Final Geotechnical Engineering Structure Report
Structure Layout for Design Submission
Broad Street Over Amtrak & Busway
State Project 63-H137
Hartford, Connecticut

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November 2, 2009

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Table of Contents

1.0 GENERAL INFORMATION 1

1.1 General 1

1.2 Datum 1

1.3 Existing Conditions 1

1.4 Design Criteria 2

1.5 Proposed Structure 2

2.0 GEOLOGY 3

2.1 Alluvial Deposit 3

2.2 Glaciolacustrine Deposit 3

2.3 Glacial Till 3

2.4 Bedrock 4

3.0 EXISTING GEOTECHNICAL INFORMATION 4

3.1 General 4

3.2 Laboratory Test Data 4

4.0 SUBSURFACE EXPLORATIONS 4

4.1 Test Borings 4

4.2 Observation Well 5

5.0 LABORATORY TESTING 5

5.1 Atterberg Limits 5

5.2 Moisture Contents 5

5.3 Gradation Analyses 6

5.4 pH and Sulfides Tests 6

5.5 Unconfined Rock Compression Tests 6

6.0 SUBSURFACE CONDITIONS 6

6.1 Subsurface Profile 6

6.2 Geotechnical Design Parameters 7

6.3 Groundwater 8

7.0 GEOTECHNICAL ISSUES AND EVALUATION 8

7.1 Reuse of Existing Substructures 8

7.2 Bridge Loads and Dimensions 8

7.3 Foundation Type Selection 9

7.4 Settlement Analyses 9

7.5 Soil Corrosion Potential 10

7.6 Liquefaction Potential 10
8.0 GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS..... 10
8.1 General Geotechnical Design Recommendations 10
8.2 Static Design Parameters 11
8.2.1 General 11
8.2.2 Bearing 11
8.2.3 Sliding/Overturning 11
8.3 Geotechnical Construction Recommendations 12
8.3.1 Demolition of Existing Foundations 12
8.3.2 Subgrade Preparation 12
8.3.3 Protection of Existing Active Railroad 12
8.3.4 Abutment Backfill Requirements 13
8.3.5 Vibrations and Construction-Induced Settlements 13
8.3.6 Abandonment of Existing Utilities 14
8.3.7 Dewatering 14
8.3.8 Re-Use of Existing Substructures and Foundations 14
8.3.9 Special Provisions 14
9.0 LIMITATIONS 14

ATTACHMENTS

Appendix 1 Figures

Appendix 2 2008 Boring Logs (B-Series)

Appendix 3 2003 Boring Logs (SB-Series)

Appendix 4 1973 Boring Logs (BH-Series)

Appendix 5 2008 Geotechnical Laboratory Testing

Appendix 6 2003 Geotechnical Laboratory Testing

Appendix 7 Limitations

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), which will carry Broad Street over Amtrak and the Busway in Hartford, Connecticut. The location of the proposed Broad Street 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

Broad Street is presently carried over Amtrak Railroad by a two-span, prestressed concrete, adjacent box-beam bridge (ConnDOT Bridge No. 03629). The existing bridge crosses over the existing Amtrak railroad with a skew of approximately 4.5 degrees; the existing abutments and piers are also at a similar skew. The bridge was reconstructed to its present configuration in 1975 as shown on Connecticut Department of Transportation, Bureau of Highways design drawings titled “Broad Street Over Penn Central Railroad” dated 1973. The existing railroad is non-electrified.

Information regarding the exiting bridge was obtained from the 1973 design drawings. The existing south abutment (termed Abutment 1 since it will be reused) is a concrete stub abutment located behind the previous masonry abutment that was left in place during the 1975 reconstruction of the bridge. The previous bridge consisted of two spans. Its pier was removed but the masonry abutments remain. Although, the old south abutment is not used to support the

present bridge, it does retain earth in front of the present stub abutment (Abutment 1). The old north abutment is presumed to be buried at a horizontal distance of about 15 feet behind the present concrete abutment, although it may have been partially demolished during construction of the existing abutment. The existing pier (termed Pier 1 since it will be reused) consists of a concrete pier cap supported by rectangular concrete columns. The columns are integral with a 7.5 ft x 3.0 ft concrete railroad crashwall. The existing north abutment is full height at approximately 27 feet with U-type stepped wing walls.

The 1973 design drawings indicate that the three existing substructures are all supported by driven HP10x57 steel piles with bottom of pile cap at approximately El. 42 except Abutment 1 and the wingwall pile caps that are at El. 59. The driven piles are battered (1H:6V) at Abutment 1 and Pier 1. At the existing north abutment, some piles are vertical and some are battered. Existing grades along the Amtrak railroad beneath the bridge are at approximately El. 46, and existing grades behind the bridge abutments are at approximately El. 70. The 1973 design drawings indicate that the Broad Street grades were raised approximately 3 to 6 feet during construction of the present bridge.

Available historical information indicates that near the bridge there are eight, 4-inch diameter, SNET conduits encased in the west sidewalk; eight, 5-inch diameter electrical conduits that are supported from the east fascia beam under the east sidewalk; and one abandoned 16-inch diameter water main along the east side of Broad Street and beneath the Amtrak railroad. Figure 2 (Appendix 1) depicts existing 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 Broad Street Bridge, the proposed Busway will parallel Amtrak's Springfield Line. Replacement of the existing bridge carrying Broad Street over Amtrak is necessary to provide more space for the Busway. The Broad Street Bridge replacement will involve a full structure replacement, reuse of the existing south abutment (Abutment 1), reuse of the existing pier (Pier 1) footing and crashwall, and construction of a new pier (Pier 2) and a new north abutment (Abutment 2). Schematic locations of existing and proposed substructures and foundations are shown on Figure 3.

The new bridge will accommodate three lanes of traffic, two sidewalks, and parapets with protective fence. When replaced, the new bridge will span the Hartford Courant access road, one active railroad track, and a siding track. It will also provide room for one future railroad track, and two Busway lanes. The new bridge will be a three-span steel structure spanning approximately 140 feet between the two abutments. The approximate locations of the existing and proposed substructures are shown on Figure 3 (Appendix 1).

2.0 GEOLOGY

Published geologic data for this locale indicate that an Alluvial deposit overlies a Glaciolacustrine deposit, the prevalent surficial material in this area, below fill. A Glacial Till underlies the Glaciolacustrine deposit. 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 Glaciolacustrine Deposit

When the late Pleistocene ice sheet in New England retreated about fifteen thousand (15,000) years ago, the Glaciolacustrine deposit was formed in Glacial Lake Hitchcock. The Glaciolacustrine deposit in this area is distinctively featured by alternating layers of clay and silt. Each pair of clay and silt layers is called a “varve”, which corresponds to glacial lake deposit of a year: when the glacier melted, melt water streams brought soil particles into Glacial Lake Hitchcock. During the summer, a larger volume of water formed a more turbulent flow. This flow was capable of carrying silt particles (sometimes even larger particles) and settling them on the lake bottom. During the winter, when the volume of melt water decreased and frozen lake surface calmed the water, clay particles were deposited out of suspension. As a result of many years’ deposit, the “varved” structure dominated the Glaciolacustrine deposit in this region. The deposit could contain several hundred or even several thousand varves. The thickness of the varves is variable.

Although this deposit contains significant amount of Silt, the literature typically refers to the Glaciolacustrine deposit in this area as Varved Clay. Conforming to tradition, the term “Varved Clay” is used in this report.

2.3 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.

2.4 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 one boring and performed soil laboratory testing. In addition, boring data from explorations performed for the design of the 1975 bridge reconstruction are available.

3.1 General

In 2003, Pilot Boring SB-93 was drilled and in 1973 Borings BH-127 through BH-130 were drilled in the general area of the bridge. Boring SB-93 is located off the east side of the bridge at approximately the mid-span and the BH-Series borings were located on the east and west sides of the bridge at each abutment. The approximate locations of the Pilot Boring and the BH-Series borings are shown on Figure 2 (Appendix 2). The log of the Pilot Boring 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 boring SB-93: moisture content, Atterberg Limits, and Gradation (Sieve and Hydrometer) Analyses. 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; six structure borings (B-01-1 through B-01-6) 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.

4.2 Observation Well

An observation well was installed in boring B-01-1. The well installation information is shown on the boring log (Appendix 2).

5.0 LABORATORY TESTING

Geo**Design** assigned laboratory tests to estimate engineering properties of the Varved Clay and Fill Materials to verify field classifications, evaluate soil corrosion potential, and determine material drainage properties. Testing was performed by Test-Con, Inc. of Danbury, Connecticut. Laboratory tests included Atterberg Limits, sulfide content, and pH on soil samples and unconfined compression strength on intact samples of bedrock. The results of these tests are discussed below and are included in Appendix 5. Laboratory testing was also performed by Baker Engineering in 2003 and the results are included in Appendix 6.

Due to the stiffness of the varved clay it was not possible to obtain undisturbed piston tube samples of this stratum. Therefore, site specific consolidation and strength testing was not possible. The compressibility and strength of this stratum was estimated from published data and laboratory test results from other nearby projects (i.e. Busway South and Amtrak Access Road).

5.1 Atterberg Limits

In 2003, Baker performed one Atterberg Limit Test on sample S-4 (depth 10.0’ to 11.5’) from Boring SB-93. Three new Atterberg Limit tests were performed on samples taken from recent Borings B-01-1 and B-01-3. 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 material respective materials.

Sample/Boring	Sample Description	PL	LL	PI
S-4/SB-93 (Baker Engineering)	sandy lean clay with gravel	14	23	9
S-4/B-01-3	varved silty clay	25	26	1
S-9/B-01-1	varved silty clay	33	64	31
S-10/B-01-1	varved silty clay	27	68	41

5.2 Moisture Contents

In 2003, Baker Engineering performed one moisture content test on sample S-7 (depth 19.5’ to 21.0’) from Boring SB-93. Three new moisture content tests were performed on the samples

which the above Atterberg Limits were also performed. Moisture content (ASTM D 2216), like Atterberg Limits, provide an easy way to characterize and compare cohesive soils.

The sample tested by Baker Engineering was described as brown silt with little fine to coarse sand and little fine to coarse gravel (Glacial Till). The moisture content from the sample was reported as 14.1 percent. This result is within the range expected for the described material.

The moisture contents for samples S-4, S-9, and S-10 described above are 27.1, 32.8, and 34.2 respectively. Based on visual classifications, these samples are described as stiff to very stiff varved Silty Clay. These results are within the range expected for the material.

5.3 Gradation Analyses

In 2003, Baker performed one gradation analysis on sample S-4 from Boring SB-93 that indicated the material consists of brown sandy lean clay. The results are included in Appendix 6.

5.4 pH and Sulfides Tests

Three pH tests and three Sulfide tests were performed on samples of the Fill from recent borings. The Sulfide and pH tests were performed on samples S-1, S-2, and S-5 from Borings taken from Borings B-01-3, B-01-6, and B-01-5, respectively.

5.5 Unconfined Rock Compression Tests

Two unconfined compression tests were performed on bedrock rock samples taken from recent Borings B-01-3 and B-01-4. Unconfined Compression Tests (ASTM D 2938) provide an indication of intact rock core strength. The unconfined compression test results indicate the intact bedrock has an unconfined compressive strength between 4,250 psi and 8,170 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. The soil and rock profile can be summarized as follows:

- **Asphalt/Concrete -** 0 to 1 foot thick;
- **Fill -** 3 to 23 feet thick;
- **Silty Sand (Alluvium Deposit)-** 0 to 11 feet thick;
- **Varved Clay (Glaciolacustrine Deposit)-** 0 to 15 feet thick;
- **Glacial Till-** 10 to 36 feet thick;
- **Bedrock (Siltstone/Shale).**

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, Ash, Cinders, Brick/Concrete fragments, and Organic Fibers. Ash and/or Cinders were identified in only three borings (B-01-1, B-01-2, and B-01-6) well above the groundwater table and generally made up less than 10 percent (i.e trace) of the sample. Fill was observed in each of the borings, including the historical borings. The Fill is thickly deposited at the abutments and thinly deposited beneath the bridge.

The **Silty Sand** was only observed in Borings B-01-1 and B-01-3 and is not indicated on the historical borings. The Silty Sand generally consists of dense to very dense fine to coarse Sand to Sand and Silt with little Gravel.

The **Varved Clay** layer was only observed in Borings B-01-1 and B-01-3 and is also indicated on the historical borings from 1973 (BH-Series). The Varved Clay (where encountered) generally consists of stiff to very stiff Silty Clay and Clayey Silt partings although one historical boring, BH-127, indicated soft consistency.

Glacial Till was encountered in all the borings. The thickness of the Glacial Till varied from approximately 10 to 36 feet. SPT "N" values indicate the density of this layer ranges from dense to very dense.

Bedrock was encountered between approximately El. 19 to 22 with the bedrock sloping slightly upward from north to south. Rock cores were taken in Borings B-01-1, B-01-3, B-01-4, B-01-5A, and B-01-6. Rock Quality Designation (RQD) values ranged between 22 and 83 percent indicating poor to good quality that generally improved with depth.

6.2 Geotechnical Design Parameters

Engineering design parameters of the subsurface soils were based, as appropriate, on the boring data, the laboratory test results. However, the consistency of the varved clay (i.e. stiff to very stiff) precluded the collection of undisturbed samples and as such engineering design parameters were also based on published data from other projects. Below is a summary of the engineering design parameters.

Strata	**Total Unit Weight (pcf)**	**Friction Angle (degrees)**	**Undrained Shear Strength (psf)**	**Recompression Ratio (Cr)**
Fill	125	32	-	-
Silty Sand	120	32	-	-
Varved Clay	115	--	1,500	0.015
Glacial Till	135	34	-	-

6.3 Groundwater

Stabilized groundwater readings were made in the observation well in Boring B-01-1. They indicate groundwater at approximately El. 54 (approximately 17 feet below the existing ground surface) in the area behind the Abutment 1. During drilling groundwater levels were also observed at approximate El. 44 in the pier area in Borings B-01-3 and B-01-4. 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 Reuse of Existing Substructures

The existing Abutment 1 stem, and the footing and crashwall at Pier 1, will be reused for support of the proposed structure. The referenced historical design drawings for the existing bridge indicate that these two substructures are supported on driven HP10x57 pile foundations. Based on estimated pile lengths of the design drawings and estimated depth to bedrock, these piles are believed to have been driven to bedrock.

The condition of the existing HP10x57 piles is unknown at this time. We recognize that the presence of Ash and/or Cinders in the wetted zone (i.e. near the groundwater level) have historically shown accelerated rates of deterioration of steel piles driven into the material. Three borings (B-01-1, B-01-2, and B-01-6) indicate the presence of Ash and/or Cinders in the Fill material on the project. The presence of Ash and/or Cinders is occasional and the amount present is minimal based on the available data and was identified above the wetted zone. Accordingly, we do not anticipate significant corrosion of the steel piles due to the presence of these materials. None the less, due to their age, we recommend that the piles supporting the two substructures that are to be reused, be explored. This is discussed further in Section 8.3.8.

Since the proposed spans which will be supported on the Abutment 1 and Pier 1 are either the same length or shorter than the existing spans, it is anticipated that superstructure vertical loading will be similar to the present loading. It was determined that the existing foundations could be safely reused during preliminary design.

7.2 Bridge Loads and Dimensions

H.W. Lochner provided the following final, unfactored loads for the proposed Pier 2 and Abutment 2:

- Pier 2 - Dead Load = 2,170 kips (Superstructure = 870 kips, Substructure = 1,300 kips)
- Pier 2 - Live Load = 310 kips
- Abutment 2 - Dead Load = 2,317 kips (Superstructure = 317 kips, Substructure = 2,000 kips)
- Abutment 2 - Live Load = 363 kips

H.W. Lochner also provided final foundation sizes at Pier 2 to be approximately 9.5 ft x 86 ft bearing at El. 38 feet; and at Abutment 2 to be approximately 22.0 ft x 83.8 ft bearing at El. 42 feet. The Pier 2 footing dimension is constrained by the available clearance to the railroad tracks. The location of the Abutment 2 stem is constrained by the Busway. Existing Pier 1 will be fixed and will carry the bridge's lateral loading.

7.3 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 analysis considering the anticipated bridge loading and dimensions indicates proposed Pier 2 and Abutment 2 can be supported on shallow spread footing foundations. In addition to being more economical and quicker to construct than deep foundations, shallow foundations will be less affected by the presence of existing piles. We therefore recommend that the two new proposed substructures (Pier 2 and Abutment 2) be supported on shallow spread footings. Based on a bottom of footing elevation for Pier 2 at approximately El. 38 ft and approximately El. 42 ft for Abutment 2, we anticipate that proposed shallow spread footing foundations will bear within either the Glacial Till or Varved Clay.

7.4 Settlement Analyses

We anticipate that the existing substructures to be reused (Abutment 1 and Pier 1) will experience negligible settlement based on the anticipated loading and the pile-supported condition.

We anticipate that Pier 2 and Abutment 2 will experience total settlements between approximately 0.9 and 1.3 inches based on the anticipated loading and subsurface conditions (i.e. presence of varved clay). Settlement of the Pier 2 and Abutment 2 are anticipated to be fairly uniform and, as such, differential settlement in the transverse direction is anticipated to be minimal and insignificant.

We anticipate that a majority of the settlement at Pier 2 and Abutment 2 will be immediate that will be completed prior to construction of the superstructure (i.e. settlement of substructure only) based on the anticipated behavior of the varved clay (i.e. limited thickness, permeability of the varves, and the stiff to very stiff consistency). Once the superstructure is constructed we anticipate approximately 0.2 inches of additional settlement at both Pier 2 and Abutment 2.

We estimated total and differential settlements of Abutment 2 and Pier 2 based on the subsurface conditions summarized in Section 6.0 and the bridge loads and dimensions summarized above. The predicted settlements are as follows:

Substructure	Total Predicted Settlement of Substructure	Total Predicted Settlement of Superstructure	Predicted Differential Settlement of Superstructure
Abutment 1	negligible	Negligible	0.2 inches
Pier 1	negligible	Negligible	
Pier 2	0.7 inches	0.2 inches	
Abutment 2	1.1 inches	0.2 inches	

These results indicate a maximum of less than about ¼ inch of differential settlement of the superstructure between the pile-supported Pier 1 and the shallow spread footing supported Pier 2. Based on a span length of 56.5 feet between these two substructures, the predicted differential settlement is approximately $^{1}/_{4000}$. This angular distortion should be used to estimate negative bending moments in the superstructure.

7.5 Soil Corrosion Potential

As noted in Section 5.4, pH and Sulfide testing on samples collected from the borings were performed. The test results indicate a low potential for corrosion as Sulfides were not detected in any if the samples and the pH levels ranged between 6.90 and 8.62.

7.6 Liquefaction Potential

Soils within and below the bearing zones of the substructures 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. The glacial till and bedrock are also not susceptible to liquefaction.

8.0 GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS

8.1 General Geotechnical Design Recommendations

We recommend that shallow spread footing foundations bear on a pad of either compacted granular fill or crushed stone over undisturbed natural soils. The thickness of the pad should be at least 18-inches at Pier 2 and 24-inches at Abutment 2. Unless restricted by the temporary lateral support system for railroad protection, the minimum lateral limits of the pad should be at least one foot beyond the edges of the footings and then extending down and away at a slope of 1V:1H to meet the undisturbed subgrade. When using crushed stone, non-woven filter fabric should be placed below the crushed stone. The granular fill should conform to the requirements of Article M.02.02 of FORM 816 and the crushed stone should conform to the requirements of Article M.01.01 (No. 6 Crushed Stone) of Form 816.

If over-excavation to subgrade level exposes any organic or otherwise deleterious materials, such unsuitable materials should be excavated and replaced with either compacted granular fill or crushed stone.

8.2 Static Design Parameters

We recommend the following static design parameters:

8.2.1 General

- Unit weight of soil above the water table of 125 pcf
- Unit weight of soil below the water table of 62.6 pcf
- Soil 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 (Rn) = 10.0 kips per square foot (ksf)
- Bearing Resistance Factor (φ_b) = 0.45
- Factored Bearing Resistance Rr = 4.5 ksf

8.2.3 Sliding/Overturning

- Coefficient of Friction for Sliding = 0.55 (AASHTO LRFD Table 3.11.5.3-1)
- Coefficient of Friction for Soil against Wall (tan δ) = 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)
- Earth pressure calculations should assume a surface surcharge of 24 inches soil depth or 250 psf.

The recommended nominal bearing capacity was determined based on shallow spread footings bearing on an engineered pad over undisturbed, stiff to very stiff varved clay. The varved clay was estimated to have design undrained shear strength of approximately 1,500 psf based on correlations with N-SPT values and moisture contents and other published data.

Please note that AASHTO LRFD Section 4.7.4.1 states that the bridges in Seismic Zone 1 need not be analyzed for seismic loads, regardless of their importance and geometry; accordingly, recommendations for dynamic lateral earth pressures are not included. However, the minimum requirements, as specified in Section 4.7.4.4 and 3.10.9, shall apply.

8.3 Geotechnical Construction Recommendations

8.3.1 Demolition of Existing Foundations

Demolition of the existing north abutment will be required to construct the proposed Pier 2 and Abutment 2. Since the existing north abutment is reportedly supported on driven piles and the proposed structures are to be supported by shallow spread footing foundations, we recommend that existing driven piles beneath proposed shallow spread footing foundations be cut off at least three feet below final subgrade level and the area backfilled with compacted granular fill to subgrade levels.

8.3.2 Subgrade Preparation

Subgrade preparation for shallow spread footings should be conducted in such a way as to minimize disturbance. The final six inches of excavation should be performed with a smooth-edged bucket or a clip attached to the bucket of the excavator or, alternatively, hand-shoveling of the loose, disturbed material 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.

8.3.3 Protection of Existing Active Railroad

Excavations to construct shallow spread footing foundations and the engineered pads at Pier 2 and Abutment 2 (to approximate El. 36.5 and El. 40.0, respectively) will entail cuts of approximately six to 10 feet below existing grades. Excavations at Pier 2 will encroach on the protected zone adjacent to live railroad tracks. Specifically, Amtrak requires protection of the existing tracks when construction occurs within two well defined zones. Temporary sheeting is required if excavations extend into “Zone 2” below the boundary defined as a 1V:1.5H downward slope beginning 10 feet outside the centerline of the nearest railroad tracks. Temporary sheeting to be left-in-place is required if excavations extend into “Zone 3” below the boundary defined as a 1V:1H downward slope beginning at the closest end of the railroad tie. It is our opinion the excavation of Pier 2 will extend into “Zone 3” which requires permanent sheeting. Abutment 2 will be at least 10 feet from “Zone 2” at all points; therefore excavations for Abutment 2 will not impact Amtrak.

Excavations for Pier 2 and Abutment 2 will require temporary lateral support as discussed above. 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. The bracing will require inclined tie-backs with rock anchors. We recommend the following design parameters for temporary lateral earth support at Broad Street:

Existing Fill/Silty Sand

Total Unit Weight = 125 pounds per cubic foot (pcf)
Submerged Unit Weight = 63 pcf
Phi = 32 degrees
$K_a = 0.31$
$K_p = 3.25$

Varved Clay

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

Glacial Till

Total Unit Weight = 135 pcf
Submerged Unit Weight = 73 pcf
Phi = 34 degrees
$K_a = 0.28$
$K_p = 3.54$

A live load surcharge based on the AREMA Cooper E80 railroad load should also be considered in the design of the temporary lateral support system for railroad protection. We recommend a live load surcharge equivalent to at least 5.5 feet of soil, or about 690 psf, based on a total soil unit weight of 125 pcf.

Appropriate contractor coordination with Amtrak will also need to be specified in the contract documents. As the design progresses, we will also provide additional recommendations for the design of the support of excavation and related track monitoring.

8.3.4 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.

8.3.5 Vibrations and Construction-Induced Settlements

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

8.3.6 Abandonment of Existing Utilities

We understand the 16-inch diameter cast iron water line beneath the existing bridge is not in service and has been abandoned. We are not aware of the methods, if any, that were used to abandon this utility. Since shallow spread footing foundations for the proposed bridge may be at or above the elevation of the existing water line, we recommend that the water line be removed in its entirety within 20 feet of Abutment 2 and Pier 2 and replaced with compacted granular fill. In other areas, we recommend the ends of the pipe be located and the pipe filled with grout.

8.3.7 Dewatering

Groundwater may be encountered during foundation installation. Therefore, contractors should be prepared to use sump pumps to control groundwater as needed. Contractors should take extra precaution to dewater in areas where bottom of foundations are close to the Varved Clay. A layer of crushed stone placed on top of the Varved Clay before dewatering is recommended to reduce disturbance to this stratum if it is reached during excavations. If the Varved Clay stratum is disturbed, the disturbed portions must be removed and replaced by crushed stone.

8.3.8 Re-Use of Existing Substructures and Foundations

As previously noted, during preliminary design Baker Engineering and ConnDOT decided to reuse the existing substructures at Abutment 1 and Pier 1. However, we note that the existing condition of the almost 25 year old piles which support these substructures is not known. In particular, the condition of the piles below Abutment 1, which were driven through the Fill may be of concern. To mitigate this possible concern, we recommend that, as a minimum during construction, test pit explorations be performed to evaluate the condition of selected existing Abutment 1 piles which are intended for re-use. These test pits should be relatively easy to excavate in front of (north of) the abutment during the partial demolition of the stub abutment required to construct new bearings and increase clearance below the new span. A review of the load capacity determined by the LRFD method should also be made based on the pile conditions. Based on the results of these explorations and evaluations, existing foundations can be modified as necessary for safe support of the new superstructure.

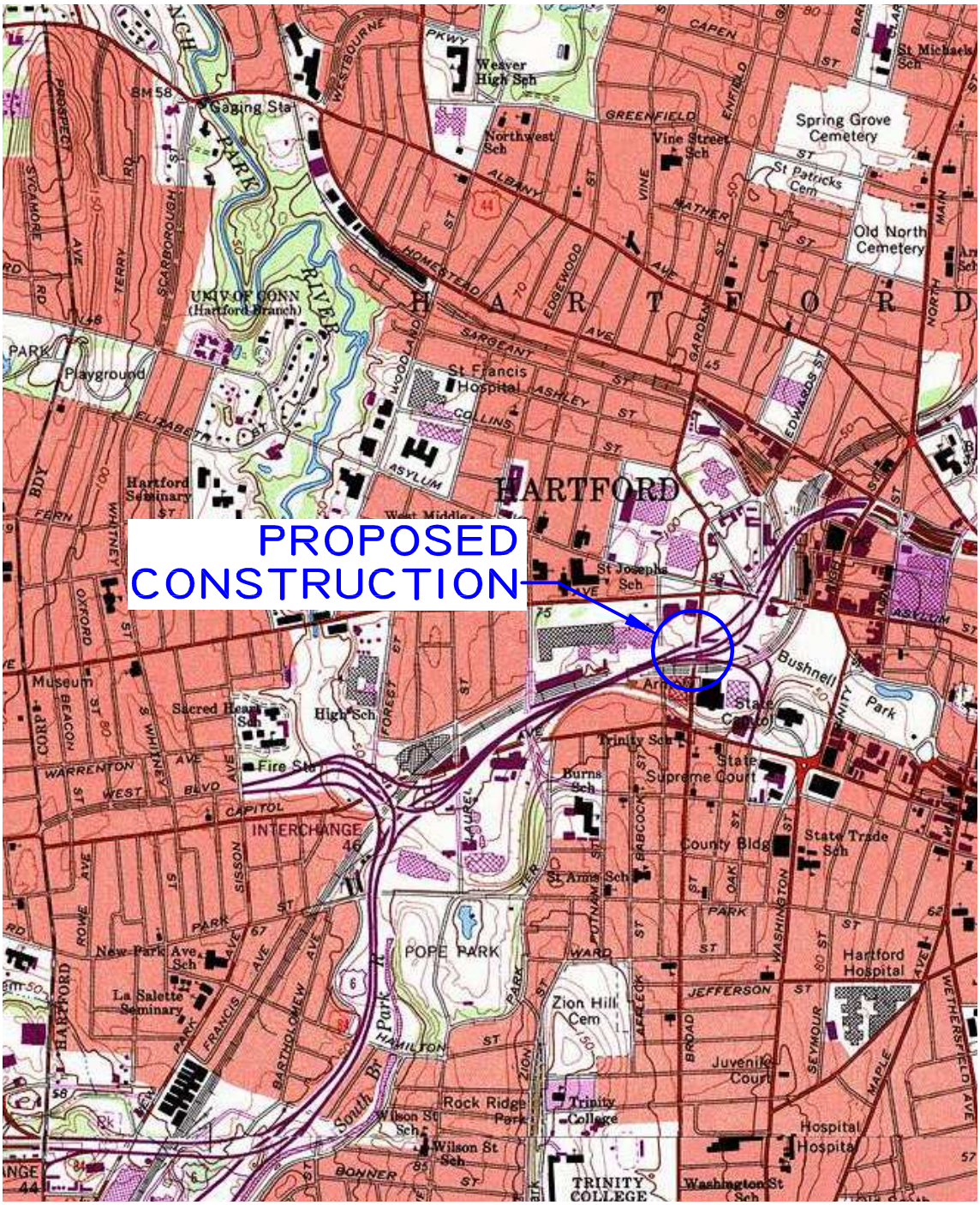
8.3.9 Special Provisions

Special provisions will be required to address vibration monitoring during sheet piling installation, track settlement monitoring, and exploration and evaluation of selected existing Abutment 1 piles.

9.0 LIMITATIONS

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

Appendix 1
Figures



GEODESIGN INCORPORATED
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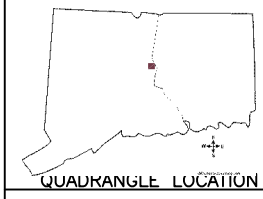
984 SOUTHFORD ROAD • MIDDLEBURY CONNECTICUT 06762
TELEPHONE: (203)758-8836 FACSIMILE: (203)758-8842

DRAWN BY: SMC

REVIEWED BY: JWK

CONNECTICUT



QUADRANGLE LOCATION

PROJECT LOCATION PLAN
BROAD STREET OVER AMTRAK & BUSWAY
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

SCALE IN FEET

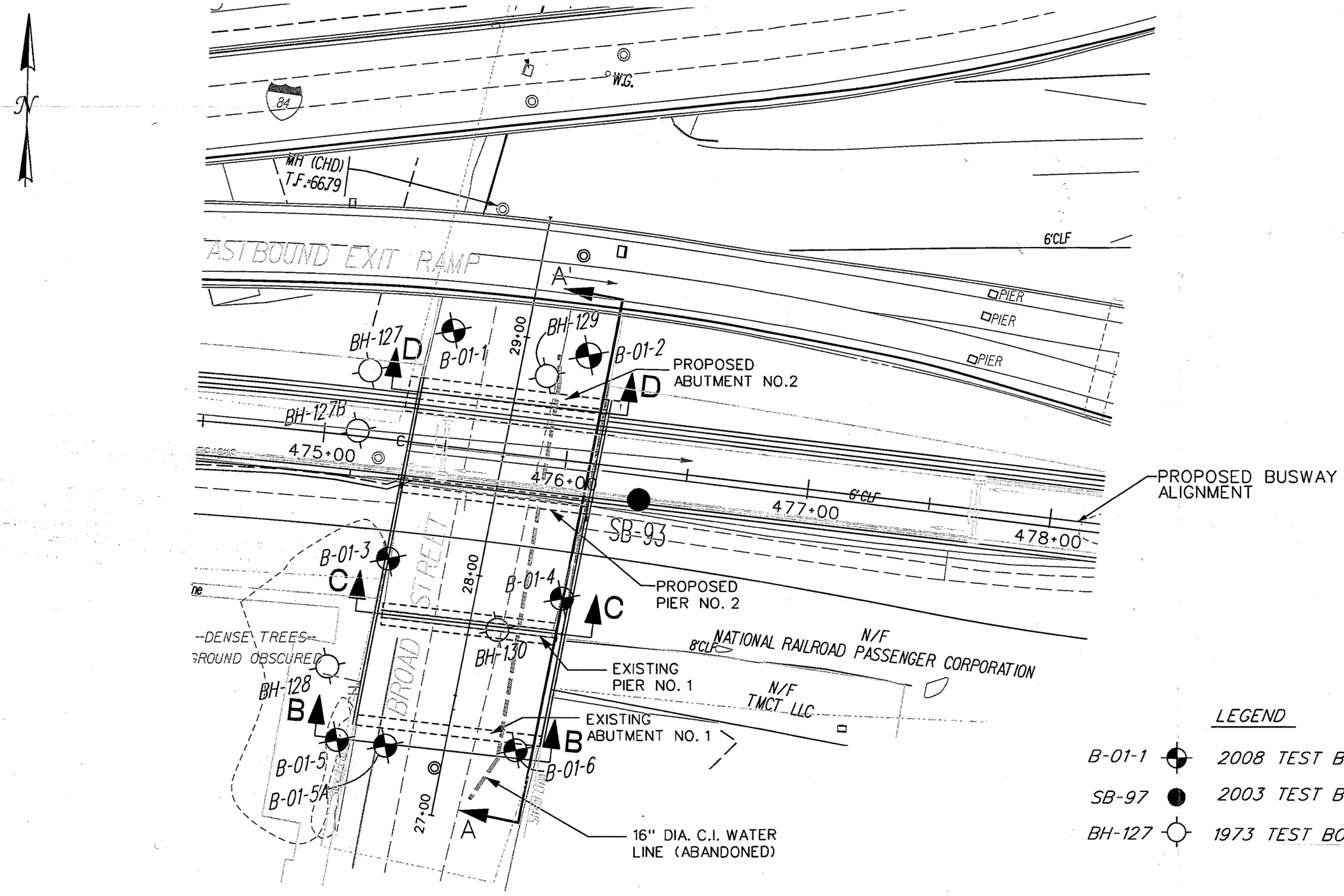
0 1000 2000 4000

PROJECT NO. 0331-014.0

DATE: 12-12-08

FIGURE NO. 1

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



M:\CL\331\14\CADD\SHEETS - HTFD BUSWAY SOUTH - PROP. BORING LOC PLAN

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 SUBSURFACE PROFILE A-A', FIGURE 4 FOR SUBSURFACE PROFILE B-B', FIGURE 5 FOR SUBSURFACE PROFILE C-C' & FIGURE 6 FOR SUBSURFACE PROFILE D-D'.

PRIME DESIGNER:
H. W. Lochner
2110 SILAS DEANE HIGHWAY
ROCKY HILL, CT. 06067
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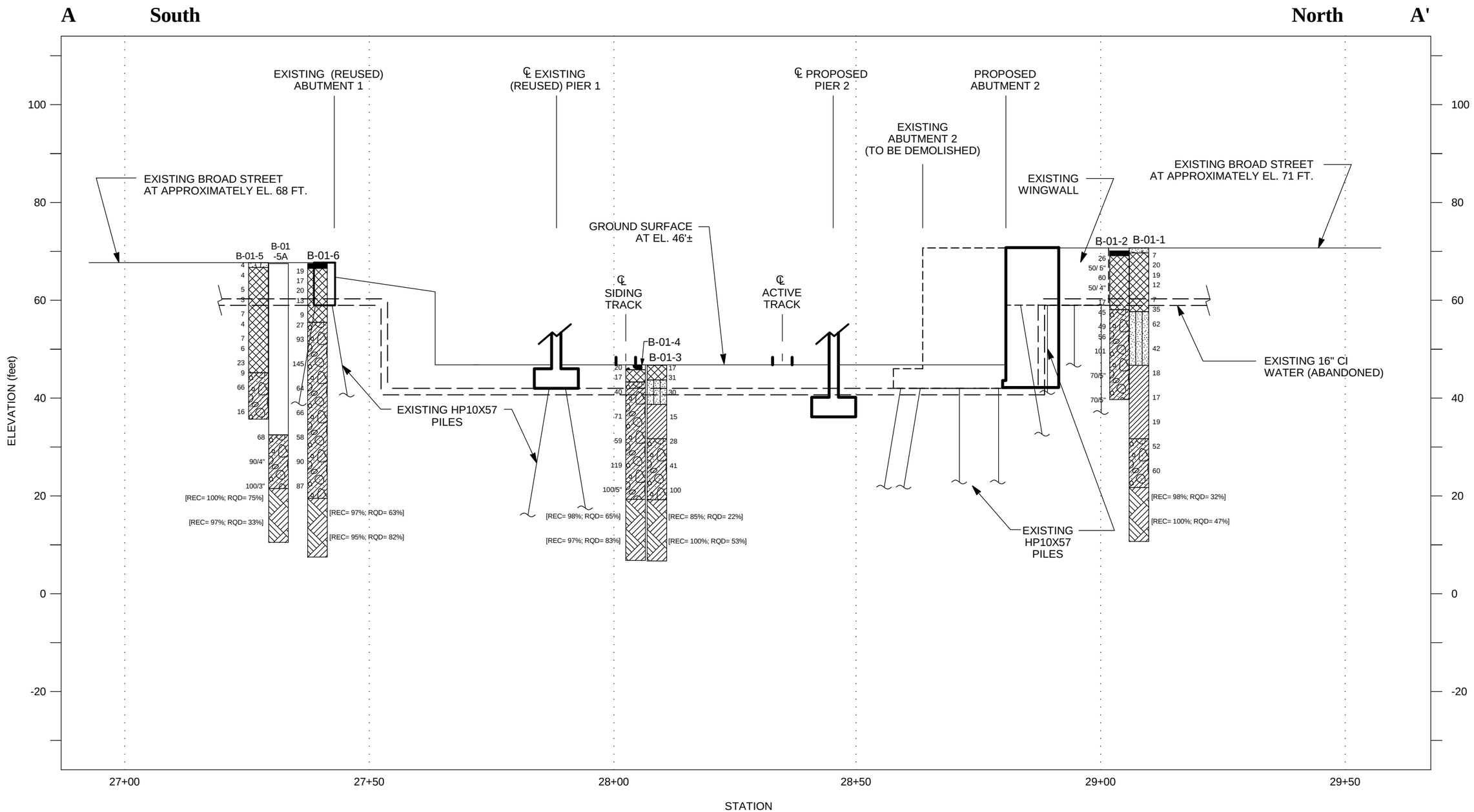
DWG. TITLE
BROAD STREET OVER AMTRAK AND BUSWAY
AS-DRILLED EXPLORATION LOCATION PLAN

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

FILE NO.	331-14
SCALE	1" = 40'
DATE	12-16-08
FIGURE NO.	2



GEO STANDARD 11 X 17 (2/19/04) BORING LOGS 2008.GPJ FBNWNL01.GDT 12/16/08

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0 20
Scale (feet)

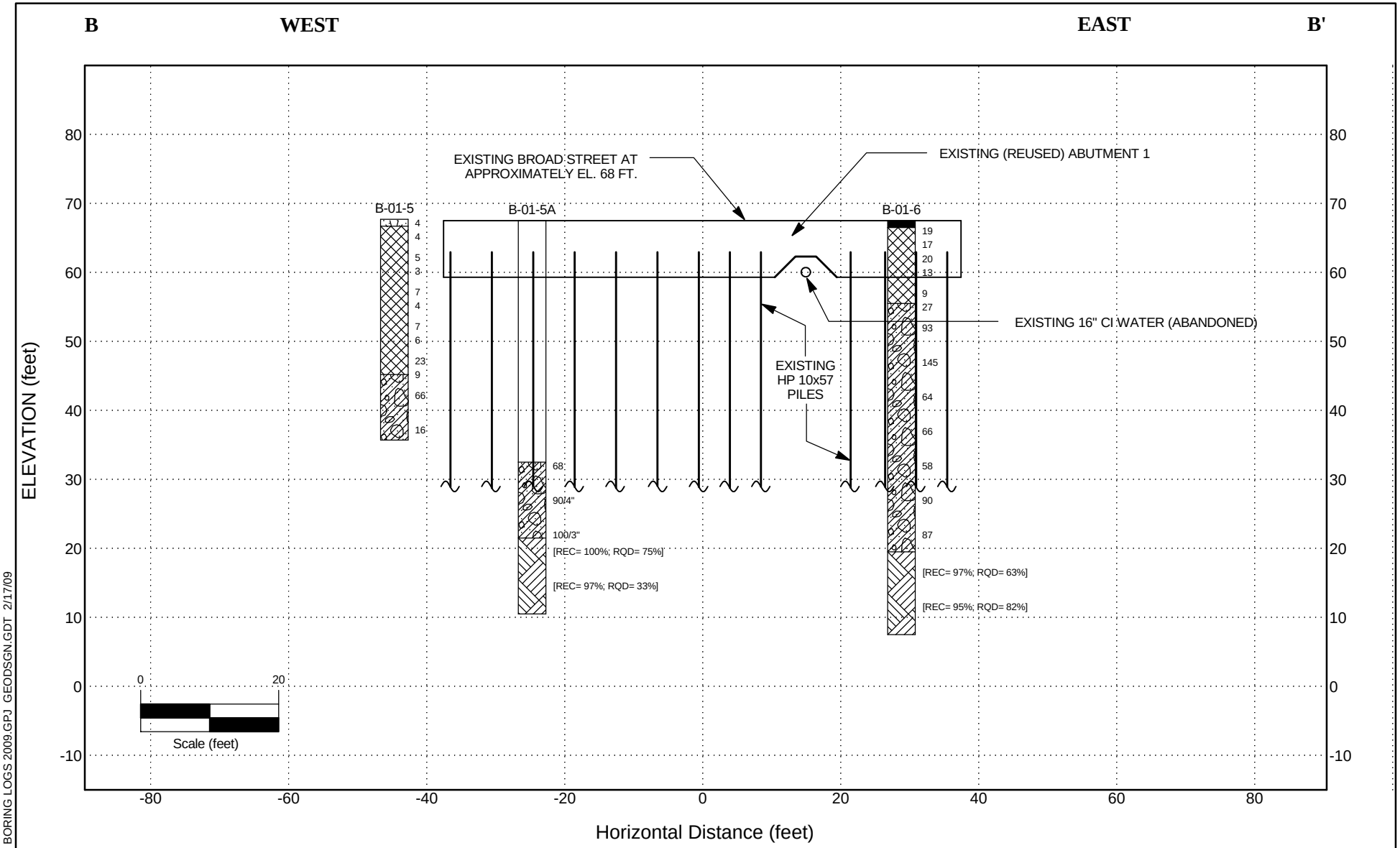
Notes:
1. Data concerning the various strata have been interpreted at boring locations only. The stratigraphy between borings may vary from that shown.
2. Refer to plan view for subsurface profile location. For strata details and symbol legend see Figure 7, Subsurface Profile Legend, and boring logs 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. Refer to 1973 design drawings for details regarding existing substructures.

Date: 2/18/09 | Drawn By: DSF | Reviewed By: JWK

SUBSURFACE PROFILE A-A'

Broad Street Bridge over Amtrak & Busway
New Britain - Hartford Busway
State Project No. 63-H137

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



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Telephone: 203-758-8836 Fax: 203-758-8842

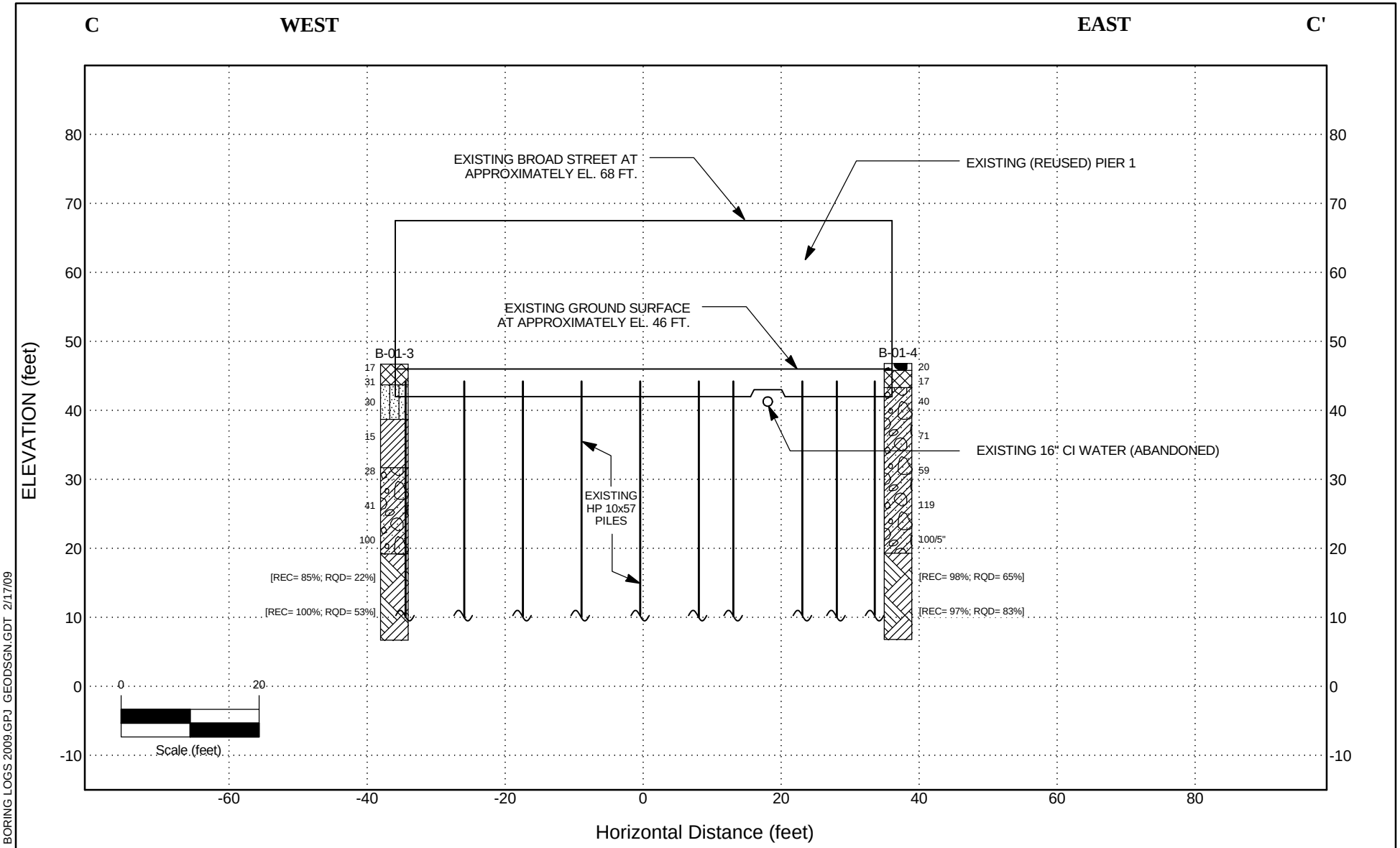
Notes:
1. Data concerning the various strata have been interpreted at boring locations only. The stratigraphy between borings may vary from that shown.
2. Refer to plan view for subsurface profile location. For strata details and symbol legend see Figure 7, Subsurface Profile Legend, and boring logs 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.

SUBSURFACE PROFILE B-B'

Broad Street Bridge over Amtrak & Busway
New Britain - Hartford Busway
State Project No. 63-H137

Date: 2/17/09	Drawn By: DSF	Reviewed By: JWK	File No.: 0331-014.0	Figure No.: 4

GEO STANDARD 8.5 X 11 (2/19/04) BORING LOGS 2009.GPJ GEODSGN.GDT 2/17/09



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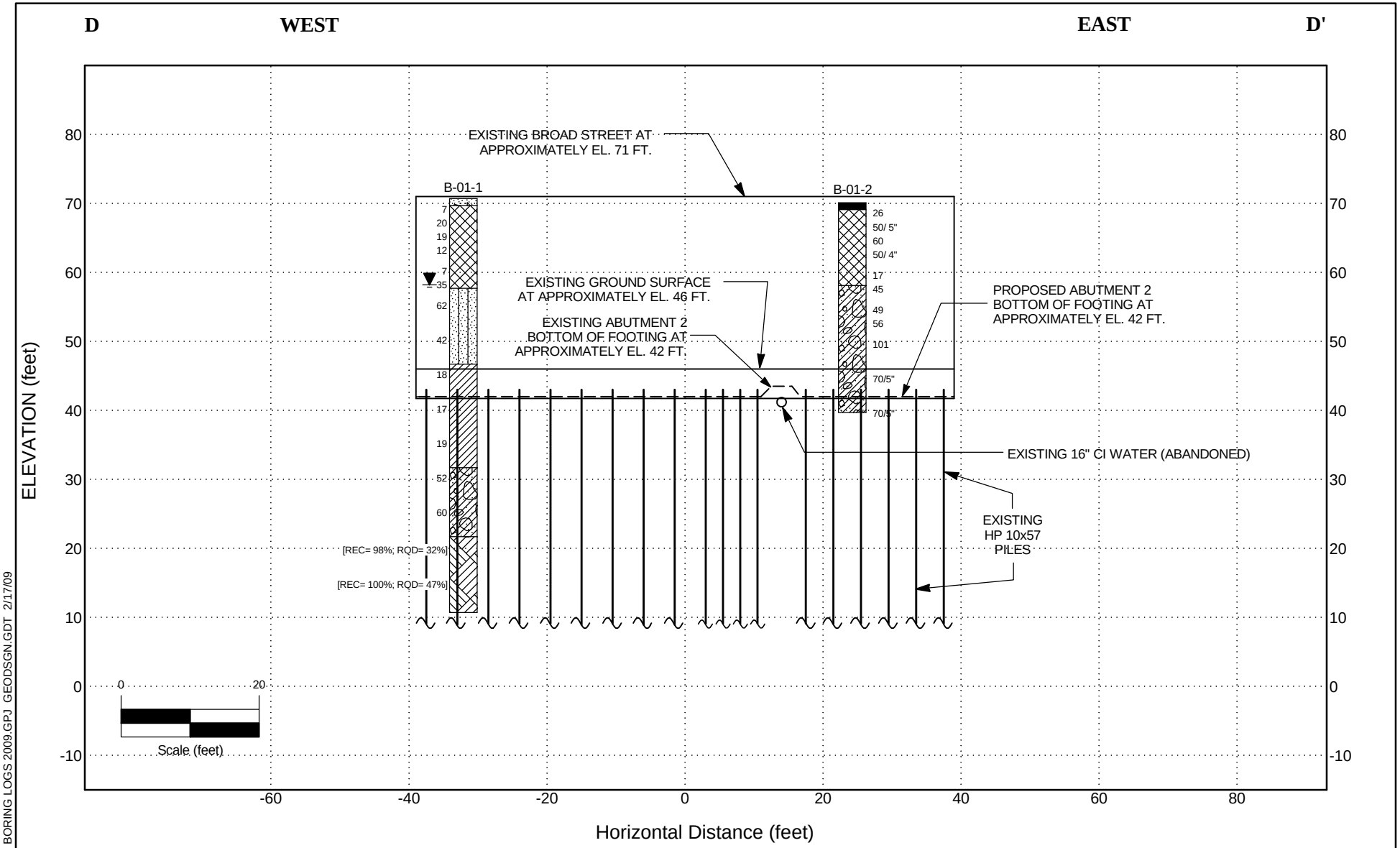
Notes:
1. Data concerning the various strata have been interpreted at boring locations only. The stratigraphy between borings may vary from that shown.
2. Refer to plan view for subsurface profile location. For strata details and symbol legend see Figure 7, Subsurface Profile Legend, and boring logs 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.

SUBSURFACE PROFILE C-C'

Broad Street Bridge over Amtrak & Busway
New Britain - Hartford Busway
State Project No. 63-H137

Date: 2/17/09	Drawn By: DSF	Reviewed By: JWK	File No.: 0331-014.0	Figure No.: 5

GEO STANDARD 8.5 X 11 (2/19/04) BORING LOGS 2009.GPJ GEODSGN.GDT 2/17/09



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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 7, 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.

SUBSURFACE PROFILE D-D'

Broad Street Bridge over Amtrak & Busway
New Britain - Hartford Busway
State Project No. 63-H137

Date: 2/17/09	Drawn By: DSF	Reviewed By: JWK	File No.: 0331-014.0	Figure No.: 6

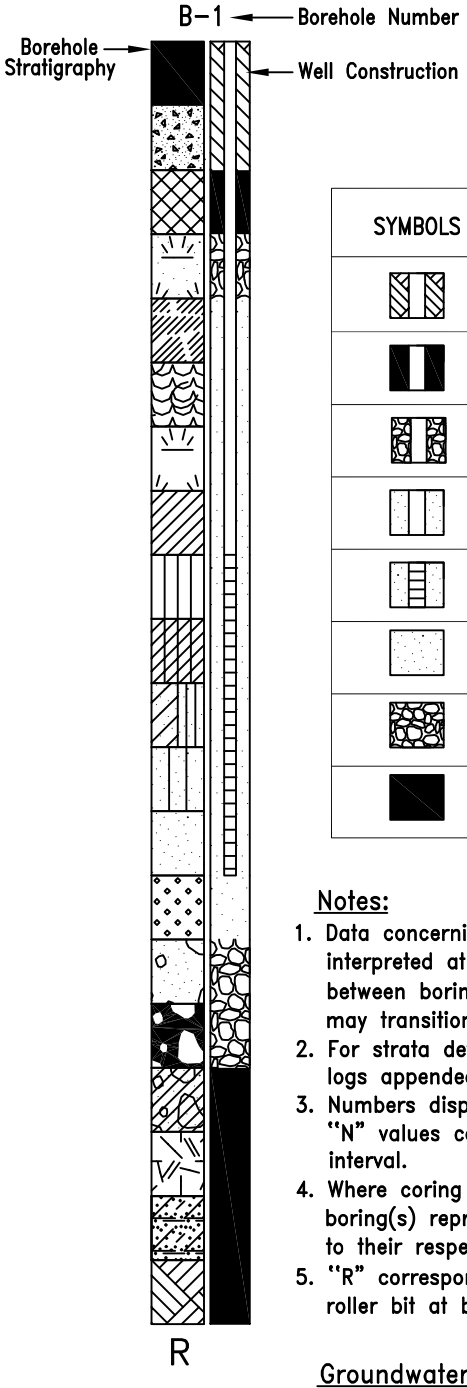
GEO STANDARD 8.5 X 11 (2/19/04) BORING LOGS 2009.GPJ GEODSGN.GDT 2/17/09

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.

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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	2-17-09	7

Appendix 2
2008 Boring Logs
(B-Series)

Connecticut DOT Boring Report

Inspector:	Garry Jacobson	Town:	Hartford	Hole No.:	B-01-1
Engineer:	Geo**Design**, Inc.	Project No.:	63-H137 / 0331-014.0	Stat./Offset:	
Start Date:	10-10-08	Route No.:		Northing:	839831.2
Finish Date:	10-10-08	Bridge No.:		Easting:	1017302.2
				Surface Elevation:	70.7

Project Description: New Britain / Hartford Busway -

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

Groundwater Observations: @12.5 after 0 hours, @16.7', after 336 hours

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						Concrete	5" CONCRETE sidewalk	70
	S-1	3 4 3 3	24	16		Fill	Loose, brown fine to medium SAND, some fine to coarse Gravel, trace Silt, (dry)	
	S-2	2 10 10 16	24	12			Medium dense, brown fine to medium SAND, little fine Gravel, trace Silt, trace Cinders, trace Ceramic, (moist)	
5	S-3	9 9 10 7	24	18			Medium dense, brown fine to medium SAND, little fine Gravel, trace Roots, (moist)	65
	S-4	9 6 6 5	24	4			Medium dense, brown fine to medium SAND, little fine Gravel, trace Silt, (moist)	
10	S-5	2 3 4 7	24	18			Loose, red brown fine SAND and SILT, little Gravel, trace Roots	60
	S-6	7 11 24 25	24	16		Silty Sand	Top 10": Dense, red brown fine SAND and SILT, little Gravel, trace Roots Bottom 6": Dense, red brown fine to medium SAND and SILT, little Gravel, (wet)	
15	S-7	19 24 38 41	24	12			Very dense, red brown fine to coarse SAND and Clayey SILT, little fine Gravel, (wet)	55
20	S-8	16 18 24 33	24	12			Dense, red brown fine to coarse SAND and Clayey SILT, little fine Gravel, (wet)	50
25						Varved Clay		

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: 50ft Rock: 10ft	NOTES: Installed 2" PVC monitoring well to 20' with 10' screen and 10' foot riser. Backfilled with filter sand to 9', bentonite to 7' and drill cuttings to surface. Flush mount protective box installed at surface. Used solid stem auger to 5', drove casing to 30', open hole 30' to 60'.	Sheet 1 of 3
No. of Soil Samples: 13 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Inspector: Garry Jacobson	Town: Hartford	Hole No.: B-01-1	
Engineer: Geo**Design**, Inc.	Project No.: 63-H137 / 0331-014.0	Stat./Offset:	
Start Date: 10-10-08	Route No.:	Northing: 839831.2	
Finish Date: 10-10-08	Bridge No.:	Easting: 1017302.2	
		Surface Elevation: 70.7	

Project Description: New Britain / Hartford Busway -

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

Groundwater Observations: @12.5 after 0 hours, @16.7', after 336 hours

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)
25	S-9	7 8 10 11	24	18		Varved Clay *(con't)*	Very stiff, red brown Silty CLAY, with Clayey SILT seams, portions have bedding inclined to approximately 30 degrees	45
30	S-10	6 8 9 13	24	22			Very stiff, red brown (varved up to 3/4") Silty CLAY and Clayey SILT and seams, all layers inclined 10 degrees	40
35	S-11	5 8 11 12	24	18			Very stiff, red brown, Silty CLAY with Clayey SILT seams and several 3-inch layers of fine to coarse SAND	35
						Glacial Till		
40	S-12	10 20 32 44	24	16			Very dense, red brown fine to coarse SAND and Silty CLAY, little fine Gravel, (wet)	30
45	S-13	21 28 32 39	24	0			No recovery	25
						Bedrock		
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: 50ft Rock: 10ft	NOTES: Installed 2" PVC monitoring well to 20' with 10' screen and 10' foot riser. Backfilled with filter sand to 9', bentonite to 7' and drill cuttings to surface. Flush mount protective box installed at surface. Used solid stem auger to 5', drove casing to 30', open hole 30' to 60'.	Sheet 2 of 3
No. of Soil Samples: 13 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Inspector: Garry Jacobson	Town: Hartford	Hole No.: B-01-1	
Engineer: Geo**Design**, Inc.	Project No.: 63-H137 / 0331-014.0	Stat./Offset:	
Start Date: 10-10-08	Route No.:	Northing: 839831.2	
Finish Date: 10-10-08	Bridge No.:	Easting: 1017302.2	
		Surface Elevation: 70.7	

Project Description: New Britain / Hartford Busway -

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

Groundwater Observations: @12.5 after 0 hours, @16.7', after 336 hours

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)
50						Bedrock *(con't)*		20
	C-1		60	59	32		Poor, Moderately Hard, Slightly Weathered, gray (turns red brown @ 5'), aphanitic SILTSTONE Primary joints (bedding plane) are low angle 1" to 6" spacing. Several vertical, curved, irregular joints, extremely weathered zone from 53.8 to 54.2 Coring time (min./ ft.): 8, 8, 8, 8, 7	
55								15
	C-2		60	60	47		Poor, Moderately Hard, Slightly Weathered, red, aphanitic SILTSTONE Primary joints (bedding plane) are low angle 1" to 6" spacing. Several vertical, curved, irregular joints, very thin bedding is evident Coring time (min./ ft.): 8, 8, 8, 9, 9	
60							END OF BORING 60ft	10
65								5
70								0
75								

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: 50ft Rock: 10ft	NOTES: Installed 2" PVC monitoring well to 20' with 10' screen and 10' foot riser. Backfilled with filter sand to 9', bentonite to 7' and drill cuttings to surface. Flush mount protective box installed at surface. Used solid stem auger to 5', drove casing to 30', open hole 30' to 60'.	Sheet 3 of 3
No. of Soil Samples: 13 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Inspector: Robert Marshall	Town: Hartford	Hole No.: B-01-2	
Engineer: Geo**Design**, Inc.	Project No.: 63-H137 / 0331-014.0	Stat./Offset:	
Start Date: 10-9-08	Route No.:	Northing: 839828.6	
Finish Date: 10-9-08	Bridge No.:	Easting: 1017358.5	
		Surface Elevation: 70.1	

Project Description: New Britain / Hartford Busway -

Casing Size/Type: 3"/NW	Sampler Type/Size: SS / 1 3/8"	Core Barrel Type: NQ
Hammer Wt.: 300 lbs. Fall: 24"	Hammer Wt.: 140 lbs. Fall: 30"	

Groundwater Observations: @15.5' after 0.0 hours

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	3" ASPHALT over 9" CONCRETE	70
	S-1	12 11 15 26	24	6		Fill	Medium dense, red brown fine to medium SAND, some Silt, little fine to coarse Gravel, trace Ash/ Cinders	
	S-2	31 50/ 5"	11	8			Very dense, brown fine to medium SAND, some Silt, little fine to coarse Gravel, trace Concrete fragments, trace Organics	
5	S-3	26 35 25 38	24	12			Very dense, brown fine to medium SAND, some fine to coarse Gravel, little Silt, trace Ash/ Cinders/Concrete fragments	65
	S-4	50/ 4"	4	3			Very dense, brown fine to medium SAND, some fine to coarse Gravel, little Silt, trace Ash/Cinders/Concrete fragments	
10	S-5	4 5 12 18	24	2			Medium dense, brown fine to coarse GRAVEL, trace fine to coarse Sand	60
	S-6	19 22 23 24	24	0		Glacial Till	No recovery	
15	S-7	39 25 24 35	24	0			No recovery	55
	S-8	18 25 31 70/4"	22	12			Very dense, red brown fine to medium SAND, some Clayey Silt, little fine to coarse Gravel, (wet)	
20	S-9	24 44 57 67	24	12			Very dense, red brown fine to medium SAND, some Silt, little fine Gravel, (wet)	50
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: 30.4ft Rock: 0ft	NOTES:	Sheet 1 of 2
No. of Soil Samples: 11 No. of Core Runs: 0		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Inspector:	Robert Marshall	Town:	Hartford	Hole No.:	B-01-2
Engineer:	Geo**Design**, Inc.	Project No.:	63-H137 / 0331-014.0	Stat./Offset:	
Start Date:	10-9-08	Route No.:		Northing:	839828.6
Finish Date:	10-9-08	Bridge No.:		Easting:	1017358.5
				Surface Elevation:	70.1

Project Description: New Britain / Hartford Busway -

Casing Size/Type: 3"/NW	Sampler Type/Size: SS / 1 3/8"	Core Barrel Type: NQ
Hammer Wt.: 300 lbs. Fall: 24"	Hammer Wt.: 140 lbs. Fall: 30"	

Groundwater Observations: @15.5' after 0.0 hours

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-10	38 57 70/5"	17	14		Glacial Till *(con't)*	Very dense, red brown fine to medium SAND, some Silt, little fine Gravel, (wet)	45
30	S-11	70/5"	5	2			Very dense, red brown coarse GRAVEL, some fine to medium Sand, little Silt, (wet)	40
							END OF BORING 30.4ft	
35								35
40								30
45								25
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: 30.4ft Rock: 0ft	NOTES:	Sheet 2 of 2
No. of Soil Samples: 11 No. of Core Runs: 0		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Inspector:	Garry Jacobson	Town:	Hartford	Hole No.:	B-01-3
Engineer:	Geo**Design**, Inc.	Project No.:	63-H137 / 0331-014.0	Stat./Offset:	
Start Date:	9-25-08	Route No.:		Northing:	839734.7
Finish Date:	9-29-08	Bridge No.:		Easting:	1017288.2
				Surface Elevation:	46.7

Project Description: New Britain / Hartford Busway -

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

Groundwater Observations: @2.5 ' after 0 hrs.

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	14 8 9 10	24	15		Fill	Top 8": Medium dense, black fine to coarse SAND and GRAVEL, little Silt Bottom 7": Medium dense, brown fine to medium SAND, trace Gravel, trace Silt	45
	S-2	10 13 18 19	24	13		Silty Sand	Top 9": Dense, brown fine to medium SAND, trace Gravel, trace Silt Bottom 4": Dense, dark red brown Clayey SILT, some fine to coarse Sand, little Gravel, (wet)	
5	S-3	15 13 17 15	24	14			Top 4": Dense, dark red brown Clayey SILT, some fine to coarse Sand, little Gravel, (wet) Bottom 10": Dense, brown SILT, (wet)	40
						Varved Clay		
10	S-4	6 7 8 12	24	16			Stiff, (varved 1" thick) red brown to tan varved CLAY	35
15	S-5	8 10 18 26	24	22		Glacial Till	Medium dense, red brown Clayey SILT, some fine to coarse Sand, little fine Gravel, (wet)	30
20	S-6	11 17 24 25	24	14			Dense, red brown Clayey SILT, some fine to coarse Sand, little fine to coarse Gravel, (wet)	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: 30ft Rock: 10ft	NOTES:	Sheet 1 of 2
No. of Soil Samples: 7 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Inspector: Garry Jacobson	Town: Hartford	Hole No.: B-01-3	
Engineer: Geo**Design**, Inc.	Project No.: 63-H137 / 0331-014.0	Stat./Offset:	
Start Date: 9-25-08	Route No.:	Northing: 839734.7	
Finish Date: 9-29-08	Bridge No.:	Easting: 1017288.2	
Project Description: New Britain / Hartford Busway -		Surface Elevation: 46.7	
Casing Size/Type: 4"/HW	Sampler Type/Size: SS / 1 3/8"	Core Barrel Type: NQ	
Hammer Wt.: 300 lbs. Fall: 24"	Hammer Wt.: 140 lbs. Fall: 30"		
Groundwater Observations: @2.5 ' after 0 hrs.			

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-7	31 100	12	12		Glacial Till *(con't)*	Very dense, red brown Clayey SILT, some fine to coarse Sand, little fine to coarse Gravel, (wet)	20
						Bedrock		
30	C-1		60	51	22		Very Poor Quality, Moderately Hard, Moderately Weathered, gray to red brown aphanitic SILTSTONE, primary joints (bedding plane) are low 2" to 8" spacing. No high joints. Coring time (min./ft.): 7, 7, 8, 8, 8	15
35	C-2		60	60	53		Fair Quality, Slightly Hard, Weathered, red brown aphanitic SILTSTONE. Primary joints are low, 2" to 10" spacing. One high angle joint is rough, curved, irregular. Coring time (min./ft.): 8, 8, 8, 8, 8	10
40							END OF BORING 40ft	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: 30ft Rock: 10ft	NOTES:	Sheet 2 of 2
No. of Soil Samples: 7 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Inspector: Garry Jacobson	Town: Hartford	Hole No.: B-01-4	
Engineer: Geo**Design**, Inc.	Project No.: 63-H137 / 0331-014.0	Stat./Offset:	
Start Date: 9-25-08	Route No.:	Northing: 839728.0	
Finish Date: 9-25-08	Bridge No.:	Easting: 1017360.9	
		Surface Elevation: 46.8	

Project Description: New Britain / Hartford Busway -

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

Groundwater Observations: @3' during drilling

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 11 9 10	24	15		Crushed Stone	Top 8": Medium dense, gray fine to coarse GRAVEL	
						Fill	Bottom 7": Medium dense, gray fine to coarse SAND and SILT, (moist)	45
	S-2	3 9 8 8	24	19			Top 12": Medium dense, brown fine to coarse SAND, trace Silt, (wet)	
						Glacial Till	Bottom 7": Medium dense, red brown Clayey SILT, some fine to coarse Sand, (wet)	
5	S-3	13 15 25 35	24	18			Dense, red brown Clayey SILT, some fine to coarse Sand, little fine to coarse Gravel, (wet)	40
10	S-4	21 33 38 44	24	20			Very dense, red brown Clayey SILT, some fine to coarse Sand, little fine to coarse Gravel, (wet)	35
15	S-5	16 24 35 38	24	14			Very dense, red brown Clayey SILT, some fine to coarse Sand, little fine to coarse Gravel, (wet)	30
20	S-6	14 19 100	18	10			Very dense, red brown Clayey SILT, some fine to coarse Sand, little fine to coarse Gravel, (wet)	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: 30ft Rock: 10ft	NOTES: Used solid stem augers to 10'. Drove casing to 20', then open hole.	Sheet 1 of 2
No. of Soil Samples: 7 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Inspector: Garry Jacobson	Town: Hartford	Hole No.: B-01-4	
Engineer: Geo**Design**, Inc.	Project No.: 63-H137 / 0331-014.0	Stat./Offset:	
Start Date: 9-25-08	Route No.:	Northing: 839728.0	
Finish Date: 9-25-08	Bridge No.:	Easting: 1017360.9	
		Surface Elevation: 46.8	

Project Description: New Britain / Hartford Busway -

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

Groundwater Observations: @3' during drilling

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-7	100/5"	5	4		Glacial Till *(con't)*	Very dense, red brown Clayey SILT, some fine to coarse Sand, little fine to coarse Gravel, (wet)	20
						Bedrock		
30	C-1		60	59	65		Fair, Moderately Hard, Slightly Weathered, gray, aphanitic SILTSTONE. Bedding is massive. Primary joints horizontal, 2" to 18" spacing. Several high angle secondary joints are rough, carved. Coring time (min./ ft.): 7, 7, 7, 8, 8	15
35	C-2		60	58	83		Fair, Moderately Hard, Slightly Weathered, gray, aphanitic SILTSTONE. Bedding is massive. Primary joint spacing is 2" to 24" and no secondary joints. Coring time (min./ ft.): 8, 8, 8, 9, 9	10
40							END OF BORING 40ft	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: 30ft Rock: 10ft	NOTES: Used solid stem augers to 10'. Drove casing to 20', then open hole.	Sheet 2 of 2
No. of Soil Samples: 7 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Inspector: Ray Underwood	Town: Hartford	Hole No.: B-01-5	
Engineer: Geo**Design**, Inc.	Project No.: 63-H137 / 0331-014.0	Stat./Offset:	
Start Date: 10-8-08	Route No.:	Northing: 839658.4	
Finish Date: 10-8-08	Bridge No.:	Easting: 1017277.3	
		Surface Elevation: 67.7	

Project Description: New Britain / Hartford Busway -

Casing Size/Type: 4"/HW	Sampler Type/Size: SS / 1 3/8"	Core Barrel Type:
Hammer Wt.: 300 lbs. Fall: 24"	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	1 2 2 3	24	13		Topsoil Fill	Loose, brown Top 6": TOPSOIL Bottom 7": CLAY, fine Sand, little Silt, (moist)	
	S-2	3 2 2 3	24	0			No recovery	65
5	S-3	6 3 2 4	24	3			Loose, red brown, fine to coarse SAND, little fine Gravel, trace Silt	
	S-4	2 2 1 2	24	1			Very loose, red brown, fine to coarse SAND, little fine Gravel, trace Silt	60
10	S-5	10 4 3 4	24	6			Loose, red brown, fine to coarse SAND, little fine Gravel, trace Silt, (wet)	
	S-6	3 2 2 3	24	0			No recovery	55
15	S-7	5 3 4 3	24	2			Loose, red brown, fine to coarse SAND, some fine Gravel, trace Silt, (wet)	
	S-8	3 2 4 3	24	2			Loose, red brown, fine to coarse SAND, some fine Gravel, trace Silt, (wet)	50
20	S-9	13 12 11 10	24	12			Medium dense, red brown, fine to coarse SAND, little fine Gravel, little Silt	
	S-10	20 4 5 7	24	9		Glacial Till	Top 4": Loose, red brown, fine to coarse SAND, little fine Gravel, little Silt Bottom 5": Loose, red brown Clayey SILT, some fine to coarse Sand, trace fine Gravel	45
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: 32ft Rock: 0ft	NOTES: Casing was pushed to 10' and spun when roller bit reached 10'. After taking S-5 pushed casing down to 15'.	Sheet 1 of 2
No. of Soil Samples: 12 No. of Core Runs: 0		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Inspector:	Ray Underwood	Town:	Hartford	Hole No.:	B-01-5
Engineer:	Geo**Design**, Inc.	Project No.:	63-H137 / 0331-014.0	Stat./Offset:	
Start Date:	10-8-08	Route No.:		Northing:	839658.4
Finish Date:	10-8-08	Bridge No.:		Easting:	1017277.3
				Surface Elevation:	67.7

Project Description: New Britain / Hartford Busway -

Casing Size/Type: 4"/HW	Sampler Type/Size: SS / 1 3/8"	Core Barrel Type:
Hammer Wt.: 300 lbs. Fall: 24"	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)
25	S-11	29 30 36 70/5"	23	14		Glacial Till *(con't)*	Very dense, red brown Clayey SILT, some fine to coarse Sand, trace fine Gravel, (moist)	40
30	S-12	5 7 9 12	24	24			Very stiff, red brown CLAY and SILT, (moist)	
							END OF BORING 32ft	35
35								30
40								25
45								20
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: 32ft Rock: 0ft	NOTES: Casing was pushed to 10' and spun when roller bit reached 10'. After taking S-5 pushed casing down to 15'.	Sheet 2 of 2
No. of Soil Samples: 12 No. of Core Runs: 0		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Inspector:	Robert Marshall	Town:	Hartford	Hole No.:	B-01-5A
Engineer:	Geo**Design**, Inc.	Project No.:	63-H137 / 0331-014.0	Stat./Offset:	
Start Date:	10-24-08	Route No.:		Northing:	839658.7
Finish Date:	10-24-08	Bridge No.:		Easting:	1017297.3
				Surface Elevation:	67.5

Project Description: New Britain / Hartford Busway -

Casing Size/Type: 4"/HW	Sampler Type/Size: SS / 1 3/8"	Core Barrel Type: NQ
Hammer Wt.: 300 lbs. Fall: 24"	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)
0						-		
								65
5								
								60
10							Refer to log of boring B-01-5 for strata description above 35 feet.	
								55
15								
								50
20								
								45
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: 47ft Rock: 10ft	NOTES: Pilot hole to 5' with 4" OD SSA, then switched to 4" casing to 30'. Boring advance open hole below 30'.	Sheet 1 of 3
No. of Soil Samples: 3 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Inspector:	Robert Marshall	Town:	Hartford	Hole No.:	B-01-5A
Engineer:	Geo**Design**, Inc.	Project No.:	63-H137 / 0331-014.0	Stat./Offset:	
Start Date:	10-24-08	Route No.:		Northing:	839658.7
Finish Date:	10-24-08	Bridge No.:		Easting:	1017297.3
				Surface Elevation:	67.5

Project Description: New Britain / Hartford Busway -

Casing Size/Type: 4"/HW	Sampler Type/Size: SS / 1 3/8"	Core Barrel Type: NQ
Hammer Wt.: 300 lbs. Fall: 24"	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)
25						- *(con't)*		
								40
30								
								35
35						Glacial Till		
	S-1	14 26 42 49	24	8			Very dense, red brown Clayey SILT, little fine to medium Sand, trace fine Gravel	
								30
40								
	S-2	49 62 90/4"	16	12			Very dense, red brown Clayey SILT, little fine to medium Sand, trace fine Gravel	
								25
45								
	S-3	80 100/3"	9	7			Very dense, red brown SILT and CLAY, little fine to medium Sand	
						Bedrock		
								20
	C-1		60	60	75		Good, Moderately Hard, Slightly Weathered, gray, SILTSTONE	
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: 47ft Rock: 10ft	NOTES: Pilot hole to 5' with 4" OD SSA, then switched to 4" casing to 30'. Boring advance open hole below 30'.	Sheet 2 of 3
No. of Soil Samples: 3 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Inspector:	Robert Marshall	Town:	Hartford	Hole No.:	B-01-5A
Engineer:	Geo**Design**, Inc.	Project No.:	63-H137 / 0331-014.0	Stat./Offset:	
Start Date:	10-24-08	Route No.:		Northing:	839658.7
Finish Date:	10-24-08	Bridge No.:		Easting:	1017297.3
				Surface Elevation:	67.5

Project Description: New Britain / Hartford Busway -

Casing Size/Type: 4"/HW	Sampler Type/Size: SS / 1 3/8"	Core Barrel Type: NQ
Hammer Wt.: 300 lbs. Fall: 24"	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)
50						Bedrock *(con't)*	Coring time (min./ft.): 6, 6, 6, 7, 6	
								15
55	C-2		60	58	33		Poor, Moderately Hard, Slightly Weathered, gray, SILTSTONE Coring time (min./ft.): 6, 6, 6, 6, 6	
							END OF BORING 57ft	10
60								
								5
65								
								0
70								
								-5
75								

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: 47ft Rock: 10ft	NOTES: Pilot hole to 5' with 4" OD SSA, then switched to 4" casing to 30'. Boring advance open hole below 30'.	Sheet 3 of 3
No. of Soil Samples: 3 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Inspector: Robert Marshall	Town: Hartford	Hole No.: B-01-6	
Engineer: Geo**Design**, Inc.	Project No.: 63-H137 / 0331-014.0	Stat./Offset:	
Start Date: 10-9-08	Route No.:	Northing: 839663.9	
Finish Date: 10-9-08	Bridge No.:	Easting: 1017350.6	
		Surface Elevation: 67.5	

Project Description: New Britain / Hartford Busway -

Casing Size/Type: 3"/NW	Sampler Type/Size: SS / 1 3/8"	Core Barrel Type: NQ
Hammer Wt.: 300 lbs. Fall: 24"	Hammer Wt.: 140 lbs. Fall: 30"	

Groundwater Observations: @10' after 0 hrs.

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	6" of ASPHALT over 6" GRAVEL Base	
	S-1	10 10 9 8	24	12		Fill	Medium dense, brown to red brown fine to medium SAND, little fine to coarse Gravel, little Silt	65
	S-2	7 8 9 11	24	8			Medium dense, brown fine to medium SAND, little fine to coarse Gravel, little Silt, little Ash/ Cinders	
5	S-3	15 11 9 8	24	12			Medium dense, red brown fine to medium SAND, little fine to coarse Gravel, little Silt	
	S-4	8 7 6 7	24	0			Medium dense, no recovery	60
10	S-5	9 5 4 7	24	12			Loose, red brown SILT, little fine to medium Sand, little fine Gravel, (wet)	
	S-6	9 11 16 17	24	16		Glacial Till	Medium dense, red brown fine to medium SAND, some Silt, little fine Gravel	55
15	S-7	21 44 49 57	24	13			Very dense, red brown fine to medium SAND, some Silt, little fine Gravel	50
20	S-8	47 60 85	18	16			Very dense, red brown fine to medium SAND, some fine to coarse Gravel, some Silt	45
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: 50ft Rock: 10ft	NOTES: Pilot hole to 5' with 4" OD SSA. Wet sample at 10'. Open hole below 30'.	Sheet 1 of 3
No. of Soil Samples: 13 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Inspector:	Robert Marshall	Town:	Hartford	Hole No.:	B-01-6
Engineer:	Geo**Design**, Inc.	Project No.:	63-H137 / 0331-014.0	Stat./Offset:	
Start Date:	10-9-08	Route No.:		Northing:	839663.9
Finish Date:	10-9-08	Bridge No.:		Easting:	1017350.6
				Surface Elevation:	67.5

Project Description: New Britain / Hartford Busway -

Casing Size/Type: 3"/NW	Sampler Type/Size: SS / 1 3/8"	Core Barrel Type: NQ
Hammer Wt.: 300 lbs. Fall: 24"	Hammer Wt.: 140 lbs. Fall: 30"	

Groundwater Observations: @10' after 0 hrs.

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)
25	S-9	20 28 36 45	24	12		Glacial Till *(con't)*	Very dense, red brown fine to medium SAND, some fine to coarse Gravel, some Silt	40
30	S-10	17 31 35 80	24	12			Very dense, red brown fine to medium SAND, some fine to coarse Gravel, some Silt	35
35	S-11	16 26 32 49	24	18			Very dense, red brown fine to medium SAND, some Silt, little fine to coarse Gravel	30
40	S-12	49 90	12	8			Very dense, red brown fine to medium SAND, some Silt, trace fine Gravel	25
45	S-13	18 27 60 59	24	16			Very dense, red brown fine to medium SAND, some Silt, trace fine Gravel	20
						Bedrock		
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: 50ft Rock: 10ft	NOTES: Pilot hole to 5' with 4" OD SSA. Wet sample at 10'. Open hole below 30'.	Sheet 2 of 3
No. of Soil Samples: 13 No. of Core Runs: 2		SM-001-M REV. 1/02

Connecticut DOT Boring Report

Inspector: Robert Marshall	Town: Hartford	Hole No.: B-01-6	
Engineer: Geo**Design**, Inc.	Project No.: 63-H137 / 0331-014.0	Stat./Offset:	
Start Date: 10-9-08	Route No.:	Northing: 839663.9	
Finish Date: 10-9-08	Bridge No.:	Easting: 1017350.6	
		Surface Elevation: 67.5	

Project Description: New Britain / Hartford Busway -

Casing Size/Type: 3"/NW	Sampler Type/Size: SS / 1 3/8"	Core Barrel Type: NQ
Hammer Wt.: 300 lbs. Fall: 24"	Hammer Wt.: 140 lbs. Fall: 30"	

Groundwater Observations: @10' after 0 hrs.

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)
50						Bedrock *(con't)*		
	C-1		60	58	63		Fair, Moderately Hard, Fresh, gray, SILTSTONE Coring time (min./ft.): 6, 6, 6, 6, 6	15
55								
	C-2		60	57	82		Good, Moderately Hard, Fresh, gray, SILTSTONE Coring time (min./ft.): 6, 5, 6, 5, 5	10
60							END OF BORING 60ft	
								5
65								
								0
70								
								-5
75								

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: 50ft Rock: 10ft	NOTES: Pilot hole to 5' with 4" OD SSA. Wet sample at 10'. Open hole below 30'.	Sheet 3 of 3
No. of Soil Samples: 13 No. of Core Runs: 2		SM-001-M REV. 1/02

Appendix 3
2003 Boring Logs
(SB-Series)

Driller: Al Augustine/GZA	**Connecticut DOT Boring Report**	Hole No.: **SB-93**
Inspector: Josh Colella	Town: West Hartford / Hartford, CT	Stat./Offset:
Engineer: Baker Engineering	Project No.: 171-0305	Northing: 839772.6
Start Date: 7/25/03	Route No.:	Easting: 1017386.8
Finish Date: 7/25/03	Bridge No.:	Surface Elevation: 45.9
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. @ 8.1 after: 0 hours, @	after: 24 hours, @	after: 48 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.)
0–1	A-N		1.5					45
1–2	S-1	4 4 4	1.5	0.7			POORLY GRADED SAND WITH SILT (SP-SM) - brown and black fine sand, trace silt; moist, loose, NP; (FILL).	44
2–3								43
3–4	A-N		1.5					42
4–5	S-2	4 2 6	1.5	0.7			POORLY GRADED SAND WITH SILT (SP-SM) - brown and black fine sand, trace silt, trace clay; moist, loose, NP; (FILL).	41
5–6								40
6–7	W-N		1.5					39
7.5'							ELEV. 38.4	
7–8	S-3	17 26 37	1.5	1.3			SILT WITH SAND (ML) - brown silt, some fine sand, trace fine to medium gravel; moist, hard, -PL (TILL).	38
8–9	W-N		1.0					37
9–10	S-4	16 23 30	1.5	1.5			SILT WITH SAND (ML) - brown silt, little fine to coarse sand, little fine to coarse gravel; moist, hard, -PL; (TILL).	36
10–11								35
11–12	W-N		2.0					34
12–13								33
13–14	S-5	12 11 15	1.5	1.4			SILT WITH SAND (ML) - brown silt, little fine to coarse sand, little fine to coarse gravel; moist, very stiff, -PL; (TILL).	32
14–15								31
15–16	W-N		1.5					30
16–17	S-6	17 23 30	1.5	0.8			SILT WITH SAND (ML) - brown silt, little fine to coarse sand, little fine to coarse gravel; moist, hard, -PL; (TILL).	29
17–18								28
18–19	W-N		1.5					27
19–20		13					SILT WITH SAND (ML) - brown silt, little fine to coarse	26

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: 27.0' Rock: 10.0' No. of Samples: 9	NOTES:	Sheet 1 of 2 SM-001-M REV. 1/02

Driller: Al Augustine/GZA	**Connecticut DOT Boring Report**	Hole No.: **SB-93**
Inspector: Josh Colella	Town: West Hartford / Hartford, CT	Stat./Offset:
Engineer: Baker Engineering	Project No.: 171-0305	Northing: 839772.6
Start Date: 7/25/03	Route No.:	Easting: 1017386.8
Finish Date: 7/25/03	Bridge No.:	Surface Elevation: 45.9

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. @ 8.1 after: 0 hours, @ after: 24 hours, @ after: 48 hours

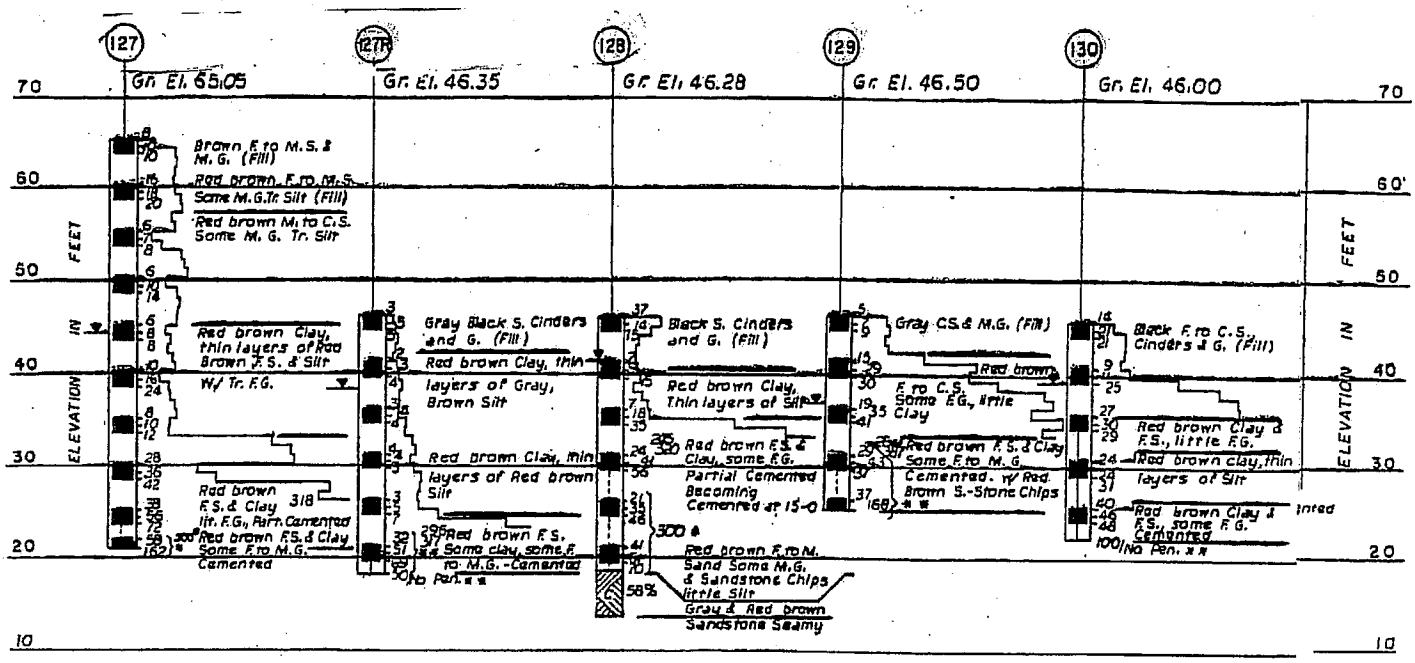
Baker Info: S.O. Number: B25624LPDSOIL41802/42002 File: northern Template: CDOT_E (LD4 1/03)

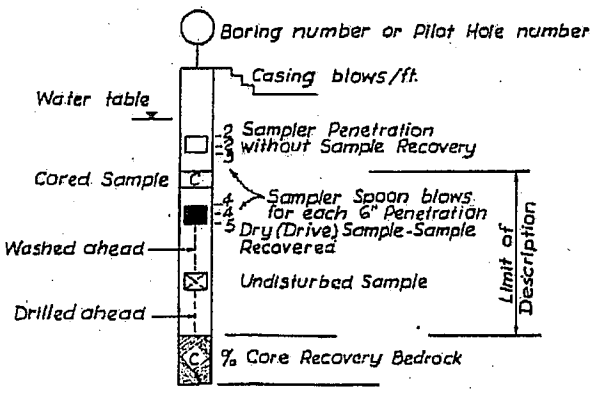
Depth (ft.)	Sample Type/No.	Blows on Sampler per 0.5 ft.	Pen. (ft.)	Rec. (ft./%)	RQD (ft./%)	Generalized Strata Description	Material Description and Notes	Elevation (ft.)
20	S-7	17 27	1.5	1.4			sand, little fine to coarse gravel; moist, hard, -PL; (TILL).	25
21								
22	W-N		1.5					24
23	S-8	13 20 23	1.5	0.8			SILT WITH SAND (ML) - brown silt, little fine to coarse sand, little fine to coarse gravel; moist, hard, -PL; (TILL).	23
24	W-N		1.0					22
25	S-9	100/0.1	0.1	0.0			NO RECOVERY ON S-9	21
26	W-N		1.9					20
27						27.0'	ELEV. 18.9	19
28				5.0	2.0		SHALE; gray, medium hard, moderately to slightly weathered.	18
29	C-1		5.0					17
30								16
31								15
32				100%	40%			14
33				4.8	4.8		SHALE; gray, medium hard, moderately to slightly weathered.	13
34	C-2		5.0					12
35								11
36								10
37				96%	96%		ELEV. 8.9	9
38							End of Boring at 37.0'	8
39								7
								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: 27.0' Rock: 10.0' No. of Samples: 9	NOTES:	Sheet **2** of **2** SM-001-M REV. 1/0

Appendix 4
1973 Boring Logs
(BH-Series)





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

Casing I.D - 2½"
Hammer Wt. - 300 lbs.
Hammer Fall - 24"
Core Bar Type - Double Tube
Core Bar I.D. - 1⅜"
Bit - B-Dia.

Mark on Sampler Blows	Unmarked	300#	*	* *
Sampler Type & I.D.	S.S.-1½"	S.S.-1½"	Open End "A" Rod	Open End "A" Rod
Hammer Wt.	140#	300#	140#	300#
Hammer Fall	30"	24"	30"	24"

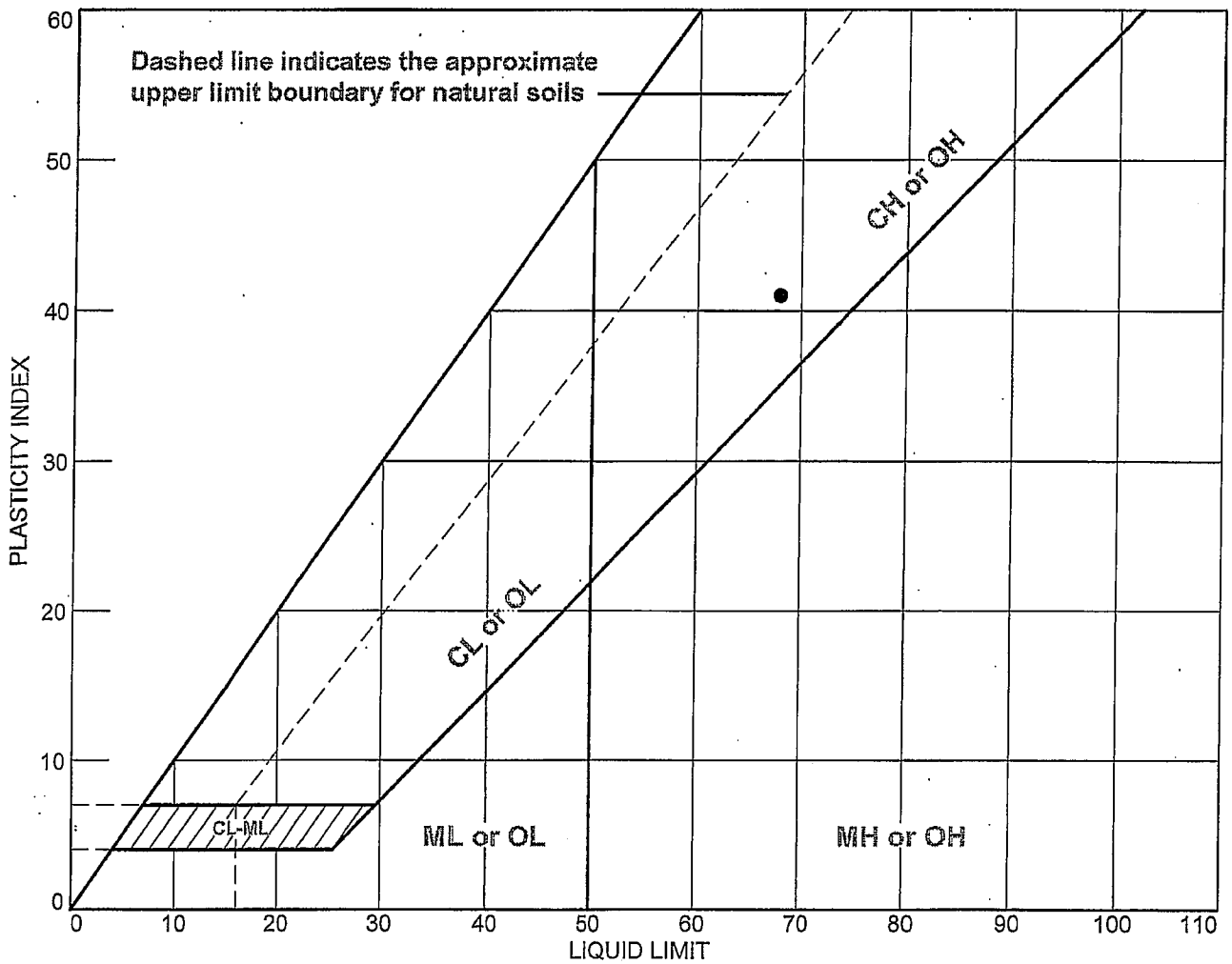
KEY AND ABBREVIATIONS

1973 Boring Logs

Broad Street Over Busway

Appendix 5
2008 Geotechnical Laboratory Testing

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	B-01-1	S-10	30 - 32'	34.2	27	68	41	

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.: **Figure**

Tested By: R. Decesare

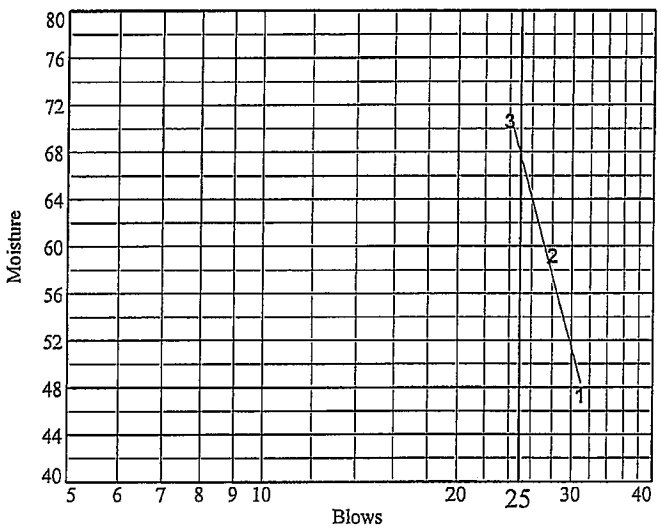
LIQUID AND PLASTIC LIMIT TEST DATA

1/2/2009

Client: GeoDesign Incorporated
Project: New Britain - Hartford Busway # 331-14
Location: B-01-1
Depth: 30 - 32'
Sample Number: S-10
Material Description: Reddish Brown color
Tested by: R. Decesare

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	7.28	6.29	5.29			
Dry+Tare	4.94	3.95	3.1			
Tare	0	0	0			
# Blows	31	28	24			
Moisture	47.4	59.2	70.6			



Liquid Limit= 68
Plastic Limit= 27
Plasticity Index= 41
Natural Moisture= 34.2
Liquidity Index= 0.2

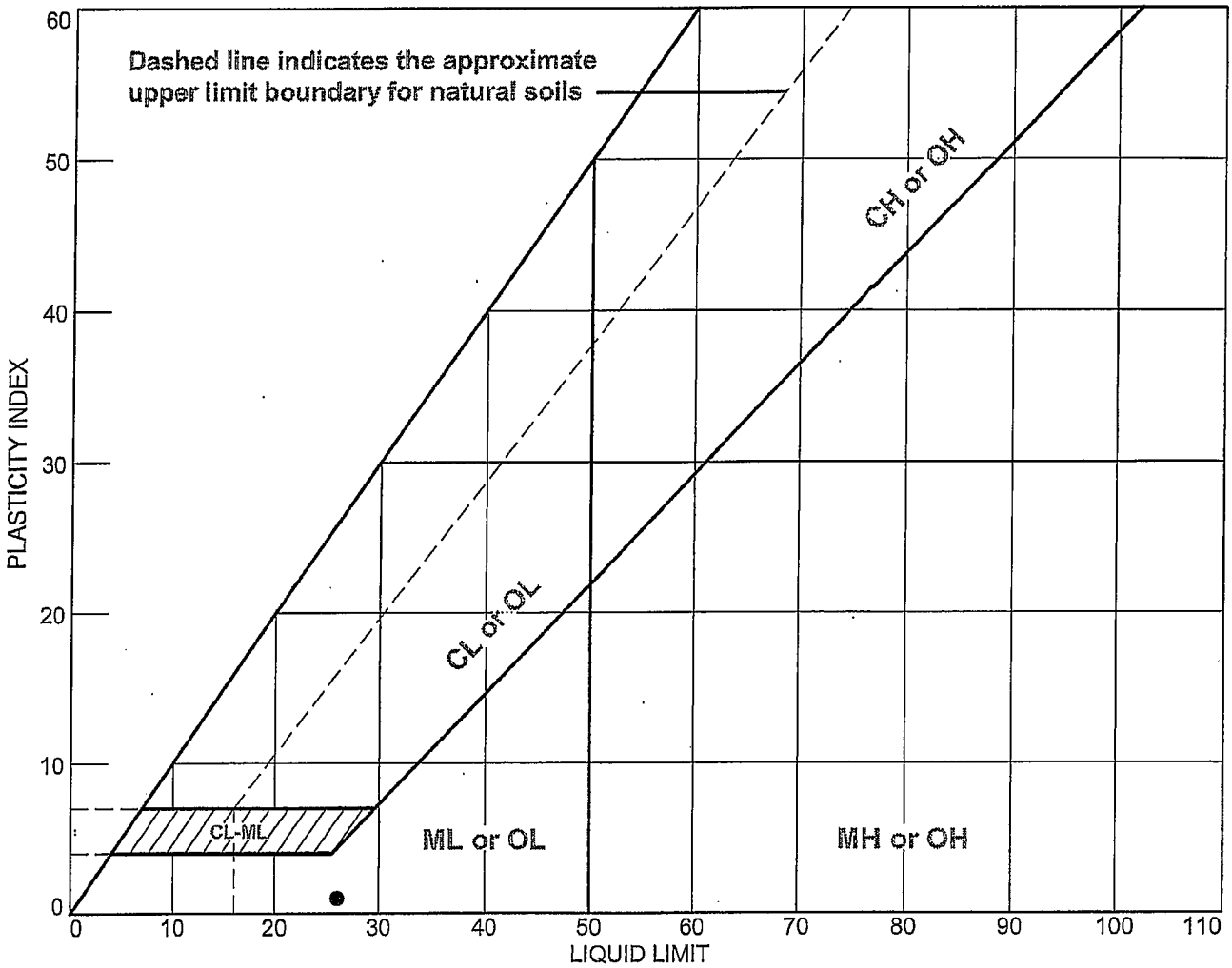
Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	3.91	2.90	1.92		
Dry+Tare	3.33	2.32	1.39		
Tare	0	0	0		
Moisture	17.4	25.0	38.1		

Natural Moisture Data

Wet+Tare	Dry+Tare	Tare	Moisture
174.6	130.1	0	34.2

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	B-01-3	S-4	10' - 12'	27.1	25	26	1	

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Client: GeoDesign Incorporated
Project: New Britain - Hartford Busway # 331-14
Project No.:
Figure

Tested By: R. DeCesare

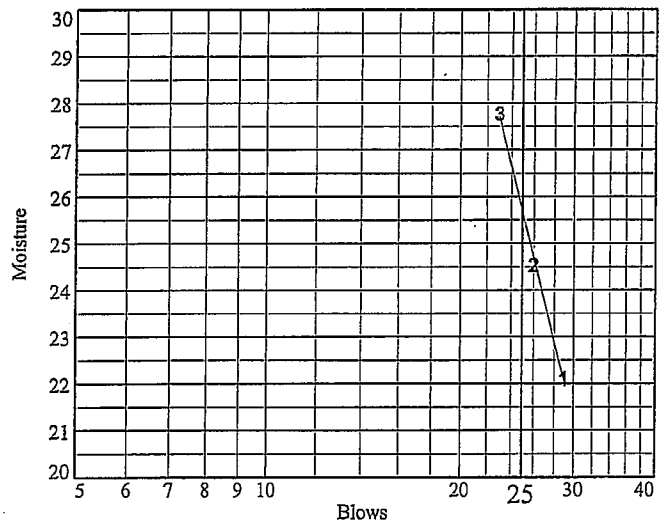
LIQUID AND PLASTIC LIMIT TEST DATA

12/30/2008

Client: GeoDesign Incorporated
Project: New Britain - Hartford Busway # 331-14
Location: B-01-3
Depth: 10' - 12' **Sample Number:** S-4
Material Description: Reddish Brown color
Tested by: R. DeCesare

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	12.70	11.77	10.67			
Dry+Tare	10.40	9.45	8.35			
Tare	0	0	0			
# Blows	29	26	23			
Moisture	22.1	24.6	27.8			



Liquid Limit= 26
Plastic Limit= 25
Plasticity Index= 1
Natural Moisture= 27.1
Liquidity Index= 2.1

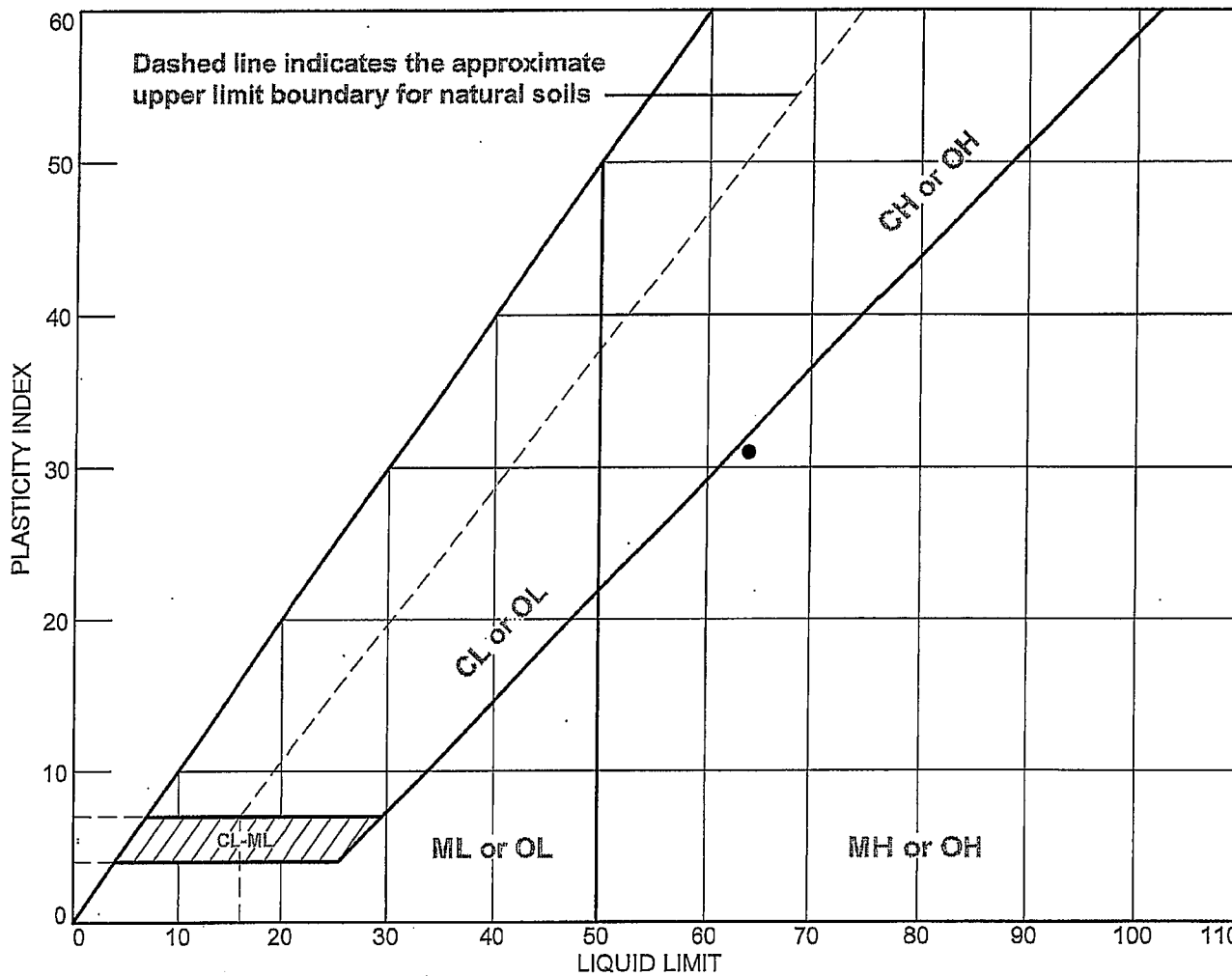
Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	6.25	5.20	4.18		
Dry+Tare	5.35	4.17	3.1		
Tare	0	0	0		
Moisture	16.8	24.7	34.8		

Natural Moisture Data

Wet+Tare	Dry+Tare	Tare	Moisture
159.9	125.8	0	27.1

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	B-01-1	S-9	25 to 27'	32.8	33	64	31	

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Client: GeoDesign Incorporated
Project: New Britain - Hartford Busway # 331-14
Project No.:
Figure

Tested By: R. DeCesare

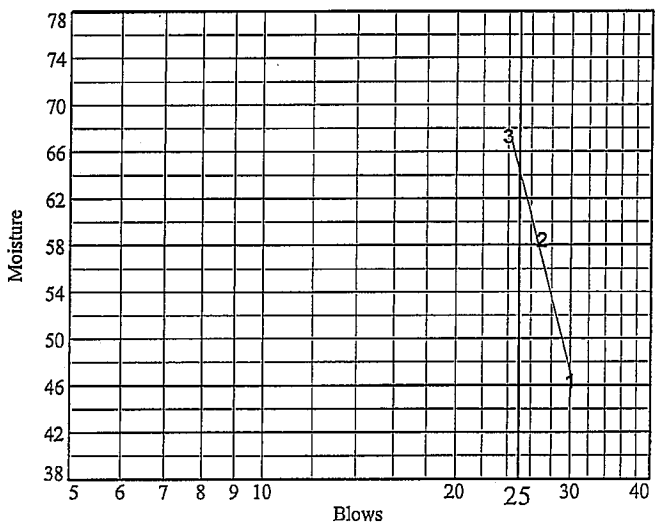
LIQUID AND PLASTIC LIMIT TEST DATA

1/2/2009

Client: GeoDesign Incorporated
Project: New Britain - Hartford Busway # 331-14
Location: B-01-1
Depth: 25 to 27'
Sample Number: S-9
Material Description: Reddish Brown color
Tested by: R. DeCesare

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	7.7	6.72	5.69			
Dry+Tare	5.26	4.24	3.4			
Tare	0	0	0			
# Blows	30	27	24			
Moisture	46.4	58.5	67.4			



Liquid Limit= 64
Plastic Limit= 33
Plasticity Index= 31
Natural Moisture= 32.8
Liquidity Index= 0.0

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	4.01	3.03	2.02		
Dry+Tare	3.29	2.35	1.35		
Tare	0	0	0		
Moisture	21.9	28.9	49.6		

Natural Moisture Data

Wet+Tare	Dry+Tare	Tare	Moisture
213.8	161.0	0	32.8

TEST-CON INCORPORATED

16 East Franklin Street
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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:**	1/14/08 York (CT # PH-0723) 12/12/08
Project:	New Britain-Hartford Busway # 331-14 Hartford/West Hartford, CT	**Matrix:** **Report No.:**	Soil 1 – 3 Sulfide (09010071)

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 otheriwise noted, are summarized in the following table(s).

Analysis Results

Boring/Test Pit No.	Sample No.	Depth (ft)	Parameter	Method	Units	Results	MDL
B01 - 3	S-1	0' – 2'	Sulfide	EPA376.1	mg/kg	Not detected	20.0
B01 - 6	S-2	3' – 5'	Sulfide	EPA376.1	mg/kg	Not detected	20.0
B01 - 5	S-5	10' – 12'	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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TEST-CON Incorporated

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E-Mail: Service@test-con.com Web-Site: www.test-con.com

PH OF SOIL MATERIAL REPORT

Date: December 23, 2008

Report #: 1 - 3pH
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 12/12/08

Test Requirements: pH

Summary Data

Boring/Test Pit No.	Sample No.	Depth (ft)	pH Test Results
B-01-5	S-5	10 - 12	7.95
B-01-6	S-2	3 - 5	8.62
B-01-3	S-1	0 – 2	6.90

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Construction Material Testing & Inspection - Geotechnical Services

ROCK CORE REPORT

Client: GeoDesign Incorporated
984 Southford Rd.
Middlebury, CT 06762
Project: New Britain-Hartford Busway # 331-14

Date: 12/23/08
Technician: R. DeCesare
Report #: 1 – 2 Core

Progress of Work: As requested, Test-Con performed unconfined compressive strength of rock core samples and the results are as follow:

Identification #:	B-01-4 C2	B-01-3 C2
Total Length of Core Recovered	13.5"	10.2"
Sample Height, inches, after cutting and capping	4"	4"
Capping Material	Sulfur	Sulfur
Diameter, inches	2.0	2.0
Area, square inches	3.14	3.14
Heigh/Diameter Ratio	2.0	2.0
Total Load, lbs.	25,656	13,350
Load, P.S.I.	8170	4251
Correction Factor	None	None
Corrected P.S.I.	8170	4251
Date Tested	12/23/08	12/23/08
No. of End Cuts	2	2

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5-15-07

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: 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} (%)	Permeability cm/sec	Strength Tests: Torvane or Type Test	$\bar{\sigma}_c$ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	Consol.: $\frac{\Delta e}{1+e_0}$	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																

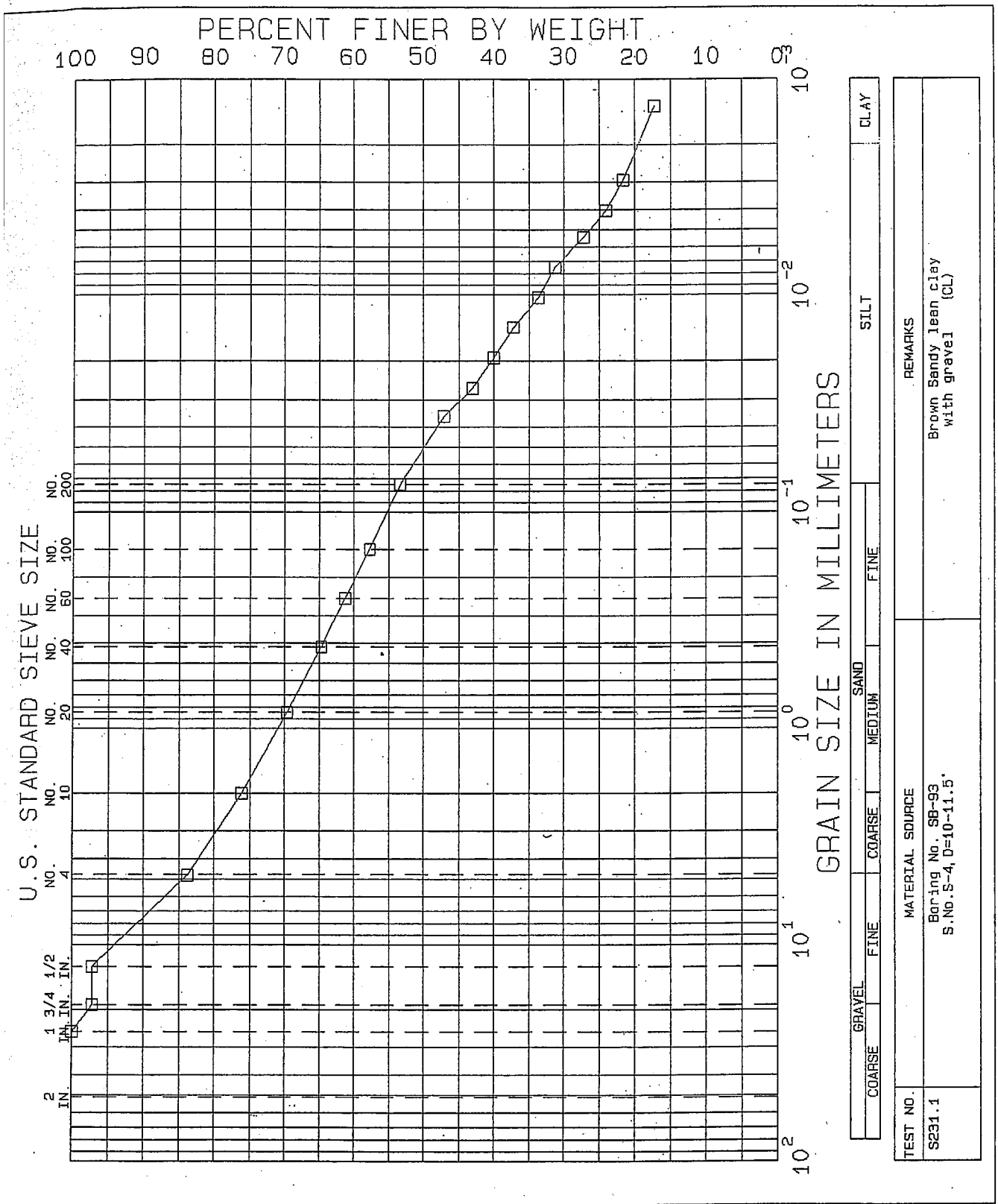
GZA GeoEnvironmental, Inc.
Q:\NEWTON\LAB\LABFORM7.XLS

labform1.xls

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: 1/8/04

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.: $\frac{C_c}{1 + e_0}$	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)



NEW BRITAIN-HARTFORD BUSWAY

CONNECTICUT

GRADATION TESTS

BORING NO.	SB-93	TEST SERIES	
SAMPLE	S-4	NO.	231
DEPTH	10-11.5'	DATE	Jan.04
TECH.	CAG		
REVIEWER	MBP	FILE	L17828

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 Broad Street Over Amtrak and the New Britain - Hartford Busway 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.