Ina
Baker

9.

Georgia Power

the southern electric system

D. E. Dutton

November 12, 1982

Director of Nuclear Reactor Regulation
Attention: Darrell G. Eisenhut, Director
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

NRC DOCKET NUMBERS 50-424 AND 50-425
CONSTRUCTION PERMIT NUMBERS CPPR-108 AND CPPR-109
VOGTLE ELECTRIC GENERATING PLANT
POSTULATED MILLETT FAULT STUDY

Dear Mr. Eisenhut:

As requested at the October 29, 1982 Postulated Millett Fault Study meeting with members of the NRC staff in Bethesda, Georgia Power Company is forwarding the seismic reflection lines from the Savannah River Plant. Please find enclosed the replay sections for the refraction lines in the vicinity of the Postulated Millett Fault, the time cross sections, the top triassic, saprolite, and crystalline rock countour maps, and the velocity gradient map. Also enclosed are five copies of a report issued as part of the reflection studies. All this information is available through the Oak Ridge, Tennessee Repository.

Should you have any questions, please inquire.

Sincerely,

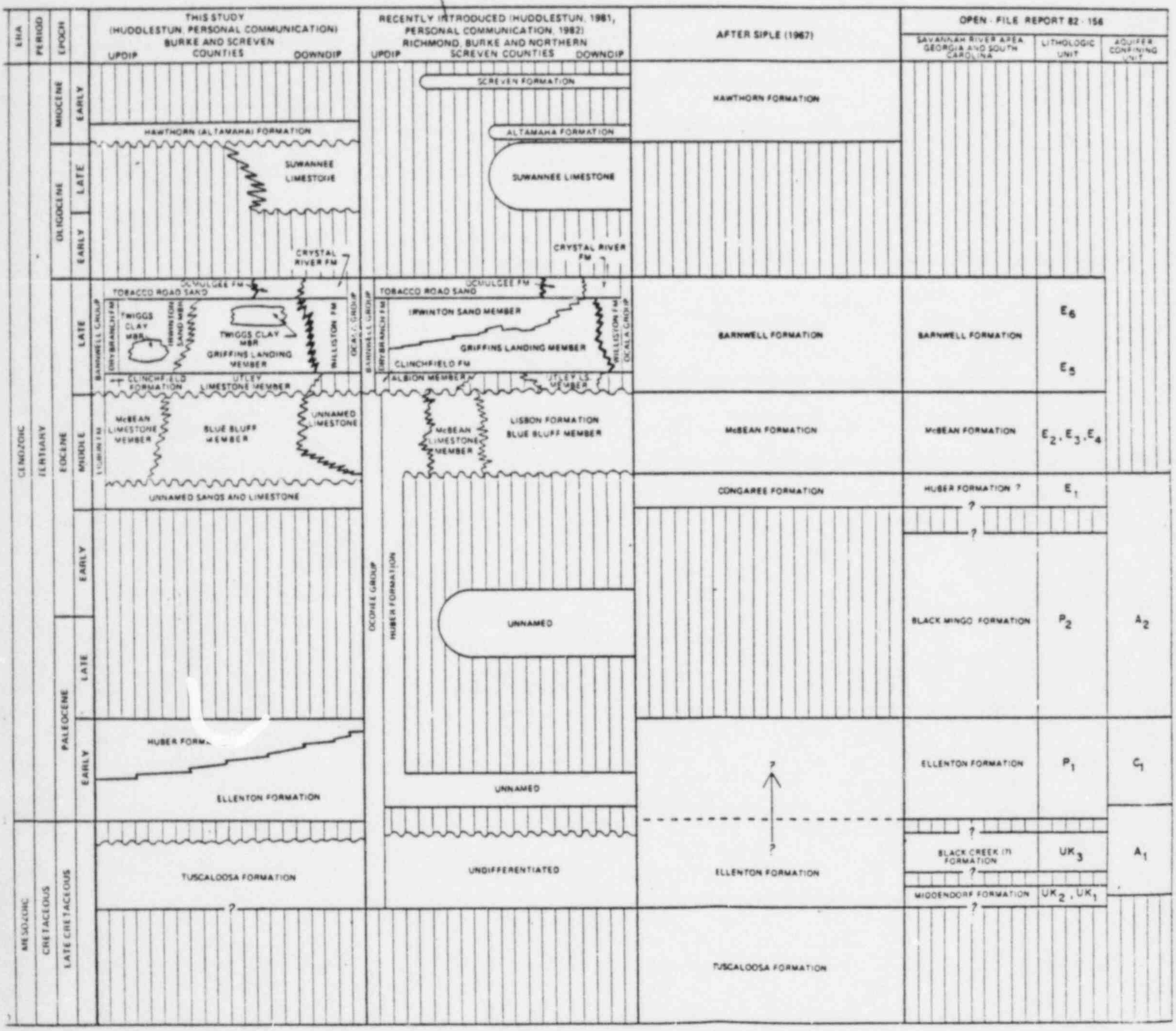
Doug Dutton

Doug Dutton
Vice President
Generating Plant Projects

DED/JAB/sw

xc: R. A. Thomas	G. S. Grainger
J. A. Bailey	~~R. A. Jackson~~
O. Batum	E. L. Doolittle
D. O. Foster	J. M. Grant
C. R. McClure	G. F. Trowbridge

13,



...977, HUDDLESTUN, 1981

ERA	SYSTEM	SERIES	AGE	UNIT	DESCRIPTION
CENOZOIC	QUATERNARY	PLEIS. & RECENT		ALLUVIUM	ALLUVIAL FILL AND TERRACE DEPOSITS IN STREAM VALLEYS. CONSISTING OF TAN TO GRAY SAND, CLAY, SILT AND GRAVEL.
CENOZOIC	TERTIARY	MIOCENE	EARLY	HAWTHORN (ALTAMAHA) FORMATION	POORLY SORTED CLAYEY SAND AND GRAVEL. TAN, RED AND PURPLE IN COLOR. CONTAINS SOME CROSS-BEDDED STRINGERS OF LIMONITE-GOETHITE PEBBLES.
CENOZOIC	TERTIARY	OLIGOCENE	LATE	SUWANNEE LIMESTONE	LIGHT-GRAY TO CREAM COLOR, FOSSILIFEROUS LIMESTONE. BASAL LAYER IS SANDY.
CENOZOIC	TERTIARY	EOCENE	LATE	TOBACCO ROAD SAND; OCMULGEE FM.; CRYSTAL RIVER FM BARNWELL GROUP: DRY BRANCH FM. (IRWINTON SAND MBR.; TWIGGS CLAY MBR.; GRIFFINS LANDING MEMBER; TWIGGS CLAY MBR.) WILLISTON FM. OCALA GROUP CLINCHFIELD FM. (UTLEY LIMESTONE MBR.	TOBACCO ROAD SAND: FINE-GRAINED AND WELL-SORTED TO COARSE AND POORLY-SORTED SAND. OCMULGEE FM: FORAMINIFERAL MARL AND LIMESTONE. CRYSTAL RIVER FM: COARSE, FOSSILIFEROUS LIMESTONE. IRWINTON SAND MBR: FINE-TO MEDIUM-GRAINED QUARTZ SAND. GRIFFINS LANDING MBR: WELL-SORTED CALCAREOUS SAND. TWIGGS CLAY MBR: GREENISH, BLUISH GRAY, SILTY SAND. WILLISTON FM: NON-FOSSILIFEROUS SANDY LIMESTONE. UTLEY LIMESTONE MBR: SANDY, GLAUCONITIC, FOSSILIFEROUS LIMESTONE.
CENOZOIC	TERTIARY	EOCENE	MIDDLE	LISBON FM.: McBEAN LIMESTONE MEMBER; BLUE BLUFF MEMBER; UNNAMED LIMESTONE UNNAMED SANDS AND LIMESTONE	BLUE BLUFF MBR: GREENISH TO BLUISH-GRAY MARL. McBEAN LIMESTONE MBR: SOFT, GRAY, SANDY LIMESTONE WITH SOME SHELL FRAGMENTS. UNNAMED LIMESTONE: GRAY, FOSSILIFEROUS LIMESTONE. UNNAMED SAND AND LIMESTONE: QUARTZ SAND, CALCAREOUS SAND AND FOSSILIFEROUS LIMESTONE.
CENOZOIC	TERTIARY	PALEOCENE	EARLY	HUBER FORMATION ELLENTON FORMATION	HUBER FM: MULTI-COLORED CLAY, CONTAINS BEDS OF SANDY KAOLIN TO COARSE BEDDED SAND. ELLENTON FM: DARK-GRAY TO BLACK SANDY LIGNITIC MICACEOUS CLAY, MEDIUM-TO DARK-GRAY COARSE SAND.
MESOZOIC	CRETACEOUS	LATE		TUSCALOOSA FORMATION	TAN, BUFF, LIGHT-GRAY AND WHITE CROSS-BEDDED MICACEOUS QUARTZITE AND ARKOSIC SAND AND GRAVEL, INTERBEDDED WITH RED, BROWN AND PURPLE CLAY AND WHITE KAOLIN.
MESOZOIC	TRIASSIC	LATE		NEWARK (?) SUPERGROUP	GRAY, DARK BROWN AND BRICK RED SANDSTONE, SILTSTONE AND CLAYSTONE WITH SECTIONS OF CONGLOMERATE AND FAN-GLOMERATE.
PRECAMBRIAN & PALEOZOIC				BASEMENT ROCK OF THE KIOKEE BELT AND BELAIR BELT	GRANITE, GNEISS, PHYLLITE AND GREENSTONE.

AFTER SIPLE, 1967; BUIE, 1978; HATCHER, 1978; HUDDLESTUN AND HETRICK, 1978, 1979; HUDDLESTUN, PERSONAL COMMUNICATION, 1982

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

JUN 8 1973

Richard C. DeYoung, Assistant Director for PWR's, L

ALVIN W. VOGTLE UNITS 1, 2, 3, & 4

PLANT NAME: Alvin W. Vogtle
LICENSING STAGE: CP
DOCKET NUMBERS: 50-424 - 50-427
RESPONSIBLE BRANCH: PWR Branch #2
REQUESTED COMPLETION DATE: 6/8/73
APPLICANTS RESPONSE DATE NECESSARY FOR
NEXT ACTION PLANNED ON PROJECT: NA
DESCRIPTION OF RESPONSE: Answer to Questions
REVIEW STATUS: Site Analysis Branch - CP

Enclosed are questions on geology and foundation engineering pertaining to proposed units of the subject plant. A copy of questions 1, 2, and 3 were previously provided to L. Crocker, RP Project Manager, who has submitted them to the applicant. A position paper, which recommends that additional site exploration work be done, is concurrently being prepared for this project.

Harold R. Denton

Harold R. Denton, Assistant Director
for Site Safety
Directorate of Licensing

Enclosure:
As stated

cc: w/o enclosure
A. Giambusso
W. McDonald

cc: w/enclosure
S. H. Hanauer
J. M. Hendrie
W. P. Gammill
K. Kniel
L. Crocker
A. T. Cardone

Dupe ~~8505280166~~

ALVIN W. VOGTLE QUESTIONS
DOCKET NOS. 50-424 - -427

1. What is the geologic significance of the clastic dikes mentioned on page 2.5-6?

2. On pages 2.5-2, 3 the basement complex is described as also including Triassic sediments. What is the configuration and location, with respect to the site of the Triassic basin? What is the evidence that the basin is not bounded by faults, in a manner similar to other fault-bounded Triassic basins in the Piedmont.

3. The cross section (B-B') illustrated in figure 2.5-6 shows a monoclinal flexure (albeit with vertical exaggeration). Discuss the structural relationship of this flexure and any bounding fault of the Triassic basin.

   Discuss possible relationship between the apparently anomalous high seismic response in the zone enclosed by the 8-1/2 value shown on figure 2.5-26 to basin bounding structures in the basement complex.

4. Provide those boring logs of holes drilled in the proposed plant area that were not submitted in the PSAR. For example, the logs for drill holes 101B, 107B, 146, 148, 149, 150, 151, 183, and 184, which are located in the containment buildings locations, were not provided in the PSAR.

5. Discuss the significance and magnitude of possible subsidence resulting from fluid withdrawal by means of the proposed water wells that will supply normal make-up water and cooling water during emergency shutdown conditions. Verify your estimate of the magnitude of subsidence by providing the appropriate analyses.

6. In order to complete the geologic and tectonic framework for the proposed site, describe and discuss the geology to the north of the Savannah River, using as guidelines the "Seismic and Geologic Siting Criteria" and the "Standard Format and Content of SAR's for Nuclear Power Plants." Show in an appropriate figure the extent and locations of the nearby Triassic Basin and clastic dikes mentioned on page 2.5-6.

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AEC Question 2.19

What is the geologic significance of the clastic dikes mentioned on page 2.5-6? 3

Response

Refer to paragraph 2.5.1.3.2. Does this respond to the Q

Vogtle Q responses attached

AEC Question 2.21

The cross section (B-B') illustrated in figure 2.5-6 shows a monoclinal flexure (albeit with vertical exaggeration). Discuss the structural relationship of this flexure and any bounding fault of the Triassic basin. 3

Response

See paragraph 2.1.1.4.3.

AEC Question 3.3

The simplified lumped mass and soil spring approach proposed in the PSAR to characterize soil-structure interaction is not appropriate. The use of equivalent soil springs may produce a pronounced filtering of the ground motion response amplitude and response frequencies due to inadequate representation of soil parameters. Indicate your intent to adopt one of the following methods for soil-structure interaction analysis:

(a) A nonlinear finite element approach with appropriate nonlinear stress-strain and damping relationship for the soil.

(b) An iterative linear finite element approach with appropriate nonlinear stress-strain and damping relationship for the soil (pseudo-nonlinear approach). 3

(c) Lumped springs to represent the soil with appropriate dampings (not more than 10% of critical damping corresponding to horizontal and vertical springs), utilizing a variation in the soil properties corresponding to the span of maximum and minimum strain levels so that the floor response spectra obtained envelop those using the finite element approach. If a pseudo-nonlinear finite element approach is used, identify the manner in which variation in the properties of the soil are accounted for. (Para. 3.7.2.1)

Response

See paragraph 3.7.2.1.1.1.

Cretaceous period. Seismic refraction surveys at the site indicate that this basement complex-Cretaceous contact occurs at a depth of approximately 950 feet. More or less constant deposition continued from the Cretaceous through mid-Tertiary periods in the Savannah River basin area with the youngest identified Tertiary sediments being Miocene in age. Variegated clays and sands lithologically similar to the Miocene Hawthorne formation were encountered in the upper portion of one of the higher holes drilled at the site, but insufficient exposures of these clays and sands were present to show as a mappable unit. For regional geology map see figure 2.5-3.

Figure 2.5-4, which is a portion of the Tectonic Map of North America, shows the relationship of the site, on the essentially undisturbed sediments of the Coastal Plain, to the Piedmont Province to the north and west with its older and more complex geologic units. The basement complex, as exposed in the Piedmont Province, has undergone at least two periods of granitic intrusion or granitization as well as well-developed faulting and folding. This activity, however, has been essentially quiescent since the deposition of the Cretaceous sediments in the coastal plain. This wedge of Cretaceous and younger sediments, which feather out at the Fall Line near Augusta, is reported to reach depths of approximately 4,000 feet at the coastal line near Savannah, Georgia. The lowest member of the sediments appears to represent an alluvial deposit, possibly of coalescing fans derived from the erosion of the older basement rocks to the west and north. The encroachment of a shallow sea in the Uppermost Cretaceous and Lower Tertiary times resulted in the shoreward migration of estuarine and shallow marine deposits. In the vicinity of the site, lignitic sands and clays are replaced by marls, coquinas, and shallow water sand. These deposits grade coastward into deeper water lithological units of the same age, such as limestone and shales. The present dip seaward of these units is approximately 30 feet per mile at the Cretaceous basement complex contact.

The basement complex is described above as including Triassic sediments. The location and configuration of these sediments with regard to the VNP is shown on figure 2.5-4A. This Triassic basin, its location, and supporting evidence are discussed in reference 2.5.7.2 (Siple, G. E., 1967). Here Siple discusses the core obtained in the bottom of the holes drilled on the SRP as lithologically characteristic of "the fanglomerate or conglomerate facies of the Newark group of late Triassic age." The outline of the basin has been determined largely on the basis of aeromagnetic surveys which show the Triassic sediments as "lows" compared to the surrounding igneous-metamorphic Piedmont complex. 3

Based on what are believed to be similar Triassic basin occurrences in the Piedmont area and on the steep magnetic gradient delineating the northwest and southeast edges of the basin, it is assumed that at least these sides are bounded by faults and that the Triassic sediments have been preserved in a down-dropped graben within the basement rock. 3

2.5.1.3.2 Stratigraphy

The stratigraphy applicable to the Savannah River basin area is summarized in table 2.5-1. Igneous and metamorphic rocks varying in age from Precambrian to Paleozoic form the lowest unit believed to be present at the site.

This material was not encountered during drilling or indicated by the deep refraction seismic work, but is known to form the true basement material by direct or inferred means throughout the Georgia-South Carolina area.

Deposition of continental sediments during the Triassic is known to have occurred from samples obtained from drilling through the coastal province. Much of this material was eroded during the post-Triassic, pre-Cretaceous time, but local basins containing Triassic sediments were preserved beneath the peneplain surface formed. Aerial magnetic surveys in the past decade have disclosed that one of these Triassic basins extends from beneath the Atomic Energy Commission's Savannah River Project (SRP) in South Carolina to several miles beyond the site of the Vogtle Nuclear Plant in Georgia. On the SRP, the basin was confirmed by seismic reflection studies and deep core holes. The deposits consist of siltstone, claystones, and sandstones resembling those of the typical Newark Group fanglomerates of the Upper Triassic period. Measurements made at the Vogtle site indicate that a material with refraction velocity of 12,000 feet per second exists at approximately 950 feet below the plant site, which agrees with the Triassic basin sediment data.

Overlying the peneplained surface of the Precambrian-Triassic basement complex is the nonmarine Tuscaloosa Formation. This formation is composed largely of detritus derived from the weathered granitic-metamorphic basement rocks and contains considerable coarse-grained quartz, partially altered feldspar, and mica (generally of the muscovite variety). In gross appearance, it consists of light-gray to light-brown to white, cross-bedded, arkosic to quartzitic sands and gravels interbedded with lenses of silt and clay, of red, white, brown, or purple color. The variegated clays are generally of relatively pure kaolin and are mined extensively in the vicinity of the Fall Line.

Overlying the Lower Cretaceous Tuscaloosa Formation is the Ellenton Formation, which occurs sporadically and locally within the Savannah River basin, but occurs consistently in the plant site area. Originally described by Siple in his work on the SRP, it is believed to be of Upper Cretaceous age. The Ellenton Formation consists of dark-gray to black, sandy, lignitic, micaceous clay interbedded with medium to coarse-grained quartz sand in its type area. The lower part of the Ellenton Formation is composed generally of a clayey quartz sand varying in texture from medium to coarse-grained, becoming locally gravelly. Decomposed pyrite or marcasite fragments, lignite, muscovite, and kaolinitic aggregates are quite common. The Ellenton Formation is distinguished from the Tuscaloosa Formation by the latter's marked preponderence of muscovite and kaolin as compared to that in the Ellenton Formation.

Above the Ellenton Formation are the Tertiary deposits of the Eocene through Miocene periods. The lowest of these is the at least post-Claiborne sediments. Although the second possibility, seismic activity, is a likely causative force, it also seems probable that the dike itself was formed both by means of infilling, at an equal pace, of overlying material and by the mechanism included in hypothesis 3. So far as is known, there is no material present now in a stratigraphically higher position in the geologic section and similar in composition to the fracture fill that conceivably might have worked down into the fissure as it was being formed. There is, however, greenish-gray clay in the Hawthorne Formation at downdip localities that could have been present in this area in the geologic past and would be a likely source for such filling. There is also similar clay stratigraphically lower in the geologic section - a fact which suggests that possibly some dikes were injected up through the younger Tertiary rocks. Conceivably this injection may have been brought about by the failure of underlying beds to support compressional stresses. Under such conditions the weight of the overlying material would cause a failure in the substructure brought about by ground water solution of the underlying calcareous beds. When these beds could no longer support the overlying formations, fractures would develop as the superstructure collapsed, and clastic material below would migrate up into the fractures. Some corroborative evidence for such an origin is indicated by the large number of solution sinks in the vicinity of the dikes, as for example, in the northeastern quarter of the Ellenton quadrangle. Conversely, dike swarms are indigenous to those areas exhibiting other features of solution and collapse." 3

The Quarternary appears largely represented by the flood plain deposits and valley fill associated with the rivers and larger streams in the area.

2.5.1.3.3 Structure

The major structural trend affecting the Georgia-South Carolina region along the southern portion is the pre-Mesozoic Appalachian system. Tectonic activity had ceased on this system before the deposition of the Cretaceous sediments in the Savannah River valley area, as is evidenced by the lack of tectonic folding or documented fault offsets in the sediments. Faulting, perhaps of major proportions, appears to have occurred in the basement complex during the pre-Cretaceous, however, to account for the down-warped or down-faulted segments of Triassic sediments found preserved within the basement complex throughout much of the Atlantic Coastal Plain.

The coastal plain sediments indicate the Savannah River basin has remained remarkably stable throughout Upper Mesozoic and to 90 feet (±) in Holes 38 and 156, are stratigraphically part of the Oligocene. This is true, also, for the shell bearing horizon in Hole 45 on the SRP.

2.5.1.4.3 Structure

The geologic structure in this area is best illustrated by figure 2.5-10 showing the contours on the top of the bearing stratum. Although the surface of this marl bed is believed to be a formational contact, the contours indicate only a minimum amount of differential erosion. The contours were derived from outcrop and drill hole information and indicate a general dip to the south and east of about 30 feet to the mile throughout the plant site area. The general dip is interrupted on the northeast by a gentle dip to a maximum slope of five percent (3 degrees) to the northwest, and lowers the reversal of the surface of the bearing stratum approximately 50 feet in that direction.

The dip reversal is seen with a 20 to 1 vertical exaggeration on section B-B' of figure 2.5-6. The trend of the axis is approximately northeast-southwest. It is an anomaly that has been the subject of much investigation and discussions. Numerous holes were drilled to determine its character, and water pressure tests were made to determine if it affected the watertightness of the bearing stratum. No indication that it was a fault controlled feature was found during the extensive investigations. It does not appear to be an erosional feature on the top of the unit as it is reflected in both the top and bottom of the bearing stratum to an approximately equal extent. It dips in the wrong direction to reflect possible near-surface 3
expression of the underlying Triassic basin boundaries. No relationship to the assumed boundary fault contact at the northern edge of the Triassic basin could be found. As the assumed northern Triassic basin boundary fault would have to be down-thrown towards the sea, the fact that the flexure in the bearing horizon slopes in the opposite direction, i.e., to the northwest, seems to negate any genetic relationship. It appears to have been formed previous to and in part possibly during the deposition of the thick shell deposits that roughly coincide with the reversal, as may be seen on figure 2.5-10A. A local, well developed, striated bedding plane was found in one hole (No. 246) at the base of the marl. This is near the southwestern or lower side of the anomaly and well away from the plant area. Water losses were also noted related to jointing in the upper 15 feet of the marl during some exploratory drilling investigating this feature. These phenomena were not observed elsewhere throughout the plant site investigation. It is believed that the reversal represents

deposition on an erosional irregularity on the underlying sands, with the possibility of some local differential compaction during or shortly after deposition of the bearing stratum.

Solution depressions are readily apparent on the topographic map of the site and, as the site explorations shown on figure 2.5-1 indicate, they were the subject of considerable

The map divides the coterminous United States into the following four zones:

Areas where there is thought to be no reasonable expectancy of earthquake damage - Zone 0

Areas of expected minor damage - Zone 1

Areas where moderate damage could be expected - Zone 2.

Areas where major destructive earthquakes may occur - Zone 3

The site lies inside Zone 2 where moderate damage could be expected. According to this map, moderate damage corresponds to intensity VII on the Modified Mercalli Scale.

The zones are based principally on the known distribution of damaging earthquakes, their intensities and geological considerations. Since the Charleston earthquake of August 31, 1886 resulted in the greatest intensities in this part of the country, the zones there will be based on data from this shock. The Dutton isoseismal map most probably forms the basis for the zones in this area; therefore, since the Dutton map included the site in the VII (MM) area, it appears in this zone of the risk map even though the site may never have experienced an intensity this high in historic times.

The high seismic response zone enclosed by the 8-1/2 (Rossi-Forel) isoseismal line shown on figure 2.5-26 has been discussed by C. E. Dutton in "The Charleston Earthquake" (USGS 9th Annual Report, 1887-88).

"......The shocks at Columbia, South Carolina, judging from all accounts, were more forcible than at Savannah. The first two impulses, which appear to have corresponded to the two maxima already described at Charleston, threw the whole city into a state of terror. The swaying of buildings was very great; the jarring, like that of a wagon rumbling over a stony pavement, was excessive, shaking down plaster, chandeliers, crockery and light objects, and producing a loud rattle, which, added to the subterranean roaring, caused the greatest consternation....... Still no instances have been reported of the demolition of any buildings. 3

The most remarkable circumstance, however, connected with Columbia is the fact that a considerably greater intensity is indicated for that city than for the localities to the southeast of it nearer to the centrum. There is, indeed, a belt of country along the Piedmont region where the same state

Throughout the State of North Carolina the vigor of the shocks was very great........ There is, however, a notable difference as a general rule between the eastern part of the State within the coastal region and the Piedmont and mountain region. It was notably less forcible in the coastal plain........ There are many indications that the vast masses of littoral deposits of unconsolidated sands, clays, and marls along the Atlantic border and coastal plain, especially in the Carolinas, greatly tempered and modified the force of the earthquake. It may be said that they 'cushioned' the shocks, not elastically, but by actually dissipating in some measure portions of the rays of energy which here affected the surface........" 3

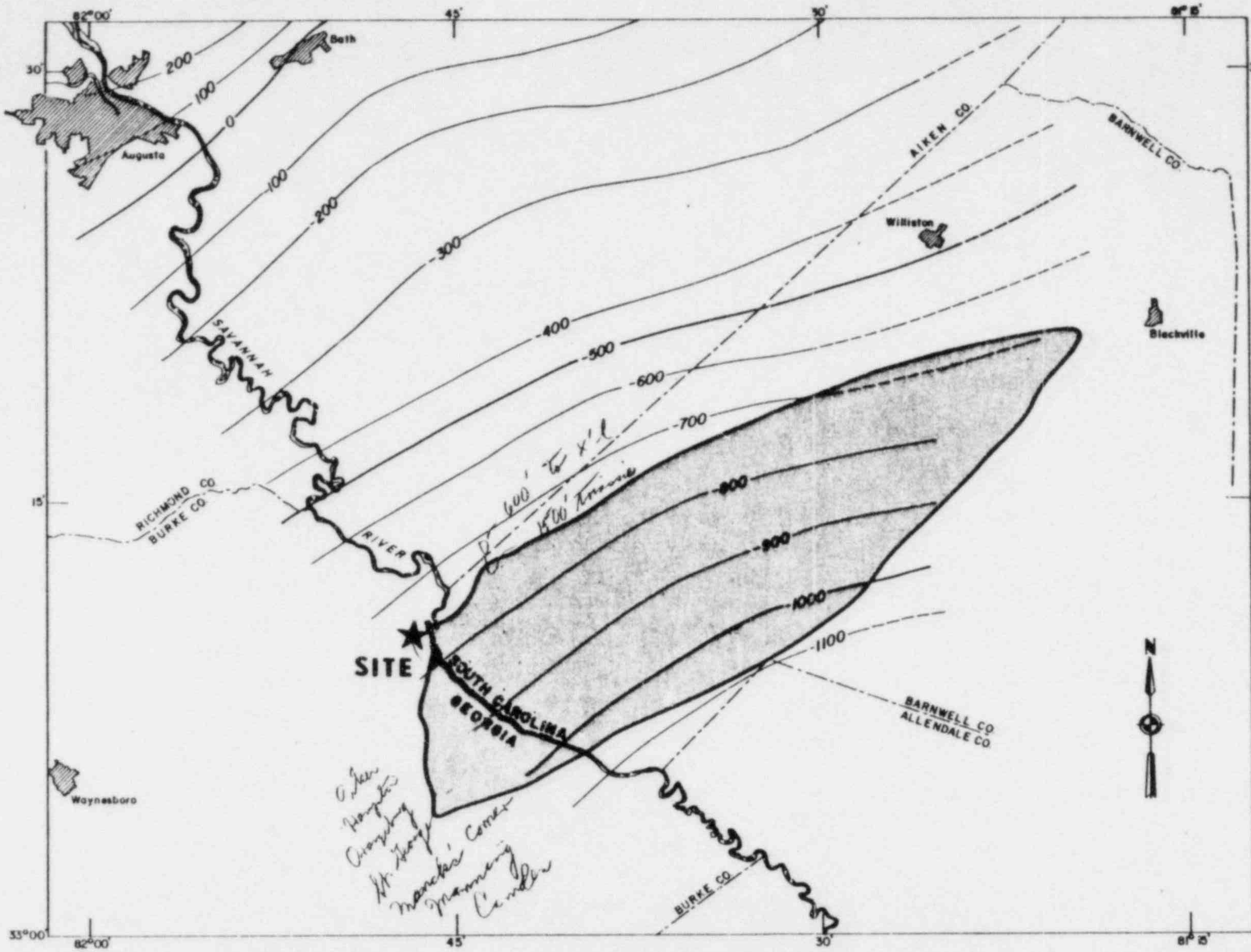
2.5.2.11 Earthquake Frequency

Table 2.5-10 shows earthquake frequency in the vicinity of the Vogtle site. It is based on actual data from the historic earthquake record of about 300 years, and shows the shocks which were felt in the site area.

2.5.2.12 Summary and Conclusions

The first historical quake felt in the eastern United States is listed as occurring in Canada in 1663, so there is an historical earthquake record of 300 years for the southeastern United States. This area of the country experiences moderate to low earthquake activity with the exception of the Charleston area. The greatest intensity experienced at the site resulted from the August 31, 1886, Charleston earthquake about 104 miles east of the site. Considering the reports from nearby towns, the intensity at the site was no greater than a VII.

The great New Madrid, Mo. 1811-1812 shocks were also felt at the site, but with no greater intensity than VI (MM). Other distant and nearby shocks, however, have been barely felt at the site, probably with no greater intensity than IV.



EXPLANATION

——-100-—— Structure contour Dashed where approximate; contour interval 100 feet; Datum is mean sea level.

▬▬ Boundary of Triassic basin inferred from aeromagnetic anomalies.

REFERENCE

Geology and Ground Water of the Savannah River Plant and Vicinity, by George E. Siple Geological Survey Water-Supply Paper 1841.

0 4 8

SCALE IN MILES

ALVIN W. VOGTLE NUCLEAR PLANT UNITS 1, 2, 3 & 4
TRIASSIC BASIN
FIGURE 2.5-4A.

7/6/73 Amendment 3

~~H-1-G...~~

DRAFT 11-2- I con... to Ina

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MEMORANDUM FOR: Ina B. Alterman, Geologist
Geology Section, GSB, DE

FROM: Phyllis A. Sobel, Seismologist
Seismology Section, GSB, DE

SUBJECT: SEISMOLOGY REVIEW OF BECHTEL REPORT, "STUDIES OF POSTULATED MILLETT FAULT"

I have reviewed the seismicity information in the Bechtel report on the Millett Fault prepared for the Vogtle applicant. The available seismicity information includes (1) felt earthquakes, (2) recent instrumentally located events, and (3) data from the Savannah River plant array, just across the Savannah River from the Vogtle site. The applicant concludes, and I agree, that historic seismicity reveals no evidence of active faulting in the area. The seismicity near the site has been scattered and low level (maximum MM intensity VI). No clustering of earthquakes is occurring near the postulated Millett or Statesboro faults.

Phyllis Sobel, Seismologist
Seismology Section
Geosciences Branch

cc: R. Jackson
L. Reiter
S. Brocoum
P. Sobel
A. K. Ibrahim