Progress Energy

Serial: NPD-NRC-2009-014
February 6, 2009

10CFR52.79

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555-0001

SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 2 AND 3
DOCKET NOS. 52-022 AND 52-023
SUPPLEMENT 2 TO RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 018 RELATED TO VIBRATORY GROUND MOTION

References: Letter from Manny Comar (NRC) to James Scarola (PEC), dated September 25, 2008, "Request for Additional Information Letter No. 018 Related to SRP Section 02.05.02 for the Harris Units 2 and 3 Combined License Application"

Letter from Garry D. Miller (PEC) to U.S. Nuclear Regulatory Commission (NRC), dated December 9, 2008, "Response to Request for Additional Information Letter No. 018 Related to Vibratory Ground Motion", Serial: NPD-NRC-2008-049

Letter from Garry D. Miller (PEC) to U.S. Nuclear Regulatory Commission (NRC), dated January 8, 2009, "Supplement 1 to Response to Request for Additional Information Letter No. 018 Related to Vibratory Ground Motion", Serial: NPD-NRC-2009-002

Ladies and Gentlemen:

Progress Energy Carolinas, Inc. (PEC) hereby submits a response to the Nuclear Regulatory Commission's (NRC) request for additional information provided in the referenced letter.

A partial response to the NRC request is provided in Enclosure 1. Two previous submittals were provided by letters dated December 9, 2008 and January 8, 2009. This letter completes our response to the referenced NRC request for additional information. Enclosure 1 also identifies changes that will be made in a future revision of the Shearon Harris Nuclear Power Plant Units 2 and 3 (HAR) application.

If you have any further questions, or need additional information, please contact Bob Kitchen at (919) 546-6992, or me at (919) 546-6107.

Progress Energy Carolinas, Inc.
P.O. Box 1551
Raleigh, NC 27602

D084
NRO

I declare under penalty of perjury that the foregoing is true and correct.

Executed on February 6, 2009.

Sincerely,

Garry D. Miller
General Manager
Nuclear Plant Development

Enclosures/Attachments

cc: U.S. NRC Director, Office of New Reactors/NRLPO
U.S. NRC Office of Nuclear Reactor Regulation/NRLPO
U.S. NRC Region II, Regional Administrator
U.S. NRC Resident Inspector, SHNPP Unit 1
Mr. Manny Comar, U.S. NRC Project Manager

Shearon Harris Nuclear Power Plant Units 2 and 3
Supplement 2 to Response to NRC Request for Additional Information Letter No. 018
Related to SRP Section 02.05.02 for the Combined License Application,
dated September 25, 2008

NRC RAI #	Progress Energy RAI #	Progress Energy Response
02.05.02-1	H-0097	January 8, 2009; NPD-NRC-2009-002
02.05.02-2	H-0098	January 8, 2009; NPD-NRC-2009-002
02.05.02-3	H-0099	January 8, 2009; NPD-NRC-2009-002
02.05.02-4	H-0100	January 8, 2009; NPD-NRC-2009-002
02.05.02-5	H-0101	December 9, 2008; NPD-NRC-2008-049
02.05.02-6	H-0102	January 8, 2009; NPD-NRC-2009-002
02.05.02-7	H-0103	Response enclosed – see following pages
02.05.02-8	H-0104	December 9, 2008; NPD-NRC-2008-049
02.05.02-9	H-0105	January 8, 2009; NPD-NRC-2009-002
02.05.02-10	H-0106	Response enclosed – see following pages
02.05.02-11	H-0107	January 8, 2009; NPD-NRC-2009-002
02.05.02-12	H-0108	Response enclosed – see following pages
02.05.02-13	H-0109	December 9, 2008; NPD-NRC-2008-049
02.05.02-14	H-0110	January 8, 2009; NPD-NRC-2009-002
02.05.02-15	H-0111	January 8, 2009; NPD-NRC-2009-002
02.05.02-16	H-0112	December 9, 2008; NPD-NRC-2008-049
02.05.02-17	H-0113	December 9, 2008; NPD-NRC-2008-049
02.05.02-18	H-0114	December 9, 2008; NPD-NRC-2008-049

Attachments/Enclosures	Associated NRC RAI #	Pages Included
Revised Figure 2.5.1-240	02.05.02-7	1 page
RAI 02.05.02-7 Figure 1	02.05.02-7	1 page
RAI 02.05.02-7 Figure 2	02.05.02-7	1 page
RAI 02.05.02-7 Figure 3	02.05.02-7	1 page
RAI 02.05.02-7 Figure 4	02.05.02-7	1 page
RAI 02.05.02-7 Figure 5	02.05.02-7	1 page
RAI 02.05.02-7 Figure 6	02.05.02-7	1 page
RAI 02.05.02-7 Figure 7	02.05.02-7	1 page
RAI 02.05.02-7 Figure 8	02.05.02-7	1 page
RAI 02.05.02-7 Figure 9	02.05.02-7	1 page
RAI 02.05.02-7 Figure 10	02.05.02-7	1 page
RAI 02.05.02-7 Figure 11	02.05.02-7	1 page
RAI 02.05.02-7 Figure 12	02.05.02-7	1 page
RAI 02.05.02-10 Figure 1	02.05.02-10	1 page

NRC Letter No.: HAR-RAI-LTR-018

NRC Letter Date: September 25, 2008

NRC Review of Final Safety Analysis Report

NRC RAI #: 02.05.02-7

Text of NRC RAI:

In Section 2.5.2.5 you indicated that "Based on the seismic reflection data shown on Figure 2.5.1-241, the estimated thickness of the Triassic sediments at the HAR site is 1524 m (5000ft.)". Please explain how this depth was calculated.

PGN RAI ID #: H-0103

PGN Response to NRC RAI:

The estimated thickness of the Triassic sedimentary rock in the Durham basin in the vicinity of the HAR site is based on analysis of resistivity (electrical sounding) data cross checked against gravity, magnetic, and site specific well data as described by Bain and Harvey (Reference RAI 02.05.02-7 01) and Bain and Brown (Reference RAI 02.05.02-7 02). FSAR Figure 2.5.1-240 shows profiles of basin depths based on resistivity data (also referred to as electrical sections) rather than FSAR Figure 2.5.1-241 as stated in Subsection 2.5.2.5.

Bain and Brown (Reference RAI 02.05.02-7 02) cite the following observations to indicate that the estimated depth to basement as shown on the interpretation of the resistivity data is correct:

1. A basement depth interpreted from an electrical sounding near to the Groce No. 1 well near Sanford compared within 4 percent with the basement depth encountered in this well.
2. The interpretation of an electrical sounding at the site of the Sears No. 1 well predicted a basement depth of 1350 m (4428 ft.), and the well was completed in Triassic sedimentary rock at a depth of 1142 m (3746 ft.) indicating basement was at least greater than 1142 m (3746 ft.) at that location.
3. The known location and sense of displacement of the Bonsal-Morrisville fault was correctly shown by the profile A-A' (revised FSAR Figure 2.5.1-240).
4. The eastern limit of the Triassic basin along both sections A-A' and B-B' agrees with known locations of the Jonesboro fault.
5. The depths on the electrical sections agree with the estimates obtained from aeromagnetic, gravity, and seismic data.

Analysis of gravity data provided another check on the configuration of the basement surface and depth of Triassic sedimentary rock in the Durham basin. A detailed Bouguer gravity map of the entire basin, which is based on data from over 1800 stations in the basin (spacing of about 2 km), is shown on RAI 02.05.02-7 Figure 1. RAI 02.05.02-7 Figure 2 shows a close-up of the same data within the site area. Bain and Harvey (Reference RAI 02.05.02-7 01) and Bain and Brown (Reference RAI 02.05.02-7 02) graphically removed the regional gravity gradient from selected sections to determine the thickness and general geometry of the Triassic sedimentary deposits. Two of these sections, A-A' and H-H', are shown in RAI 02.05.02-7 Figure 3. Depth to basement at the Sears No. 1 well (also referred to as the New Hill well site) is estimated from

the residual anomaly profile to be 1390 m (4560 ft.) and at the deepest point along the profile to be 1695 m (5560 ft.) Revised FSAR Figure 2.5.1-240 shows approximate depth to basement along resistivity profiles A-A' and B-B', which are modified from Figures 20 and 21 of Bain and Brown (Reference RAI 02.05.02-7 02), shown in RAI 02.05.02-7 Figures 4 and 5. The location of the profiles is shown in FSAR Figure 2.5.1-239.

The general gravity contours for the Durham basin suggest that the depth to basement below the HAR site, which lies approximately 5 km (3 mi.) west of gravity profile A-A', will be shallower than the deepest part of the basin as indicated on RAI 02.05.02-7 Figures 2 and 3. A thickness of 1525 m (5000 ft.), intermediate between the estimated depth to basement at the Sears No. 1 well and the deepest part of the basin, therefore was used to estimate the thickness at the HAR site. The site response analyses addressed uncertainty in the depth to hard rock by randomizing the elevation of the base of the site response model over the range – 1525 (5000 ft.) ± 91 m (300 ft.).

Additional gravity data for the region was obtained from the University of Texas at El Paso (GEONET) (Reference RAI 02.05.02-7 03) while preparing this response to the RAI. The GEONET gravity data is a compilation from multiple sources as described in USGS Open File Report 02-463 (Reference RAI 02.05.02-7 04). RAI 02.05.02-7 Figure 6 shows a contour map of the new GEONET data.

Three gravity cross-sections, shown on RAI 02.05.02-7 Figure 6, were extracted from the new GEONET data such that basin depths could be calculated using the methodology of Bain and Brown (Reference RAI 02.05.02-7 02). Gravity profiles were constructed through the Sears No. 1 Well (Profile GMX-1, shown on RAI 02.05.02-7 Figure 7), the Groce No. 1 Well (Profile GMX-2, shown on RAI 02.05.02-7 Figure 8) and through the HAR Site (Profile GMX-3, shown on RAI 02.05.02-7 Figure 9).

Profile GMX-1(RAI 02.05.02-7 Figure 7) through the Sears No. 1 Well agreed within 6% in depth with the Bain and Brown Profile H-H' (Figure RAI 2.5.2-07 Figure 3) constructed across the basin through the same well. Bain and Brown (Reference RAI 02.05.02-7 02) calculated that the basin depth at the New Hill Well (Sears No. 1 Well) was 1463 m (4800 ft.) and the calculated depth based on the new GEONET gravity data is 1549 m (5082 ft.).

Profile GMX-2 (RAI 02.05.02-7 Figure 8) through the Groce No. 1 Well agreed within 15% in basin depth with the Bain and Brown (Reference RAI 02.05.02-7 02) reported basin depth encountered in the Groce No. 1 Well. Bain and Brown reported that Groce No. 1 encountered basement at a depth of 1555 m (5100 ft.) and the calculated basin depth based on the new GEONET gravity is 1784 m (5750 ft.).

Profile GMX-3 (RAI 02.05.02-7 Figure 9) was constructed through the HAR Site. The calculated basin depth using the new GEONET gravity data is 1206 m (3956 ft.), approximately 305 m (1000 ft.) shallower than the estimate used in the site response calculations. Whether or not this new calculated depth represents a more accurate refinement is questionable. The GEONET data is a compilation of data from multiple sources presumably with varying quality and accuracy. The Bain and Brown (Reference RAI 02.05.02-7 02) gravity data and their integrated approach to basin evaluation may represent a more accurate characterization of bedrock depth.

The implication of a possible shallower depth was investigated by performing a site response sensitivity analysis. Randomized site profiles were developed by removing the bottom 305 m (1000 ft.) from the GMRS profiles HAR 2, HAR 3a, and HAR 3b. Site response calculations were performed using the 10^{-4} high frequency (HF) and low frequency (LF) deaggregation earthquake (DE) spectra for the median kappa value and the Peninsula Ranges set of modulus

reduction and damping relationships. Figures RAI 02.05.02-7 Figure 10, RAI 02.05.02-7 Figure 11, and RAI 02.05.02-7 Figure 12 compare the mean amplification functions computed for the average 1220 m (4000 ft.) depth cases versus mean amplification functions computed for a 1525 m (5000 ft.) average depth using the same kappa and modulus reduction and damping relationships. In general, the differences in the amplification functions are about 1 percent for frequencies above 2 Hz. Larger differences occur at frequencies below 2 Hz due to a shift in the fundamental modes of the profiles resulting in smaller total depth. These shifts occur in the region where the amplification functions for the 5000 ft case were conservatively smoothed. As a result, differences in a smoothed amplification function are likely to be less. These results indicate that a possible shallower depth of approximately 1220 m (4000 ft.) would not have a significant effect on the site GMRS and FIRS.

References:

Reference RAI 02.05.02-7 01

Bain, G.L., and B.W. Harvey, "Field guide to the Geology of the Durham Triassic Basin", Carolina Geological Society Guidebook, Fortieth Anniversary Meeting, 83 pp., 1977.

Reference RAI 02.05.02-7 02

Bain, G.L., and C.E. Brown, "Evaluation of the Durham Triassic Basin of North Carolina and Technique Used to Characterize Its Waste-Storage Potential," U.S. Geological Survey Open-File Report 80-1295, pp. 1 – 32, 1981.

Reference RAI 02.05.02-7 03

Pan American Center for Earth and Environmental Sciences (PACES), 2008, GeoNet Gravity and Magnetic Dataset Repository, http://irpsrvgis00.utep.edu/repositorywebsite/Default.aspx, accessed on November 14, 2008

Reference RAI 02.05.02-7 04

Hildenbrand, Thomas G.; Briesacher, Allen; Flanagan, Guy; Hinze, William J.; Hittelman, A. M.; Keller, G. R.; Kucks, R. P.; Plouff, Donald; Roest, Walter; Seeley, John; Smith, D. A.; Webring, Mike, Rationale and operational plan to upgrade the U.S. gravity database, U.S. Geological Survey Open-File-Report 02-463.

Associated HAR COL Application Revisions:

The following changes will be made to HAR FSAR Chapter 2 in a future amendment:

1. Revise paragraph 1 of FSAR Section 2.5.2.5 from:

   "The uniform hazard response spectra shown on Figure 2.5.2-242 represent ground motions occurring on generic CEUS hard rock conditions. As described in Subsection 2.5.4.1, the subsurface conditions at the HAR site consists of 1.5 to 7.6 m (5 to 25 ft.) of residual soils overlying Triassic sedimentary rock. The upper portion of the sedimentary rock is weathered. These rocks are the upper layers of the Triassic sediments that fill the Deep River basin. Based on the seismic reflection section shown on Figure 2.5.1-241, the estimated thickness of the Triassic sediments at the HAR site is 1524 m (5000 ft.)"

To read:

"The uniform hazard response spectra shown on Figure 2.5.2-242 represent ground motions occurring on generic CEUS hard rock conditions. As described in Subsection 2.5.4.1, the subsurface conditions at the HAR site consists of 1.5 to 7.6 m (5 to 25 ft.) of residual soils overlying Triassic sedimentary rock. The upper portion of the sedimentary rock is weathered. These rocks are the upper layers of the Triassic sediments that fill the Deep River basin. Based on the interpreted depth to basement inferred from resistivity data shown on Figure 2.5.1-240, the estimated thickness of the Triassic sediments at the HAR site is 1524 m (5000 ft.)

2. Revise note on FSAR Figure 2.5.1-240 from:

   "Source: Bain and Brown (1981)"

   To read:

   "Modified from Bain and Brown (1981)"

Attachments/Enclosures:

Attachment 02.05.02-7A:	Revised Figure 2.5.1-240 Durham Basin and Sanford Basin Profiles Showing Depth of Triassic Sediments Based on Resistivity Data
Attachment 02.05.02-7B	RAI 02.05.02-7 Figure 1 Bouguer Gravity Map of the Durham Basin
Attachment 02.05.02-7C	RAI 02.05.02-7 Figure 2 Bouguer Gravity Map of the Site Area
Attachment 02.05.02-7D	RAI 02.05.02-7 Figure 3 Bouguer Gravity and Resistivity Profiles A-A' and H-H'
Attachment 02.05.02-7E	RAI 02.05.02-7 Figure 4 Geophysical profiles and resistivity section A-A', Durham subbasin
Attachment 02.05.02-7F	RAI 02.05.02-7 Figure 5 Geo-electrical section for resistivity line B-B', Sanford subbasin
Attachment 02.05.02-7G	RAI 02.05.02-7 Figure 6 GeoNet Bouguer Gravity Map of the Durham Basin
Attachment 02.05.02-7H	RAI 02.05.02-7 Figure 7 Gravity Profile GMX-1
Attachment 02.05.02-7I	RAI 02.05.02-7 Figure 8 Gravity Profile GMX-2
Attachment 02.05.02-7J	RAI 02.05.02-7 Figure 9 Gravity Profile GMX-3
Attachment 02.05.02-7K	RAI 02.05.02-7 Figure 10 Average Depth Sensitivity Analysis for the HAR 2 GMRS Profile.
Attachment 02.05.02-7L	RAI 02.05.02-7 Figure 11 Average Depth Sensitivity Analysis for the HAR 3a GMRS Profile
Attachment 02.05.02M:	RAI 02.05.02-7 Figure 12 Average Depth Sensitivity Analysis for the HAR 3b GMRS Profile

NRC Letter No.: HAR-NRC-LTR-018

NRC Letter Date: September 25, 2008

NRC Review of Final Safety Analysis Report

NRC RAI #: 02.05.02-10

Text of NRC RAI:

In Section 2.5.2.4.2.1, you showed that while there is a good overall agreement with the EPRI ground motion models and the updated Atkinson and Boore (2006) model (Figure 2.5.2-221), the updated Atkinson and Boore (2006) model spectral acceleration values are about 35-40% higher at distances of about 300 kilometers compared to the mean EPRI ground motion predictions. Since this is the approximate distance to the Charleston source area and given the large contribution of the Charleston source to the seismic hazard at the Harris site, please discuss the impact of not using the updated Atkinson and Boore (2006) model on the hazard curves.

PGN RAI ID #: H-0106

PGN Response to NRC RAI:

The EPRI (Reference 2.5.2-248) ground motion model for the CEUS incorporated the previous version of the Atkinson and Boore CEUS ground motion model (Reference 2.5.2-241) into the characterization of ground motion models for assessing seismic hazards. The impact of using the updated Atkinson and Boore model (Reference 2.5.2-251) on the EPRI (Reference 2.5.2-248) ground motion model is difficult to quantify without repeating the process. However, a qualitative assessment can be made by computing the hazard at the HAR site from the Charleston source using the two Atkinson and Boore ground motion models.

RAI 02.05.02-10 Figure 1 shows hazard results for 1-Hz spectral acceleration from the Charleston source of repeated large earthquakes. These hazard results were computed using the alternative aleatory models defined by EPRI (Reference 2.5.2-252). The plot on the left shows the hazard results for hard rock conditions computed using a minimum magnitude of 5.0. The updated Atkinson and Boore ground motion model (Reference 2.5.2-251) produces slightly higher hazard than the previous model (Reference 2.5.2-241). The plot on the right shows the hazard results computed for the HAR 3 site using the CAV model for minimum magnitude. For this case, the updated model produces lower hazard.

From these results, it is concluded that use of the updated Atkinson and Boore ground motion model would produce only a minor change in the hazard results for the HAR site.

Associated HAR COL Application Revisions:

No COLA revisions have been identified associated with this response.

Attachments/Enclosures to Response to NRC:

Attachment 02.05.02-10A: RAI 02.05.02-10 Figure 1

NRC Letter No.: HAR-RAI-LTR-018

NRC Letter Date: September 25, 2008

NRC Review of Final Safety Analysis Report

NRC RAI #: 02.05.02-12

Text of NRC RAI:

Section 2.5.2.5 describes the seismic wave transmission characteristics beneath the HAR site and outlines the geometry of the Deep River basin. As seen from Figures 2.5.1-241, 2.5.4-204, 2.5.4-205 the Deep River basin and the shallow structures beneath the HAR site exhibit strong three dimensional geometries. However, your site response analyses did not take into account the effects of basin geometries and the near-surface three dimensional structures on the seismic wave propagation and amplification. Please provide justification for excluding the three-dimensional nature of the subsurface structure in your site response analysis.

PGN RAI ID #: H-0108

PGN Response to NRC RAI:

There are two aspects to the question regarding the influence of the site three-dimensional geometry on site ground motions. The first relates to the location of the site within a Triassic basin, and the second relates to the variation in near-surface site conditions.

Basin effects on ground motion have been discussed in a number of papers relating to enhancement of low frequency motions in deep sediment-filled basins. Recent papers by Choi et al. (Reference RAI 02.05.02-12 01), Day et al. (Reference RAI 02.05.02-12 02) and Campbell and Bozorgnia (Reference RAI 02.05.02-12 03) provide models for estimating the enhancement of ground motions in basins. Information in these papers suggests that there is minimal potential for basin effects at the HAR site based on the following:

- The basins in the referenced studies are typically multiple kilometers in depth and are filled with young sediments characterized by significantly lower shear wave velocities than the basement rocks. In contrast, the Deep River basin is only about 1.5 km deep or less (see Response to RAI 02.05.02-7) and is filled with older sedimentary rocks with an estimated average shear wave velocity that is only about 30 percent lower than that of the underlying basement rock. This equates to a velocity impedance ratio of about 1.5. The shallow depth and small velocity contrast with the surrounding basement rocks indicate that minimal basin effects would be expected at the HAR site. Analytical studies of ground motions in basins by Bard and Bouchon (Reference RAI 02.05.02-12 04, Reference RAI 02.05.02-12 05, Reference RAI 02.05.02-12 06) show basin effects decreasing with decreasing impedance ratio. Bard and Bouchon (Reference RAI 02.05.02-12 04, Reference RAI 02.05.02-12 05) show that valleys with a low impedance contrast do not tend to produce repeated reflections of large amplitude surface waves. Bard and Bouchon (Reference RAI 02.05.02-12 06) show little amplification due to valley resonance for an impedance ratio of 2.
- The models for estimating ground motion enhancement within basins published by Choi et al. (Reference RAI 02.05.01-10 01) and Day et al. (Reference RAI 02.05.02-12 02) use depth to the 1.5 km/sec shear wave velocity horizon as the predictor variable for basin effects. The 1.5 km/sec velocity horizon is essentially at the surface at the HAR site, indicating that no basin effects will occur following this approach.

- Campbell and Bozorgnia (Reference RAI 02.05.02-12 03) have used the modeling results produced by Day et al. (Reference RAI 02.05.02-12 02) to model basin effects based on the depth to the 2.5 km/sec shear wave velocity horizon. Their model shows no ground motion enhancement for depths in the range of 1 to 3 km. The depth to a shear wave velocity of 2.5 km/sec at the HAR site is estimated to be about 1.5 km, the depth to the base of the Triassic sediments. The shallow depth indicates that minimal basin effects would be expected at the HAR site.

The second factor that could result in three-dimensional site response effects is the variation in near-surface geology. This variation is related to the dip of the rock layers and the depth of weathering within the site as reflected by the shear wave velocity.

- The shallow stratigraphy of the HAR site shows that the rock layers dip at angles of 6 to 23 degrees. However, the rock strata exhibit increasing velocity with increasing depth. The conclusion after review of these data is that the site can be considered a uniform site (see responses to RAI 02.05.04-4 and 02.05.04-5 provided in PEC letter dated November 24, 2008, Serial: NPD-NRC-2008-051).
- The primary difference in near-surface rock velocity across the site is related to the depth of weathering, particularly at HAR 3. This variation was addressed by computing the response for two profiles that represent the different conditions across the HAR 3 site and then enveloping the response to develop the site ground motions. This type of three-dimensional effect has, therefore, been considered in the site response analyses.
- Irregularities in subsurface conditions (e.g. dipping layer boundaries, lateral variation in properties, varying azimuths to the earthquake source) are an important contributor to the variability in observed ground motions, typically represented by the standard deviation in log amplitude predictions for empirical ground motion models. The ground motion hazard at the HAR site is based on a probabilistic seismic hazard analysis that utilizes an empirically-based standard deviation in peak amplitudes, thus these effects are accounted for in the development of the site ground motions.

References:

Reference RAI 02.05.02-12 01

Choi, Y., J.P. Stewart, and R.W. Graves, 2005, Empirical model for basin effects accounts for basin depth and source location, Bulletin of the Seismological Society of America, v. 95, p. 1412–1427.

Reference RAI 02.05.02-12 02

Day, S.M., R. Graves, J. Bielak, D. Dreger, S. Larsen, K.B. Olsen. A. Pitarka, and L. Ramirex-Guzman, 2008, Model for basin effects on long-period response spectra in southern California, Earthquake Spectra, v. 24, p. 257-277.

Reference RAI 02.05.02-12 03

Campbell, K.W., and Y. Bozorgnia, 2008, NGA ground motion model for the geometric mean horizontal component of PGA, PGV, PGD and 5% damped linear elastic response spectra for periods ranging from 0.01 to 10 s, Earthquake Spectra, v. 24, p. 139-171.

Reference RAI 02.05.02-12 04

Bard, P.-Y., and M. Bouchon, 1980a, The seismic response of sediment filled valleys: Part 1, the case of incident *SH* waves, Bulletin of the Seismological Society of America, v. 70, p. 1263-1286.

Reference RAI 02.05.02-12 05

Bard, P.-Y., and M. Bouchon, 1980b, The seismic response of sediment filled valleys: Part 2, the case of incident *P* and *SV* waves, Bulletin of the Seismological Society of America, v. 70, p. 1921-1941.

Reference RAI 02.05.02-12 06

Bard, P.-Y., and M. Bouchon, 1985, The two-dimensional resonance of sediment filled valleys, Bulletin of the Seismological Society of America, v. 75, p. 519-541.

Associated HAR COL Application Revisions:

No COLA revisions have been identified associated with this response.

Attachments/Enclosures:

None.

List of Attachments/Enclosures:

1. NRC RAI # 02.05.02-07 (PGN RAI ID #H-0103):
   Attachment 02.05.02-7A: Revised Figure 2.5.1-240 (1 page)

2. NRC RAI # 02.05.02-7 (PGN RAI ID #H-0103):
   Attachment 02.05.02-7B: RAI 02.05.02-7 Figure 1 (1 page)

3. NRC RAI # 02.05.02-7 (PGN RAI ID #H-0103):
   Attachment 02.05.02-7C: RAI 02.05.02-7 Figure 2 (1 page)

4. NRC RAI # 02.05.02-7 (PGN RAI ID #H-0103):
   Attachment 02.05.02-7D: RAI 02.05.02-7 Figure 3 (1 page)

5. NRC RAI # 02.05.02-7 (PGN RAI ID #H-0103):
   Attachment 02.05.02-7E: RAI 02.05.02-7 Figure 4 (1 page)

6. NRC RAI # 02.05.02-7 (PGN RAI ID #H-0103):
   Attachment 02.05.02-7F: RAI 02.05.02-7 Figure 5 (1 page)

7. NRC RAI # 02.05.02-7 (PGN RAI ID #H-0103):
   Attachment 02.05.02-7G: RAI 02.05.02-7 Figure 6 (1 page)

8. NRC RAI # 02.05.02-7 (PGN RAI ID #H-0103):
   Attachment 02.05.02-7H: RAI 02.05.02-7 Figure 7 (1 page)

9. NRC RAI # 02.05.02-7 (PGN RAI ID #H-0103):
   Attachment 02.05.02-7I: RAI 02.05.02-7 Figure 8 (1 page)

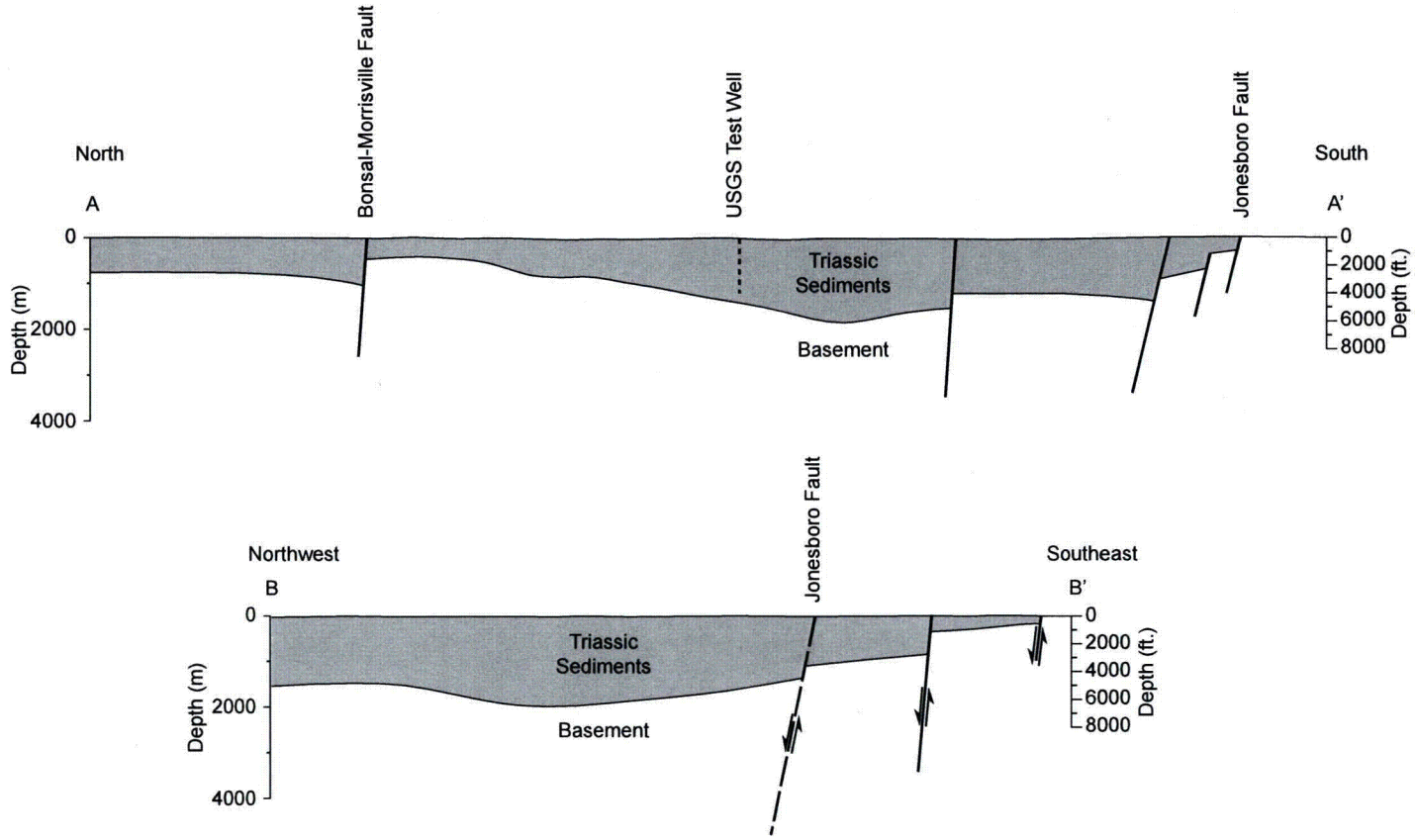
10. NRC RAI # 02.05.02-7 (PGN RAI ID #H-0103):
    Attachment 02.05.02-7J: RAI 02.05.02-7 Figure 9 (1 page)

11. NRC RAI # 02.05.02-7 (PGN RAI ID #H-0103):
    Attachment 02.05.02-7K: RAI 02.05.02-7 Figure 10 (1 page)

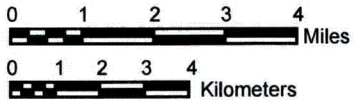
12. NRC RAI # 02.05.02-7 (PGN RAI ID #H-0103):
    Attachment 02.05.02-7L: RAI 02.05.02-7 Figure 11 (1 page)

13. NRC RAI # 02.05.02-7 (PGN RAI ID #H-0103):
    Attachment 02.05.02-7M: RAI 02.05.02-7 Figure 12 (1 page)

14. NRC RAI # 02.05.02-10 (PGN RAI ID #H-0106):
    Attachment 02.05.02-10A: RAI 02.05.02-10 Figure 1 (1 page)



Modified from Bain and Brown (1981)



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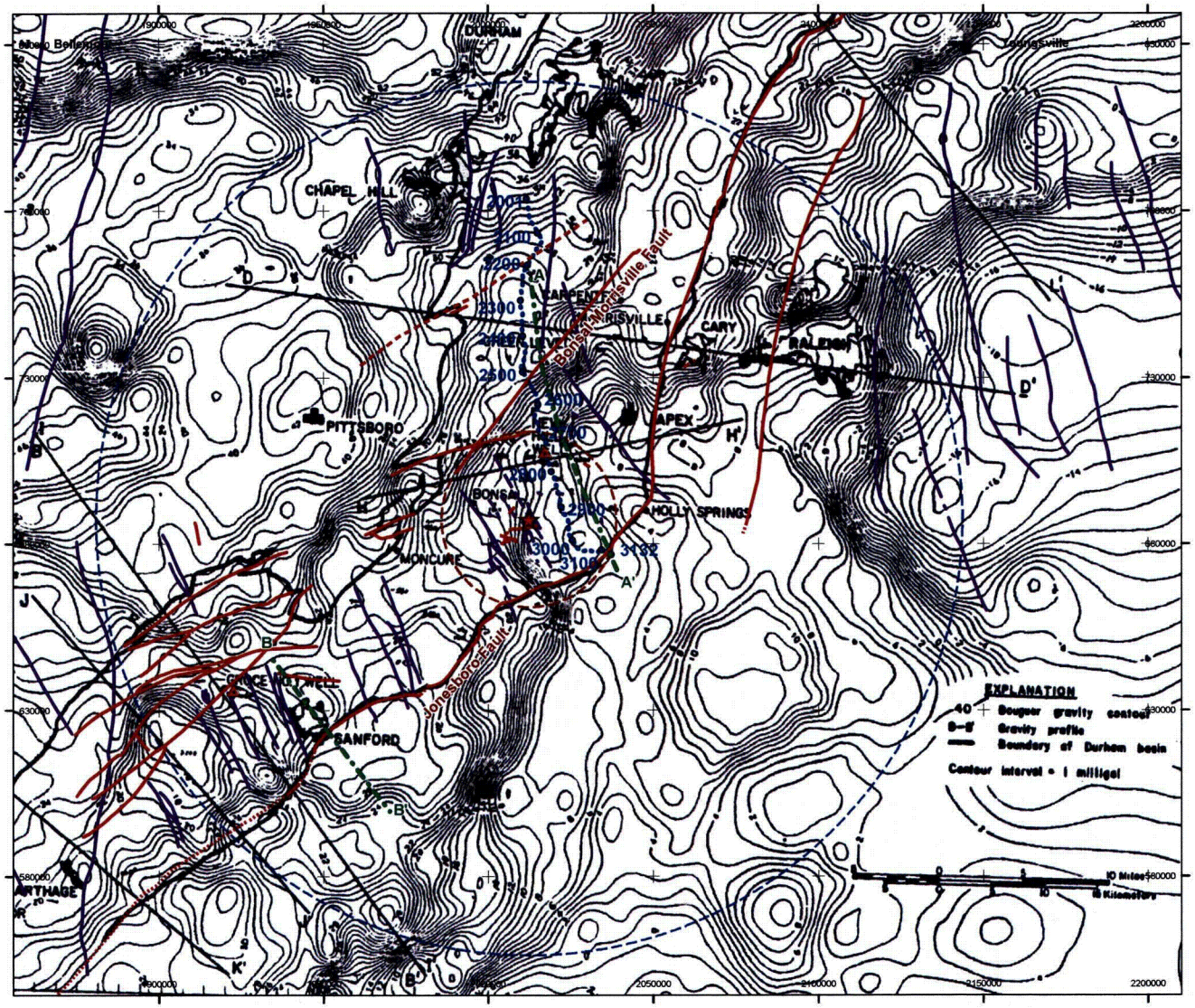
New Hill, North Carolina

Durham Basin and Sanford Basin Profiles
Showing Depth of Triassic Sediments
Based on Resistivity Data
Revised FIGURE 2.5.1-240

Rev. E



N
W E
S

LEGEND

- HAR Site
- Sears No. 1 and Groce No. 1 Wells (Bain and Brown, 1981)
- City or Town
- 8-km (5-mi.) Radius from Site
- 40-km (25-mi.) Radius from Site
- Resistivity Lines (Bain and Brown, 1981)
- Gravity Profiles (Bain and Brown, 1981)
- Seismic Reflection Line 85SD12 (Texaco, 1993)
- 2400 Shot Point Number (Texaco, 1993)
- Faults (dashed where inferred, dotted where concealed) (Ebasco, 1975, CP&L, 1983, NCGS, 1985, Wooten et al., 1996, Harding Lawson, 1997, NCGS, 2006, and this study)
- Dikes (dashed where inferred) (CP&L, 1983, NCGS, 1985, NCGS, 2006, and Technos, this study)

Grid is in the North Carolina NAD 83 State Plane Coordinate System (in feet)

Base Map: Bain and Brown (1981)

0 2.5 5 10 15
Kilometers
0 2.5 5 10
Miles

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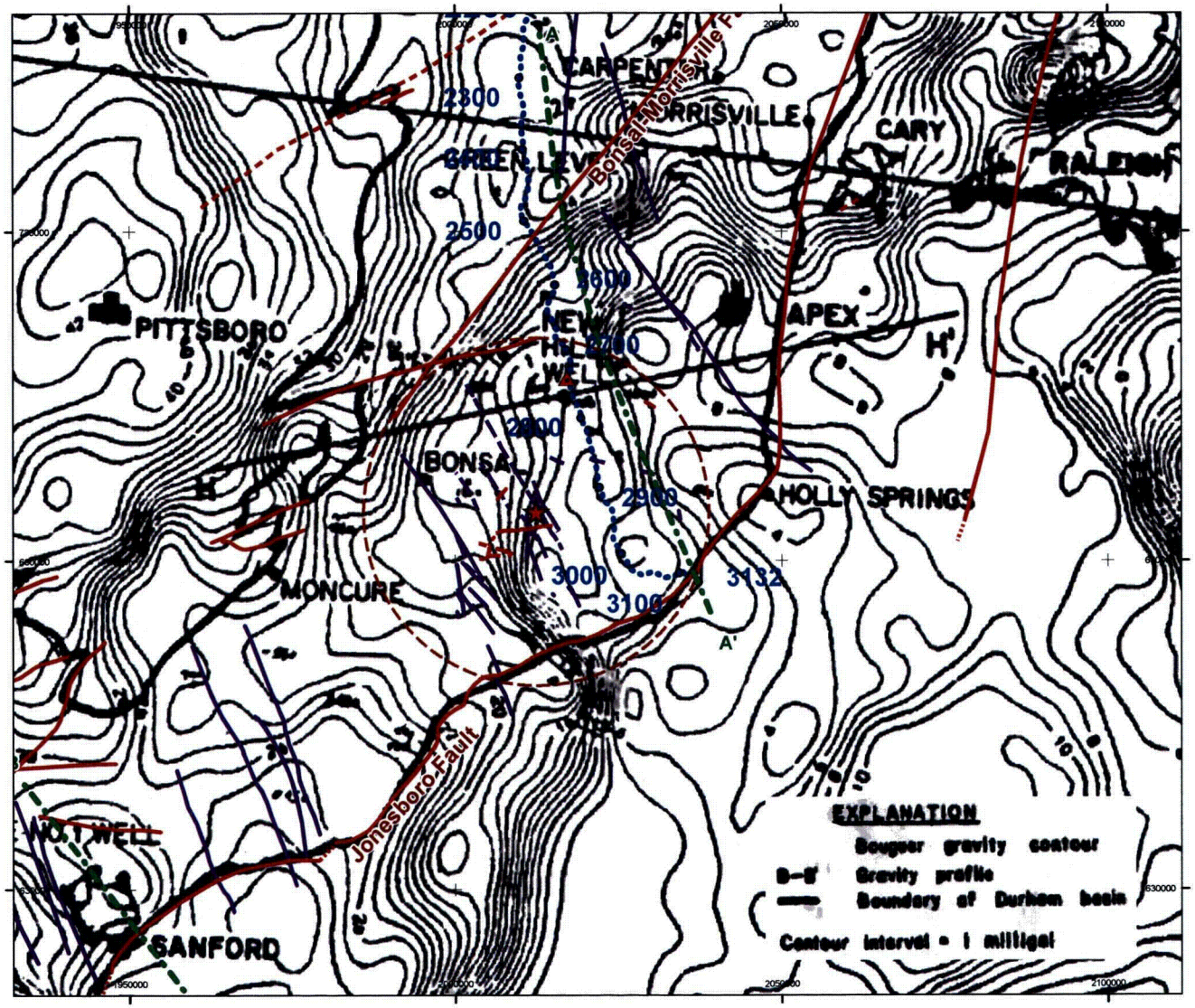
Bouger Gravity Map of the Durham Basin

RAI 2.5.2-07 FIGURE 1

File path: S:\11100\11151.002\Figures\RAI\RAI 02.05.02-07 Figure 1.mxd; Date: [01/26/2009]; User: [sbozkurt]



N
W E
S

LEGEND

- HAR Site
- Sears No. 1 and Groce No. 1 Wells (Bain and Brown, 1981)
- City or Town
- 8-km (5-mi.) Radius from Site
- Resistivity Lines (Bain and Brown, 1981)
- Gravity Profiles (Bain and Brown, 1981)
- Seismic Reflection Line 85SD12 (Texaco, 1993)
- 2400 Shot Point Number (Texaco, 1993)
- Faults (dashed where inferred, dotted where concealed) (Ebasco, 1975, CP&L, 1983, NCGS, 1985, Wooten et al., 1996, Harding Lawson, 1997, NCGS, 2006, and this study)
- Dikes (dashed where inferred) (CP&L, 1983, NCGS, 1985, NCGS, 2006, and Technos, this study)

Grid is in the North Carolina NAD 83 State Plane Coordinate System (in feet)

Base Map: Bain and Brown (1981)

0 1 2 4 6
Kilometers
0 1 2 4
Miles

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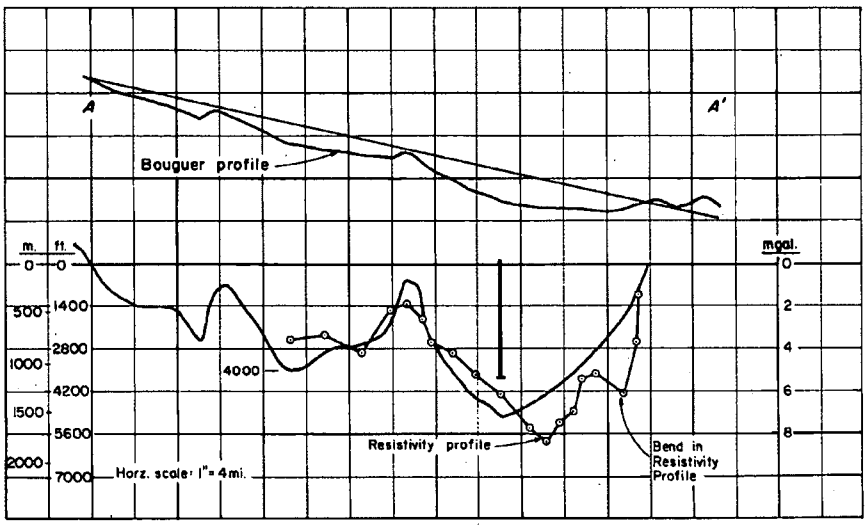
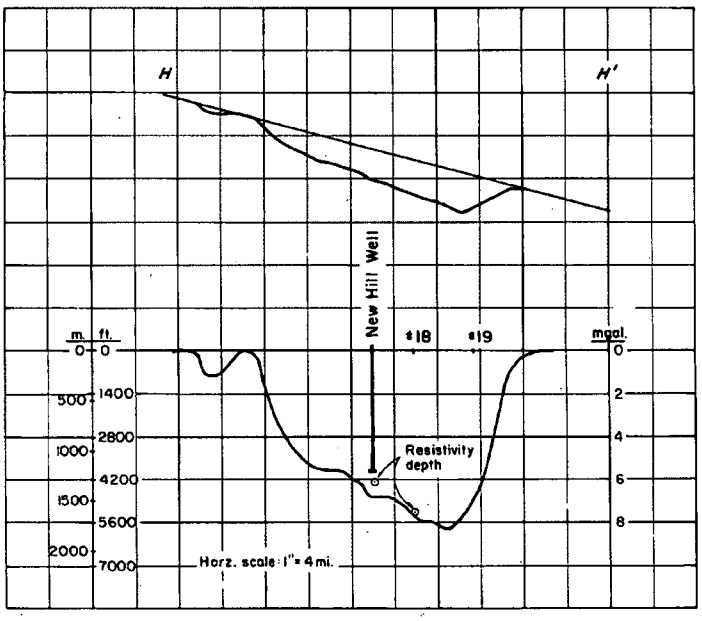
Bouger Gravity Map of the Site Area

RAI 2.5.2-07 FIGURE 2

File path: S:\11100\11151.002\Figures\RAI\RAI 02.05.02-07 Figure 2.mxd; Date: [01/26/2009]; User: [sbozkurt]



A. Residual profile A-A' along Resistivity profile A-A'.



B. Residual profile H - H'.

Source: Bain and Harvey (1977)

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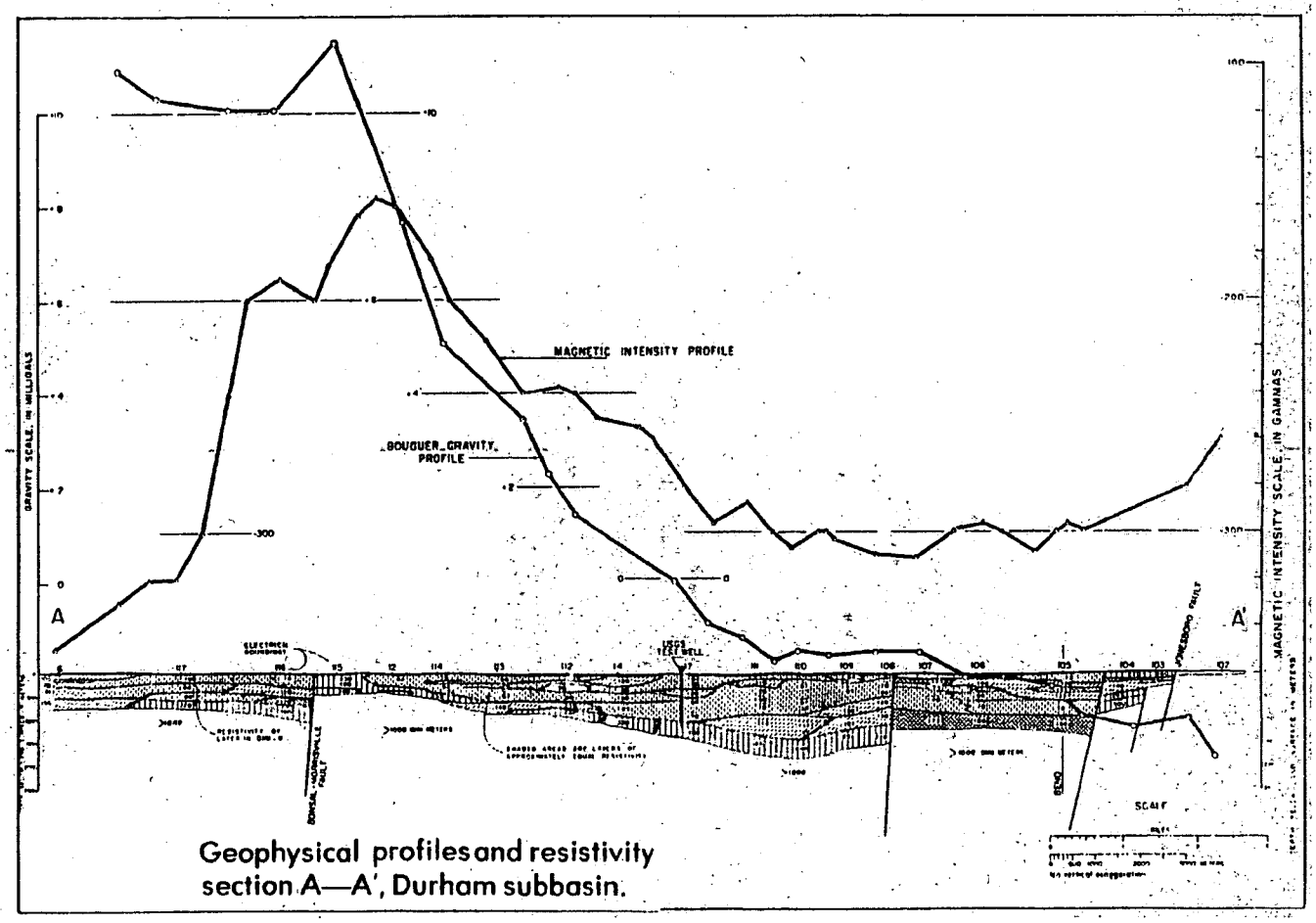
Bouger Gravity and
Resistivity Profiles A-A' and H-H'

RAI 2.5.2-07 FIGURE 3

File path: S:\11100\11151.002\Figures\RAI 02.05.02-07 Figures 3.ai; Date: [10/14/2008]; User: [sbozkurt]



Geophysical profiles and resistivity section A—A', Durham subbasin.

Source: Bain and Brown (1981)

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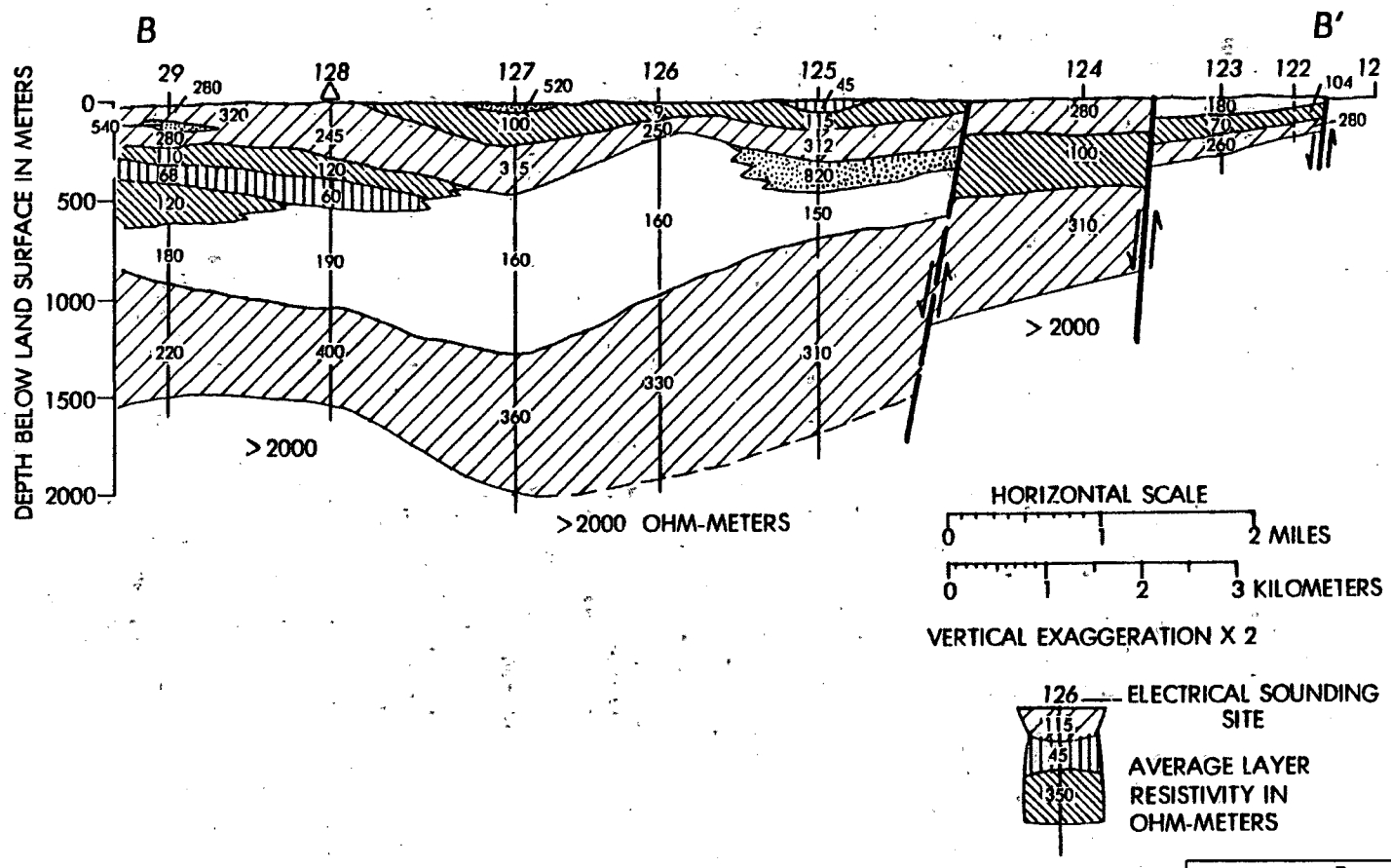
Geophysical Profiles and Resistivity Section A-A', Durham Subbasin

RAI 2.5.2-07 FIGURE 4

File path: S:\11100\11151.002\Figures\RAI 02.05.02-07 Figures 4.ai; Date: [01/27/2009]; User: [sbozkurt]



Source: Bain and Brown (1981)

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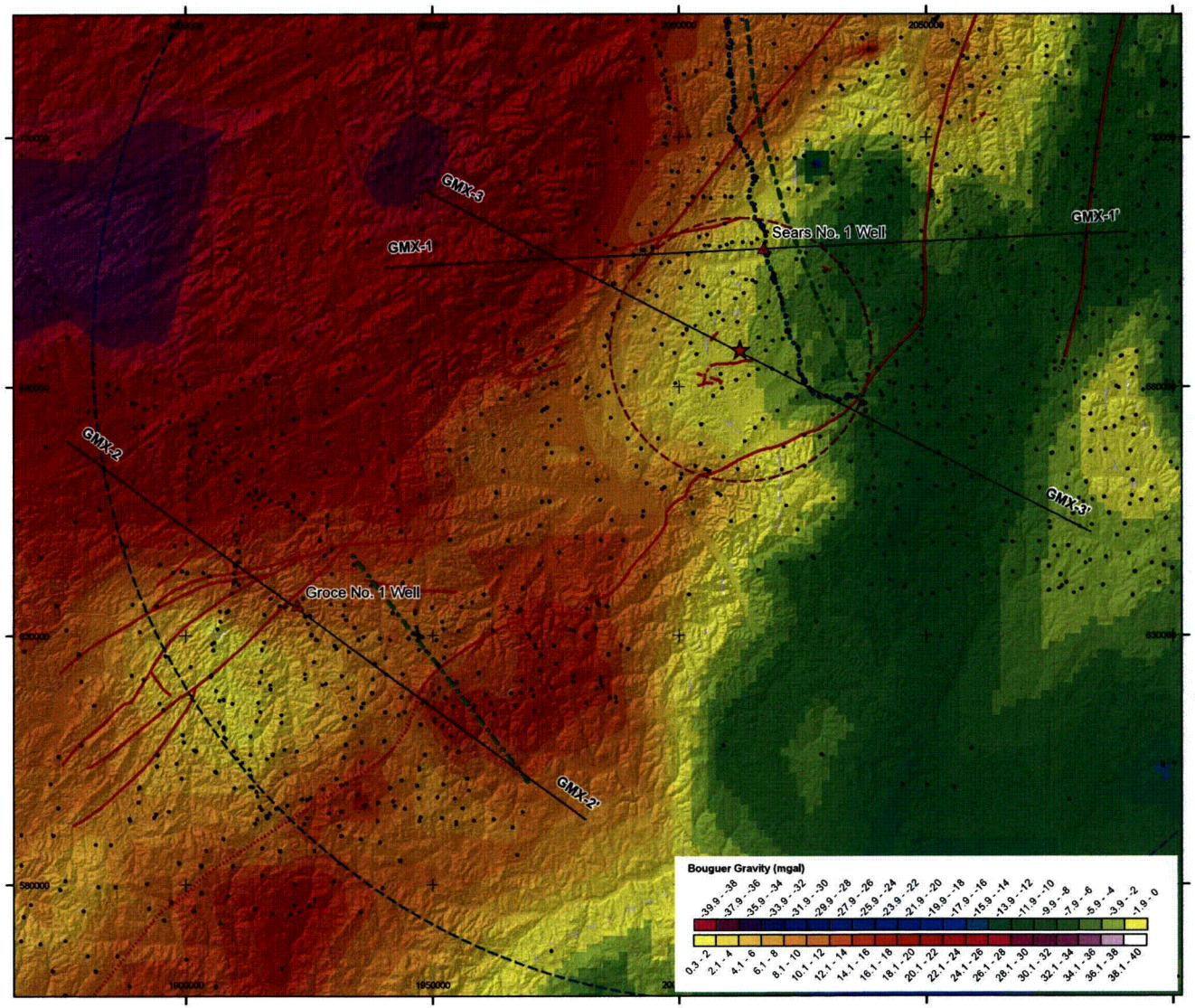
Geo-Electrical Section for Resistivity
Line B-B', Sanford Subbasin

RAI 2.5.2-07 FIGURE 5

File path: S:\11100\11151.002\Figures\RAI 02.05.02-07 Figures 5.ai; Date: [10/14/2008]; User: [sbozkurt]



N
W E
S

LEGEND

- HAR Site
- Sears No. 1 and Groce No. 1 Wells (Bain and Brown, 1981)
- 8-km (5-mi.) Radius from Site
- 40-km (25-mi.) Radius from Site
- Profile Locations
- Gravity Data Input Points (GeoNet Gravity and Magnetic Dataset Repository, 2008)
- Resistivity Lines (Bain and Brown, 1981)
- Seismic Reflection Line 85SD12 (Texaco, 1993)
- Shot Point Number (Texaco, 1993)
- Faults (dashed where inferred, dotted where concealed) (Ebasco, 1975, CP&L, 1983, NCGS, 1985, Wooten et al., 1996, Harding Lawson, 1997, NCGS, 2006, and this study)

Grid is in the North Carolina NAD 83 State Plane Coordinate System (in feet)

0 1 2 4 6 8
Kilometers

0 1 2 4 6
Miles

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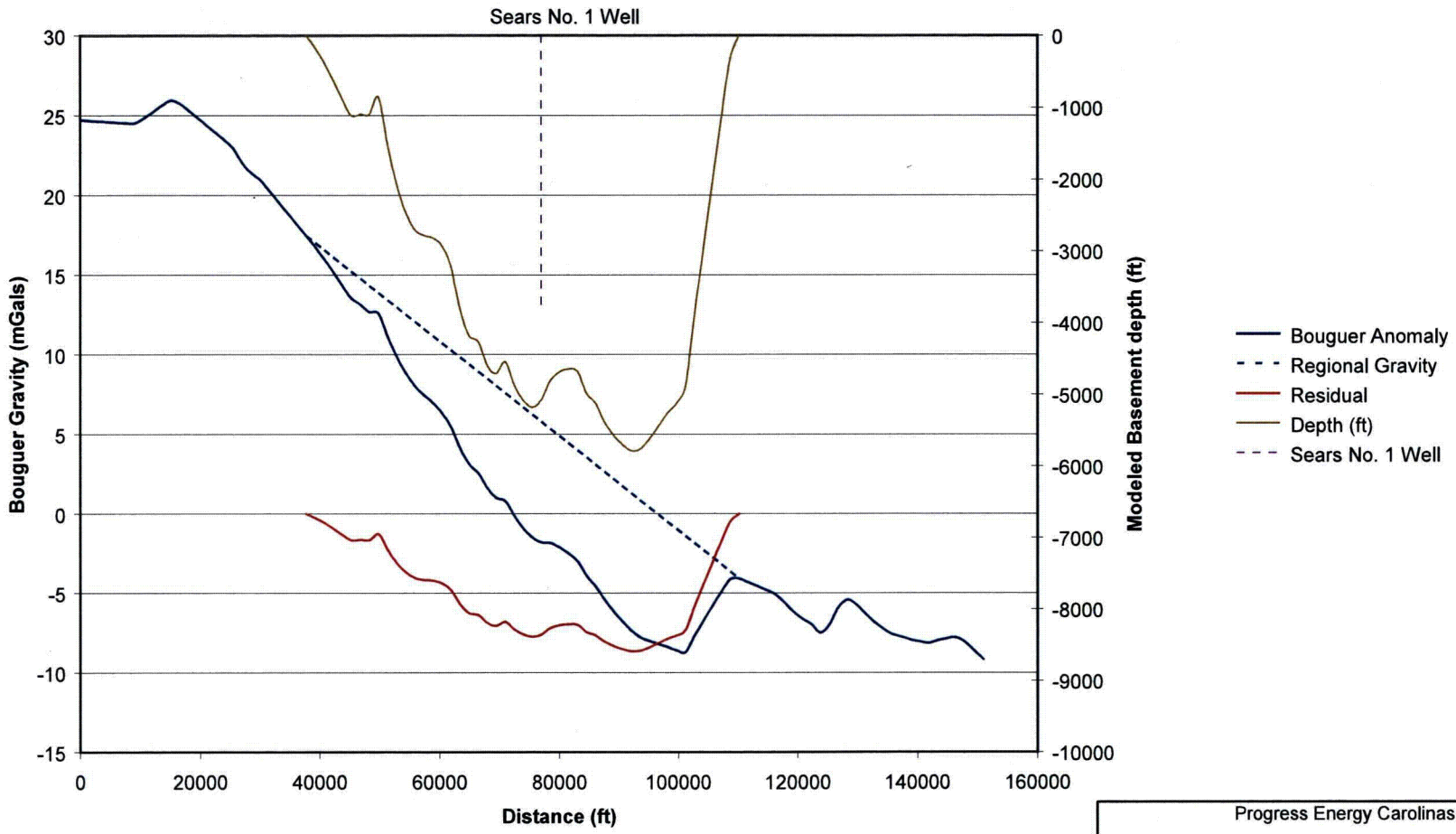
GeoNet Bouguer Gravity Map of the Durham Basin

RAI 2.5.2-07 FIGURE 6

File path: S:\11100\11151.002\Figures\RAI\RAI 02.05.02-07 Figure 6.mxd; Date: [01/26/2009]; User: [sbozkurt]



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Gravity Profile GMX-1

RAI 2.5.1-07 FIGURE 7

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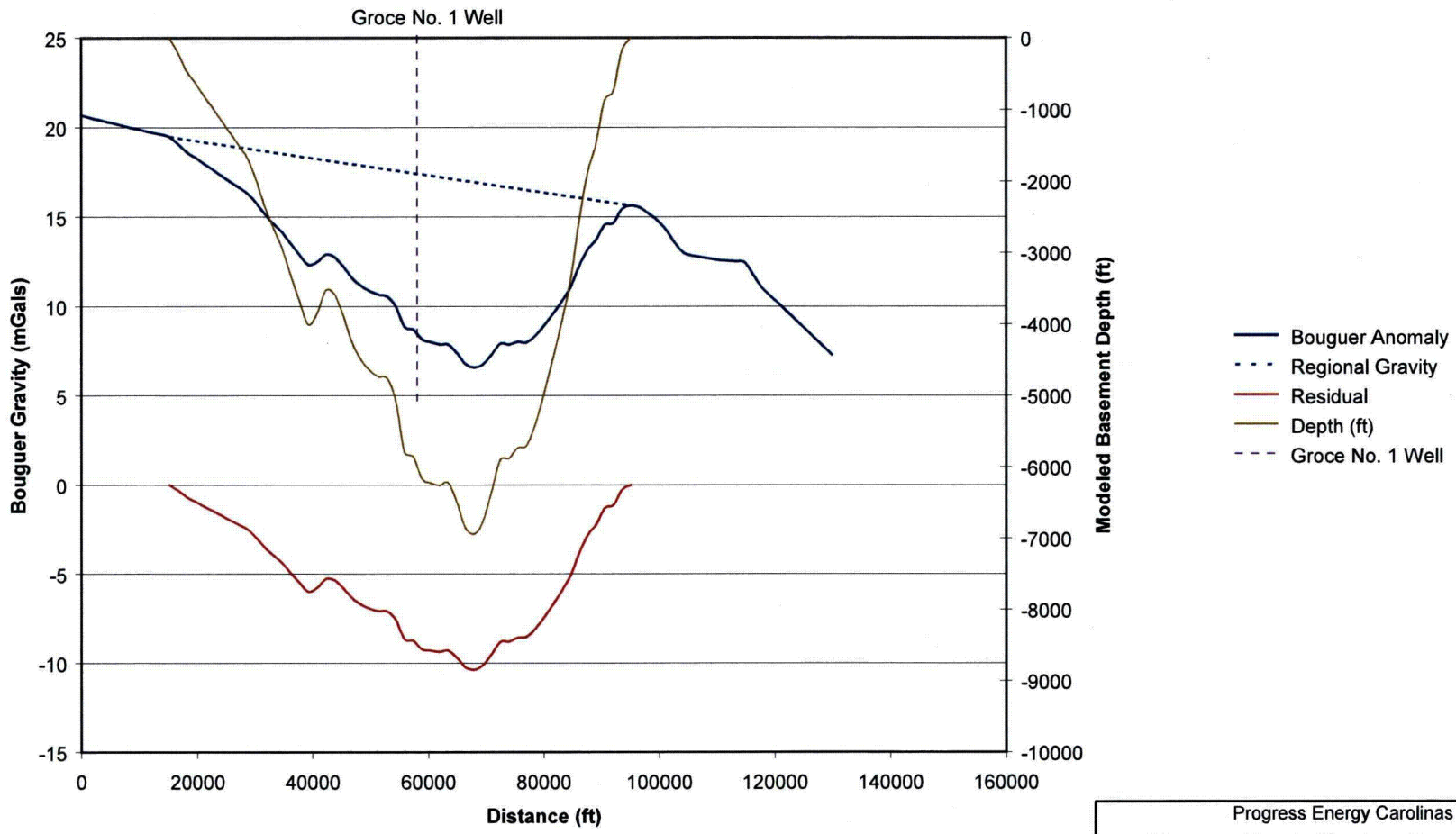

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Gravity Profile GMX-2

RAI 2.5.1-07 FIGURE 8

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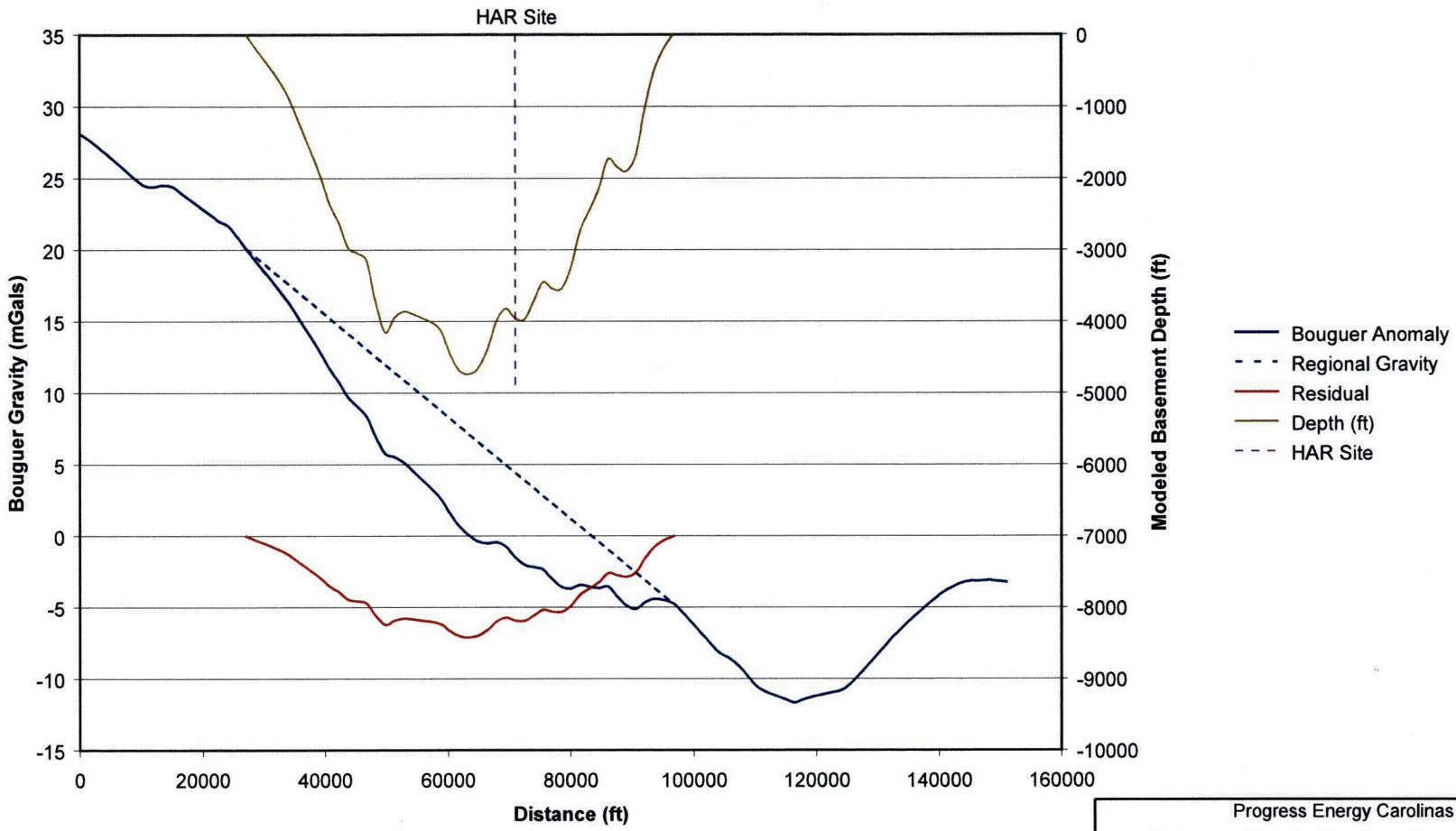

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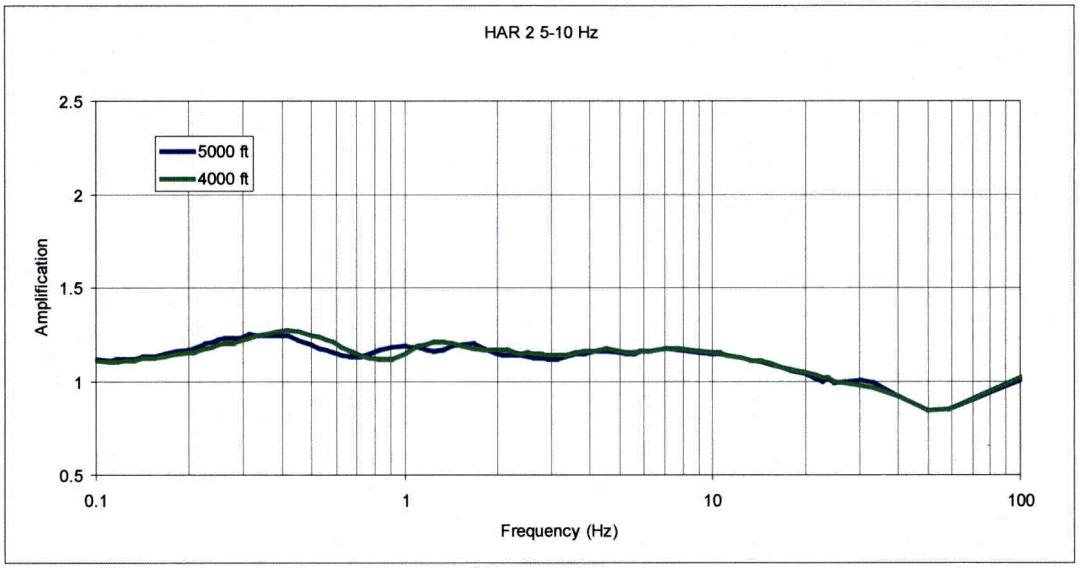
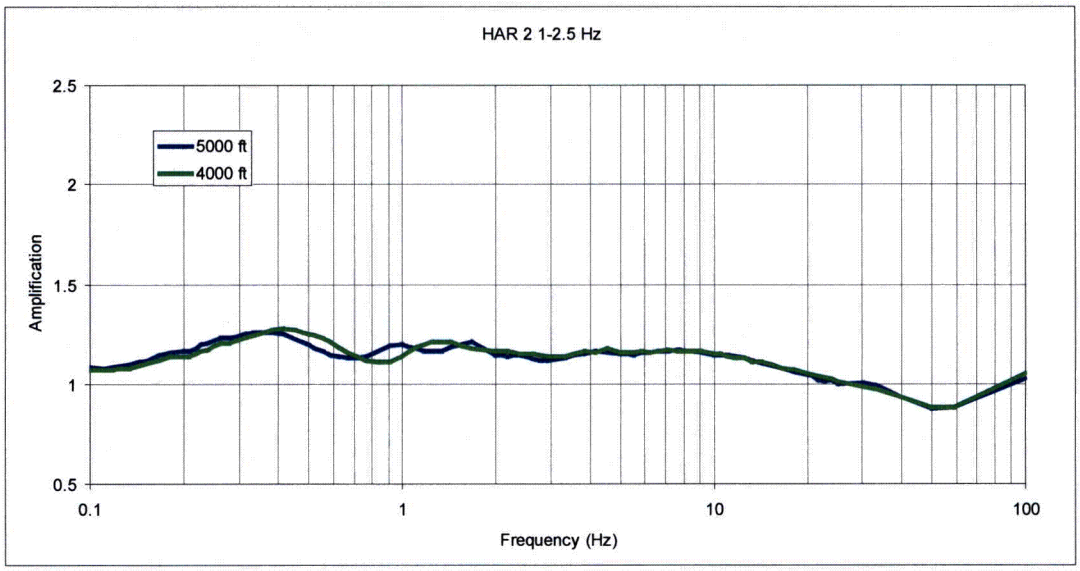
Gravity Profile GMX-3

RAI 2.5.1-07 FIGURE 9

File path: S:\11100\11151.002\Figures\RAI\RAI 02.05.02-07 Figure 9.ai; Date: [01/26/2009]; User: [sbozkurt]





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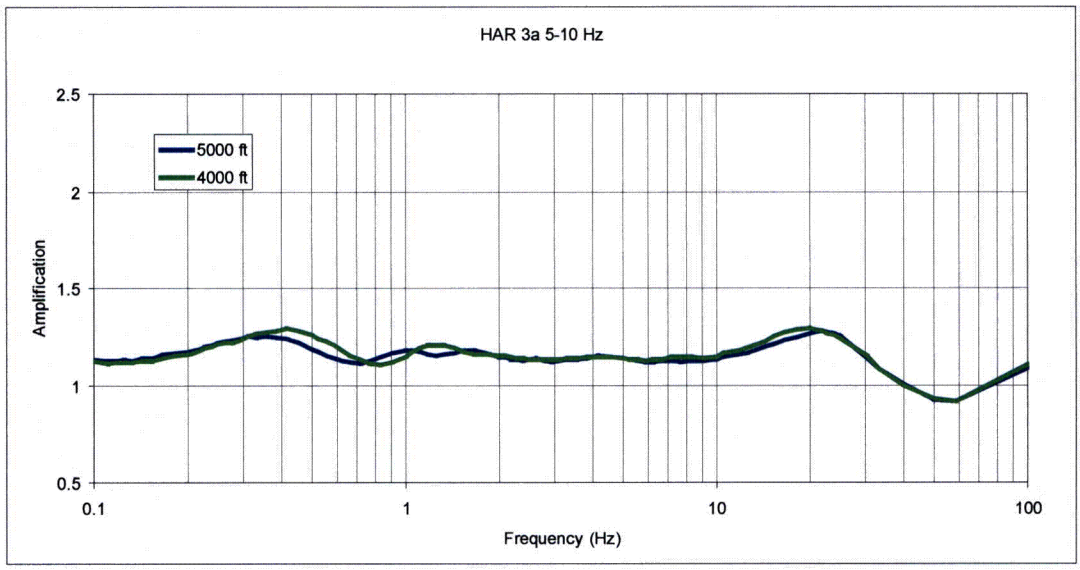
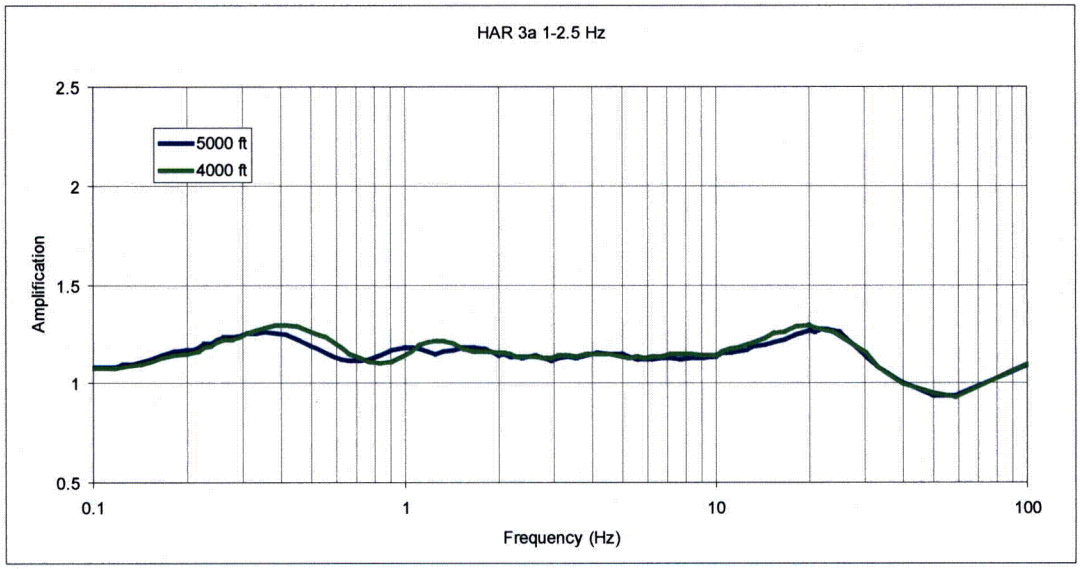
Average Depth Sensitivity Analysis for the HAR 2 GMRS Profile

RAI 2.5.2-07 FIGURE 10

File path: S:\11100\11151.002\Figures\RAI\RAI 02.05.02-07 Figure 10.ai; Date: [01/26/2009]; User: [sbozkurt]





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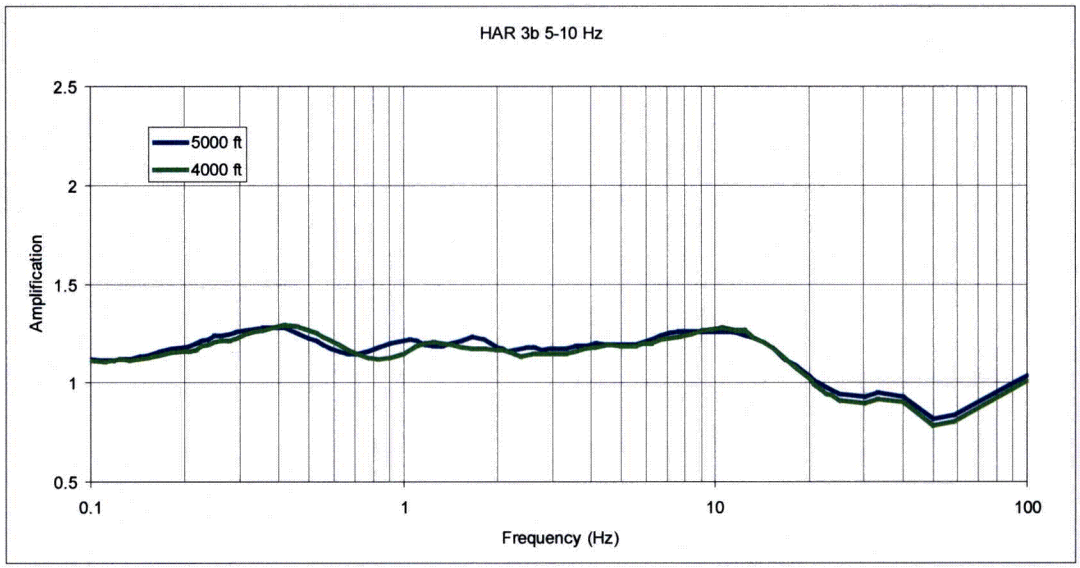
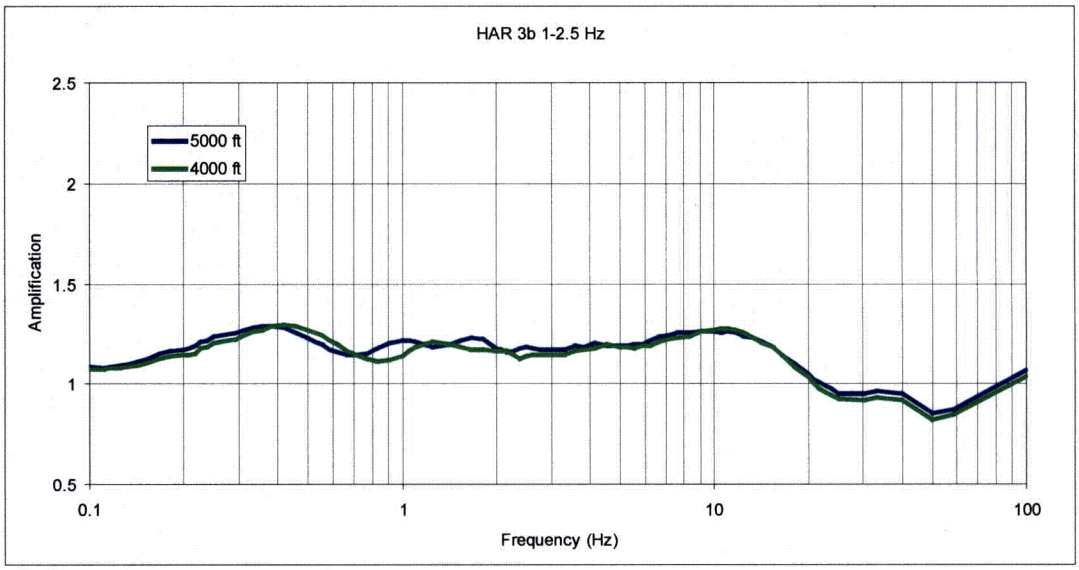
New Hill, North Carolina

Average Depth Sensitivity Analysis
for the HAR 3a GMRS Profile

RAI 2.5.2-07 FIGURE 11

File path: S:\11100\11151.002\Figures\RAI\RAI 02.05.02-07 Figure 11.ai; Date: [01/26/2009]; User: [sbozkurt]





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Average Depth Sensitivity Analysis
for the HAR 3b GMRS Profile

RAI 2.5.2-07 FIGURE 12

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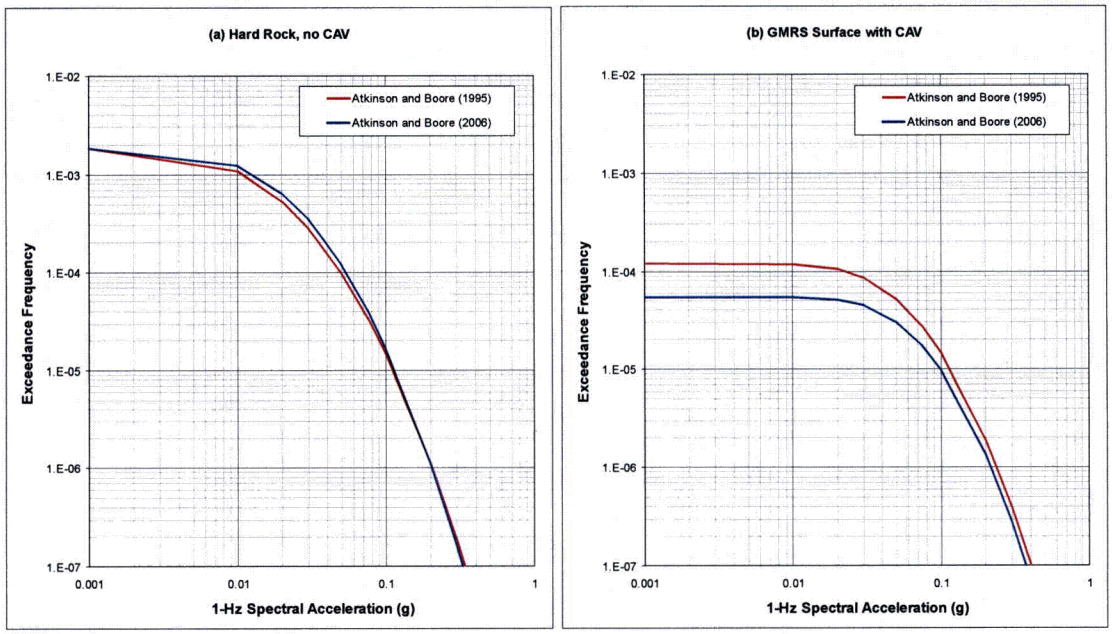

Note: Computed using the Atkinson and Boore (1995) and (2006) ground motion models.

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Hazard Curves for Generic Hard Rock and the GMRS Horizon at HAR 3
RAI 2.5.2-10 Figure 1

S:\11100\11151.002\Figures\RAI\RAI 02.05.02-10 Figure 1.ai Date: [01/13/2009]; User: [sbozkurt]