2A Subsurface and Foundations

93

7911210791

LAW ENGINEERING TESTING COMPANY

ENGINEERING CONSULTATION

LAW

P. O. BOX 13815 - STATION K
412 PLASTERS AVENUE N. E.
ATLANTA, GEORGIA 30324

October 26, 1966

Duke Power Company
General Offices
Charlotte, North Carolina

Subject: Preliminary Foundation Studies,
Oconee Nuclear Station

Gentlemen:

As authorized by Mr. Lee, we have made a study of the foundation conditions at the proposed Oconee Nuclear Station site near Seneca, South Carolina. The purpose of this investigation was to determine the character of foundation support at the site and in particular to determine if there are any unusual conditions which might adversely influence the safety of the proposed nuclear plant.

The data in this report demonstrate that the site will provide a rock foundation for the critical structures. Furthermore, they show that settlement will be negligible and there will be no adverse response to seismic activity.

Recommendations for detail design of individual plant components will be made at the appropriate stage in the plant design.

Very truly yours,

LAW ENGINEERING TESTING COMPANY

Gerald H. Fogle, Engineering Geologist

Charles S. Hedges, PE
Manager, Special Consulting Branch

George F. Sowers, Vice President

GEORGIA REGISTERED PROFESSIONAL No. 2244 ENGINEER EXPIRES Dec. 31. G. F. SOWERS

I EXPLORATION

Site Location

The proposed Oconee Nuclear Station is approximately 8 miles north of Seneca, South Carolina, on State Road 45. It is immediately downstream of the right dike of the proposed Keowee Dam. The general station area is shown on the included Location and Topographic Map, Figure 2A-1, and the site and boring layout is shown on the Boring Plan, Figure 2A-2.

Boring and Sampling

The boring program was established at the site inspection, August 5, 1966, by Messrs. W. S. Lee, L. C. Dail, G. F. Sowers, C. S. Hedges, and C. M. Kennedy. A grid pattern of borings was established to provide the maximum amount of information for determining the foundation and soil conditions and permit flexibility in final plant layout, alignment, and elevation.

The field locations and ground elevation of the borings were provided by Duke Power Company survey crews. The actual drilling operation began August 10, 1966. The drilling, sampling and rock coring were performed in accordance with methods specified by the American Society for Testing and Materials:

"Penetration Testing and Split Barrel Sampling of Soils" - D-1586-64T

"Diamond Core Drilling for Site Investigation" - D-2311-62T

"Thin Walled Tube Sampling of Soils" - D-1587-63T

NX and BX size rock cores were drilled at this site. The respective diameters of the rock cores are 2-1/8 and 1-5/8 inches. See pages 2A-14 through 2A-17 for rock description and geologic glossary. Boring logs are attached at the end of this report.

A limited amount of auger drilling, not required by the plant foundation exploration outline, was done in the vicinity of boring NA-9 for Dames & Moore, Consulting Engineers, in conjunction with their seismic field testing. Also, auger boring was done for a piezometer installation to be used during percolation inflow tests made for the Bechtel Corporation's groundwater analysis and evaluation.

Geologic Study

The geologic field work at this site was started concurrently with the drilling. The site reconnaissance was a continuation of the geologic field work done for the Keowee Dam. Local outcrops, though scarce, were examined and the rock types, joint and foliation orientation noted.

In addition to the site reconnaissance, the rock cores were examined and descriptive logs prepared as drilling progressed. Boring NA-12 was drilled at an angle of 22 degrees from the vertical to amplify the joint pattern findings of the vertical borings.

The geologic information gained from the site reconnaissance and borings was used in conjunction with the available geologic map and publications to prepare site geologic maps (1, 2, 3) Figures 2A-3 and 2A-4.

---

(1) Overstreet, W. C. and Bell, Henry III, "Geologic Map of the Crystalline Rocks of South Carolina," 1965.

(2) Cazeau, C. J. and Brown, C. Q., "Guide to the Geology of Pickens and Oconee Counties, South Carolina," Division of Geology, State Development Board, Columbia, South Carolina, Geologic Notes, Vol. 7, No. 5, 1963.

(3) Cazeau, Charles J., "Geology and Structure of the Pendleton-La France Area, Northwestern South Carolina," Division of Geology, State Development Board, Columbia, South Carolina, Geologic Notes, Vol. 7, Nos. 3 and 4, 1963.

II GEOLOGY

Relief

This site is located within the Inner Piedmont Belt, at this locality the westernmost component of the Piedmont Physiographic Province. The topography of the area is undulating to rolling; the surface elevations ranging from about 700 feet to 900 feet, MSL. The region is moderately well dissected with rounded hilltops, representing a mature regional development. The area is well drained by several intermittent streams flowing away from the center of the site in a radial pattern.

Rock

The rock present at this site is metamorphic. It is believed to be Precambrian in age; thus, it was formed over 600 million years ago. The complete history of this region is quite complex and has not been fully unravelled. However, it is the concensus of geologic opinion that the formation consisted of thick strata of sedimentary rocks which were later downwarped and altered by heat and pressure. This first rock formed is termed the country rock.

More than one episode of regional metamorphism transformed the rock into metasediments with accompanying injection and mobilization by plastic flow.

Since the formation of the country rock, most of the mass has been altered or replaced by injection of granite gneiss, biotite hornblende gneiss, and one or possibly more pegmatite dikes.

It is not definite which is the younger: the granite gneiss injection or the biotite hornblende gneiss injection. The limited evidence points to the granite gneiss as the younger of the two.

The pegmatite dikes are the youngest rock known at this site. One such dike is exposed in the road cut on the east side of the state highway passing through the site. It clearly shows the pegmatite cutting through the older rocks, and thus, demonstrates that it is the youngest.

Regional metamorphism, folding, and some minor faulting occurred concurrently much of this early time.

Regional Structure

The regional structure is typical of the southern Piedmont and Blue Ridge. The region was subjected to compression in the northwest-southeast direction which produced a complex assortment of more or less parallel folds whose axes lie in a northeast-southwest direction. The Blue Ridge uplift was the climax of the folding, and it was accompanied by major faulting, along a line stretching northeast through Atlanta and Gainesville, Georgia and across South Carolina, 11 miles northwest of the site. This has been termed the Brevard Fault, and is probably the Blue Ridge Fault suggested by White.(1)

The age of these uplifts has not been agreed on by geologists. The concensus of geologic opinion seems to require a period of severe deformation followed by at least one additional period of less severity. Probably all occurred during the Paleozoic Era, but White(1) suggested that the last major uplift was as late as the Triassic (180 million years ago) when the Coastal Plain to the east was downwarped. A number of investigators have maintained that the major deformative movements occurred at least 225 million years ago. However, all the resulting stresses have not yet been fully dissipated.(2)

There is no evidence of any displacement along these faults during either historic times or during the Geologic Recent Era as indicated in displacements in the residual soils that blanket the region. While the well known Brevard Fault passes 11 miles northwest of the site, there is no indication of a major fault in the immediate vicinity of the site. Furthermore, the major faults of the region are ancient and dormant, except for minor adjustments at considerable depth. Therefore, there is no indication of any structural hazard to foundations at the site.

Rock Structure of Site

The structure of the rock at this site is not too complex. It can be seen from the attitude of the bands of mineral segregating in the above mentioned road cut, that the rock at this site has been wrinkled and slightly folded or warped. These minor folds may either be the result of major folding to the northwest, therefore, termed sympathy folds, or these folds may be the result of minor local compressive forces.

---

(1) White, W. A., "The Blue Ridge, A Fault Scarp", Bulletin of Geol. Soc. of Am., Vol. 61, p. 1309-45, 1950.

(2) T. A. Ellens, "Test of a Quantitative Mountain Building Theory", Geophysics, Vol. 7, No. 1, p. 45, 1941.

The strike of the foliation planes or bands of mineral segregation is north 6 degrees to 15 degrees east with an average dip of 22 degrees to 28 degrees to the southeast. However, due to the local folding or warping at this site, minor variations in the strike and dip of the foliation will occur within the site.

It is almost inevitable that when minor compression folding of this nature occurs, some minor shear displacements will result. We noted only one such displacement. In boring NA-20, at a depth of about 79.6 feet below the ground surface, a shear displacement of about one-half inch was recorded. This should not be considered uncommon where hard rock or possibly slightly plastic rock has been folded. While the rock is being folded, minute cracks in the rock develop. The acting compressive forces then cause slight shifts or displacements in the rock resulting in a more relaxed state. The shear displacement noted in boring NA-20, was completely healed or recemented. There is no evidence noted of any recent displacements.

There have been periods of erosion and perhaps even continuous erosion since the close of the Paleozoic Era. The rock now encountered at this site represents the deeper portions of the original metamorphic complex.

The rock encountered at this site is of three main types; light to medium gray granite gneiss, light gray to black biotite hornblende gneiss and white quartz pegmatite with local concentrations of mica, both muscovite and biotite varieties.

The dominate rock type at this site is the light to medium gray granite gneiss. This rock type is generally moderately hard and hard below the initial soft layers encountered in the rock surface. Joints in this rock are brown iron stained in the upper softer layers, but in the deeper harder rock, the joints are not stained. This helps illustrate that the jointing at this site does not control the weathering or decomposition of the rock.

The second most abundant rock type is the biotite hornblende gneiss. The rock is generally weathered or softer to a greater depth than the granite gneiss. This is probably due to the higher percentage of biotite mica. Biotite mica is a potassium magnesium-iron aluminum silicate. The iron content of the biotite mica causes the rate of decomposition to accelerate. However, generally at the deeper portions of the borings, the biotite hornblende gneiss hardness increases to moderately hard or harder. Only a few thin soft layers were noted in this rock in the deeper portion of the borings.

A few layers of hard quartz pegmatite with local concentrations of mica were recorded. The thickness of the pegmatite layers are generally less than three feet. These pegmatite layers are dikes. A dike is a sheet-like body of igneous rock that fills a fissure in the older rock which it encountered while in a molten condition. There is an exposure of mica-quartz pegmatite dike on the east side of the state road cut passing through this project. This dike exposure is about 3.5 feet wide, but due to the lack of knowledge of orientation of the dike, the exact width cannot be computed. The quartz pegmatite encountered in the borings probably represent other smaller dikes of the same material. These dikes are of hard, sound and durable material and should cause no concern to construction or foundation requirements.

Joints

The rock at this site is moderately jointed. All of the visible rock outcrops were studied in attempting to determine the correct orientation of the joint patterns. Some moderately good rock outcrops were found and several joint pattern orientations measured. While studying and logging the rock cores, all of the joint dips were recorded. The dips of the joint patterns recorded in the rock cores were associated with the dips measured in the rock outcrops. These associated dips and accompanying strikes are shown on the geologic map at the end of this report.

Four joint patterns were found, two of which appear to be most significant. The two most significant joint patterns are: strike north 55 degrees east with a dip of 61 degrees northwest, and strike north 28 degrees west with a dip of 85 degrees southwest. The other two joint patterns are: strike north 9 degrees west with a dip of 67 degrees southwest and strike north south with a dip of 74 degrees west.

III FOUNDATIONS

Foundation Characteristics of Materials

The ability of the Piedmont formations to support foundation loads can be characterized by four zones,(1) from the surface down:

1. Red sandy silty clay or clayey silty sand.

2. Micaceous silty sand. Decomposed rock that retains the relic structure of the original rock, often termed "saprolite".

3. Alternate seams of soft decomposed rock and hard partially decomposed rock.

4. Relatively sound rock.

These are the zones used and shown on the subsurface profiles.

The first two could be termed residual soils, derived from the in-place weathering of the parent rock. The third is the transition between soil and rock.

The boundaries of these zones are seldom well defined and are not level. The different zones represent decreasing degrees of weathering from top to bottom, and each grades successively into the next. The boundaries are irregular because of the tilted banding and differential weathering. The more resistant seams weather more slowly that the feldspar-rich seams, producing a sawtooth configuration. The boundaries are complicated by the rock joints. Adjacent to the joints, the weathering is deeper while at some distance from the joints, the weathering is not as deep.

The sandy silty clay zone varies in thickness at this site. It is thin or absent on the hilltop where the reactors are centered but becomes thicker in the switchyard area. It has been severely desiccated and partially cemented by oxidation of the iron it contains. It is strong, incompressible, and should not swell appreciably when saturated.

---

(1) G. F. Sowers, "Soil and Foundation Problems in the Southern Piedmont Region", Separate 416, Proceedings ASCE, Vol. 80, March, 1954.

The saprolite micaceous silty sand and micaceous sandy silt is likewise rather thin on the hilltop, and increases in thickness to the north and east. As is indicated by the standard penetration resistance, it is firm near the ground surface in the switchyard area (where it is thickest) but becomes denser with increasing depth. At this plant site, much of this zone has penetration resistances of 30 blows per foot or more and could be described either as a dense soil or a very soft rock. In general, this stratum is elastic and somewhat compressible because it has lost most of the intercrystalline bonds of the rock due to weathering, while much of the mica has not weathered sufficiently to lose its resiliency. The compressibility decreases and the rigidity increases with increasing density as reflected in the penetration resistances. In spite of its elastic nature, it is strong when confined and exhibits limited cohesion (both inter-particle bonding and capillary tension) as well as internal friction.(2)

The zone of alternate hard and soft weathered rock is exceedingly variable in its properties depending on the relative thicknesses of the contrasting seams. It is stronger than the saprolite zone above in shear across the seams but no stronger than the weakest seam parallel to them. The elasticity and compressibility are in proportion to the thickness of the soft seams because by comparison, the harder seams do not appreciably deflect under stress.

The relatively sound rock below is both strong and rigid. The strength and elastic properties of small intact portions of the rock range from those of good concrete to several times those of concrete. The properties of the mass, however, are partially controlled by the joints and fissures. Therefore, the modulus of elasticity, the strength and the deflection of the mass are all somewhat lower than might be deduced from small scale laboratory tests of individual samples.

Foundation Design Considerations

The structural loading and their limiting deflections have not been established. However, based on similar plants, there will be loads as high as 10,000 kips for the reactor and the turbo-generators concentrated on areas of 2000 square feet to 5000

---

(2) G. F. Sowers, "Physical Properties of Residual Soils Derived from Crystalline Rocks", Proceedings Second Panamerican Conference on Soil Mechanics and Foundation Engineering, Sao Paulo, Brazil, 1963.

square feet. These loads are critical from the foundation standpoint because excessive deflection could lead to a malfunction of any of the components. The structures that protect these units (exclusive of shielding) are not heavy, and can tolerate some differential deflecting or settlement without distress.

Although the individual critical plant units may not tolerate substantial settlement, they are functionally inter-connected only by piping. This can absorb some differential movements if it is anticipated in the design.

Because of the relatively small thickness of the surface clayey soils and the irregular topography, the upper zone does not have an appreciable influence on the design of foundations for the major structures. This stratum does furnish excellent support for the smaller structures where there is no cut or only shallow fill.

Under static load alone, a major design consideration for heavy structures is the elastic deflection and consolidation of the micaceous soils of the saprolite zone and the micaceous, more weathered layers of the zone of alternate hard and soft seams. Experience, confirmed by laboratory tests, has shown that these materials can support power plant loadings without appreciable settlement when the densities are sufficient, that the penetration resistances consistently exceed 30 blows per foot.

Under dynamic load, these elastic materials may deform significantly. Experience with vibratory loading at a number of high-pressure pumping stations has demonstrated sufficient elastic response which can develop to be troublesome. The site is in a region of definite but infrequent seismic activity of moderate intensity. Under such dynamic loadings, foundations supported upon any appreciable thickness of the resilient micaceous materials could respond unfavorably, developing some magnification of the amplitude compared to the more rigid rock below.

Detailed studies of the elastic qualities of the soil-rock mass supporting the critical structures could probably develop a configuration for the structure-foundation system that would not provide amplification for the seismic frequencies anticipated. Such an analysis, however, is dependent on (1) an accurate evaluation of the rock-soil-structure elastic response and (2) an accurate knowledge of seismic frequency spectra. Available theories on soil-structure response are approximate at best and must be corrected from empirical

observations made during earthquakes. Realistic frequency spectra must properly be determined from observations of ground motion during seismic activity of the same intensity as anticipated. Unfortunately, there was no instrumental observation of any of the earthquakes of the region sufficiently close to the site that either reliable frequency spectra or structural response of the soil can be evaluated. Microtremors, while of academic interest, are not of sufficient magnitude to make a reliable evaluation of earthquake response of the magnitude of those observed. In fact, there is some evidence that microseisms may arise from different mechanisms, particularly superficial, near surface-strains and adjustments.

Foundation Design Recommendations

In regions where there is no alternate but soil support, dynamic analyses are a valuable guide to rational aseismic design. However, because of the uncertainties of the earthquake response of the saprolites and because of the shallow depth to rock, we recommend that the major structures be supported on the rock. The saprolite and seamy overburden can be excavated with sufficient ease that a rock foundation can be developed without undue expense. In order to minimize variable elastic response of the foundation of any one structure, we further recommend that the foundation of each structural entity be supported entirely by the relatively sound rock.

It is our understanding that you plan to employ a continuous mat for each of the plant structures. The foundation for each major load concentration, such as the turbogenerator, will be reinforced as if it were independent of the mat; however, it will not be separated from the mat structurally. We recommend tentatively the following elevations for the critical units:

Unit #1 Reactor Bldg.	Elevation 765
Unit #2 Reactor Bldg.	Elevation 765
Auxiliary Building	Elevation 770
Turbine Bldg. Rooms (both units at same level)	Elevation 770
Future Reactor Bldg.	Elevation 765±
Future Auxiliary Bldg.	Elevation 770±
Future Turbine Bldg.	Elevation 770±

The elevations are based on the twenty-one preliminary borings and the geologic cross-sections developed from these borings. Because of the irregular zone boundaries, there may be some points where the foundation level of turbine building will be a few feet above the rock. Beneath the load concentrations or where there is only a two or three foot difference, the foundations should be excavated to the relatively sound rock and fill concrete placed to the design foundation level. Beneath the non-critical parts of the mat where the difference in levels is more than 3 feet, we recommend supporting the mat by piers excavated to the rock.

Noncritical structures can be supported in any of the clayey, saprolite, or hard soft seam zones above the weathered rock. Detailed recommendations for bearing pressures will be furnished when the locations and loadings have been established.

Where filling is necessary to establish a convenient inter-relationship of yard levels, it should be practical to support noncritical structures, such as the switchyard components, directly on fill. When properly compacted, the hard clays and saprolites make embankments that are capable of supporting moderate loads with a high safety factor against soil failure and with only nominal settlement. Detailed recommendations for bearing pressures will be furnished when the locations and loading have been established. These recommendations will be made as the plant design develops. Tentatively, however, we recommend the following levels in the switchyard and powerhouse yard, which will entail both cut and fill:

Powerhouse Yard	Elevation 796
230 KV Switchyard	Elevation 770
500 KV Switchyard	Elevation 730

For relationship of structures, yard levels, and rock, see Figures 2A-5 through 2A-13.

ACKNOWLEDGEMENT

The structural geology evaluation of this region was prepared with the assistance of Dr. H. W. Straley III, Consultant and Professor of Geology and Geophysics, Georgia Institute of Technology, Atlanta, Georgia.

GENERAL REFERENCES

1. Cazeau, J., "Geology and structure of the Pendleton-La France Area, Northwestern South Carolina", Division of Geology, State Development Board Columbia, South Carolina, Geologic Notes, Vol. 7 Nos. 3 and 4, 1963.

2. Cazeau, C. J., and Brown, C. Q., "Guide to the Geology of Pickens and Oconee Counties, South Carolina", Division of Geology, State Development Board, Columbia, South Carolina, Geologic Notes, Vol. 7, No. 5, 1963.

3. Elkins, T. A., "Test of a Quantitative Mountain Building Theory by Appalacian Structural Dimensions", Geophysics VII, No. 1, 45-60, 1941.

4. Heck, H. N., "Earthquake Problems of the Atlantic Coastal Plain", Bulletin of the Seismological Society of America, Vol. 30, No. 2, p. 109-114 April, 1940.

5. Hedges, C. S. "Earthquake Activity and Intensity with the Southerneastern United States", private publication, Law Engineering Testing Company, 1965.

6. Housner, G. W., "Characteristics of Strong Motion Earthquakes", Bulletin of the Seismological Society of America, Vol. 37, p. 18-31, 1947.

7. Housner, G. W., "Geotechnical Problems of Destructive Earthquakes", Geotechnique, Vol. 4, p. 153-154, 1954.

8. Leet, L. Don and Leet, Florence, "Earthquake - Discoveries in Seismology," Laurel Science Original - Dell Publishing Company, 1946.

9. Neuman, Fred Robert, "The Southern Appalachian Earthquake of October 20, 1924", Bulletin of the Seismological Society of America, Vol. 14, No. 4, p.223-229, December, 1924.

10. Overstreet, W. C. and Bell, Henry III, "Geologic Map of the Crystalline Rocks of South Carolina", U.S.G.S., 1965.

GENERAL REFERENCES...Continued

11. Straley, H. W., Personal Communication-Structural Geology, 1966.

12. Taber, Stephen, "The South Carolina Earthquake of January 1, 1913," Bulletin of the Seismoiogical Society of America, Vol. 3, No. 1, p.6-13, March 1913.

13. Taber, Stephen, "The Earthquake in the Southern Appalachians, February 21, 1916," Bulletin of the Seismological Society of America, Vol. 06, No. 4, p. 218-226, December 1916.

14. White, W. A., "The Blue Ridge - A Fault Scarp", Bulletin, GSA 61, 1309-1346, 1950.

An indication of relative rock hardness is given on the Boring Logs. Rock hardness is difficult to define and an arbitrary simple method of determining hardness was used in this investigation. It consists of trying to break a sharp edge of a hand-size piece of rock by pushing the edge with a thumb. The qualitive hardness terms are defined as follows:

Very Soft	- Rock disintegrates to touch; can be hard to very hard soil.
Soft	- Rock is coherent but breaks very easily to thumb pressure at sharp edge and crumbles with a firm hand pressure.
Moderately Hard	- Rock appears to be relatively hard but small pieces can be broken off by considerable thumb pressure.
Hard	- Rock cannot be broken by thumb pressure and the feldspars are clouded.
Very Hard	- Rock cannot be broken by thumb pressure and the feldspars are unclouded.

Geologic Glossary

Alluvial Soils - Stream transported soils deposited adjacent to the stream path.

Biotite Mica - $K(Mg,Fe)_3AlSi_3O_{10}(OH)_2$, the black mica, weathers easily because of the iron.

BX - A core size; core diameter 1.655 inches.

Clay - A fine grained or colloidal particle dominantly microscopic, plastic when wet and hard when dry; generally smaller than 0.002 millimeter.

Crystalline Rock - A term generally applied to metamorphic and igneous rocks, because they are composed of interlocking crystalline mineral grains.

Decomposition - The breaking down of minerals and rocks of the earth's crust by chemical activity. Complex compounds are broken into simpler ones that are more stable under existing conditions.

Dike - A sheet-like body of igneous rock that fills a fissure in older rocks which it intruded while in a molten condition.

Feldspar - Any of an important group of rock-forming minerals the members of which have close chemical and physical similarity and which, except for a few special cases, cannot be told apart by ordinary field tests.

Fracture - The form of surface obtained by breaking in a direction other than that of the cleavage in crystallized minerals or rock.

Foliation - The banding or lamination of metamorphic rocks.

Gneiss - A more or less banded metamorphic rock with the mineral composition of granite. It designates a foliated metamorphic rock with no specific composition, but having layers that are mineralogically unlike. Usually, gneiss displays an alteration of granular minerals and tabular (schistose) minerals with the rock tending to split along the planes where tabular minerals predominate. Gneisses grade directly into schists, but schists generally are

finer-grained and show more uniformity of mineral composition and foliation. An arbitrary distinction between schist and gneiss is that based on the presence of feldspar in gneiss and its absence in schist.

Granite - A visibly granular, crystalline rock of predominatly interlocking texture, composed essentially of alkalic (potash) feldspars and quartz with lesser amounts of lime-soda feldspar and a black mineral biotite. Granites are usually of igneous origin. Granite gneiss (granitic gneiss) is a metamorphosed granite where sufficient characteristics of the original rock remain to permit recognition of the granite. The texture is coarse.

Hornblende - A common member of the amphibole group of minerals. The color is usually black, dark green, or brown.

Igneous - Rocks formed by solidification of hot mobile rock material including those formed and cooled at great depths.

Joint - A fracture or parting plane along which there has been little, if any, movement parallel with the walls.

Metamorphic - Rocks formed from original igneous or sedimentary rocks through alterations produced by pressure, heat and infiltration of other materials.

Microcline Feldspar - $(K,Na)AlSi_3O_8$, an abundant constituent of granites and granite pegmatites. Contains well developed cleavage planes. White to pink. Recognized by characteristic grid texture.

Mineral - A natural occurring crystalline solid with definite chemical and physical characteristics.

Muscovite Mica - $KAl_3Si_3O_{10}(OH)_2$, clear or white mica, not easily weathered.

Geologic Glossary

NX - A core size; core diameter 2.155 inches.

Pegmatite - A variety of crystalline igneous rocks characterized chiefly by large average grain size, interlocking texture, and especially by unusually great range in grain size.

Phenocryst - A large crystal in a fine-grained igneous rock.

Plagioclase Feldspar - $(Na,Ca)AlSi_3O_8$, solid solution (crystalline) of varying Na and Ca. At this site, the plagioclase is predominantly $NaAlSi_3O_8$. White, translucent to milky. Recognized by cleavage planes.

Porphyry - An igneous rock containing a considerable proportion of larger cystals (phenocrysts) set in a finer ground-mass of small crystals.

Recovery - The ratio of the rock sample length obtained to the length of sample drilled, expressed as a percent.

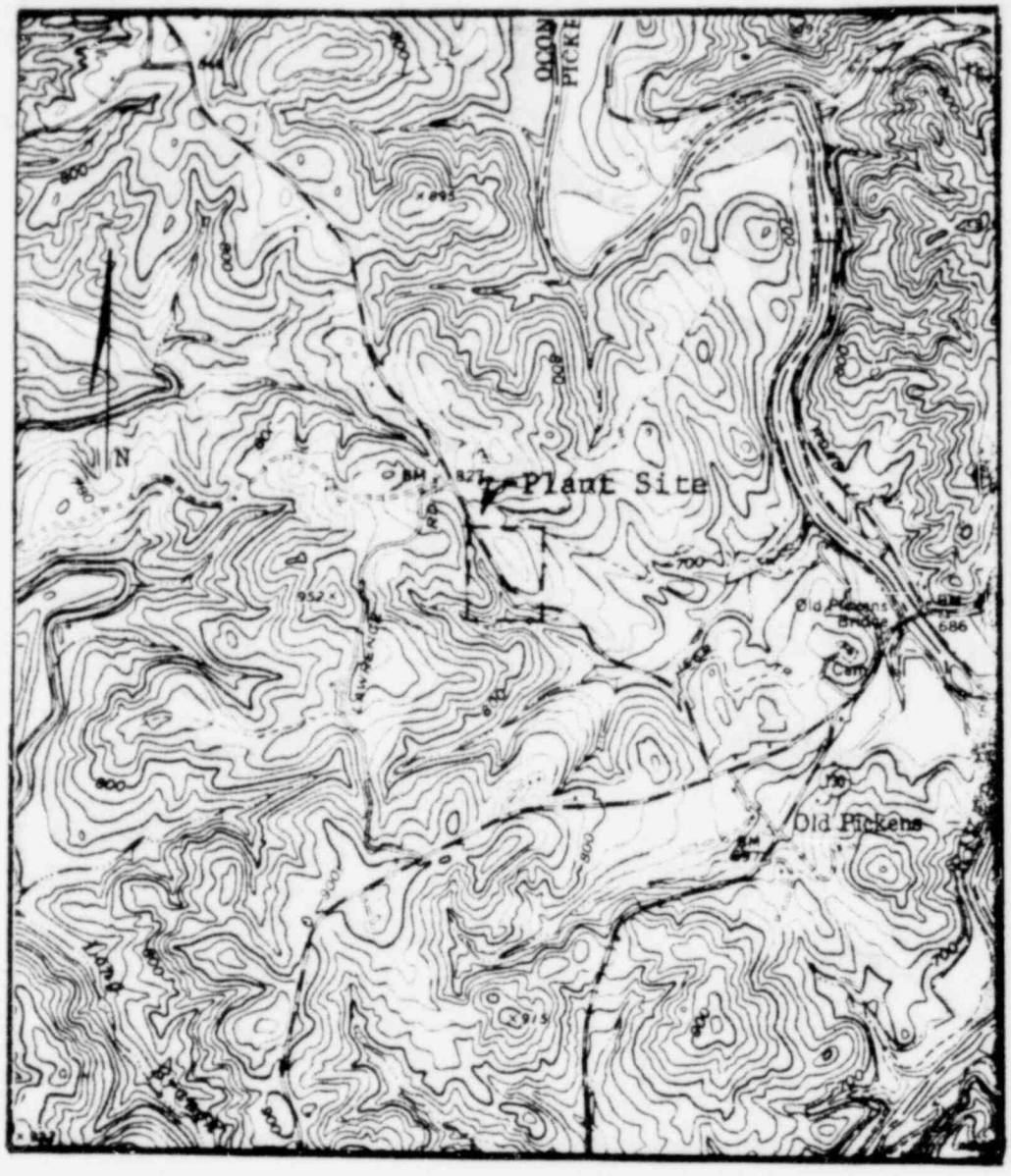
Residual - A material resulting from the decomposition of rocks.

Sand - An aggregation of mineral or rock particles, diameters between 0.075 mm and 4.5 mm.

Saprolite - A material that has been derived by disintegration and decomposition in place (residual or residuum).

Silt - A fine-grained soil that is not plastic and exhibits little or no strength when air-dried. Size between 0.002 mm and 0.075 mm.

Quartz - Crystalline SiO_2, resembles clear glass in pure crystals.



LOCATION AND TOPOGRAPHIC MAP

OCONEE NUCLEAR STATION

DUKE POWER COMPANY

From Old Pickens, South Carolina Quadrangle, 1961. Mapped, edited, and published by the United States Geological Survey.

FIGURE 2A-1

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET

DATUM IS MEAN SEA LEVEL

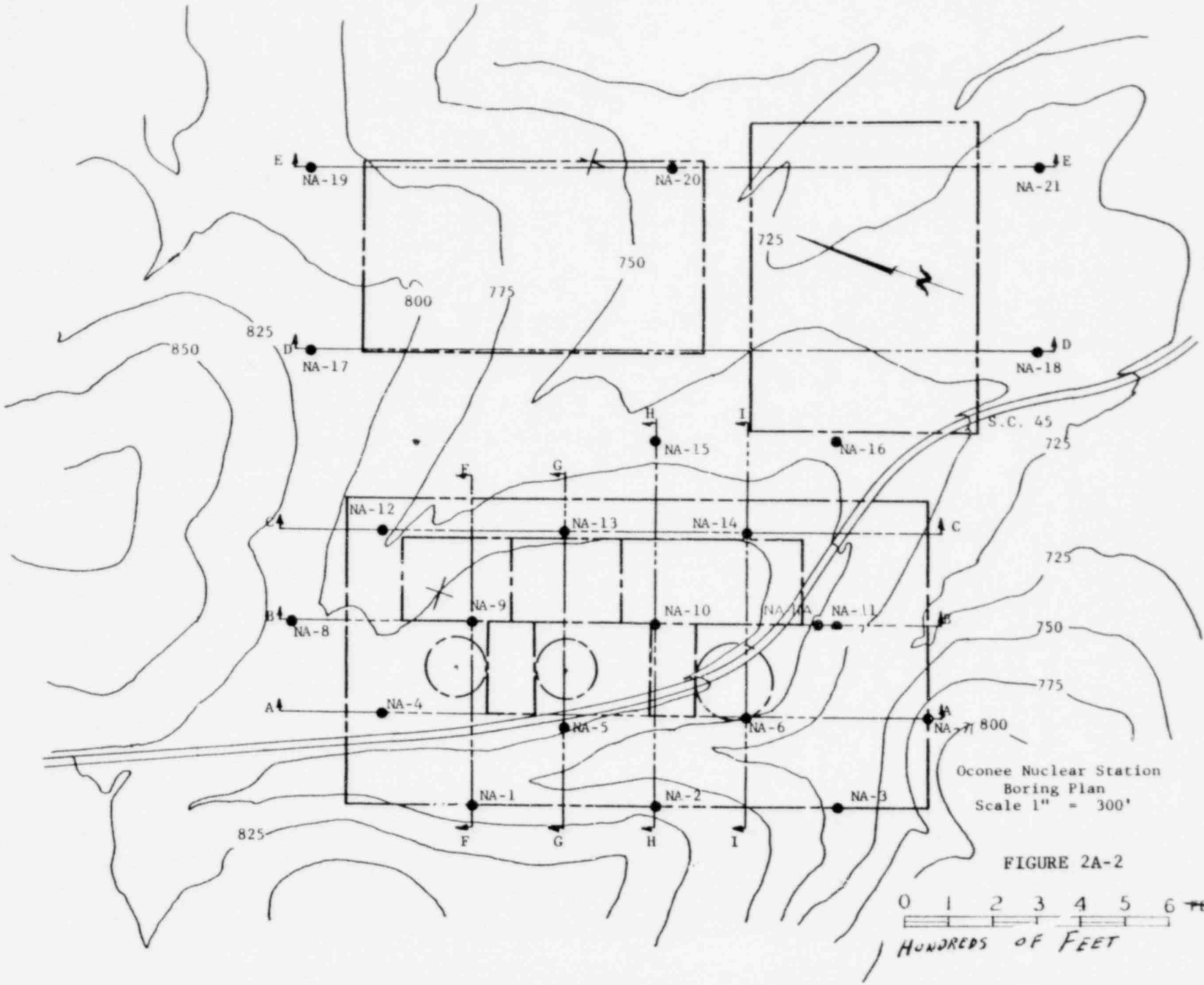
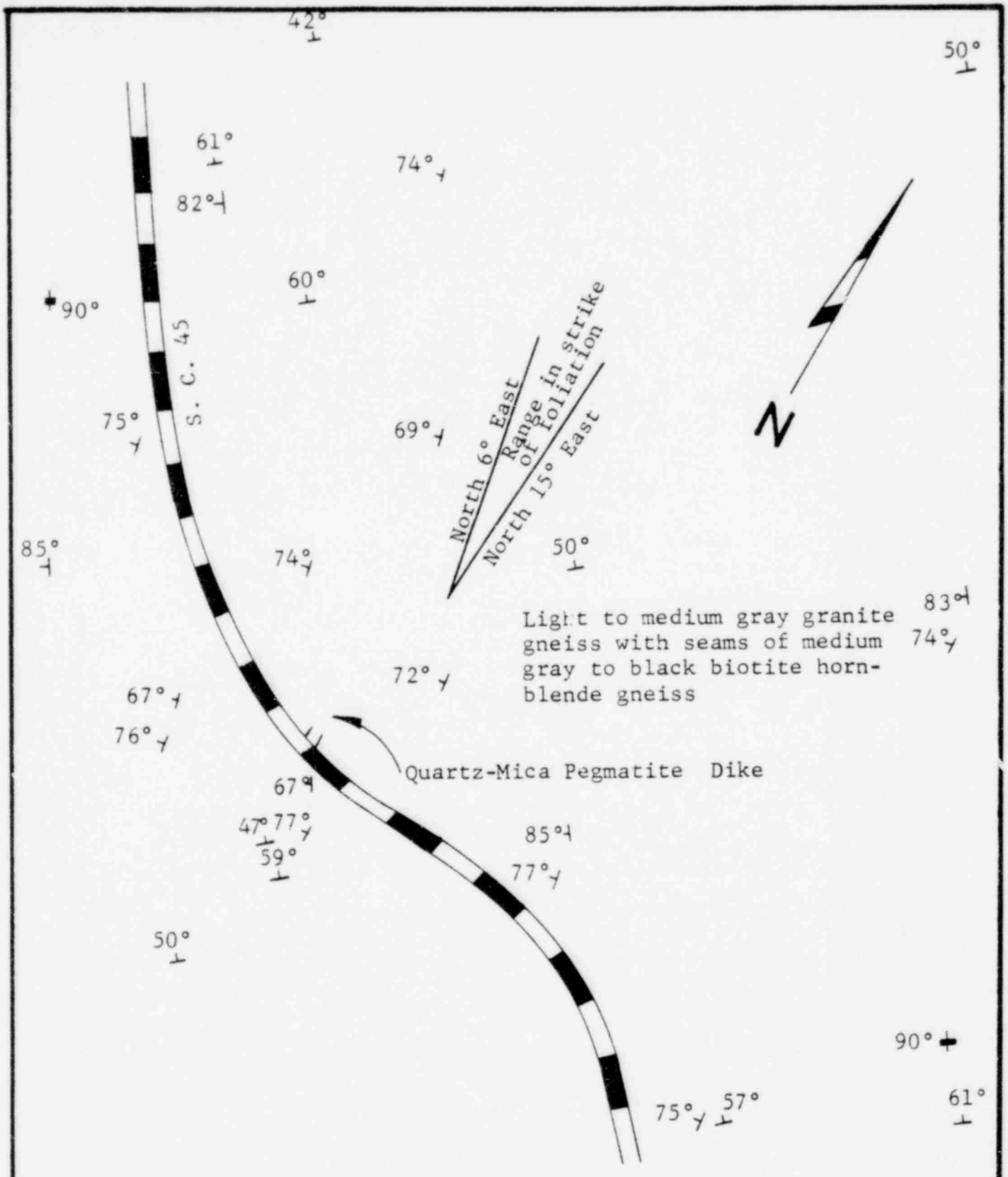
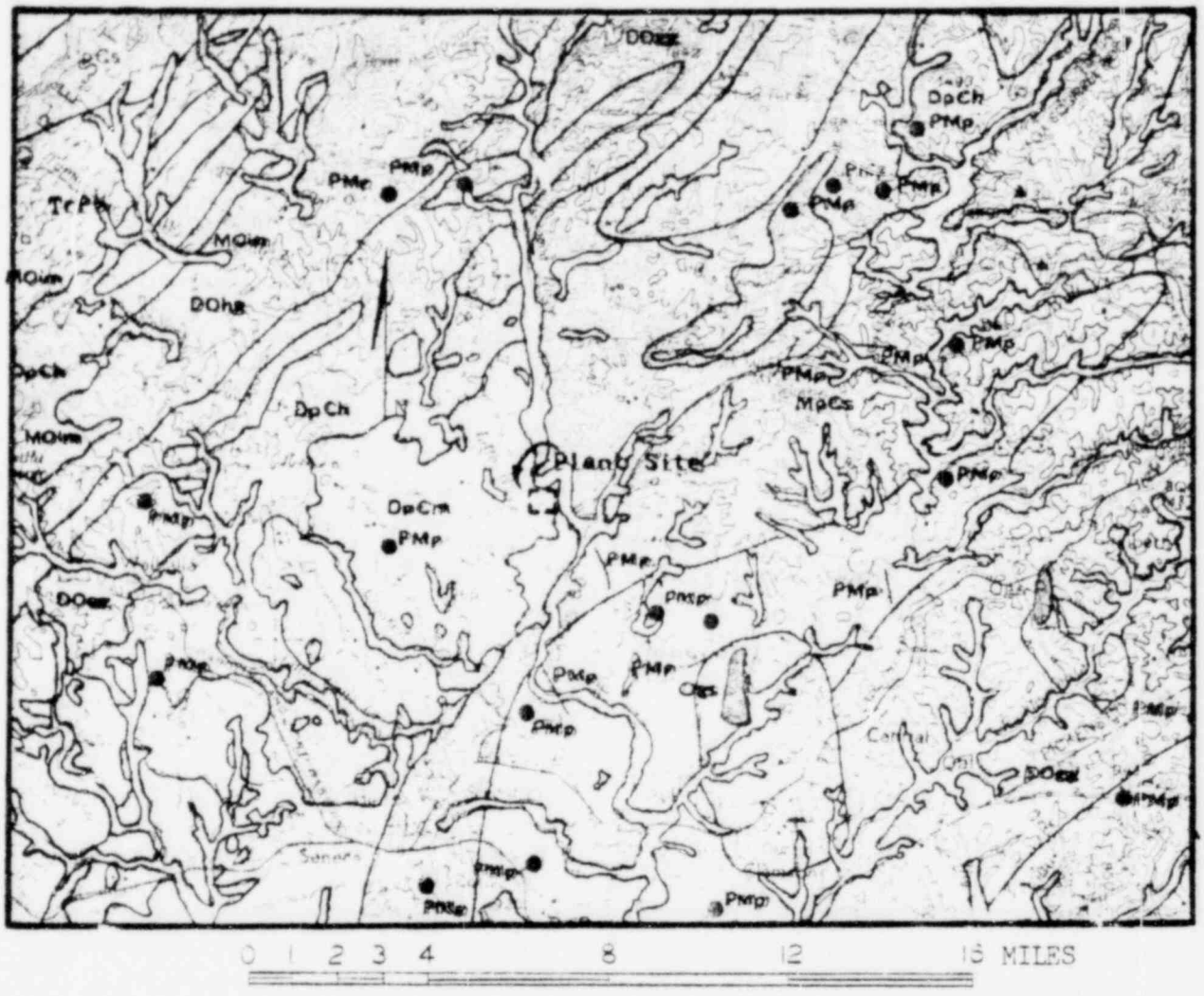

NA-19
NA-20
NA-21
NA-17
NA-18
NA-15
NA-16
NA-12
NA-13
NA-14
NA-9
NA-10
NA-11
NA-8
NA-4
NA-5
NA-6
NA-7
NA-1
NA-2
NA-3
725
750
775
800
825
850
S.C. 45
Oconee Nuclear Station
Boring Plan
Scale 1" = 300'
0 1 2 3 4 5 6 FEET
HUNDREDS OF FEET

FIGURE 2A-2



GEOLOGIC MAP
OCONEE NUCLEAR STATION
SCALE 1" - 200'
STRIKE AND DIP OF JOINT PATTERN
LAW ENGINEERING TESTING COMPANY
ATLANTA, GEORGIA
SEPTEMBER 1966

FIGURE 2A-3

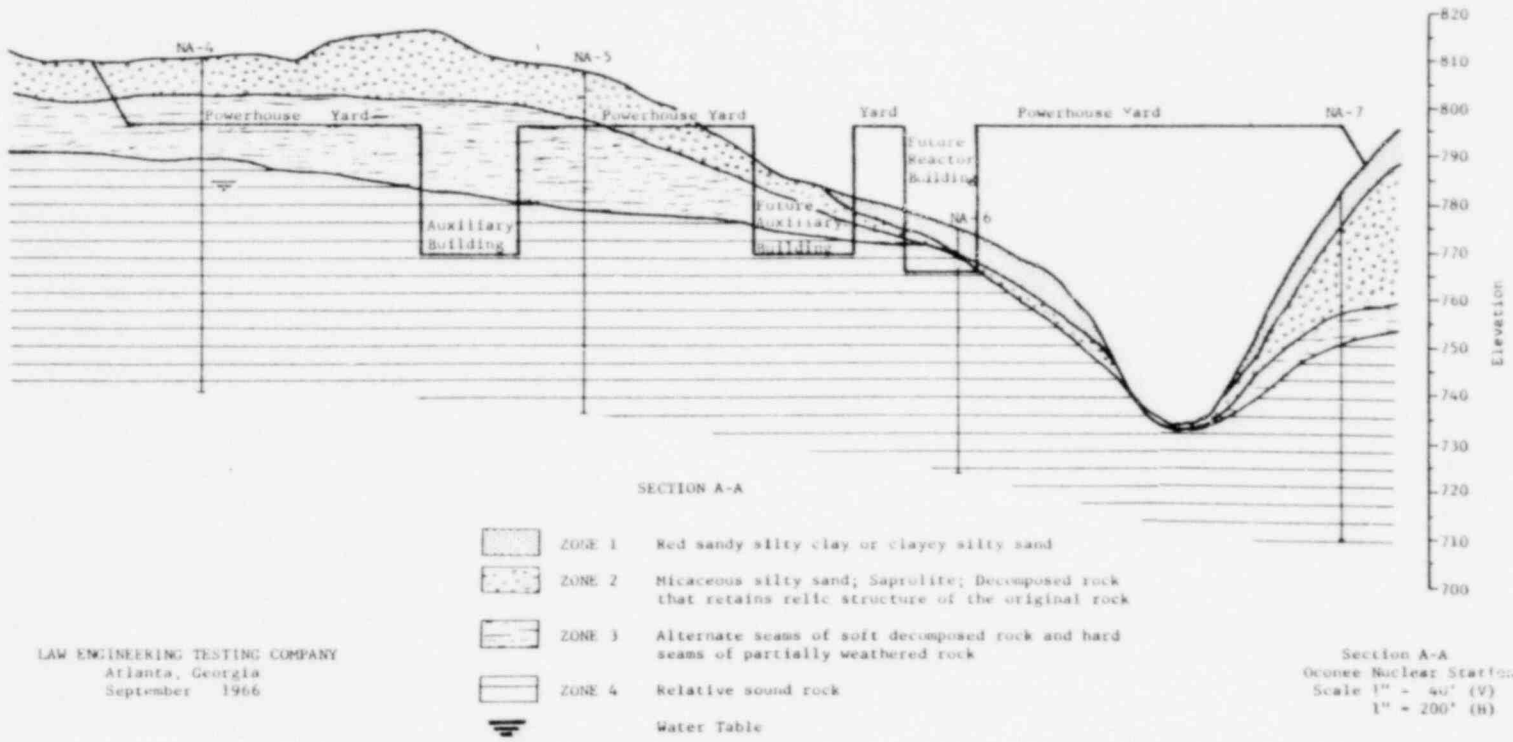


REGIONAL GEOLOGIC MAP
Scale 1" = 4 miles
OCONEE NUCLEAR STATION

SYMBOL	EXPLANATION	AGE
Qal	Alluvium	Quaternary
TrPb	Brevard Belt	Permian - Triassic (?)
PMp	Muscovite Pegmatite Dikes	Permian (?)
DOgg	Biotite Granite Gneiss	Ordovician to Devonian
DOhg	Henderson Gneiss	
Ogs	Gabbro and Soapstone	Ordovician
MOim	Quartzite	
DpCh	Hornblende Gneiss	Upper Precambrian to Devonian
DpCm	Biotite Gneiss and Migmatite	

From Geological Map of the Crystalline Rocks of South Carolina
by
William C. Overstreet and Henry Bell, III
Miscellaneous Geologic Investigations Map I - 413

FIGURE 2A-4



LAW ENGINEERING TESTING COMPANY
Atlanta, Georgia
September 1966

Section A-A
Oconee Nuclear Station
Scale 1" = 40' (V)
1" = 200' (H)

FIGURE 2A-5

FIGURE 2A-5

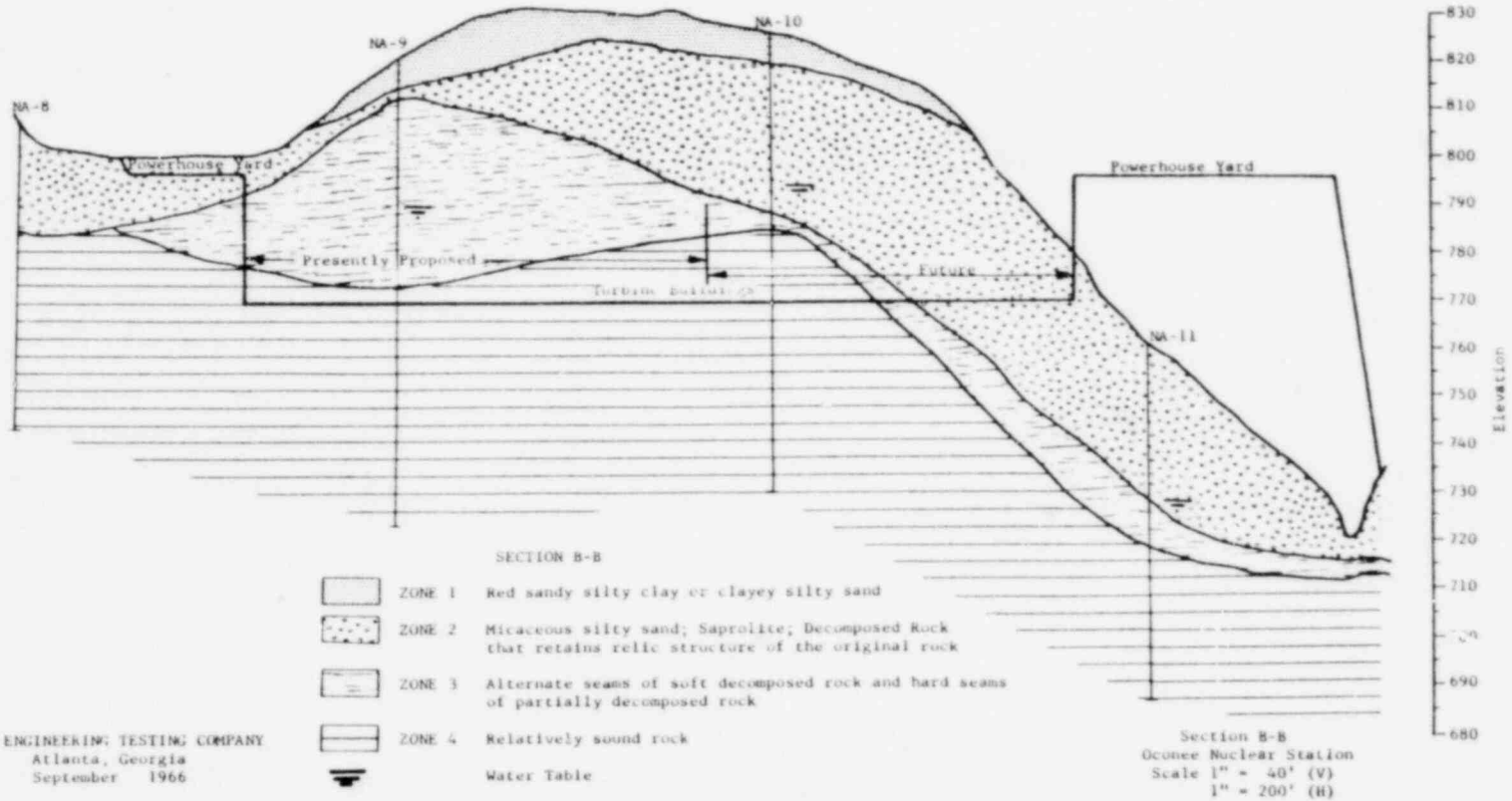
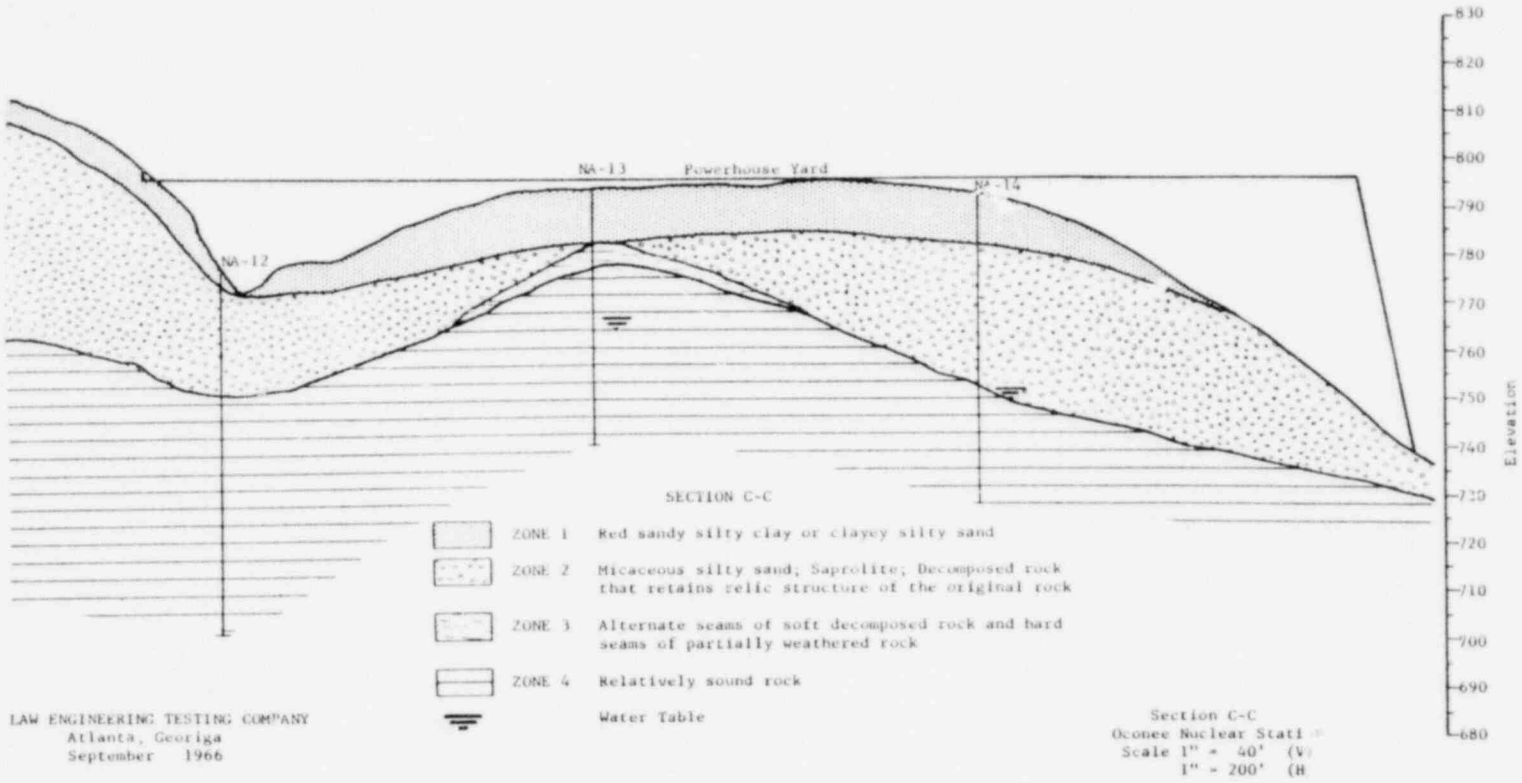

NA-8
NA-9
NA-10
NA-11
Powerhouse Yard
Presently Proposed
Future
Powerhouse Yard
Turbine Building
830
820
810
800
790
780
770
760
750
740
730
720
710
690
680
Elevation
SECTION B-B
ZONE 1 Red sandy silty clay or clayey silty sand
ZONE 2 Micaceous silty sand; Saprolite; Decomposed Rock that retains relic structure of the original rock
ZONE 3 Alternate seams of soft decomposed rock and hard seams of partially decomposed rock
ZONE 4 Relatively sound rock
Water Table
LAW ENGINEERING TESTING COMPANY
Atlanta, Georgia
September 1966
Section B-B
Oconee Nuclear Station
Scale 1" = 40' (V)
1" = 200' (H)

FIGURE 2A-6



LAW ENGINEERING TESTING COMPANY
Atlanta, Georiga
September 1966

Section C-C
Oconee Nuclear Stati
Scale 1" = 40' (V
1" = 200' (H

FIGURE 2A-7

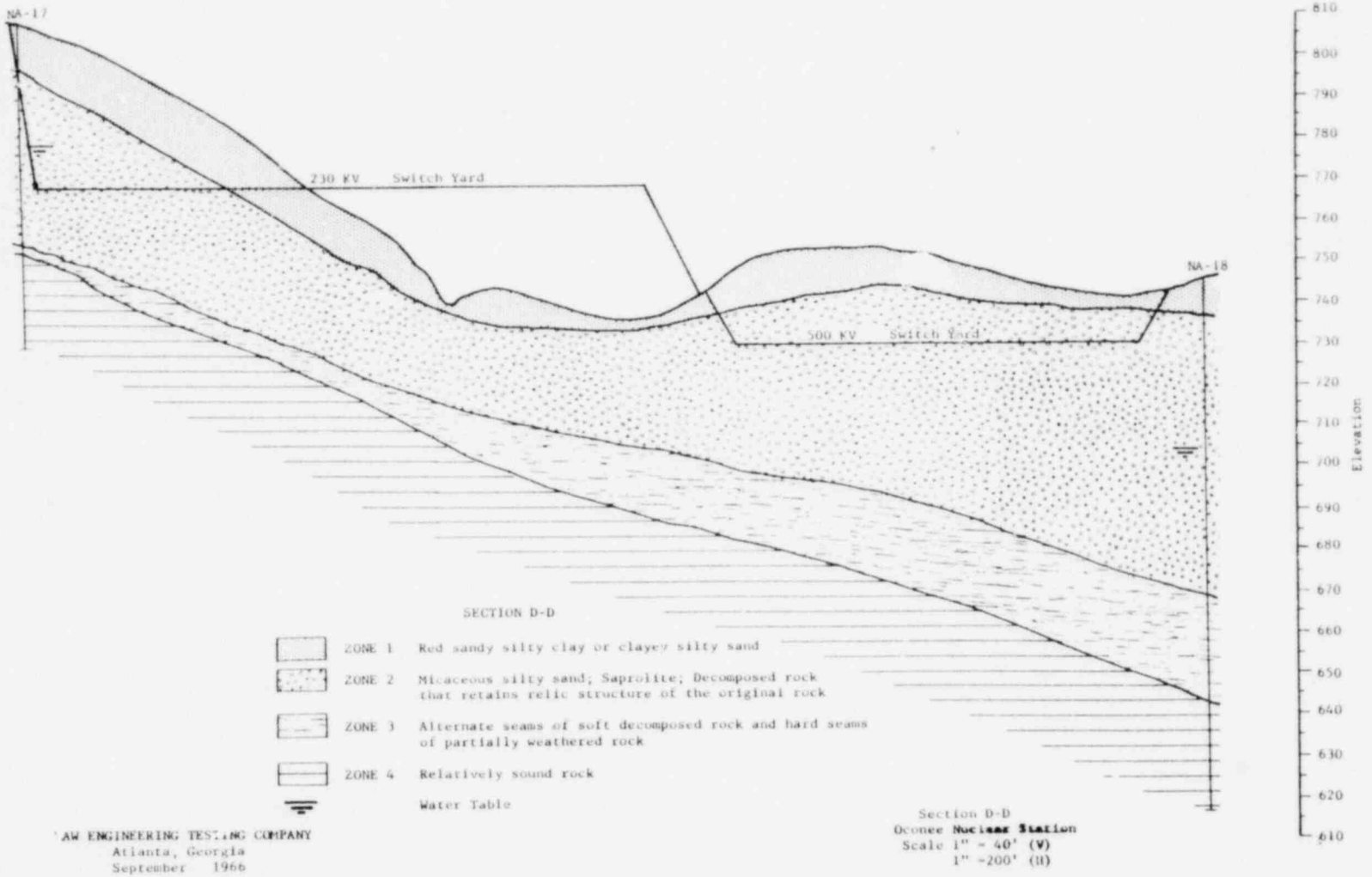
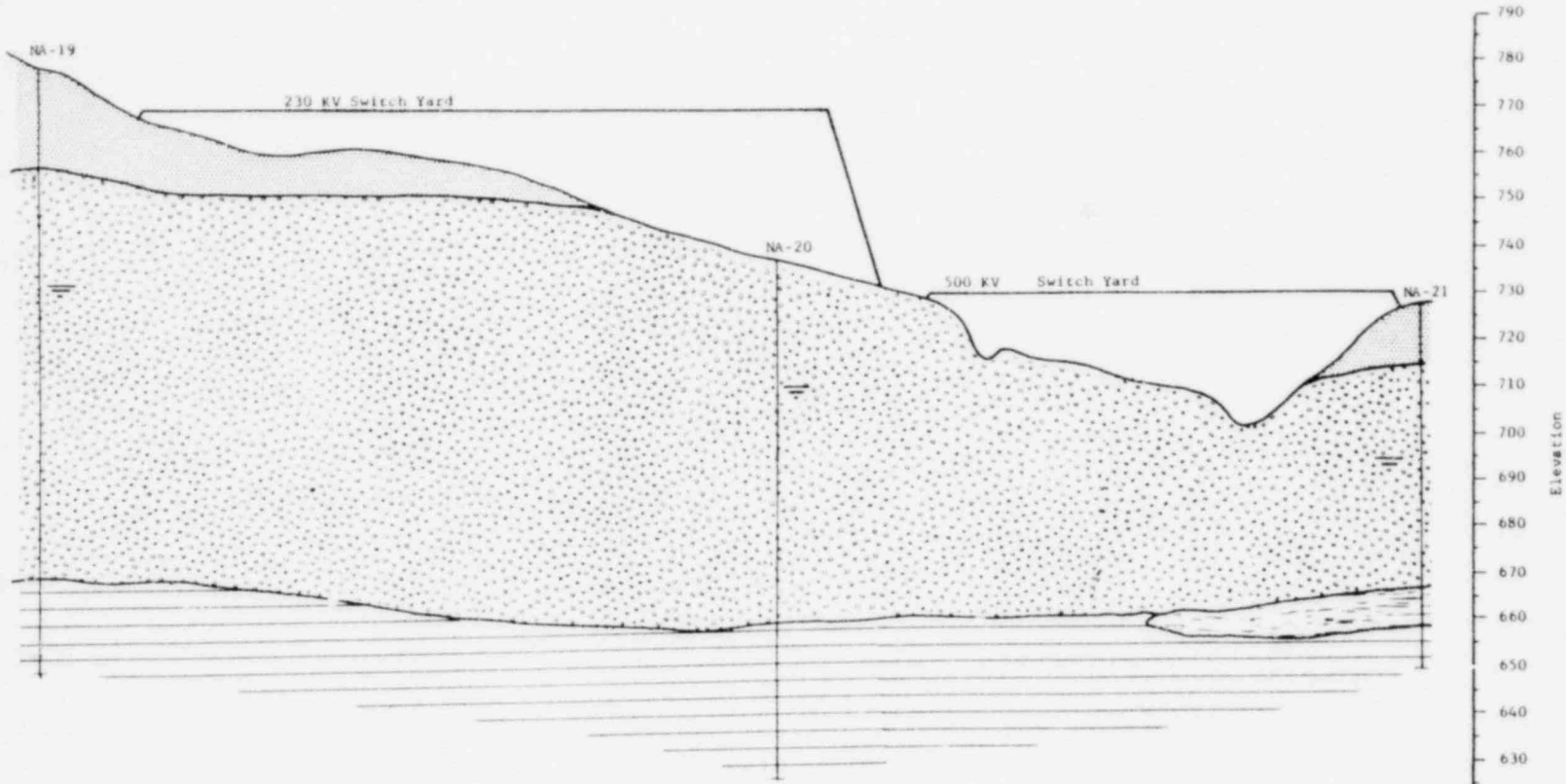

NA-17
230 KV Switch Yard
500 KV Switch Yard
NA-18
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
610
Elevation
SECTION D-D
ZONE 1 Red sandy silty clay or clayey silty sand
ZONE 2 Micaceous silty sand; Saprolite; Decomposed rock that retains relic structure of the original rock
ZONE 3 Alternate seams of soft decomposed rock and hard seams of partially weathered rock
ZONE 4 Relatively sound rock
Water Table
AW ENGINEERING TESTING COMPANY
Atlanta, Georgia
September 1966
Section D-D
Oconee Nuclear Station
Scale 1" = 40' (V)
1" =200' (H)

FIGURE 2A-8



SECTION E-E

ZONE 1 Red sandy silty clay or clayey silty sand

ZONE 2 Micaceous silty sand; Saprolite; Decomposed rock that retains relic structure of the original rock

ZONE 3 Alternate seams of soft decomposed rock and hard seams of partially weathered rock

ZONE 4 Relative sound rock

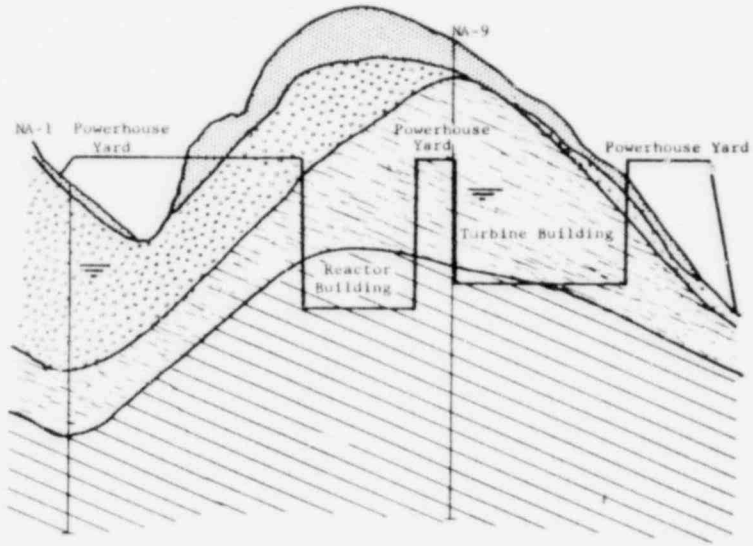
Water Table

LAW ENGINEERING TESTING COMPANY
Atlanta, Georgia
September 1966

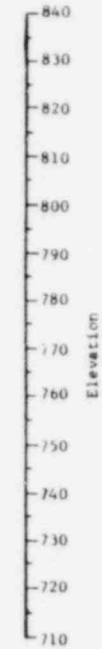
Section E-E
Oconee Nuclear Station
Scale 1" = 40' (V)
1" = 200' (H)

FIGURE 2A-9

FIGURE 2A-9



SECTION F-F

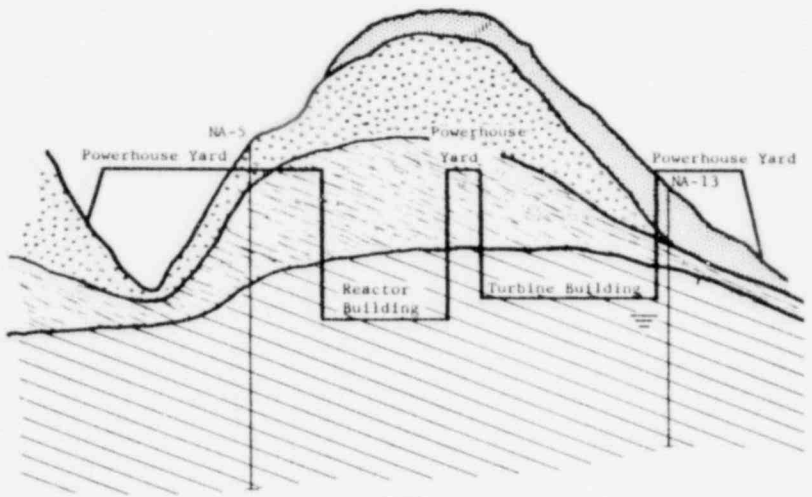


	ZONE 1	Red sandy silty clay or clayey silty sand
	ZONE 2	Micaceous silty sand; Saprolite; Decomposed rock that retains relic structure of the original rock
	ZONE 3	Alternate seams of soft decomposed rock and hard seams of partially weathered rock
	ZONE 4	Relatively sound rock
		Water Table

LAW ENGINEERING TESTING COMPANY
Atlanta, Georgia
September 1966

Section F-F
Oconee Nuclear Station
Scale 1" = 40' (V)
1" = 200' (H)

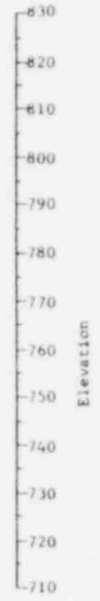
FIGURE 2A-10



SECTION G-G

	ZONE 1	Red sandy silty clay or clayey silty sand
	ZONE 2	Micaceous silty sand; Saprolite; Decomposed rock that retains relic structure of the original rock
	ZONE 3	Alternate seams of soft decomposed rock and hard seams of partially weathered rock
	ZONE 4	Relatively sound rock
		Water Table

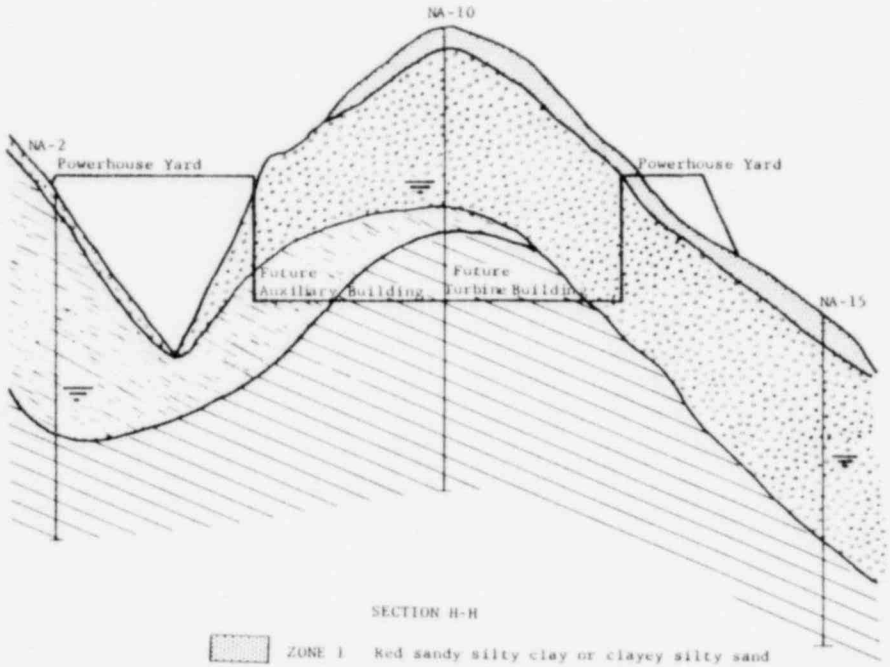
LAW ENGINEERING TESTING COMPANY
Atlanta, Georgia
September 1966



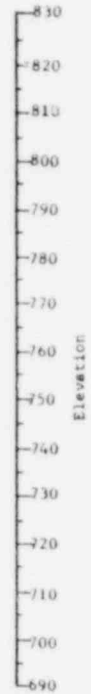
Section G-G
Oconee Nuclear Station
Scale 1" = 40' (V)
1" = 200' (H)

FIGURE 2A-11

FIGURE 2A-11



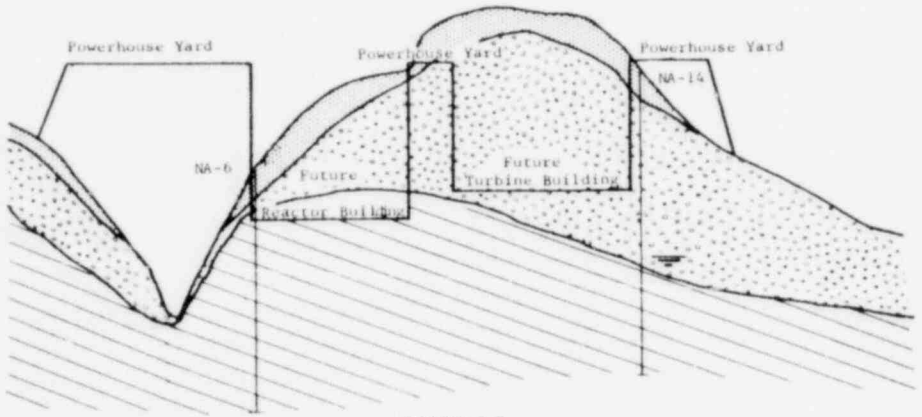
LAW ENGINEERING TESTING COMPANY
Atlanta, Georgia
September 1966



Section H-H
Oconee Nuclear Station
Scale 1" = 40' (V)
1" = 200' (H)

FIGURE 2A-12

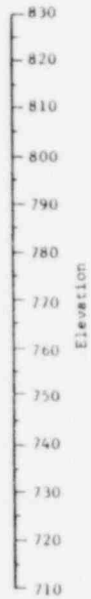
FIGURE 2A-12



SECTION I-I

	ZONE 1	Red sandy silty clay or clayey silty sand
	ZONE 2	Micaceous silty sand; Saprolite; Decomposed rock that retains relic structure of the original rock
	ZONE 3	Alternate seams of soft decomposed rock and hard seams of partially decomposed rock
	ZONE 4	Relatively sound rock
		Water Table

LAW ENGINEERING TESTING COMPANY
Atlanta, Georgia
September 1966



Section I-I
Oconee Nuclear Station
Scale 1" = 40' (V)
1" = 200' (H)

FIGURE 2A-13

FIGURE 2A-13

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
0				794.1	
	RED MICACEOUS SANDY CLAYEY SILT				
3.6	STIFF TO VERY STIFF RED YELLOW BROWN MICACEOUS FINE TO MEDIUM SANDY SILT			789.1	N = 11
					Undisturbed Sample 4.0 to 5.0 feet
				784.1	N = 20
				779.1	N = 26
18.0	VERY STIFF TO HARD GRAY BROWN MICACEOUS FINE TO MEDIUM SANDY SILT			774.1	N = 28
				769.1	N = 38
28.0	VERY DENSE GRAY BROWN BLACK MICACEOUS SILTY FINE TO COARSE SAND			764.1	N = 50
32.0	VERY DENSE YELLOW BROWN MICACEOUS SILTY FINE TO COARSE SAND			759.1	N = 65
40.0				754.1	

LI	Light	HD	Hard
DK	Dark	BI	Biotite
GY	Gray	HO	Hornblende
BK	Black	GRAN	Granite
MOD	Moderately	GN	Gneiss
MED	Medium		

End of Boring

WATER TABLE

CORE BORING RECORD

BORING NO. NA -1
JOB NO. CH 1065 N

125

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV. 754.1	REMARKS
40.0					
	SOFT GRAY AND BROWN GRANITE GNEISS	75%			
44.9				749.1	
45.6	MOD HD LI GY GN	93%			
45.8	SOFT DK GY BROWN BI HO GN				
46.0	MOD LI GY GRAN GN				28° Foliation Plane at 45.1 Feet
47.3	MOD HD DK GY BROWN BI HO GN		NX		
48.2	SOFT LI GY BROWN GRAN GN				
48.5	SOFT DK GY BROWN BI HO GN				
52.7	SOFT AND MOD HD ALTERNATING LAYERS LI GY BROWN GRAN GN			744.1	
53.6	HARD LI GY QUARTZ SEAM				
	HD LI GY GRAN GN			739.1	Vertical Joint at 50 Feet
58.5		100%			
58.8	HD DK GY BI HO GN				
60.9	HD LI GY GRAN GN			734.1	
61.1	HD DK GY BI HO GN				
63.4	HD LI GY GRAN GN		BX		
64.1	HD DK GY BI HO GN				
	HD LI GY GRAN GN WITH INCLUSIONS OF HORNBLENDE CONCENTRATIONS			729.1	
66.2		100%			
67.4	MOD HD DK GY BK BI HO GN				
67.9	HD LI GY GRAN GN				
68.2	HD DK GY BI HO GN				
70.1	HD LI GY GRAN GN			724.1	
70.3	HD DK GY BI HO GN				
73.8	HD LI GY GRAN GN WITH THIN HD GN SEAMS			720.3	
	CORING TERMINATED			719.1	

Not to Scale

CORE BORING RECORD

BORING NO. NA - 1

JOB NO. CH 1065 N

126

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
0				812.5	
	BROWN MICACEOUS SANDY SILT				
3.8					
	MOD HD LI GY BROWN GRAN GN			807.5	
4.9	VERY SOFT GRAN GN AND BROWN SANDY SILT	36%		802.5	
10.5	MOD HD LI GY BROWN GRAN GN WITH SOIL SEAMS	86%		797.5	
18.8	VERY SOFT LI GY GRAN GN WITH THIN LAYERS OF MOD HD GRAN GN	50%	NX	792.5	
				787.5	
		28%		782.5	
				777.5	
38.8					
40.0	HD LI GY GRAN GN	65%		772.5	

LI	Light	HD	Hard
DK	Dark	BI	Biotite
GY	Gray	HO	Hornblende
BK	Black	GRAN	Granite
MOD	Moderately	GN	Gneiss
MED	Medium		

127

CORE BORING RECORD

BORING NO. NA- 2
JOB NO. CH 1065 N

bjs

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
40.0				772.5	
	HD LI GY GRAN GN	65%	NX		
				767.5	
		78%			80° Joint at 46.0 - 47.5 Feet
48.7					
	SOFT DK GY BROWN BI HO GN			762.5	
50.9					
	HD LI GY GRAN GN	85%			
			BX	757.5	
58.3					
59.3	MOD HD DK GY BI HO GN				
	HD LI GY GRAN GN	100%		752.5	
63.2					
63.5	HD DK GY BK BI HO GN				
65.1	HD LI GY GRAN GN			747.5	
	HD DK GY BK BI HO GN				
68.2					
	HD LI GY GRAN GN	100%		742.5	
				739.7	
72.8					
	CORING TERMINATED			737.5	

128

CORE BORING RECORD

BORING NO. NA-2
JOB NO. CH 1065 N

bjs

End of Boring
WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
0				744.7	
	BROWN MICACEOUS SANDY SILT				
				739.7	N = 25
					Undisturbed Sample 5.5 - 6.5 Feet
				734.7	N = 99
				729.7	Refusal
				724.7	Refusal
22.0	MOD HD DK GY BK BI HO GN				
22.9	HD LI GY GRAN GN			719.7	
26.2	MOD HD DK GY BK BI HO GN				
26.3	HD LI GY GRAN GN	85 %			
26.7	MOD HD DK GY BK BI HO GN		NX		
26.8	HD LI GY GRAN GN			714.7	
		100 %			
33.5	MOD HD DK GY BI HO GN				
34.2	HD LI GY GRAN GN			709.7	
37.7		100 %	BX		
	MOD HD DK GY BK BI HO GN				
38.0	HD LI GY GRAN GN			704.7	
40.0					

LI - Light
DK - Dark
GY - Gray
BK - Black
MOD - Moderately
MED - Medium
HD - Hard

BI - Biotite
HO - Hornblende
GRAN - Granite
GN - Gneiss

CORE BORING RECORD

BORING NO. NA-3
JOB NO. CH-1065-N

129

WATER TABLE

LAW ENGINEERING TESTING CO.

bjs

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
				704.7	
40.0	HD LI GY GRAN GN	100%	BX	702.7	
42.0	CORING TERMINATED			699.7	

130

CORE BORING RECORD

BORING NO. NA-3
JOB NO. CH-1065 N

WATER TABLE

LAW ENGINEERING TESTING CO.

bis

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
0				810.42	
	VERY STIFF YELLOW BROWN MICACEOUS FINE TO MEDIUM SANDY SILT				N = 32
				805.42	
7.8					Lost Water 9.9 Feet
	MOD HD LI GY GRAN GN	96%		800.42	82° Joint at 11.8 Feet
					82° Joint at 12.2 Feet
					81° Joint at 13.2 Feet
					54° Joint at 14.0 Feet
				795.42	
15.6			NX		
	SOFT LI GY GRAN GN	60%			
17.9					
	MOD HD LI GY GRAN GN			790.42	
21.1					
	SOFT DK GY BK BI HO GN	90%			
21.7					
	HD LI GY GRAN GN			785.42	
		100	%		
26.5					
	HD DK GY BI HO GN				
26.7					
	HD LI GY GRAN GN	100	%	780.42	
30.8					
	HD DK GY BK BI HO GN	100	% BX		
34.1					
	HD LI GY GRAN GN			775.42	
34.4					
	HD DK GY BK BI HO GN				23° Foliation Plane at 36 Feet
36.6					
	HD LI GY GRAN GN				
39.3		100	%		
	HD LI GY QUARTZ PEGMATITE			770.43	
40.0					

31.0 Feet of 2" Plastic Pipe left in hole

LI	Light	HD	Hard
DK	Dark	BI	Biotite
GY	Gray	HO	Hornblende
BK	Black	GRAN	Granite
MOD	Moderately	GN	Gneiss
MED	Medium		

CORE BORING RECORD

BORING NO. NA 4
JOB NO. CH 1065 N

131

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
40.0				770.42	
	HD LI GY QUARTZ PEGMATITE	100%			
43.0					
	HD LI GY GRAN GN	100 %		765.42	
47.6					
	HD DK GY BI HO GN				
48.1					
	HD DK GY GRAN GN	100 %		760.42	
50.9					
	HD DK GY BI HO GN		BX		
51.1					
	HD LI GY GRAN GN	100 %		755.42	
56.8					
	HD DK GY BK BI HO GN				
57.3					
	HD LI GY GRAN GN				
58.0					
	HD DK GY BK BI HO GN				
58.2					
	HD LI GY GRAN GN	100 %		750.42	
58.7					
	HD DK GY BK BI HO GN				
58.9					
	HD LI GY GRAN GN				
59.3					
	HD BK BI HO GN				
59.7					
	HD LI GY GRAN GN	100 %		745.42	
		95%		740.02	
70.4					
	CORING TERMINATED			735.42	

Not to scale

CORE BORING RECORD

BORING NO. NA - 4

JOB NO. CH 1065 N

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV. 802	REMARKS
0	DENSE RED BROWN MICACEOUS SILTY FINE TO MEDIUM SAND			797	N = 42
9.0	SOFT AND SOME MOD HD LI GY GRAN GN	33%	NX	792	75° Joint at 10 Feet
				787	
		39%		782	
				777	
28.0		86%			
29.7	MOD HD LI GY GRAN GN				
30.1	MOD HD LI GY AND DK GY BK	*1		772	
31.2	MOD HD LI GY GRAN GN				
31.5	MOD HD DK GY GN				
34.2	MOD HD LI GY GRAN GN				
	HD LI GY GRAN GN			767	
38.8		100%			
39.0	MOD HD DK GY BI HO GN				
39.5	HD LI GY GRAN GN				
40.0	MOD HD DK GY BL BI HO GN			762	

*1 ALTERNATING THIN LAYERS OF GRAN GN AND BI HO GN

LI	Light	HD	Hard
DK	Dark	BI	Biotite
GY	Gray	HO	Hornblende
BK	Black	GRAN	Granite
MOD	Moderately	GN	Gneiss
MED	Medium		

No Water Encountered

133

CORE BORING RECORD

BORING NO. NA -5
JOB NO. CH1065 N

bjs

LAW ENGINEERING TESTING CO.

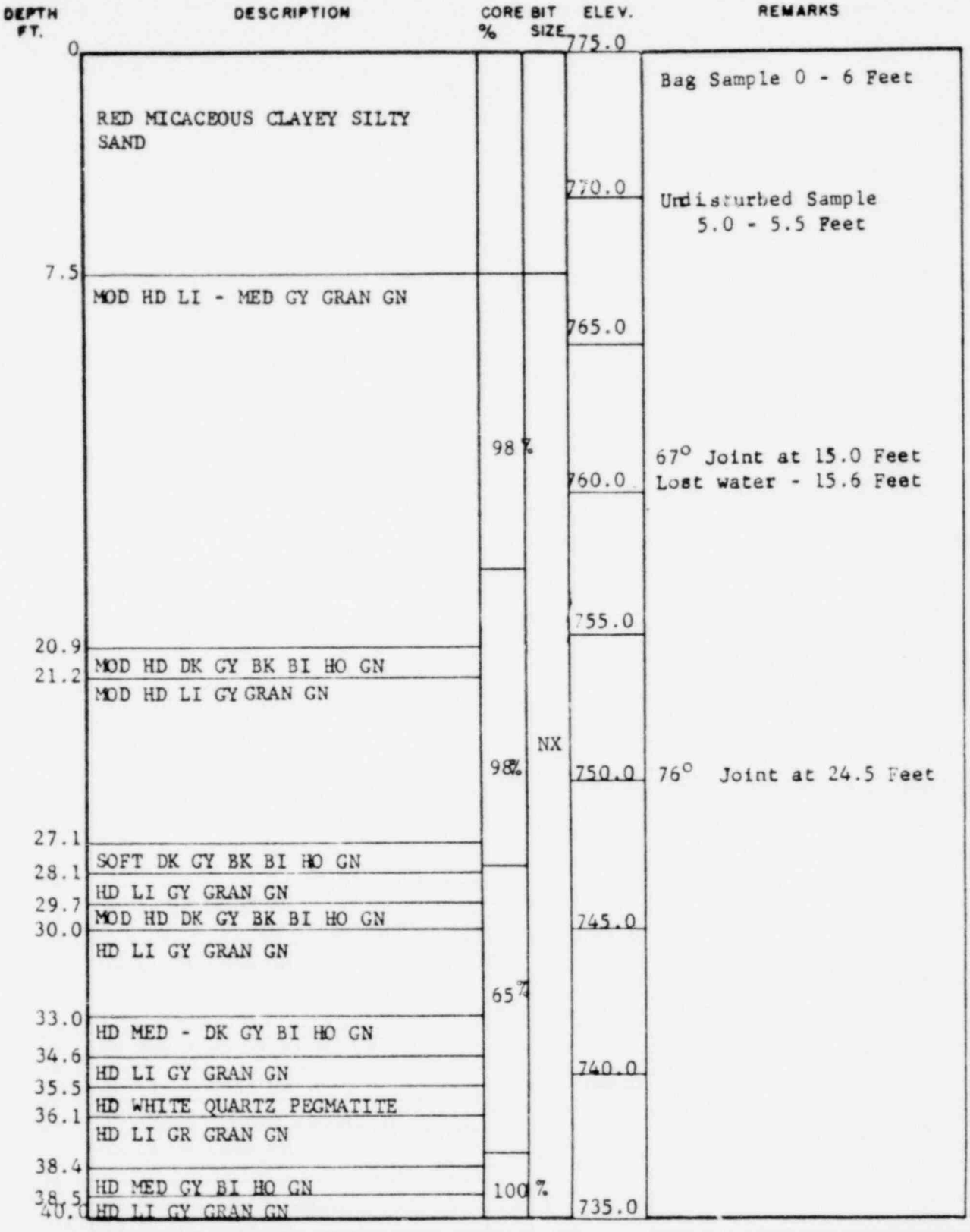
DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
40.0				762	
40.7	MOD HD DK GY BK BI HO GN				
	HD LI GY GRAN GN	92%			
44.5					
44.8	MOD HD DK GY BK BI HO GN			757	
45.8	HD LI GY GRAN GN	86%			
	MOD HD DK GY BK BI HO GN				
47.8					
	HD LI GY GRAN GN			752	
51.8					
52.5	MOD HD DK GY BK BI HO GN	98%	NX		
	HD LI GY GRAN GN			747	
57.3					
58.2	HD DK GY BI HO GN				
58.8	HD LI GY GRAN GN				
58.9	HD DK GY BI HO GN			742	
61.5	HD LI GY GRAN GN				
	HD DK GY BK BI HO GN				
63.2		100%			
64.2	HD LI GY GRAN GN				
64.4	HD DK GY BK BI HO GN			737	
	HD LI GY GRAN GN	99%			
67.1					
68.1	HD DK GY BI HO GN				
68.9	HD LI GY GRAN GN				
69.3	HD DK GY BI HO GN		BX	732	
	HD LI GY GRAN GN			731.2	
70.8					
	CORING TERMINATED			727	

CORE BORING RECORD

BORING NO. NA-5
JOB NO. CH 1065 N

LAW ENGINEERING TESTING CO.

bjs



LI - Light
DK - Dark
GY - Gray
BK - Black
MOD - Moderately
MED - Medium
HD - Hard
BI - Biotite
HO - Hornblende
GRAN - Granite
GN - Gneiss

Not to scale

CORE BORING RECORD

BORING NO. NA-6
JOB NO. CH-1065 N

135

bjs

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
40.0				735.0	
40.7	HD LI GY GRAN GN				
40.8	HD MED GY BI HO GN				
43.7	HD LI GY GRAN GY				
44.7	HD LI-DK GY ALTERNATING LAYERS*1	100 %		730.0	
45.6	HD LI GY GRAN GN				
45.9	HD MED GY BI HO GN		NX		
46.6	HD LI GY GRAN GN				
46.7	HD MED GY BI HO GN				
47.0	HD LI GY GRAN GN				
47.1	HD DK GY BK BI HO GN				
50.3	HD LI GY GRAN GN	100 %		725.0	
50.9	HD MED-DK GY BI HO GN				
51.6	HD LI GY GRAN GN				
51.7	HD MED DK GY BI HO GN			723.3	
	CORING TERMINATED				

*1 OF BI HO GN AND GRAN GN

Not to scale

CORE BORING RECORD

BORING NO. NA-6
JOB NO. CH-1065 N

LAW ENGINEERING TESTING CO.

bjs

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
0				784.5	
	VERY DENSE RED MICACEOUS CLAYEY SILTY SAND WITH SOME QUARTZ FRAGMENTS			779.5	N=50 Undisturbed sample 4.5 to 5.5 feet
5.0	VERY DENSE GRAY TO WHITE MICACEOUS SILTY SAND			774.5	N=79
				769.5	N=80
				764.5	N=44
				759.5	
25.0	SOFT MED GY GRAN GN				
29.8	MOD HD LI-MED GY GRAN GN	80%	NX	754.5	
		100%	BX	749.5	
40.0				744.5	

LI - Light
DK - Dark
GY - Gray
BK - Black
MOD - Moderately
MED- Medium

HD - Hard
BI - Boitite
HO - Hornblende
GRAN - Granite
GN - Gneiss

36.0 Feet of 2" Plastic Pipe left in hole

CORE BORING RECORD

BORING NO. NA-7
JOB NO. CH-1065'N

bjs

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
40.0				744.5	
40.1	MOD HD LI-MED GY GRAN GN	100%			50° Joint at 42.7 Feet
	MOD HD DK GY BK BI HO GN				50° Joint at 43.5 Feet
44.8				739.5	
	MOD HD LI GY GRAN GN				
46.5					
46.6	MOD HD DK GY BK BI HO GN	100%			
47.7	MOD HD LI GY GRAN GN				
47.8	MOD HD DK GY BK BI HO GN				
49.2	MOD HD LI GY GRAN GN				
49.3	MOD HD DK GY BI HO GN				
49.5	MOD HD LI GY GRAN GN				
49.8	MOD HD DK GY BI HO GN			734.5	
50.5	MOD HD LI GY GRAN GN		BX		
53.0	HD WHITE QUARTZ PEGMATITE	98%			
54.0	HD LI GY GRAN GN				
55.2	HD WHITE QUARTZ PEGMATITE			729.5	
58.0	HD LI GY GRAN GN				
58.1	MOD HD DK CY BI HO GN				
59.5	HD LI GY GRAN GN				
60.7	HD WHITE QUARTZ PEGMATITE	100%		724.5	
	HD LI GY GRAN GN				
63.7					
64.7	SOFT LI-MED GY GRAN GN			719.5	
65.3	HD LI GY QUARTZ PEGMATITE				
66.0	HD LI GY GRAN GN				
66.7	HD WHITE QUARTZ PEGMATITE	100%			
	HD LI GY GRAN GN				
69.3					
70.4	MOD HD LI-MED GY GRAN GN			713.5	
70.9	MOD HD DK GY GK BI HO GN				
71.3	MOD HD LI-MED GY GRAN GN			713.2	
	CORING TERMINATED			709.5	

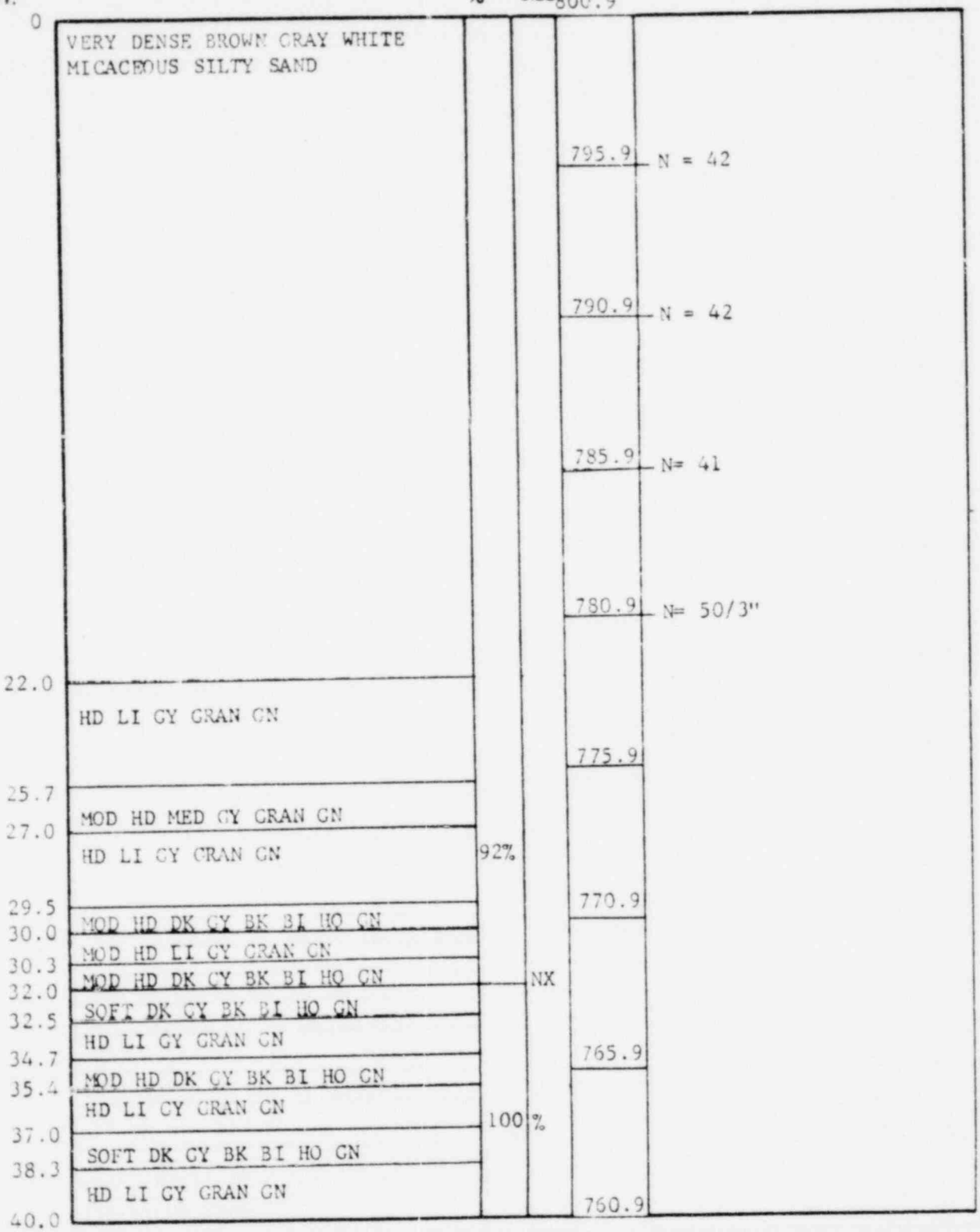
Not to scale

CORE BORING RECORD

BORING NO. NA-7
JOB NO. CH 1065 N

LAW ENGINEERING TESTING CO.

bjs



LI - Light
DK - Dark
GY - Gray
BK - Black
MOD - Moderately
MED - Medium
HD - Hard
BI - Biotite
HO - Hornblende
GRAN - Granite
GN - Gneiss

CORE BORING RECORD

BORING NO. NA-8
JOB NO. CH 1065 N

bjs

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
40.0				760.9	
40.9	HD LI GY GRAN GN	100 %	NX		42° Joint at 40.8 Feet
41.7	MOD HD DK GY BK BI HO GN				
	MOD HD LI-MED GY GRAN GN			755.9	
46.7		100 %			
46.8	MOD HD DK GY BK BI HO GN				
47.1	MOD HD LI GY GRAN GN				
47.2	MOD HD DK GY BK BI HO GN				
50.0	HD LI GY GRAN GN		BX	750.9	
50.2	HD DK GY BK BI HO GN				
	HD LI GY GRAN GN				
53.4					
54.4	HD DK GY BK BI HO GN			745.9	
	HD LI GY GRAN GN	100 %			
56.0	HD DK GY BK BI HO GN				
57.7					
58.2	HD LI GY GRAN GN				
58.7	HD DK GY BK BI HO GN			740.9	
	HD LI GY GRAN GN				
61.1					
61.5	HD DK GY BK BI HO GN				
61.6	HD LI GY GRAN GN				
	HD DK GY BK BI HO GN	100 %			
62.1				736.4	
64.5	HD LI GY GRAN GN			735.9	
	CORING TERMINATED				

Not to scale

CORE BORING RECORD

BORING NO. NA-8
JOB NO. CH- 1065 N

LAW ENGINEERING TESTING CO.

bjs

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
0				822.7	
	STIFF RED BROWN MICACEOUS FINE TO COARSE SANDY CLAYEY SILT WITH SOME QUARTZ FRAGMENTS				N = 27 N = 13
				817.7	N= 25/4"
7.5	MOD HD LI GY TO WHITE QUARTZ PEGMATITE	54%	NX	812.7	N= 20/0"
12.5	HAWTHORNE BIT - VERY DENSE GY SILTY SAND			807.7	- Refusal
				802.7	
20.0	SOFT LI GY GRAN GN				
20.4	MOD HD LI TO MED GY GRAN GN	48 %		797.7	
		93%	NX		
				792.7	60° Joint at 30.7 Feet Lost water at 30.8 Feet
		94		787.7	
		100%	BX		
38.4					
39.3	VERY SOFT MED GY GRAN GN				
40.0	MOD HD LI TO MED GY GRAN GN	100	%	782.7	

LI - Light
DK - Dark
GY - Gray
BK - Black
MOD - Moderately
MED - Medium

HD - Hard
BI - Biotite
HO - Hornblende
GRAN - Granite
GN - Gneiss

bjs

31.0 Feet of 2" Plastic Pipe left in hole

WATER TABLE

CORE BORING RECORD

BORING NO. NA-9
JOB NO. CH-1065-N

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
40.0	MOD HD LI TO MED GY GRAN GN			762.7	
			BX	777.7	
46.5		100 %			
46.6	SOFT MED GY GRAN GN				
47.4	MOD HD MED GY GRAN GN				
48.4	SOFT MED GY GRAN GN				
	MOD HD LI GY GRAN GN			772.7	
52.4					
52.9	MOD HD DK GY BI HO GN				
53.5	HD LI GY GRAN GN				
54.0	MOD HD DK GY BI HO GN	92 %			
	HD LI TO MED GY GRAN GN			767.7	
				762.7	
		100 %		757.7	
67.3			BX		
67.4	HD MED GY BI HO GN				
67.7	HD LI GY GRAN GN				
68.2	HD MED GY BI HO GN			752.7	
71.0	HD LI GY GRAN GN				
71.7	HD MED GY BI HO GN				
72.2	HD LI GY GRAN GN				
72.7	HD MED GY BI HO GN				
	HD LI GY GRAN GN	100 %		747.7	
79.7		100 %		742.7	
80.0	HD MED GY BI HO GN				

Not to scale

CORE BORING RECORD

BORING NO. NA-9
JOB NO. CH-1065 N

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
80.0				742.7	
80.2	HD MED GY BI HO GN				
81.0	HD LI GY GRAN GN				
81.3	MOD HD DK GY BI HO GN				
82.0	HD LI GY GRAN GN				
83.0	HD MED GY BI HO GN				
83.7	HD LI GY GRAN GN				
83.9	HD DK GY BI HO GN	100			
84.3	HD LI GY GRAN GN				
84.7	HD MED TO DK GY BI HO GN				
87.2	HD LI GY GRAN GN		BX	737.7	
87.5	HD MED GY BI HO GN				
88.1	HD WHITE QUARTZ PEGMATITE			732.7	
92.8	HD LI GY GRAN GN				
93.4	HD DK GY BI HO GN				
94.0	HD LI GY GRAN GN				
94.4	HD MED TO DARK GY BI HO GN				
95.7	HD LI GY GRAN GN	98		727.7	
96.5	HD MED GY BI HO GN				
96.8	HD LI GY GRAN GN				
97.3	HD MED GY BI HO GN				
99.2	HD LI GY GRAN GN			723.5	
	CORING TERMINATED				

Not to scale

143

CORE BORING RECORD

BORING NO. NA-9

JOB NO. CH-1065 N

LAW ENGINEERING TESTING CO.

bjs

WATER TABLE

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV. 826.4	REMARKS
0					
0.4	TOPSOIL AND GRASS				
	STIFF BROWN MICACEOUS CLAYEY SANDY SILT				N = 10
				821.4	
6.0	FIRM TO VERY DENSE BROWN GRAY WHITE MICACEOUS SILTY FINE TO COARSE SAND WITH ROCK FRAGMENTS				N = 9
				816.4	
				811.4	- N = 20/0" (Refusal)
					N = 52
				806.4	
22.0	VERY STIFF BROWN MICACEOUS FINE SANDY SILT				N = 16
				801.4	
26.0	VERY STIFF YELLOW BROWN MICACEOUS FINE SANDY SILT				N = 16
				796.4	
30.0	FIRM WHITE GRAY SILTY FINE TO COARSE SAND				N = 28
				791.4	
37.7	MOD HD LI TO MED GY GRAN GN	90%	NX	786.4	
40.0					

LI	Light	HD	Hard
DK	Dark	BI	Biotite
GY	Gray	HO	Hornblende
BK	Black	GRAN	Granite
MOD	Moderately	GN	Gneiss
MED	Medium		

CORE BORING RECORD

BORING NO. NA-10
JOB NO. CH-1065 M

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
40.0				786.4	
40.1	MOD HD LI TO MED GY GRAN GN	90%			74° Joint at 40.0 Feet
41.6	SOFT MED GY BROWN GRAN GN				
42.8	MOD HD LI TO MED GY GRAN GN				
	HD LI GY GRAN GN		NX	781.4	
46.0		94 %			
46.8	MOD HD LI TO MED GY GRAN GN				
48.5	MOD HD DK GY BK BI HO GN				
48.9	HD LI GY GRAN GN				
49.5	MOD HD DK GY BK BI HO GN	100%		776.4	
	HD LI GY GRAN GN				
				771.4	
		100%			
59.4				766.4	
	HD DK GY BK BI HO GN				
62.5					
63.2	HD LI GY GRAN GN				
63.8	HD DK GY BI HO GN				
64.7	HD LI GY GRAN GN		BX		
64.9	HD DK GY BI HO GN	100	%		
65.5	HD LI TO DK GY ALTERNATING THIN	*1		761.4	
65.7	HD DK GY BI HO GN				
65.9	HD LI GY GRAN GN				
66.1	HD DK GY BI HO GN				
66.7	HD LI TO DK GY ALTERNATING	*1			
66.9	HD DK GY BI HO GN				
	HD LI GY GRAN GN			756.4	
				751.4	
		100%			
78.7					
78.9	HD DK GY BI HO GN				
80.0	HD LI GY GRAN GN			746.4	

*1 LAYERS OF BI HO GN AND GRAN GN

CORE BORING RECORD.

BORING NO. NA-10
JOB NO. CH-1065 N

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
80.0				746.4	
	HD LI GY GRAN GN	100			
		100			
85.0				741.4	
	HD WHITE QUARTZ PEGMATITE		BX		
88.0					
88.6	HD DK GY BI HO GN				
	HD LI GY GRAN GN			736.4	
92.4		96%			
92.5	HD DK GY BI HO GN				
93.0	HD LI GY GRAN GN				
94.2	HD DK GY BI HO GN				
	HD LI GY GRAN GN			731.4	
96.7				729.7	
	CORING TERMINATED				
				726.4	

Not to scale

CORE BORING RECORD

BORING NO NA-10
JOB NO. CH 1065 N

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
0				763.85	
	LOOSE RED BROWN SILTY MICACEOUS FINE TO MEDIUM SAND			758.85	N = 9
8.0	STIFF TO VERY STIFF GRAY BROWN MICACEOUS FINE TO MEDIUM SANDY SILT			753.85	N = 12
				748.85	N = 14
				743.85	N = 26
23.0	DENSE BROWN MICACEOUS SILTY FINE SAND			738.85	N = 31
				733.85	N = 30
32.0	WEATHERED ROCK FRAGMENTS			728.85	
35.0	VERY SOFT DK BROWN GRAN GN AND BI HO GN	49%	NX		77° Joint at 35.5 Feet 47° Joint at 36.6 Feet
40.0				723.85	

LI	Light	HD	Hard
DK	Dark	BI	Biotite
GY	Gray	HO	Hornblende
BK	Black	GRAN	Granite
MOD	Moderately	GN	Gneiss
MED	Medium		

End of Boring

WATER TABLE

CORE BORING RECORD 147

BORING NO. NA - 11

JOB NO. CH 1065 N

bjs

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
40.0				723.85	
	VERY SOFT DK BROWN GY GRAN GN AND BI HO GN				
42.5		49%			46° Joint at 43.0 Feet (Recemented)
43.6	SOFT TO MEDIUM GY GRAN GN				
	MOD HD LI GY GRAN GN			718.85	
		80%			
				713.85	
					58° Joint at 55.3 Feet
55.0				708.85	59° Joint at 55.9 Feet
56.4	MOD HD DK GY BK BI HO GN				
57.6	HD LI GY GRAN GN	99%	NX		64° Joint at 57.Feet
58.8	HD DK GY BK BI HO GN				
	HD LI GY GRAN GN			703.85	
61.4					
62.1	HD DK GY BI HO GN				
	HD LI GY GRAN GN				
64.5				698.85	
	HD DK GY BI HO GN				
67.3					60° Joint at 67.8 Feet
68.4	HD LI GY QUARTZ PEGMATITE	92%			
	HD LI GY GRAN GN			693.85	
73.0					
	HD LI GY GRAN GN AND BI HO GN			688.85	
75.0	CORING TERMINATED				
80.0					

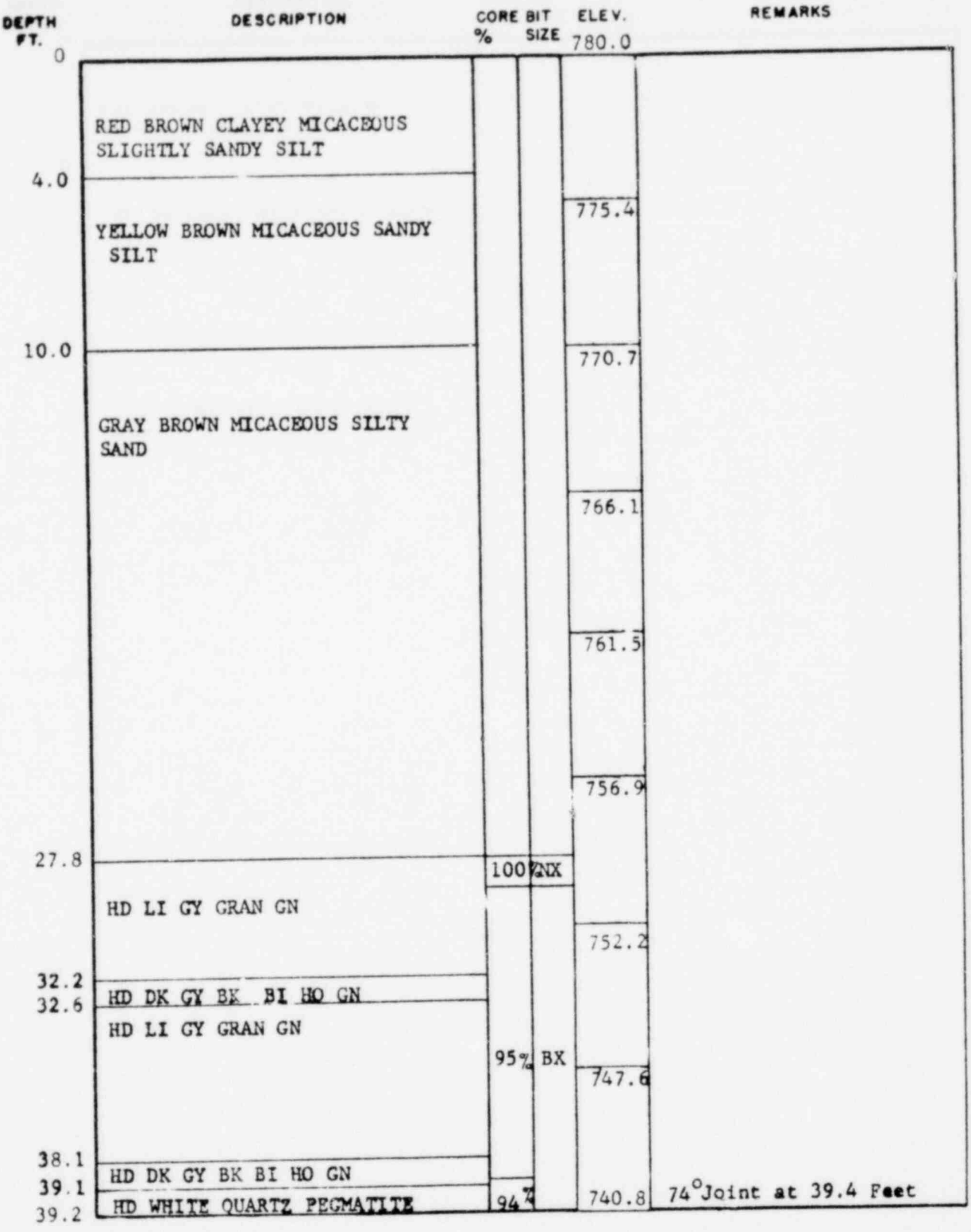
CORE BORING RECORD

BORING NO. NA-11
JOB NO. CH 1065 N

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.



LI	Light	HD	Hard
DK	Dark	BI	Biotite
GY	Gray	HO	Hornblende
BK	Black	GRAN	Granite
MOD	Moderately	GN	Gneiss
MED	Medium		

Hole inclined 22° from the vertical

CORE BORING RECORD

BORING NO. NA-12
JOB NO. CH 1065 N

149

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
39.2				740.8	
39.7	HD DK GY BK BI HO GN				
39.9	SOFT DK GY BK BI HO GN				
40.3	HD DK GY BK BI HO GN			742.9	
42.5	HD LI GY GRAN GN				
43.0	HD DK GY BK BI HO GN				
46.0	HD LI GY GRAN GN	94%			
46.4	HD DK GY BK BI HO GN			738.3	
46.5	HD WHITE QUARTZ PEGMATITE				
46.8	HD DK GY BK BI HO GN				
	HD LI GY GRAN GN		BX	733.7	
		100 %		729.1	
				724.4	
		100%		719.8	
71.9				715.2	
72.2	HD DK GY BK BI HO GN				
72.8	HD LI GY GRAN GN				
73.2	HD DK GY BK BI HO GN	98%			
	HD LI GY GRAN GN			710.5	
				702.3	
77.7	CORING TERMINATED				
				705.9	Not to scale

CORE BORING RECORD

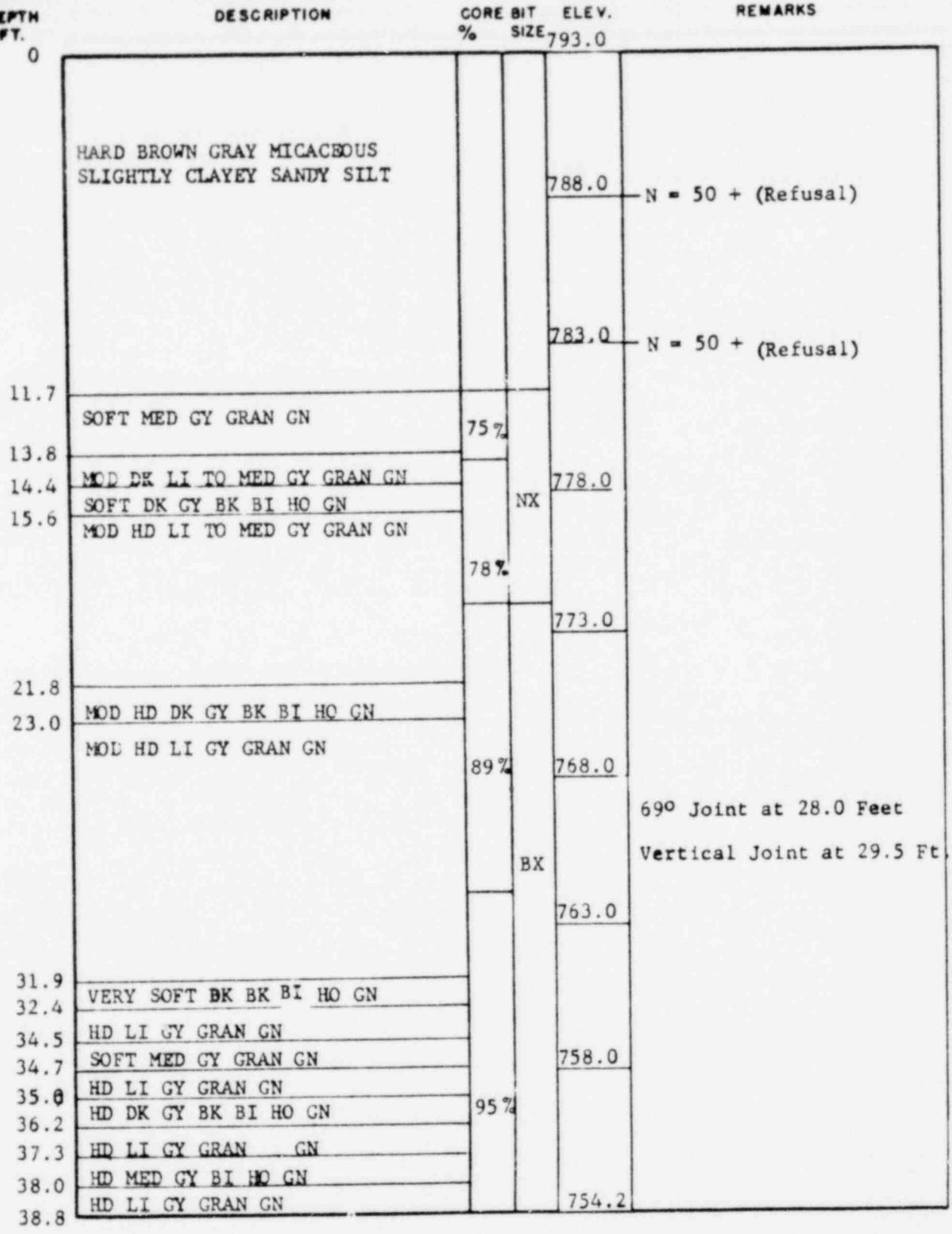
BORING NO. NA-12
JOB NO. CH-1065 N

150

WATER TABLE

LAW ENGINEERING TESTING CO.

bjs



LI	Light	HD	Hard
DK	Dark	BI	Biotite
GY	Gray	HO	Hornblende
BK	Black	GRAN	Granite
MOD	Moderately	GN	Gneiss
MED	Medium		

Not to scale

11.0 feet of 2" plastic pipe left in hole

CORE BORING RECORD

BORING NO. NA-13
JOB NO. CH-1065 N

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
38.8				754.2	
39.5	HD MED TO DK GY BI HO GN	95%		753.0	
	HD LI GY GRAN GN	100 %			
43.8					
44.0	MOD HD DK GY BK BI HO GN			748.0	
	HD LI GY GRAN GN				
47.5					
47.7	HD DK GY BK BI HO GN				
48.1	HD WHITE QUARTZ PEGMATITE		BX		
48.6	HD LI GY GRAN GN	100 %			
49.0	HD DK GY BK BI HO GN				
49.3	HD LI GY GRAN GN				
49.7	HD MOD DK GY BI HO GN			743.0	
52.3	HD LI GY GRAN GN				
53.5	HD WHITE QUARTZ PEGMATITE				
54.0	HD LI DK GY ALTERNATING LAYERS	*1		739.0	
	CORING TERMINATED			738.0	

*1 OF BI HO GN AND GRAN GN

Not to scale

CORE BORING RECORD

BORING NO. NA-13
JOB NO. CH-1065 N

152

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
0				793.0	
	STIFF YELLOW BROWN MICACEOUS SLIGHTLY CLAYEY SANDY SILT				Bag Sample 0.0 - 5'
				788.0	N = 9
					Bag Sample 5 - 10'
					Undistrubed Sample 5.0 - 6.0 feet
9.0					Undisturbed Sample 10.0-11.0 feet
	FIRM LIGHT GRAY MICACEOUS SILTY SAND			783.0	N = 19
					Bag Sample 10-15 feet
13.0					
	STIFF YELLOW BROWN MICACEOUS SLIGHTLY CLAYEY SANDY SILT			778.0	N = 9 Bag Sample 15-20'
					Undisturbed Sample 16.0-16.0 feet
17.5					
	FIRM VERY DENSE MICACEOUS GRAY BROWN SANDY SILT			773.0	N = 13 Bag Sample 20-25'
					Undisturbed Sample 20.0-21.0 Feet
				768.0	N = 47 Bag Sample 25-30'
					Undistrubed Sample 25.0-26.0 Feet
				763.0	N = 67
					Undisturbed Sample 30.0-26.0 Feet
					Undisturbed Sample 33.5 - 34.5 feet
				758.0	Refusal
40.0				753.0	Refusal

LI	Light	HD	Hard
DK	Dark	BI	Biotite
GY	Gray	HO	Hornblende
BK	Black	GRAN	Granite
MOD	Moderately	GN	Gneiss
MED	Medium		

bjs

End of Boring

WATER TABLE

CORE BORING RECORD

BORING NO. NA- 14
JOB NO. CH-1065 N

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
40.0				753.0	
41.0	FIRM-VERY DENSE GRAY BROWN SANDY	*1			
	MOD HD LI TO MED GY GRAN GN	75	NX		
44.7		87			
44.8	MOD HD DK GY BK BI HO GN				
	HD LI GY GRAN GN			748.0	
				743.0	
51.5	HD LI GY WHITE QUARTZ PEGMATITE		BX		
		100			72° Joint at 53.0 Feet
54.5				738.0	
	HD LI GY GRAN GN				
56.7					
57.8	HD DK GY BK BI HO GN				
58.1	HD LI GY GRAN GN				
58.4	HD DK GY BK BI HO GN				
59.0	HD LI GY GRAN GN				
59.5	HD DK GY BK BI HO GN	100		733.0	
61.9	HD LI GY GRAN GN				
62.1	HD DK GY BK BI HO GN				
63.4	HD LI GY GRAN GN				
63.8	HD DK GY BK BI HO GN			729.2	
	CORING TERMINATED			728.0	

*1 SILT

Not to scale

CORE BORING RECORD

BORING NO. NA 14
JOB NO. CH 1065 N

154

bjs

End of Boring
WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
0				766.1	
0.3	TOPSOIL				
	VERY STIFF BROWN CLAYEY MICACEOUS FINE TO MEDIUM SANDY SILT				N = 22
				761.1	
7.0					
	STIFF BROWN FINE TO MEDIUM SANDY MICACEOUS SILT				N = 9"
				756.1	
12.0					
	FIRM TO HARD BROWN GRAY MICACEOUS FINE TO MEDIUM SANDY SILT				N = 6"
				751.1	
					N = 7"
				746.1	
					N = 40/3"
				741.1	
27.0					
	VERY STIFF BROWN GRAY WHITE MICACEOUS FINE TO COARSE SANDY SILT				N = 19
				736.1	
32.0					
	VERY DENSE BROWN GRAY WHITE MICACEOUS SILTY FINE TO COARSE SAND				N = 20/0"
				731.1	
					N = 40/3"
				726.1	
40.0					

36.0 Feet of 2" plastic pipe left in hole

LI	Light	HD	Hard
DK	Dark	BI	Biotite
GY	Gray	HO	Hornblende
BK	Black	GRAN	Granite
MOD	Moderately	GN	Gneiss
MED	Medium		

CORE BORING RECORD

BORING NO. NA-
JOB NO. CH 1065 N

155

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
40.0				726.1	
	VERY DENSE BROWN GRAY WHITE MICACEOUS SILTY FINE TO COARSE SAND				N = Refusal
				721.1	
49.5					
				716.1	
50.8	MOD HD LI GY GRAN GN				50° Joint at 50.4 Feet
	MOD HD DK GY BI HO GN				
51.0					
	MOD HD LI GY GRAN GN				
51.6	MOD HD DK GY BI HO GN	100			
				711.1	
55.6					
	HD LI GY GRAN GN				
57.2					
	MOD HD DK GY BI HO GN	100	NX		
57.6					
	HD LI GY GRAN GN				
58.9					
	MOD HD DK GY BI HO GN				
59.2					
	HD LI GY GRAN GN				
59.6					
	HD DK GY BI HO GN			706.1	
60.0					
	HD LI GY GRAN GN				
61.1					
	MOD HD DK GY BI BI HO GN	100			
61.4					
	HD LI GY GRAN GN				
62.2					
	HD DK GY BI HO GN				
62.5				701.1	
	HD LI GY GRAN GN				
67.3					
	MOD HD DK GY BI HO GN				
67.5					
	HD LI GY GRAN GN	100			
67.6					
	MOD HD DK GY BI HO GN				
67.8					
	HD LI GY GRAN GN			696.6	
69.5					
	CORING TERMINATED			696.1	

Not to scale

CORE BORING RECORD

BORING NO. NA 15

JOB NO. CH 1065N

156

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
0				767.9	Bag Sample 0 - 25'
	STIFF RED BROWN MICACEOUS CLAYEY SANDY SILT				Undisturbed Sample 3.5-4.5 Feet
				762.9	N = 11
7.5	STIFF YELLOW BROWN MICACEOUS SANDY SILT				N = 8
				757.9	Undisturbed Sample 13.5-14.5 Feet
				752.9	N = 12
					N = 9
				747.9	Undisturbed Sample 23.5-24.5 Feet
22.0	FIRM GRAY BROWN SILTY MICACEOUS SAND WITH SOME QUARTZ FRAGMENTS			742.9	N = 16
					N = 24
				737.9	Undisturbed Sample 33.5 - 34.5 Feet.
31.5	VERY STIFF BROWN SLIGHTLY SANDY MICACEOUS SILT			732.9	N = 17
					N=23
40.0				727.9	

85.0 Feet of 2" Plastic pipe left in hole

LI	Light	HD	Hard
DK	Dark	BI	Biotite
GY	Gray	HO	Hornblende
BK	Black	GRAN	Granite
MOD	Moderately	GN	Gneiss
MED	Medium		

CORE BORING RECORD

BORING NO. NA-16
JOB NO. CH-1065 N

157

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
40.0				727.9	
	VERY DENSE GRAY BROWN WHITE MICACEOUS SILTY SAND WITH SOME QUARTZ FRAGMENTS				N=50/4"
				722.9	
				717.9	
				712.9	
				707.9	
				702.9	
69.0					
	MOD HD LIGHT TO MED GY GRAN GN	100		697.9	85° Joint at 72.7 Feet
74.9					
75.4	MOD HD DK GY BK BI HO GN		NX	692.9	
75.6	MOD HD MED GY GRAN GN				71° Joint at 76.0 Feet
76.5	MOD HD DK GY BK BI HO GN	100			77° Joint at 77.0 Feet
77.7	MOD HD MED GY GRAN GN				
78.0	SOFT DK GY BK BI HO GN				
78.2	MOD HD LI GY GRAN GN			687.9	

CORE BORING RECORD

BORING NO. NA-16
JOB NO. CH 1065 N

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
78.2				687.9	
79.1	MOD HD DK GY BK BI HO GN	100			
79.6	MOD HD MED GY GRAN GN				
79.7	SOFT DK GY BK BI HO GN				
80.0	MOD HD LI GY GRAN GN			682.9	
80.2	SOFT DK BY BK BI HO GN				
81.3	MOD HD LI GY GRAN GN	100			
82.1	MOD HD MED TO DK GY BI HO GN		NX		
84.0	MOD HD LI GY GRAN GN				
84.5	HD LI GY GRAN GN				
84.7	MOD HD DK GY BK BI HO GN				
86.0	HD LI GY GRAN GN				
86.3	SOFT DK GY BK BI HO GN	100			
87.3	HD LI GY GRAN GN				
89.0	MOD HD LI TO DK GY ALTERNATE *1	*1		678.9	
	CORING TERMINATED			672.9	

*1 LAYERS OF BI HO GN AND GRAN GN

Not to scale

CORE BORING RECORD

BORING NO. NA-16
JOB NO. CH 1065 N

159

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
0				816.0	
	FIRM BROWN CLAYEY SILTY MICACEOUS SAND			811.0	N = 15 Undisturbed Sample 4.0 - 5.0 Feet
				806.0	N = 11
12.0					
	STIFF TO VERY STIFF BROWN GRAY SANDY MICACEOUS SILT			801.0	N = 12
				796.0	N = 13
				791.0	N = 18
28.0					
	DENSE TO VERY DENSE GRAY WHITE SILTY MICACEOUS SAND WITH SOME QUARTZ FRAGMENTS			786.0	N = 19
				781.0	N = 23
				776.0	N=28
40.0					

58.0 Feet of 2" plastic pipe left in hole

LI	Light	HD	Hard
DK	Dark	BI	Biotite
GY	Gray	HO	Hornblende
BK	Black	GRAN	Granite
MOD	Moderately	GN	Gneiss
MED	Medium		

CORE BORING RECORD

BORING NO. NA-17

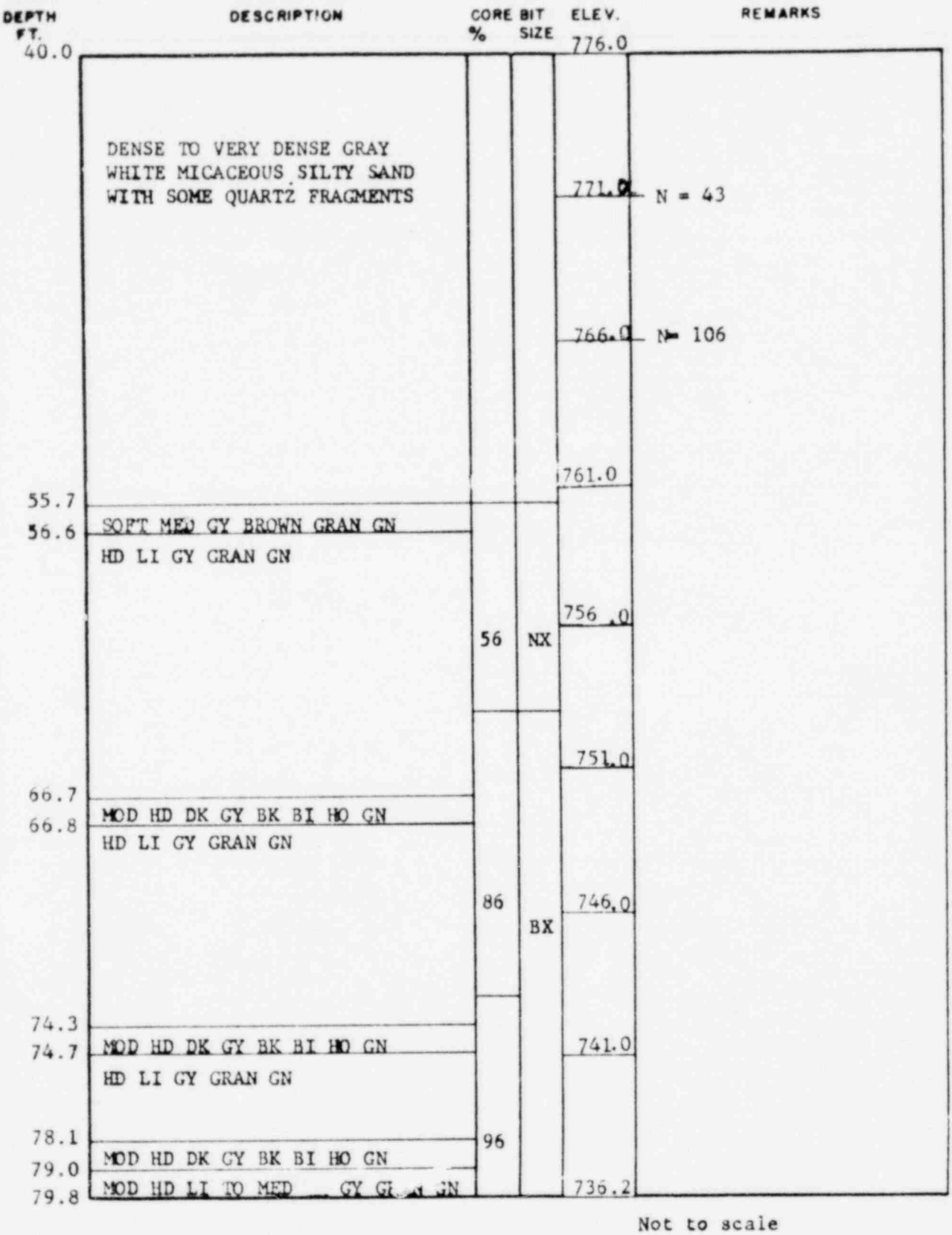
JOB NO. CH 1065 N

160

bjs

End of Boring
WATER TABLE

LAW ENGINEERING TESTING CO.



CORE BORING RECORD

BORING NO. NA-17

JOB NO. CH- 1065 N

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

161

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV. 736.2	REMARKS
79.8					
80.1	MOD HD DK GY BK BI HO GN	96	BX	736.0	
	HD LI TO MED GY GRAN GN			732.8	
83.2	CORING TERMINATED			731.0	

bjs

CORE BORING RECORD

BORING NO. NA-17

JOB NO. CH-1065 N

WATER TABLE

LAW ENGINEERING TESTING CO

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
0				745.6	
0.3	TOPSOIL AND GRASS				Bag Sample 0 - 8.0 Feet
	VERY STIFF RED BROWN SILTY MICACEOUS CLAY				Undisturbed Sample 3.5 - 4.5 Feet
				740.6	N = 18
					Undisturbed Sample 8.5-9.5 Feet
8.0					Bag Sample 8.0 -25.0 Feet
	STIFF TO VERY STIFF BROWN GRAY WHITE MICACEOUS SANDY SILT			735.6	N = 9
					Undisturbed Sample 13.5-14.5 Feet
				730.6	N = 9
					Undisturbed Sample 18.5 -19.5 Feet
				725.6	N= 11
					N = 14
				720.6	
					N = 21
				715.6	
					N = 25
				710.6	
36.0					
	VERY STIFF TO HARD GRAY BROWN BLACK MICACEOUS SANDY SILT				N = 25
40.0				705.6	

LI	Light	HD	Hard
DK	Dark	BI	Biotite
GY	Gray	HO	Hornblende
BK	Black	GRAN	Granite
MOD	Moderately	GN	Gneiss
MED	Medium		

CORE BORING RECORD

BORING NO. NA-18
JOB NO. CH 1065 N

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
40.0	VERY STIFF TO HARD GRAY BROWN BLACK MICACEOUS SANDY SILT			705.6	
				700.6	N = 36
				695.6	N = 31
				690.6	N = 26
				685.6	N = 25
				680.5	N = 34
67.0	HARD YELLOW BROWN VERY MICACEOUS SANDY SILT			675.6	N = 41
				670.6	N = 29
80.0				665.6	

CORE BORING RECORD

BORING NO. NA 18
JOB NO. CH 1065 N

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
80.0				665.6	
	VERY SOFT ROCK (NO RECOVERY)	0			
84.0				660.6	
	SOFT MED GY AND BR GRAN GN	60	BX		74° Joint at 86.0 Feet
90.0				655.6	
	HAWTHORNE BIT - VERY DENSE GY SILTY SAND			650.6	
				645.6	
104.0					
104.5	QUARTZ VEIN			640.6	
	VERY SOFT GY GRAN GN				
108.0					
	MOD HD MED GY AND BR GRAN GN	66		635.6	
			BX		
115.7				630.6	
115.9	MOD HD DK GY BK BI HO GN				75° Joint at 115.7 Feet
116.1	MOD HD LI TO MED GY GRAN GN				
118.0	SOFT DK GY BK BI HO GN				
	MOD HD LI TO MED GY GRAN GN	80		625.6	
120.0					

CORE BORING RECORD

BORING NO. NA - 18
JOB NO. CH 1065 N

bjs

WATER TABLE

LAW ENGINEERING TESTING CO

1065

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV. 625.6	REMARKS
120.0	MOD HD LI TO MED GY GRAN GN				
122.2	SOFT DK GY BK BI HO GN				
123.1	MOD HD LI TO MED GY GRAN GN	80		620.6	78° Joint at 123.0 Feet
125.3	VERY SOFT MED GY GRAN GN		BX		57° Joint at 124.0 Feet
		38		615.6	
130.0	CORING TERMINATED				

CORE BORING RECORD

BORING NO. NA 18
JOB NO. CH 1065 N

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
0				785.3	
	VERY STIFF RED BROWN MICACEOUS SLIGHTLY SANDY CLAYEY SILT				N = 15 Bag Sample 5.0 - 10.0 Feet
				780.3	N = 20
					N = 23
				775.3	N = 18
					Undisturbed Sample 8.5- 10.0 Feet
					Bag Sample 10.0 -20.0 Feet
				770.3	N = 17
18.0					
	STIFF YELLOW BROWN MICACEOUS SLIGHTLY SANDY SILTY CLAY			765.3	N = 13
22.0					
	VERY STIFF YELLOW BROWN SLIGHTLY SANDY MICACEOUS SILT			760.3	N = 23
				755.3	N =25
				750.3	N = 29
38.0					
	HARD YELLOW BROWN PINK MICACEOUS SANDY SILT			745.3	N = 35
40.0					

LI	Light	HD	Hard
DK	Dark	BI	Biotite
GY	Gray	HO	Hornblende
BK	BLACK	GRAN	Granite
MOD	Moderately	GN	Gneiss
MED	Medium		

CORE BORING RECORD

BORING NO. NA 19

JOB NO. CH 1065 N

167

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
40.0				745.3	
	HARD YELLOW BROWN PINK MICACEOUS SANDY SILT				
41.5	HARD GRAY BROWN MICACEOUS SANDY SILT				
				740.3	N= 39
				735.3	N = 45
				730.3	N = 44
				725.3	N = 42
				720.3	N = 44
67.5					
	DENSE YELLOW BROWN AND GRAY MICACEOUS SILTY SAND WITH SOME QUARTZ FRAGMENTS			715.3	N = 41
				710.3	N = 35
80.0				705.3	N = 36

bjs

CORE BORING RECORD

BORING NO. NA-19
JOB NO. CH 1065N

168

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
80.0				705.3	
	DENSE YELLOW BROWN AND GRAY MICACEOUS SILTY SAND WITH SOME QUARTZ FRAGMENTS			700.3	N = 40
				695.3	
				690.3	
				685.3	
101.0	DENSE SILTY SAND WITH THIN LAYERS OF QUARTZ			680.3	
105.3	DENSE YELLOW BROWN AND GRAY SILTY SAND WITH SOME QUARTZ FRAGMENTS			675.3	
110.0	HD LI GY GRAN GN				
112.3	MOD HD MED GY BK BI HO GN				50° Joint at 112.0 Feet
112.8	HD LI GY GRAN GN			670.3	
115.5	MOD HD DK GY BK BI HO GN	100	BX		
118.3	LD LI GY GRAN GN			665.3	
120.0					

CORE BORING RECORD

BORING NO. NA-19
JOB NO. CH 1065 N

169

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
120.0				665.3	
	HD LI GY GRAN GN				
125.0				660.3	
	MOD HD LI GY GRAN GN	100	BX		
130.0				655.3	
	CORING TERMINATED				

CORE BORING RECORD

BORING NO. NA 19
JOB NO. CH 1065 N

bja

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
0				742.6	
0.3	TOPSOIL AND GRASS				Bag Sample 0 - 4.0 Feet
	STIFF BROWN MICACEOUS SANDY SILT				Undisturbed Sample 3.5 -4.5 feet
				737.6	N = 8
					Bag Sample 4.0 -25.0 Feet
7.0	FIRM TO VERY STIFF BROWN GRAY WHITE MICACEOUS SANDY SILT			732.6	N = 6 Undisturbed Sample 8.5-9.5 Feet
				727.6	N = 12 Undisturbed Sample 13.5-14.5 Feet
					Undisturbed Sample 18.5-19.5 Feet
				722.6	N = 13
					Undisturbed Sample 23.5-24.5 Feet
				717.6	N = 15
					N = 17
				717.6	
					N = 16
				707.6	
37.0	DENSE BROWN GRAY WHITE MICACEOUS SILTY FINE TO MEDIUM SAND				N = 31
40.0				702.6	

LI	Light	HD	Hard
DK	Dark	BI	Biotite
GY	Gray	HO	Hornblende
BK	Black	GRAN	Granite
MOD	Moderately	GN	Gneiss
MED	Medium		

36.0 Feet of 2" Plastic Pipe left in hole

CORE BORING RECORD

BORING NO. NA -20

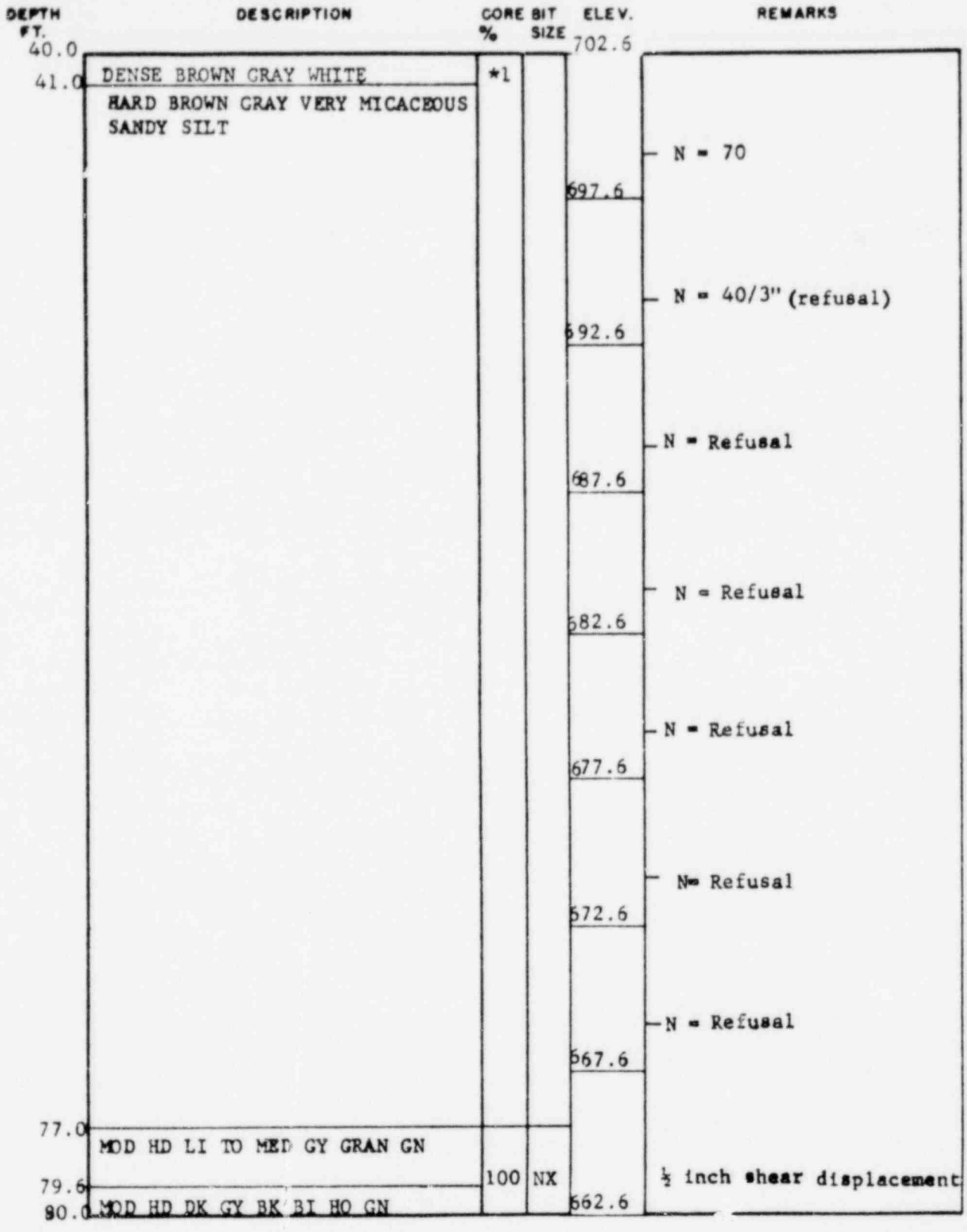
JOB NO. CH 1065 N

171

WATER TABLE

bjs

LAW ENGINEERING TESTING CO.



*1 MICACEOUS SILTY FINE TO MEDIUM SAND

CORE BORING RECORD

BORING NO. NA -20
JOB NO. CH-1065 N

172

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
80.0				662.6	
	MOD HD LI TO MED GY GRAN GN	100			82° Joint at 80.0 Feet
					85° Joint at 82.3 Feet
83.7					
83.9	MOD HD DK GY BK BI HO GN				
	MOD HD LI GY AND BR GRAN GN	100		657.6	
88.6					
88.8	MOD HD DK GY BK BI HO GN				
89.4	MOD HD LI TO MED GY & BR GRAN GN	100		652.6	
90.1	MOD HD DK GY BK BI HO GN				
92.0	MOD HD LI TO MED GY GRAN GN				
92.2	SOFT DK GY BR BI HO GN				
	MOD HD LI GY GRAN GN	100		647.6	
97.0					
97.5	MOD HD DK GY BK BI HO GN				
99.8	MOD HD LI GY GRAN GN				74° Joint at 97.0 Feet
100.3	MOD HD DK GY BK BI HO GN			642.6	
	MOD HD LI GY GRAN GN	100	NX		
104.6				637.6	
105.7	MOD HD LI TO MED GY BI HO GN				
106.1	MOD HD LI GY GRAN GN				73° Joint at 104.7 feet
106.9	MOD HD DK GY BK BI HO GN	95			
	MOD HD LI TO MED GY GRAN GN				
109.6		93			
110.0	SOFT DK GY BK BI HO GN			632.6	
110.2	MOD HD LI GY GRAN GN				
110.4	MOD HD DK GY BK BI HO GN			630.6	
112.0	MOD HD LI GY GRAN GN				
	CORING TERMINATED			627.6	

CORE BORING RECORD

BORING NO. NA - 20
JOB NO. CH 1065 N

bjs

WATER TABLE

LAW ENGINEERING TESTING CO

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV.	REMARKS
0				728.9	
0.4	TOPSOIL				
	VERY STIFF RED BROWN MICACEOUS FINE SANDY SILTY CLAY			723.9	N = 21 Undisturbed Sample 3.5-4.5 Feet
8.0	VERY STIFF BROWN MICACEOUS FINE SANDY SILT			718.9	N = 16 Undisturbed Sample 8.5-9.5 Feet
12.0	LOOSE BROWN GRAY MICACEOUS SILT FINE SAND				Undisturbed Sample 13.5-14.5 Feet
				713.9	N = 4
17.5	STIFF BROWN GRAY WHITE MICACEOUS FINE TO MEDIUM SANDY SILT				Undisturbed Sample 18.5-19.5 Feet
				708.9	N = 10 Undisturbed Sample 23.5-24.5 Feet
21.0	VERY STIFF TO HARD MICACEOUS BROWN GRAY WHITE SILTY FINE TO COARSE SAND			703.9	N = 17
				698.9	N = 45
				693.9	N = 60
36.0	HARD DARK GRAY BLACK AND WHITE FINE SANDY SILT			688.9	N = 30/1" (Refusal)
40.0					

LI	Light	HD	Hard
DK	Dark	BI	Biotite
GY	Gray	HO	Hornblende
BK	Black	GRAN	Granite
MOD	Moderately	GN	Gneiss
MED	Medium		

CORE BORING RECORD

BORING NO. NA-21

JOB NO. CH 1065 N

bjs

WATER TABLE

LAW ENGINEERING TESTING CO.

DEPTH FT.	DESCRIPTION	CORE %	BIT SIZE	ELEV. 688.9	REMARKS
40.0	HARD DARK GRAY BLACK AND WHITE FINE SANDY SILT (DECOMPOSED HORNBLENDE GNEISS)				N = 20/0" (Refusal)
				683.9	
					N = Refusal
				678.9	
53.5	MOD HD LI TO MED GY GRAN GN				
55.1				673.9	
55.5	SOFT MED GY GRAN GN				
56.0	VERY SOFT DK GY BK BI HD GN				
	MOD HD LI TO MED GY GRAN GN				Vertical Joint at 57.5 Feet
59.9					
60.2	VERY SOFT DK GY BK BI HD GN			668.9	
61.7	MOD HD LI TO MED GY GRAN GN	100			
62.1	MOD HD DK GY BI HD GN				
62.2	VERY SOFT DK GY BI HD GN				
62.4	SOFT MED GY GRAN GN		NX		
62.7	SOFT DK GY BI HD GN				
63.0	SOFT MED GY GRAN GN				
63.5	MOD HD LI TO MED GY GRAN GN				
63.8	SOFT DK GY BI HD GN				
64.0	SOFT LI TO MED GY GRAN GN				
64.2	MOD HD DR GY BI HD GN			663.9	
68.8	MOD HD LI TO MED GY GRAN GN				61° Joint at 65.0 Feet
70.6	MOD HD DK GY BK BI HD GN				
71.4	MOD HD LI TO MED GY GRAN GN	100			
71.5	VERY SOFT MED GY GRAN GN				
73.5	MOD HD LI TO MED GY GRAN GN			655.4	
	CORING TERMINATED			658.9	

Not to scale

bjs

CORE BORING RECORD

BORING NO. NA-21
JOB NO. CH 1065 N

175

WATER TABLE

LAW ENGINEERING TESTING CO.