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May 25, 2007
GEI Consultants

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Appendix A1

Preliminary Geotechnical Report
May 25, 2007

GEI Consultants

GEI Consultants

Geotechnical
Environmental and
Water Resources
Engineering

Geotechnical Report

National Synchrotron Light Source II

Advanced Concept Design Phase
Brookhaven National Laboratory
Upton, New York

Submitted to:
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Submitted by:
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May 25, 2007
Project 062152-*-1000

STATE OF NEW YORK
NATHAN L. WHETTEN
075120-1
LICENSED PROFESSIONAL ENGINEER

Nathan L. Whetten, P.E., C.G.
Senior Project Manager

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1. Introduction

1.1 Introduction

Previously, we conducted subsurface explorations and geotechnical engineering evaluations for Conceptual Design, and prepared a summary report dated November 9, 2006. The proposed building location was subsequently shifted about 500 feet to the west. In April and May 2007, we conducted supplemental explorations and engineering evaluations within the western portion of the site, to update our conceptual design recommendations for the current building configuration.

This report summarizes the results of previous (conceptual design) and recent (advanced conceptual design) subsurface explorations, and our geotechnical design and construction recommendations for conceptual design of the proposed National Synchrotron Light Source II (NSLS II). This report supersedes our conceptual design phase geotechnical report dated November 9, 2006.

1.2 Summary

The subsurface explorations encountered up to about 9 feet of fill overlying a sand deposit that extends to more than 100 feet below ground surface (bgs). We recommend that foundations be designed as spread footing foundations with slab-on-grade floors. The existing fill should be removed within the building limits and replaced with compacted Structural Fill.

1.3 Scope of Work

GEI performed the following conceptual design tasks in 2006:

1. Engaged subsurface exploration contractors to conduct test borings and cone penetrometer tests.
2. Provided a full-time field representative to observe the explorations, and classify the soil samples in the borings.
3. Engaged a materials testing laboratory to perform mechanical gradation analyses on representatives soil samples from the borings.
4. Evaluated the subsurface conditions encountered in the conceptual design explorations and prepared a summary report dated November 9, 2006.

GEI performed the following advanced conceptual design tasks in 2007:

1. Engaged subsurface exploration contractors to conduct supplemental test borings and cone penetrometer tests.
2. Provided a full-time field representative to observe the explorations, and classify the soil samples in the borings.
3. Engaged a materials testing laboratory to perform mechanical gradation analyses on representatives soil samples from the borings.
4. Evaluated the subsurface conditions encountered in the conceptual design and advanced conceptual design explorations and prepared this summary report.

1.4 Project Personnel

The following personnel performed services for this project:

Steven Hawkins	Field Engineer
Nathan Whetten, P.E.	Senior Project Manger
Michael Paster, P.E.	Technical Review

1.5 Authorization

The 2006 work was completed in accordance with our agreement dated June 26, 2006. The 2007 Advanced Concept Design phase work was completed in accordance with our agreement dated April 6, 2007.

1.6 Project Vertical Datum

Elevations in this report are in feet. The vertical coordinate system is Brookhaven National Laboratory (BNL) ’94. We understand that BNL ’94 is substantially equivalent to National Geodetic Vertical Datum of 1929 (NGVD-29).

2. Site and Project Description

2.1 Site Description

The approximately 50-acre site is bounded by Brookhaven Avenue to the north, Grove Street to the west, Fifth Street to the east, and a former landfill to the southeast. Seventh Street runs through the middle of the site in a north-south direction, and divides the site roughly in half.

The eastern portion of the site is generally a lawn area or is wooded. The western portion is occupied by several buildings, adjacent parking areas, access roads with asphalt, concrete, or gravel pavement, concrete loading docks, at-grade concrete pads, two railroad tracks, and chain link fences. Existing site features are shown on Figure 2.

The ground surface slopes gently downward from east to west. Ground surface elevations range from about El. 83 along Fifth Street to about El. 63 along Grove Street.

2.2 Project Description

Brookhaven Science Associates is planning to replace the existing National Synchrotron Light Source with a new facility, referred to as NSLS II. The new facility will be located within the BNL, south and east of the existing NSLS building (Figure 1). NSLS II will be located south of Brookhaven Avenue and east of Grove Street. The proposed facility layout is shown in plan on Figure 2.

NSLS II will be a state-of-the-art research facility. The facility will include a Ring Building, Operations Center Building, lab/office buildings, and service buildings, totaling about 382,000 square feet. The facility will also include an approximately 50,000 square foot Joint Photon Science Institute (JPSI) building.

We understand that the lowest level floors will generally be at existing site grades, and no basement levels are planned. Proposed floor elevations for the various facility components, provided by HDR Architecture, Inc. (HDR), are indicated in the table below.

Structure	Proposed Floor El.	Ground Surface Elevation
Experimental Floor Storage Ring Floor Booster Ring	El. 70 El. 71.33 El. 71.33	El. 68 (SW) to El. 77 (E) El. 68 (SW) to El. 77 (E) El. 73
Lab/Office Buildings (LOB)	El. 70	El. 73 to 74 (N LOB) El. 73 to 77 (NE LOB) El. 70 to 77 (SE LOB) El. 66 to 68 (SW LOB) El. 68 to 73 (W LOB)
Operations Center Lower Floor	El. 71.33	El. 73
Service Buildings Lower Floor	El. 70	El. 73 (N Svc Bldg) El. 74 to 75 (NE Svc Bldg) El. 72 to 75 (SE Svc Bldg) El. 70 to 71 (SW Svc Bldg)
Joint Photon Science Institute	El. 70	El. 73 to 75

Comparing the proposed floor grades with the existing site grades, up to about 9 feet of excavation and up to 4 feet of fill will be required below floors.

We understand that the floor slab for the experimental hall will be 18 inches thick, and the adjacent tunnel ring slab will be 36 inches thick. These elements will be constructed as a monolithic slab. The design live load for the floor in these areas is 250 pounds per square foot (psf).

3. Subsurface Conditions

3.1 Previous Subsurface Explorations

1977 Explorations – In 1977, Stone & Webster conducted subsurface explorations for the existing NSLS facility. The explorations included six soil borings and four test pits. The borings were drilled to depths of 100 to 102 feet and the test pits were excavated to a depth of about 12 feet. Approximate exploration locations are shown on Figure 2, and logs of the test pits and borings are presented in Appendix A.

2003 Explorations – In 2003, we conducted eleven test borings for the nearby Center for Functional Nanomaterials (CFN) building. The test borings were advanced to depths of 7 to 62 feet bgs. Drilling activities were monitored by a GEI field technician. Test boring locations are shown on Figure 2, and boring logs prepared by the driller are provided in Appendix B.

3.2 Recent Subsurface Explorations

During the periods July 19 to 21, August 16, 2006, and April 23 to 26, 2007, we conducted ten test borings, (B101-B104 and B201-B206) and fifteen cone penetrometer soundings (CPT-1 to CPT-6, CPT-8, CPT-10 to CPT-14, and CPT-201 to CPT-203). Shear wave velocity measurements were made in CPT-3, -5A, -6, -12, -202, and -203 at 10-foot intervals within the sand. Explorations were monitored by a GEI engineer.

Test borings B101, B102, and B201-B204 were drilled to depths of 47 to 62 bgs. These borings were drilled using 3-inch-diameter driven casing, and Standard Penetration Tests were conducted at 5-foot intervals. Borings B101A and B102A were drilled a few feet away from borings B101 and B102, respectively, with continuous samples taken to a depth of 10 feet. Borings B103 and B104B were drilled to a depth of 32 feet using hollow-stem augers. B104 and B104A were terminated after encountering shallow refusals. Most of the borings included continuous or semi-continuous sampling within the upper 12 to 14 feet. Logs are presented in Appendix C.

The CPT soundings penetrated to depths typically ranging from 53 to 100 feet, and were terminated at refusal or at a maximum depth of 100 feet. Shallow refusals at depths less than 10 feet were encountered in CPT-5, -7, -13, and -13A. A second sounding (CPT-5A) was completed near CPT-5 to a depth of 83 feet; a second sounding (CPT-13A) near CPT-13 encountered shallow refusal and was terminated. CPT-9 was deleted from the exploration program. Logs of CPT soundings are presented in Appendix D.

3.3 Laboratory Testing

GeoTesting Express, of Boxborough, Massachusetts, performed 21 mechanical gradation analyses on soil samples recovered from the test borings. Sixteen gradation analyses were conducted on samples from borings B101 and B102, and five were conducted on samples from borings B202, B203, B204 and B206. Results are presented in Appendix E.

3.4 Subsurface Soil Conditions

Fill

Topsoil ranging in thickness from 2 to 12 inches was encountered in test borings that were drilled in landscaped areas. Topsoil was not encountered in B103, B104, B202, and B206, which were drilled in developed areas. Bituminous concrete approximately 4 inches thick was encountered in B202, which was drilled in an existing parking lot.

Each of the borings encountered fill typically described as silty sand (SM) or widely-graded sand (SW), and the thickness ranged from 2 to 9 feet. SPT N-Values ranged from 4 to 21 blows per foot (bpf), indicating the fill is loose to medium dense. Fill was also detected within the upper 1 to 10 feet in CPT soundings made near existing buildings and roadways. Explorations B104, B104A, CPT-13, and CPT-13A, located within the southern portion of the ring building, encountered refusals believed to represent buried objects, cobbles, or boulders within the fill.

Sand

A thick layer of stratified sand, sand with silt, and sand with gravel was encountered below the fill in all of the explorations. Subsurface explorations were terminated within the sand at maximum depths of about 100 feet. The sand is light brown to brown. SPT N-values ranged from about 15 bpf (medium dense) to greater than 50 bpf (very dense). The average corrected SPT N-value calculated from the CPTs within the upper 50 feet was about 30 bpf, The CPTs detected some localized zones with equivalent N-values between 10 and 20, 40 and 50, and over 50 bpf.

Shear wave velocity measurements made in CPT-3, -5A, -6, -12, -202, -203 indicate a uniform to slightly increasing shear wave velocity with depth. Velocities varied from 660 feet per second (fps) to 1,180 fps and typically ranged from 850 fps to 1,100 fps. The average of 54 shear wave velocity tests in these six CPTs was 946 fps.

A 1999 report on the stratigraphy and hydrogeologic conditions at the lab prepared by the United States Geologic Survey[1] refers to the sand as the "Upper Glacial Aquifer," and the thickness at BNL appears to be about 185 feet. Confining clay units and additional sand and gravel aquifers overlie bedrock, which reportedly occurs at a depth of about 1,500 feet.

3.5 Groundwater Conditions

Depths to groundwater range from about 21.5 (CPT-203) to 36.5 feet (B102) bgs, and vary with location at the site. Depths were measured in temporary wells and boreholes, and using a pore pressure transducer mounted on the cone probe. At the end of the cone probes, the excess pore water pressure was allowed to dissipate to measure the static water pressure. Groundwater level measurements represent conditions at the times and locations the measurements were made. Significantly different groundwater levels may occur at other times and locations.

1 "Stratigraphy and Hydrogeologic Conditions at the Brookhaven National Laboratory and Vicinity, Suffolk County, New York 1994-1997," prepared by the United States Geologic Survey, dated 1999.

4. Preliminary Foundation Recommendations

4.1 Foundation Design

We recommend that the proposed buildings be supported on spread footings bearing directly on the sand deposit, or on compacted structural fill placed after removal of existing fill. We recommend that footings be designed for a maximum allowable bearing pressure of 2.5 tons psf, and that footings be at least 3-feet wide.

Exterior footings should bear at least 4 feet below the adjacent finished grade for frost protection. Interior footings should be founded at least 18 inches below the bottom of the floor slab. The top of all footings should be at least 6 inches below the bottom of the overlying floor slab.

4.2 Floor Slab Design

Based on a comparison of proposed floor levels with existing site grades, the lowest level floors will range from 9 feet below to 4 feet above existing site grades. The lowest level floor may be designed as a slab-on-grade.

The existing fill is not considered suitable for support of floor slabs due to the low tolerance for settlement. Therefore, we recommend that all existing fill be removed from within the building limits, and replaced with compacted structural fill. A minimum of 6 inches of compacted structural fill should be placed below all floors.

Floors are above groundwater levels encountered in the explorations. Underslab drainage will not be required.

4.3 Settlement

Column and Wall Settlement

We estimate that total settlement of spread footings will be less than 1 inch, and differential settlements will be less than 0.75 inch. Settlement will occur as loads are applied. We understand that this settlement is acceptable for column and wall footings.

Floor Settlement

We understand that the floor slab within the experimental hall will support highly sensitive scientific equipment, and that settlement of the floor slab after the equipment has been installed and calibrated must be small. Based on discussions with HDR, we understand that post-construction total and differential settlement may need to be less than about 0.25 inch.

Soils beneath the floor slab will settle in response to dead and live loads. We anticipate that settlement will be complete within about one to two weeks after load application.

Settlement resulting from floor slab dead loads and fill required beneath the floor slab is expected to occur during construction, and therefore will not contribute to post-construction settlement. However, the 250 psf live load could cause minor post-construction settlement. We calculate the total and differential post-construction settlement from the live load to be less than 0.25 inch. Differential settlement will be less than the total settlement. For sensitive equipment, it may be desirable to allow a two to three week waiting period between installation and final calibration.

4.4 Seismic Design

The soil beneath the proposed buildings has an average shear wave velocity of 946 feet per second and is classified as a stiff soil profile for earthquake design purposes as defined by the New York State Building Code. The corresponding site class is D. The soil is not considered to be susceptible to liquefaction.

4.5 Reuse of Existing Fill

Based on the results of sieve analyses conducted on soil samples recovered from borings B101 and B102, we anticipate that the natural sand deposit will be suitable for reuse as compacted structural fill below building foundations. The existing fill has a relatively high percentage of fines (silt and clay size particles) and is not suitable for reuse as structural fill. The existing fill is suitable for reuse as common fill outside the building limits.

4.6 Subsurface Explorations for Final Design

Subsurface explorations conducted for the 2006 conceptual design and 2007 advanced concept design studies included a relatively small number of widely-spaced explorations. Most of these explorations penetrated to depths of 50 to 100 feet, to evaluate general subsurface conditions in the area of the facility.

We recommend that subsurface explorations for final design include additional test borings with continuous SPT sampling, to further evaluate the nature and thickness of fill materials.

Shallow refusals were encountered in B104, B104A, CPT-13 and -13A, and may indicate buried foundations or other objects within the fill. We recommend that test pits be excavated at locations where shallow refusal was encountered within the fill.

5. Final Design Services and Limitations

5.1 Final Design Engineering Services

We recommend that GEI be engaged during final design to:

- Conduct subsurface explorations, prepare a final geotechnical engineering report, and provide geotechnical consultation to the design team.
- Review plans and specifications to confirm that our recommendations have been interpreted and implemented as intended.

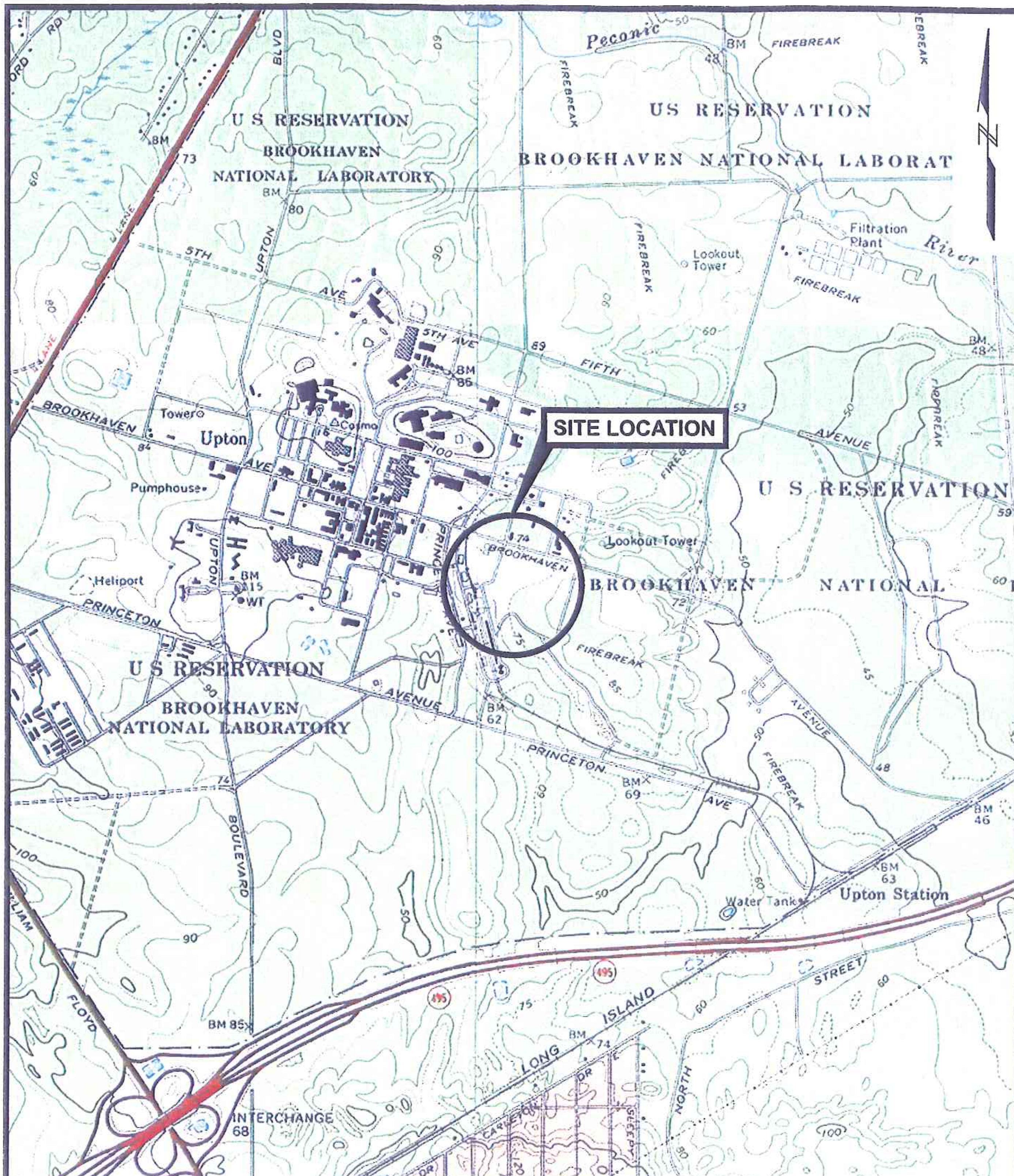
5.2 Limitations

This report was prepared for the exclusive use of HDR Architecture, Brookhaven Science Associates, and the NSLS II design team. Our recommendations are based on the project information provided to us at the time of this report and may require modification if there are any changes in the nature, design, or location of the proposed structure. We cannot accept responsibility for designs based on our recommendations unless we are engaged to review the final plans and specifications to determine whether any changes in the project affect the validity of our recommendations and whether our recommendations have been properly implemented in the design.

The recommendations in this report are based in part on the data obtained from the subsurface explorations. The nature and extent of variations between explorations may not become evident until construction. If variations from the anticipated conditions are encountered, it may be necessary to revise the recommendations in this report.

Our professional services for this project have been performed in accordance with generally accepted engineering practices. No warranty, express or implied, is made.

Figures



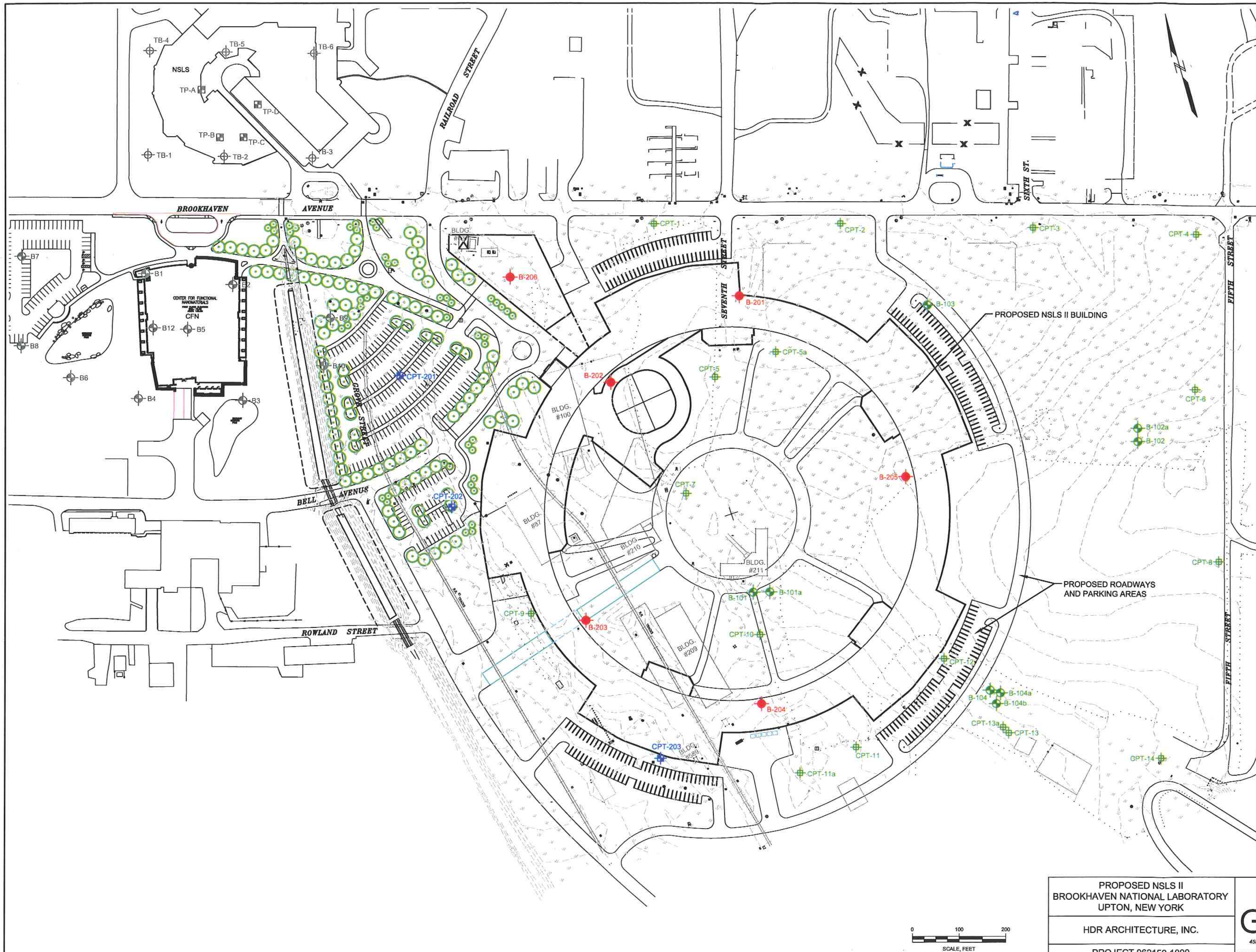
SOURCE: Map created with TOPO! ® ©2003 National Geographic (www.nationalgeographic.com/topo)

0 2000 4000

SCALE, FEET

PROPOSED NSLS II BROOKHAVEN NATIONAL LABORATORY UPTON, NEW YORK	GEI Consultants	SITE LOCATION MAP
HDR ARCHITECTURE, INC.	PROJECT 062150	August 2006 Figure 1

BROOKHAVEN NL\062150\BROOKHAVEN LOCATION MAP.CDR



LEGEND:

ADC EXPLORATIONS:

CPT-201 — APPROXIMATE LOCATION OF CONE PENETROMETER TEST MADE IN APRIL 2007

B-201 — APPROXIMATE LOCATION OF TEST BORING DRILLED IN APRIL 2007

2006 EXPLORATIONS:

B-101 — APPROXIMATE LOCATION OF TEST BORING DRILLED IN JULY AND AUGUST 2006

CPT-1 — APPROXIMATE LOCATION OF CONE PENETROMETER TEST MADE IN JULY 2006

PREVIOUS EXPLORATIONS:

TB-1 — APPROXIMATE LOCATION OF TEST BORING INSTALLED IN 1977

TP-A — APPROXIMATE LOCATION OF TEST PIT INSTALLED IN 1977

B1 — APPROXIMATE LOCATION OF TEST BORING INSTALLED IN 2003

NOTES:

1. PLAN BASED ON MAP TITLED ***TOPOGRAPHIC SURVEY, PROPOSED NSLS II SITE, SITUATED AT BNL***, UPTON, NEW YORK, PREPARED BY MUNICIPAL LAND SURVEY P.C., 10 SYLVIA LANE, MIDDLE ISLAND, NEW YORK, 11953.
2. APPROXIMATE LOCATIONS OF 2006 AND 2007 EXPLORATIONS WERE PROVIDED BY BNL, AND WERE DETERMINED BY PACING FROM SITE FEATURES. LOCATIONS OF PREVIOUS EXPLORATIONS WERE ESTIMATED BASED ON RECORD DRAWINGS.
3. THE HORIZONTAL COORDINATE SYSTEM IS IN THE STATE PLANE COORDINATE SYSTEM, NEW YORK LONG ISLAND ZONE 3104, NAD '83, EXPRESSED IN US SURVEY FEET AS DEFINED BY BNL POINT COSMO RM3.
4. THE VERTICAL COORDINATE SYSTEM IS BNL '94 WHICH IS SUBSTANTIALLY EQUIVALENT TO THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD 1929), EXPRESSED IN US SURVEY FEET AS DEFINED BY BNL POINT COSMO RM3.
5. PROPOSED BUILDING LAYOUT REVISED BASED ON MAP PROVIDED BY HDR ARCHITECTURE, INC.

PROPOSED NSLS II BROOKHAVEN NATIONAL LABORATORY UPTON, NEW YORK	GEI Consultants	ADC EXPLORATION LOCATIONS
HDR ARCHITECTURE, INC.	455 WINDING BROOK DRIVE SUITE 201 GLASTONBURY, CONNECTICUT 06033	
PROJECT 062152-1000		May 2007 Figure 2

I:\GEI\Brookhaven National Laboratory\614687\ BROOKHAVEN ADC EXPLORATION 5-07.dwg \May 23, 2007

Appendix A

1977 Test Boring and Test Pit Logs

SH 1 OF 2

SITE NATIONAL SYNCHROTRON LIGHT SOURCE J.O. No. 13011.01 BORING NO. 1
TYPE OF BORING SS LOCATION BROOKHAVEN NATIONAL LABORATORY GROUND ELEV. 77.4
DATE DRILLED August 23, 1977 DRILLED BY V. ADAMI LOGGED BY [illegible]
SUMMARY OF BORING

ELEV. FEET	DEPTH FEET	OVERALL WEATHERING AND RQD	SAMPLE BLOWS OR RECOV.	SAMPLE TYPE	GRAPHIC LOG	SOIL OR ROCK DESCRIPTION
	0		28	[illegible]	SM	TOP SOIL, SILTY SAND, WIDELY GRADED, COARSE TO FINE, MOSTLY MEDIUM AND FINE, 15-20% NONPLASTIC FINES, LIGHT BROWN.
	5		36	SS 2	SP-SM	SAND, UNIFORM, MEDIUM TO FINE, MOSTLY MEDIUM, 8-10% NONPLASTIC FINES, LIGHT YELLOWISH BROWN.
	10		18	SS 3	SM	SILTY SAND, WIDELY GRADED, FINE TO VERY FINE, 20-25% NONPLASTIC FINES, GRAYISH BROWN.
	15		43	SS 4	SP	GRAVELLY SAND, POORLY GRADED, 10-15% ROUNDED GRAVEL TO 1.0 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY COARSE AND MEDIUM 3-5% NONPLASTIC FINES, GRAYISH BROWN.
	20		16	SS 5	SP-SM	GRAVELLY SAND, 10-15% ROUNDED GRAVEL TO 0.75 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY COARSE AND MEDIUM, 8-10% NONPLASTIC FINES, BROWNISH GRAY.
	25		39	[illegible]	SP	SAND, SIMILAR TO SS #4, EXCEPT GRAVEL TO 0.5 INCH MAXIMUM
	30		77	SS 7	SP	GRAVELLY SAND, POORLY GRADED, 18-20% ROUNDED GRAVEL TO 1.0 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM, 3-5% NONPLASTIC FINES, BROWNISH GRAY.
	35		65	SS 8	SP	SAND, POORLY GRADED, COARSE TO FINE, MOSTLY MEDIUM, 3-5% NONPLASTIC FINES, BROWNISH GRAY.
	40		35	SS 9	SP	SAND, POORLY GRADED, COARSE TO FINE, MOSTLY MEDIUM AND FINE, 2-3% NONPLASTIC FINES, BROWNISH GRAY.
	45		58	SS 10	SP	GRAVELLY SAND, POORLY GRADED, 20-25% GRAVEL TO 0.75 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY COARSE AND MEDIUM 0-3% NONPLASTIC FINES, BROWNISH GRAY.
	50		63	SS 11	SP	SAND, SAME AS SS #10.
	55		51	SS 12	SP	[illegible] UNIFORM MEDIUM TO FINE, SOME COARSE PIECES, LESS THAN 3% [illegible]PLASTIC FINES, GRAY.
	60		51	SS 13	SP	GRAVELLY SAND, POORLY GRADED, 12-15% ROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE, MOSTLY COARSE AND MEDIUM, LESS THAN 3% FINES, GRAY.
	65		37	SS 14	SP	GRAVELLY SAND, SIMILAR TO SS #13, EXCEPT ROUNDED GRAVEL TO 0.3 INCH MAXIMUM.
	[illegible]		[illegible]	[illegible]	SP	SAND, POORLY GRADED, 3-5% GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM 3-5% NONPLASTIC FINES, BROWNISH GRAY.

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
2. ■2 INDICATES LOCATION OF UNDISTURBED SAMPLE. ▼6 INDICATES LOCATION OF SPLIT-SPOON SAMPLE. ▯7 INDICATES LOCATION OF SAMPLING ATTEMPT WITH NO RECOVERY. SUBSCRIPT NEXT TO SYMBOL INDICATES SAMPLE NUMBER.
3. ⊻ INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. ▯ INDICATES DEPTH & LENGTH OF NX CORING RUN.
6. DATUM IS

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION

SH 2 OF 2

SITE NATIONAL SYNCHROTRON LIGHT SOURCE J.O. No. 13011.10 BORING NO. 1
TYPE OF BORING SS LOCATION BROOKHAVEN NATIONAL LABORATORY GROUND ELEV. 73.[illegible]
DATE DRILLED [illegible] DRILLED BY V. ADAMI LOGGED BY [illegible]
SUMMARY OF BORING

ELEV. FEET	DEPTH FEET	OVERALL WEATHERING AND RQD	SAMPLE BLOWS OR RECOV.	SAMPLE TYPE	GRAPHIC LOG	SOIL OR ROCK DESCRIPTION
	75		56*	SS 16	SP	SAND, SAME AS SS #15.
	80		140	SS 17	SP	SAND, UNIFORM FINE, SOME COARSE PIECES, LESS THAN 3% NONPLASTIC FINES, LIGHT BROWNISH GRAY.
	85		58	SS 18	SP	GRAVELLY SAND, POORLY GRADED, 10-12% ROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM 3-4% NONPLASTIC FINES, BROWNISH GRAY.
	90		58	SS 19	SP	SAND, UNIFORM MEDIUM, SOME COARSE PIECES, LESS THAN 5% NONPLASTIC FINES, LIGHT BROWNISH GRAY.
	95		58	SS 20	SP	SAND, SAME AS SS #19.
	100	TERMINATED	59	SS 21	SP	SAND, SAME AS SS #19, [illegible]CE OF ROUNDED GRAVEL TO 0.3 INCH MAXIMUM. END OF BORING AT 101.5 FT.

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
2. ■2 INDICATES LOCATION OF UNDISTURBED SAMPLE. ▼6 INDICATES LOCATION OF SPLIT-SPOON SAMPLE. ▯7 INDICATES LOCATION OF SAMPLING ATTEMPT WITH NO RECOVERY. SUBSCRIPT NEXT TO SYMBOL INDICATES SAMPLE NUMBER.
3. ⊻ INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. ▯ INDICATES DEPTH & LENGTH OF NX CORING RUN.
6. DATUM IS

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION

SH. 1 OF 2

SITE: NATIONAL SYNCHROTRON LIGHT SOURCE — J.O. NO. 13011.10 — BORING NO. 2
TYPE OF BORING: SS — LOCATION: BROOKHAVEN NATIONAL LABORATORY — GROUND ELEV. 71.4
DATE DRILLED: AUGUST 27, 1977 — DRILLED BY: Y. AIMAR — LOGGED BY: RBT
SUMMARY OF BORING

ELEV. FEET	DEPTH FEET	OVERALL WEATHERING AND RQD	SAMPLE BLOWS OR RECOV.	SAMPLE TYPE	GRAPHIC LOG	SOIL OR ROCK DESCRIPTION
	0		13	SS 1	SM	SILTY SAND, WIDELY GRADED, COARSE TO FINE, MOSTLY FINE, 30-40% NONPLASTIC FINES, MOTTLED GRAY AND BROWN.
	5		15	SS 2	SP	SAND, UNIFORM, FINE, LESS THAN 5% NONPLASTIC FINES, LIGHT YELLOWISH GRAY.
	10		25	SS 3	SP	SAND, UNIFORM, MEDIUM TO FINE, MOSTLY FINE; LESS THAN 5% NONPLASTIC FINES, LIGHT YELLOWISH GRAY.
	15		23	SS 4	SP-SM	SAND, UNIFORM, MEDIUM TO FINE, MOSTLY FINE, 5-8% NONPLASTIC FINES, BROWNISH ORANGE.
	20		30	SS 5	SP	SAND, UNIFORM, MEDIUM TO FINE, MOSTLY FINE, LESS THAN 5% NONPLASTIC FINES, LIGHT YELLOWISH GRAY, SMALL BROWNISH ORANGE POCKETS OF SILTY SAND.
	25		39	SS 6	SP	GRAVELLY SAND, POORLY GRADED, 12-15% SUBROUNDED GRAVEL TO 0.25 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM AND FINE, 3-5% NONPLASTIC FINES, YELLOWISH GRAY, SMALL LAYER OF BROWNISH GRAY VERY FINE SILTY SAND.
	30		38	SS 7	SP	GRAVELLY SAND, POORLY GRADED, 20-25% SUBROUNDED TO ROUNDED GRAVEL TO 1.0 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM AND FINE, LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY.
	35		104	SS 8	SM	SILTY SAND, UNIFORM, MEDIUM TO FINE, MOSTLY FINE, 35-40% NONPLASTIC FINES, BROWN.
	40		52	SS 9	SP-SM	SAND, POORLY GRADED, 1 PIECE OF SUBROUNDED GRAVEL 1.0 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM AND FINE, 5-8% NONPLASTIC FINES, YELLOWISH GRAY.
	45		57	SS 10	SP	GRAVELLY SAND, POORLY GRADED, 10-15% ROUNDED GRAVEL TO 0.25 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM AND FINE, LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY.
	50		33	SS 11	SP	SAND, POORLY GRADED, LESS THAN 5% SUBROUNDED GRAVEL TO 0.25 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM, LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY.
	55		64	SS 12	SP	SAND, POORLY GRADED, 3-5% SUBANGULAR GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM, LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY.
	60		44	SS 13	SP	SAND, SIMILAR TO SS #12 EXCEPT MOSTLY MEDIUM AND FINE SAND.
	65		50	SS 14	SP	SAND, POORLY GRADED, LESS THAN 3% SUBANGULAR GRAVEL TO 0.25 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM, LESS THAN 3% NONPLASTIC FINES, YELLOWISH GRAY.
	70		114	SS 15	SP	GRAVELLY SAND, POORLY GRADED, 12-15% SUBROUNDED TO ROUNDED GRAVEL TO 0.75 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM AND FINE,

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
2. ▆2 INDICATES LOCATION OF UNDISTURBED SAMPLE. ╱6 INDICATES LOCATION OF SPLIT-SPOON SAMPLE. □7 INDICATES LOCATION OF SAMPLING ATTEMPT WITH NO RECOVERY. SUBSCRIPT NEXT TO SYMBOL INDICATES SAMPLE NUMBER.
3. ⯆ INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. [] INDICATES DEPTH & LENGTH OF NX CORING RUN.
6. DATUM IS

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION

SH. 2 OF 2

SITE: NATIONAL SYNCHROTRON LIGHT SOURCE — J.O. NO. 13011.10 — BORING NO. 2
TYPE OF BORING: SS — LOCATION: BROOKHAVEN NATIONAL LABORATORY — GROUND ELEV. 71.4
DATE DRILLED: AUGUST 27, 1977 — DRILLED BY: Y. AIMAR — LOGGED BY: RBT
SUMMARY OF BORING

ELEV. FEET	DEPTH FEET	OVERALL WEATHERING AND RQD	SAMPLE BLOWS OR RECOV.	SAMPLE TYPE	GRAPHIC LOG	SOIL OR ROCK DESCRIPTION
						LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY.
	75		87	SS 16	SP-SM	SAND, POORLY GRADED, LESS THAN 5% ROUNDED GRAVEL TO 0.75 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM, 5-8% NONPLASTIC FINES, YELLOWISH GRAY.
	80		52	SS 17	SP	SAND, POORLY GRADED, LESS THAN 3% SUBANGULAR GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM TO FINE; LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY.
	85		54	SS 18	SP	GRAVELLY SAND, POORLY GRADED, 15-20% ROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY COARSE AND FINE, LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY.
	90		70	SS 19	SP-SM	SAND, POORLY GRADED, COARSE TO FINE, MOSTLY MEDIUM AND FINE, 5-8% NONPLASTIC FINES, YELLOWISH GRAY, SOME REDDISH BROWN STAINING AND A FEW PIECES OF GRAVEL TO 0.75 INCH MAXIMUM.
	95		80	SS 20	SP	SAND, POORLY GRADED, LESS THAN 5% ROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM AND FINE, LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY.
	100	TERMINATED	16[illegible]	SS 21	SP-SM	SAND, POORLY GRADED, 5-8% SUBROUNDED GRAVEL TO 0.75 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY FINE, 5-8% NONPLASTIC FINES, LIGHT GRAY.
						END OF BORING AT 101.5 FT.

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
2. ▆2 INDICATES LOCATION OF UNDISTURBED SAMPLE. ╱6 INDICATES LOCATION OF SPLIT-SPOON SAMPLE. □7 INDICATES LOCATION OF SAMPLING ATTEMPT WITH NO RECOVERY. SUBSCRIPT NEXT TO SYMBOL INDICATES SAMPLE NUMBER.
3. ⯆ INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. [] INDICATES DEPTH & LENGTH OF NX CORING RUN.
6. DATUM IS

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION

SH. 1 OF 2

SITE NATIONAL SYNCHROTRON LIGHT SOURCE J.O. No. 13011.10 BORING No. 3
TYPE OF BORING SS LOCATION BROOKHAVEN NATIONAL LABORATORY GROUND ELEV. 72.3
DATE DRILLED AUGUST 24, 1977 DRILLED BY Y. AIMAN LOGGED BY DMK
SUMMARY OF BORING

ELEV. FEET	DEPTH FEET	OVERALL WEATHERING AND RQD 0 25 50 75 100	SAMPLE BLOWS & RECOV.	SAMPLE TYPE	GRAPHIC LOG	SOIL OR ROCK DESCRIPTION (FIELD AND LABORATORY TEST RESULTS; ON JOINTING, BEDDING AND FAULTING DESCRIPTIONS / SOIL STRATA DESCRIPTION; LITHOLOGY AND TEXTURE)
	0		18	SS 1	SM	TOP SOIL: SILTY SAND, WIDELY GRADED, 15-20% ANGULAR GRAVEL TO 0.7 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, 15-20% SLIGHTLY PLASTIC FINES, DARK BROWN MOTTLED WITH LIGHT BROWN, SOME ORGANIC MATERIAL
	5		30	SS 2	SP	SAND, POORLY GRADED, TRACE OF 0.4 INCH GRAVEL, COARSE TO FINE, MOSTLY MEDIUM SAND, <5% FINES, LIGHT BROWN
	10		50	SS 3	SP	GRAVELLY SAND, POORLY GRADED, 40-45% SUBANGULAR TO SUBROUNDED GRAVEL TO 0.8 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM SAND, <5% FINES, LIGHT BROWN
	15		24	SS 4	SP-SM	SAND, POORLY GRADED, 3-8% GRAVEL TO 0.5 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM SAND, 5-8% NONPLASTIC FINES, GRAYISH BROWN
	20		39	SS 5	SP-SM	GRAVELLY SAND, POORLY GRADED, 35-40% SUBROUNDED TO SUBANGULAR GRAVEL TO 0.7 [redacted] MAXIMUM COARSE TO FINE, MOSTLY MEDIUM SAND, 5-8% NONPLASTIC FINES, GRAYISH BROWN
	25		61	SS 6	SP-SM	GRAVELLY SAND, POORLY GRADED, 40-45% SUBANGULAR GRAVEL TO 0.9 INCH MAX. COARSE TO FINE, MOSTLY FINE SAND, 5-8% NONPLASTIC FINES, GRAYISH BROWN
	30		73	SS 7	SP	GRAVELLY SAND, POORLY GRADED, 15-20% SUBANGULAR GRAVEL TO 0.7 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM SAND, <5% FINES GRAYISH BROWN
	35		74	SS 8	SP	GRAVELLY SAND, SIMILAR TO ABOVE, EXCEPT 30-35% GRAVEL
	40		56	SS 9	SP	SAND, POORLY GRADED, 3-5% GRAVEL TO 0.4 INCH MAX., COARSE TO FINE, MOSTLY FINE (VERY LITTLE COARSE) SAND, <5% FINES, GRAYISH BROWN
	45		29	SS 10	SP	GRAVELLY SAND, POORLY GRADED, 30-35% SUBROUNDED GRAVEL TO 0.7 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM SAND, <5% FINES, GRAYISH BROWN
	50		43	SS 11	SP	GRAVELLY SAND, SIMILAR TO ABOVE
	55		46	SS 12	SP	GRAVELLY SAND, SIMILAR TO ABOVE, EXCEPT 25-30% GRAVEL
	60		46	SS 13	SP	GRAVELLY SAND, POORLY GRADED, 40-45% SUBANGULAR TO SUBROUNDED GRAVEL TO 0.8 INCH MAX. COARSE TO FINE MOSTLY MEDIUM SAND, <5% FINES, GRAYISH BROWN
	65		69	SS 14	SP	GRAVELLY SAND, POORLY GRADED, 25-30% SUBANGULAR TO SUBROUNDED TO 0.7 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM SAND, <5% FINES, GRAYISH BROWN
	70		65	SS 15	SP-SM	

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
2. ▇2 INDICATES LOCATION OF UNDISTURBED SAMPLE. F6 INDICATES LOCATION OF SPLIT-SPOON SAMPLE. ▯7 INDICATES LOCATION OF SAMPLING ATTEMPT WITH NO RECOVERY. SUBSCRIPT NEXT TO SYMBOL INDICATES SAMPLE NUMBER.
3. ⊥ INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. ▯ INDICATES DEPTH & LENGTH OF NX CORING RUN.
6. DATUM IS

4
3
2
1

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION

SH. 2 OF 2

SITE NATIONAL SYNCHROTRON LIGHT SOURCE J.O. No. 13011.10 BORING No. 3
TYPE OF BORING SS LOCATION BROOKHAVEN NATIONAL LABORATORY GROUND ELEV. 72.3
DATE DRILLED AUGUST 24, 1977 DRILLED BY Y. AIMAN LOGGED BY DMK
SUMMARY OF BORING

ELEV. FEET	DEPTH FEET	OVERALL WEATHERING AND RQD 0 25 50 75 100	SAMPLE BLOWS & RECOV.	SAMPLE TYPE	GRAPHIC LOG	SOIL OR ROCK DESCRIPTION (FIELD AND LABORATORY TEST RESULTS; ON JOINTING, BEDDING AND FAULTING DESCRIPTIONS / SOIL STRATA DESCRIPTION; LITHOLOGY AND TEXTURE)
						SAND, POORLY GRADED, 3-5% GRAVEL, TO 0.5 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, 5-8% NONPLASTIC FINES, GRAYISH BROWN
	75		53	SS 16	SP-SM	SAND, SIMILAR TO ABOVE
	80		63	SS 17	SP	GRAVELLY SAND, POORLY GRADED, 40-45% SUBANGULAR TO SUBROUNDED GRAVEL TO 0.7 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, <5% FINES, GRAYISH BROWN
	85		62	SS 18	SP	GRAVELLY SAND, SIMILAR TO ABOVE, EXCEPT 30-35% GRAVEL
	90		65	SS 19	SP	GRAVELLY SAND, SIMILAR TO #18
	95		73	SS 20	SP	GRAVELLY SAND, POORLY GRADED, 10-15% SUBROUNDED GRAVEL TO 0.4 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM SAND, <5% FINES, GRAYISH BROWN
	100	TERMINATED	76	SS 21	SP	SAND, UNIFORM, MEDIUM TO FINE, TRACE OF COARSE SAND, <5% FINES, MEDIUM BROWN
						END OF BORING AT 101.5 FT

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
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6. DATUM IS

4
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1

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION

SH. 1 OF 2

SITE: NATIONAL SYNCHROTRON LIGHT SOURCE J.O. NO. [illegible] BORING NO. [illegible]
TYPE OF BORING: SS LOCATION: BROOKHAVEN NATIONAL LABORATORY GROUND ELEV. 71.1
DATE DRILLED: AUGUST 25, 1977 DRILLED BY: [illegible] LOGGED BY: [illegible]
SUMMARY OF BORING:

ELEV. FEET	DEPTH FEET	OVERALL WEATHERING AND RQD	SAMPLE BLOWS OR RECOV	SAMPLE TYPE	GRAPHIC LOG	SOIL OR ROCK DESCRIPTION (FIELD AND LABORATORY TEST RESULTS, OR JOINTING, BEDDING AND FAULTING DESCRIPTIONS; SOIL STRATA DESCRIPTION, LITHOLOGY AND TEXTURE)
	0		31	SS 1	SM	TOP SOIL, SILTY SAND, WIDELY GRADED, 10-12% SUBANGULAR GRAVEL TO [illegible] INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY FINE, 25-30% NONPLASTIC FINES, BROWN, SOME BRICK FRAGMENTS, FEW ROOTS, BRICK FRAGMENTS FILL
	5		24	SS 2	SP	SAND, UNIFORM FINE, LESS THAN 5% NONPLASTIC FINES, LIGHT GRAYISH [illegible].
	10		14	SS 3	SP	SAND, UNIFORM MEDIUM TO FINE, MOSTLY FINE, 3-5% NONPLASTIC FINES, YELLOWISH GRAY.
	15		56	SS 4	SP-SM	GRAVELLY SAND, POORLY GRADED 14-16% ROUNDED GRAVEL TO 0.4 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY COARSE AND MEDIUM, 5-8% NONPLASTIC FINES, YELLOWISH GRAY, SOME POCKETS OF YELLOWISH GRAY, SILTY SAND.
	20		37	SS 5	SP-SM	GRAVELLY SAND, POORLY GRADED, 12-14% SUBROUNDED GRAVEL TO 1.0 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM AND FINE, 10-12% NONPLASTIC FINES, BROWNISH GRAY.
	25		32	SS 6	SP	GRAVELLY SAND, POORLY GRADED, 12-15% ROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM AND FINE, LESS THAN 5% NONPLASTIC FINES, GRAY.
	30		49	SS 7	SP	SAND, UNIFORM MEDIUM TO FINE (TRACE OF COARSE), LESS THAN 5% NONPLASTIC FINES, GRAY, 2 PIECE OF GRAVEL TO 0.35 INCH MAXIMUM.
	35		75	SS 8	SP-SM	GRAVELLY SAND, POORLY GRADED, 15-18% SUBROUNDED GRAVEL TO 1.0 INCH MAXIMUM, COARSE TO FINE, MOSTLY COARSE AND MEDIUM, 10-12% NONPLASTIC FINES, YELLOWISH GRAY MOTTLED WITH DARK GRAY.
	40		77	SS 9	SP	GRAVELLY SAND, POORLY GRADED, 12-15% SUBROUNDED TO ROUNDED GRAVEL, TO [illegible] INCH, COARSE TO FINE MOSTLY MEDIUM AND FINE, LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY.
	45		54	SS 10	SP	GRAVELLY SAND, POORLY GRADED, 20-25% SUBANGULAR TO SUBROUNDED GRAVEL TO 1.7 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM AND FINE LESS THAN 5% NONPLASTIC FINES. YELLOWISH GRAY.
	50		83	SS 11	SP	GRAVELLY SAND, POORLY GRADED, 15-20% SUBROUNDED GRAVEL TO 0.3 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM AND FINE (VERY LITTLE COARSE). LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY.
	55		93	SS 12	SP	GRAVELLY SAND, POORLY GRADED, 15-20% ROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM AND FINE, (VERY LITTLE COARSE) LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY.
	60		12[illegible]	SS [illegible]	SP	GRAVELLY SAND, POORLY GRADED, 10-12% ROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM AND FINE, LESS THAN 5% NONPLASTIC FINES.
	65		[illegible]	[illegible]	[illegible]	GRAVELLY SAND, POORLY GRADED, 25-30% SUBROUNDED GRAVEL TO 0.75 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM AND FINE, 4-5% NONPLASTIC FINES, [illegible] GRAY, WITH SOME BROWN STAINING.

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
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3. ⊥ INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. [] INDICATES DEPTH & LENGTH OF NX COAING RUN.
6. DATUM IS

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION

SH. 2 OF 2

SITE: NATIONAL SYNCHROTRON LIGHT SOURCE J.O. NO. [illegible] BORING NO. [illegible]
TYPE OF BORING: SS LOCATION: BROOKHAVEN NATIONAL LABORATORY GROUND ELEV. 71.1
DATE DRILLED: AUGUST 25, 1977 DRILLED BY: [illegible] LOGGED BY: [illegible]
SUMMARY OF BORING:

ELEV. FEET	DEPTH FEET	OVERALL WEATHERING AND RQD	SAMPLE BLOWS OR RECOV	SAMPLE TYPE	GRAPHIC LOG	SOIL OR ROCK DESCRIPTION (FIELD AND LABORATORY TEST RESULTS, OR JOINTING, BEDDING AND FAULTING DESCRIPTIONS; SOIL STRATA DESCRIPTION, LITHOLOGY AND TEXTURE)
						SAND, UNIFORM MEDIUM AND FINE, 2 PIECES OF ROUNDED GRAVEL TO 0.5 INCH MAXIMUM, (A TRACE OF COARSE SAND) LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY.
	75		86	SS 16	SP	GRAVELLY SAND, POORLY GRADED, [illegible]% SUBANGULAR TO SUBROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM, LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY.
	80		86	SS 17	SP	GRAVELLY SAND, POORLY GRADED, 10-15% GRAVEL TO 0.4 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM AND FINE, (TRACE OF COARSE) LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY.
	85		82	SS 18	SP	SAND, UNIFORM MEDIUM AND FINE, (TRACE OF GRAVEL TO 0.25 INCH) MOSTLY FINE, LESS THAN 5% NONPLASTIC FINES, GRAY.
	90		62	SS 19	SP	GRAVELLY SAND, POORLY GRADED 15-20% SUBROUNDED TO ROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM AND FINE, LESS THAN 5% NONPLASTIC FINES, GRAY.
	95		58	SS 20	SP	GRAVELLY SAND, POORLY GRADED, 15-20% SUBROUNDED GRAVEL, COARSE TO FINE, MOSTLY MEDIUM, LESS THAN 5% NONPLASTIC FINES, YELLOWISH GRAY.
	100	TERMINATED	137	SS 21	SP	SAND, UNIFORM MEDIUM AND FINE, (TRACE OF GRAVEL TO 0.25 INCH), LSES THAN 5% NONPLASTIC FINES, GRAY.
						END OF BORING AT 101.5 FT

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
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4. RQD - ROCK QUALITY DESIGNATION.
5. [] INDICATES DEPTH & LENGTH OF NX COAING RUN.
6. DATUM IS

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION

SITE NATIONAL SYNCHROTRON LIGHT SOURCE
J.O. NO. [illegible] BORING NO. 1
TYPE OF BORING SS LOCATION BROOKHAVEN NATIONAL LABORATORY
DATE DRILLED AUGUST 24, 1977 GROUND ELEV. 72.6
DRILLED BY TOMPKINS LOGGED BY [illegible]
SUMMARY OF BORING

ELEV. FEET	DEPTH FEET	OVERALL WEATHERING AND RQD (0 25 50 75 100)	SAMPLE: BLOWS OR RECOV	SAMPLE: TYPE	GRAPHIC LOG	SOIL OR ROCK DESCRIPTION (FIELD AND LABORATORY TEST RESULTS; RQ, JOINTING, BEDDING AND FAULTING DESCRIPTIONS / SOIL STRATA DESCRIPTION; LITHOLOGY AND TEXTURE)
	0					
	5			SS 1	SP	SAND, UNIFORM, FINE TO VERY FINE, MOSTLY FINE, < 5% NONPLASTIC FINES, GRAYISH YELLOW.
	10		22	SS 2	SP	SAND, UNIFORM, MEDIUM TO FINE, MOSTLY FINE, < 5% NONPLASTIC FINES, GRAYISH YELLOW.
	15		26	SS 3	SP	SAND, SIMILAR TO SS #2, [illegible] GRAY.
	20		42	SS 4	SP	SAND, UNIFORM, MEDIUM TO FINE, MOSTLY FINE, < 5% NONPLASTIC FINES, [illegible]
	25		67	SS 5	SP	GRAVELLY SAND, POORLY GRADED, 15-20% SUBROUNDED TO ROUNDED, GRAVEL TO 1.0 INCH MAXIMUM, COARSE TO FINE, MOSTLY MEDIUM AND FINE, < 5% NONPLASTIC FINES, YELLOWISH GRAY.
	30		35	SS 6	SP-SM	GRAVELLY SAND, POORLY GRADED, [illegible] SUBROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM AND FINE, 5-8% NONPLASTIC FINES, YELLOWISH GRAY.
	35			SS 7	SP-SM	SAND, SAME AS SS #6.
	40		[illegible]	SS 8	SP-SM	GRAVELLY SAND, POORLY GRADED, [illegible] ROUNDED GRAVEL TO 0.5 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY FINE, 5-8% NONPLASTIC FINES, MOTTLED YELLOWISH GRAY AND LIGHT YELLOWISH BROWN.
	45		79	SS 9	SP	SAND, POORLY GRADED, COARSE TO FINE, MOSTLY MEDIUM AND FINE, < 5% NONPLASTIC FINES, YELLOWISH GRAY.
	50		64	SS 10	SP	SAND, UNIFORM, MEDIUM TO FINE, MOSTLY FINE (ONE PIECE OF GRAVEL TO 0.5 INCH) < 5% NONPLASTIC FINES, YELLOWISH GRAY.
	55		[illegible]	SS 11	SP	SAND, SAME AS SS #10 (NO GRAVEL).
	60		[illegible]	SS 12	SP	SAND, UNIFORM, MEDIUM TO FINE, MOSTLY FINE (TRACE OF COARSE AND ONE PIECE OF GRAVEL TO 0.25 INCH) < 5% NONPLASTIC FINES.
	65		[illegible]	SS 13	SP	GRAVELLY SAND, GAP GRADED, 20-25% SUBROUNDED GRAVEL TO 1.0 INCH MAXIMUM, MOSTLY MEDIUM AND FINE. < 5% NONPLASTIC FINES, GRAYISH YELLOW.
	70		35	SS 14	SP	SAND, UNIFORM, FINE TO MEDIUM (ONE PIECE OF GRAVEL TO 0.5 INCH) TRACE OF COARSE SAND, < 5% NONPLASTIC FINES, YELLOWISH GRAY.

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
2. ▇2 INDICATES LOCATION OF UNDISTURBED SAMPLE. ▛6 INDICATES LOCATION OF SPLIT-SPOON SAMPLE. ▯7 INDICATES LOCATION OF SAMPLING ATTEMPT WITH NO RECOVERY. SUBSCRIPT NEXT TO SYMBOL INDICATES SAMPLE NUMBER.
3. ⊻ INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. ▯ INDICATES DEPTH & LENGTH OF NX CORING RUN.
6. DATUM IS

4	
3	
2	
1	

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION

SITE NATIONAL SYNCHROTRON LIGHT SOURCE
J.O. NO. 13011.01 BORING NO. 1
TYPE OF BORING SS LOCATION BROOKHAVEN NATIONAL LABORATORY
DATE DRILLED AUGUST 24, 1977 GROUND ELEV. 72.6
DRILLED BY TOMPKINS LOGGED BY [illegible]
SUMMARY OF BORING

ELEV. FEET	DEPTH FEET	OVERALL WEATHERING AND RQD (0 25 50 75 100)	SAMPLE: BLOWS OR RECOV	SAMPLE: TYPE	GRAPHIC LOG	SOIL OR ROCK DESCRIPTION (FIELD AND LABORATORY TEST RESULTS; RQ, JOINTING, BEDDING AND FAULTING DESCRIPTIONS / SOIL STRATA DESCRIPTION; LITHOLOGY AND TEXTURE)
	75			SS 15	SP	GRAVELLY SAND, POORLY GRADED, 12-15% SUBROUNDED GRAVEL TO 1.0 INCH MAXIMUM, MEDIUM TO FINE, MOSTLY FINE, < 5% NONPLASTIC FINES, GRAYISH YELLOW - BROKEN JAR.
	80		109	SS 16	SP	SAND, POORLY GRADED, 5-8% SUBANGULAR GRAVEL TO 0.25 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM TO FINE, < 5% NONPLASTIC FINES, YELLOWISH GRAY.
	85		121	SS 17	SP	GRAVELLY SAND, POORLY GRADED, 15-20% GRAVEL TO 0.75 INCH MAXIMUM, COARSE TO FINE SAND, MOSTLY MEDIUM AND FINE, < 5% NONPLASTIC FINES, YELLOWISH GRAY, LAYER OF GRAY FINE TO VERY FINE SAND.
	90		151	SS 18	SP	SAND, UNIFORM, MEDIUM TO FINE, MOSTLY FINE (TRACE OF COARSE) 5% NONPLASTIC FINES, GRAYISH YELLOW.
	95		196	SS 19	SP	SAND, POORLY GRADED, COARSE TO FINE, MOSTLY MEDIUM AND FINE, < 5% NONPLASTIC FINES, YELLOWISH GRAY WITH SOME REDDISH BROWN STAINING.
	100	Terminated	213	SS 20	SP	SAND, UNIFORM, FINE TO VERY FINE (TRACE OF COARSE) < 5% NONPLASTIC FINES, YELLOWISH GRAY.
	105					END OF BORING AT 102.0 FT

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
2. ▇2 INDICATES LOCATION OF UNDISTURBED SAMPLE. ▛6 INDICATES LOCATION OF SPLIT-SPOON SAMPLE. ▯7 INDICATES LOCATION OF SAMPLING ATTEMPT WITH NO RECOVERY. SUBSCRIPT NEXT TO SYMBOL INDICATES SAMPLE NUMBER.
3. ⊻ INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. ▯ INDICATES DEPTH & LENGTH OF NX CORING RUN.
6. DATUM IS

4	
3	
2	
1	

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION

SH 1 OF 2

SITE NATIONAL SYNCHROTRON LIGHT SOURCE J.O. NO. 13011.01 BORING NO. 6
TYPE OF BORING SS LOCATION BROOKHAVEN NATIONAL LABORATORY GROUND ELEV. 74.4
DATE DRILLED AUGUST 25, 1977 DRILLED BY TOMPKINS LOGGED BY DRM
SUMMARY OF BORING

ELEV. FEET	DEPTH FEET	OVERALL WEATHERING AND RQD (0 25 50 75 100)	SAMPLE BLOWS OR RECOV.	SAMPLE TYPE	GRAPHIC LOG	SOIL OR ROCK DESCRIPTION (FIELD AND LABORATORY TEST RESULTS; OR JOINTING, BEDDING AND FAULTING DESCRIPTIONS — SOIL STRATA DESCRIPTION; LITHOLOGY AND TEXTURE)
	0					
	5		[illegible]	SS 1	SM	SILTY SAND, UNIFORM MEDIUM TO FINE, MOSTLY FINE, 12-15% NONPLASTIC FINES, YELLOWISH BROWN
	10		98	SS 2	SM	SILTY SAND, WIDELY GRADED, 18-23% SUBANGULAR GRAVEL TO 0.7 INCH MAX, COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, 18-23% NONPLASTIC FINES, BROWN
	15		50	SS 3	SP	SAND, POORLY GRADED, 10-15% SUBANGULAR GRAVEL TO 0.6 INCH MAX, COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, <5% FINES, BROWN
	20		147	SS 4	GP	SANDY GRAVEL, POORLY GRADED, SUBANGULAR TO 0.8 INCH MAX, 43-47% COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, 3-5% FINES, GRAYISH BROWN
	25		126	SS 5	SP	GRAVELLY SAND, POORLY GRADED, 40-45% SUBANGULAR TO SUBROUNDED TO 0.7 INCH MAX, COARSE TO FINE, MOSTLY MEDIUM SAND, <5% FINES, GRAYISH BROWN
	30		149	SS 6	SP	GRAVELLY SAND, POORLY GRADED, 20-25% SUBANGULAR GRAVEL TO 0.8 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, <5% FINES, GRAYISH BROWN
	35		123	SS 7	SP	GRAVELLY SAND, POORLY GRADED, 40-45% SUBANGULAR GRAVEL TO 0.7 INCH MAX[redacted]MOSTLY MEDIUM TO FINE SAND, <5% FINES, GRAYISH BROWN
	40		83	SS 8	SP	GRAVELLY SAND, POORLY GRADED, 12-16% SUBROUNDED GRAVEL TO 0.5 INCH MAX, COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, <5% FINES, GRAYISH BROWN
	45		99	SS 9	SP	GRAVELLY SAND, SIMILAR TO ABOVE, EXCEPT 10-15% GRAVEL
	50		128	SS 10	SP	GRAVELLY SAND, SIMILAR TO ABOVE, EXCEPT 15-25% GRAVEL TO 0.6 INCH MAX.
	55		112	SS 11	SP-SM	SAND, POORLY GRADED, 5-8% GRAVEL TO 0.4 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, 5-8% NONPLASTIC FINES, GRAYISH BROWN
	60		40	SS 12	SP-SM	SAND, SIMILAR TO ABOVE
	65		72	SS 13	SP-SM	SAND, SIMILAR TO ABOVE
	70		57	SS 14	SP-SM	SAND, UNIFORM, MEDIUM TO FINE, TRACE OF 0.4 INCH GRAVEL, 5-8% NONPLASTIC FINES, GRAY

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
2. U2 INDICATES LOCATION OF UNDISTURBED SAMPLE. S6 INDICATES LOCATION OF SPLIT-SPOON SAMPLE. INDICATES LOCATION OF SAMPLING ATTEMPT WITH NO RECOVERY. SUBSCRIPT NEXT TO SYMBOL INDICATES SAMPLE NUMBER.
3. INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. INDICATES DEPTH & LENGTH OF NX CORING RUN.
6. DATUM IS

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION

SH 2 OF 2

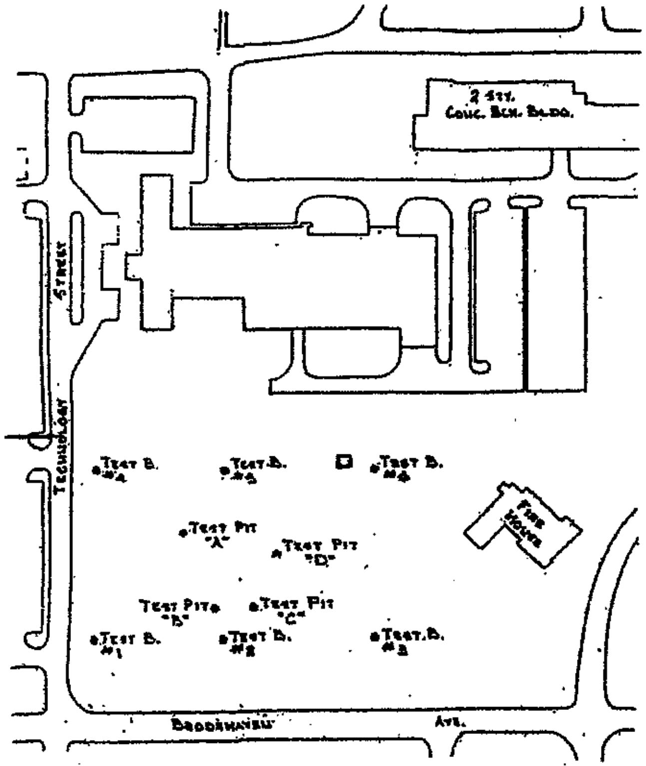
SITE NATIONAL SYNCHROTRON LIGHT SOURCE J.O. NO. 13011.01 BORING NO. 6
TYPE OF BORING SS LOCATION BROOKHAVEN NATIONAL LABORATORY GROUND ELEV. 7
DATE DRILLED AUGUST 25, 1977 DRILLED BY TOMPKINS LOGGED BY DRM
SUMMARY OF BORING

ELEV. FEET	DEPTH FEET	OVERALL WEATHERING AND RQD (0 25 50 75 100)	SAMPLE BLOWS OR RECOV.	SAMPLE TYPE	GRAPHIC LOG	SOIL OR ROCK DESCRIPTION (FIELD AND LABORATORY TEST RESULTS; OR JOINTING, BEDDING AND FAULTING DESCRIPTIONS — SOIL STRATA DESCRIPTION; LITHOLOGY AND TEXTURE)
	75		132	SS 15	SP-SM	SAND, POORLY GRADED, 8-12% GRAVEL TO 0.5 INCH MAX., COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, 5-8% NONPLASTIC FINES, GRAYISH BROWN
	80		190/9"	SS 16	SP-SM	SAND, SIMILAR TO ABOVE
	85		206	SS 17	SP-SM	GRAVELLY SAND, POORLY GRADED, 10-15% SUBANGULAR GRAVEL TO 0.5 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, 5-8% NONPLASTIC FINES, GRAYISH BROWN
	90		90	SS 18	SP-SM	SAND, UNIFORM, MEDIUM TO FINE, TRACE OF 0.4 INCH GRAVEL, 5-8% NONPLASTIC FINES, GRAYISH BROWN
	95		116	SS 19	SP	GRAVELLY SAND, POORLY GRADED, 15-20% SUBANGULAR GRAVEL TO 0.6 INCH MAX, COARSE TO FINE, MOSTLY MEDIUM TO FINE SAND, <5% FINES, GRAYISH BROWN
	100	TERMINATED	137	SS 20	SP	SAND, POORLY GRADED, 8-12% GRAVEL TO 0.5 INCH MAX. COARSE TO FINE, MOSTLY MEDIUM SAND, <5% FINES, GRAYISH BROWN END OF BORING AT 102 FT

1. FIGURES IN BLOW OR RECOVERY COLUMN OPPOSITE SOIL SAMPLE DENOTE THE NUMBER OF BLOWS OF A 140 LB HAMMER FALLING 30" REQUIRED TO DRIVE A 2" OD SAMPLE SPOON 12" OR THE DISTANCE SHOWN. FIGURES SHOWN OPPOSITE ROCK CORES DENOTE THE PERCENT OF CORE RECOVERED.
2. U2 INDICATES LOCATION OF UNDISTURBED SAMPLE. S6 INDICATES LOCATION OF SPLIT-SPOON SAMPLE. INDICATES LOCATION OF SAMPLING ATTEMPT WITH NO RECOVERY. SUBSCRIPT NEXT TO SYMBOL INDICATES SAMPLE NUMBER.
3. INDICATES LOCATION OF NATURAL GROUND WATER TABLE.
4. RQD - ROCK QUALITY DESIGNATION.
5. INDICATES DEPTH & LENGTH OF NX CORING RUN.
6. DATUM IS

NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

STONE & WEBSTER ENGINEERING CORPORATION



LOG OF TEST PITS

TEST PIT "A"
EAST WALL
0 - 2'-6" FILL, TOPSOIL AT TOP
2'-6" - 4'-0" SAND, SILTY, FINE UNIFORM, COMPACT, MEDIUM BROWN WEATHERED AND STAINED
4'-0" - 12'-0" SAND, CLEAN, MEDIUM FINE, UNIFORM, FIRM WELL ROUNDED, LIGHT YELLOW GRAY SHOWS FORE-SET BEDDING DIPPING SOUTH
WEST WALL
0 - 1'-0" FILL, SANDY TOPSOIL
1'-0" - 3'-3" FILL, SANDY
3'-3" - 5'-6" SAND, SILTY, FINE, UNIFORM, COMPACT, MEDIUM BROWN, WEATHERED AND STAINED
5'-6" - 12'-0" SAND, CLEAN, MEDIUM FINE, UNIFORM, FIRM WELL ROUNDED, LIGHT YELLOW-GRAY SHOWS FORE-SET BEDDING DIPPING SW 20°

TEST PIT "B"
0 - 3'-5" TOPSOIL (FILL?)
3'-5" - 8'-0" SAND, SILTY, FINE, UNIFORM, COMPACT MEDIUM BROWN, WEATHERED AND STAINED
8'-0" - 12'-0" SAND, CLEAN, MEDIUM FINE, UNIFORM FIRM, ROUNDED, LIGHT YELLOW GRAY SHOWS FORE-SET BEDDING DIPPING SW AT 15°-20°
NOTE: BACKFILLED TRENCH CROSSES TEST PIT IN EAST-WEST DIRECTION - BOTTOM DEPTH OF 6.8 FT. FROM SURFACE

TEST PIT "C"
0 - 1'-5" FILL - TOPSOIL
1'-5" - 2'-4" TOPSOIL
2'-4" - 5'-7" SAND, SILTY, FINE, UNIFORM, COMPACT MEDIUM BROWN, WEATHERED AND STAINED
5'-7" - 12'-0" SAND, CLEAN, MEDIUM FINE, UNIFORM, FIRM ROUNDED, LIGHT YELLOW GRAY SHOWS FORE-SET BEDDING DIPPING WSW
NOTE: BACKFILLED TRENCH CROSSES TEST PIT IN EAST-WEST DIRECTION, BOTTOM DEPTH 6'-8"

TEST PIT "D"
0 - 1'-0" TOPSOIL
1'-0" - 4'-10" SAND, SILTY, FINE, UNIFORM, COMPACT MEDIUM BROWN, WEATHERED AND STAINED
4'-10" - 11'-0" SAND, CLEAN, MEDIUM FINE, UNIFORM FIRM, ROUNDED, LIGHT YELLOW-GRAY SHOWS FORE-SET BEDDING DIPPING WSW AT 20°

LOCATION	GROUND ELEV.	COORDINATES NORTH	EAST
TEST BORING #1	72.8	100,100	100,350
" " #2	71.4	100,100	100,510
" " #3	72.3	100,100	100,700
" " #4	73.1	100,320	100,350
" " #5	72.6	100,320	100,510
" " #6	74.4	100,320	100,700
TEST PIT A	71.7	100,240	100,460
" " B	71.5	100,140	100,500
" " C	71.7	100,140	100,550
" " D	71.7	100,210	100,580

7	6	5	4	3	2	1

FOUNDATION INVESTIGATIONS
NATIONAL SYNCHROTRON LIGHT SOURCE
BROOKHAVEN NATIONAL LABORATORY

FIG. 1

Appendix B

2003 Test Boring Logs

CLIENT: GEI

PROJECT NAME: Brookhaven National Labs

LOCATION: Long Island, NY

DRILLER: T. Roe

INSPECTOR: A. Smart

DATE START: 10/28/03

DATE FINISH: 10/28/03

NEW ENGLAND BORING CONTRACTORS OF CT., INC.

129 KRIEGER LANE
GLASTONBURY, CT 06033
(860) 633-4649 – (413) 733-1232
FAX (860) 657-8046

	Casing	Sampler	Core Barrel
TYPE	HSA	SS	
SIZE I.D.	3-1/4"	1-3/8"	
HAMMER WT.		140	
HAMMER FALL		30"	

BORING No. B-1

SHEET 1 OF 1

ARCHITECT/ENGINEER

FILE NO. GEI-LongIsland, NY

SURFACE ELEV.

LINE & STATION

OFFSET

SAMPLE No.	DEPTH RANGE IN FEET	BLOWS PER 6" ON SAMPLER 0-6	6-12	12-18	18-24	REC.	CASING BLOWS/ CORING TIMES PER FT.	FIELD CLASSIFICATION AND REMARKS	Well Cons.	Installation Details
S1	0'-2'	1	1	2	1	8"		8" Dark Brown Topsoil (.6) Gray Brown Fine Sand, Some Silt, Trace of Roots - Fill (2.5)		
S2	5'-7'	5	6	8	9	14"		Light Brown Fine Sand, Stratified		
S3	10'-12'	7	7	9	12	24"		Light Brown Fine Sand, Some Silt, Stratified		
S4	15'-17'	5	12	14	13	20"		Light Brown Fine Sand, Little Gravel, Stratified; Cobble @ 19'-19'6"		
S5	20'-22'	5	7	7	9	24"		Brown Fine-Med. Sand, Trace of Gravel, Stratified		
S6	25'-27'	5	6	10	11	24"				
S7	30'-32'	9	11	13	17	20"		Brown Med.-Crs. Sand, Little Fine Sand (32.0)		
								End of Boring @ 32'; Water @ 31'		

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual.

2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of groundwater may occur due to factors other than those present at the time measurements were made.

REMARKS:

CLIENT: GEI	
PROJECT NAME: Brookhaven National Labs	
LOCATION: Long Island, NY	
DRILLER: T. Roe	
INSPECTOR: A. Smart	
DATE START: 10/28/03	
DATE FINISH: 10/28/03	

NEW ENGLAND BORING CONTRACTORS OF CT., INC.

129 KRIEGER LANE
GLASTONBURY, CT 06033
(860) 633-4649 – (413) 733-1232
FAX (860) 657-8046

	Casing	Sampler	Core Barrel
TYPE	HSA	SS	
SIZE I.D.	3-1/4"	1-3/8"	
HAMMER WT.		140	
HAMMER FALL		30"	

BORING No. B-2

SHEET 1 OF 1

ARCHITECT/ ENGINEER

FILE NO. GEI-LongIsland, NY

SURFACE ELEV.

LINE & STATION

OFFSET

SAMPLE No.	DEPTH RANGE IN FEET	BLOWS PER 6" ON SAMPLER 0-6	6-12	12-18	18-24	REC.	CASING BLOWS/ CORING TIMES PER FT.	FIELD CLASSIFICATION AND REMARKS	Well Cons.	Installation Details
S1	0'-2'	2	2	2	2	20"		5" Dark brown Sandy Topsoil (.4) Brown Fine Sand, Little Silt, Trace of Roots - Fill (3.0)		
S2	5'-7'	4	7	10	13	18"		Light Brown Fine Sand Trace of Silt @ S6, Stratified Little Silt @ S7		
S3	10'-12'	3	5	5	7	18"				
S4	15'-17'	3	4	5	5	16"				
S5	20'-22'	5	5	6	8	18"				
S6	25'-27'	6	8	10	10	20"				
S7	30'-32'	7	9	10	9	18"		(32.0)		
								End of Boring @ 32' Water @ 29' Water @ 28' Overnight		

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual. 2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of groundwater may occur due to factors other than those present at the time measurements were made.

REMARKS: *Note: Moved Hole 10' West Due to Overhead Branches*

CLIENT: GEI

PROJECT NAME: Brookhaven National Labs

LOCATION: Long Island, NY

DRILLER: T. Roe

INSPECTOR: A. Smart

DATE START: 10/28/03

DATE FINISH: 10/28/03

NEW ENGLAND BORING CONTRACTORS OF CT., INC.

129 KRIEGER LANE
GLASTONBURY, CT 06033
(860) 633-4649 – (413) 733-1232
FAX (860) 657-8046

	Casing	Sampler	Core Barrel
TYPE	HSA	SS	
SIZE I.D.	3-1/4"	1-3/8"	
HAMMER WT.		140	
HAMMER FALL		30"	

BORING No. B-3

SHEET 1 OF 1

ARCHITECT/ ENGINEER

FILE NO. GEI-LongIsland, NY

SURFACE ELEV.

LINE & STATION

OFFSET

SAMPLE No.	DEPTH RANGE IN FEET	BLOWS PER 6" ON SAMPLER 0-6	6-12	12-18	18-24	REC.	CASING BLOWS/ CORING TIMES PER FT.	FIELD CLASSIFICATION AND REMARKS	Well Cons.	Installation Details
S1	0'-2'	3	3	1	1	14"		1" Asphalt - 2" Dark Brown Topsoil. 2 Brown Fine Sand, Trace of Silt, Possible Fill 2.5 Light Brown Fine Sand, Stratified		
S2	5'-7'	3	6	8	10	20"				
S3	10'-12'	3	5	5	5	16"				
S4	15'-17'	3	2	3	4	24"				
S5	20'-22'	3	4	5	8	20"				
S6	25'-27'	4	6	6	9	24"				
S7	30'-32'	2	5	6	10	24"		32.0 End of Boring @ 32' Water @ 31' Water @ 28' Overnight		

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual.

2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of ground-water may occur due to factors other than those present at the time measurements were made.

REMARKS:

CLIENT: GEI

PROJECT NAME: Brookhaven National Labs

LOCATION: Long Island, NY

DRILLER: T. Roe

INSPECTOR: A. Smart

DATE START: 10/27/03

DATE FINISH: 10/27/03

NEW ENGLAND BORING CONTRACTORS OF CT., INC.

129 KRIEGER LANE
GLASTONBURY, CT 06033
(860) 633-4649 – (413) 733-1232
FAX (860) 657-8046

	Casing	Sampler	Core Barrel
TYPE	NW	SS	
SIZE I.D.	3"	1-3/8"	
HAMMER WT.	300	140	
HAMMER FALL	24"	30"	

BORING No. B-4

SHEET 1 OF 2

ARCHITECT/ ENGINEER

FILE NO. GEI-LongIsland, NY

SURFACE ELEV.

LINE & STATION

OFFSET

SAMPLE No.	DEPTH RANGE IN FEET	BLOWS PER 6" ON SAMPLER 0-6	6-12	12-18	18-24	REC.	CASING BLOWS/ CORING TIMES PER FT.	FIELD CLASSIFICATION AND REMARKS	Well Cons.	Installation Details
S1	0'-2'	1	2	2	3	20"		Dark Brown Sandy Topsoil (1.0) Gray Fine Sand, Little Silt, Trace of Roots - Fill (3.0) Light Brown Fine-Med. Sand, Stratified		
S2	5'-7'	8	11	13	14	20"				
S3	10'-12'	9	10	9	8	18"				
S4	15'-17'	11	14	17	19	16"		Light Brown Fine-Crs. Sand, Trace of Fine Gravel, Stratified		
S5	20'-22'	3	4	6	9	12"		Light Brown Fine Sand, Some Med.-Crs. Sand, Trace of Fine-Crs. Gravel		
S6	25'-27'	14	16	26	28	12"				
S7	30'-32'	15	25	25	28	12"				
S8	35'-37'	9	12	15	22	14"				
S9	40'-42'	13	25	34	36	12"				
S10	45'-47'	9	22	22	25	14"				
S11	50'-52'	9	15	16	14	12"				
S12	55'-57'	10	14	10	9	12"				

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual.

2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of groundwater may occur due to factors other than those present at the time measurements were made.

REMARKS:

CLIENT: GEI

PROJECT NAME: Brookhaven National Labs

LOCATION: Long Island, NY

DRILLER: T. Roe

INSPECTOR: A. Smart

DATE START: 10/27/03

DATE FINISH: 10/27/03

NEW ENGLAND BORING CONTRACTORS OF CT., INC.
129 KRIEGER LANE
GLASTONBURY, CT 06033
(860) 633-4649 – (413) 733-1232
FAX (860) 657-8046

	Casing	Sampler	Core Barrel
TYPE	NW	SS	
SIZE I.D.	3"	1-3/8"	
HAMMER WT.	300	140	
HAMMER FALL	24"	30"	

BORING No. B-4

SHEET 2 OF 2

ARCHITECT/ ENGINEER

FILE NO. GEI-LongIsland, NY

SURFACE ELEV.

LINE & STATION

OFFSET

SAMPLE No.	DEPTH RANGE IN FEET	BLOWS PER 6" ON SAMPLER 0-6	6-12	12-18	18-24	REC.	CASING BLOWS/ CORING TIMES PER FT.	FIELD CLASSIFICATION AND REMARKS	Well Cons.	Installation Details
S13	60'-62'	8	13	17	18	12"		62.0		
								End of Boring @ 62' Water @ 18' Overnight Water @ 23' After 60 Hours +/-		

CLIENT: GEI

PROJECT NAME: Brookhaven National Labs

LOCATION: Long Island, NY

DRILLER: T. Roe

INSPECTOR: A. Smart

DATE START: 10/30/03

DATE FINISH: 10/30/03

NEW ENGLAND BORING CONTRACTORS OF CT., INC.
129 KRIEGER LANE
GLASTONBURY, CT 06033
(860) 633-4649 – (413) 733-1232
FAX (860) 657-8046

	Casing	Sampler	Core Barrel
TYPE	HSA	SS	
SIZE I.D.	3-1/4"	1-3/8"	
HAMMER WT.		140	
HAMMER FALL		30"	

BORING No. B-5

SHEET 1 OF 1

ARCHITECT/ENGINEER

FILE NO. GEI-LongIsland, NY

SURFACE ELEV.

LINE & STATION

OFFSET

SAMPLE No.	DEPTH RANGE IN FEET	BLOWS PER 6" ON SAMPLER 0-6	6-12	12-18	18-24	REC.	CASING BLOWS/ CORING TIMES PER FT.	FIELD CLASSIFICATION AND REMARKS	Well Cons.	Installation Details
								6" Dark Brown Topsoil (.5)		
S1	0'-2'	2	2	2	1	18"		Brown Fine Sand, Little Silt - Fill (3.0)		
								Light Brown Fine Sand, Stratified		
S2	5'-7'	5	8	9	13	20"				
S3	10'-12'	4	5	6	7	24"				
S4	15'-17'	4	4	4	6	20"				
S5	20'-22'	4	7	9	11	24"		Brown Fine Sand, Little Silt, Stratified		
S6	25'-27'	6	10	12	16	18"		Light Brown Fine Sand, Little Fine Gravel, Stratified		
S7	30'-32'	5	4	9	8	15"		Light Brown Fine-Med. Sand, Some Gravel, Stratified (32.0)		
								End of Boring @ 32' Water @ 28' Overnight		

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual. 2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of groundwater may occur due to factors other than those present at the time measurements were made.

REMARKS:

CLIENT: GEI PROJECT NAME: Brookhaven LOCATION: Long Island, NY National Labs DRILLER: T. Roe INSPECTOR: A. Smart DATE START: 10/29/03 DATE FINISH: 10/29/03	NEW ENGLAND BORING CONTRACTORS OF CT., INC. 129 KRIEGER LANE GLASTONBURY, CT 06033 (860) 633-4649 -- (413) 733-1232 FAX (860) 657-8046	BORING No. B-6 SHEET 1 OF 1 ARCHITECT/ ENGINEER FILE NO. GEI-LongIsland, NY SURFACE ELEV. LINE & STATION OFFSET

	Casing	Sampler	Core Barrel
TYPE	HSA	SS	
SIZE I.D.	3-1/4"	1-3/8"	
HAMMER WT.		140	
HAMMER FALL		30"	

SAMPLE							CASING BLOWS/ CORING TIMES PER FT.	FIELD CLASSIFICATION AND REMARKS		Well Cons.	Installation Details
No.	DEPTH RANGE IN FEET	BLOWS PER 6" ON SAMPLER				REC.					
		0-6	6-12	12-18	18-24						
S1	0'-2'	2	7	4	2	24"		4" Dark Brown Topsoil - Fine Sand, Some Silt, Little Roots	.3		
								Brown Fine Sand, Some Silt, Stratified - Fill	5.5		
S2	5'-7'	9	11	12	19	20"		Light Brown Fine Sand, Stratified			
S3	10'-12'	9	10	12	15	24"		Trace of Gravel @ S3			
S4	15'-17'	4	9	6	7	24"					
S5	20'-22'	8	18	18	21	24"		Light Brown Fine Sand, Trace of Med.-Crs. Sand, Stratified			
S6	25'-27'	10	21	25	30	24"					
S7	30'-32'	16	27	25	22	24"			32.0		
								End of Boring @ 32' Water @ 30' +/-			

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual.

2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of groundwater may occur due to factors other than those present at the time measurements were made.

REMARKS:

CLIENT: GEI

PROJECT NAME: Brookhaven National Labs

LOCATION: Long Island, NY

DRILLER: T. Roe

INSPECTOR: A. Smart

DATE START: 10/29/03

DATE FINISH: 10/29/03

NEW ENGLAND BORING CONTRACTORS OF CT., INC.

129 KRIEGER LANE
GLASTONBURY, CT 06033
(860) 633-4649 – (413) 733-1232
FAX (860) 657-8046

	Casing	Sampler	Core Barrel
TYPE	SA	SS	
SIZE I.D.	4"	1-3/8"	
HAMMER WT.		140	
HAMMER FALL		30"	

BORING No. B-7

SHEET 1 OF 1

ARCHITECT/ ENGINEER

FILE NO. GEI-LongIsland, NY

SURFACE ELEV.

LINE & STATION

OFFSET

SAMPLE No.	DEPTH RANGE IN FEET	BLOWS PER 6" ON SAMPLER 0-6	6-12	12-18	18-24	REC.	CASING BLOWS/ CORING TIMES PER FT.	FIELD CLASSIFICATION AND REMARKS	Well Cons.	Installation Details
S1	0'-2'	1	2	1	1	24"		Dark Brown Topsoil		
								1.0		
								Brown Fine Sand, Some Silt - Fill		
								3.0		
S2	5'-7'	5	8	10	12	24"		Light Brown Fine Sand, Stratified		
								7.0		
								End of Boring @ 7' No Water		

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual.

2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of groundwater may occur due to factors other than those present at the time measurements were made.

REMARKS:

CLIENT: GEI

PROJECT NAME: Brookhaven National Labs

LOCATION: Long Island, NY

DRILLER: T. Roe

INSPECTOR: A. Smart

DATE START: 10/29/03

DATE FINISH: 10/29/03

NEW ENGLAND BORING CONTRACTORS OF CT., INC.
129 KRIEGER LANE
GLASTONBURY, CT 06033
(860) 633-4649 -- (413) 733-1232
FAX (860) 657-8046

	Casing	Sampler	Core Barrel
TYPE	SA	SS	
SIZE I.D.	4"	1-3/8"	
HAMMER WT.		140	
HAMMER FALL		30"	

BORING No. B-8

SHEET 1 OF 1

ARCHITECT/ ENGINEER

FILE NO. GEI-LongIsland, NY

SURFACE ELEV.

LINE & STATION

OFFSET

SAMPLE No.	DEPTH RANGE IN FEET	BLOWS PER 6" ON SAMPLER 0-6	6-12	12-18	18-24	REC.	CASING BLOWS/ CORING TIMES PER FT.	FIELD CLASSIFICATION AND REMARKS	Well Cons.	Installation Details
S1	0'-2'	3	2	3	2	18"		Brown Fine Sand, Little Silt - Fill		
								4.0		
S2	5'-7'	3	3	4	4	24"		Light Brown Fine Sand, Trace of Gravel, Stratified		
								7.0		
								End of Boring @ 7' No Water		

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual.

2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of groundwater may occur due to factors other than those present at the time measurements were made.

REMARKS:

CLIENT: GEI PROJECT NAME: Brookhaven National Labs LOCATION: Long Island, NY DRILLER: T. Roe INSPECTOR: A. Smart DATE START: 10/29/03 DATE FINISH: 10/29/03	NEW ENGLAND BORING CONTRACTORS OF CT., INC. 129 KRIEGER LANE GLASTONBURY, CT 06033 (860) 633-4649 -- (413) 733-1232 FAX (860) 657-8046	BORING No. B-9 SHEET 1 OF 1 ARCHITECT/ ENGINEER FILE NO. GEI-LongIsland, NY SURFACE ELEV. LINE & STATION OFFSET

	Casing	Sampler	Core Barrel
TYPE	SA	SS	
SIZE I.D.	4"	1-3/8"	
HAMMER WT.		140	
HAMMER FALL		30"	

SAMPLE No.	DEPTH RANGE IN FEET	BLOWS PER 6" ON SAMPLER 0-6	6-12	12-18	18-24	REC.	CASING BLOWS/ CORING TIMES PER FT.	FIELD CLASSIFICATION AND REMARKS	Well Cons.	Installation Details
S1	0'-2'	1	6	6	5	20"		8" Dark Brown Topsoil .6 Black Fine Sand, Trace of Roots, Ash, Brick		
S2	5'-7'	1	2	1	1	24"		Brown Fine Sand, Some Silt - Fill 7.0 Light Brown Fine Sand		
S3	10'-12'	5	5	4	7	18"		12.0 End of Boring @ 12' No Water		

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual.

2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of groundwater may occur due to factors other than those present at the time measurements were made.

REMARKS:

CLIENT: GEI

PROJECT NAME: Brookhaven National Labs

LOCATION: Long Island, NY

DRILLER: T. Roe

INSPECTOR: A. Smart

DATE START: 10/29/03

DATE FINISH: 10/29/03

NEW ENGLAND BORING CONTRACTORS OF CT., INC.

129 KRIEGER LANE
GLASTONBURY, CT 06033
(860) 633-4649 – (413) 733-1232
FAX (860) 657-8046

	Casing	Sampler	Core Barrel
TYPE	SA	SS	
SIZE I.D.	4"	1-3/8"	
HAMMER WT.		140	
HAMMER FALL		30"	

BORING No. B-10

SHEET 1 OF 1

ARCHITECT/ ENGINEER

FILE NO. GEI-LongIsland, NY

SURFACE ELEV.

LINE & STATION

OFFSET

SAMPLE No.	DEPTH RANGE IN FEET	BLOWS PER 6" ON SAMPLER 0-6	6-12	12-18	18-24	REC.	CASING BLOWS/ CORING TIMES PER FT.	FIELD CLASSIFICATION AND REMARKS	Well Cons.	Installation Details
S1	0'-2'	1	4	3	3	24"		Dark Brown Topsoil		
								1.0		
								Brown Fine Sand, Some Silt - Fill		
								5.0		
S2	5'-7'	2	4	6	5	24"		Light Brown Fine Sand, Trace of Gravel, Stratified		
								7.0		
								End of Boring @ 7' No Water		

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual.

2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of groundwater may occur due to factors other than those present at the time measurements were made.

REMARKS:

CLIENT: GEI

PROJECT NAME: Brookhaven National Labs

LOCATION: Long Island, NY

DRILLER: T. Roe

INSPECTOR: A. Smart

DATE START: 10/29/03

DATE FINISH: 10/29/03

NEW ENGLAND BORING CONTRACTORS OF CT., INC.
129 KRIEGER LANE
GLASTONBURY, CT 06033
(860) 633-4649 – (413) 733-1232
FAX (860) 657-8046

BORING No. B-12

SHEET 1 OF 1

ARCHITECT/ ENGINEER

FILE NO. GEI-LongIsland, NY

SURFACE ELEV.

LINE & STATION

OFFSET

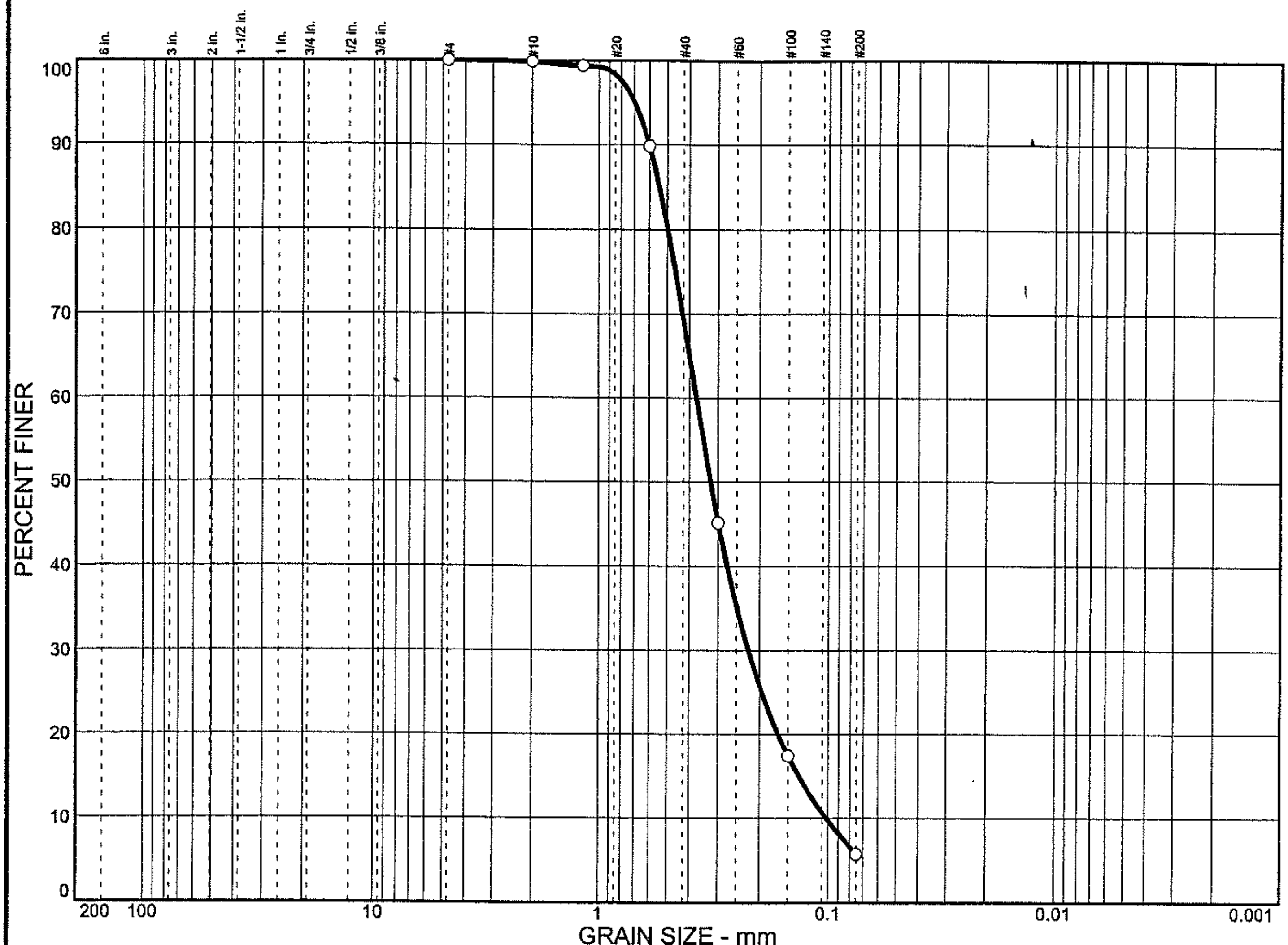
	Casing	Sampler	Core Barrel
TYPE	HSA	SS	
SIZE I.D.	3-1/4"	1-3/8"	
HAMMER WT.		140	
HAMMER FALL		30"	

SAMPLE No.	DEPTH RANGE IN FEET	BLOWS PER 6" ON SAMPLER 0-6	6-12	12-18	18-24	REC.	CASING BLOWS/ CORING TIMES PER FT.	FIELD CLASSIFICATION AND REMARKS	Well Cons.	Installation Details
S1	0'-2'	1	2	3	2	24"		8" Dark Brown Topsoil (.6); Brown Fine Sand, Little Silt - Fill (4.0)		
S2	5'-7'	2	5	8	8	24"		Brown Fine Sand, Stratified		
S3	10'-12'	5	9	9	11	24"				
S4	15'-17'	4	5	5	5	24"		Alternating 4"-10" Layers of Brown Fine Sand and Brown Fine Sand, Little Silt		
S5	20'-22'	7	11	18	19	24"		Light Brown Fine-Med. Sand, Trace of Gravel, Stratified		
S6	25'-27'	4	5	8	8	16"		Cobbles @ 22' to 24' Depth; Light Brown Med. Sand, Little Gravel, Stratified		
S7	30'-32'	9	12	14	18	20"		(32.0) End of Boring @ 32' Water @ 30' +/-		

NOTES: 1) The stratification lines represent the approximate boundary between soil types. Transitions may be gradual. 2) Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. Fluctuations in the level of groundwater may occur due to factors other than those present at the time measurements were made.

REMARKS: *Note: B-11 was Omitted*

GRAIN SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	94.3	5.7	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.544	0.374	0.324	0.223	0.135	0.102	1.31	3.67

MATERIAL DESCRIPTION	USCS	AASHTO
○ Narrowly graded SAND with Silt	SP-SM	

Project No. 03420 **Client:** HDR Architecture, Inc.

Project: Center for Functional Nanomaterials, Brookhaven National Laboratory

○ **Source:** B1 **Sample No.:** S2 **Elev./Depth:** 5 to 7 ft

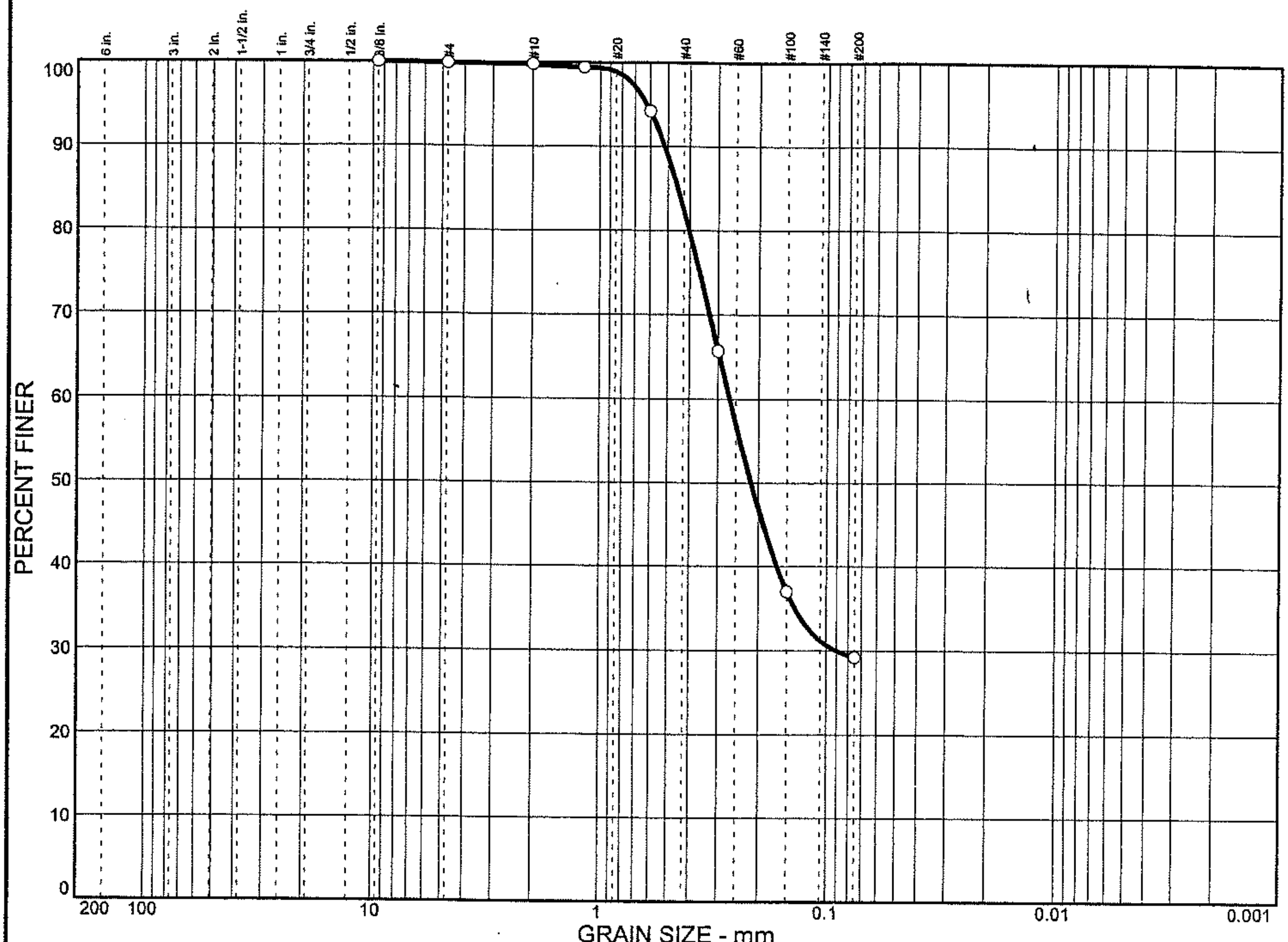
Remarks:

○

GEI Consultants, Inc.

Fig.

GRAIN SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.1	70.7	29.2	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.454	0.267	0.215	0.0903				

MATERIAL DESCRIPTION	USCS	AASHTO
○ Silty SAND	SM	

Project No. 03420 **Client:** HDR Architecture, Inc.

Project: Center for Functional Nanomaterials, Brookhaven National Laboratory

○ **Source:** B2 **Sample No.:** S1 **Elev./Depth:** 5 to 7 ft

Φ GEI Consultants, Inc.

Remarks:

○

Fig.

GRAIN SIZE DISTRIBUTION TEST REPORT

	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	97.8	2.2	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.518	0.332	0.284	0.209	0.158	0.138	0.95	2.40

MATERIAL DESCRIPTION	USCS	AASHTO
○ Narrowly graded SAND	SP	

Project No. 03420 **Client:** HDR Architecture, Inc.

Project: Center for Functional Nanomaterials, Brookhaven National Laboratory

○ **Source:** B3 **Sample No.:** S2 **Elev./Depth:** 5 to 7 ft

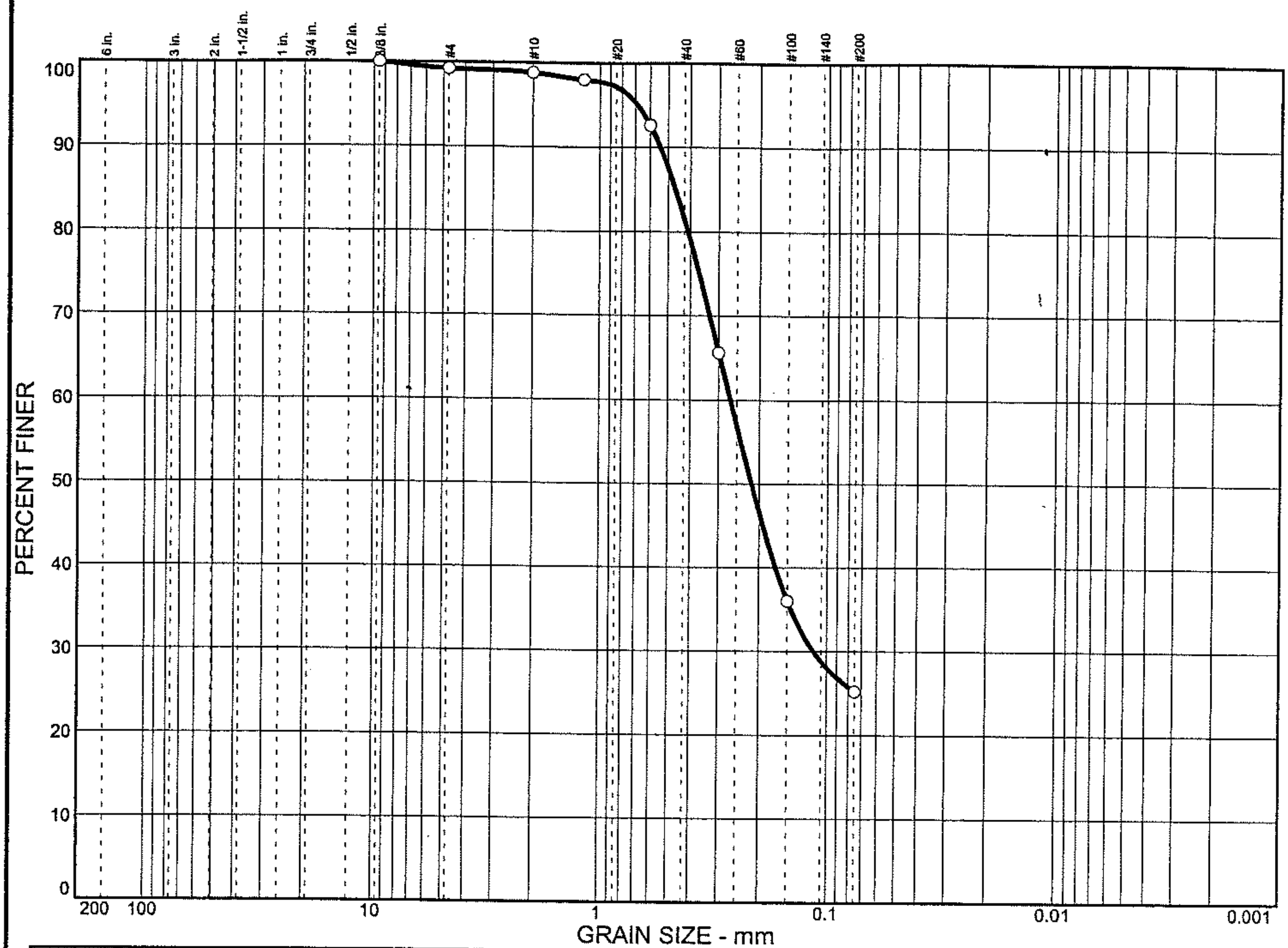
Φ GEI Consultants, Inc.

Remarks:

○

Fig.

GRAIN SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.8	74.0	25.2	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.467	0.267	0.216	0.115				

MATERIAL DESCRIPTION	USCS	AASHTO
○ Silty SAND	SM	

Project No. 03420 **Client:** HDR Architecture, Inc.

Project: Center for Functional Nanomaterials, Brookhaven National Laboratory

○ **Source:** B5 **Sample No.:** S1 **Elev./Depth:** 0 to 2 ft

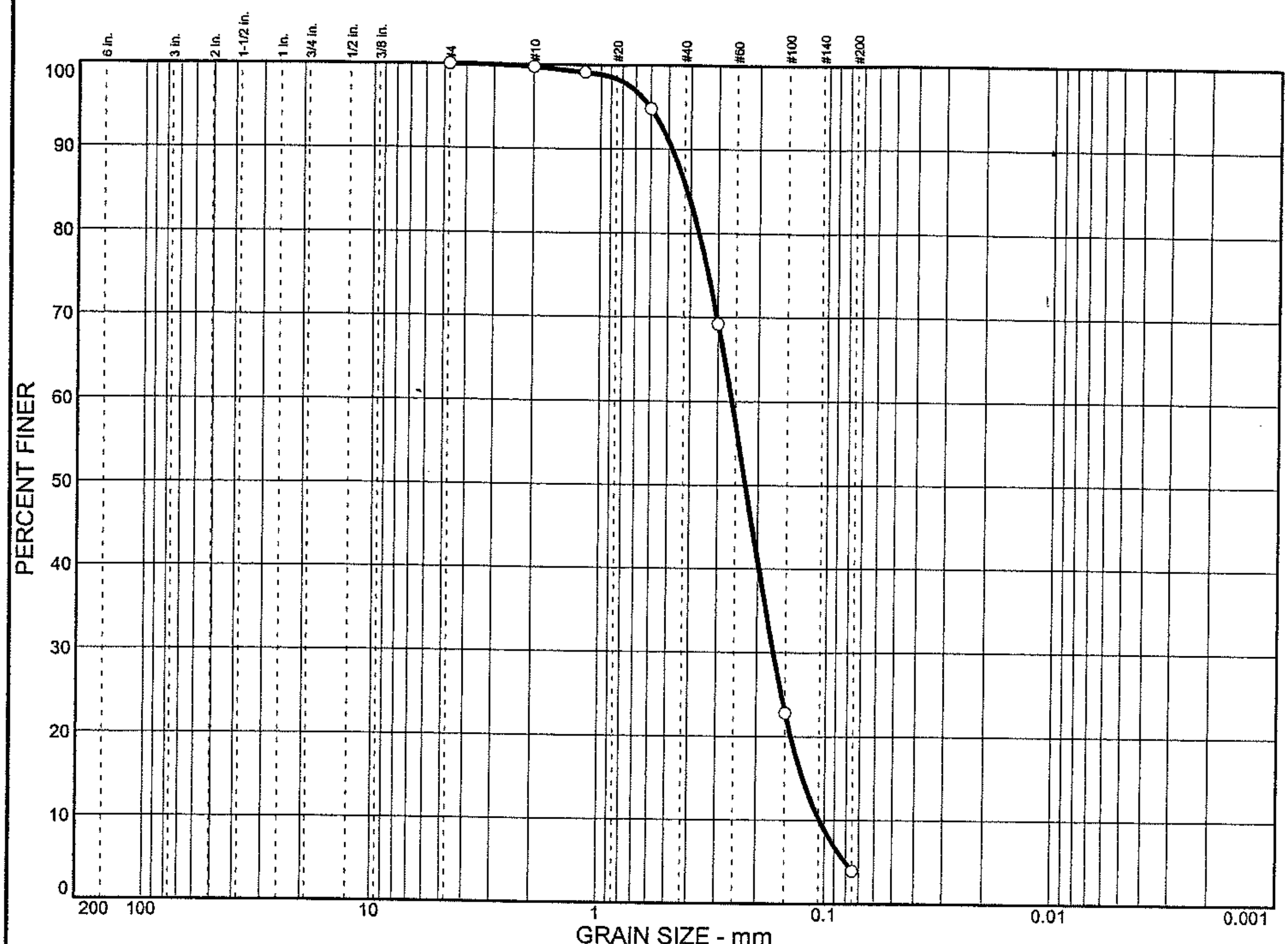
Remarks:

○

GEI Consultants, Inc.

Fig.

GRAIN SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	96.1	3.9	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.415	0.261	0.227	0.170	0.125	0.105	1.05	2.48

MATERIAL DESCRIPTION	USCS	AASHTO
○ Narrowly graded SAND	SP	

Project No. 03420 **Client:** HDR Architecture, Inc.

Project: Center for Functional Nanomaterials, Brookhaven National Laboratory

○ **Source:** B5 **Sample No.:** S2 **Elev./Depth:** 5 to 7 ft

Remarks:

○

GEI Consultants, Inc.

Fig.

Appendix C

2006-2007 Test Boring Logs

Boring Location

NORTHING: ______ EASTING: ______ STATION: ______ OFFSET: ______
HORIZONTAL DATUM: NAD 83 STATION CENTERLINE: ______
VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 74.0
LOCATION: See Figure 2

BORING **B-101**

Drilling Information

DATE START / END: 7/20/2006 - 7/20/2006 TOTAL DEPTH (FT): 52.0
CONTRACTOR: New England Boring DRILLER: Jeff Leavitt LOGGED BY: Steve Hawkins
EQUIPMENT: Mobile Drill B-53 Truck mounted Drill Rig BORING METHOD: Drive and Wash
AUGER ID/OD: N/A / N/A CASING ID/OD: N/A / 3 in CORE INFO:
HAMMER TYPE: Safety Hammer HAMMER WEIGHT (lbs): 140 HAMMER DROP (inch): 30
WATER LEVEL DEPTHS (ft):
GENERAL NOTES: Samples collected using a 2-in diameter split spoon

ABBREVIATIONS: ID = Inside Diameter, OD = Outside Diameter, Pen. = Penetration Length, Rec. = Recovery Length, bpf = Blows per Foot, mpf = Minute per Foot, S = Split Spoon, DP = Direct Push Sample, U = Undistrubed Tube Sample, C = Rock Core, V = Field Vane Shear, SC = Sonic Core, WOR = Weight of Rods, WOH = Weight of Hammer, RQD = Rock Quality Designation, OVM = Organic Vapor Meter, Q_v = Pocket Penetrometer Strength, S_v = Pocket Torvane Shear Strength, F_v = Field Vane Shear Strength, NA, NM = Not Applicable, Not Measured

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_2O Depth	Remarks
			1		0 to 2	24/18	4-6-9-9			SILTY SAND (SM); fine to coarse sand, 32% silty fines, 6% fine gravel, moist, dark brown, roots (TOPSOIL). Probable Fill, Silty Sand on auger cuttings.		
70												Strata change estimated at 3.5 feet
	5		2		5 to 7	24/12	21-25-27-30			WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, 12% silty fines, 3% fine gravel, moist, light brown.		
65												
	10		3		10 to 12	24/10	4-8-8-9			WIDELY GRADED SAND (SW); fine to coarse sand, 8% fine gravel, 1% silty fines, wet, light brown.		
60												
	15		4		15 to 17	24/10	13-15-17-17			WIDELY GRADED SAND (SW); fine to coarse sand, 6% fine gravel, 3% silty fines, wet, light brown.		
55												
	20		5		20 to 22	24/12	20-25-32-41			WIDELY GRADED SAND (SW); fine to coarse sand, 5% fine gravel, 4% silty fines, wet, light brown.		

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architecture, Inc.
PROJECT NAME: NSLS II Geotechnical Investigation
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants
GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

Boring Location
NORTHING: ____________ EASTING: ____________ STATION: ____________ OFFSET: ____________
HORIZONTAL DATUM: NAD 83 STATION CENTERLINE: ____________
VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 74.0
LOCATION: See Figure 2

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_2O Depth	Remarks
	25		6		25 to 27	24/12	25-27-29-31			WIDELY GRADED SAND WITH GRAVEL (SW); fine to coarse sand, 25% fine gravel, 5% silty fines, wet, light brown.		
45												
	30		7		30 to 32	24/10	18-22-24-29			WIDELY GRADED SAND WITH GRAVEL (SW); fine to coarse sand, ~30% fine gravel, <5% silty fines, wet, light brown.		
40												
	35		8		35 to 37	24/6	14-16-20-22			WIDELY GRADED SAND WITH GRAVEL (SW); fine to coarse sand, 27% fine to coarse gravel, 5% silty fines, wet, light brown.		
35												
	40		9		40 to 42	24/8	15-16-20-22			WIDELY GRADED SAND WITH GRAVEL (SW); fine to coarse sand, ~30% fine gravel, <5% silty fines, wet, light brown.		
30												
	45		10		45 to 47	24/8	20-26-35-47			WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, 8% silty fines, 1% fine gravel, wet, light brown.		
25												
	50		11		50 to 52	24/12	29-30-31-28			WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, ~10% silty fines, ~10% fine gravel, wet, brown.		
										End of Boring at 52 feet		
20												

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architecture, Inc.
PROJECT NAME: NSLS II Geotechnical Investigation
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

Boring Location

NORTHING: ______ EASTING: ______ STATION: ______ OFFSET: ______

HORIZONTAL DATUM: NAD 83 STATION CENTERLINE: ______

VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 74.0

LOCATION: See Figure 2

BORING

B-101a

Drilling Information

DATE START / END: 8/16/2006 - 8/16/2006 TOTAL DEPTH (FT): 10.0

CONTRACTOR: New England Borings DRILLER: Jeff Leavitt LOGGED BY: Steven Hawkins

EQUIPMENT: Mobile Drill B-53 truck mounted drill rig. BORING METHOD: Hollow Stem Auger

AUGER ID/OD: 4.25 in / N/A CASING ID/OD: N/A / N/A CORE INFO:

HAMMER TYPE: Safety Hammer HAMMER WEIGHT (lbs): 140 HAMMER DROP (inch): 30

WATER LEVEL DEPTHS (ft):

GENERAL NOTES: Samples collected using a 2-inch diameter split spoon.

ABBREVIATIONS: ID = Inside Diameter; OD = Outside Diameter; Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot; S = Split Spoon; DP = Direct Push Sample; U = Undistrubed Tube Sample; C = Rock Core; V = Field Vane Shear; SC = Sonic Core; WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; OVM = Organic Vapor Meter; Q_v = Pocket Penetrometer Strength; S_v = Pocket Torvane Shear Strength; F_v = Field Vane Shear Strength; NA, NM = Not Applicable, Not Measured

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_20 Depth	Remarks
			S-1		0 to 2	24/14	3-3-4-4			SILTY SAND (SM); fine to coarse sand, ~25% silty fines, ~5% fine gravel, dry, brown, ~10% organics, 4 inches of topsoil.		
			S-2		2 to 4	24/20	4-9-9-10			SILTY SAND (SM); fine to coarse sand, ~25% silty fines, ~5% fine gravel, dry, brown, Bottom 5 inches consists of fine to coarse sand. FILL.		Strata change estimated at 3.3 feet
70	5		S-3		4 to 6	24/12	9-10-10-12			WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, ~10% silty fines, ~5% fine gravel, dry, brown.		
			S-4		6 to 8	24/12	13-16-16-15			WIDELY GRADED SAND (SW); fine to coarse sand, ~5% silty fines, ~5% fine to coarse gravel, dry, brown.		
65			S-5		8 to 10	24/18	12-13-13-15			WIDELY GRADED SAND (SW); fine to coarse sand, ~5% silty fines, ~5% fine gravel, dry, brown.		
	10									End of Boring at 10 feet Fill with cuttings upon completion		
60	15											
55	20											

GEOTECHNICAL BORING LOG 02 BNL NSLSII ADDITONAL BORING LOGS.GPJ GEI DATA TEMPLATE.GDT 8/24/06

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.

PROJECT NAME: NSLS II Geotechnical Investigation

CITY/STATE: Upton, New York

GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

Boring Location	BORING
NORTHING: EASTING: STATION: OFFSET:	B-102
HORIZONTAL DATUM: NAD 83 STATION CENTERLINE:	PAGE 1 of 3
VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 81.0	
LOCATION: See Figure 2	

Drilling Information

DATE START / END: 7/19/2006 - 7/20/2006 TOTAL DEPTH (FT): 62.0

CONTRACTOR: New England Boring DRILLER: Jeff Leavitt LOGGED BY: Steve Hawkins

EQUIPMENT: Mobile Drill B-53 Truck mounted Drill Rig BORING METHOD: Drive and Wash

AUGER ID/OD: N/A / N/A CASING ID/OD: N/A / 3 in CORE INFO:

HAMMER TYPE: Safety Hammer HAMMER WEIGHT (lbs): 140 HAMMER DROP (inch): 30

WATER LEVEL DEPTHS (ft): ▼ 36.50 7/20/2006 9:20 am ▼ 36.50 7/20/2006 1:55 pm

GENERAL NOTES: Samples collected using a 2-in diameter split spoon

ABBREVIATIONS: ID = Inside Diameter; OD = Outside Diameter; Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot; S = Split Spoon; DP = Direct Push Sample; U = Undistrubed Tube Sample; C = Rock Core; V = Field Vane Shear; SC = Sonic Core; WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; OVM = Organic Vapor Meter; Q_v = Pocket Penetrometer Strength; S_v = Pocket Torvane Shear Strength; F_v = Field Vane Shear Strength; NA, NM = Not Applicable, Not Measured

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	Sample Description & Classification	H_2O Depth	Remarks
80			1	S	0 to 2	24/8	3-13-5-4		SILTY SAND (SM); fine to coarse sand, 27% silty fines, 11% fine gravel, dry, brown, Contains roots, TOPSOIL..		
									Probable Fill, Silty Sand on auger cuttings.		
75	5		2	S	5 to 7	24/12	8-14-15-16		WIDELY GRADED SAND (SW); fine to coarse sand, 13% fine gravel, 5% silty fines, moist, light brown.		Strata change estimated at 5.0 feet
70	10		3	S	10 to 12	24/10	8-10-13-13		WIDELY GRADED SAND (SW); fine to coarse sand, 9% fine gravel, 3% silty fines, moist, light brown.		
65	15		4	S	15 to 17	24/12	4-9-18-18		WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, 7% fine gravel, 7% silty fines, moist, light brown.		
60	20		5	S	20 to 22	24/12	12-18-24-22		WIDELY GRADED SAND WITH SILT (SW-SM); fine to medium sand, 6% silty fines, 1% fine gravel, moist, light brown.		

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architecture, Inc.
PROJECT NAME: NSLS II Geotechnical Investigation
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

Boring Location

NORTHING: ____________ EASTING: ____________ STATION: __________ OFFSET: __________

HORIZONTAL DATUM: NAD 83 STATION CENTERLINE: ____________

VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 81.0

LOCATION: See Figure 2

BORING

B-102

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_2O Depth	Remarks
55	25		6		25 to 27	24/12	27-36-46-45			WIDELY GRADED SAND WITH SILT (SW-SM); fine to medium sand, 10% silty fines, 3% fine gravel, moist, light brown.		Begins washing out ahead of casing advancement. Material too dense to drive casing.
50	30		7		30 to 32	24/10	37-45-47-61			WIDELY GRADED SAND (SW); fine to coarse sand, ~10% fine gravel, ~5% silty fines, wet, light brown.		
45	35		8		35 to 37	24/10	31-47-61-73			WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, 7% silty fines, 5% fine gravel, wet, light brown.	▼	
40	40		9		40 to 41.5	18/10	39-62-100			WIDELY GRADED SAND (SW); fine to coarse sand, ~5% fine gravel, ~5% silty fines, wet, brown.		
35	45		10		45 to 47	24/12	31-42-49-55			WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, 9% fine gravel, 8% silty fines, wet, brown.		
30	50		11		50 to 52	24/14	29-37-40-46			WIDELY GRADED SAND WITH GRAVEL (SW); fine to coarse sand, ~20% fine gravel, ~5% silty fines, wet, light brown.		

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architecture, Inc.

PROJECT NAME: NSLS II Geotechnical Investigation

CITY/STATE: Upton, New York

GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

Boring Location

NORTHING: ______ EASTING: ______ STATION: ______ OFFSET: ______

HORIZONTAL DATUM: NAD 83 STATION CENTERLINE: ______

VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 81.0

LOCATION: See Figure 2

BORING

B-102

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_2O Depth	Remarks
25			12		55 to 57	24/14	27-32-39-48			WIDELY GRADED SAND WITH GRAVEL (SW); fine to coarse sand, ~20% fine gravel, ~5% silty fines, wet, light brown.		
20	60		13		60 to 62	24/10	30-36-39-45			WIDELY GRADED SAND WITH GRAVEL (SW); fine to coarse sand, ~20% fine gravel, ~5% silty fines, wet, light brown.		
										End of Boring at 62 feet		
15	65											
10	70											
5	75											
0	80											
	85											

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architecture, Inc.

PROJECT NAME: NSLS II Geotechnical Investigation

CITY/STATE: Upton, New York

GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

Boring Location

NORTHING: ______ EASTING: ______ STATION: ______ OFFSET: ______
HORIZONTAL DATUM: NAD 83 STATION CENTERLINE: ______
VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 81.0
LOCATION: See Figure 2

BORING

B-102a

Drilling Information

DATE START / END: 8/16/2006 - 8/16/2006 TOTAL DEPTH (FT): 10.0
CONTRACTOR: New England Borings DRILLER: Jeff Leavitt LOGGED BY: Steven Hawkins
EQUIPMENT: Mobile Drill B-53 truck mounted drill rig. BORING METHOD: Hollow Stem Auger
AUGER ID/OD: 4.25 in / N/A CASING ID/OD: N/A / N/A CORE INFO:
HAMMER TYPE: Safety Hammer HAMMER WEIGHT (lbs): 140 HAMMER DROP (inch): 30
WATER LEVEL DEPTHS (ft):
GENERAL NOTES: Samples collected using a 2-inch diameter split spoon.

ABBREVIATIONS: ID = Inside Diameter, OD = Outside Diameter, Pen. = Penetration Length, Rec. = Recovery Length, bpf = Blows per Foot, mpf = Minute per Foot, S = Split Spoon, DP = Direct Push Sample, U = Undistrubed Tube Sample, C = Rock Core, V = Field Vane Shear, SC = Sonic Core, WOR = Weight of Rods, WOH = Weight of Hammer, RQD = Rock Quality Designation, OVM = Organic Vapor Meter, Q_v = Pocket Penetrometer Strength, S_v = Pocket Torvane Shear Strength, F_v = Field Vane Shear Strength, NA, NM = Not Applicable, Not Measured

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_2O Depth	Remarks
80			S-1		0 to 2	24/24	4-3-2-2			SILTY SAND (SM); fine to coarse sand, ~20% silty fines, ~10% fine to coarse gravel, dry, brown, Organics, 4 inches of Topsoil.		
			S-2		2 to 4	24/12	3-3-3-4			SILTY SAND (SM); fine to coarse sand, ~15% silty fines, ~5% fine to coarse gravel, dry, brown, FILL.		
	5		S-3		4 to 6	24/12	4-5-6-6			WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, ~10% silty fines, ~5% fine gravel, dry, light brown.		Strata change estimated at 4 feet
75			S-4		6 to 8	24/13	8-10-11-6			WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, ~10% silty fines, ~5% fine gravel, dry, light brown.		
			S-5		8 to 10	24/17	8-12-12-14			WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, ~10% silty fines, ~5% fine gravel, dry, light brown.		
	10									End of Boring at 10 feet Fill with cuttings upon completion		
70												
	15											
65												
	20											
60												

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.
PROJECT NAME: NSLS II Geotechnical Investigation
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants
GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

Boring Location

NORTHING: ______ EASTING: ______ STATION: ______ OFFSET: ______
HORIZONTAL DATUM: NAD 83 STATION CENTERLINE: ______
VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 73.0
LOCATION: See Figure 2

Drilling Information

DATE START / END: 8/16/2006 - 8/16/2006
TOTAL DEPTH (FT): 32.0
CONTRACTOR: New England Borings DRILLER: Jeff Leavitt
LOGGED BY: Steven Hawkins
EQUIPMENT: Mobile Drill B-53 truck mounted drill rig.
BORING METHOD: Hollow Stem Auger
AUGER ID/OD: 4.25 in / N/A CASING ID/OD: N/A / N/A
CORE INFO:
HAMMER TYPE: Safety Hammer HAMMER WEIGHT (lbs): 140
HAMMER DROP (inch): 30
WATER LEVEL DEPTHS (ft): ▽ 28.00 8/16/2006 10:19 am
GENERAL NOTES: Samples collected using a 2-inch diameter split spoon.

ABBREVIATIONS: ID = Inside Diameter, OD = Outside Diameter, Pen. = Penetration Length, Rec. = Recovery Length, bpf = Blows per Foot, mpf = Minute per Foot, S = Split Spoon, DP = Direct Push Sample, U = Undistrubed Tube Sample, C = Rock Core, V = Field Vane Shear, SC = Sonic Core, WOR = Weight of Rods, WOH = Weight of Hammer, RQD = Rock Quality Designation, OVM = Organic Vapor Meter, Q_v = Pocket Penetrometer Strength, S_v = Pocket Torvane Shear Strength, F_v = Field Vane Shear Strength, NA, NM = Not Applicable, Not Measured

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_2O Depth	Remarks
			S-1		0 to 2	24/12	4-7-8-8			WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, ~10% silty fines, ~5% fine gravel, dry, light brown, roots, topsoil, FILL.		
70			S-2		2 to 4	24/12	7-4-5-9			SILTY SAND (SM); fine to coarse sand, ~20% silty fines, ~5% fine gravel, moist, brown, FILL.		
										4-5 ft: Soil cuttings similar to material observed in S-2, FILL.		
	5		S-3		5 to 7	24/24	5-9-25-46			WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, ~10% silty fines, ~10% fine gravel, moist, brown.		Strata change estimated at 5 feet
65			S-4		7 to 9	24/18	16-29-30-35			SILTY SAND (SM); fine to coarse sand, ~15% silty fines, ~5% fine gravel, moist, reddish brown.		
										9-10 ft: Soil cuttings similar to material observed in S-4.		
	10		S-5		10 to 12	24/20	13-16-16-17			WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, ~10% silty fines, ~5% fine gravel, dry, brown.		
60			S-6		12 to 14	24/14	17-19-19-20			WIDELY GRADED SAND WITH SILT (SW-SM); fine to coarse sand, ~15% fine to coarse gravel, ~10% silty fines, dry, brown.		
	15		S-7		15 to 17	24/15	4-5-6-9			WIDELY GRADED SAND (SW); fine to coarse sand, ~5% silty fines, ~5% fine gravel, dry, tan.		
55												
	20		S-8		20 to 22	24/15	7-9-13-13			WIDELY GRADED SAND (SW); fine to coarse sand, ~10% fine to coarse gravel, ~5% silty fines, moist, tan.		
50												

Boring Location

NORTHING: ____ EASTING: ____ STATION: ____ OFFSET: ____

HORIZONTAL DATUM: NAD 83 STATION CENTERLINE: ____

VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 73.0

LOCATION: See Figure 2

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_2O Depth	Remarks
	25		S-9		25 to 27	24/15	9-12-16-17			WIDELY GRADED SAND (SW); fine to coarse sand, ~5% silty fines, ~5% fine gravel, moist, tan.		
45											⊻	
	30		S-10		30 to 32	24/18	13-16-19-39			WIDELY GRADED SAND (SW); fine to coarse sand, ~5% silty fines, wet, brown.		
										End of Boring at 32 feet Fill with cuttings upon completion		
40												
	35											
35												
	40											
30												
	45											
25												
	50											
20												

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.

PROJECT NAME: NSLS II Geotechnical Investigation

CITY/STATE: Upton, New York

GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

Boring Location

BORING **B-104** **PAGE 1 of 1**

NORTHING: ____ **EASTING:** ____ **STATION:** ____ **OFFSET:** ____
HORIZONTAL DATUM: NAD 83 **STATION CENTERLINE:** ____
VERTICAL DATUM: BNL 94 **GROUND SURFACE ELEVATION (FT):** 76.0
LOCATION: See Figure 2

Drilling Information

DATE START / END: 8/16/2006 - 8/16/2006 **TOTAL DEPTH (FT):** 7.0
CONTRACTOR: New England Boring **DRILLER:** Jeff Leavitt **LOGGED BY:** Steve Hawkins
EQUIPMENT: Mobile Drill B-53 truck mounted drill rig. **BORING METHOD:** Hollow Stem Auger
AUGER ID/OD: 4.25 in / N/A **CASING ID/OD:** N/A / N/A **CORE INFO:**
HAMMER TYPE: Safety Hammer **HAMMER WEIGHT (lbs):** 140 **HAMMER DROP (inch):** 30
WATER LEVEL DEPTHS (ft):
GENERAL NOTES: Samples collected using a 2-inch diameter split spoon.

ABBREVIATIONS: ID = Inside Diameter; OD = Outside Diameter; Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot; S = Split Spoon; DP = Direct Push Sample; U = Undistrubed Tube Sample; C = Rock Core; V = Field Vane Shear; SC = Sonic Core; WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; OVM = Organic Vapor Meter; Q_v = Pocket Penetrometer Strength; S_v = Pocket Torvane Shear Strength; F_v = Field Vane Shear Strength; NA, NM = Not Applicable, Not Measured

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_2O Depth	Remarks
75			S-1		0 to 2	24/12	3-4-4-3			SILTY SAND (SM); fine to coarse sand, ~25% silty fines, slight petroleum-like odor, moist, dark brown, organics, FILL.		
			S-2		2 to 4	24/15	3-4-6-16			SILTY SAND (SM); fine to coarse sand, ~30% silty fines, ~10% fine gravel, moist, brown, FILL.		
										4-5 ft: Soil cuttings similar to material observed in S-2, FILL.		
70	5		S-3		5 to 7	24/10	16-19-30-30			SILTY SAND (SM); fine to coarse sand, ~15% silty fines, ~5% fine gravel, dry, brown, Probable FILL.		
										Auger refusal encountered ~7-feet bgs. Fill with cuttings upon completion		
65	10											
60	15											
55	20											

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.
PROJECT NAME: NSLS II Geotechnical Investigation
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants
GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

Boring Location		**BORING**
NORTHING: EASTING: STATION: OFFSET:		**B-104a**
HORIZONTAL DATUM: NAD 83	STATION CENTERLINE:	PAGE 1 of 1
VERTICAL DATUM: BNL 94	GROUND SURFACE ELEVATION (FT): 76.0	
LOCATION: ~5 feet North of B-104; See Figure 2		

Drilling Information

DATE START / END: 8/16/2006 - 8/16/2006
TOTAL DEPTH (FT): 3.0
CONTRACTOR: New England Boring
DRILLER: Jeff Leavitt
LOGGED BY: Steve Hawkins
EQUIPMENT: Mobile Drill B-53 truck mounted drill rig.
BORING METHOD: Hollow Stem Auger
AUGER ID/OD: 4.25 in / N/A
CASING ID/OD: N/A / N/A
CORE INFO:
HAMMER TYPE: Safety Hammer
HAMMER WEIGHT (lbs): 140
HAMMER DROP (inch): 30
WATER LEVEL DEPTHS (ft):
GENERAL NOTES: Samples collected using a 2-inch diameter split spoon.

ABBREVIATIONS: ID = Inside Diameter; OD = Outside Diameter; Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot; S = Split Spoon; DP = Direct Push Sample; U = Undistrubed Tube Sample; C = Rock Core; V = Field Vane Shear; SC = Sonic Core; WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; OVM = Organic Vapor Meter; Q_v = Pocket Penetrometer Strength; S_v = Pocket Torvane Shear Strength; F_v = Field Vane Shear Strength; NA, NM = Not Applicable, Not Measured

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_2O Depth	Remarks
75										Soil cuttings similar to B-104a S-1, FILL.		
										Electrical wire encountered ~3-feet bgs. Auger refusal at ~3 feet bgs. Fill with cuttings upon completion		
	5											
70												
	10											
65												
	15											
60												
	20											
55												

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.
PROJECT NAME: NSLS II Geotechnical Investigation
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants
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455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

Boring Location

BORING **B-104b**

NORTHING: ______ **EASTING:** ______ **STATION:** ______ **OFFSET:** ______
HORIZONTAL DATUM: NAD 83 **STATION CENTERLINE:** ______
VERTICAL DATUM: BNL 94 **GROUND SURFACE ELEVATION (FT):** 76.0
LOCATION: ~5 feet West of B-104a; See Figure 2

Drilling Information

DATE START / END: 8/16/2006 - 8/16/2006 **TOTAL DEPTH (FT):** 32.0
CONTRACTOR: New England Borings **DRILLER:** Jeff Leavitt **LOGGED BY:** Steven Hawkins
EQUIPMENT: Mobile Drill B-53 truck mounted drill rig. **BORING METHOD:** Hollow Stem Auger
AUGER ID/OD: 4.25 in / N/A **CASING ID/OD:** N/A / N/A **CORE INFO:**
HAMMER TYPE: Safety Hammer **HAMMER WEIGHT (lbs):** 140 **HAMMER DROP (inch):** 30
WATER LEVEL DEPTHS (ft): ⊻ 31.00 8/16/2006 12:57 pm
GENERAL NOTES: Samples collected using a 2-inch diameter split spoon.

ABBREVIATIONS: ID = Inside Diameter; OD = Outside Diameter; Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot; S = Split Spoon; DP = Direct Push Sample; U = Undistrubed Tube Sample; C = Rock Core; V = Field Vane Shear; SC = Sonic Core; WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; OVM = Organic Vapor Meter; Q_v = Pocket Penetrometer Strength; S_v = Pocket Torvane Shear Strength; F_v = Field Vane Shear Strength; NA, NM = Not Applicable, Not Measured

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_2O Depth	Remarks
75										See boring log B-104a for sample information and description of material from 0 to 7-feet bgs.		
	5											
70												
			S-1		7 to 9	24/6	15-22-27-39			SILTY SAND (SM); fine to coarse sand, ~15% silty fines, ~5% fine gravel, dry, brown.		
										9-10: Soil cuttings similar to material observed in S-4.		
	10		S-2		10 to 12	24/19	9-17-19-15			SILTY SAND (SM); fine to coarse sand, ~15% silty fines, ~5% fine gravel, moist, brown.		
65												
			S-3		12 to 14	24/20	13-14-16-16			WIDELY GRADED SAND (SW); fine to coarse sand, ~5% silty fines, ~5% fine gravel, moist, brown.		
	15		S-4		15 to 17	24/12	3-4-8-7			WIDELY GRADED SAND (SW); fine to coarse sand, ~10% fine to coarse gravel, ~5% silty fines, dry, tan.		
60												
	20		S-5		20 to 22	24/18	6-9-12-10			WIDELY GRADED SAND (SW); fine to coarse sand, ~10% fine to coarse gravel, ~5% silty fines, dry, tan.		
55												

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.
PROJECT NAME: NSLS II Geotechnical Investigation
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

Boring Location

NORTHING: ______ EASTING: ______ STATION: ______ OFFSET: ______

HORIZONTAL DATUM: NAD 83 STATION CENTERLINE: ______

VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 76.0

LOCATION: ~5 feet West of B-104a; See Figure 2

BORING

B-104b

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_2O Depth	Remarks
50	25		S-6		25 to 27	24/12	10-15-19-17			WIDELY GRADED SAND WITH GRAVEL (SW); fine to coarse sand, ~15% fine to coarse gravel, ~5% silty fines, dry, tan.		
45	30		S-7		30 to 32	24/16	7-11-11-10			WIDELY GRADED SAND (SW); fine to coarse sand, ~10% fine to coarse gravel, ~5% silty fines, moist, tan.	∇	
40	35									End of Boring at 32 feet Fill with cuttings upon completion		
35	40											
30	45											
25	50											

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.

PROJECT NAME: NSLS II Geotechnical Investigation

CITY/STATE: Upton, New York

GEI PROJECT NUMBER: 062150-*-1000

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5408

Boring Location

NORTHING: EASTING: STATION: OFFSET:

HORIZONTAL DATUM: NAD83 CT STATION CENTERLINE:

VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 73.0

LOCATION: See Plan

BORING

B-201

Drilling Information

DATE START / END: 4/23/2007 - 4/23/2007 TOTAL DEPTH (FT): 47.0

CONTRACTOR: New England Borings DRILLER: Jeff Leavitt LOGGED BY: Steven Hawkins

EQUIPMENT: Truck BORING METHOD: Drive and Wash

AUGER ID/OD: N/A / N/A CASING ID/OD: 3 in / 3.25 in CORE INFO:

HAMMER TYPE: Safety Hammer HAMMER WEIGHT (lbs): 140 HAMMER DROP (inch): 30

WATER LEVEL DEPTHS (ft): ∇ 27.30 4/24/2007 7:26 am

GENERAL NOTES:

ABBREVIATIONS: ID = Inside Diameter, OD = Outside Diameter, Pen. = Penetration Length, Rec. = Recovery Length, bpf = Blows per Foot, mpf = Minute per Foot, S = Split Spoon, DP = Direct Push Sample, U = Undistrubed Tube Sample, C = Rock Core, V = Field Vane Shear, SC = Sonic Core, WOR = Weight of Rods, WOH = Weight of Hammer, RQD = Rock Quality Designation, OVM = Organic Vapor Meter, Q_v = Pocket Penetrometer Strength, S_v = Pocket Torvane Shear Strength, F_v = Field Vane Shear Strength, NA, NM = Not Applicable, Not Measured

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_2O Depth	Remarks
			S-1		0 to 2	24/15	6-4-4-4			SILTY SAND (SM); ~75% sand, ~20% fines, ~5% gravel; moist, brown, F-M sand, roots, F gravel, 4" topsoil, FILL.		
70			S-2		2 to 4	24/16	11-13-27-30			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to medium, dry, yellowish brown, F-C gravel max. 1in.		
	5		S-3		4 to 6	24/19	21-21-31-36			WIDELY GRADED SAND (SW); ~85% sand, ~10% gravel, ~5% fines; fine to medium, dry, light brown, F-C gravel max. 1in.		
			S-4		6 to 8	24/17	41-57-65-70			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to medium, dry, light brown, F-C gravel max. 1in.		
65			S-5		8 to 10	24/19	22-27-31-37			WIDELY GRADED SAND WITH SILT (SW-SM); ~85% sand, ~10% fines, ~5% gravel; fine to medium, moist, brown, F-C gravel max. 1in.		
	10		S-6		10 to 12	24/14	40-41-42-40			WIDELY GRADED SAND WITH SILT (SW-SM); ~85% sand, ~10% fines, ~5% gravel; fine to medium, moist, brown, F-C gravel max. 3/4 in.		
60												
	15		S-7		15 to 17	24/9	14-10-10-11			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, fine gravel, wet, light brown.		
55												
	20		S-8		20 to 22	24/10	19-17-22-34			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, fine gravel, wet, light brown.		
50												

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.

PROJECT NAME: NSLS II - ACD

CITY/STATE: Upton, New York

GEI PROJECT NUMBER: 062152

GEI Consultants

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

Boring Location

NORTHING: ______ **EASTING:** ______ **STATION:** ______ **OFFSET:** ______

HORIZONTAL DATUM: NAD83 CT **STATION CENTERLINE:** ______

VERTICAL DATUM: BNL 94 **GROUND SURFACE ELEVATION (FT):** 73.0

LOCATION: See Plan

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_2O Depth	Remarks
	25		S-9		25 to 27	24/11	20-21-37-29			WIDELY GRADED GRAVEL WITH SAND (GW); ~60% gravel, ~35% sand, ~5% fines; fine to coarse, rounded, wet, light brown.	▽	
45												
	30		S-10		30 to 32	24/10	20-25-30-35			WIDELY GRADED SAND (SW); ~95% sand, ~5% fines, ~0% gravel; fine to medium, wet, light brown.		
40												
	35		S-11		35 to 37	24/8	21-22-22-23			WIDELY GRADED SAND (SW); ~95% sand, ~5% fines, ~0% gravel; fine to medium, wet, light brown.		
35												
	40		S-12		40 to 42	24/8	17-21-25-39			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to medium, coarse gravel, wet, light brown.		
30												Drill Chatter
	45		S-13		45 to 47	24/2	11-12-13-17			WIDELY GRADED SAND (SW); ~70% sand, ~25% gravel, ~5% fines; fine to coarse, fine to coarse gravel, wet, brown.		Running sands, rewash out casing.
										End of Boring at 47 feet		
25												
	50											
20												

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.
PROJECT NAME: NSLS II - ACD
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062152

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

Boring Location

NORTHING: ______ **EASTING:** ______ **STATION:** ______ **OFFSET:** ______
HORIZONTAL DATUM: NAD83 CT **STATION CENTERLINE:** ______
VERTICAL DATUM: BNL 94 **GROUND SURFACE ELEVATION (FT):** 73.5
LOCATION: See Plan

BORING
B-202

Drilling Information

DATE START / END: 4/25/2007 - 4/25/2007 **TOTAL DEPTH (FT):** 47.0
CONTRACTOR: New England Borings **DRILLER:** Jeff Leavitt **LOGGED BY:** Steven Hawkins
EQUIPMENT: Truck **BORING METHOD:** Drive and Wash
AUGER ID/OD: N/A / N/A **CASING ID/OD:** 3 in / 3.25 in **CORE INFO:**
HAMMER TYPE: Safety Hammer **HAMMER WEIGHT (lbs):** 140 **HAMMER DROP (inch):** 30
WATER LEVEL DEPTHS (ft): ▼ 31.30 4/25/2007 10:14 am
GENERAL NOTES:

ABBREVIATIONS: ID = Inside Diameter, OD = Outside Diameter, Pen. = Penetration Length, Rec. = Recovery Length, bpf = Blows per Foot, mpf = Minute per Foot, S = Split Spoon, DP = Direct Push Sample, U = Undistrubed Tube Sample, C = Rock Core, V = Field Vane Shear, SC = Sonic Core, WOR = Weight of Rods, WOH = Weight of Hammer, RQD = Rock Quality Designation, OVM = Organic Vapor Meter, Q_v = Pocket Penetrometer Strength, S_v = Pocket Torvane Shear Strength, F_v = Field Vane Shear Strength, NA, NM = Not Applicable, Not Measured

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	Sample Description & Classification	H_20 Depth	Remarks
									ASPHALT; 4" asphalt, 8" subbase.		
			S-1		1 to 3	24/14	3-2-2-2		SILTY SAND (SM); ~57% sand, ~35% fines, ~8% gravel; rounded, fine to coarse gravel, moist, dark brown to brown, FILL.		
70			S-2		3 to 4.5	18/11	3-3-3		SILTY SAND (SM); ~65% sand, ~30% fines, ~5% gravel; rounded, fine to coarse gravel, moist, brown, FILL.		
	5		S-3		5 to 7	24/21	8-13-21-28		SILTY SAND (SM); ~55% sand, ~40% fines, ~5% gravel; rounded, fine to coarse gravel, moist, brown, FILL.		Drilled through cobble. Move rig north ~2ft. in order to get casing past.
									WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to medium, fine gravel, moist, light brown.		
			S-4		7 to 9	24/13	27-28-30-33		WIDELY GRADED SAND WITH SILT (SW-SM); ~85% sand, ~10% fines, ~5% gravel; fine to medium, fine gravel, moist, light brown.		
65			S-5		9 to 11	24/16	25-30-31-23		WIDELY GRADED SAND (SW); ~85% sand, ~10% gravel, ~5% fines; fine to coarse, rounded, fine to coarse gravel, dry, light brown.		
	10										
60											
	15		S-6		15 to 17	24/11	17-20-20-21		WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine to coarse gravel, dry, light brown.		
55											
	20		S-7		20 to 22	24/12	14-12-12-16		WIDELY GRADED SAND (SW); ~85% sand, ~10% gravel, ~5% fines; fine to coarse, rounded, fine gravel, dry, light brown.		
50											

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.
PROJECT NAME: NSLS II - ACD
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062152

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

Boring Location
NORTHING: **EASTING:** **STATION:** **OFFSET:**
HORIZONTAL DATUM: NAD83 CT **STATION CENTERLINE:**
VERTICAL DATUM: BNL 94 **GROUND SURFACE ELEVATION (FT):** 73.5
LOCATION: See Plan

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_20 Depth	Remarks
	25		S-8		25 to 27	24/10	20-21-17-17			WIDELY GRADED SAND (SW); ~80% sand, ~15% gravel, ~5% fines; fine to coarse, rounded, fine gravel, dry, light brown.		
45												
	30		S-9		30 to 32	24/14	17-16-12-16			WIDELY GRADED SAND (SW); ~75% sand, ~20% gravel, ~5% fines; fine to coarse, rounded, fine to coarse gravel, dry, light brown.	▼	
40												
	35		S-10		35 to 37	24/10	20-20-21-23			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine gravel, dry, light brown.		
35												
	40		S-11		40 to 42	24/9	17-14-19-25			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine gravel, dry, light brown.		
30												
	45		S-12		45 to 47	24/0	17-20-21-26			No recovery.		
										End of Boring at 47 feet		
25												
	50											
20												

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.
PROJECT NAME: NSLS II - ACD
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062152

GEI Consultants
GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

Boring Location

NORTHING: ____ **EASTING:** ____ **STATION:** ____ **OFFSET:** ____

HORIZONTAL DATUM: NAD83 CT **STATION CENTERLINE:** ____

VERTICAL DATUM: BNL 94 **GROUND SURFACE ELEVATION (FT):** 71.0

LOCATION: See Plan

BORING

B-203

Drilling Information

DATE START / END: 4/25/2007 - 4/25/2007 **TOTAL DEPTH (FT):** 47.0

CONTRACTOR: New England Borings **DRILLER:** Jeff Leavitt **LOGGED BY:** Steven Hawkins

EQUIPMENT: Truck **BORING METHOD:** Drive and Wash

AUGER ID/OD: N/A / N/A **CASING ID/OD:** 3 in / 3.25 in **CORE INFO:**

HAMMER TYPE: Safety Hammer **HAMMER WEIGHT (lbs):** 140 **HAMMER DROP (inch):** 30

WATER LEVEL DEPTHS (ft): ▼ 28.00 4/25/2007 2:07 pm

GENERAL NOTES:

ABBREVIATIONS: ID = Inside Diameter, OD = Outside Diameter, Pen. = Penetration Length, Rec. = Recovery Length, bpf = Blows per Foot, mpf = Minute per Foot, S = Split Spoon, DP = Direct Push Sample, U = Undistrubed Tube Sample, C = Rock Core, V = Field Vane Shear, SC = Sonic Core, WOR = Weight of Rods, WOH = Weight of Hammer, RQD = Rock Quality Designation, OVM = Organic Vapor Meter, Q_v = Pocket Penetrometer Strength, S_v = Pocket Torvane Shear Strength, F_v = Field Vane Shear Strength, NA, NM = Not Applicable, Not Measured

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_2O Depth	Remarks
70			S-1		0 to 2	24/14	7-8-15-11			WIDELY GRADED SAND (SW); ~70% sand, ~20% gravel, ~10% fines; fine to coarse, coarse gravel, roots, moist, dark brown to gray, Top 8" topsoil, FILL.		
			S-2		2 to 2.5	6/0	6			No recovery.		Grind through cobble/debris
	5		S-3		4 to 6	24/12	8-12-14-16			WIDELY GRADED SAND WITH SILT (SW-SM); ~78% sand, ~13% fines, ~9% gravel; fine to coarse, rounded, fine to coarse gravel, dry, light brown.		
65			S-4		6 to 8	24/16	12-16-21-28			SILTY SAND (SM); ~80% sand, ~15% fines, ~5% gravel; fine to coarse, rounded, fine gravel, dry, light brown.		
			S-5		8 to 10	24/12	8-9-10-10			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine to coarse gravel, dry, light brown.		
60	10		S-6		10 to 12	24/17	10-8-8-11			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine gravel, dry, light brown.		
55	15		S-7		15 to 17	24/10	11-12-13-14			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine gravel, moist, light brown.		
50	20		S-8		20 to 22	24/10	23-25-26-31			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine gravel, moist, light brown.		Drill chatter

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.

PROJECT NAME: NSLS II - ACD

CITY/STATE: Upton, New York

GEI PROJECT NUMBER: 062152

GEI Consultants

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

Boring Location

NORTHING: ____________ EASTING: ____________ STATION: __________ OFFSET: __________

HORIZONTAL DATUM: NAD83 CT STATION CENTERLINE: ____________

VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 71.0

LOCATION: See Plan

BORING

B-203

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_2O Depth	Remarks
45	25		S-9		25 to 27	24/8	24-36-37-43			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine gravel, moist, light brown.	▼	
40	30		S-10		30 to 32	24/11	16-14-12-10			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine gravel, moist, light brown.		
35	35		S-11		35 to 37	24/8	16-16-16-20			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine gravel, moist, light brown.		Rig chatter
30	40		S-12		40 to 42	24/7	11-10-9-9			WIDELY GRADED SAND (SW); ~75% sand, ~20% gravel, ~5% fines; fine to coarse, rounded, fine to coarse gravel, moist, light brown.		
25	45		S-13		45 to 47	24/0	11-15-12-14			No recovery.		
										End of Boring at 47 feet		
20	50											

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.

PROJECT NAME: NSLS II - ACD

CITY/STATE: Upton, New York

GEI PROJECT NUMBER: 062152

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

Boring Location

NORTHING: ______ EASTING: ______ STATION: ______ OFFSET: ______
HORIZONTAL DATUM: NAD83 CT STATION CENTERLINE: ______
VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 68.0
LOCATION: See Plan

Drilling Information

DATE START / END: 4/25/2007 - 4/26/2007
TOTAL DEPTH (FT): 47.0
CONTRACTOR: New England Borings
DRILLER: Jeff Leavitt
LOGGED BY: Steven Hawkins
EQUIPMENT: Truck
BORING METHOD: Drive and Wash
AUGER ID/OD: N/A / N/A
CASING ID/OD: 3 in / 3.25 in
CORE INFO:
HAMMER TYPE: Safety Hammer
HAMMER WEIGHT (lbs): 140
HAMMER DROP (inch): 30
WATER LEVEL DEPTHS (ft): ▼ 26.00 4/26/2007 8:31 am
GENERAL NOTES:

ABBREVIATIONS: ID = Inside Diameter; OD = Outside Diameter; Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot; S = Split Spoon; DP = Direct Push Sample; U = Undistrubed Tube Sample; C = Rock Core; V = Field Vane Shear; SC = Sonic Core; WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; OVM = Organic Vapor Meter; Q_v = Pocket Penetrometer Strength; S_v = Pocket Torvane Shear Strength; F_v = Field Vane Shear Strength; NA, NM = Not Applicable, Not Measured

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./Rec. (in)	Blows Count or RQD	Field Test Data	Sample Description & Classification	H_2O Depth	Remarks
			S-1		0 to 2	24/19	2-3-5-7		WIDELY GRADED SAND WITH SILT (SM); ~83% sand, ~13% fines, ~4% gravel; fine to coarse, fine gravel, moist, dark brown to brown, Top 8" topsoil, FILL.		
			S-2		2 to 4	24/16	7-5-2-4		SILTY SAND (SM); ~70% sand, ~25% fines, ~5% gravel; fine to coarse, fine gravel, dry, brown, FILL.		
65											
	5		S-3		4 to 6	24/20	7-9-11-12		WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, fine gravel, dry, grayish brown, FILL.		
			S-4		6 to 8	24/18	15-25-37-41		WIDELY GRADED SAND WITH SILT (SW-SM); ~80% sand, ~10% gravel, ~10% fines; fine to coarse, fine to coarse gravel, moist, grayish brown.		
60			S-5		8 to 10	24/20	37-39-49-50		WIDELY GRADED SAND WITH SILT (SW-SM); ~71% sand, ~15% gravel, ~14% fines; fine to medium, fine gravel, moist, grayish brown.		
	10		S-6		10 to 12	24/20	17-21-28-27		WIDELY GRADED SAND WITH SILT (SW-SM); ~85% sand, ~10% fines, ~5% gravel; fine to medium, fine gravel, moist, grayish brown.		
									WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, fine gravel, dry, light brown.		
55											
	15		S-7		15 to 17	24/14	27-35-34-27		WIDELY GRADED SAND (SW); ~80% sand, ~15% gravel, ~5% fines; fine to coarse, subrounded, fine to coarse gravel, dry, light brown.		
50											
	20		S-8		20 to 22	24/13	20-22-24-20		WIDELY GRADED SAND (SW); ~85% sand, ~10% gravel, ~5% fines; fine to coarse, subrounded, fine gravel, dry, light brown.		
45											

GEI Consultants
GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

Boring Location
NORTHING: ____ **EASTING:** ____ **STATION:** ____ **OFFSET:** ____
HORIZONTAL DATUM: NAD83 CT **STATION CENTERLINE:** ____
VERTICAL DATUM: BNL 94 **GROUND SURFACE ELEVATION (FT):** 68.0
LOCATION: See Plan

BORING
B-204

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_2O Depth	Remarks
	25		S-9		25 to 26.5	18/10	19-29-40			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, subrounded, fine gravel, dry, light brown.	▼	Running sands
40												
	30		S-10		30 to 32	24/12	14-14-14-11			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, subrounded, fine gravel, dry, light brown.		
35												
	35		S-11		35 to 37	24/7	9-9-7-13			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, subrounded, fine to coarse gravel, dry, light brown.		
30												
	40		S-12		40 to 42	24/7	14-18-18-26			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to medium, subrounded, coarse gravel, dry, light brown.		
25												
	45		S-13		45 to 47	24/12	20-29-35-37			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to medium, subrounded, fine gravel, dry, light brown.		
										End of Boring at 47 feet		
20												
	50											
15												

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.
PROJECT NAME: NSLS II - ACD
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062152

GEI Consultants
GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

Boring Location

NORTHING: EASTING: STATION: OFFSET:
HORIZONTAL DATUM: NAD83 CT STATION CENTERLINE:
VERTICAL DATUM: BNL 94 GROUND SURFACE ELEVATION (FT): 77.0
LOCATION: See Plan

BORING

B-205

Drilling Information

DATE START / END: 4/24/2007 - 4/24/2007 TOTAL DEPTH (FT): 47.0
CONTRACTOR: New England Borings DRILLER: Jeff Leavitt LOGGED BY: Steven Hawkins
EQUIPMENT: Truck BORING METHOD: Drive and Wash
AUGER ID/OD: N/A / N/A CASING ID/OD: 3 in / 3.25 in CORE INFO:
HAMMER TYPE: Safety Hammer HAMMER WEIGHT (lbs): 140 HAMMER DROP (inch): 30
WATER LEVEL DEPTHS (ft): ▼ 32.00 4/24/2007 11:36 am
GENERAL NOTES:

ABBREVIATIONS: ID = Inside Diameter, OD = Outside Diameter, Pen. = Penetration Length, Rec. = Recovery Length; bpf = Blows per Foot, mpf = Minute per Foot, S = Split Spoon, DP = Direct Push Sample; U = Undistrubed Tube Sample, C = Rock Core, V = Field Vane Shear, SC = Sonic Core; WOR = Weight of Rods, WOH = Weight of Hammer, RQD = Rock Quality Designation, OVM = Organic Vapor Meter; Q_v = Pocket Penetrometer Strength, S_v = Pocket Torvane Shear Strength, F_v = Field Vane Shear Strength, NA, NM = Not Applicable, Not Measured

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_2O Depth	Remarks
			S-1		0 to 2	24/19	3-3-4-4			SILTY SAND (SM); ~75% sand, ~20% fines, ~5% gravel; roots, moist, dark brown, Top 8" topsoil, FILL.		
75			S-2		2 to 4	24/17	9-11-15-26			SILTY SAND (SM); ~80% sand, ~15% fines, ~5% gravel; fine to coarse gravel, dry, grayish brown.		
	5		S-3		4 to 6	24/20	21-41-40-29			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to medium, fine to coarse gravel, dry, brown.		
70			S-4		6 to 8	24/15	21-22-25-21			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to medium, fine to coarse gravel, dry, brown.		
			S-5		8 to 10	24/16	6-7-10-10			WIDELY GRADED SAND (SW); ~90% sand, ~10% gravel, ~0% fines; fine to medium, rounded, fine to coarse gravel, dry, light brown.		
	10		S-6		10 to 12	24/14	12-10-11-10			WIDELY GRADED SAND (SW); ~90% sand, ~10% gravel, ~0% fines; medium to coarse, rounded, fine to coarse gravel, dry, light brown.		
65												
	15		S-7		15 to 17	24/8	12-15-17-21			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, rounded, fine to coarse gravel, wet, light brown.		
60												
	20		S-8		20 to 22	24/10	15-17-24-21			WIDELY GRADED SAND WITH GRAVEL (SW); ~70% sand, ~25% gravel, ~5% fines; fine to coarse, rounded, fine to coarse gravel, wet, light brown.		
55												

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.
PROJECT NAME: NSLS II - ACD
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062152

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

Boring Location

NORTHING: ____ EASTING: ____ STATION: ____ OFFSET: ____

HORIZONTAL DATUM: NAD83 CT   STATION CENTERLINE: ____

VERTICAL DATUM: BNL 94   GROUND SURFACE ELEVATION (FT): 77.0

LOCATION: See Plan

BORING

B-205

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_2O Depth	Remarks
	25		S-9		25 to 27	24/9	36-25-22-34			WIDELY GRADED SAND WITH GRAVEL (SW); ~65% sand, ~30% gravel, ~5% fines; fine to coarse, rounded, fine gravel, wet, light brown.		
50												
	30		S-10		30 to 32	24/6	15-12-8-10			WIDELY GRADED SAND WITH GRAVEL (SW); ~65% sand, ~30% gravel, ~5% fines; fine to coarse, rounded, fine gravel, wet, light brown.		
45											▼	
	35		S-11		35 to 37	24/9	16-20-21-25			WIDELY GRADED SAND (SW); ~85% sand, ~10% gravel, ~5% fines; fine to coarse, rounded, fine gravel, wet, light brown.		
40												
	40		S-12		40 to 42	24/9	20-21-20-30			WIDELY GRADED SAND (SW); ~85% sand, ~10% gravel, ~5% fines; fine to coarse, rounded, fine gravel, wet, light brown.		
35												
	45		S-13		45 to 47	24/10	17-20-24-30			WIDELY GRADED SAND (SW); ~95% sand, ~5% fines, ~0% gravel; fine to coarse, wet, brown.		
30										End of Boring at 47 feet		
	50											
25												

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.

PROJECT NAME: NSLS II - ACD

CITY/STATE: Upton, New York

GEI PROJECT NUMBER: 062152

GEI Consultants

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

Boring Location

NORTHING: ______ **EASTING:** ______ **STATION:** ______ **OFFSET:** ______

HORIZONTAL DATUM: NAD83 CT **STATION CENTERLINE:** ______

VERTICAL DATUM: BNL 94 **GROUND SURFACE ELEVATION (FT):** 73.5

LOCATION: See Plan

BORING

B-206

Drilling Information

DATE START / END: 4/24/2007 - 4/24/2007 **TOTAL DEPTH (FT):** 47.0

CONTRACTOR: New England Borings **DRILLER:** Jeff Leavitt **LOGGED BY:** Steven Hawkins

EQUIPMENT: Truck **BORING METHOD:** Drive and Wash

AUGER ID/OD: N/A / N/A **CASING ID/OD:** 3 in / 3.25 in **CORE INFO:**

HAMMER TYPE: Safety Hammer **HAMMER WEIGHT (lbs):** 140 **HAMMER DROP (inch):** 30

WATER LEVEL DEPTHS (ft): ▼ 35.00 4/24/2007 4:06 pm

GENERAL NOTES:

ABBREVIATIONS: ID = Inside Diameter; OD = Outside Diameter; Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot; S = Split Spoon; DP = Direct Push Sample; U = Undistrubed Tube Sample; C = Rock Core; V = Field Vane Shear; SC = Sonic Core; WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; OVM = Organic Vapor Meter; Q_v = Pocket Penetrometer Strength; S_v = Pocket Torvane Shear Strength; F_v = Field Vane Shear Strength; NA, NM = Not Applicable, Not Measured

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_2O Depth	Remarks
			S-1		0 to 2	24/20	6-5-5-5			SILTY SAND (SM); ~65% sand, ~30% fines, ~5% gravel; coal, dry, dark brown, FILL.		
			S-2		2 to 4	24/3	7-11-21-26			SILTY SAND (SM); ~80% sand, ~15% fines, ~5% gravel; roots, dry, dark brown, FILL.		
70												
	5		S-3		4 to 6	24/18	15-21-28-39			WIDELY GRADED SAND (SW); ~85% sand, ~10% gravel, ~5% fines; fine to medium, rounded, fine gravel, dry, light brown, FILL.		
			S-4		6 to 8	24/14	26-29-31-33			SILTY SAND (SM); ~64% sand, ~26% fines, ~10% gravel; fine to coarse, rounded, dry, brown, FILL.		
65			S-5		8 to 10	24/23	12-13-13-16			SILTY SAND (SM); ~75% sand, ~20% fines, ~5% gravel; fine to coarse, rounded, dry, brown, FILL.		
	10		S-6		10 to 12	24/14	15-12-12-15			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; medium to coarse, fine gravel, moist, light brown. WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to medium, fine gravel, dry, white.		
60												
	15		S-7		15 to 17	24/9	9-10-11-15			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, fine gravel, dry, light brown.		
55												
	20		S-8		20 to 22	24/14	14-18-20-25			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, fine gravel, dry, light brown.		
50												

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.

PROJECT NAME: NSLS II - ACD

CITY/STATE: Upton, New York

GEI PROJECT NUMBER: 062152

GEI Consultants

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

Boring Location

NORTHING: ______ **EASTING:** ______ **STATION:** ______ **OFFSET:** ______

HORIZONTAL DATUM: NAD83 CT **STATION CENTERLINE:** ______

VERTICAL DATUM: BNL 94 **GROUND SURFACE ELEVATION (FT):** 73.5

LOCATION: See Plan

Elev. (ft)	Depth (ft)	Casing Pen. (bpf) or Core Rate (mpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blows Count or RQD	Field Test Data	GRAPHIC LOG	Sample Description & Classification	H_2O Depth	Remarks
	25		S-9		25 to 27	24/12	26-25-25-25			WIDELY GRADED SAND (SW); ~90% sand, ~5% gravel, ~5% fines; fine to coarse, coarse gravel, dry, light brown, Max. gravel size 1.5".		
45												Rig chatter
	30		S-10		30 to 32	24/11	16-11-10-10			WIDELY GRADED SAND WITH GRAVEL (SW); ~80% sand, ~15% gravel, ~5% fines; fine to coarse, fine gravel, dry, light brown, Max. gravel size 1.5".		
40												
	35		S-11		35 to 37	24/8	17-23-23-26			WIDELY GRADED SAND WITH SILT (SW-SM); ~80% sand, ~10% gravel, ~10% fines; fine to coarse, fine gravel, dry, light brown, Max. gravel size 1.5".	▼	
35												
	40		S-12		40 to 42	24/6	15-16-20-23			WIDELY GRADED SAND WITH SILT (SW-SM); ~80% sand, ~10% gravel, ~10% fines; fine to coarse, fine gravel, dry, light brown, Max. gravel size 1.5".		
30												
	45		S-13		45 to 47	24/4	26-29-37-39			WIDELY GRADED SAND WITH SILT (SW-SM); ~80% sand, ~10% gravel, ~10% fines; fine to medium, fine gravel, dry, brown, Max. gravel size 1.5".		
										End of Boring at 47 feet		
25												
	50											
20												

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

CLIENT: HDR Architechture, Inc.
PROJECT NAME: NSLS II - ACD
CITY/STATE: Upton, New York
GEI PROJECT NUMBER: 062152

GEI Consultants

GEI Consultants, Inc.
455 Winding Brook Dr
Glastonbury, CT 06033
860.368.5300

Appendix D

2006-2007 Cone Penetrometer Test (CPT) Logs

CONETEC

TABLE 1 - SUMMARY OF CPTU SOUNDINGS

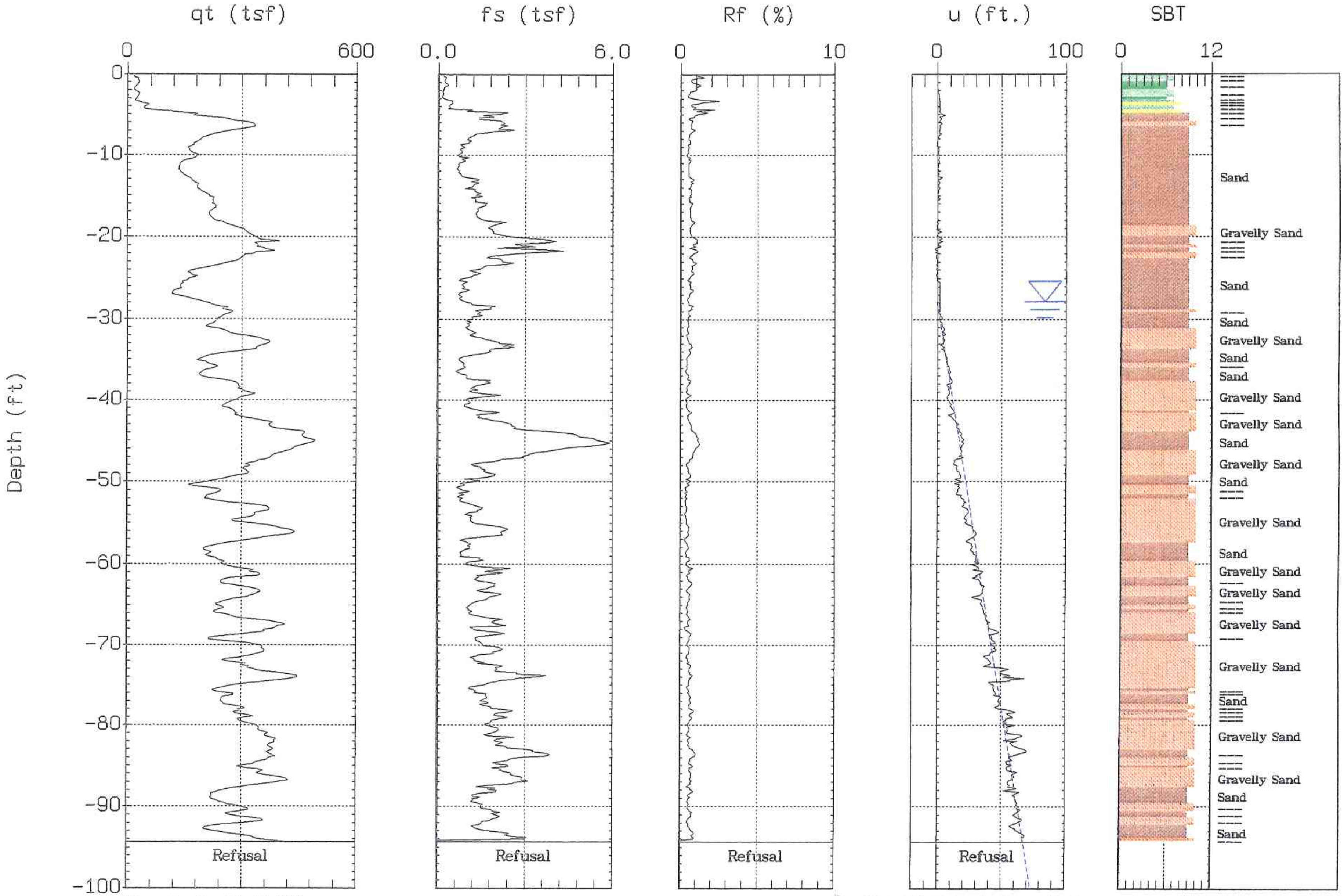
Job No.: 06-773
Location: Brookhaven National Labs
Client: GEI Consultants
Date: July 19, 20, 21, 2006

Date	CPTU Sounding	File Name	CPT Total Depth (ft)	Shear wave Velocity Tests	Comments
19-Jul-06	CPT-1	773cp01.cor	94.32		refusal
19-Jul-06	CPT-2	773cp02.cor	100.06		
20-Jul-06	CPT-3	773cp03.cor	86.12	9	refusal
19-Jul-06	CPT-4	773cp04.cor	95.14		refusal
20-Jul-06	CPT-5	773cp05.cor	7.87		refusal
20-Jul-06	CPT-5A	773cp05a.cor	82.68	9	refusal
20-Jul-06	CPT-6	773cp06.cor	100.06	10	
21-Jul-06	CPT-7	773cp07.cor	6.40		refusal
20-Jul-06	CPT-8	773cp08.cor	52.98		refusal
21-Jul-06	CPT-10	773cp10.cor	61.02		
21-Jul-06	CPT-11	773cp11.cor	73.49		
20-Jul-06	CPT-12	773cp12.cor	100.06	10	
20-Jul-06	CPT-13	773cp13.cor	6.73		refusal
20-Jul-06	CPT-13A	773cp13a.cor	5.58		refusal
21-Jul-06	CPT-14	773cp14.cor	95.80		refusal
Job Totals:		15	968.31	38	

GEI Consultants

Sounding:CPT-1
Site:National Labs

Piezocone:20 Ton AD164
Date:07:19:06 16:08



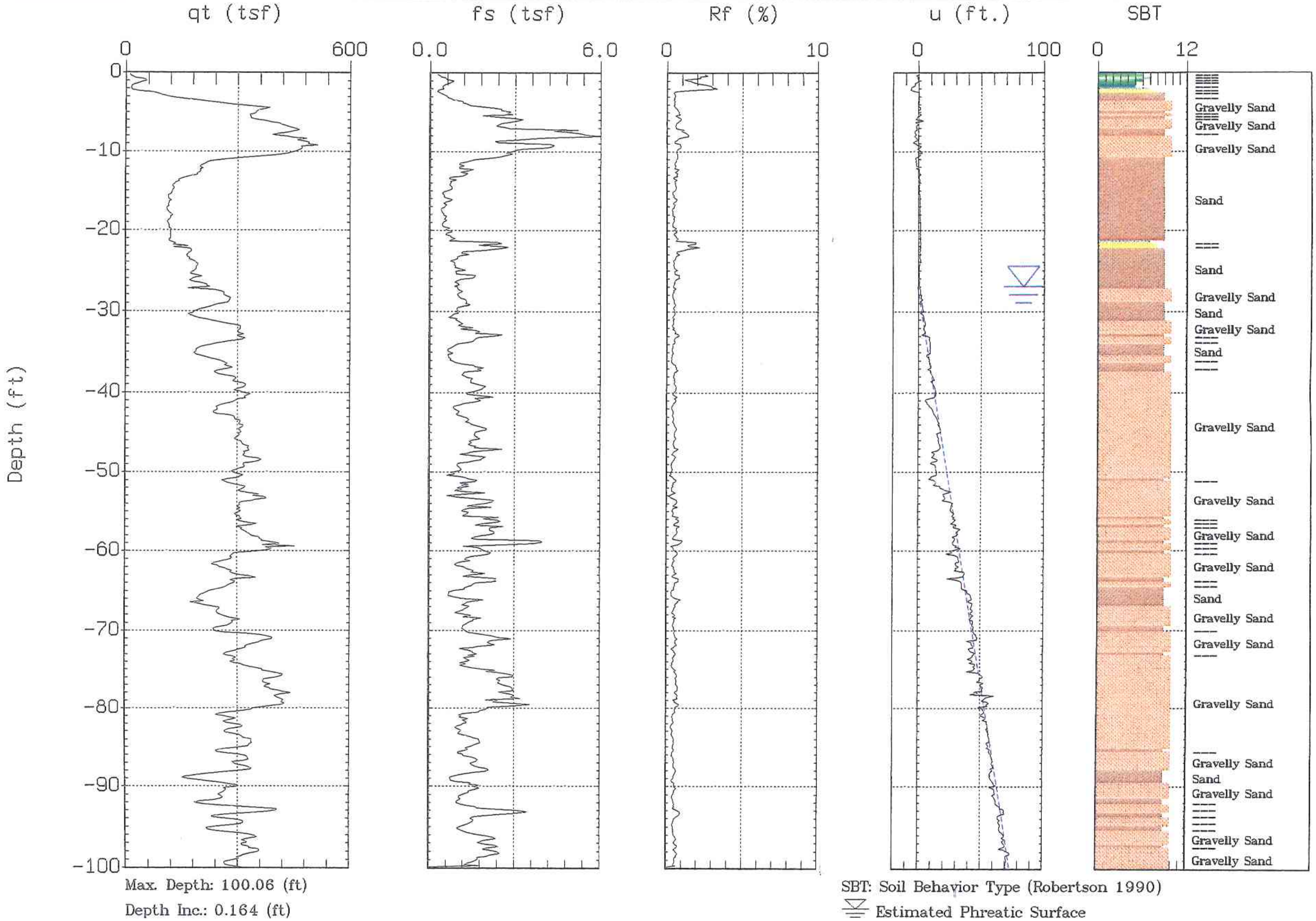
Max. Depth: 94.32 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

GEI Consultants

Sounding:CPT-2
Site:National Labs

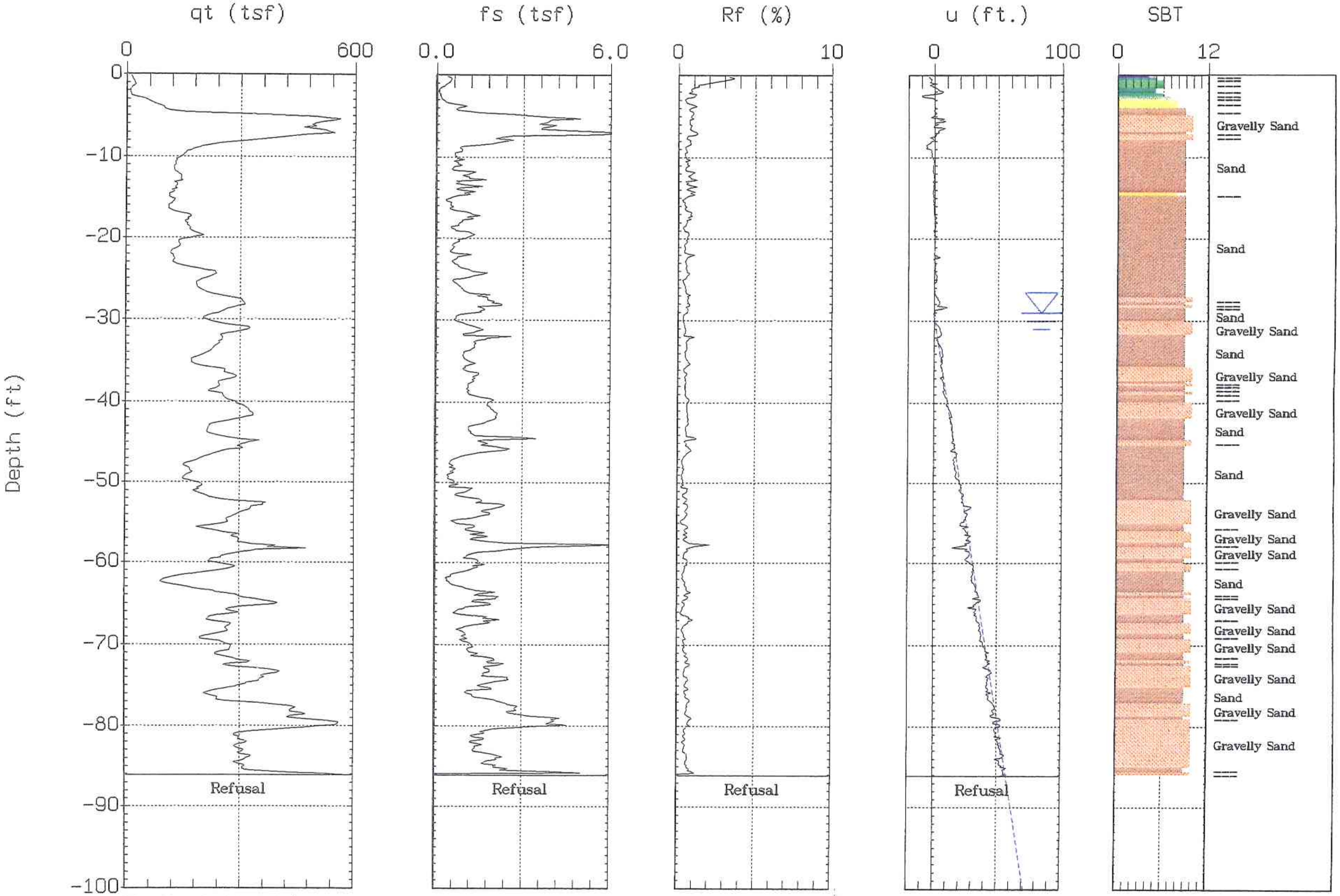
Piezocone:20 Ton AD164
Date:07:19:06 14:30



GEI Consultants

Sounding:CPT-3
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 07:32



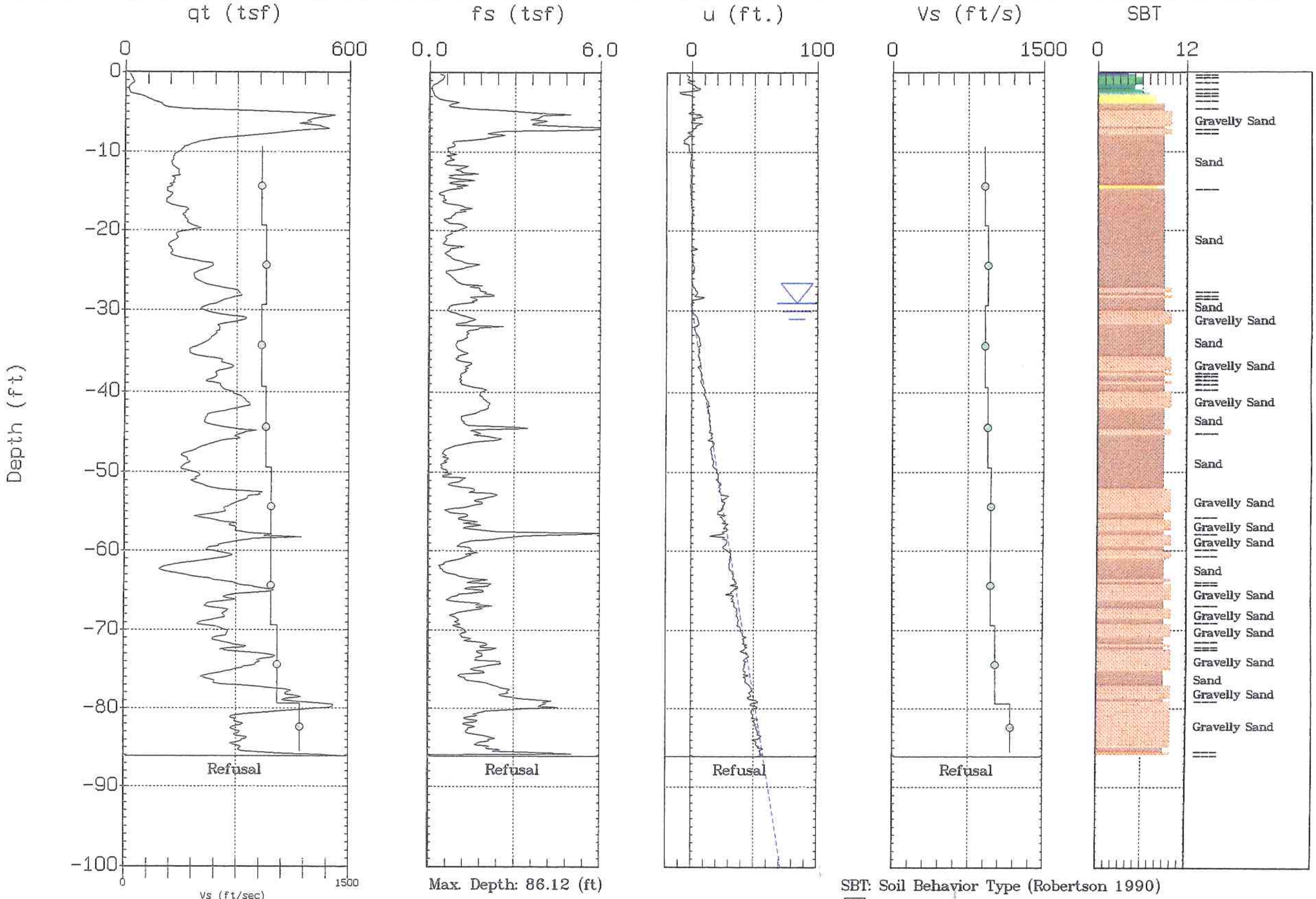
Max. Depth: 86.12 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

GEI Consultants

Sounding:CPT-3
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 07:32



Max. Depth: 86.12 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

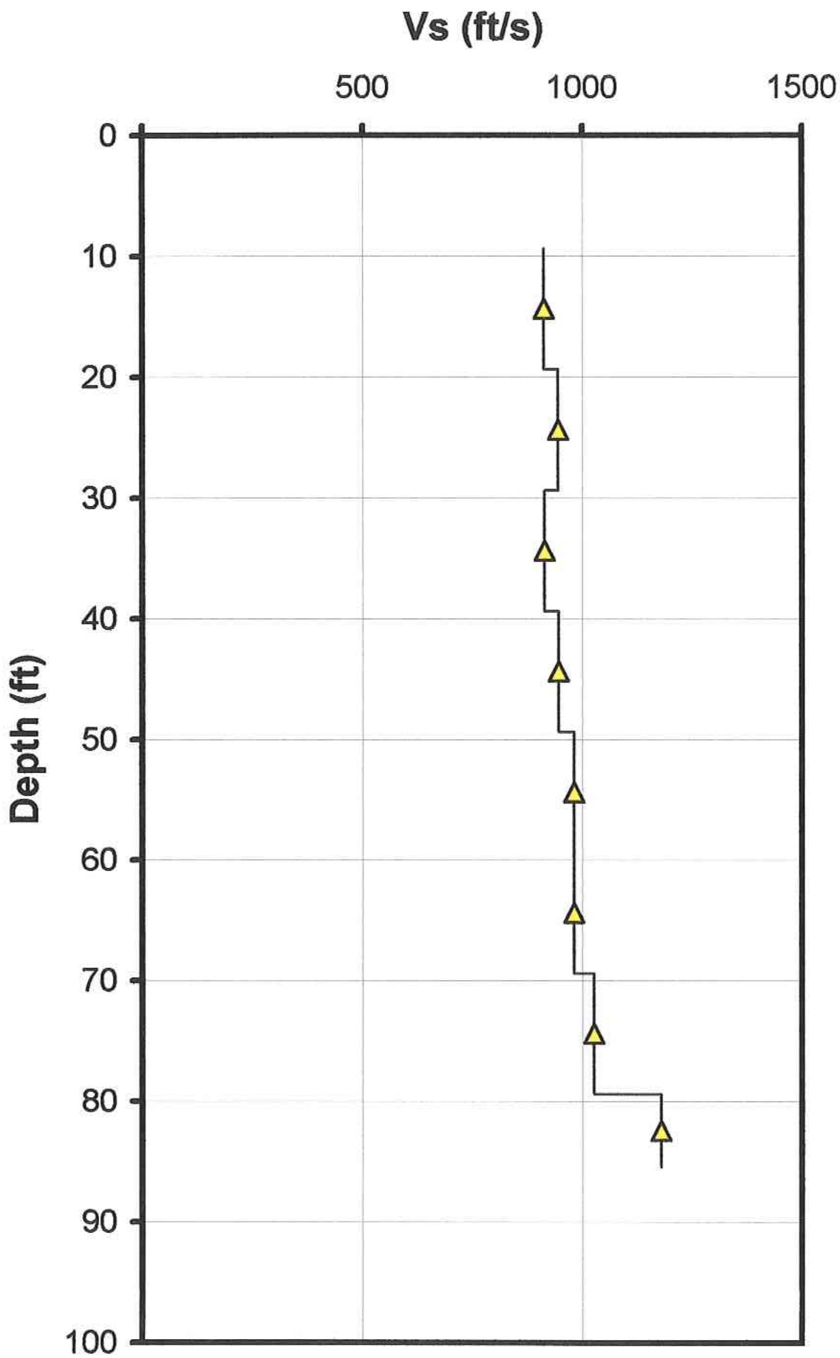
Job No	06-773
Client	GEI Consultants
Project Title	National Labs
Hole	CPT-3
Site	Brookhaven, New York
Date	7/20/2006

Seismic Source:	Beam	
Source Offset:	1.97	(ft)
Source Depth:	0.00	(ft)
Geophone Offset:	0.66	(ft)

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-layer Depth (ft)	Vs Interval Velocity (ft/s)
10.01	9.35	9.56				
20.01	19.35	19.45	9.89	10.84	14.35	913
30.02	29.36	29.43	9.98	10.57	24.36	944
40.03	39.37	39.42	9.99	10.93	34.37	914
50.03	49.37	49.41	9.99	10.57	44.37	945
60.04	59.38	59.42	10.00	10.20	54.38	981
70.05	69.39	69.42	10.01	10.20	64.39	981
80.05	79.39	79.42	10.00	9.75	74.39	1025
86.12	85.46	85.49	6.07	5.15	82.43	1178

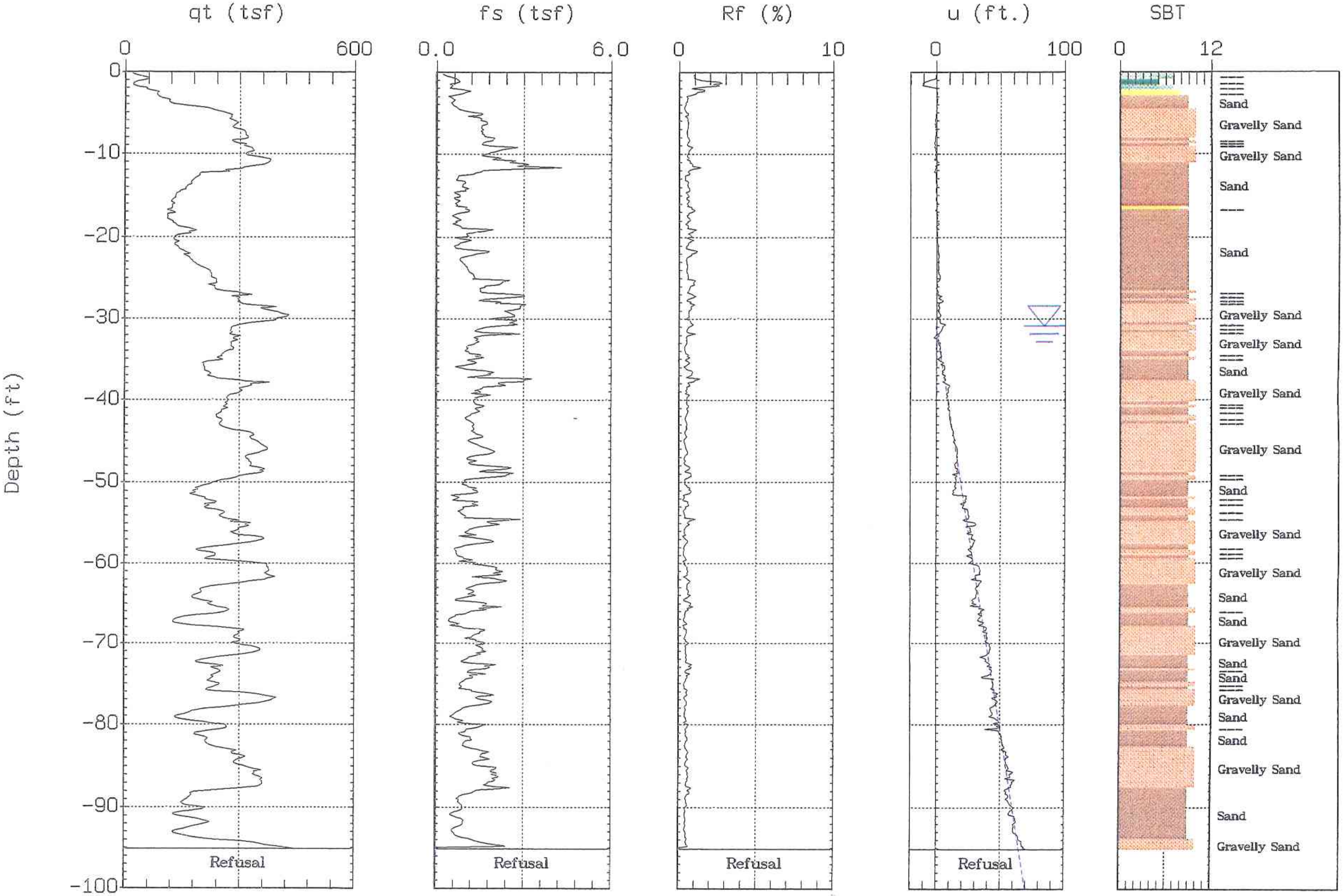
Job No: 06-773
Client: GEI Consultants
Project: National Labs
Sounding: CPT-3
Date: July 20, 2006



GEI Consultants

Sounding:CPT-4
Site:National Labs

Piezocone:20 Ton AD164
Date:07:19:06 13:13



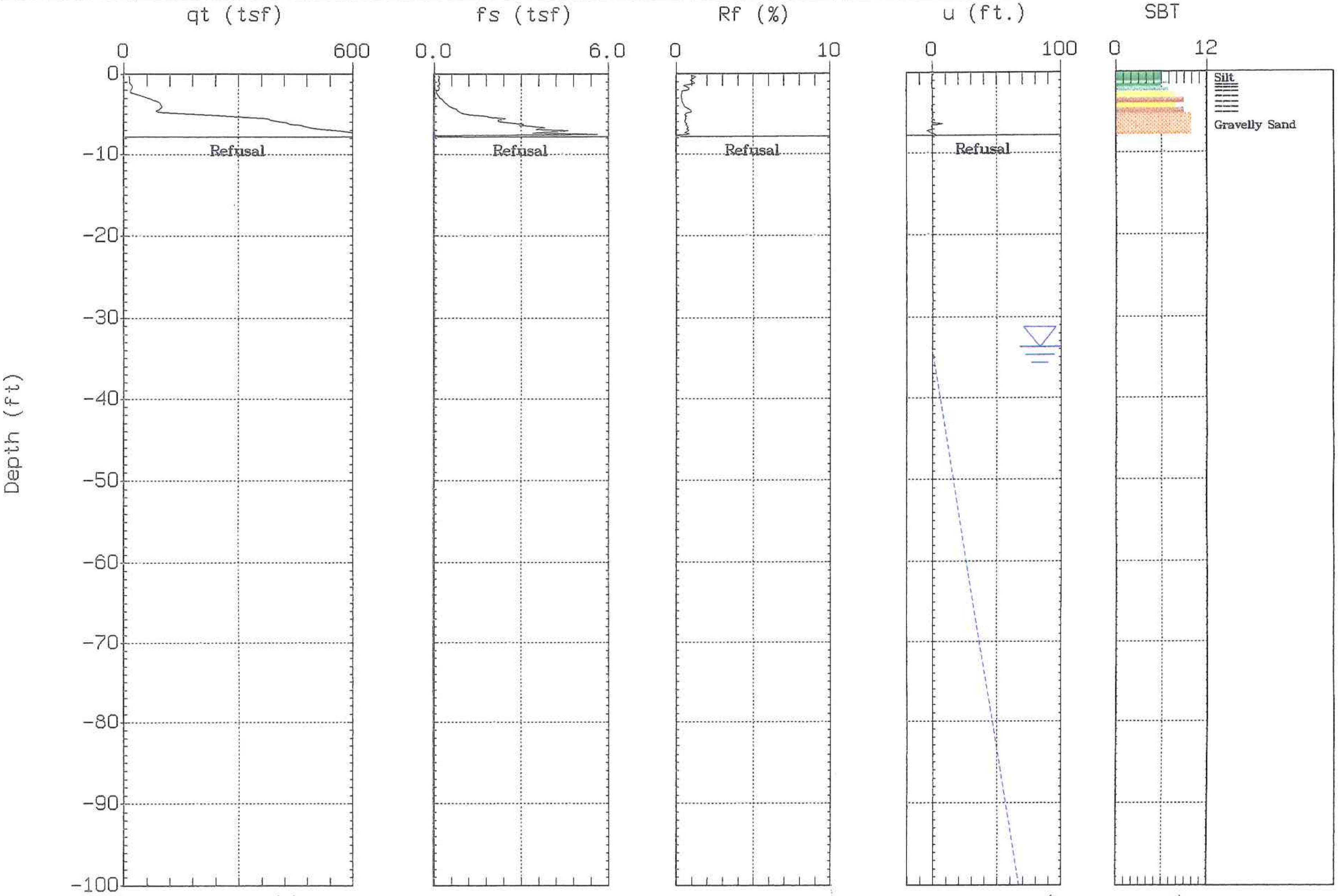
Max. Depth: 95.14 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

GEI Consultants

Sounding:CPT-5
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 08:58



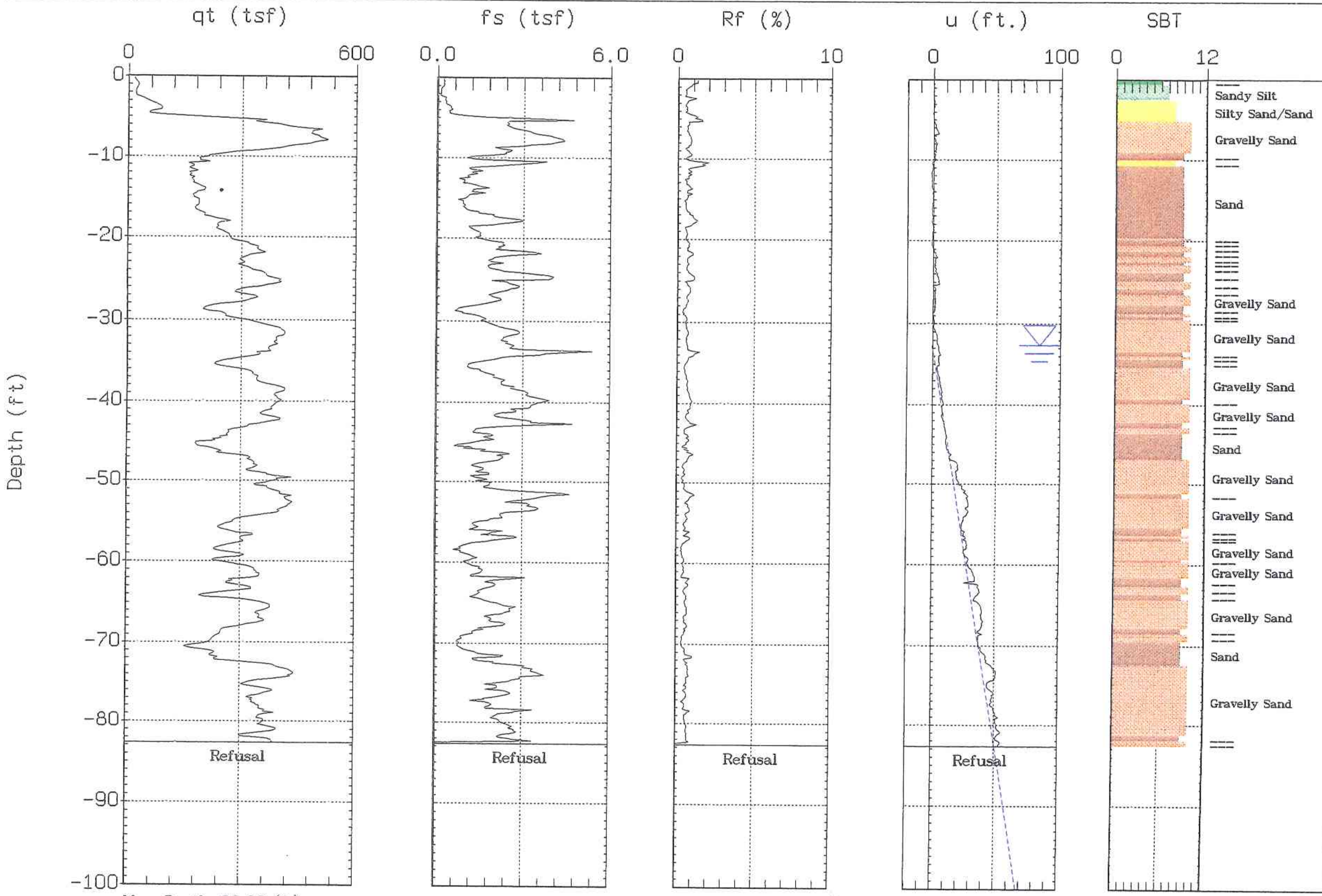
Max. Depth: 7.87 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

GEI Consultants

Sounding:CPT-5A
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 09:27



Max. Depth: 82.68 (ft)
Depth Inc.: 0.164 (ft)

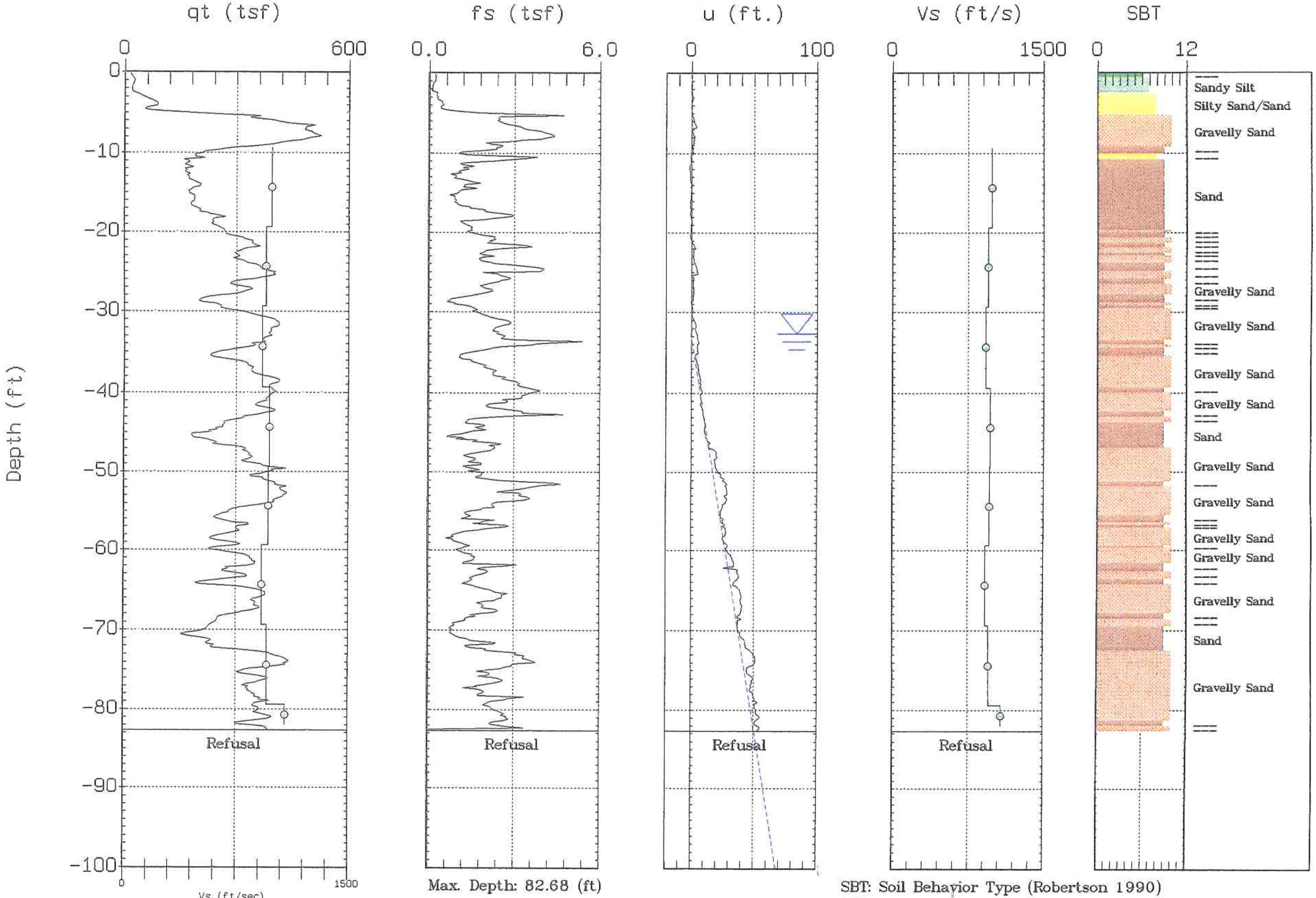
SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

GEI Consultants

Sounding:CPT-5A
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 09:27



Max. Depth: 82.68 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

Job No	06-773
Client	GEI Consultants
Project Title	National Labs
Hole	CPT-5A
Site	Brookhaven, New York
Date	7/20/2006

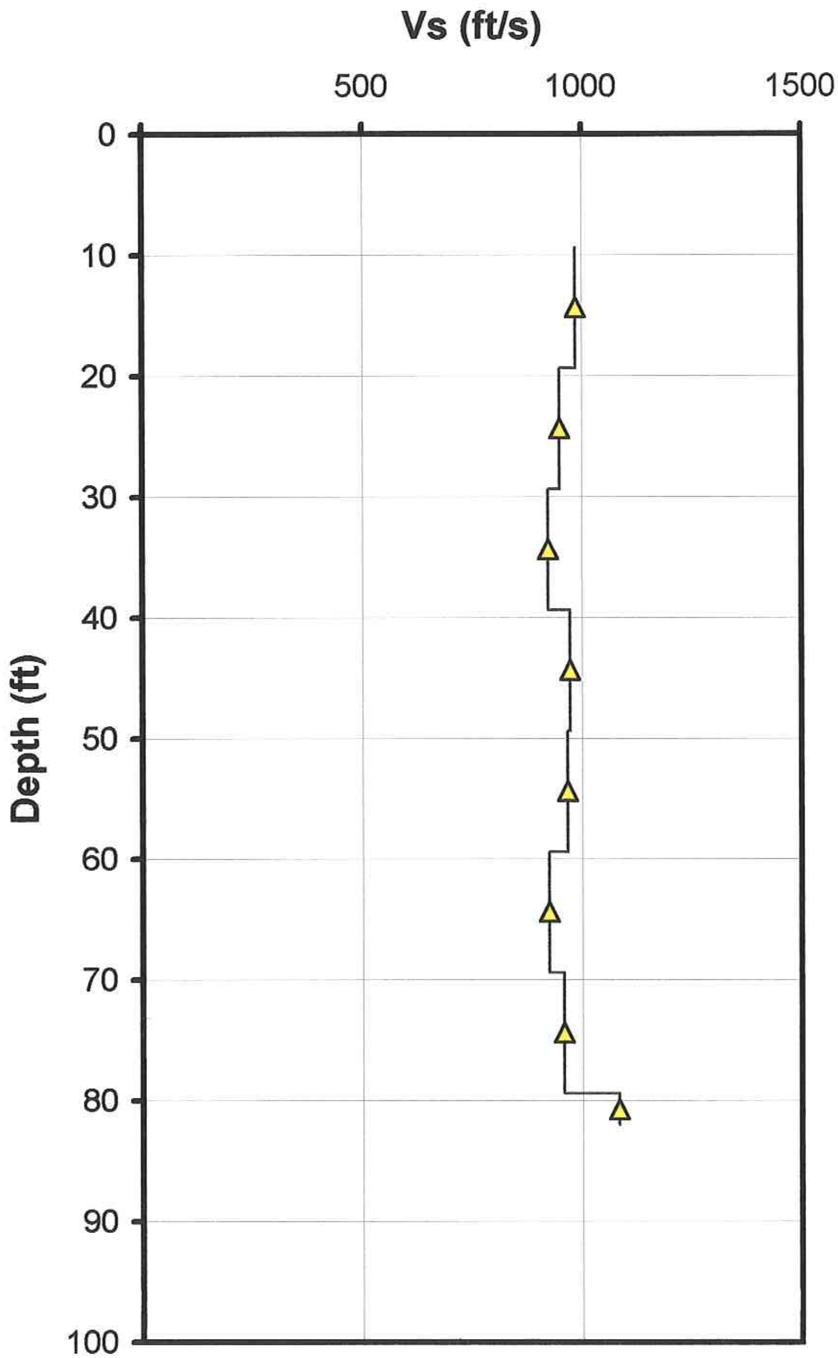
Seismic Source:	Beam	
Source Offset:	1.97	(ft)
Source Depth:	0.00	(ft)
Geophone Offset:	0.66	(ft)

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-layer Depth (ft)	Vs Interval Velocity (ft/s)
10.01	9.35	9.56				
20.01	19.35	19.45	9.89	10.05	14.35	985
30.02	29.36	29.43	9.98	10.52	24.36	948
40.03	39.37	39.42	9.99	10.83	34.37	923
50.03	49.37	49.41	9.99	10.28	44.37	972
60.04	59.38	59.42	10.00	10.36	54.38	966
70.05	69.39	69.42	10.01	10.83	64.39	924
80.05	79.39	79.42	10.00	10.44	74.39	958
82.68	82.02	82.05	2.63	2.43	80.71	1082

8

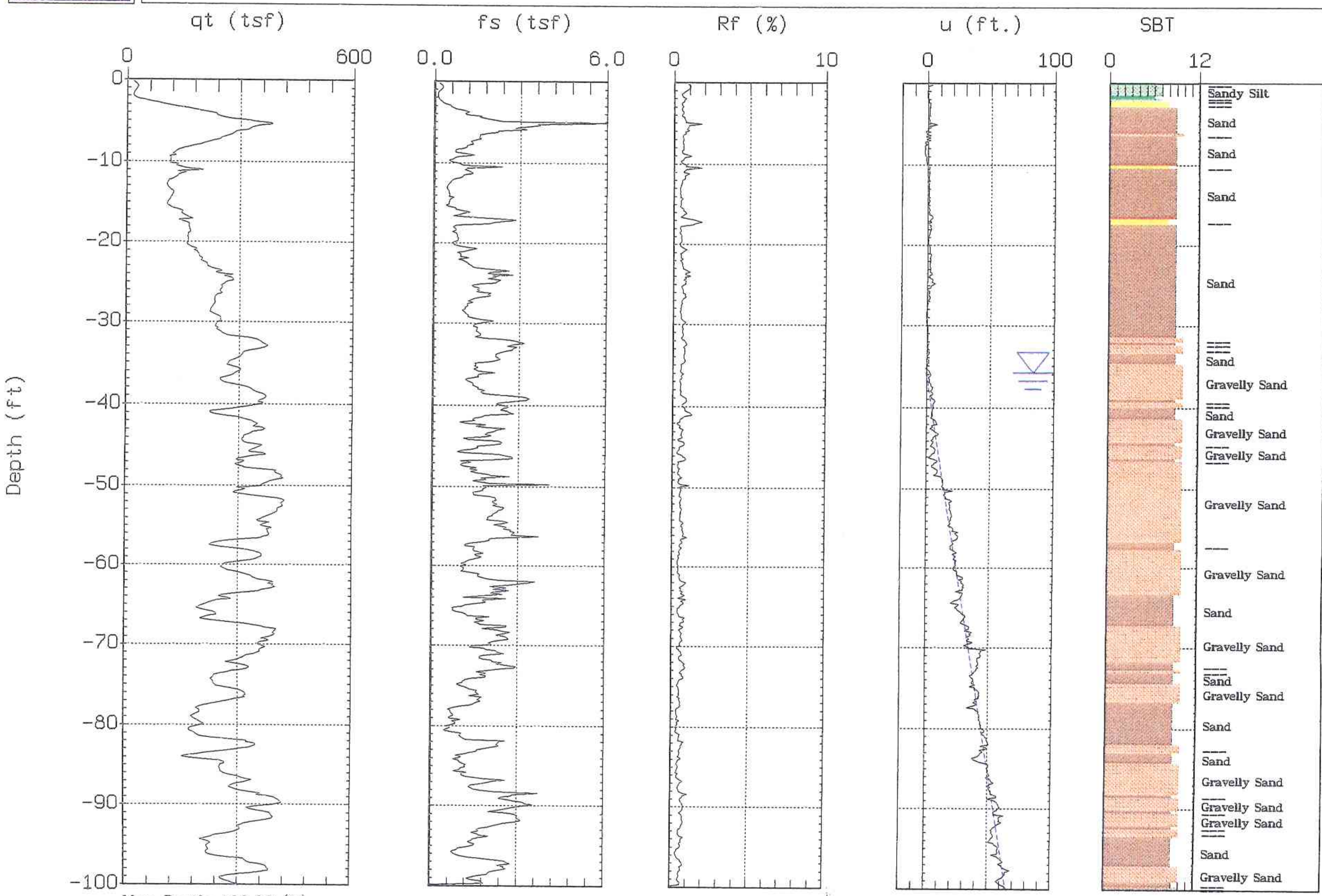
Job No: 06-773
Client: GEI Consultants
Project: National Labs
Sounding: CPT-5A
Date: July 20, 2006



GEI Consultants

Sounding:CPT-6
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 10:46



Max. Depth: 100.06 (ft)
Depth Inc.: 0.164 (ft)

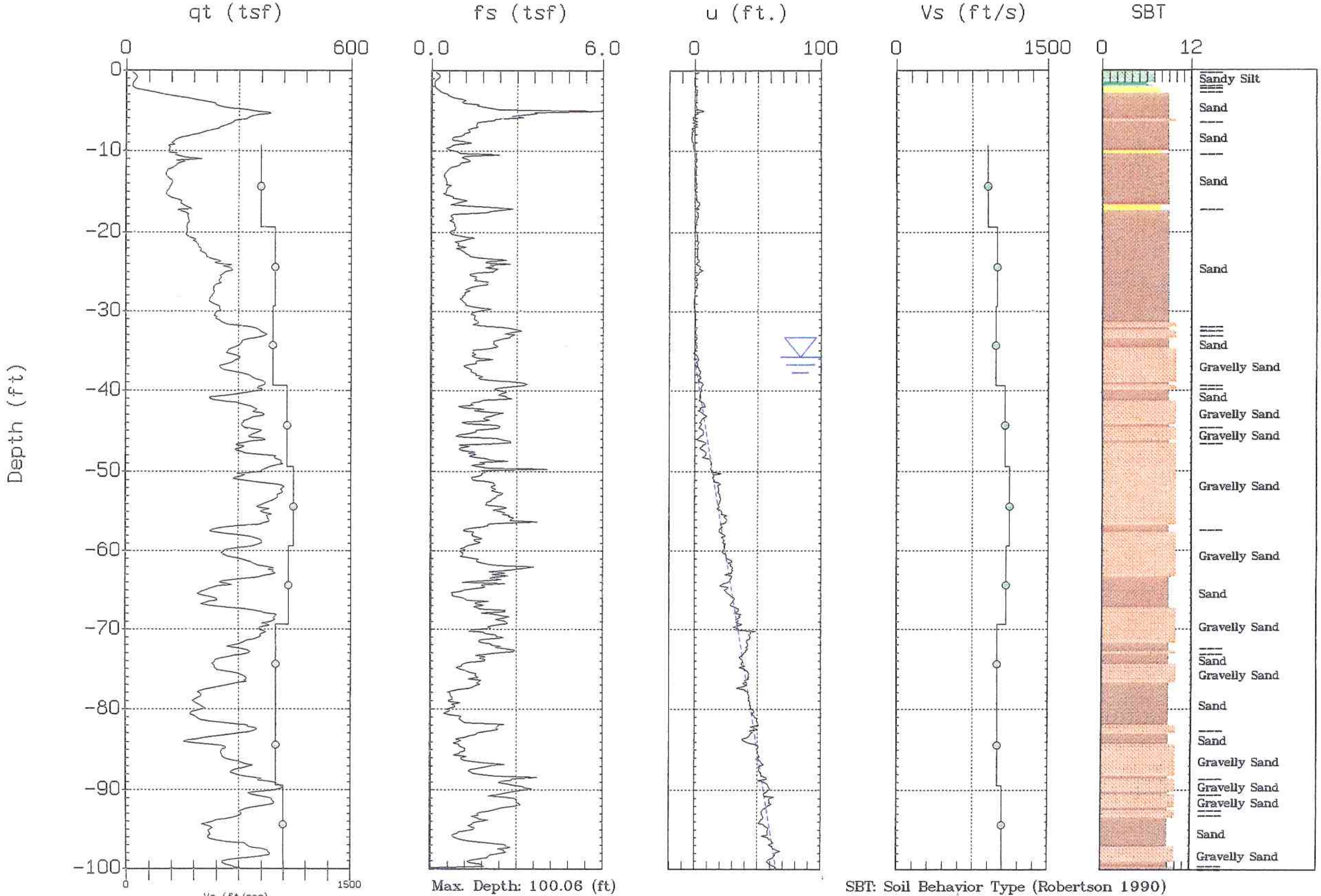
SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

GEI Consultants

Sounding:CPT-6
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 10:46



Max. Depth: 100.06 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

Job No	06-773
Client	GEI Consultants
Project Title	National Labs
Hole	CPT-6
Site	Brookhaven, New York
Date	7/20/2006

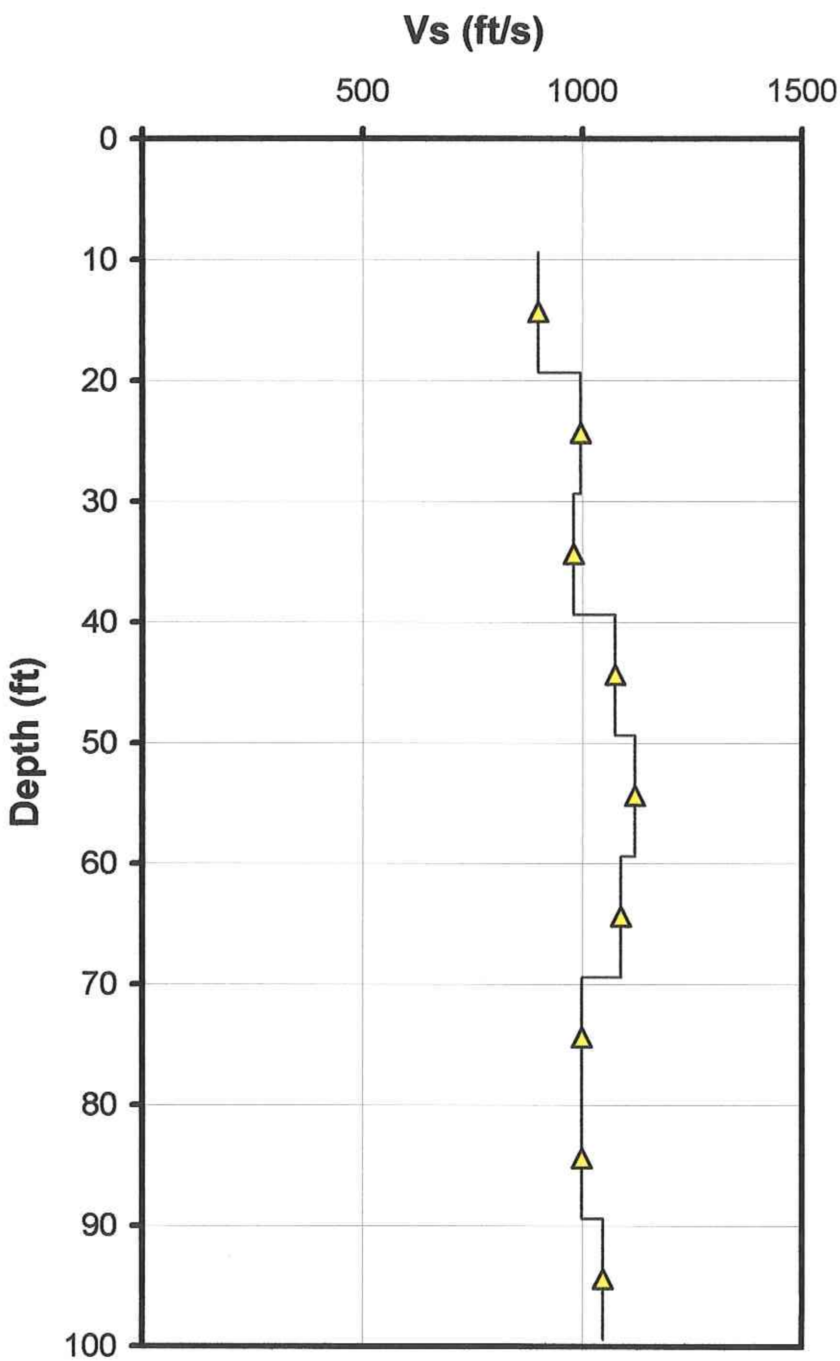
Seismic Source:	Beam	
Source Offset:	1.97	(ft)
Source Depth:	0.00	(ft)
Geophone Offset:	0.66	(ft)

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-layer Depth (ft)	Vs Interval Velocity (ft/s)
10.01	9.35	9.56				
20.01	19.35	19.45	9.89	11.00	14.35	900
30.02	29.36	29.43	9.98	10.02	24.36	996
40.03	39.37	39.42	9.99	10.20	34.37	980
50.03	49.37	49.41	9.99	9.30	44.37	1074
60.04	59.38	59.42	10.00	8.94	54.38	1119
70.05	69.39	69.42	10.01	9.21	64.39	1086
80.05	79.39	79.42	10.00	10.02	74.39	998
90.06	89.40	89.43	10.01	10.02	84.40	999
100.07	99.41	99.43	10.01	9.57	94.41	1046

9

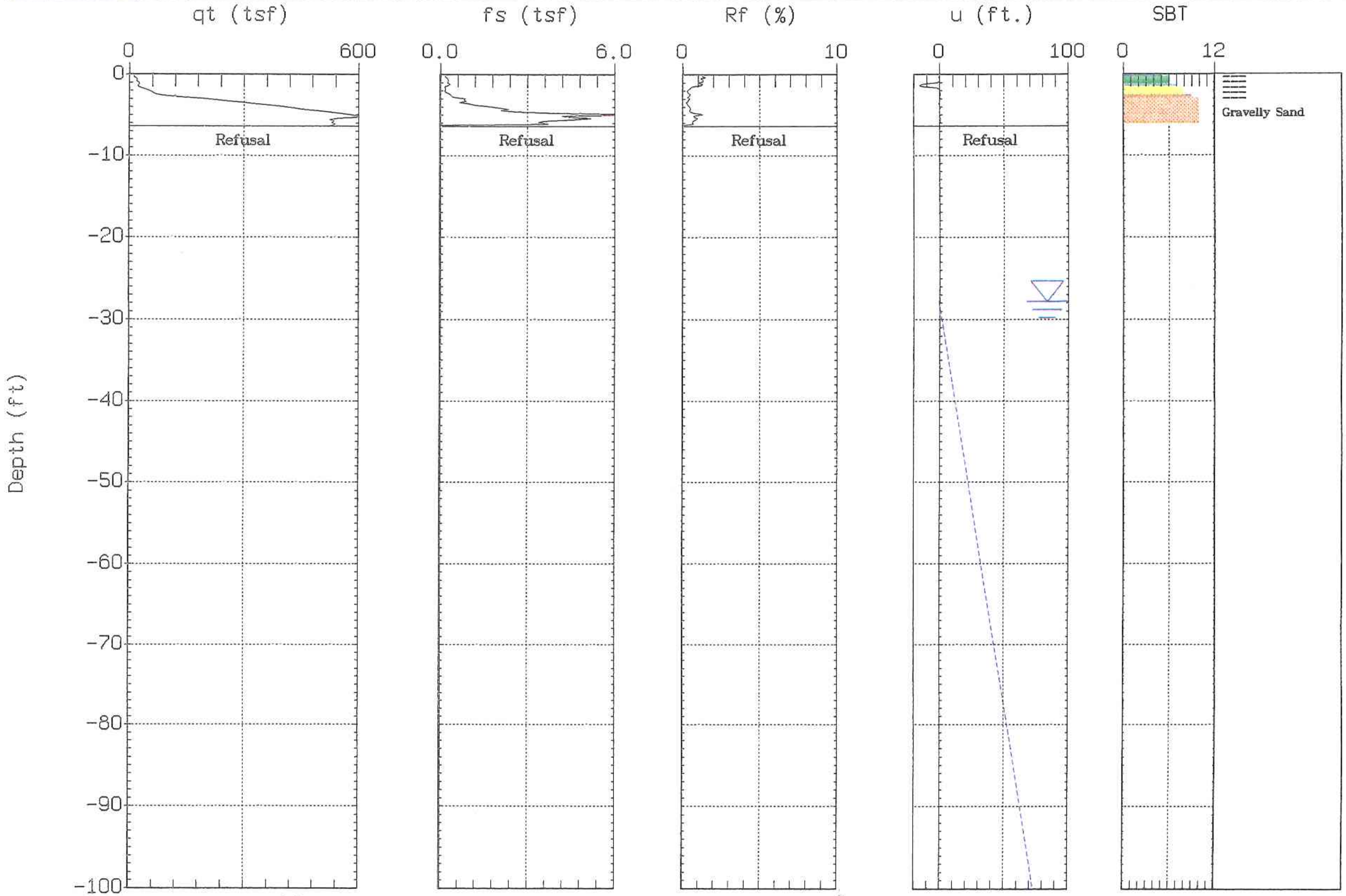
Job No: 06-773
Client: GEI Consultants
Project: National Labs
Sounding: CPT-6
Date: July 20, 2006



GEI Consultants

Sounding:CPT-7
Site:National Labs

Piezocone:20 Ton AD179
Date:07:21:06 12:03



Max. Depth: 6.40 (ft)
Depth Inc.: 0.164 (ft)

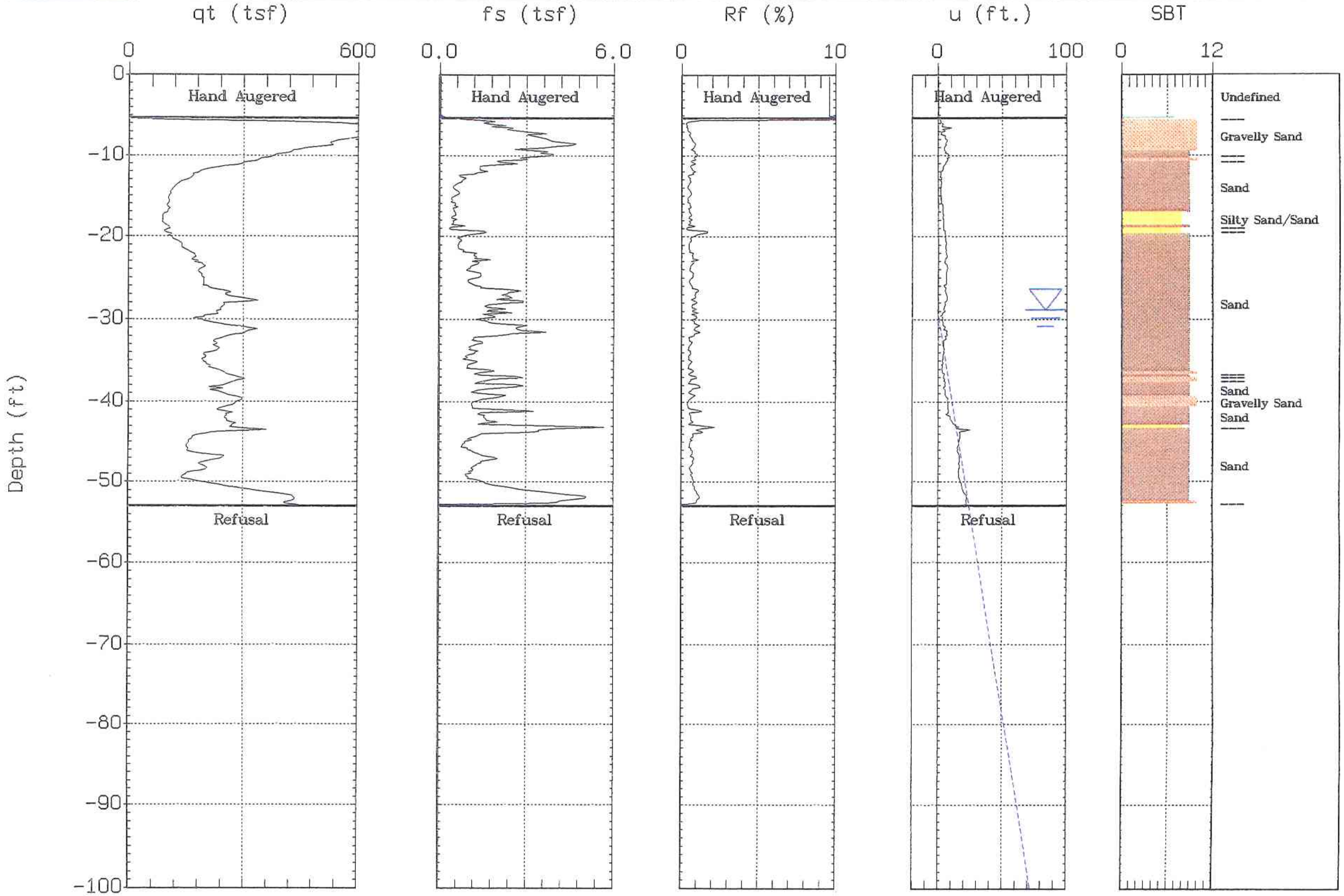
SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

GEI Consultants

Sounding:CPT-8
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 15:23



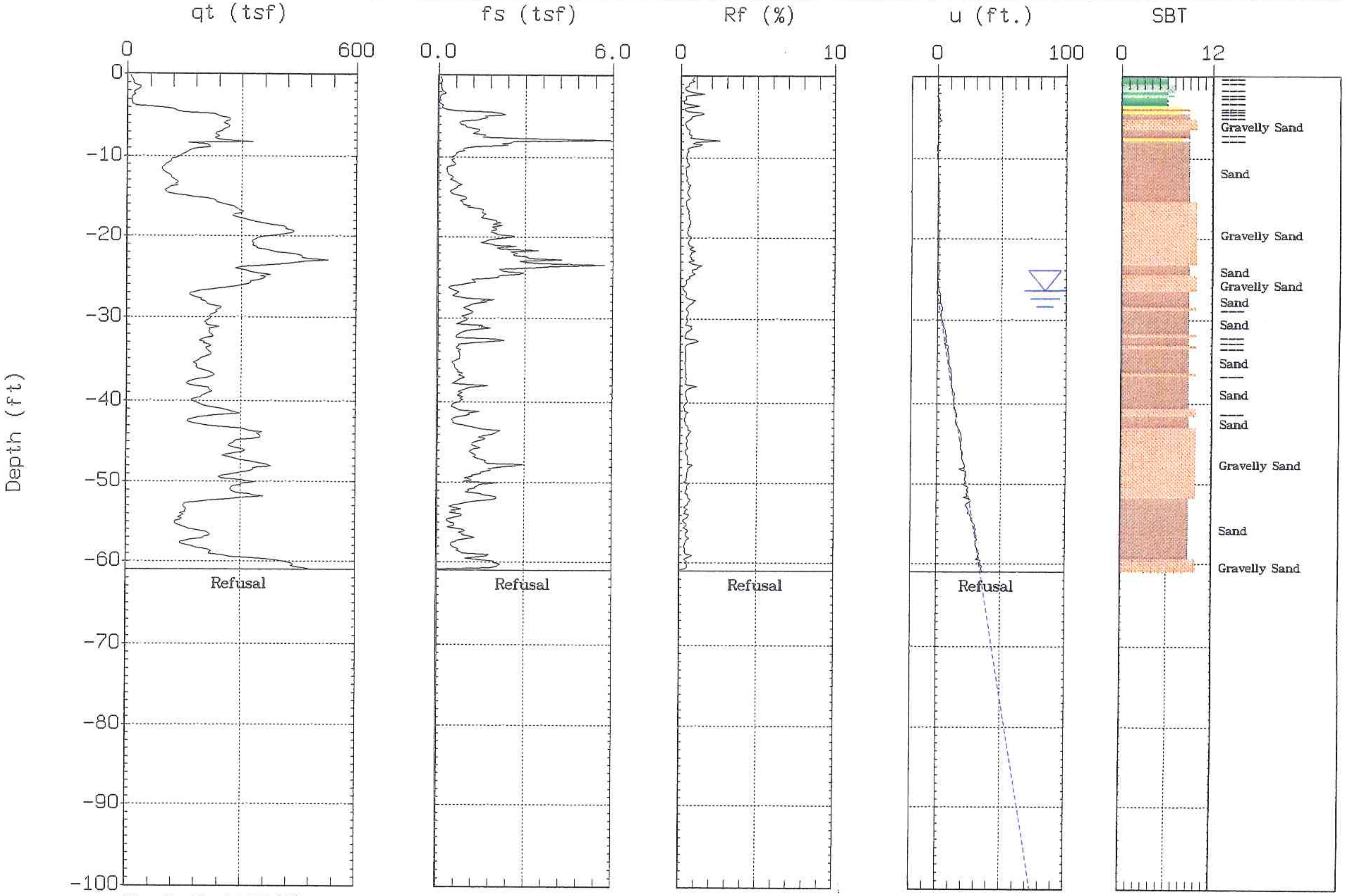
Max. Depth: 52.98 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

GEI Consultants

Sounding:CPT-10
Site:National Labs

Piezocone:20 Ton AD179
Date:07:21:06 09:56



Max. Depth: 61.02 (ft)
Depth Inc.: 0.164 (ft)

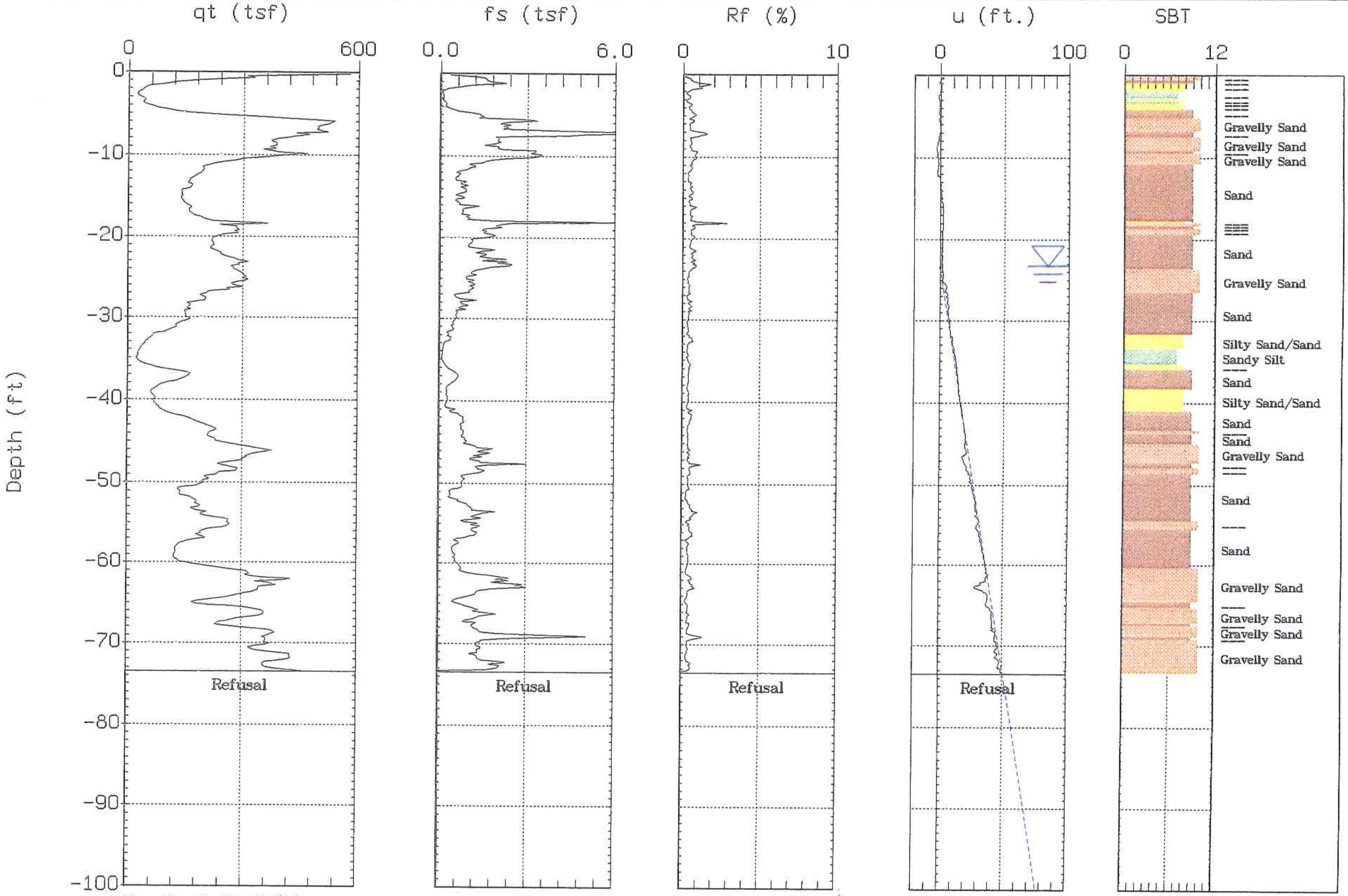
SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

GEI Consultants

Sounding:CPT-11
Site:National Labs

Piezocone:20 Ton AD179
Date:07:21:06 08:42



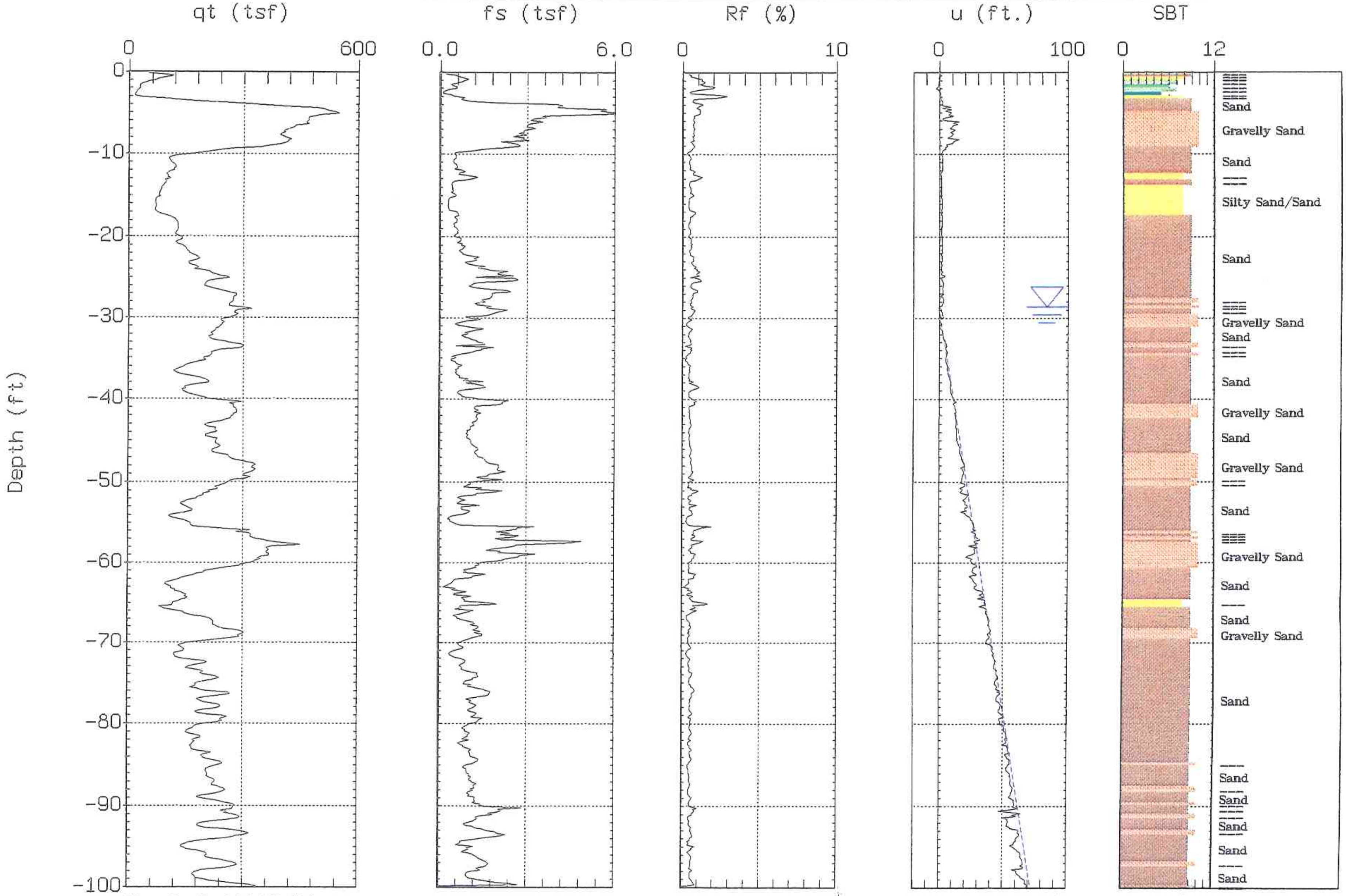
Max. Depth: 73.49 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

GEI Consultants

Sounding:CPT-12
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 13:19



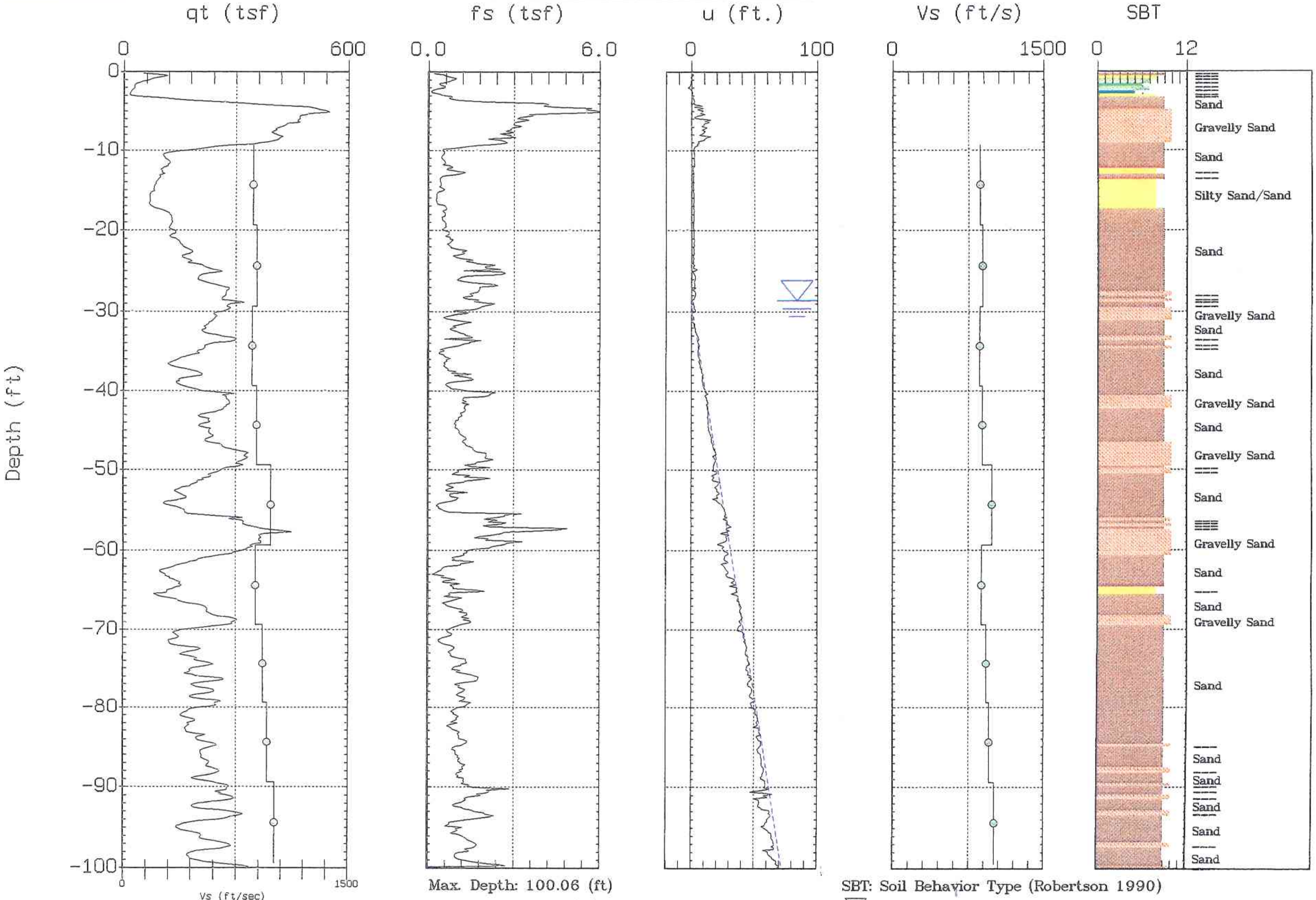
Max. Depth: 100.06 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

GEI Consultants

Sounding:CPT-12
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 13:19



Max. Depth: 100.06 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

Job No	06-773
Client	GEI Consultants
Project Title	National Labs
Hole	CPT-12
Site	Brookhaven, New York
Date	7/20/2006

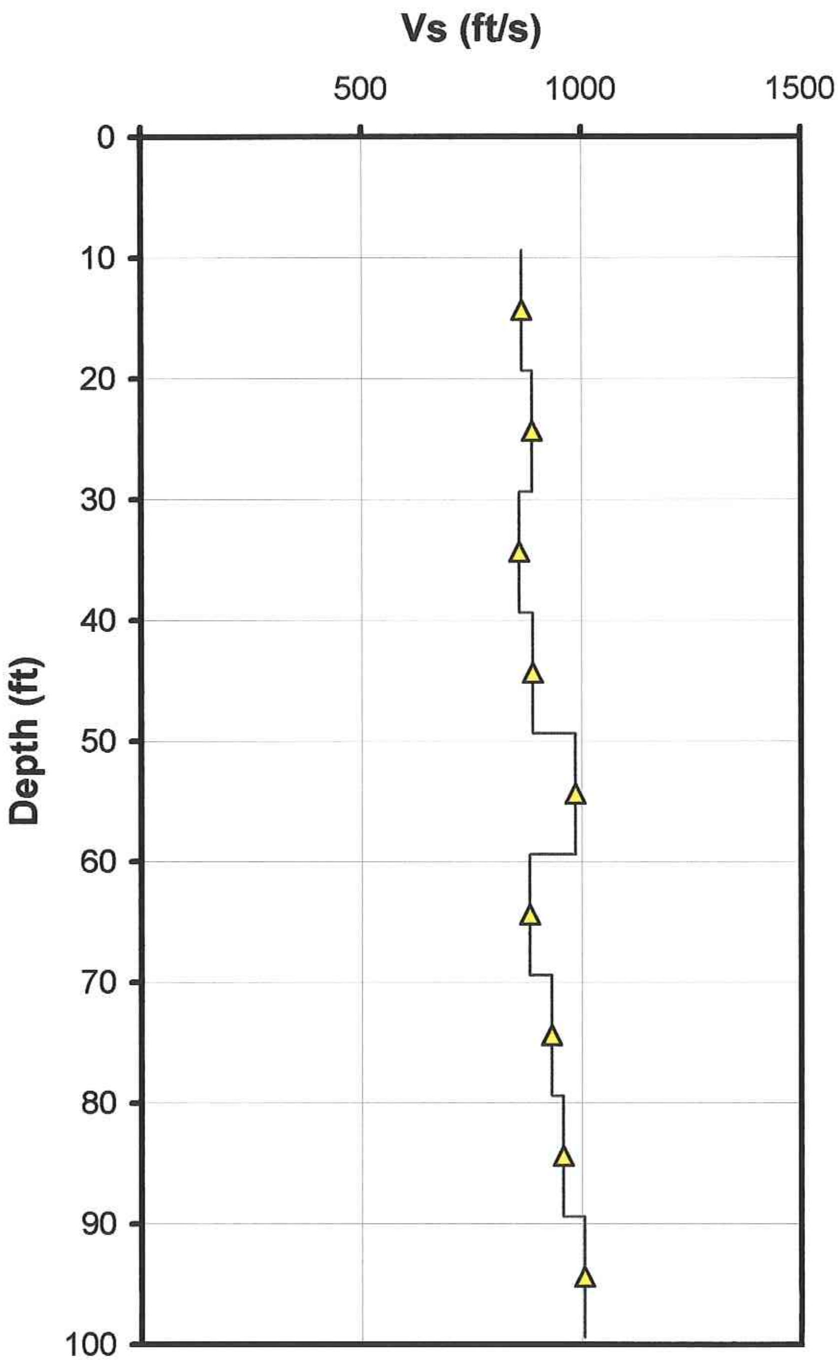
Seismic Source:	Beam	
Source Offset:	1.97	(ft)
Source Depth:	0.00	(ft)
Geophone Offset:	0.66	(ft)

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-layer Depth (ft)	Vs Interval Velocity (ft/s)
10.01	9.35	9.56				
20.01	19.35	19.45	9.89	11.44	14.35	865
30.02	29.36	29.43	9.98	11.24	24.36	888
40.03	39.37	39.42	9.99	11.64	34.37	859
50.03	49.37	49.41	9.99	11.24	44.37	889
60.04	59.38	59.42	10.00	10.15	54.38	986
70.05	69.39	69.42	10.01	11.34	64.39	882
80.05	79.39	79.42	10.00	10.74	74.39	931
90.06	89.40	89.43	10.01	10.45	84.40	958
100.07	99.41	99.43	10.01	9.95	94.41	1006

9

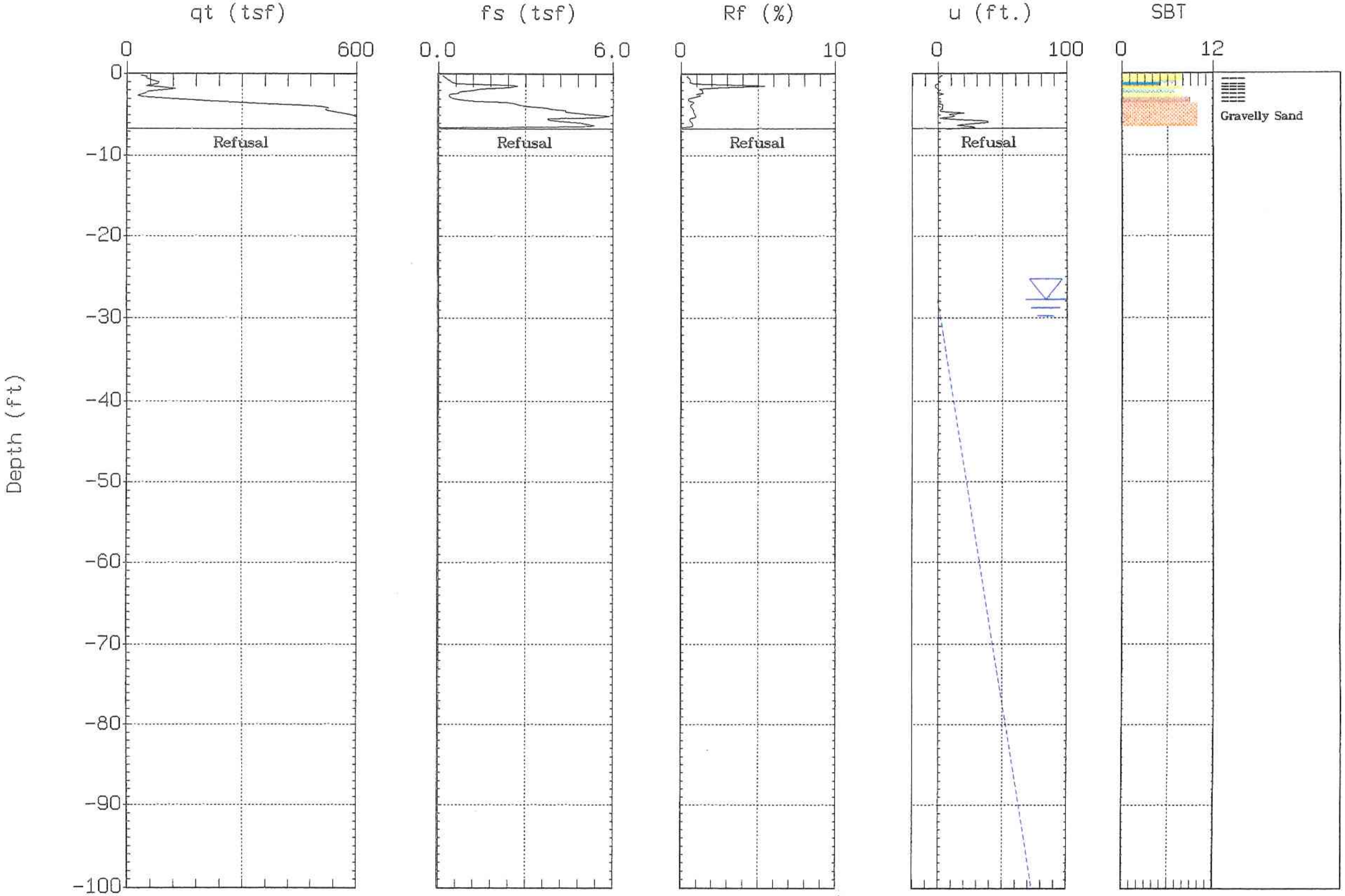
Job No: 06-773
Client: GEI Consultants
Project: National Labs
Sounding: CPT-12
Date: July 20, 2006



GEI Consultants

Sounding:CPT-13
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 12:23



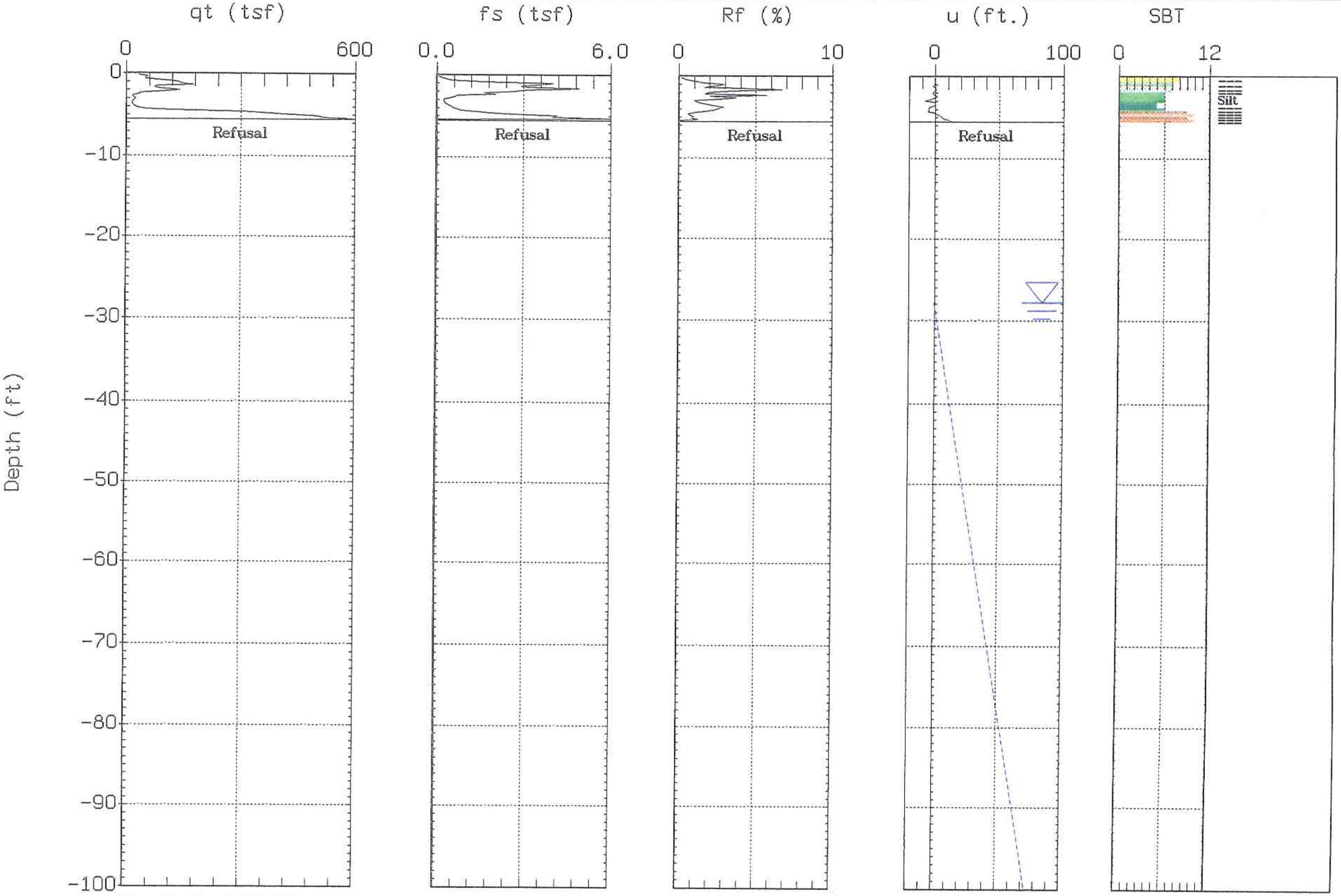
Max. Depth: 6.73 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

GEI Consultants

Sounding:CPT-13A
Site:National Labs

Piezocone:20 Ton AD164
Date:07:20:06 12:50



Max. Depth: 5.58 (ft)
Depth Inc.: 0.164 (ft)

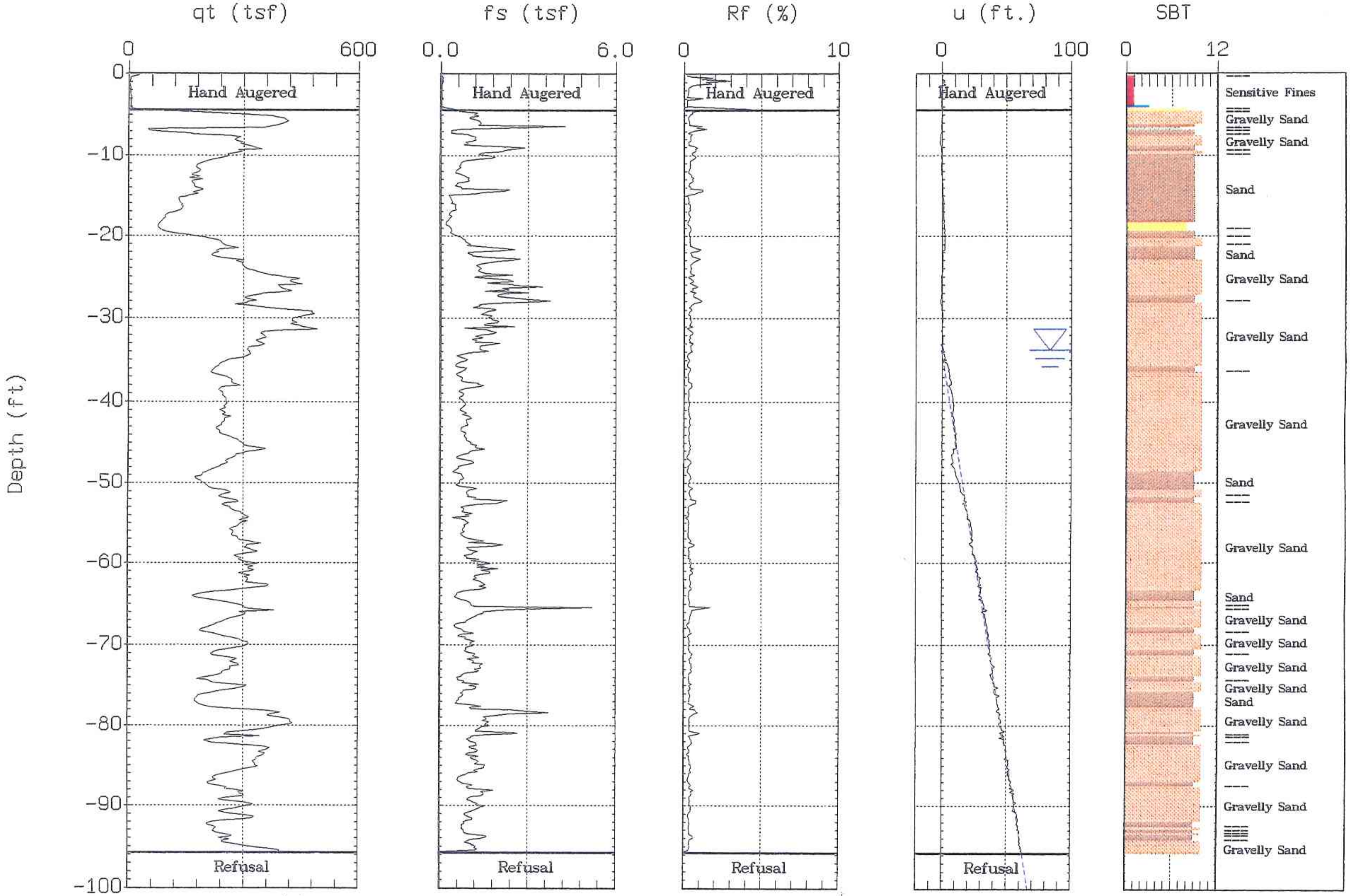
SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

GEI Consultants

Sounding:CPT-14
Site:National Labs

Piezocone:20 Ton AD179
Date:07:21:06 07:28



Max. Depth: 95.80 (ft)
Depth Inc.: 0.164 (ft)

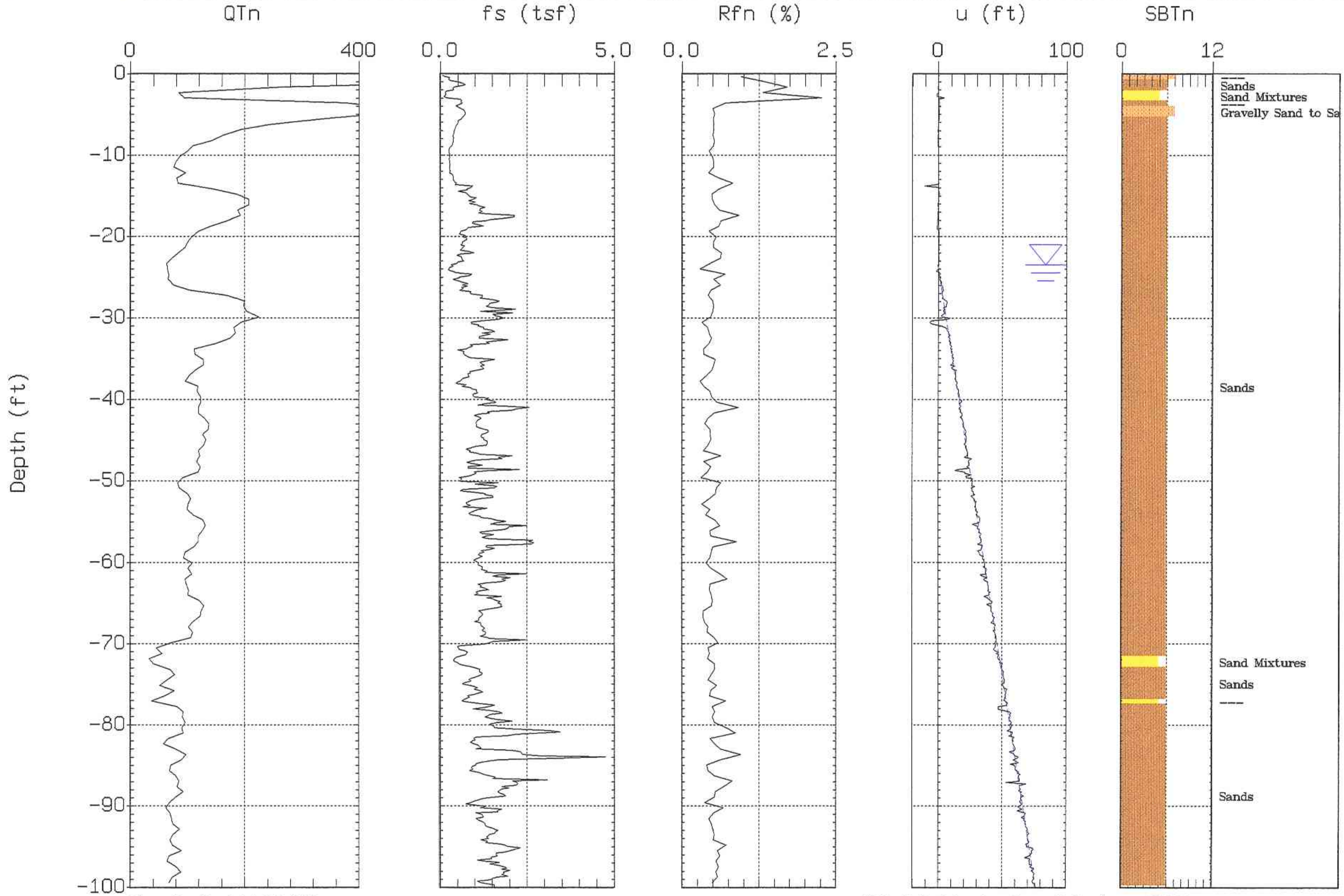
SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

GEI Consultants

Site: CPT-201
Location: Upton, NY

Cone:STD 20T AD179
Date:04:23:07 12:01



Max. Depth: 100.06 (ft)
Depth Inc.: 0.164 (ft)

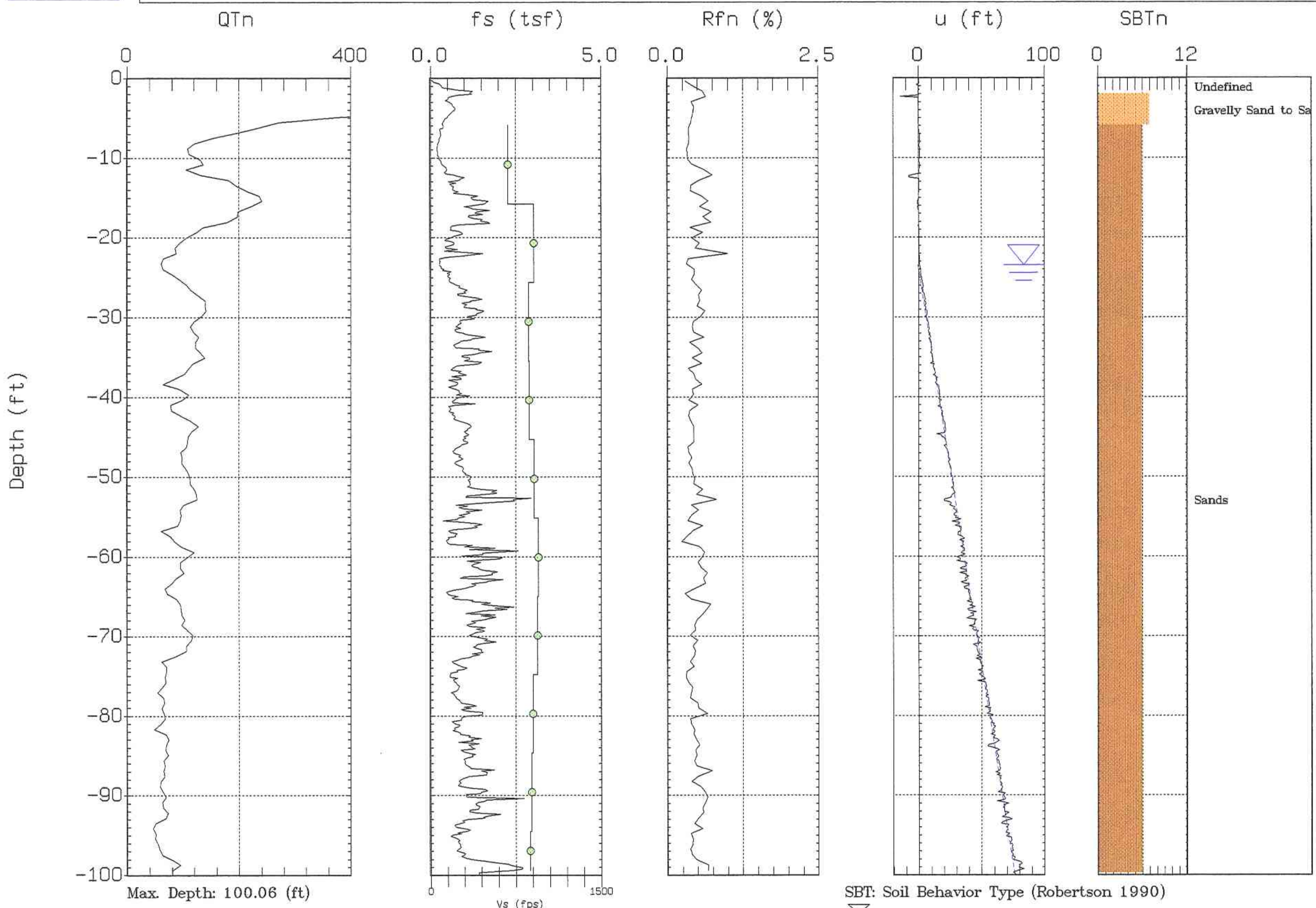
SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

GEI Consultants

Site: CPT-202
Location: Upton, NY

Cone:STD 20T AD179
Date:04:23:07 13:32



Max. Depth: 100.06 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

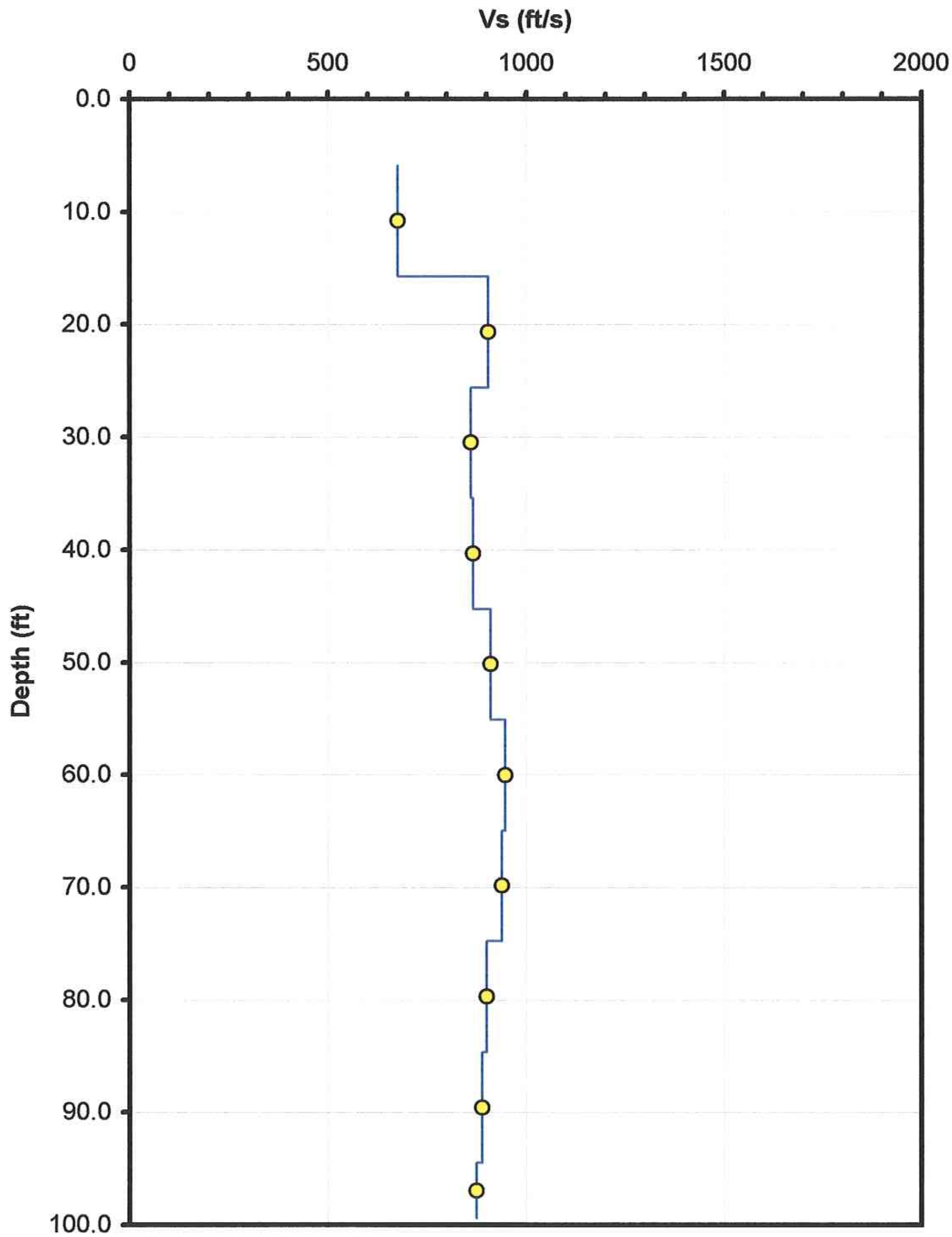
Client: GEI Consultants
Project: Brookhaven National Laboratory, Upton, NY
Sounding: CPT-202
Date: April 23, 2007

Seismic Source: Beam
Source Offset (ft): 2.00
Source Depth (ft): 0.00
Geophone Offset (ft): 0.66

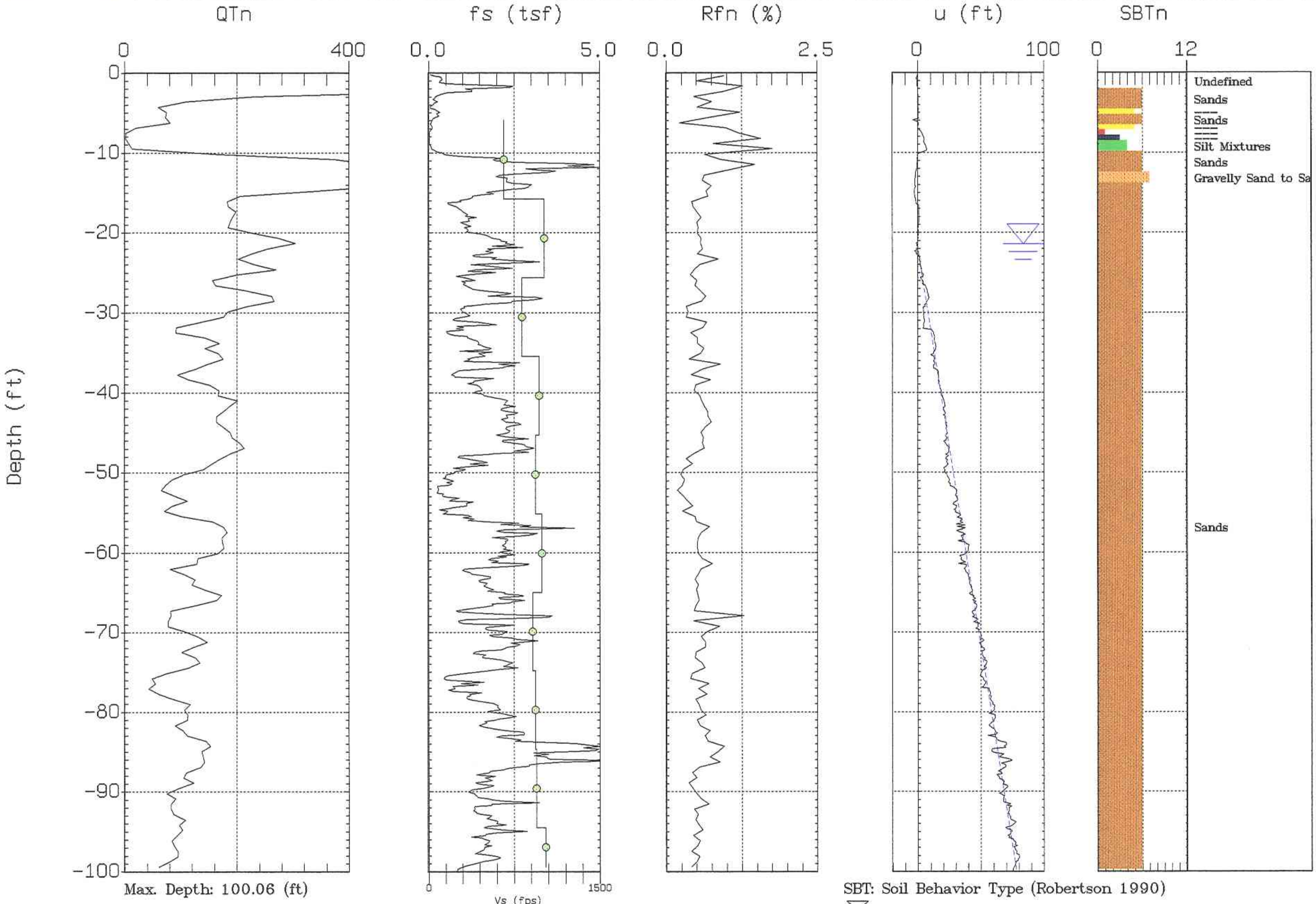
SEISMIC - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Vs (ft/s)	Mid Layer (ft)
6.56	5.90	6.23				
16.40	15.74	15.87	9.64	14.24	677	10.82
26.25	25.59	25.66	9.79	10.82	905	20.67
36.09	35.43	35.49	9.82	11.41	861	30.51
45.93	45.27	45.32	9.83	11.35	866	40.35
55.77	55.11	55.15	9.83	10.80	911	50.19
65.62	64.96	64.99	9.84	10.39	947	60.04
75.46	74.80	74.83	9.84	10.49	938	69.88
85.30	84.64	84.67	9.84	10.93	900	79.72
95.14	94.48	94.51	9.84	11.08	888	89.56
100.07	99.41	99.43	4.92	5.63	874	96.94

Client: GEI Consultants
Location: Brookhaven National Laboratory, Upton, NY
CPT Sounding: CPT-202
Date: April 23, 2007



CONETEC | GEI Consultants | Site: CPT-203
Location: Upton, NY | Cone:STD 20T AD179
Date:04:23:07 15:16



Max. Depth: 100.06 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

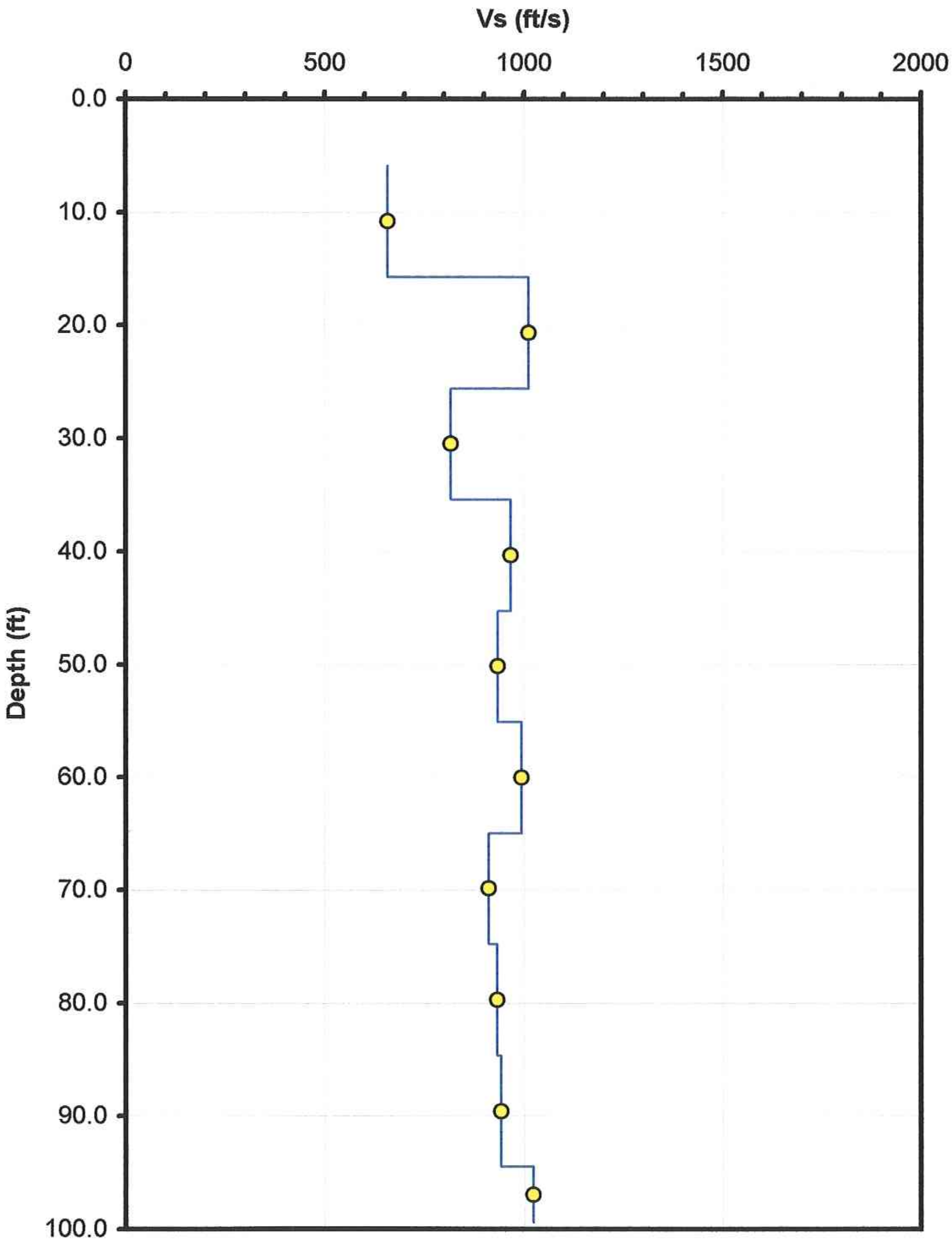
Client: GEI Consultants
Project: Brookhaven National Laboratory, Upton, NY
Sounding: CPT-203
Date: April 23, 2007

Seismic Source: Beam
Source Offset (ft): 2.00
Source Depth (ft): 0.00
Geophone Offset (ft): 0.66

SEISMIC - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Vs (ft/s)	Mid Layer (ft)
6.56	5.90	6.23				
16.40	15.74	15.87	9.64	14.63	659	10.82
26.25	25.59	25.66	9.79	9.68	1011	20.67
36.09	35.43	35.49	9.82	12.03	816	30.51
45.93	45.27	45.32	9.83	10.17	967	40.35
55.77	55.11	55.15	9.83	10.53	934	50.19
65.62	64.96	64.99	9.84	9.91	993	60.04
75.46	74.80	74.83	9.84	10.79	912	69.88
85.30	84.64	84.67	9.84	10.55	933	79.72
95.14	94.48	94.51	9.84	10.44	943	89.56
100.07	99.41	99.43	4.92	4.81	1024	96.94

Client: GEI Consultants
Location: Brookhaven National Laboratory, Upton, NY
CPT Sounding: CPT-203
Date: April 23, 2007



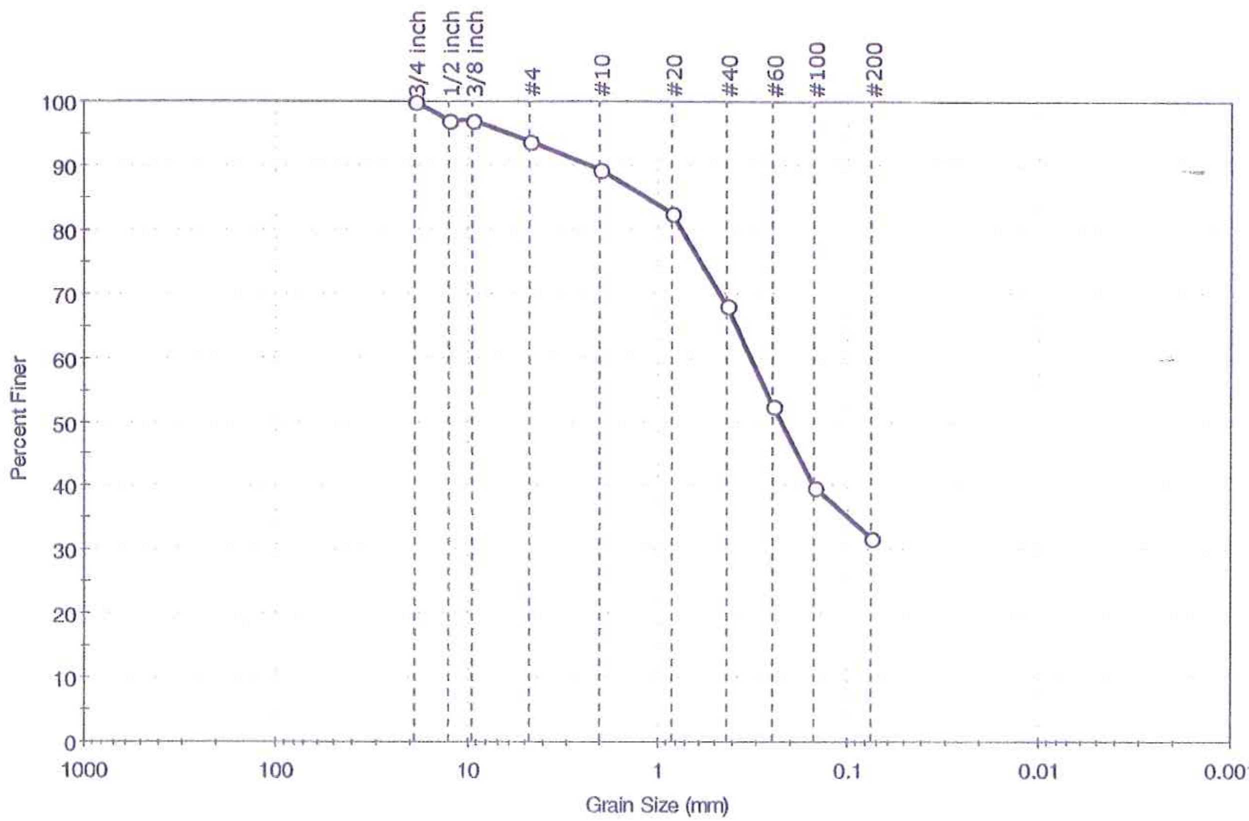
Appendix E

Laboratory Test Results

GeoTesting express
a subsidiary of Geocomp Corporation

Client: GEI Consultants			
Project: Brookhaven National Laboratory			
Location: Upton, NY		Project No:	GTX-6864
Boring ID: B-101	Sample Type: jar	Tested By:	pcs
Sample ID:S-1	Test Date: 08/04/06	Checked By:	jdt
Depth : 0-2 ft	Test Id: 94474		
Test Comment: sieve stack 6			
Sample Description: Moist, yellowish brown silty sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422



%Cobble	%Gravel	%Sand	%Silt & Clay Size
---	6.2	61.9	31.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.70	97		
3/8 inch	9.51	97		
#4	4.75	94		
#10	2.00	89		
#20	0.84	83		
#40	0.42	68		
#60	0.25	52		
#100	0.15	40		
#200	0.075	32		

Coefficients

D_{85} =1.1382 mm D_{30} =N/A
D_{60} =0.3233 mm D_{15} =N/A
D_{50} =0.2260 mm D_{10} =N/A
C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

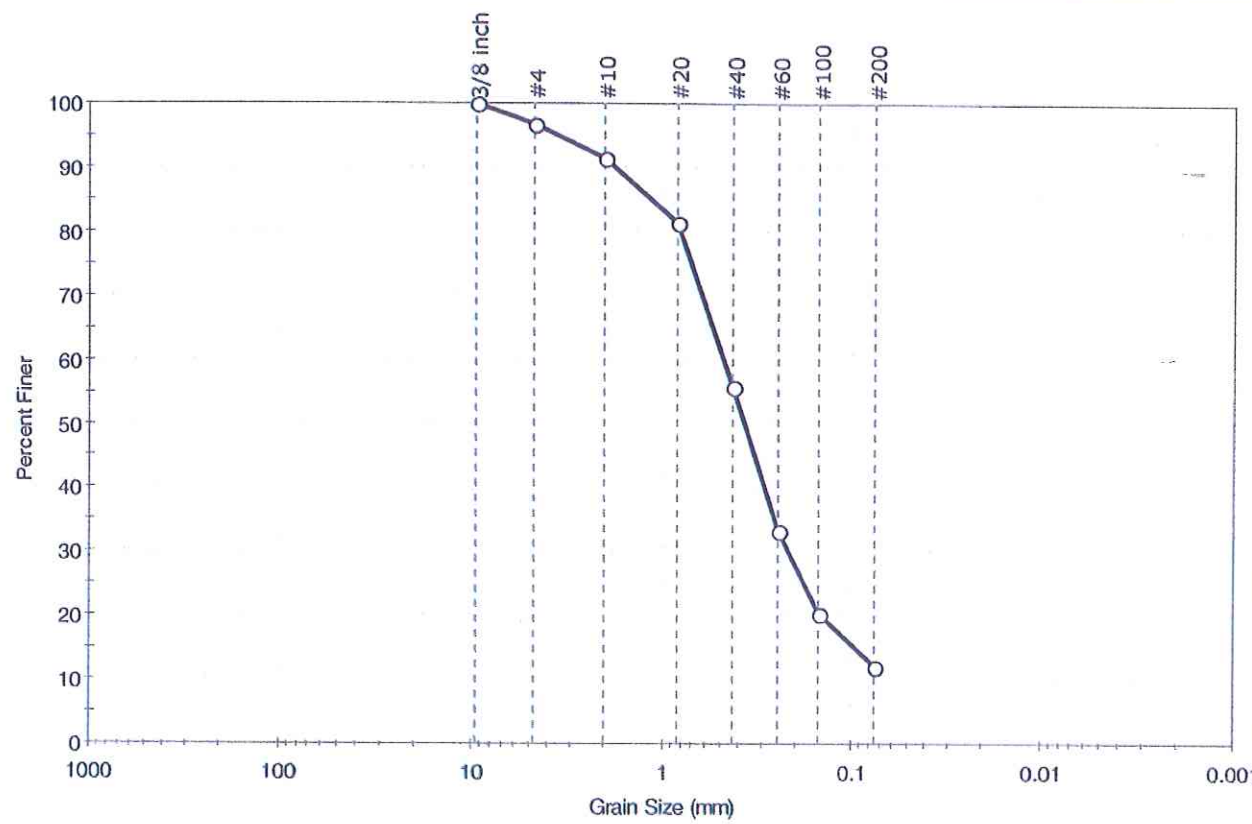
Sand/Gravel Hardness : HARD

printed 8/4/2006 11:50:52 AM

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	GEI Consultants				
Project:	Brookhaven National Laboratory				
Location:	Upton, NY			Project No:	GTX-6864
Boring ID:	B-101	Sample Type:	jar	Tested By:	pcs
Sample ID:	S-2	Test Date:	08/04/06	Checked By:	jdt
Depth :	5-7 ft	Test Id:	94475		
Test Comment:	sieve stack 6				
Sample Description:	Moist, light gray silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	3.2	84.6	12.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/8 inch	9.51	100		
#4	4.75	97		
#10	2.00	91		
#20	0.84	81		
#40	0.42	56		
#60	0.25	33		
#100	0.15	20		
#200	0.075	12		

Coefficients

D_{85} = 1.1429 mm D_{30} = 0.2189 mm
D_{60} = 0.4753 mm D_{15} = 0.0949 mm
D_{50} = 0.3706 mm D_{10} = 0.0622 mm
C_u = 7.641 C_c = 1.621

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

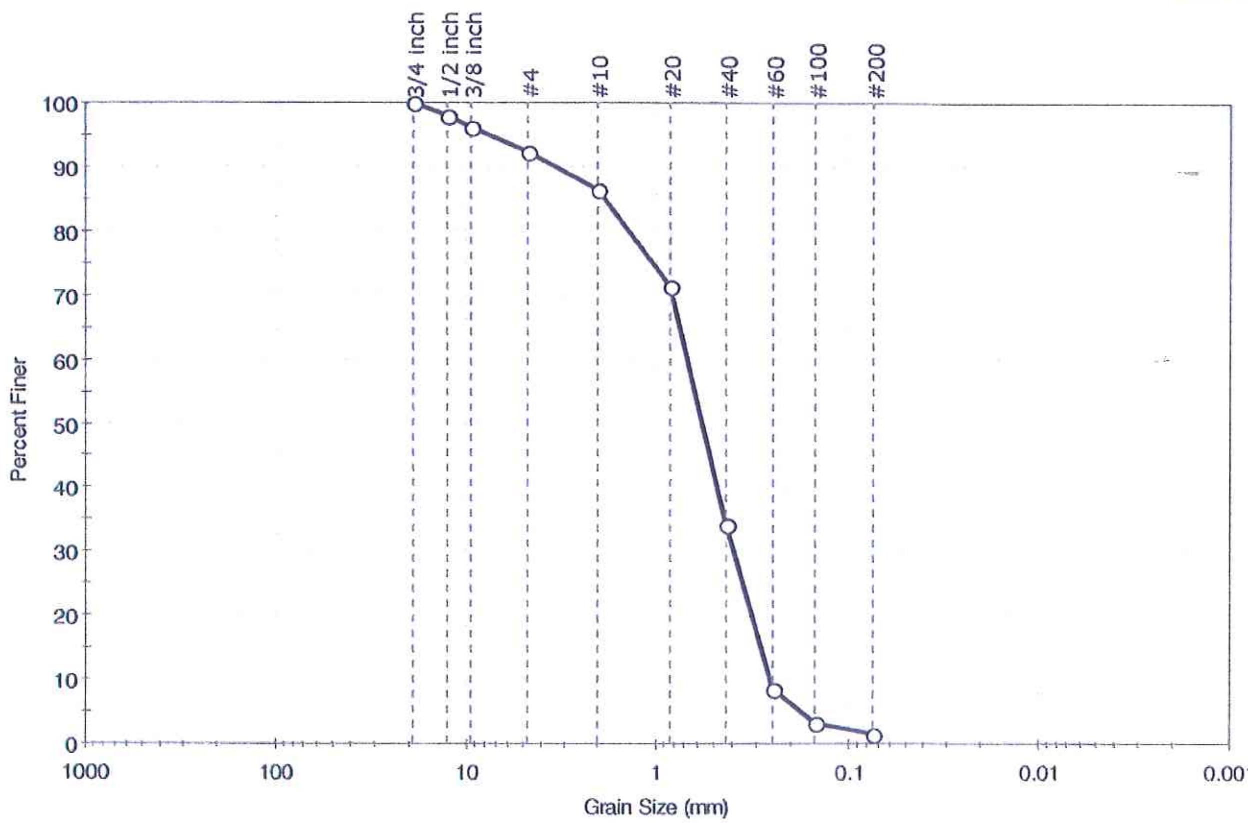
Sand/Gravel Hardness : HARD

printed 8/4/2006 11:53:06 AM

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	GEI Consultants				
Project:	Brookhaven National Laboratory				
Location:	Upton, NY			Project No:	GTX-6864
Boring ID:	B-101	Sample Type:	jar	Tested By:	pcs
Sample ID:	S-3	Test Date:	08/04/06	Checked By:	jdt
Depth :	10-12 ft	Test Id:	94476		
Test Comment:	sieve stack 6				
Sample Description:	Moist, light gray sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	7.8	90.8	1.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.70	98		
3/8 inch	9.51	96		
#4	4.75	92		
#10	2.00	86		
#20	0.84	71		
#40	0.42	34		
#60	0.25	9		
#100	0.15	3		
#200	0.075	1		

Coefficients

D_{85} =1.8530 mm D_{30} =0.3886 mm

D_{60} =0.6828 mm D_{15} =0.2854 mm

D_{50} =0.5676 mm D_{10} =0.2575 mm

C_u =2.652 C_c =0.859

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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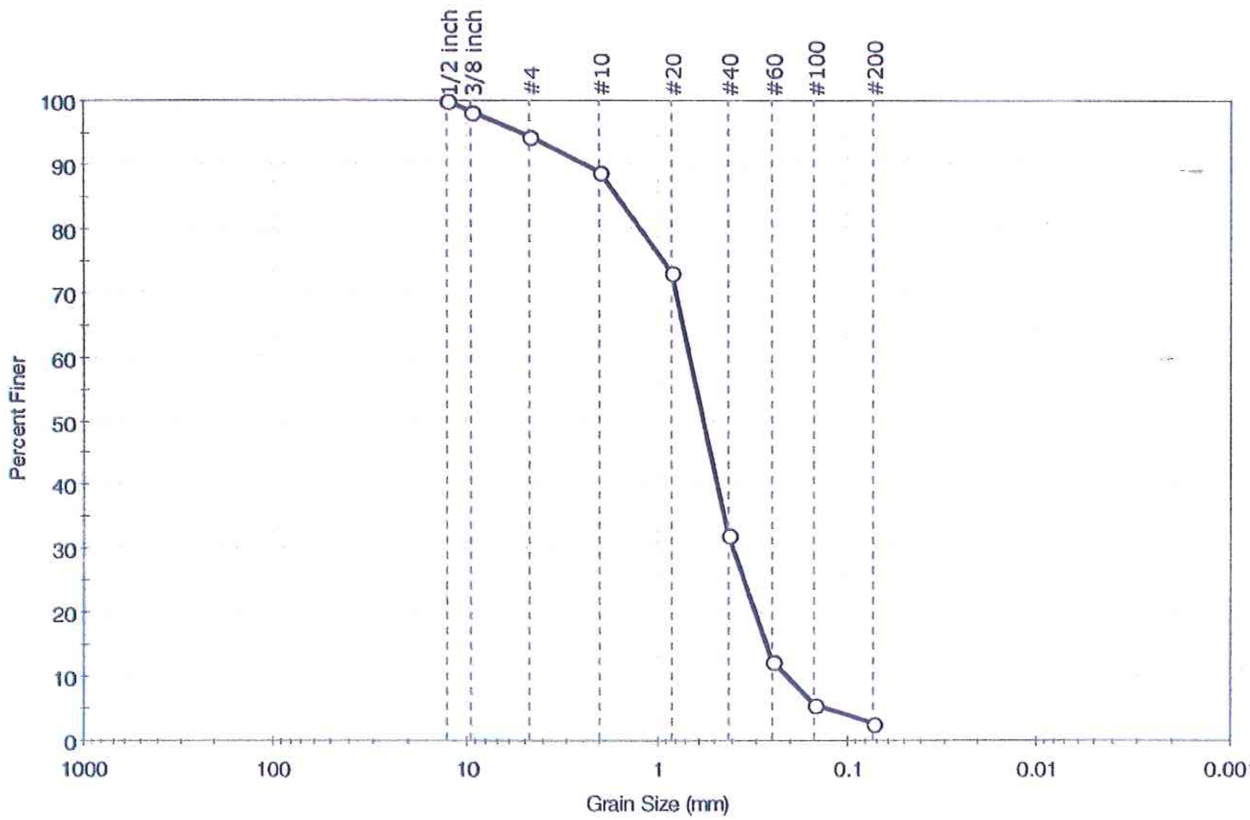
GeoTesting express
a subsidiary of Geocomp Corporation

Client:	GEI Consultants				
Project:	Brookhaven National Laboratory				
Location:	Upton, NY			Project No:	GTX-6864
Boring ID:	B-101	Sample Type:	jar	Tested By:	pcs
Sample ID:	S-4	Test Date:	08/04/06	Checked By:	jdt
Depth :	15-17 ft	Test Id:	94477		
Test Comment:	sieve stack 1				
Sample Description:	Moist, light gray sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	5.5	91.8	2.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1/2 inch	12.70	100		
3/8 inch	9.51	98		
#4	4.75	95		
#10	2.00	89		
#20	0.84	73		
#40	0.42	32		
#60	0.25	12		
#100	0.15	6		
#200	0.074	3		

Coefficients

D_{85} = 1.6294 mm	D_{30} = 0.3979 mm
D_{60} = 0.6737 mm	D_{15} = 0.2672 mm
D_{50} = 0.5689 mm	D_{10} = 0.2070 mm
C_u = 3.255	C_c = 1.135

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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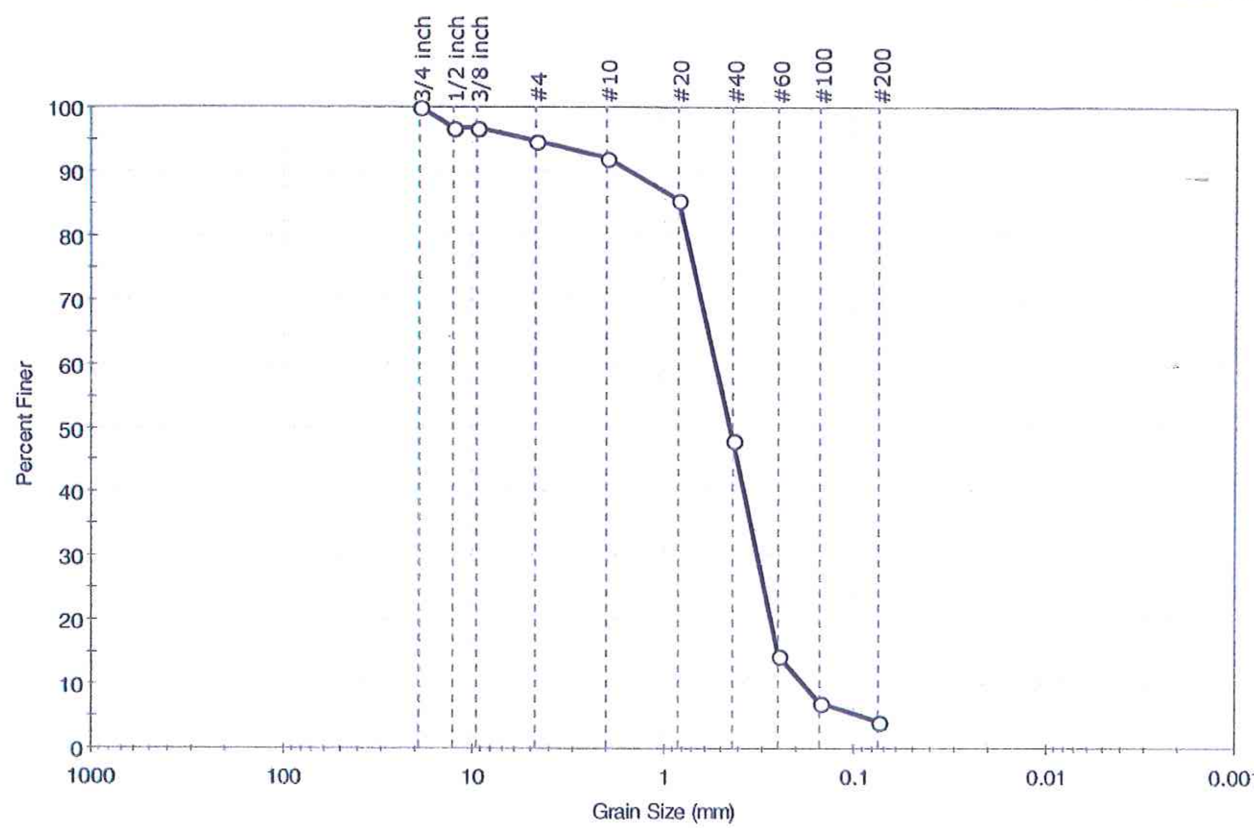
GeoTesting express
a subsidiary of Geocomp Corporation

Client:	GEI Consultants				
Project:	Brookhaven National Laboratory				
Location:	Upton, NY			Project No:	GTX-6864
Boring ID:	B-101	Sample Type:	jar	Tested By:	pcs
Sample ID:	S-5	Test Date:	08/02/06	Checked By:	jdt
Depth :	20-22 ft	Test Id:	94478		
Test Comment:	sieve stack 6				
Sample Description:	Moist, white sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	5.4	90.5	4.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.70	97		
3/8 inch	9.51	97		
#4	4.75	95		
#10	2.00	92		
#20	0.84	86		
#40	0.42	48		
#60	0.25	15		
#100	0.15	7		
#200	0.075	4		

Coefficients

D_{85} =0.8317 mm	D_{30} =0.3192 mm
D_{60} =0.5280 mm	D_{15} =0.2516 mm
D_{50} =0.4402 mm	D_{10} =0.1818 mm
C_u =2.904	C_c =1.061

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

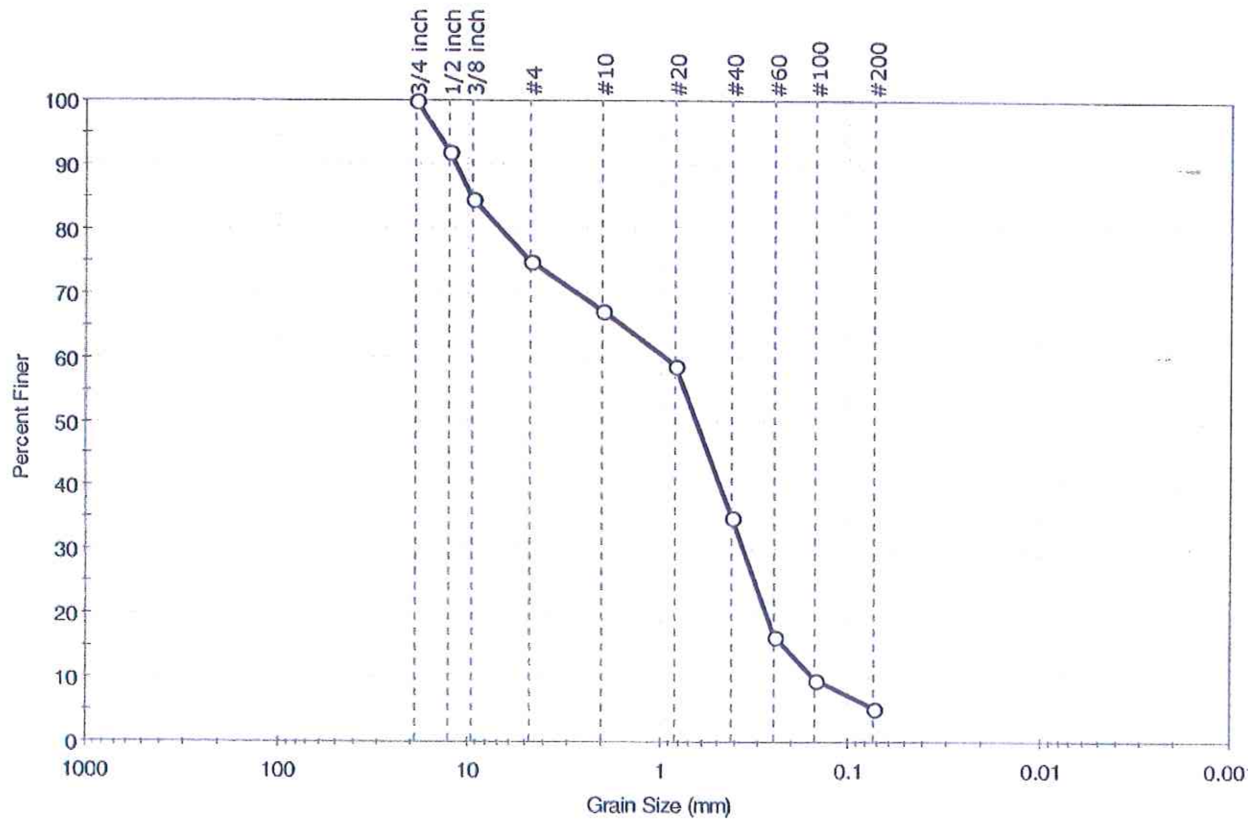
Sand/Gravel Hardness : HARD

printed 8/4/2006 11:42:21 AM

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	GEI Consultants				
Project:	Brookhaven National Laboratory				
Location:	Upton, NY			Project No:	GTX-6864
Boring ID:	B-101	Sample Type:	jar	Tested By:	pcs
Sample ID:	S-6	Test Date:	08/02/06	Checked By:	jdt
Depth :	25-27 ft	Test Id:	94479		
Test Comment:	sieve stack 1				
Sample Description:	Moist, very pale brown sand with silt and gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	25.2	69.5	5.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.70	92		
3/8 inch	9.51	85		
#4	4.75	75		
#10	2.00	67		
#20	0.84	59		
#40	0.42	35		
#60	0.25	17		
#100	0.15	10		
#200	0.074	5		

Coefficients

D_{85} =9.6327 mm	D_{30} =0.3633 mm
D_{60} =0.9539 mm	D_{15} =0.2209 mm
D_{50} =0.6500 mm	D_{10} =0.1520 mm
C_u =6.276	C_c =0.910

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

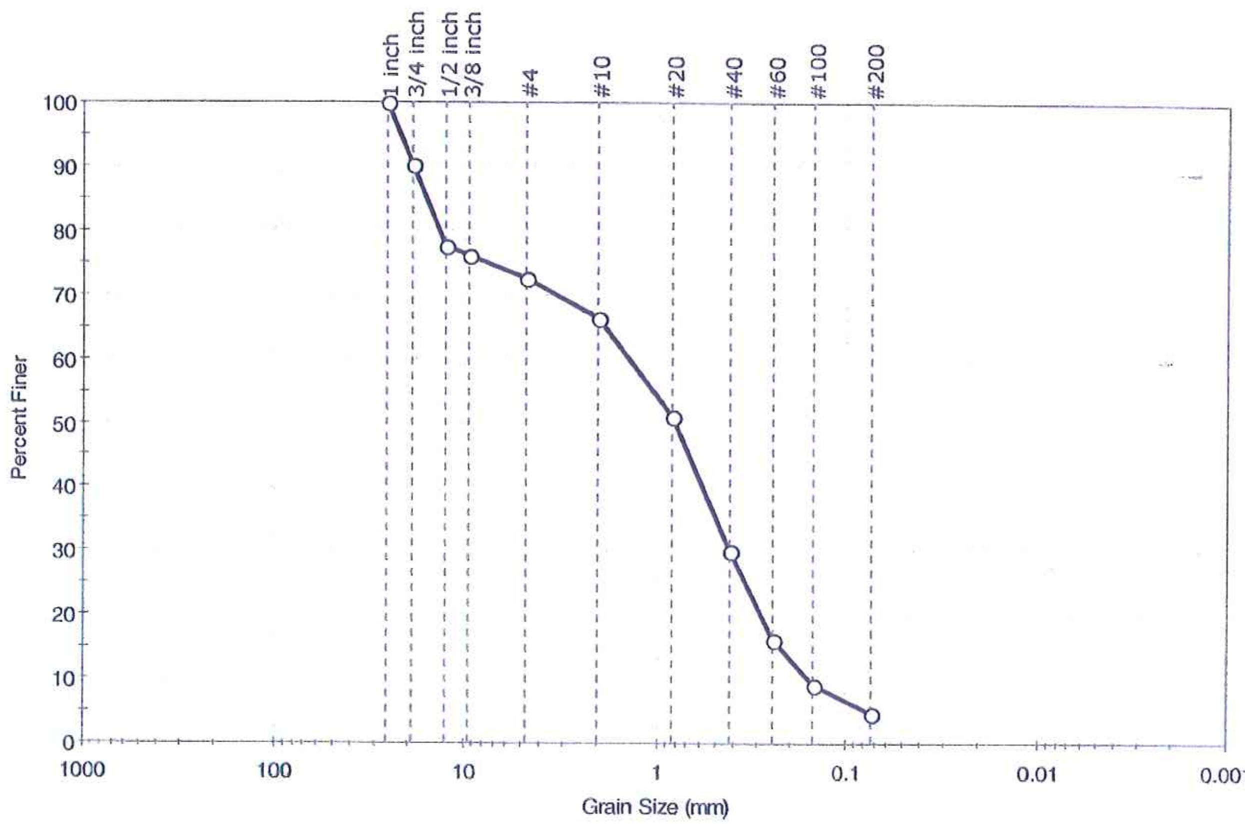
Sand/Gravel Hardness : HARD

printed 8/4/2006 11:44:43 AM

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	GEI Consultants				
Project:	Brookhaven National Laboratory				
Location:	Upton, NY			Project No:	GTX-6864
Boring ID:	B-101	Sample Type:	jar	Tested By:	pcs
Sample ID:	S-8	Test Date:	08/04/06	Checked By:	jdt
Depth :	35-37 ft	Test Id:	94480		
Test Comment:	sieve stack 1				
Sample Description:	Moist, pale brown sand with gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	27.3	68.1	4.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 inch	25.70	100		
3/4 inch	19.00	90		
1/2 inch	12.70	78		
3/8 inch	9.51	76		
#4	4.75	73		
#10	2.00	66		
#20	0.84	51		
#40	0.42	30		
#60	0.25	16		
#100	0.15	9		
#200	0.074	5		

Coefficients

D_{85} = 16.0845 mm	D_{30} = 0.4168 mm
D_{60} = 1.3899 mm	D_{15} = 0.2294 mm
D_{50} = 0.8125 mm	D_{10} = 0.1594 mm
C_u = 8.720	C_c = 0.784

Classification

ASTM Poorly graded sand with gravel (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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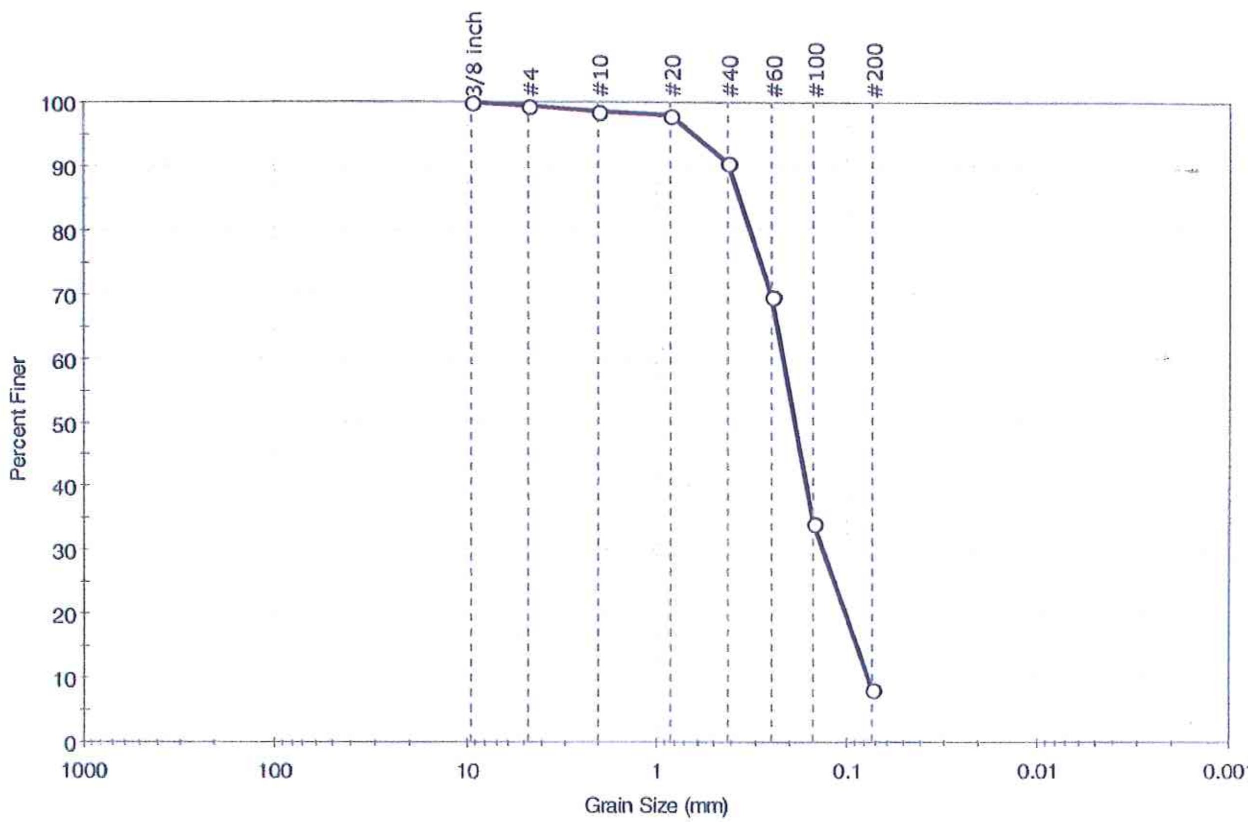
GeoTesting express
a subsidiary of Geocomp Corporation

Client: GEI Consultants			
Project: Brookhaven National Laboratory			
Location: Upton, NY		Project No:	GTX-6864
Boring ID: B-101	Sample Type: jar	Tested By:	pcs
Sample ID: S-10	Test Date: 08/04/06	Checked By:	jdt
Depth : 45-47 ft	Test Id: 94481		
Test Comment: sieve stack 1			
Sample Description: Moist, light yellowish brown sand with silt			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.5	91.2	8.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/8 inch	9.51	100		
#4	4.75	99		
#10	2.00	99		
#20	0.84	98		
#40	0.42	90		
#60	0.25	70		
#100	0.15	34		
#200	0.074	8		

Coefficients

D_{85} = 0.3666 mm　　D_{30} = 0.1332 mm

D_{60} = 0.2172 mm　　D_{15} = 0.0888 mm

D_{50} = 0.1877 mm　　D_{10} = 0.0775 mm

C_u = 2.803　　C_c = 1.054

Classification

ASTM　N/A

AASHTO　Fine Sand (A-3 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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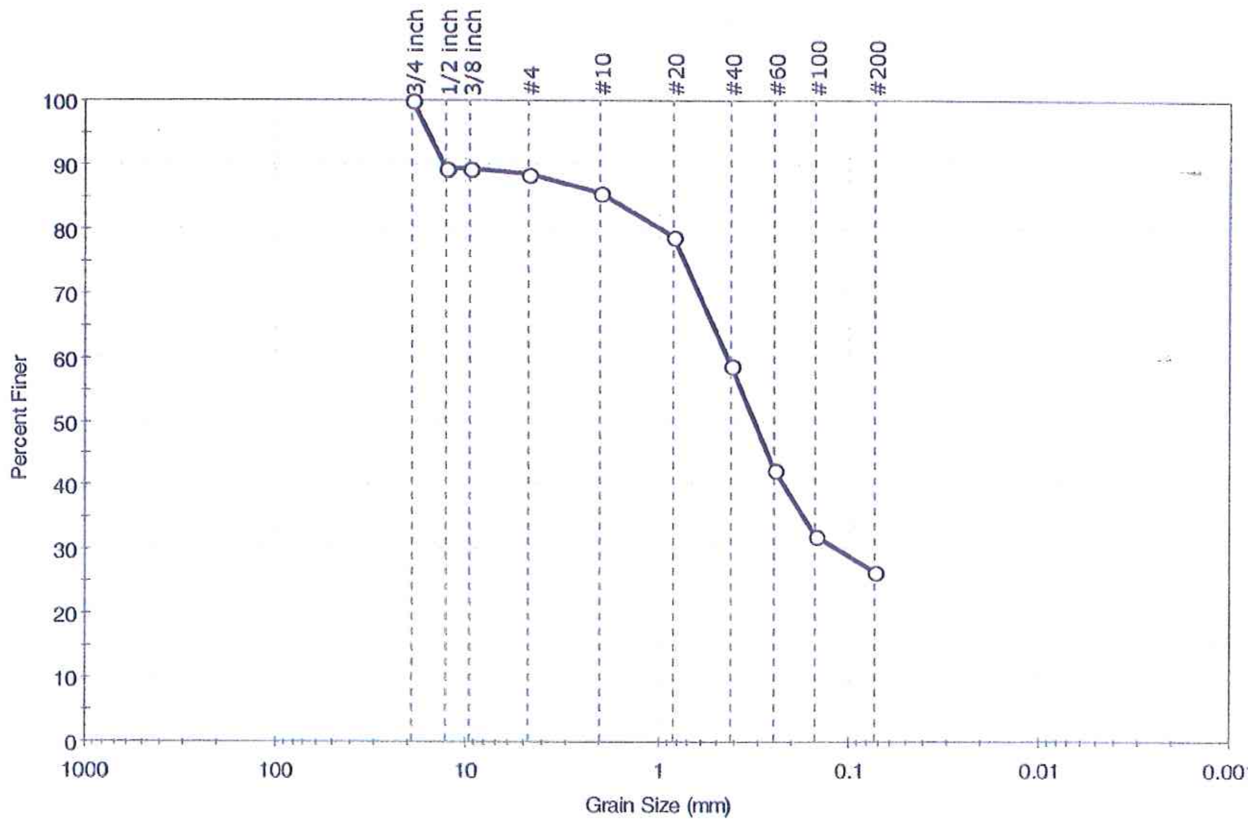
GeoTesting express
a subsidiary of Geocomp Corporation

Client: GEI Consultants			
Project: Brookhaven National Laboratory			
Location: Upton, NY		Project No:	GTX-6864
Boring ID: B-102	Sample Type: jar	Tested By:	pcs
Sample ID:S-1	Test Date: 08/04/06	Checked By:	jdt
Depth : 0-2 ft	Test Id: 94482		
Test Comment: sieve stack 1			
Sample Description: Moist, Dark yellowish brown silty sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	11.4	61.9	26.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.70	89		
3/8 inch	9.51	89		
#4	4.75	89		
#10	2.00	86		
#20	0.84	79		
#40	0.42	59		
#60	0.25	42		
#100	0.15	32		
#200	0.074	27		

Coefficients

D_{85} = 1.8592 mm	D_{30} = 0.1121 mm
D_{60} = 0.4377 mm	D_{15} = N/A
D_{50} = 0.3177 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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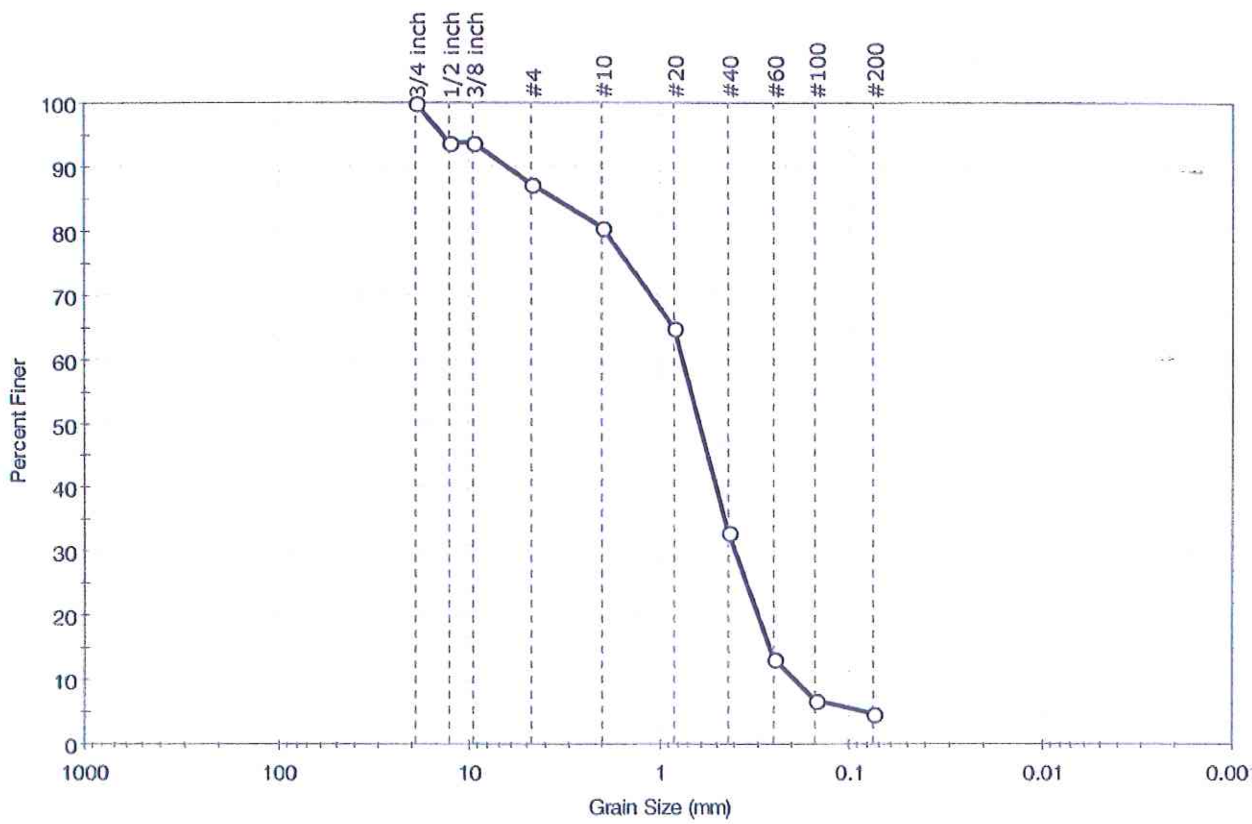
GeoTesting express
a subsidiary of Geocomp Corporation

Client:	GEI Consultants				
Project:	Brookhaven National Laboratory				
Location:	Upton, NY			Project No:	GTX-6864
Boring ID:	B-102	Sample Type:	jar	Tested By:	pcs
Sample ID:	S-2	Test Date:	08/04/06	Checked By:	jdt
Depth :	5-7 ft	Test Id:	94483		
Test Comment:	sieve stack 6				
Sample Description:	Moist, light olive brown sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	12.7	82.7	4.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.70	94		
3/8 inch	9.51	94		
#4	4.75	87		
#10	2.00	81		
#20	0.84	65		
#40	0.42	33		
#60	0.25	13		
#100	0.15	7		
#200	0.075	5		

Coefficients

D_{85} = 3.5367 mm	D_{30} = 0.3920 mm
D_{60} = 0.7575 mm	D_{15} = 0.2627 mm
D_{50} = 0.6114 mm	D_{10} = 0.1938 mm
C_u = 3.909	C_c = 1.047

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

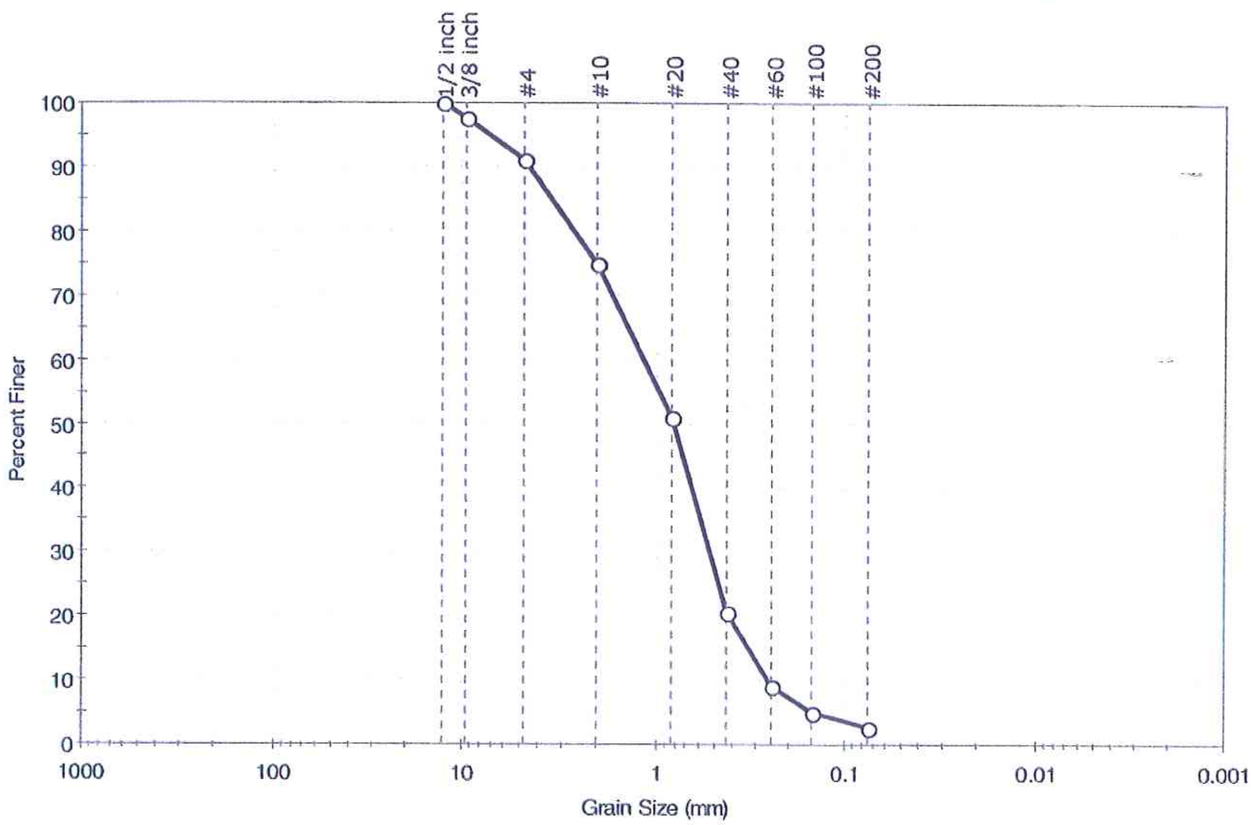
Sand/Gravel Hardness : HARD

printed 8/4/2006 11:47:27 AM

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	GEI Consultants				
Project:	Brookhaven National Laboratory				
Location:	Upton, NY			Project No:	GTX-6864
Boring ID:	B-102	Sample Type:	jar	Tested By:	pcs
Sample ID:	S-3	Test Date:	08/04/06	Checked By:	jdt
Depth :	10-12 ft	Test Id:	94484		
Test Comment:	sieve stack 6				
Sample Description:	Moist, light yellowish brown sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	9.0	88.2	2.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1/2 inch	12.70	100		
3/8 inch	9.51	98		
#4	4.75	91		
#10	2.00	75		
#20	0.84	51		
#40	0.42	21		
#60	0.25	9		
#100	0.15	5		
#200	0.075	3		

Coefficients

D_{85} = 3.4384 mm	D_{30} = 0.5240 mm
D_{60} = 1.1657 mm	D_{15} = 0.3278 mm
D_{50} = 0.8227 mm	D_{10} = 0.2611 mm
C_u = 4.465	C_c = 0.902

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape :

Sand/Gravel Hardness :

printed 8/4/2006 11:47:59 AM

GeoTesting express
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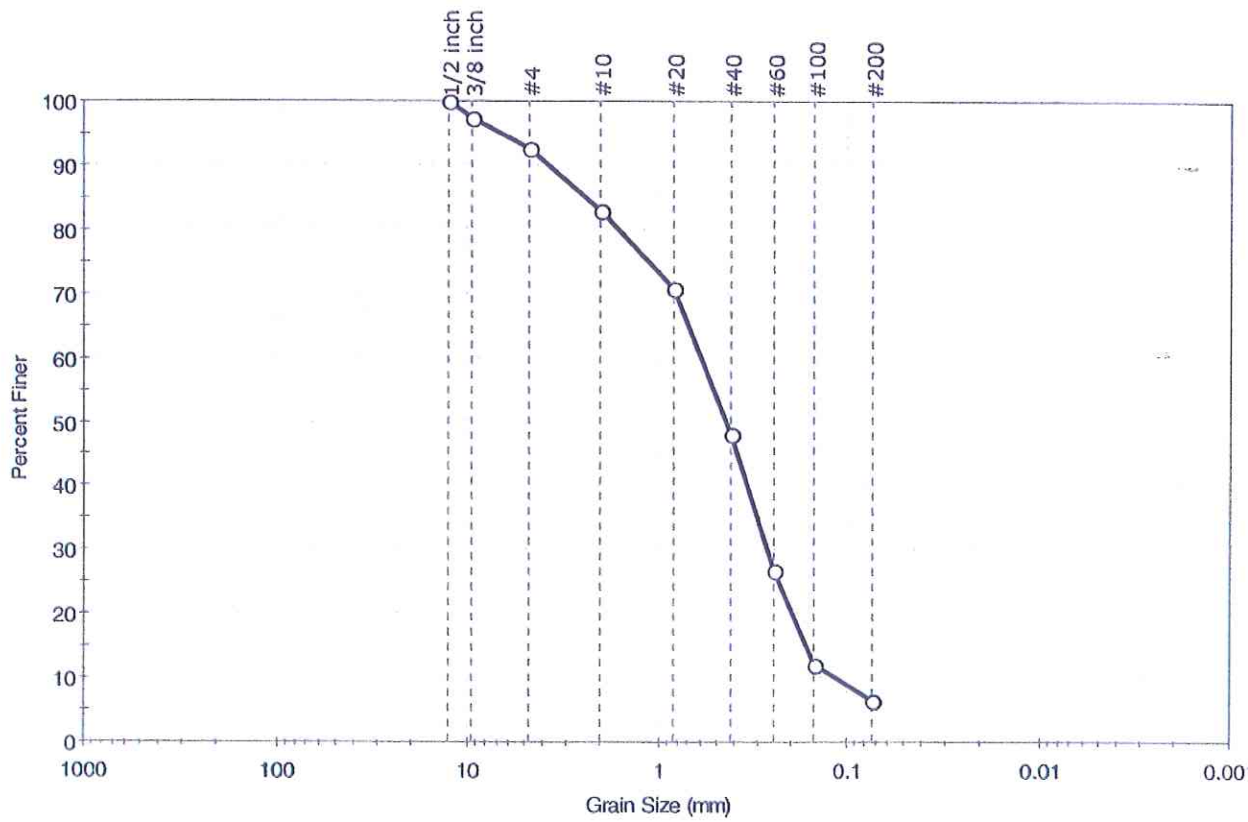
Client: GEI Consultants			
Project: Brookhaven National Laboratory			
Location: Upton, NY		Project No:	GTX-6864
Boring ID: B-102	Sample Type: jar	Tested By:	pcs
Sample ID:S-4	Test Date: 08/02/06	Checked By:	jdt
Depth : 15-17 ft	Test Id: 94485		
Test Comment: sieve stack 1			
Sample Description: Moist, brown sand with silt			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	7.4	86.1	6.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1/2 inch	12.70	100		
3/8 inch	9.51	97		
#4	4.75	93		
#10	2.00	83		
#20	0.84	71		
#40	0.42	48		
#60	0.25	27		
#100	0.15	12		
#200	0.074	7		

Coefficients

D_{85} =2.4268 mm D_{30} =0.2707 mm

D_{60} =0.6058 mm D_{15} =0.1657 mm

D_{50} =0.4464 mm D_{10} =0.1157 mm

C_u =5.236 C_c =1.045

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

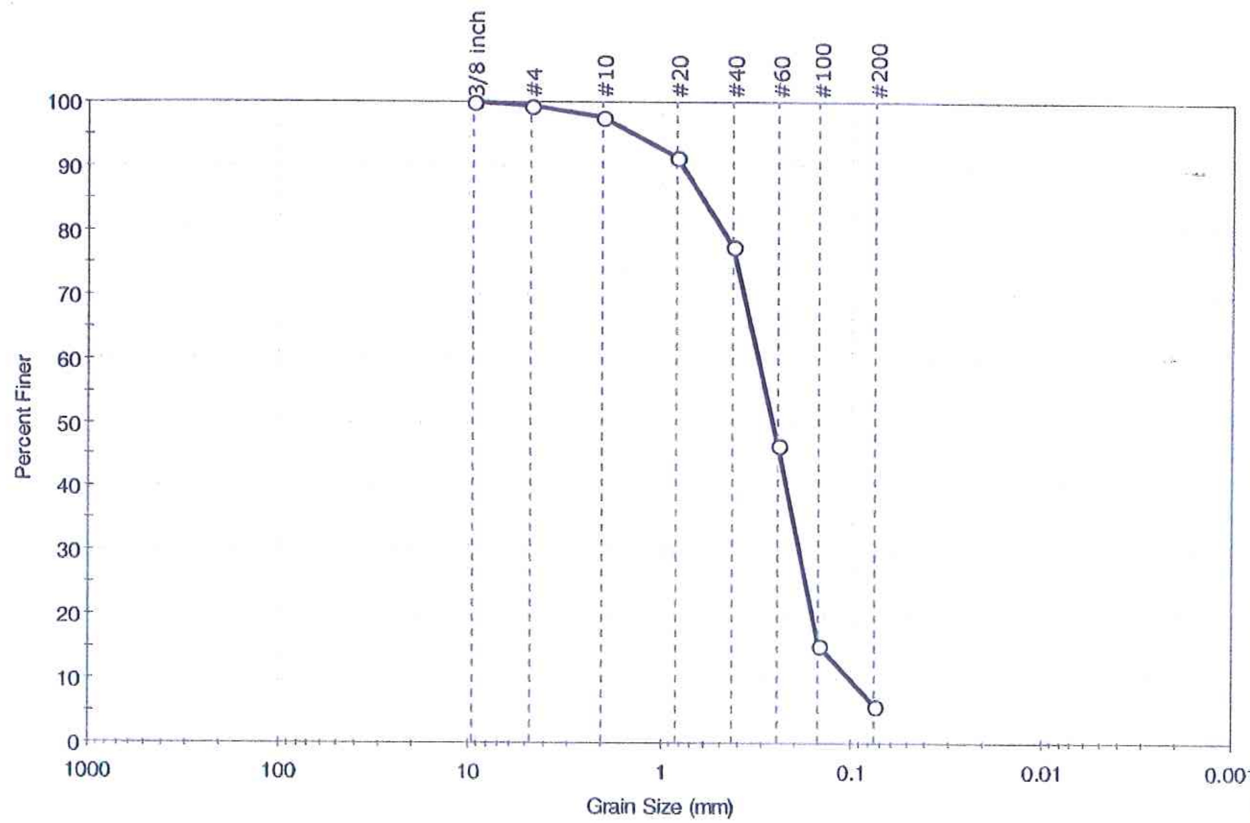
Sand/Gravel Hardness : HARD

printed 8/4/2006 11:48:25 AM

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	GEI Consultants				
Project:	Brookhaven National Laboratory				
Location:	Upton, NY			Project No:	GTX-6864
Boring ID:	B-102	Sample Type:	jar	Tested By:	pcs
Sample ID:	S-5	Test Date:	08/02/06	Checked By:	jdt
Depth :	20-22 ft	Test Id:	94486		
Test Comment:	sieve stack 6				
Sample Description:	Moist, light brown sand with silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.8	93.2	6.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/8 inch	9.51	100		
#4	4.75	99		
#10	2.00	98		
#20	0.84	92		
#40	0.42	78		
#60	0.25	47		
#100	0.15	15		
#200	0.075	6		

Coefficients

D_{85} = 0.6113 mm	D_{30} = 0.1901 mm
D_{60} = 0.3148 mm	D_{15} = 0.1455 mm
D_{50} = 0.2653 mm	D_{10} = 0.1005 mm
C_u = 3.132	C_c = 1.142

Classification

ASTM N/A

AASHTO Fine Sand (A-3 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

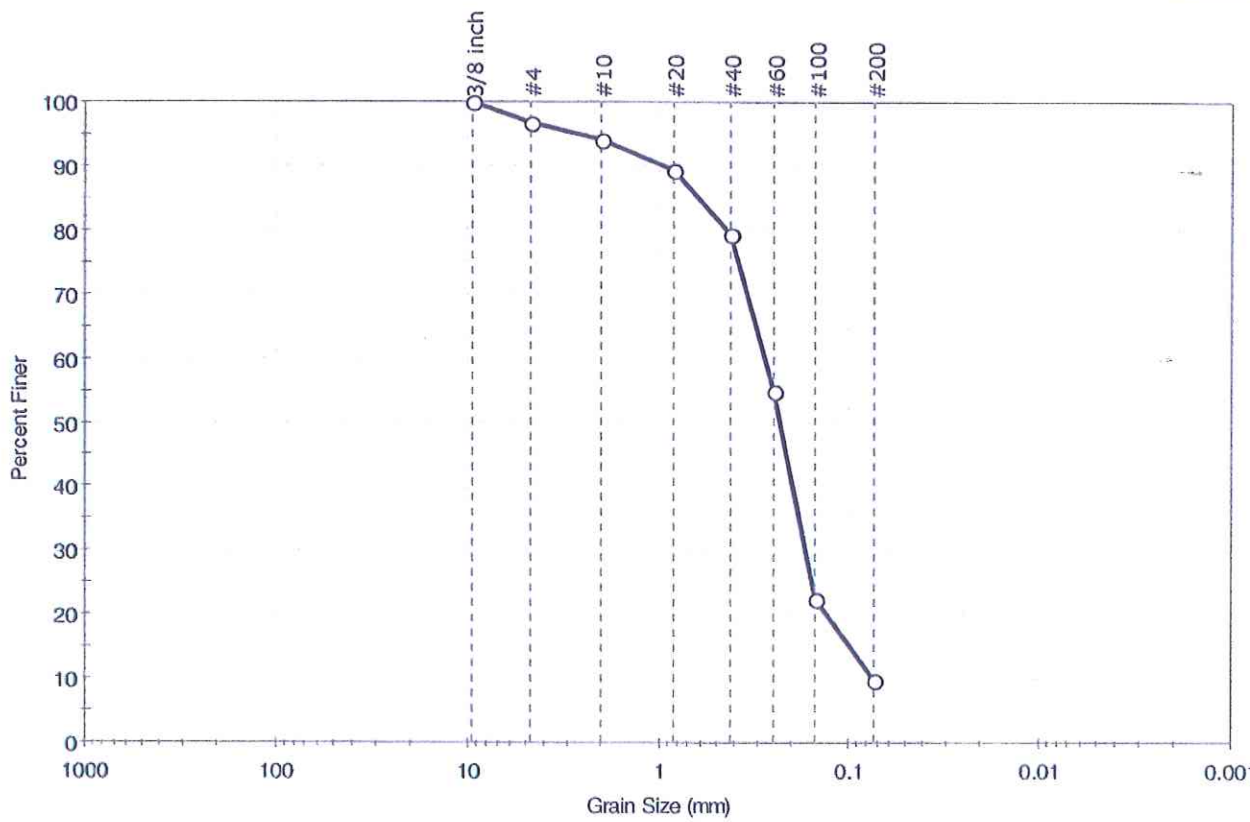
Sand/Gravel Hardness : ---

printed 8/4/2006 11:43:37 AM

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	GEI Consultants				
Project:	Brookhaven National Laboratory				
Location:	Upton, NY			Project No:	GTX-6864
Boring ID:	B-102	Sample Type:	jar	Tested By:	pcs
Sample ID:	S-6	Test Date:	08/04/06	Checked By:	jdt
Depth :	25-27 ft	Test Id:	94487		
Test Comment:	sieve stack 1				
Sample Description:	Moist, light yellowish brown sand with silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	3.4	87.0	9.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/8 inch	9.51	100		
#4	4.75	97		
#10	2.00	94		
#20	0.84	89		
#40	0.42	79		
#60	0.25	55		
#100	0.15	22		
#200	0.074	10		

Coefficients

D_{85} =0.6207 mm　　D_{30} =0.1681 mm

D_{60} =0.2791 mm　　D_{15} =0.0992 mm

D_{50} =0.2315 mm　　D_{10} =0.0756 mm

C_u =3.692　　C_c =1.339

Classification

ASTM　N/A

AASHTO　Fine Sand (A-3 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

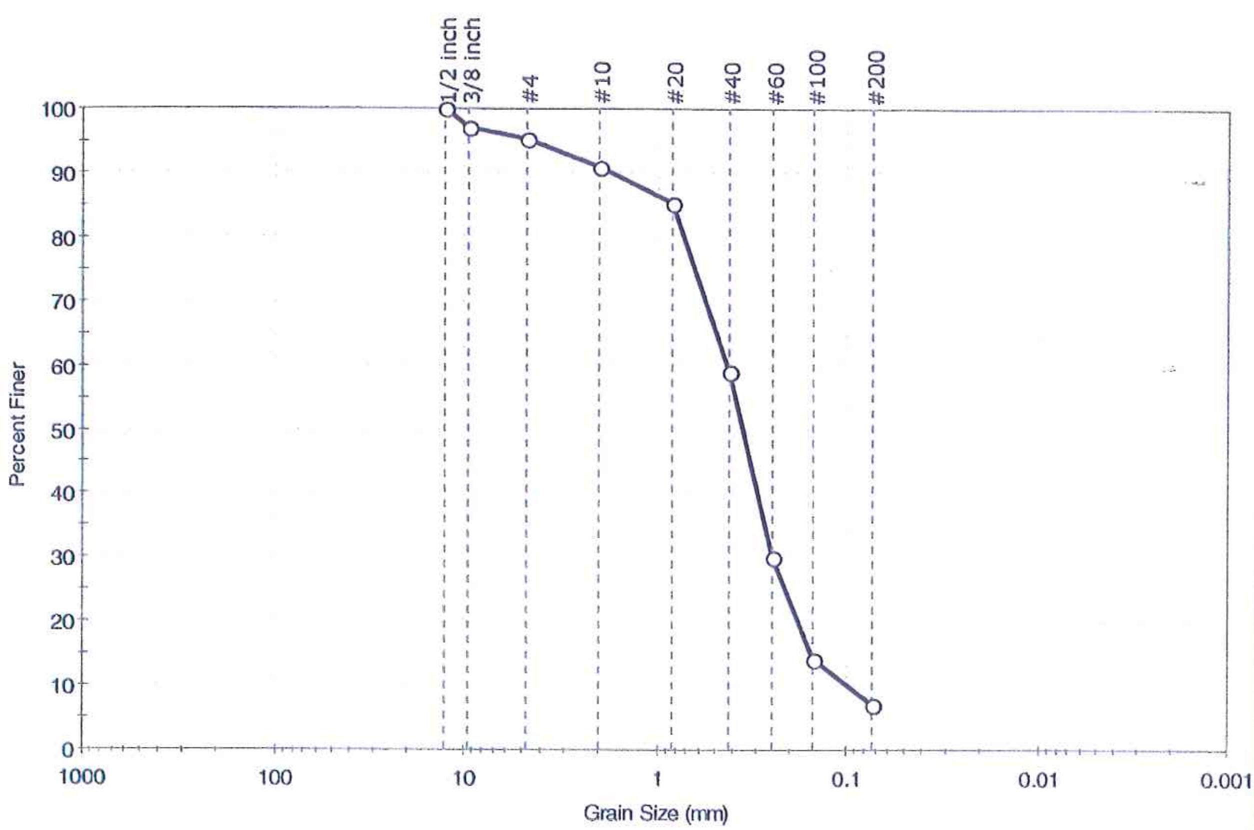
Sand/Gravel Hardness : ---

printed 8/4/2006 11:52:38 AM

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	GEI Consultants				
Project:	Brookhaven National Laboratory				
Location:	Upton, NY			Project No:	GTX-6864
Boring ID:	B-102	Sample Type:	jar	Tested By:	pcs
Sample ID:	S-8	Test Date:	08/04/06	Checked By:	jdt
Depth :	35-37 ft	Test Id:	94488		
Test Comment:	sieve stack 1				
Sample Description:	Moist, pale brown sand with silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	4.7	88.2	7.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1/2 inch	12.70	100		
3/8 inch	9.51	97		
#4	4.75	95		
#10	2.00	91		
#20	0.84	85		
#40	0.42	59		
#60	0.25	30		
#100	0.15	14		
#200	0.074	7		

Coefficients

D_{85} =0.8377 mm D_{30} =0.2499 mm

D_{60} =0.4304 mm D_{15} =0.1533 mm

D_{50} =0.3572 mm D_{10} =0.0988 mm

C_u =4.356 C_c =1.469

Classification

ASTM N/A

AASHTO Fine Sand (A-3 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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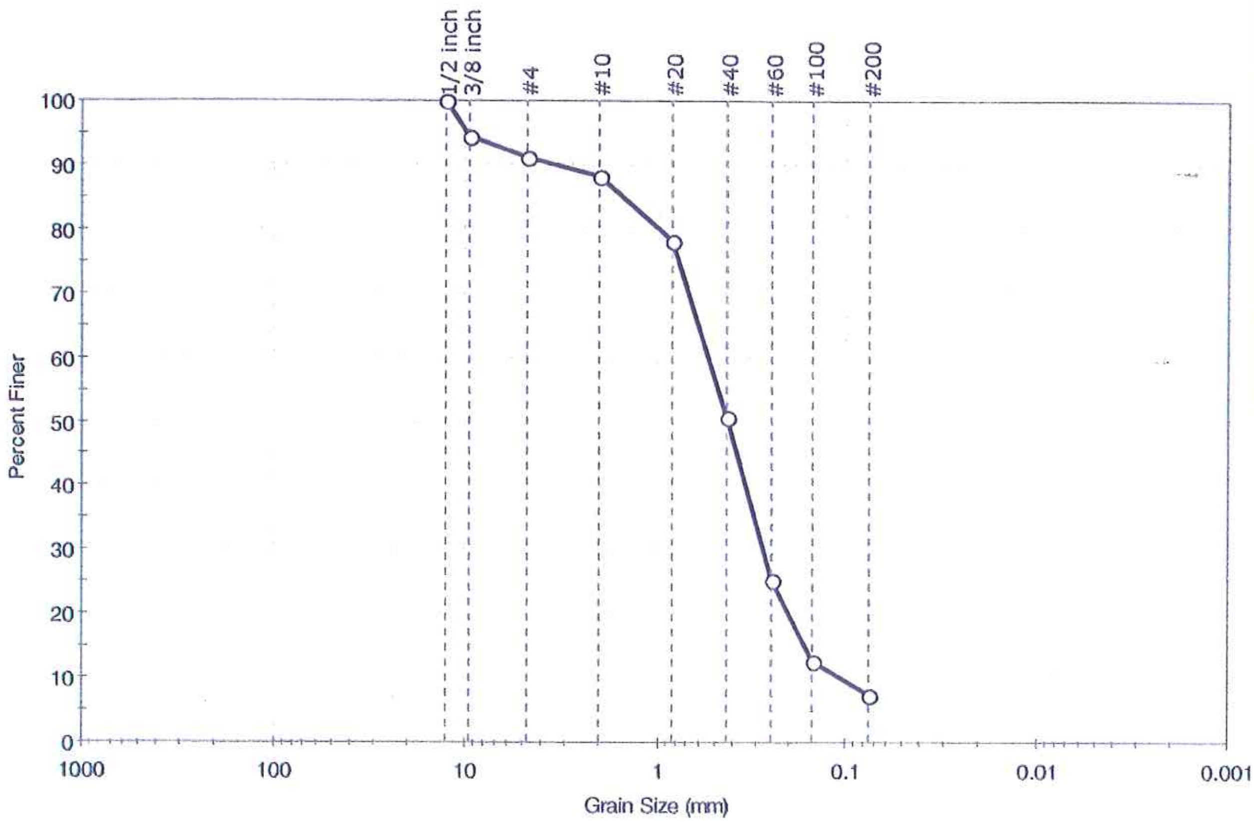
GeoTesting express
a subsidiary of Geocomp Corporation

Client: GEI Consultants			
Project: Brookhaven National Laboratory			
Location: Upton, NY		Project No:	GTX-6864
Boring ID: B-102	Sample Type: jar	Tested By:	pcs
Sample ID:S-10	Test Date: 08/04/06	Checked By:	jdt
Depth : 45-47 ft	Test Id: 94489		
Test Comment: sieve stack 6			
Sample Description: Moist, light olive brown sand with silt			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	9.0	83.5	7.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1/2 inch	12.70	100		
3/8 inch	9.51	94		
#4	4.75	91		
#10	2.00	88		
#20	0.84	78		
#40	0.42	51		
#60	0.25	25		
#100	0.15	13		
#200	0.075	7		

Coefficients

D_{85} =1.5029 mm D_{30} =0.2758 mm
D_{60} =0.5361 mm D_{15} =0.1639 mm
D_{50} =0.4196 mm D_{10} =0.1047 mm
C_u =5.120 C_c =1.355

Classification

ASTM N/A

AASHTO Fine Sand (A-3 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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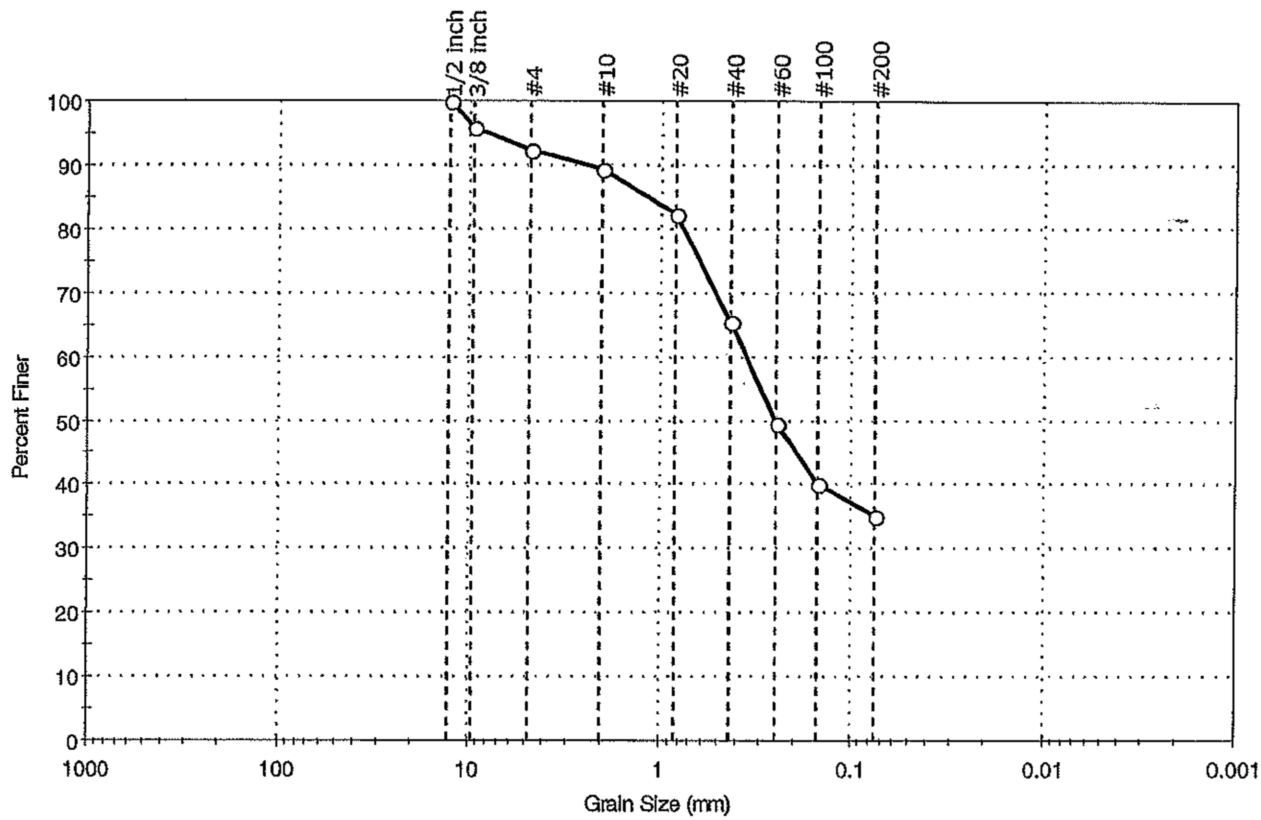
GeoTesting express
a subsidiary of Geocomp Corporation

Client: GEI Consultants			
Project: Brookhaven National Laboratory			
Location: Upton, NY		Project No:	GTX-6864
Boring ID: B-202	Sample Type: bag	Tested By:	mll
Sample ID:S-1	Test Date: 05/14/07	Checked By:	jdt
Depth : 1-3 ft	Test Id: 111381		
Test Comment: ---			
Sample Description: Moist, light olive brown clayey sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	7.7	57.2	35.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1/2 inch	12.70	100		
3/8 inch	9.51	96		
#4	4.75	92		
#10	2.00	89		
#20	0.84	82		
#40	0.42	65		
#60	0.25	49		
#100	0.15	40		
#200	0.075	35		

Coefficients

D_{85} =1.1764 mm — D_{30} =N/A
D_{60} =0.3555 mm — D_{15} =N/A
D_{50} =0.2544 mm — D_{10} =N/A
C_u =N/A — C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
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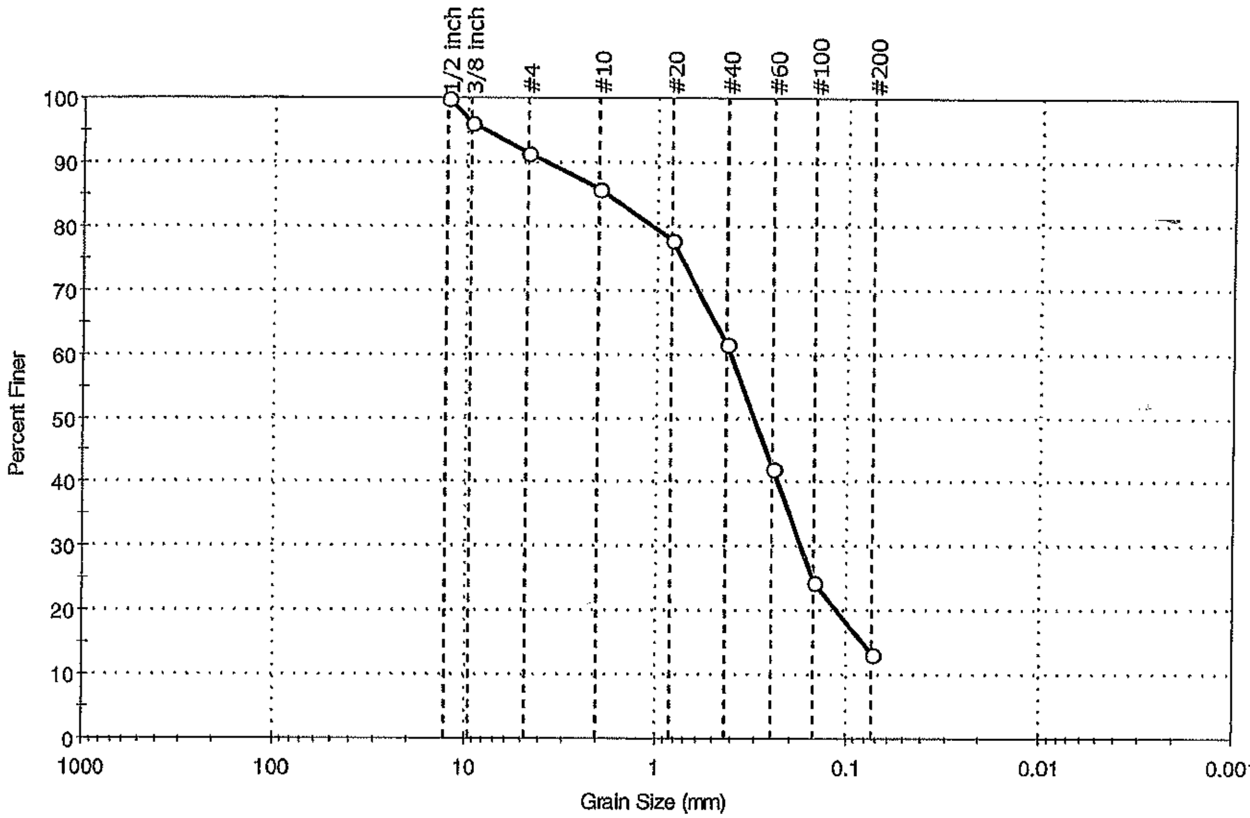
Client: GEI Consultants			
Project: Brookhaven National Laboratory			
Location: Upton, NY		Project No:	GTX-6864
Boring ID: B-203	Sample Type: bag	Tested By:	mll
Sample ID:S-3	Test Date: 05/14/07	Checked By:	jdt
Depth : 4-6 ft	Test Id: 111382		
Test Comment: ---			
Sample Description: Moist, light yellowish brown silty sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	8.6	78.1	13.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1/2 inch	12.70	100		
3/8 inch	9.51	96		
#4	4.75	91		
#10	2.00	86		
#20	0.84	78		
#40	0.42	62		
#60	0.25	42		
#100	0.15	25		
#200	0.074	13		

Coefficients

D_{85} =1.8062 mm D_{30} =0.1753 mm

D_{60} =0.4064 mm D_{15} =0.0822 mm

D_{50} =0.3087 mm D_{10} =0.0601 mm

C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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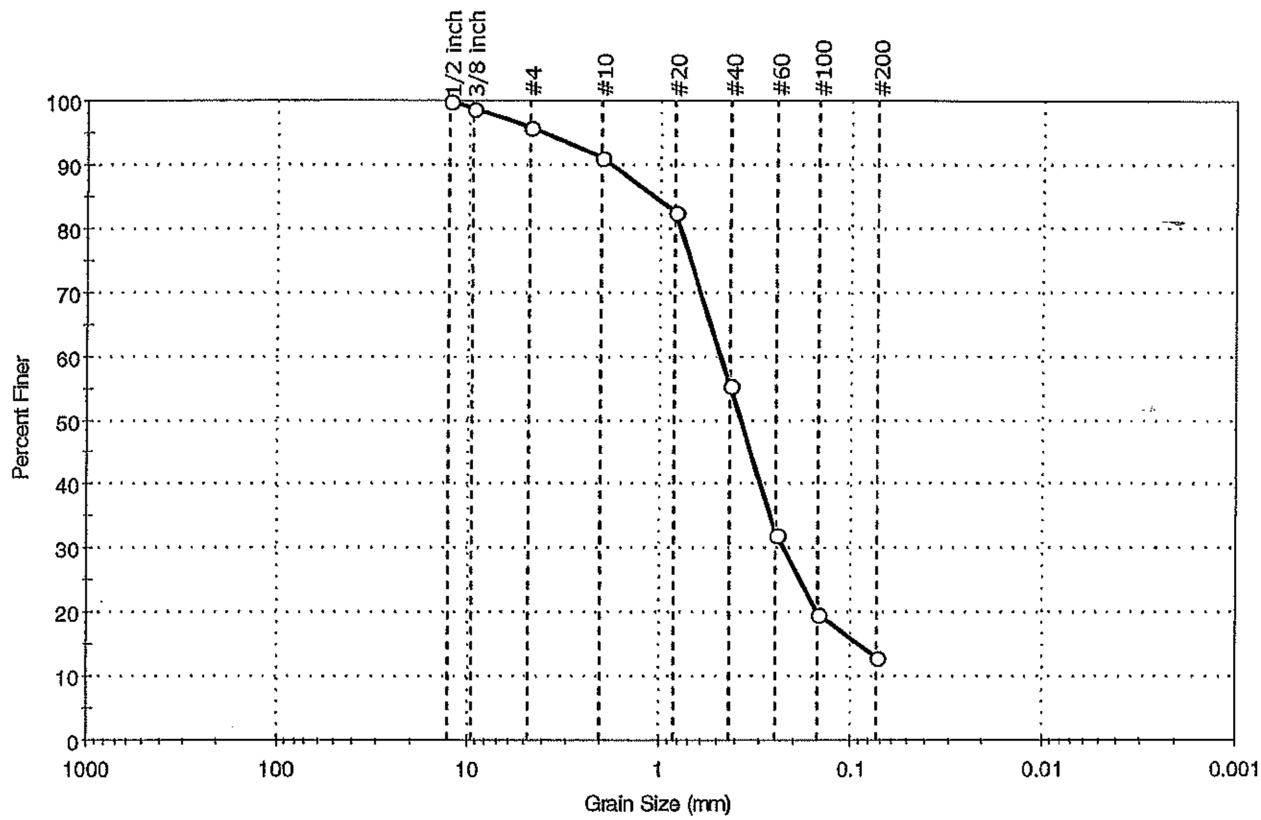
GeoTesting express
a subsidiary of Geocomp Corporation

Client:	GEI Consultants				
Project:	Brookhaven National Laboratory				
Location:	Upton, NY			Project No:	GTX-6864
Boring ID:	B-204	Sample Type:	bag	Tested By:	mll
Sample ID:	S-1	Test Date:	05/14/07	Checked By:	jdt
Depth :	0-2 ft	Test Id:	111383		

Test Comment: ---
Sample Description: Moist, olive brown silty sand
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	4.1	82.9	13.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1/2 inch	12.70	100		
3/8 inch	9.51	99		
#4	4.75	96		
#10	2.00	91		
#20	0.84	83		
#40	0.42	55		
#60	0.25	32		
#100	0.15	20		
#200	0.074	13		

Coefficients

D_{85} =1.0741 mm D_{30} =0.2279 mm
D_{60} =0.4772 mm D_{15} =0.0912 mm
D_{50} =0.3755 mm D_{10} =0.0544 mm
C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED
Sand/Gravel Hardness : HARD

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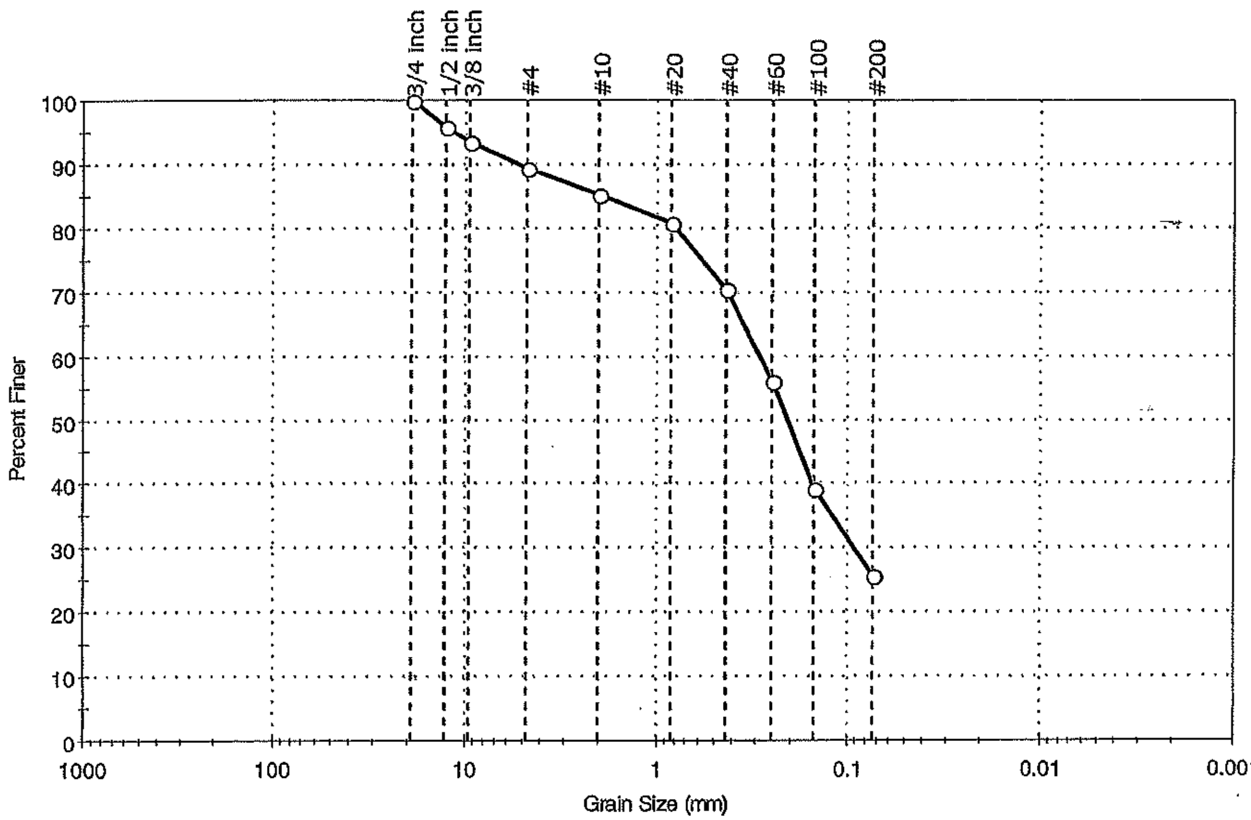
GeoTesting express
a subsidiary of Geocomp Corporation

Client:	GEI Consultants				
Project:	Brookhaven National Laboratory				
Location:	Upton, NY			Project No:	GTX-6864
Boring ID:	B-206	Sample Type:	bag	Tested By:	mll
Sample ID:	S-4	Test Date:	05/15/07	Checked By:	jdt
Depth :	6-8 ft	Test Id:	111385		
Test Comment:	---				
Sample Description:	Moist, reddish brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	10.6	63.8	25.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.70	96		
3/8 inch	9.51	93		
#4	4.75	89		
#10	2.00	85		
#20	0.84	81		
#40	0.42	70		
#60	0.25	56		
#100	0.15	39		
#200	0.074	26		

Coefficients

D_{85} =1.8829 mm | D_{30} =0.0928 mm
D_{60} =0.2898 mm | D_{15} =N/A
D_{50} =0.2083 mm | D_{10} =N/A
C_u =N/A | C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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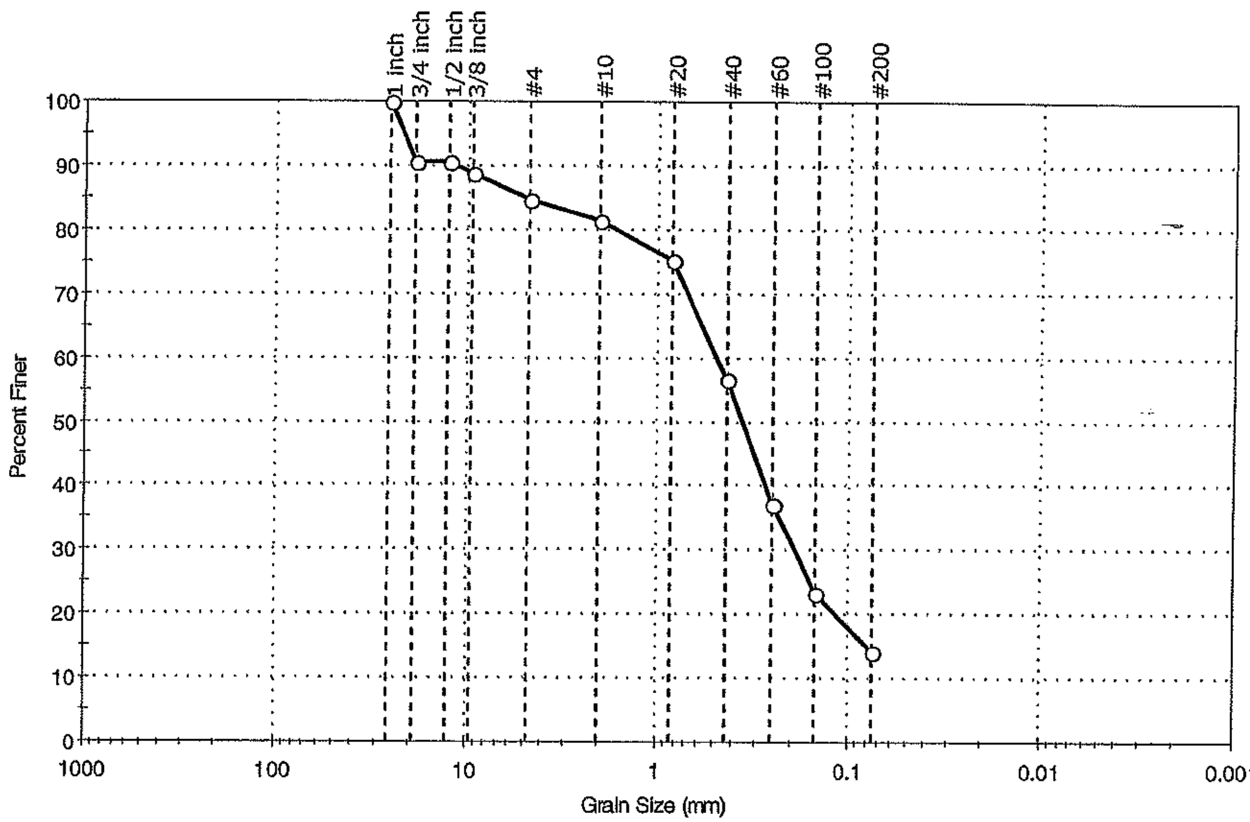
GeoTesting express
a subsidiary of Geocomp Corporation

Client: GEI Consultants			
Project: Brookhaven National Laboratory			
Location: Upton, NY		Project No:	GTX-6864
Boring ID: B-204	Sample Type: bag	Tested By:	mll
Sample ID: S-5	Test Date: 05/14/07	Checked By:	jdt
Depth : 8-10 ft	Test Id: 111384		
Test Comment: ---			
Sample Description: Moist, light olive brown silty sand with gravel			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	15.4	70.5	14.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 inch	25.70	100		
3/4 inch	19.00	91		
1/2 inch	12.70	91		
3/8 inch	9.51	89		
#4	4.75	85		
#10	2.00	81		
#20	0.84	75		
#40	0.42	57		
#60	0.25	37		
#100	0.15	23		
#200	0.075	14		

Coefficients

D_{85} =5.0799 mm D_{30} =0.1913 mm
D_{60} =0.4813 mm D_{15} =0.0804 mm
D_{50} =0.3543 mm D_{10} =0.0552 mm
C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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Appendix A2

Preliminary Vibration and Acoustic Report
September 15, 2006

Colin Gordon & Associates, Inc.

NSLS II Vibration and Acoustic Criteria

Vibration – Experiment Hall

The vibration limits of the experiment hall are those associated with the user-supplied research instruments, which are not well defined at this time. It may only be possible to represent the vibration requirements of this space using generic vibration criteria. The vibration needs of the vast majority of research equipment available today would be satisfied by a floor meeting vibration criterion VC-E or NIST-A.[1] At frequencies less than 20 Hz, the NIST-A criterion is more stringent than VC-E.

Vibration – Storage Ring

The vibration requirements for the storage ring have been provided in a much different manner. The RMS amplitude[2], *R*, is to be less than 20 to 30 nm, where *R* is defined as

$$R = \sqrt{\sum_{f=50}^{f=4} \Delta(f) \times \delta f}$$

where $\Delta(f)$ is the displacement power spectral density spectrum (in units such as m^2/Hz, where the frequency term in the denominator is the measurement bandwidth) and δf is the frequency resolution of the spectrum. The lower and upper bounds of the summation are 4 and 50 Hz, respectively. Frequency components outside this range may be neglected. The vibrations associated with fluid flow should meet the condition $R < 20$.

Acoustic Noise

The facility will have two primary groups of noise sources: (1) the facility's mechanical systems, such as air handlers, and (2) the user-provided research equipment. The noise control associated with the first group is within the purview of the NSLS II design team, but the ability to mitigate noise associated with the second group is somewhat limited. It can be anticipated via passive room noise control measures incorporated into the design, but it cannot be controlled via mechanical constraints such as airflow velocities, fan selection, or silencers, concepts typically employed for the first group.

Studies carried out during the design of the Advanced Photon Source determined that final operational room noise in the Experiment Hall would be a mix of sound from both groups of sources, and that NC-60 to NC-65 would be achievable from a combination of

[1] Vibration criteria VC-E and NIST-A are defined in **H. Amick**, M. Gendreau, T. Busch, and C. Gordon, "Evolving criteria for research facilities: vibration," *Proceedings of SPIE Conference 5933: Buildings for Nanoscale Research and Beyond*, San Diego, CA. Criterion VC-E has a one-third octave band rms velocity amplitude of 125 microinches/sec at frequencies between 1 and 100 Hz. Criterion NIST-A has a one-third octave band rms displacement amplitude of 1 microinch at frequencies between 1 and 20 Hz and a one-third octave band rms velocity amplitude of 125 microinches/sec at frequencies between 20 and 100 Hz.

[2] Simply stated, *R* is the area under the displacement PSD spectrum (m^2/Hz) between a lower and upper bound frequency.

mechanical system noise control measures on the proposed air handling system and room absorption made part of walls and ceiling.[3] This is the noise range found in many industrial cleanrooms. In the absence of absorptive material, the noise at APS was predicted to be on the order of NC-70. In order to achieve this, the recommended noise goal of the mechanical systems alone is NC-50 to NC-55.

[3] The results of the study were reported in "Acoustical Evaluation of Experiment Hall: Argonne National Laboratory", A. M. Yazdanniyaz & S. K. Bui, Acentech Report No. 56, January 1991. The noise from the experimental equipment was included in the model via sound power estimates based on measurements made at NSLS in 1989 by Acentech Incorporated as part of the APS design effort, reported in "Measurement of Noise and Vibration: National Synchrotron Light Source, Brookhaven National Laboratory", Hal Amick & Colin G. Gordon, Acentech Report No. 11, June 1989.

Site Vibration Study

Figure 1 shows an aerial photograph of the portion of the BNL complex containing the NSLS II site. Nearby are the site of the Center for Functional Nanomaterials (CFN), now under construction, and the existing NSLS. Vibrations were measured at all of these locations, as well as at Location 'A' and at a remote location to the north east of the indicated portion of the BNL campus.

Figure 2 shows a plan view of the proposed NSLS II, indicating Locations 1-6 at which ambient vibration measurements were made on the afternoon of 14 June 2006.[1] Vibrations were measured at each of these locations in each of three principal directions (vertical, north-south, and east-west). Each measurement lasted approximately two minutes, and produced an energy-averaged constant-bandwidth (FFT) rms velocity spectrum with 400 data points, 0-100 Hz frequency range, Hanning windowing, and 90% overlapping. The sensor, a seismic accelerometer, was supported on a 12" steel stake with a flat top, driven into the ground such that the flat top was flush with the ground.

The data were analyzed "live" and saved as spectra to the internal memory of the portable analyzer. The spectra were downloaded to a laptop computer and subsequently post-processed to obtain one-third octave band velocity spectra and 400-line displacement power spectral density (PSD) spectra. The PSD spectra, in turn, were processed to calculate RMS displacement amplitudes using numerical summing between a lower-frequency cutoff (CO) and 50 Hz. Nominally, the lower cutoff was 4 Hz for consistency with the particle ring criterion.

As noted previously, the nominal lower cutoff was 4 Hz for consistency with the particle ring criterion. However, in some cases the spectra below 6-7 Hz was contaminated by instrumentation noise floor. As a result, all of the RMS amplitudes are reported with low-frequency cutoff of 4, 6 and 8 Hz.

Figure 2(a) and (b) show a statistical representation of the vertical and horizontal vibrations, respectively, at the NSLS II site, in terms of one-third octave band rms velocity. These measurements were made during the mid-afternoon. Shown for reference are the VC-E and NIST-A criteria.

It should be noted in Figure 2 that the vibrations easily meet VC-E, but do not meet the NIST-A requirement. A similar observation was made at the time of the CFN vibration survey, and an additional study (using measurements at Location 'A') demonstrated that the low-frequency component which exceeds NIST-A disappears at night, and is thought to be due to traffic, probably on the Long Island Expressway.

The daytime and nighttime measurements at Location 'A' are represented in Figure 4 by open and closed triangles, respectively. At frequencies of 20 Hz and greater, the

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[1] At the suggestion of BNL personnel, vibrations were not measured in the wooded areas, in order to avoid ticks.

difference is visible though not as significant as that observed at frequencies near 4 Hz. The log mean of the vertical vibrations at the NSLS II site, represented in Figure 4 using diamond symbols, lies between the two Location 'A' spectra at frequencies of 10 Hz and less.

The data from the NSLS II measurement locations, as well as from Location 'A', were taken with the sensor supported on a steel stake. It is known that a "free-field" measurement made in this manner produces a spectrum with a higher amplitude at most frequencies than one made on a slab of significant size or inside a building.[2] Discussions of this effect in the context of the NSLS II measurements suggested the desirability of carrying out vibrations inside a building with a similar thick slab, at night when the vibrations were at their least. The vertical spectrum obtained in this manner in the partially-completed microscopy suite in CFN is shown with circle symbols, and is thought to be representative of the performance of the eventual nighttime performance of the Experiment Hall slab in NSLS II.

The constant-bandwidth FFT velocity spectra saved to the portable analyzer and downloaded to a spreadsheet on a laptop were transformed to rms displacement spectra by dividing each point in a spectrum by 2π times the frequency of that point. The rms displacement spectra were then transformed to displacement PSD spectra by squaring the amplitude and dividing each squared amplitude by the measurement bandwidth (0.375 Hz). The statistical displacement PSD spectra are shown in Figure 5(a) and (b), for vertical and horizontal vibration, respectively. The log mean (the heavier red line) will be used for comparative purposes in a discussion that will follow.

As noted previously, the vibration criterion for the ring is defined in terms of R, the area beneath the PSD spectrum $\Delta(f)$ between cutoff frequencies f_1 and f_2, defined as 4 and 50 Hz, respectively. For the discrete spectra being used in this study, this may be defined as

$$R = \sqrt{\sum_{f_2=50}^{f_1=4} \Delta(f) \times \delta f}$$

where δf is the frequency resolution of 0.25 Hz. However, it was observed during post-processing that some of the spectra were contaminated by system noise at low frequencies (found after the fact to be due to connection noise in a cable), so values of R were calculated using additional f_1 frequencies of 6 and 8 Hz. The R values are summarized for the NSLS II site in Table 1. When the lower cutoff frequency f_1 is set to 4 Hz, the RMS quantities do not meet the criterion of 30 nm specified by BNL, but when f_1 is increased to 6 Hz, the quantity is within the prescribed limits. As noted previously, the PSD content at frequencies below 6 or 7 Hz is thought to be due to system noise, not actual vibration.

[2] H. Amick, T. Xu, and M. Gendreau, "The Role of Buildings and Slabs-on-Grade in the Suppression of Low-Amplitude Ambient Ground Vibrations," *Proc. 11th Intl. Conf. on Soil Dyn. & Earthquake Engng. (11th ICSDEE) & the 3rd Intl. Conf. on Earthquake Geotech. Engng. (3rd ICEGE)*, 7-9 January, 2004, Berkeley, CA.

Supplemental measurements were carried out on 31 Aug 2006 and 1 Sept 2006. The results of those measurements, along with some taken at Location 'A' for the CFN site study, are summarized in Table 2. The most important data are likely those taken in the microscopy lab at CFN, where the RMS amplitudes at both measurement times are 20 nm or less, in any direction. (The amplitudes calculated using 6 Hz and 8 Hz cutoff frequencies are shown for interest, but the CFN space meets the most stringent interpretation of the NSLS II criterion. This demonstrates that the building effect impacts the RMS amplitude, as well as the one-third octave band spectrum (shown in Figure 4).

Vibrations were measured on the floor at Beam Line X1 in NSLS, around midnight, to provide a comparison with the vibrations measured in CFN. These results are also shown in Table 2, as Location 9. The difference between the two is quite dramatic, 71 nm for NSLS compared to 20 nm in CFN. (The same low-noise setup was used in both cases.)

BNL provided collected PSD spectra measured at several other light source facilities. The log mean PSD for the NSLS II site are shown superimposed on these data in Figure 6. The arrow indicates the NSLS II spectrum. It should be noted that the data from other facilities represent several different quantities of data points (the present data containing 200 points between 0 and 50 Hz) and quantity of averages. Either a smaller number of data points or a greater number of averages (or both) will produce a smoother spectrum. (For example, the vertical PSD spectrum from ESRF (shown in red) contains a very large number of data points, but most likely resulted from less than five spectra being averaged.) However, it is the fundamental nature of PSD spectra that spectral amplitude of stationary random vibration is roughly independent of bandwidth.

The data in Figure 6 initially suggest a rather unfavorable comparison between the NSLS II site and the other light sources. This was one of the reasons that nighttime data were subsequently measured in NSLS and CFN, such that the presence of a building could be taken into consideration, and at a remote location on the BNL property, so that proximity to the campus energy sources could be removed from consideration.

Data measured at the following locations were used for comparison:

- Microscopy suite of CFN, under construction
- Foundation of a light standard near CFN, prior to installation of the pole; this may be considered a "free-field" location, unstiffened by the presence of the building
- The floor of NSLS, directly beneath Beam Line X1 in the Experiment Hall
- A remote location near the northeast corner of BNL campus, on a hard surface at the center of a fire access road

Figure 7 shows the vertical Log Mean of site vibrations at NSLS II site (red curve marked by red arrow), expressed as PSD, compared with similar data from ALS, ESRF and SPRING-8 (using data provided by BNL). Shown also are PSD spectra measured at NSLS Beam Line X1 just after midnight, the "free-field" location near CFN, and the microscopy suite at CFN (identified by the black arrow). The vertical red dashed line indicates 4 Hz. The legend indicates the RMS amplitude using summation between 4 and 50 Hz, except for the NSLS II log mean, which is summed with a 6 Hz lower cutoff.

The vibrations near Beam Line X1 lie well above all the others, particularly at frequencies associated with rotating mechanical equipment, such as 18 Hz and 30 Hz. The data from the CFN microscopy suite lies below all the other BNL locations and ties with ALS for the -lowest RMS amplitude, at 20 nm.

Figure 8 compares the "best" BNL location—the CFN microscopy suite—with Location 'A' measured night using a stake and with the remote location simply measured on a road surface at noon. In this comparison, the remote location lies somewhat higher than the CFN spectrum at frequencies less than 8 Hz, but lies well below it at frequencies between 10 and 25 Hz. Recall from Figure 4 that there was a reduction factor of 3 to 5 times (in terms of amplitude) at frequencies below 8 Hz. In terms of power (i.e., PSD) this reduction factor becomes 9 to 25 times, which would suggest that the *surface* nighttime vibration at the remote location is less than that inside CFN, and would be lower yet inside a building at that location. Even though vibrations were not measured at night at the remote location, it is suggested that there is a cultural effect in the diurnal vibrations on the BNL campus, and that a remote site farther from the utility plant and the expressway might be worthy of consideration as design progresses.

The vibration study indicates that following the installation of the ring structure and experiment hall, which will significantly stiffen the site, the vibration environment will be comparable to that of other light source facilities. Additional modeling studies are recommended as the design progresses to examine the building and slab effect in greater detail, as much of the published experience deals with rectangular buildings, rather than toroidal. The dynamics are likely to differ to some extent.

Greater insight would be gained from carrying out a continuous vibration survey of 24 hours or more, in order to better document the diurnal variation of vibration at the site. This could be done at the ring site, using simultaneous multiple recording locations distributed around the ring. With data taken simultaneously, it may be possible to glean additional insight into the mechanism(s) and source(s) involved in the vibrations between 1 and 10 Hz.

The researchers may also benefit from a statistical representation of the temporal variation of vibration.[3]

[3] This is discussed at length in H. Amick, M. Gendreau, & N. Wongprasert, "Centile spectra, measurement times, and statistics of ground vibration," *Proceedings of the Second International Symposium on Environmental Vibrations: Prediction, Monitoring, Mitigation and Evaluation (ISEV2005)*, Okayama University, Okayama, Japan (20 to 22 September 2005)

Table 1. Summary of RMS amplitudes at NSLS II site, mid-afternoon

Location	Position		Vertical			North-South			East-West		
		f_1:	4 Hz	6 Hz	8 Hz	4 Hz	6 Hz	8 Hz	4 Hz	6 Hz	8 Hz
1	8 o'clock		69	29	23	45	23	19	35	24	21
2	10 o'clock		52	29	24	37	25	22	42	28	25
3	11 o'clock		43	26	20	30	20	17	29	19	16
4	1 o'clock		44	30	26	34	25	21	33	25	21
5	2 o'clock		36	26	22	30	23	21	46	36	33
6	7 o'clock		30	21	18	26	16	12	26	13	10

Table 2. Summary of RMS amplitudes at supplemental locations, various times

Location	Description	Time		Vertical			North-South			East-West		
			f_1:	4 Hz	6 Hz	8 Hz	4 Hz	6 Hz	8 Hz	4 Hz	6 Hz	8 Hz
7	Microscopy Lab in CFN	730pm		20	15	14	12	8	7	19	9	7
		1120pm		20	14	13	11	6	5	13	7	6
8	Free-Field, Foundation of Light Standard at CFN	1140pm		24	19	17	41	37	35	38	35	34
9	Beam Line X1 at NSLS	Midnight		71	48	42	12	9	8	13	9	7
10	Remote Site, on Wellhead	Noon		24	12	8	27	16	15	33	15	10
11	Remote Site, on Road	Noon		21	9	6	25	14	12	26	12	9
12	Location "A"	315pm		80	53	46						
		1030pm		35	29	27						

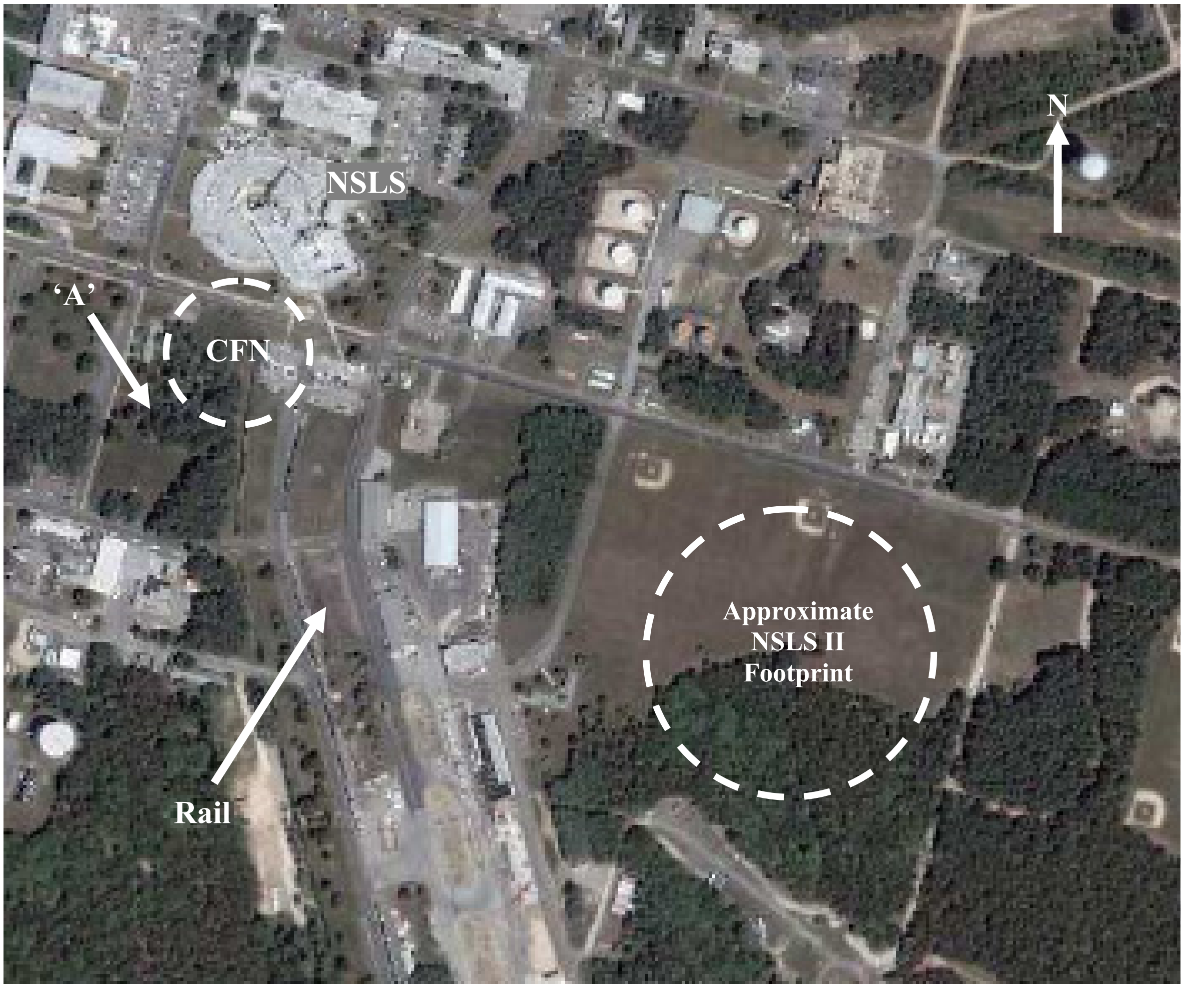


Figure 1. Aerial photograph of a portion of BNL showing approximate location for NSLS II and other relevant locations

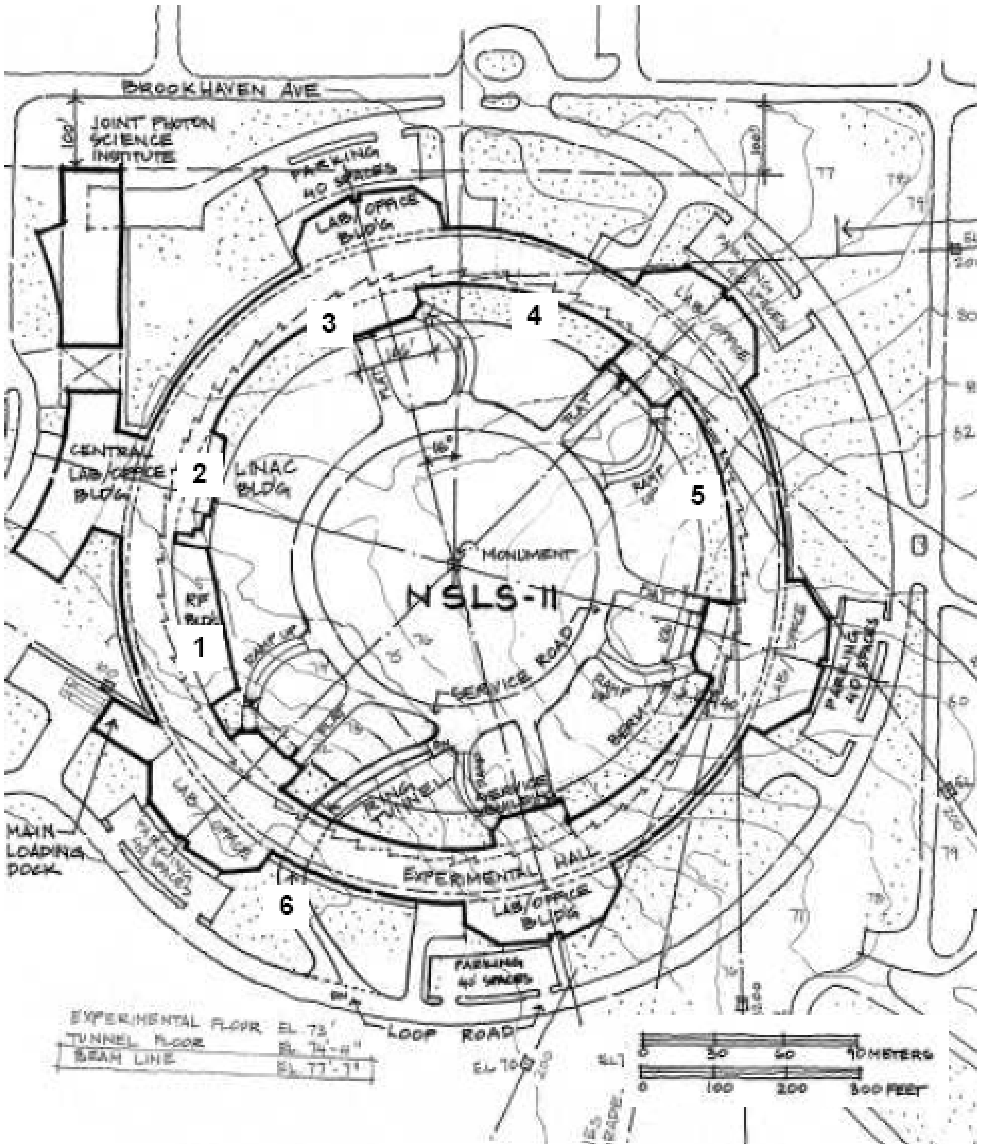


Figure 2. Site plan showing approximate location of NSLS II and the measurement locations used in this study

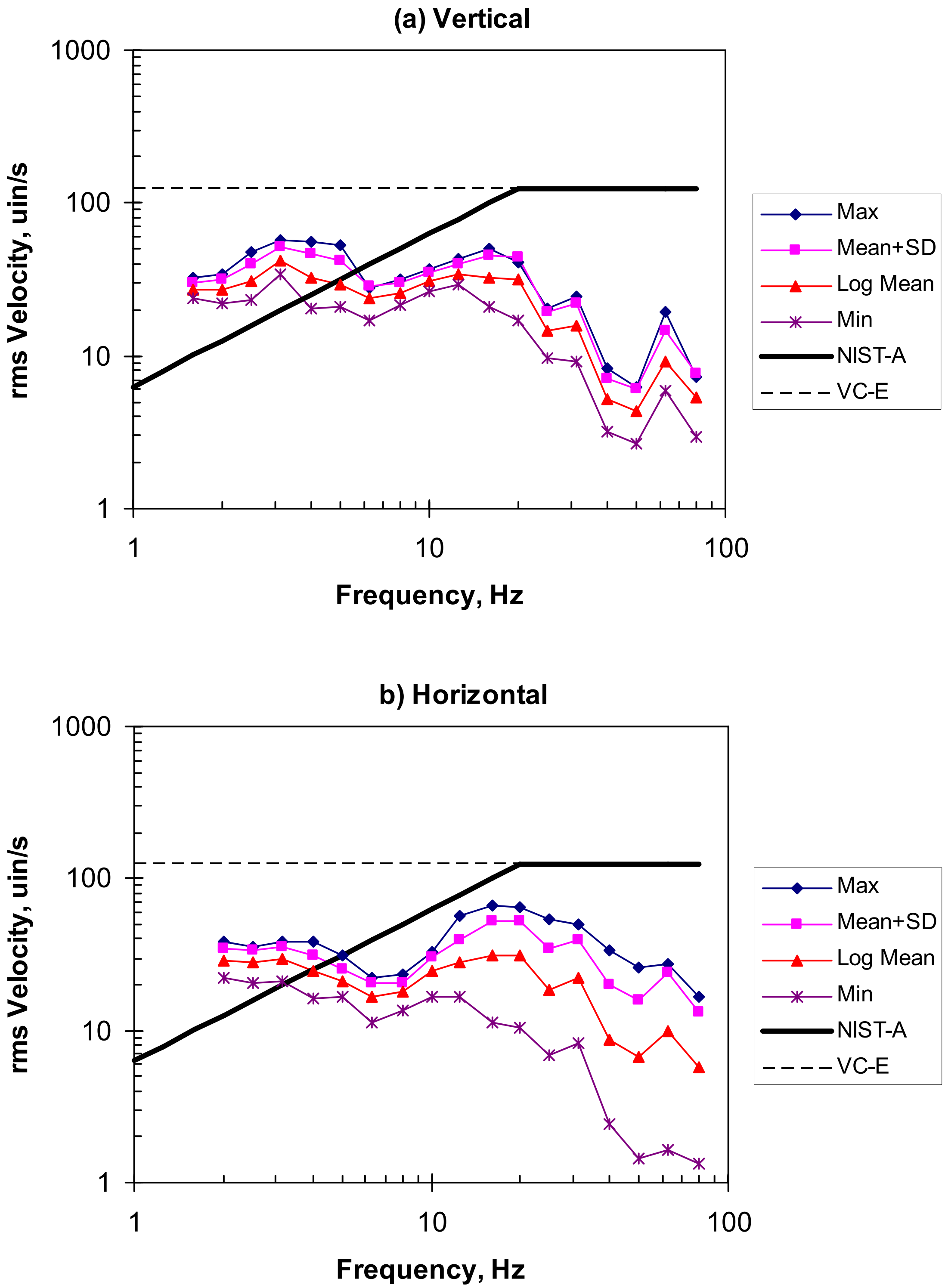


Figure 3. Statistical representation of daytime ambient site vibrations at Locations 1-6, NSLS II site

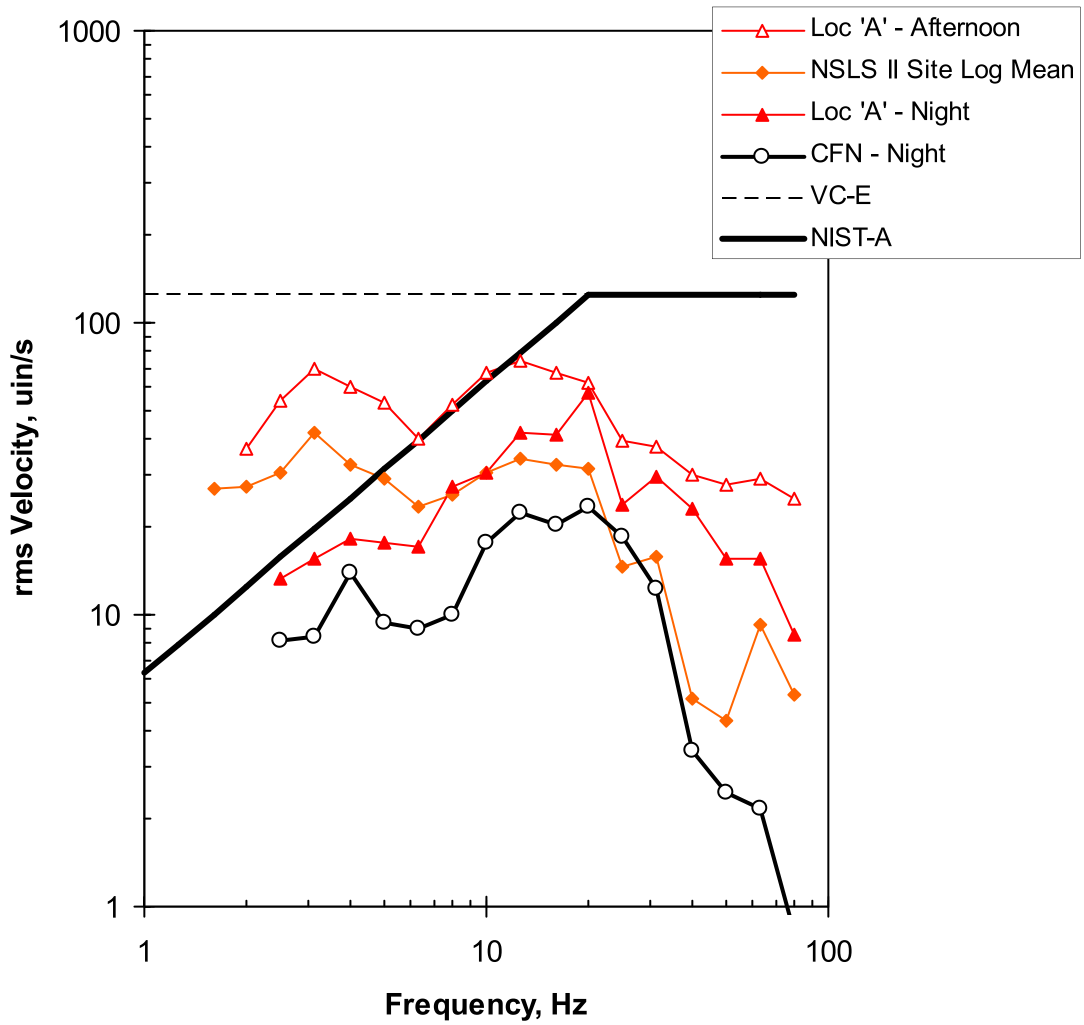


Figure 4. Comparison of one-third octave band vibrations at the NSLS II site, Location 'A', and at night in the CFN microscopy suite.

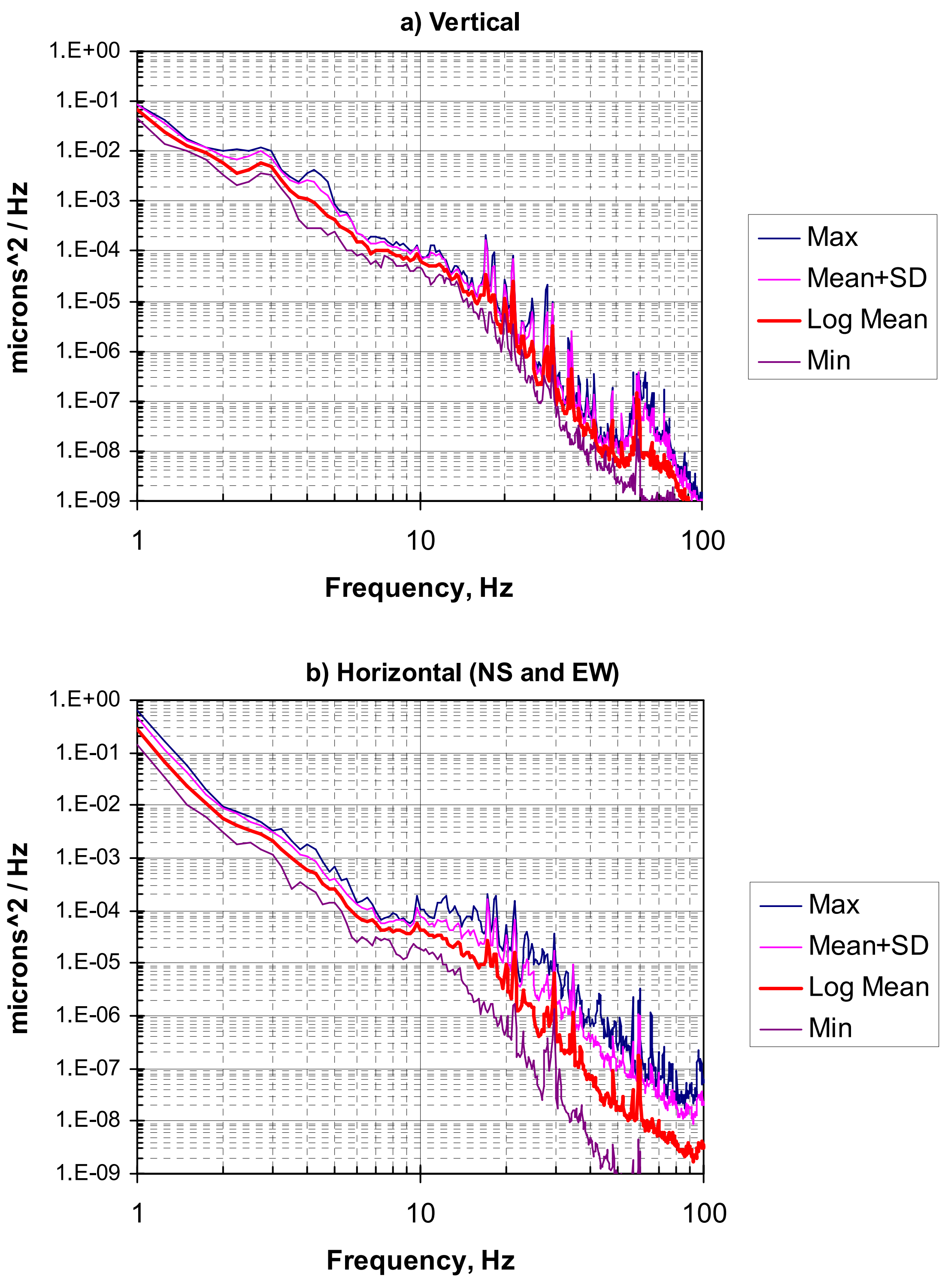
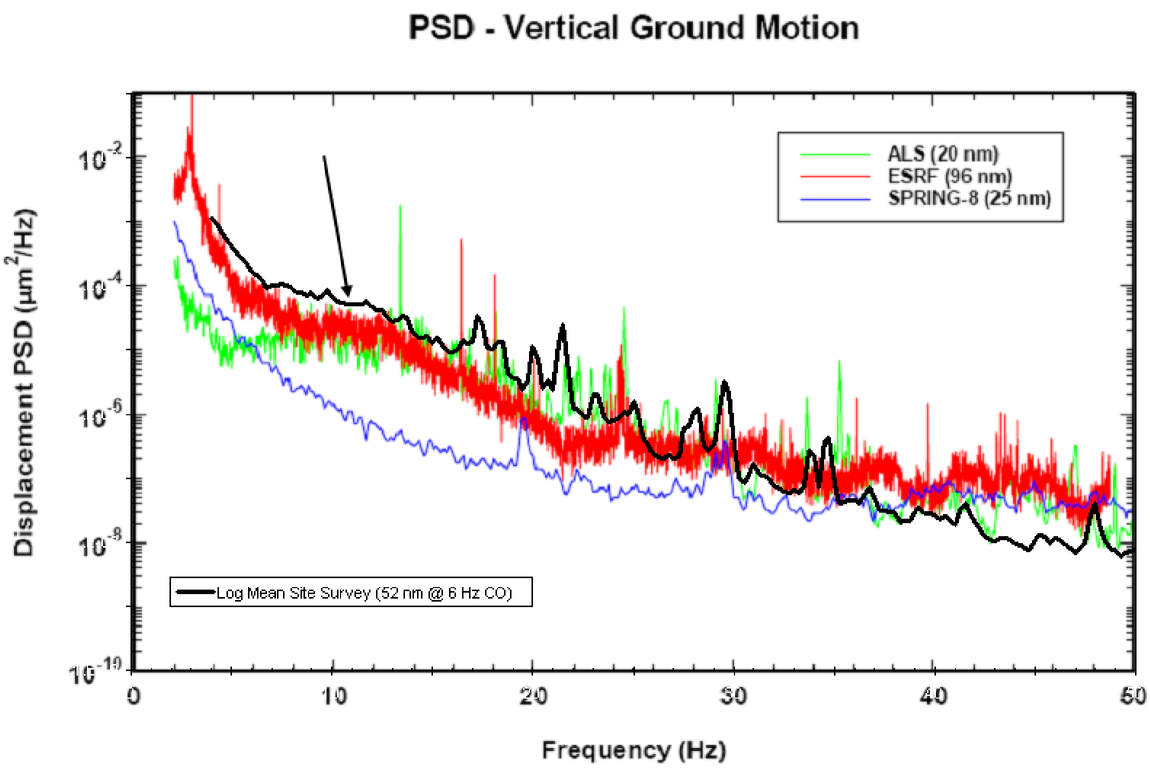


Figure 5. Statistical representation of daytime ambient site vibrations at Locations 1-6, NSLS II site, in terms of displacement power spectral density (PSD), 1-100 Hz



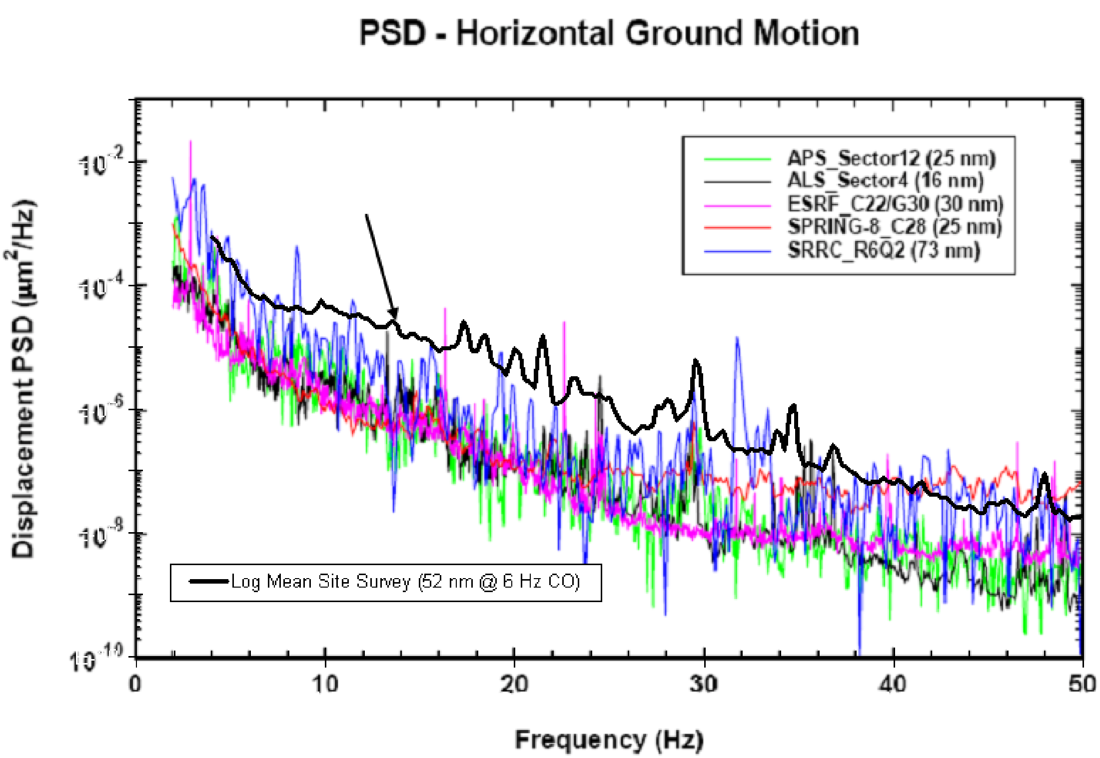


Figure 6. Log Mean of site vibrations at NSLS II site, expressed as PSD, compared with other sites (data for other sites provided by BNL)

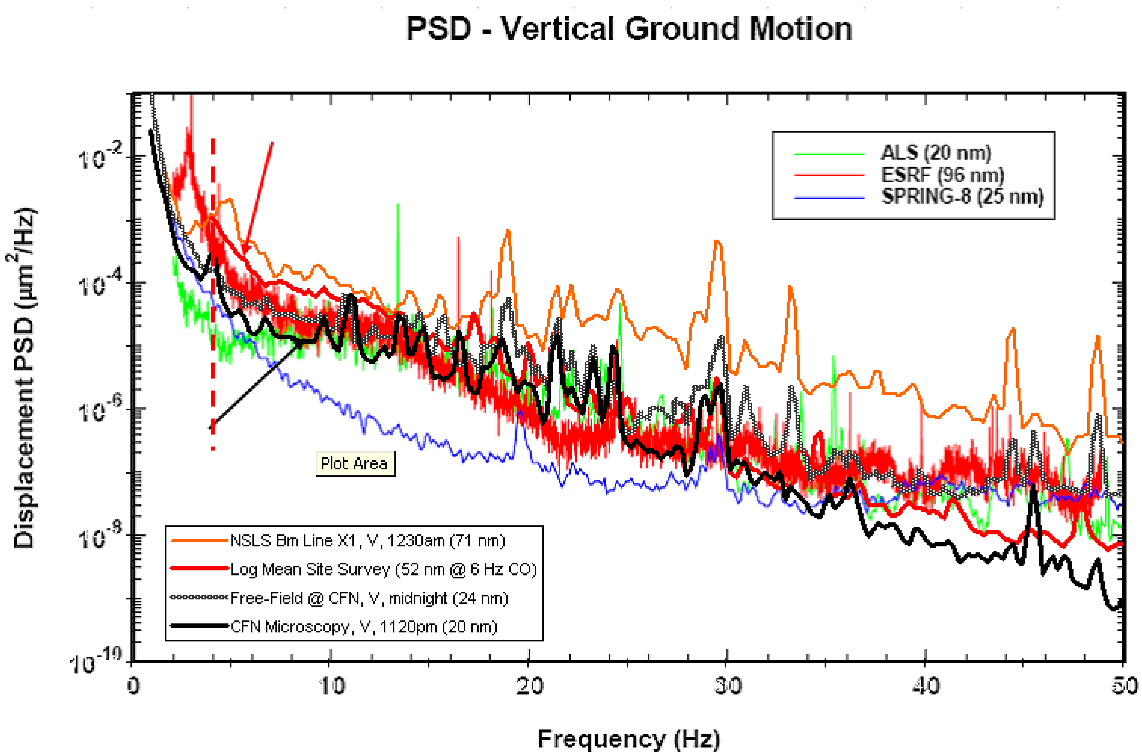


Figure 7. Log Mean of site vibrations at NSLS II site, expressed as PSD, compared with other sites (data for other sites provided by BNL) and with NSLS Beam Line X1, Free-Field at CFN, and the microscopy suite at CFN.

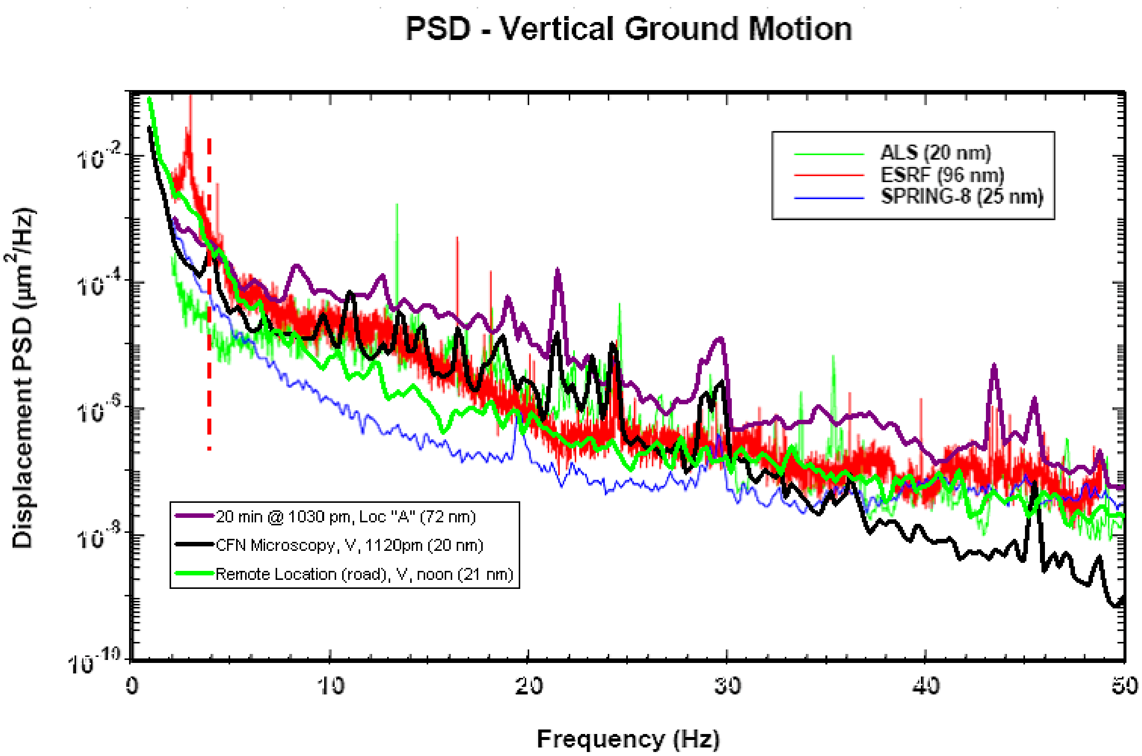


Figure 8. Comparison of PSD vibrations at three alternate reference locations, including Location 'A' and CFN Microscopy, both at night, and the remote location at noon.

Vibration and Acoustic Design Issues

Utility Distribution

Two utility concepts were examined during the course of this review. One was a distributed system along the lines of that used for APS, where the air handlers are placed at locations around the ring, perhaps along the outside of the experiment hall as at APS. The other concept was a centralized system, where the air handlers are placed at a central location and air distribution is via ducting. Each approach offers arguments pro and con, but examination of the issues specific to BNL philosophy and the proposed NSLS II layout led toward the centralized system.

From a vibration perspective, the difference between the two concepts lies in the amount of energy present in a concentrated area. (The distributed system works with a larger quantity of smaller air handlers, thus the maximum horsepower at any location near the ring is less, so there is a lower risk in placing the units closer to the ring.) However, a centralized system offers maintenance benefits, and the primary vibration control design issues become those of distance and conservative vibration isolation. It is important to maximize the distance between the air handlers themselves and the ring, though this will affect energy efficiency. A careful study of tradeoff between these two variables is recommended as design progresses.

A preference has been expressed to avoid vibration isolation on piping and ducting as much as possible. An important reason for this is that isolation works on the concept of exploiting a low resonance frequency of a sprung mass (the duct or pipe on a spring) and the random vibration energy in the duct or pipe is shifted to very low frequencies. Because the ring is sensitive to displacement, particularly at low frequencies, this is not a desirable feature. The alternatives for vibration control include low duct and pipe velocities (i.e., larger diameters) and long straight runs of mains. Both of these concepts can easily be incorporated as the design progresses.

Isolation of the Experiment Hall floor from the Ring tunnel floor

The outer corridor of the Experiment Hall will be separated from the floor slab of the Experiment Hall by means of a joint in the slab, following the APS model. This decouples the public corridor, which has pedestrian activities and deliveries, from the more vibration-sensitive Experiment Hall area.

Concerns have been expressed regarding the connectivity of the Tunnel and the floor of the Experiment Hall. This is not as simple a decision as that to decouple the outer corridor. The argument in favor of a joint is similar: it is desirable to mitigate "humming" and other vibration that might be generated by the equipment associated with the ring. The argument against a joint is that it introduces the risk of differential settlement between the Tunnel and Experiment Hall, which could cause a small, though quasi-static, beam misalignment.

The thick concrete slab of the Experiment Hall and Tunnel together will offer some improvement of the ground surface that might not be as dramatic if it is actually two ring slabs, one inside the other. This is an issue that can be addressed analytically as the design progresses.

An option worthy of consideration is the use of a damping admixture in the concrete beneath the ring. It would help to dissipate the high-frequency "humming" vibration. It could be placed as a topping on the concrete, as done in mechanical corridors at CFN. An unknown that would require evaluation is the severity of the radiation and how the polymer would respond to that radiation.

Acoustics of Experiment Hall

The Experiment Hall is a large open area which will have a vast quantity of user-supplied noise sources. A noise study was carried out in 1989 as part of the APS design effort, in part to develop a "typical" source sound power spectrum for design of the APS Experiment Hall.[1] At that time, the average noise level was found to be 69 dBA, though noise levels as high as 80 dBA were measured. It was assumed that the experiments themselves were not adversely affected (as noise protection could be built into the hutches), but the noise environment in the hall was a detriment to speech communication and contributed to researcher fatigue.

It might be worthwhile for BNL to consider imposing a limit on the allowable sound power associated with user-supplied equipment. However, the most proactive move is probably to use acoustically absorbent materials on walls and ceiling. The latter is relatively straightforward, by means of an acoustically absorbent roof deck. There are number of manufacturers of the product. Essentially it is a corrugated decking in which the grooves (as seen from above) are perforated and filled with acoustical material. The high spots are surfaces for supporting roofing or sheeting that supports concrete roof system. You can get very good performance from these systems. A facility with this kind of decking is the Experiment Hall at the Center for Advanced Microstructures and Devices (CAMD) at Louisiana State University. Some of the vendors of this product are Versa-Dek, United Steel Deck, and Vulcraft. A noise study should be carried out as the design progresses to the point that the mechanical system noise can be combined with the sound power for the research equipment.[2] That study can develop specific recommendations regarding the NRC of the decking and wall coverings and the optimal percentage of wall covering.

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[1] Amick, H., and C. G. Gordon, "Measurement of Noise and Vibration, National Synchrotron Light Source, Brookhaven National Laboratory", Acentech Report 11 (June 1989).

[2] Sound power data for typical NSLS equipment were reported in "Acoustical Evaluation of Experiment Hall: Argonne National Laboratory", A. M. Yazdanniyaz & S. K. Bui, Acentech Report No. 56, January 1991. The noise from the experimental equipment was included in their noise model via sound power estimates based on measurements made at NSLS in 1989, see Acentech Report 11.

Appendix A3

Preliminary EMI/RFI Site Assessment Study Report
September 1, 2006

VitaTech Engineering, LLC

VitaTech Engineering, LLC

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September 1, 2006

Mark Jamison, P.E. Tel: (402) 399-4908
HDR One Company
8404 Indian Hills Drive
Omaha, NE 68114

Subject: Future NSLS-II Brookhaven Labs EMI/RFI Site Assessment Study

Dear Mr. Jamison:

VitaTech Engineering was engaged by HDR to perform an EMI/RFI Site Assessment Study for the future NLSL-II building site located at Brookhaven Labs in Long Island, New York. The EMI/RFI data contained in this report was recorded on 14 June 2006 by the author of this report and Mr. Eric Friedlein of VitaTech Engineering. The proposed NSLS-II site has underground distribution circuits traveling east-west along Brookhaven Avenue and other electrical feeders west of Seventh Avenue running north-south. *VitaTech must return in late September to record additional RF data from the NEXRAD Dopper Radar 2200 ft. from the site.*

AC ELF Electromagnetic Interference (EMI)
Electron microscopes (SEMs, TEMs, STEMs), Focus Ion Beam (FIB) writers and E-Beam Writers are very susceptible to AC ELF (extremely low frequency) 3 Hz to 3000 Hz magnetic fields emanating from various electrical power sources outside of the NLSL-II building and within. VitaTech recommends a maximum of 1 mG Br (resultant) RMS AC ELF magnetic flux density emissions for NMRs and MRIs, 0.3 mG Br (resultant) RMS AC ELF magnetic flux density emissions for Cleanrooms and 0.1 mG Br (resultant) RMS AC ELF magnetic flux density emissions for SEMs, TEMs, STEMs, FIBs and E-Beam Writers as shown in the Chart #1 below:

EMI AC & DC Magnetic Field Performance Specs
NMR Maximum Requirement:
1 mG Br RMS (2.83 mG p-p)

Instrument & Quite Labs Maximum Requirement:
0.1 mG Br RMS (0.3 mG p-p)

Cleanrooms Maximum Requirement:
0.3 mG Br RMS (0.1 mG p-p)

Chart #1, Recommended EMI AC & DC Magnetic Performance Specs

Electromagnetic induction occurs when time-varying AC magnetic fields couple with any conductive object including wires, electronic equipment and people, thereby inducing circulating currents and voltages. In unshielded (susceptible) electronic equipment (computers monitors, video projectors, computers, televisions, LANs, diagnostic instruments, magnetic media, etc.) and signal cables (audio, video, telephone & data), electromagnetic induction generates electromagnetic interference (EMI), which is manifested as visible screen jitter in displays, hum in analog telephone/audio equipment, lost sync in video equipment and data errors in magnetic media or digital signal cables.

Placement of each scientific tool and instrument depends on the actual EMI susceptibility under defined thresholds, which are often not easy to ascertain from the manufacturer's performance criteria. Magnetic flux density susceptibility can be specified in magnetic field strength (A/m) or in milligauss (mG) using one of three magnetic flux density terms: Brms, Bpeak-to-peak(Bp-p) and Bpeak (Bp) according to the following conversion formula below.

$$B_{rms} = \frac{Bp-p}{2\sqrt{2}} = \frac{Bp}{\sqrt{2}}$$

To convert magnetic field strength to units of milligauss (mG), simply multiple the magnetic field strength by 4π. For example, 3 A/m is equal to 37.7 mG (3 x 12.57 = 37.7 mG). Using simulated emission profiles and the correct conversion formula, it is possible to identify the appropriate levels acceptable for each tool *if the correct EMI susceptibility figure can be ascertained from the manufacturer's specifications. Therein, lies the real EMI challenge.*

Generally, for AC ELF sources the minimum EMI threshold is 10 mG in unshielded electronic equipment, especially 14" to 17" CRT color computer monitors and analog signal cables; however, the AC ELF EMI threshold for high-resolution 17" to 21" CRT color monitors is only 5 mG. *Analog audio/video equipment and cables are susceptible to EMI noise less than 5 mG including diagnostic medical instruments such as EEGs, EKGs, EMGs, ECGs, and other electrode contract devices.*

The semiconductor industry has specified AC EMI threshold performance requirements in SEMI E33-94, Specification For Semiconductor Manufacturing Facility Electromagnetic Compatibility, as shown below in Chart #2 - The AC ELF EMI Threshold Charts:

Chart #2 – AC ELF EMI Threshold Chart

AC ELF EMI Thresholds (screen jitter & noise)
10 mG for 12-15 inch computer monitors & audio/video equipment
5 mG for 17-21 inch CRT monitors & medical (i.e., EEGs, ECGs, EMGs,. etc.).
1.0 mG for standard scientific tools (STEMs, TEMs, FIB, I-Beam, etc.)
0.1- 0.3 mG high resolution Nanotech scientific tools
0.01 mG for optimum superhigh resolution STEM tools.

SEMI E33-94 AC ELF EMC Standards
Level A - less than 0.25 mG
Level B - less than 0.50 mG
Level C - less than 1.00 mG
Level D - less than 2.00 mG
Level E - 2.0 mG and greater

AC ELF EMI Recorded Data & Assessment

On 14 June 2006 VitaTech recorded lateral AC extremely low frequency (ELF) magnetic flux density levels at 1-meter above grade with a survey wheel and the FieldStar 1000 gaussmeter (see Test Instruments for details) within the proposed NLSL-II building site. The following is an AC ELF magnetic flux density assessment of the RMS recorded data:

Figure #1 shows five lateral Hatch Plots recorded across the proposed NLSL-II building site. Each lateral data path has four color hatch marks (0.1 mG, 0.25 mG, 1.0 mG and 5.0 mG) representing the threshold level recorded at each one-foot interval (no hatch marks indicate levels less the 0.1 mG). Figure #2 presents five Profile Plots of the Figure #1 Hatch Plots with resultant Br (black) levels and three Bx (red), By (green) and Bz (blue) components shown as a function of distance.

The three north-south laterals (records #1 - #3) in Figures #1 and #2 shows the recorded magnetic fields emanating from the east-west underground distribution lines on Brookhaven Avenue (peaks 1.5 to 3.4 mG). The three north-south laterals rapidly decay to less than 0.1 mG 75 to 100 feet from the Brookhaven Avenue south curb. The levels were also very low along the east-west lateral in the center of the field rapidly decaying to 0.00 mG between Seventh and Fifth Streets except within 75 feet south of Brookhaven Avenue. The proposed NLSL-II site has very low AC ELF magnetic flux density levels 75 feet south of Brookhaven Avenue, ranging from 0.1 mG to 0.00 mG as shown in the five Figure #2 Lateral Profile Plots.

Figure #3 shows the timed wideband 3 Hz to 3,000 Hz AC ELF magnetic flux density field levels at the proposed NLSL-II site recorded with the MultiWave System II three axis fluxgate magnetometer sampled at 15 second intervals for 42 minutes. The timed Br resultant peak was 0.192 mG with an average 0.18 mG over the 42 minute period: this is the noise floor of the MultiWave System II where the actual levels are below the recording range. Therefore, the actual timed levels are 0.0 mG at this distance (200 – 250 ft) south of Brookhaven Ave.

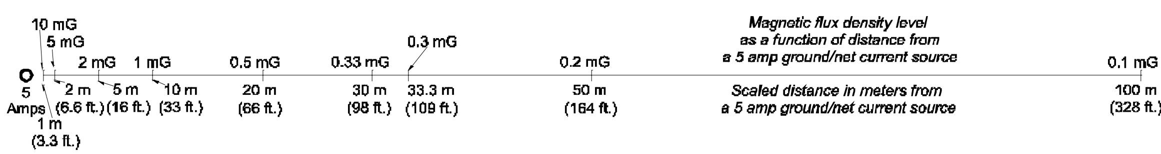
Conclusions: The recorded AC ELF magnetic flux density emissions were very low ranging from 0.1 mG at 75 to 100 feet south of Brookhaven Avenue rapidly decay to 0.00 mG at 100 feet all the way to the other side of the site including the wooded areas. The NSLS-II site complies with all four of the following AC ELF magnetic flux density performance requirements 100 feet south of Brookhaven Avenue between Seventh and Fifths Streets:

- ***0.01 to 0.1 mG EMI threshold for ultrahigh resolution STEMs;***
- ***0.1 to 0.3 mG EMI threshold for scientific tools (i.e., SEMs, TEMs, FIB, E-Beam Writers, etc.);***
- ***0.25 mG Level A SEMI E33-94 AC ELF EMF Standard; and,***
- ***10 mG long-term human exposures threshold recommended by the Swiss Bunderstat and NCRP Draft Report (see AC ELF Magnetic Field Health Issues, Standards & Guidelines)***

Ground/Net Current Issues
Ground and net currents are due to N.E.C. violations (i.e., grounded neutrals, wiring errors, etc.) in the electrical service, distribution and grounding systems of a building and N.E.S.C. violations (i.e., grounding problems, etc.) on distribution and transmission lines. Unbalanced phases on medium voltage distribution lines and 480V/208V low-voltage feeders generate zero-sequence currents, which return on the neutrals and grounding conductors. Most utilities maintain 5% and less unbalanced phases on high voltage transmission lines and 10-15% unbalanced phases on distribution lines (power quality issues) except in local neighborhoods where unbalanced phases may exceed 20%. A percentage of the zero-sequence neutral currents on distribution lines travel along other electrically conductive paths (i.e., underground water pipes, earth channels, grounded guy wires, building neutrals/grounding systems, etc.) back to the substation. If all the zero-sequence currents were to return via the multi-ground neutral system (MGN) wire mounted on the pole under the three phase conductors (sum of all phase and neutral currents are zero), then the magnetic fields would decay at the normal inverse square rate ($1/r^2$ in meters) from the single-circuit distribution line (same for transmission lines and low-voltage feeders). However, if only a fraction of the zero-sequence current returns on the MGN system or low-voltage neutral conductor, then there is a net current missing (amount of current returning via other paths) – this net current emanates a magnetic field similar to a ground current (electrical current of low voltage returning on a ground wire, water pipe or other conductive path) that decays at a linear 1/r (in meters) rate based upon the following formula:

$$\mathbf{B_{mG} = 2(I)/r} \quad \text{where I is amps and r meters}$$

Magnetic fields from ground and net (zero-sequence) currents decay at a slow, linear rate illustrated below, using a 5 amp ground/net current source: 10 mG is 1 m away, 1 mG is 10 m away, 0.5 mG is 20 m away and 0.1 m is 100 m away:



Since there is a proportional relationship between current load and magnetic flux density levels, the above chart can be used to predict the emission levels based upon ground/net current loads. Using 2.5 amps of ground/net current, the levels above the selected decay distance are calculated by dividing by 2, which is 50% of 5 amps. The ground/net current decay chart is indispensable in ascertaining the acceptable operating distance from ground and net (zero sequence) currents based upon a specified instrument performance criteria (i.e., 1 mG, 0.1 mG or 0.01 mG).

Ground and net current magnetic field emissions are difficult to shield using flat or L-shaped ferromagnetic and conductive shields -- the most effective shielding method for AC ELF ground/net current emissions requires a six-sided, seam welded aluminum plate shielding system with a waveguide entrance. *Finally, low ambient magnetic field levels can be achieved inside a research laboratory and imaging suite* *by adhering to the N.E.C. and good wiring practices. However, these low levels can only be achieved under the most pristine conditions and without any circulating ground/net currents present on the primary electrical distribution system outside of the building, low-voltage 480/208V distribution feeders and branch circuits inside the building systems and the grounding system.*

DC Electromagnetic Interference (EMI)

Large and small ferromagnetic masses in motion such as elevators, cars, trucks, trains, subways and metal doors produce geomagnetic field perturbations in the sub-extremely low frequency (SELF) 0 - 3 Hz band that radiate (similar to throwing a pebble in a pond) from the source generating DC electromagnetic interference (EMI) in sensitive scientific tools and instruments. The magnitude of the geomagnetic field perturbation and radiated distance from the source depends on the size, mass and speed of the moving ferromagnetic object. Theoretically, DC magnetic emission sources (i.e., ferromagnetic objects, magnets, etc.) decay according to the inverse cube law, in practice the decay rates are not ideal. Other problematic DC EMI sources include traction currents from underground/surface electric DC trolleys/subways, electromagnetic pulse (EMP) devices with high-voltage discharge, and finally unshielded NMRs and MRIs.

Electron microscopes (SEMs, TEMs, STEMs), Focus Ion Beam (FIB) writers and E-Beam Writers are very susceptible to DC EMI emissions and require clean DC environments. VitaTech recommends a maximum of 1 mG dB/dt Br (resultant) RMS DC EMI for NMRs and MRIs, 0.3 mG dB/dt Br (resultant) RMS DC EMI for Cleanrooms and 0.1 mG dB/dt Br (resultant) RMS DC EMI for SEMs, TEMs, STEMs, FIBs and E-Beam Writers as shown in the Chart #1 below:

EMI AC & DC Magnetic Field Performance Specs
NMR Maximum Requirement:
1 mG Br RMS (2.83 mG p-p)

Instrument & Quite Labs Maximum Requirement:
0.1 mG Br RMS (0.3 mG p-p)

Cleanrooms Maximum Requirement:
0.3 mG Br RMS (0.1 mG p-p)

Chart #1, Recommended EMI AC & DC Magnetic Performance Specs

Placement of scientific tools depends on the actual DC EMI susceptibility under defined thresholds, which are often not easy to ascertain from the manufacturer's performance criteria. Electron microscopes are sensitive at 1 mG Brms from DC disturbances while SEMs and TEMs such as the TEM JOEL 2010 have 0.4 mG horizontal and 0.2 mG vertical performance requirements while next generation EM tools are less than 0.1 mG Brms and Super STEMs (also known as ultra-high resolution STEMs) have a 0.01 mG DC EMI threshold. DC susceptibility in typical 1.5 to 4 Tesla MRIs can range from 1 mG to over 0.5 Gauss depending on the magnetic field strength, resolution and type (open vs. closed, active shielding, etc.). ***Furthermore, to ensure a safe working environment around MRIs and NMRs, adequate signage must be posted at 5 and 10 Gauss lines to warn staff and visitors with implantable devices and to minimize inadvertent data corruption (coercivity) of credit cards and other valuable magnetic media.*** Below is a list of DC EMI Thresholds in Gauss that will impact CRT displays, electronic instruments and magnetic media:

Chart #3 – DC EMI Threshold Chart

DC EMI Thresholds - CRT screen shift, noise & coercivity (data errors)
0.001 Gauss & Less SEMs, TEMs E-Beam/FIB Writers
0.75 Gauss CRT Monitors & Electronic Instruments
5 Gauss Cardiac Pacemakers & Implantable Devices Warning Sign
10 Gauss Credit Cards & Magnetic Media Warning Sign
300 Gauss Low Coercivity Mag-Stripe Cards
700 Gauss High Coercivity Mag-Sripe Cards & Video Tapes
1000 milligauss (mG) = 1 Gauss (G) & 1 mG = 0.001 G = 0.1 uT (microtesla)

According to the **National Geophysical Data Center (NGDC),** the average Br resultant DC magnetic flux density level at Brookhaven National Labs is 528.5 mG at 0 ft. elevation. Depending on the location and distance from ferromagnetic materials (pipes, steel beams, rebar, cars, etc.), the recorded average time DC Br resultant RMS levels at the site was 536.9 mG (see Figure #3), which is only a 8.4 mG differential.

<u>Moving Vehicle DC EMI Emission Profiles & Impact</u>

As discussed the DC EMI emissions from moving vehicles (cars, SUVs, VANs, trucks and busses), and trains can compromise sensitive research tools. Normally, VitaTech recommends adequate spacing between the proposed building site, roads with heavy traffic, parking garages, trains, subways and other DC EMI emission sources to minimize potential EMI problems with sensitive instruments and tools.

Figure #4 shows the timed (15 second interval) resultant (Br) and component (Bx, By and Bz) RMS DC data recorded with the MultiWave System II three-axis fluxgate magnetometer more than 200 feet from Brookhaven Avenue. The only noticeable DC dB/dt EMI data was generated from an SUV that drove up to our location (200 – 250 feet south of Brookhaven Avenue) within 10 feet of the fluxgate probe. The Br resultant chart shows a 4 mG dB/dt square pulse from the SUV vehicle as it approached the fluxgate probe.

VitaTech recorded timed DC EMI data from moving vehicles at the University of Florida several years ago as shown in Figure #5. Calculated car and bus vehicle profiles were generated by applying the decay data to Curve Fitting software – this data was overlaid on the NSLS-II site plan. Similarly, the vehicle decay chart should be used to evaluate the DC EMI impact from cars driving on Brookhaven Avenue and Seventh/Fifth Streets adjacent to the proposed site. It should be noted that in practice the magnetic fields decay more rapidly after 30 meters than the calculated levels indicate (see recorded data). Nevertheless, the calculated DC differential dB/dt emissions from a moving bus at 40 meters would be 0.2 mG while in practice the actual bus levels will be less than 0.1 mG.

Conclusions: Standard resolution imaging tools with dB/dt differential DC EMI resultant RMS thresholds of 1 mG to 0.1 mG can be located between 12 meters (40 ft) to 40 m (131.2 ft) south of Brookhaven Avenue assuming cars and busses are moving east and west. High resolution imaging tools with differential dB/dt DC EMI resultant RMS thresholds of 0.1 to 0.01 mG can be located from 40 m (131.2 ft) to 60 m (197 ft.), which is the predicted 0.01 mG isoline) south of Brookhaven Avenue. Similar separation distances are required from the north-south Seventh and Fifth streets to ensure adequate DC EMI immunity for moving vehicles of similar mass.

Radiofrequency Interference (RFI)

The Federal Communications Commission (FCC), not the local municipal zoning authorities or law enforcement, has legal jurisdiction over radiofrequency interference (RFI). Simply stated RF devices (intentional and unintentional emitters) are not permitted to cause RFI with other radio services, electronic equipment and systems. At present, there are no mandated radiofrequency interference (RFI) susceptibility government standards in the United States. The only equipment susceptibility standards that exist are unique to equipment (quality control) internal standards written by equipment manufacturers based on radiated emission standards for intentional radiators set forth by the FCC. In other words, an equipment manufacturer in United States must design the equipment to function properly within a radiated emission field level from intentional radiators set forth by the FCC, Part 15. Like any other communications facility, wireless broadband facilities must comply with these FCC limits. The following FCC parts apply to electromagnetic interference (EMI) and radio frequency interference (RFI) conducted and radiated emissions (see below):

Radio Frequency Devices - Part 15
Multipoint Distribution Service - Part 21, subpart K
Paging and Radiotelephone Service - Part 22, subpart E
Cellular Radiotelephone Service - Part 22, subpart H
Personal Communications Services - Part 24
Satellite Communications - Part 25
General Wireless Communications Service - Part 26
Wireless Communications Service - Part 27
Radio Broadcast Services - Part 73
Experimental, auxiliary, and special broadcast and other program distributional services - Part 74
Experimental Radio Service - Part 5
Stations in the Maritime Service - Part 80
Private Land Mobile, Paging Operations - Part 90
Private Land Mobile, "Covered" Specialized Mobile Radio - Part 90
Amateur Radio Service - Part 97
Local Multipoint Distribution Service - Part 101, subpart L

Mobile and portable devices used as follows:

- Cellular Radio Service
- Personal Communications Service
- Satellite Communications Branch
- General Wireless Communications Service
- Wireless Communications Service
- Maritime Service
- "Covered" Specialized Mobile Radio Service

In Europe, there are susceptibility (radiated immunity) standards, such as the EN 61000-6-1, that states 3 V/m level for residential electronic equipment, while 10 V/m is standard for industrial electronic equipment in the EN 61000-6-2. Engineers in the United States utilize the European susceptibility standards as a guideline. The SEMI E33-94 EMC Standard is 10 V/m and 3 V/m depending on frequency (see below):

Chart #4 – RFI Threshold Chart

Electric field strength RF levels were recorded in volts-per-meter (V/m) for 10 minutes sampled at 0.04-second intervals with a Narda ERM-300 electric field meter using a Probe 18 from 100 kHz to 3 Ghz (range of 0.2 to 320 V/m) and Probe 9C from 3 MHz to 18 GHz (range of 0.5 to 1000 V/m). The objective is to investigate sources of radio-frequency interference (RFI) over a wide bandwidth. It should be noted that 3 V/m is the industry standard RFI threshold and 1 V/m the medical/scientific instrument RFI threshold.

<u>SEMI E33-94 RF Immunity Standards</u>
<u>Enclosure Ports</u>
Radiated AM Immunity: 10 V/m 450-520 MHz and 800-950 MHz @ 80% AM
Radiated Pulse Modulated: 3 V/m 1.89 GHz 50% Duty cycle
<u>Signal Line Ports & Ports for Process, Measurement & Control</u>
RF Common Mode: 3 V/m 0.15 - 100 MHz @ 80% AM
<u>Input/Output DC/AC Power Ports</u>
RF Common Mode: 3 V/m 0.15 - 100 MHz @ 80% AM

RFI Electric Field Strength Site Assessments & Conclusions

<u>Timed Wideband 100 kHz – 18 GHz RF Electric Field Strength Data</u>

VitaTech recorded timed RF electric field strength data in volts-per-meter (V/m) was recorded at 1-meter above grade from 100 kHz to 3 GHz and 3 MHz to 18 GHz at 0.4 second intervals for two 10 minute periods on 14 June 2006 as shown in Figures #6 and #7. A summary of the 14 June 2006 recorded RF electric field strength levels are presented in Tables #1 and #2 below:

Table #1: 100KHz - 3GHz RF Data 14 June 2006

Site	Max (V/m)	Min (V/m)	Average (V/m)
NSLS-II	0.31	0.00	0.12

Table #2: 3MHz - 18GHz RF Data 14 June 2006

Site	Max (V/m)	Min (V/m)	Average (V/m)
NSLS-II	0.25	0.0	0.12

Tables #1 and #2 present 20 minutes of recorded RF electric field strength at the NSLS-II site as shown in Figure #6. These are very low RF electric field strength levels considering the NEXRAD Doppler Weather Radar is only 2200 ft. away from the site, therefore the radar was not operational or under low power during data collection. Figure #7 shows the maximum electric field strength thresholds recorded during two ten minute sampling periods. Again, very low maximum peak threshold levels were recorded from 100 kHz to 3 GHz and from 3 MHz to 18 GHz indicating the radar was not operational or under low power during the testing.

The NEXRAD Doppler Radar transmitter frequency range is 2.7 to 3.0 GHz with a peak output power of 750 kW (pulse width - short at 1.57 microsecond and 4.5 microsecond wide) from an S-Band center-feed parabolic dish (28 ft. outside-diameter) with a 0.95 degree pencil beam, 6 RPM azimuth rate and -1 to +20 degree elevation. VitaTech will return in late September 2006 with our new spectrum analyzer, the Narda SRM-3000 Selective Radiation Meter, to record the electric field strength and FCC Bulletin 65 (MPE) maximum permissible exposure levels at the proposed NSLS-II site with the NEXRAD Doppler Radar at maximum power (must be scheduled with the NEXRAD engineers and operators).

VitaTech previously recorded electric field strength levels for the Center for Functional Nanomaterials on the roof of the existing LightSpeed building. The RF emission levels around scientific tools such as the E-Beam Writers, NMRs, and Mass Spectrometers should be 20 mV/m or less. *Based upon the previously recorded RF emission levels at that site, RF shielding was recommended on the façade of the Center for Functional Nanomaterials, but budgetary issues deleted the RF shielding. Nevertheless, the existing LightSource building had RFI problems from the NEXRAD Dopper Radar, and RF shielding was installed around selected laboratory and research areas to reduce the RFI problems.*

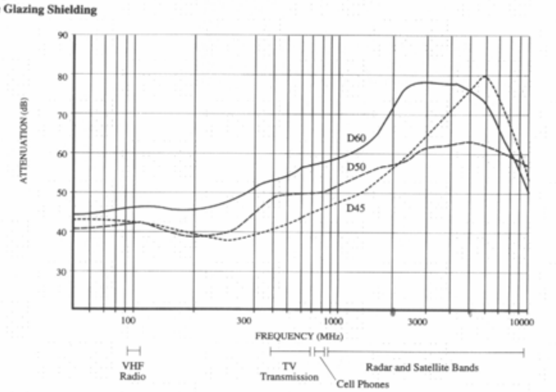
<u>Center for Functional Nanomaterials RF Shielding Assessment/Mitigation Options</u>
The following section was extracted from the Center For Functional Nanomaterials report on RFI shielding options. It should be noted that the estimated prices are not accurate and should be increased by 30% for budgetary reasons:

> The nearby NEXTRAD Doppler Radar operates between the 2.7 to 3 GHz frequency range with up to 750 kW of effective radiated power (ERP) depending resolution and weather conditions. Building materials will provide natural shielding attenuation based upon frequency and distance from the façade facing the RF emission source. At 3 GHz the aluminum metal building façade (0.04 inches thick) would provide 50 dB to 60 dB of attenuation due to the high reflection and absorption characteristics of the exterior interlocking aluminum siding/roofing. The second floor heavy gage steel floor pans (0.034 inches thick) would add another 50 dB to 60 dB of attenuation (i.e., reflection and absorption) to the roof figures for a total of 100 to 120 dB attenuation in the vertical plane. If the east façade windows and walls were not shielded the natural horizontal attenuation factor would be 25 dB at 5 meters inside the exterior wall, over 35 dB at 10 meters, and over 60 dB at 20 meters deep inside the building. Although the east façade exterior wall is covered with aluminum panels providing at least 50 to 60 dB of attenuation, the large unshielded windows provide an open portal allowing the Doppler RF energy to penetrate deep into the building. ***Therefore, RF shielding the windows is necessary to minimize potential RFI problems in the adjacent ground floor laboratories.***

VitaTech presents two RF window shielding options: transparent conductive RF film that can be applied to the windows when needed and conductive RF shielded glass with conductive gaskets and aluminum window frames. The best conductive RF film available is from 3M and sold under the Scotchtint trademark providing from 26 to 36 dB of attenuation depending on the type of film purchased (i.e., tint, conductivity, UV block and other parameters). When installed by professionals, the 3M Scotchtint has a 10 year warranty. It is supplied in 100 ft. by 5 ft. wide rolls costing from $1,200 to $1,500 per roll (not including installation) depending on the tint, shielding performance and energy rating. VitaTech provided samples of the P-18AR High Performance Silver (26 dB at 2.5 GHz) and RE35AMARL (36 dB at 2.5 GHz) to HDR several week ago. *It would cost $40,000 - $60,000 to install 3M RF film on 2,380 sq. ft. of windows including labor, expenses and profit.*

The other option is to use recently developed RF shielded glass "DATASTOP" sold by Pilkington and Tempest Security Systems, Inc. of Troy, OH. Shielding performance of the sealed double glazed DATASTOP windows ranged from 62 dB for the D50 with neutral tint up to 78 dB for the D60 with gold tint as shown below:

Figure 1
Double Glazing Shielding



The DATASTOP double glazed windows are typically two layers of ¼-inch thick glass separated by a ½-inch air gap mounted with conductive gaskets in an aluminum window frame shown below:

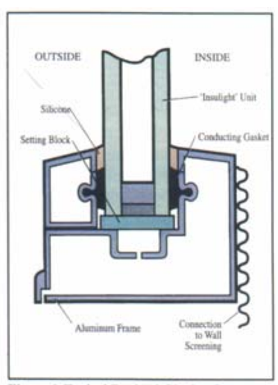


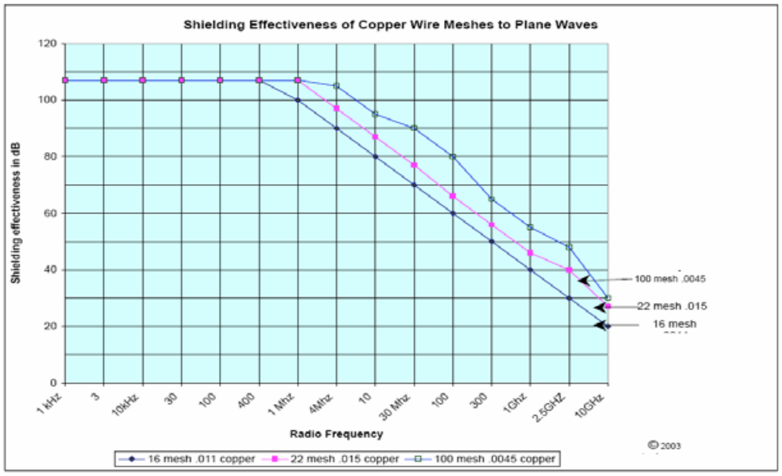
Figure 6. Typical Drained Glazing System

The basic no tint double glazed DATASTOP window costs $60 per square foot (not including installation). It has a 10 year warranty and would provide an average of 60 dB of attenuation, which is similar in attenuation to the exterior aluminum façade and aluminum roof. RF energy may penetrate into the building interior through various holes, openings, and mechanical seams in the aluminum exterior east façade wall: any space more than a 1/2λ of 3 GHz, which is 1.95 inches in diameter (see mesh section for formula). Since the DATASTOP aluminum window frames will not be conductively bonded and/or RF sealed to the exterior east aluminum wall panels, RF penetration through any 2 inch and large space will occur around the windows, doors and other separation joints between the conductive and metallic surfaces. *It would cost $290,000 - $325,000 to install 2,380 sq. ft. of DATASTOP D50 double glazed windows with no tint, fames and conductive gaskets including labor, expenses and profit.*

Shielding the east building façade with wire mesh behind the aluminum exterior panels would significantly attenuate any RF energy leakage into thorough holes and penetrations the research laboratories while providing an extra layer of RF protection. First, the wavelength of 3 GHz must be calculated using $C = \lambda f$ where C is the speed of light (2.997×10^8 m/s) and f is frequency of attenuation (3.0×10^9 in cycles per second). The wavelength λ of 3 GHz is 0.0999 meters (99.9 mm or 3.9 inches) while any wavelength greater than 1/2 λ (1.95 inches) is attenuated (i.e., lower the frequency the longer the wavelength).

Next, the ideal shielding effectiveness (SE) in decibels for wire mesh is calculated where λ (lamda) is the wavelength of the incident Doppler microwave in meters and g is the airgap in meters: $(SE)_{dB} = 20 \log_{10} (0.5\ \lambda/g)$

Assuming 60 dB of attenuation is the objective, than the calculated wire mesh spacing (airgap g) is 0.04995 mm (0.002 inches), which is equivalent to a 270 mesh. Only stainless steel fine mesh wire cloth is available in a 270 mesh size and is not used in RF shielding because of the difficulty in seam bonding and grounding. There are two other reasonable alternatives: 100 Mesh copper or aluminum screening. The calculated SE for 100 Mesh (0.0045 copper) with a 0.14 mm airgap is 51 dB while the measured SE is 47 dB as shown in the diagram below:



The 100 Mesh copper comes in 100 ft. rolls, 48 inches wide, and costs $1.30 to $1.50 per square foot (F.O.B). Aluminum 100 Mesh of the same length and width is a custom weave (must be an alloy with lower conductivity because of the needed tensile strength during the weaving process) costs $1.50 to $1.75 per square foot (F.O.B). The 100 Mesh copper and aluminum screens are easy to apply (staples, screws and adhesives) to the outside wall, can be mechanically bonded to the aluminum window frames using screws, and seam bonded (overlap edges and soldered) and grounded. Therefore, 47 dB of attenuation is available using the 100 Mesh copper and 40 dB using 100 Mesh aluminum alloy RF screening. *It would cost $55,000 - $80,000 to install 5,660 sq. ft. of aluminum 100 Mesh on the exterior walls beneath the aluminum panels and mechanically bonded to the aluminum window frames including labor, expenses and profit.*

VitaTech does not recommend applying copper and aluminum tapes with conductive adhesive backings over wire mesh seams, on window frames or other conductive structures because overall shielding performance will seriously degrade over time due to weathering and temperature variations. If wire mesh RF shielding is used on the east façade wall behind the exterior aluminum panels, it must be mechanically bonded to the window frames and all other metallic surfaces to ensure long-term performance with minimal failure (warning to avoid galvanic reactions only aluminum can be mechanically bonded to aluminum window/door frames).

<u>RF Shielding Options & Estimated Costs</u>
VitaTech presents the following RF shielding options with costs to minimize RFI interference from the nearby Doppler radar inside the new Center for Functional Nanomaterials building laboratories and offices:

Option 1: Additional RF shielding is not installed because the aluminum exterior east wall and roof building surfaces will provide at least 50 to 60 dB of attenuation coupled with the interior attenuation characteristics of the building. It should be noted that the east side 1st floor windows will provide open portals to the Doppler RF energy with only the office doors and walls to absorb and reflect the microwave energy. If RFI problems are identified and measured in specific laboratories, localized RF shielding should be applied to the area of concern to mitigate the problem, where practical. However, two alternative RF solutions are offered below with Option 1 where improved RF shielding is required:

Alternative #1: apply 3M conductive film to 1st floor windows for additional 36 dB of attenuation for an estimated cost of $40,000 - $60,000 including labor, expenses and profit. Shielding performance will be marginal because the edge between the conductive window film and window frame is difficult to bond (ground). Therefore, RF leakage around the inside glass window frames will present a serious problem.

Alternative #2: to reduce RF leakage through holes and seams along windows, doors and other openings apply 5,600 sq. ft. of aluminum 100 Mesh for an estimated costs of $55,000 - $80,000 including labor, expenses and profit. Special Note: aluminum 100 Mesh can not be applied after exterior aluminum wall panels are installed.

Option 2: Install DATASTOP RF shielded windows, conductive gaskets and frames in ground and 2nd floor east wall façade (2,380 sq. ft. area) as shown in Figure #11. Assume conductivity with aluminum exterior wall and roof to provide a reasonable RF shielding system of 60 dB and higher. Estimated cost: $290,000 - $325,000 for windows, frames, gaskets including labor, expenses and profit. Additional RF shielding is required to minimize RF leakage and improve overall shielding performance:

Alternative #3: seams with minimal electrical conductivity between DATASTOP aluminum window frames and exterior east aluminum walls will cause RF leakage penetrating into the interior building laboratories – install 100 Mesh aluminum screen to ground and 2nd floor walls behind aluminum panels and mechanically couple to the DATASTOP window frames RF sealing the east side of the building. Estimated cost: $55,000 - $80,000 for *5,660 sq. ft. of aluminum 100 Mesh includes labor, expense and profit.*

VitaTech recommends shielding the east exterior wall with the DATASTOP windows and 100 Mesh aluminum screen presented in Option 2 and Alternative #3 to provide the maximum RF shielding attenuation especially with close proximity to the ground floor research labs just several feet from the east side offices. Unfortunately, the Option 1 RF shielding solutions with Alternatives #1 and #2 will be marginally effective.

Conclusions: The four ambient timed recorded 100 kHz to 18 GHz electric field strength average and maximum peak data does not reflect the actual conditions since the Doppler Radar was probably not operational or at very low power. VitaTech will return in late September 2006 to record additional RF data with a spectrum analyzer (coordinate with engineers).

AC ELF, DC & RF Test Instruments

FieldStar 1000 Gaussmeter - AC ELF Magnetic Flux Density

VitaTech recorded the AC ELF magnetic flux density data using a FieldStar 1000 gaussmeter with a NIST traceable calibration certificate manufactured by Dexsil Corporation. The FieldStar 1000 has a resolution of 0.04 mG in the 0 - 10 mG range, 1% full-scale accuracy to 1000 mG and a frequency response of 60 Hz (55 - 65 Hz @ 3dB). Three orthogonal powdered-iron core coils are oriented to reduce interference to less than 0.25% over the full dynamic range. The three coils are arranged inside the unit holding horizontal with the display forward: Bx horizontal coil points forward, By horizontal coil points to the right side, and Bz vertical coil points upward. The microprocessor instantly converts the magnetic field to true RMS magnetic flux density (milligauss) readings of each axis (Bx, By, Bz) and simultaneously calculates the resultant R_{rms} (root-means-square) vector according to the following formula:

$$R_{rms} = \sqrt{Bx^2 + By^2 + Bz^2}$$

When collecting contour path data, a nonmetallic survey wheel is attached to the FieldStar 1000 gaussmeter and the unit is programmed to record mapped magnetic flux density data at selected (1-ft., 5-ft., 10-ft. etc.) intervals. The FieldStar 1000 is exactly 39.37 inches (1 meter) above the ground with the survey wheel attached. Along each path the distance is logged by the survey wheel and the relative direction (turns) entered on the keyboard. Up to 22,000 spot, mapped and timed data points can be stored, each containing three components (Bx, By & Bz), event markers and turn information. After completing the path surveys, magnetic flux density data is uploaded and processed. All plots display a title, time/date stamp, ID path number, and the following statistical data (in milligauss) defined below:

Peak - maximum magnetic field (flux) value measured in group.
Mean - arithmetic average of all magnetic field (flux) values collected.

The following is a quick description of the Hatch, Profile and 3-D Contour plots presented in the figures of this report:

Hatch Plot - data is represented by four difference hatch marks (0.1 mG, 0.25 mG, 0.5 mG and 1.0 mG thresholds) based on width and color as a function of distance along the survey path that shows 90 and 45 degree turns. Note: the site drawing and all Hatch Plots were scaled in feet to verify actual recorded distances and correct survey locations.

Profile Plot - data shows each recorded component (Bx, By, Bz) axis and the resultant (Br) levels as a function of distance: Bx (red) is the horizontal component parallel to the survey path, By (green) is the horizontal component normal (perpendicular) to the survey path, and Bz (blue) is the vertical component with the computed Br resultant RMS (root-means-square) summation of the three components.

EMR-300 RF Meter - Electric Field Strength Data 100 kHz - 18 GHz

The EMR-300 is an radiofrequency (RF) electric field strength meter for broadband measuring and monitoring from 100 kHz to 18 GHz. The isotropic non-directional field probe with high sensitivity records average, maximum, peak and timed data in electric fields strength volts-per-meter (V/m), magnetic field strength amps-per-meter (A/m) and power levels. Ten minute timed data was sampled at 0.4 seconds intervals from 100 kHz – 3 GHz with a Probe 18 (range 0.2 V/m to 320 V/m) and from 3 MHz to 18 GHz with Probe 9C (range 0.5 V/m to 1000 V/m) at each location.

MultiWave System II – Magnetic Flux Density 0 Hz – 3000 Hz

Geomagnetic and static DC magnetic emission measurements were recorded with a fluxgate triple-axis MultiWave System II magnetometer (serial #1045). The MultiWave System II consists of a hand-held LCD display and keyboard controller unit, wideband 10 Gauss (G) peak (DC – 3 kHz) tri-axial fluxgate magnetometer, data acquisition and processing unit with 3.5" floppy disk drive unit and 0 to 10 Gauss range, 1% accuracy, 0.1 mG resolution.

AC ELF Magnetic Field Health Issues, Standards & Guidelines

Currently, there are no Federal standards for AC ELF electric and magnetic field levels. The National Energy Policy Act of 1992 authorized the Secretary of the Department of Energy (DOE) to establish a five-year, $65 million EMF Research and Public Information Dissemination (RAPID) Program to ascertain the affects of ELF EMF on human health, develop magnetic field mitigation technologies, and provide information to the public. In May 1999, the NIEHS Director Kenneth Olden, Ph.D. delivered his final report, *Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields*, to Congress that stated the following in the Cover Letter and Executive Summary below:

> *The scientific evidence suggesting that ELF-EMF exposures pose any health risk is weak. The strongest evidence for health effects comes from associations observed in human populations with two forms of cancer: childhood leukemia and* ***chronic lymphocytic leukemia in occupationally exposed adults... The NIEHS concludes that ELF-EMI exposure cannot be recognized at this time as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard.***

U.S. & International Organizational AC ELF EMF Standards

The International Commission on Non-Ionizing Radiation Protection (IRPA/INIRC) have established 833 mG maximum human exposure limit over 24 hours for the general public and 4,167 mG for occupational workers. Whereas The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a 10,000 mG (10 Gauss) exposure limit over 24 hours for occupational workers, but specifies only 1,000 mG (1 Gauss) as a maximum exposure for workers with cardiac pacemakers.

New York State Public Service Commission AC ELF EMF Standards

Effective September 1990, the State of New York Public Service Commission (PSC) "began a process looking toward the adoption of an interim magnetic field standard for future major electric transmission facilities". The Commission concludes that a prudent approach should be taken that will avoid unnecessary increases in existing levels of magnetic field exposure. Therefore, future transmission circuits shall be designed, constructed and operated such that magnetic fields at the edges of their rights-of-way will not exceed 200 mG when the circuit phase currents are equal to the winter-normal conductor rating. They also established an electric field strength interim standard of 1.6 kV/m electric transmission facilities.

IARC June 2002 Report

In June 2002, the International Agency for Research on Cancer (IARC) issued a 400+ page report formally classifying extremely low frequency magnetic fields as ***possibly carcinogenic to humans*** based on studies of EMF and childhood leukemia. **This is the first time that a recognized public health organization has formally classified EMF as a possible cause of human cancer**. IARC found that, while selection bias in the childhood leukemia studies could not be ruled out, pooled analyses of data from a number of well-conducted studies show a fairly consistent statistical association between childhood leukemia and power-frequency residential magnetic fields above 4 milliGauss (mG), with an approximately two-fold increase in risk that is unlikely to be due to chance.

IARC is a branch of the World Health Organization. The IARC classification of EMF was made by a panel of scientists from the U.S. National Institute of Environmental Health Sciences, the U.S. Environmental Protection Agency, the U.K. National Radiological Protection Board, the California Department of Health Services, EPRI, and other institutions around the world.

Switzerland's February 2000 AC ELF Standard

The Swiss Bundersrat in February 2000 set by law an emission control limit of 10 mG from overhead and underground transmission lines, substations, transformer vaults and all electrical power sources.

VitaTech's & NCRP Draft Recommended 10 mG Standard

Section 8.4.1.3 option 3 in the National Council of Radiation Protection and Measurements (NCRP) draft report published in the July/August 1995 issue of *Microwave News* (visit the Microwave News Homepage <www.microwavenews.com> for the entire draft report) recommended the following:

> ***8.4.1.3 Option 3:*** *An exposure guideline of 1 μT (10 mG) and 100 V/m: A considerable body of observations has documented bioeffects of fields at these strengths across the gamut from isolated cells to animals, and in man. Although the majority of these reported effects do not fall directly in the category of hazards, many may be regarded as potentially hazardous. Since epidemiological studies point to increased cancer risks at even lower levels, a case can be made for recommending 1 μT (10 mG) and 100 V/m as levels not*

to be exceeded in prolonged human exposures. Most homes and occupational environments are within these values, but it would be prudent to assume that higher levels may constitute a health risk. In the short term, a safety guideline set at this level would have significant consequences, particularly in occupational settings and close to high voltage transmission and distribution systems, but it is unlikely to disrupt the present pattern of electricity usage. These levels may be exceeded in homes close to transmission lines, distribution lines and transformer substations, in some occupational environments, and for users of devices that operate close to the body, such as hair dryers and electric blankets. From a different perspective, adoption of such a guideline would serve a dual purpose: first, as a vehicle for public instruction on potential health hazards of existing systems that generate fields above these levels, as a basis for "prudent avoidance"; and second, as a point of departure in planning for acceptable field levels in future developments in housing, schooling, and the workplace, and in transportation systems, both public and private, that will be increasingly dependent on electric propulsion.

RF Human Exposure Standards

Presently, four major RF standards are used in the United States: IEEE, ACGIH (American Conference of Governmental Industrial Hygienists), NCRP (National Council on Radiation Protection and Measurements) and the ICNIRP (International Commissions of Non-Ionizing Radiation Protection). In 1991, the IEEE released a revised RF human exposure standard IEEE C95.1-1991, *Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHZ*. However, in August 1997 the Federal Communications Commission (FCC) Office of Engineering & Technology (OTE) released Bulletin 65 *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*, which became the defacto RF exposure standard in the United States. Both standards are very similar for Occupational/Controlled and General Population/Uncontrolled maximum permissible exposure (MPE), except for some minor differences -- the FCC standard is more restrictive and used in RF Safety & Exposure Testing.

The FCC's Bulletin 65 specifies separate maximum permissible exposure (MPE) limits for Occupational/Controlled and General Population/Uncontrolled exposure over a 0.3 MHz to 100 GHz bandwidth as shown below:

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

(A) Limits for Occupational/Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
0.3-3.0	614	1.63	(100)*	6

3.0-30	1842/f	4.89/f	$(900/f^2)$*	6
30-300	61.4	0.163	1.0	6
300-1500	--	--	f/300	6
1500-100,000	--	--	5	6

Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

(B) Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	$(180/f^2)$*	30
30-300	27.5	0.073	0.2	30
300-1500	--	--	f/1500	30
1500-100,000	--	--	1.0	30

f = frequency in MHz *Plane-wave equivalent power density

General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

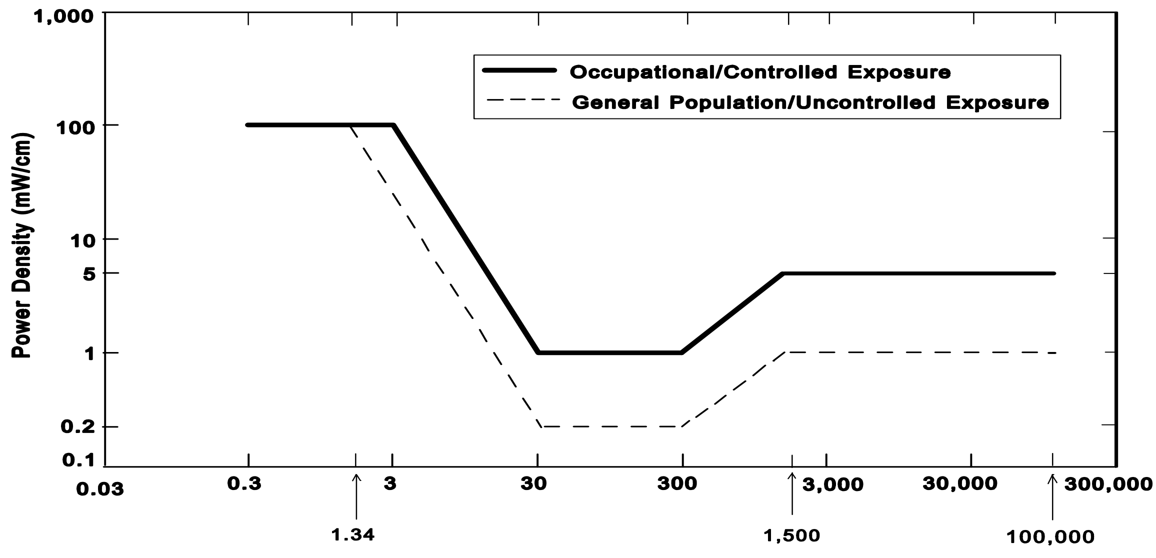
Specific Absorption Rate (SAR) is the basis of most safety standards, when applied in the far-field, plane-wave conditions. It is the rate of energy absorption per unit of body mass. When the human body is exposed to the RF field, the SAR experienced is proportional to the squared value of the electric field strength induced in the body. At an absorption level of 4 W/kg, reversible behavioral disruption is noted. Levels above 5 W/kg can result in permanent adverse affects. Therefore, most standards have been based on SAR's of 0.4 W/kg to conservatively limit exposures to 1/10th of the levels to account for biological uncertainty and to add an additional safety factor.

Unfortunately, the Occupational Safety & Health Administration (OSHA) has not revised the standard since 1978 (see OSHA Regulations Standards - 29 CFR, Non-ionizing Radiation - 1910.97), but has already cited and fined organizations for exceeding the new standards. OSHA has the right to enforce based on consensus of scientifically-based standards under its general duty clause. **Nevertheless, OSHA uses 10 mW/cm² as the maximum SAR exposure over an averaged period of 6 minutes from continuous or intermittent RF sources between 10 MHz and 100 GHz.**

Figure 1, below presents the FCC Limits for Maximum Permissible Exposure (MPE) in units of Power Density (mW/cm^2):

<u>Figure 1.</u> **FCC Limits for Maximum Permissible Exposure (MPE)**

Plane-wave Equivalent Power Density



This completes the *Future NSLS-II Brookhaven Labs EMI/RFI Site Assessment Study.*

Best regards,

Louis S. Vitale, Jr.
President & Chief Engineer

Attachments: Figures #1 - #7.

Figure #1, NSLS-II Brookhaven National Labs Proposed Site Hatch Plots AC ELF Magnetic Flux Density Levels @ 1-meter - Upton, Long Island, New York

Refer To Figure #2 for Profile Plots of Hatch Data

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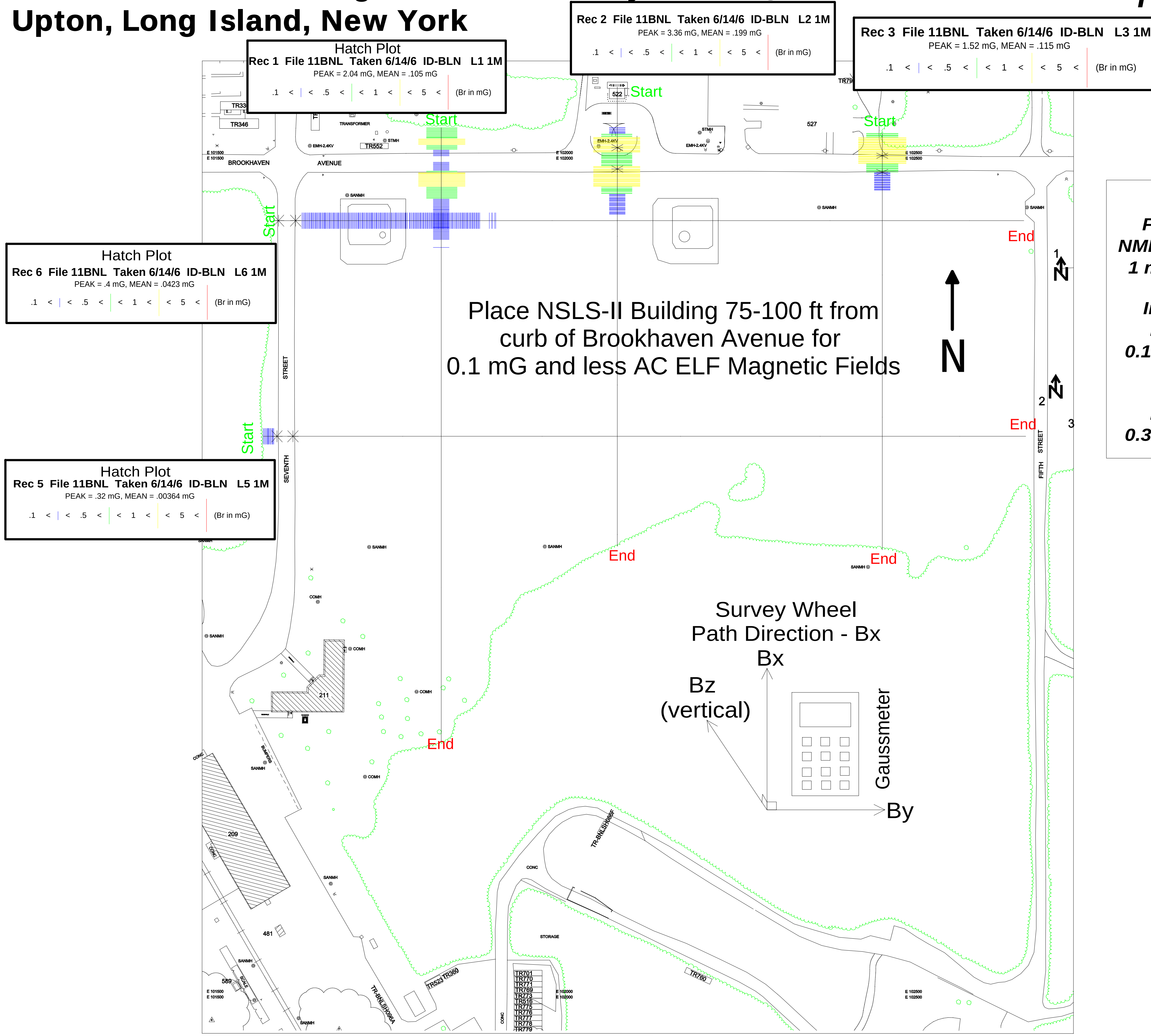

EMI AC & DC Magnetic Field Performance Specs
NMR Maximum Requirement: 1 mG Br RMS (2.83 mG p-p)

Instrument & Quite Labs Maximum Requirement: 0.1 mG Br RMS (0.3 mG p-p)

Cleanrooms Maximum Requirement: 0.3 mG Br RMS (0.1 mG p-p)

AC ELF Magnetic Field Human Exposure Standards

NYS Public Service Commission
200 mG @ 1-meter on Edge -ROW
or 50 ft. from 69 kV poles

IRPA/INIRC
833 mG over 24 hours
General Public Exposure

ACGIH
1000 mG general public
& workers with cardia pacemakers

Swiss Bunderstat
NCRP Draft Report
10 mG from overhead/underground
transmission/distribution lines,
substations, etc.

All magnetic flux density data recorded with a FieldStar 1000 gaussmeter and survey wheel.

AC ELF EMI Thresholds (screen jitter & noise)

10 mG for 12-15 inch CRT computer monitors & audio/video equipment
5 mG for 17-21 inch CRT monitors & medical (i.e., EEGs, ECGs, EMGs,. etc.).
1.0 mG for standard scientific tools (STEMs, TEMs, FIB, I-Beam, etc.)
0.1- 0.3 mG for high resolution Nanotech scientific tools
0.01 mG for optimum superhigh resolution STEM tools

SEMI E33-94 AC ELF EMC Standards
Level A - less than 0.25 mG
Level B - less than 0.50 mG
Level C - less than 1.00 mG
Level D - less than 2.00 mG
Level E - 2.0 mG and greater

Figure #2, NSLS-II Brookhaven National Labs Proposed Site Profile Plots of Hatch Data AC ELF Magnetic Flux Density Levels @ 1-meter - Upton, Long Island, New York

Refer To Figure #1 for Hatch Plots of Profile Data

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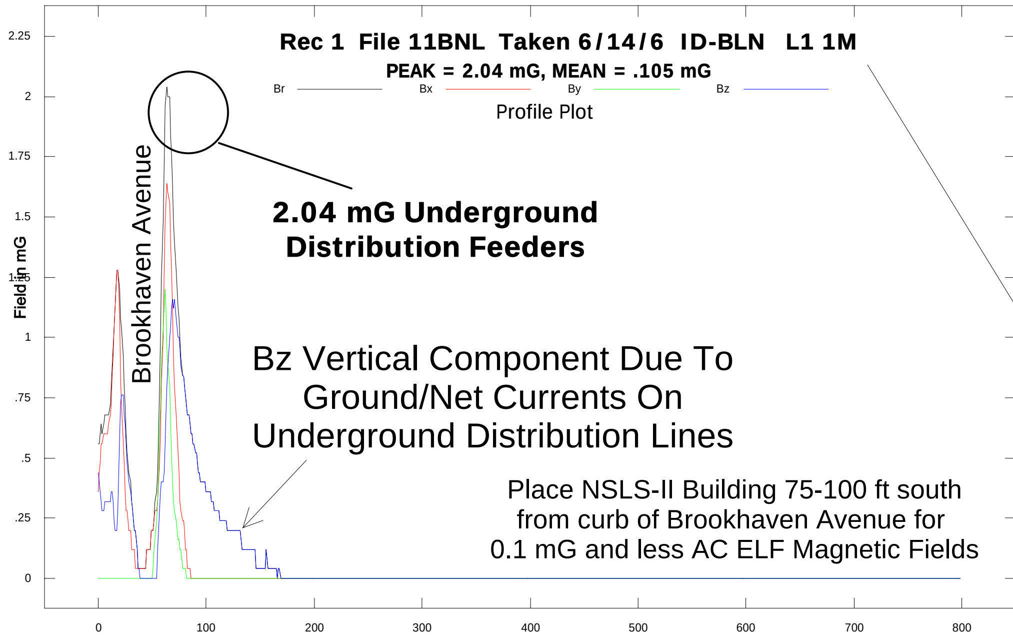

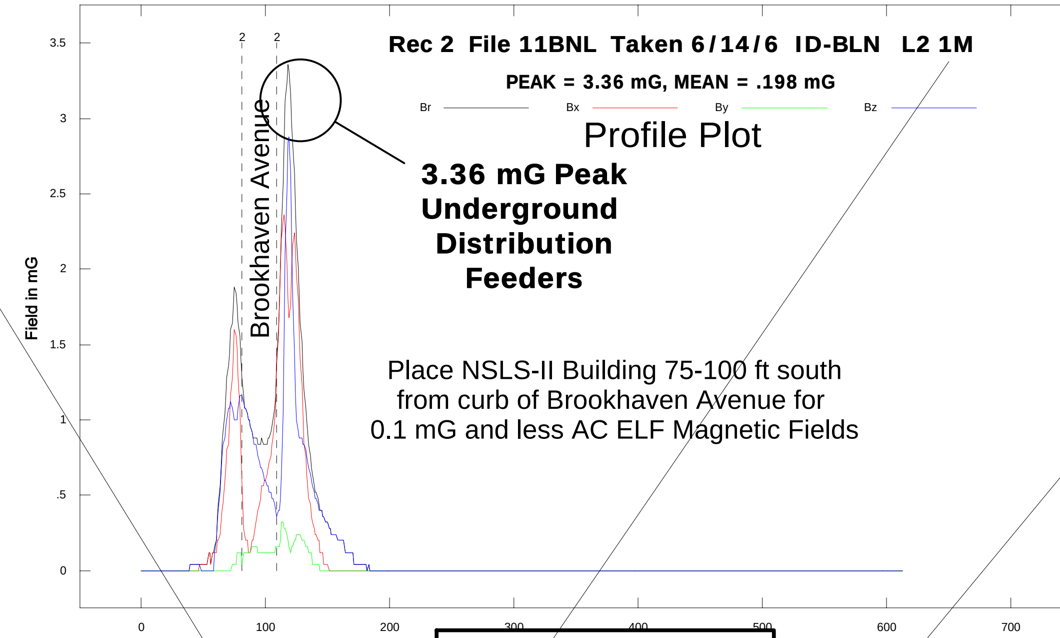

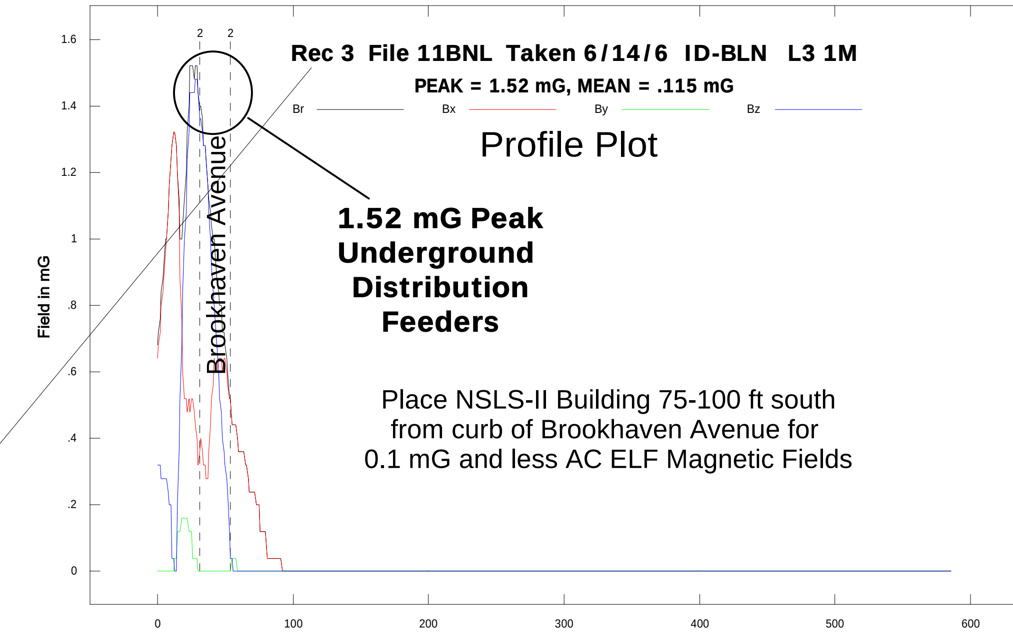

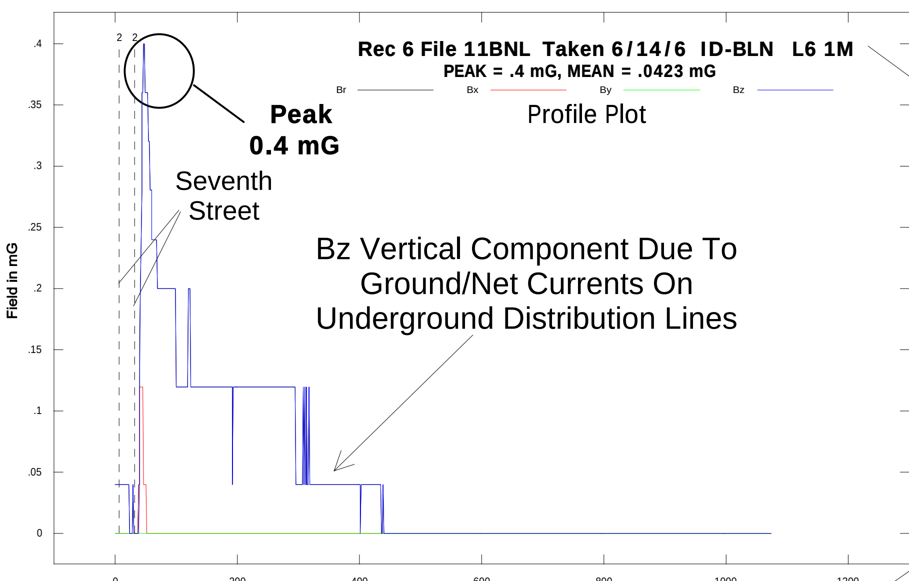

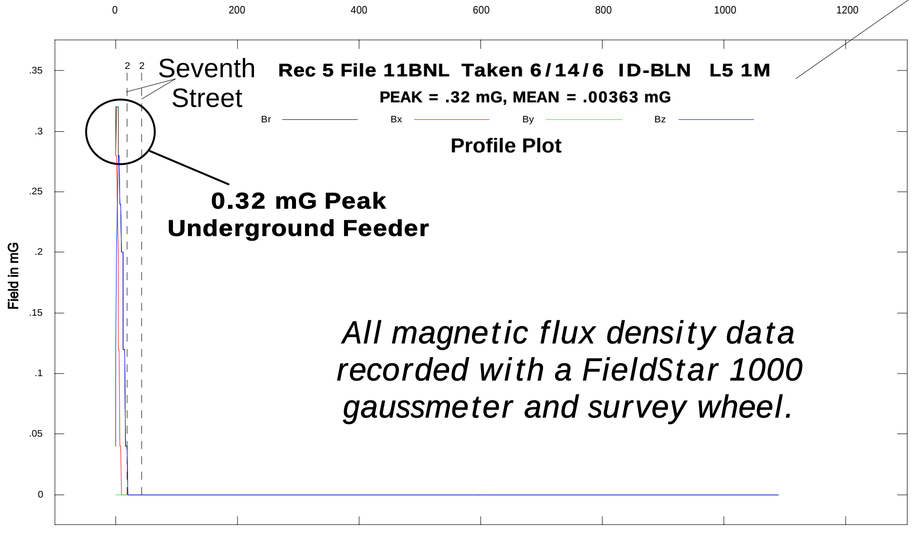

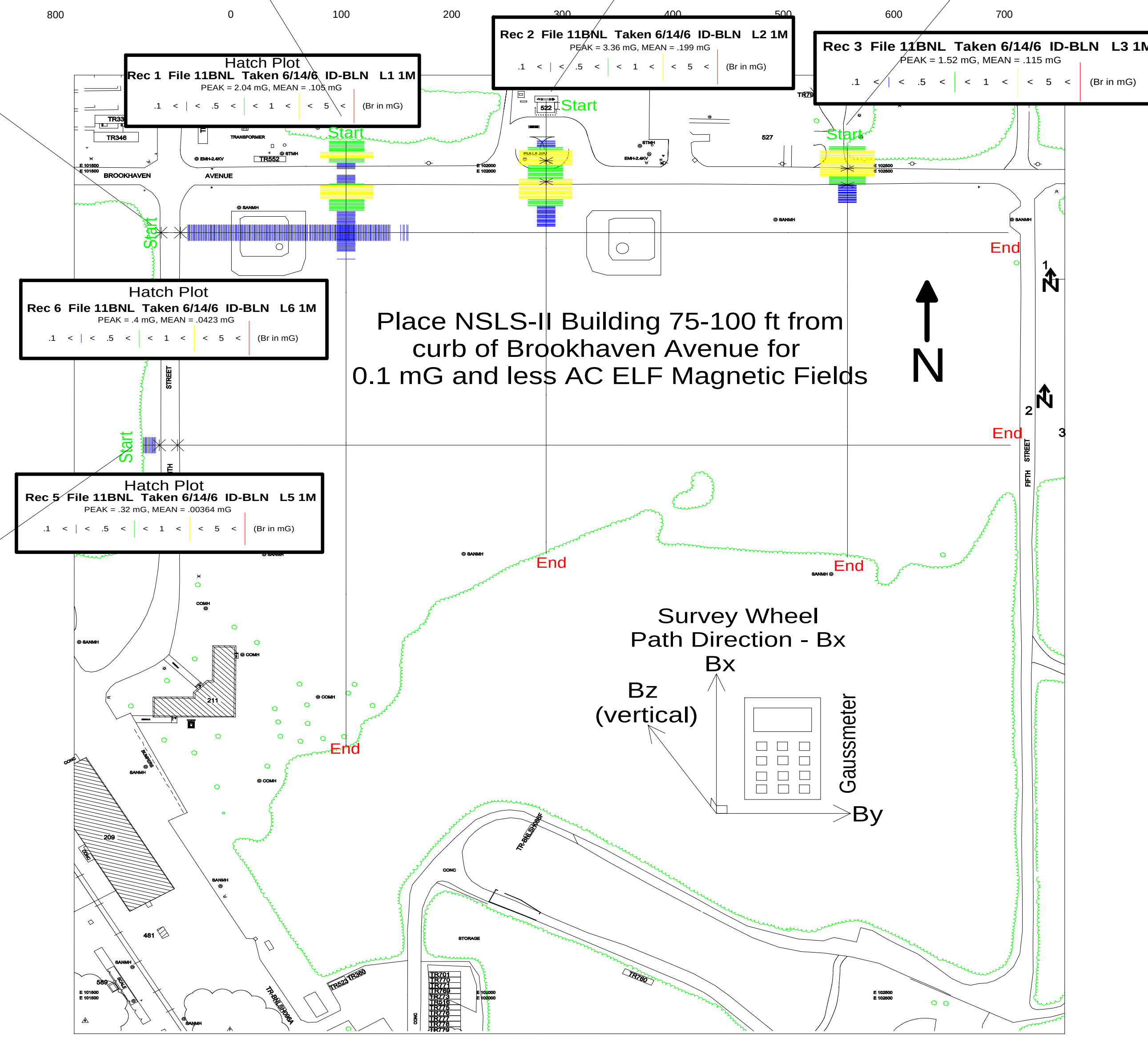

EMI AC & DC Magnetic Field Performance Specs

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Instrument & Quite Labs Maximum Requirement: 0.1 mG Br RMS (0.3 mG p-p)

Cleanrooms Maximum Requirement: 0.3 mG Br RMS (0.1 mG p-p)

AC ELF Magnetic Field Human Exposure Standards

NYS Public Service Commission
200 mG @ 1-meter on Edge -ROW
or 50 ft. from 69 kV poles

IRPA/INIRC
833 mG over 24 hours
General Public Exposure

ACGIH
1000 mG general public
& workers with cardia pacemakers

Swiss Bunderstat
NCRP Draft Report
10 mG from overhead/underground transmission/distribution lines, substations, etc.

AC ELF EMI Thresholds (screen jitter & noise)

10 mG for 12-15 inch CRT computer monitors & audio/video equipment
5 mG for 17-21 inch CRT monitors & medical (i.e., EEGs, ECGs, EMGs,. etc.).
1.0 mG for standard scientific tools (STEMs, TEMs, FIB, I-Beam, etc.)
0.1- 0.3 mG for high resolution Nanotech scientific tools
0.01 mG for optimum superhigh resolution STEM tools

SEMI E33-94 AC ELF EMC Standards
Level A - less than 0.25 mG
Level B - less than 0.50 mG
Level C - less than 1.00 mG
Level D - less than 2.00 mG
Level E - 2.0 mG and greater

Figure #3, NSLS-II Brookhaven National Labs Proposed Site
Timed AC ELF (0.3 Hz - 3,000 Hz) Magnetic Flux Density Levels @ 1-meter
Upton, Long Island, New York

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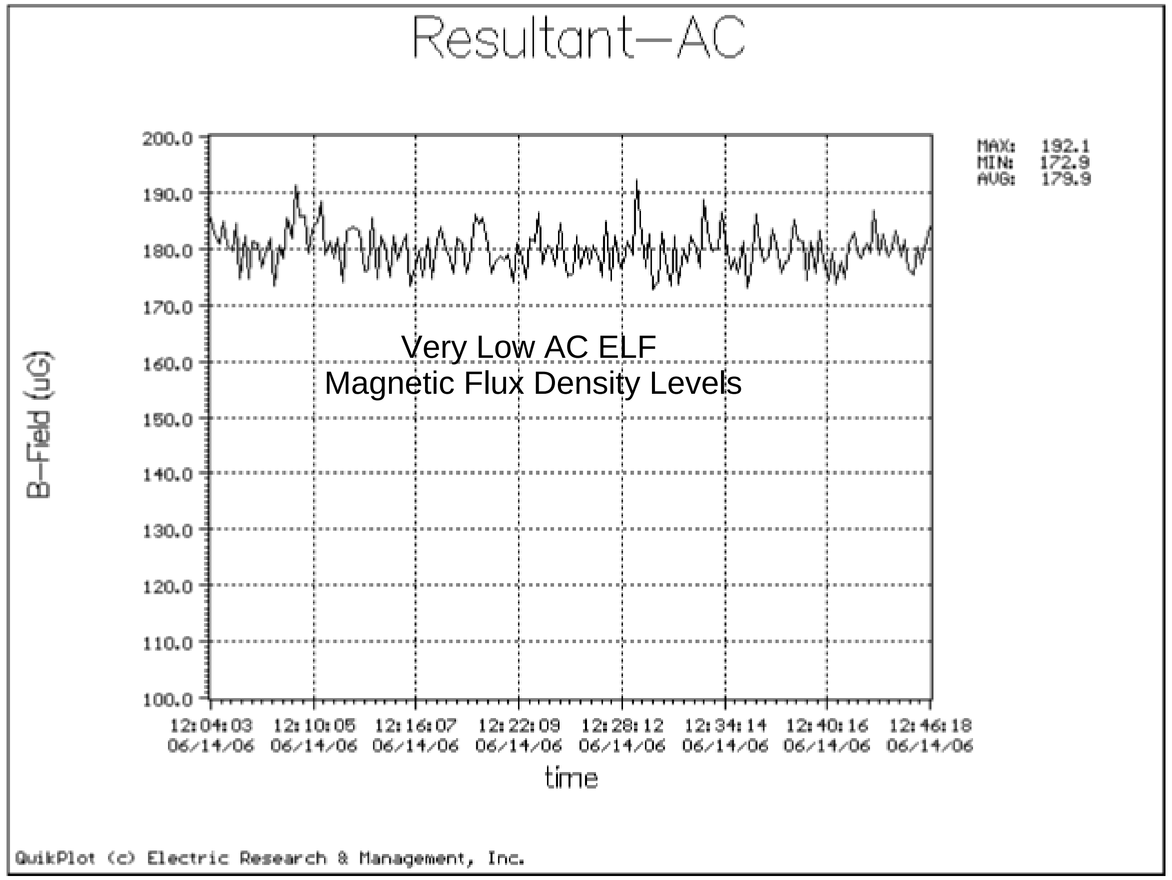

AC ELF Magnetic Field Human Exposure Standards

NYS Public Service Commission
200 mG @ 1-meter on Edge -ROW
or 50 ft. from 69 kV poles

IRPA/INIRC
833 mG over 24 hours
General Public Exposure

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1000 mG general public
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Swiss Bunderstat
NCRP Draft Report
10 mG from overhead/underground transmission/distribution lines, substations, etc.

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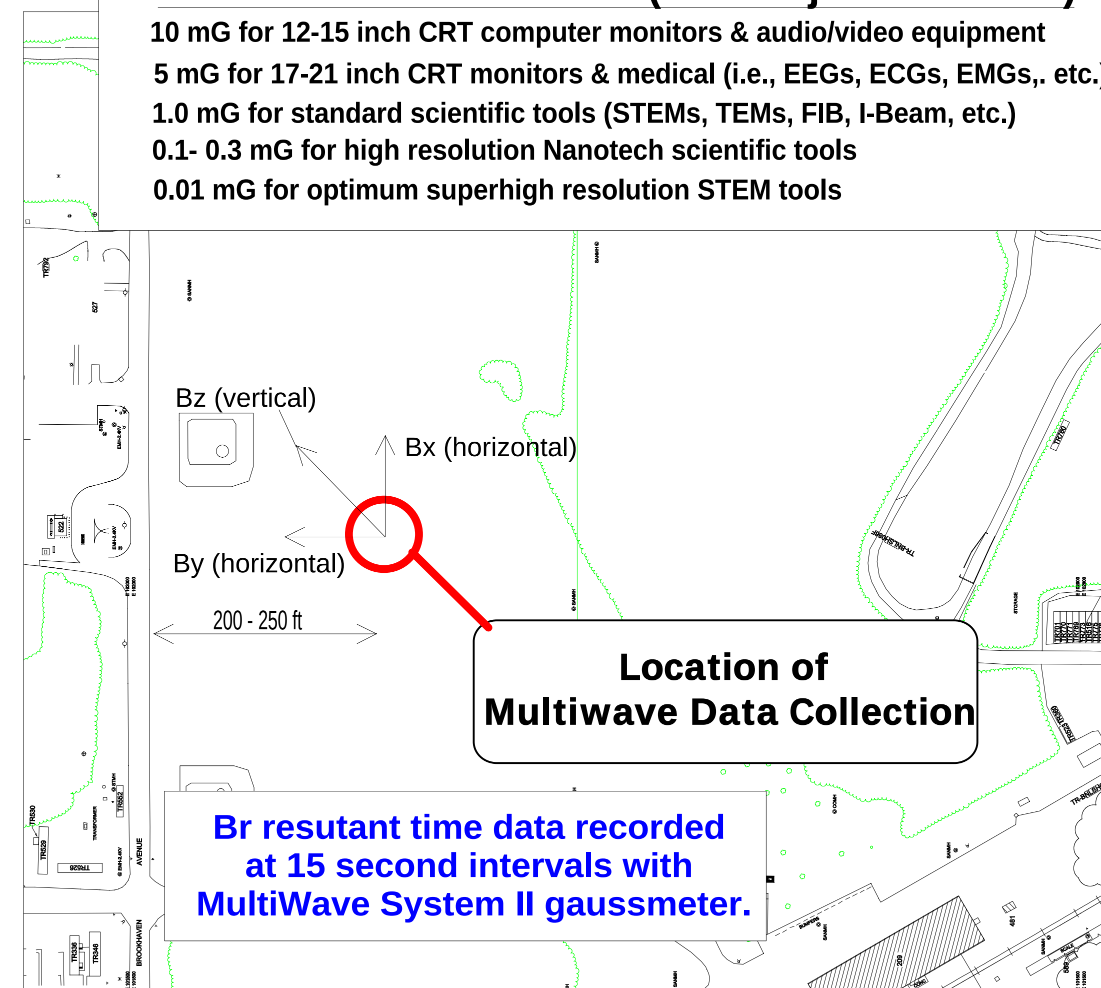
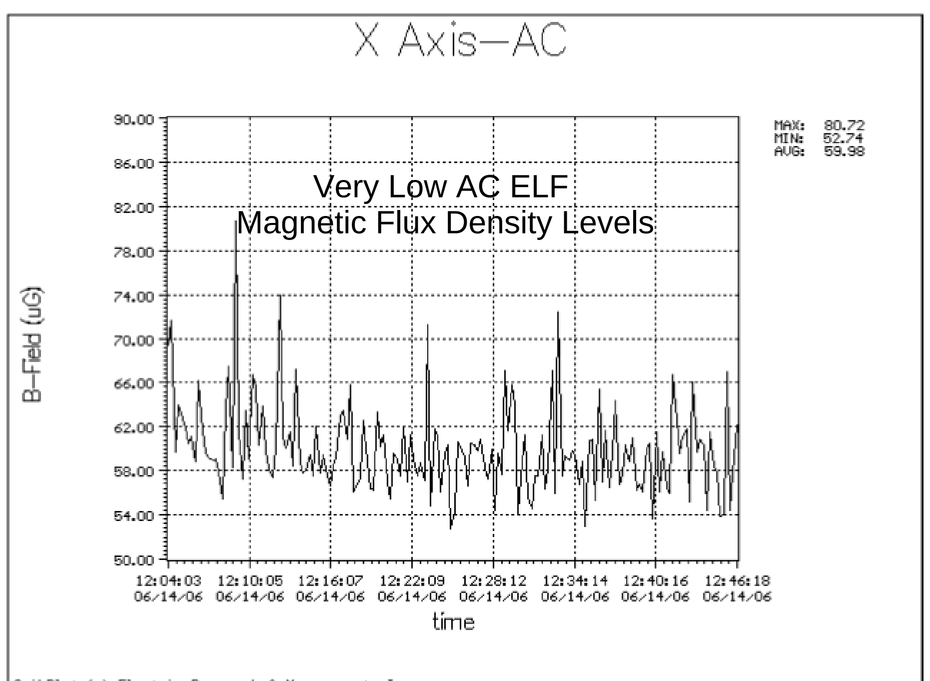
Instrument & Quite Labs Maximum Requirement:
0.1 mG Br RMS (0.3 mG p-p)

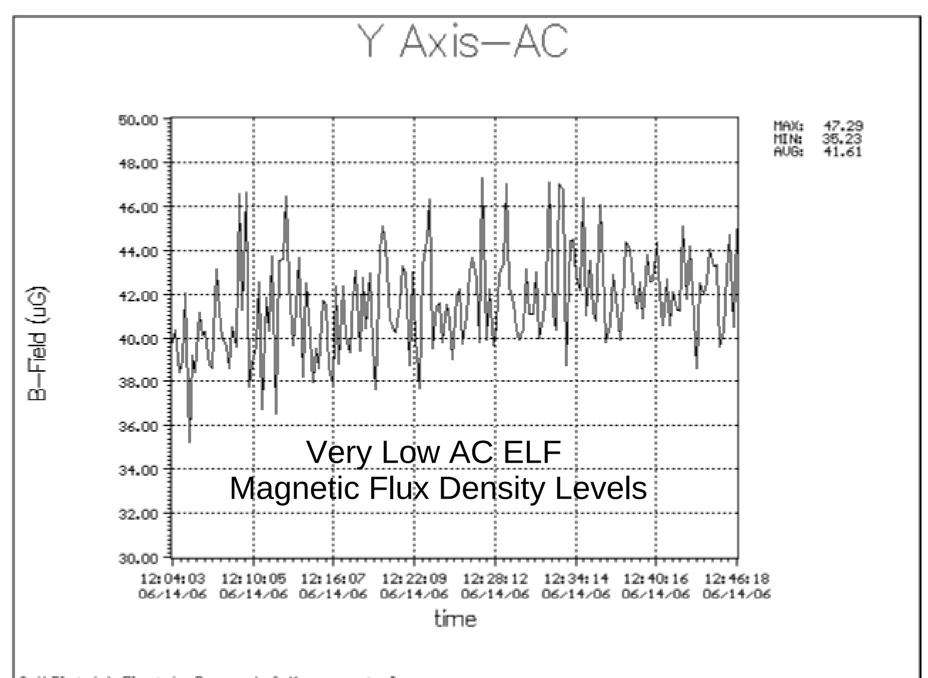
Cleanrooms Maximum Requirement:
0.3 mG Br RMS (0.1 mG p-p)

AC ELF EMI Thresholds (screen jitter & noise)

10 mG for 12-15 inch CRT computer monitors & audio/video equipment
5 mG for 17-21 inch CRT monitors & medical (i.e., EEGs, ECGs, EMGs,. etc.).
1.0 mG for standard scientific tools (STEMs, TEMs, FIB, I-Beam, etc.)
0.1- 0.3 mG for high resolution Nanotech scientific tools
0.01 mG for optimum superhigh resolution STEM tools







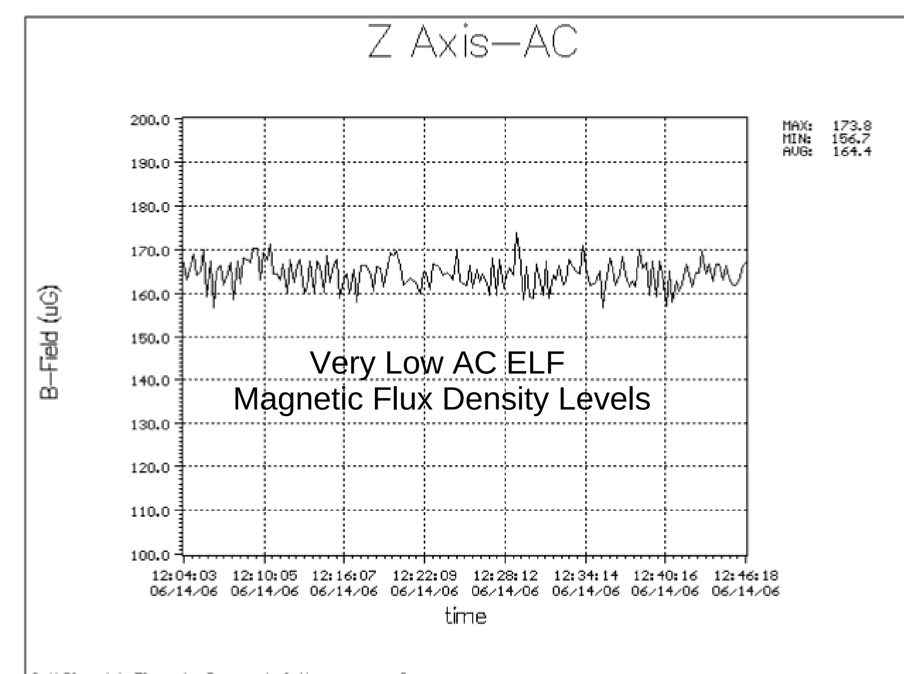


Figure #4, NSLS-II Brookhaven National Labs Proposed Site
Timed DC (0 Hz - 0.3 Hz) Magnetic Flux Density Levels @ 1-meter
Upton, Long Island, New York

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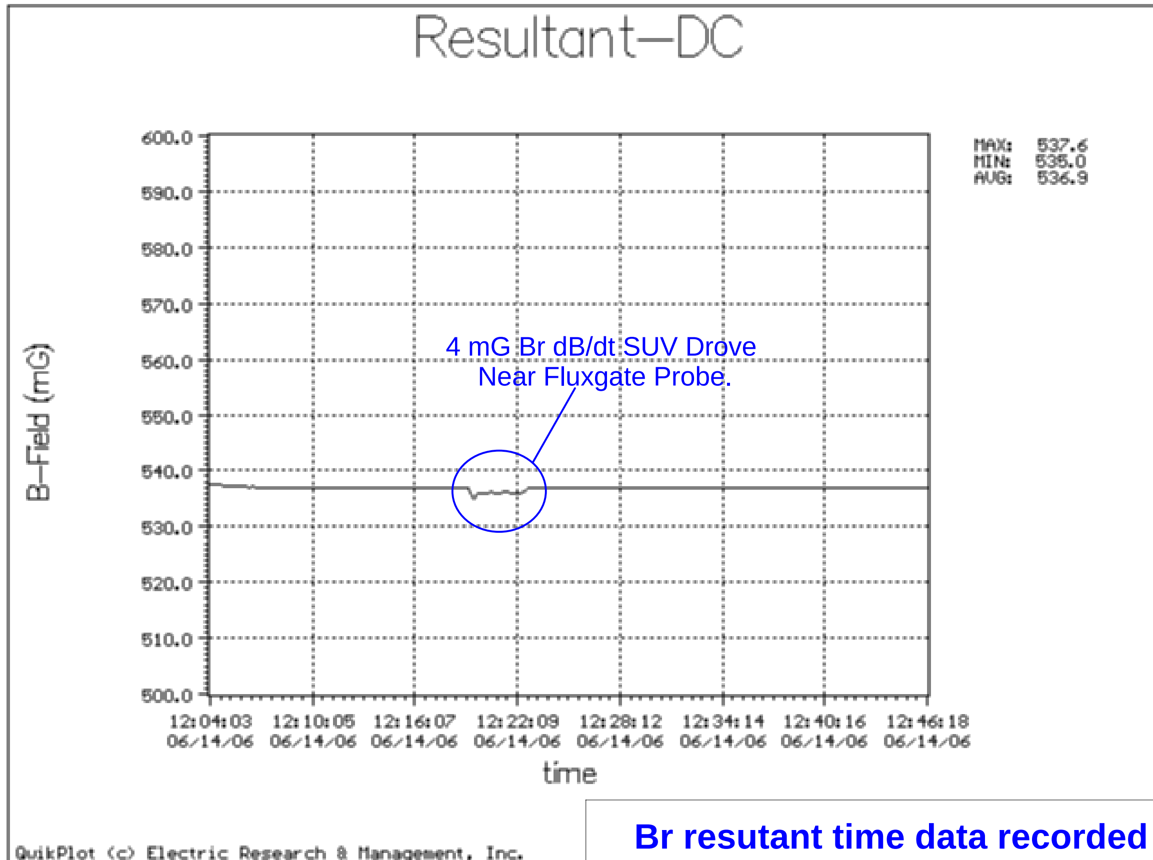
Fredericksburg, Va

DC EMI Thresholds - CRT screen shift, noise & coercivity (data errors)

0.001 Gauss & Less SEMs, TEMs E-Beam/FIB Writers
0.75 Gauss CRT Monitors & Electronic Instruments
5 Gauss Cardiac Pacemakers & Implantable Devices Warning Sign
10 Gauss Credit Cards & Magnetic Media Warning Sign
300 Gauss Low Coercivity Mag-Stripe Cards
700 Gauss High Coercivity Mag-Sripe Cards & Video Tapes

1000 milligauss (mG) = 1 Gauss (G) & 1 mG = 0.001 G = 0.1 uT (microtesla)

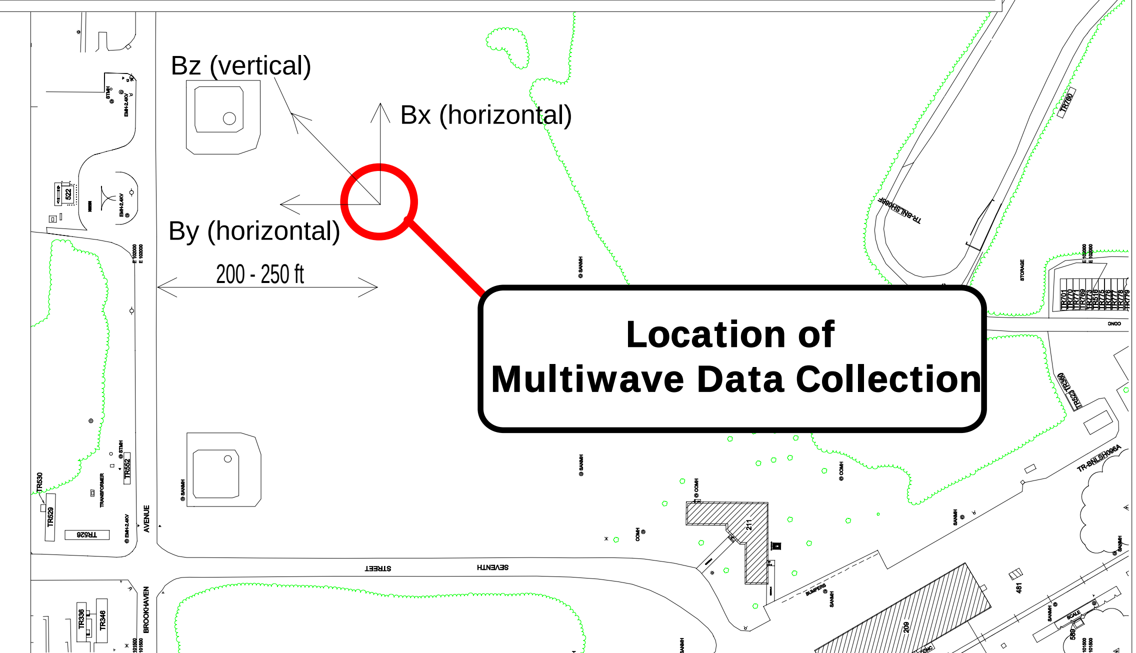


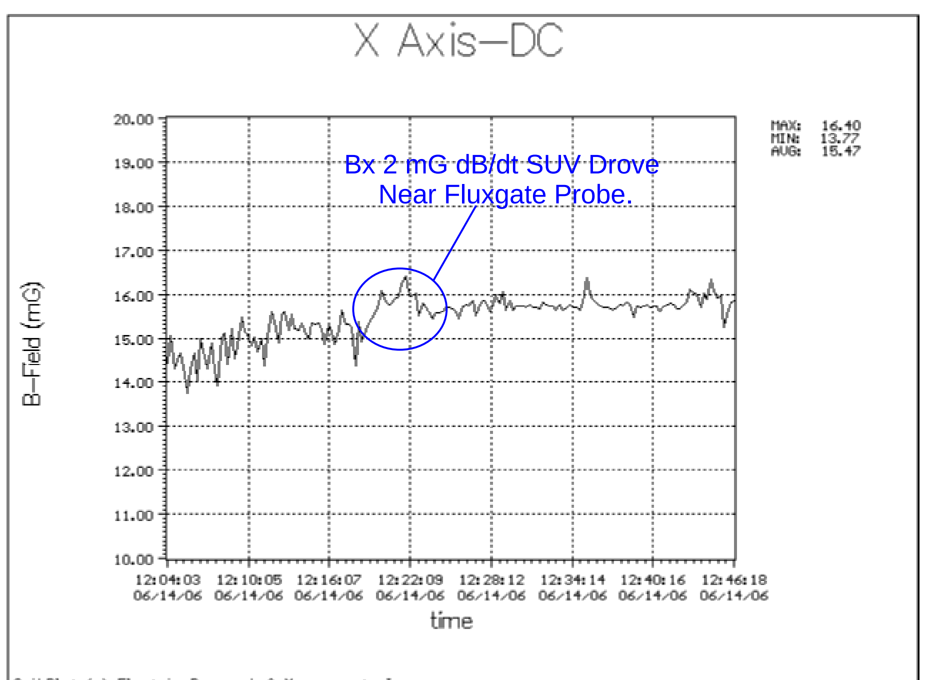
Br resutant time data recorded at 15 second intervals with MultiWave System II gaussmeter.

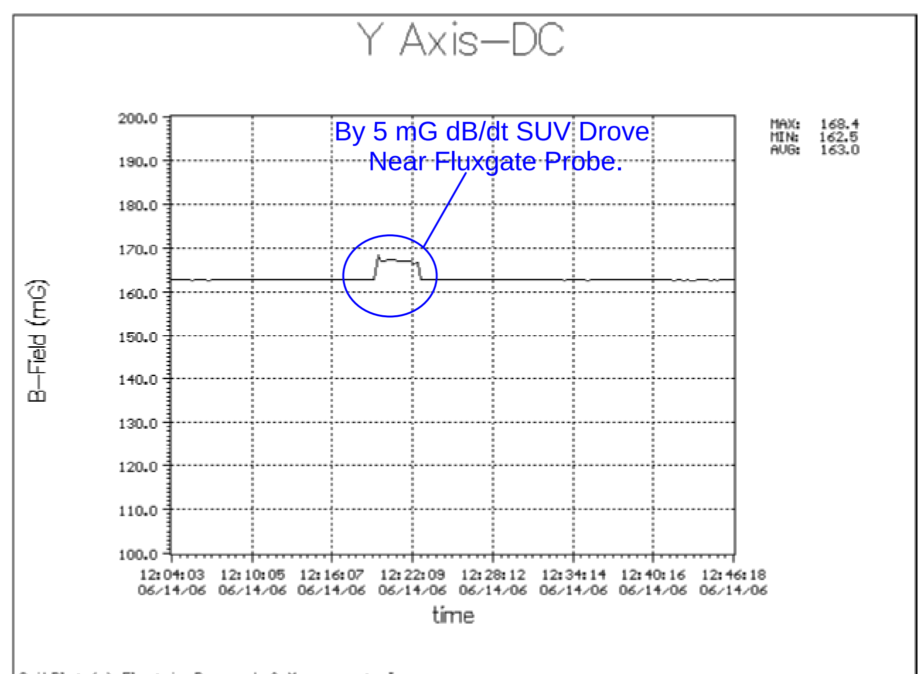
EMI AC & DC Magnetic Field Performance Specs
NMR Maximum Requirement:
1 mG Br RMS (2.83 mG p-p)

Instrument & Quite Labs Maximum Requirement:
0.1 mG Br RMS (0.3 mG p-p)

Cleanrooms Maximum Requirement:
0.3 mG Br RMS (0.1 mG p-p)







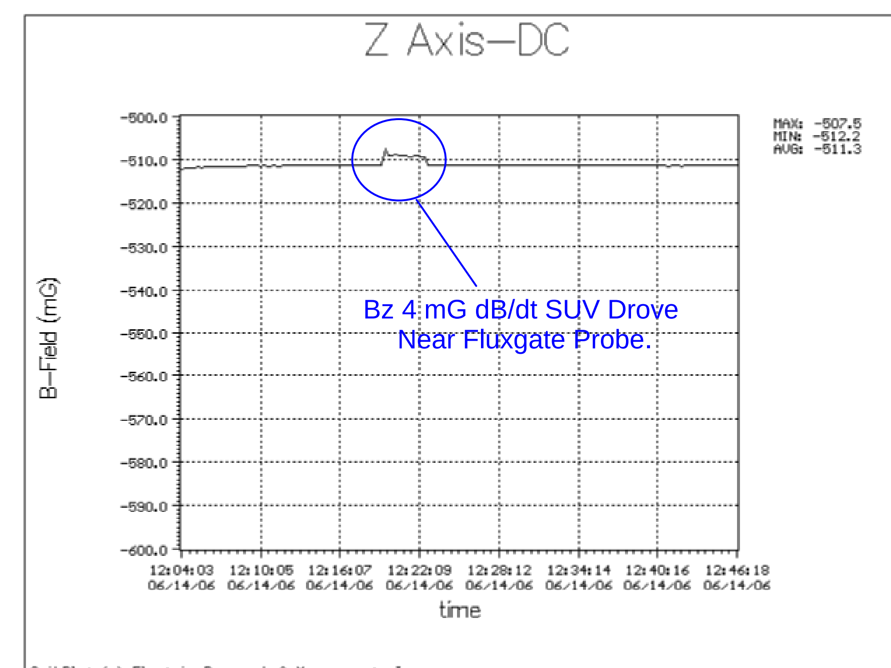
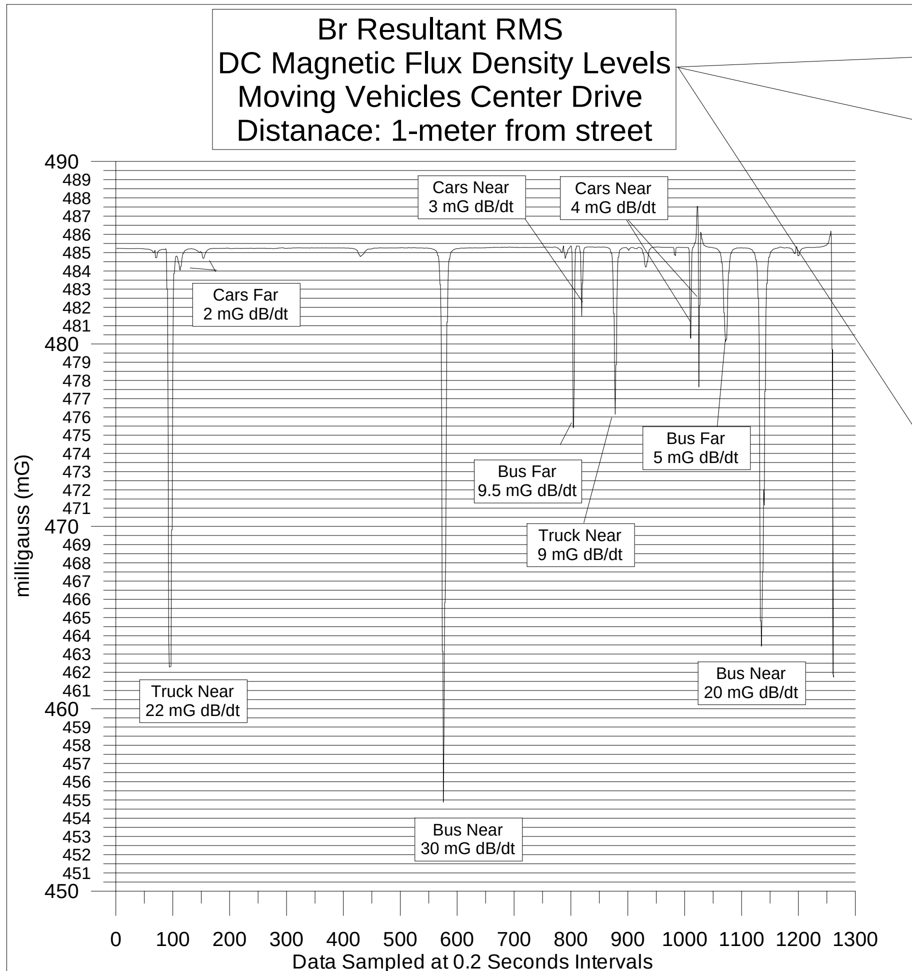
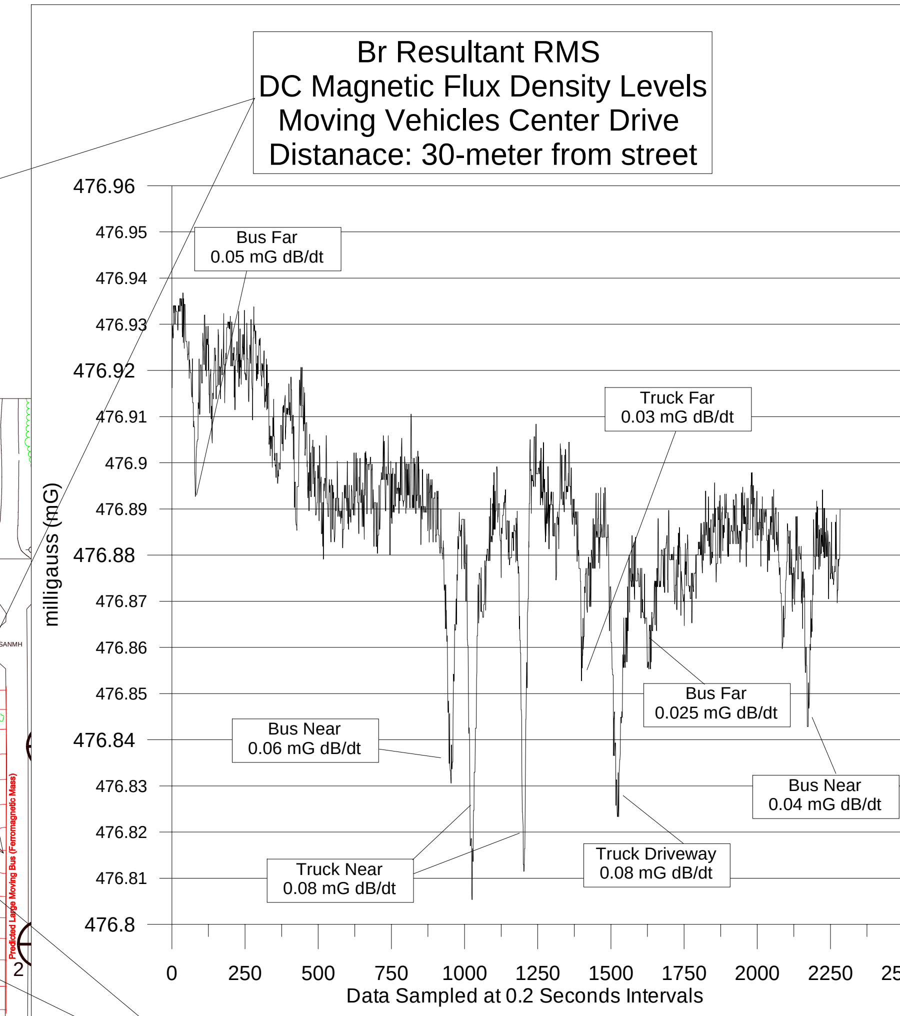
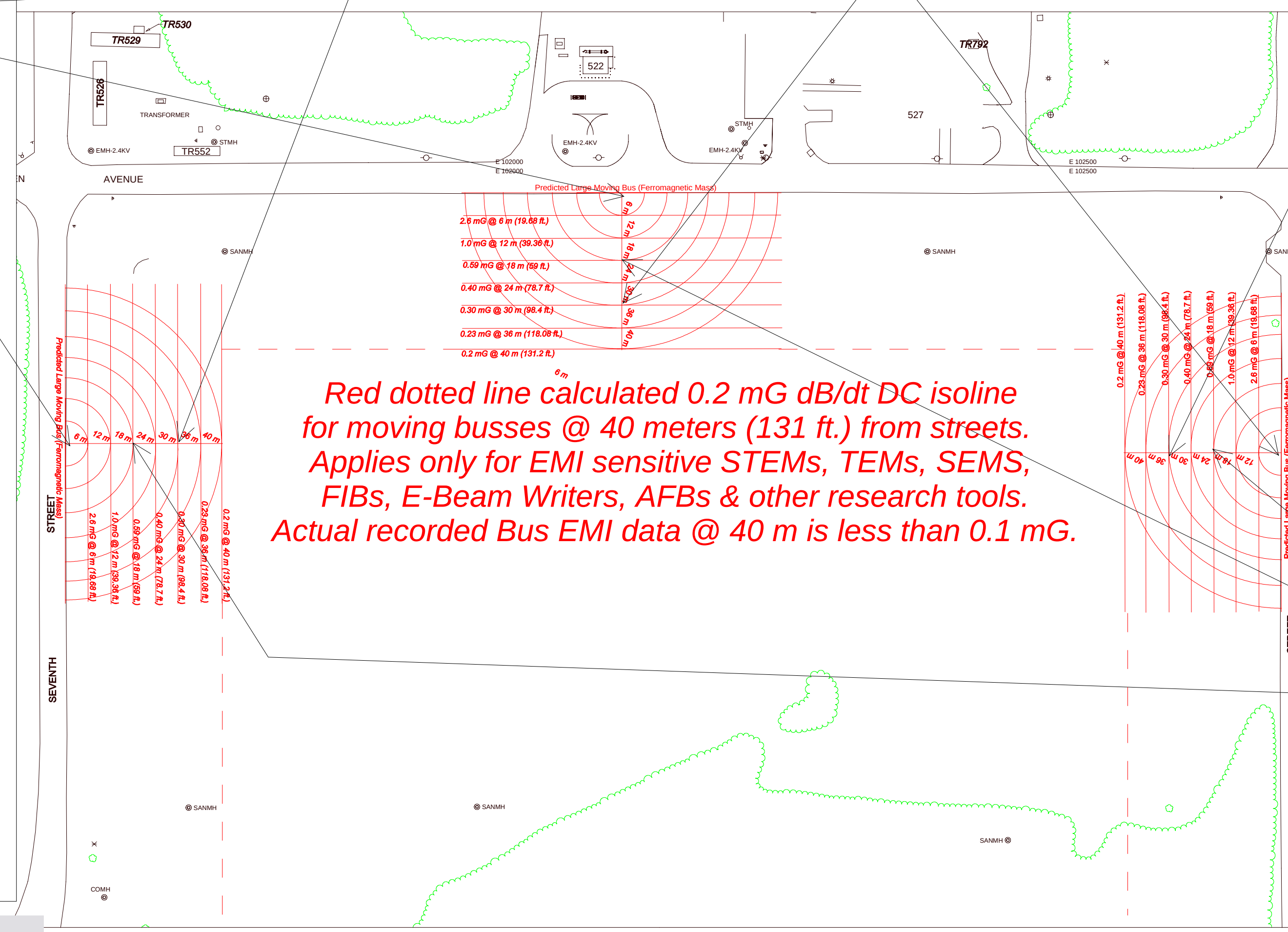


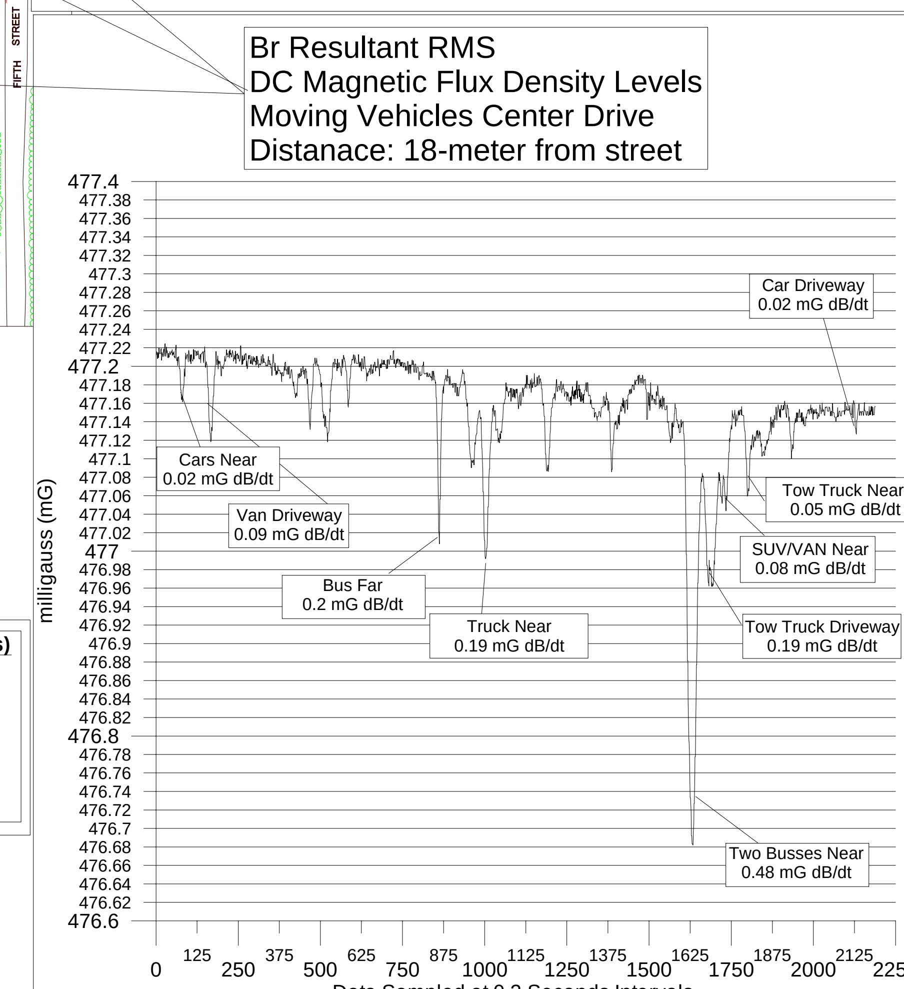
Figure #5, Comparison Recorded & Predicted Moving Vehicle DC Magnetic Emissions
DC magnetic flux density data recorded at 0.2 second intervals
University of Florida DC EMI Data
Nanoscience Institute for Medical & Engineering Technology (NIMET)
Nanoscale Research Facility (NRF), University of Florida
Overlayed on NSLS-II Brookhaven National Labs Proposed Site

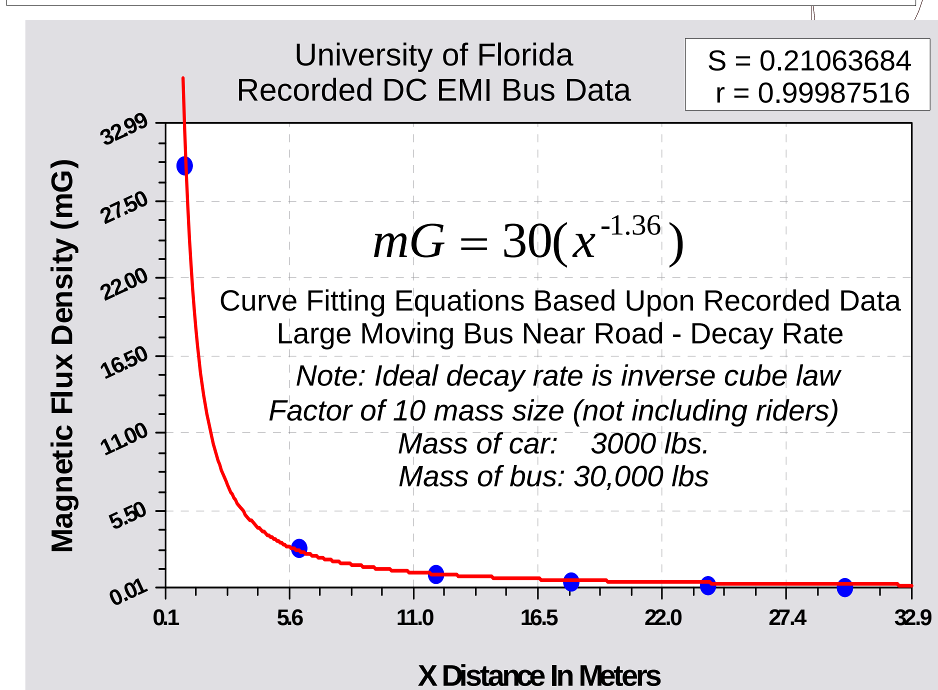
Timed DC magnetic flux density levels recorded with MEDA FVM-400 three-axis fluxgate magnetometer (bandwidth DC - 5 Hz and 0.01 mG resolution, 1200 mG maximum) Data recorded on October 6, 2004











Calculated Vehicle Profiles

Distance	Car	Bus
1 m	3.50 mG	30.0 mG
6 m	0.48 mG	2.6 mG
12 m	0.22 mG	1.0 mG
18 m	0.15 mG	0.59 mG
24 m	0.11 mG	0.40 mG
30 m	0.08 mG	0.30 mG
36 m	0.07 mG	0.23 mG
40 m	0.06 mG	0.20 mG

Special Note: magnetic fields decay more rapidly after 30 meters than the calculated levels indicate.

DC EMI Thresholds - CRT screen shift, noise & coercivity (data errors)
0.001 Gauss & Less SEMs, TEMs E-Beam/FIB Writers
0.75 Gauss CRT Monitors & Electronic Instruments
5 Gauss Cardiac Pacemakers & Implantable Devices Warning Sign
10 Gauss Credit Cards & Magnetic Media Warning Sign
300 Gauss Low Coercivity Mag-Stripe Cards
700 Gauss High Coercivity Mag-Sripe Cards & Video Tapes
1000 milligauss (mG) = 1 Gauss (G) & 1 mG = 0.001 G = 0.1 uT (microtesla)

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Fredericksburg, VA
July 20, 2006

Figure #6, NSLS-II Brookhaven National Labs Proposed Site
100 kHz to 18 GHz Timed RF Electric Field Strength Data
Upton, Long Island, New York

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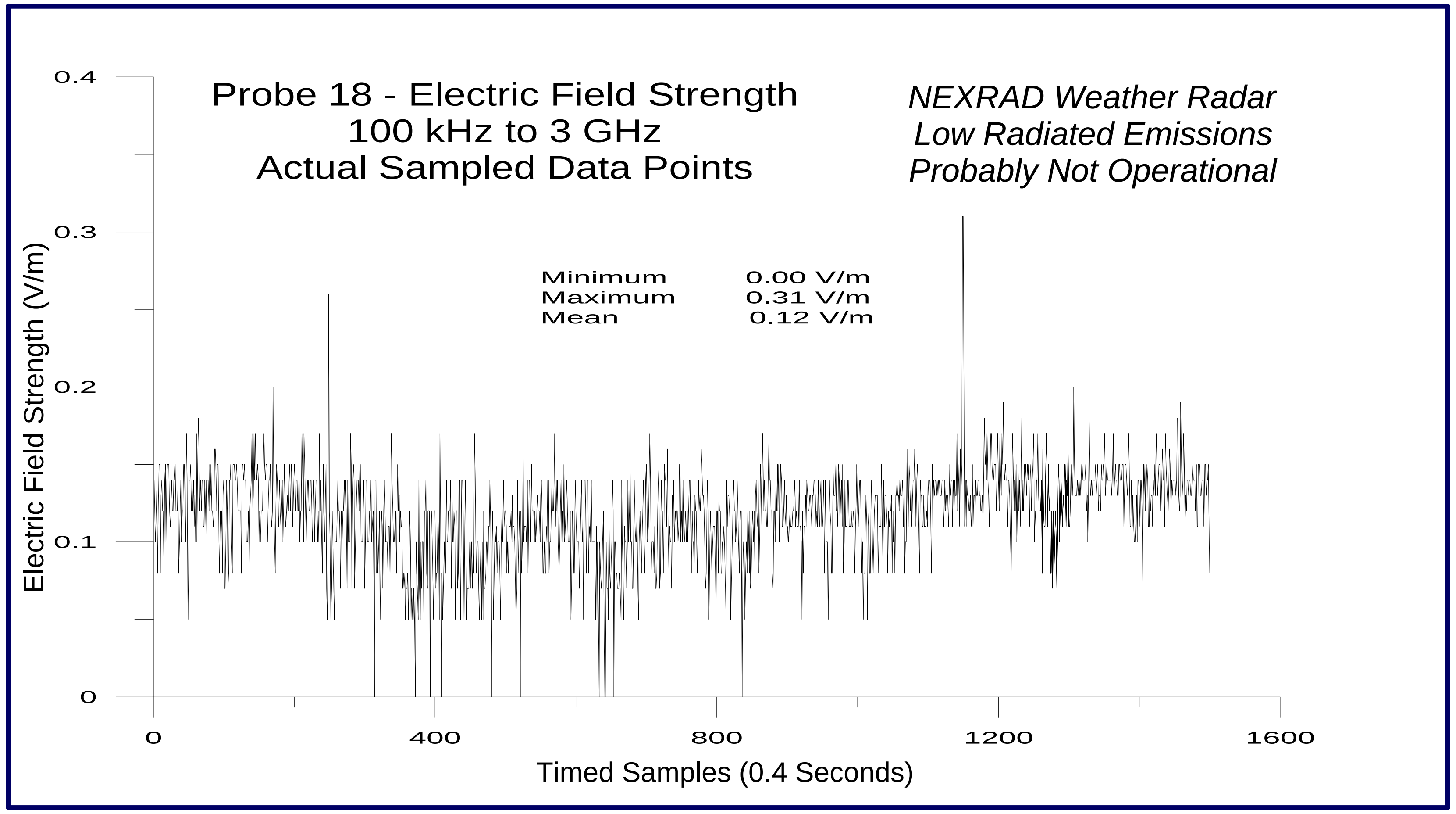
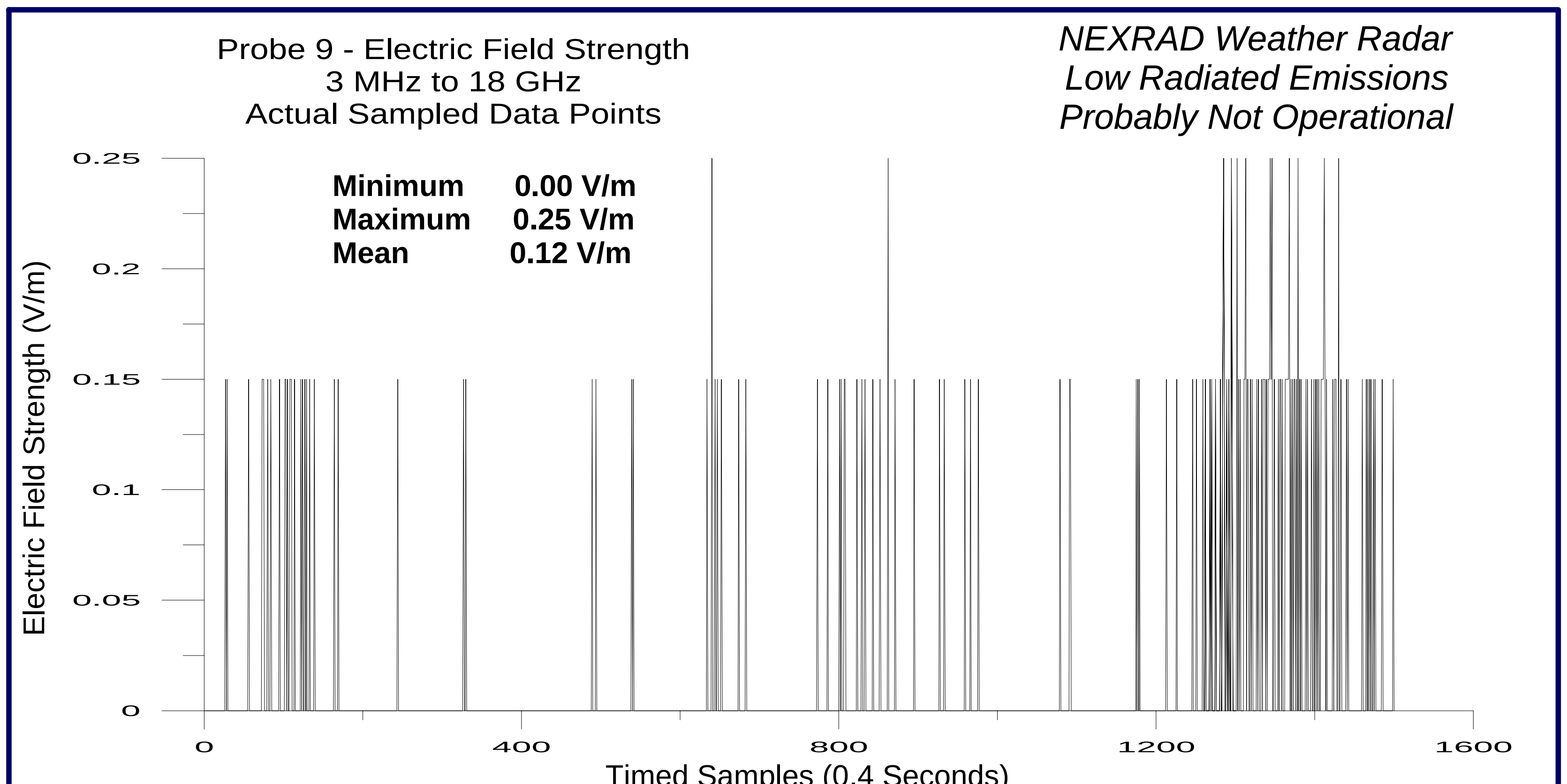
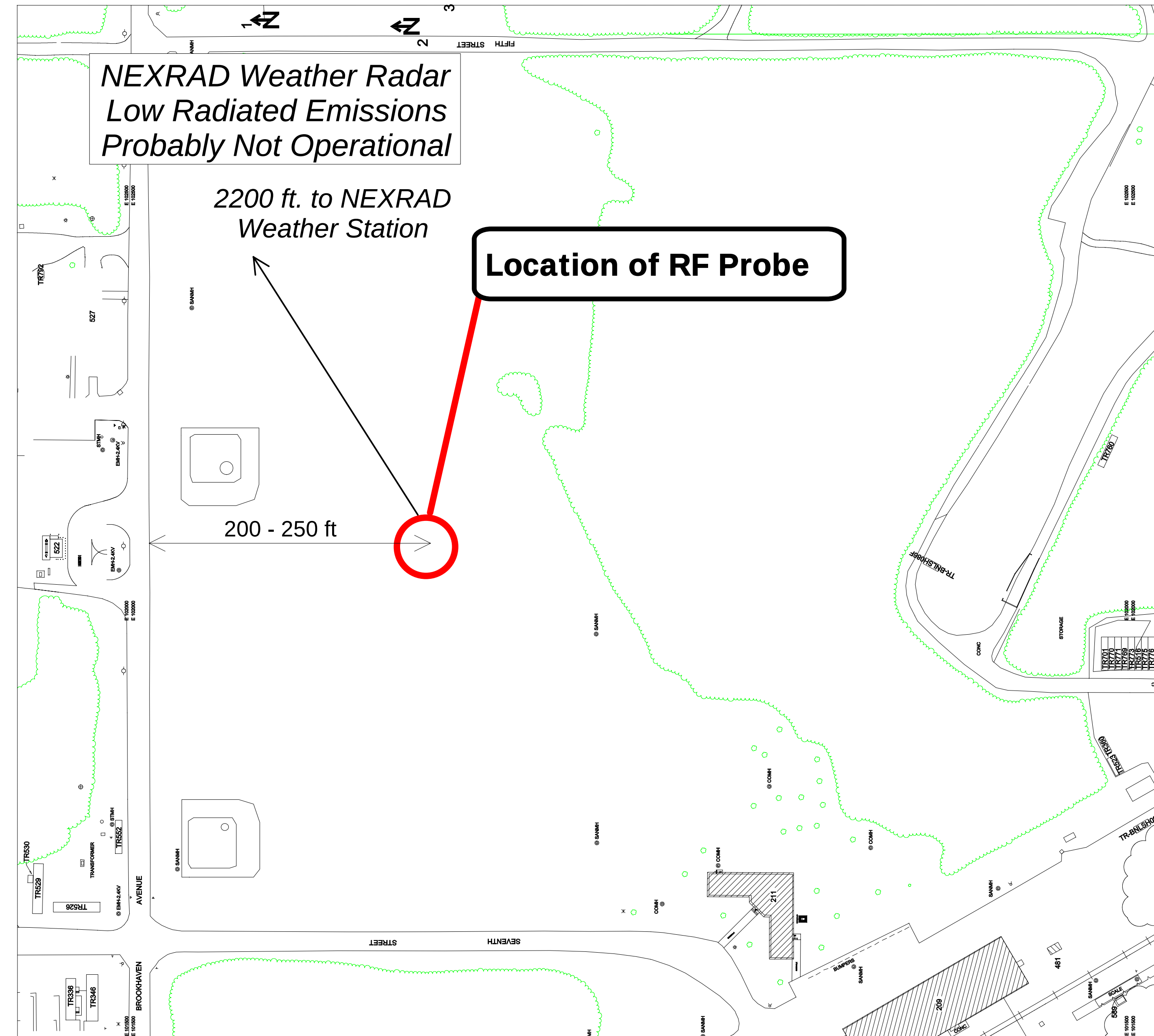
Fredericksburg, Va







Electric field strength RF levels were recorded in volts-per-meter (V/m) for 10 minutes sampled at 0.04-second intervals with a Narda ERM-300 electric field meter using a Probe 18 from 100 kHz to 3 Ghz (range of 0.2 to 320 V/m) and Probe 9C from 3 MHz to 18 GHz (range of 0.5 to 1000 V/m). The objective is to investigate sources of radio-frequency interference (RFI) over a wide bandwidth. It should be noted that 3 V/m is the industry standard RFI threshold and 1 V/m the medical/scientific instrument RFI threshold.

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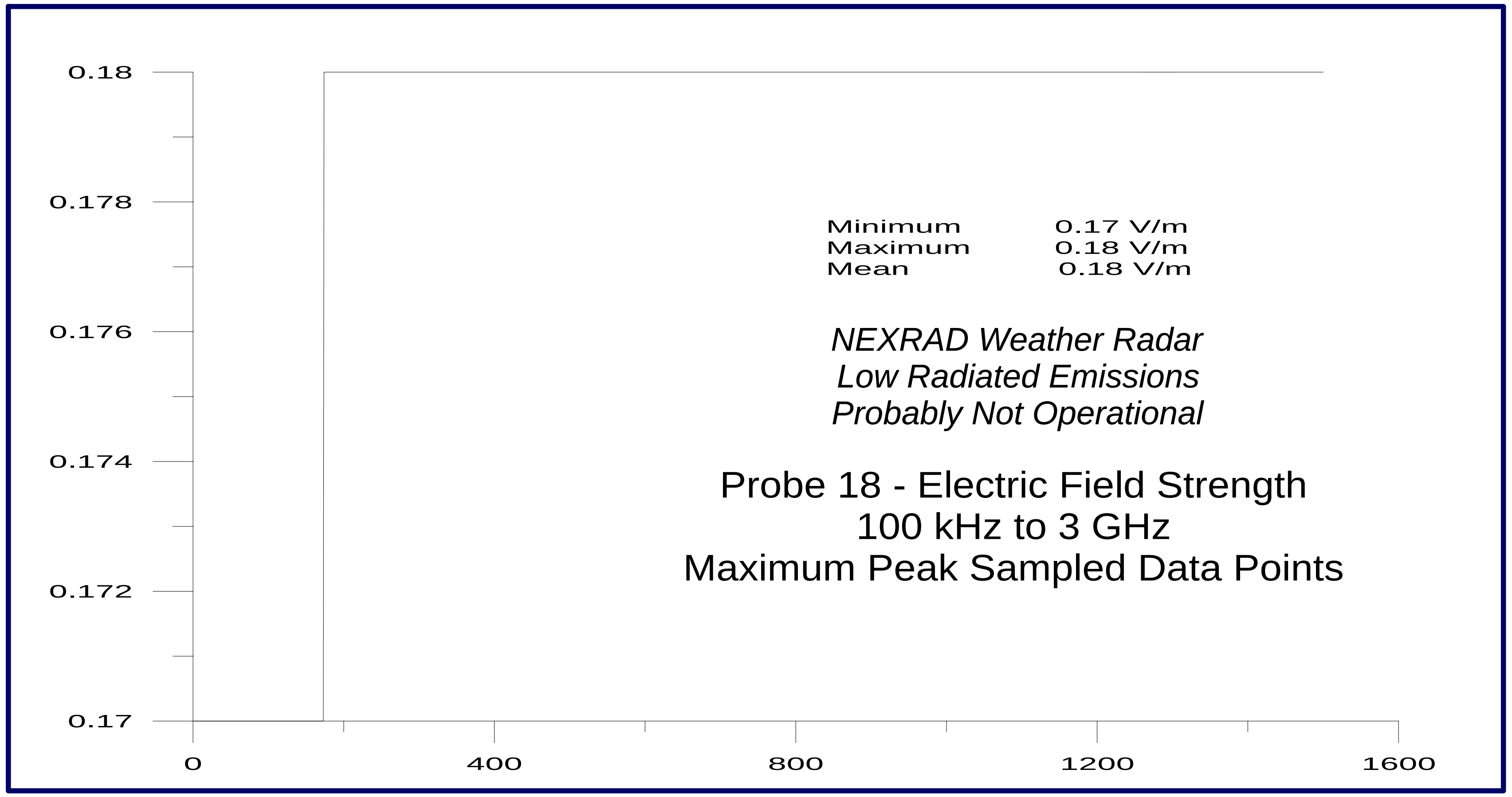
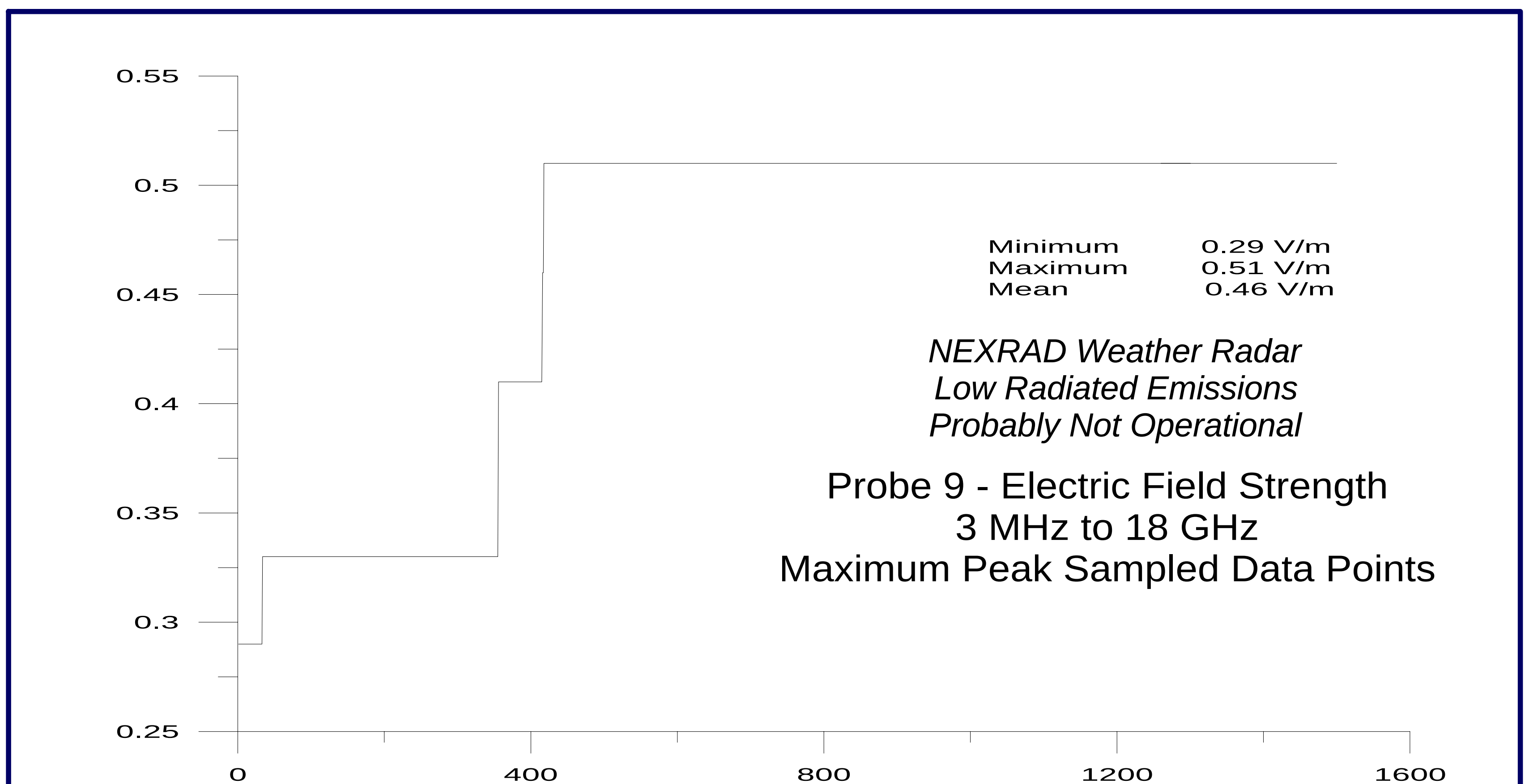
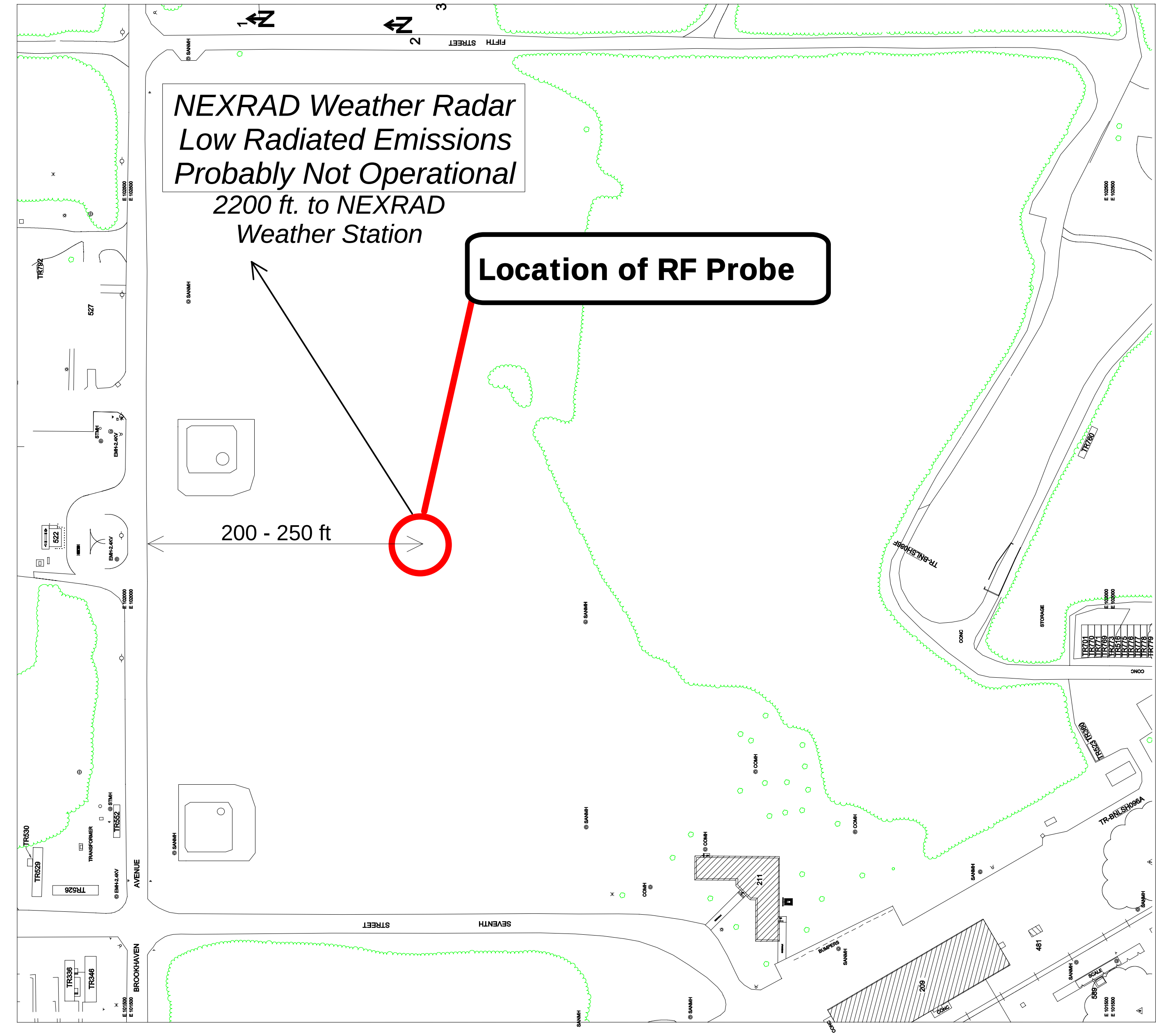
Figure #7, NSLS-II Brookhaven National Labs Proposed Site
100 kHz to 18 GHz Timed RF Maximum Electric Field Strength Data
Upton, Long Island, New York

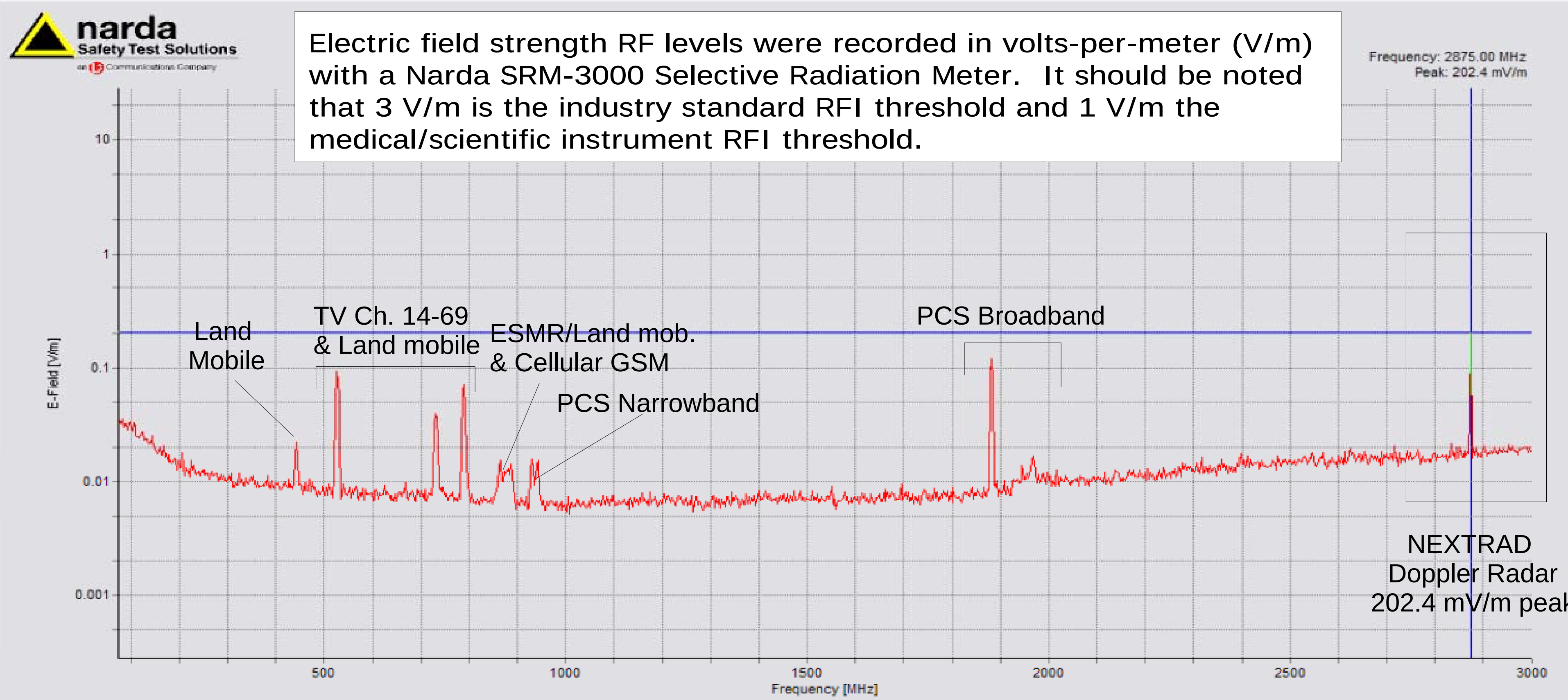






Electric field strength RF levels were recorded in volts-per-meter (V/m) for 10 minutes sampled at 0.04-second intervals with a Narda ERM-300 electric field meter using a Probe 18 from 100 kHz to 3 Ghz (range of 0.2 to 320 V/m) and Probe 9C from 3 MHz to 18 GHz (range of 0.5 to 1000 V/m). The objective is to investigate sources of radio-frequency interference (RFI) over a wide bandwidth. It should be noted that 3 V/m is the industry standard RFI threshold and 1 V/m the medical/scientific instrument RFI threshold.

Electric field strength RF levels were recorded in volts-per-meter (V/m) with a Narda SRM-3000 Selective Radiation Meter. It should be noted that 3 V/m is the industry standard RFI threshold and 1 V/m the medical/scientific instrument RFI threshold.



Spectrum Analysis 75 MHz to 3 GHz

Peak Chart By Frequency & Level

Index	Frequency	Level
1	2875.00 MHz	202.4 mV/m
2	1882.32 MHz	120.5 mV/m
3	525.70 MHz	97.07 mV/m
4	789.27 MHz	73.45 mV/m
5	730.69 MHz	39.49 mV/m
6	82.26 MHz	35.32 mV/m
7	97.02 MHz	33.77 mV/m
8	105.52 MHz	33.09 mV/m
9	88.52 MHz	32.23 mV/m
10	123.96 MHz	27.72 mV/m
11	142.63 MHz	25.48 mV/m
12	114.28 MHz	24.84 mV/m
13	130.42 MHz	23.77 mV/m
14	137.95 MHz	21.93 mV/m
15	442.51 MHz	21.88 mV/m
16	2835.09 MHz	21.26 mV/m
17	2952.94 MHz	20.85 mV/m
18	2715.16 MHz	20.76 mV/m
19	2902.43 MHz	20.65 mV/m
20	2960.11 MHz	20.62 mV/m

Dataset Type	SPEC
Store Mode	MAN
Date	09/19/2006
Time	10:02:18
Minimum Frequency [Hz]	75 MHz
Maximum Frequency [Hz]	3 GHz
Resolution Bandwidth [Hz]	5 MHz
Measurement Range [V/m]	2.5 V/m
Unit	V/m
Result Type	MAX
Number of Averages	64
Average Flag	OK
Overdrive Flag	OK
Threshold [V/m]	25 µV/m
Y-Scale Reference [V/m]	28 V/m
Y-Scale Range [dB]	100
Axis	RSS
Standard Name	ICNIRP GP
Comment	G4
Device Serial No.	J-0016
Device Calibration Date	05/15/2006
Device Firmware Version	V1.4.10
Cable Name	
Cable Serial No.	
Cable Calibration Date	
Antenna Name	3AX 75M-3G
Antenna Serial No.	G-0147
Antenna Calibration Date	05/18/2006

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Fredericksburg, Va

RF Data Recorded 9/19/2006

Figure #2 - RF Spectrum 75 MHz - 3 GHz @ 1-meter
NSLS-II Brookhaven National Labs Proposed Site

Power Spectrum Chart By Service, Level & Frequency Band

RF Data Recorded 9/19/2006

Service	Value	Lower Frequency	Upper Frequency
FM Radio	375.5 pW/cm²	88.000 MHz	108.000 MHz
Paging	56.83 pW/cm²	152.000 MHz	159.000 MHz
TV Ch. 7-13	166.3 pW/cm²	174.000 MHz	216.000 MHz
TV Ch. 14-69	2.169 nW/cm²	470.000 MHz	806.000 MHz
SMR Tx	14.06 pW/cm²	806.000 MHz	821.000 MHz
Privat lnd mob	3.397 pW/cm²	821.000 MHz	824.000 MHz
Cellular AMPS	21.99 pW/cm²	824.000 MHz	849.000 MHz
ESMR/Land mob.	48.83 pW/cm²	849.000 MHz	869.000 MHz
Cellular AMPS	82.96 pW/cm²	869.000 MHz	894.000 MHz
aerontical mobl	2.285 pW/cm²	894.000 MHz	896.000 MHz
private lnd mob	4.556 pW/cm²	896.000 MHz	901.000 MHz
pcs narrowband	1.013 pW/cm²	901.000 MHz	902.000 MHz
land mobile&Ham	57.99 pW/cm²	902.000 MHz	930.000 MHz
pcs narrowband	2.817 pW/cm²	930.000 MHz	931.000 MHz
Paging	26.71 pW/cm²	931.000 MHz	932.000 MHz
pcs narrowband	21.94 pW/cm²	940.000 MHz	941.000 MHz
public land mob	14.88 pW/cm²	941.000 MHz	960.000 MHz
PCS Broadband	283.3 pW/cm²	1850.000 MHz	1990.000 MHz
NEXTRAD Dopple	972.4 pW/cm²	2700.000 MHz	2900.000 MHz
Others	3.874 nW/cm²		
Total	8.201 nW/cm²	88.000 MHz	2900.000 MHz

Electric field strength RF levels were recorded in volts-per-meter (V/m) with a Narda SRM-3000 Selective Radiation Meter. It should be noted that 3 V/m is the industry standard RFI threshold and 1 V/m the medical/scientific instrument RFI threshold.

Service Chart By Level & Frequency Band

Service	Value	Lower Frequency	Upper Frequency
FM Radio	37.63 mV/m	88.000 MHz	108.000 MHz
Paging	14.64 mV/m	152.000 MHz	159.000 MHz
TV Ch. 7-13	25.04 mV/m	174.000 MHz	216.000 MHz
TV Ch. 14-69	90.43 mV/m	470.000 MHz	806.000 MHz
SMR Tx	7.281 mV/m	806.000 MHz	821.000 MHz
Privat lnd mob	3.579 mV/m	821.000 MHz	824.000 MHz
Cellular AMPS	9.105 mV/m	824.000 MHz	849.000 MHz
ESMR/Land mob.	13.57 mV/m	849.000 MHz	869.000 MHz
Cellular AMPS	17.68 mV/m	869.000 MHz	894.000 MHz
aerontical mobl	2.935 mV/m	894.000 MHz	896.000 MHz
private lnd mob	4.144 mV/m	896.000 MHz	901.000 MHz
pcs narrowband	1.954 mV/m	901.000 MHz	902.000 MHz
land mobile&Ham	14.79 mV/m	902.000 MHz	930.000 MHz
pcs narrowband	3.259 mV/m	930.000 MHz	931.000 MHz
Paging	10.03 mV/m	931.000 MHz	932.000 MHz
pcs narrowband	9.094 mV/m	940.000 MHz	941.000 MHz
public land mob	7.489 mV/m	941.000 MHz	960.000 MHz
PCS Broadband	32.68 mV/m	1850.000 MHz	1990.000 MHz
NEXTRAD Dopple	60.55 mV/m	2700.000 MHz	2900.000 MHz
Others	120.8 mV/m		
Total	175.8 mV/m	88.000 MHz	2900.000 MHz

Dataset Type	TAB
Store Mode	MAN
Date	09/19/2006
Time	10:06:25
Minimum Frequency [Hz]	88 MHz
Maximum Frequency [Hz]	2.9 GHz
Measurement Range [V/m]	2.5 V/m
Unit	V/m
Result Type	MAX
Number of Averages	4
Average Flag	OK
Overdrive Flag	OK
Threshold [V/m]	25 µV/m
Display	DETAIL
Axis	RSS
Standard Name	ICNIRP GP
Service Table Name	FCC STD
Comment	G5
Device Serial No.	J-0016
Device Calibration Date	05/15/2006
Device Firmware Version	V1.4.10
Cable Name	
Cable Serial No.	
Cable Calibration Date	
Antenna Name	3AX 75M-3G
Antenna Serial No.	G-0147
Antenna Calibration Date	05/18/2006

Figure #2A - FCC Spectrum 75 MHz - 3 GHz @ 1-meter
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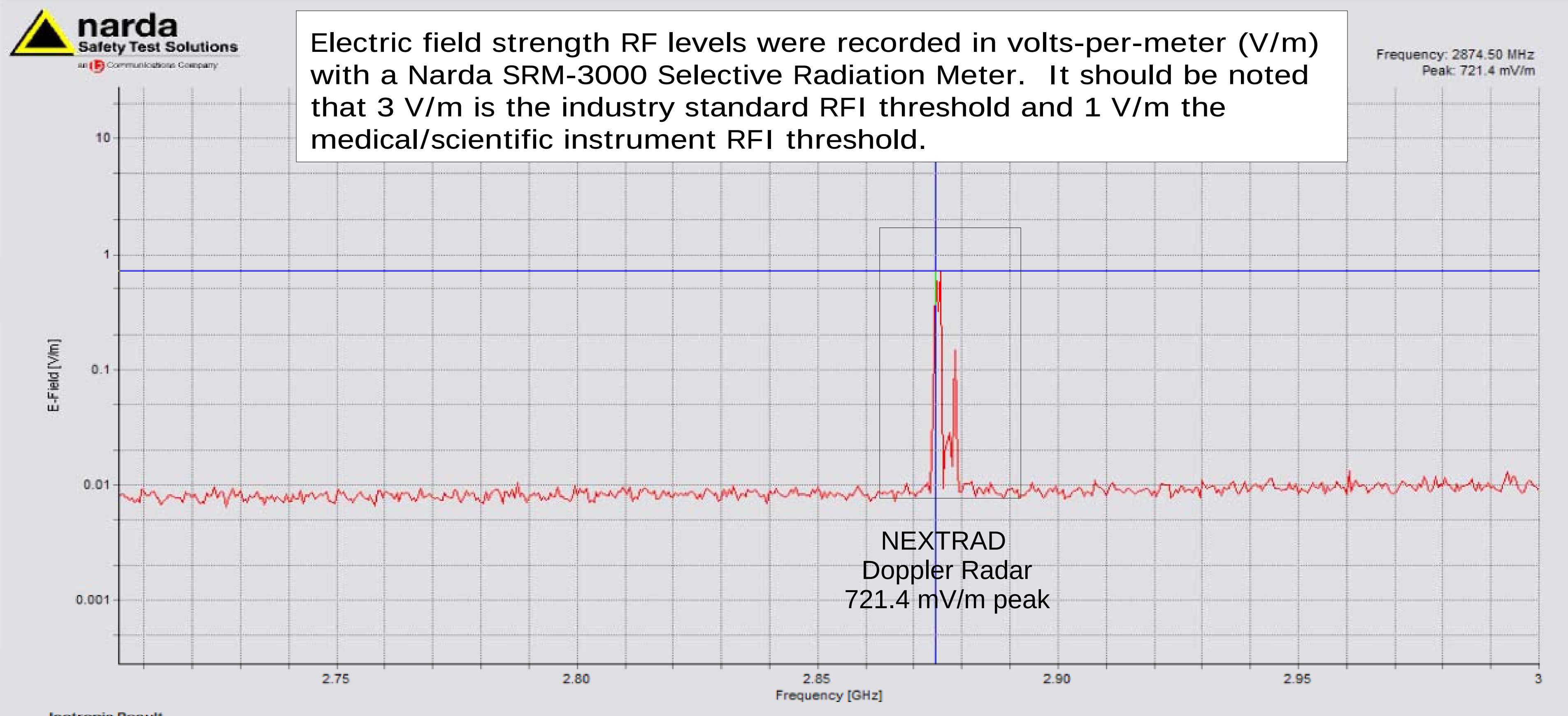

Spectrum Analysis 2.705 GHz to 3 GHz

Peak Chart By Frequency & Level

Index	Frequency	Level
1	2874.50 MHz	721.4 mV/m
2	2875.50 MHz	698.0 mV/m
3	2878.50 MHz	146.6 mV/m
4	2877.37 MHz	29.03 mV/m
5	2960.51 MHz	13.30 mV/m
6	2993.46 MHz	12.80 mV/m
7	2994.64 MHz	11.95 mV/m
8	2976.09 MHz	11.78 mV/m
9	2978.51 MHz	11.62 mV/m
10	2980.52 MHz	11.37 mV/m
11	2944.16 MHz	11.36 mV/m
12	2985.95 MHz	11.29 mV/m
13	2930.14 MHz	11.14 mV/m
14	2997.95 MHz	11.05 mV/m
15	2907.64 MHz	11.03 mV/m
16	2961.96 MHz	10.96 mV/m
17	2936.35 MHz	10.72 mV/m
18	2938.88 MHz	10.69 mV/m
19	2881.86 MHz	10.68 mV/m
20	2971.65 MHz	10.66 mV/m

Dataset Type	SPEC
Store Mode	MAN
Date	09/19/2006
Time	09:52:16
Minimum Frequency [Hz]	2.705 GHz
Maximum Frequency [Hz]	3 GHz
Resolution Bandwidth [Hz]	1 MHz
Measurement Range [V/m]	2.5 V/m
Unit	V/m
Result Type	MAX
Number of Averages	64
Average Flag	OK
Overdrive Flag	OK
Threshold [V/m]	25 µV/m
Y-Scale Reference [V/m]	28 V/m
Y-Scale Range [dB]	100
Axis	RSS
Standard Name	ICNIRP GP
Comment	G1
Device Serial No.	J-0016
Device Calibration Date	05/15/2006
Device Firmware Version	V1.4.10
Cable Name	
Cable Serial No.	
Cable Calibration Date	
Antenna Name	3AX 75M-3G
Antenna Serial No.	G-0147
Antenna Calibration Date	05/18/2006

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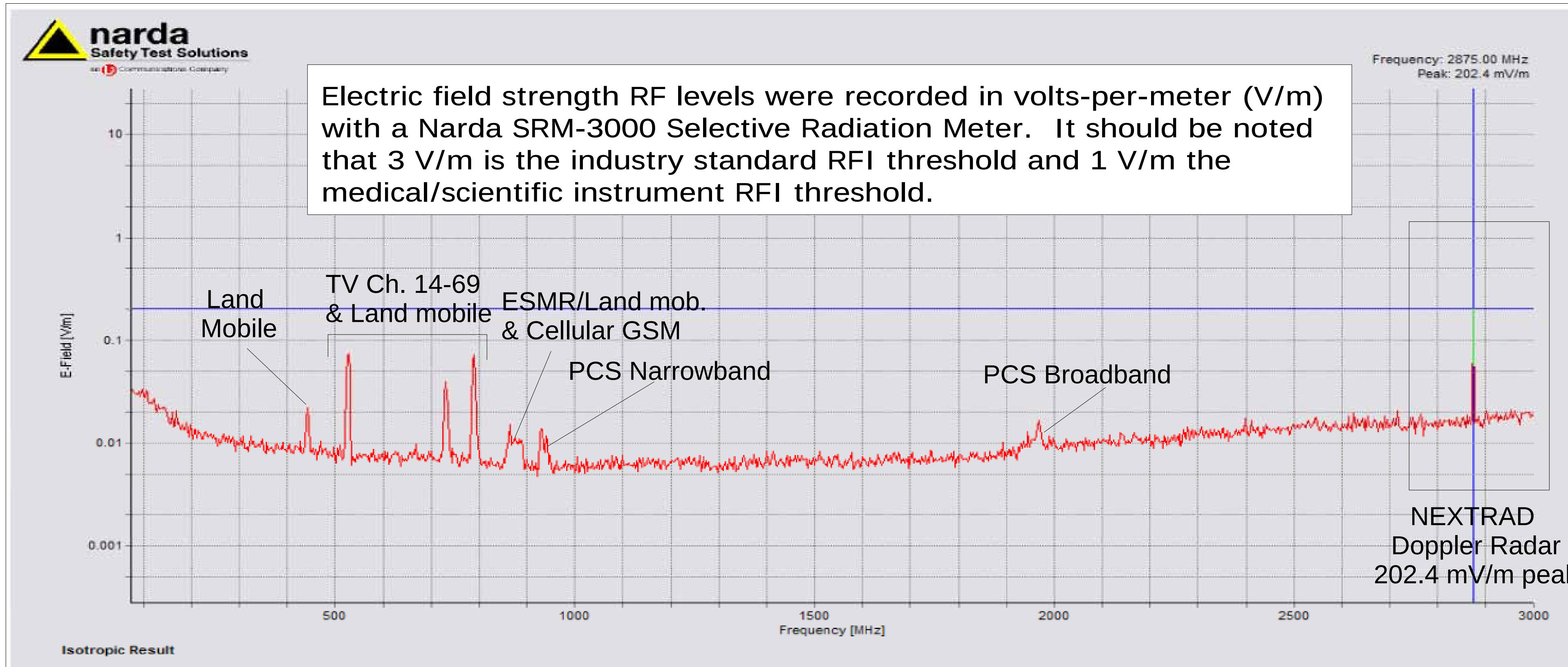
Figure #1 - RF Spectrum 2.7 - 3 GHz NEXTRAD Doppler Radar @ 1-meter
NSLS-II Brookhaven National Labs Proposed Site

RF Data Recorded
9/19/2006



Peak Chart By Frequency & Level

Index	Frequency	Level
1	2875.00 MHz	202.4 mV/m
2	526.38 MHz	76.24 mV/m
3	789.27 MHz	73.45 mV/m
4	730.05 MHz	39.06 mV/m
5	77.28 MHz	33.71 mV/m
6	96.96 MHz	33.43 mV/m
7	105.52 MHz	33.09 mV/m
8	89.69 MHz	31.85 mV/m
9	121.75 MHz	27.17 mV/m
10	114.79 MHz	24.80 mV/m
11	130.33 MHz	23.81 mV/m
12	143.68 MHz	22.49 mV/m
13	138.11 MHz	21.94 mV/m
14	442.51 MHz	21.88 mV/m
15	2952.42 MHz	20.77 mV/m
16	2715.16 MHz	20.76 mV/m
17	2902.43 MHz	20.65 mV/m
18	2960.28 MHz	20.65 mV/m
19	167.63 MHz	20.56 mV/m
20	2988.98 MHz	20.52 mV/m

Dataset Type	SPEC
Store Mode	MAN
Date	09/19/2006
Time	10:00:21
Minimum Frequency [Hz]	75 MHz
Maximum Frequency [Hz]	3 GHz
Resolution Bandwidth [Hz]	5 MHz
Measurement Range [V/m]	2.5 V/m
Unit	V/m
Result Type	MAX
Number of Averages	64
Average Flag	OK
Overdrive Flag	OK
Threshold [V/m]	25 µV/m
Y-Scale Reference [V/m]	28 V/m
Y-Scale Range [dB]	100
Axis	RSS
Standard Name	
Comment	
Device Serial No.	J-0016
Device Calibration Date	05/15/2006
Device Firmware Version	V1.4.10
Cable Name	
Cable Serial No.	
Cable Calibration Date	
Antenna Name	3AX 75M-3G
Antenna Serial No.	G-0147
Antenna Calibration Date	05/18/2006

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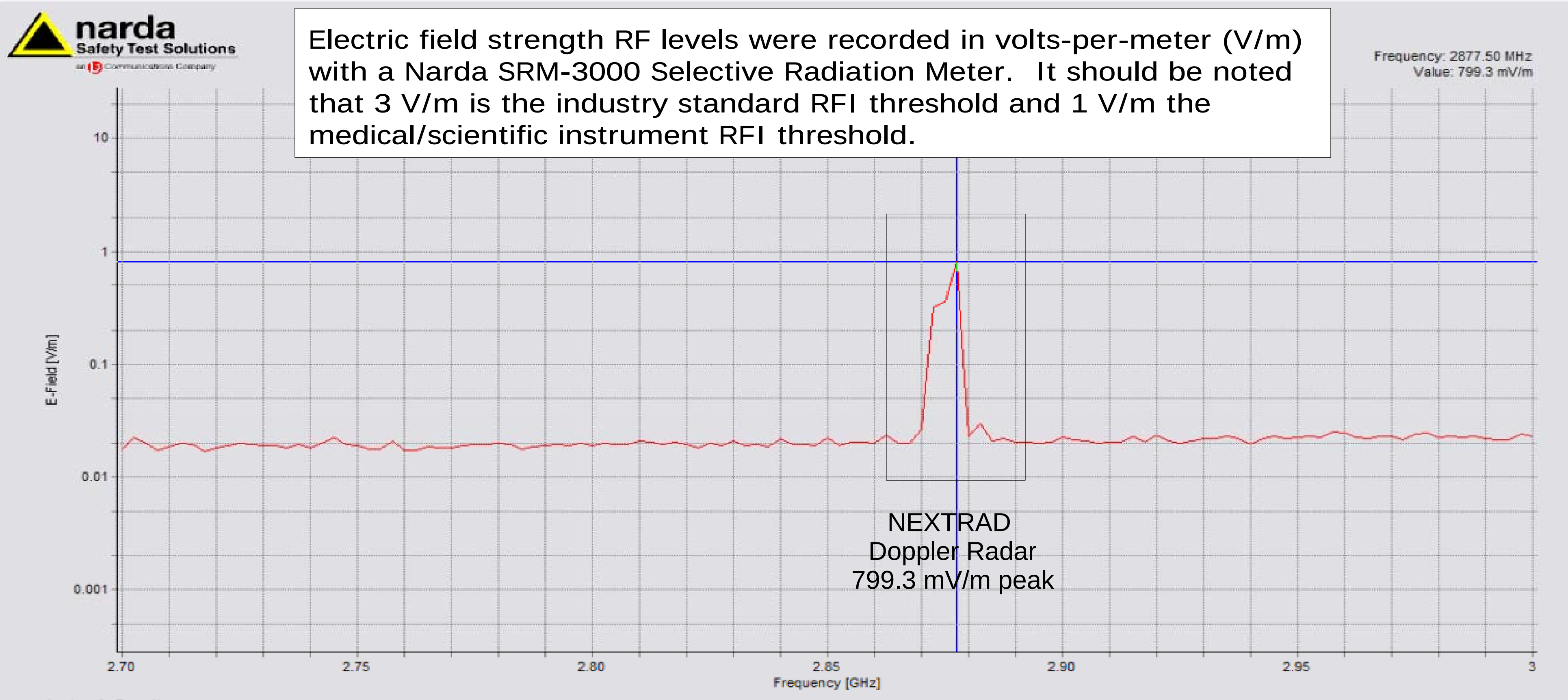
Figure #1A - RF Spectrum 75 Mz - 3 GHz @ 1-meter
NSLS-II Brookhaven National Labs Proposed Site

RF Data Recorded
9/19/2006



Spectrum Analysis 2.7 GHz to 3 GHz

Peak Chart By Frequency & Level

Index	Frequency	Level
1	2877.50 MHz	799.3 mV/m
2	2882.33 MHz	29.75 mV/m
3	2958.57 MHz	25.45 mV/m
4	2976.75 MHz	24.74 mV/m
5	2998.20 MHz	24.10 mV/m
6	2920.20 MHz	23.58 mV/m
7	2969.14 MHz	23.33 mV/m
8	2862.48 MHz	23.32 mV/m
9	2987.01 MHz	23.30 mV/m
10	2982.76 MHz	23.07 mV/m
11	2944.80 MHz	22.96 mV/m
12	2952.63 MHz	22.96 mV/m
13	2702.93 MHz	22.82 mV/m
14	2935.21 MHz	22.82 mV/m
15	2914.99 MHz	22.79 mV/m
16	2744.92 MHz	22.69 mV/m
17	2900.43 MHz	22.65 mV/m
18	2849.97 MHz	22.51 mV/m
19	2887.17 MHz	21.96 mV/m
20	2840.23 MHz	21.96 mV/m

Dataset Type	SPEC
Store Mode	MAN
Date	09/19/2006
Time	10:41:34
Minimum Frequency [Hz]	2.7 GHz
Maximum Frequency [Hz]	3 GHz
Resolution Bandwidth [Hz]	5 MHz
Measurement Range [V/m]	2.5 V/m
Unit	V/m
Result Type	MAX
Number of Averages	64
Average Flag	OK
Overdrive Flag	OK
Threshold [V/m]	25 µV/m
Y-Scale Reference [V/m]	28 V/m
Y-Scale Range [dB]	100
Axis	RSS
Standard Name	
Comment	
Device Serial No.	J-0016
Device Calibration Date	05/15/2006
Device Firmware Version	V1.4.10
Cable Name	
Cable Serial No.	
Cable Calibration Date	
Antenna Name	3AX 75M-3G
Antenna Serial No.	G-0147
Antenna Calibration Date	05/18/2006

RF Data Recorded From Cherry-Picker 9/19/2006

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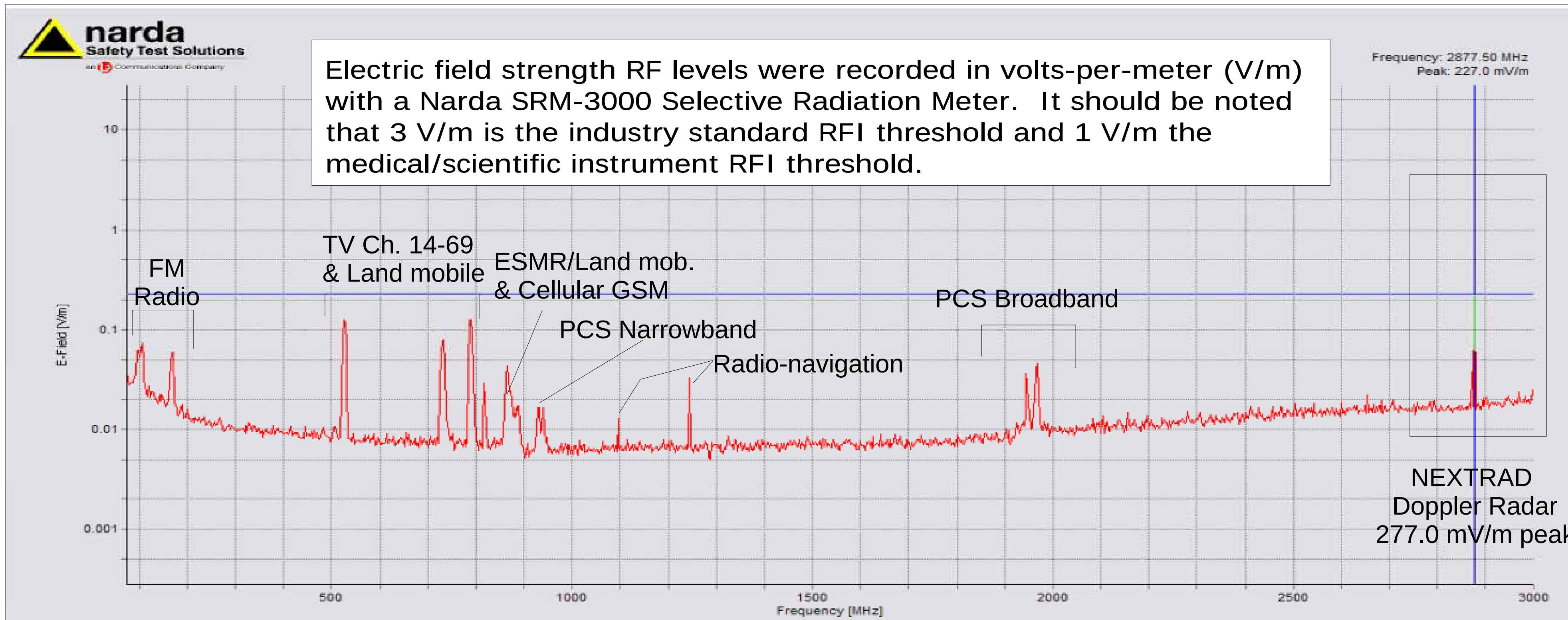
Figure #3 - RF Spectrum 75 MHz - 3 GHz @ 15.2 m (50 ft)
NSLS-II Brookhaven National Labs Proposed Site



Spectrum Analysis 75 MHz to 3 GHz

Peak Chart By Frequency & Level

Index	Frequency	Level
1	2877.50 MHz	227.0 mV/m
2	788.89 MHz	130.6 mV/m
3	526.03 MHz	129.3 mV/m
4	731.52 MHz	83.46 mV/m
5	104.60 MHz	73.53 mV/m
6	168.81 MHz	67.70 mV/m
7	96.37 MHz	64.39 mV/m
8	1966.71 MHz	47.85 mV/m
9	865.03 MHz	42.70 mV/m
10	2872.50 MHz	37.88 mV/m
11	1945.85 MHz	37.86 mV/m
12	1245.00 MHz	32.78 mV/m
13	84.61 MHz	29.72 mV/m
14	817.50 MHz	29.29 mV/m
15	119.93 MHz	26.91 mV/m
16	2997.38 MHz	24.93 mV/m
17	871.60 MHz	24.34 mV/m
18	126.17 MHz	23.81 mV/m
19	2970.19 MHz	23.73 mV/m
20	142.21 MHz	22.54 mV/m

Dataset Type	SPEC
Store Mode	MAN
Date	09/19/2006
Time	10:46:07
Minimum Frequency [Hz]	75 MHz
Maximum Frequency [Hz]	3 GHz
Resolution Bandwidth [Hz]	5 MHz
Measurement Range [V/m]	2.5 V/m
Unit	V/m
Result Type	MAX
Number of Averages	64
Average Flag	OK
Overdrive Flag	OK
Threshold [V/m]	25 µV/m
Y-Scale Reference [V/m]	28 V/m
Y-Scale Range [dB]	100
Axis	RSS
Standard Name	
Comment	
Device Serial No.	J-0016
Device Calibration Date	05/15/2006
Device Firmware Version	V1.4.10
Cable Name	
Cable Serial No.	
Cable Calibration Date	
Antenna Name	3AX 75M-3G
Antenna Serial No.	G-0147
Antenna Calibration Date	05/18/2006

RF Data Recorded From Cherry-Picker 9/19/2006

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Figure #3A - RF Spectrum 75 Mz - 3 GHz @ 15.2 m (50 ft.)
NSLS-II Brookhaven National Labs Proposed Site

Appendix A4

HVAC Calculations
Accelerator Ring Tunnel – one pentant
Experimental Hall – one pentant

HVAC

CALCULATIONS

HVAC Load Calculations for:

- One Accelerator Ring Tunnel Pentant AHU-101
- One Experimental Hall Pentant AHU – 201A and AHU-201B

HDR MECHANICAL SECTION | HEATING/COOLING LOAD CALCULATIONS

1.000 ROOM TYPES

ROOM DATA

0 CFM

PROJECT: BNL

DATE: 05-Sep-07

UNIT: AHU-101

ENGINEER: ATIENZA

ROOM NO:	T1		PEOPLE (NO EA):	15
ROOM NAME:	TUNNEL 1		LIGHTS (WATTS):	1.5
AREA (SQFT):	6393		MISC SENS (BTUH):	216000
HEIGHT (FT):	9		MISC LAT (BTUH):	
DESIGN AC:	6		RA=0/EA=1	0
RM TEMP (DEG F):	78	78	CFM/SQFT:	
PEOPLE SENS (BTUH):	450		PRESS (CFM):	0
PEOPLE LAT (BTUH):	450		NO OF RMS:	1

	WALL AREA (SQFT)	WINDOW AREA (SQFT)
N:	0	0
E:	0	0
S:	0	0
W:	0	0

ROOF AREA (SQFT):	
WALL BELOW GRADE (SQFT):	6841
SLAB ON GRADE (SQFT):	6393

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HDR MECHANICAL SECTION

HEATING/COOLING LOAD CALCULATIONS

1.000 ROOM TYPES
0 CFM

ROOM DATA

PROJECT: BNL
DATE: 05-Sep-07

UNIT: AHU-201-A
ENGINEER: ATIENZA

ROOM NO:	P1A	
ROOM NAME:	PENTANT 1A	
AREA (SQFT):	19762	
HEIGHT (FT):	12	
DESIGN AC:	6	
RM TEMP (DEG F):	75	75
PEOPLE SENS (BTUH):	450	
PEOPLE LAT (BTUH):	450	

PEOPLE (NO EA):	38
LIGHTS (WATTS):	2.0
MISC SENS (BTUH):	118000
MISC LAT (BTUH):	
RA=0/EA=1	0
CFM/SQFT:	
PRESS (CFM):	0
NO OF RMS:	1

	WALL AREA (SQFT)	WINDOW AREA (SQFT)
N:	6411	1188
E:	0	0
S:	6295	0
W:	0	0

ROOF AREA (SQFT):	19762
WALL BELOW GRADE (SQFT):	
SLAB ON GRADE (SQFT):	19762

========== =========== ======== ======== ======== ========= ======== ==========

HDR MECHANICAL SECTION | HEATING/COOLING LOAD CALCULATIONS

1.000 ROOM TYPES

ROOM DATA

0 CFM

PROJECT: BNL

UNIT: AHU-201-B

DATE: 05-Sep-07

ENGINEER: ATIENZA

ROOM NO:	P1B		PEOPLE (NO EA):	38
ROOM NAME:	PENTANT 1B		LIGHTS (WATTS):	2.8
AREA (SQFT):	19762		MISC SENS (BTUH):	118000
HEIGHT (FT):	12		MISC LAT (BTUH):	
DESIGN AC:	6		RA=0/EA=1	0
RM TEMP (DEG F):	75	75	CFM/SQFT:	
PEOPLE SENS (BTUH):	450		PRESS (CFM):	0
PEOPLE LAT (BTUH):	450		NO OF RMS:	1

	WALL AREA (SQFT)	WINDOW AREA (SQFT)
N:	6411	1188
E:	0	0
S:	6295	0
W:	0	0

ROOF AREA (SQFT):	19762
WALL BELOW GRADE (SQFT):	
SLAB ON GRADE (SQFT):	19762

========== =========== ======== ======== ======== ========= ======== ==========

HEATING/COOLING LOAD CALCULATIONS

ROOM DATA SUMMARY

PROJECT: BNL
DATE: 05-Sep-07

UNIT: AHU-101
PAGE: 1

ROOM NO	ROOM NAME	SA (CFM)	RA (CFM)	EA (CFM)	SQFT	)ES/SQFT AC	COOL AC	DT HTG
T1	TUNNEL 1	10280	10280	0	6393	6	11	4
		10280	10280	0	6393			

HEATING/COOLING LOAD CALCULATIONS

ROOM DATA SUMMARY

PROJECT: BNL
DATE: 05-Sep-07

UNIT: AHU-101
PAGE: 2

COOLING (BTUH)

ROOM NO	ROOM	TOTAL SENS	EXT SENS	INTERNAL SENSIBLE LIGHTS	PEOPLE	MISC	TOTAL LATENT	HTG (BTUH)	HTG (BTUH/FT)
T1	TUNNEL 1	255354	0	32604	6750	216000	6750	39702	
		255354	0	32604	6750	216000	6750	39702	

HEATING/COOLING LOAD CALCULATIONS

AHU DATA SUMMARY

PROJECT: BNL
DATE: 05-Sep-07

UNIT: AHU-101
PAGE: 3

COOLING LOAD SENSIBLE (BTUH)

BTUH	8	10	12	2	4	6	HTG (BTUH)		
TOTAL SENSIBLE	255354	255354	255354	255354	255354	255354	39702		
TOTAL LATENT	6750	6750	6750	6750	6750	6750	0		
GRAND TOTAL	262104	262104	262104	262104	262104	262104			
							AC CFM	SQFT CFM	HTG CFM
AVG DT	23	23	23	23	23				
SA (CFM)	10280	10280	10280	10280	10280	10280	5754	0	106387
RA (CFM)	10280	10280	10280	10280	10280	10280			
EA (CFM)	0	0	0	0	0	0			

TOTAL SA (CFM)	10280
TOTAL RA (CFM)	10280
TOTAL EA (CFM)	0

	0	0	0	0	0	0	0	0	
SENSIBLE COOLING	0	0	0	0	0	0	0	0	
	255354	255354	255354	255354	255354	255354	39702		
	=========	=========	=========	=========	=========	=========	=========	=========	=========
	255354	255354	255354	255354	255354	255354	39702	0	0
LATENT COOLING	0	0	0	0	0	0	0	0	
	6750	6750	6750	6750	6750	6750	0		
	=========	=========	=========	=========	=========	=========	=========	=========	=========
	6750	6750	6750	6750	6750	6750	0	0	0
SUPPLY AIR	0	0	0	0	0	0	0	0	
	10280	10280	10280	10280	10280	10280	5754	0	106387
	=========	=========	=========	=========	=========	=========	=========	=========	=========
	10280	10280	10280	10280	10280	10280	5754	0	106387
RETURN AIR	0	0	0	0	0	0	0	0	
	10280	10280	10280	10280	10280	10280	5754	0	60193
	=========	=========	=========	=========	=========	=========	=========	=========	=========
	10280	10280	10280	10280	10280	10280	5754	0	60193
EXHAUST AIR	0	0	0	0	0	0	0	0	
	0	0	0	0	0	0	0	0	51610
	=========	=========	=========	=========	=========	=========	=========	=========	=========
	0	0	0	0	0	0	0	0	51610

9 10 9 9 9 9 9 9 9 9 9 100

HEATING/COOLING LOAD CALCULATIONS

GLOBAL DATA

PROJECT: BNL
DATE: 05-Sep-07
ENGINEER: ATIENZA

AHU-101
PAGE: 4.00 4.00

Uwall:	0.05	20.00	PEOPLE SENS (BTUH	250.00
Uwindow s:	0.30		PEOPLE LAT (BTUH):	200.00
Uwindow w:	0.29		OAT WINT (DEG F):	0.00
Uroof:	0.04		SA TEMP (DEG F):	55.00
SHADE FC:	0.44		DT HTG (DEG F):	40.00
WALL CONST:	3.00	(BELOW GRADE)		
FLOOR CONST:	3.00	(BELOW GRADE)		

Factors Corrected for Latitude-Month

Time of Day	08:00 AM	10:00 AM	12:00 PM	02:00 PM	04:00 PM	06:00 PM
CLTDroof:	22	23	26.00	31.00	36.00	39.00
CLTDwall: TYPE B						
N:	9	8	7.64	8.47	9.30	23.00
E:	13	13	16.77	19.26	21.75	32.00
S:	12	10	10.13	10.96	13.45	43.00
W:	17	15	13.45	12.62	13.45	43.00
CLTDwindow:	3	7	12.00	16.00	17.00	12.00
SHGF:						
N:	130	130	130	130	130	130
E:	216	216	216	216	216	216
S:	205	205	205	205	205	205
W:	216	216	216	216	216	216
CLFwindow:						
N:	0.65	0.80	0.89	0.86	0.75	0.70
E:	0.80	0.62	0.27	0.22	0.17	0.16
S:	0.23	0.58	0.83	0.68	0.35	0.33
W:	0.11	0.15	0.17	0.53	0.82	0.67

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Time of Day	08:00 AM	10:00 AM	12:00 PM	02:00 PM	04:00 PM	06:00 PM

Raw Factors

CLTDroof	20	21.00	24.00	29.00	34.00	38.00

CLTDwall	TYPE E					
N:	4	6	9.00	13.00	17.00	20.00
E:	11	26	36.00	37.00	34.00	32.00
S:	3	5.00	13.00	24.00	32.00	33.00
W:	6	6.00	9.00	14.00	27.00	43.00

CLTD Correction Factor (LM)	
Roof:	1
Walls:	
N	3
E	0
S	10
W	0

HEATING/COOLING LOAD CALCULATIONS

ROOM DATA SUMMARY

PROJECT: BNL
DATE: 05-Sep-07

UNIT: AHU-201-A
PAGE: 1

ROOM NO	ROOM NAME	SA (CFM)	RA (CFM)	EA (CFM)	SQFT	)ES/SQFT AC	COOL AC	DT HTG
P1A	PENTANT 1A	23710	23710	0	19762	6	4	8
		23710	23710	0	19762			

HEATING/COOLING LOAD CALCULATIONS

ROOM DATA SUMMARY

PROJECT: BNL
DATE: 05-Sep-07

UNIT: AHU-201-A
PAGE: 2

COOLING (BTUH)

ROOM NO	ROOM	TOTAL SENS	EXT SENS	INTERNAL SENSIBLE LIGHTS	PEOPLE	MISC	TOTAL LATENT	HTG (BTUH)	HTG (BTUH/FT)
P1A	PENTANT 1A	378408	108926	134382	17100	118000	17100	192059	
		378408	108926	134382	17100	118000	17100	192059	

HEATING/COOLING LOAD CALCULATIONS

AHU DATA SUMMARY

PROJECT: BNL
DATE: 05-Sep-07

UNIT: AHU-201-A
PAGE: 3

	COOLING LOAD SENSIBLE (BTUH)						HTG (BTUH)		
BTUH	8	10	12	2	4	6			
TOTAL SENSIBLE	344150	355770	365774	369640	367524	378408	192059		
TOTAL LATENT	17100	17100	17100	17100	17100	17100	0		
GRAND TOTAL	361250	372870	382874	386740	384624	395508			
							AC CFM	SQFT CFM	HTG CFM
AVG DT	20	20	20	20	20				
SA (CFM)	15933	16471	16934	17113	17015	17519	23714	0	149622
RA (CFM)	15933	16471	16934	17113	17015	17519			
EA (CFM)	0	0	0	0	0	0			

TOTAL SA (CFM)	23710
TOTAL RA (CFM)	23710
TOTAL EA (CFM)	0

	0	0	0	0	0	0	0	0	
SENSIBLE COOLING	0	0	0	0	0	0	0	0	
	344150	355770	365774	369640	367524	378408	192059		
	=========	=========	=========	=========	=========	=========	=========	=========	=========
	344150	355770	365774	369640	367524	378408	192059	0	0
LATENT COOLING	0	0	0	0	0	0	0	0	
	17100	17100	17100	17100	17100	17100	0		
	=========	=========	=========	=========	=========	=========	=========	=========	=========
	17100	17100	17100	17100	17100	17100	0	0	0
SUPPLY AIR	0	0	0	0	0	0	0	0	
	15933	16471	16934	17113	17015	17519	23714	0	149622
	=========	=========	=========	=========	=========	=========	=========	=========	=========
	15933	16471	16934	17113	17015	17519	23714	0	149622
RETURN AIR	0	0	0	0	0	0	0	0	
	15933	16471	16934	17113	17015	17519	23714	0	103427
	=========	=========	=========	=========	=========	=========	=========	=========	=========
	15933	16471	16934	17113	17015	17519	23714	0	103427
EXHAUST AIR	0	0	0	0	0	0	0	0	
	0	0	0	0	0	0	0	0	51610
	=========	=========	=========	=========	=========	=========	=========	=========	=========
	0	0	0	0	0	0	0	0	51610

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HEATING/COOLING LOAD CALCULATIONS

GLOBAL DATA

PROJECT: BNL
DATE: 05-Sep-07
ENGINEER: ATIENZA

AHU-201-A
PAGE: 4.00 4.00

Uwall:	0.05	20.00	PEOPLE SENS (BTUH	250.00
Uwindow s:	0.30		PEOPLE LAT (BTUH):	200.00
Uwindow w:	0.29		OAT WINT (DEG F):	0.00
Uroof:	0.04		SA TEMP (DEG F):	55.00
SHADE FC:	0.44		DT HTG (DEG F):	40.00
WALL CONST:	3.00	(BELOW GRADE)		
FLOOR CONST:	3.00	(BELOW GRADE)		

Factors Corrected for Latitude-Month

Time of Day	08:00 AM	10:00 AM	12:00 PM	02:00 PM	04:00 PM	06:00 PM
CLTDroof:	22	23	26.00	31.00	36.00	39.00
CLTDwall: TYPE B						
N:	9	8	7.64	8.47	9.30	23.00
E:	13	13	16.77	19.26	21.75	32.00
S:	12	10	10.13	10.96	13.45	43.00
W:	17	15	13.45	12.62	13.45	43.00
CLTDwindow:	3	7	12.00	16.00	17.00	12.00
SHGF:						
N:	130	130	130	130	130	130
E:	216	216	216	216	216	216
S:	205	205	205	205	205	205
W:	216	216	216	216	216	216
CLFwindow:						
N:	0.65	0.80	0.89	0.86	0.75	0.70
E:	0.80	0.62	0.27	0.22	0.17	0.16
S:	0.23	0.58	0.83	0.68	0.35	0.33
W:	0.11	0.15	0.17	0.53	0.82	0.67

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Time of Day	08:00 AM	10:00 AM	12:00 PM	02:00 PM	04:00 PM	06:00 PM

Raw Factors

CLTDroof		20	21.00	24.00	29.00	34.00	38.00
CLTDwall	TYPE E						
N:		4	6	9.00	13.00	17.00	20.00
E:		11	26	36.00	37.00	34.00	32.00
S:		3	5.00	13.00	24.00	32.00	33.00
W:		6	6.00	9.00	14.00	27.00	43.00

CLTD Correction Factor (LM)	
Roof:	1
Walls:	
N	3
E	0
S	10
W	0

HEATING/COOLING LOAD CALCULATIONS

ROOM DATA SUMMARY

PROJECT: BNL
DATE: 05-Sep-07

UNIT: AHU-201-B
PAGE: 1

ROOM NO	ROOM NAME	SA (CFM)	RA (CFM)	EA (CFM)	SQFT	)ES/SQFT AC	COOL AC	DT HTG
P1B	PENTANT 1B	23710	23710	0	19762	6	5	8
		23710	23710	0	19762			

HEATING/COOLING LOAD CALCULATIONS

ROOM DATA SUMMARY

PROJECT: BNL
DATE: 05-Sep-07

UNIT: AHU-201-B
PAGE: 2

COOLING (BTUH)

ROOM NO	ROOM	TOTAL SENS	EXT SENS	INTERNAL SENSIBLE LIGHTS	PEOPLE	MISC	TOTAL LATENT	HTG (BTUH)	HTG (BTUH/FT)
P1B	PENTANT 1B	432161	108926	188134	17100	118000	17100	192059	
		432161	108926	188134	17100	118000	17100	192059	

HEATING/COOLING LOAD CALCULATIONS

AHU DATA SUMMARY

PROJECT: BNL
DATE: 05-Sep-07

UNIT: AHU-201-B
PAGE: 3

	COOLING LOAD SENSIBLE (BTUH)						HTG (BTUH)		
BTUH	8	10	12	2	4	6			
TOTAL SENSIBLE	397902	409523	419526	423393	421277	432161	192059		
TOTAL LATENT	17100	17100	17100	17100	17100	17100	0		
GRAND TOTAL	415002	426623	436626	440493	438377	449261			
							AC CFM	SQFT CFM	HTG CFM
AVG DT	20	20	20	20	20				
SA (CFM)	18421	18959	19423	19602	19504	20007	23714	0	113799
RA (CFM)	18421	18959	19423	19602	19504	20007			
EA (CFM)	0	0	0	0	0	0			

TOTAL SA (CFM)	23710
TOTAL RA (CFM)	23710
TOTAL EA (CFM)	0

	0	0	0	0	0	0	0	0	
SENSIBLE COOLING	0	0	0	0	0	0	0	0	
	397902	409523	419526	423393	421277	432161	192059		
	=========	=========	=========	=========	=========	=========	=========	=========	=========
	397902	409523	419526	423393	421277	432161	192059	0	0
LATENT COOLING	0	0	0	0	0	0	0	0	
	17100	17100	17100	17100	17100	17100	0		
	=========	=========	=========	=========	=========	=========	=========	=========	=========
	17100	17100	17100	17100	17100	17100	0	0	0
SUPPLY AIR	0	0	0	0	0	0	0	0	
	18421	18959	19423	19602	19504	20007	23714	0	113799
	=========	=========	=========	=========	=========	=========	=========	=========	=========
	18421	18959	19423	19602	19504	20007	23714	0	113799
RETURN AIR	0	0	0	0	0	0	0	0	
	18421	18959	19423	19602	19504	20007	23714	0	67604
	=========	=========	=========	=========	=========	=========	=========	=========	=========
	18421	18959	19423	19602	19504	20007	23714	0	67604
EXHAUST AIR	0	0	0	0	0	0	0	0	
	0	0	0	0	0	0	0	0	51610
	=========	=========	=========	=========	=========	=========	=========	=========	=========
	0	0	0	0	0	0	0	0	51610

9 10 9 9 9 9 9 9 9 9 9 100

HEATING/COOLING LOAD CALCULATIONS

GLOBAL DATA

PROJECT: BNL
DATE: 05-Sep-07
ENGINEER: ATIENZA

AHU-201-B
PAGE: 4.00 4.00

Uwall:	0.05	20.00	PEOPLE SENS (BTUH	250.00
Uwindow s:	0.30		PEOPLE LAT (BTUH):	200.00
Uwindow w:	0.29		OAT WINT (DEG F):	0.00
Uroof:	0.04		SA TEMP (DEG F):	55.00
SHADE FC:	0.44		DT HTG (DEG F):	40.00
WALL CONST:	3.00	(BELOW GRADE)		
FLOOR CONST:	3.00	(BELOW GRADE)		

Factors Corrected for Latitude-Month

Time of Day		08:00 AM	10:00 AM	12:00 PM	02:00 PM	04:00 PM	06:00 PM
CLTDroof:		22	23	26.00	31.00	36.00	39.00
CLTDwall:	TYPE B						
N:		9	8	7.64	8.47	9.30	23.00
E:		13	13	16.77	19.26	21.75	32.00
S:		12	10	10.13	10.96	13.45	43.00
W:		17	15	13.45	12.62	13.45	43.00
CLTDwindow:		3	7	12.00	16.00	17.00	12.00
SHGF:							
N:		130	130	130	130	130	130
E:		216	216	216	216	216	216
S:		205	205	205	205	205	205
W:		216	216	216	216	216	216
CLFwindow:							
N:		0.65	0.80	0.89	0.86	0.75	0.70
E:		0.80	0.62	0.27	0.22	0.17	0.16
S:		0.23	0.58	0.83	0.68	0.35	0.33
W:		0.11	0.15	0.17	0.53	0.82	0.67

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Time of Day	08:00 AM	10:00 AM	12:00 PM	02:00 PM	04:00 PM	06:00 PM

Raw Factors

CLTDroof		20	21.00	24.00	29.00	34.00	38.00
CLTDwall	TYPE E						
N:		4	6	9.00	13.00	17.00	20.00
E:		11	26	36.00	37.00	34.00	32.00
S:		3	5.00	13.00	24.00	32.00	33.00
W:		6	6.00	9.00	14.00	27.00	43.00

CLTD Correction Factor (LM)	
Roof:	1
Walls:	
N	3
E	0
S	10
W	0

HEATING/COOLING LOAD CALCULATIONS

ROOM DATA SUMMARY

PROJECT: BNL
DATE: 08-AUG-07

UNIT: AHU-101
PAGE: 1

ROOM NO	ROOM NAME	SA (CFM)	RA (CFM)	EA (CFM)	SQFT	DES/SQFT AC	COOL AC	DT HTG	OA	%OA
T1	TUNNEL 1	10280	10280		6393	6	11	4	540	5.25%
		10280	10280		6393				540	5.25%

AIR FLOW W/DIVERSITY	10280	CFM	
SF AIR FLOW	11822	CFM	
RF AIR FLOW	11822	CFM	
EA=SF-RF		CFM	
OA	540	CFM	5%
OA CHECK		CFM	
RELIEF	540	CFM	

OA MAX	540 CFM	
OA BY %	540 CFM	
Y	5.25%	<<<<<<<<<<
X	5.25%	
Z	5.25%	

HEATING/COOLING LOAD CALCULATIONS

ROOM DATA SUMMARY

PROJECT: BNL
DATE: 08-AUG-07

UNIT: \HU-201-A
PAGE: 1

ROOM NO	ROOM NAME	SA (CFM)	RA (CFM)	EA (CFM)	SQFT	DES/SQFT AC	COOL AC	DT HTG	OA	%OA
P1A	PENTANT 1A	23710	23710		19762	6	4	8	1368	5.77%
		23710	23710		19762				1368	5.77%

AIR FLOW W/DIVERSITY 23714 CFM

SF AIR FLOW 27272 CFM

RF AIR FLOW 27272 CFM

EA=SF-RF CFM

OA 1368 CFM 6%

OA CHECK CFM

RELIEF 1368 CFM

OA MAX 1368 CFM
OA BY % 1368 CFM

Y 5.77% <<<<<<<<<<
X 5.77%
Z 5.77%

HEATING/COOLING LOAD CALCULATIONS

ROOM DATA SUMMARY

PROJECT: BNL
DATE: 08-AUG-07

UNIT: \HU-201-B
PAGE: 1

ROOM NO	ROOM NAME	SA (CFM)	RA (CFM)	EA (CFM)	SQFT	DES/SQFT AC	COOL AC	DT HTG	OA	%OA
P1B	PENTANT 1B	23710	23710		19762	6	5	8	1368	5.77%
		23710	23710		19762				1368	5.77%

AIR FLOW W/DIVERSITY	20007 CFM	
SF AIR FLOW	23009 CFM	
RF AIR FLOW	23009 CFM	
EA=SF-RF	CFM	
OA	1368 CFM	7%
OA CHECK	CFM	
RELIEF	1368 CFM	

OA MAX	1368 CFM	
OA BY %	1368 CFM	
Y	5.77%	<<<<<<<<<<
X	5.77%	
Z	5.77%	

BNL NSLS II		AIR HANDLING UNIT PSYCHROMETRICS		
05-Sep-07		CV		
AHU-101	<<<<<<<<<	ENGINEER:	ATIENZA	<<<<<<<<<

OUTSIDE DESIGN CONDITIONS

	SUMMER		WINTER	
OA DB	95 DEG F	<<<<<<<<<	0 DEG F<<<<<	
OA WB	76 DEG F	<<<<<<<<<		
OA ENT	39.3 BTU/LB OF DRY AIR			

AIR FLOW		HEAT GAIN		HEAT LOSS	
SA	11822 CFM<<<<<	SENSIBLE	255354 BTUH<<<<<	63839 BTUH<<<<·	18776 W
RA	11282 CFM	PLENUM	0 BTUH<<<<<<<		
OA	540 CFM<<<<<	LATENT	1000 BTUH<<<<<		

FAN TOTAL PRESSURE		FAN TEMP RISE	FAN ENT RISE
SUPPLY	4 IN WG <<·	3.1 DEG F	0.74 BTU/LB OF DRY AIR
RETURN	1.5 IN WG <<·	1.4 DEG F	0.35 BTU/LB OF DRY AIR
LIGHTS TO PLENUM		0.0 DEG F	0.00 BTU/LB OF DRY AIR

AHU LAT

LAT DB	56 DEG F	<<<<<<<<<
LAT WB	53.0 DEG F	
LAT ENT	22.61 BTU/LB OF DRY AIR	

ROOM CONDITIONS

SRMTEMP DB	78.0 DEG F<<<<<<<	WRMTEMP DB	68 DEG F<<<<<<<
SRMTEMP WB	60.0 DEG F		
RMENT	27.91 BTU/LB OF DRY AIR		

RETURN AIR

RA DB	79.4 DEG F
RA WB	60.4 DEG F
RA ENT	28.26 BTU/LB OF DRY AIR

COOLING COIL

EAT DB	80.2 DEG F
EAT WB	61.2 DEG F
EA ENT	28.76 BTU/LB OF DRY AIR
LAT DB	52.9 DEG F
LAT WB	52.8 DEG F
LA ENT	21.88 BTU/LB OF DRY AIR
CAPACITY	31 TONS

PREHEAT COIL AT NORMAL OPERATION			REHEAT COILS	HEAT LOSS	TOTAL HEATING
SA WINTER	11822 CFM	<<<<<<<<<			
EAT DB	64.9 DEG F		65 DEG F EAT		
LAT DB	52.9 DEG F				
HTG CAP	0 BTUH		39658 BTUH	63839 BTUH	103496 BTUH
HTG CAP	0 KW		12 KW		
HTG CAP	0 LBS/HR STEAM		42 LBS/HR STEAM		

HUMIDIFIER

WRMTEMP DB	68.0 DEG F		0	
REL HUM	30 %	<<<<<<<<<		
HUM RAT	30 GR/LB OF DRY AIR			
CAPACITY	72 LBS/HR STEAM		ECON OA	4244 CFM
			MIN OA	540 CFM

PREHEAT COIL AT 100% OA

EAT DB	0 DEG F
LAT DB	52.9 DEG F
HTG CAP	675757 BTUH
HTG CAP	199 KW
HTG CAP	711 LBS/HR STEAM

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BNL NSLS II
05-Sep-07

AIR HANDLING UNIT PSYCHROMETRICS
VVR

AHU-201-A <<<<<<<<< ENGINEER: ATIENZA <<<<<<<<<

OUTSIDE DESIGN CONDITIONS

	SUMMER		WINTER
OA DB	95 DEG F	<<<<<<<<<	0 DEG F<<<<<
OA WB	76 DEG F	<<<<<<<<<	
OA ENT	39.3 BTU/LB OF DRY AIR		

AIR FLOW		HEAT GAIN		HEAT LOSS	
SA	27272 CFM<<<<<	SENSIBLE	589066 BTUH<<<<<	147266 BTUH<<<<	43314 W
RA	25904 CFM	PLENUM	0 BTUH<<<<<<<		
OA	1368 CFM<<<<<	LATENT	1000 BTUH<<<<<		

FAN TOTAL PRESSURE		FAN TEMP RISE	FAN ENT RISE
SUPPLY	6 IN WG <<<	4.6 DEG F	1.11 BTU/LB OF DRY AIR
RETURN	1.5 IN WG <<<	1.4 DEG F	0.35 BTU/LB OF DRY AIR
LIGHTS TO PLENUM		0.0 DEG F	0.00 BTU/LB OF DRY AIR

AHU LAT

LAT DB	56 DEG F	<<<<<<<<<
LAT WB	53.0 DEG F	
LAT ENT	22.09 BTU/LB OF DRY AIR	

ROOM CONDITIONS

SRMTEMP DB	75.0 DEG F<<<<<<<	WRMTEMP DB	68 DEG F<<<<<<<
SRMTEMP WB	60.0 DEG F		
RMENT	26.66 BTU/LB OF DRY AIR		

RETURN AIR

RA DB	76.4 DEG F
RA WB	60.4 DEG F
RA ENT	27.01 BTU/LB OF DRY AIR

COOLING COIL

EAT DB	77.4 DEG F
EAT WB	61.2 DEG F
EA ENT	27.62 BTU/LB OF DRY AIR
LAT DB	51.4 DEG F
LAT WB	51.3 DEG F
LA ENT	20.99 BTU/LB OF DRY AIR
CAPACITY	68 TONS

PREHEAT COIL AT NORMAL OPERATION			REHEAT COILS	HEAT LOSS	TOTAL HEATING
SA WINTER	27272 CFM	<<<<<<<<<			
EAT DB	64.6 DEG F		65 DEG F EAT		
LAT DB	51.4 DEG F				
HTG CAP	0 BTUH		100466 BTUH	147266 BTUH	247732 BTUH
HTG CAP	0 KW		30 KW		
HTG CAP	0 LBS/HR STEAM		106 LBS/HR STEAM		

HUMIDIFIER

WRMTEMP DB	68.0 DEG F		0	
REL HUM	30 %	<<<<<<<<<		
HUM RAT	30 GR/LB OF DRY AIR			
CAPACITY	154 LBS/HR STEAM		ECON OA	9091 CFM
			MIN OA	1368 CFM

PREHEAT COIL AT 100% OA

EAT DB	0 DEG F
LAT DB	51.4 DEG F
HTG CAP	1513618 BTUH
HTG CAP	445 KW
HTG CAP	1593 LBS/HR STEAM

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BNL NSLS II AIR HANDLING UNIT PSYCHROMETRICS
05-Sep-07 VVR

AHU-201-B <<<<<<<<< ENGINEER: ATIENZA <<<<<<<<<

OUTSIDE DESIGN CONDITIONS

	SUMMER		WINTER
OA DB	95 DEG F	<<<<<<<<<	0 DEG F<<<<<
OA WB	76 DEG F	<<<<<<<<<	
OA ENT	39.3 BTU/LB OF DRY AIR		

AIR FLOW		HEAT GAIN		HEAT LOSS	
SA	23009 CFM<<<<<	SENSIBLE	496985 BTUH<<<<<	124246 BTUH<<<<<	36543 W
RA	21641 CFM	PLENUM	0 BTUH<<<<<<<		
OA	1368 CFM<<<<<	LATENT	1000 BTUH<<<<<		

FAN TOTAL PRESSURE		FAN TEMP RISE	FAN ENT RISE
SUPPLY	6 IN WG <<<	4.6 DEG F	1.11 BTU/LB OF DRY AIR
RETURN	1.5 IN WG <<<	1.4 DEG F	0.35 BTU/LB OF DRY AIR
LIGHTS TO PLENUM		0.0 DEG F	0.00 BTU/LB OF DRY AIR

AHU LAT

LAT DB	56 DEG F	<<<<<<<<<
LAT WB	53.0 DEG F	
LAT ENT	22.09 BTU/LB OF DRY AIR	

ROOM CONDITIONS

SRMTEMP DB	75.0 DEG F<<<<<<<	WRMTEMP DB	68 DEG F<<<<<<<
SRMTEMP WB	60.0 DEG F		
RMENT	26.66 BTU/LB OF DRY AIR		

RETURN AIR

RA DB	76.4 DEG F
RA WB	60.4 DEG F
RA ENT	27.01 BTU/LB OF DRY AIR

COOLING COIL

EAT DB	77.5 DEG F
EAT WB	61.4 DEG F
EA ENT	27.74 BTU/LB OF DRY AIR
LAT DB	51.4 DEG F
LAT WB	51.3 DEG F
LA ENT	20.99 BTU/LB OF DRY AIR
CAPACITY	58 TONS

PREHEAT COIL AT NORMAL OPERATION			REHEAT COILS	HEAT LOSS	TOTAL HEATING
SA WINTER	23009 CFM	<<<<<<<<<			
EAT DB	64.0 DEG F		64 DEG F EAT		
LAT DB	51.4 DEG F				
HTG CAP	0 BTUH		100466 BTUH	124246 BTUH	224712 BTUH
HTG CAP	0 KW		30 KW		
HTG CAP	0 LBS/HR STEAM		106 LBS/HR STEAM		

HUMIDIFIER

WRMTEMP DB	68.0 DEG F		0	
REL HUM	30 %	<<<<<<<<<		
HUM RAT	30 GR/LB OF DRY AIR			
CAPACITY	130 LBS/HR STEAM		ECON OA	7670 CFM
			MIN OA	1368 CFM

PREHEAT COIL AT 100% OA

EAT DB	0 DEG F
LAT DB	51.4 DEG F
HTG CAP	1277014 BTUH
HTG CAP	376 KW
HTG CAP	1344 LBS/HR STEAM

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Appendix A5

Hourly Whole Building Energy Analysis
September 10, 2007

EMO Energy Solutions

EMO Energy Solutions
Energy Efficiency & Sustainable Design Consulting

September 10th, 2007

BROOKHAVEN NSLS II – UPTON, NEW YORK: SCHEMATIC DESIGN ENERGY ANALYSIS
HOURLY WHOLE BUILDING ENERGY ANALYSIS AND LEED®-NC V2.2 EA CR.1 OPTIMIZATION

Purpose & Scope:

The United States Department of Energy (DOE) has contracted HDR Architecture, Inc. (HDR) and for the design and implementation of sustainable design strategies and features for the new Brookhaven National Laboratory – National Synchrotron Light Source II (NSLS II) in Upton, New York. This project is intended to incorporate environmentally sensitive materials and technologies along with the principals of sustainable design and the integrated whole building design approach. To this end, HDR has contracted EMO Energy Solutions, LLC (EMO) to perform a comprehensive whole building energy simulation, energy analysis, and general sustainable design and green engineering assistance.

This project will be applying for Leadership in Energy and Environmental Design, New Construction (LEED®-NC) version 2.2 with the goal of a "Gold" level of certification. As part of this certification process, EMO will simulate the annual energy use of the building as-designed / Design Energy Cost (DEC) model and the building as if it were designed to meet ASHRAE 90.1-2004 minimum specifications / Performance Rating Method (PRM) model. The difference in consumption between the two models is used to determine the final point total for Credit-1 of the LEED®-NC Energy and Atmosphere category.

Given this stage (Schematic) in design, this energy analysis report is intended to cover the following for the design team:

- Preliminary hourly building energy analysis
- Energy performance as compared to ASHRAE 90.1-2004 baseline (*initial – performance expected to change with more refined building*)
- Provide the design team feedback with regards to energy cost savings expectations going forward into the Design Development phase
- Itemize some of the energy cost savings for different energy efficiency opportunities
- Highlight some key ASHRAE 90.1-2004 Appendix G requirements
- Provide the design team information regarding energy utilization in the proposed facility and how to improve LEED®-NC EA Cr.1 performance

For this "SD Level" energy analysis, EMO has incorporated the estimated envelope, building design, and HVAC system options for the SD phase as well as all other parameters and components as represented in the documents (dated 27 January 2007), the "Title I Preliminary Design Report – 50% Review Submittal" and conversations with HDR.

Methodology:

The standard sustainable design approach employed by EMO is based upon and optimized by the interactive design approach. Sustainable improvements are defined as modifications that will reduce the negative environmental impact of the building for future generations by minimizing the energy and water consumption, minimizing pollution emissions, and increasing the useful life of the building by improving the quality of the occupied spaces. This process incorporates four distinct, but fluid processes that work with the design team through the course of the design:

- **Generate the Baseline** - Generate a DOE-2.2 energy model of the current design of the facility, of which include all proposed building systems including the ASHRAE 90.1 guidelines for new construction where applicable.
- **Evaluate the Baseline** - Compare to ASHRAE or existing building code and PRM for LEED® ; determine energy goals and targets
- **Generate and Evaluate ECMs** - Generate parametric runs for any and all applicable ECMs to account for any associated savings that would add any LEED® credits in the Energy & Atmosphere category of the LEED® Rating System
- **Final Design** - Present the packaged ECMs, highlighting the energy savings, the overall Energy Usage Intensity (EUI-kBtu/sf) reduction, and the potential LEED® credits awarded.

The process of identifying energy efficiency and conservation measures relies on the following three step strategy. This strategy is applied to optimize and fully capitalize on the associated savings and emphasis on reduction of waste:

- **Minimize Building Loads** - Improve the building envelope, reduce lighting power densities and usage, incorporate suitable day lighting techniques, reduce equipment power densities and usage, and reduce water consumption flow rates.
- **Improve System Effectiveness** – Improve HVAC system design, increase motor efficiencies, utilize solar heating technologies, incorporate energy recovery technologies, and utilize applicable controls strategies.
- **Optimize Resource Delivery** – Provide renewable energy generation, incorporate energy storage techniques, increase the efficiency of the plant, review utility rate options, and investigate district heating and cooling options.

The method of evaluation closely followed the guidelines stipulated by the US Green Building Council's LEED® design approach and the ASHRAE/IESNA 90.1-2004 interactive calculation method.

All project energy modeling used eQUEST 3.61e, a program that utilizes DOE-2.2 to simulate the hourly energy consumption and demand load shapes for a given facility. To develop a model, the user creates a graphic representation of the building, using floor plans, floor heights, and window configurations. Specifics of the central plant, air-handling units, and building envelope are included along with the operating parameters such as lighting power density, occupancy, building schedules, and airflow rates. The simulation uses 30-year average hourly weather data to accurately estimate the energy consumption of the building for each hour of the year.

Results Summary:

With the assumptions and strategies represented in the design drawings and implementation of all listed measures this project is expected to save ~**$492,908/yr (~21.8%)** in total energy costs when compared to the ASHRAE baseline **meeting EA Prerequisite 2** and equating to **(3-4) LEED®-NC v2.2 E&A Credit 1 (New Construction) points.**

It is important to note that the quoted performance will change once the design is developed further. However, it gives the project team an idea of the expectation following an aggressive design. [Review section "Energy Performance Issues"]

Brief Modeling Description:

The following is a list, in no particular order, of some of the major modeling parameters accounted for at this stage. A more detailed line-by-line description of the differences between the "As-designed (DEC)" and "Initial Baseline (PRM)" energy simulations is shown in Figure 1.

- DOE Energy Information Administration published blended utility rates for New York State ($0.1543/kWh)
- Assumed a district steam rate of $25.00/MMBtu-delivered
- Utilizing typical meteorological year TMY2 hourly weather file for New York City, NY
- Utilized Title 24 approved diversity schedules for lighting, occupancy, plugs, process, etc.
- All envelop parameters (layer-by-layer assemblies, vertical glazings, programming, etc.)
- All internal loads (lighting, equipment "plugs", domestic hot water, occupancy, etc.)
- All external loads (climate zone, infiltration, solar transmitted, ground conductance, etc.)
- Photocells, occupancy sensors, CO_2, etc. / where anticipated
- All HVAC components (Chillers – ASHRAE 90.1, district steam, air-side equipment, controls, circulation loop infrastructure, settings, thermal zones, etc)
- Assumed on-site ASHRAE 90.1-2004 compliant chillers (per requirement for district system)
- All unknown parameters assumed to be ASHRAE 90.1-2004 Appendix G minimally compliant
- Water-cooled Synchrotron cooling neglected (i.e. ~2400 tons cooling, etc.); only energy uses of which can be controlled are included in addition to the LEED®-NC requirement for process energy
- Others…

DEC – "As-Designed"

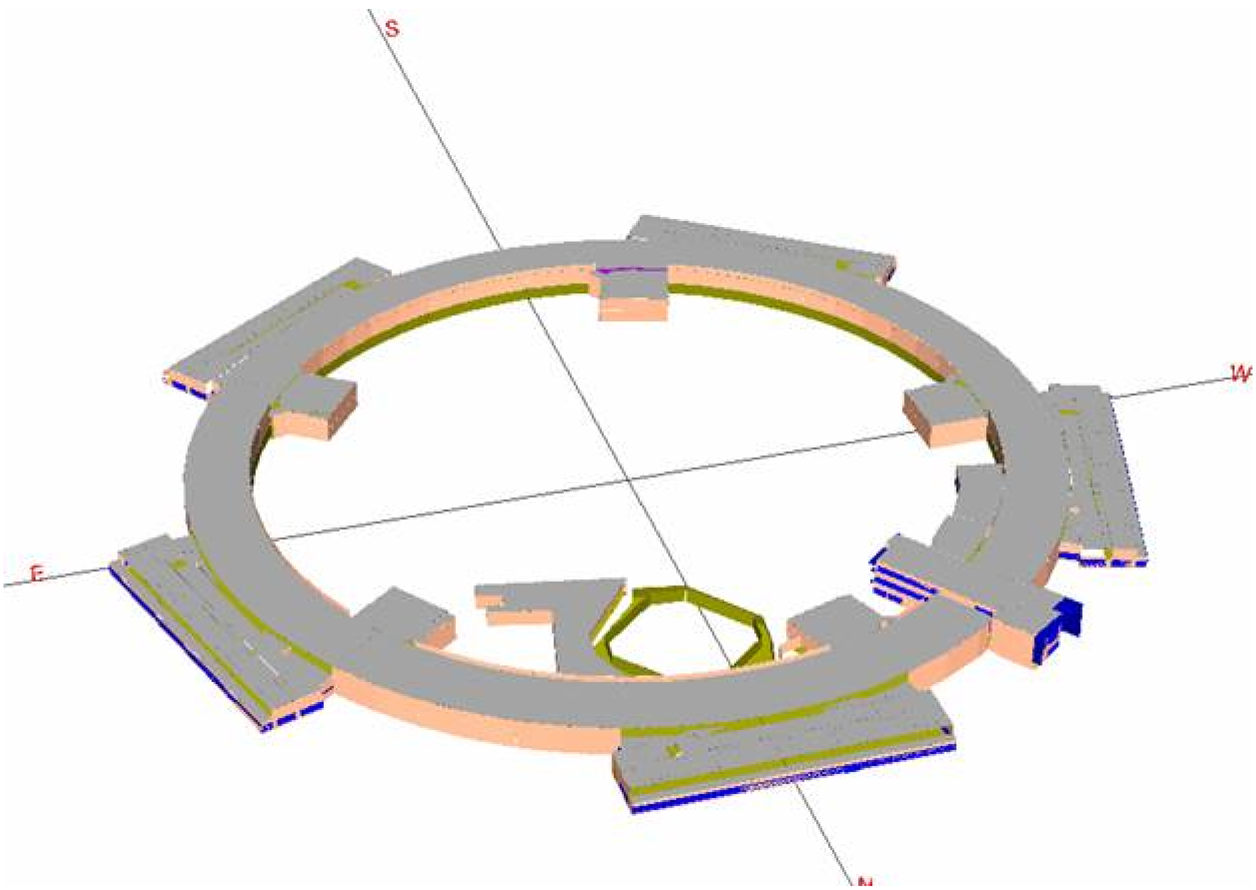

Figure 1: 3-D Energy Model Renderings of the Design Energy Cost

Energy Performance Issues:

This section of the memo is intended to highlight some of the energy performance "highlights" and energy "hogs" of which will work either for or against optimizing total energy cost savings for LEED®-NC v2.2 Energy & Atmosphere Credit 1. The following, in no particular order, is a list of key parameters that are both improving and reducing our energy performance related to the ASHRAE 90.1-2004 Appendix G Performance Rating Method:

Improved Energy Cost Performance

- Having high process energy and tight indoor thermal requirements (i.e. 1°F) enables the project to do rather well when compared to ASHRAE 90.1-2004 compliance
- Long Island is one of the only areas in New York that doesn't require air-side economizers. **Including economizers at a facility with high internal heat gains will pay huge dividends.** If the site was located elsewhere the annual energy cost savings would be significantly less (see "Energy Efficiency Opportunities")
- Outside air economizers (N.R. per ASHRAE climate zone 4a)
- Having tight thermal requirements for the Experimental Hall provides significant opportunity (more so than most projects) for energy cost savings with a significantly improved envelope

  Centria® Formawall®: **U-value = 0.045**
  (see "Appendix A")

  Metal Deck Roof: **U-value = 0.054**
  (High Albedo white roof w/ low absorptance)

  High Performance Glazing:
  U-value = 0.311 | SHGC =
  (BOD: Viracon VE 1-2M)

- High efficiency lighting for Experimental Hall (**0.8 W/sf**), Offices (**0.9 W/sf**), and Laboratories (**1.0 W/sf**)
- Daylighting and photocell control for perimeter LOB offices (N.R. per ASHRAE 90.1)

Reduced Energy Cost Performance

- Stringent requirement for Total Fan Power. **Assumed ASHRAE 90.1-2004 Appendix G fan power** (very important to confirm) – Designers should review the following:

  Appendix G Table G3.1.2.9
  Section G31.2.9
  Appendix G User's Manual (Pgs G-28, G-29)

- District steam does not provide the opportunity to generate plant level heating savings given no site level heating source (Appendix G3.1.1.1)
- District chilled water does not provide the opportunity to generate plant level heating savings given no site level heating source (Appendix G3.1.3.7)
- **Constant volume** AHUs for Laboratory spaces
- Other parameters are unknown and a judgment cannot be made either way as to their impact at this time

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Energy Efficiency Opportunities:

Variable Air Volume AHUs for Laboratories: Currently, the proposed facility is utilizing constant volume AHUs for the laboratories. If this is the case then the project cannot claim the energy cost savings associated with the sensible heat recovery since it will be required per ASHRAE 90.1-2004 G3.1.2.10. If VAV AHUs are utilized then the savings for ventilation energy or heat recovery can be claimed. Table 1 illustrates the savings associated with VAV AHUs equipped with variable speed drives.

Table 1. Savings Summary for EEO-1

EEO No.	Description	Electricity Savings (kWh)	Annual Steam Savings (MMBtu)	Annual Energy Cost Savings	Total % Cost Savings
1	VAV for Laboratories	129,777	-1	$19,977	1.1%

High Performance Glazings: As mentioned earlier, having tight thermal conditions in a large space volume opens up the opportunity for significant energy cost savings with improvements in the building envelope. The Experimental Hall is required to be maintained at 75°F year round with a 1.0°F tolerance. Therefore, there will be a significant amount of off-peak heating required and as such improving the glazing will generate energy cost savings. The basis-of-design for the "As-Designed" glazing is Viracon VE 1-2M or equivalent with improved conduction and reduced solar heat gain coefficient compared to that required by ASHRAE 90.1-2004 Climate Zone 4a. Table 2 illustrates the savings associated with VAV AHUs equipped with variable speed drives.

Table 2. Savings Summary for EEO-2

EEO No.	Description	Electricity Savings (kWh)	Annual Steam Savings (MMBtu)	Annual Energy Cost Savings	Total % Cost Savings
2	High Performance Glazings	45,439	764	$26,089	1.5%

Daylighting Control: Currently, the proposed design shows several photocells in the commons areas, laboratories, classrooms, and main stairwell. EMO has elected to itemize the energy cost savings associated with turning off electrical lighting for the perimeter LOB office space only where adequate natural light is sufficient in supporting the specific space's primary function. Table 3 illustrates the savings associated with a typical LOB perimeter office employing photocell control based on natural light.

Table 3. Brief Daylighting Statistics

Space	Percentage Lighting controlled	Foot Candle photocell setpoint	Peak Energy Reduction (Daylit hours)	Percentage Runtime Reduction (All hours)
LOB Perimeter Office	100%	50	79.0%	46.0%

Table 4 of this report illustrates the energy cost savings associated with this measure.

Table 4. Savings Summary for EEO-3

EEO No.	Description	Electricity Savings (kWh)	Annual Steam Savings (MMBtu)	Annual Energy Cost Savings	Total % Cost Savings
3	Daylighting (Perimeter Offices Only)	39,953	-37	$5,232	0.3%

Improved Building Envelope: Similar to that of EEO-2 an improved envelope will generate substantial savings at this site. EMO has itemized the savings with the improved wall assembly, roof assembly, and roof absorptance proposed for this project to illustrate the importance of the measure. Table 5 of this report illustrates the energy cost savings associated with this measure.

Table 5. Savings Summary for EEO-4

EEO No.	Description	Electricity Savings (kWh)	Annual Steam Savings (MMBtu)	Annual Energy Cost Savings	Total % Cost Savings
4	Improved Building Envelope	99,318	1,757	$59,231	3.2%

Air-side Economizers: Upton, New York is one of the only regions in New York State of which air-side economizers are not required (Climate Zone 4a). The savings for this measure are much higher than in a typical building given the high internal heat gains, substantial exterior surface area, and only 75°F cooling requirement. Table 6 of this report illustrates the energy cost savings associated with this measure.

Table 6. Savings Summary for EEO-5

EEO No.	Description	Electricity Savings (kWh)	Annual Steam Savings (MMBtu)	Annual Energy Cost Savings	Total % Cost Savings
5	Air-side Economizer	1,826,471	-354	$272,952	13.4%

Improved Lighting Efficiency: HDR is expecting to have low peak power densities for a significant portion of the building. The majority of the electrical lighting in this facility is that of the Experimental Hall. The ASHRAE Table 9.6.1 requirement for this Laboratory type space is a lighting power density (LPD-W/sf) of 1.40 W/sf. HDR has indicated that the Experimental Hall will be designed to an LPD of 0.80 W/sf (43% improvement). This will require an aggressive lighting design most likely including 5-lamp T5HO technology in lieu of HID or T8 lighting technologies. Furthermore, HDR is designing to 0.90 W/sf in the Offices and 1.00 W/sf in the LOB laboratories. Table 7 of this report illustrates the energy cost savings associated with improving the lighting as indicated.

Table 7. Savings Summary for EEO-6

EEO No.	Description	Electricity Savings (kWh)	Annual Steam Savings (MMBtu)	Annual Energy Cost Savings	Total % Cost Savings
6	Improved Lighting Efficiency	632,559	-871	$75,810	4.1%

Figure 2 and Figure 3 provide energy and cost by building end-use for the “Initial PRM” and “All EEOs” simulations.

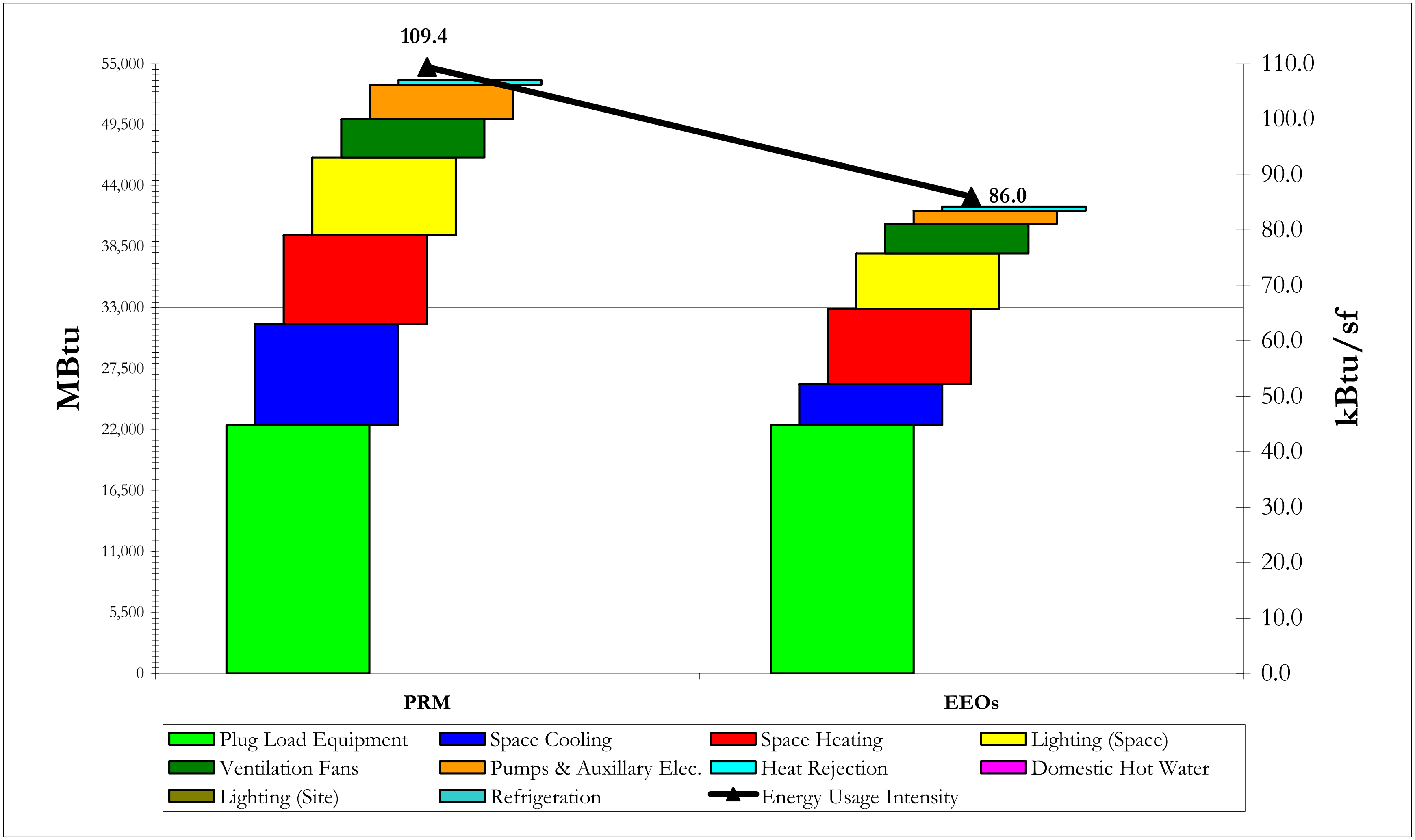


Figure 2: Energy End-Use Breakdown and Energy Usage Intensity

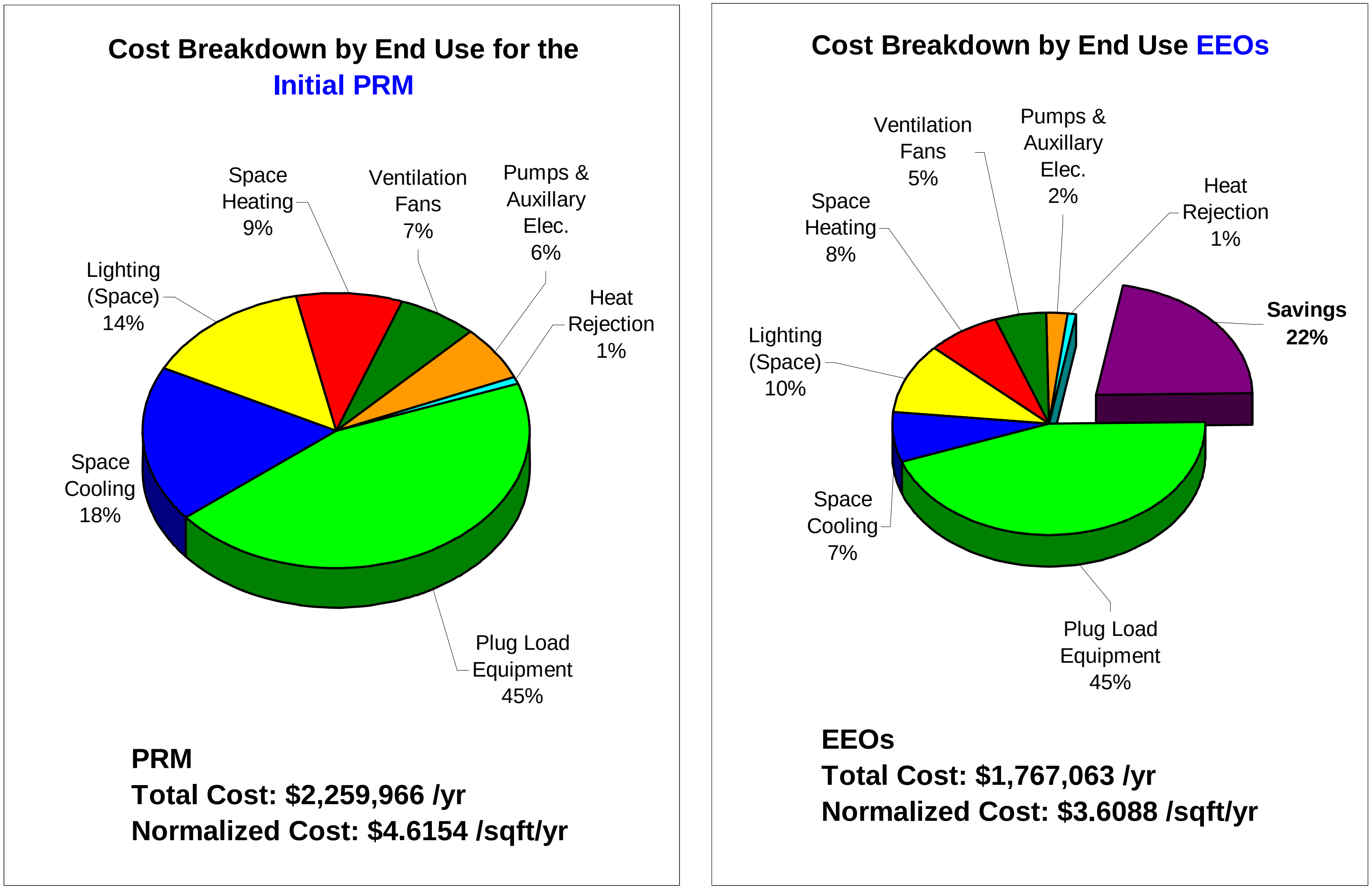


Figure 3: Energy Cost Breakdown by End-Use and Annual Utility Budgets

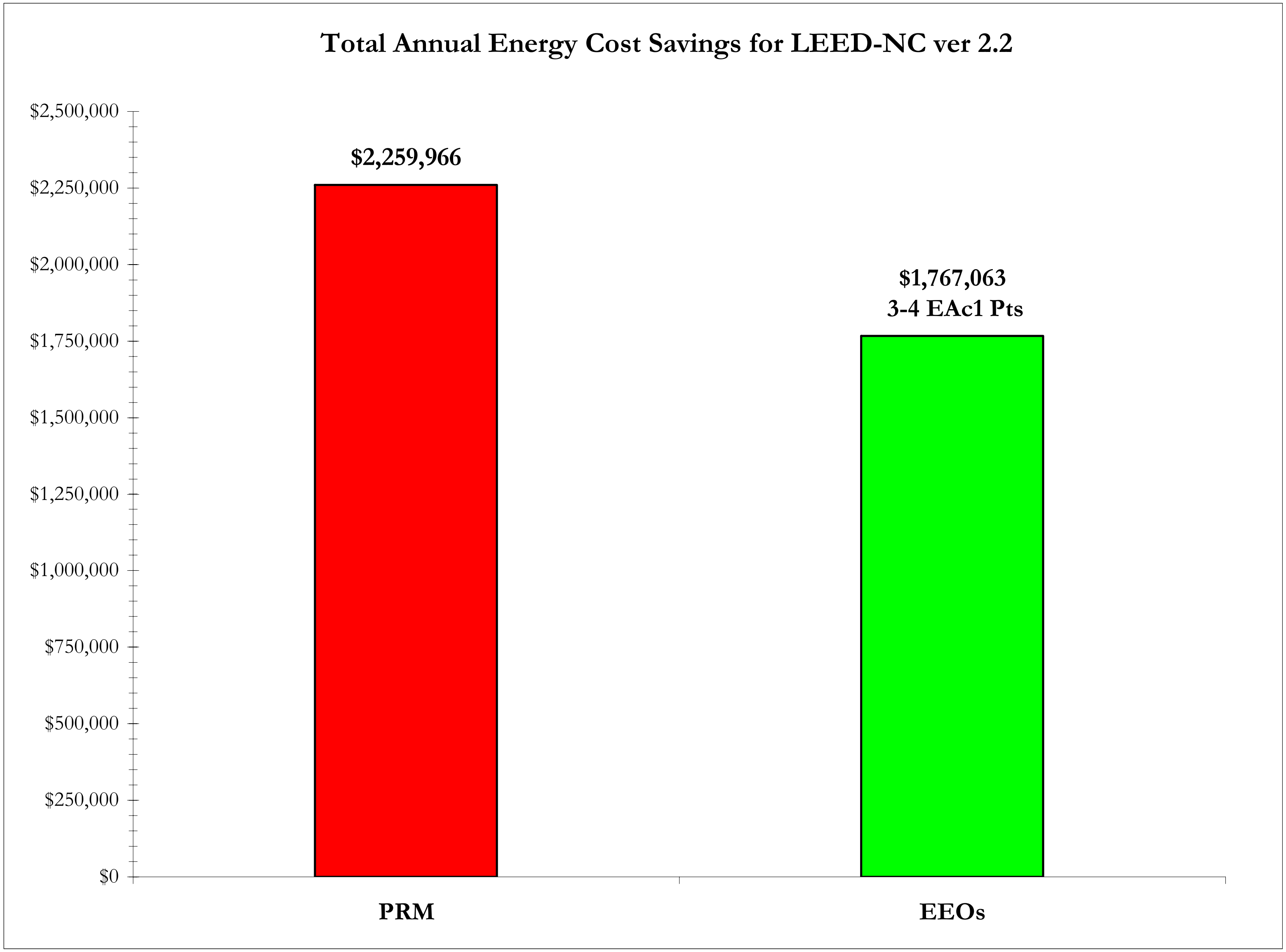
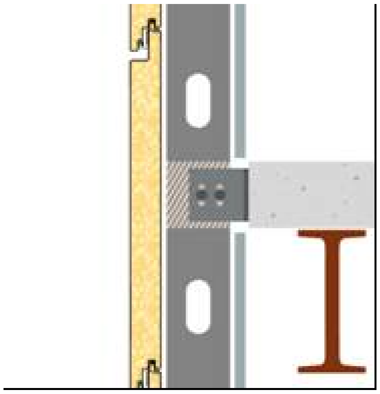
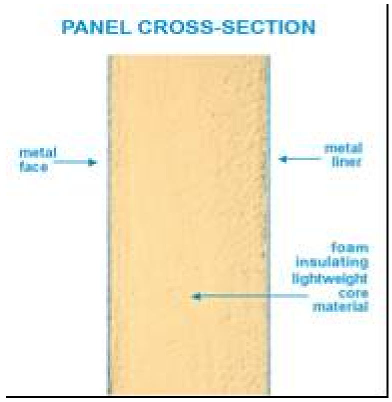


Figure 4: Annual Energy Cost and LEED-NC ver 2.2 Points

Appendix A: Centria® Formawall™





ASHRAE 90.1 R-Value Reductions Per ASTM C236 System Tests for Fiberglass Stud Insulation

Nominal Framing Depth	Nominal Insulation R-Value	x	Correction Factor	=	Effective R-Value
4" @ 16" o.c.	R-15		0.43		R-6.4
4" @ 24" o.c.	R-15		0.52		R-7.8
6" @ 16" o.c.	R-21		0.35		R-7.4
6" @ 24" o.c.	R-21		0.43		R-9.0

SUBSTANTIAL REDUCTIONS

LEED® Quick Hits

- Significantly reduces thermal bridging from outside-to-inside and conduction for drastically improved envelope assembly (**Total wall = R-22.2 | AHSRAE 90.1-2004 = R-8.1**). [LEED®-NC EA Cr.1]
- Opportunity for earning **LEED® Innovation Credit for utilizing a "Cradle-to-Cradle" certified building material**
- Formawall™ panels contain an average of at least **16% post-consumer and 6% post-industrial recycled content**. [LEED®-NC MR Cr 4.1 & 4.2]
- **Panels have a VOC content of 180 grams/liter**, which is less than the maximum limit of 250 grams/liter established by this regulation for architectural sealants. [LEED®-NC EQ Cr. 4.1]
- **No VOC's are generated at the jobsite** from field-painting operations. [LEED®-NC EQ Cr 4.2]