REPORT

GEOLOGIC INVESTIGATIONS

PROJECT IV STORAGE CAPACITY EXPANSION
NEAR MORRIS, ILLINOIS

THE GENERAL ELECTRIC COMPANY

Prepared by

DAMES & MOORE

August 26, 1977
Job No. 1674-099-07

DAMES & MOORE

August 26, 1977

General Electric Company
Nuclear Energy Division
175 Curtner Avenue
San Jose, California 95125

Gentlemen:

Re: P.O. 529-JIT-99X
Report
Geologic Investigations
Project IV - Fuel Storage Capacity Expansion
Near Morris, Illinois
General Electric Company

This letter transmits seven copies of our "Report - Geologic Investigations Project IV - Fuel Storage Capacity Expansion near Morris, Illinois". This report has been revised to include General Electric's comments and represents the completion of the work required by Task A, of the referenced purchase order. Figure 10 has not been returned from the printer and will be sent under separate cover.

If there are any questions regarding this report, or any other work performed for the Morris Facility, please contact us.

Very truly yours,

DAMES & MOORE

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Enclosure

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ABSTRACT

A geological investigation was conducted near Morris, Illinois for the General Electric Company to provide geotechnical data required for the design and licensing of the proposed basin expansion; to determine the structural and stratigraphic relationships of a northwest-trending fault zone; and to substantiate the age of faulting at the site.

Field investigations included soil and rock core drilling, borehole water pressure testing, piezometer installation, geophysical surveys, trenching across the fault zone, and geologic mapping of the trenches.

This investigation showed that multiple northwest-trending faults are present in an en echelon pattern instead of a single fault as previously interpreted. Furthermore, it was interpreted that cross faults trend northeasterly and also occur in an en echelon pattern.

Relative movement of the northwest-trending fault zone is down-to-the-southwest. Several faults exposed in trenches have downward displacement to the northeast; however, most individual faults also are displaced down-to-the-southwest. The faults probably converge with depth creating step-like extensional blocks that have variable displacements relative to adjacent blocks as well as rotational displacements. The variability of displacements of fault blocks is characteristic of en echelon gravity faults produced by antithetic tensional forces.

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Stratigraphic evidence indicates that major movement occurred prior to deposition of Pennsylvanian sandstone (Spoon Formation) found at the site. Direct conclusive evidence documenting that faulting definitely occurred prior to deposition of the Spoon Formation was found in Trench CT-7 where the Spoon Sandstone extends continuously over several faults. This evidence establishes that faulting at the General Electric site occurred over 280 million years before the present; therefore the faulting is not capable as defined by the United States Nuclear Regulatory Commission in 10CFR100, Appendix A.

REPORT

GEOLOGIC INVESTIGATIONS

PROJECT IV STORAGE CAPACITY EXPANSION

NEAR MORRIS, ILLINOIS

FOR

THE GENERAL ELECTRIC COMPANY

INTRODUCTION

This report presents the results of the geologic investigations recently performed at the site of the proposed basin expansion to General Electric's Morris operation, a spent fuel storage facility near Morris, Illinois (Figure 1). The purpose of this investigation was to provide the geotechnical data required for the design and licensing of the proposed basin expansion to the existing fuel storage facility (Figure 2). The most critical issue of this investigation from a geologic, hydrologic and foundation engineering aspect was the dating and delineation of the northwest-trending fault zone identified by Dames & Moore from boring data initially obtained during a foundation investigation in 1967. The fault zone, southwest of the existing Fuel Storage Building, was studied in detail in 1974, at which time it was shown to have an offset of 35 to 40 feet with the southwest side dropped down in relation to the northeast side. Although the most probable time of faulting was determined to be between late Ordovician and early Pennsylvanian time, conclusive evidence

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was not found which would document that the fault was not capable as defined by the United States Nuclear Regulatory Commission (NRC). The detailed geologic structural analyses of the proposed expansion area, and the stratigraphic evidence presented herein conclusively substantiate the age of faulting in the site area as pre-Early Pennsylvanian, i.e. the faults are incapable.

SCOPE OF WORK

The purposes of the investigation were to:

1. Determine the structural and stratigraphic relationships of the foundation materials and underlying bedrock;
2. Determine the characteristics and location of the northwest-trending normal fault zone and determine its relationship to the proposed structure;
3. Substantiate the age of faulting, if possible; and
4. Perform field investigations to augment and develop data for use in evaluating the ground-water regime, the geophysical properties of the subsurface materials, and foundation conditions.

Dames & Moore's field investigations consisted of soil and rock core drilling, borehole water pressure testing, piezometer installation, trenching perpendicular to the fault trace, and geologic mapping of the trenches. The locations of the field investigations are shown on Figures 2 and 3. The results of these investigations, which form the basis of our conclusions and document the character and age of the fault zone, are presented herein. Geophysical surveys were also performed and are discussed

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in our report, Geophysical Investigations (1977). Details of the ground-water conditions found at the site are described in our report, Ground Water Investigation (1977). Foundation recommendations for design parameters were provided from analyses of our work and are given in our report, Evaluation of Foundation Recommendations (1977).

DESCRIPTION OF THE SITE

The site is located east of Morris, Illinois in the southeast 1/4 of Section 35, Township 34 North, Range 8 East in Grundy County. This is about 1 mile south of the Illinois River and about 1/2 mile west of the Kankakee River on a relatively high area about 30 feet above normal pool level of the Kankakee River (530 feet MSL). The topography of the area is gently rolling and generally reflects the bedrock structure and lithology. The land surface slopes generally gently to the south and east with poorly developed and integrated drainage. Figure 1 shows the site location in relation to local features and the topography near the site.

Soil and overburden deposits range from 0 to a few feet in thickness with a maximum thickness of about 10 feet just west of the fault zone. Within the area of the proposed expansion, the soil is generally less than 2 feet thick.

PREVIOUS INVESTIGATIONS

Several geotechnical investigations have been made at the site in the past by Dames & Moore. The results of these studies, as well as boring and piezometer data, have been used to provide data for this investigation. These Dames & Moore reports are included in the general reference list at the end of this report.

METHOD OF INVESTIGATION

The initial field investigation involved drilling nine borings and excavating one trench perpendicular to the anticipated major northwest-trending fault, as interpreted from previous Dames & Moore investigations (1974, 1975). The field data obtained during the early stages of the investigation indicated that multiple faults, rather than one major fault, are present in a step-like pattern which forms a northwest-trending fault zone of multiple blocks positioned at different elevations (Figures 10 and 13). In order to better document and explain this interpretation, the program was revised to include a total of 17 borings and 11 trenches.

The investigation, as executed, is described in the following paragraphs.

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DRILLING PROGRAM

A total of 17 borings (B-1 and B-3 through B-18) were drilled between March 26 and April 3, 1976. Five ground-water observation wells, D-1 through D-5, were also drilled. The locations of the borings and observation wells are shown on Figure 3, Plot Plan - Proposed Basin Expansion Area. Detailed descriptions of the subsurface materials encountered are presented on the boring logs, Figures 4.1 through 4.18.

The drill rig and crew were supplied by Raymond International, Inc., Elk Grove Village, Illinois. The coordinate locations and elevations of the borings were surveyed by George Reiter & Associates of Joliet, Illinois. Dames & Moore geologists supervised the field operations. The borings were drilled to depths ranging from 10.0 to 186.0 feet and were advanced by rotary wash method. Three of the borings (B-1, B-3 and B-4) were drilled at a 60-degree angle from the horizontal across the fault trace (Figure 3). The angle borings were drilled to determine the characteristics and hydrologic conditions within the fault zone, to intersect the fault zone at the foundation grade, and to establish the elevation of the Scales Shale in the borings.

The shallow soil conditions at the site were evaluated by logging cuttings from 4-inch solid flight augers. All soil was classified in the field in accordance with the Unified Soil Classification System. Core recovery and RQD (rock quality designation) of the rock from the borings aided in delineating the location of fracture zones penetrated by the borings and provided further basis for indicating the fault locations shown on Figures 9 and 10.

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Rock samples were obtained utilizing NX wireline core barrels 10 feet in length. Coring began in several borings at elevations several feet above the Scales Shale in order to determine the top of the unit for stratigraphic correlation. For each core run, recovery and the RQD were determined. The percent recovery was calculated by dividing the total amount of core obtained by the total length of the core run. RQD was determined by measuring all pieces of core 4 inches or greater in length, summing this quantity and dividing it by the total length of core run. Photographs of the rock core were taken to document the recovery and condition of the core. All core obtained is stored in wooden core boxes at the site.

Pressure testing was performed in eight borings using air inflatable packers with both double-packer, 10-foot spacing and single-packer, variable spacing. Borings B-1 and B-3 through B-9 were tested and the results of the tests are presented on the boring logs as K, permeability in centimeters per second. The values obtained from the pressure tests were used to calculate the permeabilities. Borings on both the upthrown and downthrown side of the fault trace were pressure tested in order to determine the effect of faulting on the movement of ground-water under the site. A discussion of the analysis and the results of the pressure tests are presented in the Ground Water Investigations report (1977).

Ground-water observation wells (D-borings) were drilled with a roller bit. Rock core was not obtained. The tops of formations encountered in these borings were established by inspection of cuttings.

Piezometers were installed in 12 borings (B-1, B-3 through B-7, B-9 and D-1 through D-5) following drilling and pressure testing. In angle borings B-1, B-3 and B-4, 3/4-inch diameter PVC (polyvinyl chloride) pipe was used. All other piezometers installed consisted of 2-inch inside diameter PVC pipe slotted to monitor a specific interval. The pipe was lowered to the selected depth and the annular space around the slotted interval of the pipe was backfilled with clean pea gravel. About 2 feet of clean sand was placed over the pea gravel and from 1 to 2 feet of bentonite balls was placed over the sand to prevent migration of grout into the pea gravel. The remainder of the boring was then backfilled to ground surface with a cement-bentonite grout. The PVC pipe was protected with a 5-foot length of embedded steel pipe and a steel cap at the ground surface. Piezometer installation data are presented in the Ground Water Investigations report (1977).

TRENCHING PROGRAM

Three trenches (BT-1, BT-2 and BT-3) were excavated and mapped between March 26 and April 23, 1976. Eight additional trenches (CT-1 through CT-8) were excavated and mapped between May 10 and May 25, 1977. The locations of all the trenches are shown on Figure 3.

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The backhoe, capable of excavating to a depth of 12 feet, and operator were supplied by Stark Excavating Company of Morris, Illinois. The coordinate locations and elevations of the trenches were surveyed by George Reiter & Associates of Joliet, Illinois. Dames & Moore geologists directed the field activities and mapped the trenches.

These trenches were excavated to refine the definition of the structural relationships associated with the fault zone adjacent to the proposed expansion, and to determine if stratigraphic evidence was present that would establish the age of faulting. The walls of trenches were mapped to determine the stratigraphic and/or structural relationships and to provide details for use in the interpretation of site geology presented in this report. Where not obscured, floors of trenches were also mapped. Features revealed on the trench floors were oftentimes not apparent on wall profiles. Cross sections of the trenches are shown on Figures 5.1 through 5.11.

REGIONAL GEOLOGY

Regional structures in northern and northeastern Illinois trend northwest and are characterized by asymmetrical folds with steep southwestern limbs and by vertical faults and joints that trend northwesterly. Fracture sets trending northeast also occur within the region.

The site is located on the northeastern flank of the Illinois Basin. The long axis of this elliptical-shaped basin strikes north-northwest through most of Illinois and is bounded on the east by the Cincinnati Arch and on the north by the Wisconsin Arch.

The LaSalle Anticlinal Belt, a north-northwesterly trending band of asymmetrical en echelon folds, extends from north-central Illinois to extreme southeastern Illinois. The western limb of the LaSalle Anticlinal Belt dips steeply into the center of the Illinois Basin with the eastern limb dipping gently into the eastern shelf area of the basin (Figure 6). The crestal axis of the folded belt plunges to the south-southeast and narrows to only a few miles wide at the southern end where it plunges into the deepest part of the Illinois Basin.

Initial deformation along the LaSalle Anticlinal Belt began in post-Mississippian/pre-Pennsylvanian time at the northern end. Deformation migrated progressively southward with time during the Pennsylvanian (Payne, 1940, p. 7; and Eardley, 1962, p. 45). Renewed activity occurred after Pennsylvanian time, probably at the close of the Paleozoic Era.

Smaller asymmetrical structures have been identified within the LaSalle Anticlinal Belt and include the Herscher Dome, the Herscher Northwest Anticline, and the Ashton Arch. The Herscher Dome and the Herscher Northwest Anticline are both asymmetrical, doubly-plunging anticlines trending north-northwest (Figure 6). In describing the Herscher Dome, Buschbach (1964, p. 63) states that "As in other en echelon structures in the LaSalle

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Anticlinal Belt, the strata dip rather steeply on the western flank and more gently on the eastern."

The Ashton Arch is an anticline that trends west-northwest across northern Illinois from western Kendall County to central Ogle County (Figure 6). Cambrian and lower Ordovician rocks are exposed at the surface along the trend of the arch. The Ashton Arch is bounded on the north by the Sandwich Fault Zone. The southwest flank of the arch merges with the LaSalle Anticlinal Belt and dips steeply into the Illinois Basin. Structural relief on the southwestern side is approximately 1900 feet, and the maximum relief on the northern side is approximately 900 feet (Willman and Templeton, 1951, p. 121). Uplift along the arch was at least post-Silurian and may have taken place at about the same time that movement occurred along the LaSalle Anticlinal Belt in post-Mississippian/pre-Pennsylvanian time, followed by additional, lesser uplift in post-Pennsylvanian time (Willman and Templeton, 1951).

The Sandwich Fault Zone trends west-northwest across northern Illinois to within 6 miles northeast of the site. The zone is mapped on the surface and in the subsurface for nearly 90 miles. The fault zone is essentially vertical and forms the northern boundary of the Ashton Arch. The northern block is downthrown a maximum of 900 feet by the main fault (Templeton and Willman, 1952), and near the northwestern end of the zone there are numerous associated short faults. The throw decreases toward the southeastern end of the zone, and a scissors effect causes the southwestern block along a subsidiary fault to be downthrown a little more than a hundred feet (Bristol and Buschbach, 1973, Plate 1). Bristol and Buschbach (1971, Figure 3) indicated more than 500 feet of vertical displacement in the basement surface. Movements along the Sandwich Fault Zone are dated as post-Silurian/pre-Pleistocene. However, major movements along the fault zone may have occurred when the LaSalle Anticlinal Belt was uplifted in post-Mississippian/pre-Pennsylvanian time (Willman and Templeton, 1951, p. 123).

The attitude of the folds and faults of the region indicate that compressive forces were acting along northeast-southwest lines during deformation in the Paleozoic Era. Faults and joints parallel to the axial planes of folds form at right angles to the maximum compressive force and also form at this attitude as a result of tensional forces on the convex side of folded strata, or anticlines (Billings, 1972). Extension fractures form parallel to maximum compression and shear fractures are symmetrically inclined (angles less than 45°) about the compressive force axis. The continuum from tensional fractures to shear fractures is demonstrated by such examples as the Sandwich Fault, and locally identified faults of lesser magnitude (discussed below and later in this report).

At the Dresden Nuclear Power Station, approximately one-half mile northeast of the site and within 5-1/2 miles of the Sandwich Fault, northwest-trending, near vertical, en echelon

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faults and northeast-trending faults and joints were mapped on the top of the Maquoketa Group by the Illinois State Geological Survey (Ekblau, 1956; Dames & Moore, 1965).

The locations of these faults and others observed within the area between the LaSalle Anticlinal Belt and the Sandwich Fault provide strong evidence for direct relationship between faults mapped adjacent to the site and regional structures (Kempton, 1975). The aerial photograph of the site vicinity (Figure 11) sh ws the trace of faults and joint sets that trend northeast and northwest across the region. Figure 12 is a map of these lineaments and delineates the individual features.

SITE GEOLOGY

The subsurface conditions of the site area were determined from borings and trenches drilled and excavated between 1967 and 1977. The data gathered prior to 1976 were reanalyzed and correlated with the results of the current studies. Structures shown in trenches excavated in 1974 may not have been recognized or explained at the time of their initial presentation. Information available prior to 1976 indicated a northwest-trending fault across the site area with downward displacement to the southwest (Dames & Moore, 1974 and 1975). A system of northwest- and northeast-trending joint sets and a southeastward plunging anticline were also documented (Dames & Moore, 1975). The fault was documented as cutting through Ordovician-age rocks and was

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dated as late Ordovician to early Pennsylvanian since Pennsylvanian sandstone unconformably overlies the Ordovician-age rocks at the site. The Silurian, Devonian and Mississippian systems are not present and were either not deposited or were eroded.

As a result of 1977 data, it was interpreted that multiple faults are present in an en echelon pattern and that a fault zone trends northwest across the site area instead of a single fault, as previously interpreted. Furthermore, it was interpreted that cross faults trend northeasterly and also occur in an en echelon pattern. Conclusive evidence for dating the fault was found and is discussed in this report.

STRATIGRAPHY

The stratigraphy of the site area, previously described in detail by Dames & Moore (1974, 1975), is substantiated by these field investigations and depicted on Figure 7.

Borings drilled in 1976 encountered all the geologic formations previously described by Dames & Moore. Two borings (B-3 and B-4) extended 5.7 feet into the Galena dolomite, and the other 16 borings were terminated in the Scales Shale. Surficial materials and rock formations encountered during the drilling are described below in descending stratigraphic order.

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Soil

Boring logs (Figures 4.1 to 4.18) show the thickness of soil encountered in each boring and give a description of the material. These same deposits were found on the sides of trenches excavated at the site, as seen on Figures 5.1 to 5.11, Trench Cross Sections.

The trench cross sections present a detailed account of the overburden materials, the upper several feet of bedrock, and the structural relationships within the fault zone which are discussed later in this report. The overburden soils encountered in the borings consist of a light brown to brown, clayey silt with sand and gravel underlain by a light brown to brown-gray, silty, fine sand with weathered sandstone fragments throughout. Soil thicknesses determined from borings on the upthrown side of the fault zone ranged from 0 to 3 feet; whereas on the downthrown side of the zone, the range was between 4.5 to about 10 feet.

<u>Bedrock</u>

The areal distribution of rock formations that form the bedrock surface in the site area is shown on Figure 8. The bedrock surface in the area of the proposed expansion is the Fort Atkinson Limestone which extends from the fault zone to include most of the site area. The Spoon Formation is found on the downthrown side of the fault zone, immediately southwest and west of the proposed expansion. Brainard Shale forms the bedrock surface, with occasional areas of Spoon Sandstone probably overlying it, in the southwestern portion of the site area.

<u>Spoon Formation</u> - This unit is Pennsylvanian in age and has previously been called the Pottsville Formation. The Spoon

Formation at the site is a light gray, fine- to medium-grained, thin- to medium-bedded sandstone, which contains mica and some clay. The sandstone is locally calcareous and is generally iron stained along bedding planes and fractures. The sandstone is absent in some areas and is in excess of 10 feet in thickness in the southwestern portion of the site.

"Limestone-Clay Rubble" - This rubble, a regolith developed before deposition of the Spoon Formation, is a silty clay and limestone unit that forms a wedge-shaped deposit on the downthrown side of the fault zone. The silty, illitic clay contains 25 to 35 percent angular limestone fragments, that vary from less than 1 inch to 1 foot in diameter, with the average size of less than 3 inches.

Brainard Formation - The Ordovician-age Brainard Shale unconformably underlies the Spoon Formation and is a gray to greenish-gray shale with interbedded light gray, calcareous and argillaceous siltstone. The unit is fossiliferous, thinly laminated, and highly weathered. The Brainard Shale is not found in the vicinity of the proposed expansion since it was removed by erosion prior to deposition of the Spoon Formation. A maximum thickness of 13 feet of Brainard Shale is found in the southern portion of the site area where it conformably overlies the Fort Atkinson Formation (Dames & Moore, 1975).

Fort Atkinson Formation - The Fort Atkinson Formation consists of an upper interbedded, gray shale and limestone unit, and a lower, light gray to white, coarsely crystalline limestone.

A transitional zone occurs at the base of the formation and consists of a 1- to 5-foot-thick gray, silty limestone interbedded with green-gray, silty clay layers. The Fort Atkinson is generally the upper bedrock unit in the area of the proposed expansion, particularly on the upthrown side of the fault zone, and weathers to a yellowish-reddish-brown limestone with solutioning evident along joint and bedding planes and fractures; clay fillings and secondary calcite also occur in these fractures and bedding planes.

A maximum thickness of 49 feet was penetrated by borings; however, where faulting has affected the unit, repetition of strata has thickened this formation (B-6, B-16 and B-17). Erosion has greatly reduced the interval on the upthrown side of the fault zone.

Scales Formation - Conformably underlying the Fort Atkinson Limestone, is this medium to dark gray, calcareous shale which is locally fossiliferous. Bedding characteristics vary from massive to thinly bedded, depending on the silt content of the shale. Where not influenced by faulting, the average thickness of the Scales Shale is 68 feet.

Galena Group - The upper dolomite unit of the Galena Group unconformably underlies the Scales Shale. The dolomite is medium to light gray, argillaceous, finely crystalline, medium to thick bedded and locally vuggy. The total thickness was not penetrated by the borings.

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GEOLOGIC STRUCTURE

General

The general structure of the site is shown on Figure 9. Regional dip of the bedrock is to the southeast. Structure contours on top of the Scales Shale in the area of the site were prepared and show a southeasterly dip of 138 feet per mile. The Scales Shale is structurally higher at the northwest corner of the site (northeast side of the fault zone), and dips to the southeast with the axis of plunge parallel to the strike of the fault zone. The southeast-plunging anticline is responsible for the variations in dip seen on the structural contours drawn on top of the Scales Shale.

Joint directions exposed in trenches were mapped and indicate two dominant joint trends. One dominant joint set trends nearly parallel to the fault zone (about N40°W, ranging from N10°W to N50°W) and the second dominant joint set trends nearly perpendicular to the fault zone (about N65°E, ranging from N60°E to east-west)(Figure 9). The joints range from closed to solution-widened and filled with silt, clay and sand fill material. Northeast joint sets mapped at the site and regionally identified are extensional features formed perpendicular to fault axes.

The location of the northwest-trending en echelon faults along the crest of the anticline (Figure 9) and the direction of the joints measured across the anticline indicate 1) that tensional forces across the crest of the fold produced the northwest-trending faults and joints, and 2) that extensional forces created the joints perpendicular to the fault. As can be concluded from regional tectonic forces, the compressive conditions that caused the northwest-trending folding are also responsible for faulting and contemporaneous jointing. A strain ellipse diagram shown on Figure 9 gives the orientation of strain axes to the geologic structures found at the site. The major and minor axes of the strain ellipse correspond to the direction of regional tectonic forces previously discussed. From a structural standpoint, the most logical location for the fracture pattern developed at the site is along the crestal high of the anticline, as shown on Figure 9.

The location of the fault zone, the length of segments, displacements, and the trend of the different segments have been inferred from boring data, geophysical surveys, and exposures from trenches excavated at the site (Figure 9). Displacement measured on top of the Scales Shale Formation along the fault zone varies from about 10 feet at the southeast corner of the site area to 45 feet adjacent to the proposed expansion.

Geophysical profiles conducted in 1974 (Dames & Moore, 1975) revealed several anomalous areas which could not be fully explained by the information available at that time. Interpretations from subsequent studies have shown some of these anomalies to be areas where the en echelon segments of the fault zone occur. Recent boring data substantiates this interpretation.

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The individual segments of the fault zone were found to vary in trend from N40°W to N48°W but average N45°W.

Details of the area outlined by the rectangle (proposed expansion area) in the northwest portion of the map (Figure 9) are shown on Figure 10 and are discussed in the following sections of this report.

Geologic Structure of the Proposed Expansion Area

The proposed expansion area has been extensively studied (Figure 2). Fault locations and relative displacements of the faults are shown on Figure 10. These normal faults are drawn from data obtained directly from borings (Figures 4.1 to 4.18), from trench exposures (Figures 5.1 to 5.11), and from data extrapolated between the trenches and borings. The trench excavations provided the most comprehensive information concerning the detailed structural relationships of the fault zone, including displacements of faults, orientation of faults and joints, and continuity of fault blocks.

Borings revealed a general decrease in elevation of the Scales Shale (Figure 10) and the bedrock surface to the southeast. Elevations on top of the Scales Shale varied from 523.1 feet at Boring 9 to 439.0 feet at B-6 as a result of multiple fault blocks which occur in a step-like pattern between the two borings. The greatest drop in elevation was found across a northwest fault zone that was traced between Borings A-8 and A-9,

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between A-2 and B-13, and between A-6 and A-7 (Figures 9 and 10). This trend, in effect, is the trace of several en echelon faults with major displacements on two of the faults (Figure 9). These two major faults, located on each side of A-8, were traced in trench exposures from CT-4 northward for 140 feet to CT-7 and reveal one block about 4 to 6 feet wide between the two faults. Evidence that indicates this trace continues further to the northwest was found in AT-4 and CT-6, excavated outside the fence line of the facility. At these locations faults were not identified within the rocks exposed; however, relationships of the near surface bedrock support the occurrence of structure beneath or near the excavations.

Two borings, A-8 and B-13, were drilled within this block separating the two faults. Boring A-8 was at the southern part of the proposed expansion area and had an elevation of 501.9 feet for the top of the Scales Shale. The Scales Shale was found at 520.1 feet in Boring A-9, 15 feet northeast of A-8. In Boring B-13, drilled on the same block as A-8, the elevation of the Scales Shale was 501.4 feet. Elevation of the Scales was 518.1 at B-14, [illegible] feet to the northeast and on the upthrown side of the faults.

Trenches AT-1, AT-2, and AT-3 (T-1 through T-3 of 1974 report) revealed a faulted block of Fort Atkinson Limestone and provided exposures that later supported the presence of sets of multiple fractures in the proposed expansion area (Figure 10).

Trenches CT-1 through CT-5, and CT-7 were dug to further delineate this structure and for correlation of previously known fault blocks. During excavation of the CT trenches additional faults were uncovered which were probably several feet below the level of the AT-and BT-series trenches.

Relative displacements of northwest-trending normal faults within the proposed expansion area are predominantly down-to-the-southwest. Several faults exposed in Trenches BT-1, CT-1, CT-2, and CT-5 have downward displacements to the northeast on the top of bedrock, and a graben block, exposed in CT-3, exhibited displacement of about 1 foot on the top of bedrock. The variability of displacements of fault blocks and the different amounts of throw measured on the Fort Atkinson Limestone and the Scales Shale are characteristic of en echelon gravity faults produced by antithetic tensional forces.

These faults probably converge with depth, creating step-like extensional blocks that have variable displacements relative to adjacent blocks, and may also have moved rotatively in association with individual blocks. Tilted blocks, as seen at CT-3 (Figure 5.6) have been gravity-induced and are slightly arcuate with depth.

Cross faults and joints in the proposed expansion area are perpendicular to the northwest-trending fault axes and create a series of en echelon down-to-the-southeast blocks that are shown on Figure 10. Their occurrence has resulted in two phenomena evident in the proposed expansion area.

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First, the trend of the northwest-trending en echelon faults changes from N45^{o}W in the southern part of the proposed expansion area to about N25^{o}W north of the two northeast-trending faults near Boring B-6. Based on field data, the N45^{o}W trend is again predominant to the northwest of the proposed basin expansion and demonstrates the local nature of the direction changes of the fault zone's segments.

Secondly, lower elevations of the top of the Scales Shale are found locally on the south side of the northeast-trending faults. This occurrence is evident at Boring 2 (drilled in 1967) and is particularly noticeable at Borings B-6, B-16 and B-17 where 40 feet of downward throw has occurred between the two en echelon, northeast-trending faults. Boring B-6 was drilled early in the field investigation of 1976 and revealed an unusually thick section of Fort Atkinson Limestone (78.6 feet). The elevation of the top of the Scales Shale at B-6 was 439.0 feet which is 36.1 feet lower than at B-15, approximately 12 feet to the northeast; and approximately 75 to 80 feet lower than the formational top on the upthrown side of the fault zone. At Boring B-17, about 12 feet east-southeast of B-6, the top of the Scales Shale was at 440.8 feet with 78 feet of Fort Atkinson present. The top of the Scales in B-16 was at 452.5 feet; whereas on the north side of the northeast-trending cross-fault, the elevation of the Scales Shale at B-15 was 475.1 feet. This relationship indicates a localized structural feature at Borings

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B-6, B-16 and B-17 which can be interpreted as a localized, fault-bounded block with maximum downward displacement, or tilt, to the north.

Faults mapped within the trench excavations correlated well with fracture zones measured in the angle borings, B-1, B-3 and B-4. Figure 13 shows the relationship between the boring and trench data and depicts the continuity of the faults across the proposed expansion area. Angle borings were drilled at 60 degrees from horizontal in a direction perpendicular to the fault zone (Figure 10).

The correlation between the trench exposures and the boring logs is indicated by the shaded area on Figure 13. There are two reasons for this shaded area of correlation. First, direction changes, both vertical and horizontal, are unavoidable in any angled drilling operation. Secondly, the fault planes are undoubtedly variable along the trace of the fault and an average value, depicted as a straight line, is shown rather than multiple short segments with variable inclination which are closer to actual conditions. The dip of the faults ranges from 80 degrees (inclined to the southwest) to vertical as measured in the field.

The interpreted sequence of closely spaced, near-surface faults shown adjacent to the proposed expansion area but not in other parts of the area is the result of extensive field investigations within this area and the lack of near-surface evidence for faults near B-6 and further to the west. Apparently, faults located at B-6 and further west are expressed at

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lower elevations than in adjacent areas. Boring data indicate their presence, but the thicker and deeper (relative to ground level) deposits of Spoon Sandstone have covered the faults found within the Fort Atkinson Limestone on the east side of the fault zone.

The faults shown on Figure 10 are in the center of a complex structural zone (Figure 12). This area, which includes the regional fault zone shown on Figure 9, is bounded to the southwest by a graben which extends for about 2000 feet to the southwest where it is bounded by another northwest-trending fault (Figure 12). The upthrown blocks are capped by Fort Atkinson Limestone and the downthrown block is capped by Spoon Sandstone which covers the Fort Atkinson and filled in the topographic low created by the graben.

In order to relate the results of the extensive site investigation to the regional geology, lineaments were mapped from an aerial photograph (Figure 11). Lineaments interpreted as structurally related are often expressed on the ground surface by slight topographic relief and predominantly trend either northwest or northeast. The interpretations of lineaments are presented on Figure 12.

SITE GEOLOGIC HISTORY

The geologic history of the site area since the Ordovician Period has been described and documented in previous Dames & Moore reports (1975). Studies prior to 1977 provided

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evidence that indirectly indicated that major movement of the fault zone occurred prior to deposition of the Pennsylvanian sandstone (Spoon Formation), based on three spatial relationships.

First, deposits of Pennsylvanian sandstone fill solution-widened joints at the site and grade outward to argillaceous siltstone and/or clayey silts. These siltstones and clayey silts apparently represent the original pre-Pennsylvanian joint fill that was later cut and filled with Spoon Sandstone.

Secondly, a regolith, consisting of silty clay and limestone fragments and formed prior to sandstone deposition, cover the surface of the exposed Fort Atkinson Limestone. It was during this period of erosion (non-deposition) that the wedge-shaped deposit of clay-limestone rubble, over which the Spoon Formation was deposited, was laid on the downthrown, southwest side of the fault zone. This clay-limestone rubble was deposited as a colluvium shortly after faulting, and shortly before the Spoon Sandstone was deposited. If this was not the case, erosion and material slope development would have removed this temporal unconsolidated deposit after a short span of geologic time. Either during and/or shortly after deposition of the sandstone, differential compaction and slumping probably occurred in the wedge of unconsolidated regolith, which resulted in gentle sagging of the overlying Spoon Formation bedding and increased the inclination of the beds

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DAMES & MOORE

Thirdly, in the northwest corner of the site area, sandstone overlies the basal 7.5 feet of Fort Atkinson Limestone on the upthrown side of the fault zone; the remaining section has been eroded. The sandstone on the downthrown side of the fault zone overlies 42 feet of Fort Atkinson Limestone.

These three relationships provide stratigraphic evidence that indirectly demonstrates pre-Spoon Formation faulting. More specifically, the presence of the clay-limestone rubble as a colluvial regolith places the time of faulting shortly before deposition of the Spoon Sandstone -- i.e., Early Desmoisian (earliest Pennsylvanian) to post-Chesterian (latest Mississippian). This time interval (approximately 280 million years b.p.) for faulting is further supported by the lack of comparable offsets in the Colchester Coal (Middle Desmoisian) which is the lowest unit in the Carbondale Formation and overlies the Spoon Formation in the area. The Colchester Coal (also termed the No. 2 Coal) has been extensively mined where present south of the site area, and numerous mine exposures and pit slopes have shown no significant structural displacement associated with faulting (Buschbach, 1977).

The Illinois State Geological Survey in 1975 performed X-ray diffraction analyses on Pleistocene glacial till samples which directly overlie the fault planes in several trenches. Their analyses dated the material at 15,000 to 17,000 years (b.p.) and definitely shows that faulting occurred at least before this time since the in-situ Pleistocene strata were undisturbed (Dames & Moore, 1975).

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Potassium-argon radiometric analyses of clay taken from the fault plane exposed in BT-1 were made in 1977 (Krueger, 1977). Results dated the clay at 457 million years (b.p.) ± 16 million years. The results indicate that the clay is the same age as the surrounding Ordovician Limestone (430 - 500 million years. Willman and others, 1975) also exposed in the trench, and thus were not substantiating.

Field work in 1977, however, provided direct, conclusive evidence documenting that faulting definitely occurred prior to deposition of the Spoon Sandstone. This evidence was found in the exposure of Trench CT-7 (Figure 5.10). At this locality, the Spoon Sandstone extends continuously bedded from the southwest end of the trench to within 5 feet of the northern edge of the trench. Within this 50-foot interval, the sandstone is nearly horizontally bedded over the Fort Atkinson Limestone on the downthrown side of one fault, continues at a slight dip over the wedge-shaped clay-limestone rubble adjacent to the upthrown block formed by the fault movement, and directly overlies the fault plane and adjacent upthrown block. The sandstone is found over the width of this fault block and continues to a second fault that bounds the block to the north (Figure 5.10). The perspective of the trench wall shown on Figure 5.10 gives the apparent view that the sandstone overlaps the uppermost fault block. The sandstone does not lie over this block as determined from field inspection; however, due to the oblique angle of the trench to the strike of the fault plane, this relationship is not apparent when shown as a two-dimensional profile.

CONCLUSIONS

The evidence of the Spoon Sandstone directly overlying a fault and fault block of Fort Atkinson Limestone conclusively dates the fault as having occurred no later than pre-early or early Desmoisian. The presence of the clay-limestone rubble as a colluvial wedge-shaped deposit along the fault block supports a probable post-Chesterian age of faulting. This age of faulting (post-Chesterian/early-Desmoisian) at the site is supported further by the regional geologic history. Initial deformation along the LaSalle Anticlinal Belt and the major movements of the Sandwich Fault occurred during post-Mississippian/pre-Pennsylvanian time (Payne, 1940; Willman and Templeton, 1951) and is equivalent to the age of site deformation.

Continued uplift within the area occurred after Pennsylvanian time, but this renewed activity was of less magnitude (Willman and Templeton, 1951) and may be partially responsible for warping or increased inclination of bedding planes within the Spoon Formation during its unlithified, unconsolidated state. No displacement or offset is found within the beds of the Spoon Formation at the site.

The NRC criteria for faulting as defined in 10CFR100 requires that a fault has not moved in the last 35,000 years or has no history of recurrent movement in the last 500,000 years. The stratigraphic evidence found throughout the site, both in this and previous investigations, indicates a pre-Spoon deposition age for faulting. The relationships observed in Trench

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CT-7 provide substantiated proof that the faulting occurred in post-Chesterian to early Desmoisian time (approximately 280 million years before the present). Therefore, the faulting at the site is not capable.

Expansion of the storage basin at the site will involve excavation of the area shown in Figure 3. This excavation will be mapped by Dames & Moore personnel in order to fulfill NRC regulations regarding mapping and documentation of safety-related excavations for nuclear facilities.

--ooOoo--

The attached tables and figures complete this report.

Respectfully submitted,

DAMES & MOORE

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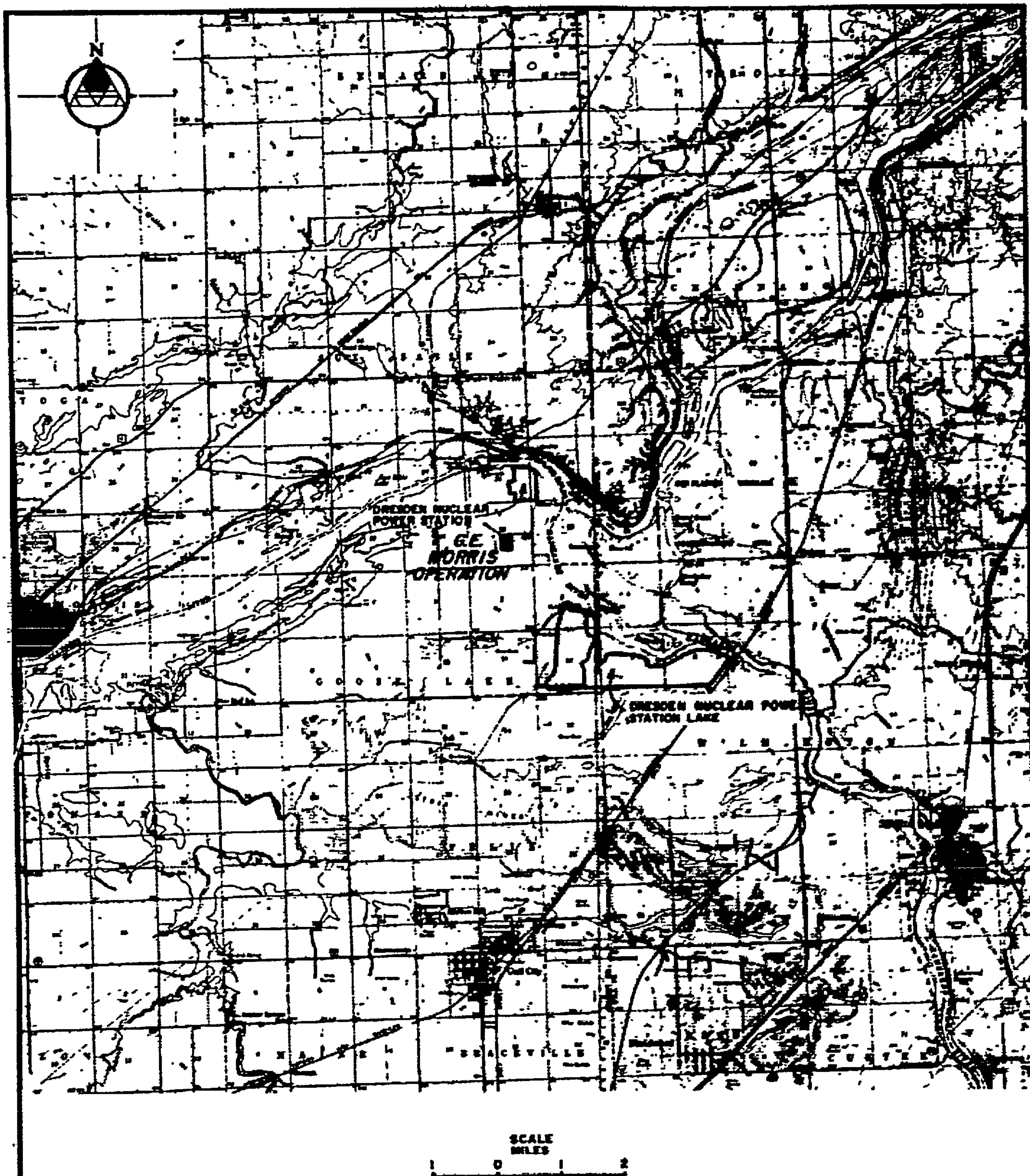
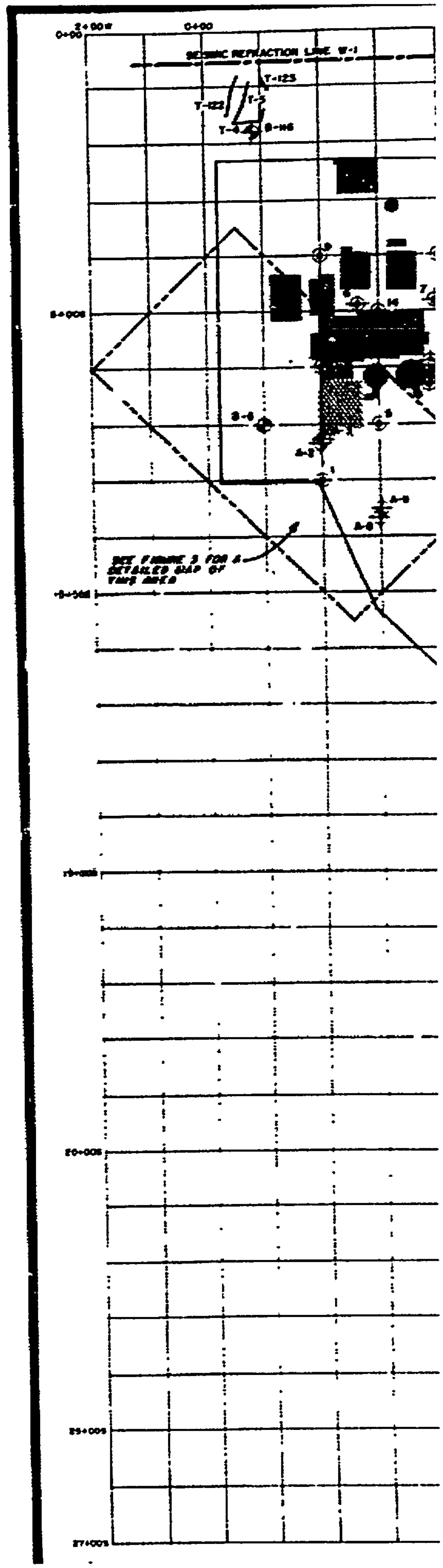


BASE MAP REFERENCE:
PORTION OF MORRIS AND WILMINGTON, ILLINOIS,
15 MIN. U.S.G.S. TOPOGRAPHIC QUADRANGLES, 1954.

SITE VICINITY MAP

1674-099/101-07



2+00W
0+00
0+00
SEISMIC REFRACTION LINE W-1
T-123
T-122
T-5
T-4
5+00S
B-6
SEE FIGURE 3 FOR A DETAILED MAP OF THIS AREA
20+00S
25+00S
27+00S

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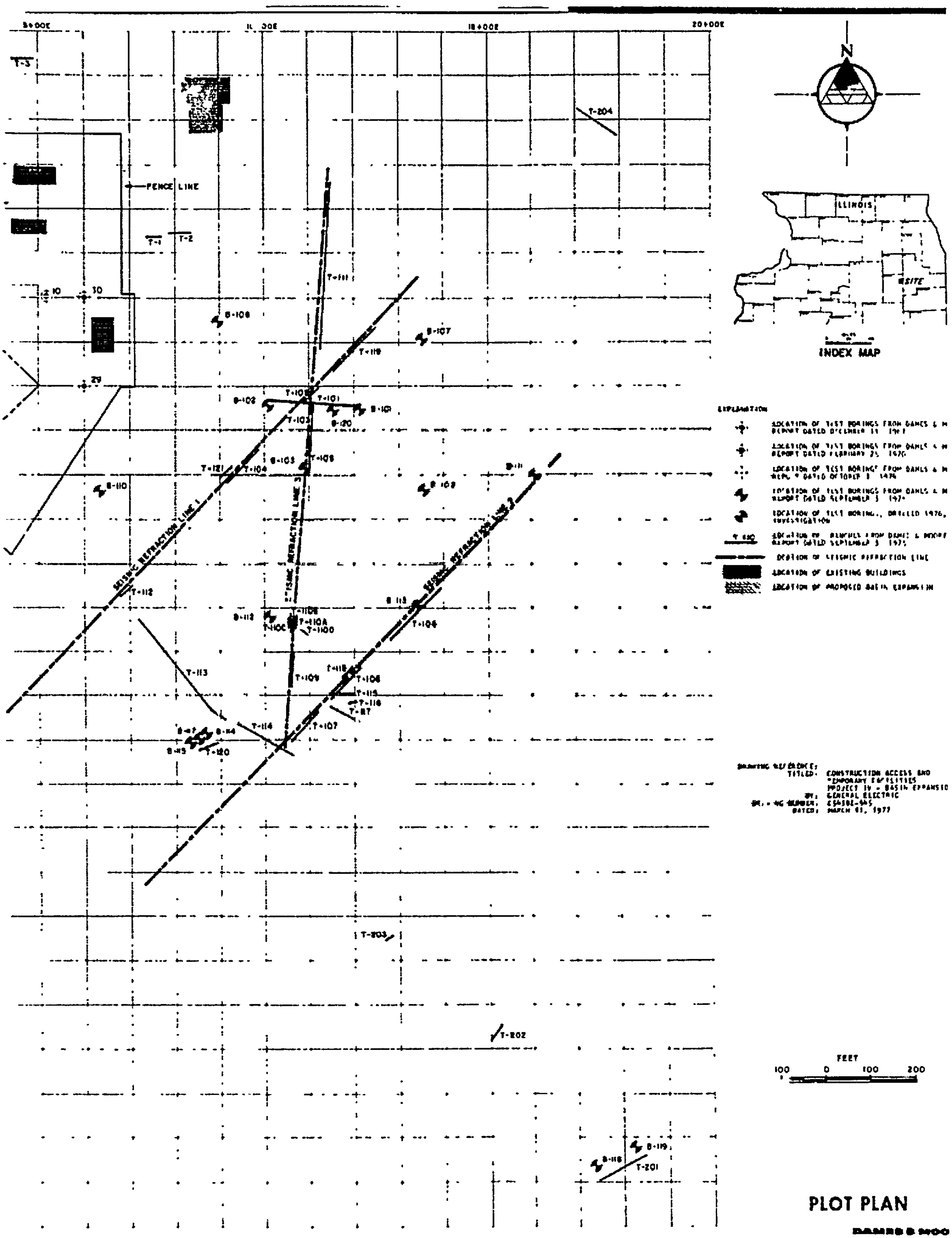
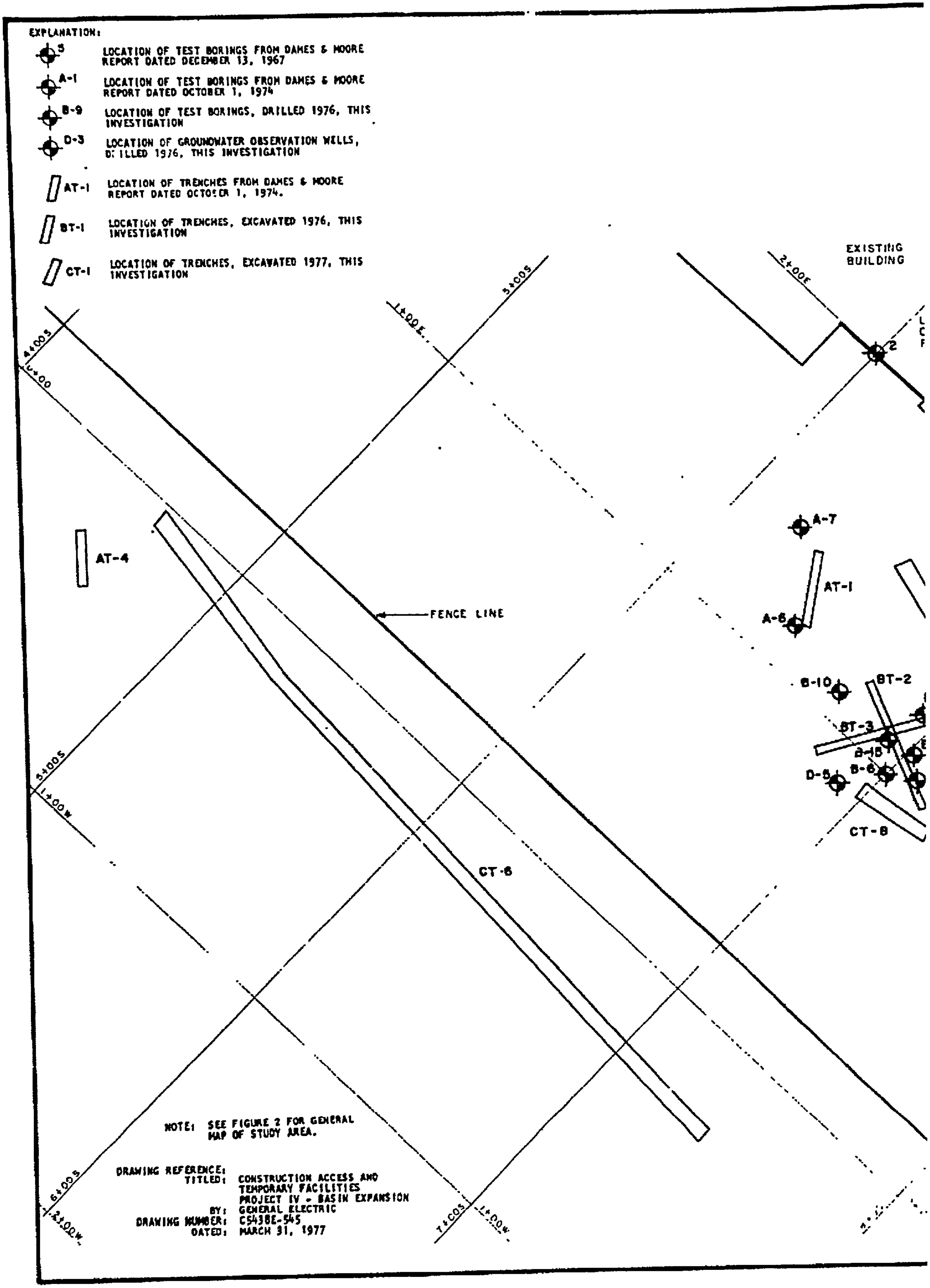
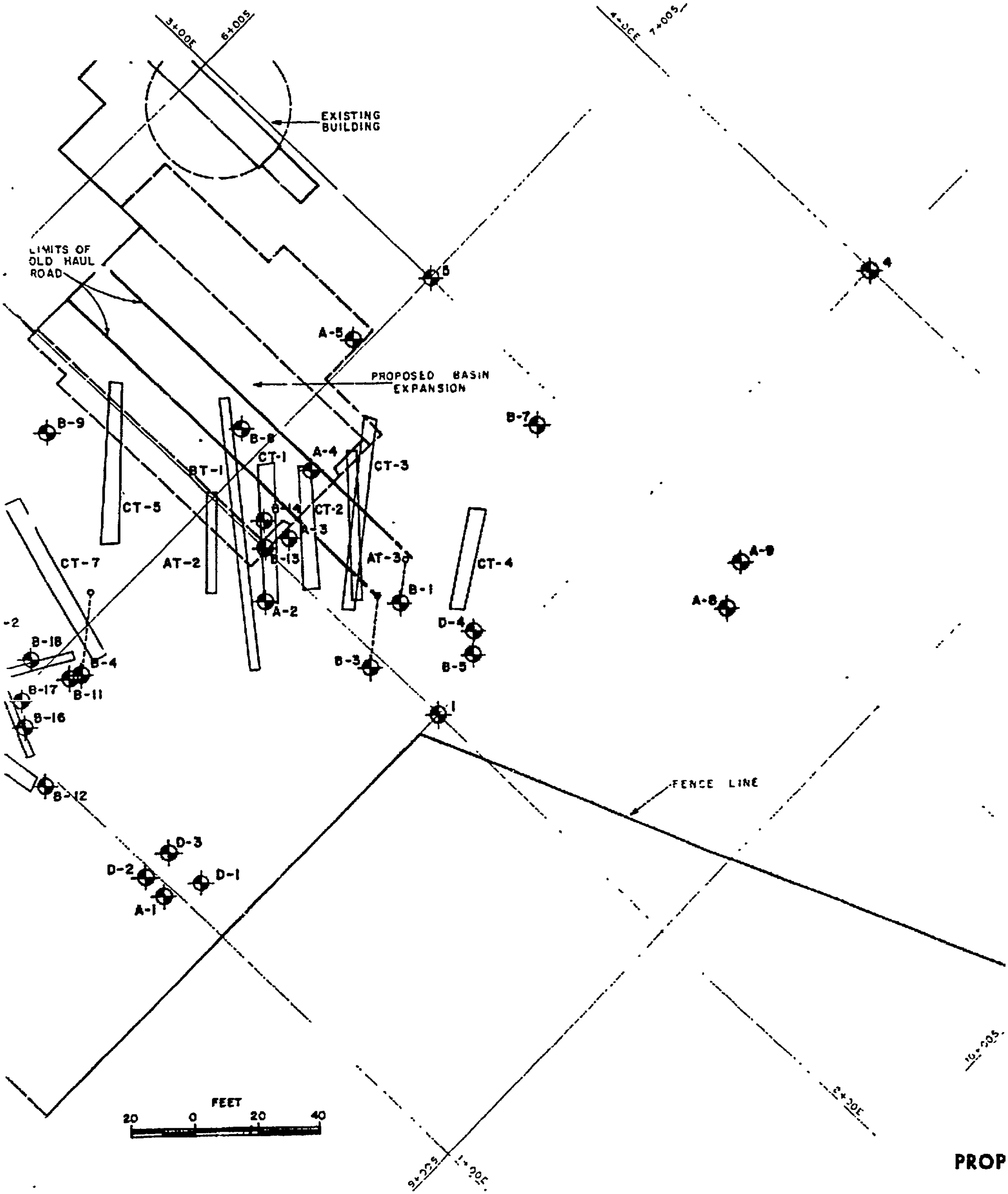


FENCE LINE
T-1
T-2
T-3
T-204
T-111
B-108
B-107
T-119
T-102
T-101
B-102
B-101
T-103
B-120
T-121
T-104
B-103
T-105
B-110
B-109
SEISMIC REFRACTION LINE 1
SEISMIC REFRACTION LINE 3
SEISMIC REFRACTION LINE 2
T-112
B-113
B-112
T-110B
T-110A
T-110C
T-110D
T-106
T-113
T-109
T-118
T-108
T-115
T-116
T-117
T-114
T-107
T-120
T-203
T-202
B-118
B-119
T-201
N
ILLINOIS
SITE
INDEX MAP
EXPLANATION
LOCATION OF SEISMIC REFRACTION LINE
LOCATION OF EXISTING BUILDINGS
LOCATION OF PROPOSED BASIN EXPANSION
FEET
100
0
100
200
PLOT PLAN

FIGURE 2

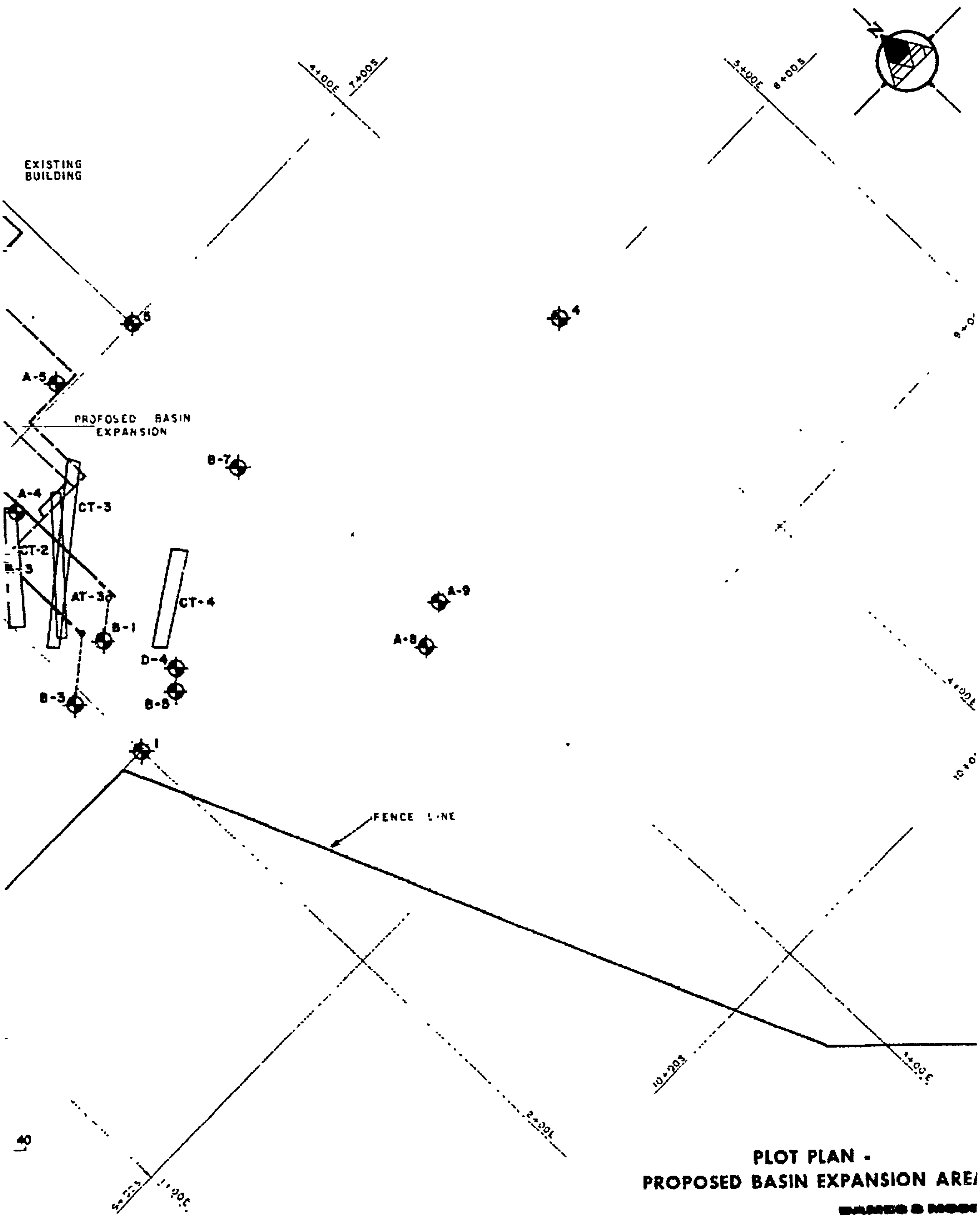

EXPLANATION:
5 LOCATION OF TEST BORINGS FROM DAMES & MOORE REPORT DATED DECEMBER 13, 1967
A-1 LOCATION OF TEST BORINGS FROM DAMES & MOORE REPORT DATED OCTOBER 1, 1974
B-9 LOCATION OF TEST BORINGS, DRILLED 1976, THIS INVESTIGATION
D-3 LOCATION OF GROUNDWATER OBSERVATION WELLS, DRILLED 1976, THIS INVESTIGATION
AT-1 LOCATION OF TRENCHES FROM DAMES & MOORE REPORT DATED OCTOBER 1, 1974.
BT-1 LOCATION OF TRENCHES, EXCAVATED 1976, THIS INVESTIGATION
CT-1 LOCATION OF TRENCHES, EXCAVATED 1977, THIS INVESTIGATION
EXISTING BUILDING
2+00E
5+00S
1+00E
4+00S
0+00
5+00S
1+00W
6+00S
2+00W
7+00S
1+00W
A-7
AT-1
A-6
AT-4
FENCE LINE
B-10
BT-2
BT-3
B-15
B-6
D-5
CT-8
CT-6
NOTE: SEE FIGURE 2 FOR GENERAL MAP OF STUDY AREA.
DRAWING REFERENCE:
TITLED: CONSTRUCTION ACCESS AND TEMPORARY FACILITIES PROJECT IV - BASIN EXPANSION
BY: GENERAL ELECTRIC
DRAWING NUMBER: C5438E-545
DATED: MARCH 31, 1977

1674-099-07



3+00E
6+00S
4+00E
7+00S
EXISTING BUILDING
LIMITS OF OLD HAUL ROAD
PROPOSED BASIN EXPANSION
5
4
A-5
B-9
B-8
B-7
CT-1
A-4
CT-3
BT-1
CT-5
B-14
CT-2
A-3
B-13
AT-3
CT-4
CT-7
AT-2
A-9
A-8
B-1
A-2
D-4
B-5
B-3
B-18
B-4
B-11
B-17
B-16
1
B-12
FENCE LINE
D-3
D-2
D-1
A-1
FEET
20
0
20
40
9+00S
1+00E
8+00E
10+00S

PROP



40

PLOT PLAN -
PROPOSED BASIN EXPANSION ARE/

FIGURE 3

KEY:

INDICATES PERCENT OF CORE RECOVERED.

100
(50)

INDICATES DEPTH AND LENGTH OF CORE RUN FOR NX DIAMOND ROCK CORING.

INDICATES ROCK QUALITY DESIGNATION.

6.2×10^{-5}

INDICATES DEPTH AND LENGTH PRESSURE TESTED AND PERMEABILITY IN CENTIMETERS PER SECOND.

NOTES:

1) SOIL DESCRIPTIONS ARE IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM.

2) SOILS WERE VISUALLY CLASSIFIED USING AUGER SAMPLES.

3) ANGLE BORINGS ARE MEASURED FROM THE HORIZONTAL (GROUND SURFACE).

4) FRACTURE ANGLES WITHIN ROCK CORE ARE MEASURED PERPENDICULAR TO THE LONGITUDINAL AXIS OF THE CORE.

5) COORDINATES REFER TO GENERAL ELECTRIC PLANT COORDINATES.

6) ELEVATIONS REFER TO U.S. GEOLOGICAL SURVEY, MEAN SEA LEVEL.

BEDDING TERMINOLOGY

THINLY LAMINATED	-	LESS THAN 1/4 INCH
LAMINATED	-	1/4 TO 2 INCHES
THIN BEDDED	-	2 TO 6 INCHES
MEDIUM BEDDED	-	6 TO 12 INCHES
MASSIVE BEDDED	-	GREATER THAN 12 INCHES

WEATHERING TERMINOLOGY

FRESH	THE ROCK SHOWS NO DISCOLORATION, LOSS OF STRENGTH OR ANY OTHER EFFECT DUE TO WEATHERING.
SLIGHTLY WEATHERED	ROCK IS SLIGHTLY DISCOLORED WITH A SLIGHTLY LOWER STRENGTH THAN UNWEATHERED ROCK.
MODERATELY WEATHERED	ROCK IS CONSIDERABLY DISCOLORED WITH A SIGNIFICANTLY LOWER STRENGTH THAN UNWEATHERED ROCK.
HIGHLY WEATHERED	ROCK IS DISCOLORED AND WEAKENED SO INTENSELY THAT 2 INCH DIAMETER ROCK CORES CAN BE BROKEN READILY BY HAND. WET STRENGTH IS USUALLY MUCH LOWER THAN DRY STRENGTH.

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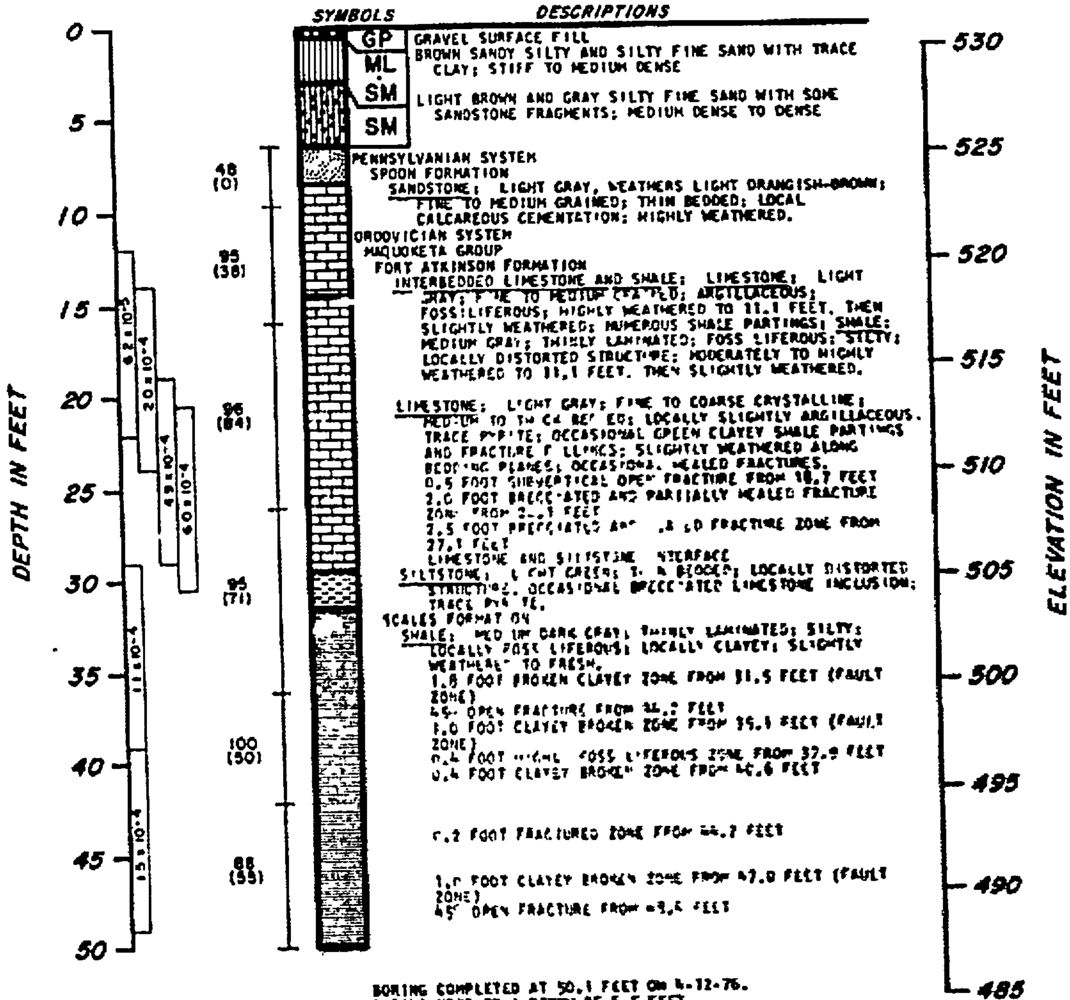
KEY AND GENERAL NOTES FOR LOG OF BORINGS

DAMES & MOORE

FIGURE 4.0

BORING B-1

SURFACE ELEVATION 531.2
COORDINATES S 766.6 E 218.9
60 DEGREE ANGLF BORING



BORING COMPLETED AT 50.1 FEET ON 4-12-76.
CASING USED TO A DEPTH OF 6.5 FEET.
GROUNDWATER LEVEL RECORDED AT 8.5 FEET ON 4-13-76.
PIEZOMETER INSTALLED BETWEEN 18.0 AND 50.1 FEET ON 4-13-76.

LOG OF BORINGS

DAMES & MOORE

FIGURE 4.1

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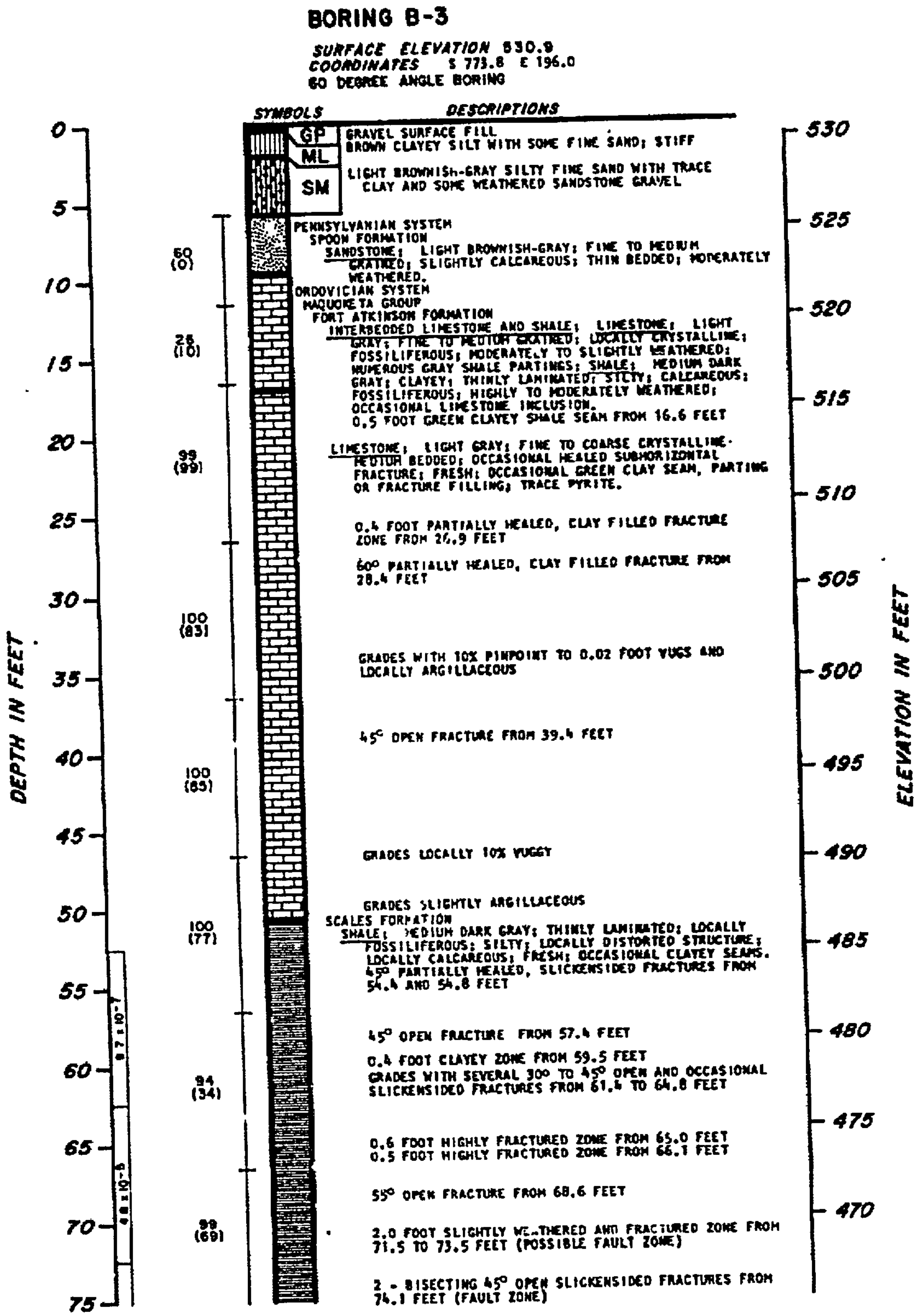

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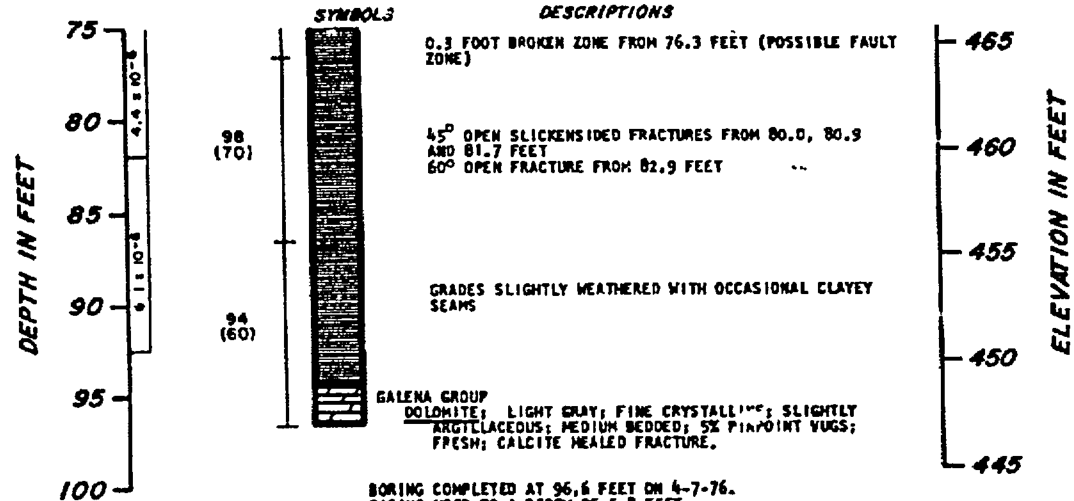
LOG OF BORINGS
SHEET 1 OF 2

DAMES & MOORE

FIGURE 4.2

BORING B-3 CONT.

SURFACE ELEVATION 530.9
COORDINATES S 773.8 E 196.0
60 DEGREE ANGLE BORING



BORING COMPLETED AT 96.6 FEET ON 4-7-76.
CASING USED TO A DEPTH OF 5.8 FEET.
GROUNDWATER LEVEL RECORDED AT 8.0 FEET ON 4-8-76.
PIEZOMETER INSTALLED BETWEEN 48.0 AND 96.6 FEET ON 4-7-76.

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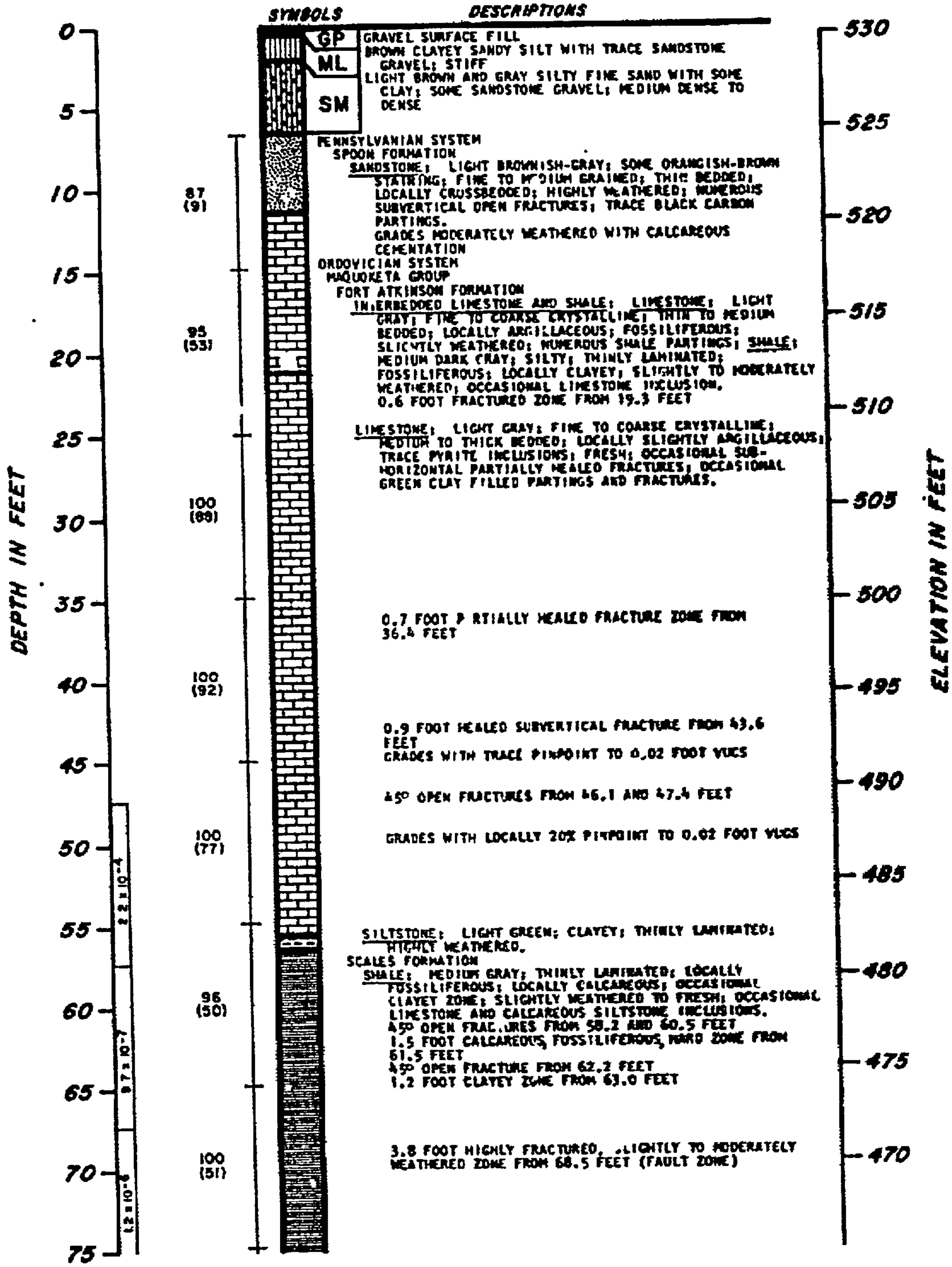
LOG OF BORINGS
SHEET 2 OF 2

DAMES & MOORE

FIGURE 4.2

BORING B-4

SURFACE ELEVATION 530.5
COORDINATES S 710.0 E 130.0
60 DEGREE ANGLE BORING



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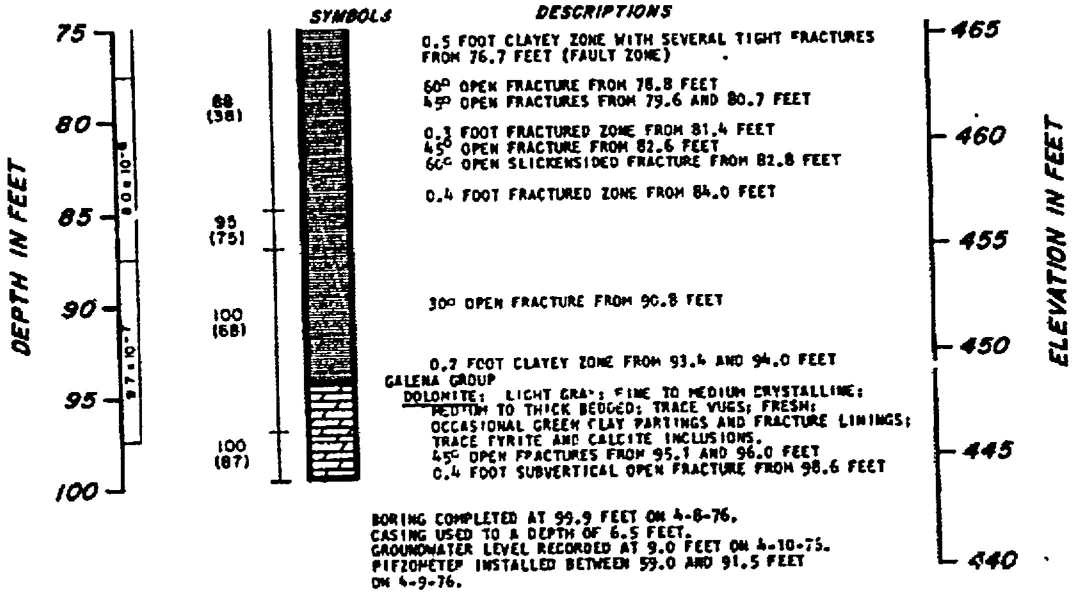
LOG OF BORINGS
SHEET 1 OF 2

DAMES & MOORE

FIGURE 4.3

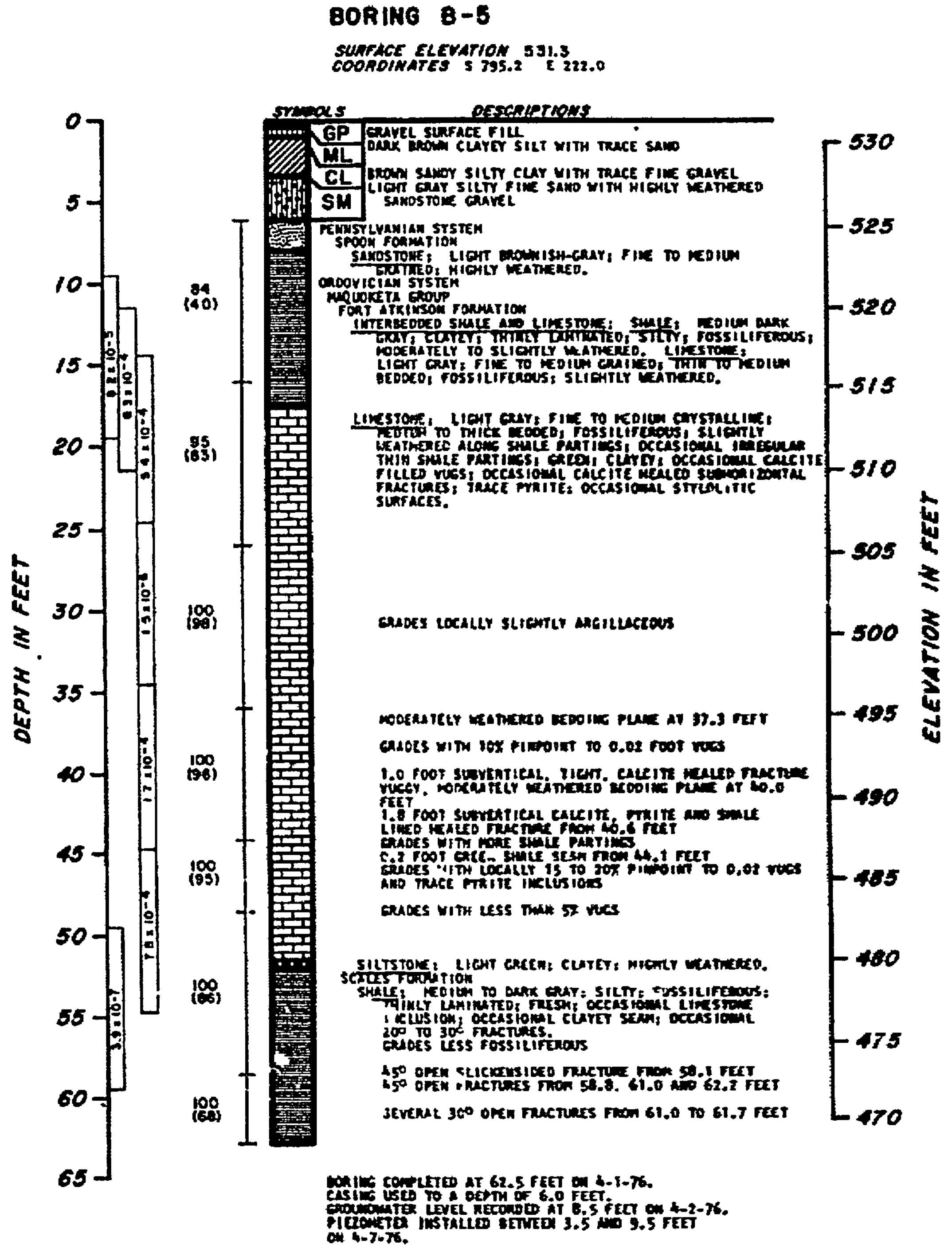


LOG OF BORINGS
SHEET 2 OF 2

DAMES & MOORE

1674-099-07

FIGURE 4.3

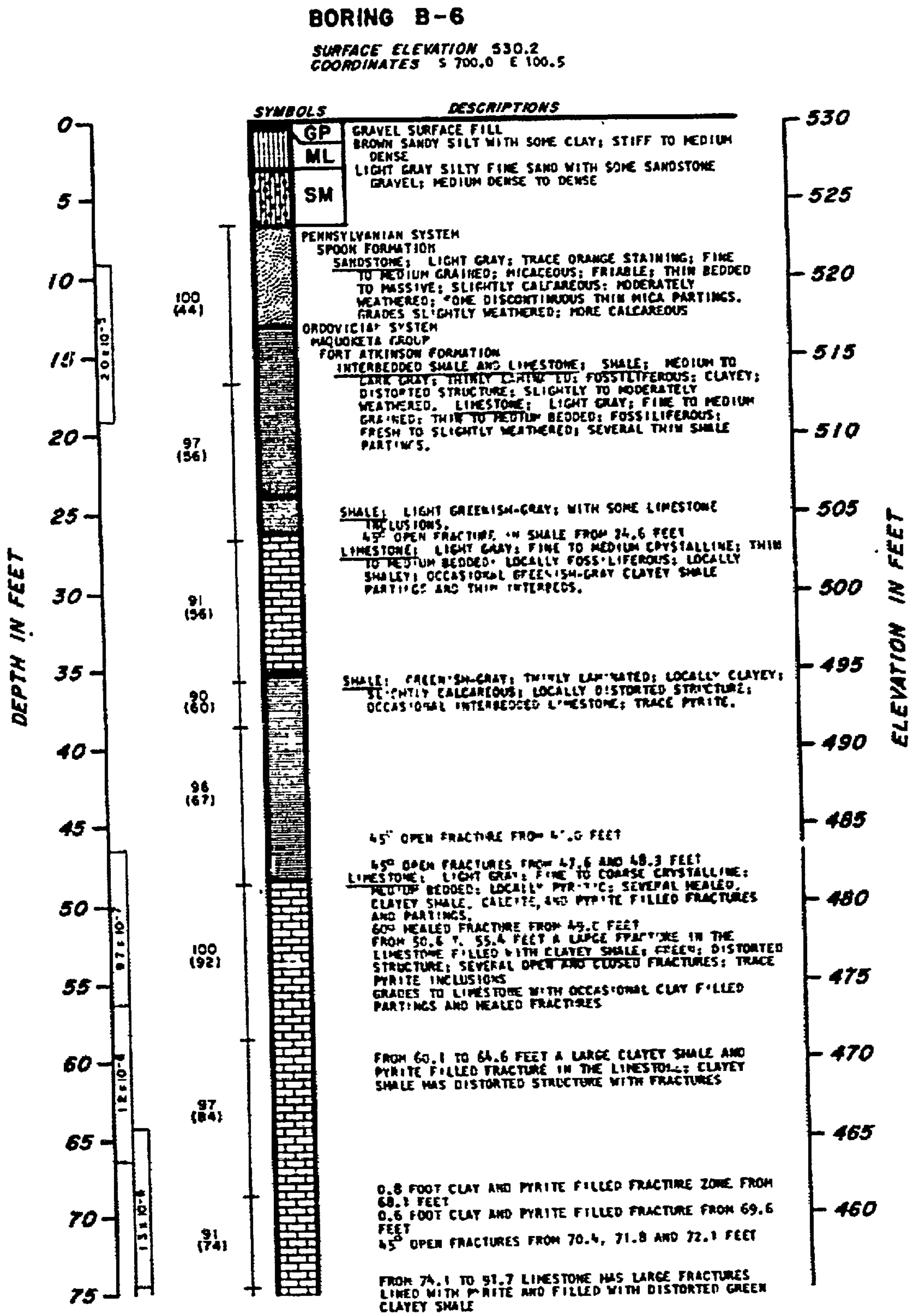


LOG OF BORINGS

DAMES & MOORE

FIGURE 4.4

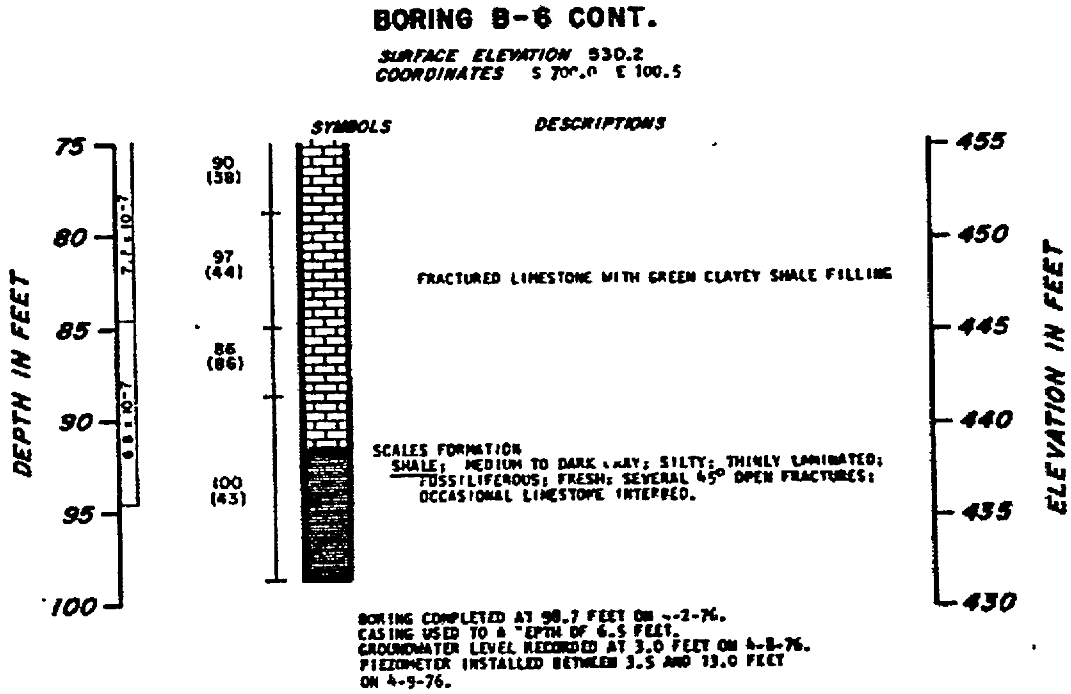
1674-099-07



LOG OF BORINGS
SHEET 1 OF 2

DAMES & MOORE

FIGURE 4.5



LOG OF BORINGS

SHEET 2 OF 2

FIGURE 4.5

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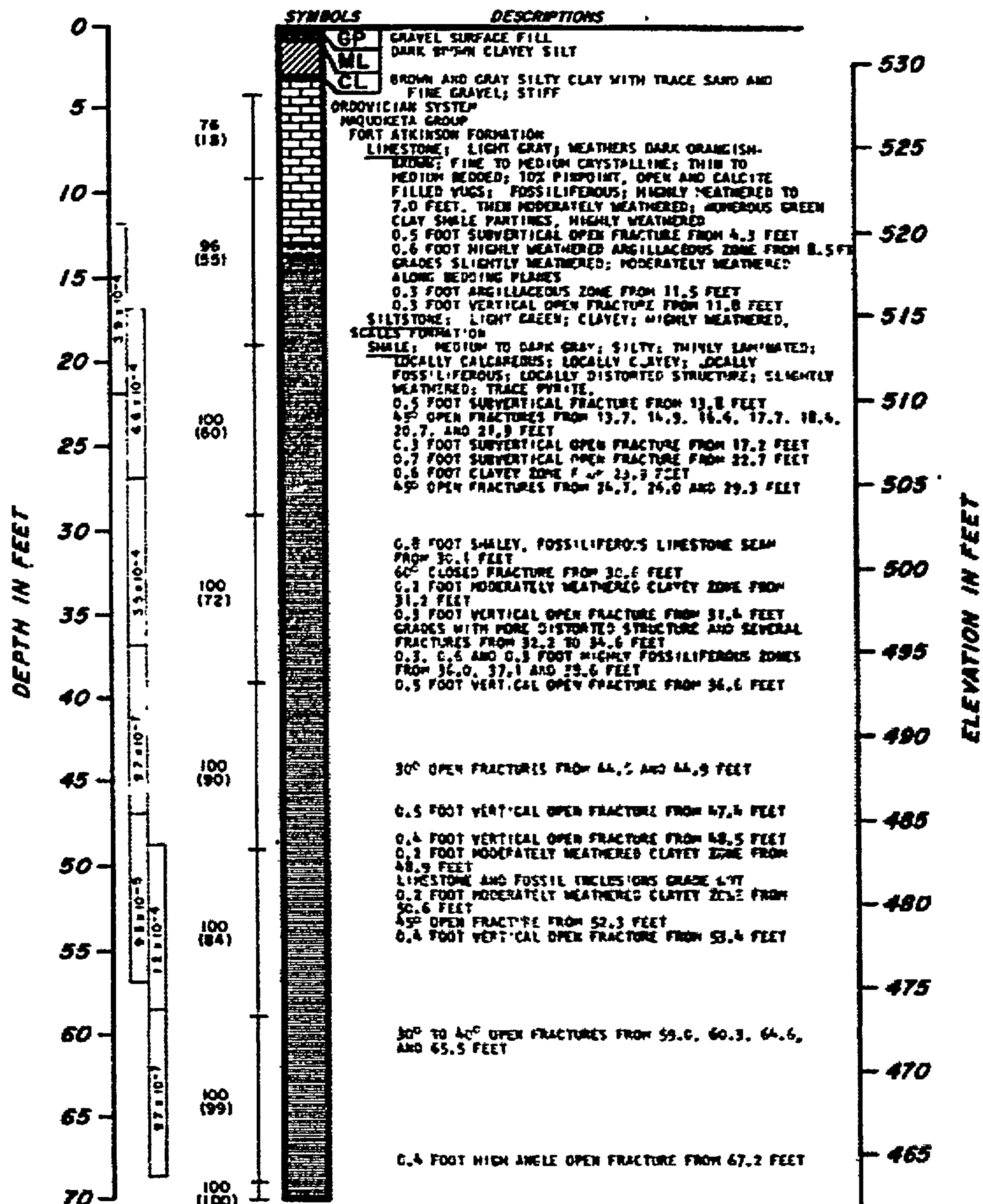
BORING B-7

SURFACE ELEVATION 532.2
COORDINATES S 768.0 E 290.0



BORING COMPLETED AT 70.0 FEET ON 3-31-76.
CASING USED TO A DEPTH OF 3.6 FEET.
GROUNDWATER LEVEL RECORDED AT 4.5 FEET ON 4-1-76.
PIEZOMETER INSTALLED BETWEEN 18.0 AND 42.0 FEET ON 4-22-76.

LOG OF BORINGS

DAMES & MOORE

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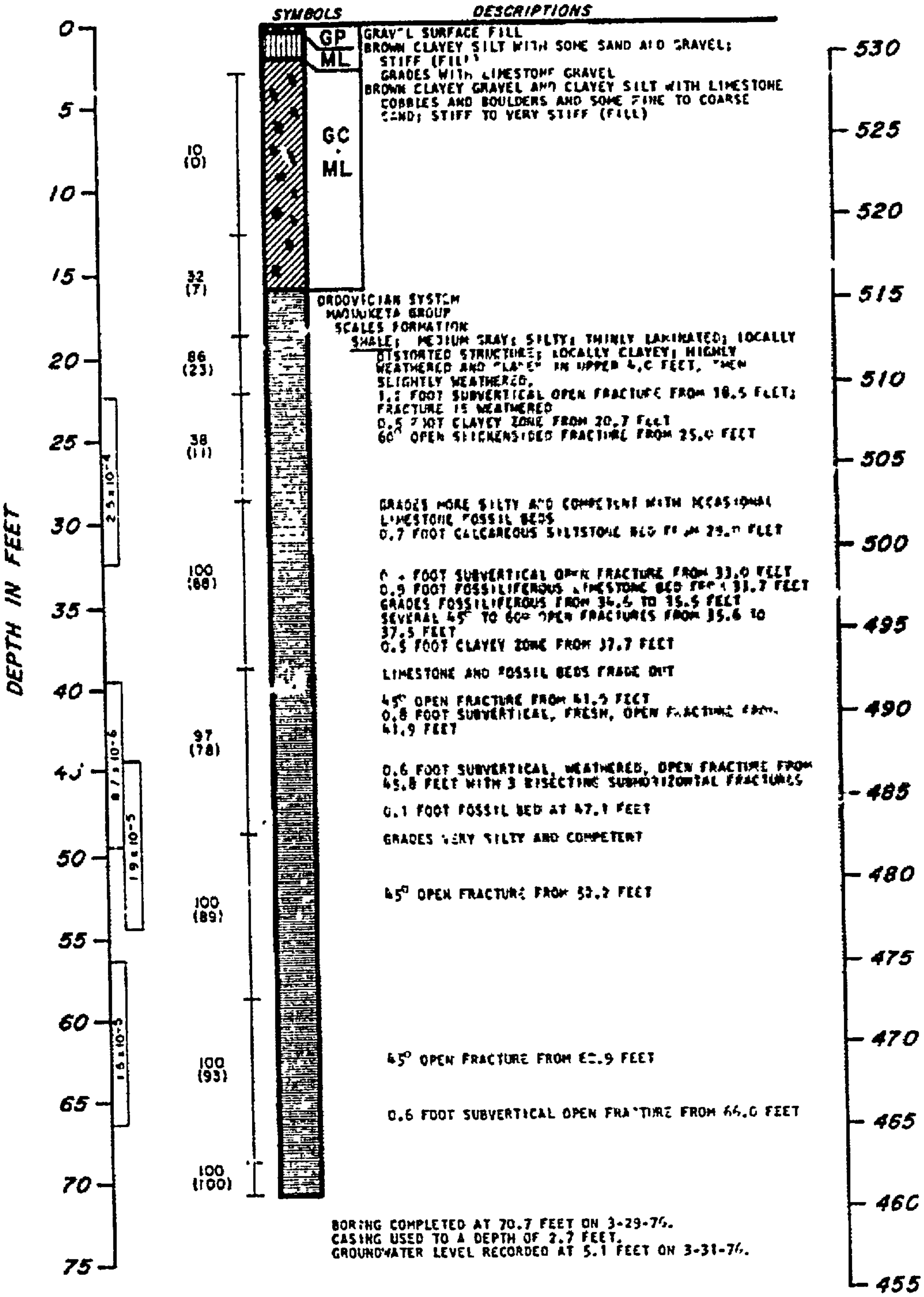
FIGURE 4-?

BORING B-8

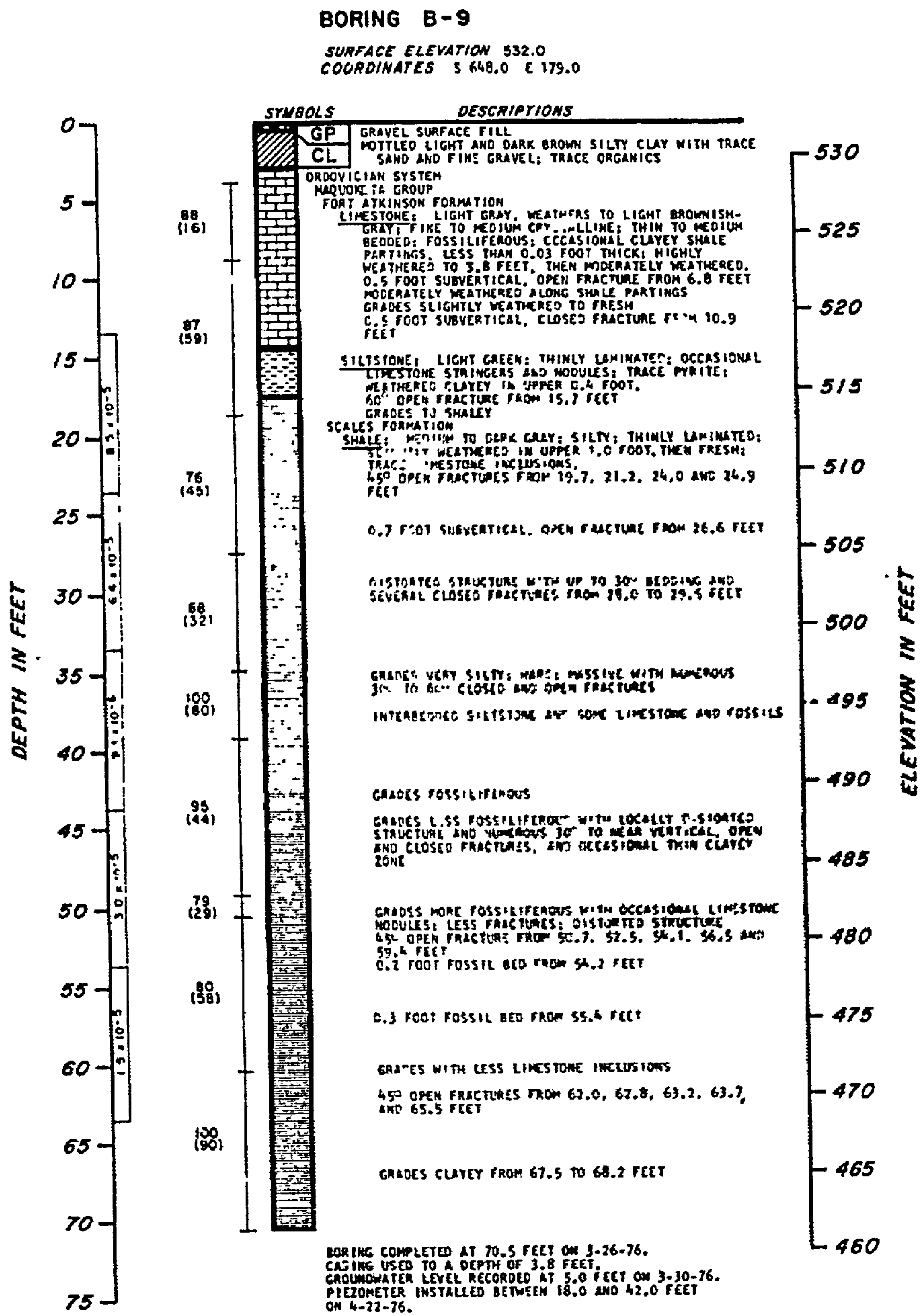
SURFACE ELEVATION 531.7
COORDINATES S 691.0 E 223.0



LOG OF BORINGS

DAMES & MOORE

1674-099-07



LOG OF BORINGS

DAMES & MOORE

FIGURE 4.8

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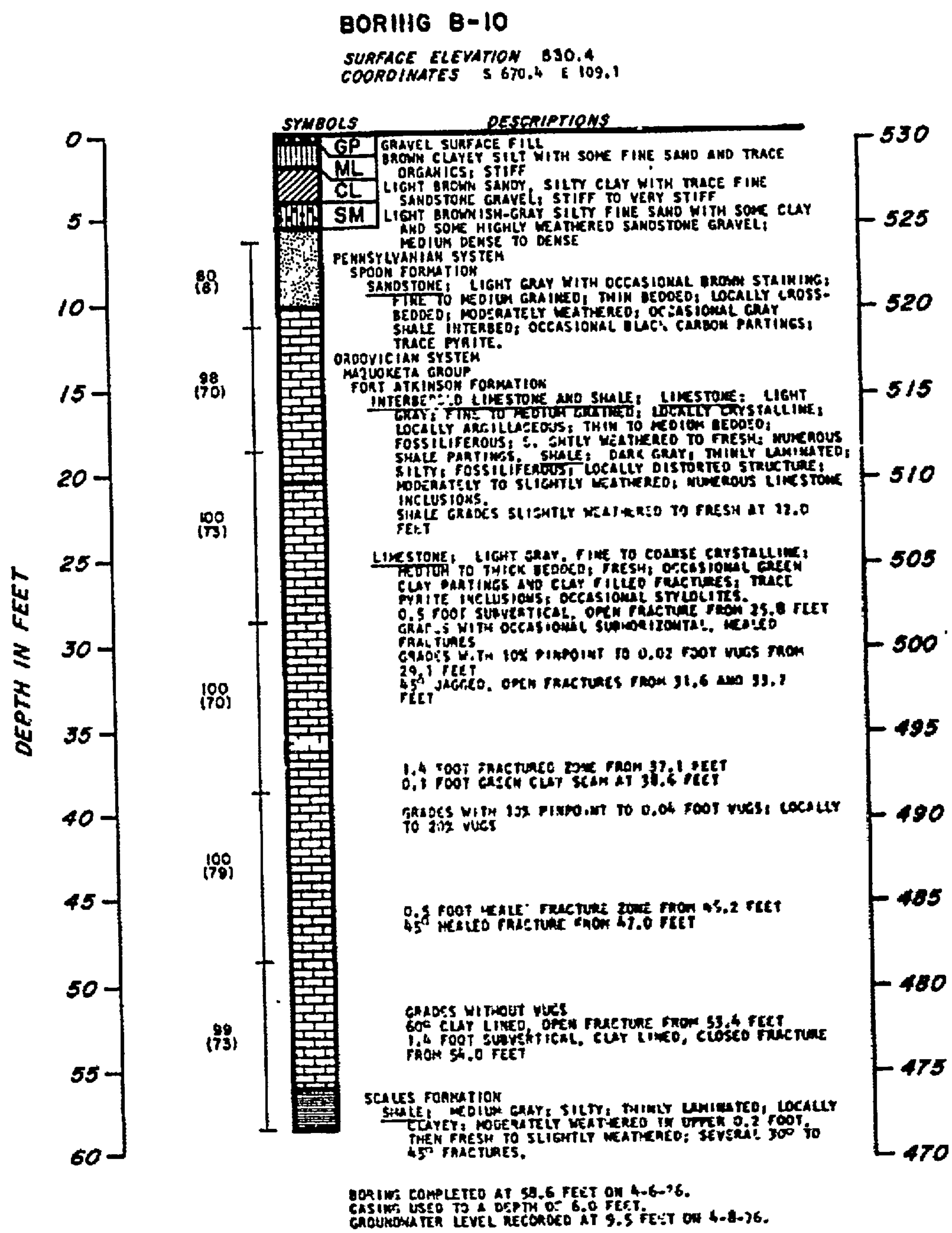

1674-099-07

LOG OF BORINGS

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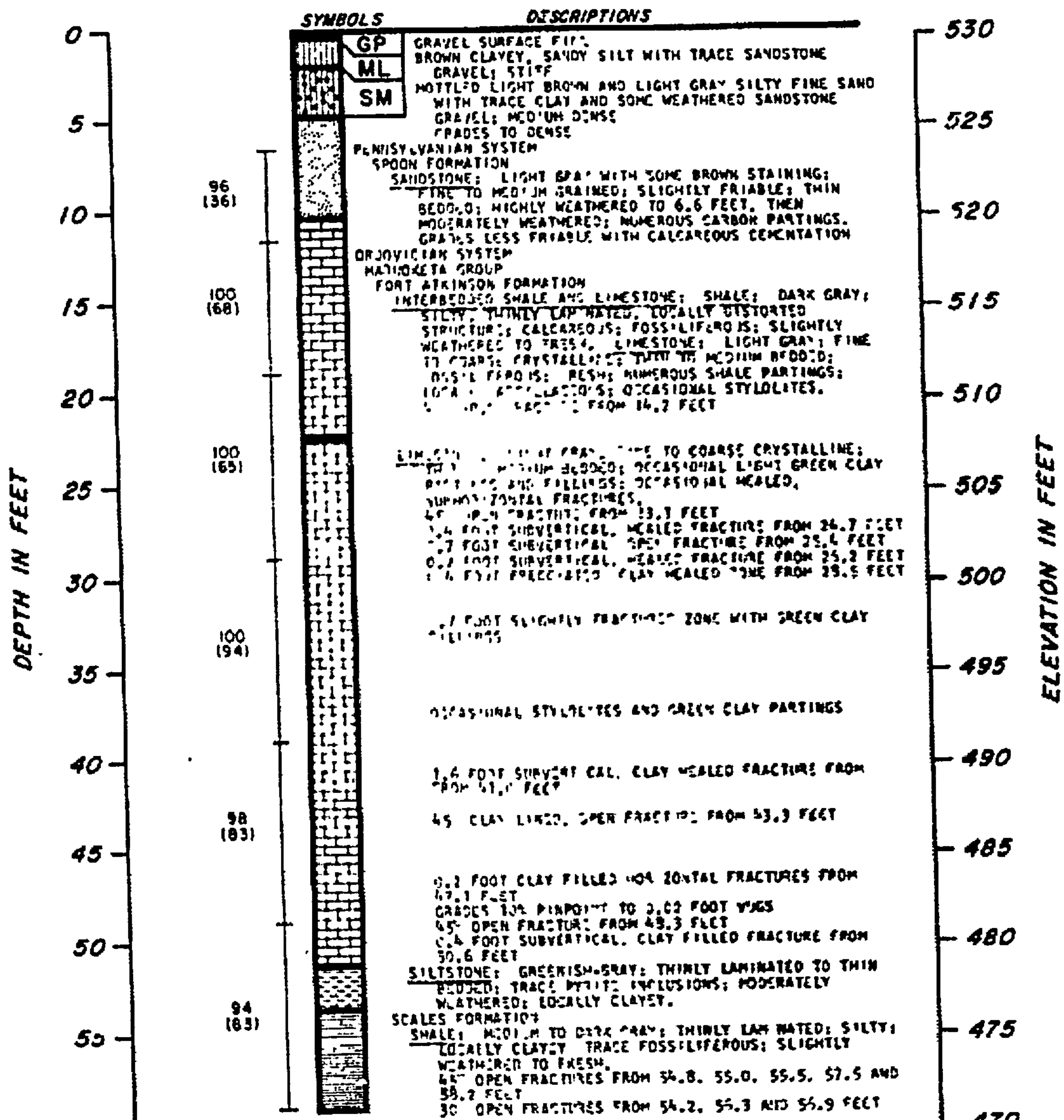
FIGURE 4.9

BORING B-11

SURFACE ELEVATION 530.4
COORDINATES S 708.2 E 126.6



BORING COMPLETED AT 58.9 FEET ON 4-6-75.
CASING USED TO A DEPTH OF 6.5 FEET.
GROUNDWATER LEVEL RECORDED AT 17.7 FEET ON 4-8-75.

LOG OF BORINGS

DAMES & MOORE

FIGURE 4.10

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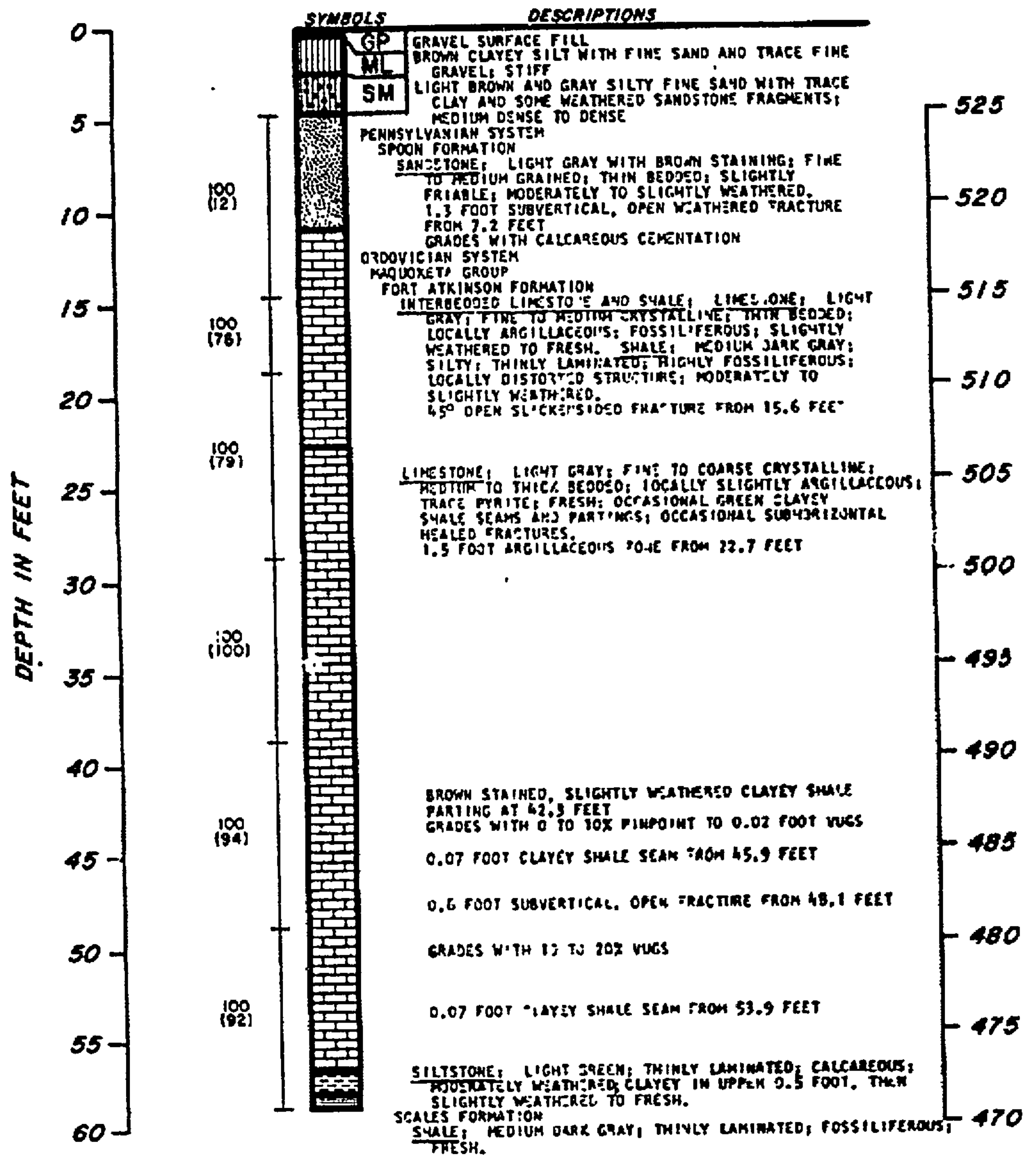
BORING B-12

SURFACE ELEVATIC · 529.6
COORDINATES S ‾ E 86.2



BORING COMPLETED AT 58.7 FEET ON 4-14-76.
CASING USED TO A DEPTH OF 4.5 FEET.
GROUNDWATER LEVEL RECORDED AT 12.6 FEET ON 4-19-76.

LOG OF BORINGS

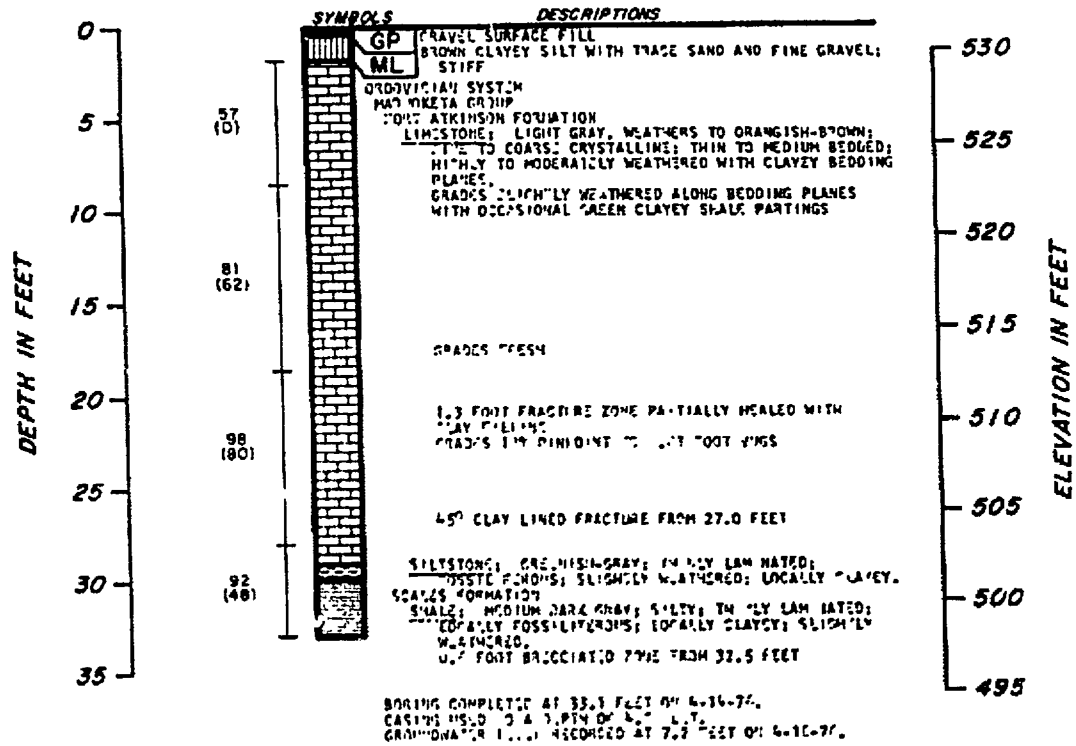
DAMES & MOORE

FIGURE 4.11

1674-099-07

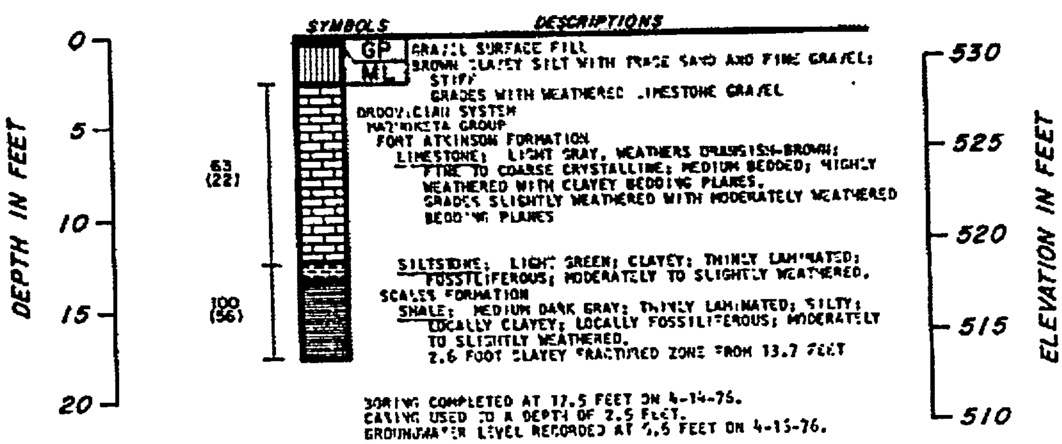
BORING B-13

SURFACE ELEVATION 531.4
COORDINATES S 722.9 E 200.3



BORING B-14

SURFACE ELEVATION 531.4
COORDINATES S 716.7 E 206.4



1674-099-07

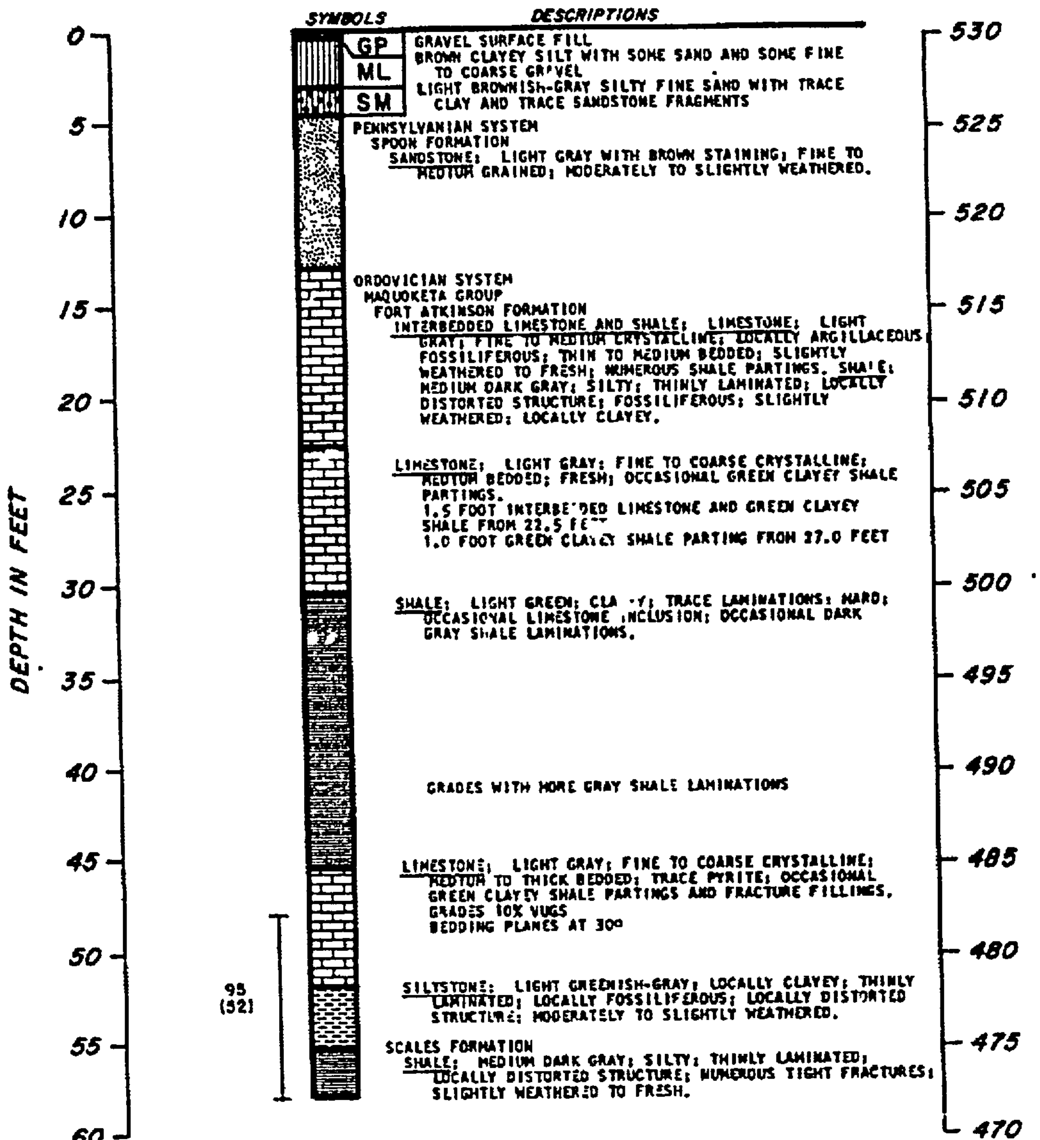
LOG OF BORINGS

DAMES & MOORE

FIGURE 4.12

BORING B-15

SURFACE ELEVATION 530.3
COORDINATES S 692.9 E 108.4



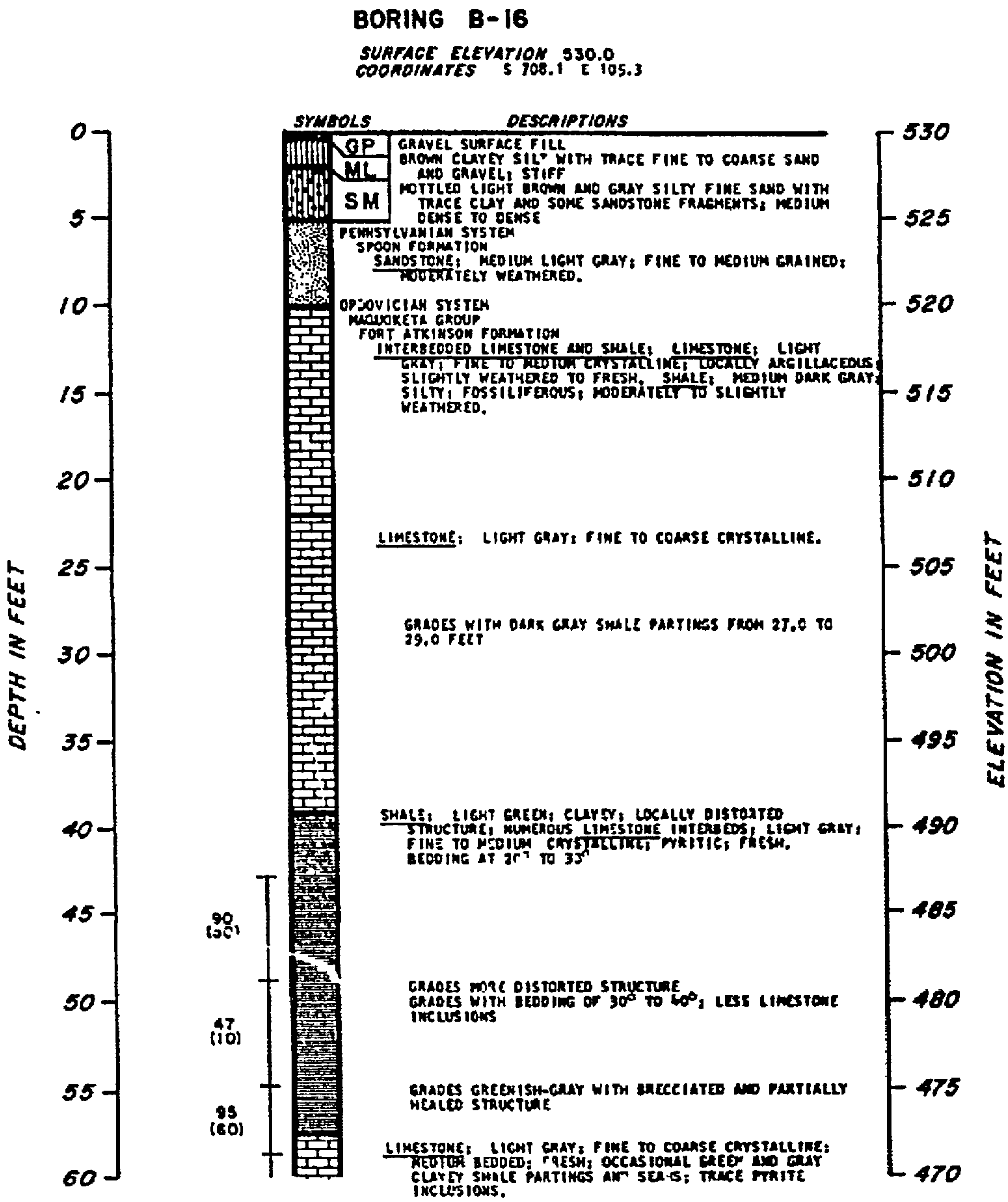
BORING COMPLETED AT 57.9 FEET ON 4-16-76.
CASING USED TO A DEPTH OF 4.5 FEET.
GROUNDWATER LEVEL RECORDED AT 11.6 FEET ON 4-21-76.

1674-099-07

LOG OF BORINGS

DAMES & MOORE

FIGURE 4.13



1674-099-07

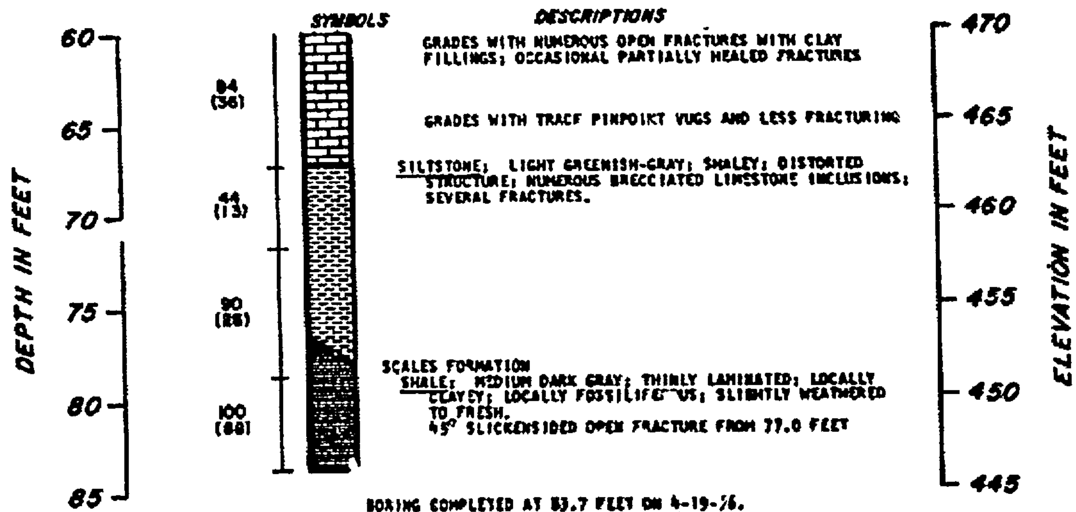
LOG OF BORINGS
SHEET 1 OF 2

DAMES & MOORE

FIGURE 4.14

BORING B-16 CONT.

SURFACE ELEVATION 530.0
COORDINATES S 708.1 E 105.3



BORING COMPLETED AT 83.7 FEET ON 4-19-76.
CASING USED TO A DEPTH OF 7.0 FEET
GROUNDWATER LEVEL RECORDED AT 4.1 FEET ON 4-23-76.

LOG OF BORINGS
SHEET 2 OF 2

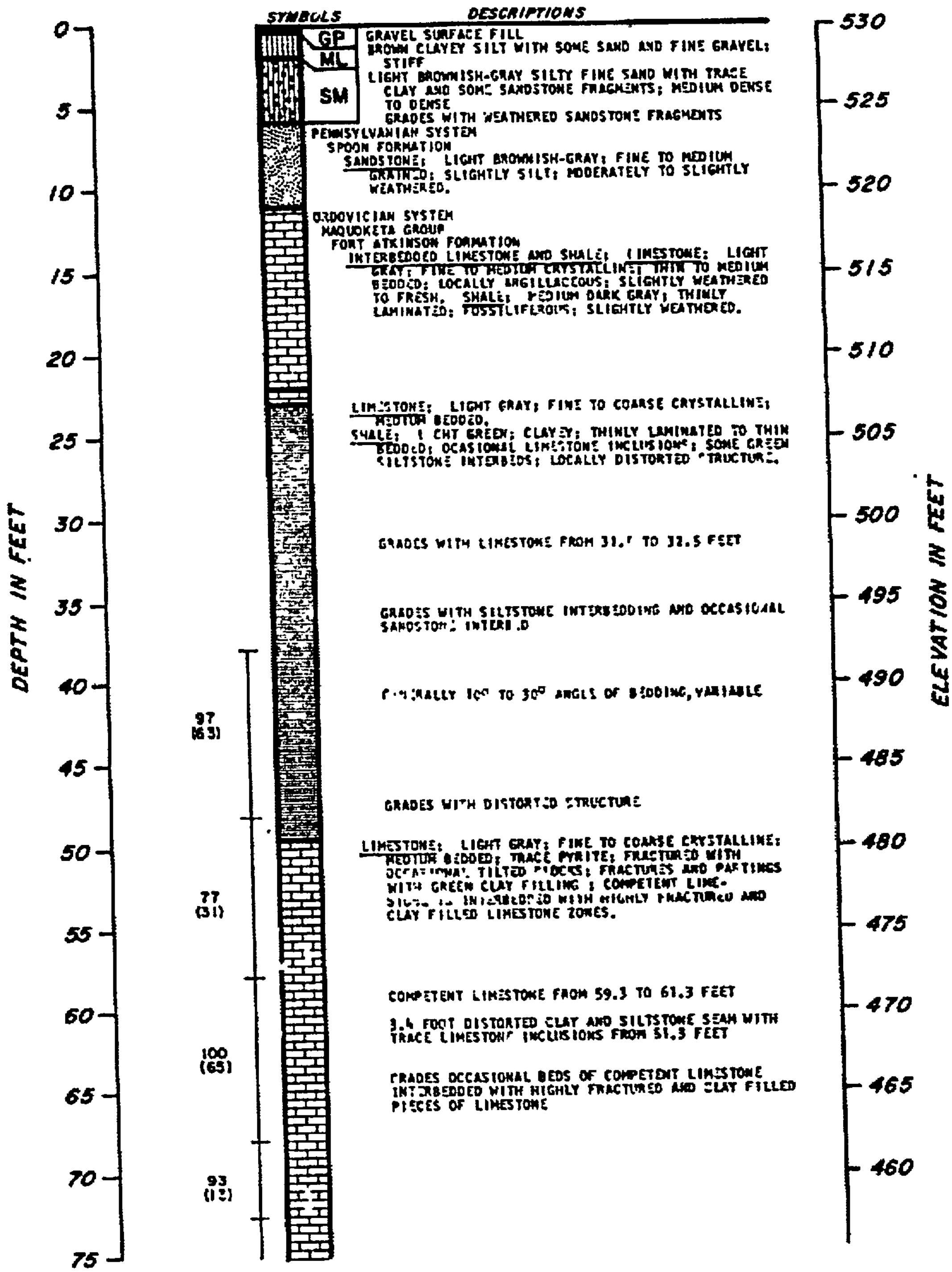
DAMES & MOORE

1674-099-07

FIGURE 4.14

BORING B-17

SURFACE ELEVATION 530.1
COORDINATES S 702.1 E 111.4



1674-099-07

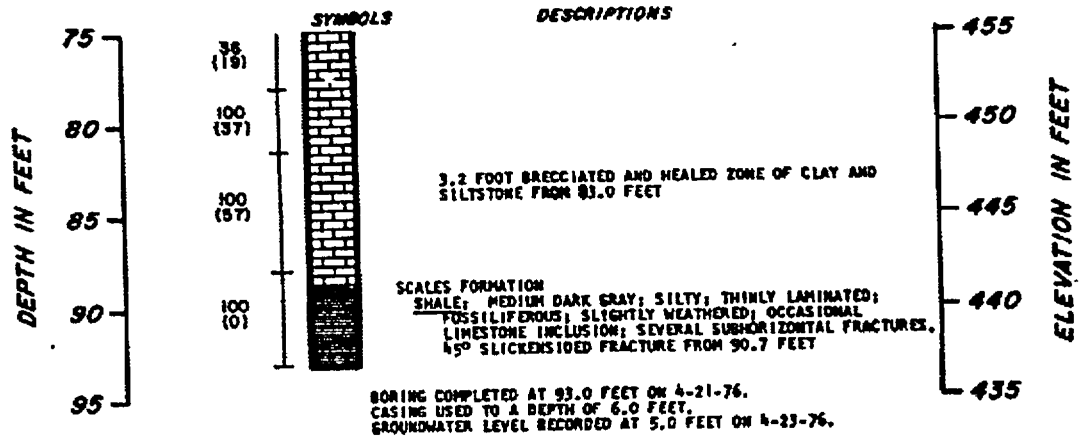
LOG OF BORINGS
SHEET 1 OF 2

DAMES & MOORE

FIGURE 4.15

BORING B-17 CONT.

SURFACE ELEVATION 530.1
COORDINATES S 702.1 E 111.414



1674-099-07

LOG OF BORINGS

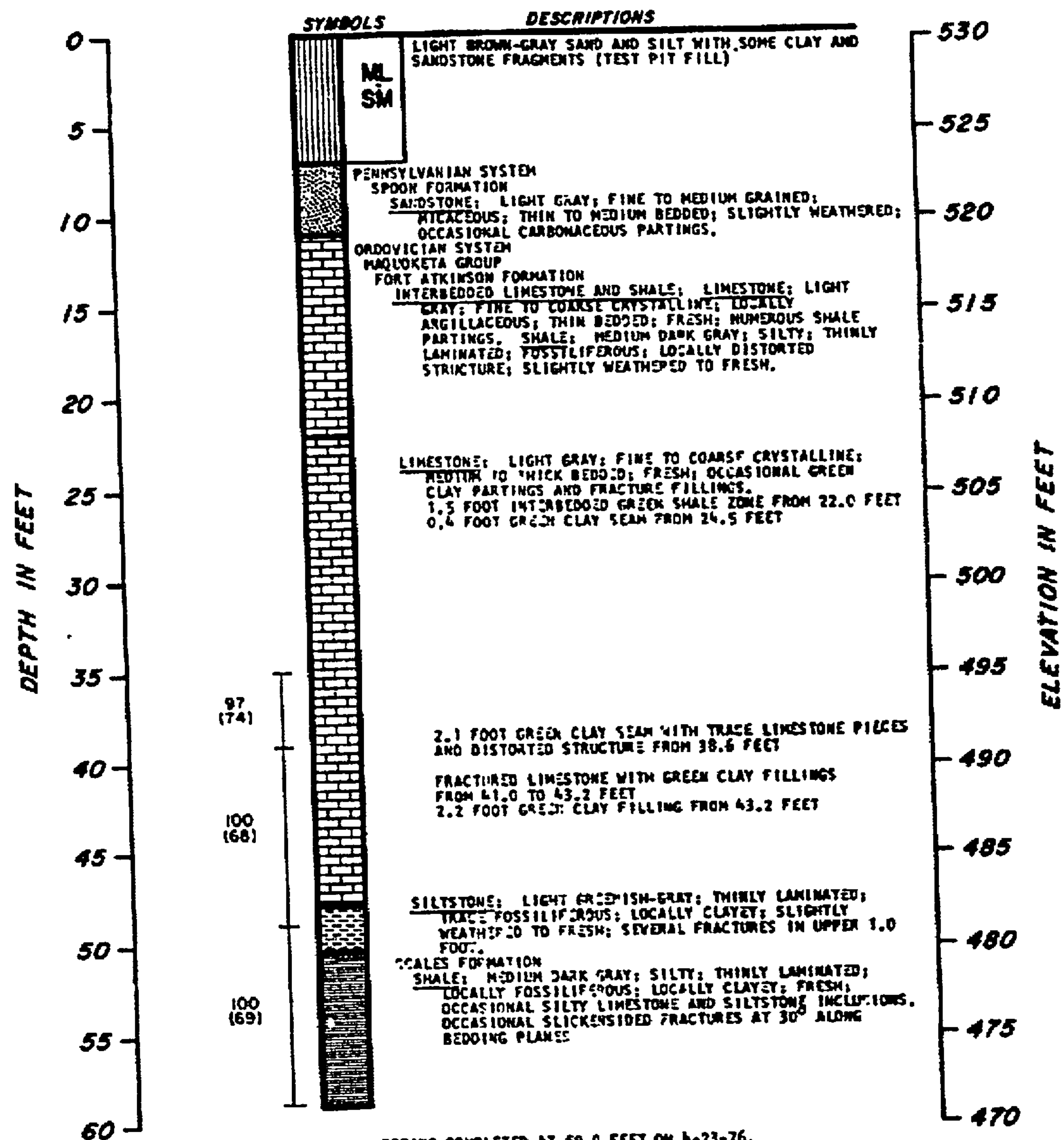
SHEET 2 OF 2

DAMES & MOORE

FIGURE 4.15

BORING B-18

SURFACE ELEVATION 530.3
COORDINATES S 695.0 E 123.0



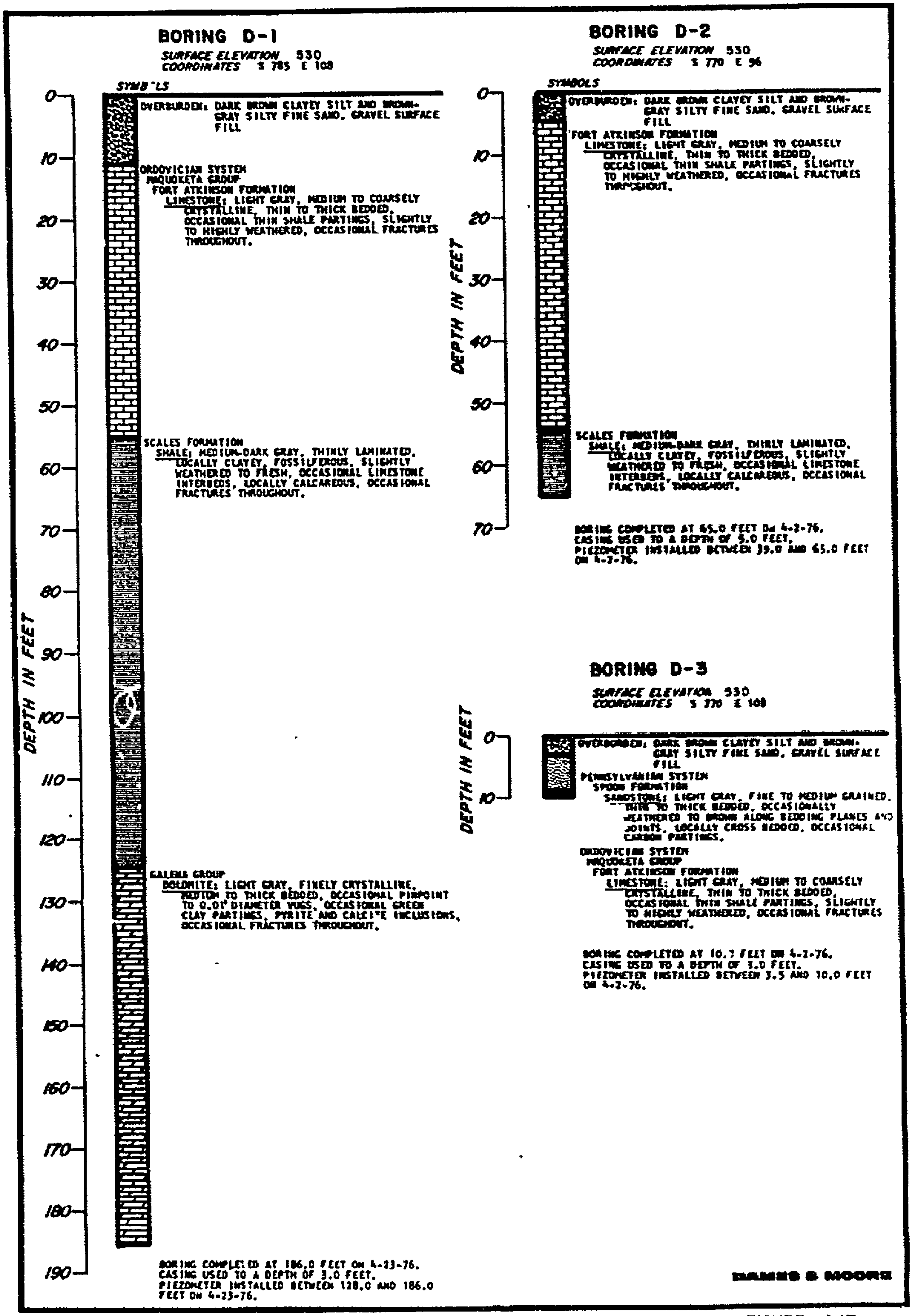
BORING COMPLETED AT 59.0 FEET ON 4-23-76.
CASING USED TO A DEPTH OF 7.0 FEET.
GROUNDWATER LEVEL NOT RECORDED.

1674-099-07

LOG OF BORINGS

DAMES & MOORE

FIGURE 4.16

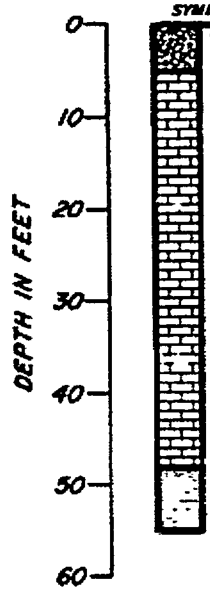


1674-099-07

FIGURE 4.17

BORING D-4

SURFACE ELEVATION 531
COORDINATES S 790 E 227



OVERBURDEN: DARK BROWN CLAYEY SILT AND BROWN-GRAY SILTY FINE SAND. GRAVEL SURFACE FILL

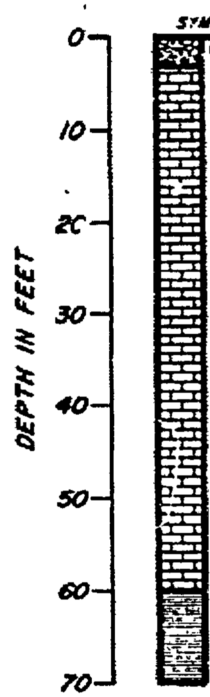
FORT ATKINSON FORMATION
LIMESTONE: LIGHT GRAY, MEDIUM TO COARSELY CRYSTALLINE, THIN TO THICK BEDDED, OCCASIONAL THIN SHALE PARTINGS, SLIGHTLY TO HIGHLY WEATHERED, OCCASIONAL FRACTURES THROUGHOUT.

SCALES FORMATION
SHALE: MEDIUM-DARK GRAY, THINLY LAMINATED, LOCALLY CLAYEY, FOSSILFEROUS, SLIGHTLY WEATHERED TO FRESH, OCCASIONAL LIMESTONE INTERBEDS, LOCALLY CALCAREOUS, OCCASIONAL FRACTURES THROUGHOUT.

BORING COMPLETED AT 55.0 FEET ON 4-8-76.
CASING USED TO A DEPTH OF 5.0 FEET.
PIEZOMETER INSTALLED BETWEEN 32.0 AND 55.0 FEET ON 4-8-76.

BORING D-5

SURFACE ELEVATION 530
COORDINATES S 691 E 86



OVERBURDEN: DARK BROWN CLAYEY SILT AND BROWN-GRAY SILTY FINE SAND. GRAVEL SURFACE FILL

FORT ATKINSON FORMATION
LIMESTONE: LIGHT GRAY, MEDIUM TO COARSELY CRYSTALLINE, THIN TO THICK BEDDED, OCCASIONAL THIN SHALE PARTINGS, SLIGHTLY TO HIGHLY WEATHERED, OCCASIONAL FRACTURES THROUGHOUT.

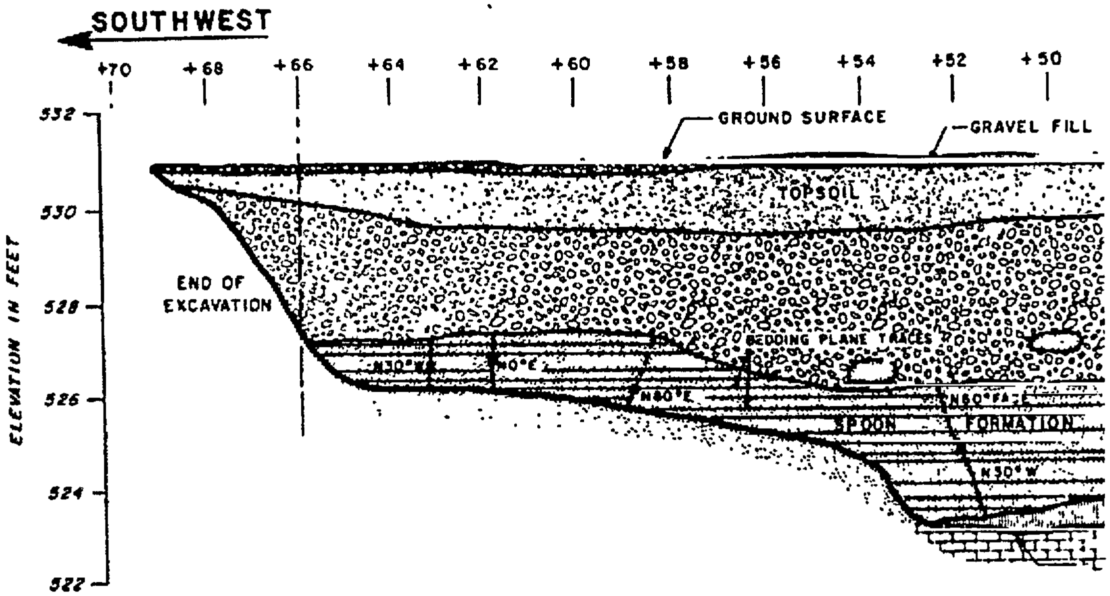
SCALES FORMATION
SHALE: MEDIUM-DARK GRAY, THINLY LAMINATED, LOCALLY CLAYEY, FOSSILFEROUS, SLIGHTLY WEATHERED TO FRESH, OCCASIONAL LIMESTONE INTERBEDS, LOCALLY CALCAREOUS, OCCASIONAL FRACTURES THROUGHOUT.

BORING COMPLETED AT 70.0 FEET ON 4-21-76.
CASING USED TO A DEPTH OF 3.0 FEET.
PIEZOMETER INSTALLED BETWEEN 43.0 AND 70.0 FEET ON 4-21-76.

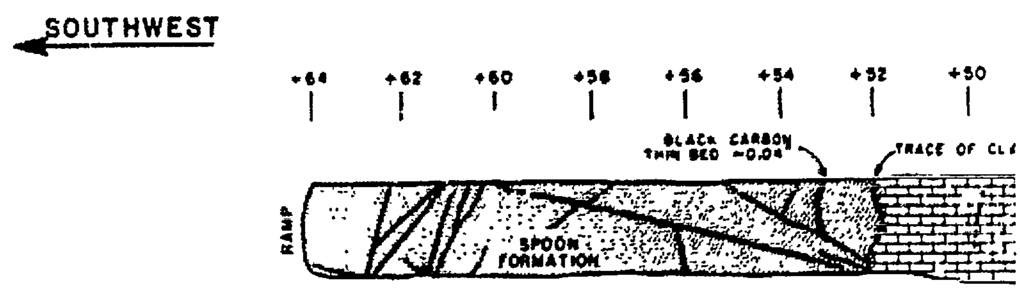
DAMES & MOORE

FIGURE 4.18

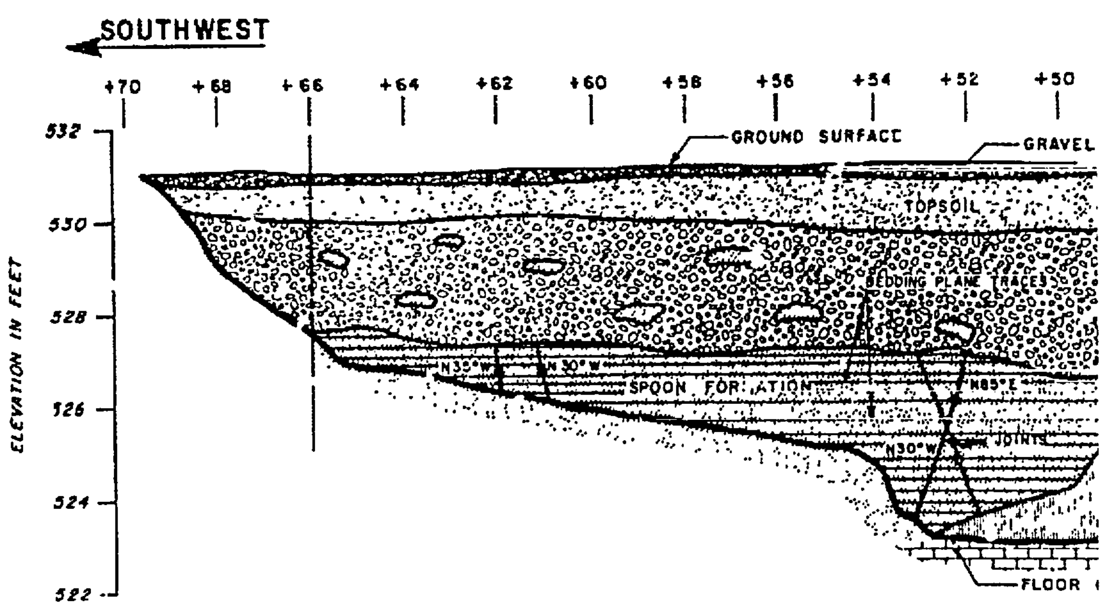
1674-093-07



NORTH \

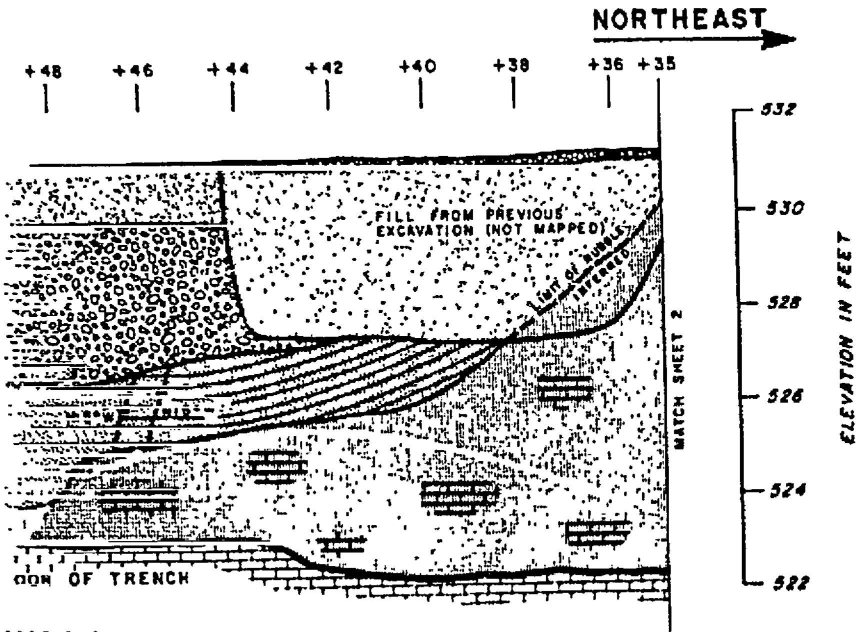


TRENCH F

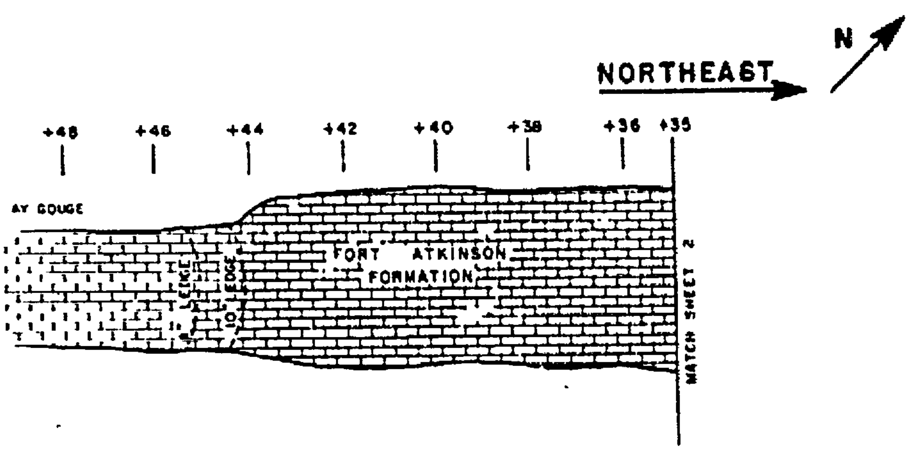


SOUTH \

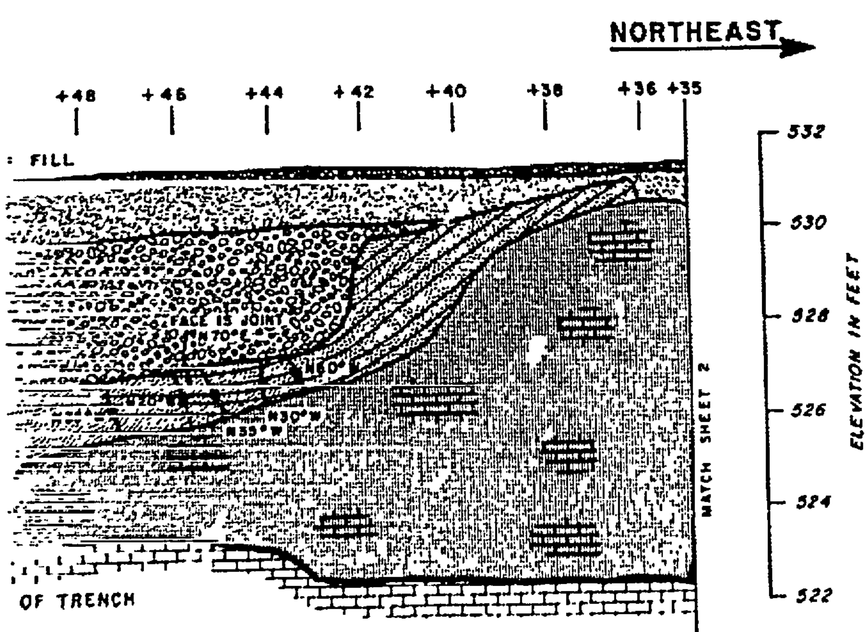
1674-099-07



WALL



LOOR PLAN



WALL

EXPLANATION:

FILL: BLACK ORGANIC CLAY AND SILT WITH CONSTRUCTION MATERIAL.

TILL: DARK BROWN AND BROWNISH-YELLOW SILTY CLAY MATRIX; WITH 40% ROUNDED GRAVELS; CALCAREOUS; POORLY SORTED; OCCASIONAL ANGULAR AND SUB-ANGULAR SANDSTONE SLABS.

SANDSTONE: LIGHT GRAY WITH YELLOWISH-RED CONCRETIONS; FINE TO MEDIUM GRAINED; THI BEDDED; MICACEOUS; FRESH TO MODERATELY WEATHERED; INCLINED BEDDING SW FROM IMMEDIATE VICINITY OF FAULT.

LIMESTONE CLAY 'RUBBLE': LIGHT GRAYISH-BRO SILTY CLAY MATRIX WITH ANGULAR FRAGMENTS LIMESTONE UP TO 1 FOOT; VERY CALCAREOUS; POORLY SORTED, POORLY GRADED; OCCASIONAL WEATHERED CHEAT FRAGMENTS.

LIMESTONE: LIGHT GRAY; COARSE CRYSTALLINE; MEDIUM TO THICK BEDDED; WEATHERS YELLOWI BROWN; MODERATELY WEATHERED AND OCCASION CLAY-FILLED ALONG BEDDING PLANES, JOINTS FRACTURES; FOSSILIFEROUS; OCCASIONAL CAL CRYSTALS ALONG JOINT SURFACES.

SILTY CLAY: GREENISH-GRAY; OCCASIONALLY CONTAINS INCLUSIONS OF EXTREMELY WEATHERED LIMESTONE FRAGMENTS; FOUND WITHIN FRACTURES AND ALONG LIMESTC BEDDING PLANES; WEATHERS YELLOWISH-BROWN

JOINT

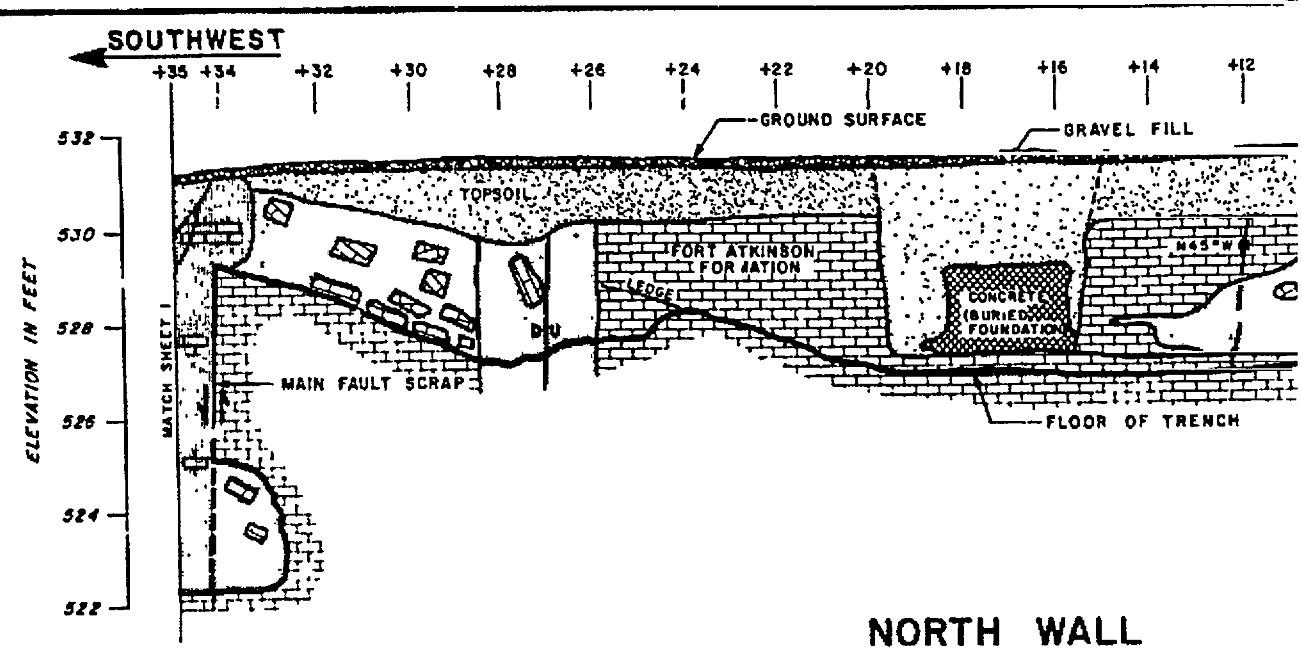
NOTES:

1. TRENCH PROFILES ARE SHOWN FROM THE SAME DIRECTION, LOOKING NORTHWEST.
2. SOME FREATURES SEEN ON PROFILES OF TRENCHI ARE OBSCURED ON FLOOR AND DO NOT APPEAR.
3. DATA SHOWN BELOW TRENCH FLOOR IS INTERPRE' BASED ON BORING DATA AND VISUAL INSPECTIO OF TRENCHES.

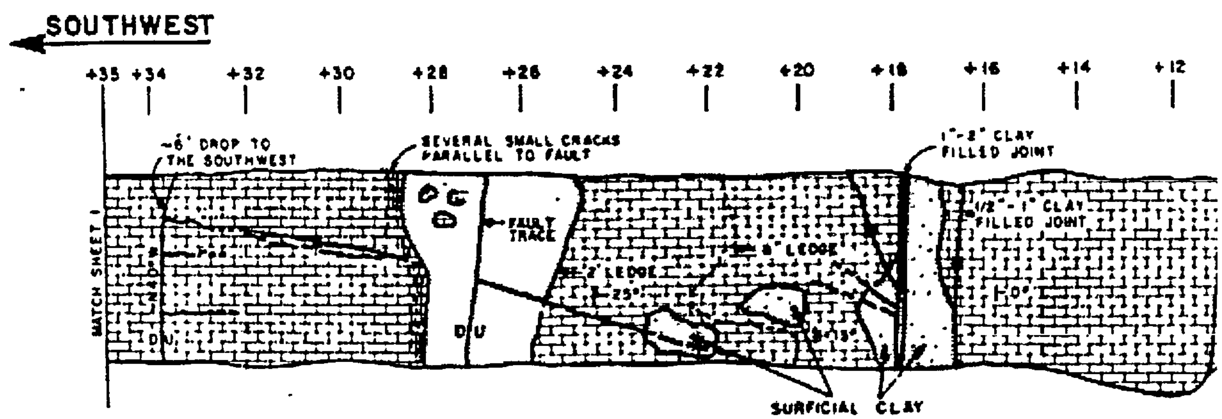
NO VERTICAL EXAGGERATION

TRENCH CROSS-SEC
BT - 1
SHEET 1 OF 2

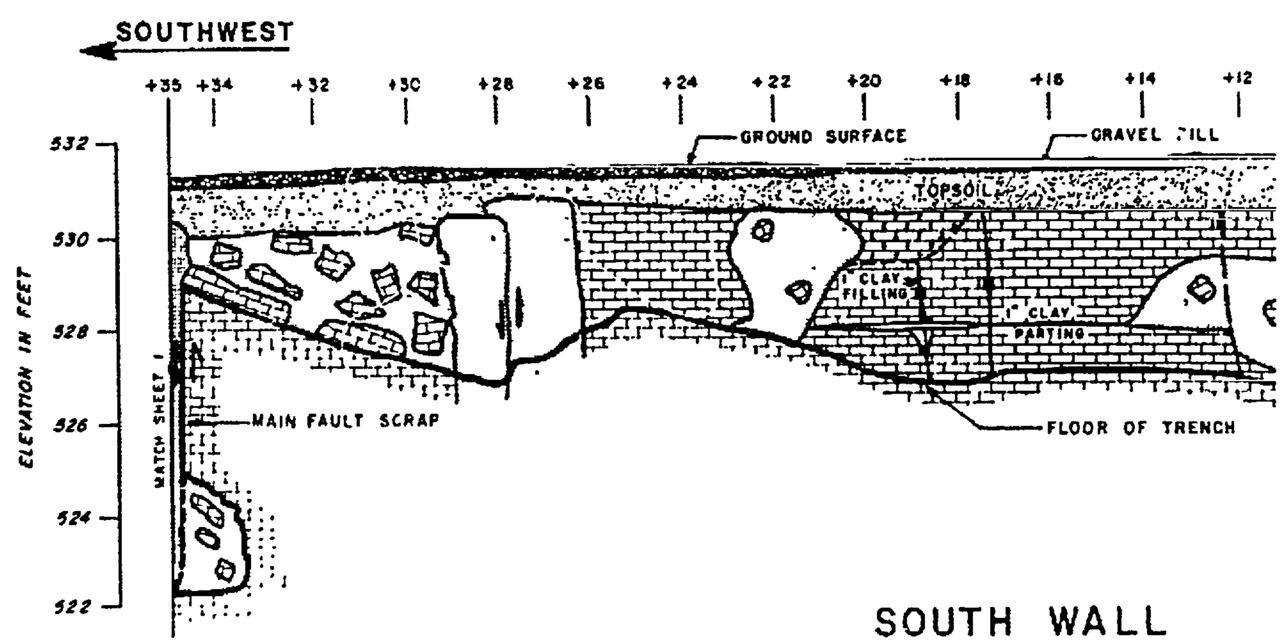
FIGURE



NORTH WALL

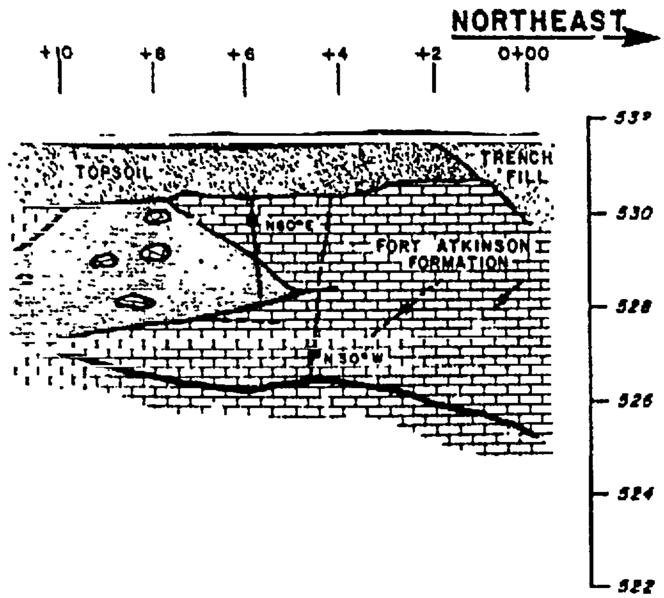


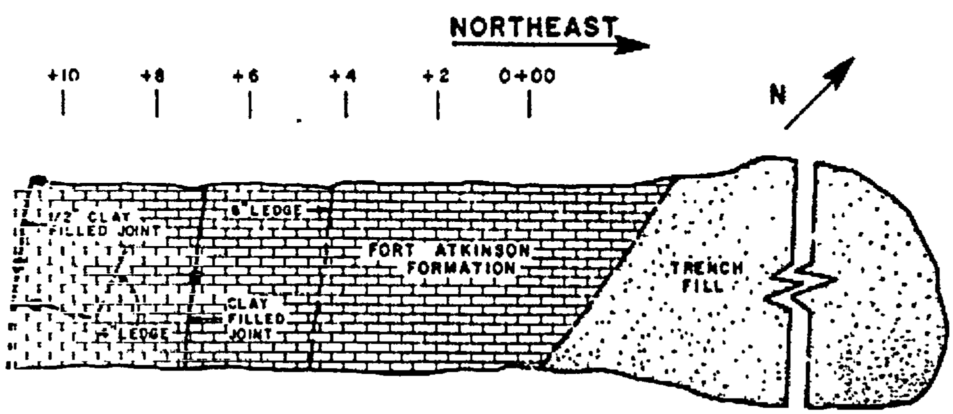
TRENCH FLOOR PLAN

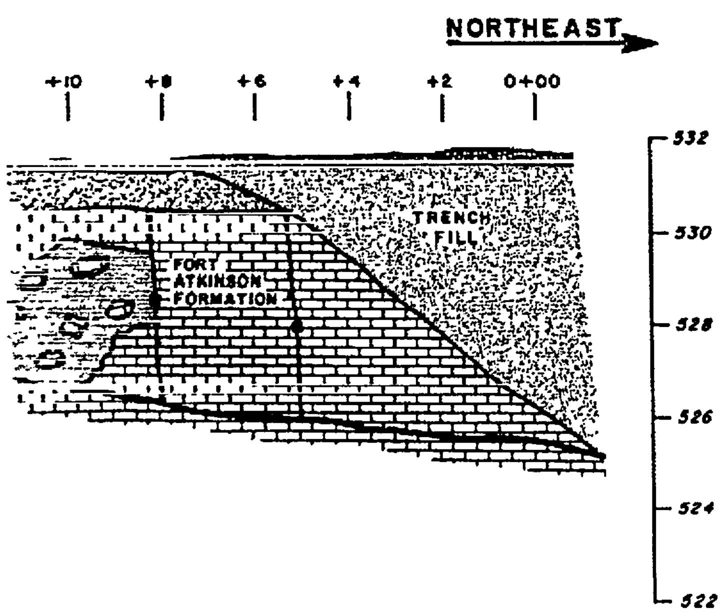


SOUTH WALL

1674-099-07







EXPLANATION:

FILL: BLACK ORGANIC CLAY AND SILT WITH CONSTRUCTION MATERIAL.

TILL: DARK BROWN AND BROWNISH-YELLOW SIL CLAY MATRIX; WITH 40% ROUNDED GRAVELS; CALCAREOUS; POORLY SORTED; OCCASIONAL ANGULAR AND SUB-ANGULAR SANDSTONE SLAB

SANDSTONE. LIGHT GRAY WITH YELLOWISH-RED LAMINATIONS; FINE TO MEDIUM GRAINED; T BEDDED; MICACEOUS; FRESH TO MODERATELY WEATHERED; INCLINED BEDDING SW FROM IMMEDIATE VICINITY OF FAULT.

LIMESTONE CLAY 'RUBBLE': LIGHT GRAYISH-B SILTY CLAY MATRIX WITH ANGULAR FRAGMEN LIMESTONE UP TO 1 FOOT; VERY CALCAREOU POORLY SORTED, POORLY GRADED; OCCASION WEATHERED CHERT FRAGMENTS.

LIMESTONE: LIGHT GRAY; COARSE CRYSTALLIN MEDIUM TO THICK BEDDED; WEATHERS YELLO BROWN; MODERATELY WEATHERED AND OCCASI CLAY-FILLED ALONG BEDDING PLANES, JOIN FRACTURES; FOSSILIFEROUS; OCCASIONAL C CRYSTALS ALONG JOINT SURFACES.

LIMESTONE: HIGHLY WEATHERED

SILTY CL' : GREENISH-GRAY; OCCASIONALLY CONTAINS INCLUSIONS OF EXTREMELY WEATHERED LIMESTONE FRAGMENT FOUND WITHIN FRACTURES AND ALONG LIMES BEDDING PLANES; WEATHERS YELLOWISH-BRO

JOINT

-125° DIP AND DIRECTION OF BEDDING PLANE

NOTES:

1. TRENCH PROFILES ARE SHOWN FROM THE SAME DIRECTION, LOOKING NORTHWEST.
2. SOME FREATURES SEEN ON PROFILES OF TRENCHES ARE OBSCURED ON FLOOR AND DO NOT APPEAR.
3. DATA SHOWN BELOW TRENCH FLOOR IS INTERPRETE BASED ON BORING DATA AND VISUAL INSPECTION OF TRENCHES.

FEET
2 0 2 4
NO VERTICAL EXAGGERATION

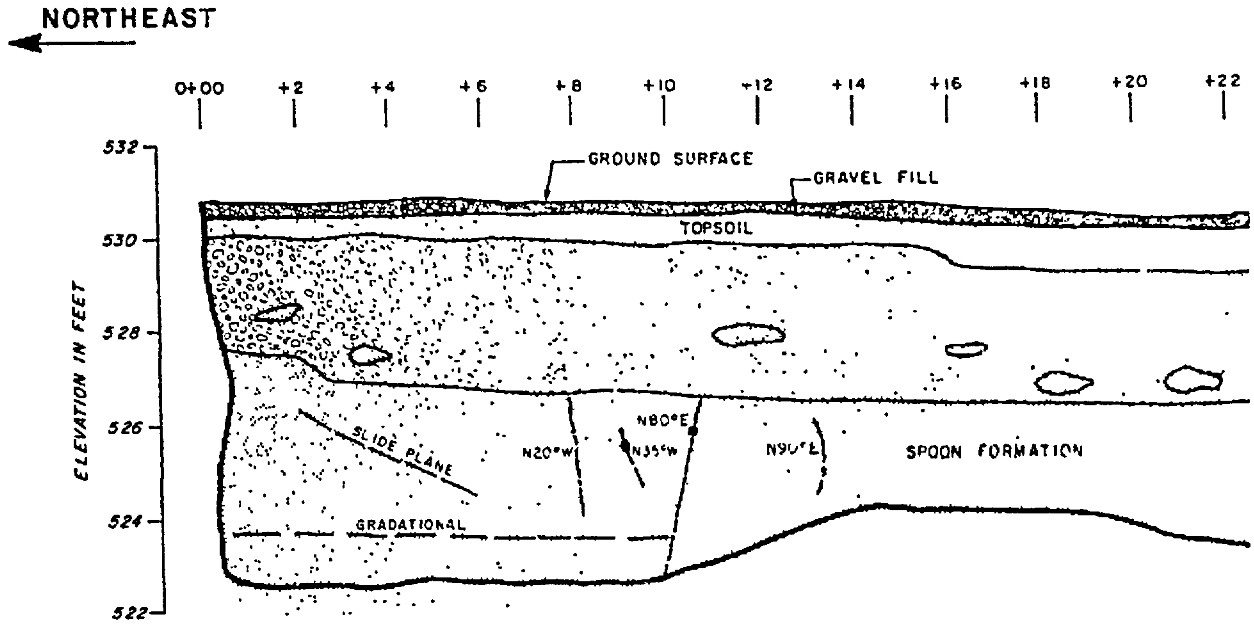
TRENCH CROSS-SECTIO

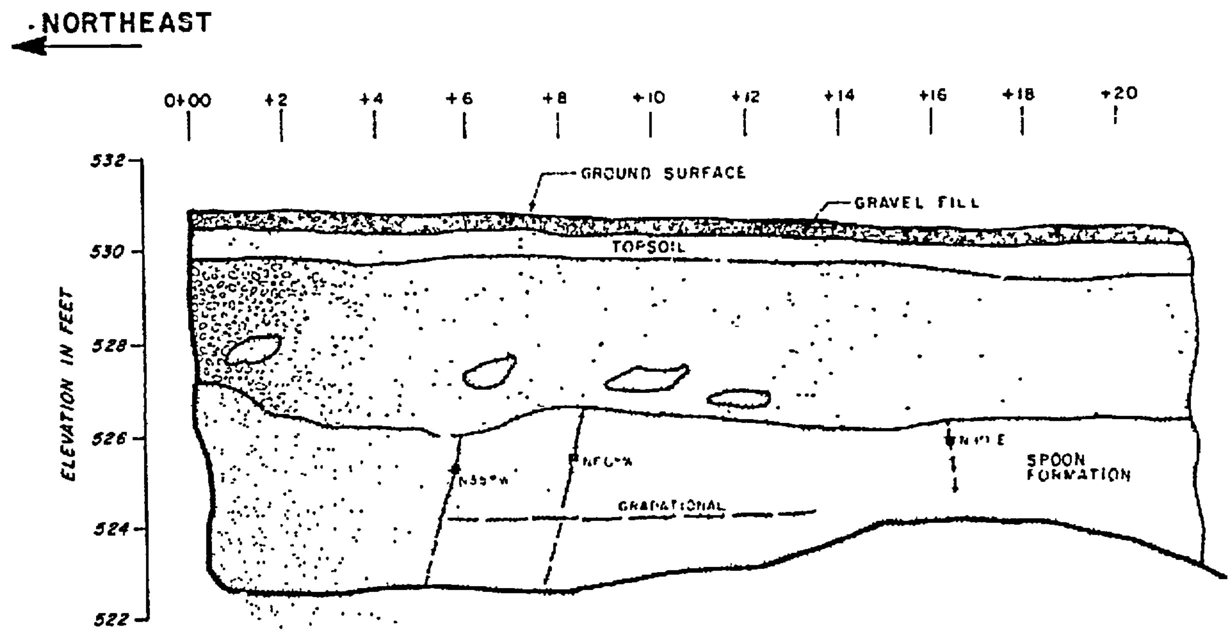
BT - 1

SHEET 2 OF 2

DAMES & MO

FIGURE 5





SOU

EXPLANATION:

TILL: DARK BROWN AND [illegible] WITH 40% ROUNDED GRAVEL; [illegible] OCCASIONAL ANGULAR AND [illegible] GRADES WITH [illegible]

SANDSTONE: GRAY WITH YELLOW [illegible] MEDIUM GRAINED, THIN [illegible] MODERATELY WEATHERED; FROM [illegible] HIGHLY WEATHERED TO SLIGHTLY [illegible] IN IRREGULAR [illegible]

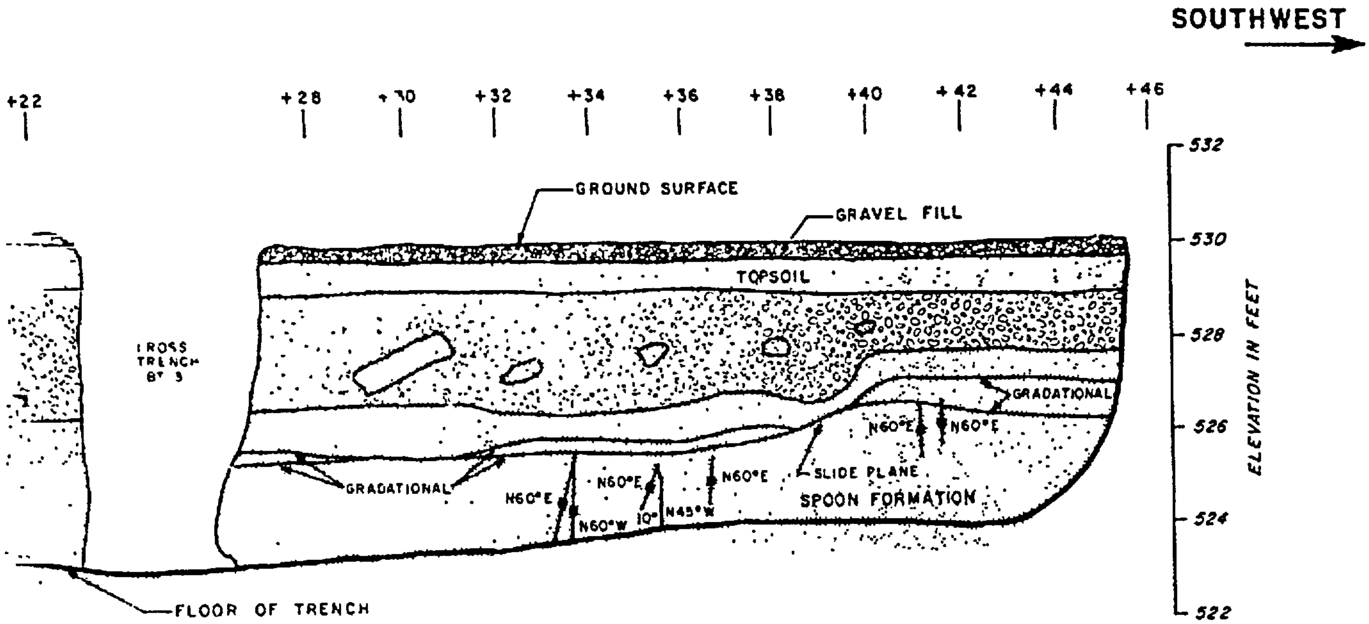
JOINT

NOTE:

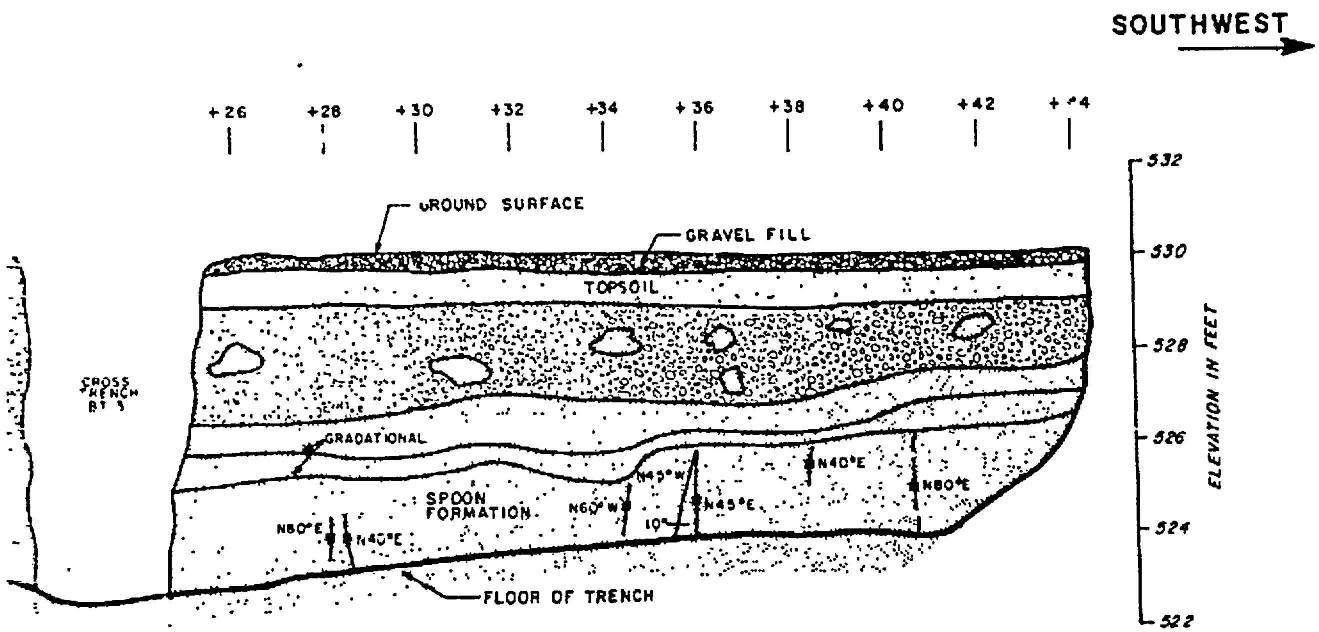
1. [illegible]

2. [illegible]

1674-099-07



NORTH WALL



OUTH WALL

FEET
0 2 4

VERTICAL EXAGGERATION

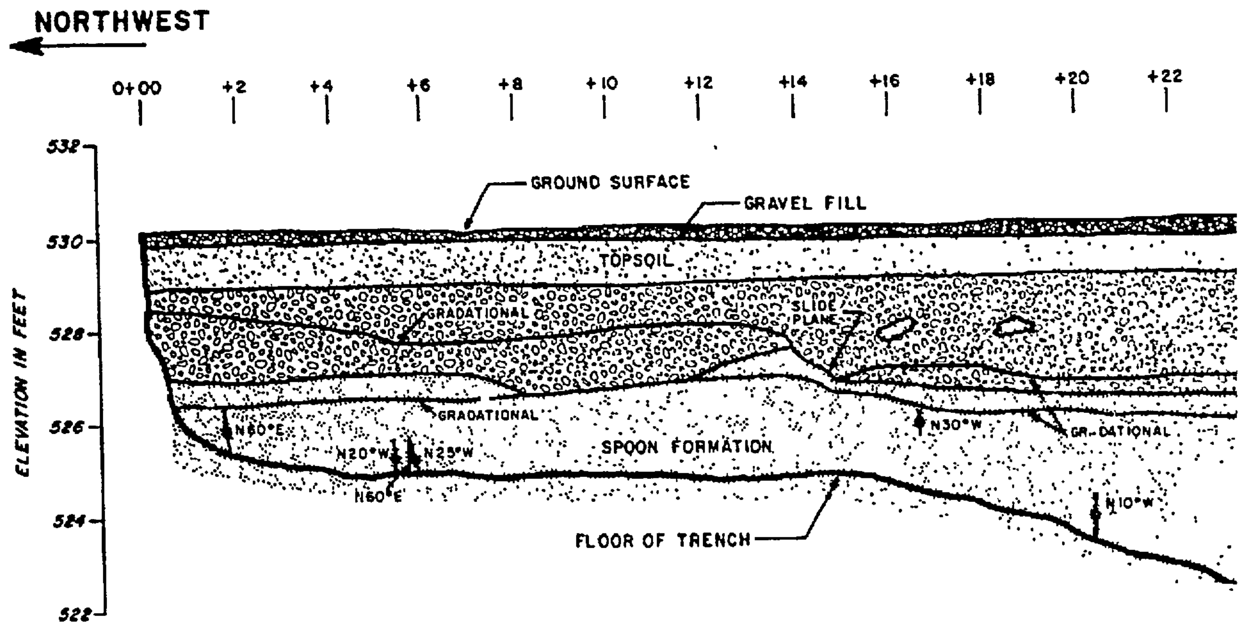
FROM THE SAME DIRECTION LOOKING NORTHWEST.

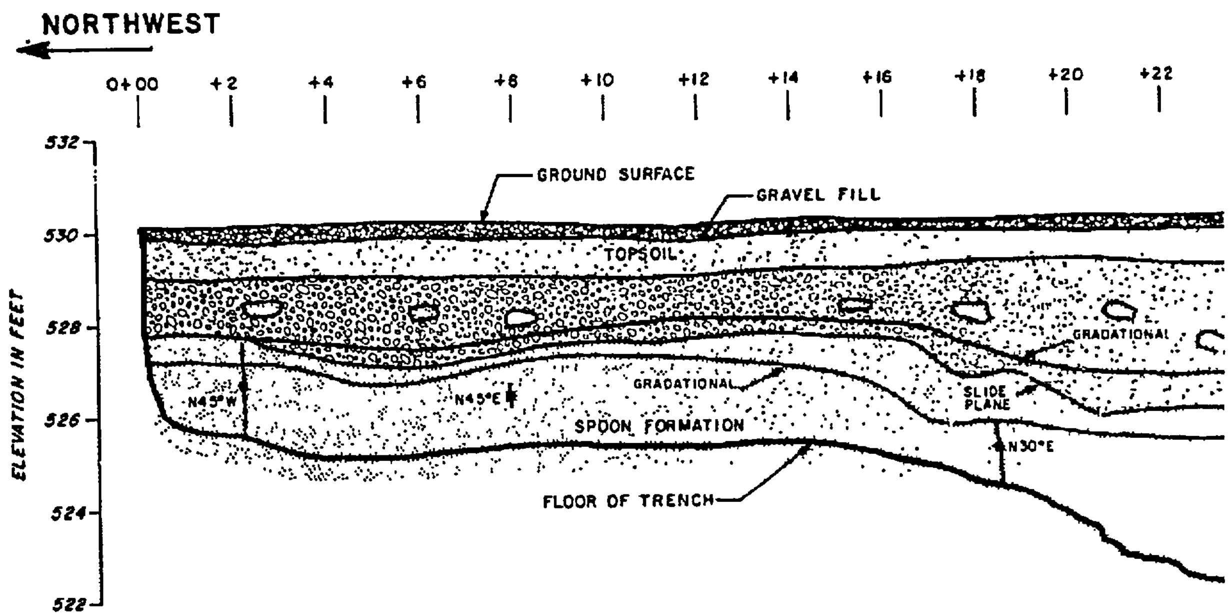
FLOOR OF PIT ... BASED ON BORING DATA THROUGH ...

TPENCH CROSS-S
BT - 2

DAMES & I

FIGURE





2

EXPLANATION:

TILL: DARK BROWN AND BROWNISH-YELLOW SILTY CLAY MATRIX; WITH 40% ROUNDED GRAVEL; CALCAREOUS; POORLY SORTED; OCCASIONAL ANGULAR AND SUB-ANGULAR SANDSTONE SLABS; GRADES WITH NUMEROUS SANDSTONE SLABS IN BASAL SECTION

SANDSTONE: GRAY WITH YELLOWISH-RED LAMINATIONS; FINE TO MEDIUM GRAINED; THIN BEDDED; MICACEOUS; FRESH TO MODERATELY WEATHERED; FROM 0+00 TO +24 GRADES FROM HIGHLY WEATHERED TO SLIGHTLY WEATHERED WITH DEPTH. IN IRREGULAR CONTACT WITH TILL ABOVE.

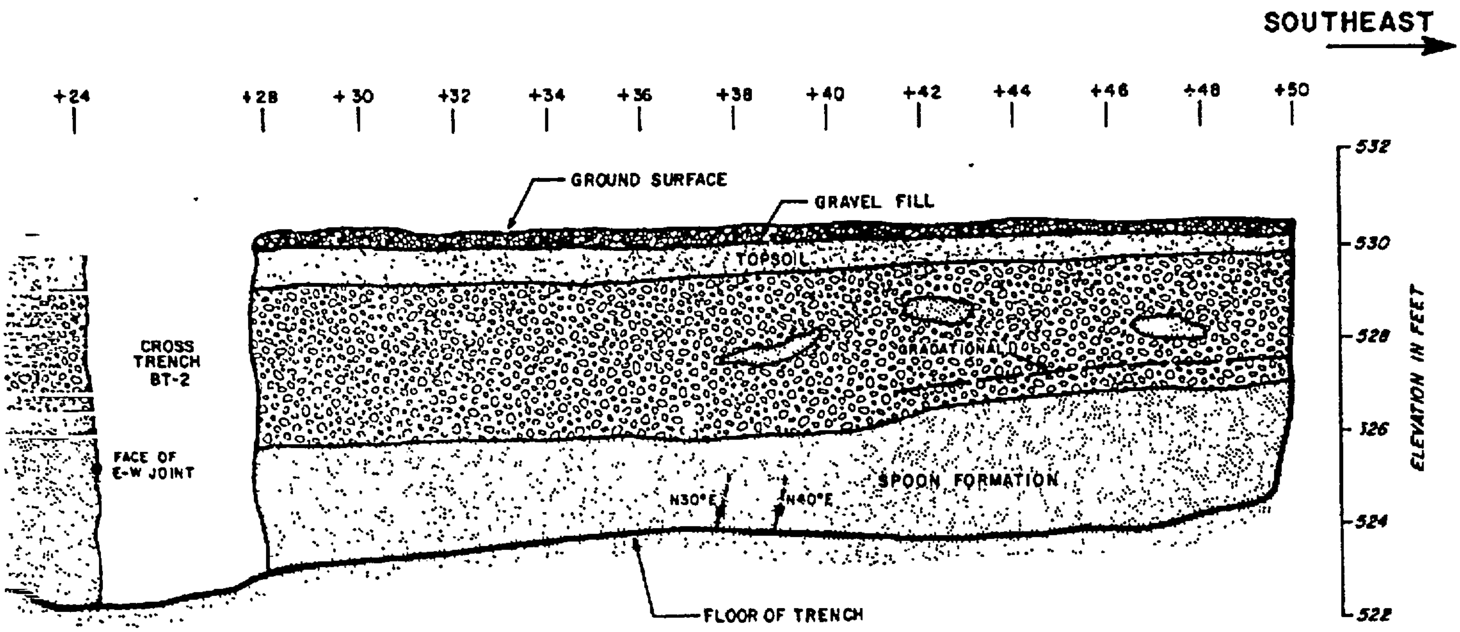
JOINT

NOTES:

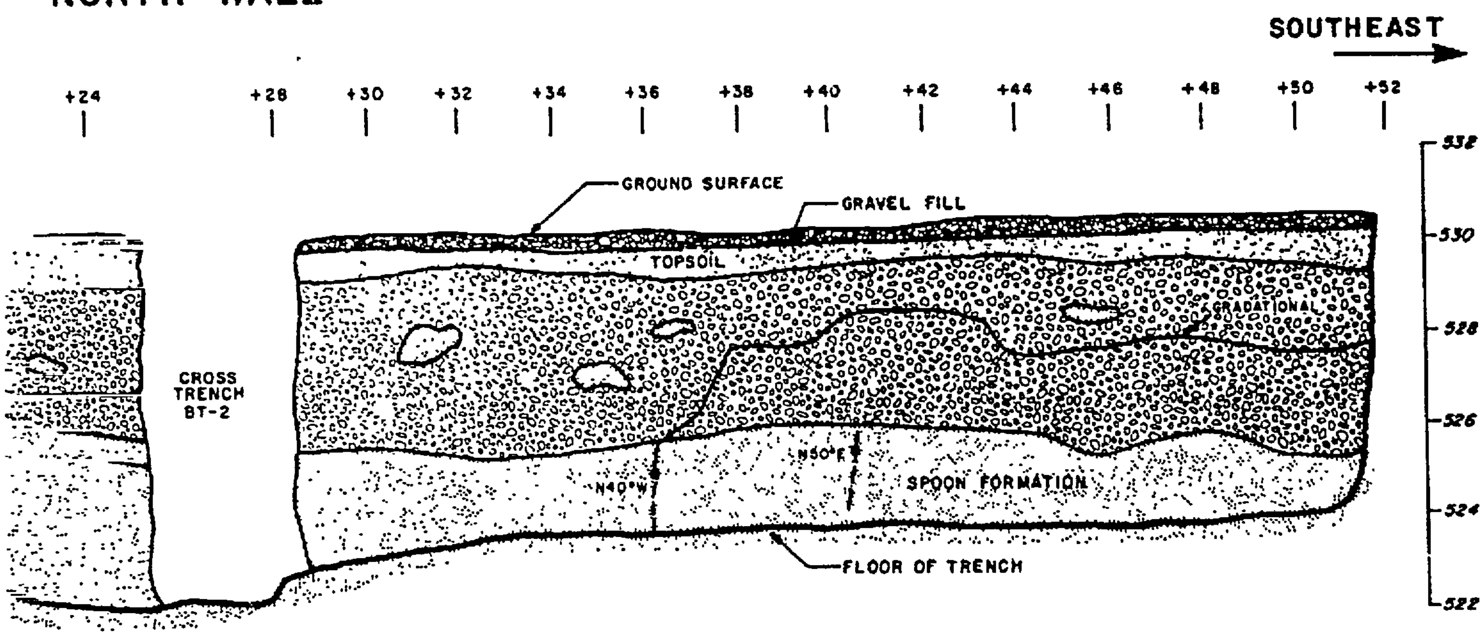
1. TRENCH PRO

2. DATA SHOWN AND VISUAL

1674-099-07



NORTH WALL



SOUTH WALL

FEET
2 0 2 4
NO VERTICAL EXAGGERATION

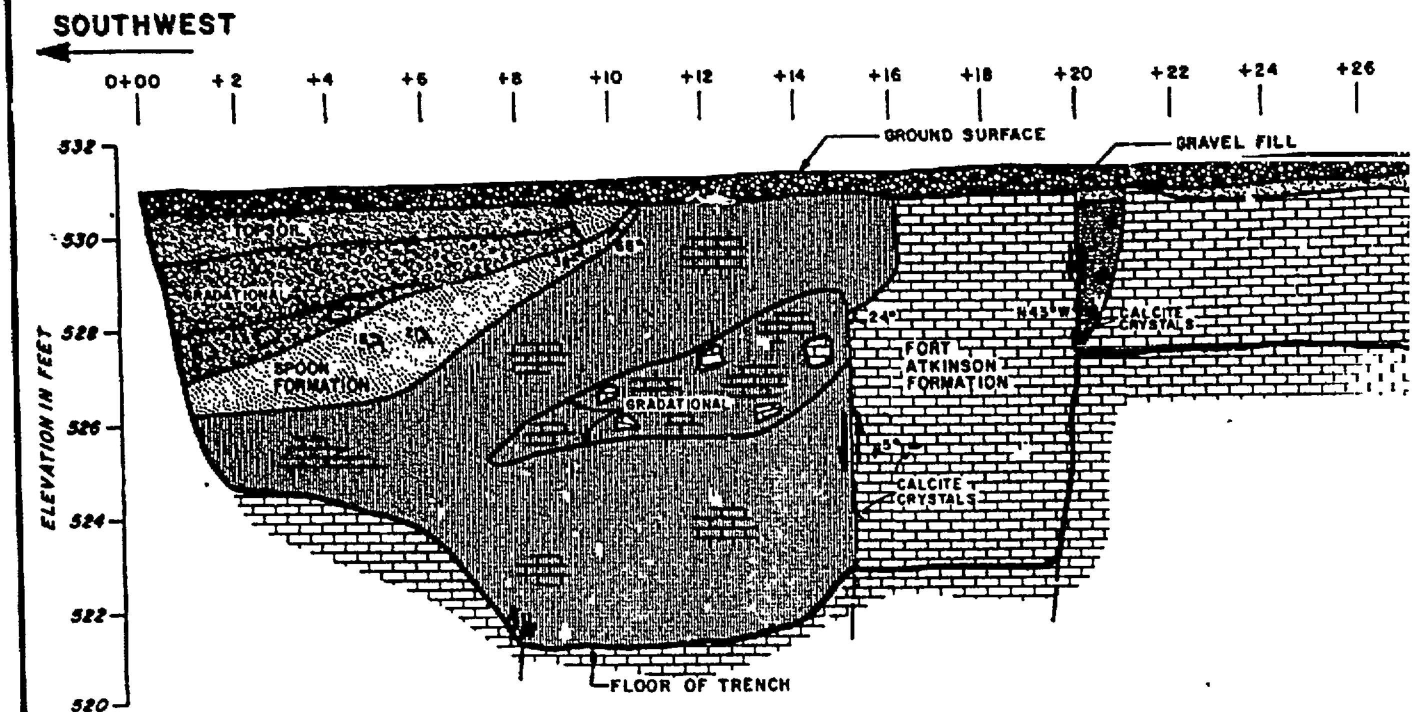
PROFILES ARE SHOWN FROM THE SAME DIRECTION, LOOKING NORTHWEST.

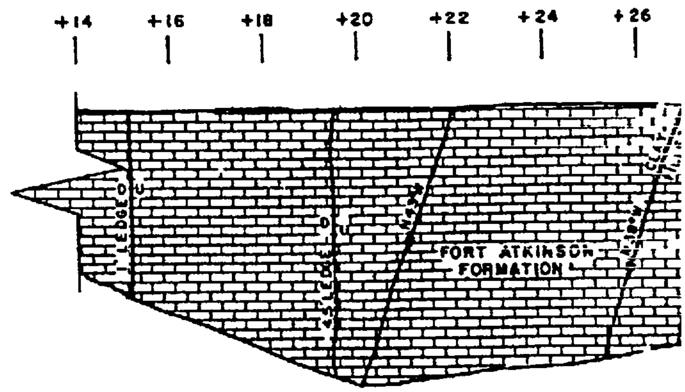
... BELOW TRENCH FLOOR IS INTERPRETED BASED ON BORING DATA
...UAL INSPECTION OF TRENCHES.

TRENCH CROSS-SI
BT - 3

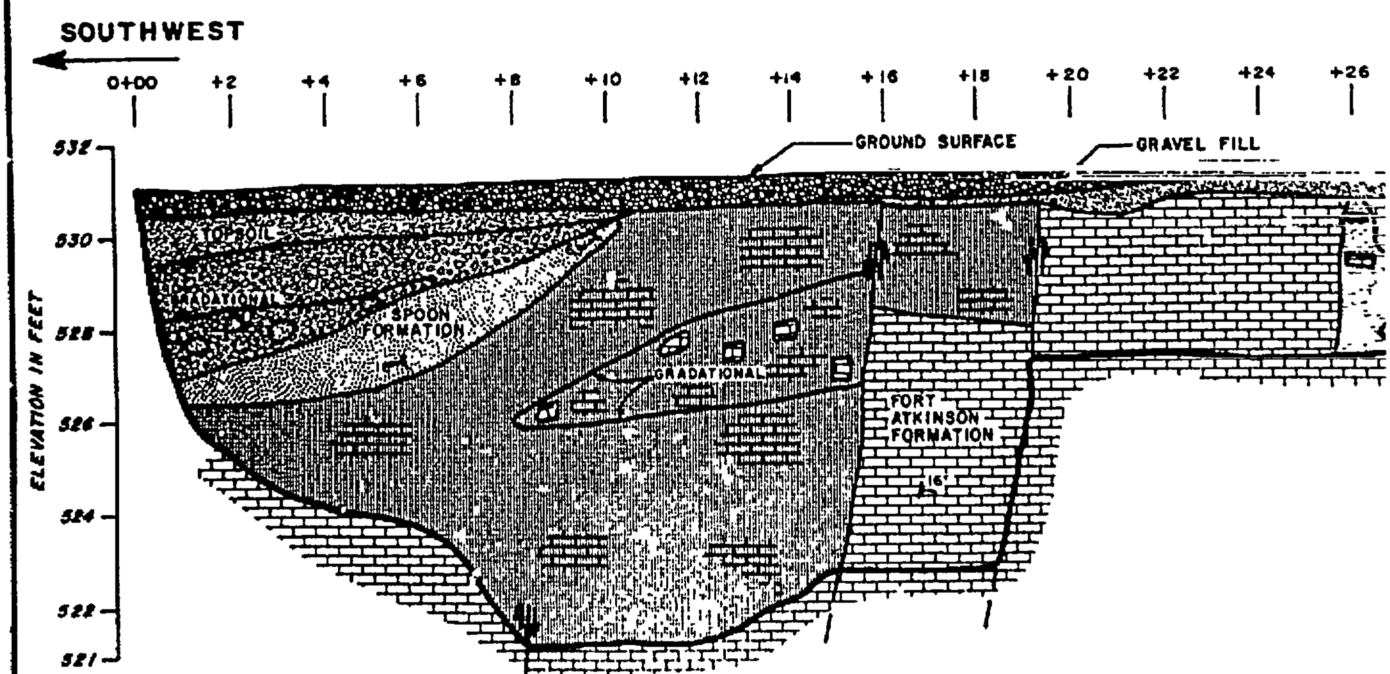
DAMES & M

FIGURE

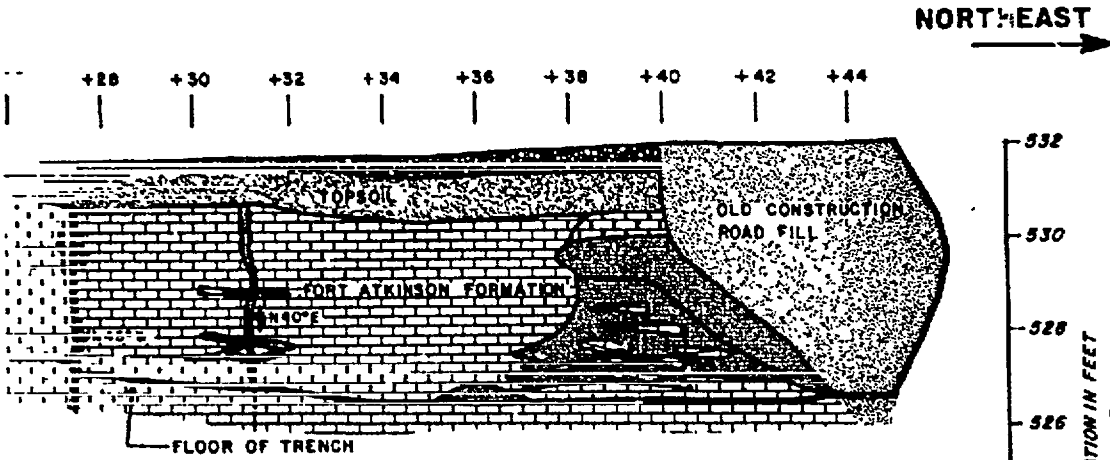




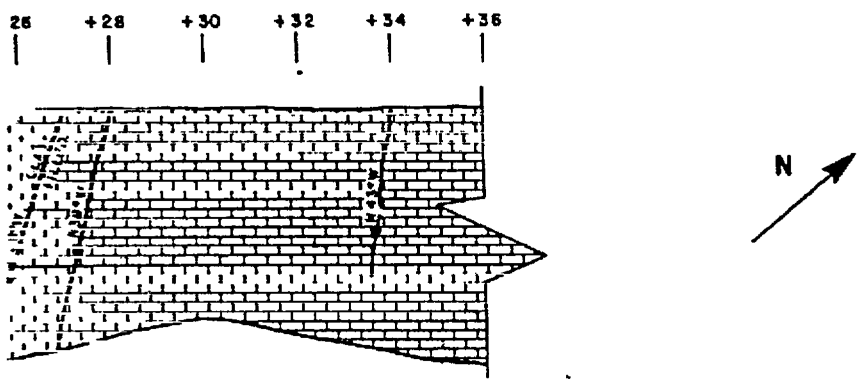
TRE



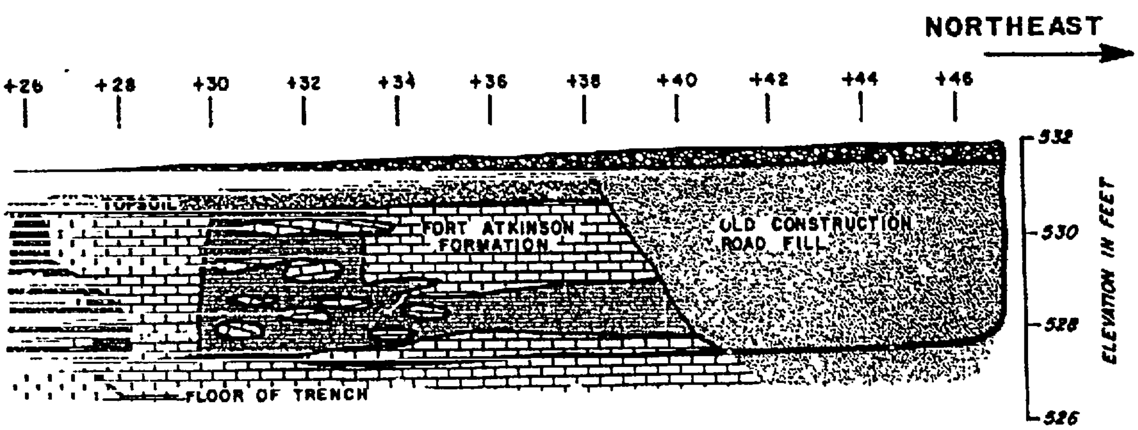
1674-099-07



NORTH WALL



RENCH FLOOR PLAN



SOUTH WALL

EXPLANATION:

FILL: BLACK ORGANIC CLAY AND WITH CONSTRUCTION MATERIAL

TILL: DARK BROWN AND BROWNIS YELLOW SILTY CLAY MATRIX; 40% ROUNDED GRAVELS; CALCA POORLY SORTED; OCCASIONAL AND SUB-ANGULAR SANDSTONE

SANDSTONE: GRAY; FINE TO MED GRAINED; THIN BEDDED; MICA FRESH TO MODERATELY WEATHE INCLINED BEDDING SW FROM IMMEDIATE VICINITY OF FAUL IRREGULAR CONTACT WITH TIL

LIMESTONE CLAY 'RUBBLE': LIG GRAYISH-BROWN SILTY CLAY WITH ANGULAR FRAGMENTS OF STONE UP TO 1 FOOT; VERY C EOUS; POORLY SORTED; OCCAS WEATHERED CHERT FRAGMENTS; OCCASIONAL GRADATIONAL ZON NUMEROUS LIMESTONE FRAGMEN

LIMESTONE: LIGHT GRAY; COARS CRYSTALLINE; MEDIUM TO THI WEATHERS YELLOWISH-BROWN; ATELY WEATHERED AND OCCAS CLAY-FILLED ALONG BEDDING JOINTS AND FRACTURES; FOS OCCASIONAL CALCITE CRYSTA JOINT SURFACES.

SILTY CLAY: GREENISH-GRAY; OCCASIONALLY CONTAINS INC EXTREMELY WEATHERED LIMES MENTS; FOUND WITHIN FRACT ALONG LIMESTONE BEDDING P WEATHERS YELLOWISH-BROWN.

JOINT

30° DIP AND DIRECTION OF BEDDING

NOTES:

1. TRENCH PROFILES ARE SHOWN FROM T DIRECTION, LOOKING NORTHWEST.
2. SOME FREATURES SEEN ON PROFILES ARE OBSCURED ON FLOOR AND DO NOT
3. DATA SHOWN BELOW TRENCH FLOOR IS BASED ON BORING DATA AND VISUAL OF TRENCHES.

FEET

2 0 2

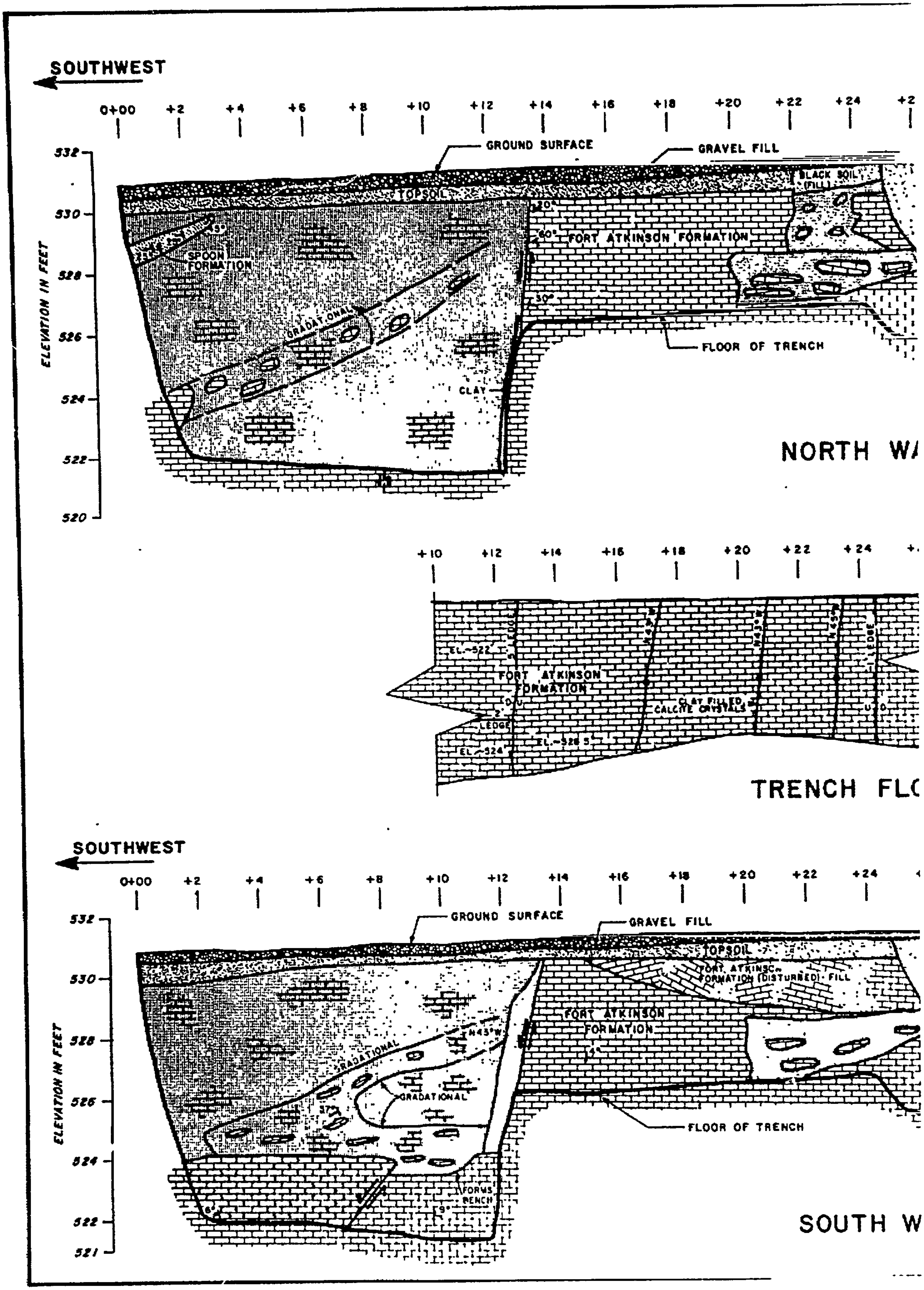
NO VERTICAL EXAGGERATION

TRENCH CROSS-SE

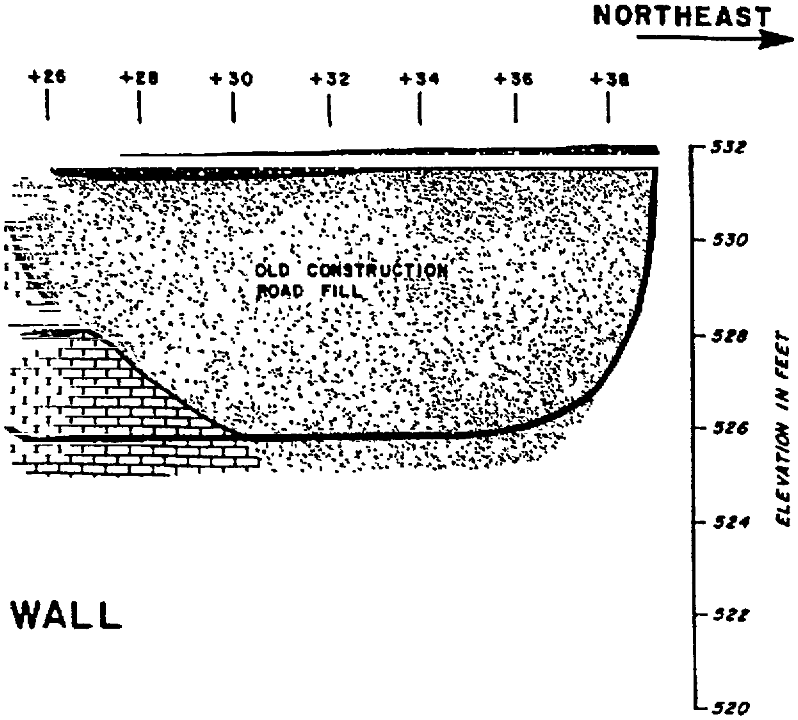
CT - 1

DAMES &

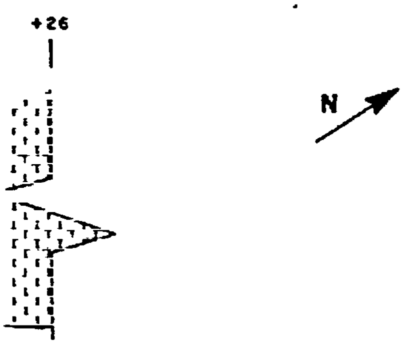
FIGURE


SOUTHWEST
0+00
+2
+4
+6
+8
+10
+12
+14
+16
+18
+20
+22
+24
ELEVATION IN FEET
532
530
528
526
524
522
520
GROUND SURFACE
GRAVEL FILL
BLACK SOIL (FILL)
TOPSOIL
SPOON FORMATION
GRADATIONAL
FORT ATKINSON FORMATION
20°
60°
30°
CLAY
FLOOR OF TRENCH
NORTH WA
EL.~522
FORT ATKINSON FORMATION
LEDGE
EL.~524
EL.~526.5
CLAY FILLED, CALCITE CRYSTALS
TRENCH FL
SOUTHWEST
GROUND SURFACE
GRAVEL FILL
TOPSOIL
FORT ATKINSON FORMATION (DISTURBED) - FILL
FORT ATKINSON FORMATION
N43°W
GRADATIONAL
FORMS BENCH
FLOOR OF TRENCH
521
SOUTH W

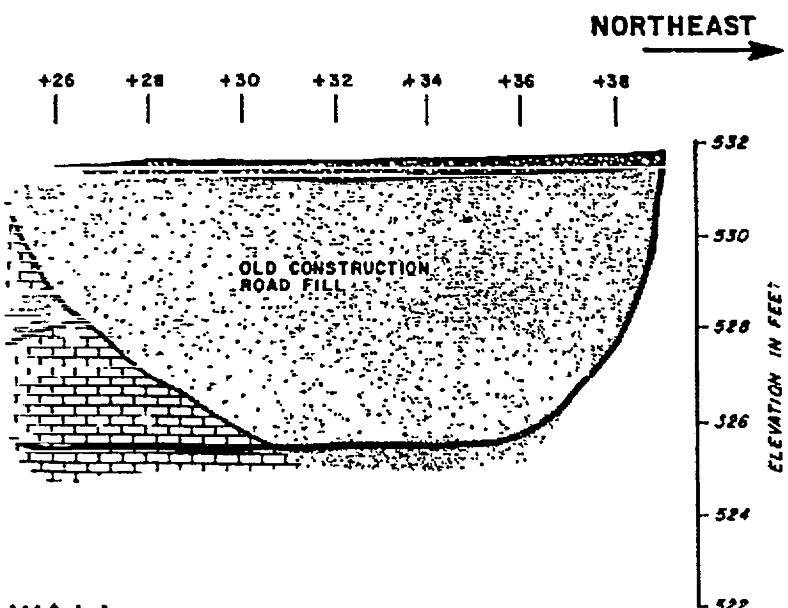
1674-099-07



WALL



LOOR TRENCH



WALL

EXPLANATION:

FILL: BLACK ORGANIC CLAY AND SILT WITH CONSTRUCTION M/ FROM +15 TO +25 ON SOUTH WALL, FILL CONSISTS OF DIS1 FORT ATKINSON BLOCKS.

SANDSTONE: LIGHT GRAY; FINE TO MEDIUM GRAINED; THINLY BEDDED; MICACEOUS; FRESH TO MODERATELY WEATHERED; INCLINED BEDDING SW FROM IMMEDIATE VICINITY OF FAUL'

LIMESTONE CLAY 'RUBBLE': LIGHT GRAYISH-BROWN SILTY CL/ MATRIX WITH ANGULAR FRAGMENTS OF LIMESTONE UP TO 1 I VERY CALCAREOUS; POORLY SORTED, POORLY GRADED; OCCA! WEATHERED CHERT FRAGMENTS; OCCASIONAL GRADATIONAL Z(NUMEROUS LIMESTONE FRAGMENTS.

LIMESTONE: LIGHT GRAY; COARSE CRYSTALLINE; MEDIUM TO ' BEDDED; WEATHERS YELLOWISH-BROWN; MODERATELY WEATHEI AND OCCASIONALLY CLAY-FILLED ALONG BEDDING PLANES, . AND FRACTURES; FOSSILIFEROUS.

LIMESTONE: HIGHLY WEATHERED

SILTY CLAY: GREENISH-GRAY; OCCASIONALLY CONTAINS INCLI OF EXTREMELY WEATHERED LIMESTONE FRAGMENTS; FOUND W FRACTURES AND ALONG LIMESTONE BEDDING PLANES; WEATH YELLOWISH-BROWN.

JOINT

25° DIP AND DIRECTION OF BEDDING PLANE

NOTES:

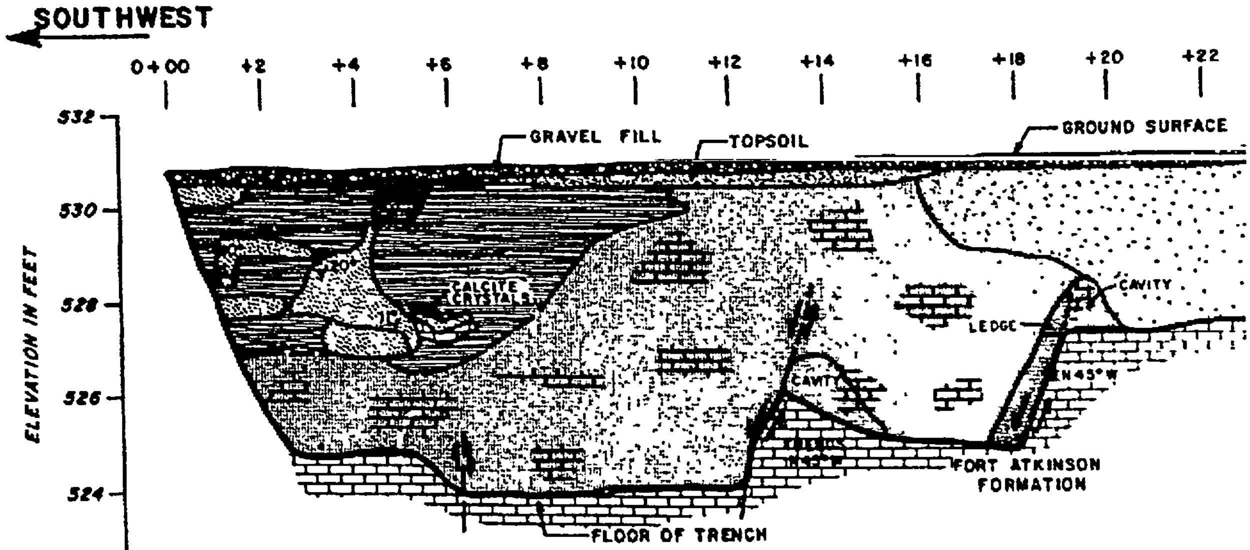
1. TRENCH PROFILES ARE SHOWN FROM THE SAME DIRECTION, LOOKING NOR
2. SOME FEATURES SEEN ON PROFILES OF TRENCHES ARE OBSCURED ON FLO AND DO NOT APPREAR.
3. DATA SHOWN BELOW TRENCH FLOOR IS INTERPRETED BASED ON 'BORING D AND VISUAL INSPECTION OF TRENCHES.

FEET
2 0 2 4
NO VERTICAL EXAGGERATION

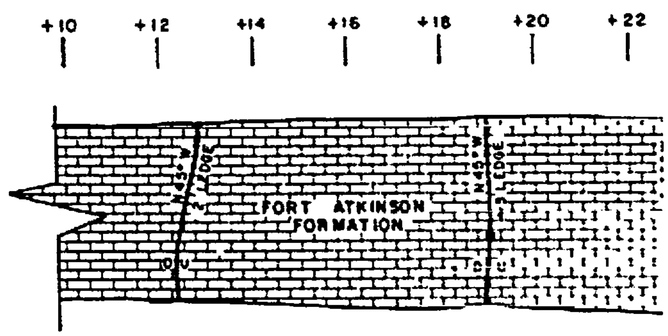
TRENCH CROSS-SEC
CT - 2

DAMES & M

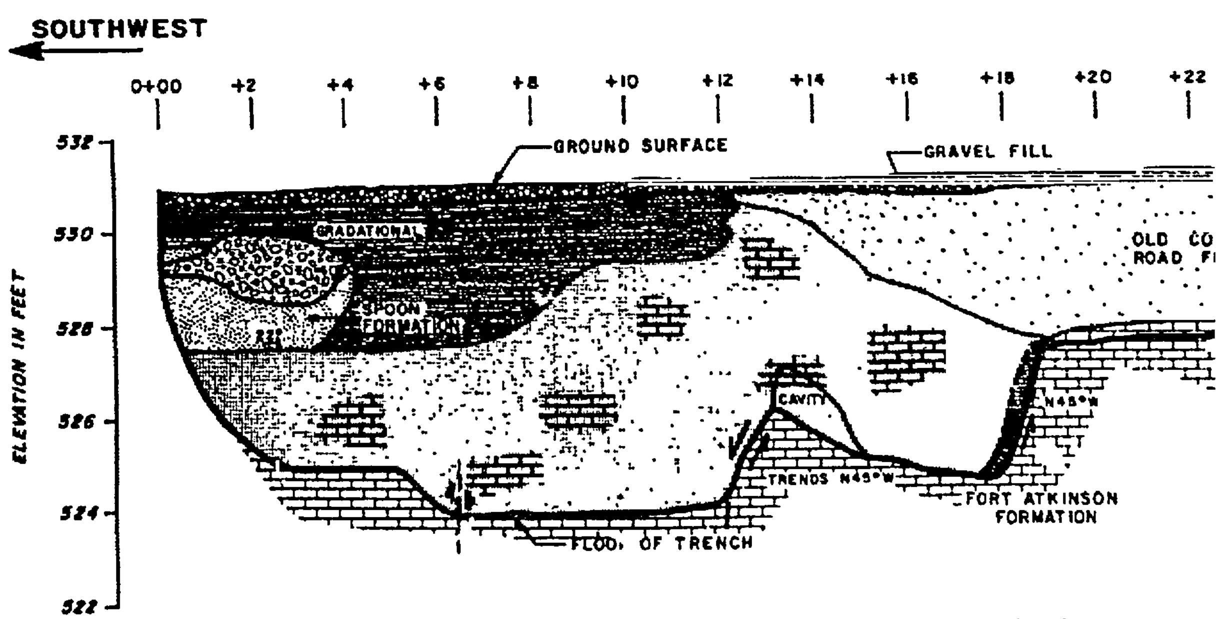
FIGURE



NORTH WALL

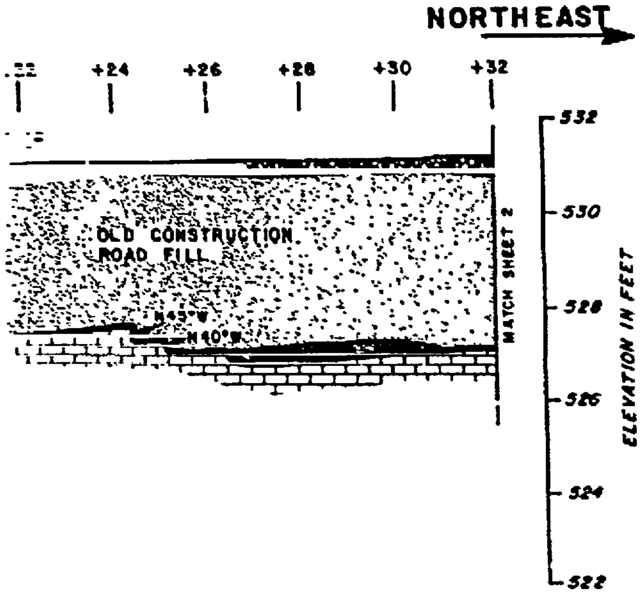


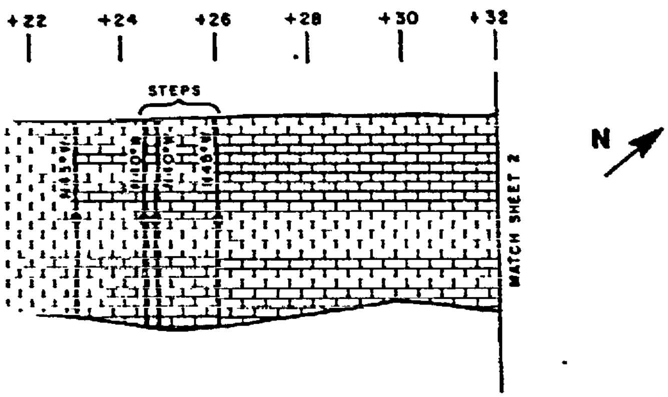
TRENCH FLOOR PLAI



SOUTH WALL

1674-099-07





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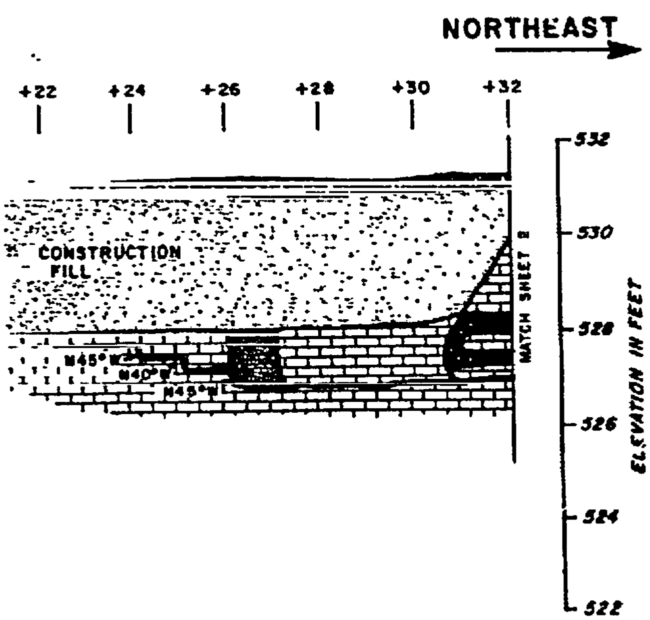


EXPLANATION:

FILL: BLACK ORGANIC CLAY AND SILT WITH CONSTRUCTION MATERIAL.

TILL: BROWN SANDY SILT WITH SOME CLAY AND GRAVEL; NUMER LARGE INTACT THINLY BEDDED SANDSTONE FRAGMENTS; OCCASI MOTTLING.

TILL: BROWN SANDY CLAY WITH SOME GRAVEL; OCCASIONAL MOTTLING.

TILL: DARK BROWN AND BROWNISH-YELLOW SILTY CLAY MATRIX; WITH 40% ROUNDED GRAVELS; CALCAREOUS; POORLY SORTED; OCCASIONAL ANGULAR AND SUB-ANGULAR SANDSTONE SLABS.

SANDSTONE: GRAY WITH YELLOWISH-RED LAMINATIONS; FINE TO MEDIUM GRAINED; THIN BEDDED; MICACEOUS; FRESH TO MODE WEATHERED. IN IRREGULAR CONTACT WITH TILL ABOVE AND LIMESTONE RUBBLE BELOW.

LIMESTONE CLAY 'RUBBLE': LIGHT GRAYISH-BROWN SILTY CLAY MATRIX WITH ANGULAR FRAGMENTS OF LIMESTONE UP TO 1 FO VERY CALCAREOUS; POORLY SORTED, POORLY GRADED; OCCASI WEATHERED CHERT FRAGMENTS.

LIMESTONE: LIGHT GRAY; COARSE CRYSTALLINE; MEDIUM TO TH BEDDED; WEATHERS YELLOWISH-BROWN; MODERATELY WEATHERE OCCASIONALLY CLAY-FILLED ALONG BEDDING PLANES, JOINTS FRACTURES; FOSSILIFEROUS; OCCASIONAL CALCITE CRYSTALS JOINT SURFACES.

LIMESTONE: HIGHLY WEATHERED.

SILTY CLAY: GREENISH-GRAY; OCCASIONALLY CONTAINS INCLUS OF EXTREMELY WEATHERED LIMESTONE FRAGMENTS; FOUND WIT FRACTURES AND ALONG LIMESTONE BEDDING PLANES; WEATHER YELLOWISH-BROWN.

JOINT

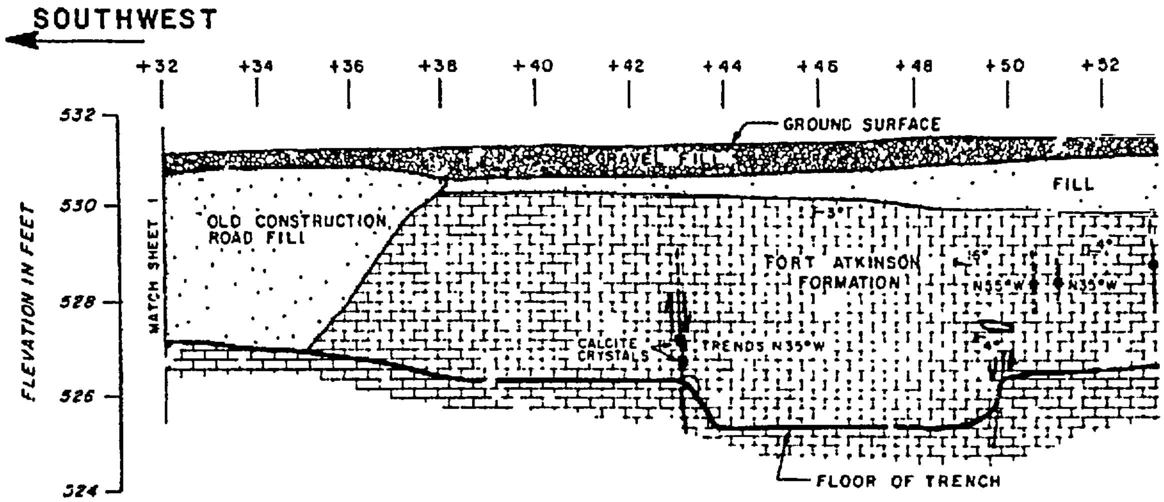
20° DIP AND DIRECTION OF BEDDING PLANE

NOTES:

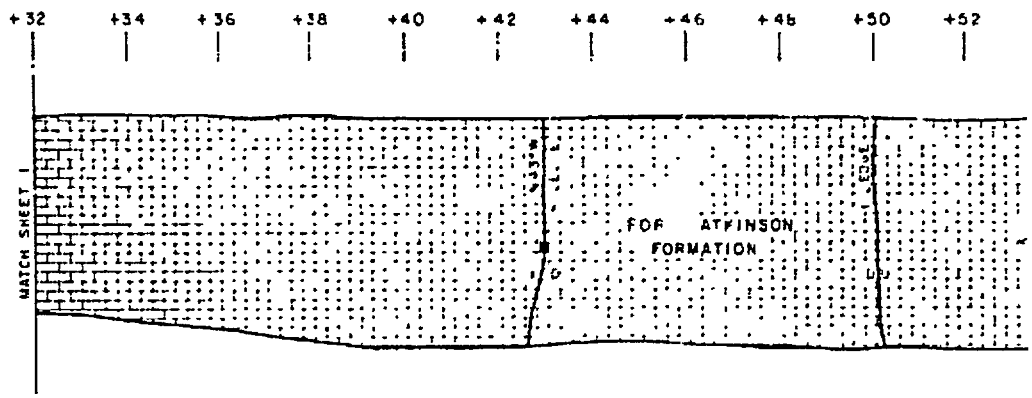
1. TRENCH PROFILES ARE SHOWN FROM THE SAME DIRECTION, LOOKING OR
2. SOME FEATURES SEEN ON PROFILES OF TRENCHES ARE OBSCURED ON FLO AND DO NOT APPREAR.
3. DATA SHOWN BELOW TRENCH FLOOR IS INTERPRETED BASED ON BORING D AND VISUAL INSPECTION OF TRENCHES.

FEET
2 0 2 4
NO VERTICAL EXAGGERATION

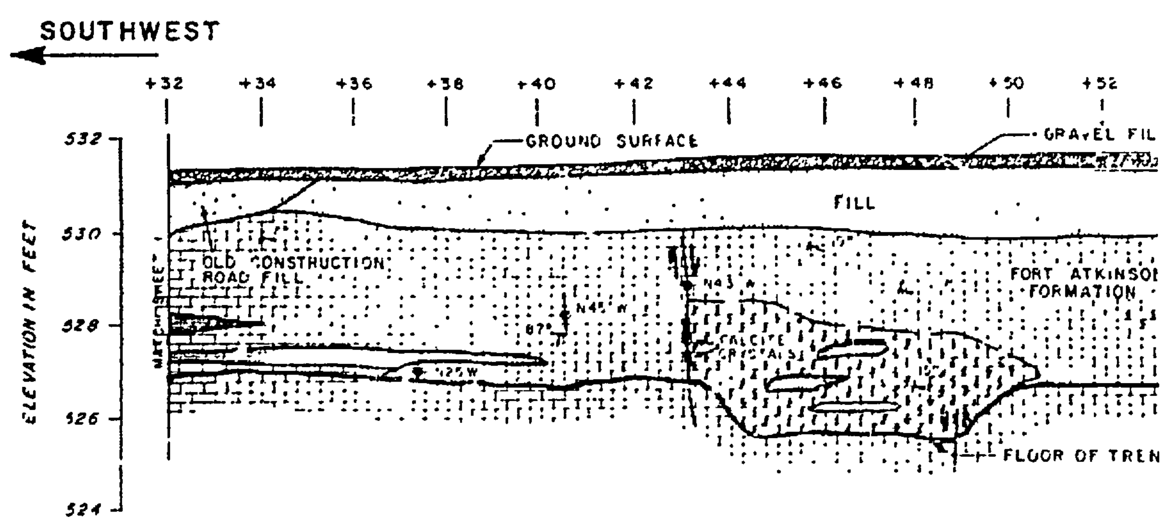
TRENCH CROSS-S
CT - 3
SHEET 1 OF 2



NORTH WALL

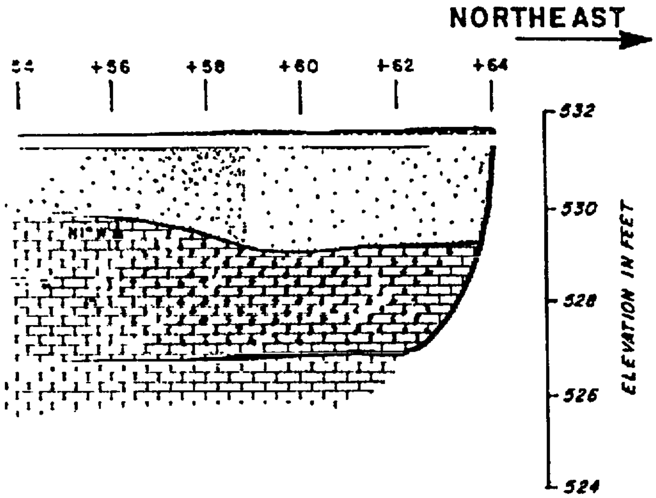


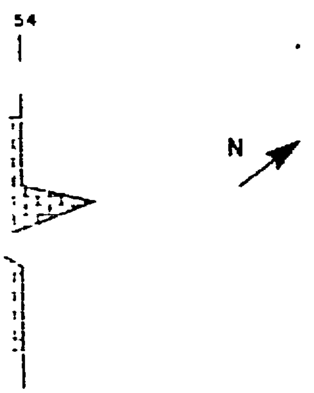
TRENCH FLOOR PLAN

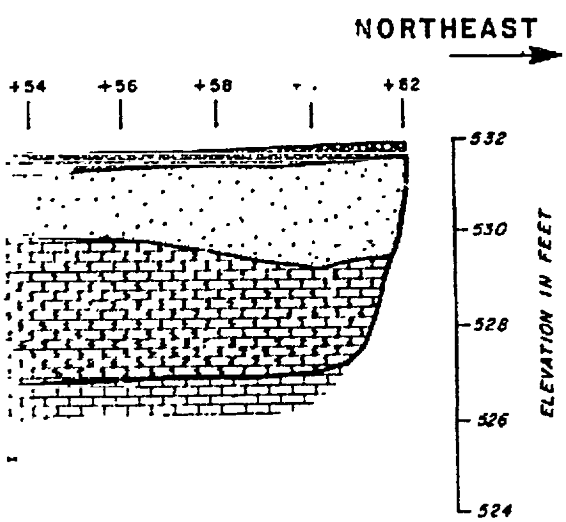


SOUTH WALL

'674-009-07







EXPLANATION:

FILL: BLACK ORGANIC CLAY AND SILT WITH CONSTRUCTION MATERIAL.

TILL: BROWN SANDY SILT WITH SOME CLAY AND GRAVEL; NUMEROUS LARGE INTACT THIN BEDDED SANDSTONE FRAGMENTS; OCCASIONAL MOTTLING.

TILL: BROWN SANDY CLAY WITH SOME GRAVEL; OCCASIONAL MOTTLING.

TILL: DARK BROWN AND BROWNISH-YELLOW SILTY CLAY MATRIX; WITH 40% ROUNDED GRAVELS; CALCAREOUS; POORLY SORTED; OCCASIONAL ANGULAR AND SUB-ANGULAR SANDSTONE SLABS.

SANDSTONE: GRAY WITH YELLOWISH-RED LAMINATIONS; FINE TO MEDIUM GRAINED; THIN BEDDED, MICACEOUS; FRESH TO MODERATELY WEATHERED. IN IRREGULAR CONTACT WITH TILL ABOVE AND LIMESTONE RUBBLE BELOW.

LIMESTONE CLAY 'RUBBLE': LIGHT GRAYISH-BROWN SILTY CLAY MATRIX WITH ANGULAR FRAGMENTS OF LIMESTONE UP TO 1 FOOT; VERY CALCAREOUS; POORLY SORTED, POORLY GRADED; OCCASIONAL WEATHERED CHERT FRAGMENTS.

LIMESTONE: LIGHT GRAY; COARSE CRYSTALLINE; MEDIUM TO THICK BEDDED; WEATHERS YELLOWISH-BROWN, MODERATELY WEATHERED AND OCCASIONALLY CLAY-FILLED ALONG BEDDING PLANES, JOINTS AND FRACTURES; FOSSILIFEROUS; OCCASIONAL CALCITE CRYSTALS ALONG JOINT SURFACES.

LIMESTONE: HIGHLY WEATHERED.

SILTY CLAY: GREENISH-GRAY, OCCASIONALLY CONTAINS INCLUSIONS OF EXTREMELY WEATHERED LIMESTONE FRAGMENTS; FOUND WITHIN FRACTURES AND ALONG LIMESTONE BEDDING PLANES, WEATHERS YELLOWISH-BROWN.

JOINT

20° DIP AND DIRECTION OF BEDDING PLANE

NOTES:

1. TRENCH PROFILES ARE SHOWN FROM THE SAME DIRECTION, LOOKING NORTHWEST.
2. SOME FEATURES SEEN ON PROFILES OF TRENCHES ARE OBSCURED ON FLOOR AND DO NOT APPEAR.
3. DATA SHOWN BELOW TRENCH FLOOR IS INTERPRETED BASED ON BORING DATA AND VISUAL INSPECTION OF TRENCHES.

FEET

2 0 2 4

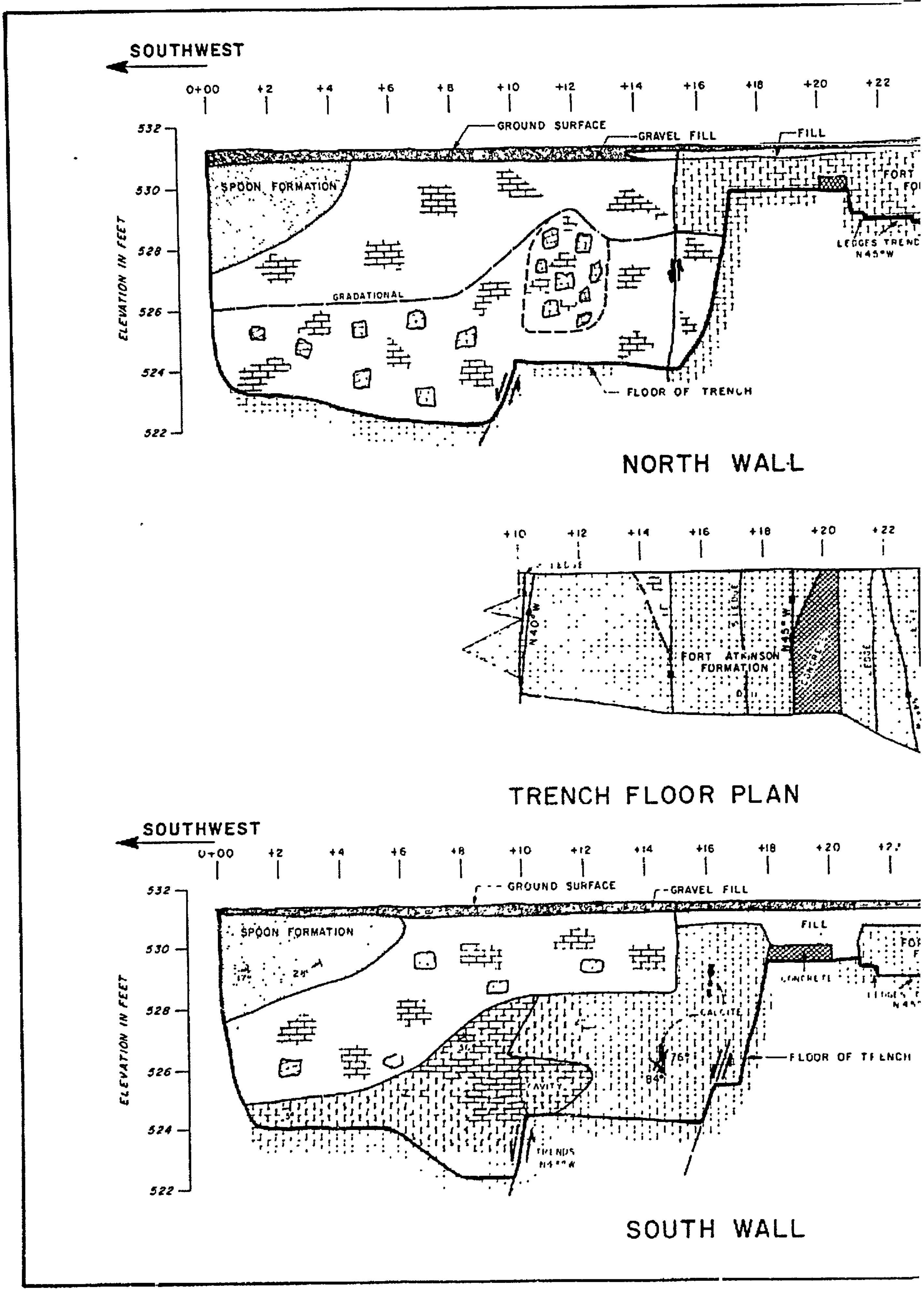
NO VERTICAL EXAGGERATION

TRENCH CROSS-SECTIO

CT - 3

SHEET 2 OF 2

DAMES & MOOI


SOUTHWEST
0+00
+2
+4
+6
+8
+10
+12
+14
+16
+18
+20
+22
ELEVATION IN FEET
532
530
528
526
524
522
GROUND SURFACE
GRAVEL FILL
FILL
SPOON FORMATION
GRADATIONAL
FLOOR OF TRENCH
LEDGES TREND N45°W
NORTH WALL
N40°W
N45°W
FORT ATKINSON FORMATION
TRENCH FLOOR PLAN
SOUTHWEST
GROUND SURFACE
GRAVEL FILL
FILL
SPOON FORMATION
CONCRETE
CALCITE
CAVITY
76°
84°
TRENDS N45°W
FLOOR OF TRENCH
SOUTH WALL

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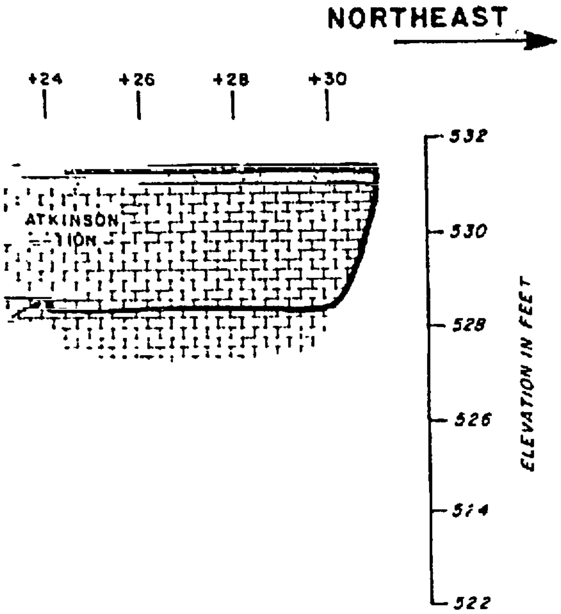
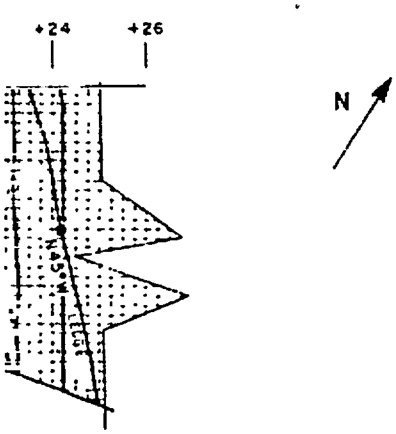
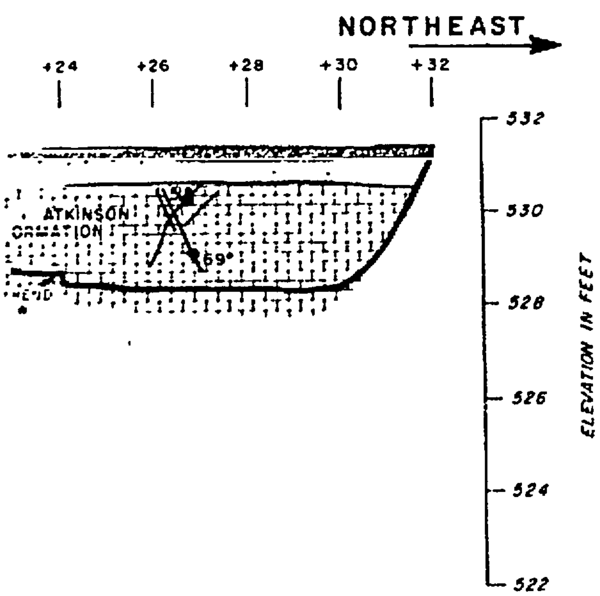






EXPLANATION:

FILL: BLACK CLAY, BLOCKY.

CONCRETE: POURED AROUND UTILITY CONDUIT.

SANDSTONE: LIGHT GRAY WITH YELLOWISH-RED LAMINATIONS; FINE TO MEDIUM GRAINED, THINLY BEDDED; MICACEOUS; FRESH TO MODERATLEY WEATHERED; INCLINED BEDDING SW FROM IMMEDIATE VICINITY OF FAULT.

LIMESTONE CLAY "RUBBLE": LIGHT GRAYISH-BROWN SILTY CLAY MATRIX WITH ANGULAR FRAGMENTS OF LIMESTONE UP TO 1 FOOT; VERY CALCAREOUS; POORLY SORTED, POORLY GRADED; OCCASIONAL WEATHERED CHERT FRAGMENTS; OCCASIONAL GRADATIONAL ZONES OF NUMEROUS LIMESTONE FRAGMENTS.

LIMESTONE: LIGHT GRAY; COARSE CRYSTALLINE; MEDIUM TO THICK BEDDED; WEATHERS YELLOWISH-BROWN; MODERATELY WEATHERED AND OCCASIONALLY CLAY-FILLED ALONG BEDDING PLANES, JOINTS AND FRACTURES; FOSSILIFEROUS; OCCASIONAL CALCITE CRYSTAL ALONG JOINT SURFACES AND FRACTURES.

LIMESTONE: HIGHLY WEATHERED.

JOINT

3° DIP AND DIRECTION OF BEDDING PLANES

NOTES:

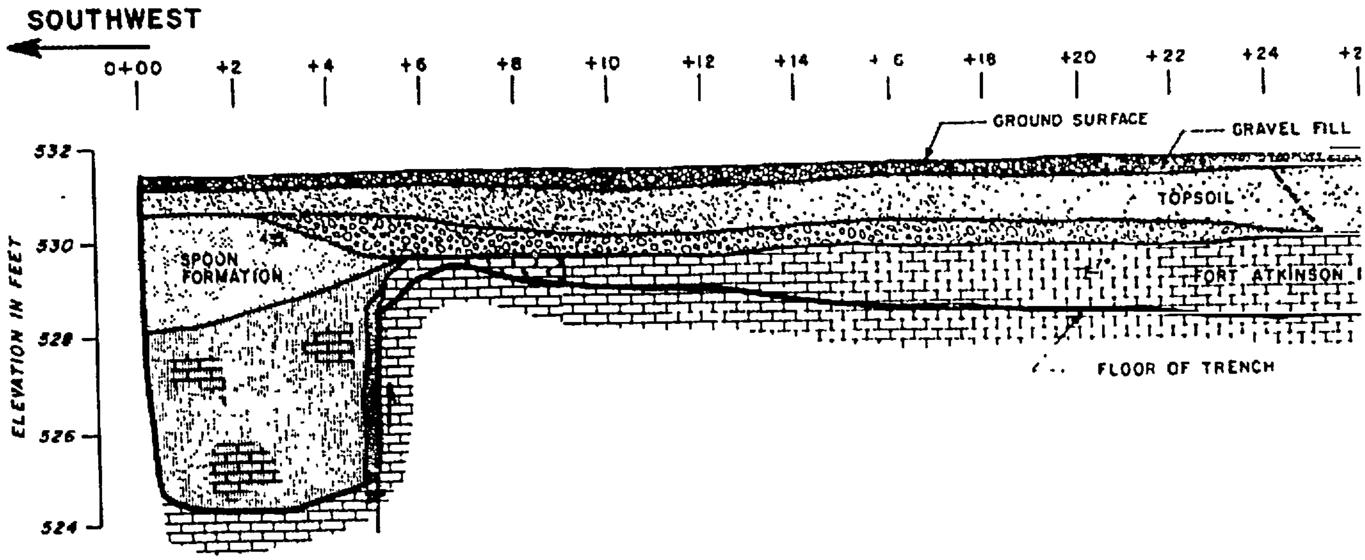
1. TRENCH PROFILES ARE SHOWN FROM THE SAME DIRECTION, LOOKING NORTHWEST.
2. SOME FEATURES SEEN ON PROFILES OF TRENCHES ARE OBSCURED ON FLOOR AND DO NOT APPREAR.
3. DATA SHOWN BELOW TRENCH FLOOR IS INTERPRETED BASED ON BORING DATA AND VISUAL INSPECTION OF TRENCHES.

TRENCH CROSS-SECTI

CT - 4

DAMES & MO

FIGURE 5



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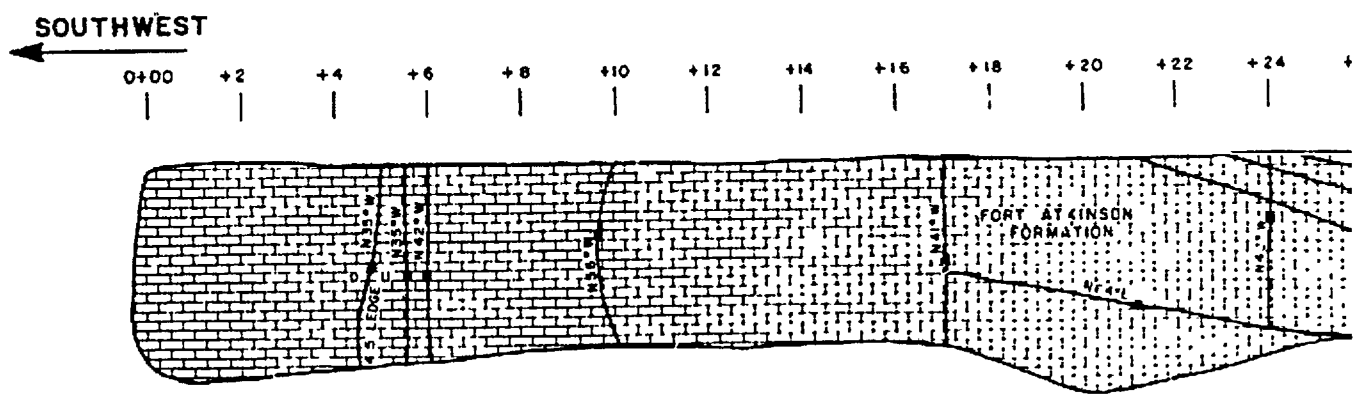

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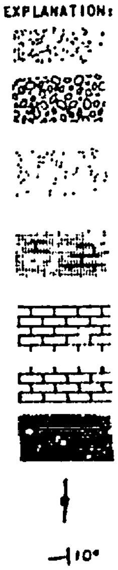
EXPLANATION:



TOPSOIL (FILL): DARK BROWN CLAY; BLOCKY.

TILL: DARK BROWN AND BROWNISH-YELLOW SILTY CLAY MATRIX; WITH 40% ROUNDED GRAVELS; POORLY SORTED, OCCASIONAL ANGULAR AND SUB-ANGULAR SANDSTONE SLABS.

SANDSTONE: LIGHT GRAY WITH YELLOWISH-RED LAMINATIONS; FINE TO MEDIUM GRAINED; THINLY BEDDED; MICACEOUS; FRESH TO MODERATELY WEATHERED; INCLINED BEDDING SW FROM IMMEDIATE VICINITY OF FAULT.

LIMESTONE CLAY 'RUBBLE': LIGHT GRAYISH-BROWN SILTY CLAY MATRIX WITH ANGULAR FRAGMENTS OF LIMESTONE UP TO 1 FOOT, VERY CALCAREOUS; POORLY SORTED, POORLY GRADED; OCCASIONAL WEATHERED CHERT FRAGMENTS.

LIMESTONE: LIGHT GRAY; COARSE CRYSTALLINE; MEDIUM TO THICK BEDDED; WEATHERS YELLOWISH-BROWN; MODERATELY WEATHERED AND OCCASIONALLY CLAY-FILLED ALONG BEDDING PLANES, JOINTS AND FRACTURES; FOSSILIFEROUS.

LIMESTONE: HIGHLY WEATHERED

SILTY CLAY: GREENISH-GRAY; OCCASIONALLY CONTAINS INCLUSIONS OF EXTREMELY WEATHERED LIMESTONE FRAGMENTS; FOUND WITHIN FRACTURES AND ALONG LIMESTONE BEDDING PLANES; WEATHERS YELLOWISH-BROWN.

JOINT

10° DIP AND DIRECTION OF BEDDING PLANE

NOTES:

1. SOME FEATURES ... AND DO NOT APPEAR.

2. DATA SHOWN BELOW TRE... AND VISUAL INSPECTIO...

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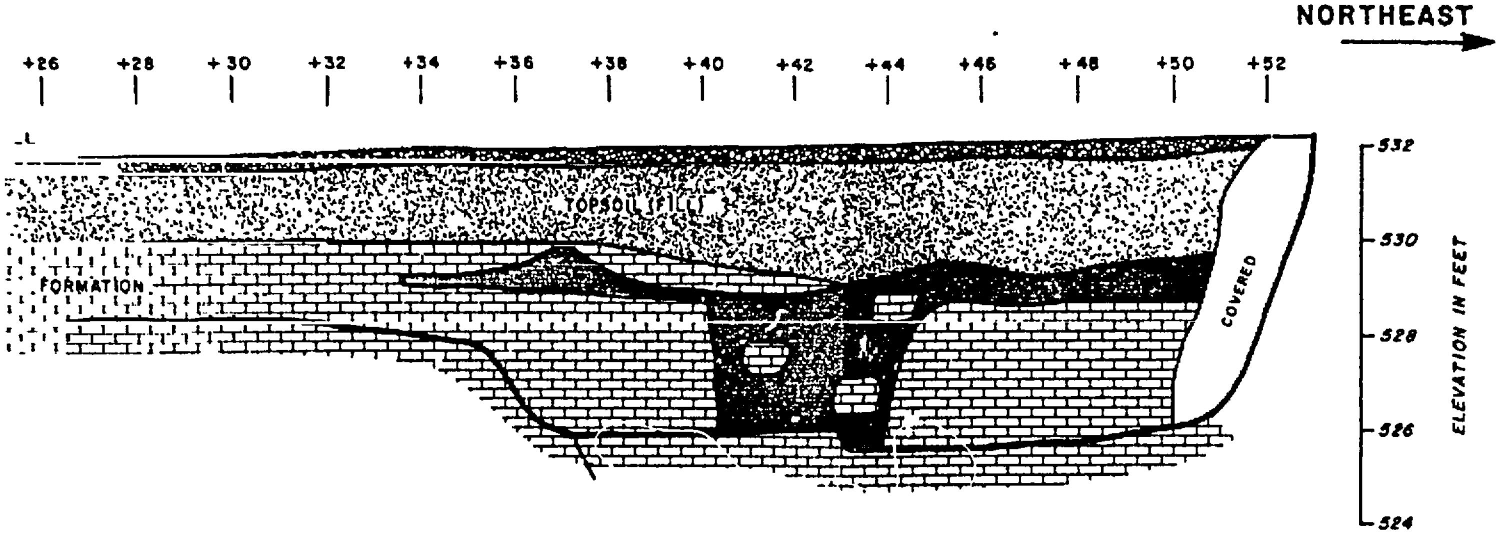
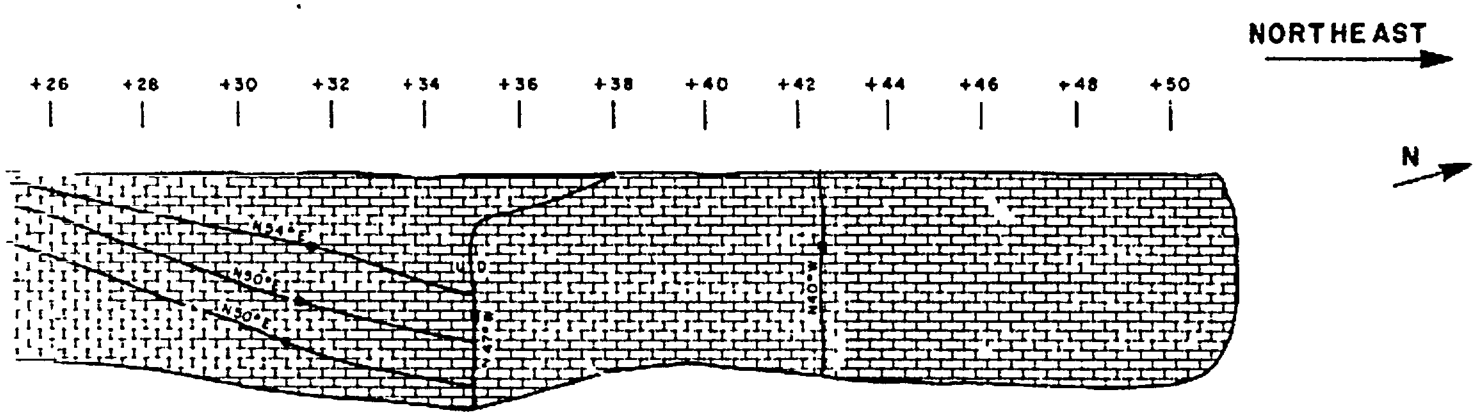


ORTH WALL



'CH FLOOR PLAN

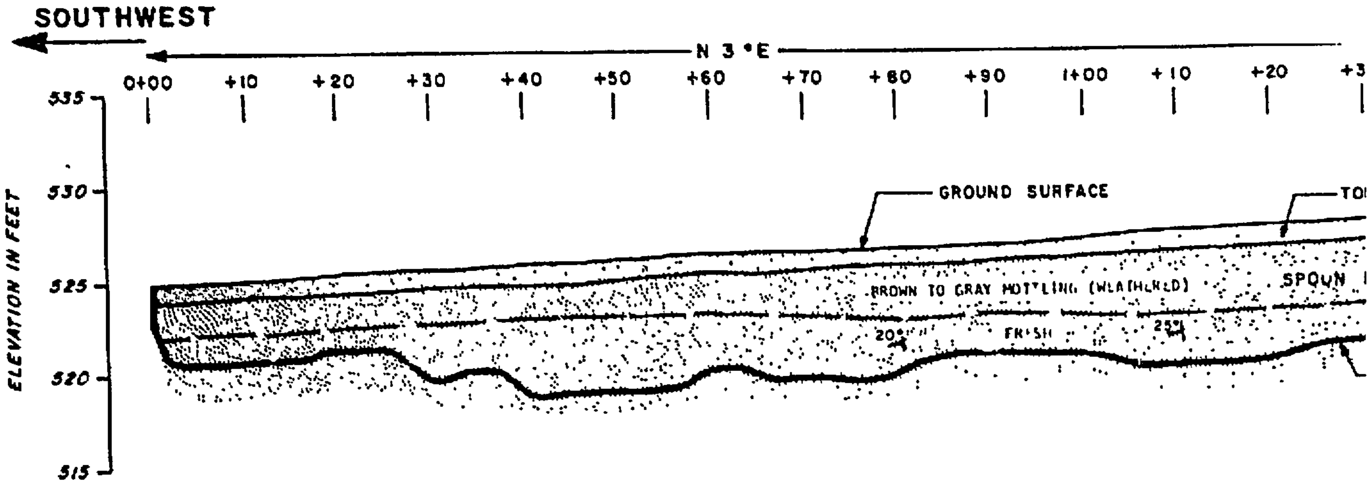
FEET
0 2 4
NO VERTICAL EXAGGERATION

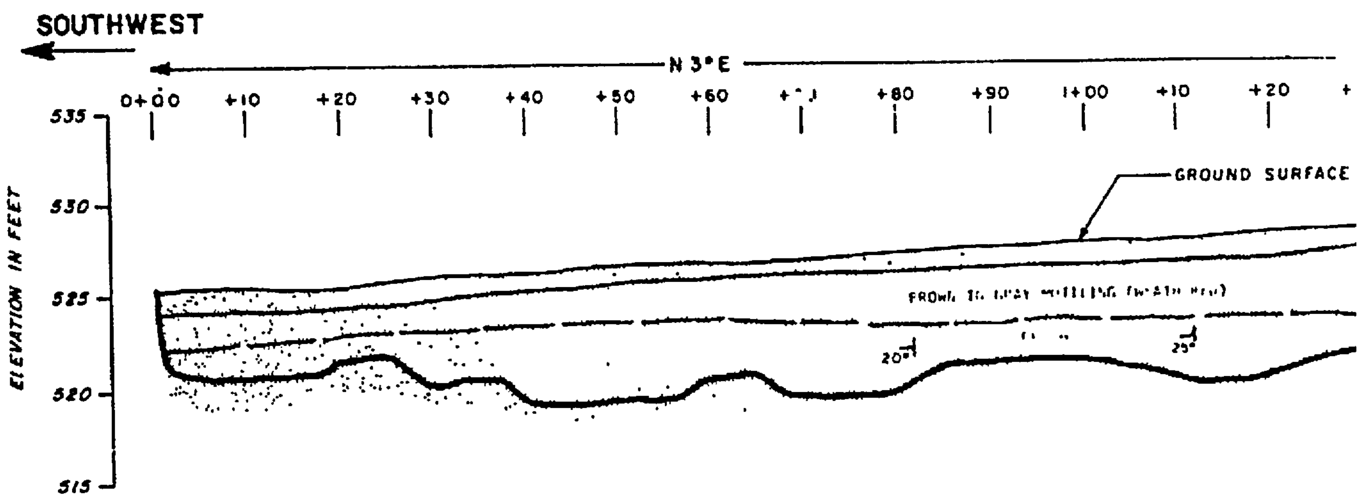
...ON PROFILES OF TRENCHES ARE OBSCURED ON FLOOR

...NCH FLOOR IS INTERPRETED BASED ON BORING DATA
...ON OF TRENCHES.

TRENCH CROSS-SEC
CT - 5

DAMES & M





EXPLANATION:

TILL: DARK BROWN AND BROWNISH-YELLOW SILTY CLAY MATRIX; WITH 40% ROUNDED GRAVELS; POORLY SORTED; OCCASIONAL ANGULAR AND SUB-ANGULAR SANDSTONE SLABS.

SANDSTONE: GRAY; FINE TO MEDIUM GRAINED, THINLY BEDDED; MICACEOUS; FRESH TO MODERATELY WEATHERED, UPPER 3 TO 4 FEET WEATHERED TO MOTTLED GRAYISH-BROWN; FROM 2+10 TO 2+50 HIGHLY WEATHERED.

LIMESTONE CLAY "RUBBLE": LIGHT GRAYISH-BROWN SILTY CLAY MATRIX WITH ANGULAR FRAGMENTS OF LIMESOTNE UP TO 1 FOOT; VERY CALCAREOUS; POORLY SORTED, POORLY GRADED; OCCASIONAL WEATHERED CHERT FRAGMENTS.

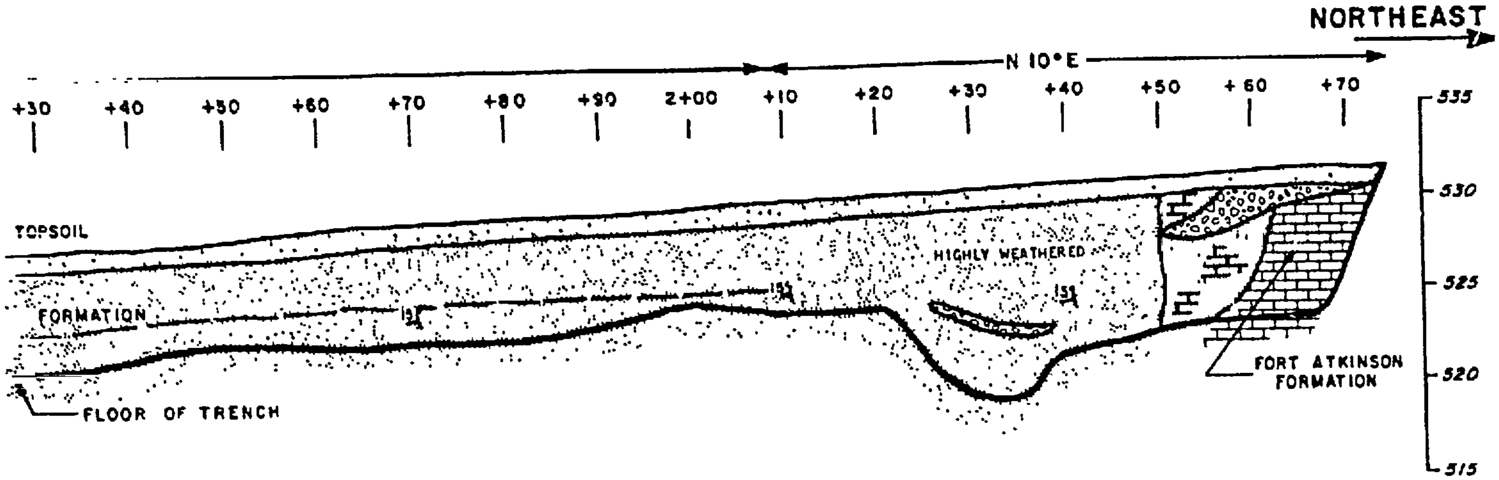
LIMESTONE: LIGHT GRAY, COARSE CRYSTALLINE, MEDIUM TO THICK BEDDED; WEATHERS YELLOWISH-BROWN; MODERATELY WEATHERED AND OCCASIONALLY CLAY-FILLED ALONG BEDDING PLANES, JOINTS AND FRACTURES; FOSSILIFEROUS.

15° DIP AND DIRECTION OF BEDDING PLANE

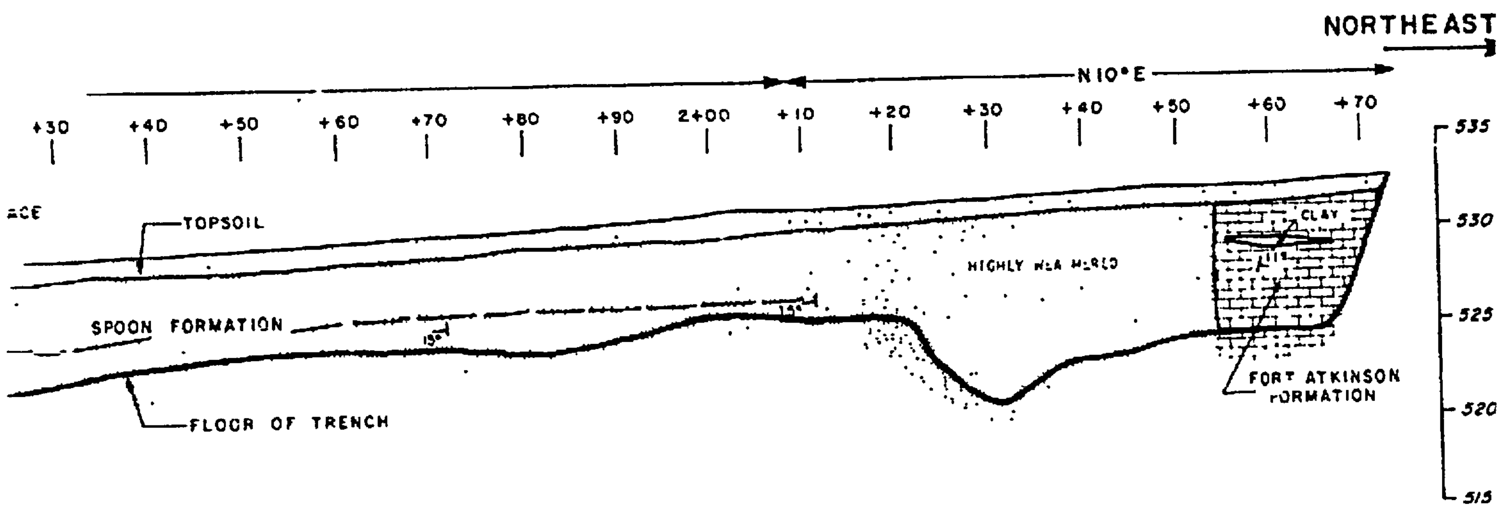
NOTES:

1. TRENCH PROFILES ARE SHOWN FROM THE SAME DIRECTION, LOOKING WEST-NORTHWEST.
2. DATA SHOWN BELOW TRENCH FLOOR [illegible] BASED ON BORING DATA AND VISUAL INSPECTION [illegible]

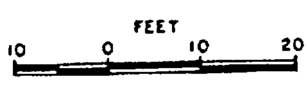
1674-099-07



WEST WALL



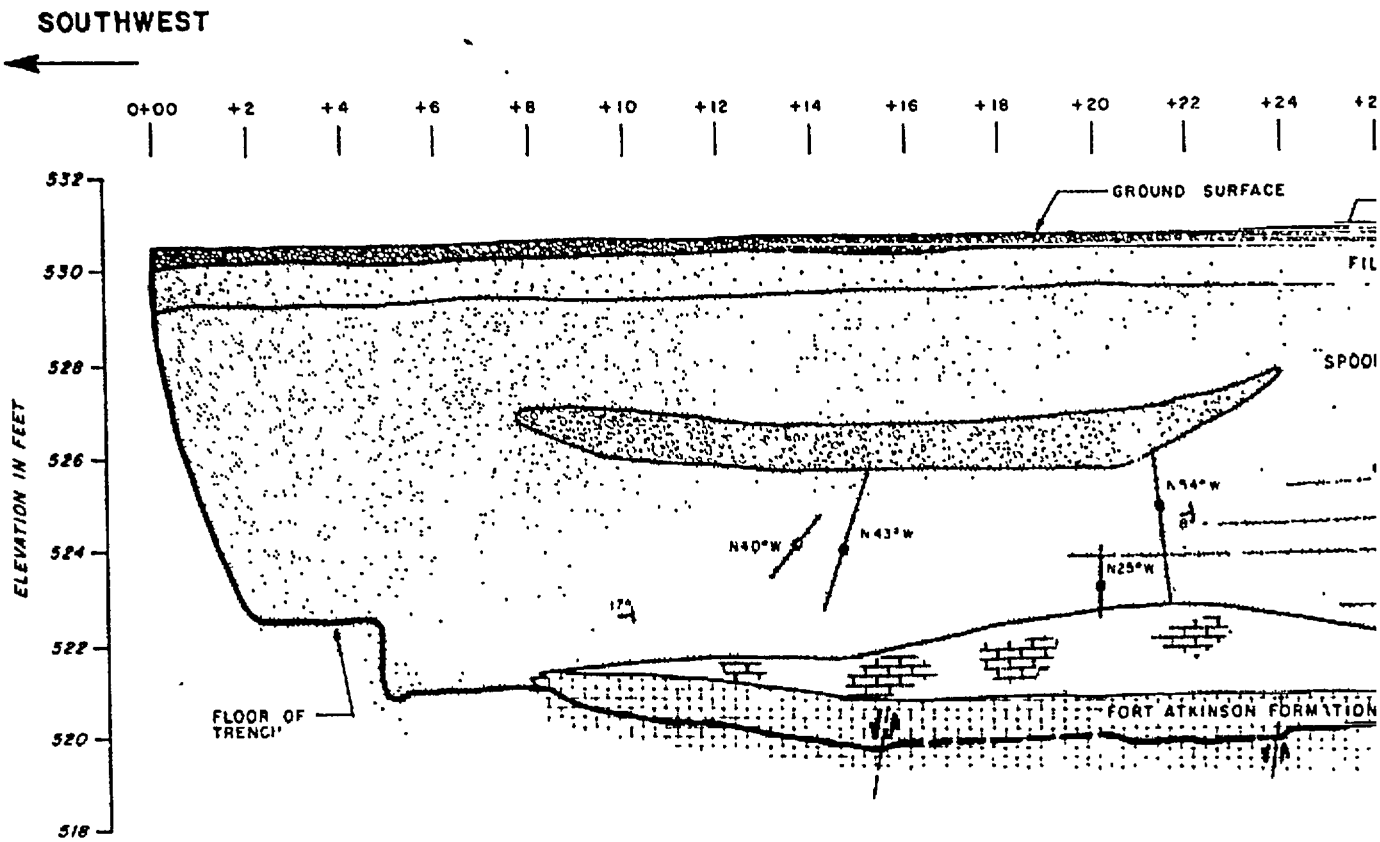
EAST WALL



TRENCH CROSS-SE
CT - 6

DAMES &

FIGURE



WEST

FEET

EXPLANATION:

FILL: BLACK CLAY, BLOCKY.

TILL. DARK BROWN AND BROWNISH-YELLOW SILTY CLAY MATRIX, WITH 40% ROUNDED GRAVELS; POORLY SORTED; OCCASIONAL ANGULAR AND SUB-ANGULAR SANDSTONE SLABS.

SANDSTONE: GRAY, FINE TO MEDIUM GRAINED; THINLY BEDDED, MICACEOUS; OCCASIONAL BLACK ORGANIC SEAMS [illegible] THICK; FRESH TO MODERATELY WEATHERED, FROM [illegible] HIGHLY WEATHERED.

LIMESTONE CLAY "RUBBLE": LIGHT GRAYISH-BROWN SILTY CLAY MATRIX WITH ANGULAR FRAGMENTS OF LIMESTONE [illegible] VERY CALCAREOUS; POORLY SORTED, [illegible] WEATHERED CHERT FRAGMENTS.

LIMESTONE: LIGHT GRAY; COARSE [illegible], MEDIUM TO THICK BEDDED, [illegible] YELLOWISH-BROWN, MODERATELY WEATHERED AND OCCASIONALLY CLAY-FILLED ALONG BEDDING PLANES, JOINTS AND FRACTURES; FOSSILIFEROUS, OCCASIONAL CALCITE CRYSTALS ALONG JOINT SURFACES.

LIMESTONE: HIGHLY WEATHERED

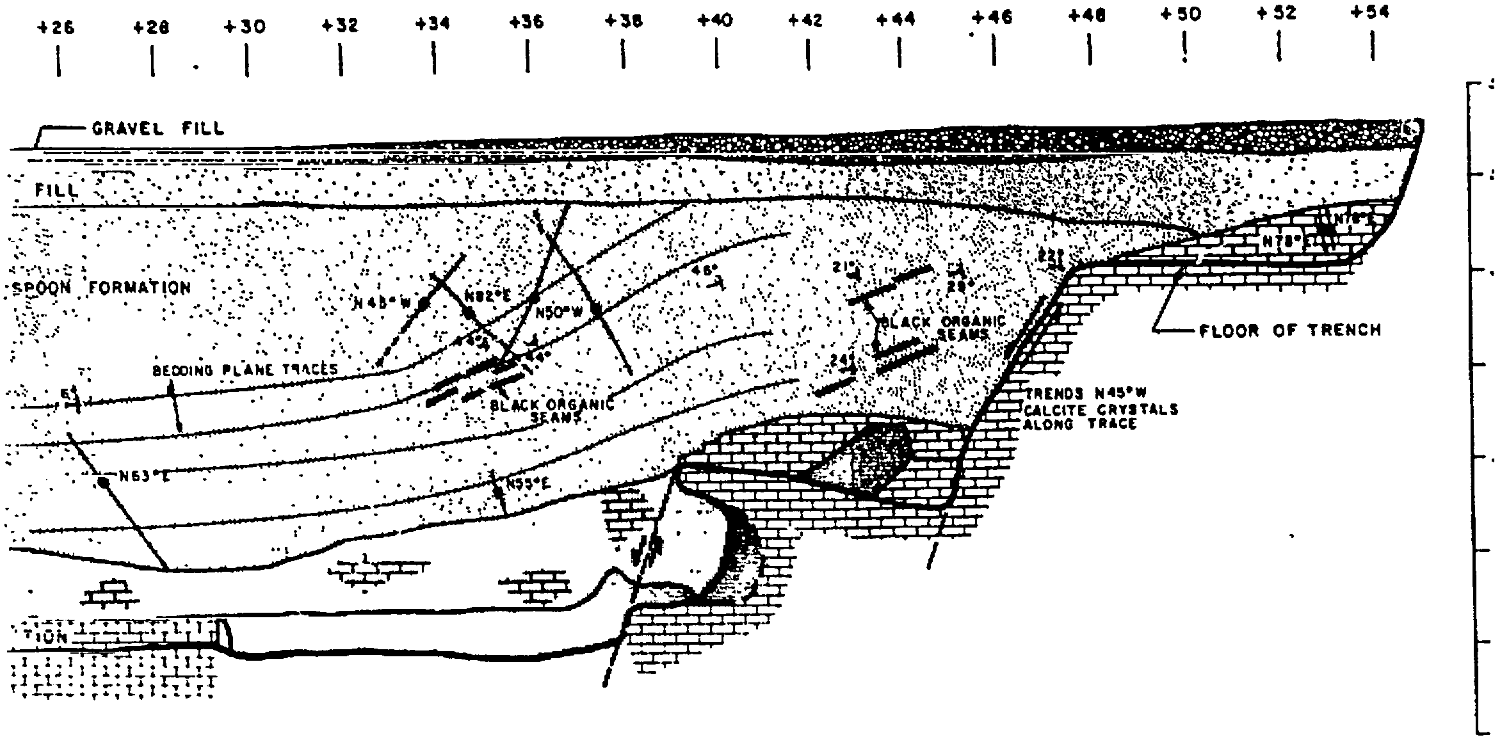
SILTY CLAY: GREENISH-GRAY, OCCASIONALLY CONTAINS [illegible] OF EXTREMELY WEATHERED LIMESTONE FRAGMENTS, FOUND WITHIN FRACTURES AND ALONG LIMESTONE BEDDING PLANES, WEATHERS YELLOWISH BROWN

JOINT

[illegible]

1674-099-07

NORTHEA



T WALL

FEET
2 4

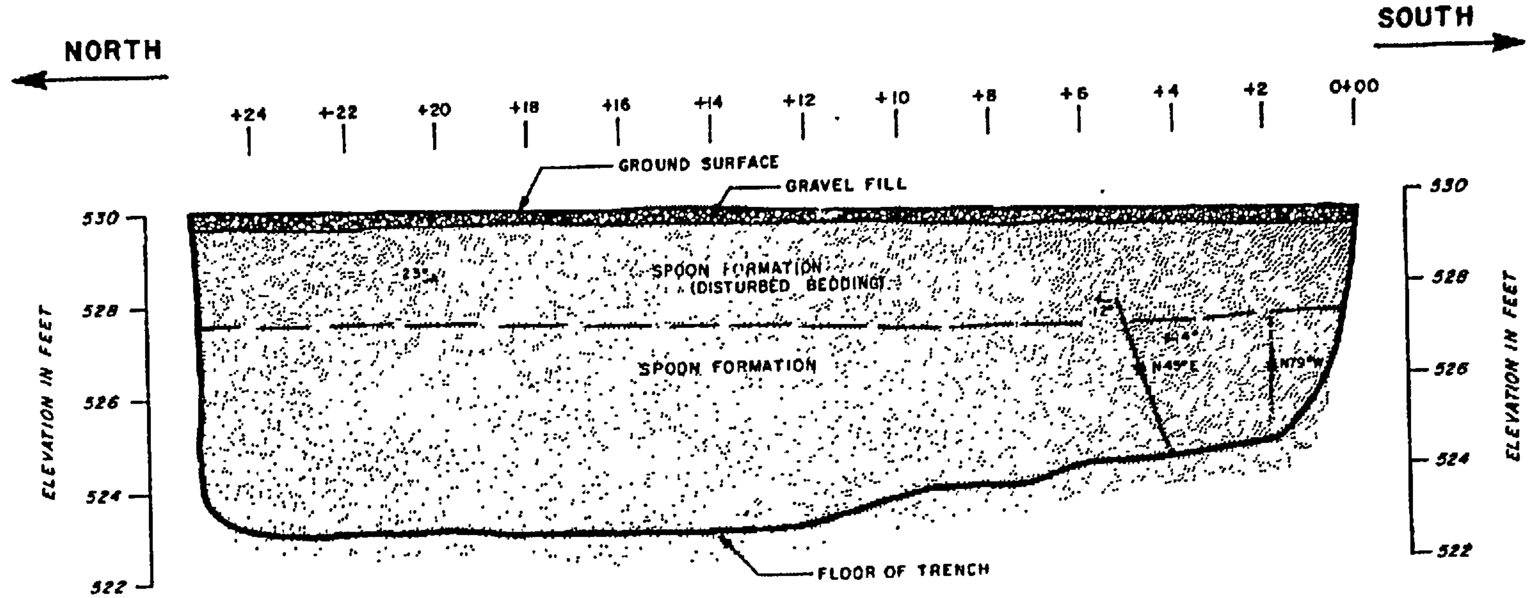
ICAL EXAGGERATION

TH FLOOR IS INTERPRETED BASED ON BORING DATA
ION OF TRENCHES.

TRENCH CROSS-S
CT - 7

FIGURE

1674-099-07



EAST WALL

FEET

2 0 2 4

NO VERTICAL EXAGGERATION

EXPLANATION:

SANDSTONE- GRAY; FINE TO MEDIUM GRAINED; THINLY BEDDED; MICACEOUS; MODERATELY WEATHERED IN UPPER 2.5 FEET. DISTURBED BEDDING IN UPPER 2.5 FEET IS DUE TO GLACIAL ACTION.

JOINT

23° DIP AND DIRECTION OF BEDDING PLANES

NOTE:

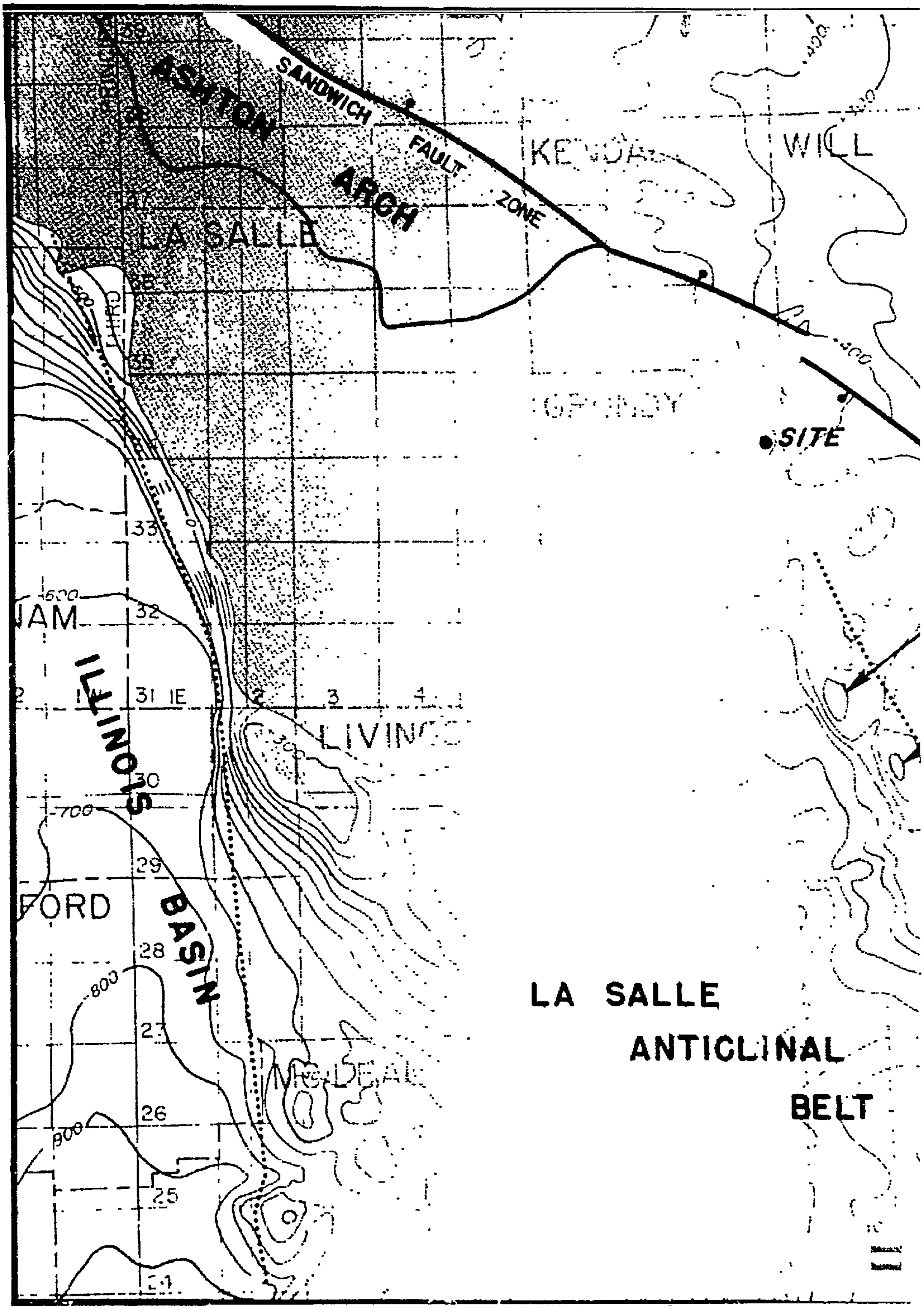
DATA SHOWN BELOW TRENCH FLOOR IS INTERPRETED BASED ON BORING DATA AND VISUAL INSPECTION OF TRENCHES.

TRENCH CROSS-SECTION

CT - 8

DAMES & MOORE

FIGURE 5.11



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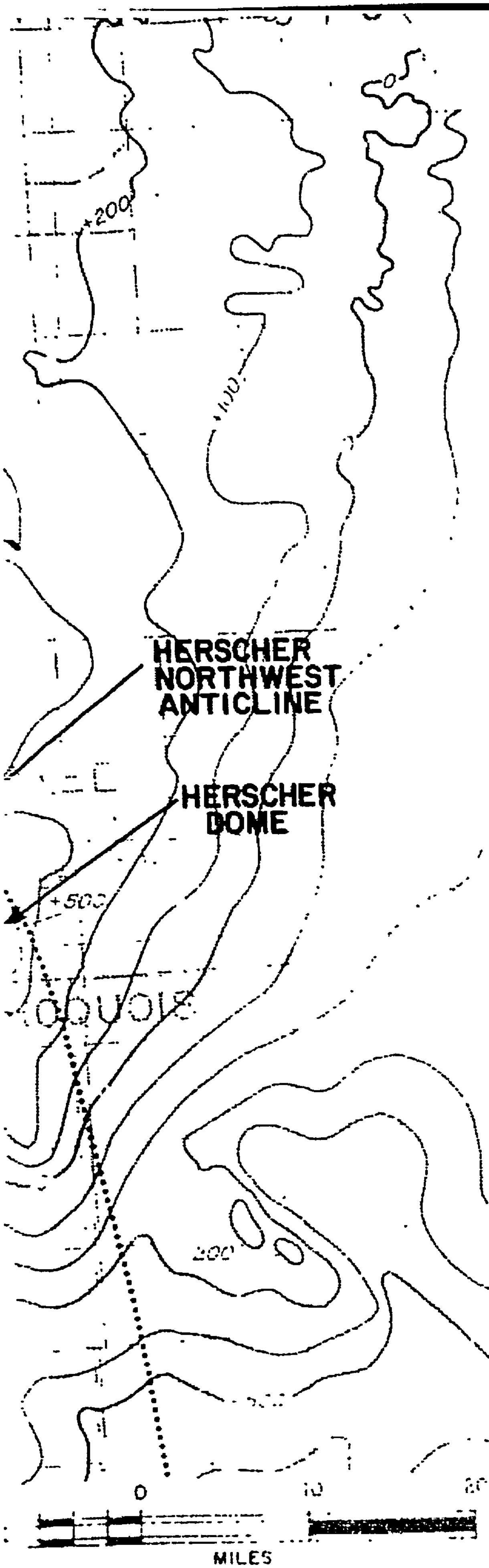


EXPLANATION

STRUCTURE CONTOURS ON TOP OF THE GALENA GROUP CONTOUR INTERVAL 100 FEET; DATUM SEA LEVEL

MAQUOKETA ABSENT, TOP OF GALENA ERODED

FAULT, DOWNTHROWN SIDE INDICATED

APPROXIMATE BOUNDARY OF THE LA SALLE ANTICLINAL BELT

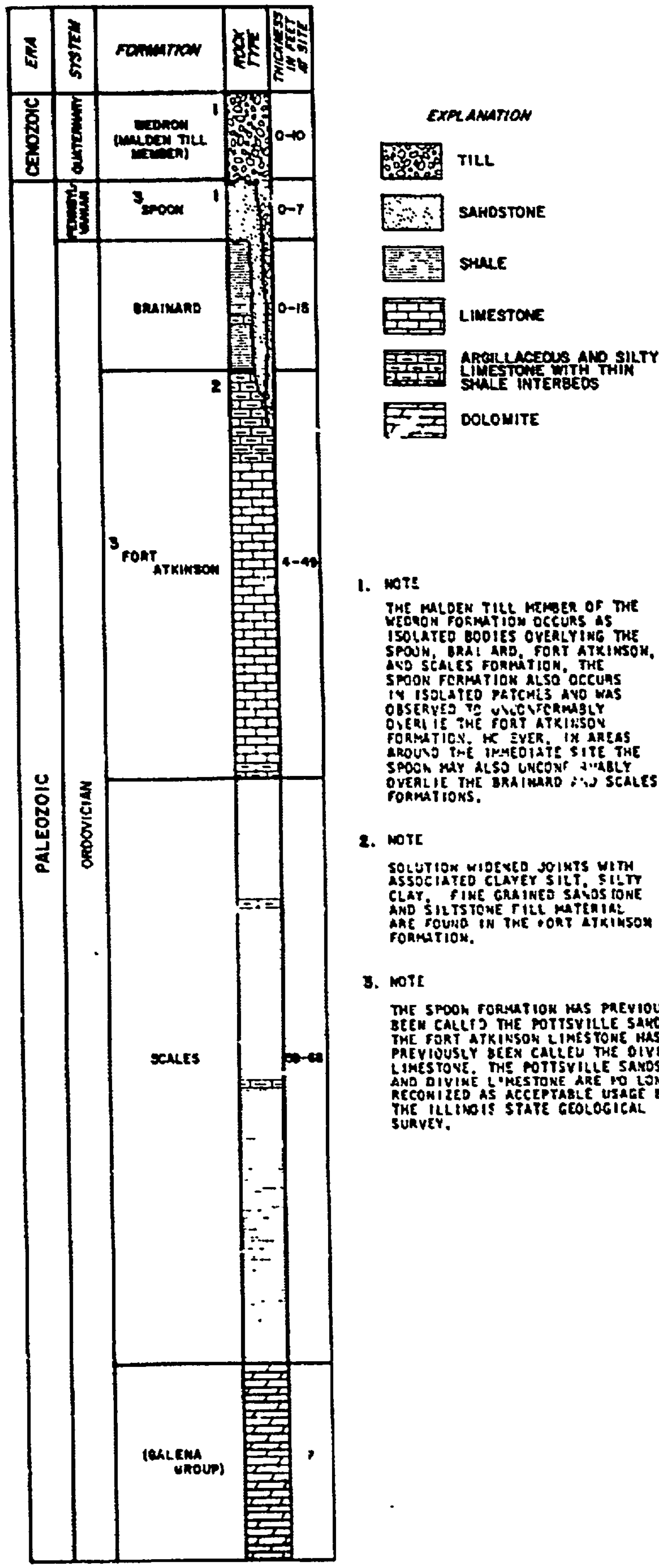
REFERENCE: MODIFIED FROM

BRISTOL, H.M. AND BUSCHBACH, T.C 1973, ORDOVICIAN GALENA GROUP (TRENTON) OF ILLINOIS-STRUCTURE AND OIL FIELDS; ILLINOIS STATE GEOLOGICAL SURVEY, ILL. PET. 99, PLATE 1.

REGIONAL STRUCTURE /

DAMES & I

FIGURE



1. NOTE

THE MALDEN TILL MEMBER OF THE WEDRON FORMATION OCCURS AS ISOLATED BODIES OVERLYING THE SPOON, BRAINARD, FORT ATKINSON, AND SCALES FORMATION, THE SPOON FORMATION ALSO OCCURS IN ISOLATED PATCHES AND WAS OBSERVED TO UNCONFORMABLY OVERLIE THE FORT ATKINSON FORMATION. HOWEVER, IN AREAS AROUND THE IMMEDIATE SITE THE SPOON MAY ALSO UNCONFORMABLY OVERLIE THE BRAINARD AND SCALES FORMATIONS.

2. NOTE

SOLUTION WIDENED JOINTS WITH ASSOCIATED CLAYEY SILT, SILTY CLAY, FINE GRAINED SANDSTONE AND SILTSTONE FILL MATERIAL ARE FOUND IN THE FORT ATKINSON FORMATION.

3. NOTE

THE SPOON FORMATION HAS PREVIOUSLY BEEN CALLED THE POTTSVILLE SANDSTONE. THE FORT ATKINSON LIMESTONE HAS PREVIOUSLY BEEN CALLED THE DIVINE LIMESTONE. THE POTTSVILLE SANDSTONE AND DIVINE LIMESTONE ARE NO LONGER RECONIZED AS ACCEPTABLE USAGE BY THE ILLINOIS STATE GEOLOGICAL SURVEY.

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SITE STRATIGRAPHIC COLUMN

DAMES & MOORE

FIGURE 7

Certificate of Authenticity

This is to certify that microphotographs appearing on this film were produced in the normal course of business.

General Electric Company
Nuclear Energy Division
175 Curtner Avenue
San Jose, California

Microfilm Requested By Component No. 810

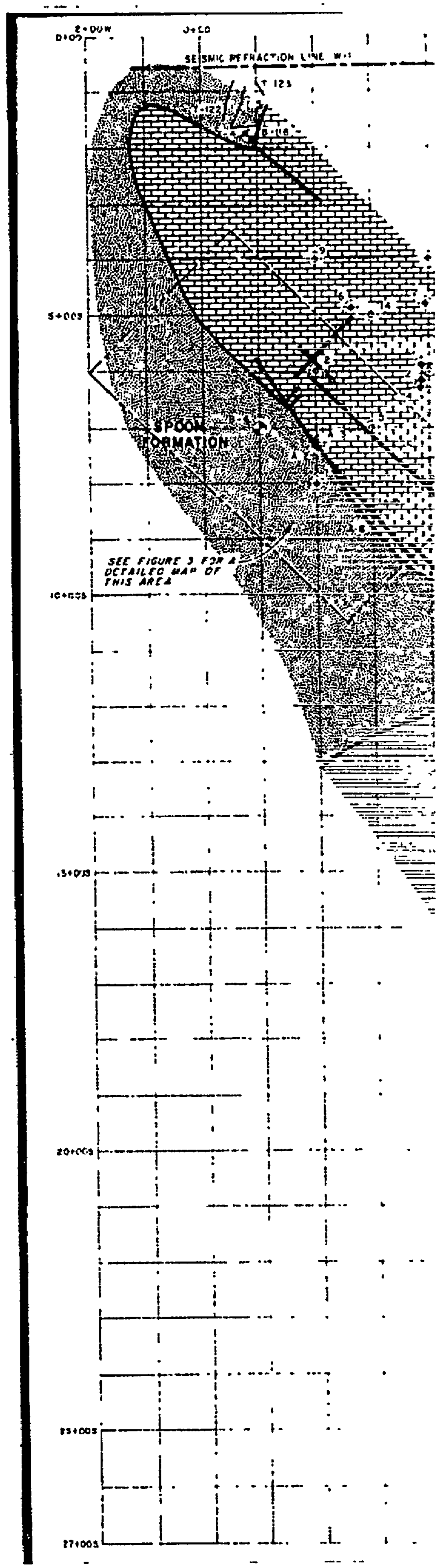
Microfilm Title REPORT-GEOLOGIC INVESTIGATIONS FOR PROJ.1V AUG.1977NEDO-21326 APPENDIX B.14

Microfilm is complete and accurate as submitted by requestor.

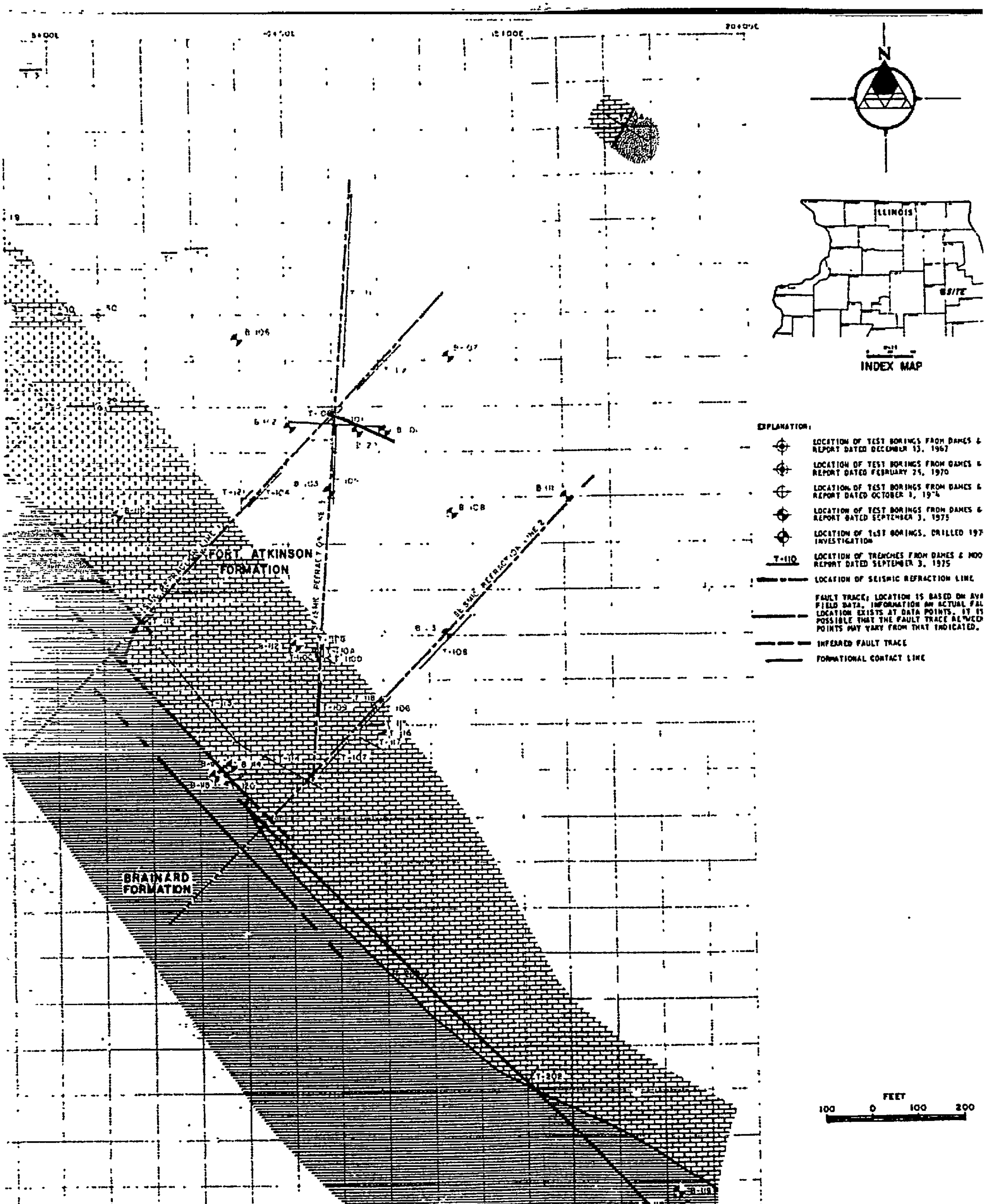
Camera Operator: K.

Date Produced: 9-6-77

Place: San Jose, California

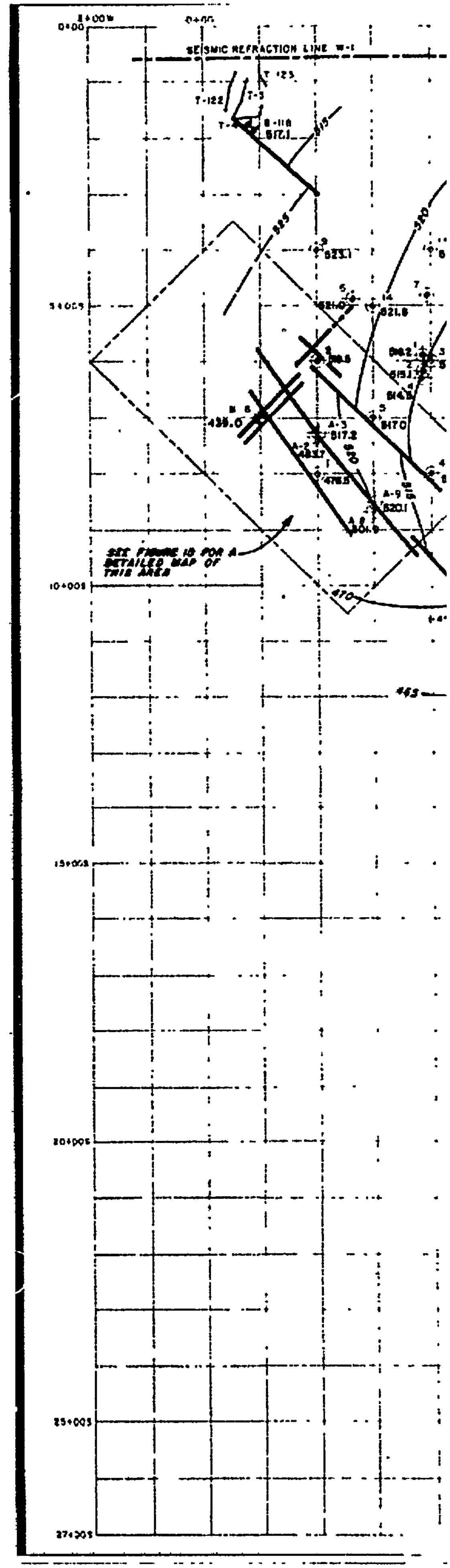

SEISMIC REFRACTION LINE W-1
SPOON FORMATION
SEE FIGURE 3 FOR A DETAILED MAP OF THIS AREA
5+00S
10+00S
20+00S
25+00S
27+00S

1674-099-07

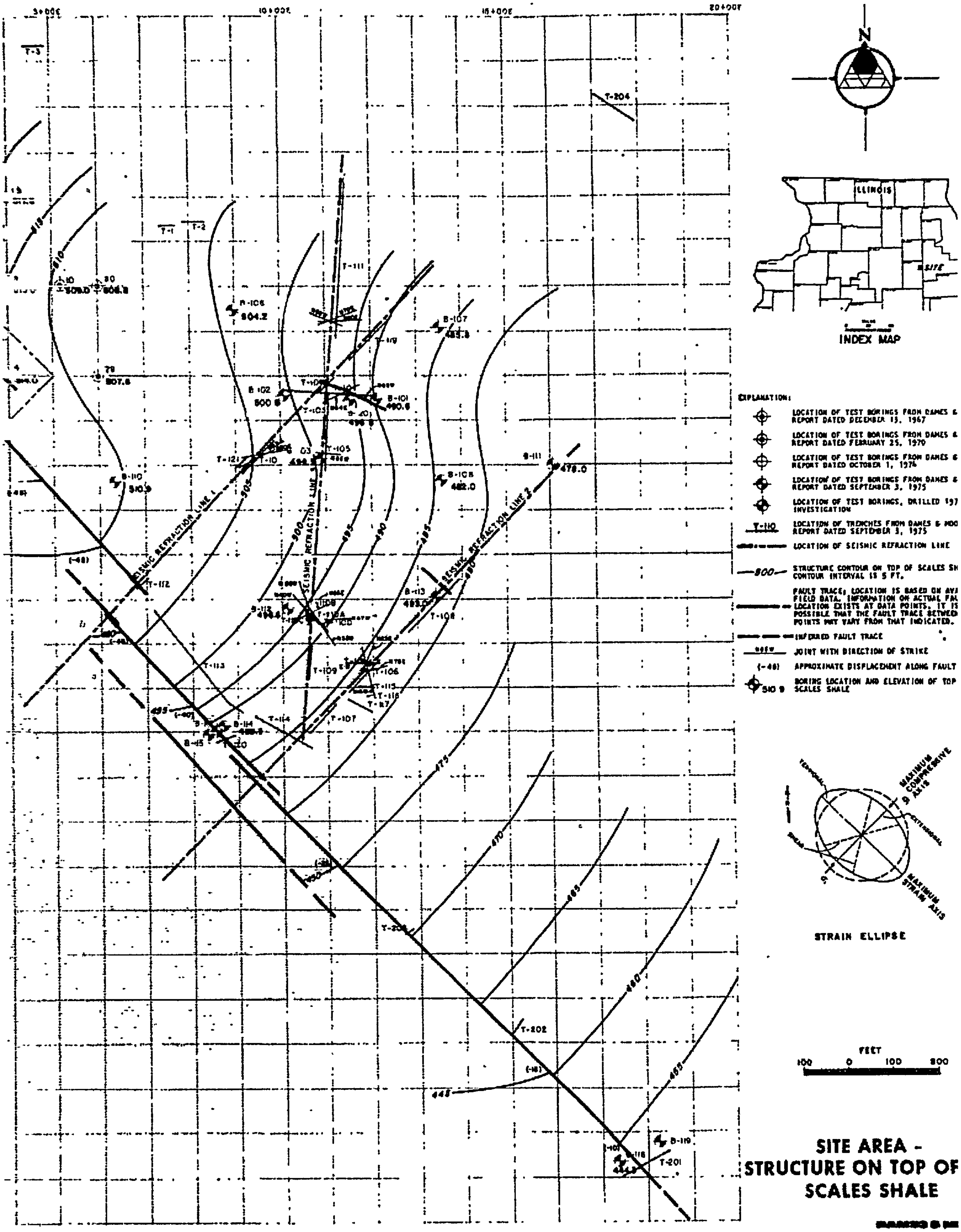


SITE AREA - BEDROCK LITHOLOGY

FIGURE

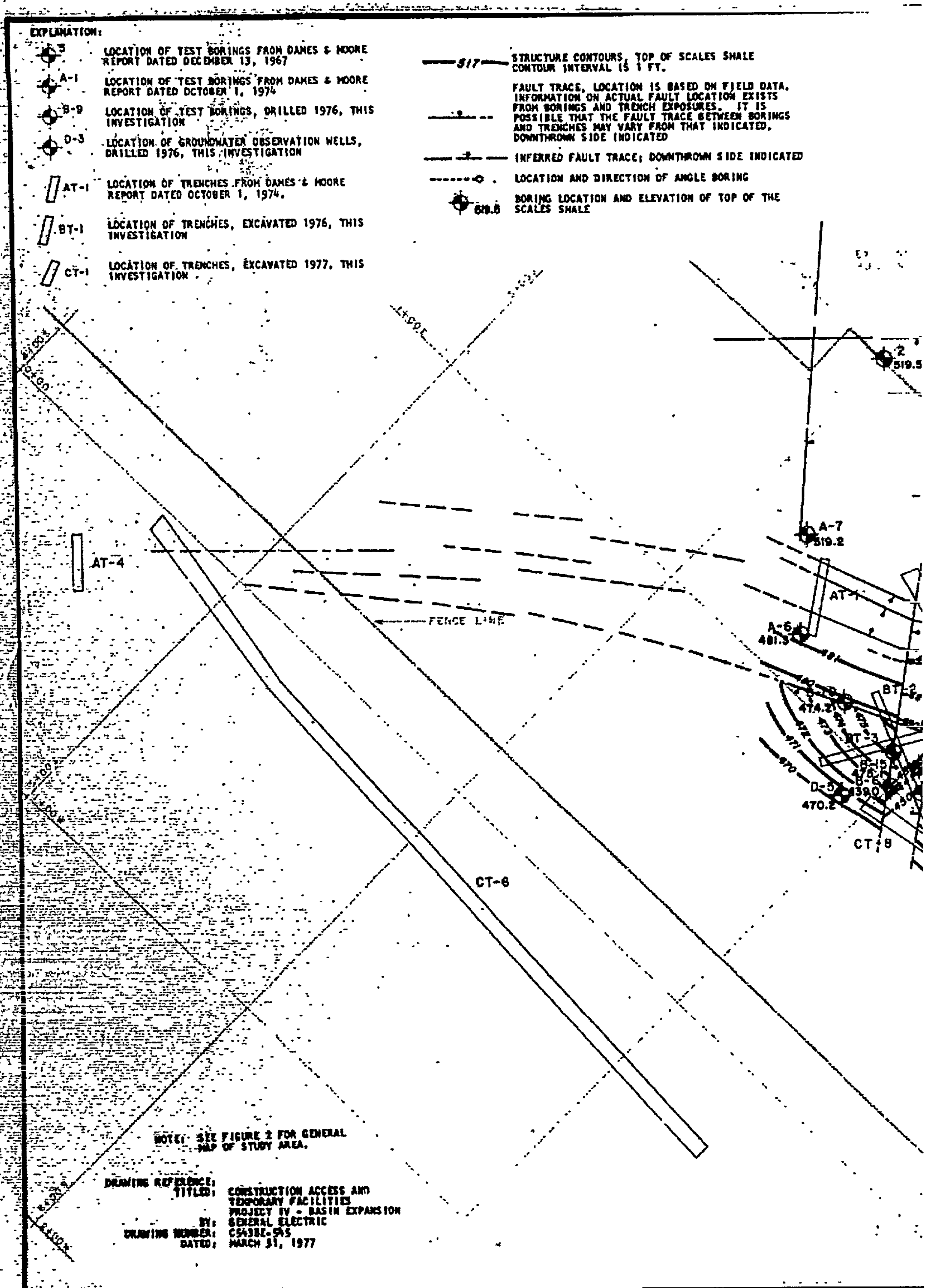

SEISMIC REFRACTION LINE W-1
SEE FIGURE FOR A DETAILED MAP OF THIS AREA
5+00S
10+00S
15+00S
20+00S
25+00S
27+00S

1674-099-07



SITE AREA -
STRUCTURE ON TOP OF
SCALES SHALE

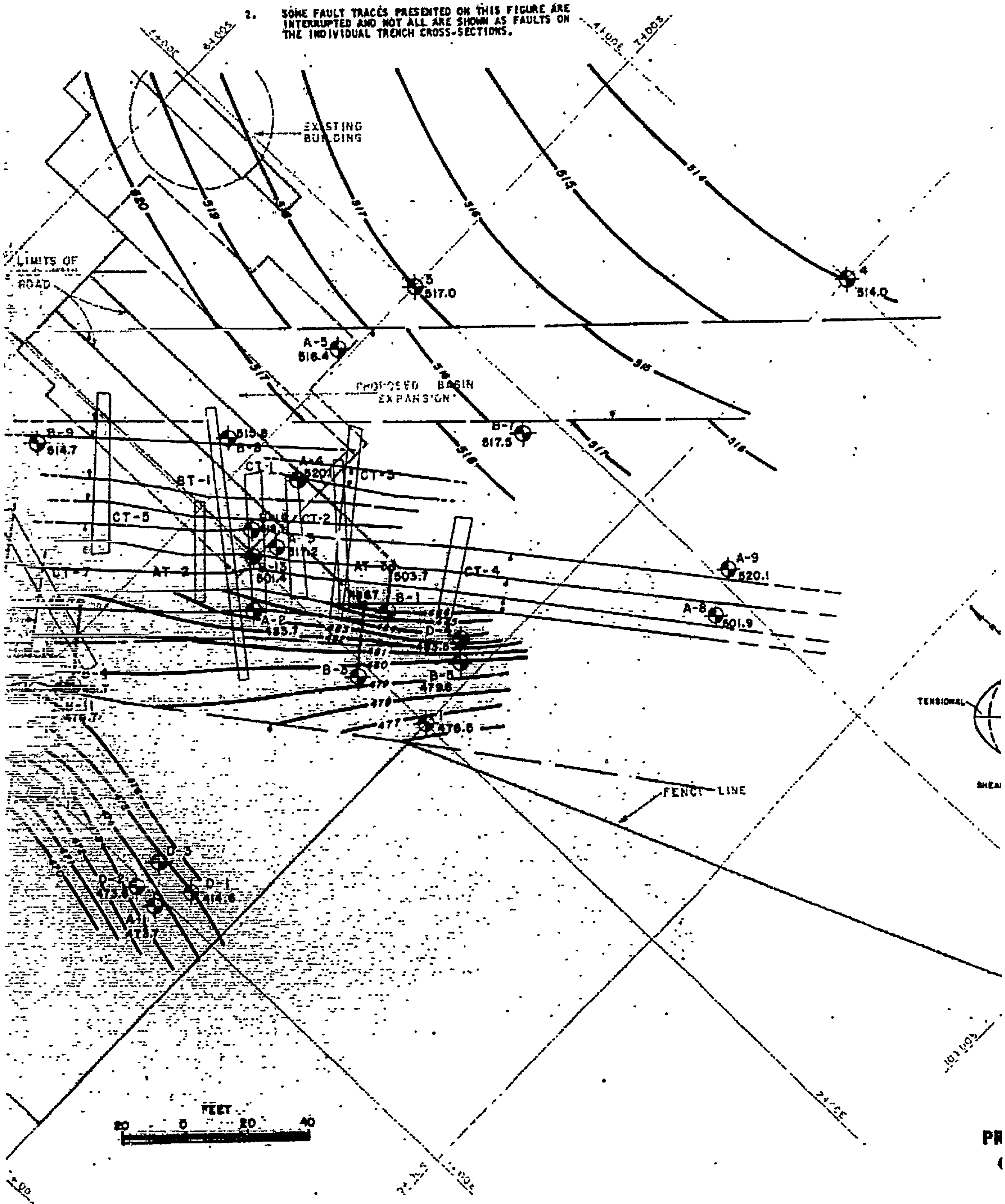
FIGURE


EXPLANATION:
LOCATION OF TEST BORINGS FROM DAMES & MOORE REPORT DATED DECEMBER 13, 1967
A-1 LOCATION OF TEST BORINGS FROM DAMES & MOORE REPORT DATED OCTOBER 1, 1974
B-9 LOCATION OF TEST BORINGS, DRILLED 1976, THIS INVESTIGATION
D-3 LOCATION OF GROUNDWATER OBSERVATION WELLS, DRILLED 1976, THIS INVESTIGATION
AT-1 LOCATION OF TRENCHES FROM DAMES & MOORE REPORT DATED OCTOBER 1, 1974.
BT-1 LOCATION OF TRENCHES, EXCAVATED 1976, THIS INVESTIGATION
CT-1 LOCATION OF TRENCHES, EXCAVATED 1977, THIS INVESTIGATION
517 STRUCTURE CONTOURS, TOP OF SCALES SHALE CONTOUR INTERVAL IS 1 FT.
FAULT TRACE, LOCATION IS BASED ON FIELD DATA. INFORMATION ON ACTUAL FAULT LOCATION EXISTS FROM BORINGS AND TRENCH EXPOSURES. IT IS POSSIBLE THAT THE FAULT TRACE BETWEEN BORINGS AND TRENCHES MAY VARY FROM THAT INDICATED, DOWNTHROWN SIDE INDICATED
INFERRED FAULT TRACE; DOWNTHROWN SIDE INDICATED
LOCATION AND DIRECTION OF ANGLE BORING
519.8 BORING LOCATION AND ELEVATION OF TOP OF THE SCALES SHALE
AT-4
FENCE LINE
CT-6
2
519.5
A-7
519.2
AT-1
A-6
481.3
BT-2
474.2
BT-3
B-15
B-6
D-5
470.2
CT-8
NOTE: SEE FIGURE 2 FOR GENERAL MAP OF STUDY AREA.
DRAWING REFERENCE:
TITLED: CONSTRUCTION ACCESS AND TEMPORARY FACILITIES PROJECT IV - BASIN EXPANSION
BY: GENERAL ELECTRIC
DRAWING NUMBER: C5438E-545
DATED: MARCH 31, 1977

NOTES:

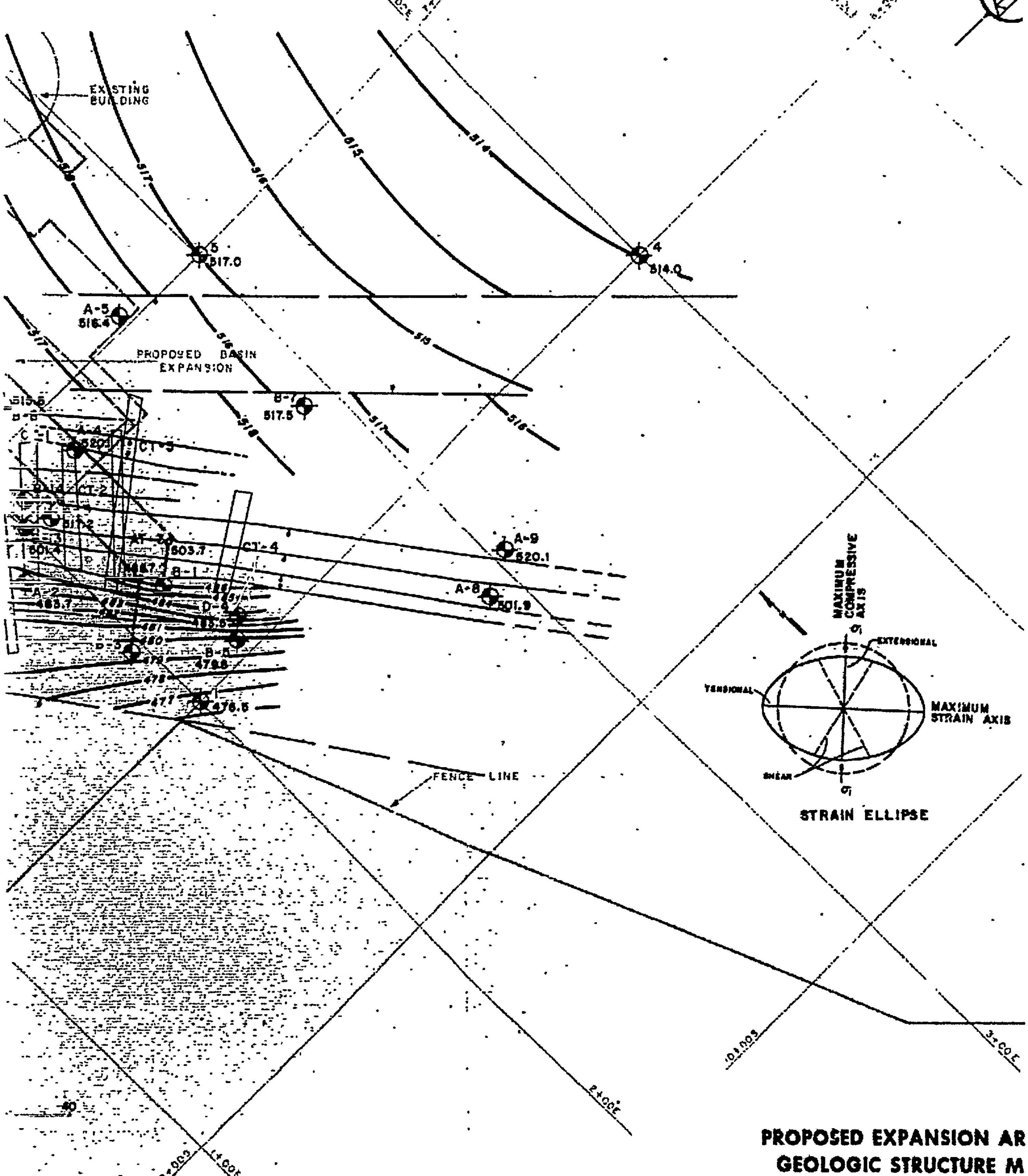
1. STRUCTURE IN THIS AREA IS BASED ON DATA POINTS SHOWN ON FIGURE 9.

2. SOME FAULT TRACES PRESENTED ON THIS FIGURE ARE INTERRUPTED AND NOT ALL ARE SHOWN AS FAULTS ON THE INDIVIDUAL TRENCH CROSS-SECTIONS.



NOTES:

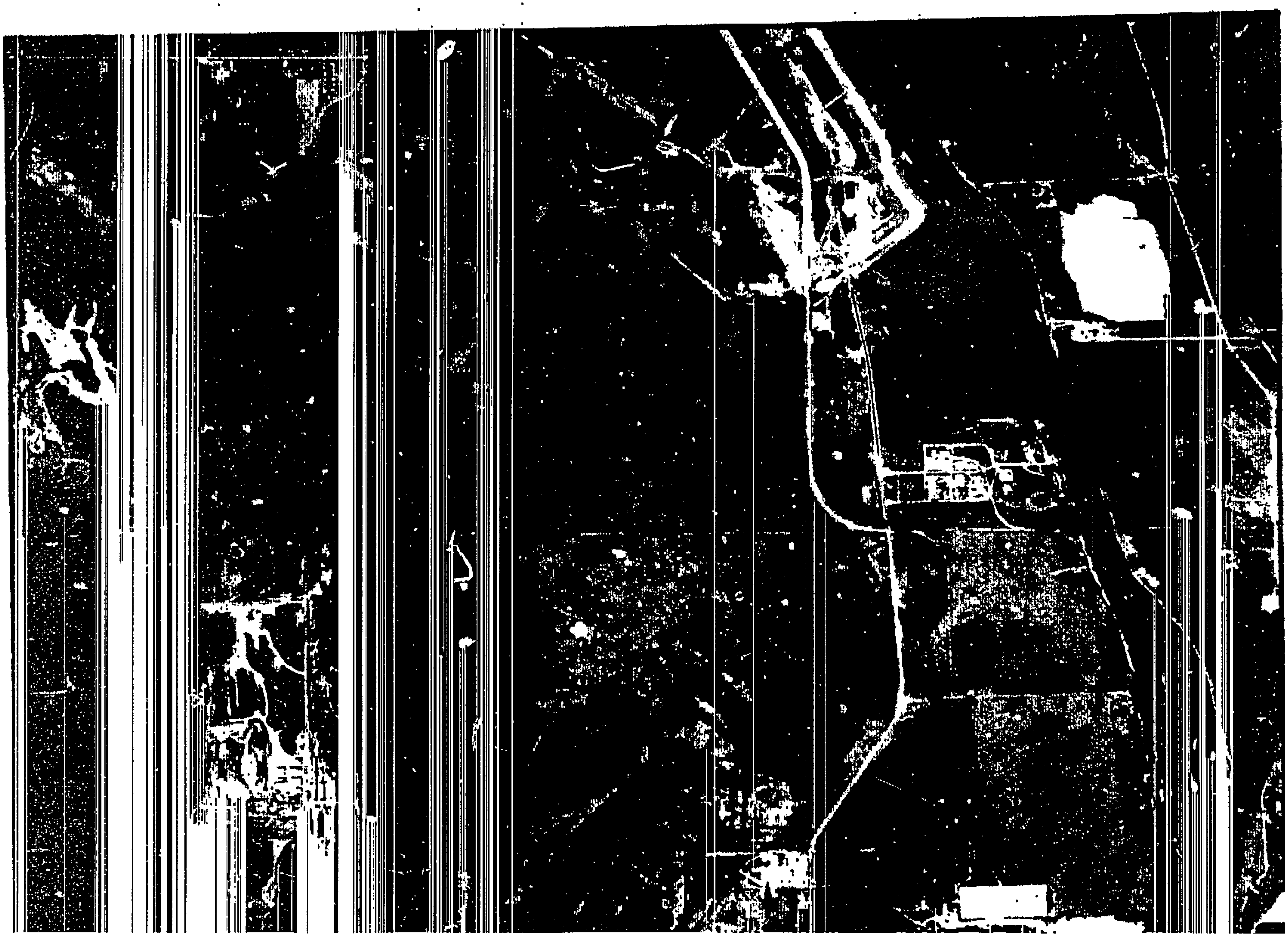
1. STRUCTURE IN THIS AREA IS BASED ON DATA POINTS SHOWN ON FIGURE 9.
2. SOME FAULT TRACES PRESENTED ON THIS FIGURE ARE INTERRUPTED AND NOT ALL ARE SHOWN AS FAULTS ON THE INDIVIDUAL TRENCH CROSS-SECTIONS.

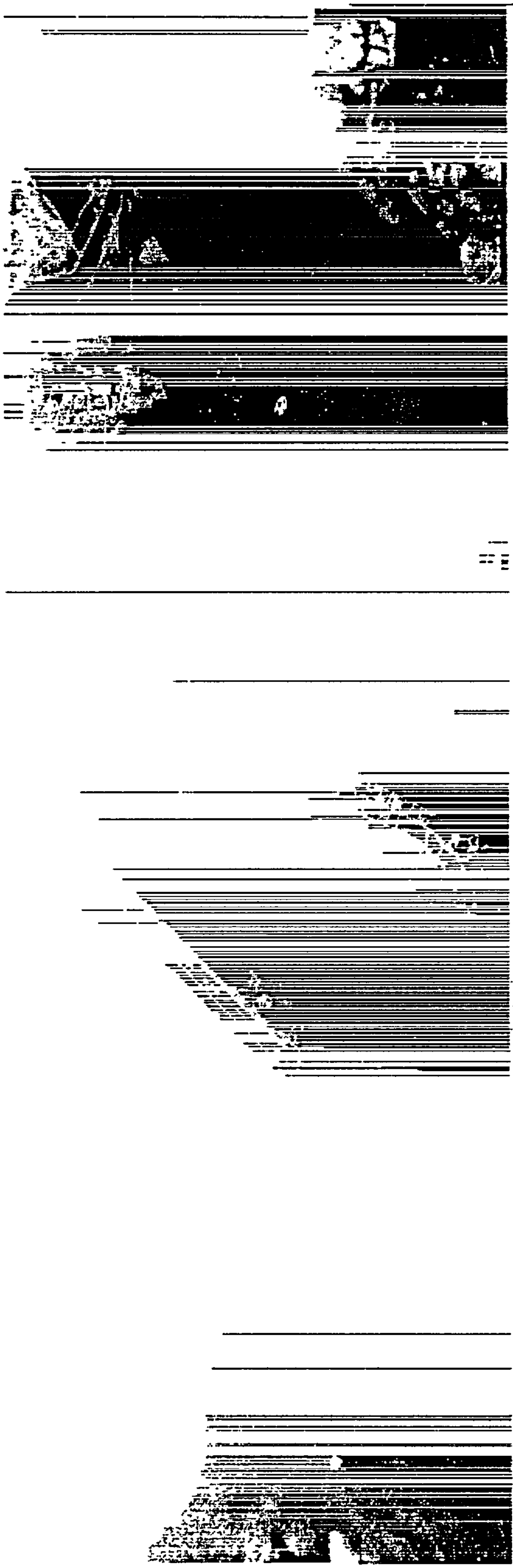


PROPOSED EXPANSION AR
GEOLOGIC STRUCTURE M

FIGURE

1674-099-07





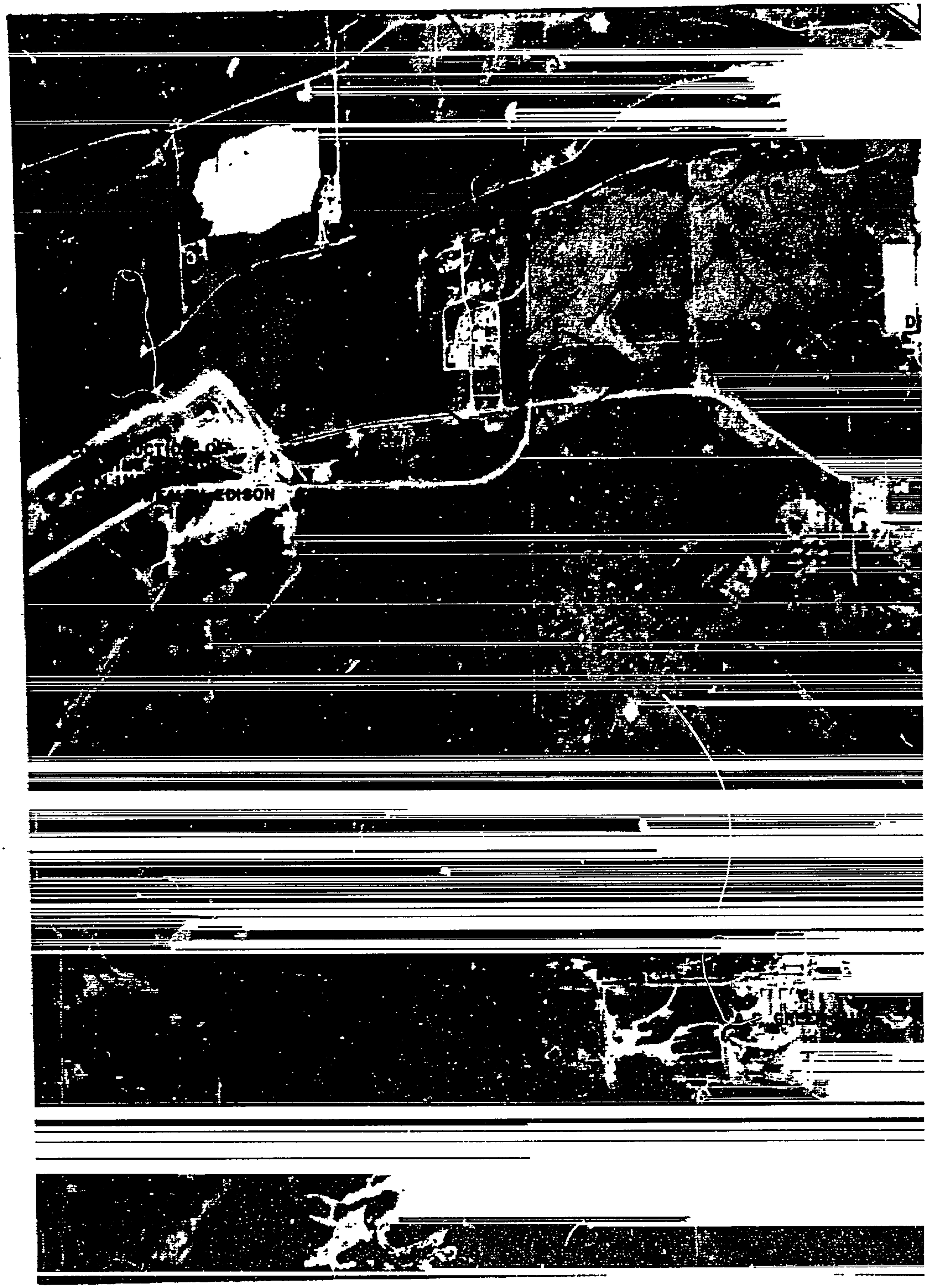
REFERENCE:

U.S. DEPT. OF AGRICULTURE, 1:40,000; PHOTO NO. 174-93
DATED SEPTEMBER 23, 1974.

0 ½ MILE

AERIAL PHOTOGRAPH - SITE AI

FIGURE 11



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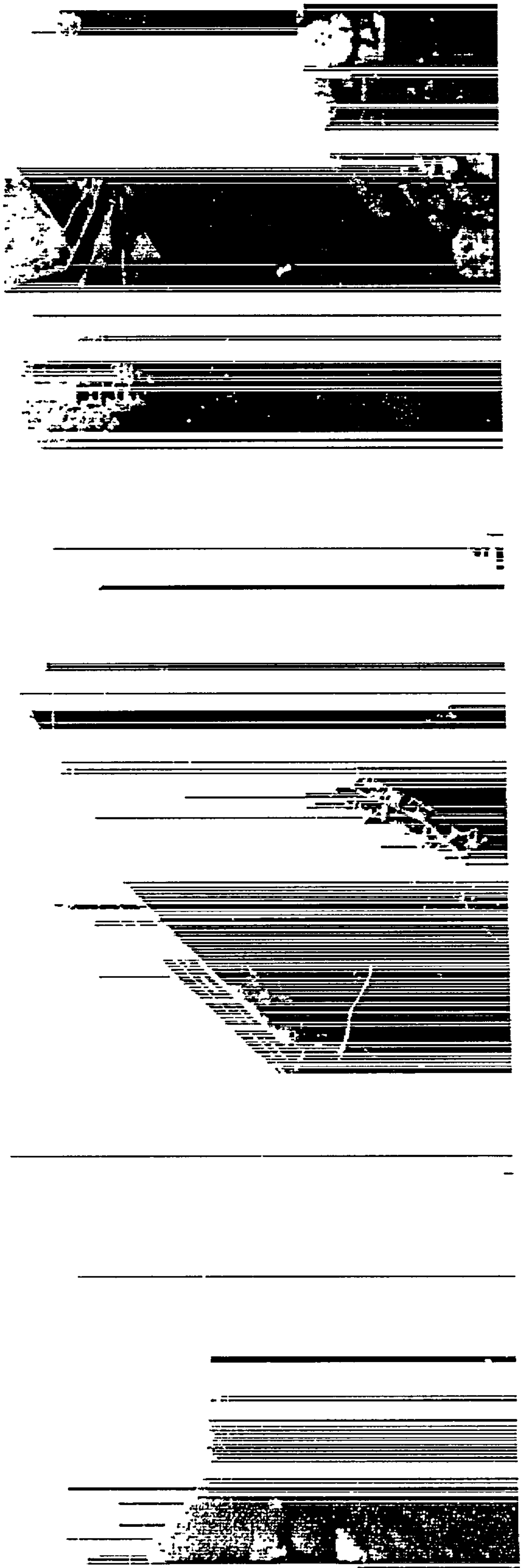


N

EXPLANATION

LINEAMENTS INTERPRETED TO BE SURFICIAL EXPRESSION OF BEDROCK STRUCTURE.

LINEAMENTS INTERPRETED AS DRAINAGE-RELATED FEATURES.

NOTE:

LINEAMENTS EXTENDED ACROSS SITE FROM 1959 AERIAL PHOTOGRAPH, CHICAGO AERIAL SURVEY.

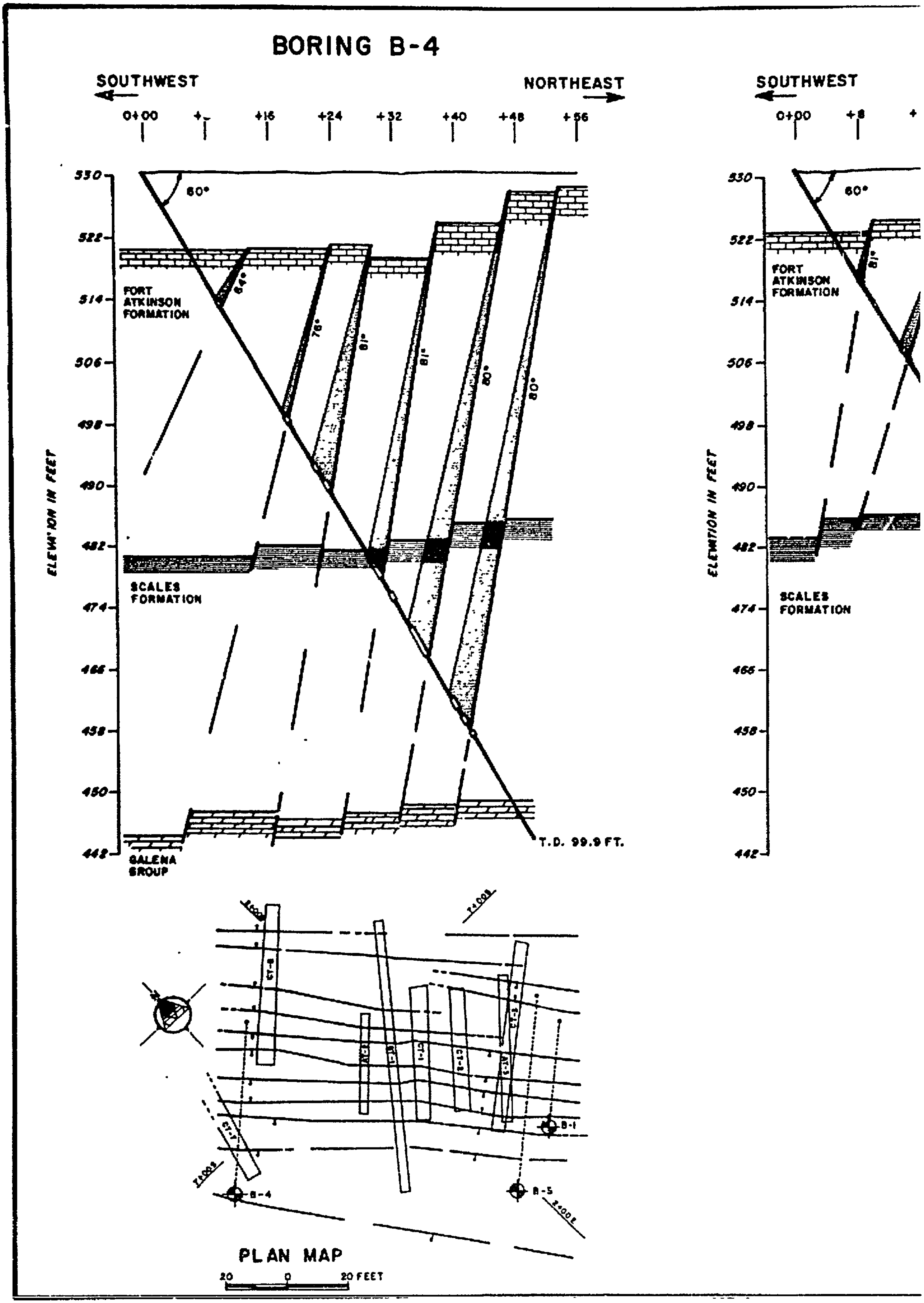
AERIAL PHOTOGRAPH REFERENCE:

U.S. DEPT. OF AGRICULTURE, 1:40,000; PHOTO NO. 174-93 DATED SEPTEMBER 23, 1974.

0 ½ 1 MILE

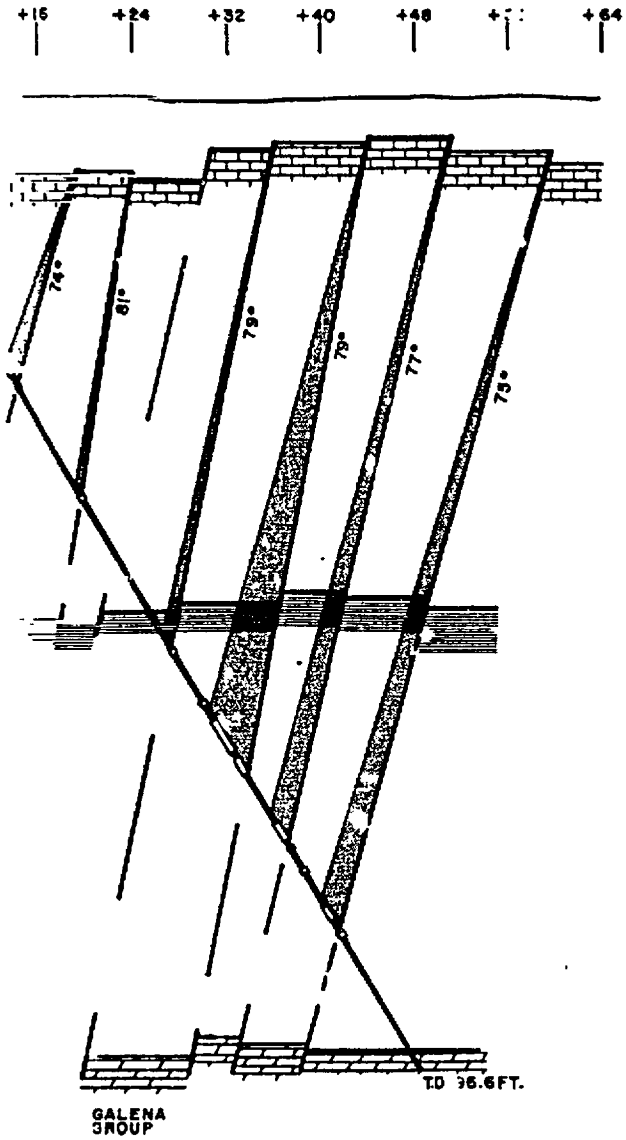
LINEAMENT MAP - SITE ARE

FIGURE 12

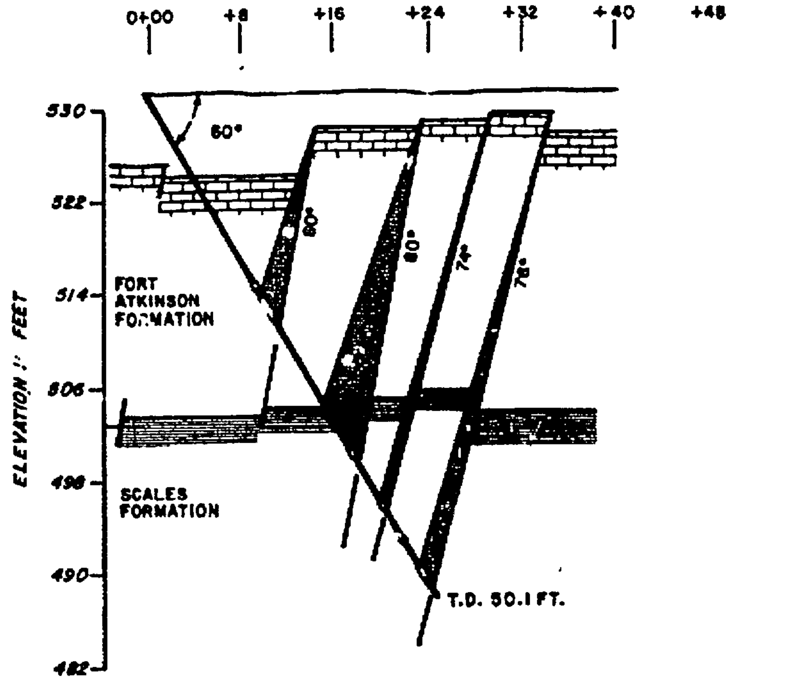

BORING B-4
SOUTHWEST
NORTHEAST
0+00
+16
+24
+32
+40
+48
+56
530
522
514
506
498
490
482
474
466
458
450
442
ELEVATION IN FEET
60°
64°
76°
81°
81°
80°
80°
FORT ATKINSON FORMATION
SCALES FORMATION
GALENA GROUP
T.D. 99.9 FT.
SOUTHWEST
0+00
+8
60°
81°
FORT ATKINSON FORMATION
SCALES FORMATION
ELEVATION IN FEET
B-1
B-4
B-5
PLAN MAP
20
0
20 FEET

1674-099-07

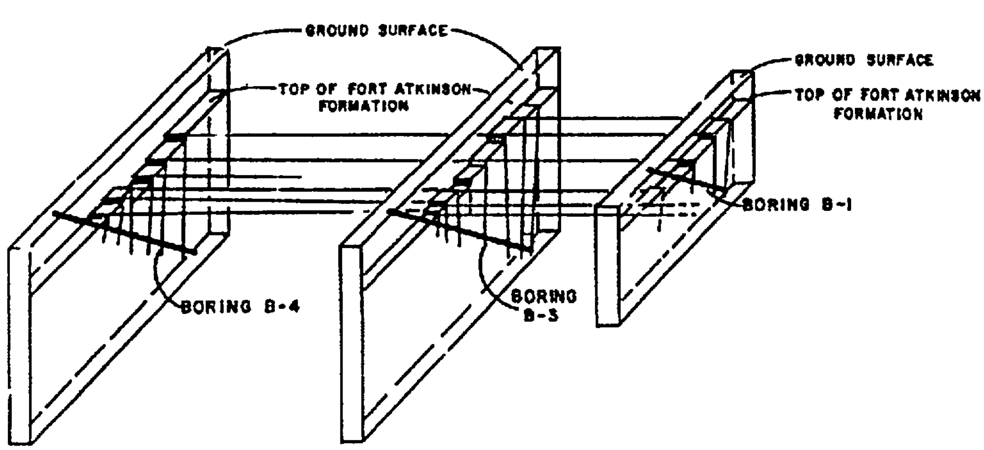
BORING B-3



BORING B-1



NOTE: THE SHADED AREA OF CORRELATION BETWEEN THE TRENCH EXPOSURES AND BORING LOGS IS DUE TO VARIATIONS IN DRILLING AND FAULT ANGLES. FAULT PLANES AND BORE-HOLES ARE SHOWN AS STRAIGHT LINES REPRESENTING AN AVERAGE; THE SHADED AREA INDICATES THE RANGE IN WHICH THE PLANE MAY OCCUR.



PERSPECTIVE VIEW

(NOT TO SCALE)

CORRELATION OF ANGLE BO AND TRENCHES

FIGURE

END