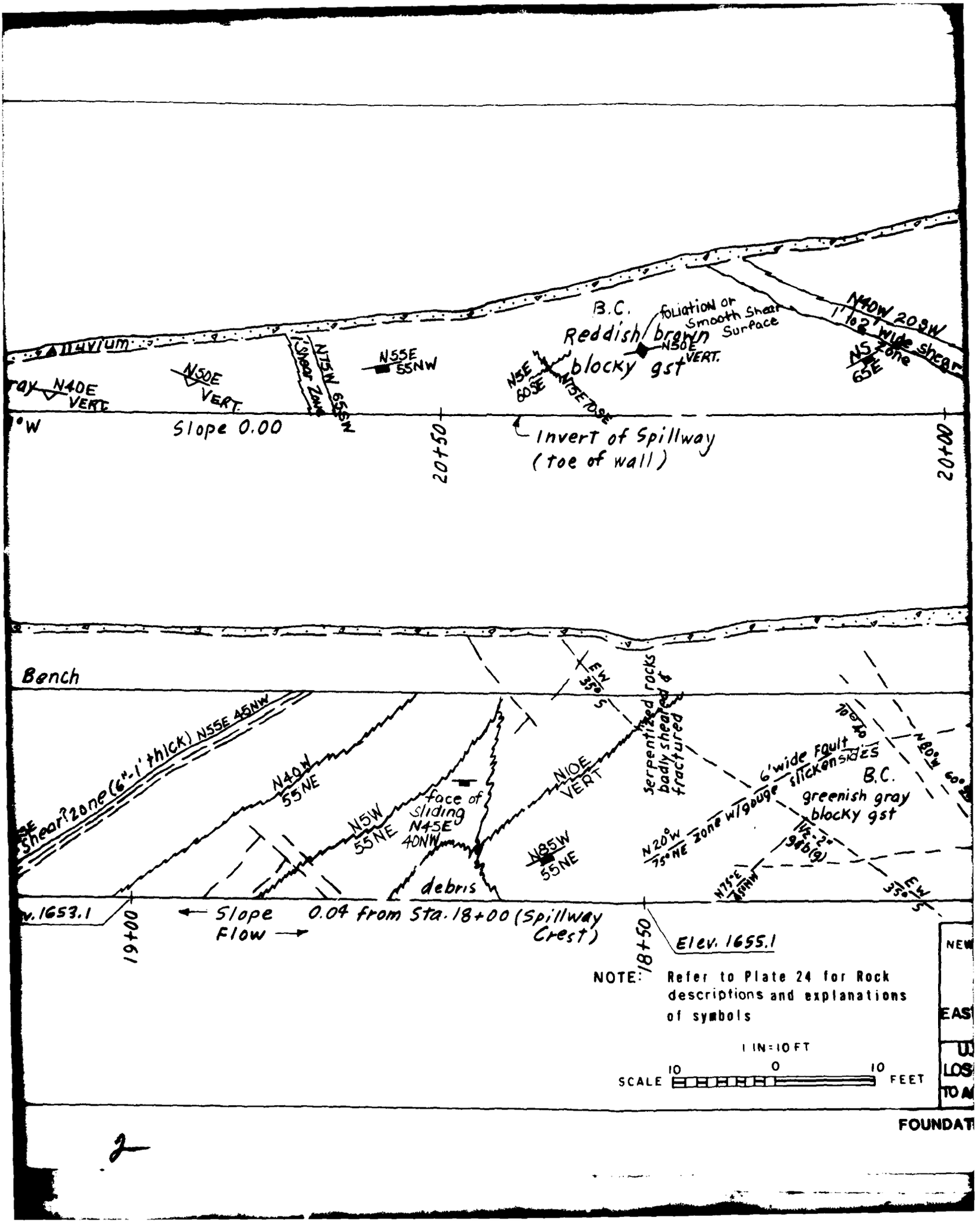
CAVE BUTTES DAM
SPILLWAY GEOLOGY
EAST (LEFT) WALL OF SPILLWAY CUT
STA. 25+50 to STA. 21+67

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

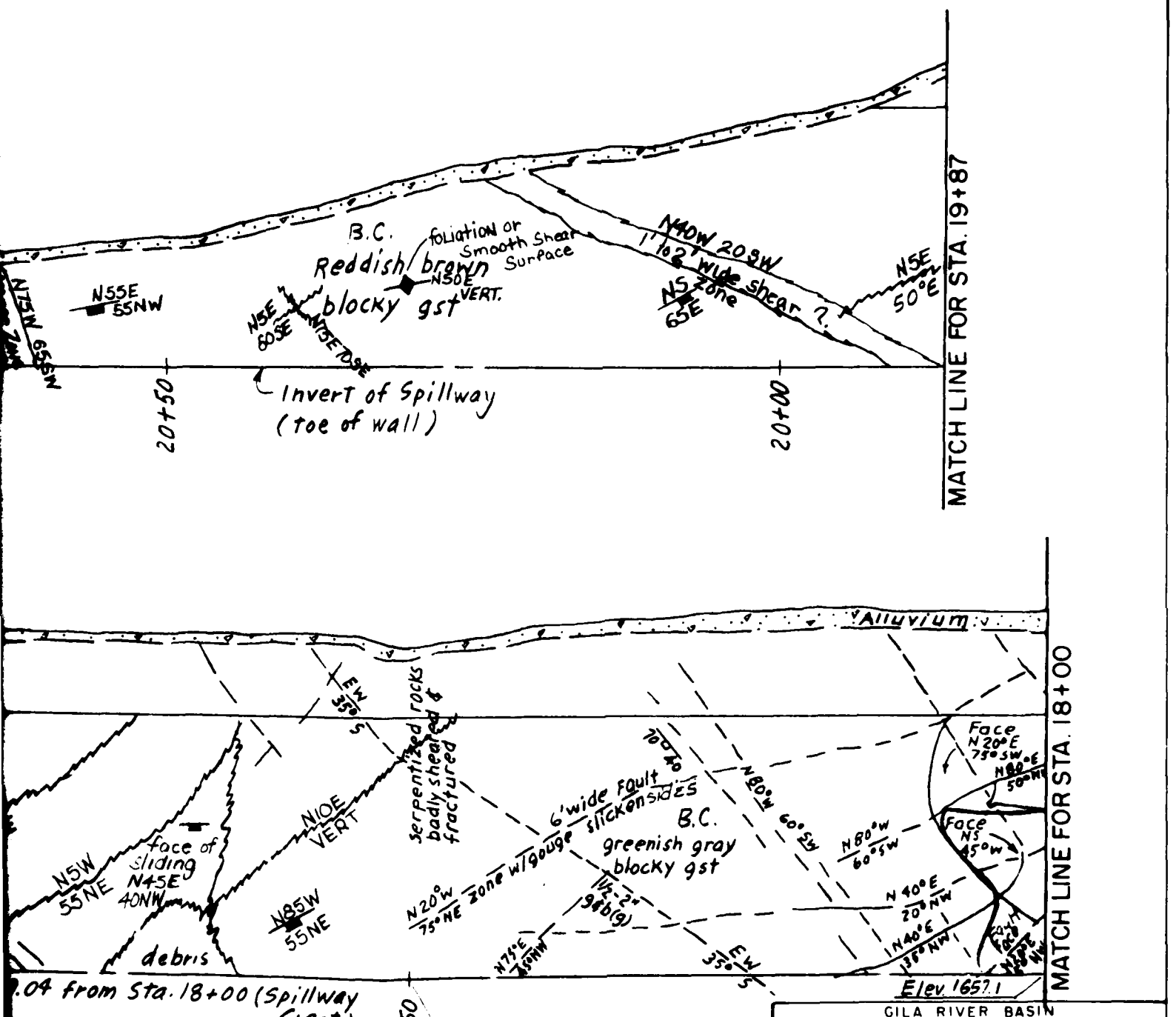
FOUNDATION REPORT PLATE 50

U.S. ARMY ENGINEER DISTRICT




Alluvium
N40E VERT.
N50E VERT.
N75W 65SW
Shear Zone
N55E 55NW
B.C.
Reddish brown blocky gst
foliation or Smooth Shear Surface
N50E VERT.
N5E 60SE
N75E 70SE
N40W 20SW
1'-2' wide shear
N5 Zone 65E
Slope 0.00
20+50
Invert of Spillway (toe of wall)
20+00
Bench
N40W 55NE
Shear? zone (6"-1' thick) N55E 45NW
N5W 55NE
face of sliding N45E 40NW
N10E VERT
serpentinized rocks badly sheared & fractured
N85W 55NE
N20°W 75°NE zone w/gouge
6' wide fault slickensides
B.C. greenish gray blocky gst
N80°W 60°
N75°E 45NW
debris
Elev. 1653.1
19+00
Slope Flow
0.04 from Sta. 18+00 (Spillway Crest)
18+50
Elev. 1655.1
NOTE: Refer to Plate 24 for Rock descriptions and explanations of symbols
1 IN=10 FT
SCALE 10 0 10 FEET
NEW
EAST
FOUNDAT
2

CORPS OF ENGINEERS



NOTE: Refer to Plate 24 for Rock descriptions and explanations of symbols

SCALE 1 IN = 10 FT
10 0 10 FEET

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

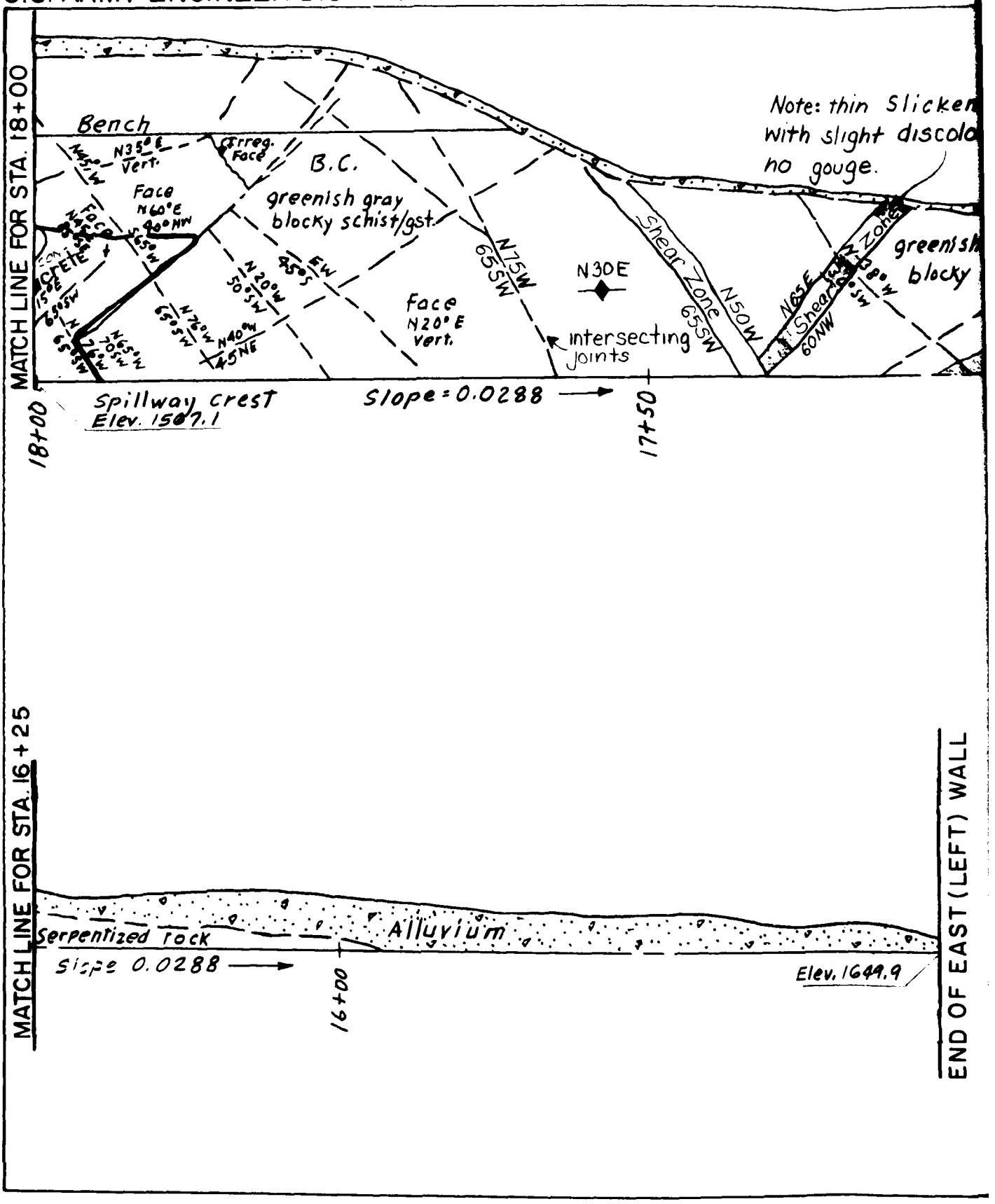
CAVE BUTTES DAM
SPILLWAY GEOLOGY
EAST (LEFT) WALL OF SPILLWAY CUT
STA. 21+67 to STA. 18+00

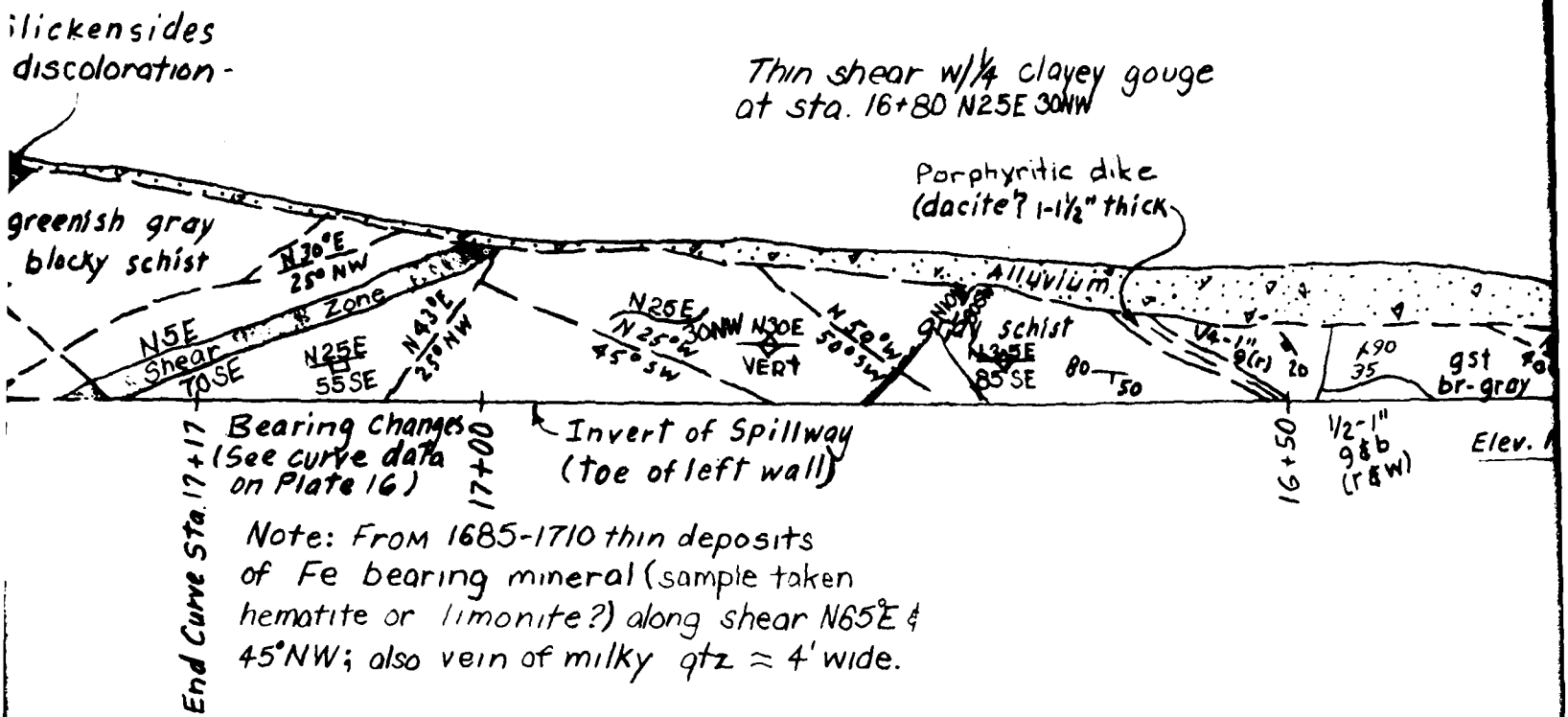
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

FOUNDATION REPORT PLATE 51

3

U.S. ARMY ENGINEER DISTRICT





Note: From 1685-1710 thin deposits of Fe bearing mineral (sample taken hematite or limonite?) along shear N65°E & 45°NW; also vein of milky qtz ≈ 4' wide.

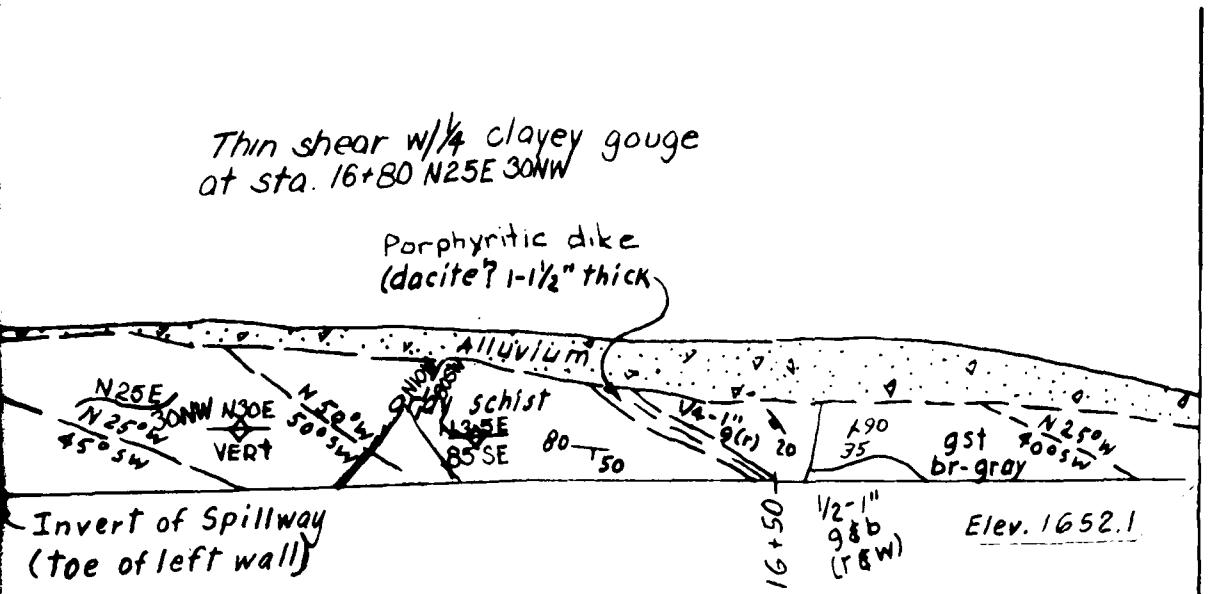
END OF EAST (LEFT) WALL

1 IN=10 FT

SCALE 10 0 10 FEET

FOU

2



MATCH LINE FOR STA. 16+25

...710 thin deposits
...ineral (sample taken
...ite?) along shear N65°E &
...f milky qtz ≈ 4' wide.

NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols

SCALE 1 IN=10 FT
10 0 10 FEET

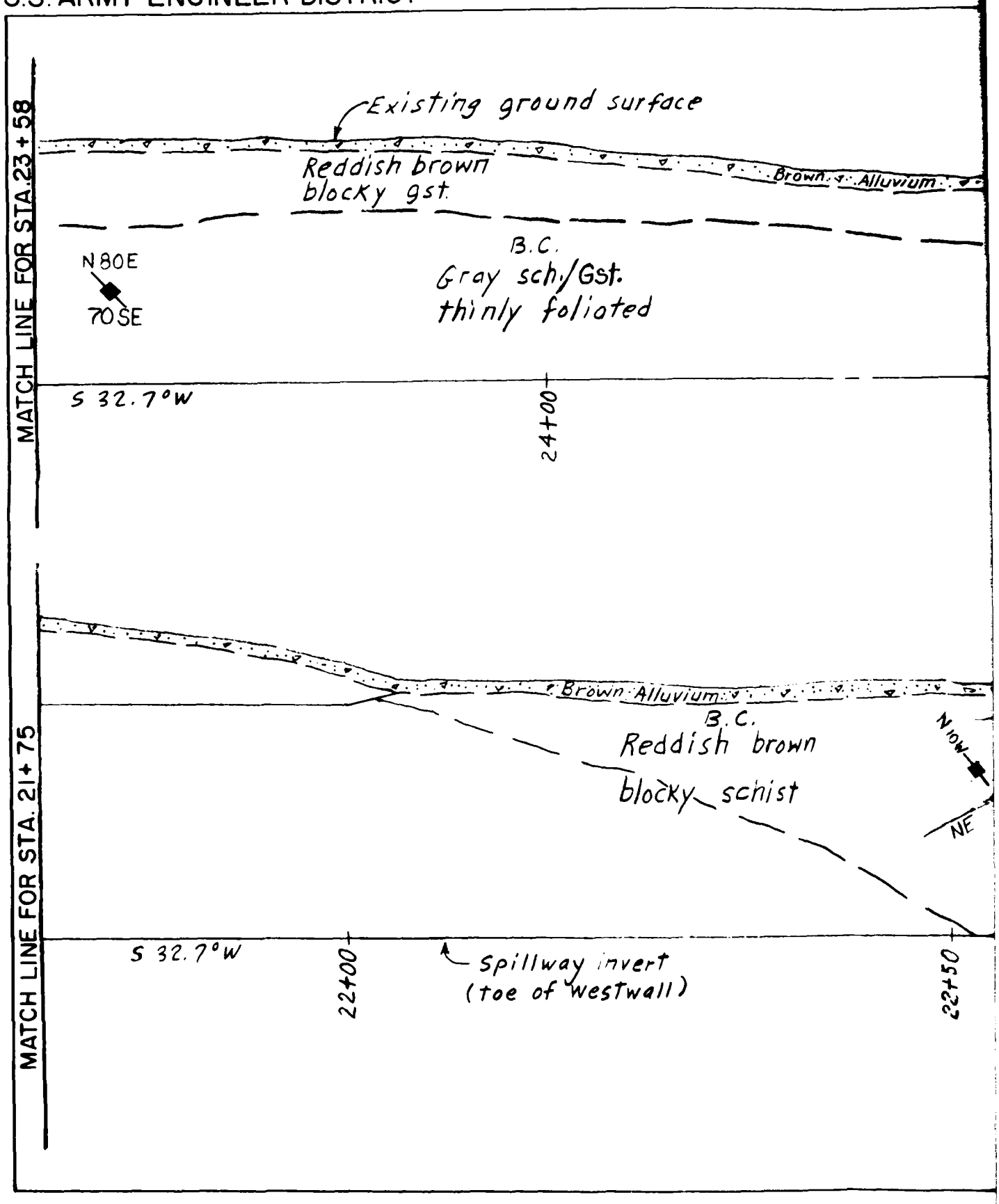
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

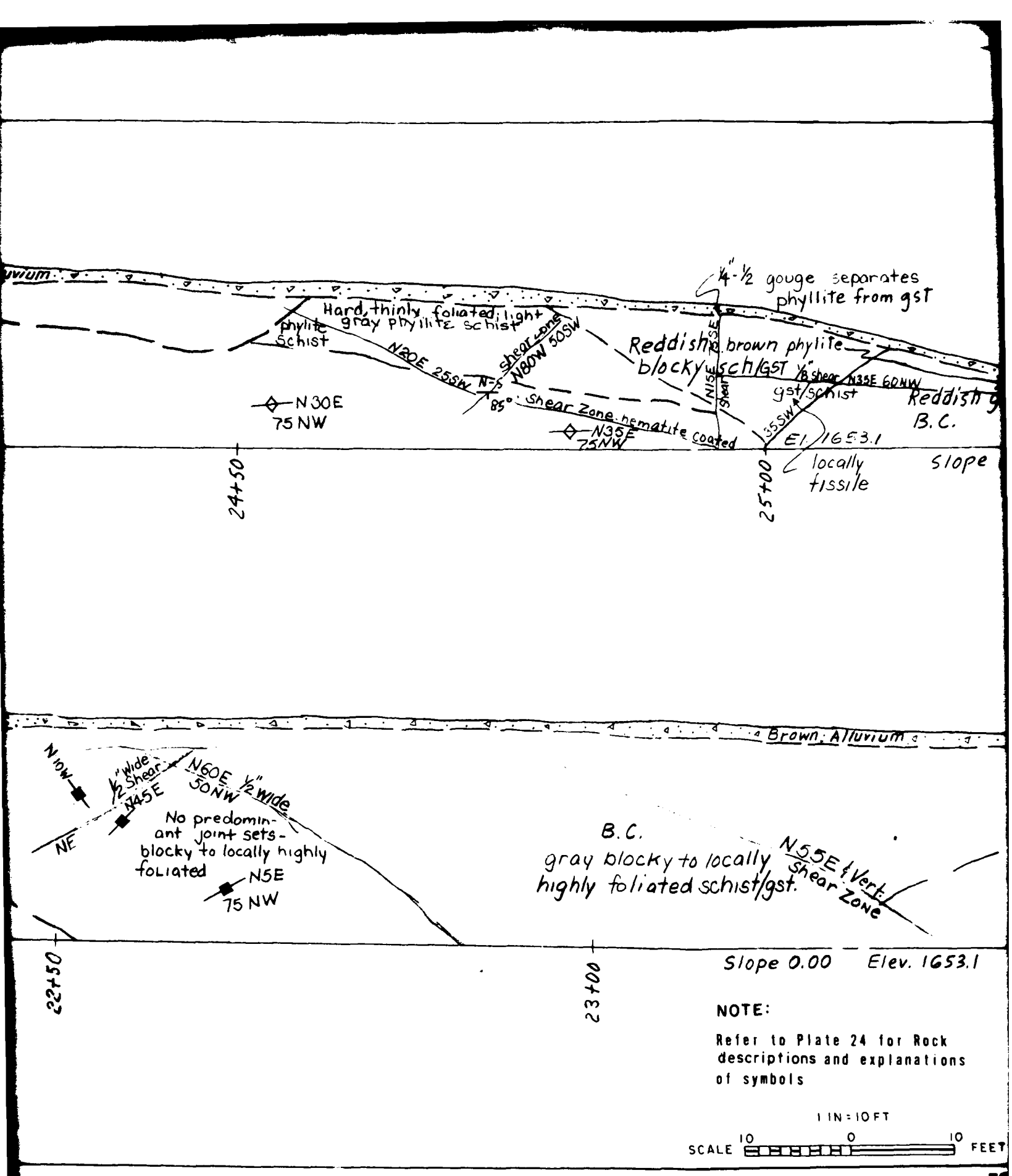
CAVE BUTTES DAM
SPILLWAY GEOLOGY
EAST (LEFT) WALL OF SPILLWAY CUT
STA. 18+00 to STA. 15+50

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

FOUNDATION REPORT PLATE 52

U.S. ARMY ENGINEER DISTRICT





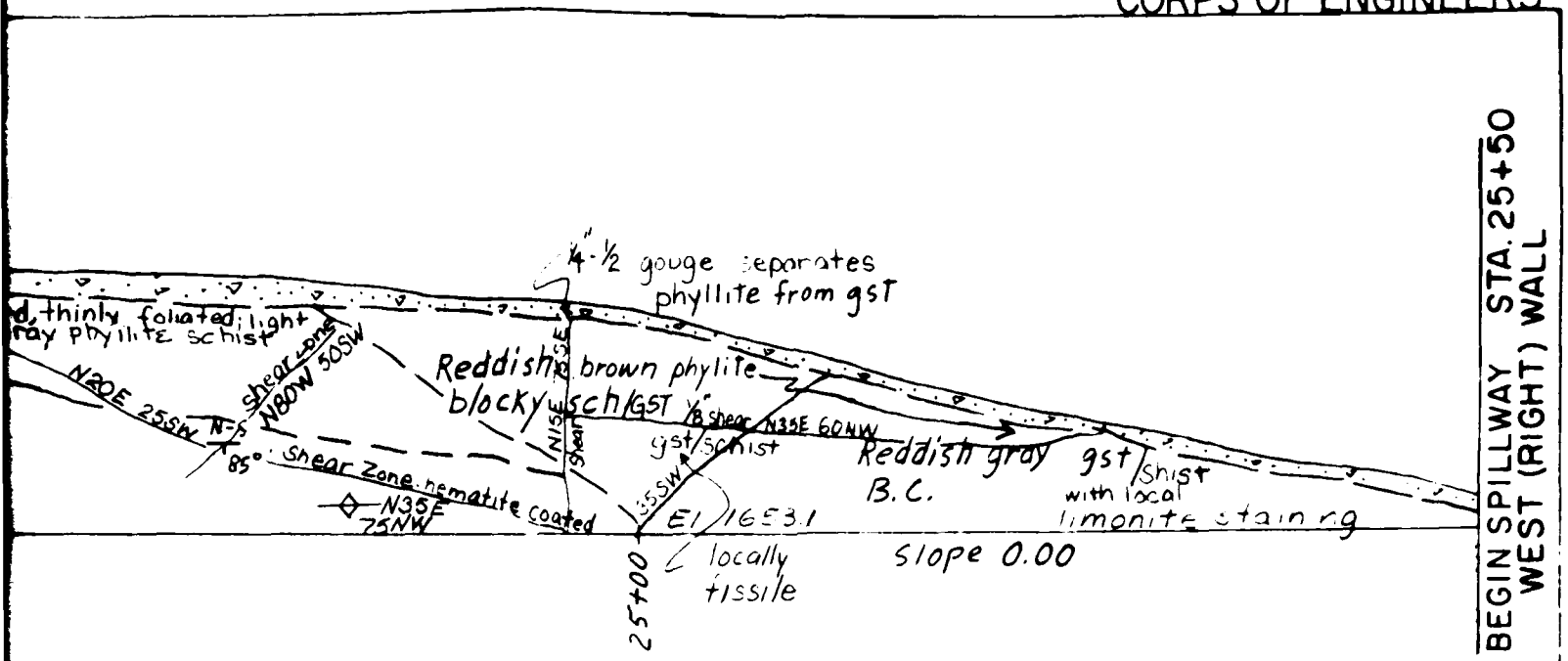
NOTE:

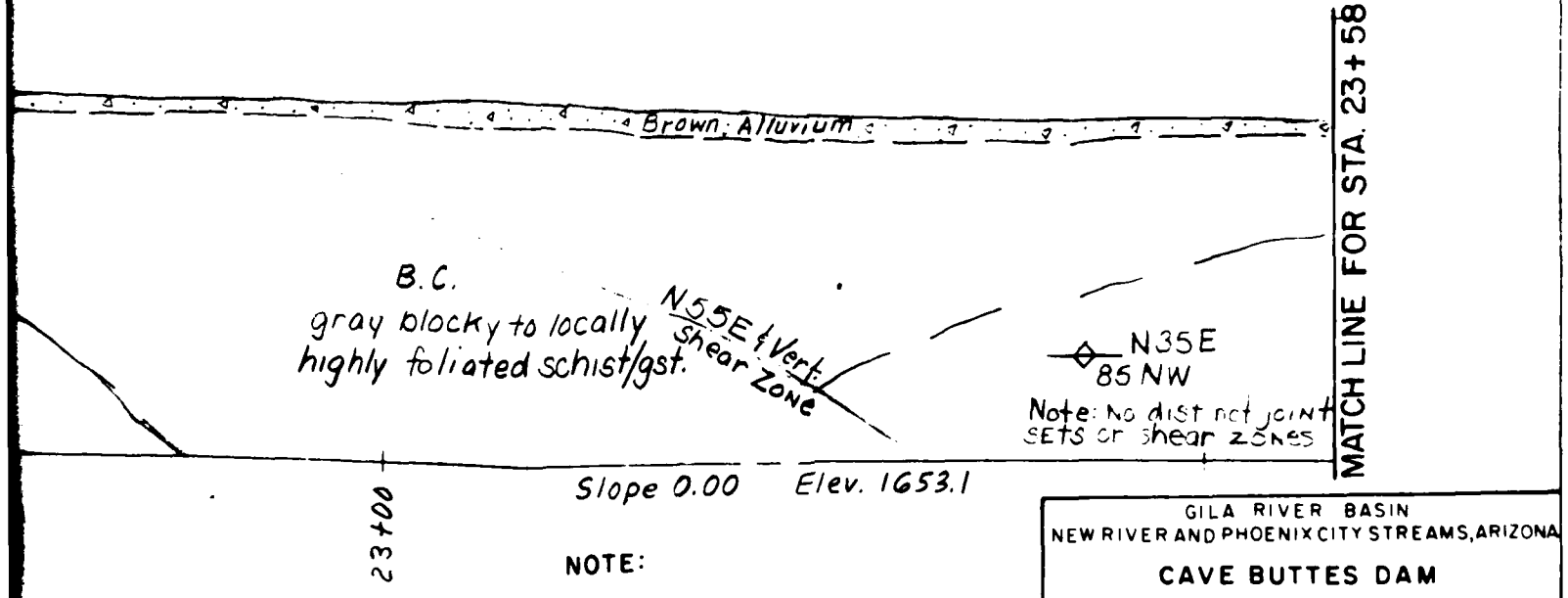
Refer to Plate 24 for Rock descriptions and explanations of symbols

1 IN = 10 FT

SCALE 10 0 10 FEET

CORPS OF ENGINEERS





NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols

1 IN = 10 FT

SCALE 10 0 10 FEET

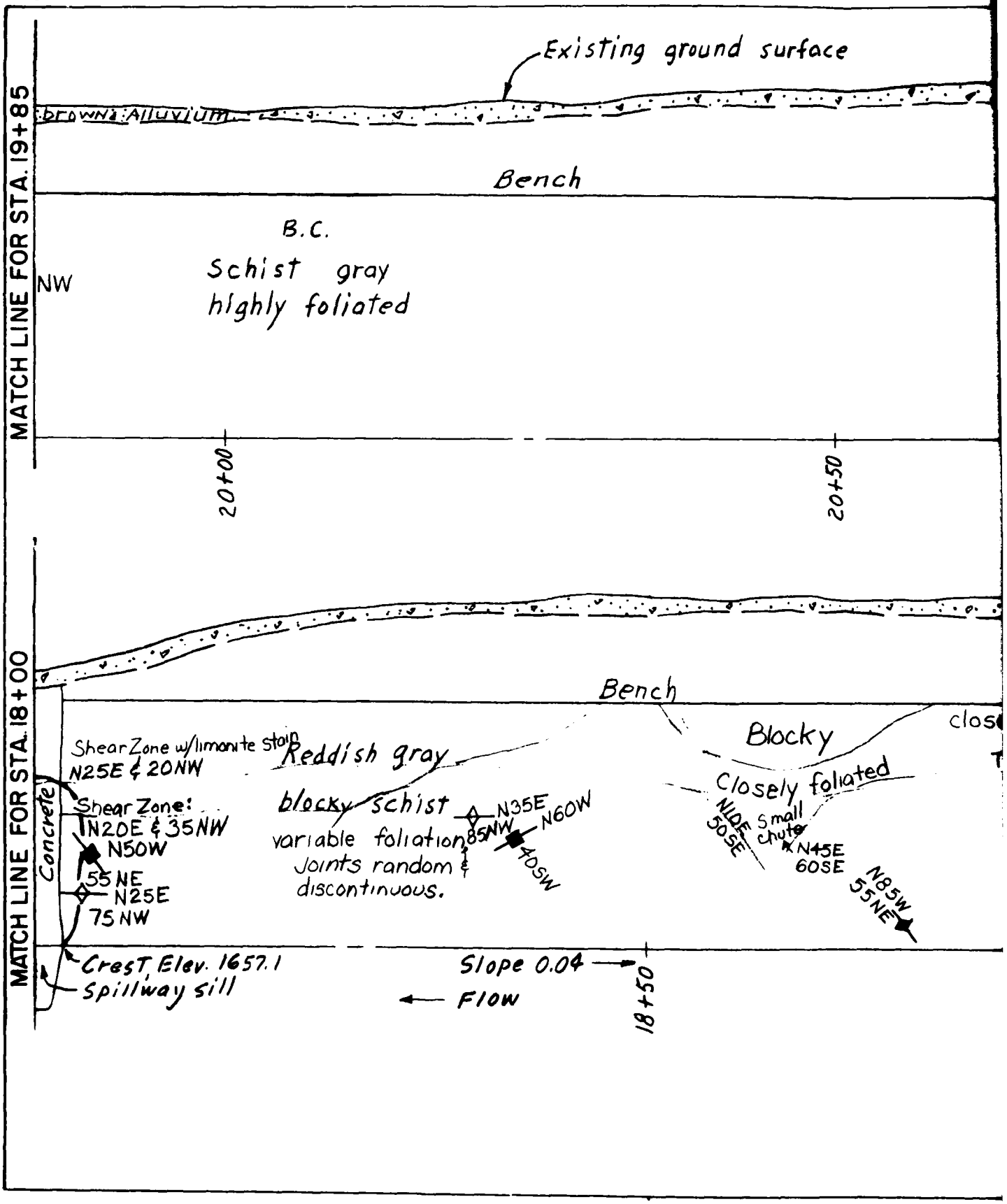
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

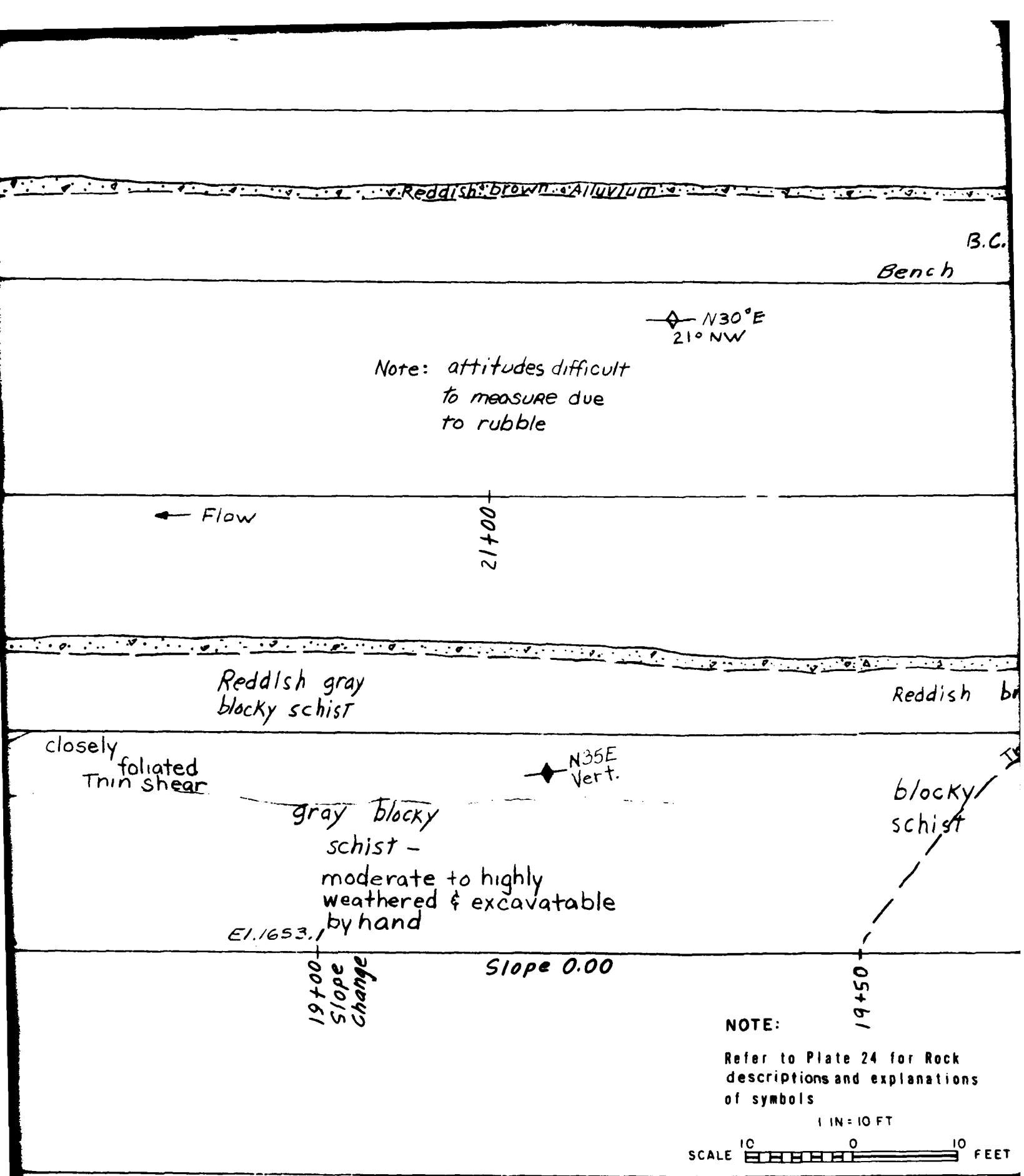
CAVE BUTTES DAM
SPILLWAY GEOLOGY
WEST (RIGHT) WALL OF SPILLWAY
STA. 25+50 to STA. 21+75

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

FOUNDATION REPORT **PLATE 53**

U.S. ARMY ENGINEER DISTRICT

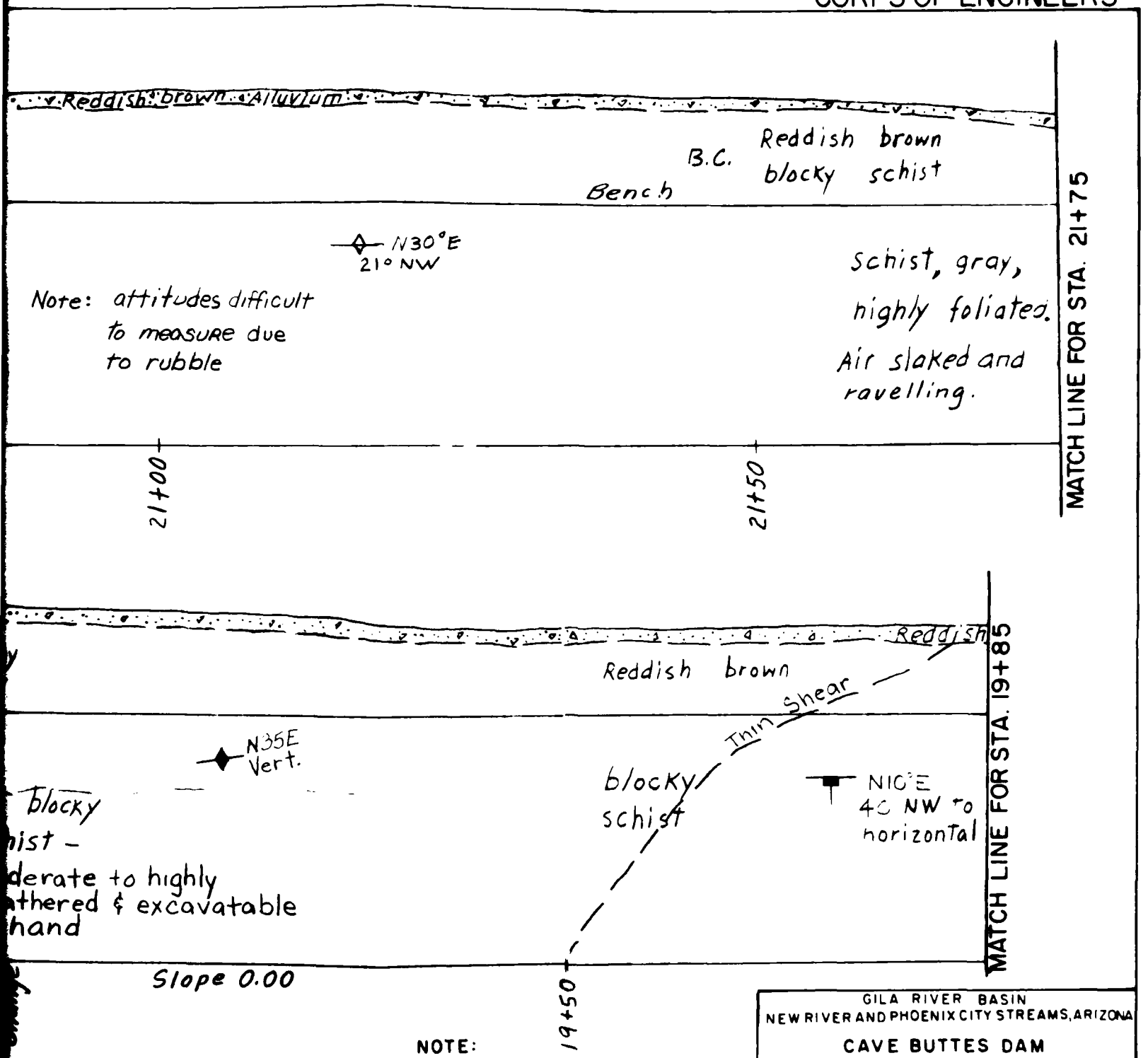



Reddish brown Alluvium
B.C.
Bench
N30°E
21° NW
Note: attitudes difficult to measure due to rubble
Flow
21+00
Reddish gray blocky schist
Reddish br
closely foliated Thin shear
N35E
Vert.
gray blocky schist - moderate to highly weathered & excavatable by hand
blocky schist
El. 1653.1
19+00 Slope Change
Slope 0.00
19+50
NOTE:
Refer to Plate 24 for Rock descriptions and explanations of symbols
1 IN = 10 FT
SCALE 10 0 10 FEET

FOU

2

CORPS OF ENGINEERS



NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols

1 IN = 10 FT

SCALE 10 0 10 FEET

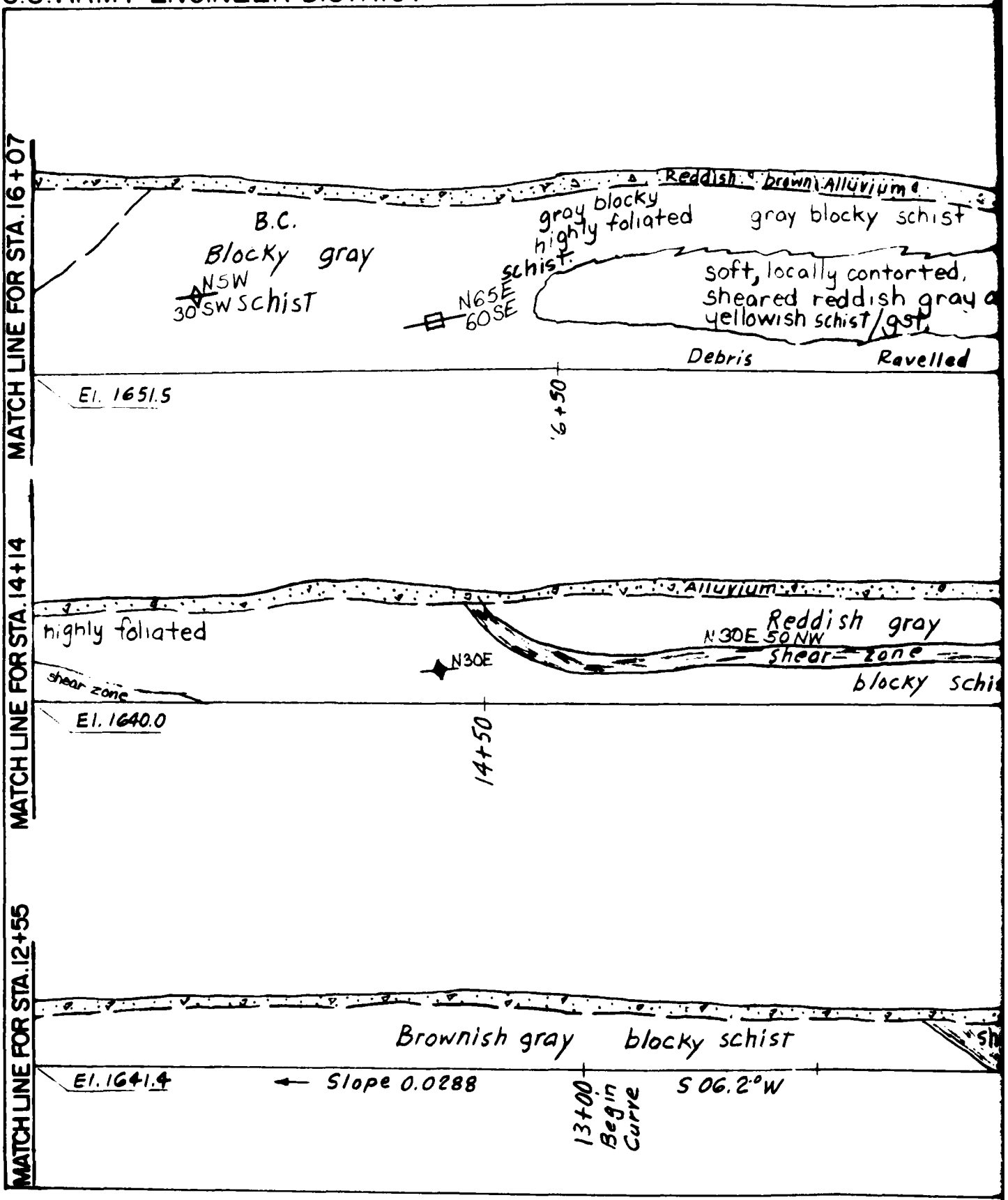
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

CAVE BUTTES DAM
SPILLWAY GEOLOGY
WEST (RIGHT) WALL OF SPILLWAY
STA. 21+75 to STA. 18+00

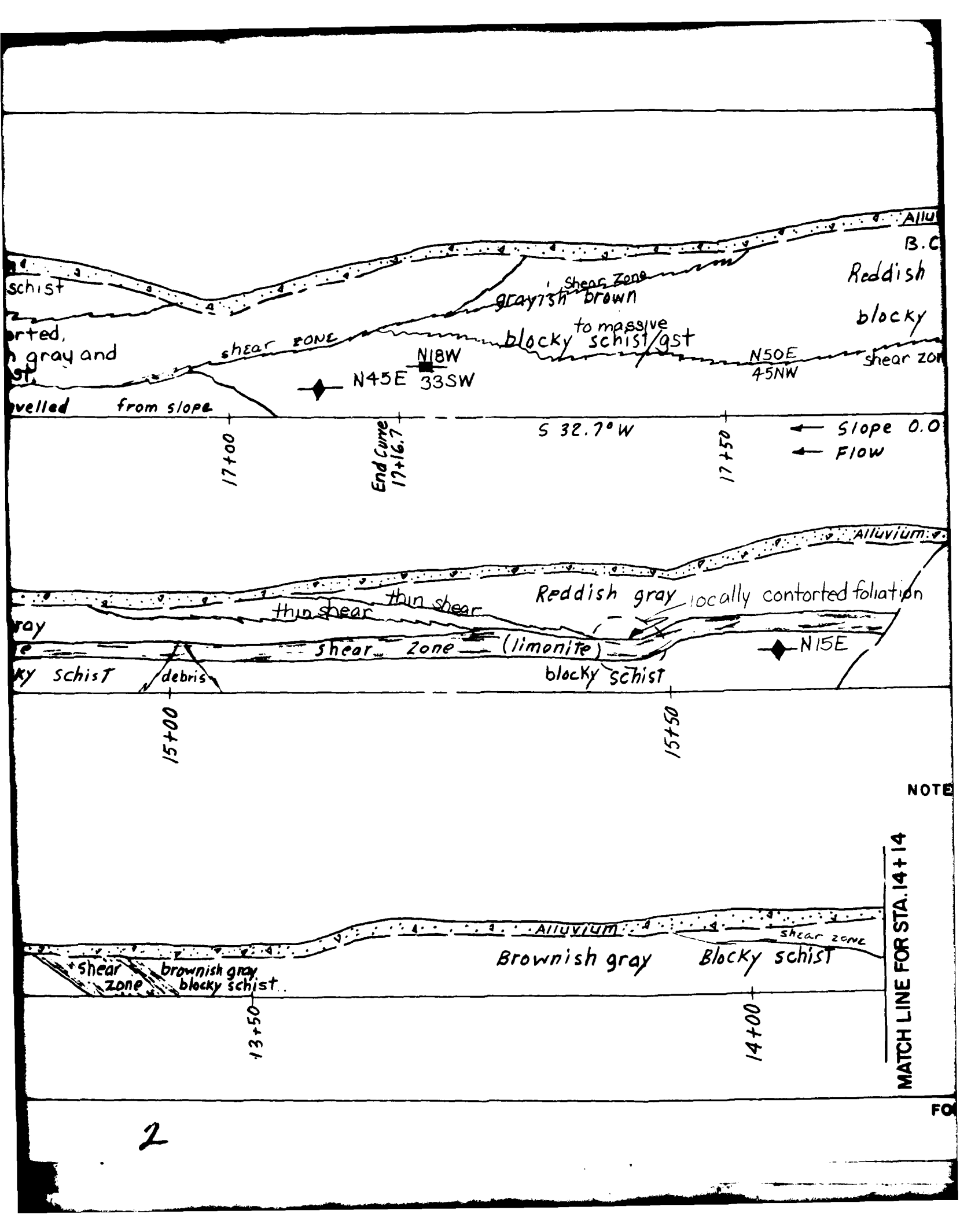
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

FOUNDATION REPORT PLATE 54

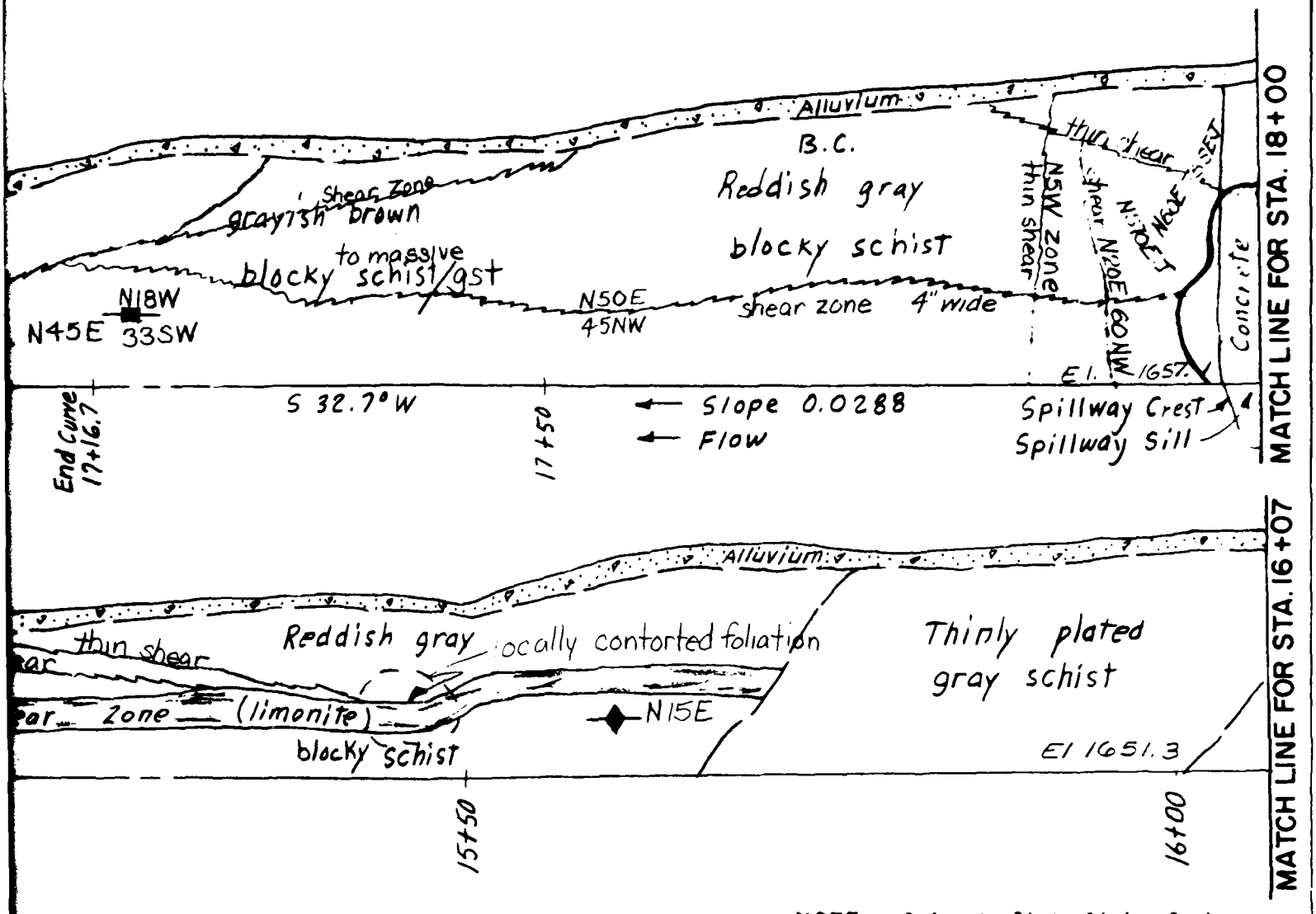
U.S. ARMY ENGINEER DISTRICT



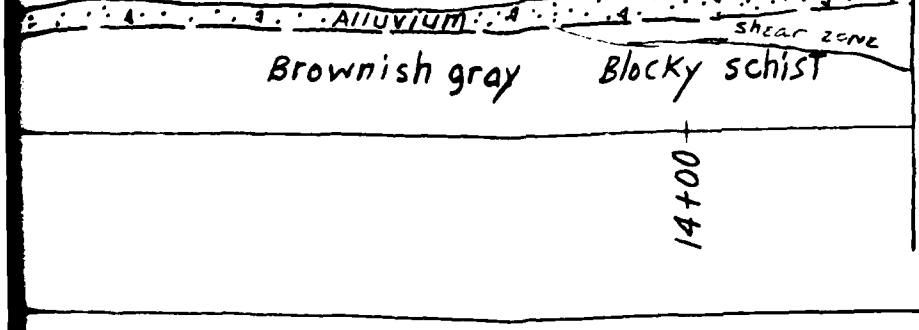
1


Allu
B.C
Reddish
blocky
schist
rted,
gray and
st
velled from slope
shear zone
Shear Zone
grayish brown
to massive
blocky schist/gst
shear zon
N18W
N45E 33SW
N50E
45NW
S 32.7°W
Slope 0.0
Flow
17+00
End Curve
17+16.7
17+50
Alluvium
thin shear
thin shear
Reddish gray locally contorted foliation
ray
shear zone (limonite)
N15E
ky schist
debris
blocky schist
15+00
15+50
NOTE
Alluvium
shear zone
shear zone
brownish gray
blocky schist
Brownish gray
Blocky schist
13+50
14+00
MATCH LINE FOR STA. 14+14
FO
2

CORPS OF ENGINEERS



NOTE: Refer to Plate 24 for Rock descriptions and explanations of symbols



1 IN = 10 FT

SCALE 10 0 10 FEET

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

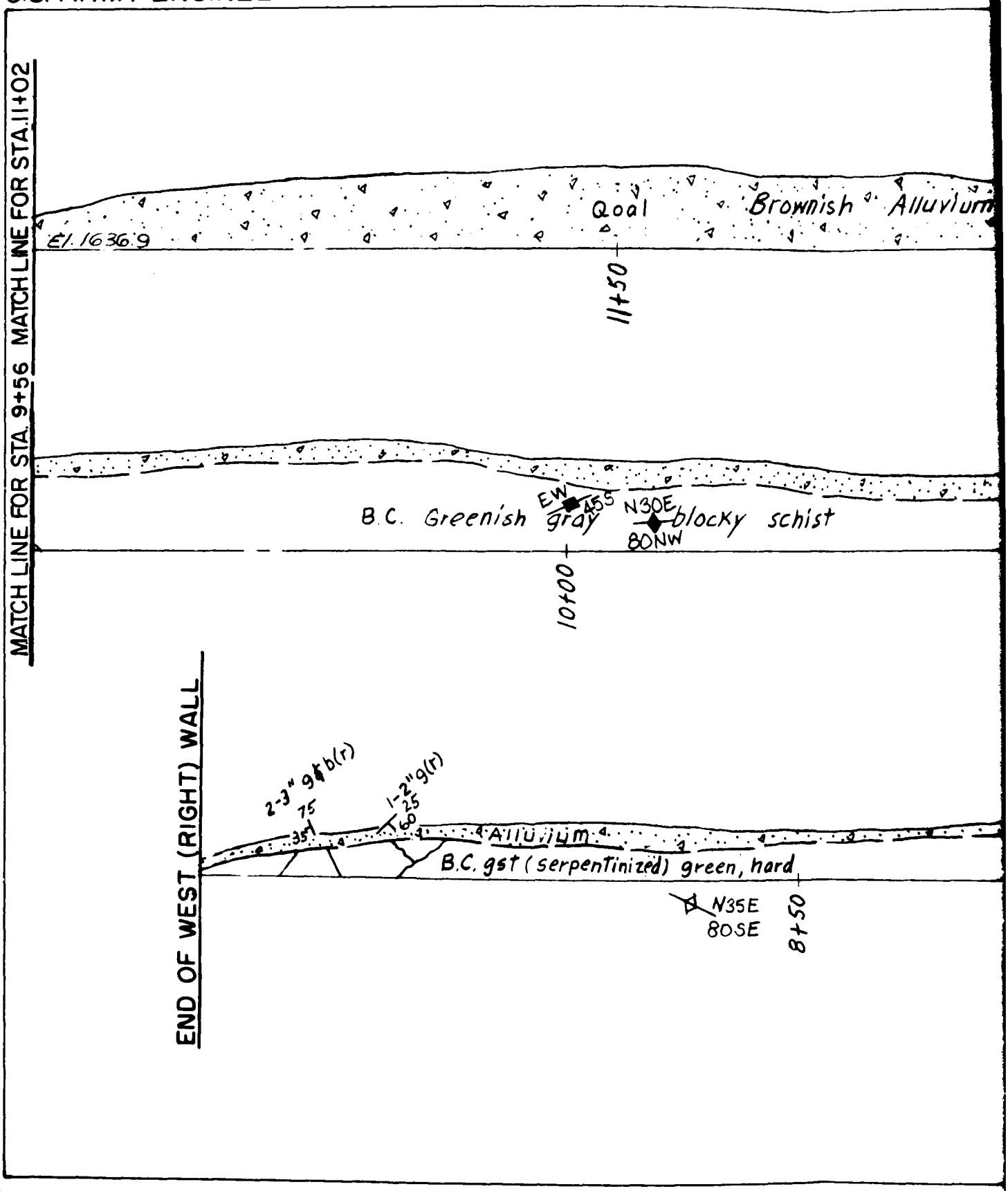
CAVE BUTTES DAM
SPILLWAY GEOLOGY
WEST (RIGHT) WALL OF SPILLWAY
STA. 18+00 to STA. 12+55

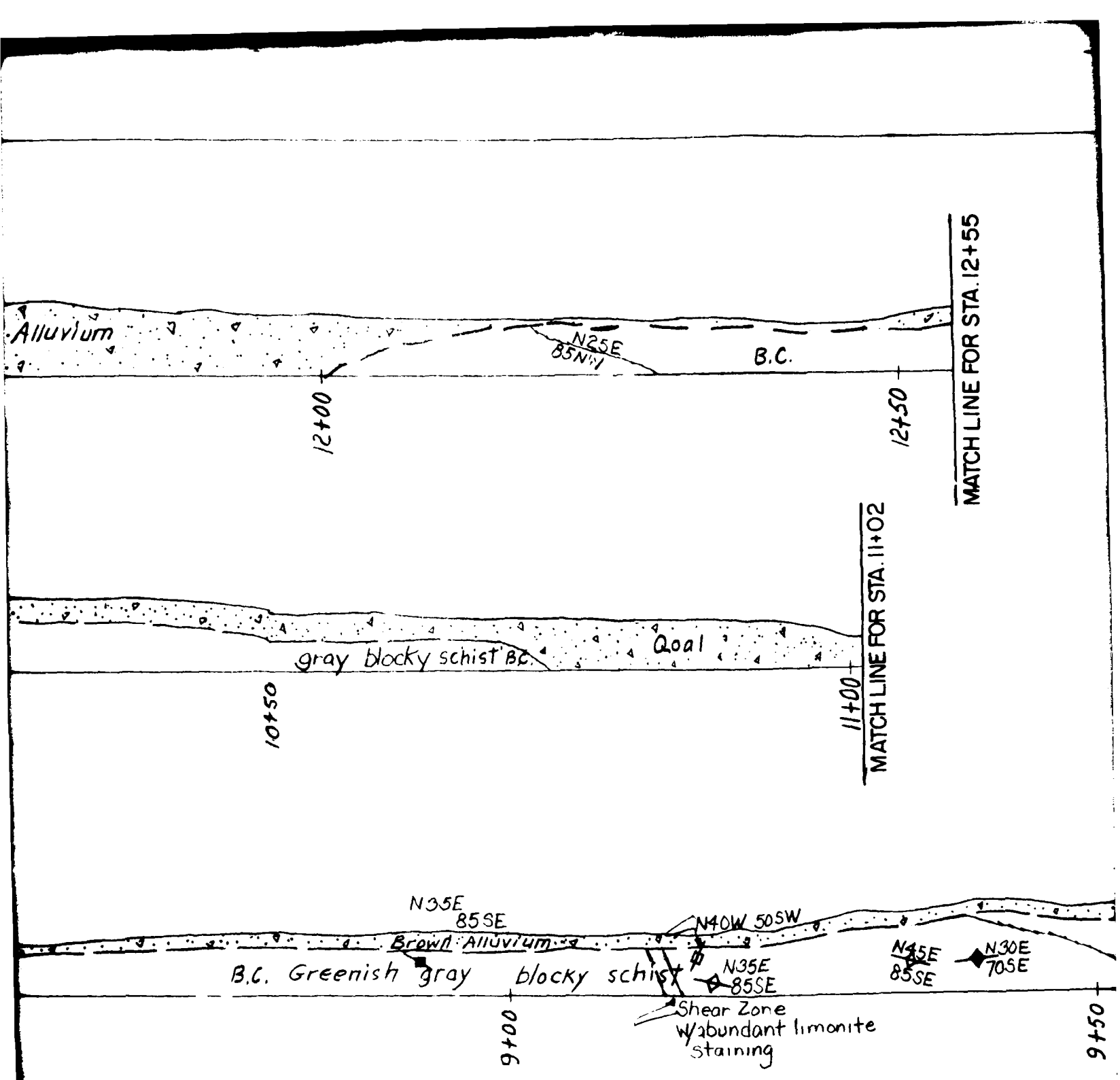
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

FOUNDATION REPORT PLATE 55

3

U.S. ARMY ENGINEER DISTRICT





NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols

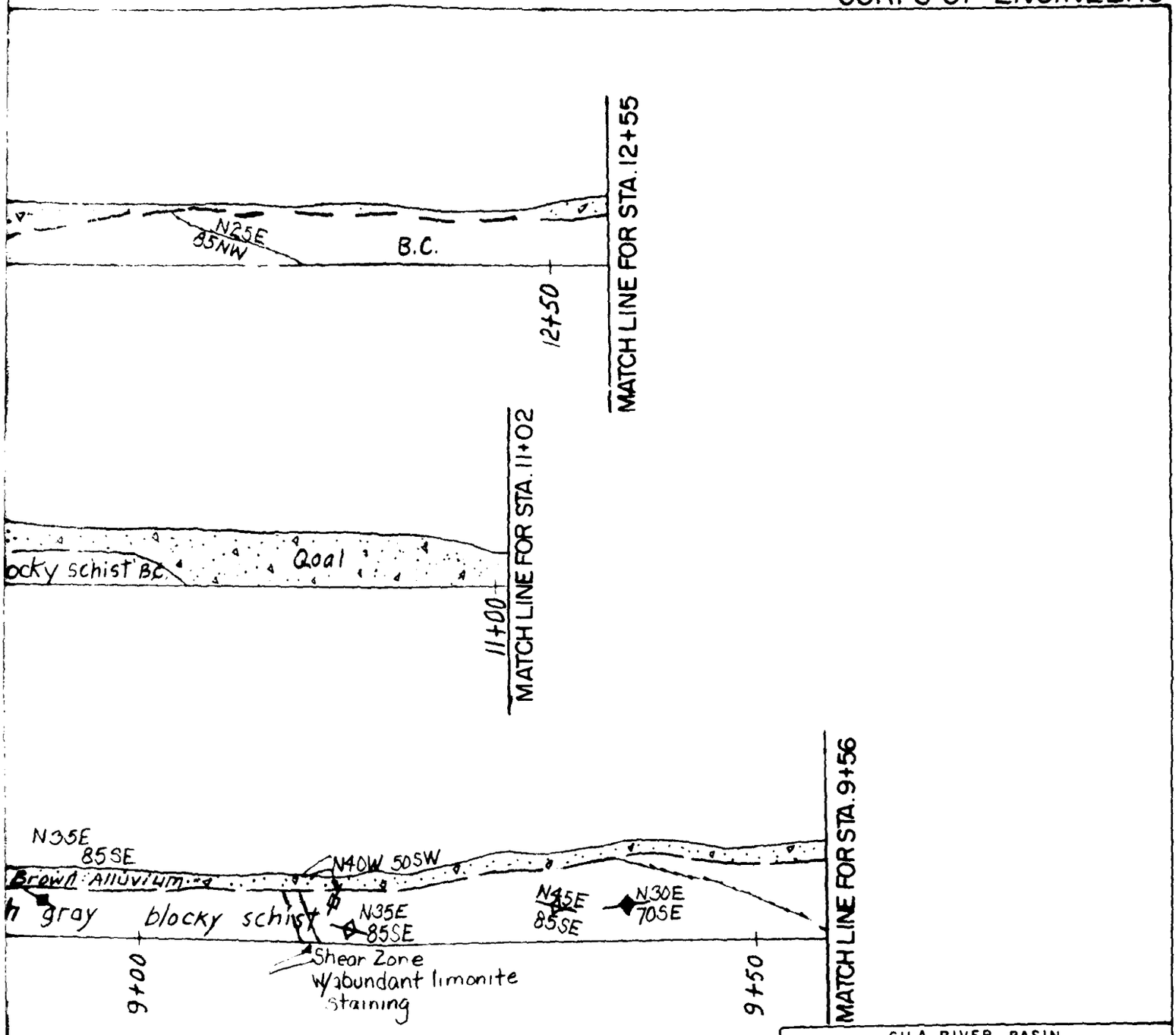
1 IN = 10 FT

SCALE 10 0 10 FEET

FOU

2

CORPS OF ENGINEERS



NOTE:

Refer to Plate 24 for Rock descriptions and explanations of symbols

1 IN = 10 FT

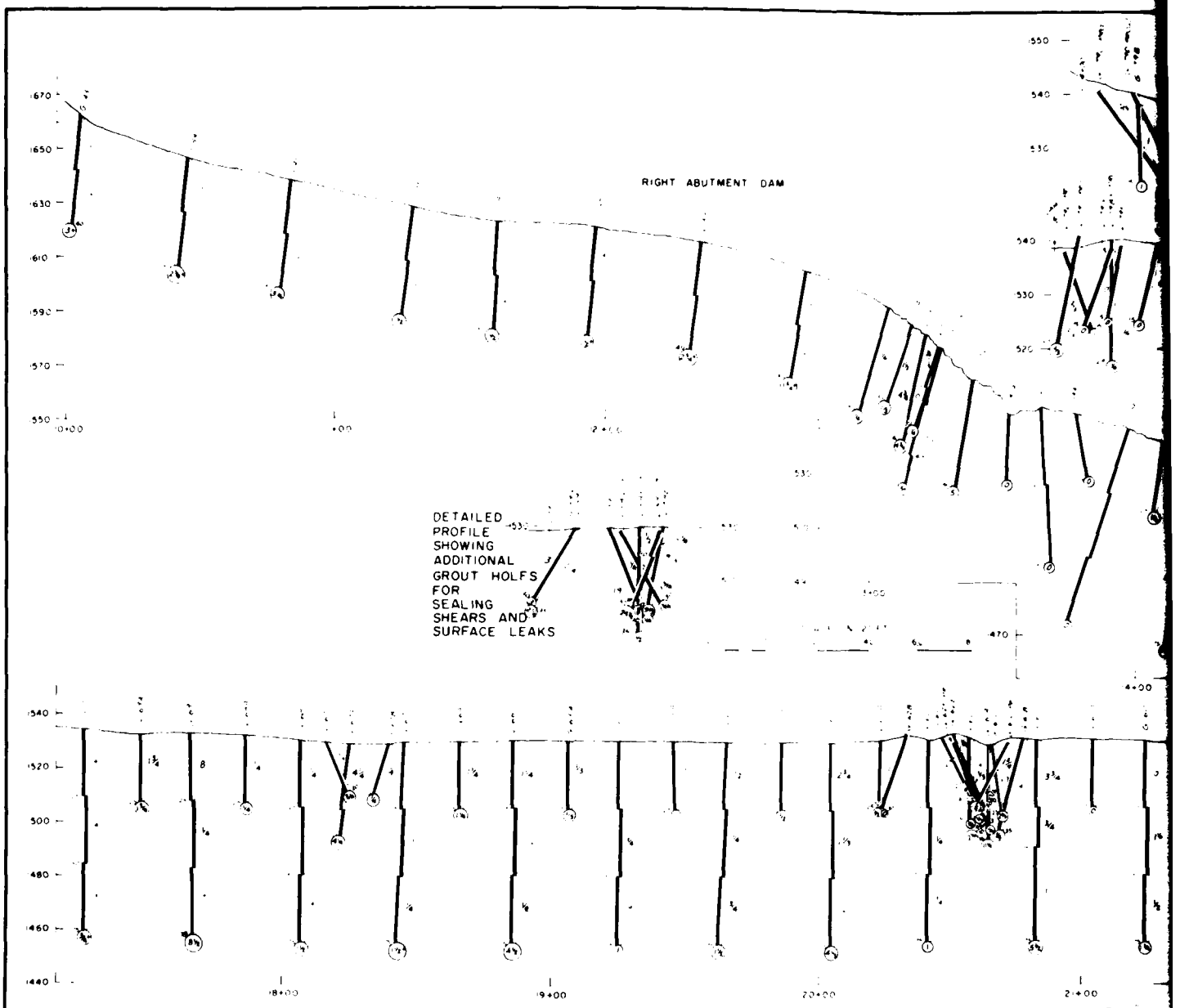
SCALE 10 0 10 FEET

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

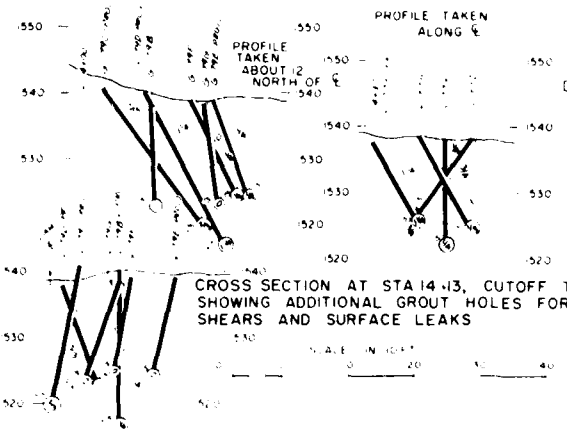
CAVE BUTTES DAM
SPILLWAY GEOLOGY
WEST (RIGHT) WALL OF SPILLWAY
STA. 12+55 to STA. 8+00

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

FOUNDATION REPORT PLATE 56

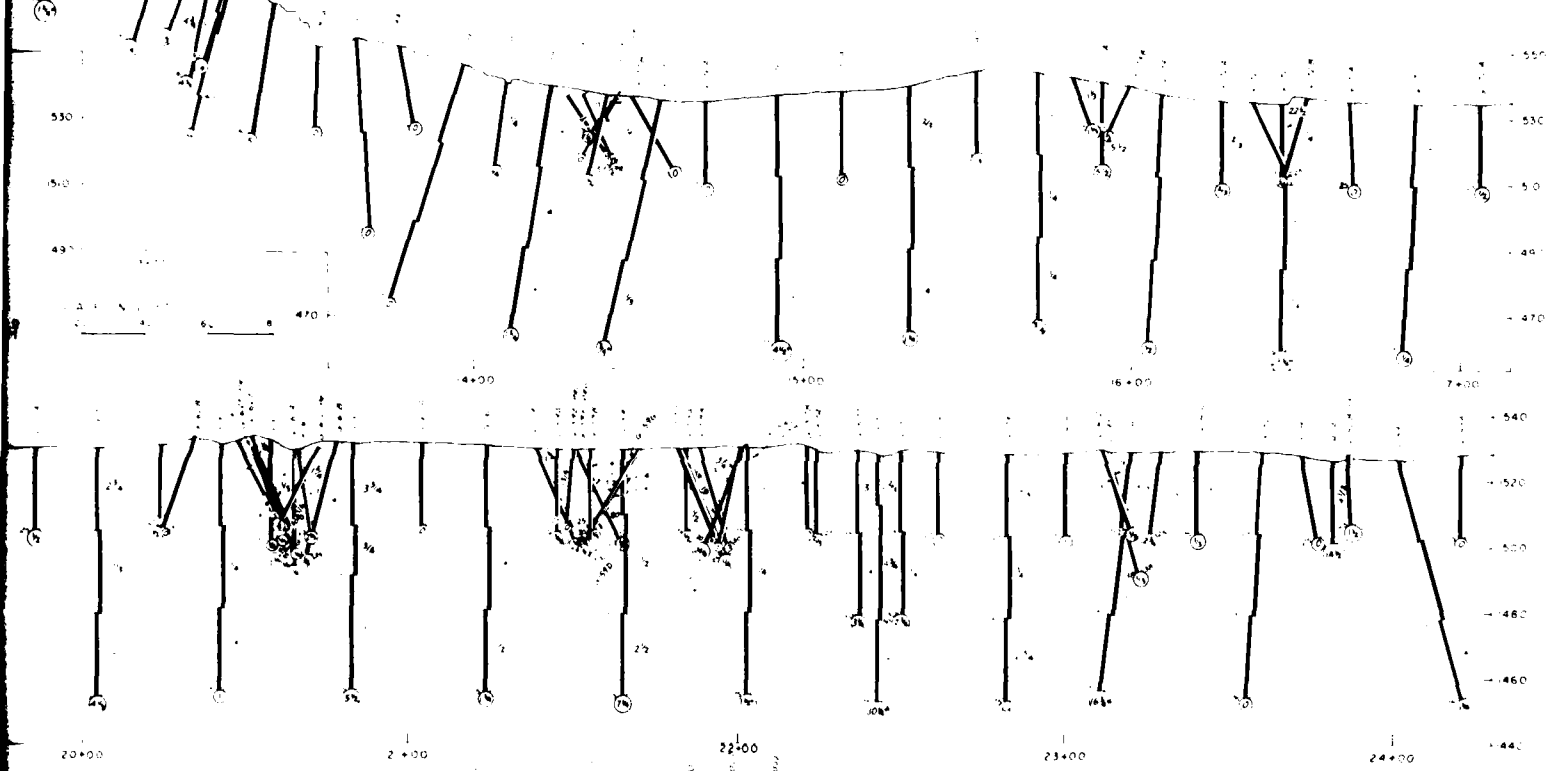


PROFILE ALONG CENTER OF CUTOFF TRENCH
MAIN EMBANKMENT

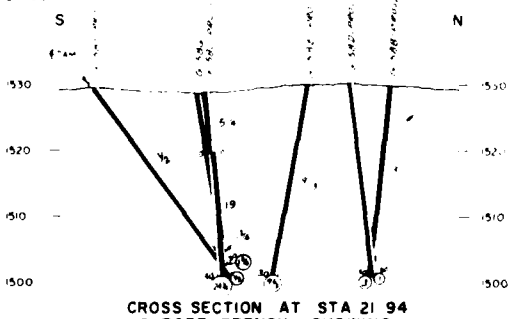


CROSS SECTION AT STA 14+13, CUTOFF TRENCH, SHOWING ADDITIONAL GROUT HOLES FOR SEALING SHEARS AND SURFACE LEAKS

SCALE IN FEET



NTER OF CUTOFF TRENCH
EMBANKMENT



CROSS SECTION AT STA 21 94 CUTOFF TRENCH, SHOWING ADDITIONAL GROUT HOLES FOR SEALING SHEARS AND SURFACE LEAKS

SCALE 1 IN = 10 FT

DATUM IS MEAN SEA LEVEL

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

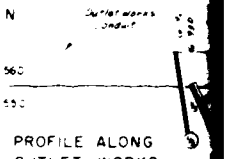
U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY
DRAWN BY
CHECKED BY

CAVE BUTTES DAM
FOUNDATION GEOLOGY
GROUTING DATA
PROFILES AND SECTIONS - SHEET I

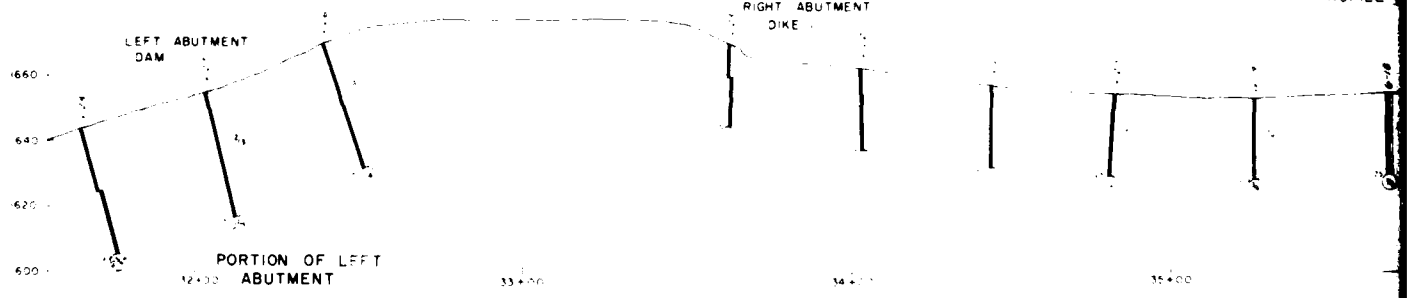
SUBMITTED BY: CHIEF, ____ BRANCH
APPROVED: CHIEF, ____ BRANCH
APPROVAL RECOMMENDED: CHIEF ENGINEERING DIVISION
SPEC. NO. DACW 09- ____ -
DISTRICT FILE NO.
DATE:
SHEET OF SHEETS

FOUNDATION REPORT 2 PLATE 57

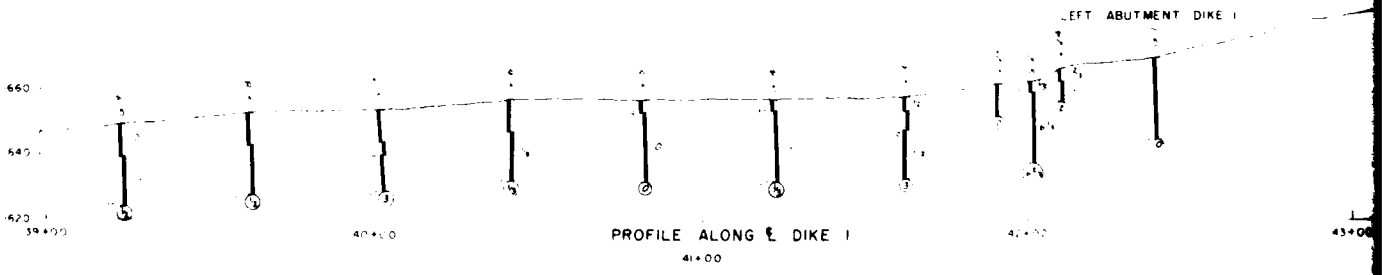


PROFILE ALONG OUTLET WORKS SHOWING GROUT HOLES DRILLED ALONG CONDUIT

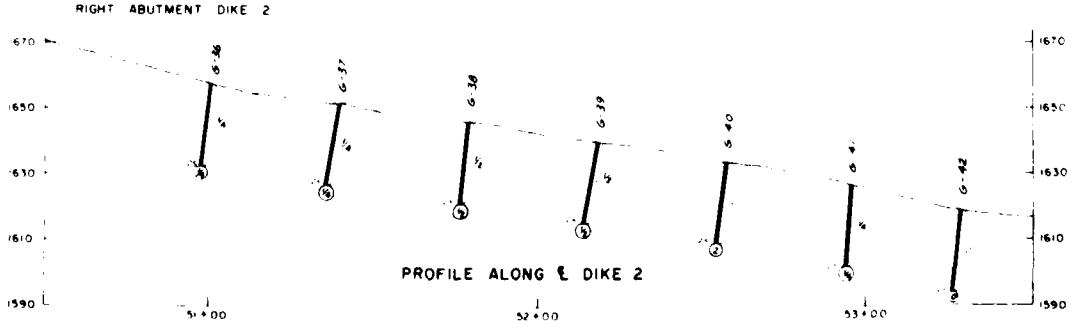
PROFILE



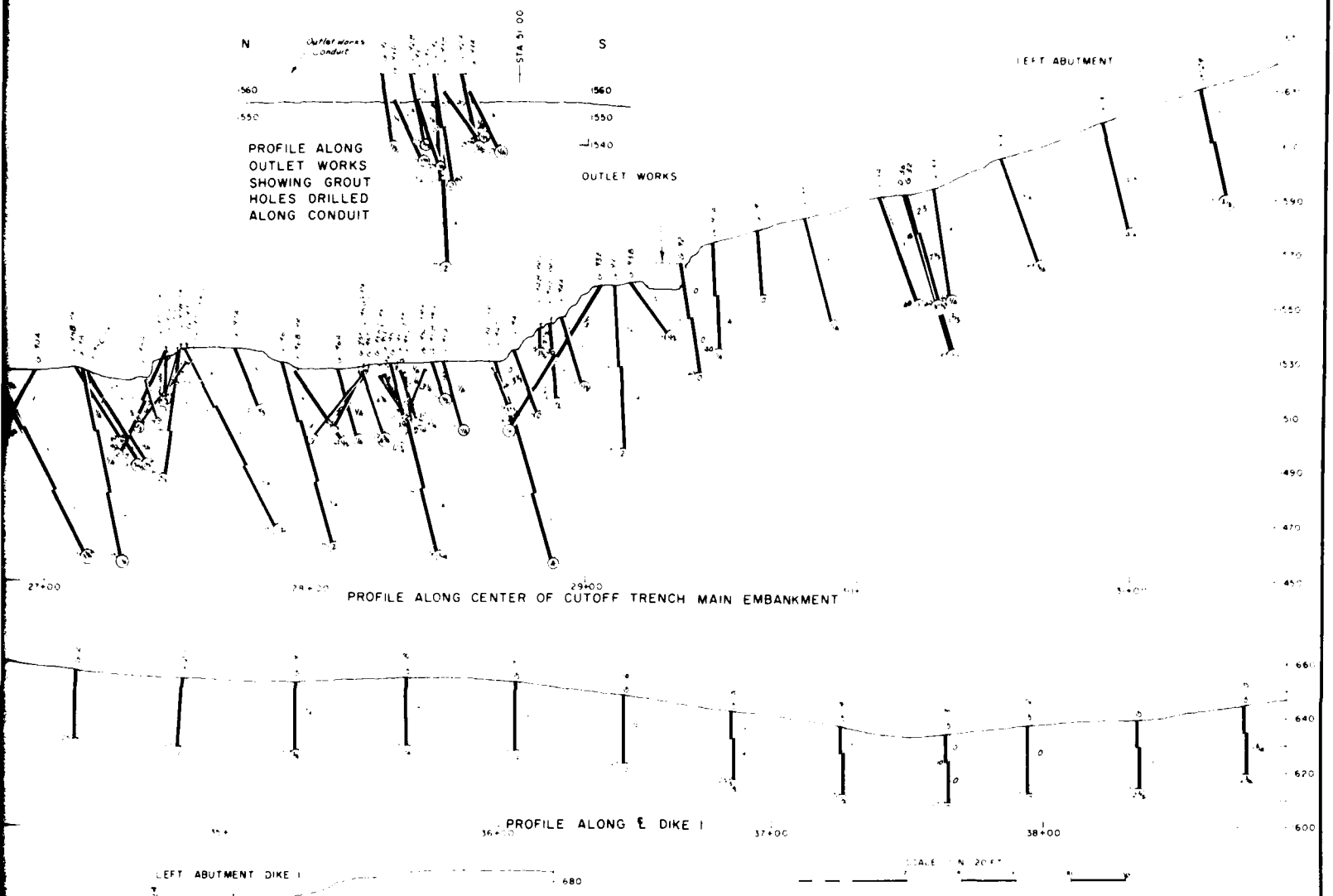
PORTION OF LEFT ABUTMENT

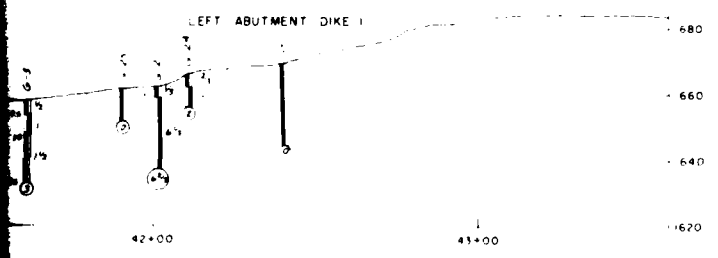


PROFILE ALONG ℄ DIKE 1



PROFILE ALONG ℄ DIKE 2



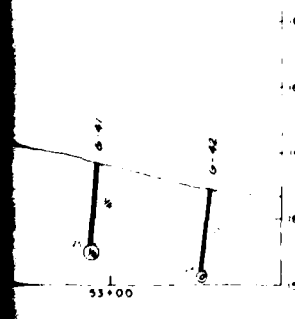


SCALE IN 20 FT

GENERAL NOTES

See Sheets 25 through 49 for plan showing grout hole locations and geology of foundation.
2 Apparent dips of grout holes determined by stereonet.
3 Holes drilled at angles to intersect greatest possible number of fissures thereby ensuring more effective grout curtain.
4 Volumes given refer to cement were generally limited to 7 sacks per stage except where surface leaks or large takes occurred.

LEGEND



Granite light gray to yellow, medium grained, moderately hard

Schist light gray to dark green, moderately hard

Basement Complex undifferentiated mostly greenstone with some serpentinite

Grout Hole
Right side number sacks cement placed
Left side number stage drilled depth
Circle total sacks cement placed

Fault dashed where approximate, dotted where inferred, queried where unknown. Arrows indicate directions of relative movement

DATUM IS MEAN SEA LEVEL

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

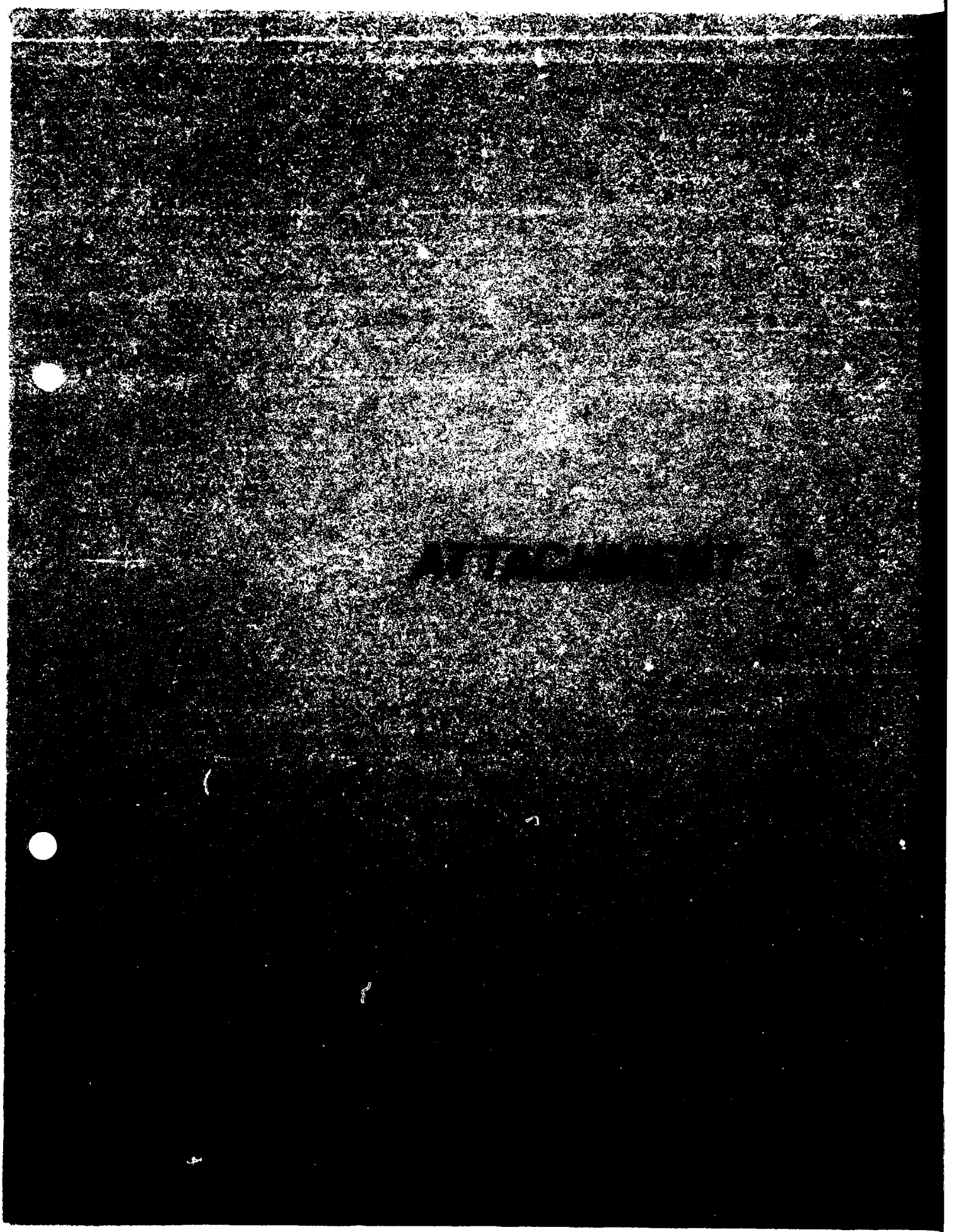
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY
DRAWN BY
CHECKED BY

CAVE BUTTES DAM
FOUNDATION GEOLOGY
GROUTING DATA
PROFILES AND SECTIONS - SHEET II

SUBMITTED BY: CHIEF, ENGINEERING DIVISION
APPROVED: COLONEL, CE, DISTRICT ENGINEER
APPROVAL RECOMMENDED: CHIEF, ENGINEERING DIVISION
SPEC NO DACW09-
DISTRICT FILE NO
DATE
SHEET OF SHEETS

FOUNDATION REPORT PLATE 58



CONTRACT QUANTITIES AND COSTS - CAVE BUTTES DAM

Item No.	Description	Estimated Quantity	Final Quantity	Unit	Unit Price	Total Amount
1	Diversion and Control of Water	1	100%	Job	L.S.	$ 60,000.00
1-A	Mobilization and Preparatory Work	1	100%	Job	L.S.	530,000.00
2	Clearing and Grubbing	1	100%	Job	L.S.	200,000.00
3	Stripping	299,000	291,638.47	C.Y.	.45	131,237.31
4	Scaling					
	a. First 100 C.Y.	100	100	C.Y.	100.00	10,000.00
	b. Over 100 C.Y.	200	352.01	C.Y.	90.00	31,680.90
5	Excavation, Abutment	64,000	95,803.89	C.Y.	4.00	383,215.56
6	Excavation, Foundation	313,000	416,576.48	C.Y.	1.00	416,576.48
7	Excavation, Foundation Trench	59,000	58,973.98	C.Y.	.50	29,486.99
8	Excavation, Cutoff Trench	146,000	259,486.49	C.Y.	1.50	389,229.73
9	Excavation, Dental					
	a. First 100 C.Y.	100	100	C.Y.	100.00	10,000.00
	b. Over 100 C.Y.	200	200	C.Y.	90.00	285,660.00
10	Excavation, Outlet	6,000	8,040.90	C.Y.	10.00	80,409.36
11	Excavation, Spillway	337,000	336,840.24	C.Y.	2.10	707,364.51
12	Excavation, Bypass Channel	160,200	139,637.35	C.Y.	1.50	209,456.03
13	Excavation, Drainage Channel	24,000	23,920.42	C.Y.	1.00	23,920.42

CONTRACT QUANTITIES AND COSTS - CAVE BUTTES DAM

Item No.	Description	Estimated Quantity	Final Quantity	Unit	Unit Price	Total Amount
13-A	Excavation, Outlet Works Channel	60,000	60,028.57	C.Y.	1.80	$ 108,051.42
14	Excavation, Roads	36,000	35,921.36	C.Y.	2.00	71,842.68
15	Excavation, Toe	22,600	22,471.34	C.Y.	2.00	44,943.68
16	Fill, Outlet Works	3,000	3,064.28	C.Y.	4.00	12,257.14
17	Fill, Roads	134,000	134,026.20	C.Y.	.75	100,519.65
18	Fill, Miscellaneous	131,000	131,000.00	C.Y.	.40	52,400.00
19	Embankment, Dam zone I	289,000	323,926.98	C.Y.	.85	275,368.53
20	Embankment, Dam zone II	1,262,600	1,362,224.64	C.Y.	.75	1,021,668.50
21	Embankment, Dam zone III	975,000	1,003,705.60	C.Y.	1.90	1,907,040.63
22	Embankment, Dikes zone II	710,000	710,107.34	C.Y.	.65	461,569.77
23	Embankment, Dikes zone III	270,000	270,185.56	C.Y.	2.00	540,371.13
24	Additional Rolling	500	497.70	HR.	50.00	24,885.00
25	Filter Material	6,900	6,835.39	C.Y.	4.00	27,341.57
26	Stone, Type I, Dam	32,300	32,143.90	TN.	4.00	128,575.60
27	Stone, Type I, Dikes	39,500	39,349.46	TN.	5.00	196,747.32
28	Riprap, Dam	65,450	65,375.76	TN.	3.00	196,127.27
29	Riprap, Dikes	75,580	75,487.26	TN.	4.00	301,949.06
30	Grouting, Stonework	1,020	1,033.04	C.Y.	30.00	30,992.23

CONTRACT QUANTITIES AND COSTS - CAVE BUTTES DAM

Item No.	Description	Estimated Quantity	Final Quantity	Unit	Unit Price	Total Amount
31	Concrete, Spillway Sill	600	598.62	C.Y.	50.00	$ 29,931.00
32	Outlet Works	1	1	Job	L.S.	200,000.00
33	Concrete, Dental					
	a. First 100	100	100	C.Y.	150.00	15,000.00
	b. Over 100	50	667.23	C.Y.	130.00	86,739.90
34	Grout, Slurry					
	a. First 100	100	100	C.F.	7.00	700.00
	b. Over 100	100	264	C.F.	6.00	1,584.00
35	Portland Cement	13,450	13,504.14	CWT.	3.00	40,512.43
36	Steel Reinforcement	18,000	18,087.37	LB.	.30	5,426.21
37	Foundation Drilling and Grouting					
	a. Mobilization and Demobilization	1	100%	Job	L.S.	15,000.00
	b. Drilling Exploratory Grout Holes	225	150	L.F.	30.00	4,500.00
	c. Drilling Grout Holes	6,850	9,347	L.F.	7.00	65,429.00
	d. Pipe for Grout Holes	420	763.5	L.F.	10.00	7,635.00
	e. Drill Set-ups	290	344	EA.	30.00	10,320.00
	f. Washing and Pressure Testing	135	143	HR.	85.00	12,155.00

CONTRACT QUANTITIES AND COSTS - CAVE BUTTES DAM

Item No.	Description	Estimated Quantity	Final Quantity	Unit	Unit Price	Total Amount
	g. Grout Pump Connections	270	378	EA.	20.00	$ 7,560.00
	h. Placing Grout	1,755	625.5	Sack	10.00	6,255.00
38	Double Drive Gate	3	3	EA.	1,000.00	3,000.00
39	Corrugated Metal Pipe Arch, 29x18-inch	152	153.10	L.F.	20.00	3,062.00
40	Metal End Sections for 20x18-inch CMP Arch	3	3.02	EA.	85.00	256.08
41	Corrugated Metal Pipe, 36-inch	564	627.24	L.F.	30.00	18,817.26
42	Metal End Section for 36-inch CMP	8	9	EA.	225.00	2,025.00
43	Corrugated Metal Pipe, 54-inch	56	56.37	L.F.	55.00	3,100.24
44	Metal End Section for 54-inch CMP	1	1	EA.	650.00	650.00
45	Reinforced Concrete Pipe, 108-inch	170	161.95	L.F.	250.00	40,488.50
46	Pipe Culvert Inlet and Outlet Structure	4	4	EA.	6,500.00	26,000.00
47	Aggregate Base and Surfacing	7,700	7,697.84	C.Y.	6.00	46,187.03
48	Asphalt Concrete Pavement	3,750	3,751.66	TN.	18.00	67,529.81
49	Traffic Control Devices	1	1	Job	L.S.	3,000.00
50	Guard Rail	110	110.70	L.F.	10.00	1,100.69
51	Water Surface Recording Facility	1	1	Job	L.S.	10,000.00
52	Instrumentation	1	1	Job	L.S.	5,000.00

CONTRACT QUANTITIES AND COSTS - CAVE BUTTES DAM

Item No.	Description	Estimated Quantity	Final Quantity	Unit	Unit Price	Total Amount
53	Overlook Structure and View Point Slab	1	1	Job	L.S.	$ 43,000.00
54	Overlook Restroom	1	1	Job	L.S.	30,000.00
55	Landscape Fill	19,000	18,954.74	C.Y.	3.50	66,341.58
56	Planting	1	1	Job	L.S.	1,500.00
57	Seeding	28	28	Acre	1,800.00	50,400.00
58	Project Sign	1	1	Job	L.S.	8,000.00
59	Topsoiling	21,000	20,991.58	C.Y.	2.00	41,983.15
					TOTAL	$9,981,076.36

CONTRACT QUANTITIES AND COSTS - CAVE BUTTES DAM

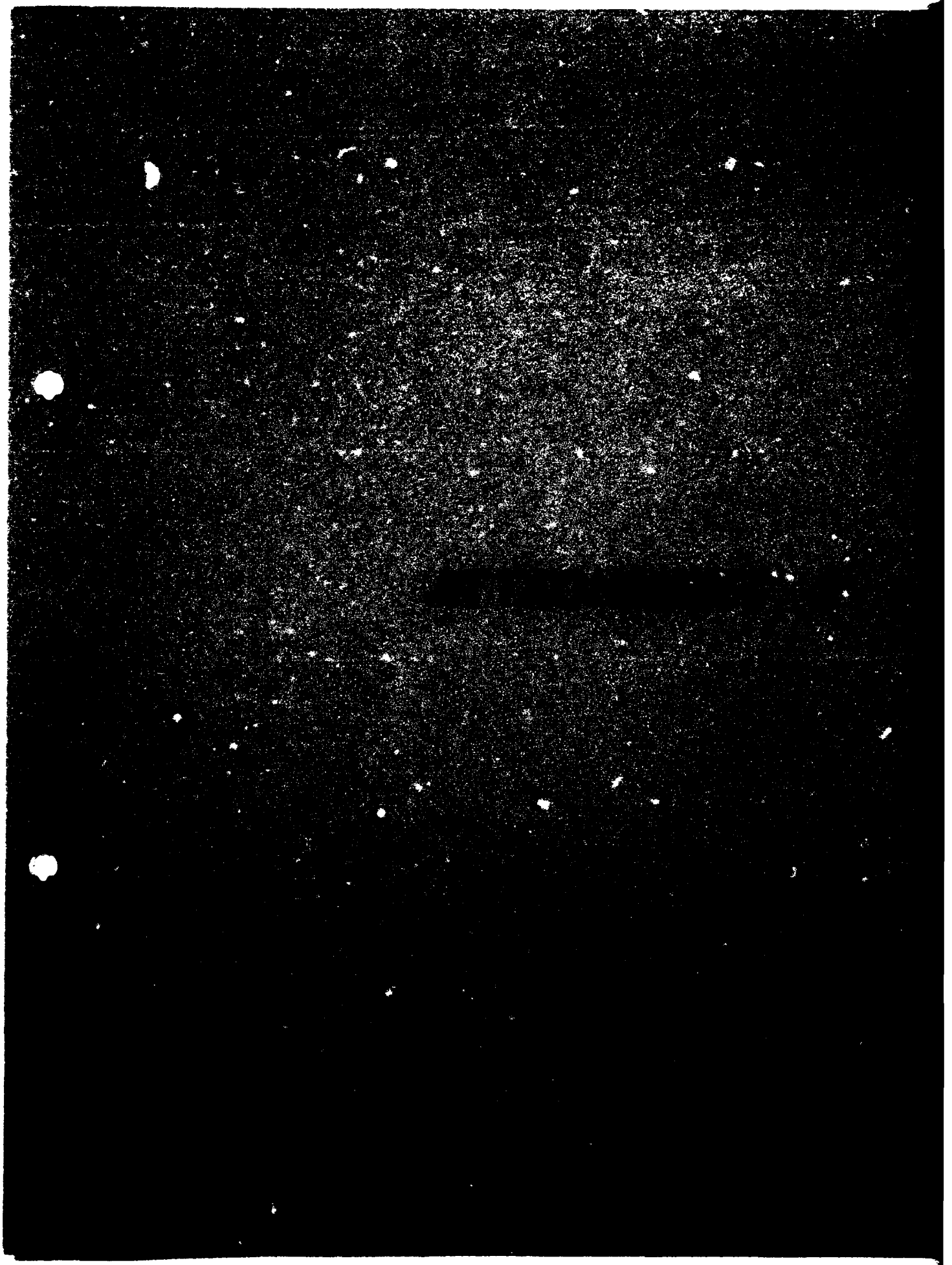
Item No.	Description	Estimated Quantity	Final Quantity	Unit	Unit Price	Total Amount
	MODIFICATIONS					
P00001	Part 2, Modify Outlet Works, dated 08 Aug 1980. No time.		100%	Job		$ 128,849.00
P00002	Flood Emergency Work, dated 25 Sept 78. Extended to 14 Sept 79.		100%	Job		42,470.00
P00003	Revise Overlook Road, dated 26 Sept 78.		100%	Job		12,087.00
P00004	Revise Scaling, dated 27 Sept 78. No time.		100%	Job		13,885.00
P00005	Temporary Overlook, dated 25 Apr 78. No time.			Job		-0-
P00006	Excavation Disposal and Seeding, dated 18 Aug 78. No time.			Job		-0-
P00007	Modify Cave Creek Road, dated 14 Sept 78. No time.		100%	Job		CR 906.00
P00008	Part 2, Revise Diversion and Control, dated 18 Jul 80. No time.		100%	Job		198,812.00
P00009	Part 2, Revise Cutoff Trench, dated 20 Jul 80. No time.		100%	Job		256,647.00
P000010	Part 2, Repair Abutments, dated 16 Nov 78. No time		100%	Job		1,538,451.00
P000011	Part 2, Excavate Core Material, dated 6 Aug 80. No time.		100%	Job		56,141.00

CONTRACT QUANTITIES AND COSTS - CAVE BUTTES DAM

Item No.	Description	Estimated Quantity	Final Quantity	Unit	Unit Price	Total Amount
P000012	Part 2, Modify Concrete Plug, dated 28 Jul 80. No time.		100%	Job		35,736.00
P000013	Revise Cave Creek Detour, dated 26 Feb 79. No time.		100%	Job		730.00
P000014	Change Measurement of Stone, dated 28 Feb 79. No time.		100%	Job		-0-
P000015	Admin. Change to P00007, dated 8 May 79. No time.		100%	Job		-0-
P000016	Install Barriers on Cave Creek Dam, dated 8 Sept 79. No time.		100%	Job		4,717.00
P000017	Concrete Pad and Canopy, dated 8 May 79. No time.		100%	Job		10,770.00
P000018	Grouted Stone - Outlet Channel, dated 30 Oct 79. No time.		100%	Job		7,381.00
P000019	Office Trailers and Accessories, dated 27 Jul 79. No time.		100%	Job		19,045.00
P000020	Part 2, Impact Claim, dated 17 Sept 80. No time.		100%	Job		2 458,162.00
P000021	Clean-up Borrow Area #4, dated 21 Jul 79. No time.		100%	Job		14,862.00
P000022	Misc. Changes, dated 22 Jul 80. No time		100%	Job		24,685.00
P000023	Prepare and Slot Work, dated 23 Jul 80. No time.		100%	Job		80,644.00

CONTRACT QUANTITIES AND COSTS - CAVE BUTTES DAM

Item No.	Description	Estimated Quantity	Final Quantity	Unit	Unit Price	Total Amount
P000024	Remove ramps, dated 24 Jul 80. No time.		100%	Job		50,169.00
P000025	Modify Overlook Road, dated 25 Jul 80. No time.		100%	Job		21,091.00
P000026	Excess Cost, Dike #2, dated 4 Sept 80. No time.		100%	Job		157,006.00
P000027	Clean-up Borrow Area #1, dated 29 Jul 80. No time.		100%	Job		33,346.00
P000028	Fill zone 3 Pit, dated 30 Jul 80. No time		100%	Job		42,595.00
P000029	Extra Well Costs, dated 29 Jul 80. No time.		100%	Job		50,000.00
P000030	Misc. Work on Overlook Road, dated 1 Aug 80. No time.		100%	Job		24,458.00
P000031	Relocate Office Trailers, dated 4 Aug 80. No time.		100%	Job		19,060.00
P000032	Flood Damage and Quantity Variations, dated 16 Sept 80. No time.		100%	Job		41,969.56
P000033	Backfill Borrow Area #2, dated 1 Oct 80. No time.		100%	Job		60,000.00



DAM FOUNDATION GROUTING SUMMARY

"REMARKS" CODES AND NOTES

REMARKS

1. Hole caving.
2. No pressure test due to excess surface leaks.
3. First stage tight (less than 0.5 GPM take during pressure test), deferred grouting to next stage.
4. No pressure test at stage indicated.
5. Slight water seepage from nearby surface cracks during pressure test.
6. Slight grout leak at surface in area near hole, unless location otherwise stated.
7. Water and grout from nearby surface cracks during grouting.
8. Grouting done through wash rods and then through nipple.
9. Hole tight, filled with thick grout mix by hand.

NOTES

1. Offsets are measured left (upstream) of dam centerline, except where otherwise indicated.
2. Pressures are measured at hole collar (1 to 2 feet above the ground surface).
3. K values are measured to the nearest 0.1 ft./day.
4. Holes 92A through 93D (7 holes) were contact grout holes behind the concrete plug in the outlet conduit.

CAVE BUTTES DAM ARIZONA — FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
RIGHT ABUTMENT														
43	10+06	2.4L	1662.5	83	S63W	0-20	4/14/78	8.2	1.1	20	1/3	20	4:1-5:1	
						20-40	4/19/78	11.5	.7	40	2-3/4	40	5:1	
44	10+46	6.0L	1646.5	84	S75W	0-20	4/14/78	15.2	2.1	15	2-1/3	15	4.5:1-4.1	
						20-40	4/19/78	3.1	.2	40	1/2	40	5:1	
45	10+85	10.9L	1638.5	80	S50W	0-20	4/14/78	12.4	1.7	20	1-1/2	20	6:1-4.5:1	
						20-40	4/19/78	15.4	1.0	40	1-3/4	40	5:1	
46	11+30	9.0L	1628.5	83	W	0-20	4/14/78	0	0	20	1/4	20	5:1	
						20-40	4/19/78	0	0	40	1/4	40	5.1	
47	11+61	11.7L	1623.	86	S50W	0-20	4/14/78	3.6	.5	20	1/4	20	5.1	
						20-40	4/19/78	0	0	40	1/4	40	5.1	
48	11+97	15.0L	1620.5	84	S84W	0-20	4/14/78	0	0	20	1/4	20	5.1	
						20-40	4/19/78	0	0	40	1/3	40	5.1	
49	12+36	16.9L	1615.	83	S80W	0-20	4/14/78	8.6	1.2	20	1-1/3	20	5.5:1-5:1	
						20-40	4/19/78	9.3	.6	40	1-1/2	40	5:1	
50	12+75	20.3L	1604.5	80	S80W	0-20	4/14/78	4.3	.6	20	2/3	20	6.1	
						20-40	4/19/78	17.8	1.1	40	1-1/4	40	5:1-4:1	

CAVE BUTTES DAM ARIZONA—FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
51	13+07	26.7L	1592.5	72	S85W	0-40	4/24/78	22.5	.9	40	1-1/4	40	3:1-5:1	3
54	13+17	26.8L	1585.5	70	N80W	0-30	4/25/78	12.3	.6	30	1-1/3	25	5.1	3
53	13+22	27.8L	1582.	77	N68W	0-40	4/24/78	19.2	1.0	30	4-3/4	10	3.1-1.1	5,3
55	13+28	28.4L	1576.5	71	W	0-15	4/25/78	1.7	.4	15	1/4	15	5:1	
							4/27/78	0	0	30	0	30	5.1	
52	13+39	25.4L	1565.	80	N76W	0-40	4/24/78	23.0	.9	40	5.0	40	5.1	3
CUTOFF TRENCH														
80A	13+53	29.6L	1552.	78	S11W	0-25	7/17/78	0	0	15	0	20	7.5:1	
80	13+65	26.6L	1554.5	73	S11E	0-30	6/17/78	0	0	15	0	20	7.5:1	
						30-60		0	0	45	0	45	7.5:1	
79A	13+78	25.9L	1552.	66	S23E	0-25	6/17/78	0	0	15	0	20	7.5:1	
79	13+97	26.2L	1546.5	72	S76W	0-25	6/14/78	0	0	15	0	15	6:1	
						25-50	6/16/78	0	0	25	0	25	4.4:1	
						50-75	6/17/78	0	0	45	0	50	6:1	
79C	14+03	4.7L	1541.	52	S71E	0-30	4/16/78	0	0	10	2/3	20	4.4:1	
79B	14+09	10.5L	1540.5	62	N87E	0-25	4/16/78	4.8	1.3	5	1-1/4	15	3:1	5, from nearby seep area

CAVE BUTTES DAM ARIZONA — FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
79D	14+10	2.0L	1538.	69	N07E	0-15	6/17/78	2.0	1.0	5	1	15	3:1-2.8:6	7, from nearby seep area
79F	14+17	12.4L	1539.	62	S67E	0-15	6/24/78	0	0	15	1/4	15	8:1	5
79G	14+18	10.6L	1538.5	70	S05E	0-15	6/24/78	0	0	15	0	15	8:1	
79E	14+20	19.1L	1539.	66	S57E	0-15	6/24/78	.2	.1	10	1/4	15	8:1-6:1	
78	14+24	26.2L	1540.	80	S62W	0-25	6/14/78	1.0	.2	10	1-1/4	15	6:1	
77E	14+29	16.6L	1537.	54	N64E	0-25	6/24/78	6.9	1.0	15	2-1/3	15	8.1:2:1	5,6
77I	14+30	19.5L	1537.5	48	N37E	0-15	6/26/78	3.6	1.2	10	3/4	20	6.1-3.8:1	5
77D	14+34	25.4L	1537.5	66	N88E	0-20	6/24/78	3.3	.6	10	1/2	20	6:1	5,6
77H	14+37	34.0L	1538.5	59	N66E	0-15	6/24/78	1.6	.5	10	1/3	15	6.1	5
77G	14+41	36.6L	1538.	80	S	0-15	6/26/78	2.5	.8	10	1/4	10	6:1	5,6 and Hole 77G
77A	14+41	26.7L	1537.	76	N81W	0-25	6/16/78	4.4	.6	15	1-1/2	15	1:1-3:1	5
77C	14+44	23.4L	1536.	58	S83W	0-20	6/24/78	0	0	15	0	20	8:1	

CAVE BUTTES DAM ARIZONA — FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
77F	14+45	34.3L	1538.	55	N85W	0-15	6/26/78	1.1	.6	5	1-1/4	15	6:1-	5,6 at 77G
													4:1	
77B	14+49	28.2L	1538.5	60	S70E	0-25	6/17/78	0	0	15	0	15	6:1	
77	14+57	26.5L	1536.5	76	N80W	0-25	6/14/78	0	0	15	0	15	6:1	
						25-50	6/16/78	0	0	25	1/2	30	5:1	
						50-75	6/17/78	0	0	15	1/3	40	3:1-	
													6:1	
76A	14+71	32.4L	1535.	vert	----	0-25	6/15/78	0	0	15	0	25	5.1	
76	14+93	28.4L	1537.	vert	----	0-25	6/14/78	12.1	2.2	10	2-1/3	15	2:1-	5
													3.1	
						25-50	6/15/78	7.1	.4	35	2	25	4:1-	
													2.5:1	
						50-75	6/16/78	0	0	55	1/4	50	5:1	
75A	15+12	29.3L	1538.5	vert	----	0-25	6/14/78	0	0	15	0	15	5:1-	
													6:1	
75	15+33	30.5L	1540.5	vert	----	0-25	6/14/78	5.3	.7	15	2/3	15	5:1	
						25-50	6/15/78	0	0	35	1/3	30	6:1	
						50-75	6/16/78	0	0	55	1/4	50	5.1	
74A	15+53	33.4L	1544.5	vert	----	0-25	6/14/78	4.9	.7	15	1/3	15	5:1	
74	15+72	33.7L	1544.	vert	----	0-25	6/06/78	0	0	15	1/4	15	6:1	
						25-50	6/08/78	0	0	40	1/4	40	6:1	
						50-75	6/09/78	0	0	55	1/4	50	6:1	

CAVE BUTTES DAM ARIZONA — FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
73C	15+83	34.5L	1542.5	69	N81E	0-15	6/17/78	1.6	.5	10	1-1/3	10	3:1-	5,6
													1:1	
73A	15+19	35.1L	1542.	vert	----	0-25	6/06/78	9.9	2.7	5	5-1/2	15	6:1-	
													3:1	
73B	16+00	34.0L	1540.	65	S75W	0-15	6/17/78	2.1	.7	10	1/3	15	3:1	
73	16+10	36.7L	1537.5	86	N47W	0-25	6/06/78	9.8	1.4	15	1.2	15	3.1	
						25-50	6/08/78	0	0	40	0	40	6:1	
						50-75	6/19/78	0	0	55	0	50	6:1	
72A	16+28	39.3L	1535.5	vert	----	0-25	6/06/78	5.1	.9	10	2/3	15	6:1	
72C	16+37	37.6L	1535.	62	N65E	0-25	6/12/78	6.8	1.2	10	1	15	1:1	
72	16+46	40.1L	1534.5	vert	----	0-25	6/06/78	10.2	2.8	5	22-1/2	5	1:1	6 from shear
						25-50	6/08/78	5.0	.3	30	2/3	30	2:1-	
													4:1	
						50-75	6/12/78	2.4	.1	20	3/4	50	2:1-	
													3:1	
72B	16+54	42.4L	1536.5	70	S58W	0-25	6/12/78	0	0	10	1/4	20	6:1	
71A	16+67	41.4L	1535.5	87	S75E	0-25	6/02/78	0	0	15	0	15	5.1	
71	16+87	42.3L	1535.	86	N82W	0-25	6/02/78	0	0	15	1/4	10	5.1	
						25-50	6/06/78	0	0	35	0	25	6.1	
						50-75	6/12/78	0	0	50	0	55	6.1	

5

CAVE BUTTES DAM ARIZONA—FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
70A	17+07	39.8L	1535.	vert	----	0-25	6/02/78	5.5	.8	15	1/2	15	5:1	5,8
70	17+27	38.3L	1534.	vert	----	0-25	6/02/78	0	0	15	1/4	15	5:1	
						25-50	6/06/78	12.2	.7	35	1/4	30	6:1	
													3:1	
						50-75	6/12/78	3.3	.1	45	1/3	50	3:1	
69A	17+48	37.5L	1532.5	vert	----	0-25	6/07/78	7.0	1.3	10	1-3/4	15	4:1	5
69	17+67	38.7L	1533.	88	N68E	0-25	6/02/78	13.0	1.8	15	8	10	3:1	5,6
													1:1	
						25-50	6/07/78	0	0	40	1/4	35	5:1	
						50-75	6/12/78	0	0	55	1/4	55	6.1	
68A	17+87	39.5L	1532.	vert	----	0-25	6/02/78	0	0	15	1/4	15	1:1	
													4:1	
68	18+08	39.7L	1530.5	89	S34W	0-25	6/02/78	0	0	15	1/4	15	4:1	
						25-50	6/07/78	4.7	.3	30	1	30	2:1	6
													3:1	
						50-75	6/12/78	4.2	.2	30	1/4	55	3:1	5
													4:1	
67C	18+17	44.6L	1530.	66	S80E	0-20	6/12/78	6.0	1.4	10	3/4	15	6:1	5,6
													3:1	
67A	18+26	40.2L	1529.	82	N60W	0-25	6/07/78	3.5	1.0	5	4-1/4	3	1:1	5,6
						25-50	6/12/78	0	0	25	0	25	6.1	
67B	18+40	33.7L	1529.	67	N60W	0-20	6/12/78	0	0	15	0	15	6:1	

CAVE BUTTES DAM ARIZONA—FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
67	18+46	39.4L	1530.	87	S70W	0-25	6/02/78	0	0	15	1.0	15	4:1	
						25-50	6/07/78	0	0	40	1/3	40	5:1	
						50-75	6/12/78	0	0	55	1/4	55	6:1	
66A	18+68	39.6L	1530.5	vert	----	0-25	6/02/78	5.4	.8	15	1-1/4	15	5:1-	5,6 from
													3:1	nearby shear
66	18+86	39.4L	1530.5	vert	----	0-25	5/09/78	5.6	.6	20	1-1/4	20	2.5:1-	6
													1:1	
						25-50	5/12/78	15.2	.8	35	2-3/4	50	5:1	6
						50-75	5/16/78	9.8	.3	60	1/2	25	5:1-	6
													2:1	
65A	19+06	39.6L	1530.5	vert	----	0-25	5/16/78	0	0	15	1/3	15	5:1	
65	19+25	40.6L	1530.5	88	S13E	0-25	5/09/78	3.4	.3	25	1/2	25	5:1	
						25-50	5/12/78	0	0	40	1/4	50	5:1	
						50-75	5/16/78	0	0	60	1/4	55	5:1	
64A	19+49	39.4L	1530.5	87	S47E	0-25	5/16/78	6.6	1.2	10	1	25	5:1-	6
													2:1	
64	19+65	38.5L	1530.0	87	S67W	0-25	5/09/78	6.1	.8	15	1/2	25	2:1	6
						25-50	5/12/78	0	0	35	1/4	35	2:1-	
													4:1	
						50-75	5/16/78	0	0	55	3/4	60	2:1-	
													5.5:1	
63A	19+86	39.9L	1530.	vert	----	0-25	5/19/78	4.2	.6	15	1/2	25	4.5:1	6

CAVE BUTTES DAM ARIZONA—FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
63	20+05	42.0L	1529.5	vert	----	0-25	5/09/78	0	0	25	2-3/4	20	5:1-1:1	6
						25-50	5/12/78	3.3	.3	20	1-1/3	40	1:1-2:1	6
						50-75	5/19/78	0	0	50	1/4	35	4.5:1	
62A	20+25	42.5L	1530.5	88	N70W	0-25	5/19/78	0	0	20	1/2	20	4.5:1	
62B	20+36	36.7L	1532.5	66	N60W	0-30	5/24/78	0	0	25	0	20	4.1	
62	20+44	42.3L	1530.5	vert	----	0-25	5/09/78	0	0	25	0	25	5:1	
						25-50	5/12/78	0	0	40	1/4	50	4.5:1-6:1	
						50-75	5/19/78	1.8	.1	50	3/4	50	1:1-3:1	
62C	20+49	41.9L	1532.	55	S47E	0-20	5/24/78	0	0	15	2	15	4:1	6
						20-40	5/26/78	0	0	15	1/4	10	2:1-3:1	
62E	20+53	44.6L	1533.	64	N65E	0-30	5/26/78	0	0	10	1/3	10	3:1	
62F	20+53	28.0L	1529.5	57	N42E	0-35	5/26/78	0	0	10	1/4	10	1.5:1-2:1	
62D	20+59	43.2L	1531.5	87	S27E	0-30	5/24/78	6	.7	15	1/4	15	1.5:1	5
61A	10+66	43.7L	1529.	vert	----	0-25	5/19/78	17.5	2.4	15	8-1/4	5	2:1-1:1	6
						25-35	5/24/78	5.6	1.2	15	3	5	2:1	6 at 61C

CAVE BUTTES DAM ARIZONA — FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
61C	20+67	40.4	1529.	81	S64E	0-25	5/23/78	10.2	1.4	15	2-1/3	10	1:1	6 at 61A
61D	20+73	29.7L	1529.5	63	N77W	0-25	5/26/78	6.0	.8	15	1-3/4	5	1.5:1	6 at 61A
61B	20+79	45.3L	1531.5	76	N88W	0-35	5/24/78	4.1	.5	10	1/4	15	1.5:1	5
61	20+84	45.0L	1531.	vert	----	0-25	5/05/78	1.8	.2	25	3-3/4	20	8:1-	8,6
													1.5:1	
						25-40	5/11/78	--	--	30	3/4	35	2:1-	6
													5:1	
						40-75	5/16/78	6.0	.2	35	1	50	5:1	
60A	21+05	42.5L	1531.5	vert	----	0-25	5/16/78	0	0	15	0	15	5:1	
60	21+24	45.7L	1530.5	vert	----	0-25	5/05/78	0	0	25	0	25	5:1	
						25-50	5/11/78	9.6	.4	60	1	10	4:1-	
													1.5:1	
						50-75	5/16/78	0	0	25	1/2	50	3:1-	
													5:1	
59C	21+39	46.3L	1529.5	65	S67E	0-30	5/23/78	0	0	25	1-3/4	25	5:1-	8
													2:1	
59A	21+45	44.4L	1529.5	vert	----	0-25	5/16/78	.6	.2	5	1-3/4	15	1.6:1	8,6
59E	21+50	30.3L	1529.5	63	N11W	0-25	5/26/78	0	0	10	1/4	10	1.4:1-	
													3:1	
59F	21+51	27.2L	1529.	63	N76E	0-30	5/26/78	2.7	.4	10	1/2	10	3:1	

CAVE BUTTES DAM ARIZONA—FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
59B	21+54	40.3L	1520.4	vert	----	0-25	5/23/78	2.7	.5	10	1-1/4	20	2:1-	5,8,6
													3.4:1	
59	21+66	43.4L	1529.5	vert	----	0-20	5/05/78	0	0	25	2-1/4	25	5:1-	8
													1:1	
						20-50	5/11/78	5.0	.4	15	2-1/2	5	4:1-	8
													1.5:1	
						50-75	5/16/78	0	0	30	2-1/2	30	1:1-	
													3:1	
59G	21+70	35.3L	1529.	59	S77W	0-30	5/26/78	4.6	.7	10	3	10	3:1-	
													1.8:1	
59D	21+70	38.9L	1529.	55	N54W	0-35	5/23/78	0	0	25	2-1/4	25	5:1-	8
													2:1	
59H	21+82	46.4L	1529.5	66	N71E	0-35	5/26/78	0	0	10	1/4	10	3:1	
58	21+85	43.9L	1530.	vert	----	0-25	5/05/78	0	0	25	1/3	15	4.5:1	
						25-50	5/11/78	2.5	.1	40	1/4	35	2:1	
						50-75	5/19/78	3.6	.2	20	1	20	2:1	
58G	21+87	16.6L	1528.5	60	N73E	0-30	5/30/78	4.6	.7	10	1-3/4	10	2:1	
58B	21+89	46.0L	1529.5	73	S70E	0-25	5/23/78	1.0	.2	10	3	5	5:1-	5,6
													1.1	
58F	21+94	2.0L	1529.5	54	N	0-35	5/30/78	0	0	10	1/2	15	3:1	

CAVE BUTTES DAM ARIZONA—FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
58C	22+01	17.7L	1529.	68	N67W	0-10	5/23/78	--	--	--	5-1/4	5	1:1-	6
													5:1	
						10-30	5/26/78	9.6	1.7	10	19	5	2:1-	
													1:1	
58D	22+01	39.7L	1530.5	76	N57W	0-30	5/23/78	9.0	1.3	10	1	25	1:1-	
													2:1	
58E	22+02	33.4L	1530.	64	S23W	0-30	5/30/78	3.5	.5	10	9-1/3	15	1:1	
58	22+04	43.9L	1530.	vert	----	0-25	5/05/78	0	0	25	1/3	15	4.5:1	
						25-50	5/11/78	2.5	.1	40	1/4	35	2:1	
						50-75	5/19/78	3.6	.2	20	1	20	2:1	
57B	22+23	38.7L	1530.	vert	----	0-25	5/23/78	0	0	15	1/4	20	5:1	
57A	22+25	43.3L	1529.	vert	----	0-25	5/19/78	0	0	20	2/3	20	5:1	
57D	22+37	39.9L	1529.	vert	----	0-25	5/25/78	4.0	1.1	5	3	5	2:1-	
													1:1	
						25-50	5/30/78	1.3	.1	10	1/4	15	2:1	8
57	22+43	41.4L	1527.5	vert	----	0-15	5/05/78	10.0	5.2	5	2-2/3	15	1.5:1	5
						15-50	5/11/78	0	0	35	4-3/4	40	3:1-	
													1.5:1	
						50-75	5/19/78	2.9	.2	15	3	5	2.5:1-	
													1:1	
57C	22+50	35.3L	1529.	vert	----	0-25	5/25/78	0	0	10	2	15	2:1	8
						25-50	5/30/78	3.6	.4	10	3/4	15	2:1	

CAVE BUTTES DAM ARIZONA—FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
56A	22+62	35.4L	1528.5	vert	----	0-25	5/19/78	0	0	15	0	20	5:1	
56	22+83	43.4L	1528	vert	----	0-25	5/05/78	0	0	25	1-2/3	25	5:1	
						25-50	5/11/78	3.6	.4	10	3/4	35	5:1	8
						50-75	5/19/78	0	0	10	2-3/4	5	2.5:1	
81B	23+01	40.9L	1528.	vert	----	0-25	6/27/78	13	2.4	10	1	15	2:1	6 at shear
81D	23+12	41.3L	1529.	69	S72E	0-25	7/07/78	0	0	15	1/3	15	6:1	
81	23+21	41.9L	1529.	74	N26W	0-25	6/28/78	1.8	.5	5	16-1/3	5	4:1-1:1	5,6
						25-50	6/30/78	11.0	.9	20	1/2	30	1:1	5
						50-75	7/11/78	0	0	45	0	55	6:1	
81C	23+21	42.8L	1529.	81	S52W	0-25	7/07/78	3.6	.5	15	2-3/4	15	2:1	5,6 and 7 at 81D
81A	23+41	40.7L	1529.	vert	----	0-25	6/28/78	4.0	.6	15	1/3	20	4:1-1:1	
82	23+61	39.7L	1528.5	87	N63W	0-25	6/28/78	0	0	15	0	15	5:1	
						25-50	6/30/78	0	0	30	0	35	6:1	
						50-75	7/11/78	0	0	55	0	55	6.5:1	
82C	23+73	38.4L	1527.	76	N49E	0-25	7/07/78	0	0	15	0	15	6:1	
82A	23+82	42.2L	1526.	83	S	0-25	6/27/78	4.4	.8	10	14-1/2	10	2:1-1:1	6 and at nearby shears

12

CAVE BUTTES DAM ARIZONA — FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
82B	23+87	53.5L	1528.	59	S6E	0-25	7/07/78	2.0	.3	15	1-1/2	15	3:1	5,6
83	24+02	37.9L	1526.	76	S20E	0-25	6/27/78	4.4	.6	15	0	15	2:1	
						25-50	6/30/78	4.3	.3	20	1	25	3:1-2:1	5,6 at shear 4ft. SE
						50-75	7/11/78	0	0	45	1/4	55	6.5:1	
83A	24+21	37.0L	1528.	vert	----	0-25	6/28/78	.5	.1	15	0	15	5:1	
84	24+41	39.3L	1528.	75	N5E	0-25	6/28/78	0	0	15	1/3	15	5:1	6
						25-50	6/30/78	8.5	.5	30	1/2	30	3:1	5,6
						50-75	7/11/78	1.6	.1	35	1/3	40	6.5:1	
84C	24+54	35.1L	1528.5	68	S42E	0-25	7/07/78	9.6	2.5	15	1/4	15	6:1	
84A	24+62	38.2L	1529.	79	S28E	0-25	6/27/78	2.8	.8	5	7	15	2:1-1:1	5,6 at nearby shear
84B	24+70	39.0L	1529.	66	S7E	0-25	7/07/78	9.6	2.6	5	10	10	3:1-1:1	5,6
85	24+82	37.6L	1527.5	74	S28E	0-25	6/29/78	0	0	15	1/4	15	5:1	5,6 at 85A
						25-50	7/06/78	7.2	.4	35	1/4	35	5.5:1	5,6
						50-75	7/12/78	3.5	.3	10	1/2	40	4:1	
85A	24+99	39.7L	1526.	64	S33E	0-25	6/29/78	4.5	1.2	5	1-3/4	15	1:1	5,6
86	25+23	43.1L	1526	73	S6E	0-25	7/06/78	2.4	.2	15	1/3	15	5.5:1-2.5:1	5,6
						25-50	7/06/78	2.4	.2	15	1-3/4	25	5.5:1	5,6 and shears 2 to 4ft. away

13

CAVE BUTTES DAM ARIZONA—FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
86	(CONTINUED)					50-75	7/12/78	6.9	.5	15	1/4	45	4:1	
86A	25+23	39.5L	1527.	81	S35W	0-25	6/29/78	7.5	1.0	15	3/4	15	1:1	5,6
87	25+58	39.8L	1527.	80	S25E	0-25	6/29/78	5.7	1.5	5	1/4	15	1:1	
						25-50	7/06/78	9.2	.8	15	1/4	35	5.5:1	
						50-75	7/12/78	8.0	.7	5	1-1/3	30	2:1	5,6
87A	25+78	37.9L	1526.	70	S36E	0-25	6/29/78	0	0	15	0	15	5:1	
88	26+02	34.4L	1527.	78	S40E	0-25	6/29/78	0	0	15	0	15	5:1	
						25-50	7/05/78	0	0	35	1/4	35	6.5:1	
						50-75	7/07/78	0	0	55	1/4	55	6:1	
88A	26+24	35.6L	1526.5	71	S44E	0-25	6/29/78	2.0	.5	5	1-3/4	15	2:1	5
89	26+42	35.6L	1526.5	80	S52E	0-25	6/29/78	1.4	.2	15	1	15	3.1	5,6-5' to joint
						25-50	7/05/78	1.1	.1	25	2/3	35	6.5:1	
						50-75	7/07/78	3.0	.1	35	1/4	55	6:1	
89A	26+63	36.8L	1526.5	78	S52E	0-25	6/29/78	2.9	.4	15	1	15	3:1	5-15'south from hole
90	26+81	39.3L	1526.5	62	S74E	0-25	7/06/78	2.6	.5	10	1/2	15	5:1	
						25-50	7/07/78	0	0	35	1/3	35	6:1	
						50-75	7/12/78	0	0	45	3	35	5:1-1.5:1	6

CAVE BUTTES DAM ARIZONA—FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
90A	26+97	38.3L	1526.5	56	S53W	0-25	7/12/78	0	0	15	1/3	15	5.5:1	
78B	27+12	41.5L	1527.5	56	S81E	0-30	8/04/78	5.5	1.2	5	2/3	15	4:1	
						30-40	8/07/78	1.1	.1	35	0	30	6:1	
98	27+14	36.7L	1526.5	64	S25E	0-25	7/29/78	0	0	15	1/4	15	6.5:1	
						25-50	8/01/78	4.3	.2	40	1/4	40	5:1	
						50-75	8/04/78	3.3	.2	25	3/4	45	5:1	
98C	27+15	26.0L	1527.	56	S82E	0-30	8/04/78	7.5	1.1	10	1-1/3	15	3.5:1-2.5:1	5
						30-40	8/07/78	1.6	.2	30	1/4	30	5:1	
98A	27+34	41.7L	1524.	87	S77E	0-25	7/29/78	0	0	15	0	20	6.5:1	
97C	27+45	47.5L	1534.5	64	S68W	0-20	8/02/78	4.4	1	10	2/3	20	6:1-3:1	5 on rock face below
						20-40	8/04/78	6.2	.9	10	1-1/3	20	6:1-3:1	
97E	27+45	36.0	1532.5	60	S5W	0-15	8/09/78	4.0	1.3	10	1	10	4:1	5-8' SSW at base of cut slope
97F	27+49	30.8L	1534.	66	S41W	0-17	8/09/78	0	0	10	2/3	15	5.5:1-4:1	
97B	27+50	40.7L	1534.5	59	S13W	0-40	8/02/78	9.1	.7	15	1-1/3	15	3:1	3,6 at 98A

15

CAVE BUTTES DAM ARIZONA—FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
97B	(CONTINUED)					40-60	8/04/78	5.5	.5	15	1	35	5:1	
97D	27+52	16.5L	1530	48	N57W	0-15	8/02/78	---	--	--	1/2	15	2:1	2,5,6
						15-27	8/04/78	---	--	--	2	10	5:1-	2,5,6
													3:1	
						0-20	8/07/78	6.7	2.4	5	1	10	5.3:1-	re-drill and
													3.5:1	re-grout
97	27+53	38.5L	1535.	59	S66E	0-25	7/29/78	2.7	.4	15	1/4	15	6.5:1	
						25-50	8/01/78	6.5	.6	15	1/2	40	5.5:1	5
						50-75	8/02/78	7.0	.4	20	3/4	45	5:1-	
													3.5:1	
97A	27+72	36.0L	1535.	57	S40E	0-25	7/29/78	4.9	.5	20	1/3	15	6.5:1	
96	27+90	34.1L	1529.5	62	S31E	0-25	7/29/78	6.8	.8	20	1/4	15	6.5:1-	
						25-50	8/01/78	4.7	.4	15	1/4	40	5.5:1	
						50-75	8/07/78	6.7	.3	45	3/4	45	5.5:1	
96B	27+94	50.2L	1526.5	55	S80E	0-30	8/07/78	1.2	.1	15	1/2	15	6:1	
96A	28+1-	31.3L	1527.	66	S41E	0-25	8/01/78	1.9	.4	10	1/4	20	5:1	
95F	28+19	61.6L	1526.5	64	S47E	0-25	8/07/78	4.3	.6	15	1	10	6:1-	5
													5:1	
95G	28+19	44.0L	1526.	54	N45W	0-25	8/09/78	5.6	1.5	5	4-3/4	10	5:1-	
													2:1	
95E	28+20	50.7L	1525.	51	S80W	0-30	8/07/78	3.0	.4	10	1/3	15	6:1	

CAVE BUTTES DAM ARIZONA — FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
95D	28+27	61.6L	1525.5	59	N56E	0-20	8/07/78	1.3	.3	10	2-3/4	10	6:1-	6 at seep
													4:1	4ft east
95H	28+29	64.3L	1525.	60	S54E	0-15	8/09/78	4.3	2.2	5	1/4	15	3:1	5,6 at 95I
95	28+29	32.2L	1529.	66	S33E	0-25	8/01/78	2.5	.3	15	1/2	20	5:1	
						25-50	8/02/78	2.5	.4	25	1	25	5:1	
						50-75	8/04/78	1.9	.1	45	1-1/4	45	6:1	
95C	28+32	58.5L	1526.5	61	N38E	0-20	8/07/78	5.7	2.0	5	1/4	15	6:1	
95I	28+34	62.7L	1534.	73	S33E	0-15	8/09/78	2.6	.8	10	2-1/4	10	3:1	5,6
95J	28+42	44.0L	1527.	59	N38W	0-15	8/09/78	5.4	1.7	10	3-1/4	5	6:1-	5,6
													1.6:1	
95B	28+45	63.6L	1530.5	53	S26E	0-15	8/07/78	2.2	.7	10	1/2	15	6:1	5
95A	28+49	31.9L	1530.	68	S48E	0-25	7/29/78	4.9	.7	15	1/4	20	6:1	
94D	28+67	63.3L	1525.5	48	S28E	0-15	8/07/78	2.5	.9	8	3-1/3	5	6:1-	5,6
													3:1	
94C	28+68	34.7L	1530.	61	S32E	0-25	8/04/78	0	0	15	0	15	7:1	
						25-50	8/07/78	6.4	.4	30	1	30	6:1	6 near 94D
						50-75	8/08/78	15.9	.6	50	3	40	6:1-	
													4:1	
94	28+74	28.0L	1534.	65	S51E	0-25	7/28/78	0	0	15	0	15	7:1	

CAVE BUTTES DAM ARIZONA—FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
94B	28+84	36.5L	1540.5	67	S03E	0-8	7/28/78	2.6	2.7	5	3-1/2	5	7:1-2:1	5,6
94E	28+88	53.1L	1544.	65	S11E	0-30	8/08/78	9.5	1.4	10	1/2	15	6.5:1-5.5:1	5
94A	28+92	34.9L	1546.5	68	S52E	0-25	7/27/78	4.8	.7	15	1/3	15	6.5:1	
	OUTLET WORKS													
93A	29+15	17.7L	1560.	44	S30E	0-25	7/26/78	0	0	15	1/4	15	6:1	
93B	29+16	26.9L	1559.	46	S47E	0-25	7/26/78	7.4	1	15	1/2	20	5:1-4:1	
93C	29+21	36.0L	1557.	51	S25E	0-25	7/28/78	2.7	.4	15	1/4	15	6:1	
93D	29+21	45.3L	1556.5	57	S46E	0-25	7/28/78	8.9	1.2	15	2-1/4	20	5:1	
92A	29+26	19.6L	1565.5	76	S70E	0-25	7/24/78	3.1	.4	15	0	20	7.5:1	
92B	29+32	39.0L	1565.5	77	S77E	0-25	7/24/78	.4	.1	15	2/3	15	7.5:1-6:1	
92C	29+35	49.4L	1565.5	81	S76E	0-25	7/24/78	1.3	.2	15	1/3	20	7.5:1	

CAVE BUTTES DAM ARIZONA—FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
	LEFT ABUTMENT													
93	29+10	29.3L	1556.5	81	S18E	0-30	7/26/78	7.3	.7	20	3/4	40	6.5:1	
						30-60	7/27/78	3.3	.1	40	1-1/4	20	7.5:1-6:1	
92	29+31	29.1L	1564.3	79	S76E	0-20	7/20/78	2.1	.4	15	0	20	7.5:1	
						20-40	7/24/78	2.1	.2	20	0	35	6:1	
91A	29+47	26.8L	1574.	74	S20E	0-20	7/20/78	0	0	15	0	15	7.5:1	
						20-40	7/24/78	1.0	.1	25	1/4	30	8:1	
91	29+63	27.1L	1578.5	69	S22E	0-25	7/24/78	0	0	15	0	20	7.5:1	
35	29+81	25.3L	1583.	70	N47E	0-40	7/23/78	0	0	40	1/4	40	6:1	3
34	30+09	23.4L	1591.	69	S79E	0-40	7/23/78	7.5	.3	40	1	40	6:1	3
33	30+29	14.7L	1594.	80	S73E	0-40	7/22/78	2.9	.1	40	1/4	40	6:1	3
32	30+19	20.5L	1592.	72	S68E	0-15	2/15/78	14.5	7.4	5	23	10	5:1-2:1	
						15-40	2/21/78	17.2	.9	40	7-1/3	40	5:1-3:1	
31	30+54	13.2L	1605.5	70	N78E	0-40	2/15/78	12.7	.5	40	3/4	40	5:1	3
30	30+91	13.0L	1618.5	75	S65E	0-40	2/15/78	5.0	.2	40	4-1/4	40	5:1	

CAVE BUTTES DAM ARIZONA—FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
29	31+27	5.2L	1631	78	E	0-20	2/15/78	5.0	.7	20	1/3	20	5:1	
						20-40	2/21/78	0	0	40	1/3	35	5:1	
28	31+65	5.5L	1644.5	74	N70E	0-20	2/15/78	18.1	2.5	20	2-1/3	20	5:1	
27	32+04	1.6L	1655.5	71	S45E	0-40	2/21/78	16.4	.6	40	2-2/3	40	5:1	3
	DIKE NO. 1													
26	32+40	2.0L	1670.	71	N75E	0-40	2/21/78	4.2	.2	40	1/4	40	5:1	3
23	34+03	0.6R	1670.	87	N48W	0-10	2/08/78	----	---	--	1	5	2:1	2
						10-25	2/09/78	0	0	25	1/4	--	5:1	
22	34+03	℄	1662.5	87	S58E	0-25	2/08/78	0	0	25	0	--	5:1	9
21	34+43	2.1L	1657.5	vert	----	0-25	2/08/78	0	0	25	0	--	5:1	9
20	34+83	0.2L	1654.5	85	S48W	0-25	2/09/78	9.1	.8	25	1/2	25	5:1	
19	35+25	1.0L	1653.5	vert	----	0-25	2/09/78	8.0	1.1	15	3/4	25	2:1-5:1	5
18	35+66	0.2L	1655.	87	N48E	0-25	2/09/78	7.1	.8	20	1/4	25	5:1	
17	36+06	0.3L	1653.5	vert	----	0-25	2/08/78	8.7	1.2	15	1/2	25	5:1	
16	36+46	1.2L	1648.5	vert	----	0-25	2/08/78	2.9	.4	15	1/2	25	5:1	
15	36+85	1.5L	1642.5	vert	----	0-10	2/02/78	---	---	---	1/2	5	5:1	5,6
						10-25	2/06/78	---	---	---	1/4	25	5:1	

CAVE BUTTES DAM ARIZONA—FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
14	37+25	0.4L	1636.5	vert	----	0-10	2/02/78	--	---	---	1/2	5	5:1	5,6
						10-25	2/06/78	--	---	---	1	25	5:1-	
													1.5:1	
13	37+64	0.6R	1633.5	vert	----	0-10	2/02/78	--	---	---	0	25	5:1	5
12	38+04	0.3R	1637.	vert	----	0-25	2/08/78	0	0	25	0	25	3:1	9
11	38+44	2.7L	1639.	89	N35E	0-10	1/31/78	3.4	1.6	10	2	5	1:1	5,6
10	38+83	1.9L	1644.5	89	N54W	0-10	1/31/78	8.8	4.2	10	1	10	1:1	5,6
													5:1	
9	39+23	1.3L	1649.5	88	N55E	0-10	1/31/78	.2	1	10	0	5	1:1	1
						10-25	2/03/78	--	---	---	1/2	25	5:1	
8	39+62	℄	1653.	87	S75E	0-10	1/31/78	1.9	.9	10	1/2	10	1:1	
						10-25	2/03/78	--	---	---	0	25	5.1	
7	40+02	2.6R	1654.	86	N85E	0-10	1/31/78	6.0	4.9	5	1/2	5	5:1	
													3:1	
						10-14	2/01/78	--	---	---	1	15	2.5:1-	5,6
													5:1	
						14-25	2/03/78	--	---	---	1-1/2	25	5:1	
6	40+41	0.7R	1657.5	vert	----	0-10	1/31/78	7.0	.1	10	0	10	5:1	
						10-25	1/31/78	--	---	---	1/3	25	5:1	
5	40+81	2.4R	1658.	86	N41E	0-4	1/31/78	--	---	---	0	10	5:1	
							2/02/78	.6	.1	8	0	25	5:1	

CAVE BUTTES DAM ARIZONA—FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
4	41+21	2.4R	1658.	87	S85E	0-4	1/31/78	--	---	---	0	10	5:1	
						4-25	2/02/78	.7	.2	8	1/3	25	5:1	
3	41+62	2.4R	1658.5	vert	----	0-10	1/31/78	5.5	4.4	5	1-1/2	5	3.5:1	8
						10-25	2/03/78	---	---	---	1-1/2	25	5:1-	
													2.5:1	
25	42+90	0.5R	1662.	vert	----	0-10	2/03/78	---	---	---	----	10	5:1	
2	42+01	1.4R	1663.	87	S22E	0-10	1/31/78	---	---	---	1/3	10	5:1	
						10-25	2/01/78	0	0	30	6-1/3	25	5:1-	
													3:1-	
24	42+10	0.9R	1666.5	vert	----	0-4	2/02/78	---	---	---	1-2/3	5	1:1	6
						4-10	2/03/78	---	---	---	1/3	10	5:1	
1	42+40	0.8R	1670.	87	S22E	0-25	1/26/78	0	0	30	0	30	3:1	9
	DIKE NO. 2													
36	51+01	4.2R	1657.5	81	N54W	0-25	2/28/78	0	0	25	1/4	25	6:1	
37	51+40	1.6L	1652.	80	N85W	0-25	2/28/78	5.8	.5	25	1/4	25	8:1	
38	51+79	0.3L	1646.5	83	N69W	0-25	2/28/78	1.6	.2	25	1/2	25	6:1	
39	52+19	1.8L	1640.5	80	N82W	0-25	2/28/78	2.8	.3	25	1.2	25	6:1	
40	52+58	0.8R	1634.5	83	W	0-25	2/28/78	8.9	.8	25	2	25	6:1	

CAVE BUTTES DAM ARIZONA — FOUNDATION GROUTING SUMMARY

HOLE NO.	HOLE LOCATION		G.S. ELEV. (feet)	INCLINATION (deg.)	BEARING (deg.)	DEPTH	DATE GROUTED	PRESSURE TESTING			GROUTING			REMARKS
	DAM STATION	OFFSET FROM ℄						FLOW (gpm)	K ft./day	PRESS. (psi)	TAKE (bags)	PRESS. (psi)	MIX (w/c)	
41	52+96	0.3L	1627.	86	S76W	0-25	2/28/78	.8	.1	25	1/4	25	6:1	
42	53+31	0.8R	1619.	82	N71W	0-25	2/28/78	0	0	25	1/4	25	6:1	
	RIGHT ABUTMENT EXPLORATORY GROUT HOLE													
D-34	13+28	31.4L	1577.	75	N80W	0-22	4/27/78	4.2	.5	20	1/3	20	5:1	6
	CUTOFF TRENCH EXPLORATORY GROUT HOLE													
D-35	23+13	42.5L	1528.5	73	S61E	0-38	7/13/78	5.5	.4	20	1/3	30	6.5:1	6
	LEFT ABUTMENT EXPLORATORY GROUT HOLE													
D-36	30+18	22.0L	1591.	68	S51E	0-60	7/26/78	4.6	.2	25	1-2/3	40	5:1	3


DAT
FILM