Final Geotechnical Engineering Structure Report
Final Plans for Review (FPFR) Submission
Southbound Busway Over I-84 West Bound On-Ramp
State Project 63-H137
Hartford, Connecticut

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January 22, 2010

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1.0 GENERAL INFORMATION

1.1 General

This report summarizes the final design subsurface exploration program, inferred subsurface conditions, and geotechnical analyses; and provides geotechnical engineering recommendations for foundation design for a proposed bridge structure for the Hartford North segment of the proposed New Britain-Hartford Busway (Busway). The bridge will carry the Southbound Busway over the I-84 Westbound On-Ramp in Hartford, Connecticut. The location of the proposed bridge is shown on Figure 1 (Appendix 1).

The Busway project entails the design and construction of a 9.4-mile corridor between downtown New Britain and downtown Hartford that follows an abandoned railroad right-of-way. The Busway will be a dedicated roadway that will be reserved for buses as part of the Bus Rapid Transit System (BRT).

The Hartford North segment of the Busway begins approximately 725 feet south of the proposed Sigourney Station at Sta. 450+00, and ends at-grade at Asylum Street at Sta. 490+55. The resulting project length along the baseline is approximately 4,055 feet or about 0.77 miles. This segment of the project is bordered to the south by the Hartford South segment.

H.W. Lochner is the Prime Designer for this section of the Busway. Geo**Design**, Inc. (Geo**Design**) is the Geotechnical Subconsultant to H.W. Lochner.

1.2 Datum

All elevations referenced in this report are in feet and are based on NGVD 1929. The coordinates are based on Connecticut Coordinate System, NAD 1983.

1.3 Existing Conditions

The new bridge will carry the proposed Southbound Busway over the existing I-84 Westbound On-Ramp from Capitol Avenue and under the I-84 Eastbound Off-Ramp to Asylum Avenue to facilitate the proposed Asylum Avenue touchdown while maintaining minimum vertical clearances. Existing grades along the I-84 Westbound On-Ramp beneath the proposed bridge are at approximately Elev. 27.

The proposed bridge will be constructed north of the existing Bridge No. 3305, which is reportedly constructed on shallow spread footings. Existing grades along the adjacent Amtrak railroad are at approximately Elev. 52. The existing railroad is non-electrified. Information regarding the existing railroad bridge was obtained from the 1963 design drawings.

Based on the Structure Type Study Report for the proposed bridge, it is anticipated that no utilities will be affected by the construction of the bridge. Figure 2 (Appendix 1) depicts existing and proposed site conditions.

1.4 Design Criteria

Foundation design recommendations are based on AASHTO Load and Resistance Factor Bridge Design Specifications, 4th Edition, 2007 (AASHTO LRFD) with Interim Specifications through 2008, and Connecticut Department of Transportation Geotechnical Engineering Manual, 2005 Edition. Recommendations are also based on State of Connecticut Department of Transportation (ConnDOT) Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 (2004). American Society for Testing and Materials (ASTM) publications were followed as the reference standards for all field and laboratory tests applicable.

1.5 Proposed Structure

In the area of the proposed bridge, the proposed Busway will diverge just south of existing Bridge No. 3305 and will touch down at the intersection of Asylum Street. Construction of the proposed bridge is necessary to carry the Southbound Busway traffic over the existing I-84 Westbound On-Ramp.

The new bridge will be a single-span, steel, multi-beam structure spanning approximately 78.5 feet between the two abutments that will accommodate one, 12-foot wide, lane of Southbound Busway traffic with shoulders and parapets. The new bridge will pass over the existing I-84 Westbound On-Ramp from Capitol Avenue at a skew of approximately 10 degrees and under the existing I-84 Eastbound Off-Ramp at a skew of about 70 degrees. We understand the roadway profile of the Busway has been selected to maximize vertical clearance to the structures above and below. The approximate location of the proposed bridge is shown on Figure 2 (Appendix 1). Figure 3 also depicts an elevation view of the proposed abutments.

2.0 GEOLOGY

Published geologic data for this locale indicate that an Alluvial deposit overlies a Glacial Till deposit, the prevalent surficial material in this area, below fill. These unconsolidated materials overlie bedrock of the Portland Arkose formation. These layers were formed in a bottom to top sequence; thus, the shallower a layer the younger its geological age.

2.1 Alluvial Deposit

Alluvial deposits consist of sediments deposited by present day streams. This deposit is a non-continuous layer with a varying thickness. It consists of fine to medium grained Sand/Silt, with some Clay and little Gravel.

2.2 Glacial Till

Glacial Till consists of a heterogeneous mixture of different sized particles. The composition of Till demonstrates a wide range of variation in particle size and distribution. Two extremes of these variations are stony till and clayey till. The former contains more than fifty percent of gravels, pebbles, cobbles and boulders. The latter consists of more than fifty percent of clay size particles.

2.3 Bedrock

The Portland Arkose formation, a sedimentary bedrock unit, is the dominating formation in this locale. Its texture ranges from coarse conglomerate to shale.

3.0 EXISTING GEOTECHNICAL INFORMATION

During the preliminary design phase in 2003, Baker Engineering N.Y. (Baker) and their subcontractors drilled two borings and performed soil laboratory testing in the area of the proposed bridge. In addition, boring data from explorations performed in 1963 for the design of the existing railroad bridge are available.

3.1 General

In 2003, Pilot Borings SB-97 and SB-98 were drilled and in 1963 Borings BH-171 through BH-176 were drilled in the general area of the bridge. Boring SB-97 is located southwest of the proposed bridge and Boring SB-98 is located southeast of the proposed bridge. The BH-Series borings were generally located southeast of the proposed bridge although Boring BH-171 was located near Abutment 1. The approximate locations of the Pilot Borings and the BH-Series borings are shown on Figure 2 (Appendix 2). The logs of the Pilot Borings and the BH-Series borings are included in Appendix 3 and 4, respectively.

3.2 Laboratory Test Data

Baker conducted one of each of the following laboratory tests on samples retrieved from Borings SB-97 and SB-98: moisture content, Atterberg Limits, gradation (Sieve and Hydrometer) analyses, and unconfined rock compression testing. The results from these tests are presented in Appendix 6. Details of each test and a discussion of the results are provided in Section 5.0.

4.0 SUBSURFACE EXPLORATIONS

Geo**Design** conducted additional subsurface explorations during final design. Details of these explorations are described in this section:

4.1 Test Borings

Geo**Design** coordinated the services of New England Boring Contractors of CT, Inc. (NEBC) to perform Standard Penetration Test (SPT, ASTM D 1586) borings at the proposed bridge site; five structure borings (B-02-1 through B-02-5) were drilled. Boring locations were initially field located by tape measurement and line of sight and then the Connecticut Department of Transportation (ConnDOT) survey crews recorded the locations and elevations of the borings by surveying the as drilled boring locations. As-drilled borings locations are shown on Figure 2 (Appendix 1) and boring logs are included in Appendix 2.

5.0 LABORATORY TESTING

Geo**Design** assigned laboratory tests to verify field classifications and evaluate soil corrosion potential of the Fill material. Testing was performed by Test-Con, Inc. of Danbury, Connecticut and included gradation analyses, sulfide content, pH, and Resistivity. The results of these tests are presented below and are included in Appendix 5. Laboratory testing was also performed by Baker in 2003. The results of these tests are presented below and are included in Appendix 6.

5.1 Atterberg Limits

In 2003, Baker performed two Atterberg Limit Tests; one on sample S-8 (depth 25.0' to 26.5') from Boring SB-97 and one on sample S-3 (depth 7.5' to 9.0') from Boring SB-98. Atterberg Limits (ASTM D 4318) provide the Liquid Limit (LL), the Plastic Limit (PL) and the Plasticity Index (PI) of cohesive soil samples. These tests can characterize cohesive soils and provide a reference to compare soil properties at different depths and locations. A description of the samples tested and the test results are presented below, which are within the range expected for the described materials.

Sample/Boring	Sample Description	PL	LL	PI
S-8/SB-97	Sandy, lean clay	14	23	9
S-3/SB-98	Sand	NP	NP	NP

*NP = Non-Plastic

5.2 Moisture Contents

In 2003, Baker performed four moisture content tests on samples S-4 (depth 13.5' to 15.0') and S-8 from Boring SB-97 and samples S-3 and S-6 (depth 16.5' to 18.0') from Boring SB-98. Moisture content (ASTM D 2216), like Atterberg Limits, provide an easy way to characterize and compare cohesive soils. Samples S-4 and S-8 from Boring SB-97 were described as silt with sand and samples S-3 and S-6 from Boring SB-98 were described as sand and gravelly silt with sand, respectively. The moisture contents from the samples were reported as 9.7, 9.9, 2.3, and 11.1 percent for samples S-4 and S-8 from Boring SB-97 and S-3 and S-6 from Boring SB-98, respectively. These results are within the range expected for the described materials.

5.3 Gradation Analyses

In 2003, Baker performed a gradation analysis on sample S-8 from Borings SB-97 and on sample S-3 from Boring SB-98. The gradation analyses indicate that sample S-8 consists of brown sandy lean clay with gravel (e.g. not varved clay) and sample S-3 consists of brown poorly graded sand.

Gradation analyses were also performed on samples obtained from recent borings. Gradation analyses were performed on samples S-1 and S-3 from Boring B-02-2 and on sample S-1 from Boring B-02-3. The gradation analyses indicate the samples tested ranged from silty sand to poorly graded sand with gravel.

5.4 pH, Sulfides Tests, and Resistivity

Three pH tests, three Sulfide tests, and one Resistivity test were performed on samples of the Fill from recent borings. The pH and Sulfide tests were performed on samples S-1, S-3 taken from Boring B-02-2 and sample S-1 taken from Boring B-02-3. The resistivity test was performed on sample S-1 taken from Boring B-02-2.

5.5 Unconfined Rock Compression Tests

In 2003, Baker performed one unconfined compression test on a bedrock rock sample taken from Boring SB-98. Unconfined Compression Tests (ASTM D 2938) provide an indication of intact rock core strength. The unconfined compression test result indicates the intact bedrock has a unit weight of approximately 161 pounds per cubic foot (pcf) and an unconfined compressive strength of approximately 6,230 psi.

6.0 SUBSURFACE CONDITIONS

6.1 Subsurface Profile

A subsurface profile is shown on Figure 3 (Appendix 1). This profile depicts the generalized subsurface conditions based on the existing and recent subsurface exploration data. The legend for the subsurface profile is included as Figure 4. Since the proposed bridge is narrow, we have not prepared transverse profiles at the abutments.

The soil and rock profile can be summarized as follows:

- **Asphalt -** 0 to 1 foot thick;
- **Fill -** 4 to 10 feet thick;
- **Glacial Till**- 8 to 20 feet thick;
- **Bedrock (Siltstone/Shale).**

Fill was encountered in all the borings. The thickness of the Fill varied from approximately 4 to 10 feet. The Fill generally consists of loose to very dense, fine to coarse sand with varying proportions of silt, and (where present) fine to coarse gravel, asphalt, brick fragments, and concrete (existing footing). Ash and/or cinders were not identified in the Fill in any of the borings.

Glacial Till was encountered in two (B-02-3 and B-02-5) of the borings. Where encountered, the thickness of the Glacial Till varied from approximately 4 to 20 feet with the thickness of the Glacial Till increasing from north to south. The Glacial Till generally consists of either fine to coarse sand and gravel or clayey silt. SPT "N" values indicate the density of this layer ranges from medium dense to very dense.

Bedrock was encountered between approximately Elev. 12 to 24 with the bedrock sloping slightly upward from north to south. Rock cores were taken in all of the borings. Rock Quality Designation (RQD) values ranged between 0 and 75 percent indicating very poor to good quality that generally improves with depth.

6.2 Geotechnical Design Parameters

Engineering design parameters of the subsurface soils were based on the boring data and/or on the laboratory test results. Total unit weights and internal friction angles for the Fill and Glacial Till were estimated to be 125 pcf and 32 degrees, and 135 pcf and 34 degrees, respectively.

6.3 Groundwater

During drilling, groundwater observations were made in the borings under the conditions stated on the logs. The observations indicate groundwater is at approximately Elev. 14.5 (approximately 13 feet below the existing ground surface) in the area in front of Abutment 1. Groundwater conditions will vary depending on factors such as temperature, season, precipitation, construction activity and other conditions, which may be different from those at the time of these readings.

7.0 GEOTECHNICAL ISSUES AND EVALUATION

7.1 Bridge Loads and Dimensions

Loads for the proposed structure were not available. However, based on the bridge dimensions and the design vehicular loading (HL-93) presented in the Structure Type Study Report by Baker Engineering, we anticipate live loads to be less than 100 kips and dead loads less than 500 kips. Based on the Structure Type Study, preliminary foundation sizes for the abutments are expected to be approximately 9 ft x 20 ft. The bottom of footing level for Abutment 1 is anticipated to be El. 23.0, and the bottom of footing level for Abutment 2 is anticipated to be El. 24.0.

7.2 Foundation Type Selection

The primary issue that impacts the foundation selection for proposed substructures are the nominal bearing of subgrade soils and the settlement of the superstructure under the anticipated loading.

Our evaluation of the subsurface conditions and our analyses considering the anticipated bridge loading and dimensions indicate that the proposed abutments can be supported on shallow spread footing foundations. We therefore recommend that both abutments be supported on shallow spread footings. We also recommend using a one-foot minimum thickness of compacted granular fill over either firm Glacial Till or Bedrock strata that are expected at footing level.

7.3 Settlement Analyses

We estimate that the abutments will experience total settlements up to approximately $^{1}/_{2}$ inch based on the anticipated loading and subsurface conditions. Settlement of the abutments is anticipated to be fairly uniform and, as such, differential settlement in the transverse direction is anticipated to be minimal and insignificant.

Based on the anticipated behavior of foundation materials, we anticipate that most of the substructure settlement will be immediate and will be completed prior to construction of the superstructure.

7.4 Soil Corrosion Potential

As noted in Section 5.4, pH, Sulfide, and Resistivity testing on samples collected from the borings were performed. The test results indicate a low potential for corrosion as pH levels ranged between 7.58 and 8.59, Sulfides were not detected, and Resistivity was 5,000 Ohm-cm.

7.5 Liquefaction Potential

Soils within and below the bearing zones of the substructures (i.e. Glacial Till and Bedrock) were analyzed with regard to their potential to liquefy during the AASHTO design seismic event for this locale. Based on their relative density and their fines content, the saturated soils are not considered susceptible to liquefaction in the event of a design earthquake.

7.6 Stability of Embankment Fills

Embankment fills are proposed as part of the construction of the new bridge. Anticipated fills have been evaluated for their potential impact to existing structures; particularly the existing ConnDOT Bridge No. 3305.

Limited filling is anticipated at the west wing walls of the proposed bridge; however, impacts to the existing railroad bridge are anticipated to be negligible. We do not anticipate the placement

of fill for the construction of Abutment 2 will have impacts on the existing railroad bridge or other existing structures. By inspection, the embankment fills are anticipated to be stable.

8.0 GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS

8.1 General Geotechnical Design Recommendations

Based on bottom of footing elevations between approximately Elev. 23 and 24, we anticipate that proposed shallow spread footing foundations will bear on either Glacial Till or Bedrock. We recommend that shallow spread footing foundations bear on a minimum of one-foot (12-inches) of compacted granular fill (Form 816, Article M.02.02) over these existing natural materials. If Fill or other deleterious materials are identified at foundation subgrade levels, such materials should be over-excavated to the top of firm Glacial Till or Bedrock and replaced with either compacted granular fill or crushed stone to proposed subgrade levels. The minimum limits of over-excavation and replacement should be at least one foot beyond the edges of the footings and extending down and away from the footings at a slope of 1V:1H.

8.2 Static Design Parameters

We recommend the following static design parameters:

8.2.1 General

- Unit weight of compacted backfill above the water table of 125 pcf
- Unit weight of compacted backfill below the water table of 62.6 pcf
- Backfill angle of internal friction, $\varphi = 32°$
- Load Factors should be selected from AASHTO LRFD Table 3.4.1-2.

8.2.2 Bearing

- Nominal Bearing Resistance = 14.0 kips per square foot (ksf)
- Bearing Resistance Factor (φ_b) = 0.45

8.2.3 Sliding/Overturning

- Sliding Coefficient = 0.55 (AASHTO LRFD Table 3.11.5.3-1)
- Coefficient of Friction for Soil against Wall ($\tan \delta$) = 0.40
- Coefficient of Passive Earth Pressure, $K_P = 3.5$
- Coefficient of Active Earth Pressure, $K_a = 0.28$
- Sliding Resistance Factor (φ_τ) = 0.8 (AASHTO LRFD Table 10.5.5.2.2-1)
- Calculations should assume a surcharge of 24 inches soil depth or 250 psf.

The recommended nominal bearing capacity and sliding/overturning parameters were determined based on a 12-inch thick compacted granular fill pad over firm, undisturbed Glacial Till or Bedrock.

AASHTO LRFD Section 4.7.4.1 states that the bridges located in Seismic Zone 1 need not be analyzed for seismic loads, regardless of their importance or geometry; accordingly, recommendations for dynamic lateral earth pressures are not provided.

8.3 Geotechnical Construction Recommendations

8.3.1 Site Access Limitations

There is ample staging area in the vicinity of the proposed bridge for construction activities. However, it should be noted that there is limited vertical clearance to work with under the existing I-84 Eastbound Off-Ramp especially during the construction of temporary lateral support systems for the protection of the railroad and erection of the bridge superstructure.

8.3.2 Demolition of Existing Foundations

Limited demolition of the existing railroad bridge wing walls will be required to construct the proposed bridge. Approximately 48 feet of the southwest wing wall and 11 feet of the northwest wing wall will have to be demolished. All other demolition to the existing railroad bridge is included as part of the rehabilitation for the Northbound Busway.

Demolished structures and substructures should be removed to the limits required and the area backfilled with compacted granular fill to subgrade levels.

8.3.3 Subgrade Preparation

Subgrade preparation for shallow spread footings should be conducted in such a way as to minimize disturbance in Glacial Till. The final six inches of excavation should be performed such that the subgrade remains essentially undisturbed. Construction operations should be planned to mitigate disturbance to the final subgrade. Disturbed subgrades should be over-excavated to firm stable ground and replaced by compacted granular fill or crushed stone wrapped in a non-woven filter fabric.

8.3.4 Protection of Existing Active Railroad

Excavations to construct shallow spread footing foundations at Abutment 1 and 2 (to Elev. 23 and 24, respectively) will require protection of the existing I-84 EB off-ramp piers. Based on soil and groundwater conditions, and depth to bedrock, we recommend that braced continuous steel sheet piling be used to provide the support of excavation (SOE) protection at Abutments 1 and 2. The bracing will require either inclined tie-backs with rock anchors or another bracing method. We recommend the following soil parameters for SOE design:

Existing Fill/Silty Sand

Total Unit Weight = 125 pounds per cubic foot (pcf)
Submerged Unit Weight = 63 pcf
Phi = 32 degrees
Ka = 0.31
Kp = 3.25

Varved Clay

Total Unit Weight = 115 pcf
Submerged Unit Weight = 53 pcf
Su (Undrained Shear Strength) = 1500 psf

Glacial Till

Total Unit Weight = 135 pcf
Submerged Unit Weight = 73 pcf
Phi = 34 degrees
Ka = 0.28
Kp = 3.54

8.3.5 Abutment Backfill Requirements

Abutments and wing walls should be designed to comply with ConnDOT Manual Standard, Plate Number 3.5.2 – U-Type wing wall or wall drainage and backfill requirements.

8.3.6 Vibrations and Construction-Induced Settlements

The subsurface conditions encountered do not indicate the presence of soils that are particularly susceptible to settlement-induced by vibrations from construction activities. In addition, we are not aware of existing structures that would be sensitive to vibrations from anticipated construction activities. Nonetheless, the existing railroad tracks should be monitored in accordance with Amtrak requirements.

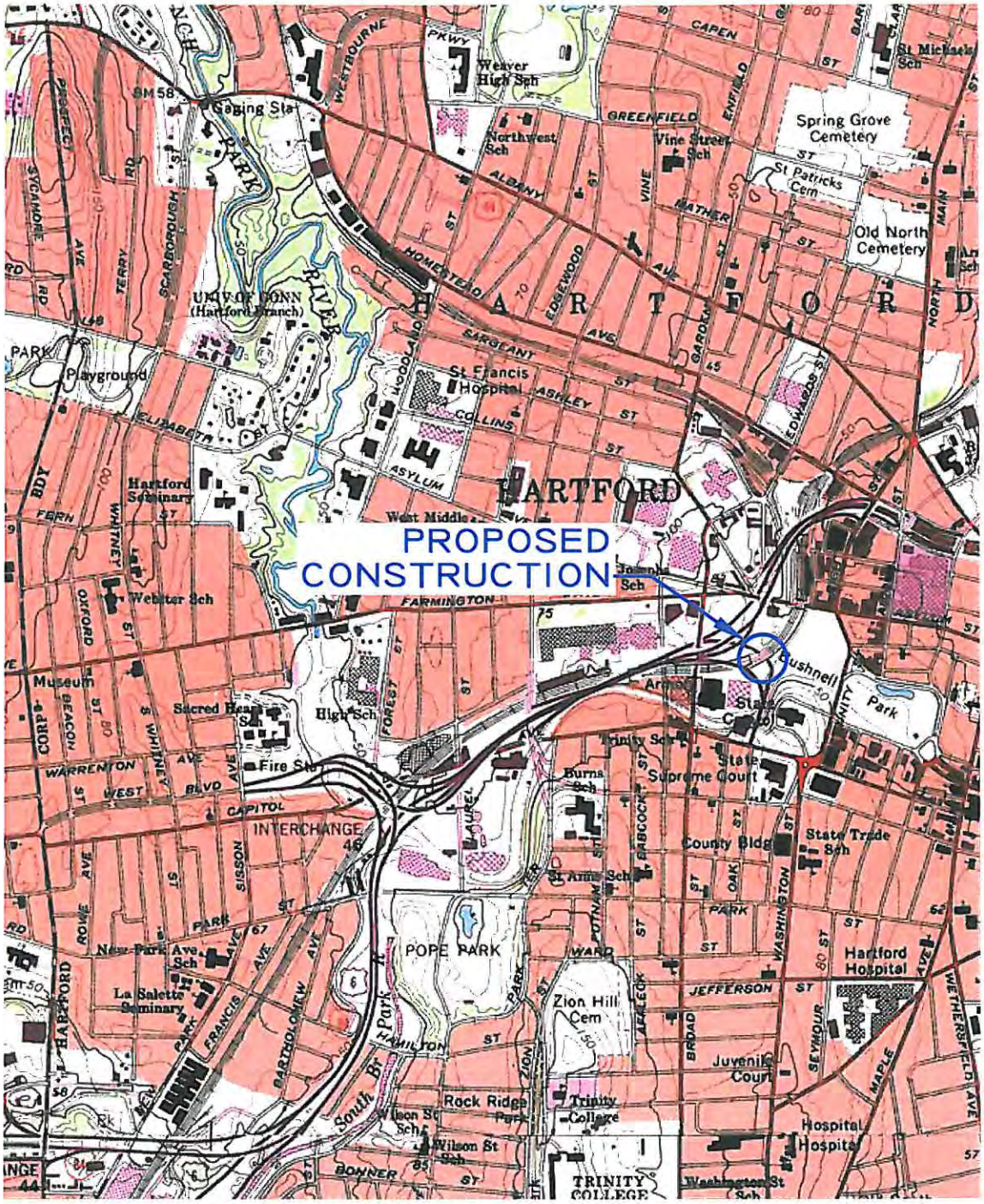
8.3.7 Special Provisions

Special provisions will be required to address vibration monitoring during sheet piling installation and track settlement monitoring.

9.0 LIMITATIONS

This report is subject to the limitations attached in Appendix 7.

Appendix 1
Figures



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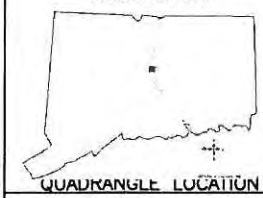
CONNECTICUT



QUADRANGLE LOCATION

SCALE IN FEET

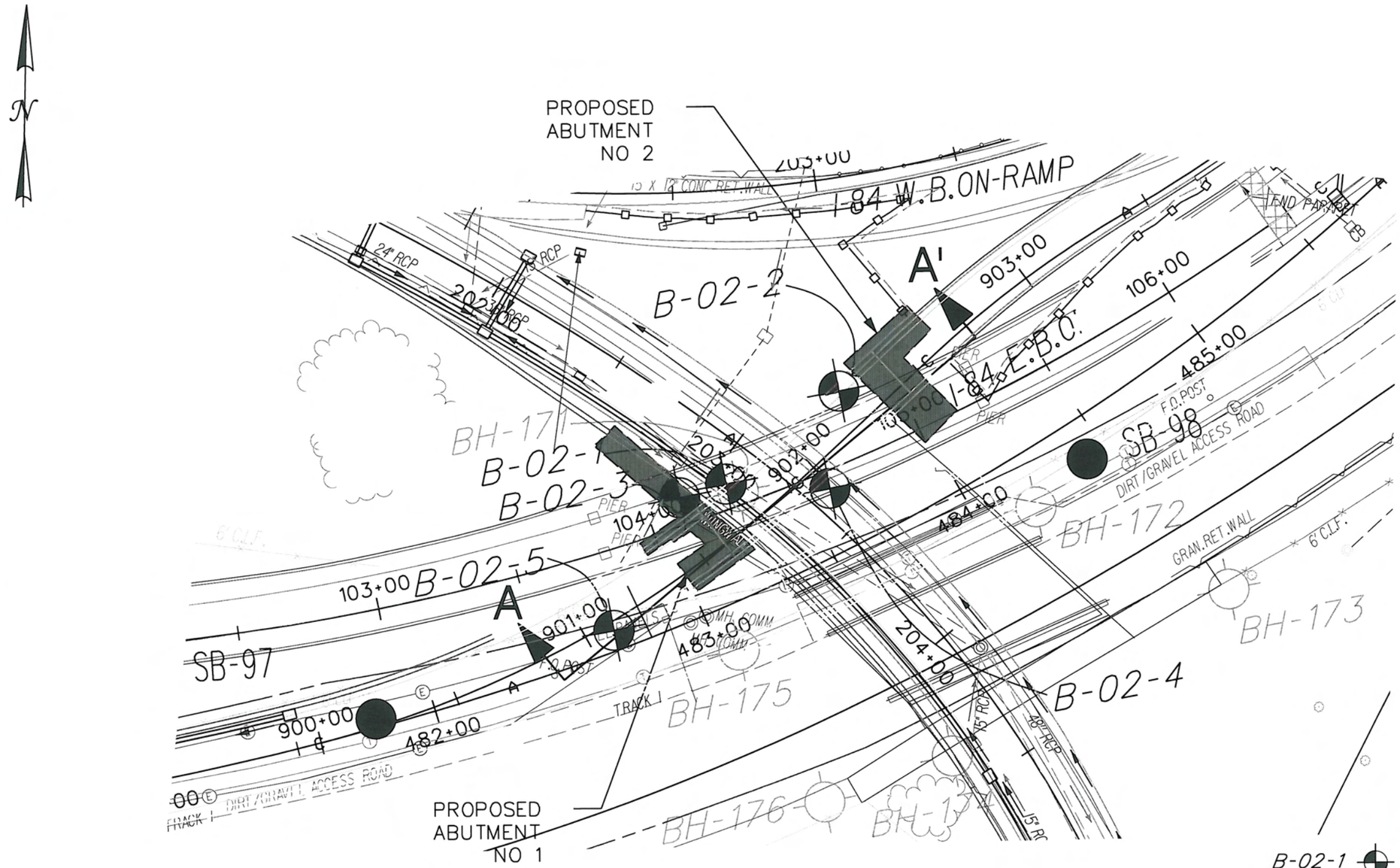
0 1000 2000 4000

PROJECT LOCATION PLAN
BUSWAY SB OVER I-84 WB ON-RAMP
NEW BRITAIN-HARTFORD BUSWAY
STATE PROJECT NO. 63-H137

REFERENCE:
U.S.G.S. 7.5 MINUTE QUADRANGLE: HARTFORD, CT.
Figure was created using TOPO! 2003 software

PROJECT NO. 0331-14
DATE: 1-05-09
FIGURE NO. 1

ACAD FILE No. M:\GL\331\14\CADD\Area Map - Broad Street AAR.dwg



LEGEND

B-02-1	2008 TEST BORING
SB-97	2003 TEST BORING
BH-171	1963 TEST BORING

DESIGNED BY	JWK
DRAWN BY	SMC
CHECKED BY	JWK
APPROVED BY	ULF

NO.	DATE		DRWN.	CHKD	APPVD

REVISIONS

BORINGS LOCATED BY CTDOT SURVEY.
SEE FIGURE 3 FOR GENERALIZED SUBSURFACE PROFILE A-A.

PRIME DESIGNER:

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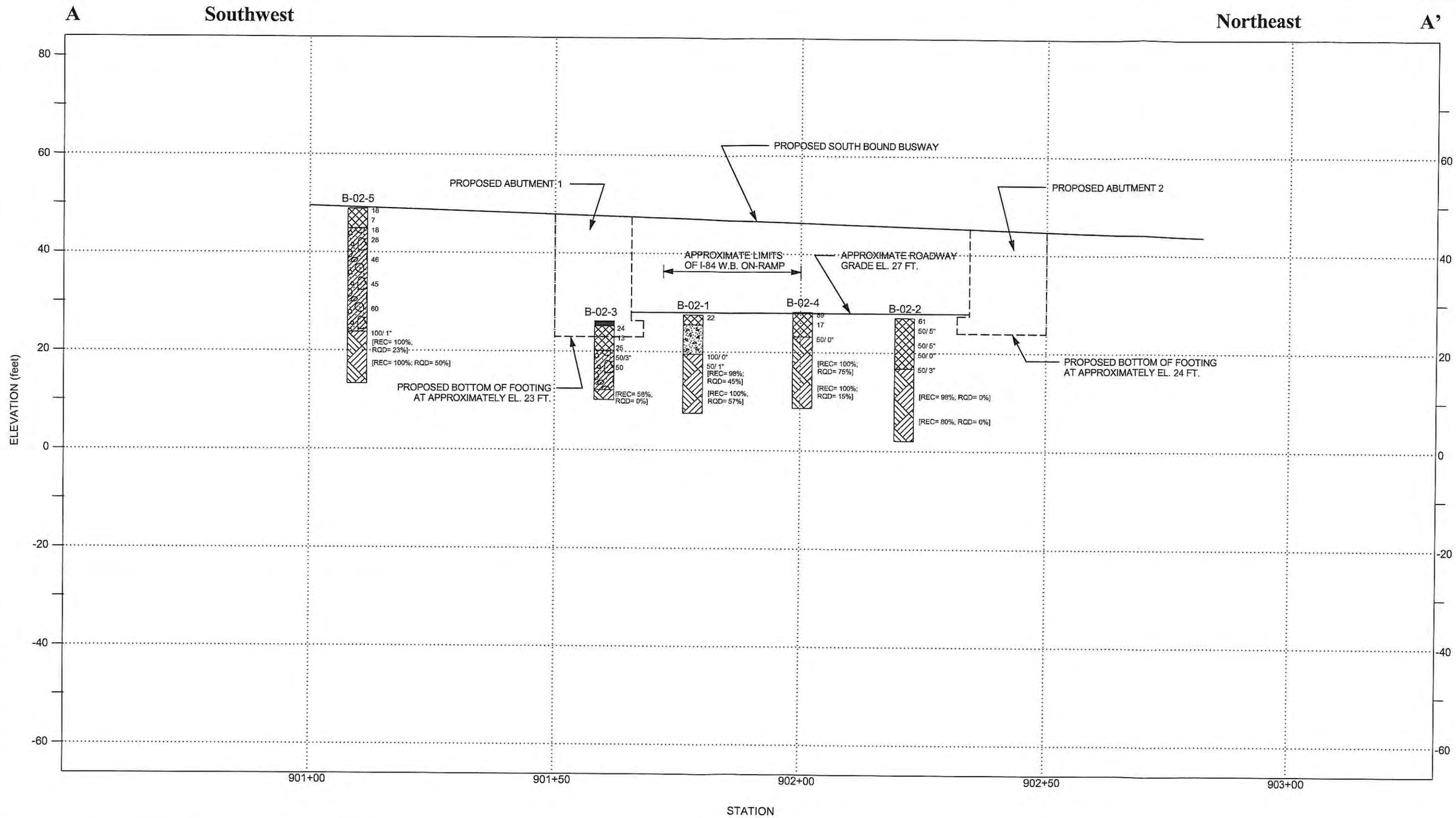
DWG. TITLE
SB BUSWAY OVER I-84 WB ON-RAMP
AS-DRILLED EXPLORATION LOCATION PLAN

PROJECT
NEW BRITAIN – HARTFORD BUSWAY
STATE PROJECT NO. 63-H137

FILE NO.	331-14
SCALE	1" = 40'
DATE	1-08-09
FIGURE NO.	2



GEO STANDARD 11 X 17 (2/19/04) BORING LOGS 2009.GPJ FBNWNL01.GDT 1/30/09

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0 20
Scale (feet)

Notes:
1. Data concerning the various strata have been interpreted at boring locations only. The stratigraphy between borings may vary from that shown.
2. Refer to plan view for subsurface profile location. For strata details and symbol legend see Figure 4, Subsurface Profile Legend, and boring logs appended to this report.
3. Numbers displayed beside boring(s) represent SPT "N" values corresponding to their respective sampling interval. Where coring was performed, numbers represent Recovery and RQD values.
4. Structure locations and ground surface profile approximate.

Date: 2/5/2009 | Drawn By: DSF | Reviewed By: JWK

SUBSURFACE PROFILE A-A'

SB Busway over I-84 WB On-Ramp
New Britain - Hartford Busway
State Project No. 63-H137

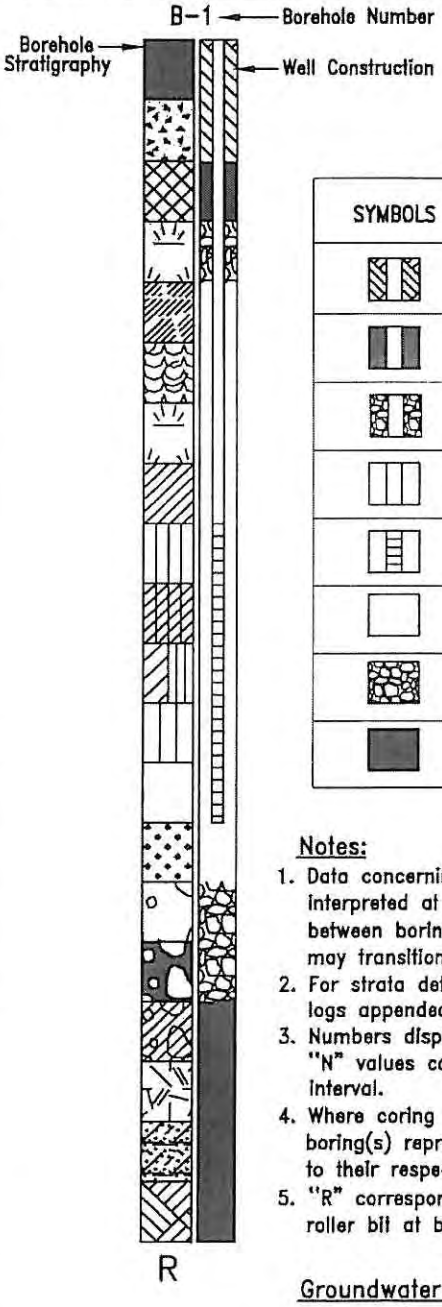
File No.: 0331-014.0 | Figure No.: 3

M:\CL\331\14CADD\331-14 SUBSURFACE PROFILE LEGEND.dwg

STRATIGRAPHY SYMBOLS

SYMBOLS	TYPICAL DESCRIPTIONS OF PREDOMINENT MATERIAL TYPE
	ASPHALT
	CONCRETE
	FILL
	TOPSOIL
	SUBSOIL
	ORGANIC SILT OR CLAY WITH SHELLS
	PEAT
	CLAY
	SILT
	CLAY/SILT MIXTURE
	CLAY/SILT/SAND MIXTURE
	SILT/SAND MIXTURE
	SAND/SILT MIXTURE
	POORLY-GRADED SAND
	WELL-GRADED SAND
	SAND/GRAVEL MIXTURE
	SAND/GRAVEL/SILT MIXTURE
	BOULDERS AND/OR COBBLES
	GLACIAL TILL
	DECOMPOSED BEDROCK
	SANDSTONE
	BEDROCK

EXPLANATION OF BORING



WELL SYMBOLS

SYMBOLS	TYPICAL DESCRIPTIONS
	CEMENT SEAL: 1 PIPE
	BENTONITE SEAL: 1 PIPE
	SLOUGH BACKFILL: 1 PIPE
	FILTER PACK: 1 PIPE
	SLOTTED PIPE WITH FILTER PACK: 1 PIPE
	FILTER PACK AT BOTTOM OF HOLE
	SLOUGH AT BOTTOM OF HOLE
	BENTONITE AT BOTTOM OF HOLE

Notes:

1. Data concerning the various strata have been interpreted at boring locations only. The stratigraphy between borings may vary from that shown, and may transition more gradually within borings.
2. For strata details, see Report and boring logs appended to this report.
3. Numbers displayed beside boring(s) represent SPT "N" values corresponding to their respective sampling interval.
4. Where coring was performed, numbers displayed beside boring(s) represent Recovery and RQD values corresponding to their respective sampling interval.
5. "R" corresponds to refusal of sampler, casing and/or roller bit at bottom of boring.

Groundwater Observations (where applicable)

▽ Water Level Reading at time of drilling.

▼ Water Level Reading after completing drilling.

GEODESIGN INCORPORATED

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NEW BRITAIN - HARTFORD BUSWAY
STATE PROJECT NO. 63-H137
FILE NO. 331-14
SUBSURFACE PROFILE LEGEND

DRAWN BY:	CHECKED BY:	DATE:	FIGURE NO.
SMC	JWK	12-16-08	4

Appendix 2
2008 Boring Logs
(B-Series)

Connecticut DOT Boring Report

Inspector: Garry Jacobson	Town: Hartford	Hole No.: B-02-1	
Engineer: Geo**Design**, Inc.	Project No.: 63-H137 / 0331-014.0	Stat./Offset:	
Start Date: 10-3-08	Route No.:	Northing: 839954.7	
Finish Date: 10-3-08	Bridge No.:	Easting: 1018018.1	
		Surface Elevation: 27.5	

Project Description: New Britain / Hartford Busway - Busway SB Over I-84 WB On-Ramp

Casing Size/Type: 3"/NW	Sampler Type/Size: SS / 1 3/8"	Core Barrel Type: NQ
Hammer Wt.: Fall:	Hammer Wt.: 140 lbs. Fall: 30"	

Groundwater Observations: @13 feet

Depth (ft)	Sample Type/No.	Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Generalized Strata Description	Material Description and Notes	Elevation (ft)
0	S-1	6 10 12 60	24	14		Fill	Medium dense, red brown fine to coarse SAND and SILT, little Gravel, trace Clay	
						Concrete		25
5								
								20
	S-2	100/ 0"	0	0		Bedrock		
10	S-3	50/ 1"	1	1			Very dense, red brown weathered SILTSTONE	
	C-1		60	59	45		Poor quality, moderately hard, slightly weathered, red brown, aphanitic SILTSTONE. Primary (bedding plane) joint set is low angle, 1" to 8" spacing, several high angle joints are rough and curved	15
15	C-2		60	60	57		Fair quality, moderately hard, slightly weathered, gray, aphanitic SILTSTONE. Primary (bedding plane) joint set is low angle, 1" to 8" spacing, several high angle joints are rough and curved	10
20							END OF BORING 20ft	
								5
25								

Sample Type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1 - 10%, Little = 10 - 20%, Some = 20 - 35%, And = 35 - 50%

Total Penetration in Earth: 10ft Rock: 10ft	NOTES: Switched to NW casing at 9.9 feet Used solid auger to grind through apparent concrete footing from 2 to 8 feet.	Sheet 1 of 1
No. of Soil Samples: 3 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Inspector: Garry Jacobson	Town: Hartford	Hole No.: B-02-2	
Engineer: Geo**Design**, Inc.	Project No.: 63-H137 / 0331-014.0	Stat./Offset:	
Start Date: 10-2-08	Route No.:	Northing: 839999.1	
Finish Date: 10-2-08	Bridge No.:	Easting: 1018068.5	
		Surface Elevation: 27.1	

Project Description: New Britain / Hartford Busway - Busway SB Over I-84 WB On-Ramp

Casing Size/Type: 4"/HW, 3"/NW	Sampler Type/Size: SS / 1 3/8"	Core Barrel Type: NQ
Hammer Wt.: Fall:	Hammer Wt.: 140 lbs. Fall: 30"	

Groundwater Observations: @None observed

Depth (ft)	Sample Type/No.	Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Generalized Strata Description	Material Description and Notes	Elevation (ft)
0						Fill		
	S-1	2 21 40 52	24	16			Very dense, brown to red brown, fine to coarse SAND, some Silt	
	S-2	50/ 5"	5	0				25
5	S-3	50/ 5"	5	4			Very dense, red brown fine to coarse SAND, some Silt, little Gravel, (wet)	
	S-4	50/ 0"	0	0				20
10	S-5	50/ 3"	3	2			Very dense, red brown fine to coarse SAND, some Silt, trace decomposed Siltstone	
						Bedrock		15
15	C-1		60	59	0		Very poor quality, moderately weathered, moderately hard, red brown to gray aphanitic SILTSTONE, primary (bedding plane) joints are horizontal 1/2 to 3" spacing. Coring time (Min/Ft) 1,4,4,4,4	10
20	C-2		60	48	0		Very poor quality, moderately weathered, moderately hard, red brown, gray aphanitic SILTSTONE Coring time (Min/Ft) 4,2,4,4,4	5
25							END OF BORING 25ft	

Sample Type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1 - 10%, Little = 10 - 20%, Some = 20 - 35%, And = 35 - 50%

Total Penetration in Earth: 15ft Rock: 10ft	NOTES: HW casing used from 0' to 5' NW casing used from 5' to 14"	Sheet 1 of 1
No. of Soil Samples: 5 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Inspector: Garry Jacobson	Town: Hartford	Hole No.: B-02-3	
Engineer: Geo**Design**, Inc.	Project No.: 63-H137 / 0331-014.0	Stat./Offset:	
Start Date: 10-3-08	Route No.:	Northing: 839961.6	
Finish Date: 10-3-08	Bridge No.:	Easting: 1018033.6	
		Surface Elevation: 26.2	

Project Description: New Britain / Hartford Busway - Busway SB Over I-84 WB On-Ramp

Casing Size/Type: 4"/HW, 3"/NW	Sampler Type/Size: SS / 1 3/8"	Core Barrel Type: NQ
Hammer Wt.: Fall:	Hammer Wt.: 140 lbs. Fall: 30"	

Groundwater Observations: @None observed

Depth (ft)	Sample Type/No.	Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Generalized Strata Description	Material Description and Notes	Elevation (ft)
0						Pavement	Asphalt over gravel base	
						Fill		25
	S-1	18 15 9 5	24	12			Medium dense, gray fine to coarse SAND and GRAVEL, little Silt	
	S-2	11 6 7 8	24	16			Medium dense, gray fine to coarse SAND and GRAVEL, little Silt	
5							Medium dense	
	S-3	9 10 15 24	24	18			Top 6": gray fine to coarse SAND and GRAVEL, little Silt	20
	S-4	50/3"	3	3			Bottom 6": red brown fine to medium SAND, trace Silt	
							Very dense, brown coarse GRAVEL and fine to coarse SAND, little Silt	
							Top 4": Very dense, brown coarse GRAVEL and fine to coarse SAND, little Silt	
10	S-5	7 16 34 38	24	14		Glacial Till	Bottom 10": Very dense, red brown fine to coarse SAND and GRAVEL, little Silt	15
						Bedrock	Very poor quality, moderately to highly weathered, moderately hard, red brown aphanitic SILTSTONE with horizontal jointing at 1/2 to 3 inch spacing.	
15	C-1		24	14	0		Coring time(Min./Ft.) 3,2	10
							END OF BORING 16.2ft	
20								5
25								

Sample Type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1 - 10%, Little = 10 - 20%, Some = 20 - 35%, And = 35 - 50%

Total Penetration in Earth: 14ft Rock: 2ft	NOTES: HW casing used from 0 to 5 feet NW casing used from 5 to 14 feet Rollerbit refusal at approximately 14 feet	Sheet 1 of 1
No. of Soil Samples: 5 No. of Core Runs: 1		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Inspector:	Garry Jacobson	Town:	Hartford	Hole No.:	B-02-4
Engineer:	Geo**Design**, Inc.	Project No.:	63-H137 / 0331-014.0	Stat./Offset:	
Start Date:	10-3-08	Route No.:		Northing:	839964.8
Finish Date:	10-3-08	Bridge No.:		Easting:	1018069.8
				Surface Elevation:	28.2

Project Description: New Britain / Hartford Busway - Busway SB Over I-84 WB On-Ramp

Casing Size/Type: 3"/NW	Sampler Type/Size: SS / 1 3/8"	Core Barrel Type: NQ
Hammer Wt.: Fall:	Hammer Wt.: 140 lbs. Fall: 30"	

Groundwater Observations: @None observed

Depth (ft)	Sample Type/No.	Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Generalized Strata Description	Material Description and Notes	Elevation (ft)
0						Fill		
	S-1	40 47 42 33	24	18			Very dense, red brown fine to medium SAND, some Silt, little Gravel	
	S-2	13 9 8 60	24	14			Top 8": Medium dense, red brown fine to medium SAND, trace Silt Middle 4": Medium dense, gray GRAVEL Bottom 6": Very dense, red brown fine to coarse SAND, little Silt	25
5	S-3	50/ 0"	0	0		Bedrock		
								20
10	C-1		60	60	75		Good quality, medium hard, slighty weathered, red brown, aphanitic SILTSTONE. Primary (bedding joints) joints are low angle 2-12" spacing. Coring time (min./ft.): 6, 6, 6, 6, 6	15
15	C-2		60	60	15		Very poor quality, medium hard, moderately weathered, red brown, aphanitic SILTSTONE. Primary joints are low angle 1-4" spacing Coring time (min./ft.): 6, 6, 6, 6, 6	10
20							END OF BORING 19.5ft	

Sample Type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1 - 10%, Little = 10 - 20%, Some = 20 - 35%, And = 35 - 50%

Total Penetration in Earth: 9.5ft Rock: 10ft	NOTES:	Sheet 1 of 1
No. of Soil Samples: 3 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Inspector:	Dan Farstad	Town:	Hartford	Hole No.:	B-02-5
Engineer:	Geo**Design**, Inc.	Project No.:	63-H137 / 0331-014.0	Stat./Offset:	
Start Date:	10-16-08	Route No.:		Northing:	839905.4
Finish Date:	10-17-08	Bridge No.:		Easting:	1018001.2
				Surface Elevation:	48.9

Project Description: New Britain / Hartford Busway - Busway SB Over I-84 WB On-Ramp

Casing Size/Type: 3 1/4" HSA	Sampler Type/Size: SS / 1 3/8"	Core Barrel Type: NQ
Hammer Wt.: Fall:	Hammer Wt.: 140 lbs. Fall: 30"	

Groundwater Observations: @None observed

Depth (ft)	Sample Type/No.	Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Generalized Strata Description	Material Description and Notes	Elevation (ft)
0	S-1	3 10 8 12	24	6		Fill	Medium dense, red brown fine to medium SAND, little Gravel, little Silt, trace Brick	
	S-2	3 4 3 6	24	12			Loose, brown fine to medium SAND, trace Silt	45
5	S-3	4 8 10 16	24	2		Glacial Till	Medium dense, red brown Clayey SILT, little fine to coarse Sand	
	S-4	7 12 16 22	24	10			Medium dense, red brown Clayey SILT, some Gravel, little fine to coarse Sand	40
10	S-5	17 21 25 29	24	22			Dense, red brown Clayey SILT, some Gravel, little fine to coarse Sand	35
15	S-6	17 20 25 31	24	24			Dense, red brown Clayey SILT, some Gravel, little fine to coarse Sand	30
20	S-7	21 29 31 38	24	24			Very dense, red brown Clayey SILT, some Gravel, little fine to coarse Sand	25
25								

Sample Type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1 - 10%, Little = 10 - 20%, Some = 20 - 35%, And = 35 - 50%

Total Penetration in Earth: 25.6ft Rock: 10ft	NOTES:	Sheet 1 of 2
No. of Soil Samples: 8 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Inspector: Dan Farstad	Town: Hartford	Hole No.: B-02-5	
Engineer: Geo**Design**, Inc.	Project No.: 63-H137 / 0331-014.0	Stat./Offset:	
Start Date: 10-16-08	Route No.:	Northing: 839905.4	
Finish Date: 10-17-08	Bridge No.:	Easting: 1018001.2	
		Surface Elevation: 48.9	

Project Description: New Britain / Hartford Busway - Busway SB Over I-84 WB On-Ramp

Casing Size/Type: 3 1/4" HSA	Sampler Type/Size: SS / 1 3/8"	Core Barrel Type: NQ
Hammer Wt.: Fall:	Hammer Wt.: 140 lbs. Fall: 30"	

Groundwater Observations: @None observed

Depth (ft)	SAMPLES: Sample Type/No.	Blows on Sampler per 6 inches	Pen. (in.)	Rec. (in.)	RQD %	Generalized Strata Description	Material Description and Notes	Elevation (ft)
25	S-8	100/ 1"	1	1		Bedrock	Very dense, red brown weathered SILTSTONE	
	C-1		60	60	23		Very poor quality, moderately hard, slightly weathered, red brown, SILTSTONE Coring time (min./ft.): 2, 3, 3, 5, 3	20
30	C-2		60	60	50		Poor quality, moderately hard, slightly weathered, red brown, SILTSTONE Coring time (min./ft.): 3, 3, 4, 3, 3	15
35							END OF BORING 35.6ft	10
40								5
45								0
50								

Sample Type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test

Proportions Used: Trace = 1 - 10%, Little = 10 - 20%, Some = 20 - 35%, And = 35 - 50%

Total Penetration in Earth: 25.6ft Rock: 10ft	NOTES:	Sheet 2 of 2
No. of Soil Samples: 8 No. of Core Runs: 2		SM-001-M REV. 1/02

Appendix 3
2003 Boring Logs
(SB-Series)

Driller: Seth Murkette/GZA	**Connecticut DOT Boring Report**	Hole No.: **SB-97**
Inspector: Rachael Marks	Town: West Hartford / Hartford, CT	Stat./Offset:
Engineer: Baker Engineering	Project No.: 171-0305	Northing: 839863.9
Start Date: 7/25/03	Route No.:	Easting: 1017922.6
Finish Date: 7/28/03	Bridge No.:	Surface Elevation: 49.1

Project Description: New Britain to Hartford Busway

Casing Type/Size: HW/4"	Sampler Type/Size: SS/1-3/8"	Core Barrel Type: NQ/1-7/8"I.D.
Hammer Wt.: 300 Fall: 24"	Hammer Wt.: 140 Fall: 30"	

Groundwater Obs. @ 29.9 after: 0 hours, @6.0 after: 48 hours, @ after: hours

Baker Info: S.O. Number: B25624LPDSOIL41802/42002 File: northern Template: CDOT_E (LD4 1/03)

Depth (ft.)	Sample Type/No.	Blows on Sampler per 0.5 ft.	Pen. (ft.)	Rec. (ft./%)	RQD (ft./%)	Generalized Strata Description	Material Description and Notes	Elevation (ft.)
0								49
1	A-N		1.5					48
2	S-1	14 14 16	1.5	0.3			SILT WITH SAND (ML) - dark gray silt, some fine sand, trace clay, trace gravel; moist, dense, NP; (FILL).	47
3								46
4	A-N		1.5					45
						4.5'	ELEV. 44.6	
5	S-2	7 9 14	1.5	0.3			WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM) - brown fine to coarse sand, some silt, some fine gravel; moist, medium dense, NP; (FILL).	44
6								43
7								42
8	W-N		4.0				NO SAMPLE AT 7.5' - CASING PLUGGED	41
9								40
10						10.0'	ELEV. 39.1	39
11	S-3	7 12 17	1.5	0.4			SILT WITH SAND (ML) - reddish brown silt, some fine to coarse sand; moist, medium dense, NP.	38
12								37
13	W-N		2.0					36
14	S-4	16 20 24	1.5	1.0			SILT WITH SAND (ML) - reddish brown silt, some fine to coarse sand; moist, dense, NP.	35
15								34
16	W-N		1.5					33
17	S-5	9 17 22	1.5	0.9			SILT WITH SAND (ML) - reddish brown silt, some fine to coarse sand; moist, dense, NP.	32
18								31
19	W-N		1.5					30
		8				19.5'	ELEV. 29.6	

Sample Type: S=Split Spoon C=Core UP=Undisturbed Piston V=Vane Shear Test A=Auger

Proportions Used: Trace = 1 - 10%, Little = 10 -20%, Some = 20 - 35%, And = 35 - 50%

Total Penetration in Earth: 39.0' Rock: 10.0' No. of Samples: 10	NOTES:	Sheet 1 of 3 SM-001-M REV. 1/0

Driller: Seth Murkette/GZA	**Connecticut DOT Boring Report**	Hole No.: **SB-97**
Inspector: Rachael Marks	Town: West Hartford / Hartford, CT	Stat./Offset:
Engineer: Baker Engineering	Project No.: 171-0305	Northing: 839863.9
Start Date: 7/25/03	Route No.:	Easting: 1017922.6
Finish Date: 7/28/03	Bridge No.:	Surface Elevation: 49.1

Project Description: New Britain to Hartford Busway

Casing Type/Size: HW/4"	Sampler Type/Size: SS/1-3/8"	Core Barrel Type: NQ/1-7/8"I.D.
Hammer Wt.: 300 Fall: 24"	Hammer Wt.: 140 Fall: 30"	

Groundwater Obs. @ 29.9 after: 0 hours, @6.0 after: 48 hours, @ after: hours

Baker Info: S.O. Number: B25624LPDSOIL41802/42002 File: northern Template: CDOT_E (LD4 1/03)

Depth (ft.)	Sample Type/No.	Blows on Sampler per 0.5 ft.	Pen. (ft.)	Rec. (ft./%)	RQD (ft./%)	Generalized Strata Description	Material Description and Notes	Elevation (ft.)
20	S-6	20 24	1.5	0.9			SILT WITH SAND (ML) - reddish brown silt, some fine to coarse sand, some fine to medium gravel; moist, dense, NP; (TILL).	29
21								28
22	W-N		1.5					27
23	S-7	14 23 32	1.5	0.0			NO RECOVERY ON S-8	26
24	W-N		1.0					25
25	S-8	14 21 27	1.5	1.5			SILT WITH SAND (ML) - reddish brown silt, some fine to coarse sand, trace fine gravel; moist, dense, NP; (TILL).	24
26								23
27	W-N		2.0					22
28								21
29	S-9	27 6 50	1.5	0.5			SILT WITH SAND (ML) - reddish brown silt, some fine to coarse sand, some fine gravel; moist, very dense, NP; (TILL).	20
30								19
31								18
32	W-N		5.0					17
33								16
34								15
35	S-10	16 31 70	1.5	1.0			SILT WITH SAND (ML) - reddish brown silt, some fine to coarse sand, some fine gravel; moist, very dense, NP; (TILL).	14
36								13
37	W-N		2.5					12
38								11
39				4.0	0.35	39.0'	ELEV. 10.1 SHALE; gray, soft, highly weathered, with calcite	10

Sample Type: S=Split Spoon C=Core UP=Undisturbed Piston V=Vane Shear Test A=Auger

Proportions Used: Trace = 1 - 10%, Little = 10 -20%, Some = 20 - 35%, And = 35 - 50%

Total Penetration in Earth: 39.0' Rock: 10.0' No. of Samples: 10	NOTES:	Sheet 2 of 3

SM-001-M REV. 1/

Driller: Seth Murkette/GZA	**Connecticut DOT Boring Report**	Hole No.: **SB-97**
Inspector: Rachael Marks	Town: West Hartford / Hartford, CT	Stat./Offset:
Engineer: Baker Engineering	Project No.: 171-0305	Northing: 839863.9
Start Date: 7/25/03	Route No.:	Easting: 1017922.6
Finish Date: 7/28/03	Bridge No.:	Surface Elevation: 49.1
Project Description: New Britain to Hartford Busway		
Casing Type/Size: HW/4"	Sampler Type/Size: SS/1-3/8"	Core Barrel Type: NQ/1-7/8"I.D.
Hammer Wt.: 300 Fall: 24"	Hammer Wt.: 140 Fall: 30"	

Groundwater Obs. @ 29.9 after: 0 hours, @6.0 after: 48 hours, @ after: hours

Baker Info: S.O. Number: B25624LPDSOIL41802/42002 File: northern Template: CDOT_E (LD4 1/03)

Depth (ft.)	Sample Type/No.	Blows on Sampler per 0.5 ft.	Pen. (ft.)	Rec. (ft./%)	RQD (ft./%)	Generalized Strata Description	Material Description and Notes	Elevation (ft.)
40							inclusions and slickensides.	9
41	C-1		5.0					8
42								7
43				80%	7%			6
44				5.0	0.0		SHALE; gray, soft, highly weathered, with calcite inclusions and many slickensides.	5
45								4
46	C-2		5.0					3
47						47.5'	ELEV. 1.6	2
48				100%	0%		SILTSTONE; reddish brown, soft, fresh, with slickensides.	1
49							ELEV. 0.1	0
							End of Boring at 49.0'	
50								-1
51								-2
52								-3
53								-4
54								-5
55								-6
56								-7
57								-8
58								-9
59								-10

Sample Type: S=Split Spoon C=Core UP=Undisturbed Piston V=Vane Shear Test A=Auger
Proportions Used: Trace = 1 - 10%, Little = 10 -20%, Some = 20 - 35%, And = 35 - 50%

Total Penetration in Earth: 39.0' Rock: 10.0' No. of Samples: 10	NOTES:	Sheet 3 of 3

Driller: Mike St. John/NEBC	**Connecticut DOT Boring Report**	Hole No.: **SB-98**
Inspector: Rachael Marks	Town: West Hartford / Hartford, CT	Stat./Offset:
Engineer: Baker Engineering	Project No.: 171-0305	Northing: 839986.4
Start Date: 7/25/03	Route No.:	Easting: 1018157.9
Finish Date: 7/25/03	Bridge No.:	Surface Elevation: 50.4

Project Description: New Britain to Hartford Busway

Casing Type/Size: HW/4"	Sampler Type/Size: SS/1-3/8"	Core Barrel Type: NQ/1-7/8"I.D.
Hammer Wt.: 300 Fall: 24"	Hammer Wt.: 140 Fall: 30"	

Groundwater Obs. @ 12.0 after: 0 hours, @6.0 after: 48 hours, @ after: hours

Baker Info: S.O. Number: B25624LPDSOIL41802/42002 File: northern Template: CDOT_E (LD4 1/03)

Depth (ft.)	Sample Type/No.	Blows on Sampler per 0.5 ft.	Pen. (ft.)	Rec. (ft./%)	RQD (ft./%)	Generalized Strata Description	Material Description and Notes	Elevation (ft.)
0								50
1	A-N		1.5					49
2	S-1	2 3 3	1.5	1.0			WELL GRADED SAND (SW) - brown fine to medium sand, trace silt; moist, loose, NP.	48
3								47
4	A-N		1.5					46
5	S-2	4 5 6	1.5	1.3			WELL GRADED SAND (SW) - brown fine to medium sand, trace silt; moist, medium dense, NP.	45
6								44
7	A-N		1.5					43
8	S-3	5 7 7	1.5	1.0			WELL GRADED SAND (SW) - brown fine to medium sand, trace silt; moist, medium dense, NP.	42
9								41
10	A-N		1.5					40
11	S-4	8 10 15	1.5	0.8			WELL GRADED SAND (SW) - brown fine to medium sand, trace silt; moist, medium dense, NP.	39
12								38
13	W-N		1.5					37
14	S-5	15 16 19	1.5	0.3			WELL GRADED SAND (SW) - brown fine to medium sand, trace silt; moist, dense, NP.	36
15								35
16	W-N		1.5					34
						16.5'	ELEV. 33.9	
17	S-6	24 28 45	1.5	1.3			GRAVELLY SILT WITH SAND (ML) - reddish brown silt, some fine to coarse gravel, some fine to coarse sand; moist, very dense, NP; (TILL).	33
18								32
19	W-N		2.0					31

Sample Type: S=Split Spoon C=Core UP=Undisturbed Piston V=Vane Shear Test A=Auger

Proportions Used: Trace = 1 - 10%, Little = 10 -20%, Some = 20 - 35%, And = 35 - 50%

Total Penetration in Earth: 20.0' Rock: 10.0'
No. of Samples: 6

NOTES:

SM-001-M REV. 1/

Driller: Mike St. John/NEBC	**Connecticut DOT Boring Report**	Hole No.: **SB-98**
Inspector: Rachael Marks	Town: West Hartford / Hartford, CT	Stat./Offset:
Engineer: Baker Engineering	Project No.: 171-0305	Northing: 839986.4
Start Date: 7/25/03	Route No.:	Easting: 1018157.9
Finish Date: 7/25/03	Bridge No.:	Surface Elevation: 50.4

Project Description: New Britain to Hartford Busway

Casing Type/Size: HW/4"	Sampler Type/Size: SS/1-3/8"	Core Barrel Type: NQ/1-7/8"I.D.
Hammer Wt.: 300 Fall: 24"	Hammer Wt.: 140 Fall: 30"	

Groundwater Obs. @ 12.0 after: 0 hours, @6.0 after: 48 hours, @ after: hours

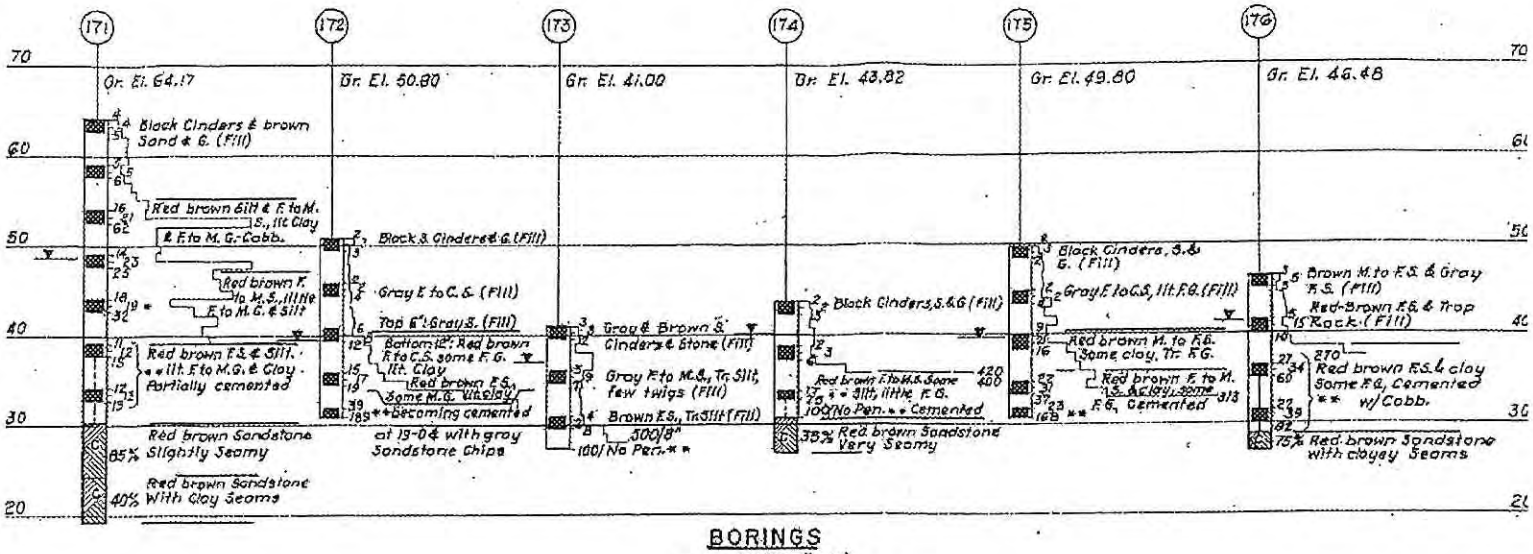
Baker Info: S.O. Number: B25624LPDSOIL41802/42002 File: northern Template: CDOT_E (LD4 1/03)

Depth (ft.)	SAMPLES Sample Type/No.	Blows on Sampler per 0.5 ft.	Pen. (ft.)	Rec. (ft./%)	RQD (ft./%)	Generalized Strata Description	Material Description and Notes	Elevation (ft.)
20				4.4	2.8	20.0'	ELEV. 30.4	30
21							SILTSTONE; reddish brown, medium hard to hard, slightly weathered.	29
22	C-1		5.0					28
23								27
24				88%	56%			26
25				5.0	1.8		SILTSTONE; reddish brown, medium hard to hard, slightly weathered.	25
26								24
27	C-2		5.0					23
28								22
29								21
30				100%	36%		ELEV. 20.4	20
31							End of Boring at 30.0'	19
32								18
33								17
34								16
35								15
36								14
37								13
38								12
39								11

Sample Type: S=Split Spoon C=Core UP=Undisturbed Piston V=Vane Shear Test A=Auger
Proportions Used: Trace = 1 - 10%, Little = 10 -20%, Some = 20 - 35%, And = 35 - 50%

Total Penetration in Earth: 20.0' Rock: 10.0' No. of Samples: 6	NOTES:	Sheet 2 of 2

Appendix 4
1963 Boring Logs
(BH-Series)



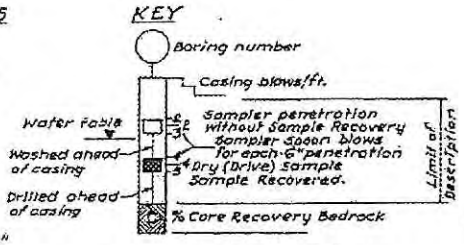
BORINGS

SCALE: VERT. 1" = 10'
CASING 1" = 100 BLOWS

ABBREVIATIONS

C.	Coarse
F.	Fine
M.	Medium
G.	Gravel
S.	Sand
Cobb.	Cobbles
lit.	little
Tr.	Trace

KEY



Casing I.D. = 2½"
Hammer Wt. = 300#
Hammer Fall = 24"
*Open End "A" Rod with 140# @ 30" drop

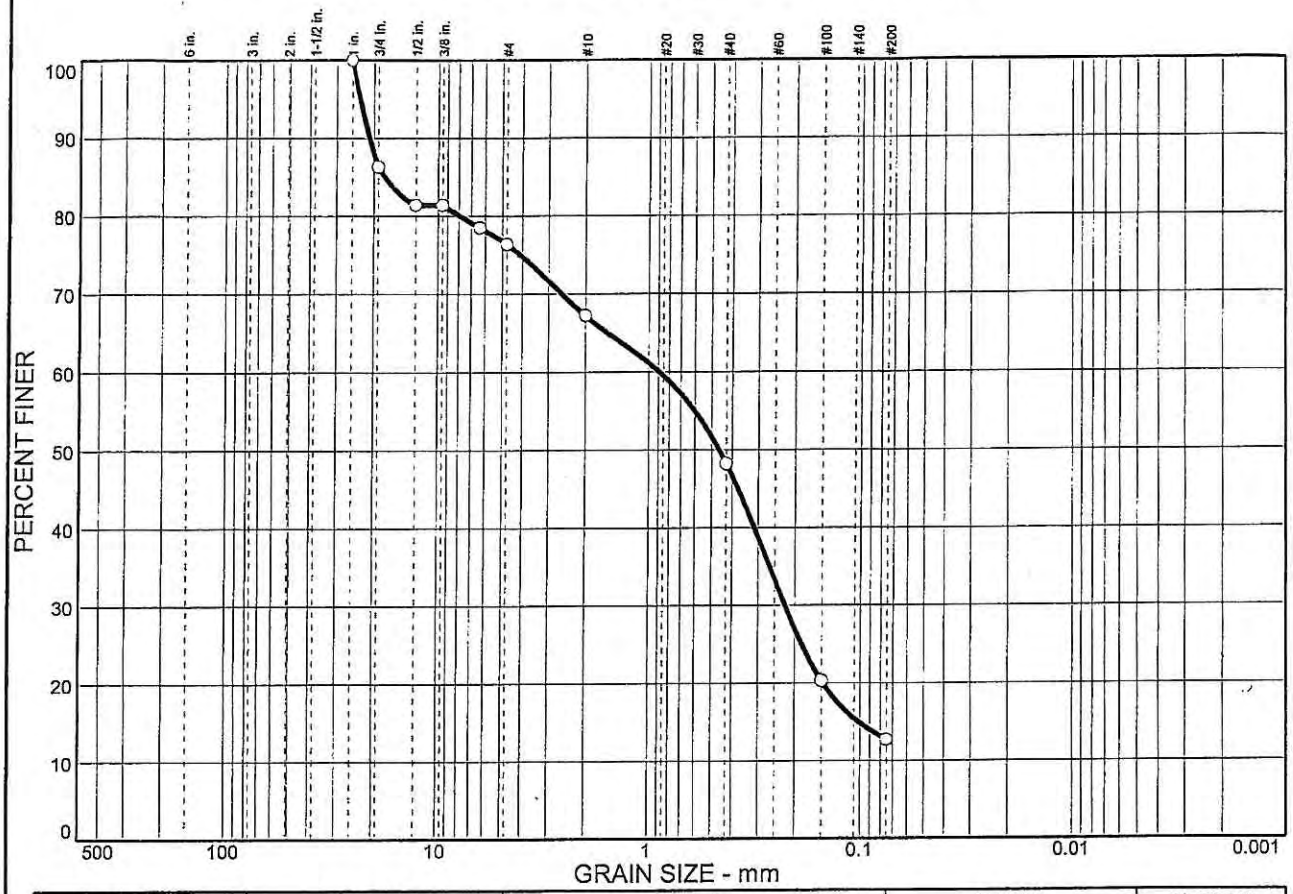
Sampler I.D. = 1⅜"
Hammer Wt. = 140 Lbs.
Hammer Fall = 30"
**Open End "A" Rod w/ 300 Lbs Hammer @ 24" drop

1963 BORING LOGS
ROADWAY "B" AND CAPITOL AVENUE ON RAMP

CL\331\14\CADD\Structure 3- Busway NB over I-84W Ramp - Boring Log - Elevations.dwg

Appendix 5
2008 Geotechnical Laboratory Testing

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	23.6	63.7	12.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
0.75 in.	86.3		
0.50 in.	81.4		
0.375 in.	81.4		
0.25 in.	78.5		
# 4	76.4		
# 10	67.2		
# 40	48.2		
# 100	20.3		
# 200	12.7		

* (no specification provided)

Soil Description

Reddish Brown - Silty sand with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 17.7 D_{60}= 0.889 D_{50}= 0.460
D_{30}= 0.223 D_{15}= 0.101 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

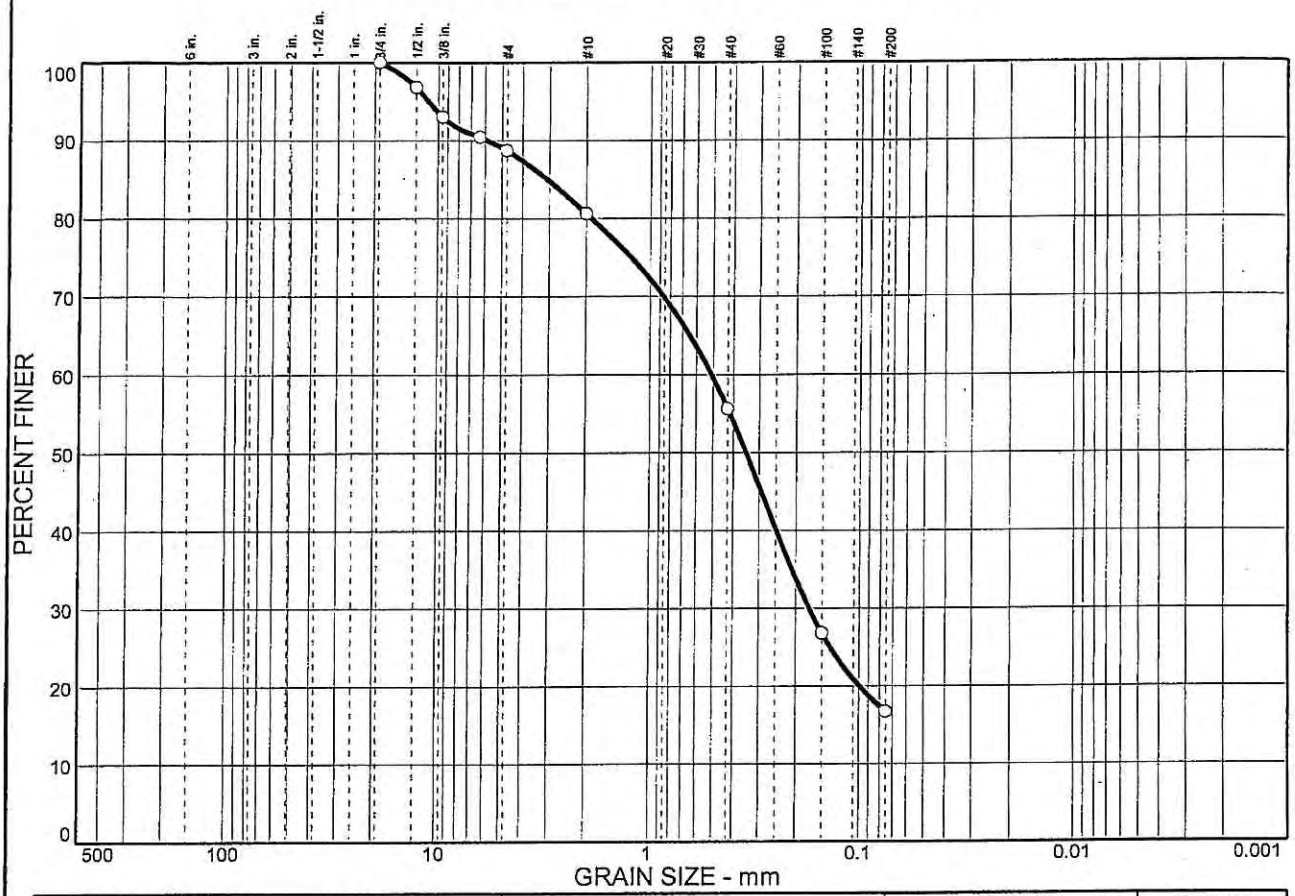
Remarks

Material dropped off by Client. Tested by R. DeCesare on 2/5/09.

Sample No.: S-1 **Source of Sample:** B-02-3 **Date:** 2/5/09
Location: **Elev./Depth:**

TEST-CON INCORPORATED **16 East Franklin Street, PO BOX 3116** **DANBURY, CT 06813-3116**	**Client:** GeoDesign Incorporated **Project:** New Britain - Hartford Busway # 331-14 **Project No:** **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	11.3	72.0	16.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.75 in.	100.0		
0.50 in.	96.8		
0.375 in.	93.0		
0.25 in.	90.4		
# 4	88.7		
# 10	80.6		
# 40	55.6		
# 100	26.8		
# 200	16.7		

* (no specification provided)

Soil Description

Reddish/Brown - Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 3.06 D_{60}= 0.509 D_{50}= 0.347
D_{30}= 0.172 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

Sample dropped off by Client. Tested by R. DeCesare on 2/5/09.

Sample No.: S-1 **Source of Sample:** B-02-2 **Date:** 2/5/09
Location: **Elev./Depth:**

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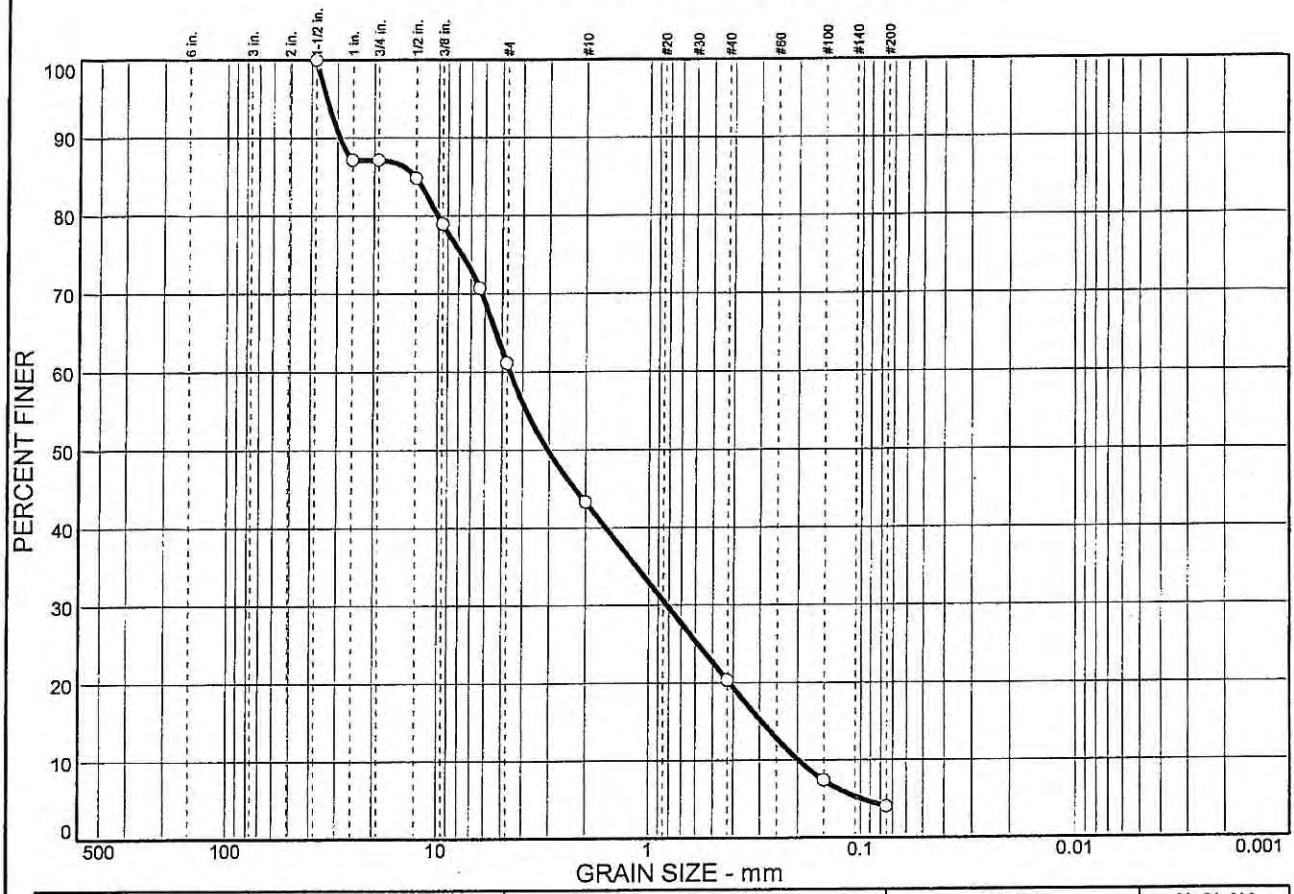
Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	38.9	57.1	4.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	87.1		
0.75 in.	87.1		
0.50 in.	84.8		
0.375 in.	78.9		
0.25 in.	70.7		
# 4	61.1		
# 10	43.3		
# 40	20.3		
# 100	7.4		
# 200	4.0		

* (no specification provided)

Soil Description

Brownish/Red - Poorly graded sand with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 12.9 D_{60}= 4.59 D_{50}= 3.04
D_{30}= 0.816 D_{15}= 0.294 D_{10}= 0.197
C_u= 23.25 C_c= 0.74

Classification

USCS= SP AASHTO=

Remarks

Sample dropped by Client. Tested by R. DeCesare on 2/5/09.

Sample No.: S-3 **Source of Sample:** B-02-2 **Date:** 2/5/09
Location: **Elev./Depth:**

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16 East Franklin Street, PO BOX 3116
DANBURY, CT 06813-3116

Client: GeoDesign Incorporated
Project: New Britain - Hartford Busway # 331-14
Project No: **Plate**

TEST-CON INCORPORATED

TEST-CON Incorporated

16 East Franklin Street
P. O. Box 3116
Danbury, CT 06813-3116
Telephone: (203) 748-3012 Fax: (203) 778-0633
E-Mail: Service@test-con.com Web-Site: www.test-con.com

PH OF SOIL MATERIAL REPORT

Date: February 05, 2008

Report #: 4 -10pH
Technician: R. DeCesare

Client: GeoDesign Incorporated
984 Southford Rd.
Middlebury, CT 06762

Project: New Britain-Harford Bus way
331-14

Date Received: Delivered by Client on 1/27/09

Test Requirements: pH

Summary Data

Boring/Test Pit No.	Sample No.	pH Test Results
B-02-3	S-1	8.34
B-03-3	S-2	5.95
B-03-1	S-1	7.15
B-03-3	S-5	6.28
B-02-2	S-3	8.59
B-02-2	S-1	7.58
B-03-1	S-2	6.96

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5/15/07

TEST-CON Incorporated

TEST-CON INCORPORATED

16 East Franklin Street
P. O. Box 3116
Danbury, CT 06813-3116
Phone: (203) 748-3012 Fax: (203) 778-0633
E-Mail: Service@test-con.com Web-Site: www.test-con.com

Construction Material Testing & Inspection - Geotechnical Services

SULFIDE TEST REPORT

Client:	GeoDesign Incorporated 984 Southford Rd. Middlebury, CT 06762	**Date:** **Tested by:** **Receive Date:**	2/23/08 York (CT # PH-0723) 1/27/09
Project:	New Britain-Hartford Busway # 331-14 Hartford/West Hartford, CT	**Matrix:** **Report No.:**	Soil 4 – 10 Sulfide (09020528)

Progress of Work:
The analyses were conducted utilizing appropriate EPA, Standard Methods, and ASTM methods as detailed in the summary tables.

The results of the analysis, which are all reported on an as-received basis unless otherwise noted, are summarized in the following table(s).

Analysis Results

Boring/Test Pit No.	Sample No.	Depth (ft)	Parameter	Method	Units	Results	MDL
B-03-1	S-2	5 - 7	Sulfide	EPA376.1	mg/kg	Not detected	20.0
B-03-3	S-2	2.5 - 4.5	Sulfide	EPA376.1	mg/kg	Not detected	20.0
B-02-2	S-3	5 - 7	Sulfide	EPA376.1	mg/kg	Not detected	20.0
B-03-1	S-1	0 - 2	Sulfide	EPA376.1	mg/kg	Not detected	20.0
B-02-2	S-1	0 - 2	Sulfide	EPA376.1	mg/kg	Not detected	20.0
B-03-3	S-5	10 - 12	Sulfide	EPA376.1	mg/kg	Not detected	20.0
B-02-3	S-1	0 - 2	Sulfide	EPA376.1	mg/kg	Not detected	20.0

Units Key: For Waters/Liquids: mg/L = ppm ; ug/L – ppb For Soils/Solids: mg/hg = ppm ; ug/kg = ppb

Notes:

1. The MDL (Minimum Detectable Limit) reported is adjusted for any dilution necessary due to the levels of target and/or non-target analytes and matrix interference. This MDL is the REPORTING LIMIT and is based upon the lowest standard utilized for calibration where applicable.
2. Samples are retained for a period of thirty days after submittal of report, unless other arrangements are made.
3. Test-Con's liability for the above data is limited to the dollar value paid to Test-Con for this test.
4. All samples were received in proper condition for analysis with proper documentation.

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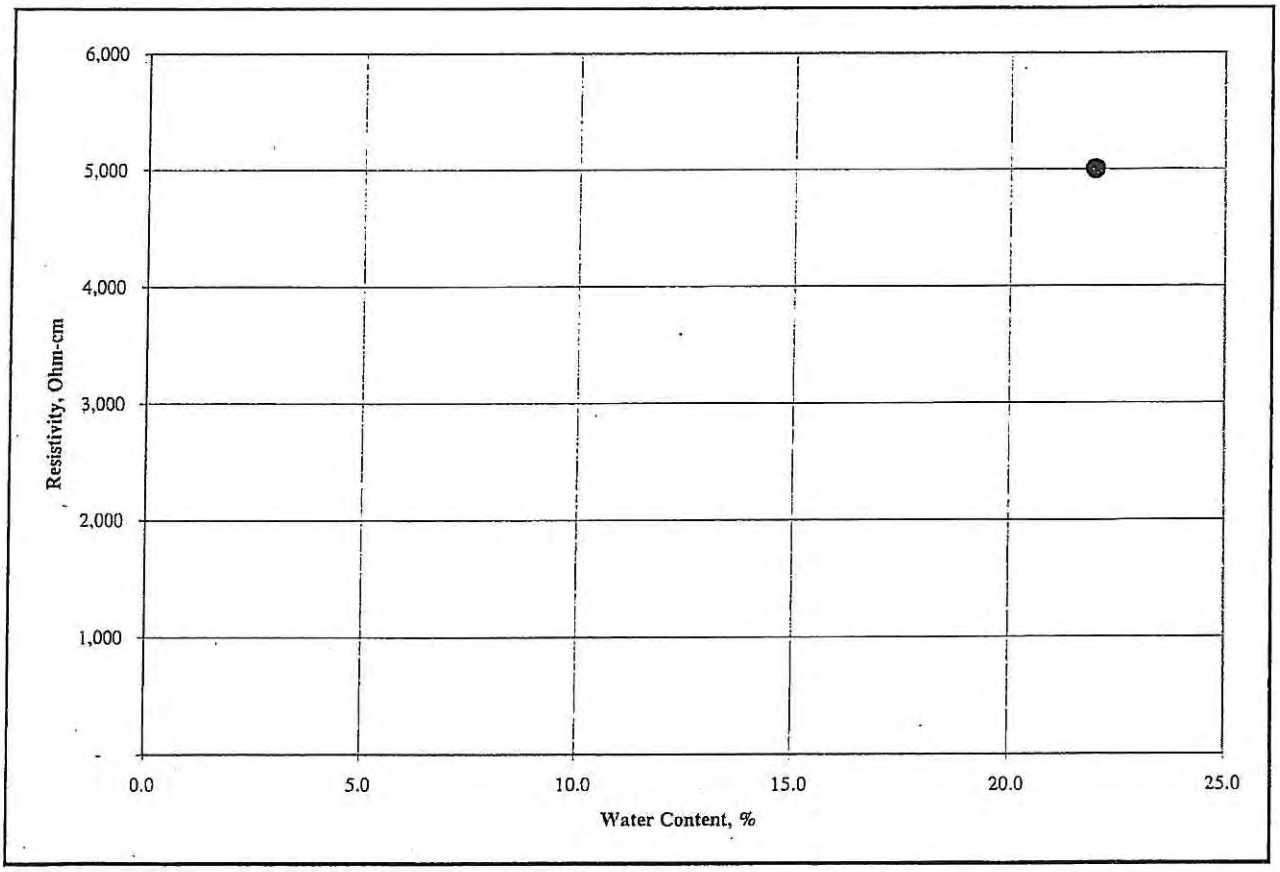
Soil Resistivity - 1 Point
AASHTO - T288

Client	Geodesign Incorporated	Boring	NA
Client Project	New Britain/Hartford Busway	Depth	NA
Project No.	29165	Sample	B-02-2 (S-1)
		Lab Sample No.	29165001

SOIL BOX PARAMETERS	
Soil Box Length, cm	11.2
Soil Box Area, cm^2	6.89
Electrode Spacing, cm	6.89
Soil Box Factor, cm (Area/Spacing)	1
Soil Box Volume, cc	77
Soil Box Weight, gm	123.76

RESISTIVITY TESTED	
WC at Resistivty Tested, %	22.0
Resistivity Tested, Ohm-cm	5000

Tested WC %	Resistance Ohms	Soil Box Factor cm	Resistivity Ohm-cm
22.0	5000	1	5000



Input Validation: Reviewed By: Date Tested: 2/20/2009

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Appendix 6
2003 Geotechnical Laboratory Testing

LABORATORY TESTING DATA SHEET

Project Name: NEW BRITAIN-HARTFORD BUSWAY CONNECTICUT
Project No: L17828
Project Engineer: D. SCHULZE
Assigned By: D GAFFNEY
Date: DEC.03
Reviewed By: Don Schulze
Date Reviewed: 1/6/04

Boring/ Test Pit No	Sample No.	Depth ft.	Lab No	Identification Tests: Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	ORG %	G_s	Dry unit wt pcf	Density: γ_d MAX (pcf) W_{opt} (%)	Permeability cm/sec	Strength Tests: Torvane or Type Test	$\bar{\sigma}_c$ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	Consol.: $\frac{\sigma_c}{1+e_o}$	Laboratory Log and Soil Description
SB-92	S-2	4.5-6.0	230	30.8	45	24	97	48												Brown Lean clay (CL)
SB-93	S-4	10.0-11.5	231	9.1	23	14	53	20												Brown Sandy lean clay with gravel (CL)
SB-94	S-2 S-3	4.5-9.0	232	10.7	26	17	42	15												Brown Clayey sand with gravel (SC)
SB-95	S-2	4.5-6.0	233	11.5	20	19	38	9												Black Silty sand with gravel (SM)
SB-96	S-2	4.5-6.0	234	17.2	NP	NP	4													Brown Poorly graded sand (SP)
SB-97	S-8	25.0-26.5	235	9.9	23	14	59	20												Brown Sandy lean clay (CL)
SB-98	S-3	7.5-9.0	236	2.3	NP	NP	4													Brown Poorly graded sand (SP)
SB-99	S-9	25.0-26.5	237	37.4	35	20	93	37												Brown Lean clay (CL)
SB-100	S-4	10.0-11.5	238	38.0	41	20	78	54												Gray Sandy lean clay (CL)
SB-101	S-4	10.0-11.5	239	32.6	51	24	90	53												Gray Fat clay (CH)

LABORATORY TESTING DATA SHEET

Project Name: NEW BRITAIN-HARTFORD BUSWAY CONNECTICUT
Project No.: L17828
Project Engineer: D. SCHULZE
Assigned By: D. GAFFNEY
Date: DEC.03
Reviewed By: Dave Schulze
Date Reviewed: 12/30/03

Boring/ Test Pit No	Sample No.	Depth ft.	Lab No.	Identification Tests: Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	ORG %	G_s	Dry unit wt. pcf	Density: γ_d MAX (pcf) W_{opt} (%)	Perme-ability cm/sec	Strength Tests: Torvane or Type Test	$\bar{\sigma}_c$ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	Consol. $\frac{G_s}{1+e_0}$	Laboratory Log and Soil Description
SB-83	S-10	28.5-30.0	365	44.8																
SB-85	S-6	16.5-18.0	366	23.3																
SB-87	S-8	22.5-24.0	367	59.1																
SB-88	S-3	7.5-9.0	368	23.6																
SB-88	S-10	28.5-30.0	369	54.2																
SB-90	S-4	10.5-12.0	370	40.3																
SB-93	S-7	19.5-21.0	371	14.1																
SB-97	S-4	13.5-15.0	372	9.7																
SB-98	S-6	16.5-18.0	373	11.1																
SB-99	S-6	16.5-18.0	374	11.6																
SB-99	S-7	19.5-21.0	375	23.2																
SB-99	S-8	22.5-24.0	376	30.3																
SB-99	S-10	28.5-30.0	377	11.0																

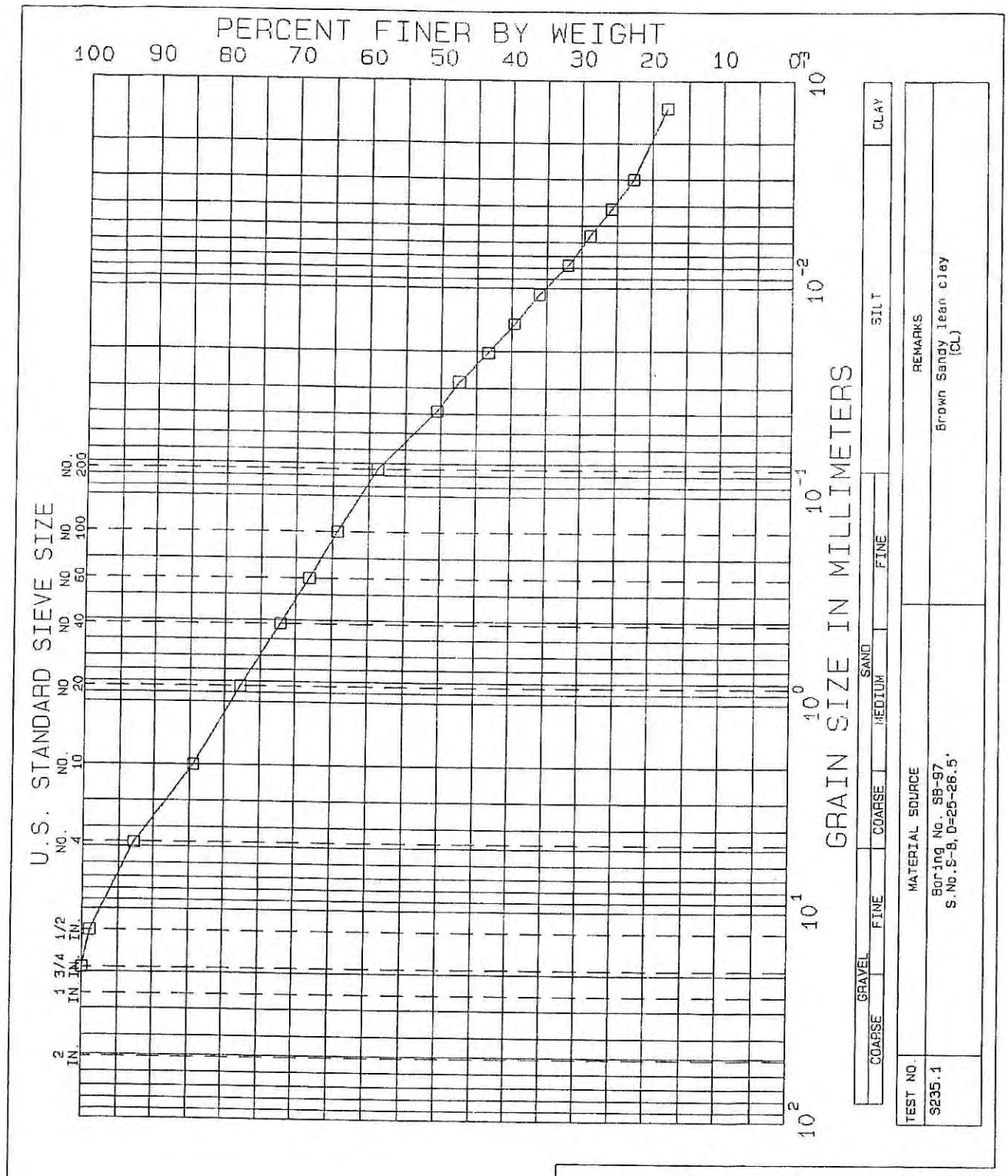
LABORATORY TESTING DATA SHEET

Project Name: NEW BRITAIN-HARTFORD BUSWAY CONNECTICUT
Project No.: L17828
Project Engineer: D. SCHULZE
Assigned By: D. Gaffney
Date: Mar.04
Reviewed By: [signature]
Date Reviewed: 3/11/04

Boring/ Test Pit No.	Sample No	Depth Ft.	Lab No.	Sample Data: Water Content %	Do in.	L in.	(1) Unit Wt. PCF	(2) Wet Density PCF	Bulk Gs.	(3) Other Tests	Compression Tests: (4) Strength KSI	(5) Strain %	(6) Conf. Stress	(7) E tan PSI EE+06	(8) E sec PSI EE+06	(9) Poisson's Ratio	σt KSI	Is_{50} KSI	Rock Formation or Description or Remarks
SB-44		65.0-65.5	439		1.965	4.394	156.9			U	* 4.45								* Sample failed on joint plane
SB-89		27.3-27.7	440		1.961	4.365	159.2			U	7.45								
SB-90		90.8-91.2	441																Sample not testable due to fracture along bedding plane
SB-92		42.0-42.4	442		1.941	3.846	158.7			U	4.73								
SB-95		16.8-17.4	443		1.981	4.314	161.6			U	10.06								
SB-96		16.8-17.3	444																Sample not testable due to fracture along bedding plane
SB-98		21.0-21.5	445		1.971	4.036	160.9			U	6.23								* Sample failed on joint plane
SB-99		37.6-38.0	446																Sample not testable due to fracture along bedding plane
SB-31		43.5-43.9	447		1.974	4.255	161.5			U	6.05								
SB-16		48.3-48.9	448		1.961	4.092	159.5			U	4.47								

(1) Volume Determined By Measuring Dimensions
(2) Determined by Measuring Dimensions and Weight of Saturated Sample
(3) P=Petrographic PLD=Point Load (diametrical). PLA= Point Load (Axial) RST= Splitting Tensile U= Unconfined Compressive Strength

(4) Taken at Peak Deviator Stress
(5) Strain at Deviator Stress
(6) Represents Confining Stress on Triaxial Tests
(7) Represents Tangent Modulus at 50% of Total Failure Stress
(8) Represents Secant Modulus at 50% of Total Failure Stress
(9) Represents Secant Poisson's Ratio at 50% of Total Failure Stress

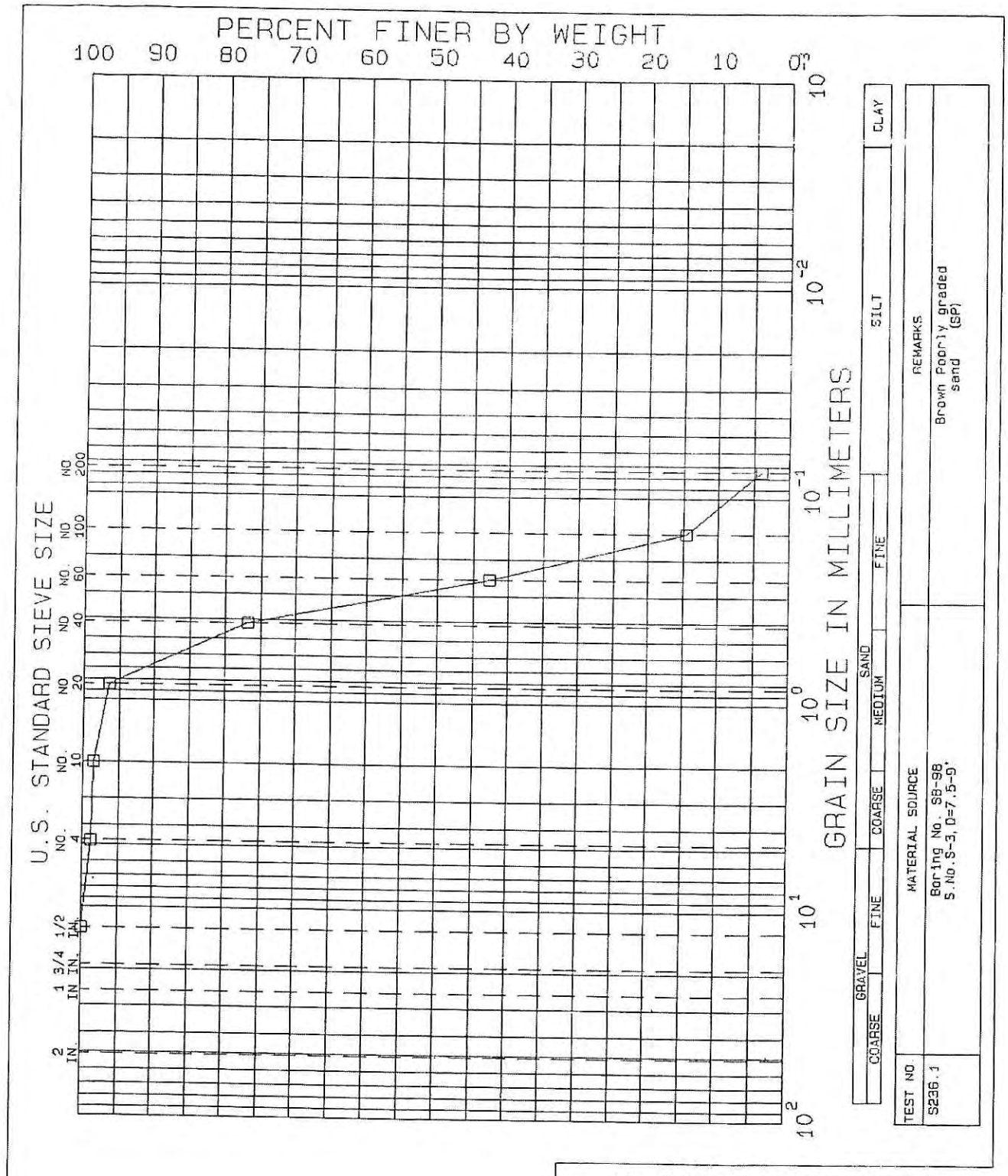


NEW BRITAIN-HARTFORD BUSWAY

CONNECTICUT

GRADATION TESTS

BORING NO.	SB-97	TEST SERIES	
SAMPLE	S-8	NO	235
DEPTH	25-26.5'	DATE	Jan.04
TECH	CAG		
REVIEWER	MBP	FILE	L17828



NEW BRITAIN-HARTFORD BUSWAY

CONNECTICUT

GRADATION TESTS

BORING NO. SB-98
SAMPLE S-3
DEPTH 7.5-9'
TECH CAG
REVIEWER MBP

TEST SERIES
NO. 236
DATE Jan 04

FILE L17828

GZA GEOENVIRONMENTAL, INC.
ENGINEERS AND SCIENTISTS

Appendix 7
Limitations

GEOTECHNICAL LIMITATIONS

Explorations

1. The analyses and recommendations submitted in this report are based in part upon the data obtained from widely spaced subsurface explorations. The nature and extent of variations between these explorations may not become evident until further explorations are made and construction occurs. If variations then appear evident, it will be necessary to reevaluate the recommendations of this report.

2. The generalized soil and bedrock profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil and bedrock transitions are probably more erratic. For specific information, refer to the boring logs.

3. The geologic and geomorphologic settings at this site are complex and the uncertain historic site usage has resulted in the varied distribution and stress history of compressible soils across the site. Limited spacing of borings and lab testing can at best, only allow for estimates to be developed for duration and magnitude of consolidation settlements.

4. Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. These data have been reviewed and interpretations have been made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in river levels, rainfall, temperature, and other factors occurring since the time measurements were made.

Review

5. In the event that any changes in the nature, design or location, of the proposed bridge the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing by Geo**Design**, Inc. It is recommended that this firm be provided the opportunity for a general review of design and specifications in order that earthwork and foundation recommendations may be properly interpreted and implemented in the design and specifications.

Use of Report

6. This report has been prepared for the exclusive use H.W. Lochner, Inc., the Connecticut Department of Transportation (ConnDOT), and other members of the design team for specific application to the construction of South Bound Bridge over I-84 West Bound Capitol Avenue On-Ramp located in Hartford, Connecticut, in accordance with generally accepted soil and foundation engineering practices. No other warranty, express or implied, is made.

7. This final design soil and foundation engineering report has been prepared for this project by Geo**Design**. This report is for design purposes only and is not sufficient to prepare an accurate bid. Contractors wishing a copy of the report may secure it with the understanding that its scope is limited to design considerations only.