

**GEOTECHNICAL STUDY**

**CONSTRUCTION OF THE  
NEW BRITAIN - HARTFORD BUSWAY  
ConnDOT Project 171-305**

**Proposed Box Culvert At  
Busway Sta 174+80**

**Prepared for:  
Close, Jensen & Miller, P.C.**

**Prepared by:  
Dr. Clarence Welti, P. E., P. C.**

**April, 2011**



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## **1.0 Introduction and Background:**

**1.1** This study addresses the geotechnical requirements for the proposed box culvert replacement to be located at Busway Sta 174+80. The existing stone masonry culvert is located at Sta 174+82. The new culvert will carry an unnamed water course beneath the embankment supporting the Busway and Multi-Use Trail and southeasterly to Piper Brook. This study also includes general recommendations pertaining to temporary sheet piling during construction.

**1.2** The subject structure will be a single cell, precast box culvert with inside dimensions measuring 6 feet wide by 6 feet high. The 60± feet long culvert will be oriented at 90° to the Busway baseline. The inlet will extend through Retaining Wall 103 on the left side of the Multi-Use Trail. The outlet will have an end wall with flared wings. Standard cut-off walls will be placed at the inlet and outlet. The end walls and cut-offs would typically have cast-in-place construction. The nominal flow line will be at Elev. 65.2 and the finished Busway grade will be at Elev. 76.8 above the roof of the structure. A riprap scour hole will be placed at the discharge end.

**1.3** The excavations will generally fall in proximity to or below the water table. It should be anticipated that the excavations will require de-watering. It may be possible to place the culvert barrel without extensive cofferdam apparatus with pumping from open excavations. However, the deeper excavations for cut-offs and end wall footings will probably fall a few feet below the water table with requirements for more definitive cofferdams. The requirements for cofferdams and de-watering should fall within the standard specifications of Form 816 for such items. Temporary Sheet Piling and Cofferdam & Pumping are contractor provided items.

**1.4** The design of the culvert and walls will be completed in U.S. Customary Units and in accordance with the LRFD method. It is presumed that the designs for temporary shoring can be completed with other methods such as Allowable Stress Design (ASD) or Load Factor Design (LFD).

**1.5 Field exploration** for the proposed wall included two test borings RW-105-5 and R-22 drilled by Associated Borings Company, Inc. in August, 2007. Four supplemental borings, SBX-1~~0~~2, SBX-3, SBX-4 and SBX-5, were drilled in March, 2011 by Associated Borings Company. The supplemental borings were required because the structures were relocated from the preliminary design alignments. The borings were drilled with a 2.5" dia. hollow stem auger to a maximum depth of 30 feet below the rail bed grade. Sampling was completed with a standard 2" dia. split spoon sampler using a 140 pound hammer and a hammer fall of 30 inches. Reference is made herein to pilot test boring SB-39 That boring was drilled by Seaboard Drilling, Inc. in March of 2003 for the pilot subsurface investigation. Baker Engineering of NY performed the inspection services for the pilot program.

## **2.0 Geology and Soils Cross Section + Soil Properties:**

**2.1** The **Geologic Origin** of the natural soils (beneath the fills) at the site and environs are predominantly from glacial lake deposits. The lake deposits consist generally of loose to medium compact silt with trace clay or fine sand and silt. The bedrock from geologic mapping is Portland Arkose (Sandstone or Siltstone).

**2.2** The **Soils/Rock Cross Sections** from the borings are generally as follows:

### **RW-101-5 (Busway Sta 174+80; Elev. 75.3):**

FILL; fine to medium SAND, some Gravel and Silt to 3 feet, medium compact

FILL; fine SAND, some Silt, trace Gravel to 12 feet, dense

Stratum of fine SAND and SILT with little Organic layers to 16 feet, medium compact

Clayey SILT to 30+ feet, medium compact to stiff

### **R-22 (Busway Sta 175+0; Elev. 65):**

Topsoil to 2 feet

FILL; fine to coarse SAND and GRAVEL to 5 feet, medium compact

SILT to 20+ feet, loose to medium compact

### **Pilot Boring SB-39 (Sta 174+70 ; Elev. 75.2):**

FILL; fine to coarse SAND, some Gravel, trace Silt to 10.5 feet, medium compact

SILT with trace fine Sand, Gravel and Clay to 44± feet, medium compact

Very Dense fine to coarse GRAVEL, little Silt to the top of Siltstone at 45.5 feet

### **Boring SBX-1-2 (Sta 174+50 ; Elev. 75.3), SBX-3 (Sta 174+50 ; Elev. 75.2):**

FILL; fine to medium SAND, some Gravel and Silt, some Brick, Ash and Wood to 5 feet, loose to medium compact

Fine to medium SAND, some Silt and Gravel to 7.5 to 11 feet, medium compact

Strata of SILT and fine SAND with Silt to 25+ to 32.5 feet

At SBX-1-2; fine to medium SAND, some Silt and Gravel with Silt layers to 35+ feet, medium compact to dense

**Boring SBX-4 (Sta 174+30 ; Elev. 66.1), SBX -5 (Sta 174+70, Elev. 64.9):**

Topsoil to 2 feet, loose

Fine to medium SAND, some Silt, trace Clay and Gravel to 4 to 5 feet, medium compact

SILT to 21 feet, loose to medium compact

Fine to medium SAND, TRACE Gravel and Silt to 22+ feet, dense

**2.3 The Water Table** was observed generally near the bottom of the existing fills at 3 feet to 15 feet below grade (Elev. 60 to Elev. 65).

**2.4** Regarding the **Soil Properties** the following will apply:

**New Backfill (Material of Section 3.3 below):**

Unit Weight (moist):	125 pcf
Water Content:	6 to 8%
Angle of Internal Friction:	34°

**Existing Fills:**

Unit Weight:	125 pcf
Submerged Unit Weight:	68 pcf
Angle of Internal Friction:	33+°
Stiffness Modulus:	400+ Tons/sf

**Natural Fine Sand and Silt:**

Unit Weight:	120 to 125 pcf
Submerged Unit Weight:	66 pcf
Angle of Internal Friction:	34+°
Stiffness Modulus:	400 to 500 Tons/sf

**Natural Silt with trace Clay:**

Unit Weight:	120 pcf
Submerged Unit Weight:	60 pcf
Angle of Internal Friction:	29° to 30°

Cohesion, assumed: 0 psf  
Typical Stiffness Modulus: 150 to 200+ tons/sf

*Notes:*

*The above soil parameters can be used for the design of temporary shoring.*

*The values of internal friction angle cited are estimated from SPT data*

**2.5** In general, it should be assumed that the natural soils will be susceptible to remolding under equipment when wet from ground water or stormwater onto the exposed subgrades.

### 3.0 Foundations and Design Considerations:

**3.1** Regarding **Design of the Box Culvert and Walls**, soil bearing, lateral pressure, overturning and sliding must be addressed in the foundations. The total loading beneath box culverts is typically less than about 1 Tons/sf. The **Criteria for Foundation Type and Loading** are assumed as follows:

1. The maximum total settlement shall not exceed 1.5" and the maximum differential settlement shall not exceed  $\frac{1}{2}$  the maximum settlement.
2. The seismic section of the ConnDOT and AASHTO bridge design specifications will not apply to the subject culvert and wing walls.

**3.2** The recommended **Foundation Type** is with spread footings. From the borings, the existing fills extend to about Elev. 63 to Elev. 64±. The subgrades beneath the culvert, the wing walls and cut-off walls will largely fall in the natural silt, or otherwise near the bottom of the existing fills. Regarding establishment of an ultimate bearing capacity, the ultimate loading is based on the internal friction angle, which is related to the soil density and overburden weight. Based on the sample blow counts in the natural silt deposits, the angle of internal friction is at least  $29^\circ$ , which indicates an ultimate capacity of at least 12 ksf. The AASHTO LRFD resistance factor based on friction angle estimated from SPT data would be  $\phi_R = 0.35$ . This indicates a design bearing resistance of about 4 ksf. Based on review of LRFD programs, particularly as relates to reduction for inclined loading, a significant reduction from ultimate bearing capacity is indicated, based on the ratio of lateral loading to vertical loading. This reduction is almost double the reduction for the ASD procedure. **To address this reduction it is suggested that the more appropriate LRFD value for  $\phi$  be 0.50.** *The estimated stiffness modulus of the Silt deposits is 150+ Tons/sf. The design bearing pressure should be limited to 3 ksf to maintain settlements within the design criteria.*

**3.2.1** The natural soils at subgrades will include silts that will probably be saturated or close to saturation and will be susceptible to remolding under equipment. There will be a requirement for underlay beneath the culvert, cut-offs and wing wall foundations. The underlay beneath the culvert bottom, cut-offs and wing walls shall be with at least a 12" layer of No. 8 crushed stone on a woven stabilization geotextile. The crushed stone can be placed on one lift and does not need to be compacted. *An initial 2" thick concrete mud mat (minimum  $f'c = 2,000$  psi) will be required beneath the geotextile and crushed stone layer if the subgrades are in wet silt.* The excavations to the subgrades shall be made with a smooth edged bucket to avoid over-disturbance of the soils below the foundations.

**3.3** The required backfill for the walls shall be Pervious Structure Backfill conforming to ConnDOT Form 816, M.02.05. This material will have a unit weight of 125 pcf and internal friction angle of  $34^\circ$ .

**3.4** The ultimate friction angle between the concrete and soil at the footing bases is about  $29^\circ$ . This would result in ultimate sliding factor of **0.55**, based on AASHTO criteria. The applicable resistance factor for sliding of pre-cast concrete on the soil can be  $\phi_R = 0.90$  and for cast in place concrete the

factor is  $\phi_R = 0.80$ .

**3.5 Regarding Lateral Soil Pressure**, design of the free standing retaining walls can be based on active earth pressure using the active pressure coefficient  $K_A = 0.28$  (level backfill). The lateral soil loading on box culverts shall be based on at-rest pressure according to the ConnDOT Bridge manual. The at-rest coefficient is  $K_o = 0.45$ . The design lateral loads for highway structures typically include a live load surcharge (usually up to 2 feet of soil).

**3.6 Regarding groundwater mitigation**, this will be addressed at the inlet side by the structure under-drains required at Retaining Wall 104. The wing walls at the culvert outlet can have weep holes.

**3.7 The Frost Protection Depth** by ConnDOT for structure footings is 4.0 feet below finished grades.

**3.8 Summary of Preliminary Foundation Design Parameters for Wall #101A:**

PARAMETER	LRFD DESIGN VALUE	ULTIMATE RESISTANCE	COMMENTS
Design Bearing Resistance	3 ksf (based on settlement)	12 ksf	Resistance factor $\phi_R = 0.35$
Backfill Unit Weight *	125 pcf	–	ConnDOT Form 816 M.02.05
Angle of Internal Friction $\phi_1$ (Backfill) *	34°	–	Compacted Pervious Backfill 95% of MOD
Sliding Factor, pre-cast concrete on soil	0.50	0.55	Resistance factor $\phi_R = 0.90$
Sliding Factor, cast in place concrete on soil	0.44	0.55	Resistance factor $\phi_R = 0.80$
Interface Friction Angle Concrete to Backfill, $\delta$	21°	30°	Value from AASHTO LRFD Manual
Active Pressure Coefficient, $K_A$ (Backfill)	0.28	–	
At-Rest Pressure Coefficient, $K_o$	0.45	–	
Frost Protection Depth	4 feet	–	ConnDOT Bridge Design Guide

\* For Backfill conforming to Pervious Structure backfill (section M.02.05)

**4.0 Report Conditions:** This report has been prepared for specific a application to the subject project in accordance with generally accepted soil and foundation engineering practices. No other warranty, express or implied, is made. In the event that any changes in the nature, design and location of structures are planned, the conclusions and recommendations contained in this report should not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing.

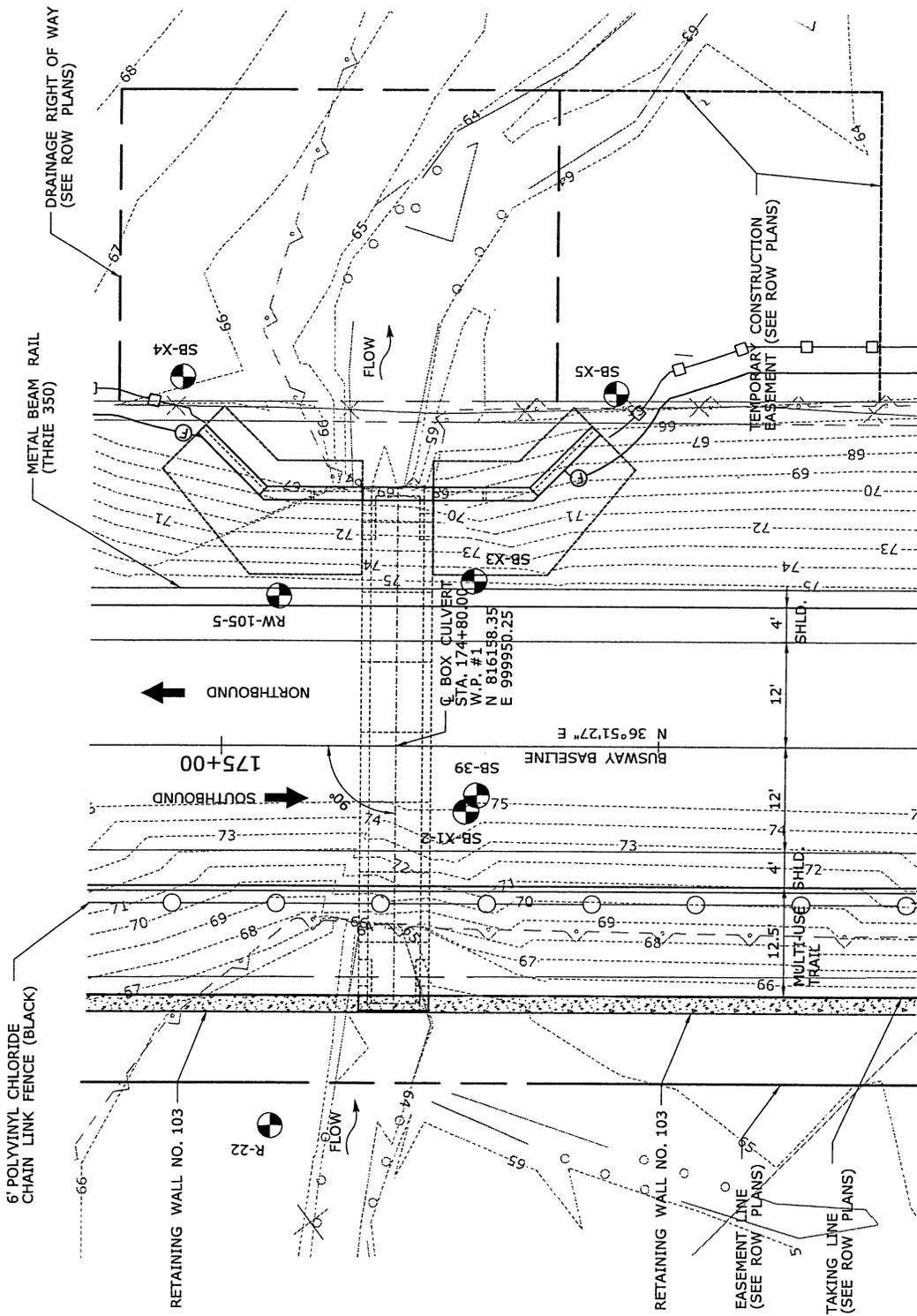
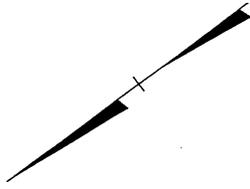
The analyses and recommendations submitted in this report are based in part upon data obtained from referenced explorations. The extent of variations between explorations may not become evident until construction. If variations then appear evident, it will be necessary to re-evaluate the recommendations of this report.

Dr. Clarence Welti, P.E., P.C., should perform a general review of the final design and specifications in order that geotechnical design recommendations may be properly interpreted and implemented as they were intended.

**APPENDIX 1**

**TEST BORING LOGS**

**BORING LOCATION PLAN**



**PLAN**

**LEGEND**



BORING SYMBOL

Thomas Lloret		SM-001 REV. 10/92		BORING REPORT		SHEET 1 OF 1								
DRILLER Matt Stark		STATE OF CONNECTICUT DEPARTMENT OF TRANSPORTATION				Associated Borings Co., Inc.								
INSPECTOR Welti & Associates, P.C.		TOWN: New Britain/Newington, CT		BORING CONTRACTOR Close Jensen & Miller, P.C.		DESIGN ENGINEER								
SOILS ENGINEER		PROJECT NAME: Hartford-New Britain Busway		PROJECT NUMBER: 171-305										
Surface Elevation: 75.3		LOCATION:												
Date Started: 3/21/2011		Auger		Casing		Hole No. <b>SBX1-2</b>								
Date Finished: 3/21/2011		Type		HSA		Line & Station 174+72								
Groundwater Observations		Size I. D.		2 1/4 in		Offset 7' LT								
AT 15 'AFTER 0 HRS		Hammer		140 lb		N Coordinate 816156.43								
AT 'AFTER HRS		Fall		30 in		E. Coordinate 999939.45								
DEPTH	Casing blows per foot	SAMPLE					BLOWS PER 6 INCHES ON SAMPLER				STRATA CHANGE: DEPTH, ELEV.	FIELD IDENTIFICATION OF SOIL, REMARKS (INCL. COLOR, LOSS OF WASH WATER, ETC.)		
		DEPTH IN FEET FROM - TO	NO.	PEN. INCH	REC. INCH	TYPE								
							0-6	6-12	12-18	18-24				
5		0.0 - 2.0	1	24	3	D	2	2	2	3	5	Blk. M-F Sand, Some C-F Gravel, Brick, Wood (Fill)		
		2.0 - 4.0	2	24	8	D	2	3	3	4			7.5	Red Br. M-F Silty Sand, Some M-F Gravel
		4.0 - 6.0	3	24	6	D	5	6	5	5				
	6.0 - 8.0	4	24	10	D	5	6	6	5	13	Red Br. M-F Silty Sand and C-F Gravel			
	8.0 - 10.0	5	24	6	D	4	6	10	10			15	Red Br. Silt	
	10.0 - 12.0	6	24	8	D	W	W	2	3	20	Red Br. M-F Silty Sand and C-F Gravel			
	15.0 - 17.0	7	24	6	D	6	10	14	11					25
	20.0 - 22.0	8	24	20	D	3	4	4	5			30	Red Br. M-F Silty Sand, Some M-F Gravel, Layers of Silt	
	25.0 - 27.0	9	24	20	D	W	2	4	4	35	End of Boring - 35.0			
	30.0 - 32.0	10	24	20	D	W	1	4	4					40
	33.0 - 35.0	11	24	20	D	5	9	16	16					
From Ground Surface to		Feet Used		Inch Casing Then		Inch Casing For		Feet						
Footage in Earth 35.0		Footage in Rock 0.0		No. of Samples 11		Hole No. <b>SBX1-2</b>								
SAMPLE TYPE CODING:		D = DRIVEN		C = CORE		A = AUGER		UP = UNDISTURBED PISTON						
PROPORTIONS USED:		TRACE = 1-10%		LITTLE = 10-20%		SOME = 20-35%		AND = 35-50%						

Thomas Lloret		SM-001 REV. 10/92		BORING REPORT		SHEET 1 OF 1						
DRILLER Matt Stark		STATE OF CONNECTICUT DEPARTMENT OF TRANSPORTATION				Associated Borings Co., Inc.						
INSPECTOR Welti & Associates, P.C.		TOWN: New Britain/Newington, CT				BORING CONTRACTOR Close Jensen & Miller, P.C.						
SOILS ENGINEER		PROJECT NAME: Hartford-New Britain Busway				DESIGN ENGINEER						
Surface Elevation: 75.2		PROJECT NUMBER: 171-305										
Date Started: 3/22/2011		LOCATION:		Auger		Casing						
Date Finished: 3/22/2011		Type		HSA		Sampler						
Groundwater Observations		Size I. D.		2 1/4 in		2 in						
AT 15 ' AFTER 0 HRS		Hammer				140 lb Bit						
AT ' AFTER HRS		Fall				30 in						
Hole No.		SBX-3										
Line & Station		174+71										
Offset		20' RT										
N Coordinate		816140.08										
E. Coordinate		999960.10										
DEPTH	Casing blows per foot	SAMPLE					BLOWS PER 6 INCHES ON SAMPLER				STRATA CHANGE: DEPTH, ELEV.	FIELD IDENTIFICATION OF SOIL, REMARKS (INCL. COLOR, LOSS OF WASH WATER, ETC.)
		DEPTH IN FEET FROM - TO	NO.	PEN. INCH	REC. INCH	TYPE	0-6	6-12	12-18	18-24		
5		0.0 - 2.0	1	24	3	D	2	3	4	7	5	Blk. M-F Silty Sand, Tr. C-F Gravel, Ash, Wood, (Fill)
		2.0 - 4.0	2	24	4	D	2	2	3	5		
		4.0 - 6.0	3	24	8	D	5	9	9	8		
		6.0 - 8.0	4	24	6	D	3	5	7	9		
		8.0 - 10.0	5	24	6	D	3	5	7	6		
10		10.0 - 12.0	6	24	10	D	5	7	7	9	11	Red Br. M-F Silty Sand, Tr. M-F Gravel
15		15.0 - 17.0	7	24	5	D	7	6	6	5	25	Red Br. Silt
20		20.0 - 22.0	8	24	20	D	3	5	4	3	25	End of Boring - 25.0
25		23.0 - 25.0	9	24	20	D	4	3	2	2	25	End of Boring - 25.0
30											25	End of Boring - 25.0
35											25	End of Boring - 25.0
40											25	End of Boring - 25.0
From Ground Surface to		Feet Used		Inch Casing Then		Inch Casing For		Feet				
Footage in Earth		25.0		Footage in Rock		0.0		No. of Samples		9		Hole No. SBX-3
SAMPLE TYPE CODING:		D = DRIVEN		C = CORE		A = AUGER		UP = UNDISTURBED PISTON				
PROPORTIONS USED:		TRACE = 1-10%		LITTLE = 10-20%		SOME = 20-35%		AND = 35-50%				

Thomas Lloret		SM-001 REV. 10/92				BORING REPORT				SHEET 1 OF 1		
DRILLER		STATE OF CONNECTICUT				DEPARTMENT OF TRANSPORTATION				Associated Borings Co., Inc.		
Matt Stark		TOWN: New Britain/Newington, CT				PROJECT NAME: Hartford-New Britain Busway				BORING CONTRACTOR		
INSPECTOR		PROJECT NUMBER: 171-305				DESIGN ENGINEER				Close Jensen & Miller, P.C.		
Welti & Associates, P.C.		LOCATION:										
SOILS ENGINEER		Surface Elevation: 66.1				Date Started: 3/18/2011				Hole No. <b>SBX-4</b>		
		Date Finished: 3/18/2011				Auger HSA				Line & Station 175+05		
Groundwater Observations		Size I. D. 2 1/4 in				Sampler 2 in				Offset 42' RT		
AT 4 'AFTER 0 HRS		Hammer				140 lb Bit				N Coordinate 816152.93		
AT 'AFTER HRS		Fall				30 in				E. Coordinate 999998.81		
DEPTH	Casing blows per foot	SAMPLE					BLOWS PER 6 INCHES ON SAMPLER				STRATA CHANGE: DEPTH, ELEV.	FIELD IDENTIFICATION OF SOIL, REMARKS (INCL. COLOR, LOSS OF WASH WATER, ETC.)
		DEPTH IN FEET FROM - TO	NO.	PEN. INCH	REC. INCH	TYPE	0-6	6-12	12-18	18-24		
5		0.0 - 2.0	1	24	3	D	1	13	2	1	2	Topsoil
		2.0 - 4.0	2	24	4	D	1	2	1	2		Red Br. M-F Silty Sand, Tr. Clay, Tr. M-F Gravel
10		5.0 - 7.0	3	24	12	D	4	5	5	6	5	Red Br. Silt
		10.0 - 12.0	4	24	18	D	3	5	6	6		
15		15.0 - 17.0	5	24	8	D	2	3	3	4	21	
		20.0 - 22.0	6	24	10	D	2	2	2	4		
20		22.0 - 23.0	7	12	8	D	2	3	X	X	22	Red Br. M-F Sand, Tr. M-F Gravel
												End of Boring - 22.0
25												
30												
35												
40												
From Ground Surface to		Feet Used		Inch Casing Then		Inch Casing For		Feet				
Footage in Earth		Footage in Rock		No. of Samples		Hole No.						
23.0		0.0		7		SBX-4						
SAMPLE TYPE CODING:		D = DRIVEN		C = CORE		A = AUGER		UP = UNDISTURBED PISTON				
PROPORTIONS USED:		TRACE = 1-10%		LITTLE = 10-20%		SOME = 20-35%		AND = 35-50%				

Thomas Lloret		SM-001 REV. 10/92				BORING REPORT				SHEET 1 OF 1		
DRILLER Matt Stark		STATE OF CONNECTICUT				DEPARTMENT OF TRANSPORTATION				Associated Borings Co., Inc.		
INSPECTOR Welti & Associates, P.C.		TOWN: New Britain/Newington, CT				PROJECT NAME: Hartford-New Britain Busway				BORING CONTRACTOR Close Jensen & Miller, P.C.		
SOILS ENGINEER		PROJECT NUMBER: 171-305				DESIGN ENGINEER						
Surface Elevation: 64.9		LOCATION:										
Date Started: 3/18/2011		Auger		Casing		Sampler		Core Bar		Hole No. <b>SBX-5</b>		
Date Finished: 3/18/2011		Type		HSA						Line & Station 174+55		
Groundwater Observations		Size I. D.		2 1/4 in		2 in				Offset 40' RT		
AT 3 'AFTER 0 HRS		Hammer				140 lb		Bit		N Coordinate 816114.40		
AT 'AFTER HRS		Fall				30 in				E. Coordinate 999967.59		
DEPTH	Casing blows per foot	SAMPLE					BLOWS PER 6 INCHES ON SAMPLER				STRATA CHANGE: DEPTH, ELEV.	FIELD IDENTIFICATION OF SOIL, REMARKS (INCL. COLOR, LOSS OF WASH WATER, ETC.)
		DEPTH IN FEET FROM - TO	NO.	PEN. INCH	REC. INCH	TYPE	0 - 6	6 - 12	12-18	18-24		
5		0.0 - 2.0	1	24	3	D	1	1	1	2	2	Topsoil
		2.0 - 4.0	2	24	6	D	13	4	5	5		4
		4.0 - 6.0	3	24	12	D	2	3	4	5	Red Br. Silt	
		6.0 - 8.0	4	24	20	D	3	4	5	6		
10		10.0 - 12.0	5	24	8	D	3	3	3	4		
15		15.0 - 17.0	6	24	20	D	2	1	2	1		
20		20.0 - 22.0	7	24	20	D	2	2	13	15	21	
											22	Red Br. M-F Sand, Tr. M-F Gravel
												End of Boring - 22.0
25												
30												
35												
40												
From Ground Surface to		Feet Used		Inch Casing Then		Inch Casing For		Feet				
Footage in Earth 22.0		Footage in Rock 0.0		No. of Samples 7		Hole No. SBX-5						
SAMPLE TYPE CODING: D = DRIVEN		C = CORE		A = AUGER		UP = UNDISTURBED PISTON						
PROPORTIONS USED: TRACE = 1-10%		LITTLE = 10-20%		SOME = 20-35%		AND = 35-50%						

Jaime Lloret	<b>SM-001 REV. 10/92</b>	<b>BORING REPORT</b>	SHEET 1 OF 1
DRILLER Don Moodie	STATE OF CONNECTICUT DEPARTMENT OF TRANSPORTATION		Associated Borings Co., Inc.
INSPECTOR Welti & Associates, P.C.	TOWN: New Britain/Newington, CT		BORING CONTRACTOR Close Jensen & Miller, P.C.
SOILS ENGINEER	PROJECT NAME: Hartford-New Britain Busway		DESIGN ENGINEER
Surface Elevation: 75.26	LOCATION:		

Date Started: 8/29/2007	Auger	Casing	Sampler	Core Bar	Hole No. <b>RW-105-5</b>
Date Finished: 8/29/2007	Type	HSA	SS		Line & Station 174+80
Groundwater Observations	Size I. D.	2 1/4 in	2 in		Offset 30' RT
AT 14 'AFTER 0 HRS	Hammer		140 lb	Bit	N Coordinate 816158.91
AT 'AFTER HRS	Fall		30 in		E. Coordinate 999972.04

D E P T H	Casing blows per foot	SAMPLE					BLOWS PER 6 INCHES ON SAMPLER				STRATA CHANGE: DEPTH, ELEV.	FIELD IDENTIFICATION OF SOIL, REMARKS (INCL. COLOR, LOSS OF WASH WATER, ETC.)
		DEPTH IN FEET FROM - TO	NO.	PEN. INCH	REC. INCH	TYPE						
							0-6	6-12	12-18	18-24		
5		0.0 - 2.0	1	24	7	D	4	6	11	12	3	Blk. M-F Sand, Some C-F Gravel, Some Silt (Fill)
		2.0 - 4.0	2	24	12	D	16	14	7	9		
		4.0 - 6.0	3	24	12	D	16	29	31	40		Red Br. F. Sand, Some Silt, Tr. C-F Gravel (Fill)
		6.0 - 8.0	4	24	14	D	31	46	38	29		
		8.0 - 10.0	5	24	17	D	21	26	40	50		
10		10.0 - 12.0	6	24	14	D	13	17	21	30	<del>12</del>	Blk and Red F. Sand and Silt, W/Organic Layers
		12.0 - 14.0	7	24	10	D	9	7	7	6		
15		14.0 - 16.0	8	24	18	D	6	7	7	6	16	Red Br. Clayey Silt
		16.0 - 18.0	9	24	18	D	4	6	7	6		
20		20.0 - 22.0	10	24	12	D	4	5	6	5	30	End of Boring - 30.0
		25.0 - 27.0	11	24	10	D	4	3	5	5		
25		28.0 - 30.0	12	24	12	D	4	6	7	7		
30												
35												
40												

From Ground Surface to	Feet Used	Inch Casing Then	Inch Casing For	Feet
Footage in Earth 30.0	Footage in Rock 0.0	No. of Samples 12	Hole No. <b>RW-105-5</b>	
SAMPLE TYPE CODING: D = DRIVEN C = CORE		A = AUGER UP = UNDISTURBED PISTON		
PROPORTIONS USED: TRACE = 1-10% LITTLE = 10-20%		SOME = 20-35% AND = 35-50%		

Thomas Lloret		SM-001 REV. 10/92		BORING REPORT		SHEET 1 OF 1						
DRILLER Don Moodie		STATE OF CONNECTICUT DEPARTMENT OF TRANSPORTATION				Associated Borings Co., Inc.						
INSPECTOR Welti & Associates, P.C.		TOWN: New Britain/Newington, CT		BORING CONTRACTOR Close Jensen & Miller, P.C.								
SOILS ENGINEER		PROJECT NAME: Hartford-New Britain Busway		DESIGN ENGINEER								
PROJECT NUMBER: 171-305		LOCATION:										
Surface Elevation: 65.08		Type		Auger		Hole No. <b>R-22</b>						
Date Started: 8/31/2007		HSA		Casing		Line & Station 175+0						
Date Finished: 8/31/2007		SS		Sampler		Offset 40' LT						
Groundwater Observations		Size I. D. 2 1/4 in		2 in		N Coordinate 816195.62						
AT 3 'AFTER 0 HRS		Hammer		140 lb		E. Coordinate 999923.95						
AT 'AFTER HRS		Fall		30 in								
DEPTH	Casing blows per foot	SAMPLE					BLOWS PER 6 INCHES ON SAMPLER				STRATA CHANGE: DEPTH, ELEV.	FIELD IDENTIFICATION OF SOIL, REMARKS (INCL. COLOR, LOSS OF WASH WATER, ETC.)
		DEPTH IN FEET FROM - TO	NO.	PEN. INCH	REC. INCH	TYPE	0 - 6	6 - 12	12-18	18-24		
5		0.0 - 2.0	1	24	4	D	2	2	2	2	2	Topsoil
		2.0 - 4.0	2	24	9	D	7	13	19	20		5 6'
		4.0 - 6.0	3	24	11	D	7	7	8	8		
10		10.0 - 12.0	4	24	13	D	3	3	4	4	20	End of Boring - 20.0
		15.0 - 17.0	5	24	14	D	4	4	4	4		
15		18.0 - 20.0	6	24	13	D	5	4	4	6		
20												
25												
30												
35												
40												
From Ground Surface to		Feet Used		Inch Casing Then		Inch Casing For		Feet				
Footage in Earth 20.0		Footage in Rock 0.0		No. of Samples 6		Hole No. <b>R-22</b>						
SAMPLE TYPE CODING: D = DRIVEN C = CORE		A = AUGER		UP = UNDISTURBED PISTON								
PROPORTIONS USED: TRACE = 1-10% LITTLE = 10-20%		SOME = 20-35%		AND = 35-50%								

Driller: J. Galvin/Geologic	<b>Connecticut DOT Boring Report</b>	Hole No.: <b>SB-39</b>
Inspector: E. Glisan	Town: New Britain / Newington, CT	Stat./Offset:
Engineer: Baker Engineering	Project No.: 171-0305	Northing: 816154.4
Start Date: 03/05/03	Route No.:	Easting: 999940.2
Finish Date: 03/06/03	Bridge No.:	Surface Elevation: 75.2

Project Description: New Britain - Hartford Busway

Casing Type/Size: HW/4" I.D. | Sampler Type/Size: SS/1-3/8" I.D. | Core Barrel Type: NX/2-1/8" I.D.

Hammer Wt.: 300 Fall: 24" | Hammer Wt.: 140 Fall: 30"

Groundwater Obs. @ 9.2' after: 0 hours, @9.2' after: 24 hours, @8.7' after: 48 hours

Baker Info: S.O. Number: B25624LPDSOIL41802/42002 | File: southern | Template: CDOT E (LD4 1/03)

Depth (ft.)	SAMPLES					Generalized Strata Description	Material Description and Notes	Elevation (ft.)
	Sample Type/No.	Blows on Sampler per 0.5 ft.	Pen. (ft.)	Rec. (ft./%)	RQD (ft./%)			
0								75
1	W-N		1.5			10.5'	POORLY GRADED SAND WITH GRAVEL (SP) - black and brown fine to coarse sand, some medium to coarse gravel, trace silt; moist, dense, NP; (FILL).	74
2	S-1	22 18 22	1.5	1.3				73
3								72
4	W-N		1.5					71
5	S-2	15 16 22	1.5	1.0				70
6								69
7	W-N		1.5					68
8	S-3	8 8 11	1.5	0.2				67
9								66
10	W-N		1.5					65
11	S-4	4 24 16	1.5	1.0		ELEV. 64.7	64	
12						63		
13	W-N		1.5			62		
14	S-5	19 19 21	1.5	1.3		SILT (ML) - gray-brown silt, trace coarse gravel; moist, dense, NP.	61	
15						60		
16	W-N		1.5			59		
17	S-6	12 8 8	1.5	1.1		ELEV. 58.7	58	
18						57		
19	W-N		1.5			56		
		5				ELASTIC SILT (MH) - gray-brown silt, trace fine to		

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: 49.0' Rock: 10.0' No. of Samples: 13	NOTES:	Sheet 1 of 3 SM-001-M REV. 1/02
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Driller: J. Galvin/Geologic	<b>Connecticut DOT Boring Report</b>	Hole No.: <b>SB-39</b>
Inspector: E. Glisan	Town: New Britain / Newington, CT	Stat./Offset:
Engineer: Baker Engineering	Project No.: 171-0305	Northing: 816154.4
Start Date: 03/05/03	Route No.:	Easting: 999940.2
Finish Date: 03/06/03	Bridge No.:	Surface Elevation: 75.2

Project Description: New Britain - Hartford Busway

Casing Type/Size: HW/4" I.D. Sampler Type/Size: SS/1-3/8" I.D. Core Barrel Type: NX/2-1/8" I.D.

Hammer Wt.: 300 Fall: 24" Hammer Wt.: 140 Fall: 30"

Groundwater Obs. @ 9.2' after: 0 hours, @ 9.2' after: 24 hours, @ 8.7' after: 48 hours

Baker Info: S.O. Number: B25624LPDSOIL41802/42002 File: southern Template: CDOT E (LD4 1/03)

Depth (ft.)	SAMPLES						Generalized Strata Description	Material Description and Notes	Elevation (ft.)
	Sample Type/No.	Blows on Sampler per 0.5 ft.	Pen. (ft.)	Rec. (ft./%)	RQD (ft./%)				
20	S-7	8	1.5	1.3			medium sand, trace clay; moist, very stiff, +PL.	55	
21		9						54	
22	W-N		1.5					53	
23	S-8	7 8	1.5	1.5			ELASTIC SILT (MH) - gray-brown silt, trace fine to medium sand, trace clay; moist, very stiff, +PL.	52	
24		12						51	
25	W-N		1.5					50	
26	S-9	7 6	1.5	1.5			ELASTIC SILT (MH) - gray-brown silt, trace fine to medium sand, trace clay; moist, stiff, +PL.	49	
27		7						48	
28	W-N		1.5					47	
29	S-10	4 4	1.5	1.5			ELASTIC SILT (MH) - gray-brown silt, trace fine to medium sand, trace clay; moist, stiff, +PL.	46	
30		5						45	
31								44	
32	W-N		4.0					43	
33								42	
34		17						41	
35	S-11	12 9	1.5	0.9			ELASTIC SILT (MH) - gray-brown silt, trace medium to coarse gravel, trace fine to medium sand, trace clay; moist, very stiff, +PL.	40	
36								39	
37	W-N		3.5					38	
38								37	
39	S-12	12 24	1.5	0.7			ELASTIC SILT (MH) - gray-brown silt, trace medium to coarse gravel, trace fine to medium sand, trace clay;	36	

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: 49.0' Rock: 10.0'  
 No. of Samples: 13

NOTES:

Driller: J. Galvin/Geologic	<b>Connecticut DOT Boring Report</b>		Hole No.: <b>SB-39</b>
Inspector: E. Glisan	Town: New Britain / Newington, CT		Stat./Offset:
Engineer: Baker Engineering	Project No.: 171-0305		Northing: 816154.4
Start Date: 03/05/03	Route No.:		Easting: 999940.2
Finish Date: 03/06/03	Bridge No.:		Surface Elevation: 75.2
Project Description: New Britain - Hartford Busway			
Casing Type/Size: HW/4" I.D.		Sampler Type/Size: SS/1-3/8" I.D.	Core Barrel Type: NX/2-1/8" I.D.
Hammer Wt.: 300 Fall: 24"		Hammer Wt.: 140 Fall: 30"	
Groundwater Obs. @ 9.2' after: 0 hours, @ 9.2' after: 24 hours, @ 8.7' after: 48 hours			
Baker Info: S.O. Number: B25624LPDSOIL41802/42002		File: southern	Template: CDOT E (LD4 1/03)

Depth (ft.)	SAMPLES					Generalized Strata Description	Material Description and Notes	Elevation (ft.)
	Sample Type/No.	Blows on Sampler per 0.5 ft.	Pen. (ft.)	Rec. (ft./%)	RQD (ft./%)			
40		18				moist, hard, +PL.	35	
41							34	
42	W-N		3.5			moist, hard, +PL.	33	
43							32	
44		71				44.0'	ELEV. 31.2	
45	S-13	67 93	1.5	1.3		SILTY GRAVEL (GM) - gray fine to coarse gravel, little silt; moist, very dense, NP; gravel is weathered shale fragments; (DECOMPOSED ROCK).	31	
46							45.5'	ELEV. 29.7
47	W-N		3.5			SILTSTONE; reddish brown, medium hard to hard, slightly to moderately weathered.	29	
48							28	
49				4.5	2.3	SILTSTONE; reddish brown, medium hard to hard, slightly to moderately weathered.	27	
50							26	
51	C-1		5.0			SILTSTONE WITH INTERBEDDED SANDSTONE; reddish brown, medium hard to hard, slightly to moderately weathered.	25	
52							24	
53						SILTSTONE WITH INTERBEDDED SANDSTONE; reddish brown, medium hard to hard, slightly to moderately weathered.	23	
54				90%	46%		22	
55				5.0	1.5	SILTSTONE WITH INTERBEDDED SANDSTONE; reddish brown, medium hard to hard, slightly to moderately weathered.	21	
56	C-2		5.0				20	
57						SILTSTONE WITH INTERBEDDED SANDSTONE; reddish brown, medium hard to hard, slightly to moderately weathered.	19	
58							18	
59				100%	30%	End of Boring at 59.0'.	17	
							ELEV. 16.2	16

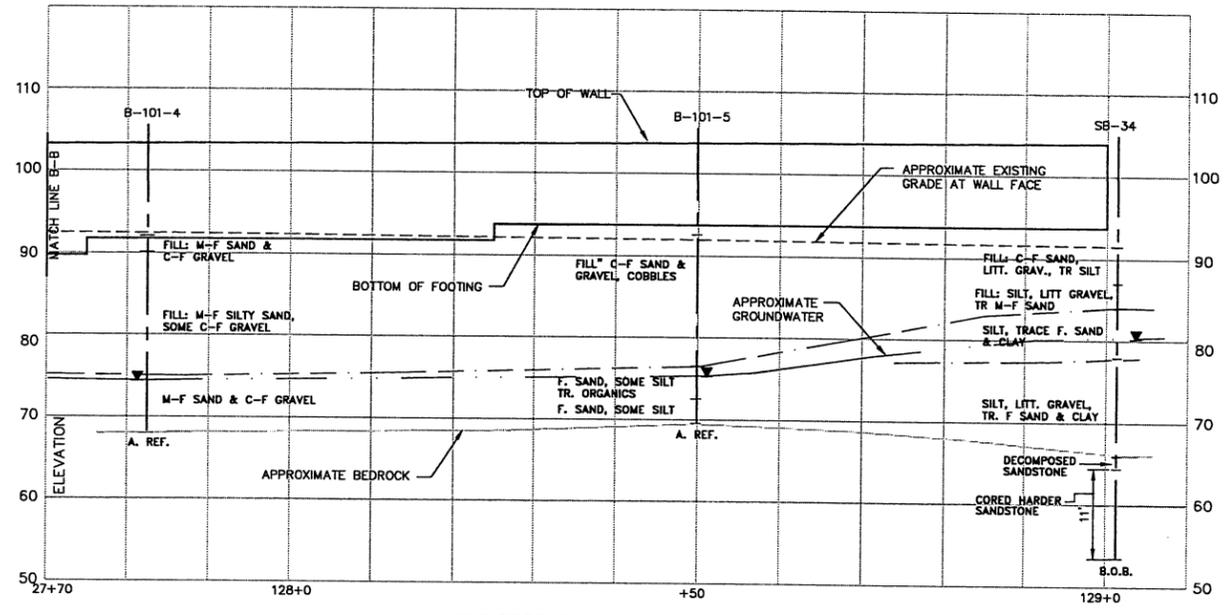
Sample Type: S=Split Spoon C=Core UP=Undisturbed Piston V=Vane Shear Test A=Auger  
Proportions Used: Trace = 1 - 10%, Little = 10 - 20%, Some = 20 - 35%, And = 35 - 50%

Total Penetration in Earth: 49.0' Rock: 10.0'  
No. of Samples: 13

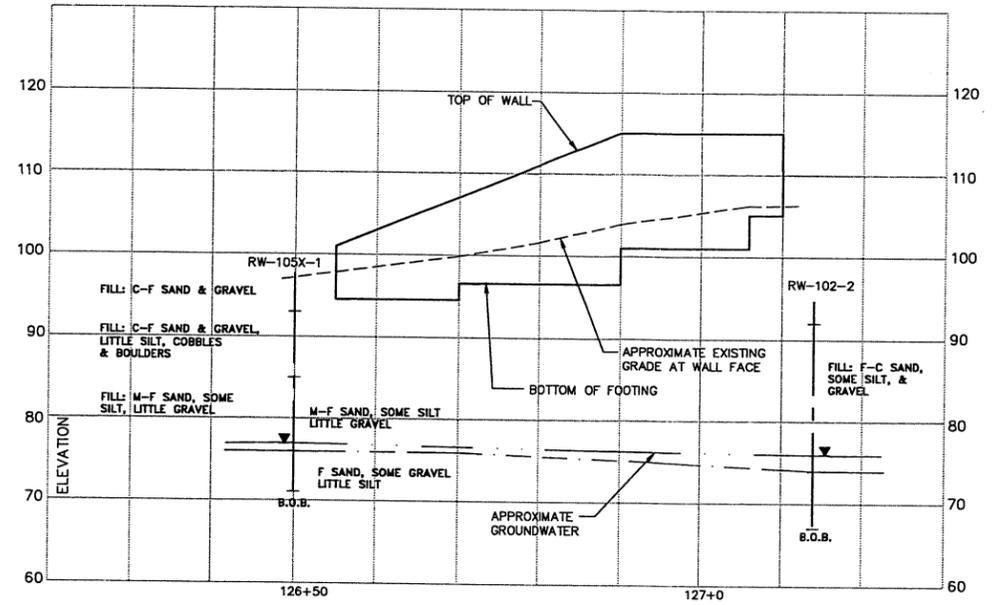
NOTES:

## **APPENDIX 2**

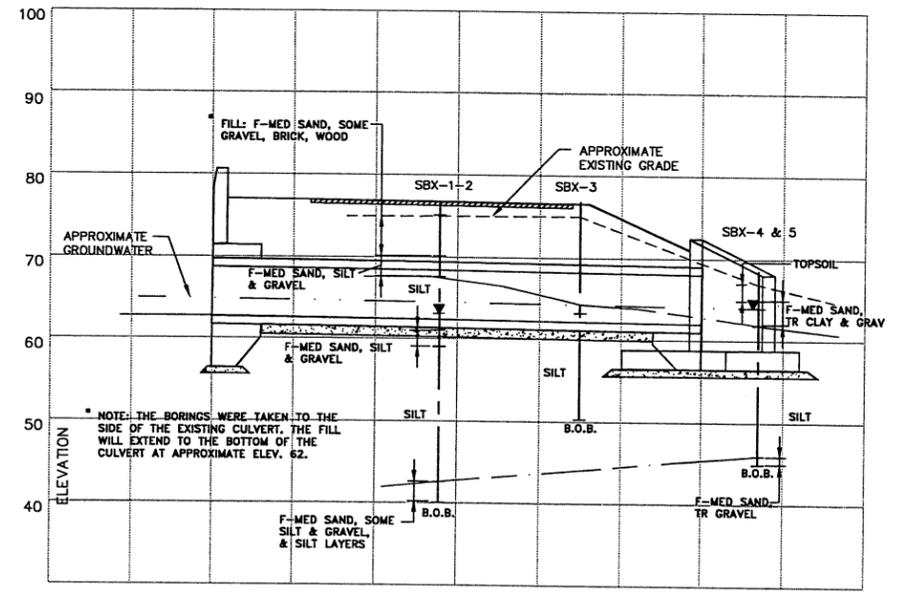
### **Geologic Sections + Grain Size Gradations (if any)**



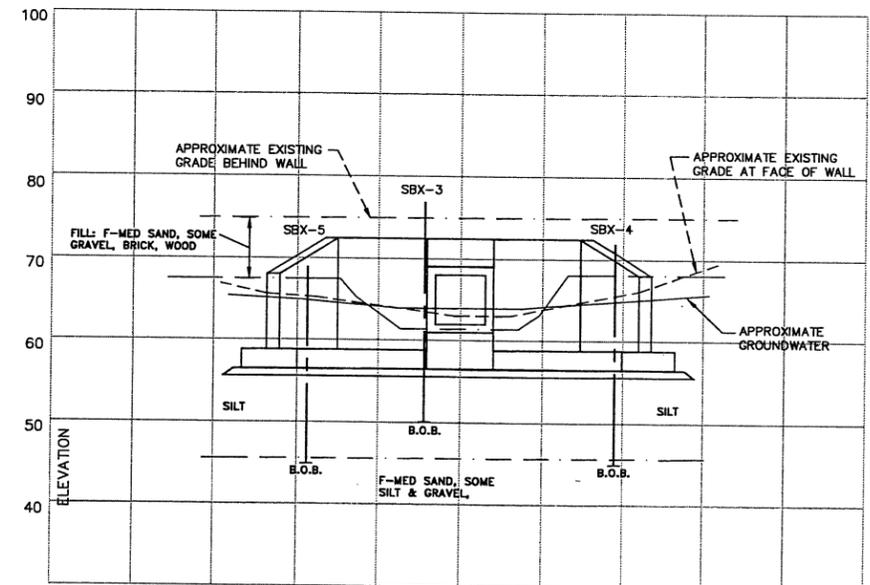
SOIL PROFILE - WALL 101



SOIL PROFILE WALL 105



BOX CULVERT STA 174+80



BOX CULVERT OUTLET WALL

- A. REF. = AUGER REFUSAL
- B.O.B. = BOTTOM OF BORING
- ▼ = OBSERVED GROUNDWATER LEVEL
- = ESTIMATED WATER TABLE
- = STRATUM CHANGE
- = GRADE LINE

REVISIONS		
DATE	NO.	DESCRIPTION

NEW BRITAIN - HARTFORD BUSWAY  
NEWINGTON SECTIONS A & B

STRUCTURE GEOTECHNICAL SECTIONS

SCALE: 1" = 10'

DATE: MARCH 30, 2011

DR. CLARENCE WELTI, P.E., P.C.  
227 WILLIAMS STREET, P.O. BOX 397  
GLASTONBURY, CONNECTICUT 06033

SHEET 2