APPENDIX A – PAGES FROM RTA 1 BRIDGE SOIL DESIGN PARAMETERS BY GZA GEOENVIRONMENTAL, INC.

GZA

Proactive by Design

GEOTECHNICAL
ENVIRONMENTAL
ECOLOGICAL
WATER
CONSTRUCTION MANAGEMENT

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MEMORANDUM

To: Jason Stern, P.E. (GPI)

From: Russell Morgan, P.E.; Andrew Rizk, P.E. (GZA)

CC Michael Shaw (GZA);

Date: June 28, 2019

File No.: 14.0079527.00

Re: Geotechnical Soil Design Parameters for RTA1 Bridges Stabilization Design
Gowanus Canal Superfund Site Remediation Project

GZA is pleased to provide GPI with this technical memorandum summarizing geotechnical design parameters to support GPI's design of stabilization measures for the three bridges: Union Street, Carroll Street, and Third Street Bridges, which are located within the Remediation Target Area (RTA) 1 portion of the Gowanus Canal Superfund Site Remediation project.

The basis of these soil parameters is based on data collected by Geosyntec and presented in Geosyntec's Summary of Geotechnical Design Parameters document dated October 28, 2016 (Report). Data from selected borings and cone penetrometer test soundings (CPTs) as well as laboratory testing data located near or around the referenced bridges were evaluated by GZA. The design parameters provided by Geosyntec in their Report were reviewed by GZA and deemed acceptable to be used for the design of the bridge stabilization measures. The selected explorations were overlaid by GZA on the existing bathymetry plan and profile between station 8+00 to 24+00on drawing number DR-2 and DR-3 of 22 prepared by Geosyntec and dated October 2017.

The soil design parameters including total unit weight, effective friction angle, undrained shear strength, and thickness of each strata for canal and upland subsurface materials are summarized and tabulated in the two attached tables. The approximate locations of the selected explorations which were evaluated are shown on the existing bathymetry survey and profile in Attachment A. The logs of the selected borings and the graphical data from the selected CPTs are shown in Appendix B.

Should you have any questions or comments, please do not hesitate to reach Andrew Rizk, P.E. at 732-356-3400 or Russell Morgan , P.E. at 401.427.2708.

TABLES

GZA GeoEnvironmental of New York
RTA 1 Bridge Soil Design Parameters
July 11, 2018

Summary of Design Parameters for Canal Soils

Soil Unit	Total Unit Weight, γ (pcf)	Effective Friction Angle, ϕ' (degrees)	Undrained Shear Strength, S_u (psf), See Note 1	Stratum Thickness Union Street (feet)	Stratum Thickness Carroll Street (feet)	Stratum Thickness 3rd Street (feet)
Soft Sediment	80	28	$0.3\sigma'_v$	6	5	7
Native Alluvial Sediment	115	28	250 if > El. -20 ft 500 if < El. -20 ft	4	4	7
Glacial Deposit	125	34	-	See Note 2	See Note 2	See Note 2

1. $\sigma'v$ = (total unit weight of soil - 62.4 pcf)*depth
2. Explorations were terminated in this stratum and it is expected that the stabilization design for the bridges will also terminate here.

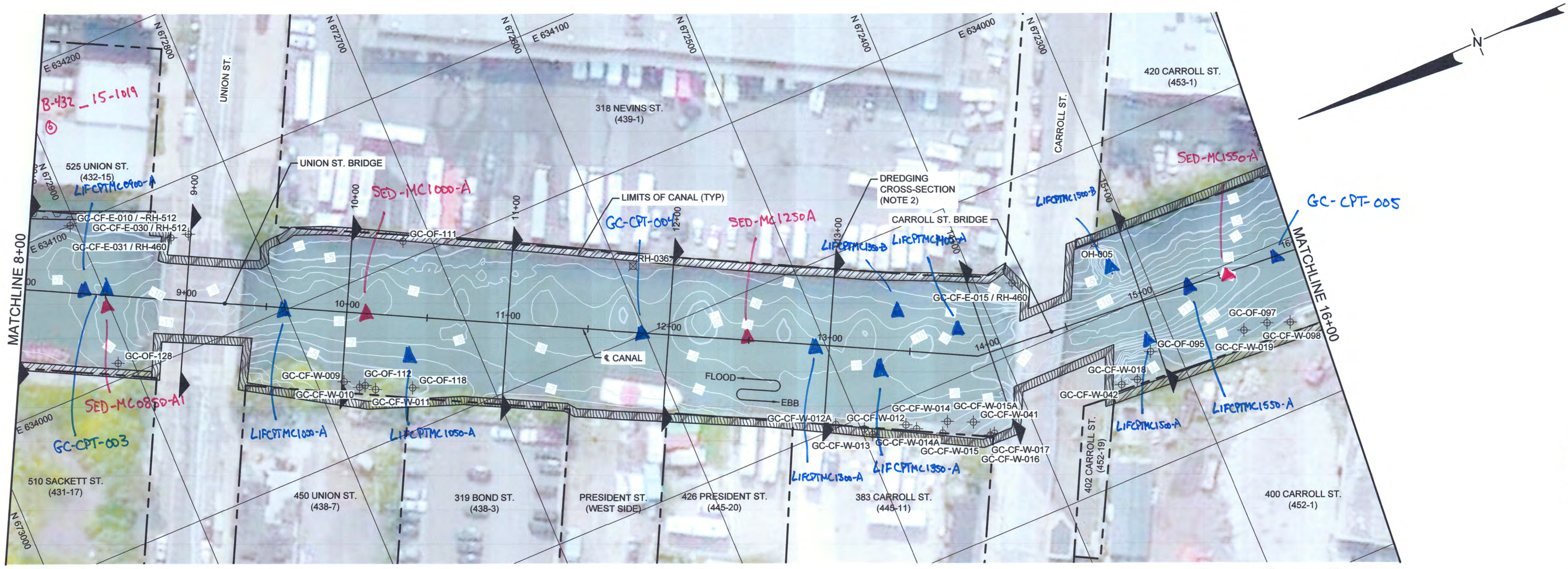
Summary of Design Parameters for Upland Soils

Soil Unit	Total Unit Weight, γ (pcf)	Effective Friction Angle, ϕ' (degrees)	Undrained Shear Strength, S_u (psf), See Note 1
Fill	120	32	-
Organic Sediment	95	23	$0.25\sigma'_v$ min. 250 psf
Native Alluvial Sediment	115	28	$0.35\sigma'_v$ min. 250 psf
Glacial Deposit w/ Fines	125	28	$0.5\sigma'_v$ min. 500 psf
Glacial Deposit w/ Sands	125	34	-

1. $\sigma'v$ = total unit weight of soil*depth above the water table and $\sigma'v$ = (total unit weight of soil - 62.4 pcf)*depth below the water table.

ATTACHMENT A

EXISTING BATHYMETRY PLAN AND PROFILE (STATIONS 8+00 TO 24+00) WITH SELECTED EXPLORATIONS

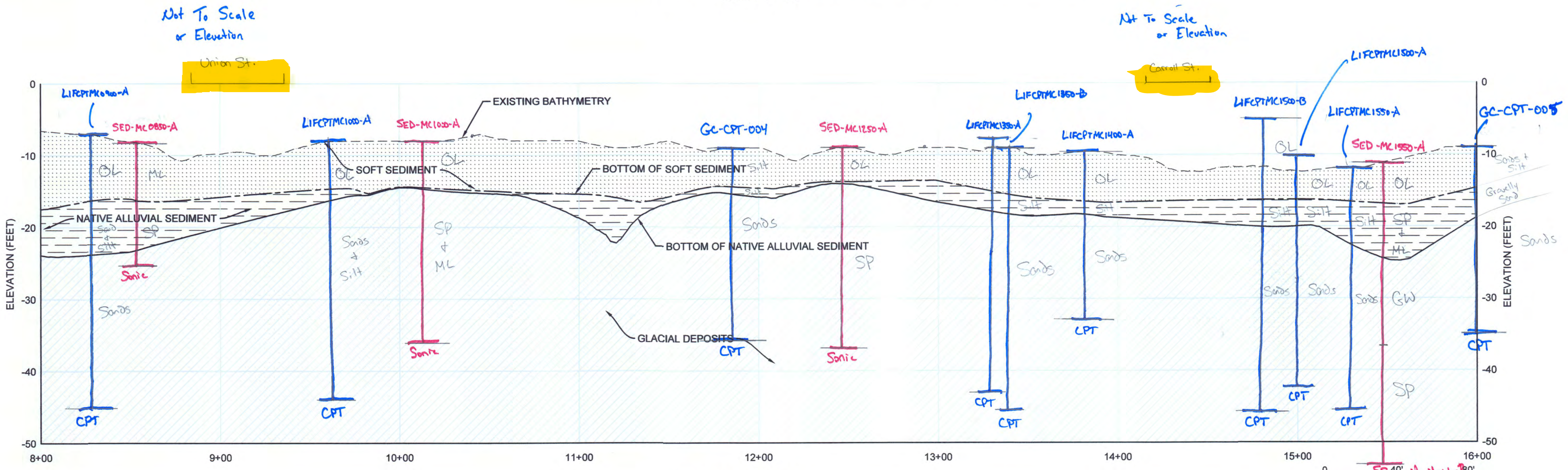


0 40' 80'
SCALE IN FEET

6 PLAN
G-3

EXISTING BATHYMETRY (STA. 8+00 TO 16+00)

SCALE: 1" = 40'



0 40' 80'
SCALE IN FEET (HORIZONTAL)

0 10' 20'
SCALE IN FEET (VERTICAL)

DISTANCE (FEET)

7 PROFILE
DR-2

EXISTING BATHYMETRY (STA. 8+00 TO 16+00)

SCALE: 1" = 40' (HORIZONTAL); 1" = 10' (VERTICAL)

LEGEND

┈┈	BATHYMETRY ELEVATION
──	CANAL BOUNDARY
— — —	PROPERTY LINE
- - - -	EXISTING BATHYMETRY
– · – · –	BOTTOM OF SOFT SEDIMENT
– · · – · · –	BOTTOM OF NATIVE ALLUVIAL SEDIMENT
10+00	CANAL STATIONING
▨	STEEL SHEET PILE BULKHEAD
▨	TIMBER CRIB BULKHEAD
○○○	TIMBER PILE BULKHEAD
░	SOFT SEDIMENT
☰	NATIVE ALLUVIAL SEDIMENT
☐	GLACIAL DEPOSITS
⌖	OUTFALL (NOTE 4)
⊠	CSO (NOTE 4)
(417-21)	BLOCK AND LOT
▲	Boring
▲	CPT

NOTES:

1. DEBRIS IN RTA1 IS PRESENTED ON DRAWINGS DR-6 TO DR-8.
2. DREDGE CROSS-SECTIONS ARE PRESENTED ON DRAWINGS DR-17 AND DR-18.
3. THE BULKHEAD TYPE FOR EACH PROPERTY IS PRIMARILY BASED ON A PRELIMINARY DESKTOP STUDY COMPLETED BY GEOSYNTEC (2014) TITLED "CONDITION ASSESSMENT OF EXISTING BULKHEADS" ALONG WITH MORE RECENT SUPPLEMENTARY INFORMATION (E.G., SITE WALKS, ENGINEERING DRAWINGS).
4. CONTRACTOR IS RESPONSIBLE FOR DOCUMENTING AND VERIFYING THE LOCATION AND DESCRIPTION OF OUTFALLS. ONLY RTA1 OUTFALLS DATA ARE PRESENTED ON THE DRAWING. OUTFALL DATA IS PROVIDED AS TABLE 1 ON DRAWING G-2 AND DESCRIBED WITHIN THE ASSOCIATED NOTES.

REV	DATE	DESCRIPTION	DRN	APP
C2	10.31.17	RTA1 65% REMEDIAL DESIGN TO RD GROUP	SRN	JFB
B	12.23.16	RTA1 35% REMEDIAL DESIGN - CAPPING AND ISS	SRN	JFB
A	10.31.16	RTA1 35% REMEDIAL DESIGN – DREDGING AND TREATMENT	SRN	JFB

Gowanus Canal
Remedial Design
Group

Geosyntec
consultants
7 GRAPHICS DRIVE, SUITE 106
EWING, NEW JERSEY 08628, USA
PHONE: 609.895.1400

Beech and Bonaparte
engineering p.c.
an affiliate of Geosyntec Consultants

TITLE:
EXISTING BATHYMETRY PLAN (STA. 8+00 TO 16+00)

PROJECT:
REMEDIATION TARGET AREA (RTA) 1
65% REMEDIAL DESIGN

SITE:
GOWANUS CANAL SUPERFUND SITE, BROOKLYN, NEW YORK

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

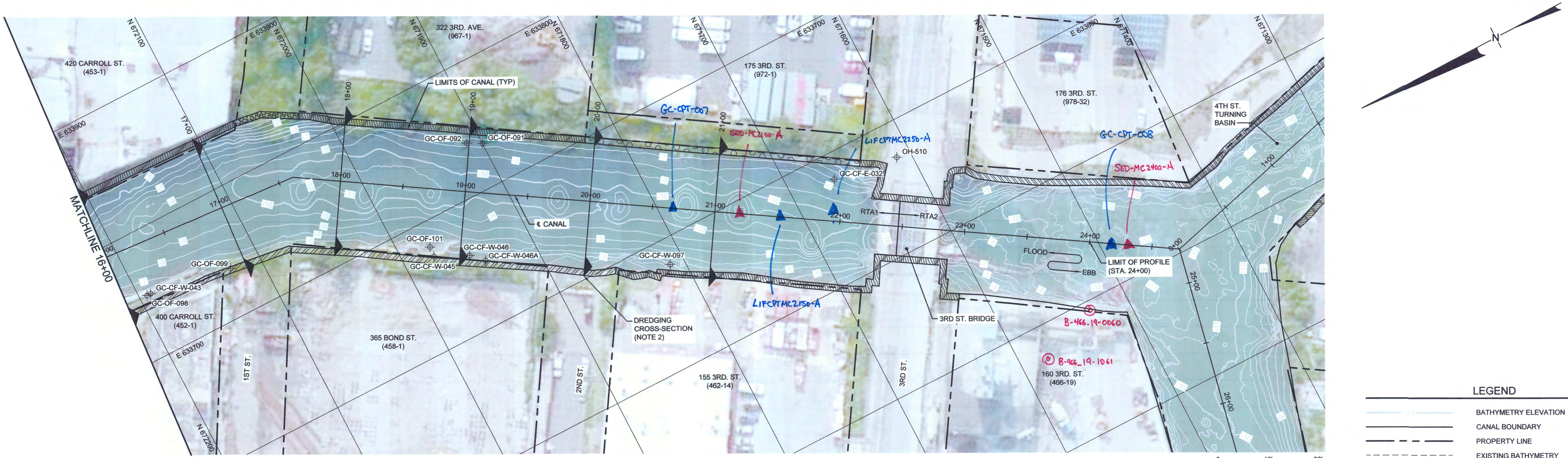
SIGNATURE

DATE

DESIGN BY:	JMG	DATE:	OCTOBER 2017
DRAWN BY:	SRN	PROJECT NO.:	HPH106A
CHECKED BY:	JMG	FILE:	HPH106A-DR006
REVIEWED BY:	MWS	DRAWING NO.:	DR-2 OF 22
APPROVED BY:	JFB		

NOT ISSUED FOR CONSTRUCTION

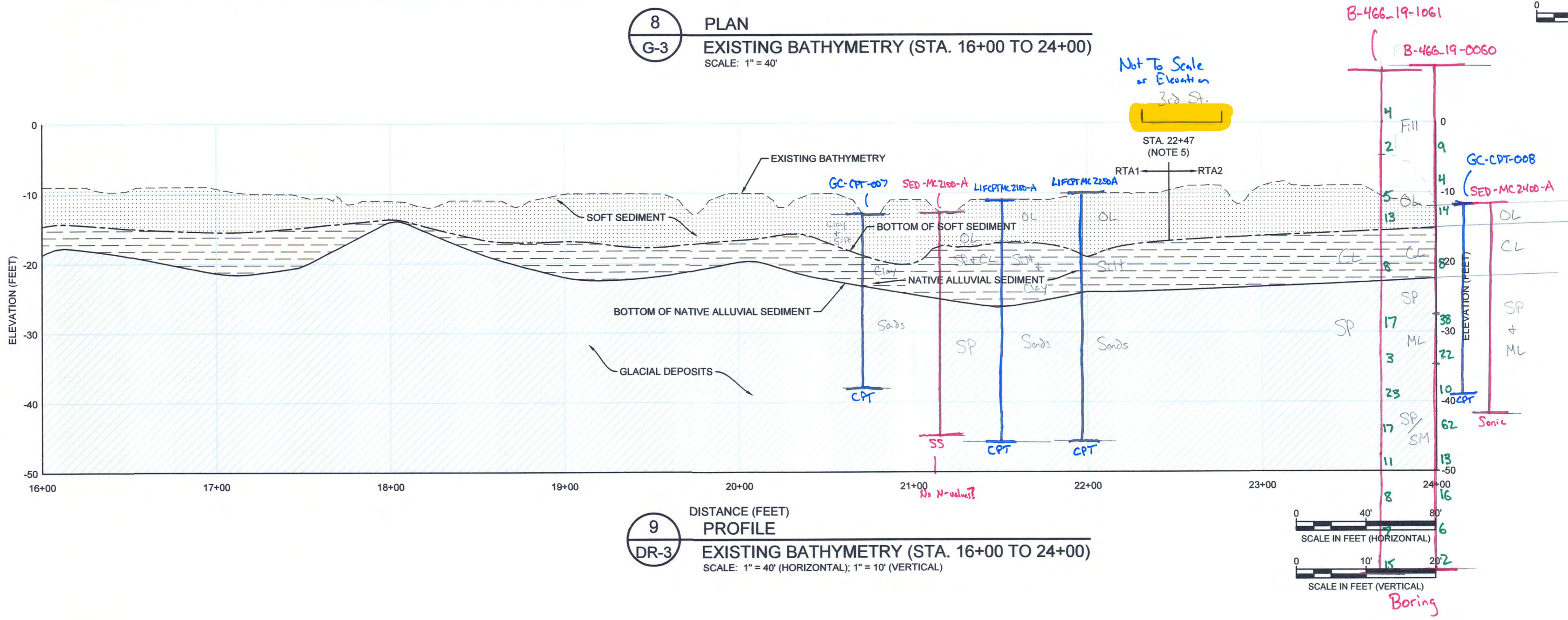
X:\00_CADD\DREDGING DESIGN\RTA1\DRAWINGS\HPH106A-DR006



0 40' 80'
SCALE IN FEET

8 G-3 PLAN
EXISTING BATHYMETRY (STA. 16+00 TO 24+00)

SCALE: 1" = 40'



9 DR-3 PROFILE
EXISTING BATHYMETRY (STA. 16+00 TO 24+00)

SCALE: 1" = 40' (HORIZONTAL); 1" = 10' (VERTICAL)

LEGEND

⋯	BATHYMETRY ELEVATION
——	CANAL BOUNDARY
— — —	PROPERTY LINE
- - - -	EXISTING BATHYMETRY
—·—·—	BOTTOM OF SOFT SEDIMENT
——	BOTTOM OF NATIVE ALLUVIAL SEDIMENT
20+00	CANAL STATIONING
▨	STEEL SHEET PILE BULKHEAD
▨	TIMBER CRIB BULKHEAD
○○○	TIMBER PILE BULKHEAD
⋯	SOFT SEDIMENT
▤	NATIVE ALLUVIAL SEDIMENT
☐	GLACIAL DEPOSITS
⌖	OUTFALL (NOTE 4)
⊠	CSO (NOTE 4)
(417-21)	BLOCK AND LOT
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NOTES:

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3. THE BULKHEAD TYPE FOR EACH PROPERTY IS PRIMARILY BASED ON A PRELIMINARY DESKTOP STUDY COMPLETED BY GEOSYNTEC (2014) TITLED "CONDITION ASSESSMENT OF EXISTING BULKHEADS" ALONG WITH MORE RECENT SUPPLEMENTARY INFORMATION (E.G., SITE WALKS, ENGINEERING DRAWINGS).
4. CONTRACTOR IS RESPONSIBLE FOR DOCUMENTING AND VERIFYING THE LOCATION AND DESCRIPTION OF OUTFALLS. ONLY RTA1 OUTFALLS ARE PRESENTED ON THE DRAWING. OUTFALL DATA IS PROVIDED AS TABLE 1 ON DRAWING G-2 AND DESCRIBED WITHIN THE ASSOCIATED DREDGING NOTES.
5. THE BOUNDARY BETWEEN RTA1 AND RTA2 PRESENTED IS BASED ON A FIGURE IDENTIFIED IN THE EPA FEASIBILITY STUDY (2011).

REV	DATE	DESCRIPTION	DRN	APP
C2	10.31.17	RTA1 65% REMEDIAL DESIGN TO RD GROUP	SRN	JFB
B	12.23.16	RTA1 35% REMEDIAL DESIGN - CAPPING AND ISS	SRN	JFB
A	10.31.16	RTA1 35% REMEDIAL DESIGN – DREDGING AND TREATMENT	SRN	JFB

Gowanus Canal
Remedial Design
Group

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EWING, NEW JERSEY 08628, USA
PHONE: 609.895.1400

Beech and Bonaparte
engineering p.c.
an affiliate of Geosyntec Consultants

TITLE:
EXISTING BATHYMETRY PLAN (STA. 16+00 TO 24+00)

PROJECT:
REMEDIATION TARGET AREA (RTA) 1
65% REMEDIAL DESIGN

SITE:
GOWANUS CANAL SUPERFUND SITE, BROOKLYN, NEW YORK

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY:	JMG	DATE:	OCTOBER 2017
DRAWN BY:	SRN	PROJECT NO.:	HPH106A
CHECKED BY:	JMG	FILE:	HPH106A-DR007
REVIEWED BY:	MWS	DRAWING NO.:	DR-3 OF 22
APPROVED BY:	JFB		

NOT ISSUED FOR CONSTRUCTION

ATTACHMENT B

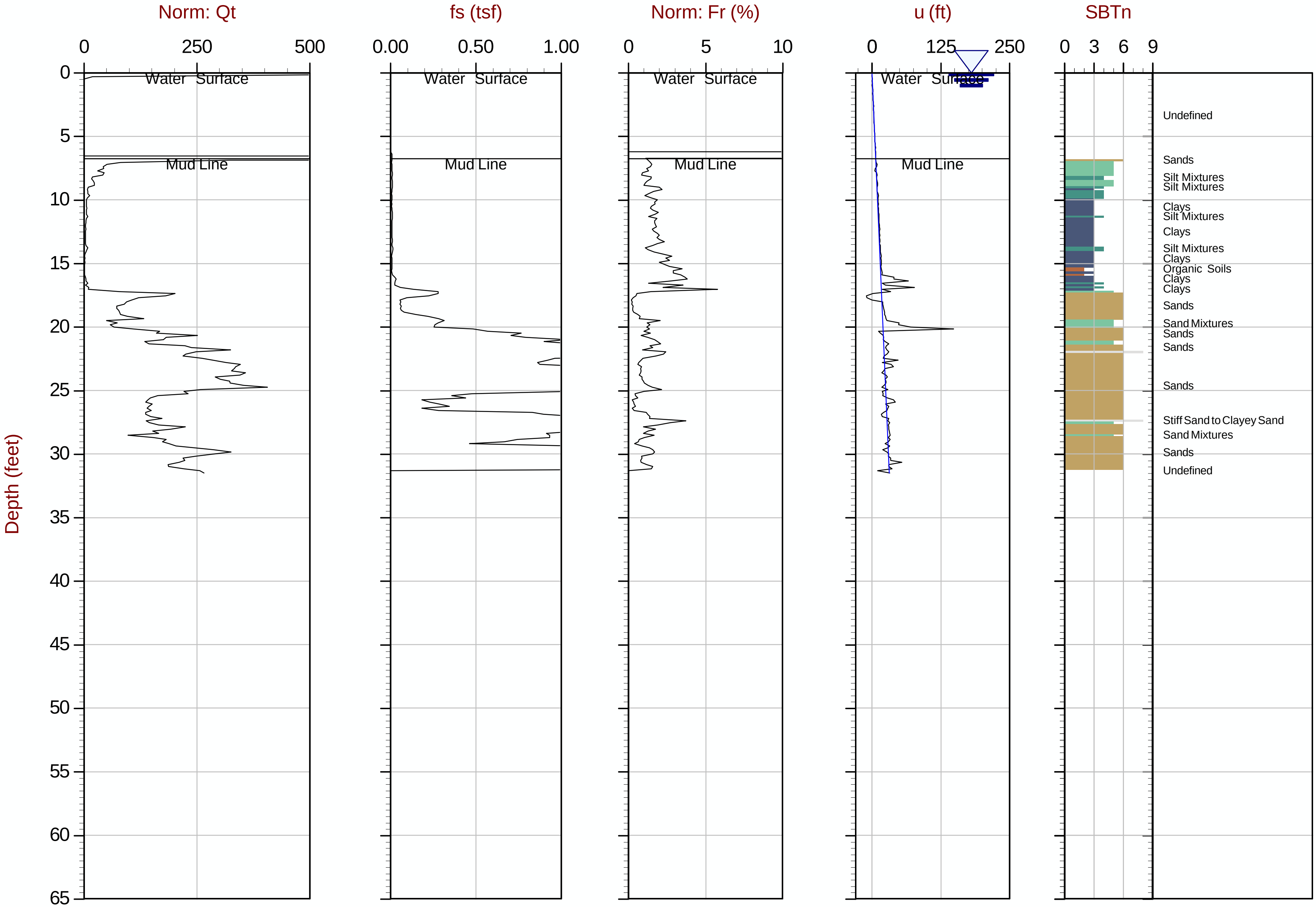
LOGS OF SELECTED BORINGS AND GRAPHICAL DATA OF SELECTED CPTS

CONETEC

GEI Consultants

Job No: 12-748
Date: 08:22:12 08:11
Site: Gowanus Canal

Sounding: GC-CPT-003
Cone: 366:T1500F15U500



Max Depth: 9.600 m / 31.50 ft
Depth Inc: 0.050 m / 0.164 ft

File: 748CP03.COR

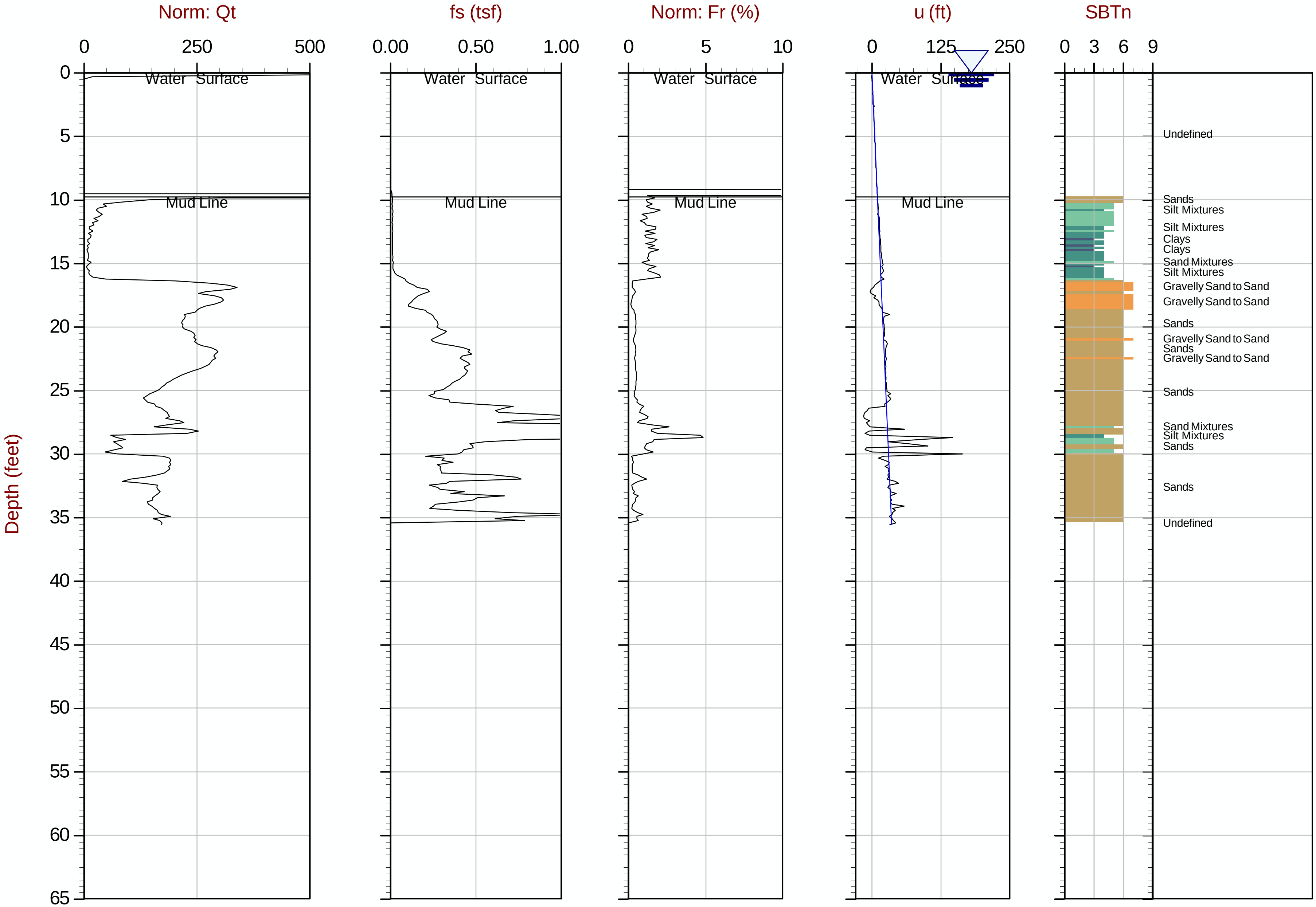
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4503692 E: 585502

CONETEC

GEI Consultants

Job No: 12-748
Date: 08:22:12 09:27
Site: Gowanus Canal

Sounding: GC-CPT-004
Cone: 366:T1500F15U500



Max Depth: 10.850 m / 35.60 ft
Depth Inc: 0.050 m / 0.164 ft

File: 748CP04.COR

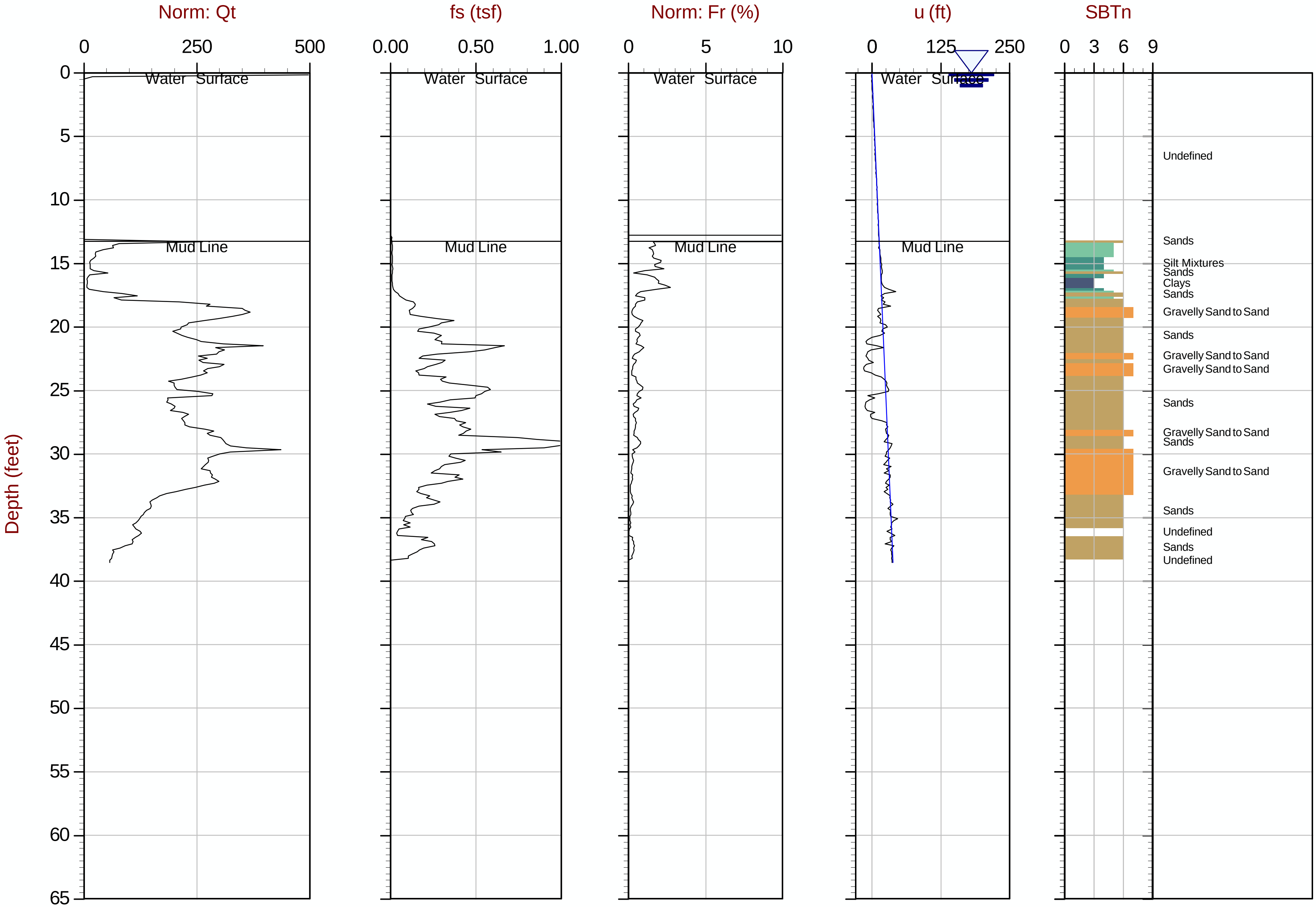
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4503601 E: 585466

CONETEC

GEI Consultants

Job No: 12-748
Date: 08:22:12 12:24
Site: Gowanus Canal

Sounding: GC-CPT-005
Cone: 366:T1500F15U500



Max Depth: 11.750 m / 38.55 ft
Depth Inc: 0.050 m / 0.164 ft

File: 748CP05.COR

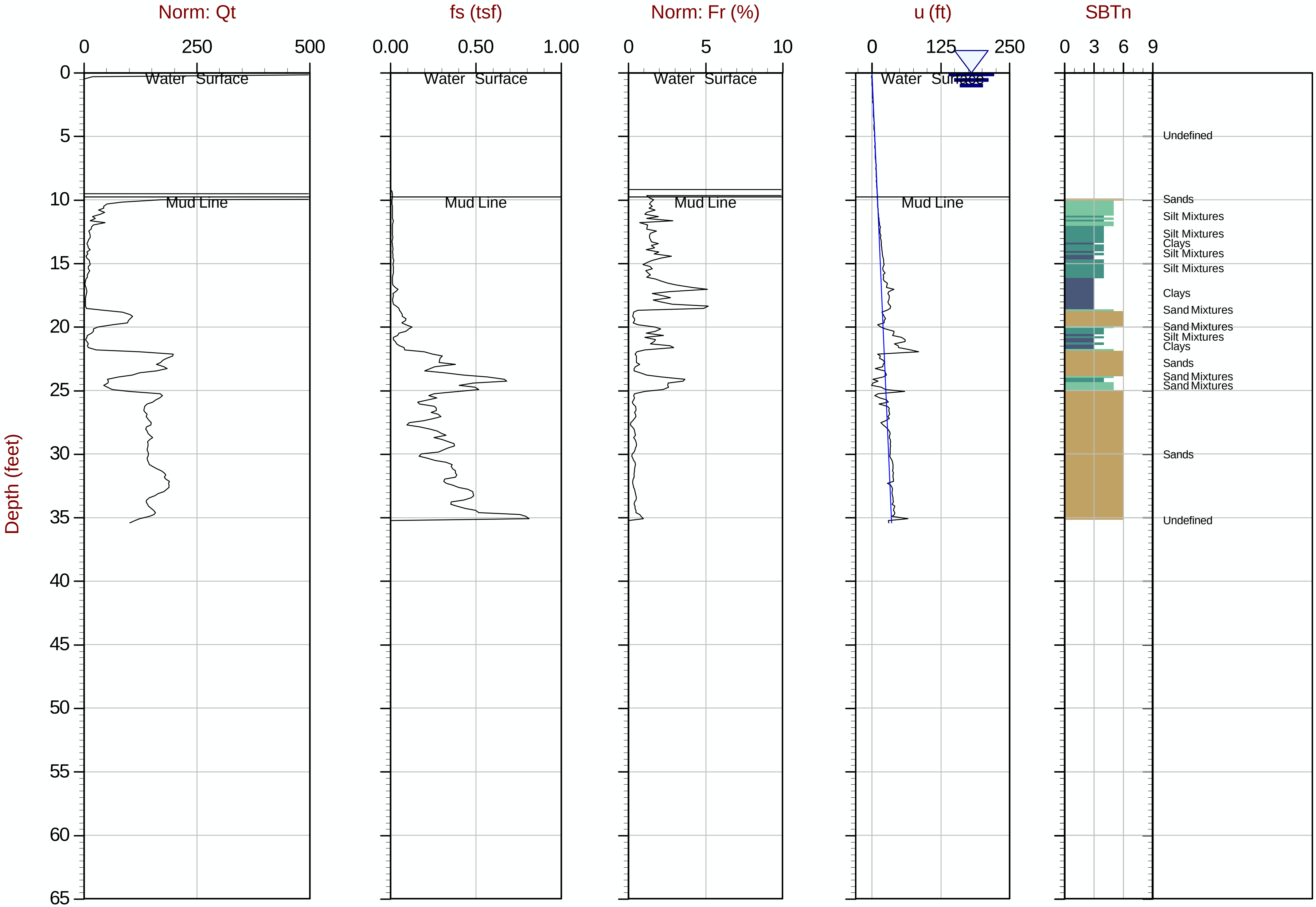
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4503479 E: 585431

CONETEC

GEI Consultants

Job No: 12-748
Date: 08:23:12 09:23
Site: Gowanus Canal

Sounding: GC-CPT-007
Cone: 366:T1500F15U500



Max Depth: 10.800 m / 35.43 ft
Depth Inc: 0.050 m / 0.164 ft

File: 748CP07.COR

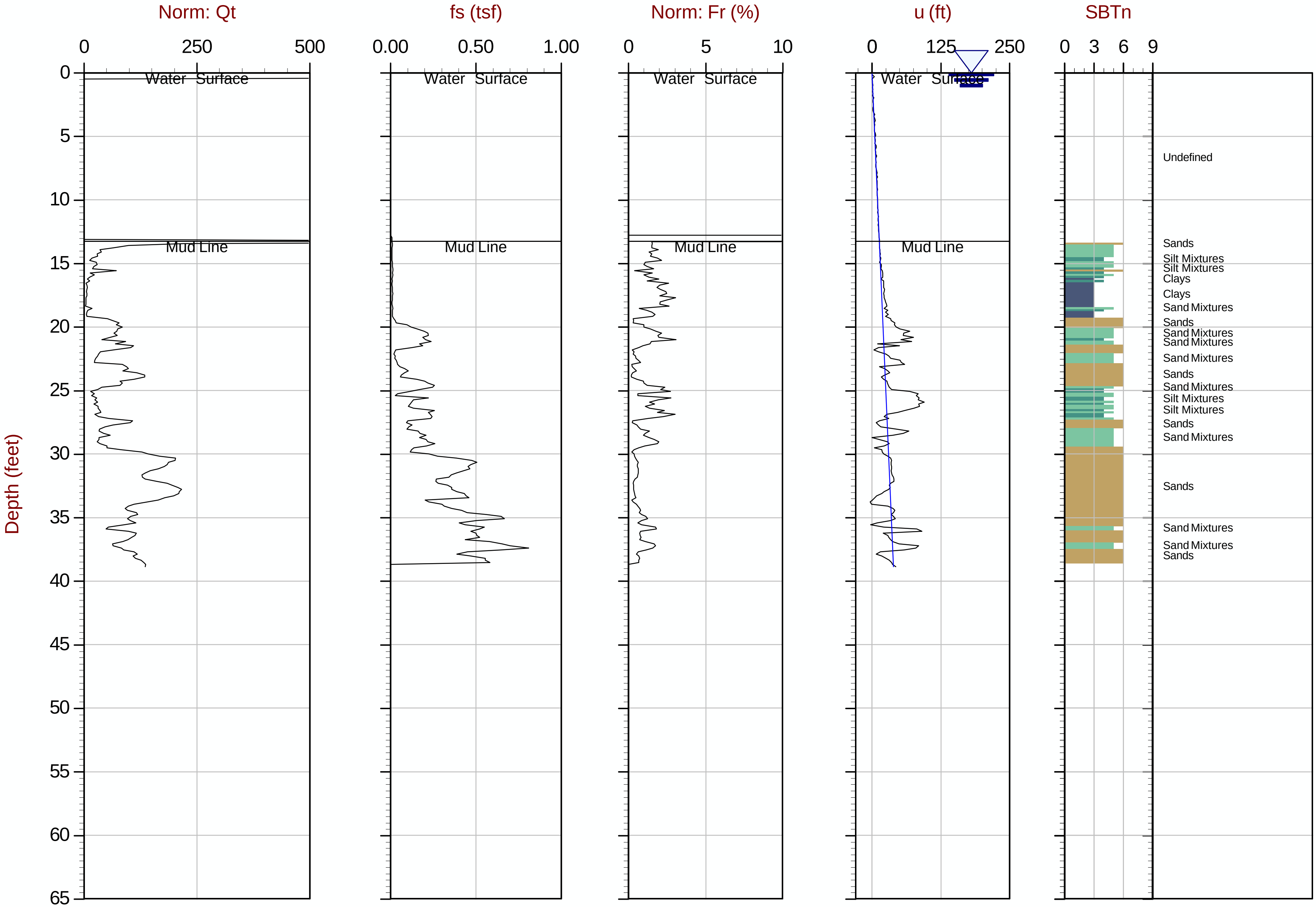
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4503356 E: 585374

CONETEC

GEI Consultants

Job No: 12-748
Date: 08:23:12 11:40
Site: Gowanus Canal

Sounding: GC-CPT-008
Cone: 366:T1500F15U500



Max Depth: 11.850 m / 38.88 ft
Depth Inc: 0.050 m / 0.164 ft

File: 748CP08.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4503252 E: 585323

Geosyntec consultants

BORING NUMBER SED-MC1000-A

CLIENT Gowanus Canal Remedial Design Group

PROJECT NAME Gowanus Canal Superfund

PROJECT NUMBER HPH106

PROJECT LOCATION Gowanus Brooklyn, NY

DATE STARTED 5/1/15 **COMPLETED** 5/1/15

MUDLINE ELEVATION -7.91 ft NAVD88

DRILLING CONTRACTOR Cascade

BOREHOLE DIAMETER 6 inches

DRILLING METHOD Sonic Drilling

SAMPLER 3.5 in. Sonic Core - Lexan Liner

LOGGED BY PS, MM **CHECKED BY** PS

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	LABORATORY SAMPLES	COMMENTS
0.0	60/60	OL		1.8	black, very soft, wet SILT, little clay, sheen, strong odor	-9.7		
2.5		OL		4.0	black, soft, wet SILT, little clay, organic debris, sheen, strong odor	-11.9		
5.0				5.0		-12.9	SED-MC1000-A-4-5	
	60/58.8	OL		6.2	black, soft, wet SILT, little clay, organic debris, sheen, strong odor	-14.1		Soft Sediments/ Glacial Deposits Interface [Elevation of -14.11 ft NAVD88]
7.5 10.0	60/60	SP		11.1	brown/tan, loose, wet, fine SAND, little silt, sheen, some stain, strong odor	-19.0		
		ML		11.9	brown, tan, medium stiff, moist, micaceous SILT, some fine sand, sheen, odor	-19.8		
		SM		12.0	gray, medium stiff, moist SILT and fine SAND	-19.9		
12.5				13.0		-20.9	SED-MC1000-A-12-13	
				14.0		-21.9	SED-MC1000-A-13-14	
		GW		14.3	gray, loose, wet, medium GRAVEL and coarse SAND, trace silt, heavy staining, sheen, strong odor	-22.2		
15.0		ML		15.0	black, medium stiff, moist SILT, trace fine sand, heavily stained,	-22.9		

NOTES

(Continued Next Page)

Geosyntec consultants

BORING NUMBER SED-MC1000-A

PAGE 2 OF 2

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal Superfund
PROJECT NUMBER HPH106
PROJECT LOCATION Gowanus Brooklyn, NY

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	LABORATORY SAMPLES	COMMENTS
15.0	36/33.6	SP	⁘	15.5	sheen, strong odor (linear path of stain/NAPL)	-23.4		
		GW	⁘	16.0	brown to gray, loose, damp, fine to medium SAND, trace silt, trace fine gravel	-23.9		
				17.0	brown to gray, loose, damp, medium SAND and GRAVEL, some staining, sheen, strong odor	-24.9	SED-MC1000-A-16-17	
		SC	▨	17.3	brown, loose to medium stiff, damp, medium SAND and silty CLAY, heavily stained in sand, sheen, strong odor	-25.2		
17.5		SP	⁘	17.6		-25.5		
		CL-ML	▥	17.8	black, loose, moist, medium SAND, trace gravel, heavy staining, sheen, strong odor	-25.7		
				18.5	brown, medium stiff, moist, clayey SILT, trace fine sand, sheen, odor	-26.4		
	18/10.8	SM	▥	18.9	NO CORE COLLECTED	-26.8	SED-MC1000-A-18.5-20	Blow count: 2/2/4 [Elevations: -26.41 to -26.91/ -26.91 to -27.41/-27.41 to -27.91 ft NAVD88]
		SP	⁘	19.2	gray, loose, wet, fine SAND with SILT, sheen	-27.1		
		CL-ML	▥	19.9	gray, loose, wet, fine to medium SAND, little silt, heavily stained, strong odor, sheen	-27.8		
20.0					black, medium stiff, wet CLAY, some silt, trace gravel, heavily stained, strong odor, sheen NO CORE COLLECTED			
22.5				22.5		-30.4		
	18/19.2	SP	⁘	22.6	gray, loose, wet, medium SAND, little silt, heavy staining, strong odor, free product	-30.5	SED-MC1000-A-22.5-24	Blow count: 2.5/4/6 [Elevations: -30.41 to -30.91/ -30.91 to -31.41/-31.41 to -31.91 ft NAVD88]
		CL	▨	24.1	tan, stiff, damp CLAY, little silt, trace gravel	-32.0		
25.0				26.5	NO CORE COLLECTED	-34.4		
	18/18	SP	⁘	27.3	brown, medium stiff, wet, fine SAND, some silt, little clay, sheen, little stain, odor	-35.2	SED-MC1000-A-26.5-28	Blow count: 2/2/2 [Elevations: -34.41 to -34.91/ -34.91 to -35.41/-35.41 to -35.91 ft NAVD88]
27.5		CL	▨	28.0	brown, stiff, moist to wet CLAY, some silt, little fine sand	-35.9		
30.0					Bottom of borehole at 28.0 feet.			

Geosyntec consultants

BORING NUMBER SED-MC1250-A

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal Superfund
PROJECT NUMBER HPH106
PROJECT LOCATION Gowanus Brooklyn, NY
DATE STARTED 5/4/15 **COMPLETED** 5/5/15
MUDLINE ELEVATION -8.88 ft NAVD88
DRILLING CONTRACTOR Cascade
BOREHOLE DIAMETER 6 inches
DRILLING METHOD Sonic Drilling
SAMPLER 3.5 in. Sonic Core - Lexan Liner
LOGGED BY GB, MM **CHECKED BY** PS

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	LABORATORY SAMPLES	COMMENTS
0.0	60/39.6	OL			black, soft, wet SILT, trace clay, detritus, strong odor, sheen			
2.5							SED-MC1250-A-2.3-3.3	
				3.3		-12.2		
5.0	60/44.4	SP			gray, loose, wet, fine SAND, trace silt, native sediment content; (3" glass bottle fragment)			Soft Sediments/ Glacial Deposits Interface [Elevation of -13.88 ft NAVD88]
7.5								
				8.7		-17.6		
10.0	60/60						SED-MC1250-A-10-11	
				11.0		-19.9	SED-MC1250-A-11-12	
				12.0		-20.9		
		SP			gray, medium dense, fine SAND, little medium sand, little gravel at 14.1', slight odor			
12.5								
15.0				15.0		-23.9		

NOTES 15 to 18 ft below mudline was heavily stained cause 5 ft of recovery. After pulling rods, sample loss at bottom and only 2 ft of recovery. Likely. The first native sediment was observed in 5-10 ft. No soft sediment was observed in 5-10 ft interval.

(Continued Next Page)

BORING NUMBER SED-MC1250-A

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal Superfund
PROJECT NUMBER HPH106
PROJECT LOCATION Gowanus Brooklyn, NY

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	LABORATORY SAMPLES	COMMENTS
15.0	36/20.4	SP		16.7	gray, medium dense, fine SAND, little medium sand, slight odor	-25.6		
17.5	60/46.8			19.0		-27.9	SED-MC1250-A-18-19	
20.0		SP		22.9	dark gray, medium dense, moist fine to medium SAND, trace gravel, some staining, sheen, odor	-31.8		
22.5	60/56.4			24.0		-32.9	SED-MC1250-A-23-24	
25.0		SP		27.7	dark gray, medium dense, moist fine to medium SAND, trace gravel, some staining, sheen, odor	-36.6	SED-MC1250-A-26.5-27.5	Staining was observed throughout the core and followed the coarser grained material.
27.5								

Bottom of borehole at 28.0 feet.

30.0

BORING NUMBER SED-MC1550-A

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal Superfund
PROJECT NUMBER HPH106
PROJECT LOCATION Gowanus Brooklyn, NY
DATE STARTED 6/3/15 **COMPLETED** 6/4/15
MUDLINE ELEVATION -11.78 ft NAVD88
DRILLING CONTRACTOR Aquifer Drilling and Testing
BOREHOLE DIAMETER 4 inches
DRILLING METHOD Split Spoon
SAMPLER 3 in. Split Spoon
LOGGED BY AW **CHECKED BY** PS

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	LABORATORY SAMPLES	COMMENTS
0					NO CORE COLLECTED			
5	24/20.4	OL		5.0 5.3	black, very soft, wet SILT, little fine sand, little gravel, trace organic debris	-16.8 -17.1		Soft Sediments/ Native Alluvial Sediments Interface [Elevation of -17.08 ft NAVD88]
		SP		5.7	dark gray, dense, wet, fine SAND, sheen	-17.5		
		SP		6.7	dark brown to black, medium dense, wet, fine SAND, heavy staining, sheen, strong odor	-18.5	SED-MC1550-A-5.7-6.7	
					NO CORE COLLECTED			
10	24/19.2	ML		10.0 10.3	dark gray, stiff, moist SILT, some fine sand, little clay, some organic debris, hairs, and fibers, some gravel	-21.8 -22.1		
		SP		10.5	black, medium dense, wet, fine SAND, heavy staining, sheen, strong odor	-22.3		
		ML		11.1	dark gray, stiff, moist SILT, trace fine sand, trace clay	-22.9		
		SP		11.6	grayish brown, medium stiff, wet, fine SAND with SILT, trace clay, sheen	-23.4	SED-MC1550-A-10-11.6	Native Alluvial Sediments/ Glacial Deposits Interface [Elevation of > -26.78 ft NAVD88]
					NO CORE COLLECTED			
15	24/10.8	GW		15.0 15.9	dark brown, loose, wet, coarse SAND with medium GRAVEL	-26.8 -27.7	SED-MC1550-A-15-15.9	
	24/12	GW		17.3	dark brown, loose, wet, coarse SAND with medium GRAVEL	-29.1	SED-MC1550-A-17.3-18.3	
					NO CORE COLLECTED			
20	24/12	GW		20.0 21.0	dark brown, loose, wet, coarse SAND with medium GRAVEL, some large gravel, wet	-31.8 -32.8	SED-MC1550-A-20-21	
					NO CORE COLLECTED			
25				25.0		-36.8		

NOTES

(Continued Next Page)

BORING NUMBER SED-MC1550-A

PAGE 2 OF 2

CLIENT Gowanus Canal Remedial Design Group

PROJECT NAME Gowanus Canal Superfund

PROJECT NUMBER HPH106

PROJECT LOCATION Gowanus Brooklyn, NY

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	LABORATORY SAMPLES	COMMENTS
25	24/16.8	SP		25.2	grayish brown, loose, wet, medium to coarse SAND, some medium gravel	-37.0	SED-MC1550-A-25-26.4	
		SP		25.8	black, medium dense, wet, medium to coarse SAND, some medium gravel, heavily stained, strong odor, sheen, very sticky	-37.6		
		SP		26.0	black, medium dense, wet, fine SAND, some medium gravel, heavily stained, strong odor, sheen, very sticky	-37.8		
		SP		26.4	brown, medium dense, wet, fine to medium SAND, no staining, no odor	-38.2		
					NO CORE COLLECTED			
30	24/18			30.0		-41.8		
		SP		30.5	black, dense, wet, fine SAND, no staining, no odor	-42.3	SED-MC1550-A-30-31.5	
		SP		31.5	brown, dense, wet, fine to medium SAND, no staining, no odor	-43.3		
					NO CORE COLLECTED			
35	24/13.2			35.0		-46.8		
		SP		35.5	brown, dense, wet, medium to coarse SAND, no staining, no odor	-47.3	SED-MC1550-A-35-36.1	
		GW		36.1	brown, dense, wet, medium to coarse SAND with medium GRAVEL, no staining, no odor	-47.9		
					NO CORE COLLECTED			
40	24/15.6			40.0		-51.8		
		GW		40.7	brown, medium dense, wet, coarse SAND and medium to coarse GRAVEL	-52.5	SED-MC1550-A-40-41.3	
		SP		41.3	brown, dense, wet, fine SAND, little medium gravel, trace silt	-53.1		

Bottom of borehole at 42.0 feet.

45

50

BORING NUMBER SED-MC2100-A

CLIENT Gowanus Canal Remedial Design Group

PROJECT NAME Gowanus Canal Superfund

PROJECT NUMBER HPH106

PROJECT LOCATION Gowanus Brooklyn, NY

DATE STARTED 6/4/15 **COMPLETED** 6/5/15

MUDLINE ELEVATION -11.81 ft NAVD88

DRILLING CONTRACTOR Aquifer Drilling and Testing

BOREHOLE DIAMETER 4 inches

DRILLING METHOD Split Spoon

SAMPLER 3 in. Split Spoon

LOGGED BY AW **CHECKED BY** PS

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	LABORATORY SAMPLES	COMMENTS
0.0					NO CORE COLLECTED			
2.5								
5.0	24/24	OL		5.0	dark gray to black, soft, wet, little clay, slight staining	-16.8	SED-MC2100-A-6-7	Soft Sediments/ Native Alluvial Sediments Interface [Elevation of -17.01 ft NAVD88]; Blow Count: 7 [Elevation: -16.81 to -18.81 ft NAVD88]
		CL		5.2	dark gray, very stiff, damp CLAY, little silt, trace organic debris	-17.0		
		SP		6.1	dark brown, loose, wet, fine SAND, sheen, heavy staining, strong odor	-17.9		
		CL		6.2	dark gray, very stiff, damp CLAY, little silt, trace organic debris	-18.0		
		SP		6.3	dark brown, loose, wet, fine SAND, sheen, heavy staining, strong odor	-18.1		
		CL		6.4	dark gray, very stiff, damp CLAY, little silt, trace organic debris	-18.2		
		SP		6.6	dark brown, loose, wet, fine SAND, sheen, heavy staining, strong odor	-18.4		
7.5		CL		6.7	dark gray, very stiff, damp CLAY, little silt, trace organic debris	-18.5		
				7.0	NO CORE COLLECTED	-18.8		
10.0								
	24/24	CL-ML		12.0	black, very stiff, damp SILT with CLAY, sheen, staining, odor	-23.8	SED-MC2100-A-12-14	[Elevation: -23.81 to -25.81 ft NAVD88] Native Alluvial Sediments/ Glacial Deposits Interface [Elevation of -25.11 ft NAVD88]
12.5		CL		12.3	dark gray, very stiff, damp CLAY, some silt, staining, odor	-24.1		
		SP		13.3	dark brown, dense, wet, medium SAND, some silt, heavy staining, strong odor, trace medium gravel	-25.1		
		SP		13.7	brown, dense, wet, fine SAND, staining, odor	-25.5		
15.0				14.0	NO CORE COLLECTED	-25.8		
				16.0		-27.8		

NOTES

ENVIRONMENTAL BH - 3 - NO - PID2 - GEOSYNTECNJ_STD.GDT - 12/22/15 16:47 - T:\DATABASE\GINT\PROJECTS\HPH106 - GOWANUS\PD-7 SEDIMENT BORING LOGS.GPJ

BORING NUMBER SED-MC2100-A

PAGE 2 OF 2

CLIENT Gowanus Canal Remedial Design Group

PROJECT NAME Gowanus Canal Superfund

PROJECT NUMBER HPH106

PROJECT LOCATION Gowanus Brooklyn, NY

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	LABORATORY SAMPLES	COMMENTS
	24/20.4	SC		16.1	black, stiff, moist, CLAY with fine SAND, sheen, staining	-27.9	SED-MC2100-A-16-17.7	[Elevation: -27.81 to -29.81 ft NAVD88]
		SM		16.6	grayish brown, stiff, wet SILT with fine SAND, sheen	-28.4		
		CL		16.9	brown, hard, damp CLAY, sheen	-28.7		
		SP		17.0	dark brown, loose, wet, fine SAND, some silt, sheen	-28.8		
17.5		SP		17.7	brown to dark brown, loose, wet, fine SAND, some silt, sheen	-29.5		
	24/24	ML		18.2	brown, very soft, saturated SILT, some fine sand, sheen	-30.0		[Elevation: -29.81 to -31.81 ft NAVD88]
		SP		18.5	brown, medium dense, saturated, fine SAND, trace gravel	-30.3		
		SP		19.0	brown, medium dense, wet, fine SAND, trace medium gravel	-30.8		
		SP		19.6	brown, very dense, wet, fine SAND, trace medium gravel, slight staining	-31.4	SED-MC2100-A-19-20	
20.0		SP		19.7	greenish brown, dense, wet, fine SAND, heavy sheen	-31.5		
	24/24	SP		20.0	dark brown to black, medium dense, wet, fine to medium SAND	-31.8	SED-MC2100-A-20-22	[Elevation: -31.81 to -33.81 ft NAVD88]
		SP		20.6	black, medium dense, wet, medium SAND, some fine gravel, heavy staining, sheen, strong odor	-32.4		
		SP		21.6	black, dense, wet, fine SAND, some fine gravel, heavy staining, sheen, strong odor, large cobble at 21.2 ft	-33.4		
		SP		22.0	dark gray, dense, wet, fine SAND, sheen, no staining, no odor	-33.8		
22.5					NO CORE COLLECTED`			
25.0	24/19.2			25.0		-36.8		
		SP		25.2	dark gray, medium dense, wet, medium SAND, trace fine gravel, no staining, no odor	-37.0	SED-MC2100-A-25-26.6	[Elevation: -36.81 to -38.81 ft NAVD88]
		SP		26.3	black, very dense, wet, fine SAND, trace fine gravel, trace coarse sand, no staining, no odor	-38.1		
		GW		26.6	brown, medium dense, wet, coarse SAND with fine GRAVEL, little medium gravel, no staining, no odor	-38.4		
27.5					NO CORE COLLECTED			
30.0	24/15.6			30.0		-41.8		
		SP		30.3	dark brown, loose, wet, medium to coarse SAND, no staining, no odor	-42.1	SED-MC2100-A-30-31.3	[Elevation: -41.81 to -43.81 ft NAVD88]
		ML		30.4	black, stiff, wet SILT, no staining, no odor	-42.2		
		SP		31.1	brown, dense, wet, fine to medium SAND, no staining, no odor	-42.9		
		SP		31.3	light brown, dense, wet, fine to medium SAND, no staining, no odor	-43.1		
32.5					Bottom of borehole at 32.0 feet.			

Geosyntec consultants

BORING NUMBER SED-MC2400-A

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal Superfund
PROJECT NUMBER HPH106
PROJECT LOCATION Gowanus Brooklyn, NY
DATE STARTED 5/19/15 **COMPLETED** 5/19/15
MUDLINE ELEVATION -12.04 ft NAVD88
DRILLING CONTRACTOR Cascade
BOREHOLE DIAMETER 6 inches
DRILLING METHOD Sonic Drilling
SAMPLER 3.5 in. Sonic Core - Lexan Liner
LOGGED BY PS, LC **CHECKED BY** PS

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	LABORATORY SAMPLES	COMMENTS
0.0	60/48	OL		2.0	black, wet, very soft SILT, some clay, organic debris, hair, trash, lots of sheen, odor	-14.0		
		OL		2.2	black, wet, soft SILT and CLAY, organic debris, hair, trash, little sheen, odor	-14.2		
2.5		OL		2.7	black, wet, very soft, SILT, some clay, lots of organic debris, hair, trash, lots of sheen, odor	-14.7		Soft Sediments/ Native Alluvial Sediments Interface [Elevation of -14.74 ft NAVD88]
		CL		3.0	bluish gray, moist, medium stiff CLAY, some silt, little fine sand, trace root material, sheen is heavily concentrated in root traces	-15.0		
				4.0		-16.0	SED-MC2400-A-3-4	
5.0	60/60	CL		7.7	gray, wet, stiff CLAY, some silt, little fine sand, lots of sheen, sheen is concentrated in vertically oriented fine sand units, root/plant material found, very strong odor	-19.7		
7.5		ML		8.9	brownish gray, stiff, wet SILT, some fine sand, trace clay, plant material, lots of sheen concentrated in fine sand in horizontal and vertically oriented units, strong odor	-20.9		
		SP		9.6	brownish gray, wet, medium dense, fine SAND, little silt, plant material, very heavy sheen and brown staining, strong odor	-21.6		
10.0		CL-ML		10.0	gray, moist, stiff CLAY with SILT, some fine sand, some sheen concentrated in fine sand units, fine sand units are horizontal	-22.0		Native Alluvial Sediments/ Glacial Deposits Interface [Elevation of -22.04 ft NAVD88]
	60/60	SP		10.4	brown, wet, loose, fine SAND, little silt, trace gravel, some sheen, strong odor	-22.4		
		ML		12.0	brown, moist, stiff SILT, little clay, little fine sand, trace, medium sand, little sheen, odor	-24.0		
12.5				13.0		-25.0	SED-MC2400-A-12-13	
		ML		13.4	brown, moist, stiff SILT, little clay, little fine sand, trace, medium sand, little sheen, odor	-25.4		
		SP		13.9	brown, wet, medium dense, fine SAND, some silt, some medium sand, little staining, odor	-25.9		
15.0		SP		15.0	black with stratified brown units, wet, medium dense, fine SAND, some silt, little medium sand, heavy sheen /staining, strong odor	-27.0		

NOTES

(Continued Next Page)

BORING NUMBER SED-MC2400-A

PAGE 2 OF 2

CLIENT Gowanus Canal Remedial Design Group

PROJECT NAME Gowanus Canal Superfund

PROJECT NUMBER HPH106

PROJECT LOCATION Gowanus Brooklyn, NY

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	LABORATORY SAMPLES	COMMENTS
15.0	60/56	SP		16.1	dark gray and brown, wet, loose, fine SAND, some silt, little medium sand, heavy sheen/staining, very strong odor	-28.1		
		ML		16.7	brown, wet, medium stiff SILT, some fine sand, little clay, lot of sheen, strong odor	-28.7		
17.5		SM		17.7		-29.7	SED-MC2400-A-17-18	
				18.7		-30.7	SED-MC2400-A-18-19	
				19.7	greenish brown, from 18.7-18.8 and redish brown from 18.8-19.7, wet, medium stiff, SILT with fine SAND, generally finer texture upward, slight odor, little sheen	-31.7		
20.0	60/60	SW		21.0		-33.0	SED-MC2400-A-20-21	
22.5				24.0	brown with black staining, wet, medium dense, fine to medium SAND, some silt, macro pore structures, sheen, staining, and very strong odor	-36.0		
		SP		25.0		-37.0	SED-MC2400-A-24-25	
25.0	60/54			28.0	brown, medium dense, wet, fine to medium SAND, little silt, isolated pockets of sheen, odor	-40.0		
27.5				29.0		-41.0	SED-MC2400-A-28-29	
		SP		29.6	brown, medium dense, wet, fine to medium SAND, little silt, isolated pockets of sheen, odor	-41.6		
30.0								

Bottom of borehole at 30.0 feet.

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BORING NUMBER B-432_15-1019

PAGE 1 OF 3

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal PD-5 Phase 1
PROJECT NUMBER HPH106-17
PROJECT LOCATION Brooklyn, NY
DATE STARTED 7/15/15 2:30 pm **COMPLETED** 7/16/15 10:00 am
GROUND ELEVATION 8.59 ft. NAVD88 **HOLE SIZE** 6"
DRILLING CONTRACTOR Aquifer Drilling & Testing
COORDINATES N: 672878.8, E: 634173.0 NAD 83 NY EAST 3101
DRILLING EQUIPMENT XL Max 362 (FRASTE)
∇ **GWL AT TIME OF DRILLING DRILLING** 6.5 ft. bgs 7/16/15 7:00 am
DRILLING METHOD Sonic, ASTM D6914
GWL AT END OF DRILLING ---
LOGGED BY D. Woeste **CHECKED BY** P. Andonyadis
GWL AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
5	0 5		**SANDY GRAVEL** (GW) [FILL]: dark brown (10YR 4/2); small to large sized gravel; fine to coarse grained sand; trace asphalt and brick fragments; moist NOTE: Material description based on soft excavation completed on 7/15/15.		0/				0.0				
			∇ **SANDY SILT** (ML) [FILL]: brown (10YR 4/3); low plasticity; fine grained sand; medium stiff; wet [NYCBC class 7] Some small sized gravel from 7 to 10 ft.	SS 5-7	18/ 24	6-4-2-3 (6)			0.0	14.7	NP	NP	NP
0	10			SC 7-10	30/ 36				0.0	19.7			
			WELL GRADED GRAVEL (GW) [FILL]: brown (10YR 4/3); small sized gravel; some fine to coarse grained sand; trace silt; dense; wet [NYCBC class 7] Oxidation staining at 11 ft.	SS 10-12	16/ 24	21-19-20-13 (39)			0.0				
-5	15		**SANDY GRAVEL** (GW) [FILL]: brown (10YR 4/3); small to large sized rounded and subrounded gravel; fine to coarse grained sand; trace silt; wet	SC 12-15	14/ 36				0.0				
			Subtle sheen in Split Spoon sampler at 15 ft. Medium dense [NYCBC class 7]	SS 15-17	8/ 24	6-6-5-5 (11)			0.5				
-10	20		**POORLY GRADED SAND** (SP) [GLACIAL DEPOSITS]: dark gray (7.5YR 4/1); fine to medium grained sand; some coarse grained sand; trace small sized gravel; wet; sheen present	SC 17-20	24/ 36				7.4				
			SANDY GRAVEL (GW) [GLACIAL DEPOSITS]: dark gray (7.5YR 4/1): small to large sized subangular gravel; fine to coarse grained sand; sheen present; medium dense; wet; small pocket of silt [NYCBC class 2b]	SS 20-22	9/ 24	5-6-14-15 (20)			14.6				
-15	25		Same as above Sheen and slight staining present	SC 22-25	20/ 36								

(Continued Next Page)

BORING NUMBER B-432_15-1019

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal PD-5 Phase 1
PROJECT NUMBER HPH106-17
PROJECT LOCATION Brooklyn, NY

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		
											LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
	25		**SANDY GRAVEL** (GW) [GLACIAL DEPOSITS]: dark gray (7.5YR 4/1): small to large sized subangular gravel; fine to coarse grained sand; sheen present; medium dense; wet; small pocket of silt [NYCBC class 2b] *(continued)*	SS 25-27	11/ 24	12-13-7-4 (20)			40.4				
-20	30		Same as above without silt pocket Note: Casing dropped during driving of split spoon (approx. 6") **WELL GRADED SAND** (SW) [GLACIAL DEPOSITS]: dark gray (7.5YR 4/1): fine to coarse grained sand; some small to large sized gravel; sheen and odor present; wet	SC 27-30	24/ 36				43.3				
			POORLY GRADED GRAVEL (GP) [GLACIAL DEPOSITS]: dark gray (7.5YR 4/1); small sized subangular gravel; some medium to coarse grained gravel; little fine grained sand; medium dense; wet; sheen and odor present [NYCBC class 2b]	SS 30-32	11/ 24	6-9-8-5 (17)			14.8	9.3			
-25	35												
			No Recovery Angular rock in shoe	SS 35-37	0/24	24-10-10- 12 (20)							
-30	40												
			No Recovery **WELL GRADED SAND** (SW) [WASH] in shoe	SS 40-42	0/24	17-15-9-6 (24)							
-35	45												
			WELL GRADED SAND (SW) [GLACIAL DEPOSITS]: grayish brown (10YR 5/2): medium to coarse grained sand; some fine sand; little small sized gravel; trace large subangular gravel; medium dense; wet [NYCBC class 3b]	SS 45-47	7/ 24	17-7-3-3 (10)			0.0	15.2			
-40	50												
			No Recovery	SS 50-52	0/24	15-7-3-4 (10)							
			Thin layer of large sized subrounded gravel and small cobbles at 53 ft.	SC									

(Continued Next Page)

BORING NUMBER B-432_15-1019

PAGE 3 OF 3

CLIENT Gowanus Canal Remedial Design Group

PROJECT NAME Gowanus Canal PD-5 Phase 1

PROJECT NUMBER HPH106-17

PROJECT LOCATION Brooklyn, NY

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	ATTERBERG LIMITS PLASTIC LIMIT	ATTERBERG LIMITS PLASTICITY INDEX
-45	55		**WELL GRADED SAND** (SW) [GLACIAL DEPOSITS]: grayish brown (10YR 5/2): medium to coarse grained sand; some fine sand; little small sized gravel; trace large subangular gravel; medium dense; wet [NYCBC class 3b] *(continued)*	52-55	0/36				0.0	11.3			
				SS 55-57	9/ 24	8-6-7-6 (13)			0.0				
-50	60												
			POORLY GRADED GRAVEL (GP) [GLACIAL DEPOSITS]: dark gray (10YR 4/1): small to large sized subangular and subrounded gravel; little fine to coarse grained sand; medium dense; wet [NYCBC class 2b]	SS 60-62	7/ 24	17-10-12-15 (22)			0.0	8.7			
-55	65												
			POORLY GRADED GRAVEL (GP) [GLACIAL DEPOSITS]: gray (10YR 5/1); large sized subangular gravel; very dense; wet [NYCBC class 2a]	SS 65-67	1/ 6	50/6"			0.0				
-60	70												
			SANDY GRAVEL (GW) [GLACIAL DEPOSITS]: brown (10YR 4/3): small to large sized subrounded gravel; fine to medium grained sand; some coarse sand; trace fractured siltstone; red (10R 4/3) [NYCBC class 2b]	SS 70-72	10/ 24	24-13-8-13 (21)			0.0				
			Bottom of borehole at 72.0 ft.										
-65	75												
-70	80												

NOTE (1): PID readings with samples enclosed in jars. Breathing zone PID monitoring did not exceed 0 ppm.

NOTE (2): 7/16/15: Tremie grout hole with mixture: 376 lbs cement; 10 lbs bentonite; 35 gallons water.

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BORING NUMBER B-466_19-1061

PAGE 1 OF 3

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal PD-5 Phase 2
PROJECT NUMBER HPH106A
PROJECT LOCATION Brooklyn, NY
DATE STARTED 1/20/16 9:30 am **COMPLETED** 1/21/16 9:30 am
GROUND ELEVATION 7.45 ft. NAVD88 **HOLE SIZE** 3.5"
DRILLING CONTRACTOR Cascade Drilling
COORDINATES N: 633375.72, E: 671562.58 NAD 83 NY EAST 3101
DRILLING EQUIPMENT 100c mini-sonic (B&L)
GWL AT TIME OF DRILLING ---
DRILLING METHOD Sonic, ASTM D6914
GWL AT END OF DRILLING ---
LOGGED BY R. Fischer **CHECKED BY** P. Andonyadis
GWL AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
5	0		**CONCRETE** [FILL]	BULK 0-5	0/60				0.4				
	5		**SILTY SAND WITH GRAVEL** (SM) [FILL]: black (Gley 2 2.5/10G); fine to coarse sand; some concrete pieces; moist										
			Same as above. Grades to SAND (SP); brown (7.5YR 4/2); fine to medium; very loose; wet	SS 5-7	16/ 24	3-WOH-4-2			0.2				
0	10		Same as above. Little cobbles; timber and organics present; organic odor present	SC 7-10	36/ 36				7.3	13.6			
			Same as above. Trace brick; organic clay in shoe.	SS 10-12	6/ 24	1-1-1-9 (2)			19.2				
-5	15		**ORGANIC SILT** (OH) [NATIVE ALLUVIAL SEDIMENTS]: dark greenish gray (Gley 1 4/5GY); high plasticity; bedded with plant fiber; little brick; trace shells; wet; organic odor present	SC 12-15	36/ 36		0.5 0.75	0.3 0.3	0.3	54.8			
			Same as above	ST 15-17	27/ 24		0.5 0.5	0.3 0.3		69.8	82	39	43
-10			Same as above. Medium stiff.	SS 17-19	24/ 24	2-2-3-2 (5)			0.0	84.4			
	20		Same as above	SC 17-20	36/ 36				0.2				
			LEAN CLAY WITH SAND (CL) [NATIVE ALLUVIAL SEDIMENTS]: dark greenish gray (Gley 1 4/5GY); low plasticity; trace organics; mottling; stiff; wet	SS 20-22	24/ 24	3-4-9-10 (13)			0.0	21.2	26	14	12
-15	25		Same as above	SC 22-25	36/ 36		3.75 2.5	0.625 0.65	0.2	24.4	34	17	17

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BORING NUMBER B-466_19-1061

CLIENT Gowanus Canal Remedial Design Group

PROJECT NAME Gowanus Canal PD-5 Phase 2

PROJECT NUMBER HPH106A

PROJECT LOCATION Brooklyn, NY

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	ATTERBERG LIMITS PLASTIC LIMIT	ATTERBERG LIMITS PLASTICITY INDEX
	25	▨	**LEAN CLAY WITH SAND** (CL) [NATIVE ALLUVIAL SEDIMENTS]: dark greenish gray (Gley 1 4/5GY); low plasticity; trace organics; mottling; stiff; wet *(continued)*	ST 25-27	24/ 24					27.4	31	17	14
-20		░	**POORLY GRADED SAND** (SP) [GLACIAL DEPOSITS]; at bottom of tube; black (10YR 2/1); fine grained sand; staining and odor present; wet Same as above. Grades to very fine to fine sand; some clay; loose; wet	SS 27-29	24/ 24	2-2-6-7 (8)			31.2				
-25	30	░	* Note: Driller missed split spoon sample from 30 to 32 ft. Sonic core drilling straight down to 35 ft. bgs.										
	35	░	**POORLY GRADED SAND** (SP) [GLACIAL DEPOSITS]: brown (7.5YR 4/2); very fine to fine grained sand; trace clay; staining present; medium dense; wet	SS 35-37	12/ 24	6-7-10-7 (17)			6.6				
-30		░											
	40	░	**POORLY GRADED SAND** (SP) [GLACIAL DEPOSITS]: dark grayish brown (10YR 4/2); fine to medium grained sand; trace clay; trace coarse sand; very loose; wet	SS 40-42	3/ 24	4-3-WOH-1			1.9				
-35		░											
	45	░	No Recovery. Medium dense.	SS 45-47	0/24	6-10-13-16 (23)							
-40		░											
	50	░	No Recovery. Medium dense.	SS 50-52	0/24	7-8-9-10 (17)							
-45		░	**POORLY GRADED SAND** (SP) [GLACIAL DEPOSITS]: brown (7.5YR 4/2); very fine to fine grained sand										

(Continued Next Page)

BORING NUMBER B-466_19-1061

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal PD-5 Phase 2
PROJECT NUMBER HPH106A
PROJECT LOCATION Brooklyn, NY

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		
											LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
	55		**POORLY GRADED SAND** (SP) [GLACIAL DEPOSITS]: brown (7.5YR 4/2); very fine to fine grained sand *(continued)* 1" thick clay layer at 54.5 ft. bgs.	SC 52-55	36/ 34				4.1				
			Same as above. Trace clay; medium dense; wet	SS 55-57	8/ 24	7-6-5-10 (11)			0.6				
-50	60												
			SILTY SAND (SM): dark grayish brown (10YR 4/2); very fine to fine grained sand; loose; wet	SS 60-62	11/ 24	3-5-3-2 (8)			0.5				
-55	65												
			Same as above. Trace clay.	SS 65-67	18/ 24	4-3-4-6 (7)			0.4				
-60	70												
			Same as above. Medium dense.	SS 70-72	20/ 24	6-6-9-10 (15)			0.3	24.2			
-65	75		Bottom of borehole at 72 ft. bgs NOTE (1): PID readings with samples enclosed in jars. Breathing zone PID monitoring did not exceed 0 ppm. NOTE (2): Borehole abandonment: Tremie grout hole with mixture: 1600 lbs cement; 60 lbs bentonite; 100 gallons water.										
-70	80												

Geosyntec consultants
Beech and Bonaparte engineering p.c.
an affiliate of Geosyntec Consultants

BORING NUMBER B-466_19-0060

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal PD-5 Phase 2
PROJECT NUMBER HPH106A
PROJECT LOCATION Brooklyn, NY
DATE STARTED 1/15/16 12:00 pm **COMPLETED** 1/19/16 9:30 am
GROUND ELEVATION 7.74 ft. NAVD88 **HOLE SIZE** 7"
DRILLING CONTRACTOR Cascade Drilling
COORDINATES N: 633397.98, E: 671540.01 NAD 83 NY EAST 3101
DRILLING EQUIPMENT 100c mini-sonic (B&L)
GWL AT TIME OF DRILLING ---
DRILLING METHOD Sonic, ASTM D6914
GWL AT END OF DRILLING ---
LOGGED BY R. Fischer **CHECKED BY** P. Andonyadis
GWL AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		
											LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
5	0		**CONCRETE** [FILL]	BULK 0-5					0.0				
	5		No Recovery	SS 5-7	0/3	70/3"							
0			**POORLY GRADED GRAVEL WITH SILT AND SAND** (GP-GM) [FILL]: black (5Y 2.5/1); wet; strong organic odor Wood at 9.5 ft.	SC 7-10	36/ 36				0.6	18.1			
	10		**SILT** (ML) [FILL]: dark gray (5Y 4/1): low plasticity; some subangular gravel; little timber bulkhead; loose; wet; organic odor present	SS 10-12	4/ 24	4-3-6-4 (9)			0.4				
-5			Same as above. Cobbles.	SC 12-15	6/ 36				1.0				
	15		Same as above. Trace brick. Becomes very loose.	SS 15-17	6/ 24	2-3-1-12 (4)			0.4				
-10			Same as above. Some cobbles. No recoverable-sized samples.	SC 17-20	3/ 36								
	20		**TIMBER** (bulkhead): black (5Y 2.5/1); wet; organic odor present	SS 20-22	4/ 24	16-8-6-7 (14)			279.2				
-15	25		Same as above. Decaying timber; odor present. **LEAN CLAY** (CL) [NATIVE ALLUVIAL SEDIMENTS]: dark gray (Gley 1 4/N); low plasticity; stiff; wet	SC 22-25	36/ 36		1.75 1.25	0.6 0.6	0.6				

(Continued Next Page)

BORING NUMBER B-466_19-0060

CLIENT Gowanus Canal Remedial Design Group

PROJECT NAME Gowanus Canal PD-5 Phase 2

PROJECT NUMBER HPH106A

PROJECT LOCATION Brooklyn, NY

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		
											LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
	25		**LEAN CLAY** (CL) [NATIVE ALLUVIAL SEDIMENTS]: dark gray (Gley 1 4/N); low plasticity; stiff; wet *(continued)* No Recovery.	ST 25-27	0/24								
-20			Same as above **POORLY GRADED SAND** (SP) [GLACIAL DEPOSITS]: very dark gray (2.5Y 3/1); fine to very fine grained sand; little clay; loose; wet; staining and odor present; clean out to 30 ft. bgs.	SC 25-30 SS 27-29	60/ 60 24/ 24	4-3-5-4 (8)			23.2				
	30												
			Same as above	SS 30-32	16/ 24	5-4-4-6 (8)			23.2				
-25	35		Same as above. Trace gravel. **POORLY GRADED SAND** (SP) [GLACIAL DEPOSITS]: brown (7.5YR 4/2); very fine to fine grained sand; little clay; wet; staining present	SC 32-35	36/ 36				23.5				
			SILT WITH SAND (ML) [GLACIAL DEPOSITS]: brown (7.5 YR 4/2); non-plastic; very fine to fine grained sand; laminated with little clay; dense; wet; staining and mottling present	SS 35-37	14/ 24	13-18-20-12 (38)			4.7	20.3	NP	NP	
-30	40		Same as above. Little medium grained sand; trace gravel.	SC 37-40	36/ 36				4.4	20.0			
			No Recovery. Medium dense.	SS 40-42	0/24	2-2-20-30 (22)							
-35	45		**POORLY GRADED SAND** (SP) [GLACIAL DEPOSITS]: brown (7.5YR 4/2); fine grained sand; some medium to coarse sand; wet; no visible staining	SC 42-45	36/ 36				0.9				
			No Recovery. Loose.	SS 45-47	0/24	2-3-7-7 (10)							
-40	50		No Recovery	SC 47-50	0/36								
			POORLY GRADED SAND WITH SILT (SP-SM) [GLACIAL DEPOSITS]: brown (7.5YR 4/2); fine grained sand; very dense; wet; staining present	SS 50-52	14/ 24	18-36-26-30 (62)			1.7	20.4			
-45													

(Continued Next Page)

BORING NUMBER B-466_19-0060

PAGE 3 OF 3

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal PD-5 Phase 2
PROJECT NUMBER HPH106A
PROJECT LOCATION Brooklyn, NY

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		
											LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
	55		Same as above. 1.5 ft. layer of staining and odor present. **<u>POORLY GRADED SAND WITH SILT</u>** (SP-SM) [GLACIAL DEPOSITS]: brown (7.5YR 4/2); fine grained sand; very dense; wet; staining present *(continued)*	SC 52-55	36/ 36				71.2				
			Same as above. Medium dense.	SS 55-57	21/ 24	3-6-7-5 (13)			7.5				
-50	60		Same as above. Trace layers of clayey sand.	SC 57-60	36/ 36				0.9				
			Same as above. Medium dense.	SS 60-62	10/ 24	3-8-8-12 (16)			1.0				
-55	65		Same as above	SC 62-65	36/ 36				0.0				
			Same as above. Loose. 1" layer of clay at 65.5 ft.; dark greenish gray (Gley 2 4/1); high plasticity; medium stiff; wet	SS 65-67	19/ 24	1-3-3-2 (6)			0.2				
-60	70		Same as above	SC 67-70	24/ 36				0.1				
			Same as above. Very loose.	SS 70-72	16/ 24	1-WOH-2-3			0.2				
-65 -70	75 80		Bottom of borehole at 72 ft. bgs										

NOTE (1): PID readings with samples enclosed in jars. Breathing zone PID monitoring did not exceed 0 ppm.

NOTE (2): Set 70 ft. long 3"-ID Schedule 40 PVC casing to bottom of hole with grout mixture: 1200 lbs cement; 45 lbs bentonite; 75 gallons water.

Geosyntec consultants

BORING NUMBER SED-MC0850-A

CLIENT Gowanus Canal Remedial Design Group

PROJECT NAME Gowanus Canal Superfund

PROJECT NUMBER HPH106

PROJECT LOCATION Gowanus Brooklyn, NY

DATE STARTED 9/21/15 **COMPLETED** 9/21/15

MUDLINE ELEVATION -8.2 ft NAVD88

DRILLING CONTRACTOR Cascade

BOREHOLE DIAMETER 6 inches

DRILLING METHOD Sonic Rig

SAMPLER 3.5 in. Sonic Core - Lexan Liner

LOGGED BY JC **CHECKED BY** DWT

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	PID (ppm)	LABORATORY SAMPLES	COMMENTS
0.0	60/18	ML		1.5	black, very soft, wet SILT, some organic debris, odor, slight sheen	-9.7	0 0.9 0 0		
2.5				5.0		-13.2			
5.0	60/30	ML		7.3	black, very soft, wet SILT, some organic debris, odor, slight sheen	-15.5	1 1.4 1.9 2.7 4.3		
7.5		SP		7.5	grayish brown, loose, wet, fine to medium SAND, little silt, staining and sheen	-15.7	86.4		Soft Sediments/ Native Alluvial Sediments Interface [Elevation of -15.5 ft NAVD88]
		SP			grayish brown, loose, wet, fine to medium SAND, little silt, staining and sheen				
10.0									

NOTES No recovery from 12-17 ft - team mob to SED-MC0850-A1 for continuous coring

(Continued Next Page)

BORING NUMBER SED-MC0850-A

PAGE 2 OF 2

CLIENT Gowanus Canal Remedial Design Group

PROJECT NAME Gowanus Canal Superfund

PROJECT NUMBER HPH106

PROJECT LOCATION Gowanus Brooklyn, NY

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	PID (ppm)	LABORATORY SAMPLES	COMMENTS
10.0	24/18	SP	░	10.7	grayish brown, loose, wet, fine to medium SAND, little silt, staining and sheen *(continued)*	-18.9	6.7 234.4		
		SP	░	11.5	grayish brown, loose, wet, medium SAND, little silt, staining and sheen	-19.7	264.2 278.8		
	60/0								
12.5									
15.0									

Bottom of borehole at 17 feet

17.5

20.0

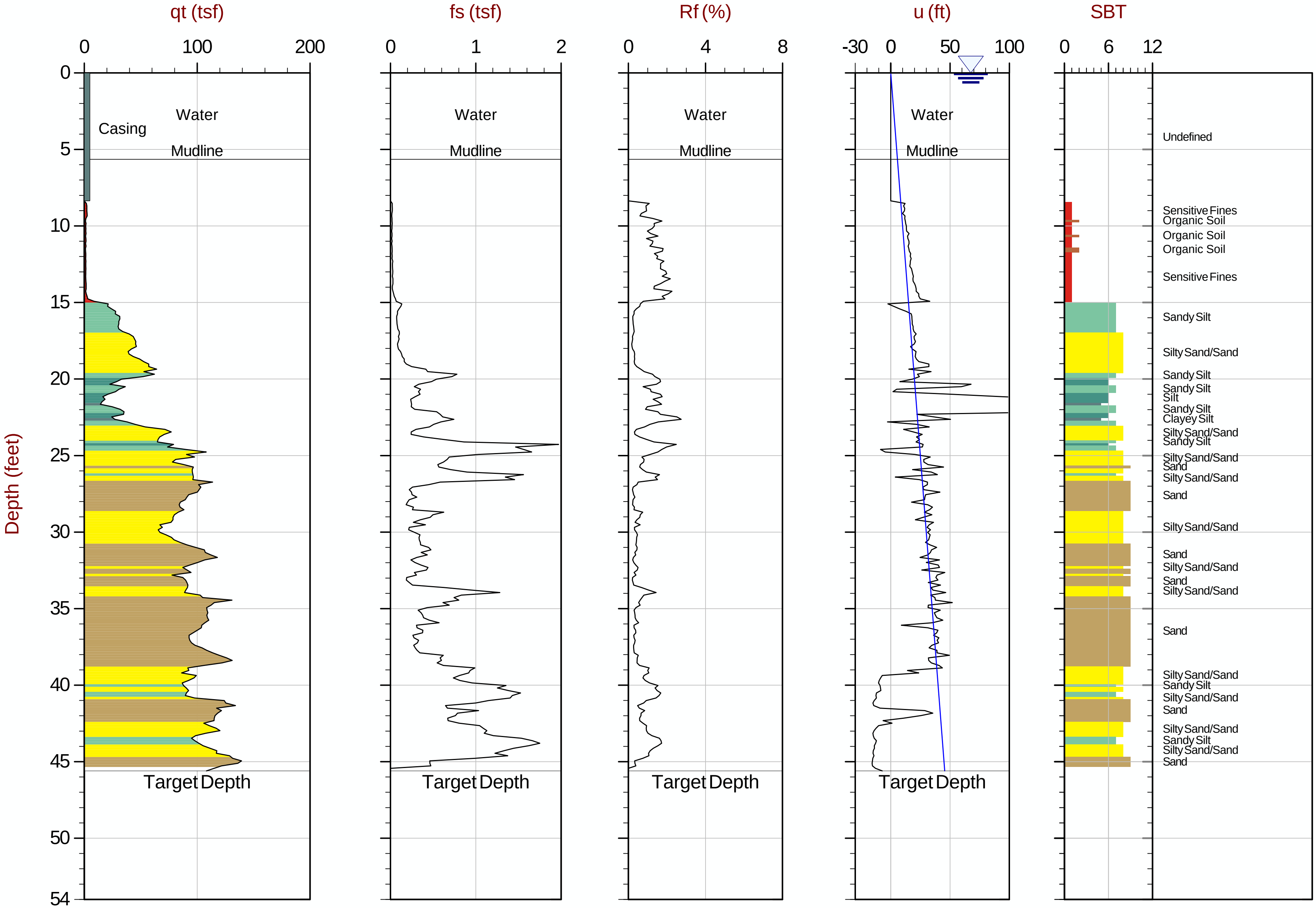
Preliminary Working Draft Document Subject to Change. Full Technical Review Not Yet Complete.

ENVIRONMENTAL BH - ALL - SED - GEOSYNTECNJ_STD.GDT - 10/5/16 10:20 - T:\DATABASE\GINT\PROJECTS\HPH106 - GOWANUS\PD-8 SEDIMENT BORING LOGS.GPJ

Geosyntec Consultants

Job No: 15-53060
Date: 08:24:15 10:41
Site: Gowanus Canal

Sounding: LIF-MC0900-A
Cone: 236:T1500F15U500



Max Depth: 13.900 m / 45.60 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53060_LIFCPTMC0900-A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 18 N: 4503687m E: 585501m

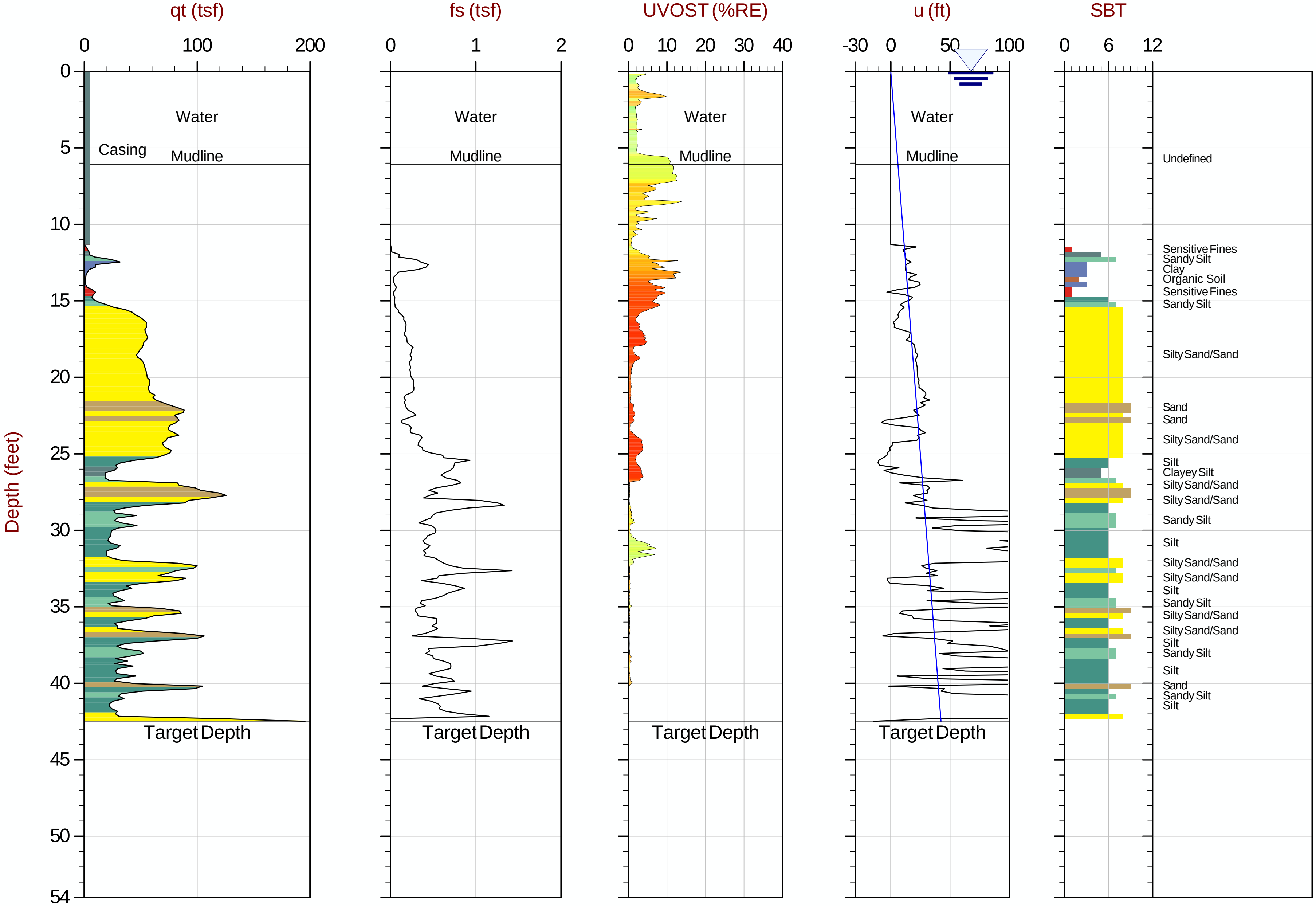
Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Geosyntec Consultants

Job No: 15-53060
Date: 08:14:15 13:15
Site: Gowanus Canal

Sounding: LIF-MC1000-A
Cone: 406:T1500F15U500



Max Depth: 12.950 m / 42.49 ft
Depth Inc: 0.050 m / 0.164 ft

File: 15-53060_LIFCPTMC1000-A.COR

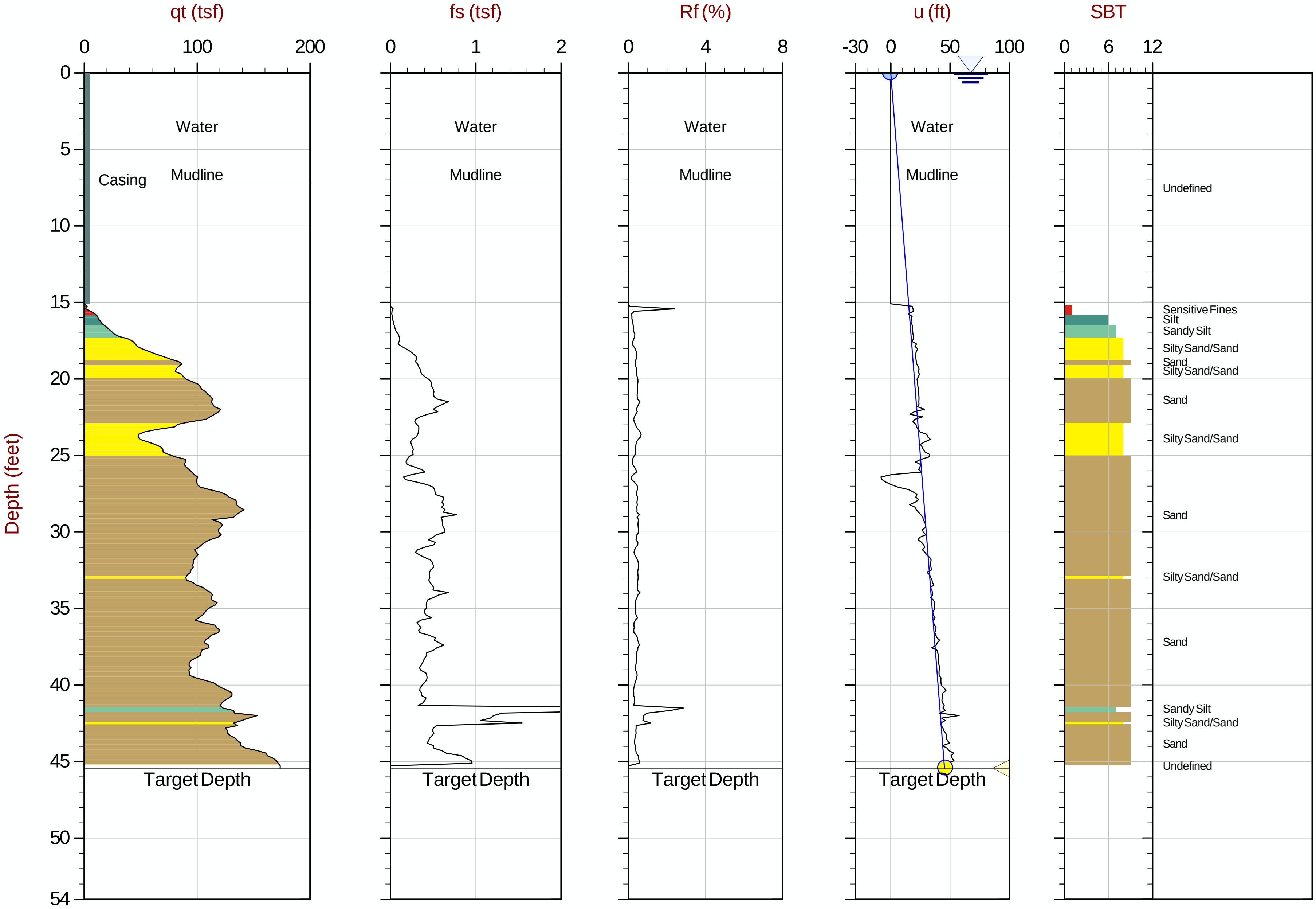
SBT: Robertson and Campanella, 1986
Coords: UTM Zone 18 N: 4503652m E: 585479m

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Geosyntec Consultants

Job No: 15-53060
Date: 08:12:15 15:19
Site: Gowanus Canal

Sounding: LIF-MC1350-A
Cone: 406:T1500F15U500



Max Depth: 13.850 m / 45.44 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53060_LIFCPTMC1350-A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 18 N: 4503503m E: 585416m

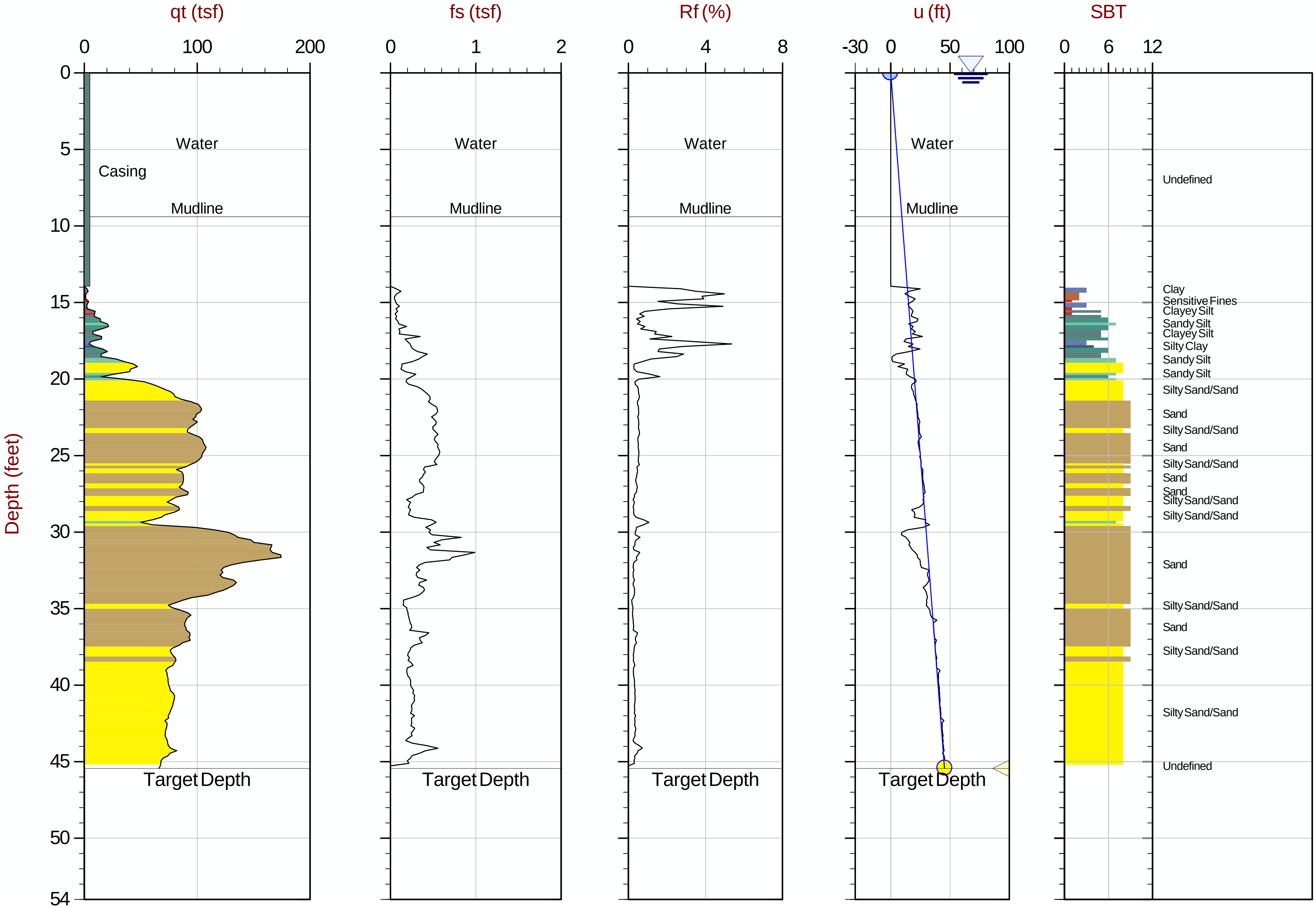
Hydrostatic Line ○ Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Geosyntec Consultants

Job No: 15-53060
Date: 08:13:15 09:12
Site: Gowanus Canal

Sounding: LIF-MC1350-B
Cone: 406:T1500F15U500



Max Depth: 13.850 m / 45.44 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53060_LIFCPTMC1350-B.COR

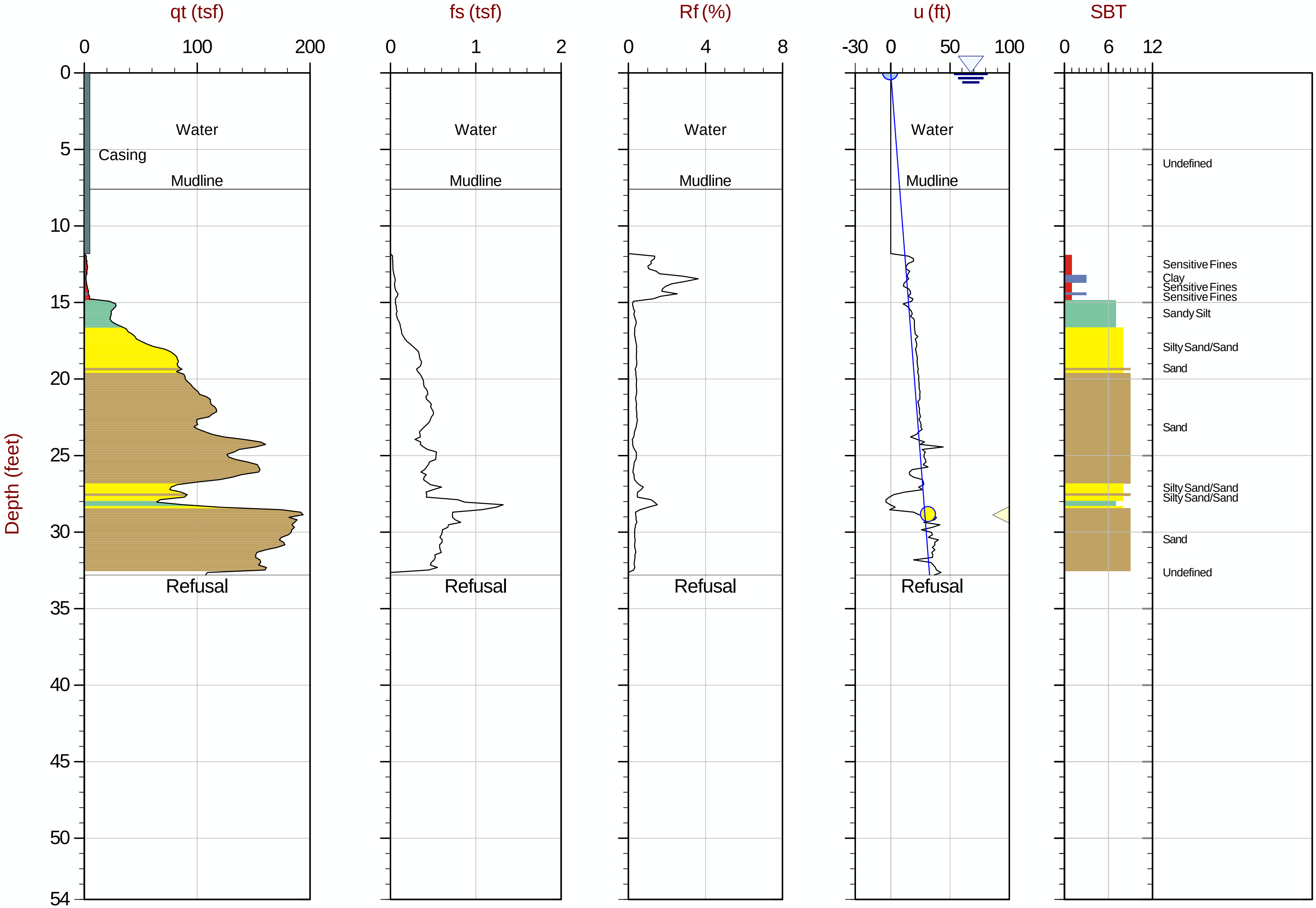
SBT: Robertson and Campanella, 1986
Coords: UTM Zone 18 N: 4503548m E: 585439m

Hydrostatic Line ○ Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Geosyntec Consultants

Job No: 15-53060
Date: 08:25:15 10:34
Site: Gowanus Canal
Sounding: LIF-MC1400-A
Cone: 236:T1500F15U500



Max Depth: 10.000 m / 32.81 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53060_LIFCPTMC1400-A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 18 N: 4503541m E: 585429m

Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved

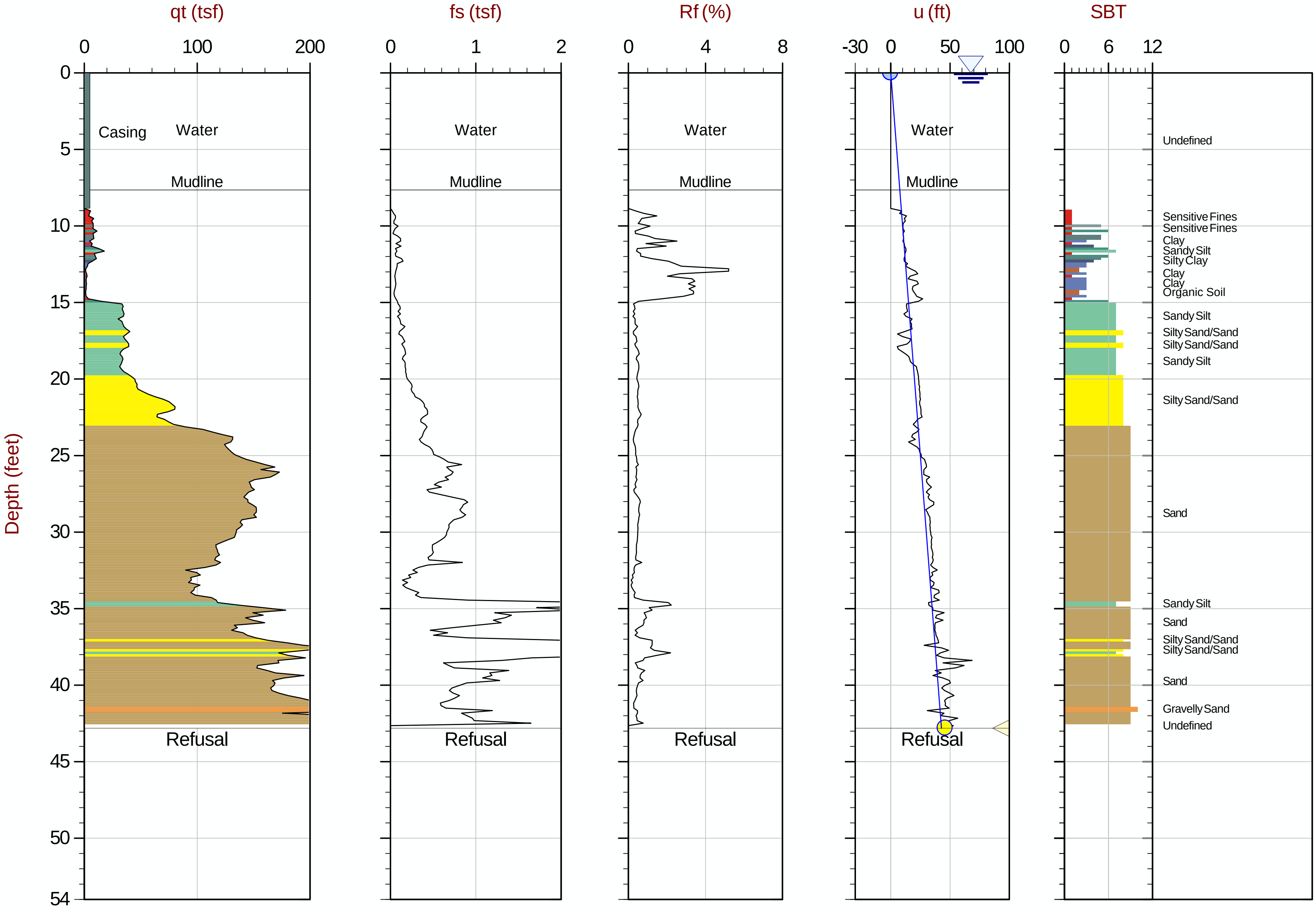
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Geosyntec Consultants

Job No: 15-53060
Date: 08:12:15 13:43
Site: Gowanus Canal

Sounding: LIF-MC1500-A
Cone: 406:T1500F15U500



Max Depth: 13.050 m / 42.81 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53060_LIFCPTMC1500-A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 18 N: 4503503m E: 585416m

Hydrostatic Line ○ Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved

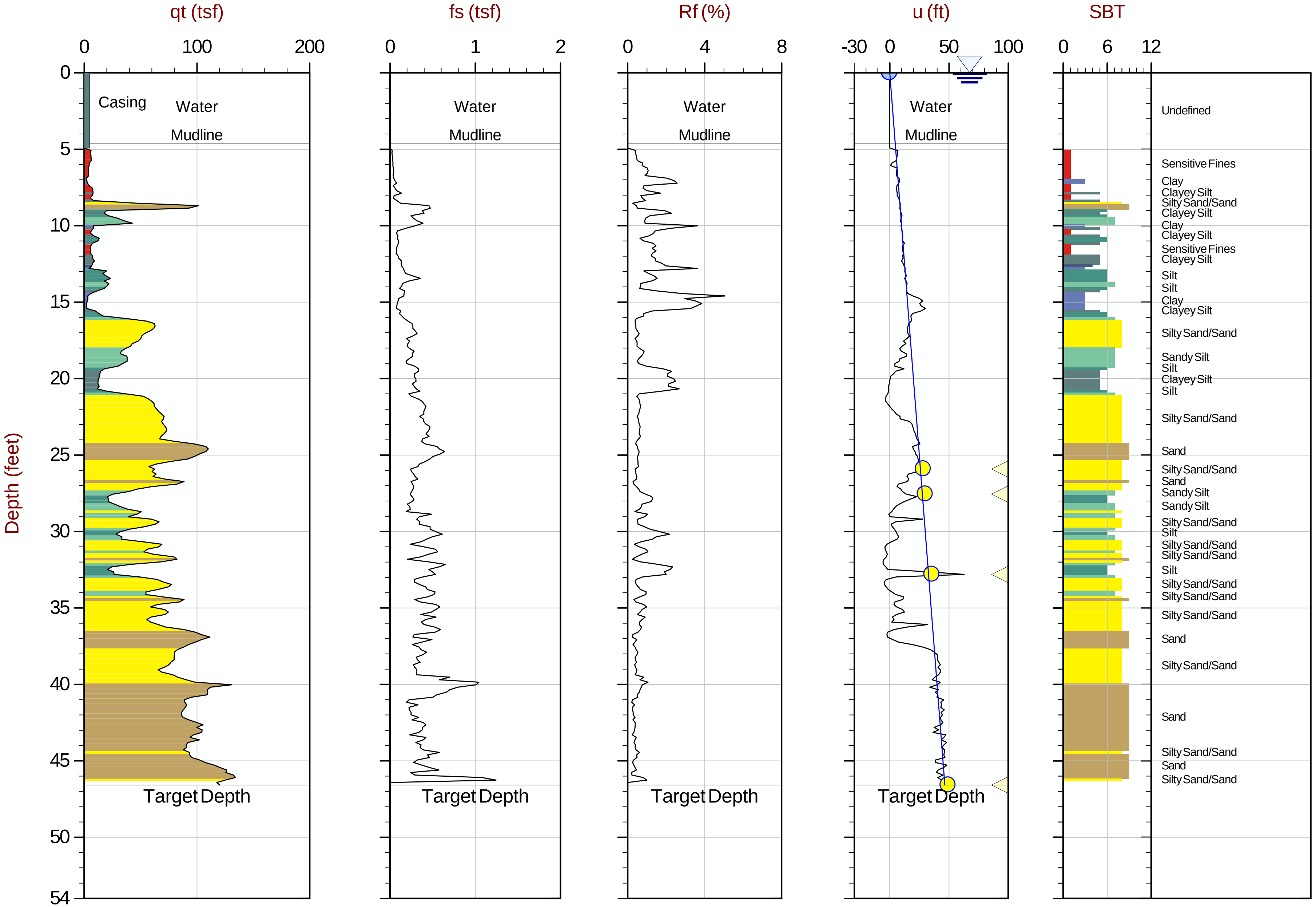
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Geosyntec Consultants

Job No: 15-53060
Date: 08:12:15 11:31
Site: Gowanus Canal

Sounding: LIF-MC1500-B
Cone: 406:T1500F15U500



Max Depth: 14.200 m / 46.59 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53060_LIFCPTMC1500-B.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 18 N: 4503505m E: 585432m

— Hydrostatic Line ○ Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved

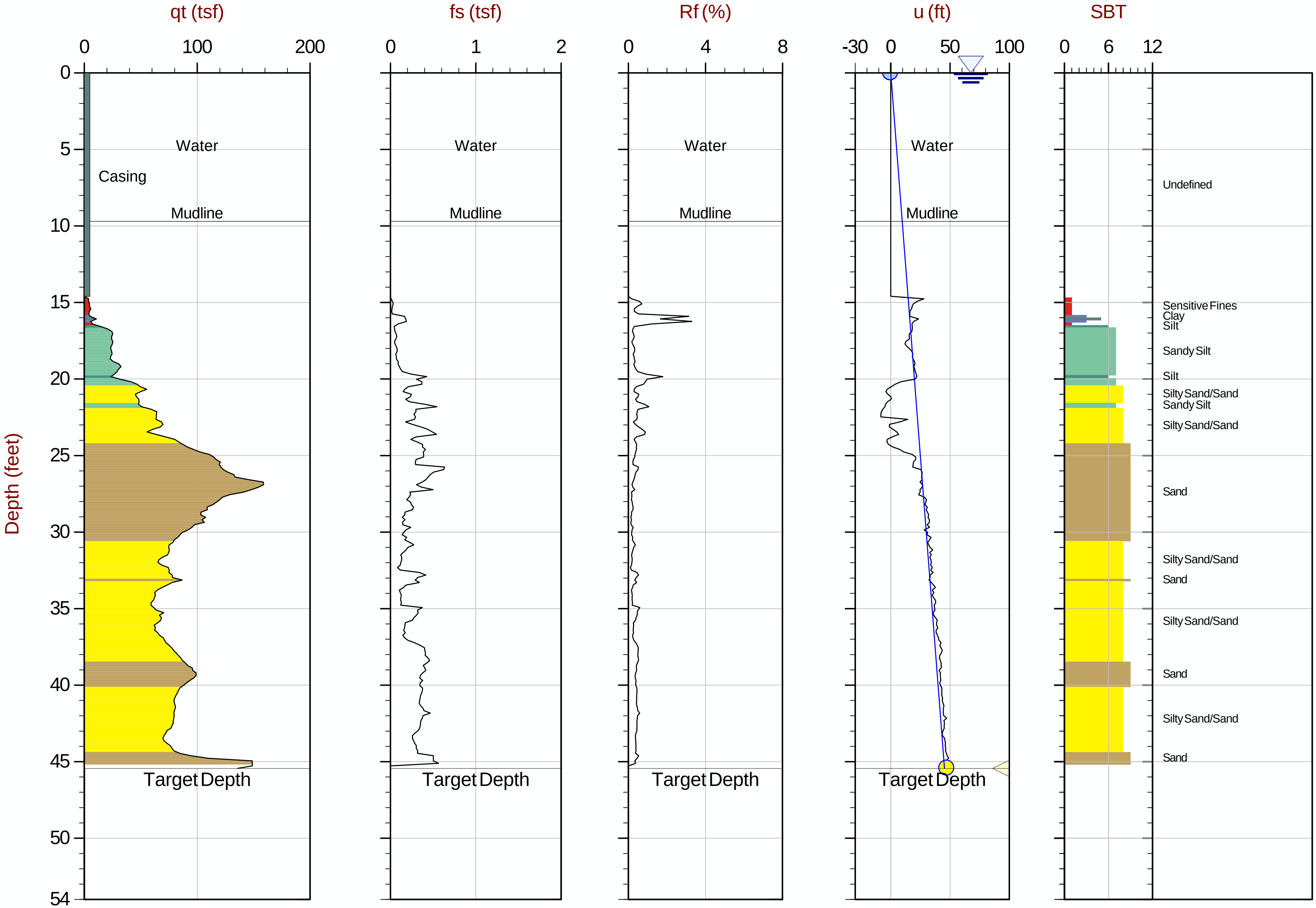
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Geosyntec Consultants

Job No: 15-53060
Date: 08:12:15 10:15
Site: Gowanus Canal

Sounding: LIF-MC1550-A
Cone: 406:T1500F15U500



Max Depth: 13.850 m / 45.44 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53060_LIFCPTMC1550-A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 18 N: 4503487m E: 585425m

Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved

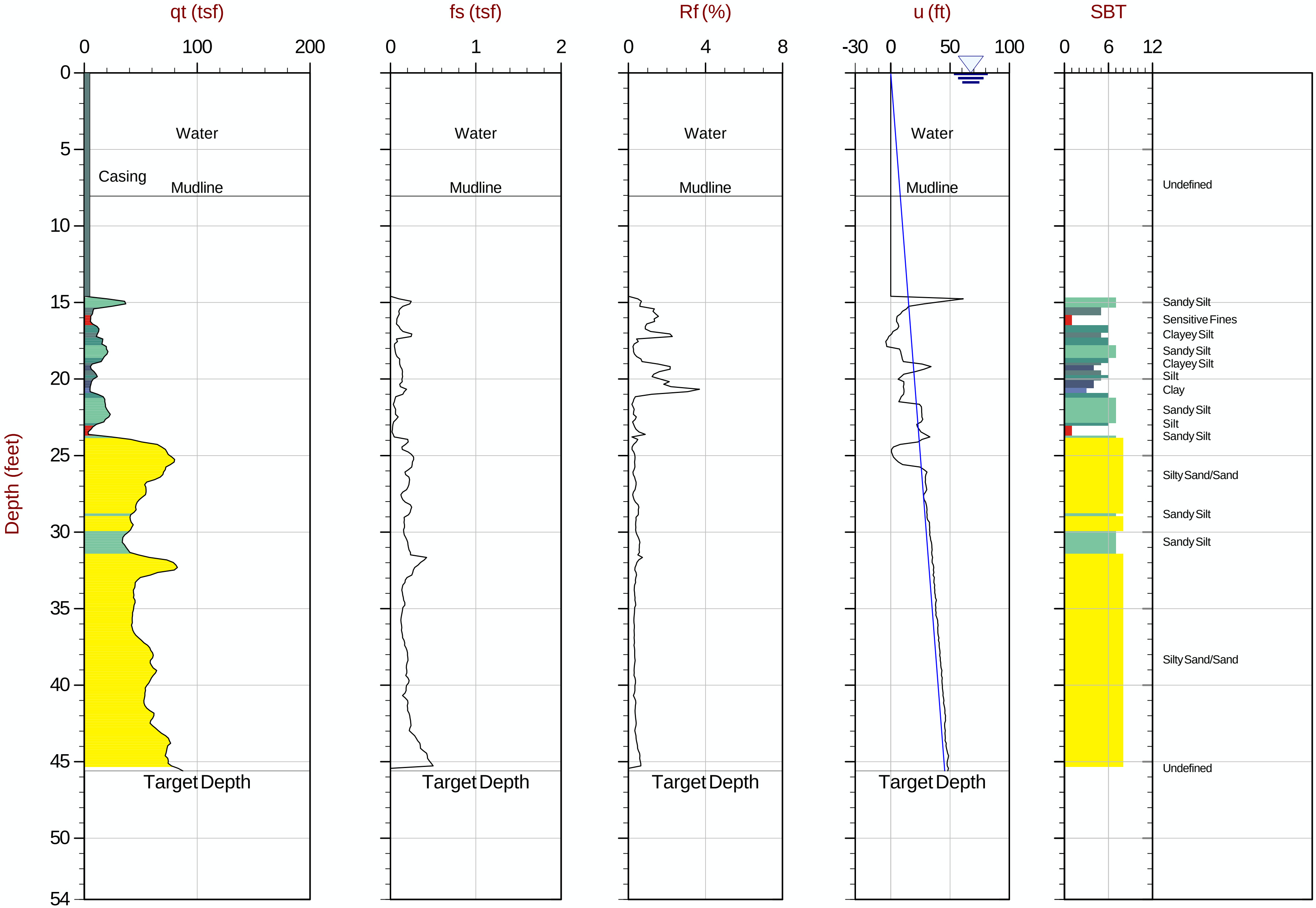
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Geosyntec Consultants

Job No: 15-53060
Date: 07:30:15 14:35
Site: Gowanus Canal

Sounding: LIF-MC2150-A
Cone: 406:T1500F15U500



Max Depth: 13.900 m / 45.60 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53060_LIFCPTMC2150-A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 18 N: 4503327m E: 585358m

— Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved

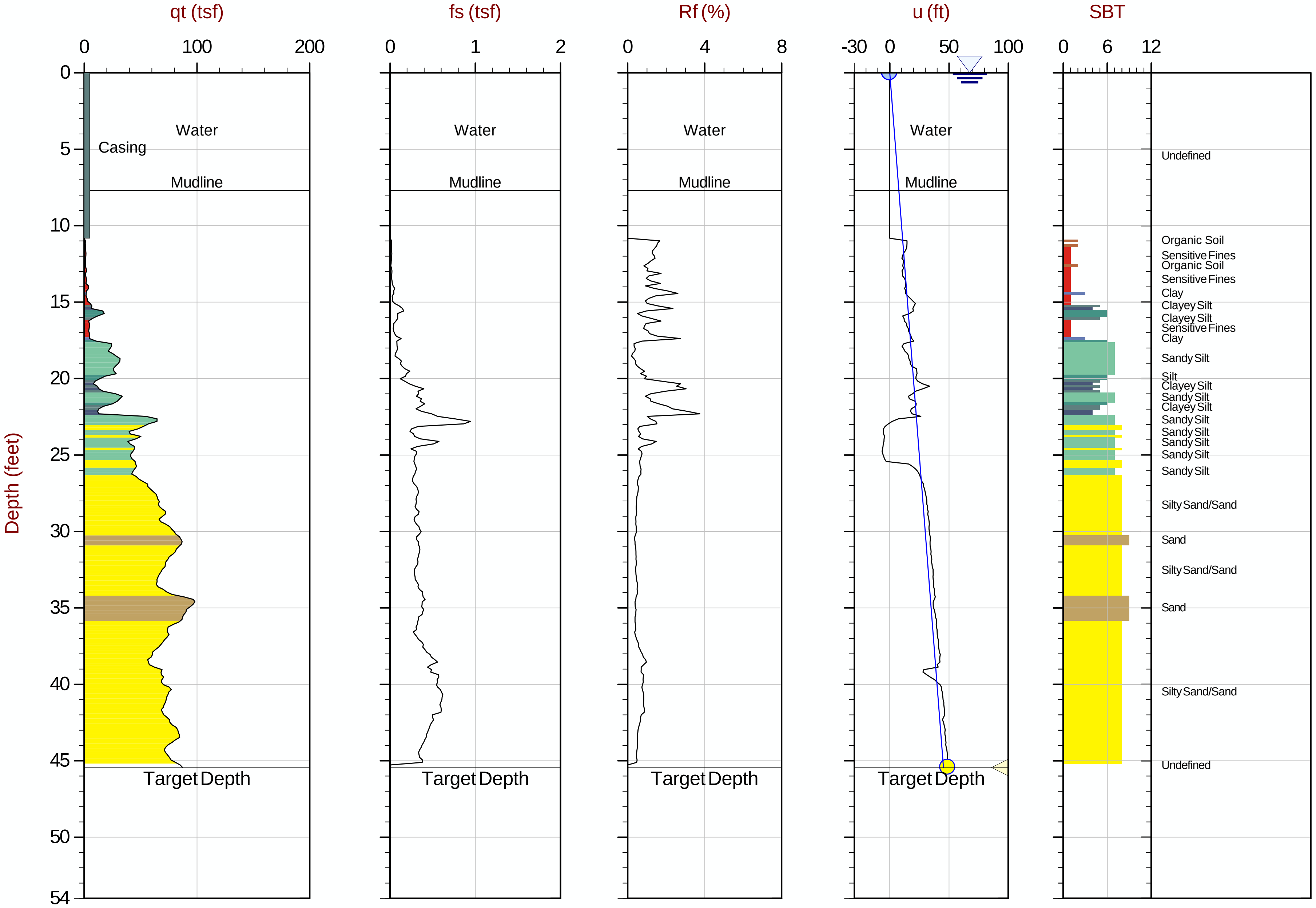
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Geosyntec Consultants

Job No: 15-53060
Date: 07:30:15 13:28
Site: Gowanus Canal

Sounding: LIF-MC2250-A
Cone: 406:T1500F15U500



Max Depth: 13.850 m / 45.44 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53060_LIFCPTMC2250-A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 18 N: 4503315m E: 585395m

— Hydrostatic Line ○ Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

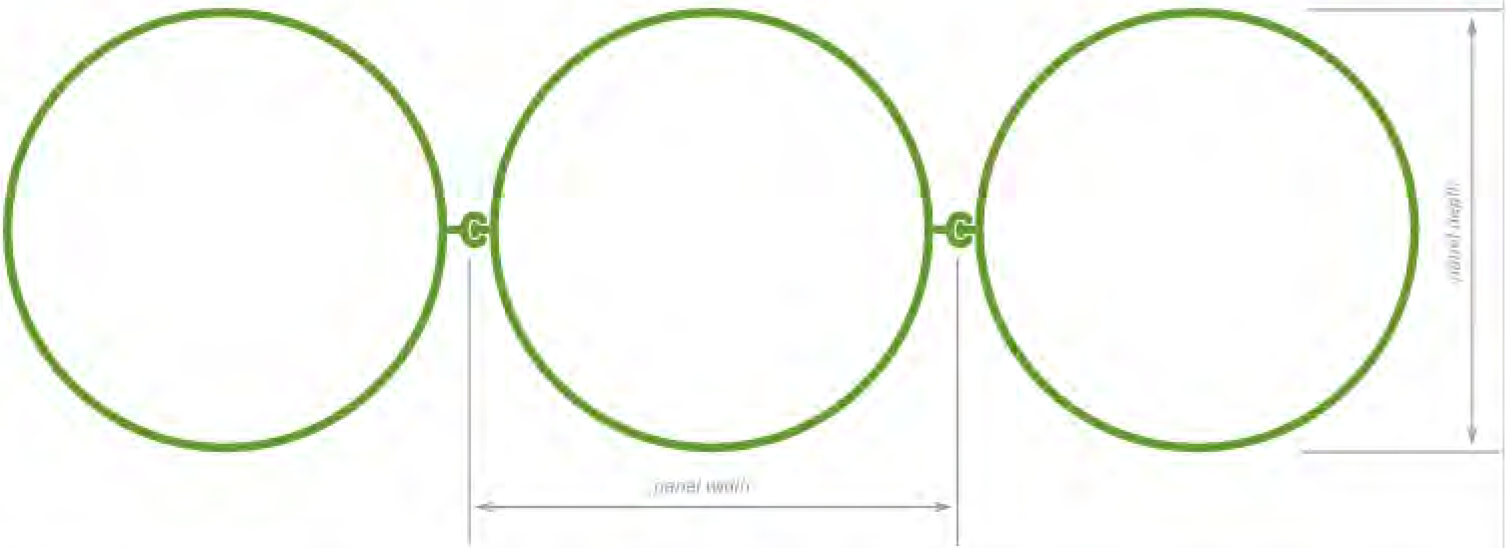
APPENDIX B – O-PILE DATA SHEET

O-Pile

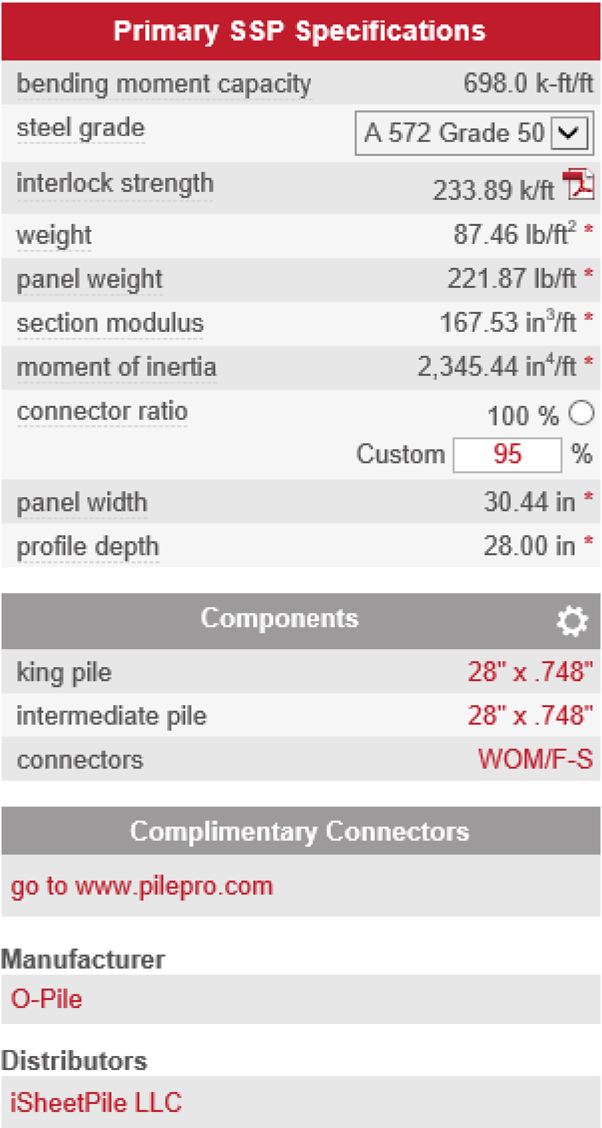
Product ID

O-Pile 3105 (50ksi_28"_.748"_WOM-S/WOF-S/2.4"@.5")

Available steel grade options: A 252 Grade 1 | A 252 Grade 2 | A 252 Grade 3 | A 572 Grade 50 | A 572 Grade 55 | A 572 Grade 60 | A 572 Grade 65 | x70 | x80



Build a wall using O-Pile 4323 (70ksi_28"_.748"_WOM-S/WOF-S/2.4"@.5"):



Primary SSP Specifications

bending moment capacity	698.0 k-ft/ft
steel grade	A 572 Grade 50 ⌄
interlock strength	233.89 k/ft
weight	87.46 lb/ft² *
panel weight	221.87 lb/ft *
section modulus	167.53 in³/ft *
moment of inertia	2,345.44 in⁴/ft *
connector ratio	100 % ○ Custom 95 %
panel width	30.44 in *
profile depth	28.00 in *

Components

king pile	28" x .748"
intermediate pile	28" x .748"
connectors	WOM/F-S

Complimentary Connectors

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APPENDIX C – PAGES FROM SUMMARY OF GEOTECHNICAL DESIGN PARAMETERS BY GEOSYNTEC CONSULTANTS

200 100 0 200 Feet

Legend

- ■ CPT Location
- ☐ Gowanus Canal
- ▨ RTA1
- ▨ RTA2
- ▨ RTA3A
- ▨ RTA3B

Locations of CPTs in RTA1 and TB4 From the Geosyntec PD-8 (2015c) Investigation Report

Gowanus Canal Superfund Site, Brooklyn, NY

Gowanus Canal Remedial Design Group

Geosyntec consultants

Beech and Bonaparte engineering p.c.

Ewing, NJ

August 2016

Figure 5a

X:\03_GIS\mxd\geotech\geotech_parameters_report\Figure05a_CPT_Borings_Locations_PD-8.mxd; 5/19/2016

Table 1d. Geosyntec (2015c) PD-8 CPT Locations

Location	CPT Name	As Built Northing	As Built Easting	Elevation Mudline/Ground (ft)	Elevation of Soft-Native Interface (ft)	Elevation of Native-Glacial Interface (ft)
RTA2 and TB7	15-53013_LIFCPT000-A	671270.91	631999.42	-14.31	-24.01	-26.91
	15-53013_LIFCPT000-B	671217.54	632037.94	-13.18	-23.28	-26.63
	15-53013_LIFCPT000-C	671244.36	632062.31	-12.90	-23.00	-25.30
	15-53013_LIFCPT025-A	671241.01	631999.15	-14.83	-18.43	-25.03
	15-53013_LIFCPT075-A1	671208.06	632074.85	-7.03	-18.03	-22.93
	15-53013_LIFCPT075-B	671248.88	632112.94	-6.67	-21.67	-24.17
	15-53013_LIFCPT075-C	671230.68	632093.58	-6.51	-26.51	-27.01
	15-53013_LIFCPT110-A	671199.72	632124.58	-5.42	-19.42	-21.47
	15-53013_LIFCPT110-B	671223.73	632139.57	-6.00	-23.00	-26.00
	15-53013_LIFCPT110-C	671204.69	632103.67	-5.50	-17.40	-19.20
	15-53013_LIFCPT145-A	671177.10	632144.17	-5.35	-15.15	-18.10
	15-53013_LIFCPT145-B	671200.50	632170.23	-6.74	-22.34	-27.64
	15-53013_LIFCPT145-C	671182.96	632190.27	-6.98	-23.98	-26.48
	15-53013_LIFCPT170-A1	671168.31	632180.15	-7.05	-20.20	-26.45
	15-53013_LIFCPT200-A	671154.44	632209.29	-7.01	-22.46	-24.46
	15-53013_LIFCPT200-C	671171.90	632230.04	-8.26	-21.56	-27.56
	15-53013_LIFCPT400-A	671605.68	632473.53	-14.80	-17.10	-21.40
	15-53013_LIFCPT400-B1	671564.02	632461.03	-14.01	-19.91	-24.81
	15-53013_LIFCPT450-A	671580.80	632432.90	-15.21	-21.81	-25.11
	15-53013_LIFCPT500-A	671582.11	632388.71	-14.94	-18.24	-23.22
	15-53013_LIFCPT500-B	671536.96	632412.67	-13.86	-22.66	-24.51
	15-53013_LIFCPT550-A	671540.17	632370.55	-16.00	-21.00	-25.50
	15-53013_LIFCPT600-A	671576.68	632340.95	-13.92	-20.52	-22.72
	15-53013_LIFCPT600-B	671497.13	632342.55	-14.95	-20.55	-24.75
	15-53013_LIFCPT700-A	671479.94	632174.56	-14.61	-22.01	-25.31
	15-53013_LIFCPT700-B1	671426.07	632193.54	-14.49	-22.59	-26.54
	15-53013_LIFCPT750-B1	671450.08	632138.07	-14.85	-19.25	-23.35
	15-53013_LIFCPT800-A	671418.21	632114.23	-15.44	-21.49	-25.44
	15-53013_LIFCPT800-B	671375.97	632159.66	-13.07	-18.37	-23.47
	15-53013_LIFCPT850-A	671365.59	632105.32	-17.44	-23.84	-25.54
	15-53013_LIFCPT850-B	671384.00	632082.20	-14.21	-23.11	-25.51
	15-53013_LIFCPT900-A	671344.71	632047.97	-14.22	-23.22	-24.97
	15-53013_LIFCPT900-B	671314.45	632100.96	-16.90	-21.00	-23.80
	15-53013_LIFCPT950-A	671287.64	632046.84	-17.57	-21.37	-25.62
	15-53013_LIFCPT950-B	671301.79	632027.68	-14.19	-19.99	-24.33

Legend:
CPT - Cone Penetration Test
TB - Turning Basin
RTA - Remediation Target Area
ft - Feet

APPENDIX D – NYCDOT DIVISION OF BRIDGES REVIEW PROCEDURE FOR PRIVATE DEVELOPMENT PROJECT NEAR BRIDGE STRUCTURE

NYCDOT – Division of Bridges Review Procedure for Private Development Project near Bridge Structure

Please be aware that section 2-11(d) of DOT's Highway Rules requires that street opening and excavation permit applications state "whether the proposed work will be within 100 feet on, above or below or in either direction of any portion of a bridge, tunnel, underpass or overpass (if so, approval from the Division of Bridges shall be obtained)". For purposes of this section "portion" shall include, but not be limited to, approach slabs, retaining walls, and support columns. The method of excavation and final restoration shall be reviewed and approved by the Division of Bridges."

Also, as further described in section 3.5.1 of DOT's Street Works Manual, if the Project will be within 100 feet of a bridge, the project owner or its consultant must submit a scaled drawing showing the work to be performed and its exact location relative to the bridge, in order for DOT to consider its construction activity permit application. The drawing shall be reviewed and approved by the DOT's Division of Bridges before such permit will be issued.

Therefore, no construction activity shall take place within the 100 feet of the Bridge before the required information has been submitted (as stated below) and DOT's Division of Bridges' approval has been obtained. **All Private developers' projects will be submitted for CDOT – Division of Bridges. Division of Bridge's approval if granted does not constitute approval from NYCDOT. General requirements for the submission to Division of Bridges are as follows:**

A. **General Scope:**
A description of the general scope of the project, and the specific nature of the work that will be performed in closest proximity to the bridge. It should include a location map (Google map, etc.), Block and Lot numbers, address of the property, developers name, address, key contact person details include phone number.

B. **Design documents:**
Plans and sectional elevations of the proposed work near the bridge; horizontal and vertical clearances between the bridge's superstructure, foundation, and the closest proposed building lines or property lines. Support of excavations, foundation plans and design calculations showing the foundation loads due to the proposed construction does not impose any additional loads on to the existing bridge foundation structure.

C. Pre and Post Construction Reports and Bridge Monitoring Plan:

In order to protect the bridge's integrity, DOT will require that an approved monitoring plan to observe cracking, vibration and settlement, be in place prior to commencement of any construction activity within 100 ft. of the bridge. Submission of pre-construction and post-construction survey reports (including photographs of existing condition prior to the project start and after competition of the project) of the bridge structure will be required. In accordance with the Division of Bridges standards, the threshold limit for vibration (PPV) is 0.5 inches/sec and settlement is 0.25 inches. A preconstruction report must be submitted to the Division at least 10 working days prior to commence of the project.

Note: The access to the bridge to perform pre and post construction survey shall be obtained by contacting Mr. George Klein, P.E., deputy Chief Engineer, Bureau of Maintenance, Inspection and Operations at (212)839-4846 or gklein@dot.nyc.gov .

a) The Pre-construction report shall clearly specify the existing condition of the bridge structure adjacent to the project limits, offsets from the bridge structure to the actual work, and any preexisting conditions such as cracks, spalls, and deterioration shall be pointed out in the report with photographs. Copies of all documents shall be sent to the Division of Bridges before construction begins. Any damage that was not documented to have existed before construction (including cracks that have expanded) will be deemed to have occurred as a result of construction activities and shall be repaired by the developer, to Division of Bridges satisfaction, and at no cost to the City.

b) The Bridge Monitoring Plan shall contain a general description of the project, project limits, project schedule, period of monitoring plan in place, location and number of monitoring points provided for measuring movement, settlements, vibration monitoring, and crack monitoring. It shall also contain the type of monitoring instruments used, monitoring procedures, reporting system and threshold limits for monitoring.

If the construction activity is in very close proximity to the bridge structure, as determined by the Division of Bridges, the monitoring reports shall be submitted on a weekly basis to the designated Engineer at the Division of Bridges. As the construction work progresses away from the bridge structure then the reports shall be submitted on Bi-weekly after getting approval from Division of Bridges. The report shall include but not limited to the monitoring values observed, nature of the contractor's activity, work location with respect to the bridge structure, day time/night time activity, and weather condition, etc. The Division of Bridges may require more frequent reports if deemed necessary.

c) The Post-Construction report shall contain the pre/post conditions of the structure, with photographs. Any deviation from pre-construction report shall be highlighted and any damage that may have occurred due to construction activity shall be repaired and brought to its original condition, as per the Division of Bridges' direction and at no cost to the City.

D. Land Use:
If the private development projects require temporary easements/land use related issues of CDOT properties as part of their construction, such requests shall be clearly mentioned in the drawings.

E. Truck Permit Program Unit:
The Construction Manager of the private development project shall familiarize himself/herself with all NYC regulations with respect to overweight and overdimensional permits and shall document that all trucks working on the project have the required permits. The Division of Bridges' review and approval is limited to the review of the subject plans. However, Overweight/Over dimensional trucks and cranes, that move in and out of New York City, are required to submit permit applications to the CDOT-Permit Unit. The contact person is Mr. Kevin Lobat, Director of Truck Permit Program Unit and he can be reached at (212)839-6335.

F. Bridge Hold: Any planned work requiring a Building Operations/ Construction Activity Permit that may potentially be within 100 feet of a bridge structure will be placed on a Bridge hold. If any proposed work is within 100 feet of a bridge or structure, applicants must submit a scaled drawing showing the work and exact location. If the work is more than 100 feet away from the bridge structure, applicants must send a certification by e-mail stating so. Either response must be sent to NYC DOT's Division of Bridges at bridgeshold@dot.nyc.gov for review and release prior to commencing work.

In general should you have any questions regarding our review and approval process, please contact Mr. Uday Dommaraju, P.E., Director of Engineering Review Section at (212)839-4029 or udommaraju@dot.nyc.gov.

CALCULATIONS
FOR
PIPE PILE WALLS

STRUCTURE

CARROLL STREET BRIDGE
B.I.N. 2-24026-0

PREPARED FOR

GOWANUS ENVIRONMENTAL REMEDIATION TRUST

RTA1 BRIDGE STABILITY FINAL DESIGN

PREPARED BY

Greenman-Pedersen, Inc.

FEB 2020

DESIGN SUMMARY

Design Criteria:

Manuals & Specifications References

1. NYSDOT Geotechnical Design Procedure for Flexible Wall Systems - Aug 2015
2. NYSDOT Bridge Manual, 2017 Edition, updated August 2017
3. AASHTO Standard Specifications for Highway Bridges, 17th Edition - 2002
4. USS Sheet Piling Design Manual – 1984
5. AASHTO LRFD Bridge Design Specifications – Seventh Edition with 2016 Interim Revisions
6. NYSDOT Standard Specifications
7. NYCDOT Seismic Design Guidelines for Bridges in Downstate Region - May 2016

Other References:

- Hsieh, Pio-Go and Ou, Chang-Yu. "Shape of Ground Surface Settlement Profiles Caused by Excavation." Canadian Geotechnical Journal 35(6):1004-1017 (1998)

Software Used:

- CivilTech Shoring Suite – Version 8
- Microsoft Excel
- LEAP CONSYS – Version 01.03.02.00

Design Approach:

The dredging of the Gowanus Canal for RTA 1 proposed by Geosyntec will undermine the substructures of the Carroll Street bridge. Since the elevations of the bottom of the timber crib bulkhead abutments of the bridge are unknown, these bulkhead walls cannot be relied on to provide adequate support to the bridge during the canal cleanup work. Interlocking pipe pile walls will be installed along the existing bulkhead and bridge abutments to protect them during dredging. Upon completion of the dredging and capping work, the walls will be cut and left in place. The design of the pipe pile walls was done in ASD following the procedure in the NYSDOT Geotechnical Design Procedure for Flexible Wall Systems (GDP-11). The design of the walls is split into six locations notated as follows:

- CSDL01 – CA 0+00 TO CA 0+41 (Northwest corner of the bridge)
- CSDL02 – CA 0+41 TO CA 1+10 (West Abutment face)
- CSDL03 – CA 1+10 TO CA 1+41 (Southwest corner of the bridge)
- CSDL04 – CB 0+00 TO CB 0+42 (Northeast corner of the bridge)
- CSDL05 – CB 0+42 TO CB 0+81 (East Abutment face)
- CSDL06 – CB 0+81 TO CB 1+28 (Southeast corner of the bridge)

Six design cases were evaluated for the previously mentioned design locations (CSDL01-CSDL06).

Design Case I:

This design case represents a temporary condition during the dredging of the canal where vehicular traffic exists behind the wall. A surcharge of 250 psf is applied to the wall design, which was obtained from Section II.A.2 of the NYSDOT Geotechnical Design Procedure for Flexible Wall Systems. Design locations CSDL01, CSDL04 and CSDL06 are evaluated for this condition due to the proximity of vehicular traffic behind the walls at properties 383 Carroll Street, 318

Nevins Street and 420 Carroll Street. Since the bridge will be greater than 35 feet away from the wall and is located on piles, the effects of the bridge dead load are not considered in the design case.

Design Case II:

Design Case II represents a temporary condition after dredging but prior to capping of the canal. Since the bridge will be open to traffic before the capping is completed, this case will include both the dead and live load surcharge from the bridge structure. The proposed pipe pile wall is designed for the uniform surcharge of 250 psf to account for vehicular traffic behind the wall due to the lack of an approach slab at this location. The contract drawings specifically prohibit any construction activities or heavy equipment from being placed behind the wall. Design location CSDL05 is evaluated for this condition.

Design Case III:

Design Case III represents a temporary condition post dredging but prior to capping of the canal. Since the bridge will be open to traffic before the capping is completed, this case will include both the dead and live load surcharge from the bridge structure. The contract drawings specifically prohibit any construction activities or heavy equipment from being placed behind the wall. Design locations CSDL02 and CSDL03 are evaluated due to the proximity of the rail support.

Design Case IV:

Design Case IV case represents the final condition where there is vehicular traffic behind the wall. A surcharge of 250 psf is applied to the wall design, which was obtained from Section II.A.2 of the NYSDOT Geotechnical Design Procedure for Flexible Wall Systems. Design locations CSDL01, CSDL04 and CSDL06 are evaluated for this condition due to the proximity of vehicular traffic behind the walls at properties 383 Carroll Street, 318 Nevins Street and 420 Carroll Street. During this condition, the Bridge will be in the closed position (open to traffic). Since the bridge will be greater than 35 feet away from the wall and is located on piles, the effects of the bridge dead load are not considered in the design case. Since this design case represents a final condition, seismic loading will be applied as per NYCDOT Seismic Design Guidelines for Bridges in Downstate Region.

Design Case V:

Design Case V represents the final condition, where the bridge is in the closed position (open to traffic). The canal has been dredged to the required elevation and the remediation cap installed. The design locations for this case are CSDL02 and CSLD03. Due the proximity of the bridge rail support while the bridge is in the closed position (open to traffic), the proposed pipe pile wall is designed for the surcharge loading of the bridge dead and live load at the center pier location. Since this design case represents a final condition, seismic loading will be applied as per NYCDOT Seismic Design Guidelines for Bridges in Downstate Region.

Design Case VI:

Design Case VI represents the final condition, where the bridge is in the closed position (open to traffic). The canal has been dredged to the required elevation and the remediation cap installed. The design location for the case is CSDL05. Due the proximity of the east abutment while the bridge is in the closed position (open to traffic), the proposed pipe pile wall is designed for the surcharge loading of the bridge dead and live load from the east abutment. It will also be designed for vehicular live load acting behind the wall. The 250 psf surcharge will be included here as well. Since this design case represents a final condition, seismic loading will be applied as per NYCDOT Seismic Design Guidelines for Bridges in Downstate Region.

Ground Settlements:

Settlement of substructures are limited to 0.25" as per NYCDOT - Division of Bridges Review Procedure for Private Development Project near Bridge Structure (see Appendix D). Due to the unknown depth and condition of timber piles and cribbing, ground settlements adjacent to bridge substructures will be limited to 0.25". This is a conservative design criterion being that the substructures are located on piles. Settlements caused by the installation of walls have been minimized through the DTH drilling method with spiral flush technology. Ground settlements induced by lateral wall deflection have been estimated using the procedure found in "Shape of Ground Surface Settlement Profiles Caused by Excavation" by Hsieh and Ou (1998). For more on the calculation of ground settlement, see *Attachment C – Procedure for Estimating Ground Settlement*.

Seismic Design:

Seismic design of the pipe pile walls is completed in CivilTech Shoring Suite. The additional earthquake forces are applied using the wedge analysis described in Ref. 5 Section A11.3.2. Seismic loading is only considered for the final design condition. Ground acceleration coefficients have been calculated using the procedure found in the NYCDOT Seismic Design Guidelines for Bridges in Downstate Region, summarized below:

> Calculation of PGA (Reference – NYCDOT Seismic Design Guidelines for Bridges in Downstate Region):
>
> Since the rock surface is greater than 10 ft below the surface, the site is classified as a soil site as per Section 6. The soil information provided by GZA GeoEnvironmental, shows that average undrained shear strength (s_u) of the canal soils is less than 1000 psf. Using Table 11, soil class E has been chosen for this site. The PGA has been selected using table 13. Since the rock level and classification in this region is unknown, soil on top of rock class B has been conservativity assumed. For more on the seismic classification and calculation of PGA, see *Attachment D – Seismic Design Parameters.*

Analysis Methods and Design Assumptions:

All Design Cases:

- All soil information including soil design properties and soil layer thicknesses were obtained from the RTA 1 Bridge Soil Design Parameters prepared by GZA GeoEnvironmental, Inc. dated July 11, 2018 (*Appendix A*). Soil layer thicknesses have been modified for certain design locations per the Summary of Geotechnical Design Parameters prepared by Geosyntec Consultants (*Appendix C*).
- All upland (non-canal) soils are assumed to be retained by the existing bulkhead and/or bridge abutments.
- As per NYSDOT GDP-11 Section II.A.7, cohesive soils are modeled as cohesiveless soils using the internal angle of friction specified in the RTA 1 Bridge Soil Design Parameters.
- Rankine Theory was used for the development of earth pressures on the pipe pile wall as per NYSDOT GDP-11 Section II.A.1.
- Soil in front and behind the proposed pipe pile wall is assumed to be in the fully submerged condition throughout construction. Pipe piles will be cut below M.L.W. eliminating any tidal lag effects on the wall.

- The timber piles supporting the bridge abutment bulkheads and rail foundation caps are of an unknown length and are assumed to be 20ft long.
- Pipe pile wall design was performed using the program CivilTech Shoring Suite – Version 8. Verification of the program shows that it conforms to the guidelines, theories, and design methods found in NYSDOT GDP-11.
- For loading control movement combined with the rigidity of the pipe pile wall, the at-rest earth pressure coefficient, k_o will be used when calculating the earth pressures on the active side of the wall.
- Dredge depths were obtained from the bottom of soft sediment surface provided by Geosyntec Consultants. An over dredge allowance of six inches was included during the calculation of final dredge depths.
- Settlements behind the wall due to lateral wall deflections were calculated using the procedure described in “Shape of Ground Surface Settlement Profiles Caused by Excavation” by Hsieh and Ou (1998).
- Carroll Street Bridge has a seismic classification of other based on the performance criteria defined in the NYCDOT Seismic Design Guidelines for Bridges in Downstate Region
- Pipe pile walls will be analyzed for a single earthquake hazard level having 7% probability of being exceeded in 75 years (1000 years Return Period) as per NYCDOT Seismic Design Guidelines for Bridges in Downstate Region Section 2.
- The vertical seismic acceleration cofficient (kv) is equal to zero as per AASHTO LRFD Bridge Design Specifications Section A11.3.2.

Design Case I:

- A factor of Safety of 1.25 for a temporary condition is be applied to the coefficient of passive earth pressure as per NYSDOT GDP-11 Section II.B.
- A surcharge of 250 psf is applied to the wall design, which was obtained from Section II.A.2 of the NYSDOT Geotechnical Design Procedure for Flexible Wall Systems.
- Loading effects from the bridge dead load are not included due to the distance (35 feet from CSDL01) from the wall at the applicable design location.

Design Case II:

- A factor of Safety of 1.25 for a temporary condition is be applied to the coefficient of passive earth pressure as per NYSDOT GDP-11 Section II.B.
- Since there is no approach slab at CSDL05, as per AASHTO Standard Specifications for Highway Bridges, 17th Edition – 2002 Section 3.20.4, a live load surcharge of 250 psf will be added, which was obtained from Section II.A.2 of the NYSDOT Geotechnical Design Procedure for Flexible Wall Systems
- Loading effects from the bridge dead and live load are included.
- Surcharge load from the bridge is assumed to be distributed along the rail foundation cap and will be applied as a strip load surcharge to the proposed pipe pile wall (see section 3.11.6.3-1 of AASHTO LRFD Bridge Design Specifications).
- The strip load is applied using an equivalent footing for the pile group after Hannigan et al. (2006) (see Figure 10.7.2.3.1-1 of AASHTO LRFD Bridge Design Specifications for application).
- Sidewalk loading of 85 psf is applied as a uniform surcharge as per AASHTO Standard Specifications for Highway Bridges, 17th Edition – 2002.
- HS-20 Truck live loading is applied to the structure due to the bridge load posting. Impact is not included.
- Analysis of bridge reactions was performed using the software LEAP CONSYS.

Design Case III:

- Surcharge load from the bridge is assumed to be distributed along the rail foundation cap and will be applied as a strip load surcharge to the proposed pipe pile wall (see section 3.11.6.3-1 of AASHTO LRFD Bridge Design Specifications).
- The strip load is applied using an equivalent footing for the pile group after Hannigan et al. (2006) (see Figure 10.7.2.3.1-1 of AASHTO LRFD Bridge Design Specifications for application).
- Sidewalk loading of 85 psf is applied as a uniform surcharge as per AASHTO Standard Specifications for Highway Bridges, 17th Edition – 2002.
- Loading effects from the bridge dead and live load are included.
- HS-20 Truck live loading is applied to the structure due to the bridge load posting. Impact is not included.
- Analysis of bridge reactions was performed using the software LEAP CONSYS.
- A factor of Safety of 1.25 is be applied to the coefficient of passive earth pressure as per NYSDOT GDP-11 Section II.B.

Design Case IV:

- A factor of Safety of 1.5 for a permanent condition is be applied to the coefficient of passive earth pressure as per NYSDOT GDP-11 Section II.B.
- A surcharge of 250 psf is applied to the wall design, which was obtained from Section II.A.2 of the NYSDOT Geotechnical Design Procedure for Flexible Wall Systems.
- Loading effects from the bridge dead load are not included due to the distance (35 feet from CSDL01) from the wall at the applicable design location.

Design Case V:

- Since the sand backfill layer is selected by the contractor based on gradation given in Section 733-15 of the NYSDOT Standard Specifications, the soil parameters have been assumed based on these tables. The sand is assumed to have a unit weight of 115 pcf and an effective friction angle of 30 degrees. The cap is assumed to be more rigid than the sand backfill layer and will be included in this layer for calculation purposes.
- Surcharge load from the bridge is assumed to be distributed along the rail foundation cap and will be applied as a strip load surcharge to the proposed pipe pile wall (see section 3.11.6.3-1 of AASHTO LRFD Bridge Design Specifications).
- The strip load is applied using an equivalent footing for the pile group after Hannigan et al. (2006) (see Figure 10.7.2.3.1-1 of AASHTO LRFD Bridge Design Specifications for application).
- The maximum bridge reaction is located at the center support of the south fascia girder. Reactions from the south fascia girder are calculated using a 2-span continuous beam. The effect of the overhead steel frame is conservatively ignored.
- HS-20 Truck live loading is applied to the structure due to the bridge load posting. Impact is not included.
- Analysis of bridge reactions was performed using the software LEAP CONSYS.
- A factor of Safety of 1.5 is applied to the coefficient of passive earth pressure as per NYSDOT GDP-11 Section II.B.

Design Case VI:

- Since the sand backfill layer is selected by the contractor based on gradation given in Section 733-15 of the NYSDOT Standard Specifications, the soil parameters have been assumed based on these tables. The sand is assumed to have a unit weight of 115 pcf and an effective friction angle of 30 degrees. The cap is assumed to be more rigid than the sand backfill layer and will be included in this layer for calculation purposes.
- Surcharge load from the bridge is assumed to be distributed along the rail foundation cap and will be applied as a strip load surcharge to the proposed pipe pile wall (see section 3.11.6.3-1 of AASHTO LRFD Bridge Design Specifications).
- The strip load is applied using an equivalent footing for the pile group after Hannigan et al. (2006) (see Figure 10.7.2.3.1-1 of AASHTO LRFD Bridge Design Specifications for application).
- The maximum bridge reaction is located at the end support of the south fascia girder. Reactions from the south fascia girder are calculated using a 2-span continuous beam. The effect of the overhead steel frame is conservatively ignored.
- HS-20 Truck live loading is applied to the structure due to the bridge load posting. Impact is not included.
- Analysis of bridge reactions was performed using the software LEAP CONSYS.
- A factor of Safety of 1.5 is applied to the coefficient of passive earth pressure as per NYSDOT GDP-11 Section II.B.

Summary of Results:

Design Checks									
	Moment Capacity				Settlement (in)				
Design Location	Z_{req} (in^3)	Z (in^3)	D/C	Check	δ_v	$\delta_{v, allow}$	D/C	Check	Controlling Design Case
CSDL01	13.61	95.56	0.14	OK	0.21	0.25	0.83	OK	Design Case I
CSDL02	1.41	95.56	0.01	OK	0.03	0.25	0.12	OK	Design Case III
CSDL03	6.89	95.56	0.07	OK	0.12	0.25	0.46	OK	Design Case III
CSDL04	11.56	95.56	0.12	OK	0.15	0.25	0.59	OK	Design Case I
CSDL05	11.24	95.56	0.12	OK	0.10	0.25	0.41	OK	Design Case II
CSDL06	14.16	95.56	0.15	OK	0.19	0.25	0.76	OK	Design Case I

Sheet Pile Information					
	Elevations (ft)				
Design Location	Top	Min. Tip	Dredge	Section	Wall Height (ft)
CSDL01	-3.00	-37.00	-18.00	O-Pile 20"_0.625"	14.00
CSDL02	-8.77	-28.00	-18.00	O-Pile 20"_0.5"	7.50
CSDL03	-3.00	-33.00	-17.75	O-Pile 20"_0.625"	14.00
CSDL04	-3.00	-35.00	-16.50	O-Pile 20"_0.625"	12.75
CSDL05	-8.77	-37.00	-17.50	O-Pile 20"_0.5"	8.50
CSDL06	-3.00	-36.00	-16.50	O-Pile 20"_0.625"	13.50

TABLE OF CONTENTS

DESIGN CASE I

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: OF
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case I CHECKED BY: JRA DATE: 6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case I - Summary of Results

References:

1. NYSDOT Geotechnical Design Procedure for Flexible Wall Systems - Aug 2015
2. NYSDOT Bridge Manual - 2017
3. AASHTO Standard Specifications for Highway Bridges, 17th Edition - 2002
4. USS Sheet Piling Design Manual - 1984
5. AASHTO LRFD Bridge Design Specifications - Seventh Edition with 2016 Iterim Revisions
6. NYSDOT Standard Specifications
7. Hsieh, Pio-Go and Ou, Chang-Yu. "Shape of Ground Surface Settlement Profiles Caused by Excavation." *Canadian Geotechnical Journal 35(6):1004-1017* (1998)

Appendices:

Appendix A - RTA 1 Bridge Soil Design Parameters by GZA GeoEnvironmental, Inc.
Appendix B - O-Pile Datasheet
Appendix C - Summary of Geotechnical Design Parameters by Geosyntec Consultants

Purpose & Assumptions:

This design case represents a temporary condition where the bridge is in the open position (closed to traffic). See design summary for full list of assumptions.

- A surcharge loading of 250 psf is applied to the proposed pipe pile wall.
- Factory of safety of 1.25 will be applied to the coefficient of passive earth pressure as per Reference 1 Section II.B.1.

Summary of Results:

The results of the verification are summarized in the table below:

Design Checks								
Design Location	Moment Capacity				Settlement (in)			
	Z_{req} (in^3)	Z (in^3)	D/C	Check	δ_v	$\delta_{v, allow}$	D/C	Check
CSDL01	13.61	95.56	0.14	OK	0.21	0.25	0.83	OK
CSDL04	11.56	95.56	0.12	OK	0.15	0.25	0.59	OK
CSDL06	14.16	95.56	0.15	OK	0.19	0.25	0.76	OK

Pipe Pile Information						
Design Location	Elevations (ft)			Section	Wall Height	Pile Length
	Top	Min. Tip	Dredge			
CSDL01	-3.00	-37.00	-18.00	O-Pile 20"_0.625"	14.00	34.00
CSDL04	-3.00	-35.00	-16.50	O-Pile 20"_0.625"	12.75	32.00
CSDL06	-3.00	-36.00	-16.50	O-Pile 20"_0.625"	13.50	33.00

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case I	CHECKED BY:	JRA	DATE:	6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case I - Inputs

Pipe Pile Material:

ASTM A 572 Gr. 50 Steel:

F_y =	50 *ksi*			
E =	29000 *ksi*			*Ref. 5 Section 6.4.1*

Soil Parameters:

Constants:

γ_w =	62.4 *pcf*	(Unit weight of water)		

Soil Layer 1 - Soft Sediment:

γ =	80 *pcf*	(Total unit weight)		*Appendix A - Page AP-1*
φ' =	28 *deg*	(Effective Friction Angle)		*Appendix A - Page AP-1*
$\gamma' = \gamma - \gamma_w$		(Effective unit weight)		
			γ' =	17.6 *pcf*
$K_o = 1 - \sin Ø'$		(At-rest pressure coefficient)		*Ref. 5 Eq. 3.11.5.2-1*
			k_o =	0.53
$K_p = \dfrac{1 + \sin Ø'}{1 - \sin Ø'}$		(Passive pressure coefficient)		*Ref. 1 Appendix A - Page A-1*
			k_p =	2.77
$F.S.$ =	1.25	(Factor of Safety)		*Ref. 1 Section II.B.1*
$K_p' = K_p/F.S.$		(Effective Passive Pressure Coefficient)		
			K_p' =	2.22

Soil Layer 2 - Native Alluvial Sediment:

γ =	115 *pcf*	(Total unit weight)		*Appendix A - Page AP-1*
φ' =	28 *deg*	(Effective Friction Angle)		*Appendix A - Page AP-1*
$\gamma' = \gamma - \gamma_w$		(Effective unit weight)		
			γ' =	52.6 *pcf*
$K_o = 1 - \sin Ø'$		(At-rest pressure coefficient)		*Ref. 5 Eq. 3.11.5.2-1*
			k_o =	0.53
$K_p = \dfrac{1 + \sin Ø'}{1 - \sin Ø'}$		(Passive pressure coefficient)		*Ref. 1 Appendix A - Page A-1*
			k_p =	2.77
$F.S.$ =	1.25	(Factor of Safety)		*Ref. 1 Section II.B.1*
$K_p' = K_p/F.S.$		(Effective Passive Pressure Coefficient)		
			K_p' =	2.22

Soil Layer 3 - Glacial Deposit:

γ =	125 *pcf*	(Total unit weight)		*Appendix A - Page AP-1*
φ' =	34 *deg*	(Effective Friction Angle)		*Appendix A - Page AP-1*
γ' =	$\gamma - \gamma_w$	(Effective unit weight)		
			γ' =	62.6 *pcf*
$K_o = 1 - \sin \emptyset'$		(At-rest pressure coefficient)		*Ref. 5 Eq. 3.11.5.2-1*
			k_o =	0.44
$K_p = \frac{1 + \sin \emptyset'}{1 - \sin \emptyset'}$		(Passive pressure coefficient)		*Ref. 1 Appendix A - Page A-1*
			k_p =	3.54
F.S. =	1.25	(Factor of Safety)		*Ref. 1 Section II.B.1*
K_p' =	K_p/F.S.	(Effective Passive Pressure Coefficient)		
			K_p' =	2.83

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case I CHECKED BY: JRA DATE: 6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case I - CSDL01

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88)

EL_1 = -4.00 *ft* (Minimum existing bathmetry elevation)
EL_2 = -17.50 *ft* (Minimum el. of soft-native interface) *Appendix C Table 1d*
EL_3 = -19.34 *ft* (Minimum el. of native-glacial interface) *Appendix C Table 1d*
El_D = -18.00 *ft* (Dredge elevation)
H = 14.00 *ft* (Dredge height)
EL_{TOP} = -3.00 *ft* (Top of wall elevation)
EL_{TOE} = -37.00 *ft* (Toe of wall elevation)
H_w = 34.00 *ft* (Total length of pile, 20% Additional Embedment included)
MHW EL = 1.96 *ft* (Mean high water elevation)
MLW EL = -2.57 *ft* (Mean low water elevation)

Design of Pile (using CivilTech Shoring Suite):

Pipe Pile Section Properties: *Appendix B*

Pile: O-Pile 20"_0.625"
Wt = 74.51 lb/ft (Wt of pipe pile)
b = 22.44 *in* (Width of pipe pile)
I = 955.56 in^4/ft (Moment of inertia of pipe pile)
Z = 95.56 in^3/ft (Plastic section modulus of pipe pile)

Surcharge Loading:

q = 250 *psf* (Applied Surcharge) *Ref. 1 Section II.A.2*

Check Pipe Pile Section:

M_{max} = 34.02 *k-ft* (Maximum moment on wall) *Attachment A - Page A-1*
$\sigma_{allow} = 0.6f_y$ (Allowable stress in pipe pile)

σ_{allow} = 30 *ksi*

$Z_{min} = M_{max} / \sigma_{allow}$ (Minimum section modulus)

Z_{min} = 13.61 in^3
D/C* = 0.14** ***OK

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case I CHECKED BY: JRA DATE: 6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case I - CSDL01

Calculate Settlement Behind Wall:

See "Attachment C - Procedure for Estimating Ground Settlement"

δ_{hm} = 0.25 *in* (Calc. Deflection @ top of soil layer 1) *Attachment A - Page A-1*

δ_{vm} = $R\delta_{hm}$ (Maximum ground settlement) δ_{vm} = 0.25 *in*

R = 1.0 (Ratio between ground settlement and wall deflection)

$$\delta_v = \left(-0.636\sqrt{\frac{d}{H_e}} + 1\right)\delta_{vm}\ if\ \frac{d}{H_e} \le 2;\ and$$

$$\delta_v = \left(-0.171\sqrt{\frac{d}{H_e}} + 0.342\right)\delta_{vm}\ if\ 2 < \frac{d}{H_e} \le 4$$

d = 1 *ft* (Distance behind the wall)

H_e = 14.00 *ft* (Height of excavation)

δ_v = 0.21 *in* (Ground Settlement at distance d behind the wall)

$\delta_{v,\,allow}$ = 0.25 *in* (Allowable ground settlement)

D/C* =** **0.83** ***OK

Depth of Pipe Pile:

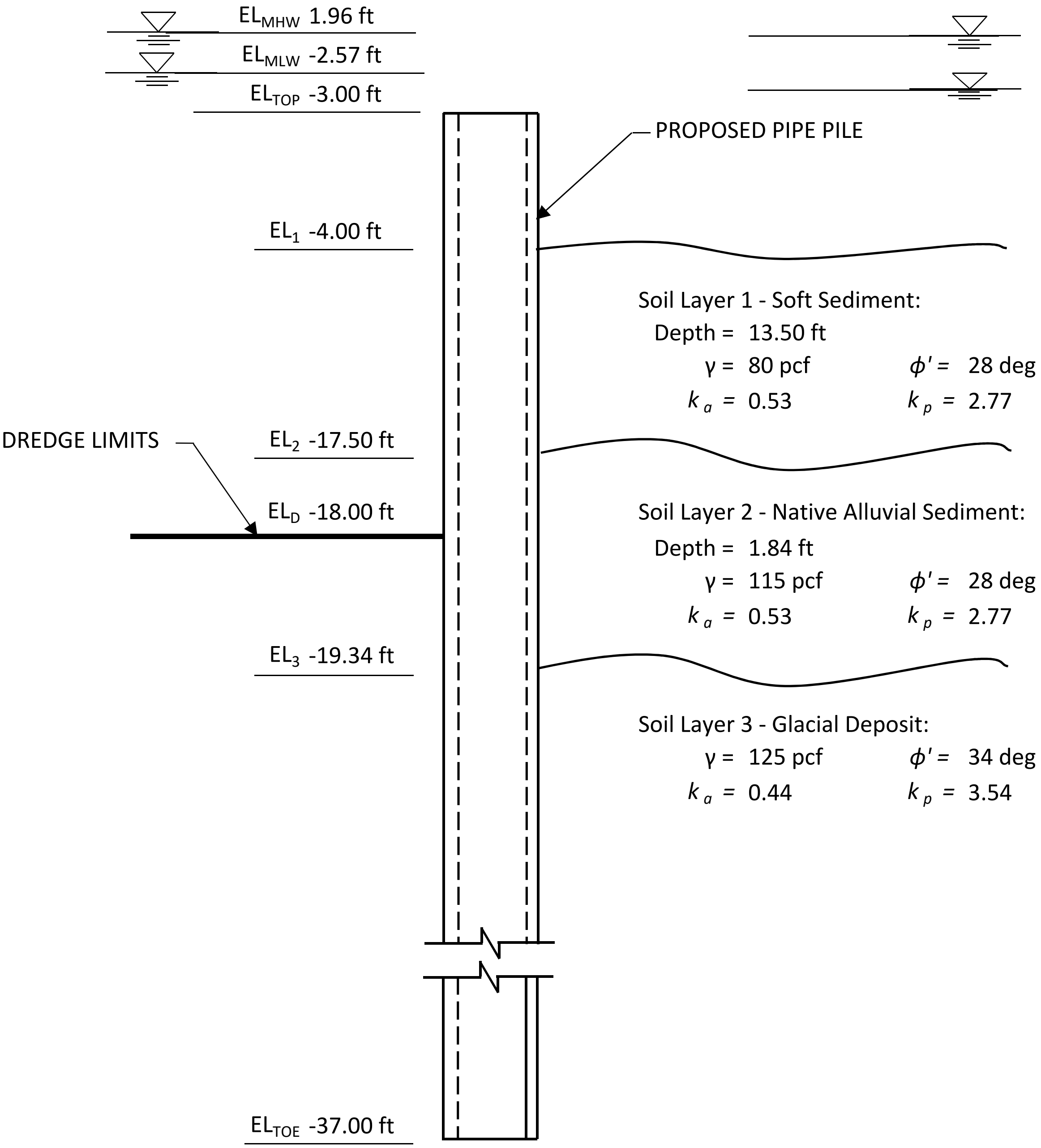
D = 32.29 *ft* (Top of Soil Layer 1 to Toe of Pile) *Attachment A - Page A-1*
(20% additional embedment included)

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case I	CHECKED BY:	JRA	DATE:	6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case I - CSDL01

Pipe Pile Wall Section (Not to Scale):



GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case I	CHECKED BY:	JRA	DATE:	6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case I - CSDL04

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88)

EL_1 =	-3.75	*ft*	(Minimum existing bathmetry elevation)	
EL_2 =	-15.00	*ft*	(Minimum el. of soft-native interface)	*Appendix C Table 1d*
EL_3 =	-18.00	*ft*	(Minimum el. of native-glacial interface)	*Appendix C Table 1d*
El_D =	-16.50	*ft*	(Dredge elevation)	
H =	12.75	*ft*	(Dredge height)	
EL_{TOP} =	-3.00	*ft*	(Top of wall elevation)	
EL_{TOE} =	-35.00	*ft*	(Toe of wall elevation)	
H_w =	32.00	*ft*	(Total length of pile, 20% Additional Embedment included)	
MHW EL =	1.96	*ft*	(Mean high water elevation)	
MLW EL =	-2.57	*ft*	(Mean low water elevation)	

Design of Pile (using CivilTech Shoring Suite):

Pipe Pile Section Properties: *Appendix B*

Pile:	O-Pile 20"_0.625"			
Wt =	74.51	lb/ft	(Wt of pipe pile)	
b =	22.44	*in*	(Width of pipe pile)	
I =	955.56	in^4/ft	(Moment of inertia of pipe pile)	
Z =	95.56	in^3/ft	(Plastic section modulus of pipe pile)	

Surcharge Loading:

q =	250	*psf*	(Applied Surcharge)	*Ref. 1 Section II.A.2*

Check Pile Section:

M_{max} =	28.89	*k-ft*	(Maximum moment on wall)	*Attachment A - Page A-5*

$\sigma_{allow} = 0.6f_y$ (Allowable stress in pipe pile)

σ_{allow} = 30 *ksi*

$Z_{min} = M_{max} / \sigma_{allow}$ (Minimum section modulus)

Z_{min} = 11.56 in^3

D/C* =** **0.12** ***OK

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case I	CHECKED BY:	JRA	DATE:	6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case I - CSDL04

Calculate Settlement Behind Wall:

See "Attachment C - Procedure for Estimating Ground Settlement"

δ_{hm} = 0.18 *in* (Calc. Deflection @ top of soil layer 1) *Attachment A - Page A-5*

δ_{vm} = $R\delta_{hm}$ (Maximum ground settlement) δ_{vm} = 0.18

R = 1.0 (Ratio between ground settlement and wall deflection)

$$\delta_v = \left(-0.636\sqrt{\frac{d}{H_e}} + 1\right)\delta_{vm}\ if\ \frac{d}{H_e} \leq 2; and$$

$$\delta_v = \left(-0.171\sqrt{\frac{d}{H_e}} + 0.342\right)\delta_{vm}\ if\ 2 < \frac{d}{H_e} \leq 4$$

d = *1* *ft* (Distance behind the wall)

H_e = 12.75 *ft* (Height of excavation)

δ_v = *0.15* *in* (Ground Settlement at distance d behind the wall)

$\delta_{v,\ allow}$ = 0.25 *in* (Allowable ground settlement)

D/C* =** **0.59** ***OK

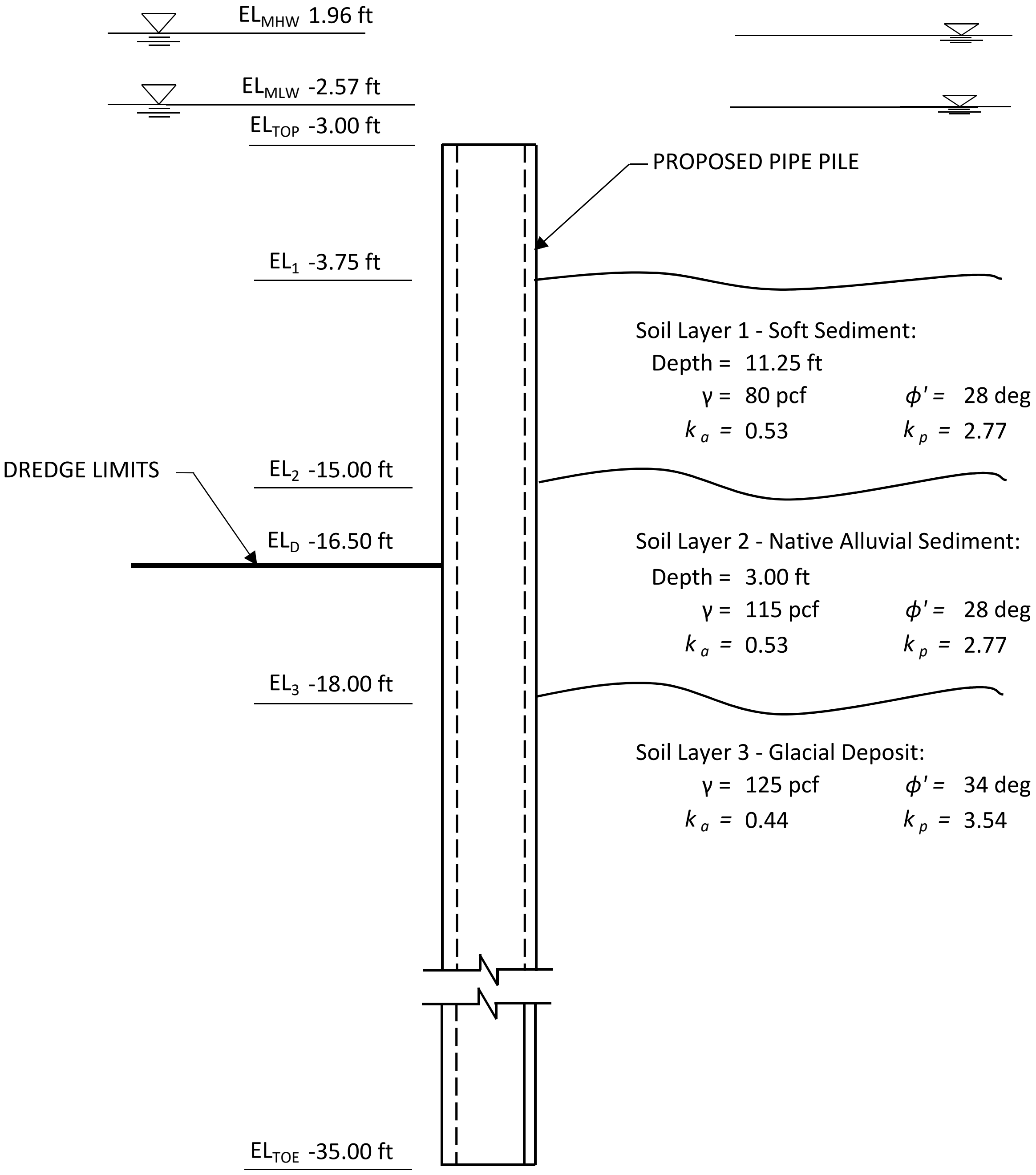
Depth of Sheeting:

D = 30.29 *ft* (Top of Soil Layer 1 to Toe of Pile) *Attachment A - Page A-5*

(20% additional embedment included)

RTA 1 - Carroll Street Pipe Pile Design Case I - CSDL04

Pipe Pile Wall Section (Not to Scale):



GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case I	CHECKED BY:	JRA	DATE:	6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case I - CSDL06

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88)

EL_1 = -3.00 *ft* (Minimum existing bathmetry elevation)

EL_2 = -16.00 *ft* (Minimum el. of soft-native interface) *Appendix C Table 1d*

EL_3 = -21.67 *ft* (Minimum el. of native-glacial interface) *Appendix C Table 1d*

El_D = -16.50 *ft* (Dredge elevation)

H = 13.50 *ft* (Dredge height)

EL_{TOP} = -3.00 *ft* (Top of wall elevation)

EL_{TOE} = -36.00 *ft* (Toe of wall elevation)

H_w = 33.00 *ft* (Total length of pile, 20% Additional Embedment included)

MHW EL = 1.96 *ft* (Mean high water elevation)

MLW EL = -2.57 *ft* (Mean low water elevation)

Design of Pile (using CivilTech Shoring Suite):

Pipe Pile Section Properties: *Appendix B*

Pile: O-Pile 20"_0.625"

Wt = 74.51 lb/ft (Wt of pipe pile)

b = 22.44 *in* (Width of pipe pile)

I = 955.56 in^4/ft (Moment of inertia of pipe pile)

Z = 95.56 in^3/ft (Plastic section modulus of pipe pile)

Surcharge Loading:

q = 250 *psf* (Applied Surcharge) *Ref. 1 Section II.A.2*

Check Pile Section:

M_{max} = 35.41 *k-ft* (Maximum moment on wall) *Attachment A - Page A-9*

$\sigma_{allow} = 0.6f_y$ (Allowable stress in pile)

σ_{allow} = 30 *ksi*

$Z_{min} = M_{max} / \sigma_{allow}$ (Minimum section modulus)

Z_{min} = 14.16 in^3

D/C* =** **0.15** ***OK

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case I	CHECKED BY:	JRA	DATE:	6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case I - CSDL06

Calculate Settlement Behind Wall:

See "Attachment C - Procedure for Estimating Ground Settlement"

δ_{hm} = 0.23 *in* (Calc. Deflection @ top of soil layer 1) *Attachment A - Page A-9*

$\delta_{vm} = R\delta_{hm}$ (Maximum ground settlement) δ_{vm} = 0.23

R = 1.0 (Ratio between ground settlement and wall deflection)

$$\delta_v = \left(-0.636\sqrt{\frac{d}{H_e}}+1\right)\delta_{vm}\ if\ \frac{d}{H_e} \le 2;\ and$$

$$\delta_v = \left(-0.171\sqrt{\frac{d}{H_e}}+0.342\right)\delta_{vm}\ if\ 2 < \frac{d}{H_e} \le 4$$

d = *1* *ft* (Distance behind the wall)

H_e = 13.50 *ft* (Height of excavation)

δ_v = *0.19* *in* (Ground Settlement at distance d behind the wall)

$\delta_{v, allow}$ = 0.25 *in* (Allowable ground settlement)

D/C* =** **0.76** ***OK

Depth of Sheeting:

D = 32.85 *ft* (Top of Soil Layer 1 to Toe of Pile) *Attachment A - Page A-9*

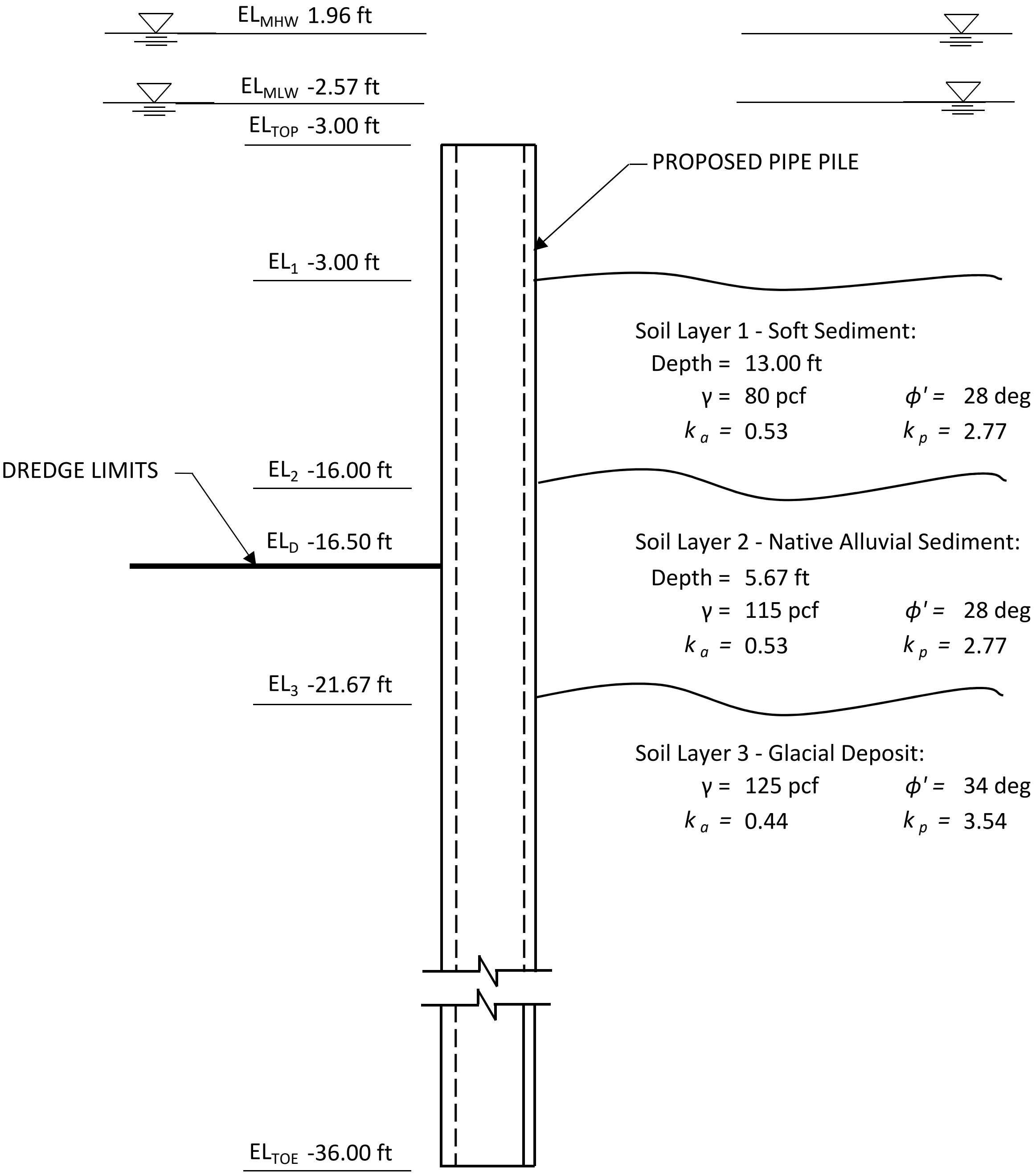
(20% additional embedment included)

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ____ OF ____
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case I CHECKED BY: JRA DATE: 6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case I - CSDL06

Pipe Pile Wall Section (Not to Scale):



DESIGN CASE II

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case II	CHECKED BY:	JRA	DATE:	6/6/19

RTA 1 - Carroll Street Design Case II - Summary of Results

References:

1. NYSDOT Geotechnical Design Procedure for Flexible Wall Systems - Aug 2015
2. NYSDOT Bridge Manual - 2017
3. AASHTO Standard Specifications for Highway Bridges, 17th Edition - 2002
4. USS Sheet Piling Design Manual - 1984
5. AASHTO LRFD Bridge Design Specifications - Seventh Edition with 2016 Iterim Revisions
6. NYSDOT Standard Specifications
7. Hsieh, Pio-Go and Ou, Chang-Yu. "Shape of Ground Surface Settlement Profiles Caused by Excavation." *Canadian Geotechnical Journal 35(6):1004-1017* (1998)

Appendices:

Appendix A - RTA 1 Bridge Soil Design Parameters by GZA GeoEnvironmental, Inc.
Appendix B - O-Pile Datasheet
Appendix C - Summary of Geotechnical Design Parameters by Geosyntec Consultants

Purpose & Assumptions:

This design case represents a temporary condition post dredge, but prior to capping. For full list of assumptions, see design summary.

- Factory of safety of 1.25 will be applied to the coefficient of passive earth pressure as per Reference 1 Section II.B.2.

Summary of Results:

The results of the verification are summarized in the table below:

Design Checks								
Design Location	Moment Capacity				Settlement (in)			
	Z_{req} (in^3)	Z (in^3)	D/C	Check	δ_v	$\delta_{v, allow}$	D/C	Check
CSDL05	11.24	95.56	0.12	OK	0.10	0.25	0.41	OK

Pipe Pile Information						
Design Location	Elevations (ft)			Section	Wall Height	Pile Length
	Top	Min. Tip	Dredge			
CSDL05	-8.77	-37.00	-17.50	O-Pile 20"_0.625"	8.50	29.00

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case II	CHECKED BY:	JRA	DATE:	6/6/19

RTA 1 - Carroll Street Design Case II - Inputs

Pipe Pile Material:

ASTM A 572 Gr. 50 Steel: *Ref. 6 Section 715-17*

F_y = 50 *ksi*

E = 29000 *ksi* *Ref. 5 Section 6.4.1*

Soil Parameters:

Constants:

γ_w = 62.4 *pcf* (Unit weight of water)

Soil Layer 1 - Soft Sediment:

γ = 80 *pcf* (Total unit weight) *Appendix A - Page AP-1*

φ' = 28 *deg* (Effective Friction Angle) *Appendix A - Page AP-1*

$\gamma' = \gamma - \gamma_w$ (Effective unit weight)

γ' = 17.6 *pcf*

$K_o = 1 - \sin \emptyset'$ (At-rest pressure coefficient) *Ref. 5 Eq. 3.11.5.2-1*

k_o = 0.53

$K_p = \frac{1 + \sin \emptyset'}{1 - \sin \emptyset'}$ (Passive pressure coefficient) *Ref. 1 Appendix A - Page A-1*

k_p = 2.77

$F.S.$ = 1.25 (Factor of Safety) *Ref. 1 Section II.B.2*

$K_p' = K_p/F.S.$ (Effective Passive Pressure Coefficient)

K_p' = 2.22

Soil Layer 2 - Native Alluvial Sediment:

γ = 115 *pcf* (Total unit weight) *Appendix A - Page AP-1*

φ' = 28 *deg* (Effective Friction Angle) *Appendix A - Page AP-1*

$\gamma' = \gamma - \gamma_w$ (Effective unit weight)

γ' = 52.6 *pcf*

$K_o = 1 - \sin \emptyset'$ (At-rest pressure coefficient) *Ref. 5 Eq. 3.11.5.2-1*

k_o = 0.53

$K_p = \frac{1 + \sin \emptyset'}{1 - \sin \emptyset'}$ (Passive pressure coefficient) *Ref. 1 Appendix A - Page A-1*

k_p = 2.77

$F.S.$ = 1.25 (Factor of Safety) *Ref. 1 Section II.B.2*

$K_p' = K_p/F.S.$ (Effective Passive Pressure Coefficient)

K_p' = 2.22

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case II	CHECKED BY:	JRA	DATE:	6/6/19

Soil Layer 3 - Glacial Deposit:

$\gamma =$ 125 *pcf* (Total unit weight) *Appendix A - Page AP-1*

$\varphi' =$ 34 *deg* (Effective Friction Angle) *Appendix A - Page AP-1*

$\gamma' = \gamma - \gamma_w$ (Effective unit weight)

$\gamma' =$ 62.6 *pcf*

$$K_o = 1 - \sin \emptyset'$$

(At-rest pressure coefficient) *Ref. 5 Eq. 3.11.5.2-1*

$k_o =$ 0.44

$$K_p = \frac{1 + \sin \emptyset'}{1 - \sin \emptyset'}$$

(Passive pressure coefficient) *Ref. 1 Appendix A - Page A-1*

$k_p =$ 3.54

F.S. = 1.25 (Factor of Safety) *Ref. 1 Section II.B.2*

$K_p' = K_p/F.S.$ (Effective Passive Pressure Coefficient)

$K_p' =$ 2.83

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case II CHECKED BY: JRA DATE: 6/6/19

Carroll Street Design Case II - Area Load Surcharge

Dead Load of Bridge:

Calculate the reaction at the south fascia interior support on the rail concrete cap beam:

Material Weights:

wt_s = 490 *pcf* (Unit weight of steel) *Ref. 5 Table 3.5.1-1*
wt_w = 60 *pcf* (Unit weight of wood) *Ref. 5 Table 3.5.1-1*
wt_C = 150 *pcf* (Unit weight of concrete) *Ref. 5 C3.5.1-1*

Geometry:

S = 105 *ft* (Combined span length of bridge)
S_1 = 61 *ft* (Length of span 1)
S_2 = 44 *ft* (Length of span 2)
L_{sg} = 120 *ft* (Length of s. fascia girder)
L_{sg1} = 75 *ft* (Length of s. fascia girder span 1)
L_{sg2} = 45 *ft* (Length of s. fascia girder span 2)
t_d = 8 *in* (Thickness of timber deck)
W_d = 19 *ft* (Width of deck)
W_r = 15 *ft* (Width of Roadway)
W_s = 4.5 *ft* (Width of sidewalk)
t_s = 2 *in* (Thickness of timber sidewalk deck)
s_g = 19 *ft* (Spacing of girders)

Built-up Girders:

South Fascia Girder (Controls):

Top & Bottom Flange:

n_{af} = 2 (Number of Angles per flange)
Angles = L5x3-1/2x7/16
Wt_{af} = 12 *lb/ft* (wt. per foot per angle)
n_{covf} = 3 (Number of cover plates per flange)
w_{cov} = 12 *in* (Width of cover plate)
t_{cov} = 0.375 *in* (Thickness of cover plate)

Web:

t_{web} = 0.38 *in* (Thickness of web plate)
h_{web} = 60 *in* (Height of web plate)

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case II	CHECKED BY:	JRA	DATE:	6/6/19

Carroll Street Design Case II - Area Load Surcharge

Transverse Stiffener Angles:

n_{ats} = 112 (Number of transverse stiffener angles)

Angles = L3-1/2x3-1/2x3/8

Wt_{ats} = 8.5

L_{ats} = 5 *ft* (Lenth of transverse stiffener angles)

wt_g = 256.10 *lb/ft* (Wt./ft of s. fascia girder)

wt/ft = 294.52 *lb/ft* (Total weight per ft w/ 15% added for rivits)

Stringers:

n_s = 7 (Number of longitudinal stringers)

size = W8x48 (Size of member)

wt_{st} = 48 *lb/ft* (Wt. per ft)

Total wt/ft = 336 *lb/ft* (Total weight per ft of bridge)

Floor Beam:

n_{fb} = 8 (Number of floor beams on bridge)

size = W21x83 (Size of member)

wt_{fb} = 83 *lb/ft* (Wt. per ft)

Total wt/ft = 120 *lb/ft* (Total weight per ft of bridge)

Deck:

Total wt/ft = 760 *lb/ft* (Total weight per ft of bridge)

S. Fascia Sidewalk deck:

Total wt/ft = 45 *lb/ft* (Total weight per ft of girder)

Sidewalk Longitudinal Joists:

n_{sj} = 3 (Number of joists)

b_{ds} = 2 *in* (Assume 2"x8" timber deck supports)

d_{ds} = 8 *in*

Total wt/ft = 20 *lb/ft* (Total weight per ft of bridge)

Sidewalk Transverse deck supports:

n_{sss} = 18 (Number of sidewalk supports on south fascia)

size = 2L3x3x3/8 (Size of angle sidwalk supports)

wt_{ss} = 14.36 *lb/ft* (wt. per ft of angle)

Total wt/ft = 21 *lb/ft* (Total weight per ft of bridge)

Railing:

Total wt/ft = 200 *lb/ft* (Assume 200lb/ft)

Curb:

size = 1'x1' *ft* (Size of timber curb)

Total wt/ft = 60 *lb/ft* (Total weight per ft of bridge)

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: OF
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case II CHECKED BY: JRA DATE: 6/6/19

Carroll Street Design Case II - Area Load Surcharge

Overhead Steel Frame:

n_c = 4 (Number of channels in steel frame)
size = C6x40 (Size of channel)
wt_c = 40 *lb/ft*
L_c = 16 *ft* (Length of channels)
Total wt= *2560 lb* (Total wt. of channels)
n_{ta} = 12 (number of truss angles)
size = L2-1/2x2-1/2x3/8 (Size of truss angles)
wt_{ss} = 5.90 *lb/ft* (wt. per ft of truss angle)
L_{ta} = 3 *ft* (Length of truss angles)
Total wt= 212 *lb/ft* (Total weight of truss angles)
n_{sa} = 2 (Number of top and bottom angle struts)
size = L3x3x3/8 (size of top and bottom angle struts)
wt_{ss} = 7.20 *lb/ft* (wt. per foot of top and bottom angle struts)
L_{ta} = 19 *ft* (Top and bottom angle struts)
Total wt= 274 *lb* (Total wt. of top and bottom angle struts)
Total wt = 3046 *lb/ft* (Total weight of overhead steel frame)

Total DL per ft. of S. Fascia Girder:

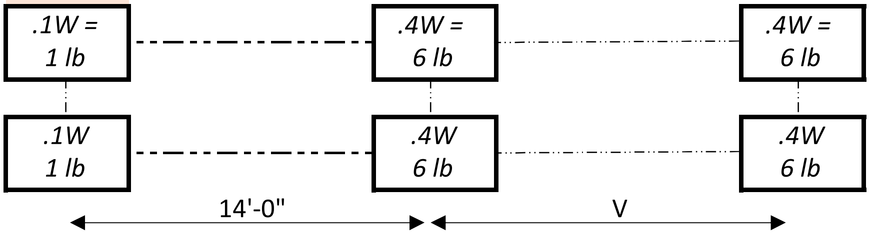
w_{DL} = 1498 *lb/ft* (20% Added to account for DL of Connections and assumptions)
P_{DL} = 1904 *lb* (Dead load from Overhead Steel Frame 20% added)

Live Load:

Vehicular Live Load:

Standard HS-20 Truck:

$W_{HS\text{-}20}$ = 40000 *lb* Stand H Truck: *Ref. 3 Figure 3.7.7A*



Standard HS-20 Lane Loading: *Ref. 3 Figure 3.7.6B*

w_{LL} = 0.64 *klf* (Uniform lane load per linear foot of lane load
$P_{LL,S}$ = 26 kip (Concentrated load for shear)
$P_{LL,m}$ = 18 kip (Concentrated load for moment)

Sidewalk Loading:

P_s = 85 *psf* *Ref. 3 Section 3.14.1.3*
w_{sw} = 383 *lb/ft* (Live load sidewalk loading per ft of bridge)

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: OF
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case II CHECKED BY: JRA DATE: 6/6/19

Carroll Street Design Case II - Area Load Surcharge

Distribution Factor:

DF = 1.00

Combinations of Loads: *Ref. 5 Table 3.22.1A*

AASHTO Loading	
Group	Factors Used
I	$\gamma\,(D + LL + \beta_E E)$

**No impact included for substructures or retaining walls* Ref. 5 Section 3.8.1.2

γ = *1.0* *Ref. 5 Table 3.22.1A*

β_E = *1.0* *for vertical and lateral earth pressure on retaining walls*

Calculate Rail Reaction (R_3) due to DL&LL of Bridge:

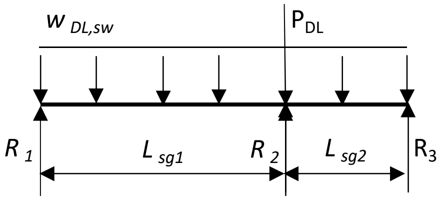
LEAP CONSYS was used to calculate the rail reaction due to DL, HS-20 LL and Sidewalk LL

R_{3DL} = 15916 *lb* *Attachment B Page B-1*

$R_{3HS\text{-}20}$ = 54809 *lb* *Attachment B Page B-2*

R_{3LANE} = 39019 *lb* *Attachment B Page B-3*

R_{3SW} = 4069 *lb*



GROUP I Total Vertical Load (P_{vl}')

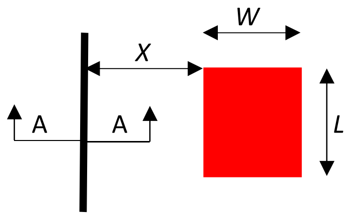
$P_{vl}' = (R_{3DL} + Max(R_{3HS\text{-}20}, R_{3LANE}) + R_{3SW})*2bearings$

P_{vl}' = 149588 *lb* (Total Vertical Load on Footing)

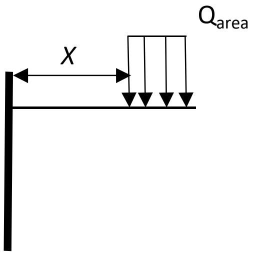
Calculate Magnitude of Area Load input into CivilTech:

				Group I
Design Location	*L (ft)*	*W (ft)*	*X (ft)*	*Q_{area} (ksf)*
CSDL05	*32.58*	*6*	*1*	*0.77*

**See diagram for definition of L, W, X and Q_{area}*



Wall Plan View



Section A-A

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PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case II	CHECKED BY:	JRA	DATE:	6/6/19

Carroll Street Design Case II - Area Load Surcharge

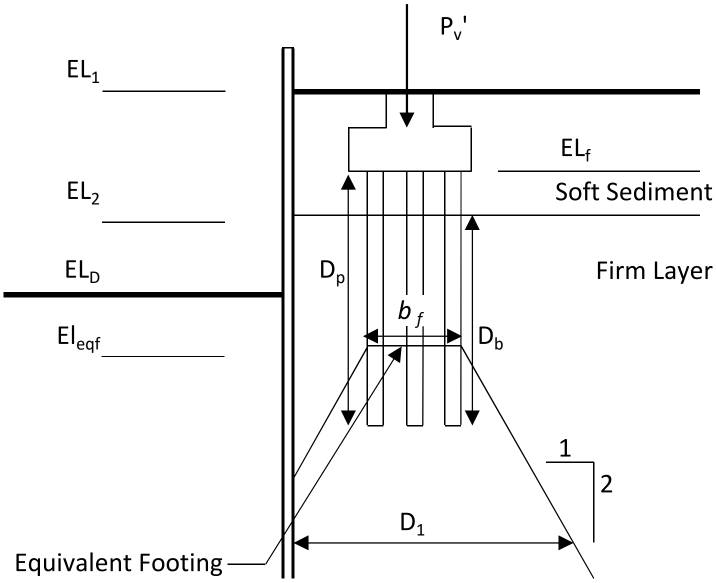
Calculation of Depth of Applied Surcharge Loading:

Calculate Location of Equivalent Footing: *Ref. 5 Figure 10.7.2.3.1-1*

$D_b = D_p\text{-}(EL_f\text{-}EL_2)$ (Total depth of pile in firm soil layer)

$EL_{eqf} = EL_f\text{-}D_p+1/3D_b$ (Elevation of equivalent footing) *Ref. 5 Figure 10.7.2.3.1-1*

Design Location	EL_f	EL_1	EL_2	D_p	D_b	El_{eqf}
CSDL05	*4.58*	*-9.00*	*-16.00*	*20.00*	-0.58	-15.61



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PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case II	CHECKED BY:	JRA	DATE:	6/6/19

RTA 1 - Carroll Street Design Case II - CSDL05

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88)

EL_1 = -9.00 *ft* (Minimum existing bathmetry elevation)

EL_2 = -16.00 *ft* (Minimum el. of soft-native interface) *Appendix C Table 1d*

EL_3 = -19.00 *ft* (Minimum el. of native-glacial interface) *Appendix C Table 1d*

El_D = -17.50 *ft* (Dredge elevation)

H = 8.50 *ft* (Dredge height)

EL_{TOP} = -8.77 *ft* (Top of wall elevation)

EL_{TOE} = -37.00 *ft* (Toe of wall elevation)

H_w = 29.00 *ft* (Total length of pile, 20% Additional Embedment included)

MHW EL = 1.96 *ft* (Mean high water elevation)

MLW EL = -2.57 *ft* (Mean low water elevation)

Design of Pile Wall (using CivilTech Shoring Suite):

PIpe Pile Section Properties: *Appendix B*

Pipe: O-Pile 20"_0.625"

Wt = 74.51 lb/ft (Wt of Pipe pile)

b = 22.44 *in* (Width of Pipe pile)

I = 955.56 in^4/ft (Moment of inertia of Pipe pile)

Z = 95.56 in^3/ft (Plastic section modulus of Pipe pile)

Surcharge Loading:

q = 250 *psf* (Applied Surcharge) *Ref. 1 Section II.A.2*

Q_{area} = 0.77 *psf* (Surcharge from bridge superstructure)

Check Pipeing Section:

M_{max} = 28.11 *k-ft* (Maximum moment on wall) *Attachment A - Page A-13*

$\sigma_{allow} = 0.6f_y$ (Allowable stress in Pipe pile)

σ_{allow} = 30 *ksi*

$Z_{min} = M_{max}/\sigma_{allow}$ (Minimum section modulus)

Z_{min} = 11.24 in^3

D/C = 0.12 ***OK***

RTA 1 - Carroll Street Design Case II - CSDL05

Calculate Settlement Behind Wall:

See "Attachment C - Procedure for Estimating Ground Settlement"

δ_{hm} = 0.13 *in* (Calc. Deflection @ top of soil layer 1) *Attachment A - Page A-13*

δ_{vm} = $R\delta_{hm}$ (Maximum ground settlement) δ_{vm} = 0.13 *in*

R = 1.0 (Ratio between ground settlement and wall deflection)

$$\delta_v = \left(-0.636\sqrt{\frac{d}{H_e}} + 1\right)\delta_{vm}\ if\ \frac{d}{H_e} \leq 2;\ and$$

$$\delta_v = \left(-0.171\sqrt{\frac{d}{H_e}} + 0.342\right)\delta_{vm}\ if\ 2 < \frac{d}{H_e} \leq 4$$

d = *1* *ft* (Distance behind the wall)

H_e = 8.50 *ft* (Height of excavation)

δ_v = *0.10* *in* (Ground Settlement at distance d behind the wall)

$\delta_{v,\,allow}$ = 0.25 *in* (Allowable ground settlement)

D/C* =** **0.41** ***OK

Depth of Pipe Pile Wall

D = 27.35 *ft* (Top of Soil Layer 1 to Toe of Pile) *Attachment A - Page A-13*

(20% additional embedment included)

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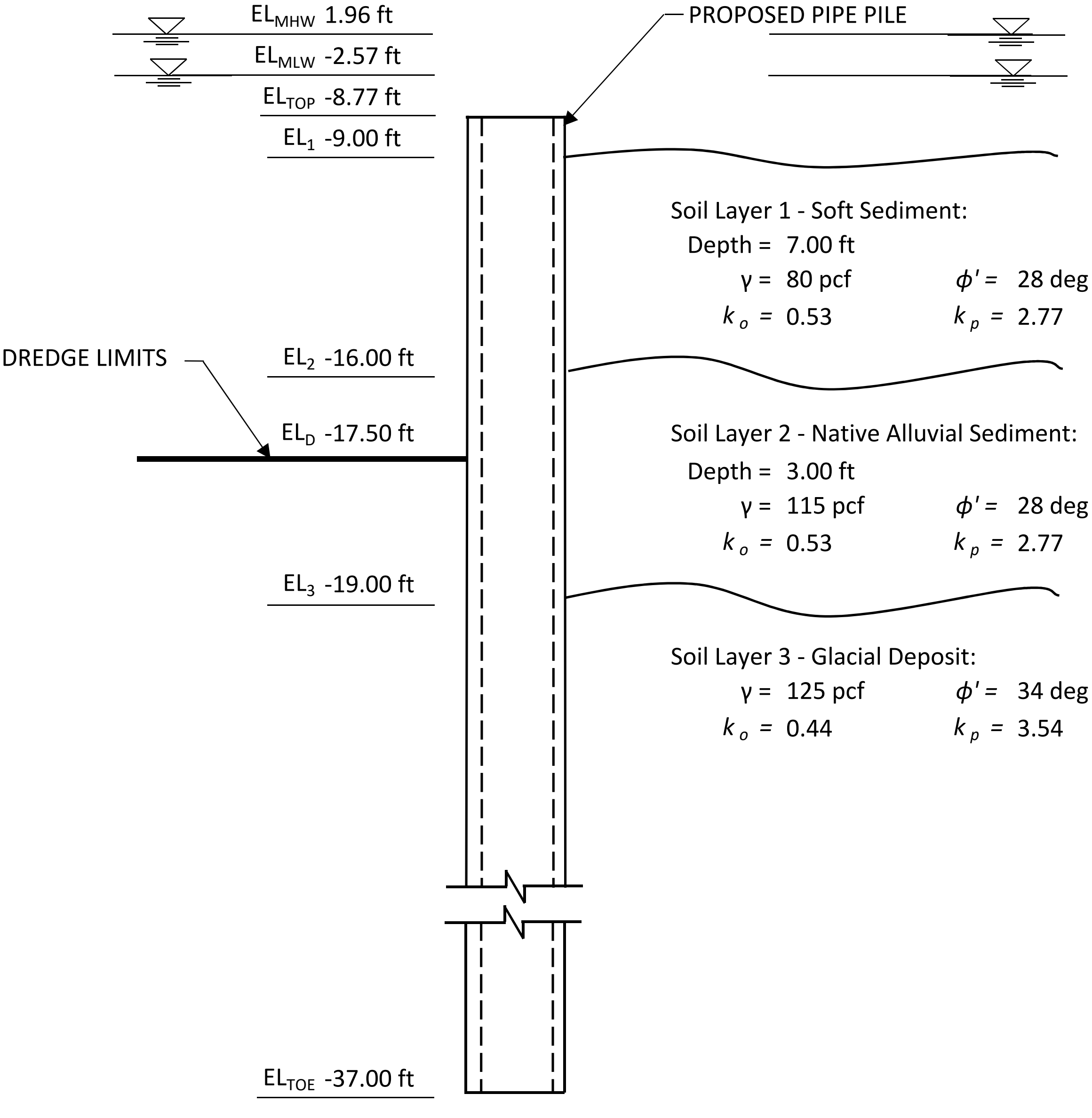
PROJECT: RTA 1 Bridge Stability Final Design SHEET: _____ OF _____
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case II CHECKED BY: JRA DATE: 6/6/19

RTA 1 - Carroll Street Design Case II - CSDL05

Pipe Pile Cross-Section (Not to Scale):



DESIGN CASE III

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PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case III CHECKED BY: JRA DATE: 6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case III - Summary of Results

References:

1. NYSDOT Geotechnical Design Procedure for Flexible Wall Systems - Aug 2015
2. NYSDOT Bridge Manual - 2017
3. AASHTO Standard Specifications for Highway Bridges, 17th Edition - 2002
4. USS Sheet Piling Design Manual - 1984
5. AASHTO LRFD Bridge Design Specifications - Seventh Edition with 2016 Iterim Revisions
6. NYSDOT Standard Specifications
7. Hsieh, Pio-Go and Ou, Chang-Yu. "Shape of Ground Surface Settlement Profiles Caused by Excavation." *Canadian Geotechnical Journal 35(6):1004-1017* (1998)

Appendices:

Appendix A - RTA 1 Bridge Soil Design Parameters by GZA GeoEnvironmental, Inc.
Appendix B - O-Pile Datasheet
Appendix C - Summary of Geotechnical Design Parameters by Geosyntec Consultants

Purpose & Assumptions:

This design case represents a temporary condition where the bridge is in the open position (closed to traffic). See design summary for full assumptions.

- Factory of safety of 1.25 will be applied to the coefficient of passive earth pressure as per Reference 1 Section II.B.1.

Summary of Results:

The results of the verification are summarized in the table below:

Design Checks								
Design Location	**Moment Capacity**				**Settlement (in)**			
	Z_{req} (in^3)	Z (in^3)	**D/C**	**Check**	δ_v	$\delta_{v, allow}$	**D/C**	**Check**
CSDL02	1.41	95.56	0.01	OK	0.03	0.25	0.12	OK
CSDL03	6.89	95.56	0.07	OK	0.12	0.25	0.46	OK

Pipe Pile Information						
Design Location	**Elevations (ft)**			**Section**	**Wall Height**	**Pile Length**
	Top	Min. Tip	Dredge			
CSDL02	-8.77	-27.00	-18.00	O-Pile 20"_0.625"	7.50	19.00
CSDL03	-3.00	-33.00	-17.75	O-Pile 20"_0.625"	14.00	30.00

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PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case III	CHECKED BY:	JRA	DATE:	6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case I - Inputs

Pipe Pile Material:

ASTM A 572 Gr. 50 Steel:

F_y = 50 *ksi*

E = 29000 *ksi* *Ref. 5 Section 6.4.1*

Soil Parameters:

Constants:

γ_w = 62.4 *pcf* (Unit weight of water)

Soil Layer 1 - Soft Sediment:

γ = 80 *pcf* (Total unit weight) *Appendix A - Page AP-1*

φ' = 28 *deg* (Effective Friction Angle) *Appendix A - Page AP-1*

$\gamma' = \gamma - \gamma_w$ (Effective unit weight)

γ' = 17.6 *pcf*

$K_o = 1 - \sin \emptyset'$ (At-rest pressure coefficient) *Ref. 5 Eq. 3.11.5.2-1*

k_o = 0.53

$$K_p = \frac{1 + \sin \emptyset'}{1 - \sin \emptyset'}$$ (Passive pressure coefficient) *Ref. 1 Appendix A - Page A-1*

k_p = 2.77

$F.S.$ = 1.25 (Factor of Safety) *Ref. 1 Section II.B.1*

$K_p' = K_p/F.S.$ (Effective Passive Pressure Coefficient)

K_p' = 2.22

Soil Layer 2 - Native Alluvial Sediment:

γ = 115 *pcf* (Total unit weight) *Appendix A - Page AP-1*

φ' = 28 *deg* (Effective Friction Angle) *Appendix A - Page AP-1*

$\gamma' = \gamma - \gamma_w$ (Effective unit weight)

γ' = 52.6 *pcf*

$K_o = 1 - \sin \emptyset'$ (At-rest pressure coefficient) *Ref. 5 Eq. 3.11.5.2-1*

k_o = 0.53

$$K_p = \frac{1 + \sin \emptyset'}{1 - \sin \emptyset'}$$ (Passive pressure coefficient) *Ref. 1 Appendix A - Page A-1*

k_p = 2.77

$F.S.$ = 1.25 (Factor of Safety) *Ref. 1 Section II.B.1*

$K_p' = K_p/F.S.$ (Effective Passive Pressure Coefficient)

K_p' = 2.22

Soil Layer 3 - Glacial Deposit:

γ = 125 *pcf* (Total unit weight) *Appendix A - Page AP-1*

φ' = 34 *deg* (Effective Friction Angle) *Appendix A - Page AP-1*

$\gamma' = \gamma - \gamma_w$ (Effective unit weight)

γ' = 62.6 *pcf*

$K_o = 1 - \sin \emptyset'$ (At-rest pressure coefficient) *Ref. 5 Eq. 3.11.5.2-1*

k_o = 0.44

$$K_p = \frac{1 + \sin \emptyset'}{1 - \sin \emptyset'}$$

(Passive pressure coefficient) *Ref. 1 Appendix A - Page A-1*

k_p = 3.54

F.S. = 1.25 (Factor of Safety) *Ref. 1 Section II.B.1*

$K_p' = K_p/F.S.$ (Effective Passive Pressure Coefficient)

K_p' = 2.83

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PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case III	CHECKED BY:	JRA	DATE:	6/4/19

Carroll Street Pipe Pile Design Case III - Surcharge

Dead Load of Bridge:

Calculate the reaction at the south fascia interior support on the rail concrete cap beam:

Material Weights:

wt_s =	490	*pcf*	(Unit weight of steel)	*Ref. 5 Table 3.5.1-1*
wt_w =	60	*pcf*	(Unit weight of hard wood)	*Ref. 5 Table 3.5.1-1*
wt_C =	150	*pcf*	(Unit weight of concrete)	*Ref. 5 C3.5.1-1*

Geometry:

S =	105	*ft*	(Combined span length of bridge)
S_1 =	61	*ft*	(Length of span 1)
S_2 =	44	*ft*	(Length of span 2)
L_{sg} =	120	*ft*	(Length of s. fascia girder)
L_{sg1} =	75	*ft*	(Length of s. fascia girder span 1)
L_{sg2} =	45	*ft*	(Length of s. fascia girder span 2)
t_d =	8	*in*	(Thickness of timber deck)
W_d =	19	*ft*	(Width of deck)
W_s =	4.5	*ft*	(Width of sidewalk)
t_s =	2	*in*	(Thickness of timber sidewalk deck)
s_g =	19	*ft*	(Spacing of girders)

Built-up Girders:

South Fascia Girder (Controls):

Top & Bottom Flange:

n_{af} =	2		(Number of Angles per flange)
Angles =	L5x3-1/2x7/16		
Wt_{af} =	12	*lb/ft*	(wt. per foot per angle)
n_{covf} =	3		(Number of cover plates per flange)
w_{cov} =	12	*in*	(Width of cover plate)
t_{cov} =	0.375	*in*	(Thickness of cover plate)

Web:

t_{web} =	0.38	*in*	(Thickness of web plate)
h_{web} =	60	*in*	(Height of web plate)

Transverse Stiffener Angles:

n_{ats} =	112		(Number of transverse stiffener angles)
Angles =	L3-1/2x3-1/2x3/8		
Wt_{ats} =	8.5		
L_{ats} =	5	*ft*	(Lenth of transverse stiffener angles)
wt_g =	256.10	*lb/ft*	(Wt./ft of s. fascia girder)
wt/ft =	294.52	*lb/ft*	(Total weight per ft w/ 15% added for rivits)

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PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______

JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19

SUBJECT: RTA 1 - Carroll Street Design Case III CHECKED BY: JRA DATE: 6/4/19

Carroll Street Pipe Pile Design Case III - Surcharge

Stringers:

n_s = 7 (Number of longitudinal stringers)

size = W8x48 (Size of member)

wt_{st} = 48 *lb/ft* (Wt. per ft)

Total wt/ft = 336 *lb/ft* (Total weight per ft of bridge)

Floor Beam:

n_{fb} = 8 (Number of floor beams on bridge)

size = W21x83 (Size of member)

wt_{fb} = 83 *lb/ft* (Wt. per ft)

Total wt/ft = 120 *lb/ft* (Total weight per ft of bridge)

Deck:

Total wt/ft = 760 *lb/ft* (Total weight per ft of bridge)

S. Fascia Sidewalk deck:

Total wt/ft = 45 *lb/ft* (Total weight per ft of girder)

Sidewalk Longitudinal Joists:

n_{sj} = 3 (Number of joists)

b_{ds} = 2 *in* (Assume 2"x8" timber deck supports)

d_{ds} = 8 *in*

Total wt/ft = 20 *lb/ft* (Total weight per ft of bridge)

Sidewalk Transverse deck supports:

n_{sss} = 18 (Number of sidewalk supports on south fascia)

size = 2L3x3x3/8 (Size of angle sidwalk supports)

wt_{ss} = 14.36 *lb/ft* (wt. per ft of angle)

Total wt/ft = 21 *lb/ft* (Total weight per ft of bridge)

Railing:

Total wt/ft = 200 *lb/ft* (Assume 200lb/ft)

Curb:

size = 1'x1' *ft* (Size of timber curb)

Total wt/ft = 60 *lb/ft* (Total weight per ft of bridge)

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PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case III	CHECKED BY:	JRA	DATE:	6/4/19

Carroll Street Pipe Pile Design Case III - Surcharge

Overhead Steel Frame:

n_c =	4		(Number of channels in steel frame)
size =	C6x40		(Size of channel)
wt_c =	40	*lb/ft*	
L_c =	16	*ft*	(Length of channels)
Total wt=	*2560*	*lb*	(Total wt. of channels)
n_{ta} =	12		(number of truss angles)
size =	L2-1/2x2-1/2x3/8		(Size of truss angles)
wt_{ss} =	5.90	*lb/ft*	(wt. per ft of truss angle)
L_{ta} =	3	*ft*	(Length of truss angles)
Total wt=	212	*lb/ft*	(Total weight of truss angles)
n_{sa} =	2		(Number of top and bottom angle struts)
size =	L3x3x3/8		(size of top and bottom angle struts)
wt_{ss} =	7.20	*lb/ft*	(wt. per foot of top and bottom angle struts)
L_{ta} =	19	*ft*	(Top and bottom angle struts)
Total wt=	274	*lb*	(Total wt. of top and bottom angle struts)
Total wt =	3046	*lb/ft*	(Total weight of overhead steel frame)

Total DL per ft. of S. Fascia Girder:

w_{DL} =	1498	*lb/ft*	(20% Added to account for DL of Connections and assumptions)
P_{DL} =	1904	*lb*	(Dead load from Overhead Steel Frame 20% added)

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PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case III	CHECKED BY:	JRA	DATE:	6/4/19

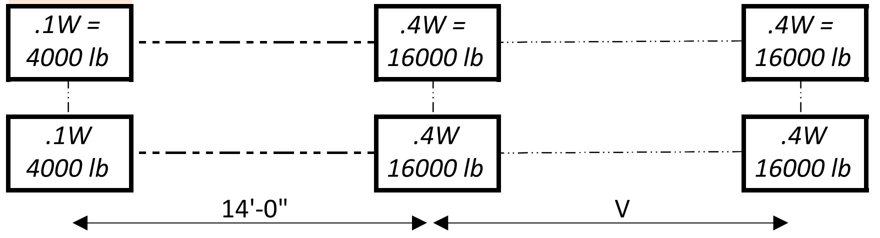
Carroll Street Pipe Pile Design Case III - Surcharge

Live Load:

Vehicular Live Load:

Standard HS-20 Truck:

$W_{HS\text{-}20}$ = 40000 *lb* Stand H Truck: *Ref. 3 Figure 3.7.7A*



Standard HS-20 Lane Loading: *Ref. 3 Figure 3.7.6B*

w_{LL} = 0.64 *klf* (Uniform lane load per linear foot of lane load

$P_{LL,S}$ = 26 kip (Concentrated load for shear)

$P_{LL,m}$ = 18 kip (Concentrated load for moment)

Sidewalk Loading:

P_s = 85 *psf* *Ref. 3 Section 3.14.1.3*

w_{sw} = 170 *lb/ft* (Live load sidewalk loading per ft of bridge)

Distribution Factor:

DF = 1.00

Combinations of Loads: *Ref. 3 Table 3.22.1A*

AASHTO Loading	
Group	Factors Used
I	$\gamma\,(D + LL + \beta_E E)$

**No impact included for substructures or retaining walls* Ref. 3 Section 3.8.1.2

γ = *1.0* *Ref. 3 Table 3.22.1A*

β_E = *1.0* *for vertical and lateral earth pressure on retaining walls*

Calculate Rail Reaction (R_2) due to DL&LL of Bridge:

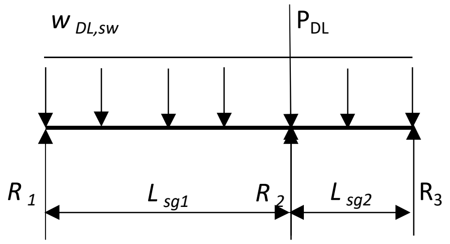
LEAP CONSYS was used to calculate the rail reaction due to DL, HS-20 LL and Sidewalk LL

R_{2DL} = 120246 *lb* *Attachment B Page B-1*

$R_{2HS\text{-}20}$ = 73042 *lb* *Attachment B Page B-2*

R_{2LANE} = 77665 *lb*

R_{2SW} = 30257 *lb* *Attachment B Page B-3*



PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case III	CHECKED BY:	JRA	DATE:	6/4/19

Carroll Street Pipe Pile Design Case III - Surcharge

Calculation of Area Surcharge due to Bridge DL&LL:

Calculate Total Vertical Load on rectangular footing:

b_f = 4.5 *ft* (Width of rail cap beam footing)

L_c = 54 *ft* (Length of rail cap beam footing)

t_f = 2.50 *ft* (Thickness of rail cap footing)

b_s = 2.00 *ft* (Thickness of rail cap stem)

h_s = 3.00 *ft* (Height of rail cap stem)

GROUP I Total Vertical Load (P_{vl}')

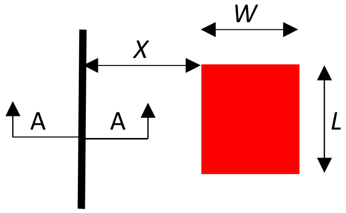
$$P_{vl}' = R_{2DL} + Max(R_{2HS-20}, R_{2LANE}) + R_{2SW} + (h_s b_s + t_f b_f) L_c w_c$$

P_{vl}' = 367893 *lb* (Total Vertical Load on Footing Group I)

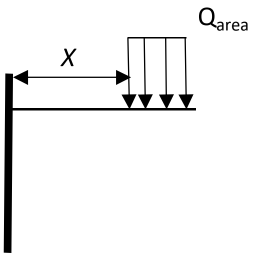
Calculate Magnitude of Area Load input into CivilTech:

				Group I
Design Location	*L (ft)*	*W (ft)*	*X (ft)*	Q_{area} *(ksf)*
CSDL02	*4.5*	*54*	*2*	*1.51*
CSDL03	*54*	*4.5*	*12*	*1.51*

**See diagram for definition of L, W, X and* Q_{area}



Wall Plan View



Section A-A

Carroll Street Pipe Pile Design Case III - Surcharge

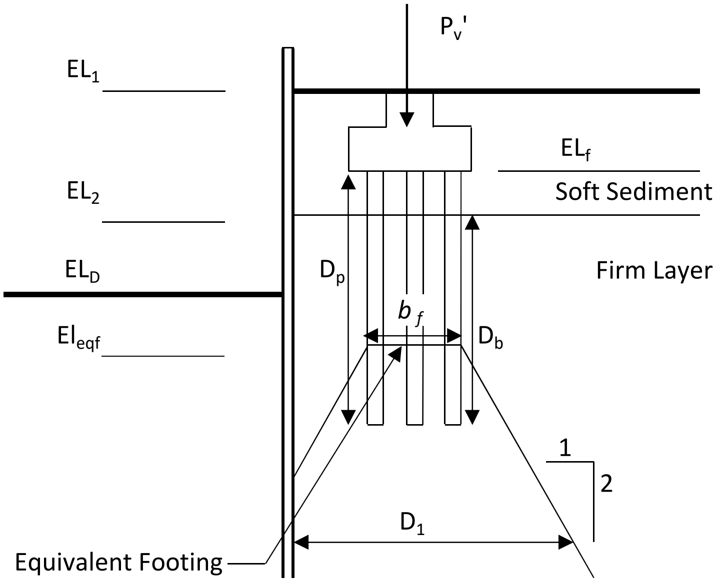
Calculation of Depth of Applied Surcharge Loading:

Calculate Location of Equivalent Footing: *Ref. 5 Figure 10.7.2.3.1-1*

$D_b = D_p-(EL_f-EL_2)$ (Total depth of pile in firm soil layer)

$EL_{eqf} = EL_f-D_p+1/3D_b$ (Elevation of equivalent footing) *Ref. 5 Figure 10.7.2.3.1-1*

Design Location	EL_f	EL_1	EL_2	D_p	D_b	El_{eqf}
CSDL02	*-2.41*	*-10.50*	*-17.50*	*20.00*	4.91	-20.7733
CSDL03	*-2.41*	*-3.75*	*-17.50*	*20.00*	4.91	-20.7733



GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case III	CHECKED BY:	JRA	DATE:	6/4/19

RTA 1 - Carroll Street Design Case III - CSDL02

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88)

EL_1 =	-10.50	*ft*	(Minimum existing bathmetry elevation)	
EL_2 =	-17.50	*ft*	(Minimum el. of soft-native interface)	*Appendix C Table 1d*
EL_3 =	-18.00	*ft*	(Minimum el. of native-glacial interface)	*Appendix C Table 1d*
El_D =	-18.00	*ft*	(Dredge elevation)	
H =	7.50	*ft*	(Dredge height)	
EL_{TOP} =	-8.77	*ft*	(Top of wall elevation)	
EL_{TOE} =	-27.00	*ft*	(Toe of wall elevation)	
H_w =	18.23	*ft*	(Total length of pile, 20% Additional Embedment included)	
MHW EL =	1.96	*ft*	(Mean high water elevation)	
MLW EL =	-2.57	*ft*	(Mean low water elevation)	

Design of Pile (using CivilTech Shoring Suite):

Pipe Pile Section Properties: *Appendix B*

Pile: O-Pile 20"_0.625"

Wt =	74.51	lb/ft	(Wt of pipe pile)	
b =	22.44	*in*	(Width of pipe pile)	
I =	955.56	in^4/ft	(Moment of inertia of pipe pile)	
Z =	95.56	in^3/ft	(Plastic section modulus of pipe pile)	

Surcharge Loading:

q =	85	*psf*	(Applied Surcharge)	*Ref. 5 Section 3.14.1*
Q_{area} =	1513.96	*psf*	(Area surcharge from bridge structure)	

Check Pile Section:

M_{max} =	3.52	*k-ft*	(Maximum moment on wall)	*Attachment A - Page A-20*

$\sigma_{allow} = 0.6f_y$ (Allowable stress in pipe pile)

σ_{allow} = 30 *ksi*

$Z_{min} = M_{max} / \sigma_{allow}$ (Minimum section modulus)

Z_{min} = 1.41 in^3

D/C = 0.01 ***OK***

RTA 1 - Carroll Street Design Case III - CSDL02

Calculate Settlement Behind Wall:

See "Attachment C - Procedure for Estimating Ground Settlement"

δ_{hm} = 0.04 *in* (Calc. Deflection @ top of soil layer 1) *Attachment A - Page A-20*

$\delta_{vm} = R\delta_{hm}$ (Maximum ground settlement) δ_{vm} = 0.04 *in*

R = 1.0 (Ratio between ground settlement and wall deflection)

$$\delta_v = \left(-0.636\sqrt{\frac{d}{H_e}} + 1\right)\delta_{vm}\ if\ \frac{d}{H_e} \leq 2; and$$

$$\delta_v = \left(-0.171\sqrt{\frac{d}{H_e}} + 0.342\right)\delta_{vm}\ if\ 2 < \frac{d}{H_e} \leq 4$$

d = 1 *ft* (Distance behind the wall)

H_e = 7.50 *ft* (Height of excavation)

δ_v = *0.03 in* (Ground Settlement at distance d behind the wall)

$\delta_{v, allow}$ = 0.25 *in* (Allowable ground settlement)

D/C* = 0.12** ***OK

Depth of Sheeting:

D = 16.2 *ft* (Top of Soil Layer 1 to Toe of Pile) *Attachment A - Page A-20*

(20% additional embedment included)

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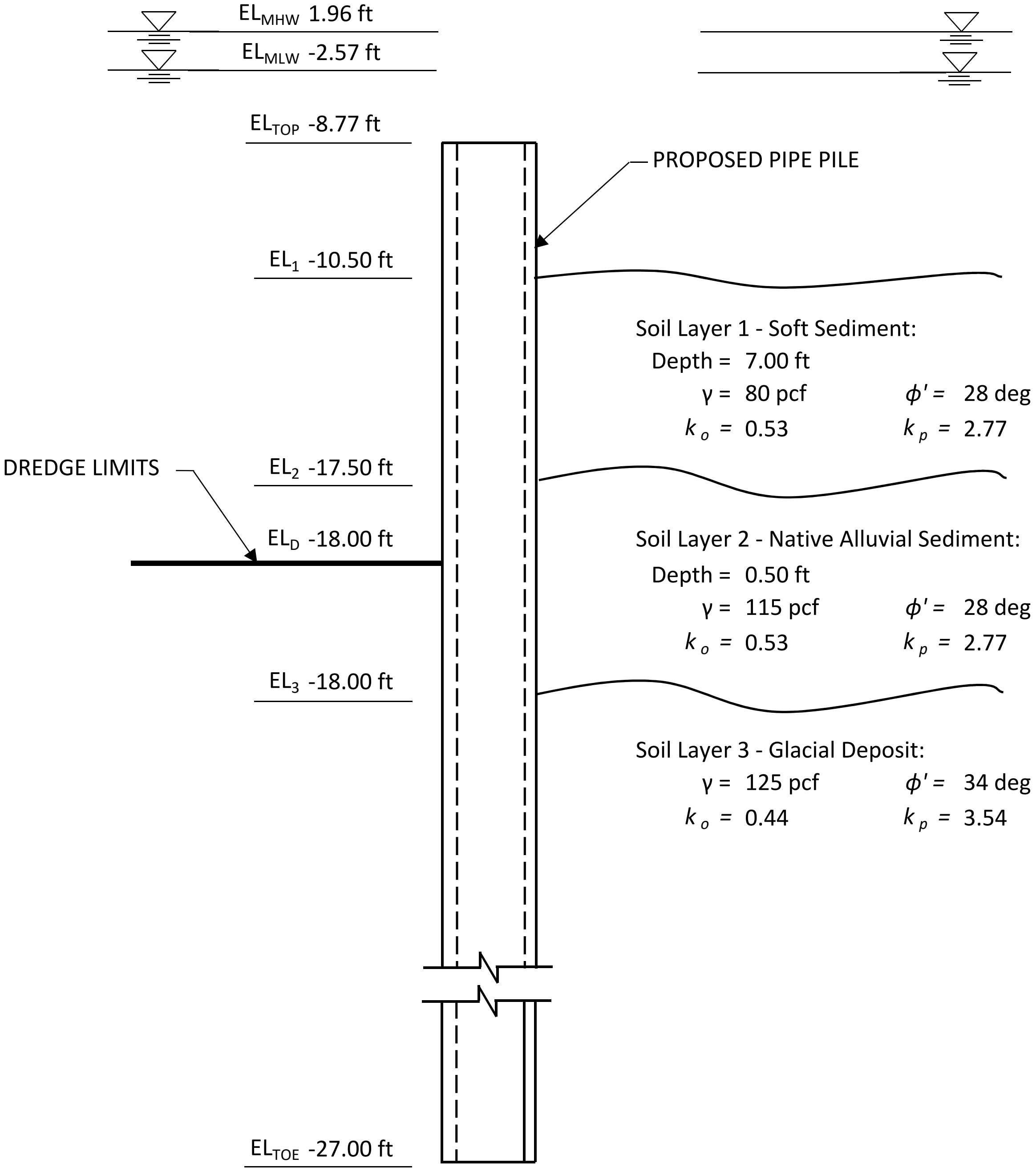
PROJECT: RTA 1 Bridge Stability Final Design SHEET: OF
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case III CHECKED BY: JRA DATE: 6/4/19

RTA 1 - Carroll Street Design Case III - CSDL02

Sheet Pile Cross-Section (Not to Scale):



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PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case III	CHECKED BY:	JRA	DATE:	6/4/19

RTA 1 - Carroll Street Design Case III - CSDL03

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88)

EL_1 =	-3.75	*ft*	(Minimum existing bathmetry elevation)	
EL_2 =	-17.25	*ft*	(Minimum el. of soft-native interface)	*Appendix C Table 1d*
EL_3 =	-21.00	*ft*	(Minimum el. of native-glacial interface)	*Appendix C Table 1d*
El_D =	-17.75	*ft*	(Dredge elevation)	
H =	14.00	*ft*	(Dredge height)	
EL_{TOP} =	-3.00	*ft*	(Top of wall elevation)	
EL_{TOE} =	-33.00	*ft*	(Toe of wall elevation)	
H_w =	30.00	*ft*	(Total length of pile, 20% Additional Embedment included)	
MHW EL =	1.96	*ft*	(Mean high water elevation)	
MLW EL =	-2.57	*ft*	(Mean low water elevation)	

Design of Pile (using CivilTech Shoring Suite):

Pipe Pile Section Properties: *Appendix B*

Pile:	O-Pile 20"_0.625"			
Wt =	74.51	lb/ft	(Wt of pipe pile)	
b =	22.44	*in*	(Width of pipe pile)	
I =	955.56	in^4/ft	(Moment of inertia of pipe pile)	
Z =	95.56	in^3/ft	(Plastic section modulus of pipe pile)	

Surcharge Loading:

q =	85	*psf*	(Applied Surcharge)	*Ref. 5 Section 3.14.1*
Q_{area} =	1513.96	*psf*	(Area surcharge from bridge structure)	

Check Pile Section:

M_{max} =	17.22	*k-ft*	(Maximum moment on wall)	*Attachment A - Page A-26*

$\sigma_{allow} = 0.6f_y$ (Allowable stress in pipe pile)

$\sigma_{allow} =$ 30 *ksi*

$Z_{min} = M_{max} / \sigma_{allow}$ (Minimum section modulus)

$Z_{min} =$ 6.89 in^3

D/C = 0.07 ***OK***

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case III CHECKED BY: JRA DATE: 6/4/19

RTA 1 - Carroll Street Design Case III - CSDL03

Calculate Settlement Behind Wall:

See "Attachment C - Procedure for Estimating Ground Settlement"

δ_{hm} = 0.14 *in* (Calc. Deflection @ top of soil layer 1) *Attachment A - Page A-26*
δ_{vm} = $R\delta_{hm}$ (Maximum ground settlement) δ_{vm} = 0.14
R = 1.0 (Ratio between ground settlement and wall deflection)

$$\delta_v = \left(-0.636\sqrt{\frac{d}{H_e}} + 1\right)\delta_{vm}\ if\ \frac{d}{H_e} \le 2;\ and$$

$$\delta_v = \left(-0.171\sqrt{\frac{d}{H_e}} + 0.342\right)\delta_{vm}\ if\ 2 < \frac{d}{H_e} \le 4$$

d = *1* *ft* (Distance behind the wall)
H_e = 14.00 *ft* (Height of excavation)
δ_v = *0.12* *in* (Ground Settlement at distance d behind the wall)
$\delta_{v,\ allow}$ = 0.25 *in* (Allowable ground settlement)
D/C* =** **0.46** ***OK

Depth of Sheeting:

D = 28.97 *ft* (Top of Soil Layer 1 to Toe of Pile) *Attachment A - Page A-26*
(20% additional embedment included)

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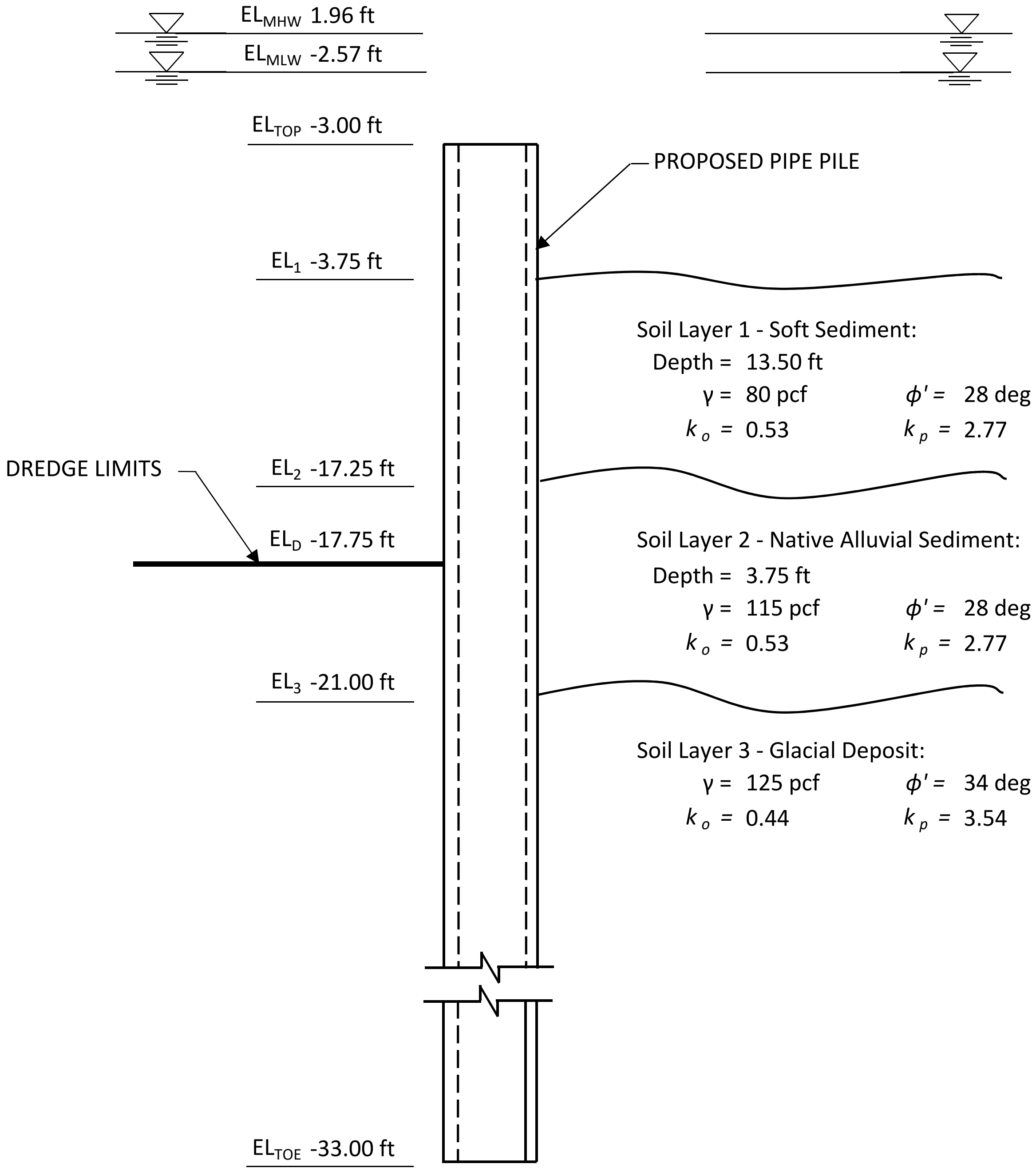
PROJECT: RTA 1 Bridge Stability Final Design SHEET: OF
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case III CHECKED BY: JRA DATE: 6/4/19

RTA 1 - Carroll Street Design Case III - CSDL03

O-Pile Cross-Section (Not to Scale):



DESIGN CASE IV

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case IV CHECKED BY: JRA DATE: 6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case IV - Summary of Results

References:

1. NYSDOT Geotechnical Design Procedure for Flexible Wall Systems - Aug 2015
2. NYSDOT Bridge Manual - 2017
3. AASHTO Standard Specifications for Highway Bridges, 17th Edition - 2002
4. USS Sheet Piling Design Manual - 1984
5. AASHTO LRFD Bridge Design Specifications - Seventh Edition with 2016 Iterim Revisions
6. NYSDOT Standard Specifications
7. Hsieh, Pio-Go and Ou, Chang-Yu. "Shape of Ground Surface Settlement Profiles Caused by Excavation." *Canadian Geotechnical Journal 35(6):1004-1017* (1998)
8. NYCDOT Seismic Design Guidelines for Bridges in Downstate Region - May 2016

Appendices:

Appendix A - RTA 1 Bridge Soil Design Parameters by GZA GeoEnvironmental, Inc.
Appendix B - O-Pile Datasheet
Appendix C - Summary of Geotechnical Design Parameters by Geosyntec Consultants

Purpose & Assumptions:

This design case represents a final condition where the bridge is in the closed position (open to traffic). See design summary for full list of assumptions.

- A surcharge loading of 250 psf is applied to the proposed pipe pile wall.
- Factory of safety of 1.5 will be applied to the coefficient of passive earth pressure as per Reference 1 Section II.B.2.

Summary of Results:

The design results are summarized in the table below:

Design Checks									
Design Location	**Load Group**	**Moment Capacity**				**Settlement (in)**			
		Z_{req} (in^3)	Z (in^3)	**D/C**	**Check**	δ_v	$\delta_{v, allow}$	**D/C**	**Check**
CSDL01	I	9.60	95.56	0.10	OK	0.11	0.25	0.45	OK
	VII	2.56	95.56	0.03	OK	0.08	0.25	0.32	OK
CSDL04	I	9.21	95.56	0.10	OK	0.11	0.25	0.45	OK
	VII	2.38	95.56	0.02	OK	0.10	0.25	0.38	OK
CSDL06	I	9.72	95.56	0.10	OK	0.12	0.25	0.48	OK
	VII	2.32	95.56	0.02	OK	0.10	0.25	0.39	OK

Pipe Pile Information						
Design Location	**Elevations (ft)**			**Section**	**Wall Height**	**Pile Length**
	Top	Min. Tip	Dredge			
CSDL01	-3.00	-34.00	-15.00	O-Pile 20"_0.625"	11.00	31.00
CSDL04	-3.00	-33.00	-13.50	O-Pile 20"_0.625"	9.75	30.00
CSDL06	-3.00	-33.00	-13.50	O-Pile 20"_0.625"	10.50	30.00

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PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case IV	CHECKED BY:	JRA	DATE:	6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case IV - Inputs

Pipe Pile Material:

ASTM A 572 Gr. 50 Steel:

F_y = 50 ksi

E = 29000 ksi *Ref. 5 Section 6.4.1*

Soil Parameters:

Constants:

γ_w = 62.4 pcf (Unit weight of water)

Soil Layer 1 - Soft Sediment:

γ = 80 pcf (Total unit weight) *Appendix A - Page AP-1*

φ' = 28 deg (Effective Friction Angle) *Appendix A - Page AP-1*

$\gamma' = \gamma - \gamma_w$ (Effective unit weight)

γ' = 17.6 pcf

$$K_o = 1 - \sin \emptyset'$$

(At-rest pressure coefficient) *Ref. 5 Eq. 3.11.5.2-1*

k_o = 0.53

$$K_p = \frac{1 + \sin \emptyset'}{1 - \sin \emptyset'}$$

(Passive pressure coefficient) *Ref. 1 Appendix A - Page A-1*

k_p = 2.77

F.S. = 1.5 (Factor of Safety) *Ref. 1 Section II.B.2*

$K_p' = K_p/F.S.$ (Effective Passive Pressure Coefficient)

K_p' = 1.85

Soil Layer 2 - Native Alluvial Sediment:

γ = 115 pcf (Total unit weight) *Appendix A - Page AP-1*

φ' = 28 deg (Effective Friction Angle) *Appendix A - Page AP-1*

$\gamma' = \gamma - \gamma_w$ (Effective unit weight)

γ' = 52.6 pcf

$$K_o = 1 - \sin \emptyset'$$

(At-rest pressure coefficient) *Ref. 5 Eq. 3.11.5.2-1*

k_o = 0.53

$$K_p = \frac{1 + \sin \emptyset'}{1 - \sin \emptyset'}$$

(Passive pressure coefficient) *Ref. 1 Appendix A - Page A-1*

k_p = 2.77

F.S. = 1.5 (Factor of Safety) *Ref. 1 Section II.B.2*

$K_p' = K_p/F.S.$ (Effective Passive Pressure Coefficient)

K_p' = 1.85

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case IV	CHECKED BY:	JRA	DATE:	6/4/19

Soil Layer 3 - Glacial Deposit:

γ = 125 *pcf* (Total unit weight) *Appendix A - Page AP-1*

φ' = 34 *deg* (Effective Friction Angle) *Appendix A - Page AP-1*

$\gamma' = \gamma - \gamma_w$ (Effective unit weight)

γ' = 62.6 *pcf*

$$K_o = 1 - \sin \emptyset'$$

(At-rest pressure coefficient) *Ref. 5 Eq. 3.11.5.2-1*

k_o = 0.44

$$K_p = \frac{1 + \sin \emptyset'}{1 - \sin \emptyset'}$$

(Passive pressure coefficient) *Ref. 1 Appendix A - Page A-1*

k_p = 3.54

F.S. = 1.5 (Factor of Safety) *Ref. 1 Section II.B.2*

$K_p' = K_p/F.S.$ (Effective Passive Pressure Coefficient)

K_p' = 2.36

Soil Layer 4 - Sand Backfill/Cap:

γ = 115 *pcf* (Total unit weight) *Appendix A - Page AP-1*

φ' = 30 *deg* (Effective Friction Angle) *Appendix A - Page AP-1*

$\gamma' = \gamma - \gamma_w$ (Effective unit weight)

γ' = 115 *pcf*

$$K_o = 1 - \sin \emptyset'$$

(At-rest pressure coefficient) *Ref. 5 Eq. 3.11.5.2-1*

k_o = 0.50

$$K_p = \frac{1 + \sin \emptyset'}{1 - \sin \emptyset'}$$

(Passive pressure coefficient) *Ref. 1 Appendix A - Page A-1*

k_p = 3.00

F.S. = 1.5 (Factor of Safety) *Ref. 1 Section II.B.2*

$K_p' = K_p/F.S.$ (Effective Passive Pressure Coefficient)

K_p' = 2.00

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PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case IV	CHECKED BY:	JRA	DATE:	6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case IV - CSDL01

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88)

EL_1 =	-4.00	*ft*	(Minimum existing bathmetry elevation)	
EL_2 =	-17.50	*ft*	(Minimum el. of soft-native interface)	*Appendix C Table 1d*
EL_3 =	-19.34	*ft*	(Minimum el. of native-glacial interface)	*Appendix C Table 1d*
EL_C =	-15.00	*ft*	(Environmental cap elevation)	
H =	11.00	*ft*	(Dredge height)	
EL_{TOP} =	-3.00	*ft*	(Top of wall elevation)	
EL_{TOE} =	-34.00	*ft*	(Toe of wall elevation)	
H_w =	31.00	*ft*	(Total length of pile, 20% Additional Embedment included)	
MHW EL =	1.96	*ft*	(Mean high water elevation)	
MLW EL =	-2.57	*ft*	(Mean low water elevation)	

Design of Pile (using CivilTech Shoring Suite):

Pile Pile Section Properties: *Appendix B*

Pile:	O-Pile 20"_0.625"		
Wt =	74.51	lb/ft	(Wt of pipe pile)
b =	22.44	*in*	(Width of pipe pile)
I =	955.56	in^4/ft	(Moment of inertia of pipe pile)
Z =	95.56	in^3/ft	(Plastic section modulus of pipe pile)

Load Combinations:

AASHTO Loading	
Group	Factors Used
I	$\gamma (D + LL + \beta_E E)$
VII	$\gamma (D + E)$

**No impact included for substructures or retaining walls* Ref. 3 Section 3.8.1.2

γ = *1.0* *Ref. 3 Table 3.22.1A*

β_E = *1.0* *for vertical and lateral earth pressure on retaining walls*

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case IV CHECKED BY: JRA DATE: 6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case IV - CSDL01

Load Combination Group I:

Surcharge Loading:

$q =$ 250 *psf* (Applied Surcharge) *Ref. 1 Section II.A.2*

Check Pile Section:

$M_{max} =$ 24.01 *k-ft* (Maximum moment on wall) *Attachment A - Page A-32*

$\sigma_{allow} = 0.6f_y$ (Allowable stress in pipe pile)

$\sigma_{allow} =$ 30 *ksi*

$Z_{min} = M_{max}/\sigma_{allow}$ (Minimum section modulus)

$Z_{min} =$ 9.60 in^3

D/C = **0.10** ***OK***

Calculate Settlement Behind Wall:

See "Attachment C - Procedure for Estimating Ground Settlement"

$\delta_{hm} =$ 0.14 *in* (Calc. Deflection @ top of soil layer 1) *Attachment A - Page A-32*

$\delta_{vm} = R\delta_{hm}$ (Maximum ground settlement) $\delta_{vm} =$ 0.14 *in*

$R =$ 1.0 (Ratio between ground settlement and wall deflection)

$$\delta_v = \left(-0.636\sqrt{\frac{d}{H_e}} + 1\right)\delta_{vm}\ if\ \frac{d}{H_e} \leq 2; and$$

$$\delta_v = \left(-0.171\sqrt{\frac{d}{H_e}} + 0.342\right)\delta_{vm}\ if\ 2 < \frac{d}{H_e} \leq 4$$

$d =$ 1 *ft* (Distance behind the wall)

$H_e =$ 11.00 *ft* (Height of excavation)

$\delta_v =$ *0.11 in* (Ground Settlement at distance d behind the wall)

$\delta_{v, allow} =$ 0.25 *in* (Allowable ground settlement)

D/C = **0.45** ***OK***

Depth of Sheeting:

$D =$ 29.23 *ft* (Top of Soil Layer 1 to Toe of Pile) *Attachment A - Page A-32*
(20% additional embedment included)

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case IV CHECKED BY: JRA DATE: 6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case IV - CSDL01

Load Combination Group VII:

Seismic Loading:

k_h = 0.29 (Horizontal acceleration coefficient) *Attachment D - Page D-2*

k_v = 0 (Vertical acceleration coefficient) *Attachment D - Page D-2*

Check Pile Section:

M_{max} = 6.41 *k-ft* (Maximum moment on wall) *Attachment A - Page A-37*

$\sigma_{allow} = 0.6f_y$ (Allowable stress in pipe pile)

σ_{allow} = 30 *ksi*

$Z_{min} = M_{max} / \sigma_{allow}$ (Minimum section modulus)

Z_{min} = 2.56 in^3

D/C* = 0.03** ***OK

Calculate Settlement Behind Wall:

See "Attachment C - Procedure for Estimating Ground Settlement"

δ_{hm} = 0.1 *in* (Calc. Deflection @ top of soil layer 1) *Attachment A - Page A-37*

$\delta_{vm} = R\delta_{hm}$ (Maximum ground settlement) δ_{vm} = 0.10 *in*

R = 1.0 (Ratio between ground settlement and wall deflection)

$$\delta_v = \left(-0.636\sqrt{\frac{d}{H_e}} + 1\right)\delta_{vm}\ if\ \frac{d}{H_e} \le 2; and$$

$$\delta_v = \left(-0.171\sqrt{\frac{d}{H_e}} + 0.342\right)\delta_{vm}\ if\ 2 < \frac{d}{H_e} \le 4$$

d = 1 *ft* (Distance behind the wall)

H_e = 11.00 *ft* (Height of excavation)

δ_v = *0.08 in* (Ground Settlement at distance d behind the wall)

$\delta_{v,\ allow}$ = 0.25 *in* (Allowable ground settlement)

D/C* = 0.32** ***OK

Depth of Sheeting:

D = 23.68 *ft* (Top of Soil Layer 1 to Toe of Pile) *Attachment A - Page A-37*
(20% additional embedment included)

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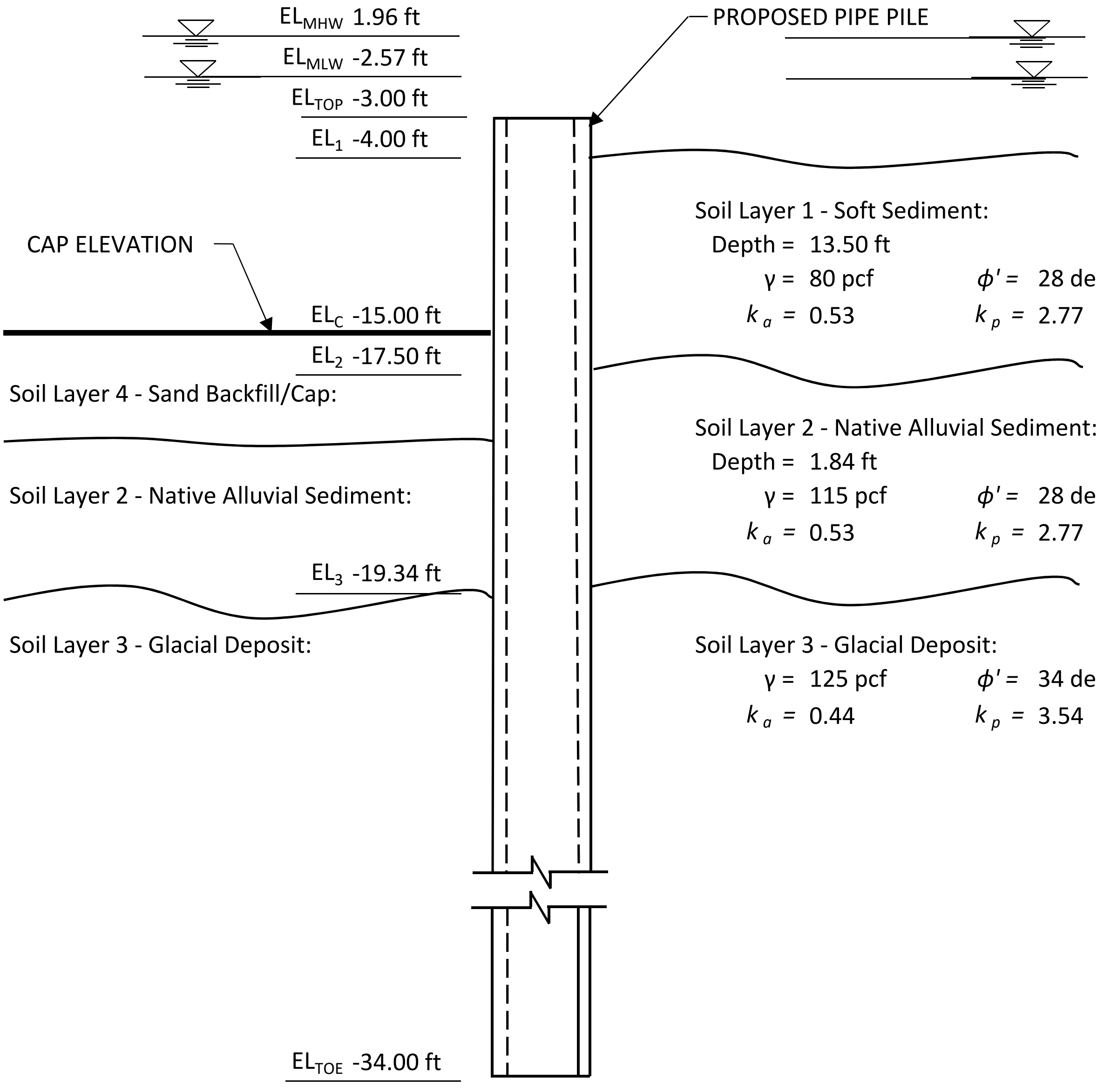
PROJECT: RTA 1 Bridge Stability Final Design SHEET: OF
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case IV CHECKED BY: JRA DATE: 6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case IV - CSDL01

Sheet Pile Cross-Section (Not to Scale):



RTA 1 - Carroll Street Pipe Pile Design Case IV - CSDL04

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88)

EL_1 =	-3.75	ft	(Minimum existing bathmetry elevation)	
EL_2 =	-15.00	ft	(Minimum el. of soft-native interface)	*Appendix C Table 1d*
EL_3 =	-18.00	ft	(Minimum el. of native-glacial interface)	*Appendix C Table 1d*
EL_C =	-13.50	ft	(Environmental cap elevation)	
H =	9.75	ft	(Dredge height)	
EL_{TOP} =	-3.00	ft	(Top of wall elevation)	
EL_{TOE} =	-33.00	ft	(Toe of wall elevation)	
H_w =	30.00	ft	(Total length of pile, 20% Additional Embedment included)	
MHW EL =	1.96	ft	(Mean high water elevation)	
MLW EL =	-2.57	ft	(Mean low water elevation)	

Design of Pile (using CivilTech Shoring Suite):

Pipe Pile Section Properties: *Appendix B*

Pile:	O-Pile 20"_0.625"		
Wt =	74.51	lb/ft	(Wt of pipe pile)
b =	22.44	in	(Width of pipe pile)
I =	955.56	in^4/ft	(Moment of inertia of pipe pile)
Z =	95.56	in^3/ft	(Plastic section modulus of pipe pile)

Load Combinations:

AASHTO Loading	
Group	Factors Used
I	$\gamma (D + LL + \beta_E E)$
VII	$\gamma (D + E)$

**No impact included for substructures or retaining walls* Ref. 3 Section 3.8.1.2

γ = *1.0* *Ref. 3 Table 3.22.1A*

β_E = *1.0* *for vertical and lateral earth pressure on retaining walls*

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case IV CHECKED BY: JRA DATE: 6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case IV - CSDL04

Load Combination Group I:

Surcharge Loading:

q = 250 psf (Applied Surcharge) *Ref. 1 Section II.A.2*

Check Pile Section:

M_{max} = 23.03 k-ft (Maximum moment on wall) *Attachment A - Page A-41*

$\sigma_{allow} = 0.6f_y$ (Allowable stress in pipe pile)

σ_{allow} = 30 ksi

$Z_{min} = M_{max} / \sigma_{allow}$ (Minimum section modulus)

Z_{min} = 9.21 in^3

D/C* = 0.10 *OK

Calculate Settlement Behind Wall:

See "Attachment C - Procedure for Estimating Ground Settlement"

δ_{hm} = 0.14 in (Calc. Deflection @ top of soil layer 1) *Attachment A - Page A-41*

$\delta_{vm} = R\delta_{hm}$ (Maximum ground settlement) δ_{vm} = 0.14 in

R = 1.0 (Ratio between ground settlement and wall deflection)

$$\delta_v = \left(-0.636\sqrt{\frac{d}{H_e}} + 1\right)\delta_{vm}\ if\ \frac{d}{H_e} \le 2;\ and$$

$$\delta_v = \left(-0.171\sqrt{\frac{d}{H_e}} + 0.342\right)\delta_{vm}\ if\ 2 < \frac{d}{H_e} \le 4$$

d = 1 ft (Distance behind the wall)

H_e = 9.75 ft (Height of excavation)

δ_v = 0.11 in (Ground Settlement at distance d behind the wall)

$\delta_{v,\ allow}$ = 0.25 in (Allowable ground settlement)

D/C* = 0.45 *OK

Depth of Sheeting:

D = 29.02 ft (Top of Soil Layer 1 to Toe of Pile) *Attachment A - Page A-41*
(20% additional embedment included)

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case IV	CHECKED BY:	JRA	DATE:	6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case IV - CSDL04

Load Combination Group VII:

Seismic Loading:

k_h = 0.29 (Horizontal acceleration coefficient) *Attachment D - Page D-2*

k_v = 0 (Vertical acceleration coefficient) *Attachment D - Page D-2*

Check Pile Section:

M_{max} = 5.96 *k-ft* (Maximum moment on wall) *Attachment A - Page A-46*

$\sigma_{allow} = 0.6f_y$ (Allowable stress in pipe pile)

σ_{allow} = 30 *ksi*

$Z_{min} = M_{max}/\sigma_{allow}$ (Minimum section modulus)

Z_{min} = 2.38 in^3

D/C* =** **0.02** ***OK

Calculate Settlement Behind Wall:

See "Attachment C - Procedure for Estimating Ground Settlement"

δ_{hm} = 0.12 *in* (Calc. Deflection @ top of soil layer 1) *Attachment A - Page A-46*

$\delta_{vm} = R\delta_{hm}$ (Maximum ground settlement) δ_{vm} = 0.12 *in*

R = 1.0 (Ratio between ground settlement and wall deflection)

$$\delta_v = \left(-0.636\sqrt{\frac{d}{H_e}}+1\right)\delta_{vm}\ if\ \frac{d}{H_e} \leq 2;\ and$$

$$\delta_v = \left(-0.171\sqrt{\frac{d}{H_e}}+0.342\right)\delta_{vm}\ if\ 2 < \frac{d}{H_e} \leq 4$$

d = 1 *ft* (Distance behind the wall)

H_e = 9.75 *ft* (Height of excavation)

δ_v = *0.10* *in* (Ground Settlement at distance d behind the wall)

$\delta_{v,\ allow}$ = 0.25 *in* (Allowable ground settlement)

D/C* =** **0.38** ***OK

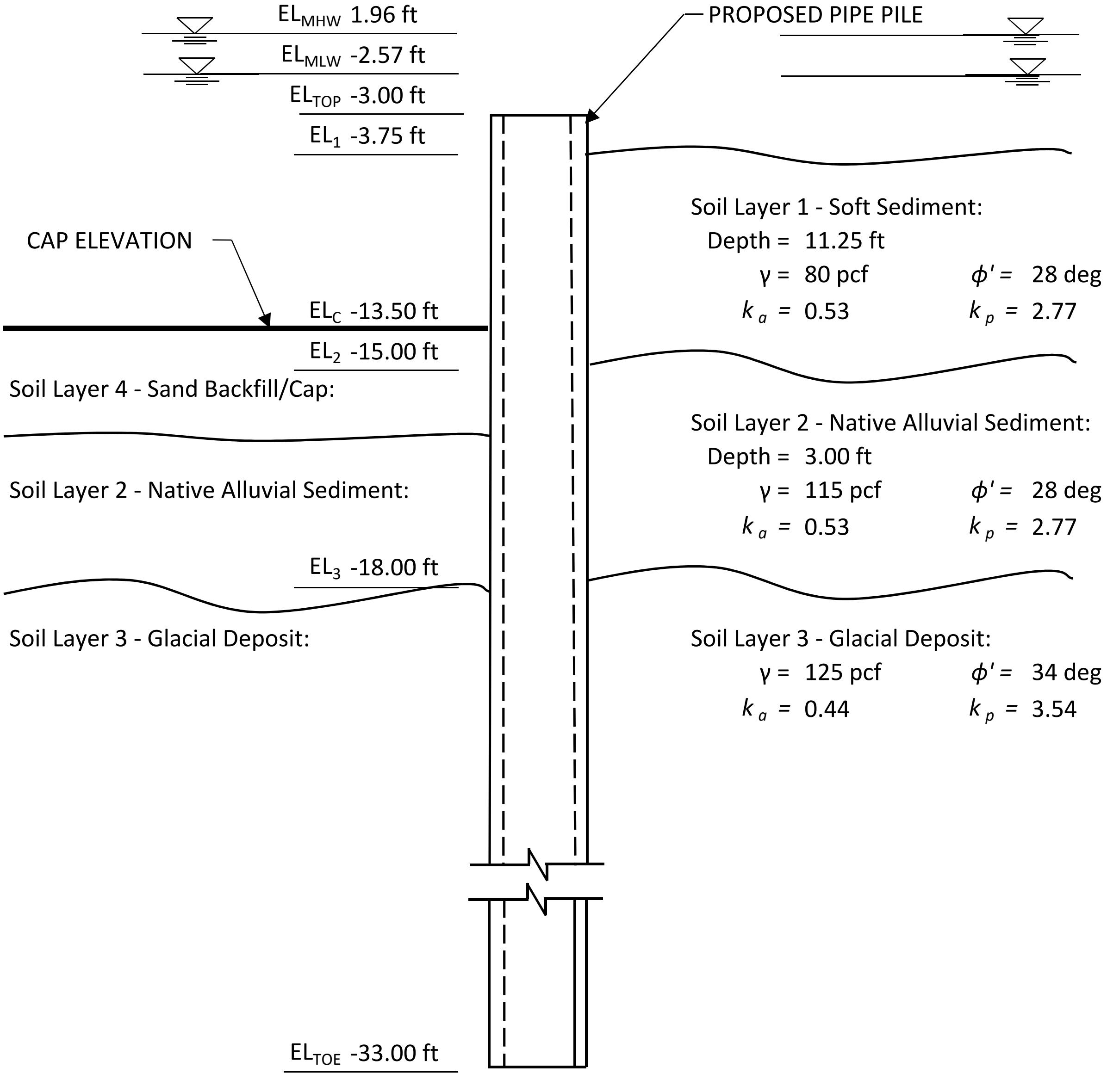
Depth of Sheeting:

D = 23.5 *ft* (Top of Soil Layer 1 to Toe of Pile) *Attachment A - Page A-46*

(20% additional embedment included)

RTA 1 - Carroll Street Pipe Pile Design Case IV - CSDL04

Sheet Pile Cross-Section (Not to Scale):



GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case IV	CHECKED BY:	JRA	DATE:	6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case IV - CSDL06

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88)

EL_1 =	-3.00	*ft*	(Minimum existing bathmetry elevation)	
EL_2 =	-16.00	*ft*	(Minimum el. of soft-native interface)	*Appendix C Table 1d*
EL_3 =	-21.67	*ft*	(Minimum el. of native-glacial interface)	*Appendix C Table 1d*
EL_C =	-13.50	*ft*	(Environmental cap elevation)	
H =	10.50	*ft*	(Dredge height)	
EL_{TOP} =	-3.00	*ft*	(Top of wall elevation)	
EL_{TOE} =	-33.00	*ft*	(Toe of wall elevation)	
H_w =	30.00	*ft*	(Total length of pile, 20% Additional Embedment included)	
MHW EL =	1.96	*ft*	(Mean high water elevation)	
MLW EL =	-2.57	*ft*	(Mean low water elevation)	

Design of Pile (using CivilTech Shoring Suite):

Pipe Pile Section Properties: *Appendix B*

Pile:	O-Pile 20"_0.625"		
Wt =	74.51	lb/ft	(Wt of pipe pile)
b =	22.44	*in*	(Width of pipe pile)
I =	955.56	in^4/ft	(Moment of inertia of pipe pile)
Z =	95.56	in^3/ft	(Plastic section modulus of pipe pile)

Load Combinations:

AASHTO Loading	
Group	Factors Used
I	$\gamma (D + LL + \beta_E E)$
VII	$\gamma (D + E)$

**No impact included for substructures or retaining walls* Ref. 3 Section 3.8.1.2

γ = *1.0* *Ref. 3 Table 3.22.1A*

β_E = *1.0* *for vertical and lateral earth pressure on retaining walls*

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case IV	CHECKED BY:	JRA	DATE:	6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case IV - CSDL06

Load Combination Group I:

Surcharge Loading:

$q =$ 250 *psf* (Applied Surcharge) *Ref. 1 Section II.A.2*

Check Pile Section:

$M_{max} =$ 24.31 *k-ft* (Maximum moment on wall) *Attachment A - Page A-50*

$\sigma_{allow} = 0.6f_y$ (Allowable stress in pipe pile)

$\sigma_{allow} =$ 30 *ksi*

$Z_{min} = M_{max} / \sigma_{allow}$ (Minimum section modulus)

$Z_{min} =$ 9.72 in^3

D/C = **0.10** ***OK***

Calculate Settlement Behind Wall:

See "Attachment C - Procedure for Estimating Ground Settlement"

$\delta_{hm} =$ 0.15 *in* (Calc. Deflection @ top of soil layer 1) *Attachment A - Page A-50*

$\delta_{vm} = R\delta_{hm}$ (Maximum ground settlement) $\delta_{vm} =$ 0.15 *in*

$R =$ 1.0 (Ratio between ground settlement and wall deflection)

$$\delta_v = \left(-0.636\sqrt{\frac{d}{H_e}} + 1\right)\delta_{vm}\ if\ \frac{d}{H_e} \le 2; and$$

$$\delta_v = \left(-0.171\sqrt{\frac{d}{H_e}} + 0.342\right)\delta_{vm}\ if\ 2 < \frac{d}{H_e} \le 4$$

$d =$ 1 *ft* (Distance behind the wall)

$H_e =$ 10.50 *ft* (Height of excavation)

$\delta_v =$ 0.12 *in* (Ground Settlement at distance d behind the wall)

$\delta_{v, allow} =$ 0.25 *in* (Allowable ground settlement)

D/C = **0.48** ***OK***

Depth of Sheeting:

$D =$ 29.91 *ft* (Top of Soil Layer 1 to Toe of Pile) *Attachment A - Page A-50*

(20% additional embedment included)

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case IV	CHECKED BY:	JRA	DATE:	6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case IV - CSDL06

Load Combination Group VII:

Seismic Loading:

k_h = 0.29 (Horizontal acceleration coefficient) *Attachment D - Page D-2*

k_v = 0 (Vertical acceleration coefficient) *Attachment D - Page D-2*

Check Pile Section:

M_{max} = 5.80 *k-ft* (Maximum moment on wall) *Attachment A - Page A-55*

$\sigma_{allow} = 0.6f_y$ (Allowable stress in pipe pile)

σ_{allow} = 30 *ksi*

$Z_{min} = M_{max}/\sigma_{allow}$ (Minimum section modulus)

Z_{min} = 2.32 in^3

D/C = **0.02** ***OK***

Calculate Settlement Behind Wall:

See "Attachment C - Procedure for Estimating Ground Settlement"

δ_{hm} = 0.12 *in* (Calc. Deflection @ top of soil layer 1) *Attachment A - Page A-55*

$\delta_{vm} = R\delta_{hm}$ (Maximum ground settlement) δ_{vm} = 0.12 *in*

R = 1.0 (Ratio between ground settlement and wall deflection)

$$\delta_v = \left(-0.636\sqrt{\frac{d}{H_e}}+1\right)\delta_{vm}\ if\ \frac{d}{H_e} \leq 2;\ and$$

$$\delta_v = \left(-0.171\sqrt{\frac{d}{H_e}}+0.342\right)\delta_{vm}\ if\ 2 < \frac{d}{H_e} \leq 4$$

d = 1 *ft* (Distance behind the wall)

H_e = 10.50 *ft* (Height of excavation)

δ_v = *0.10 in* (Ground Settlement at distance d behind the wall)

$\delta_{v,\ allow}$ = 0.25 *in* (Allowable ground settlement)

D/C = **0.39** ***OK***

Depth of Sheeting:

D = 24.36 *ft* (Top of Soil Layer 1 to Toe of Pile) *Attachment A - Page A-55*

(20% additional embedment included)

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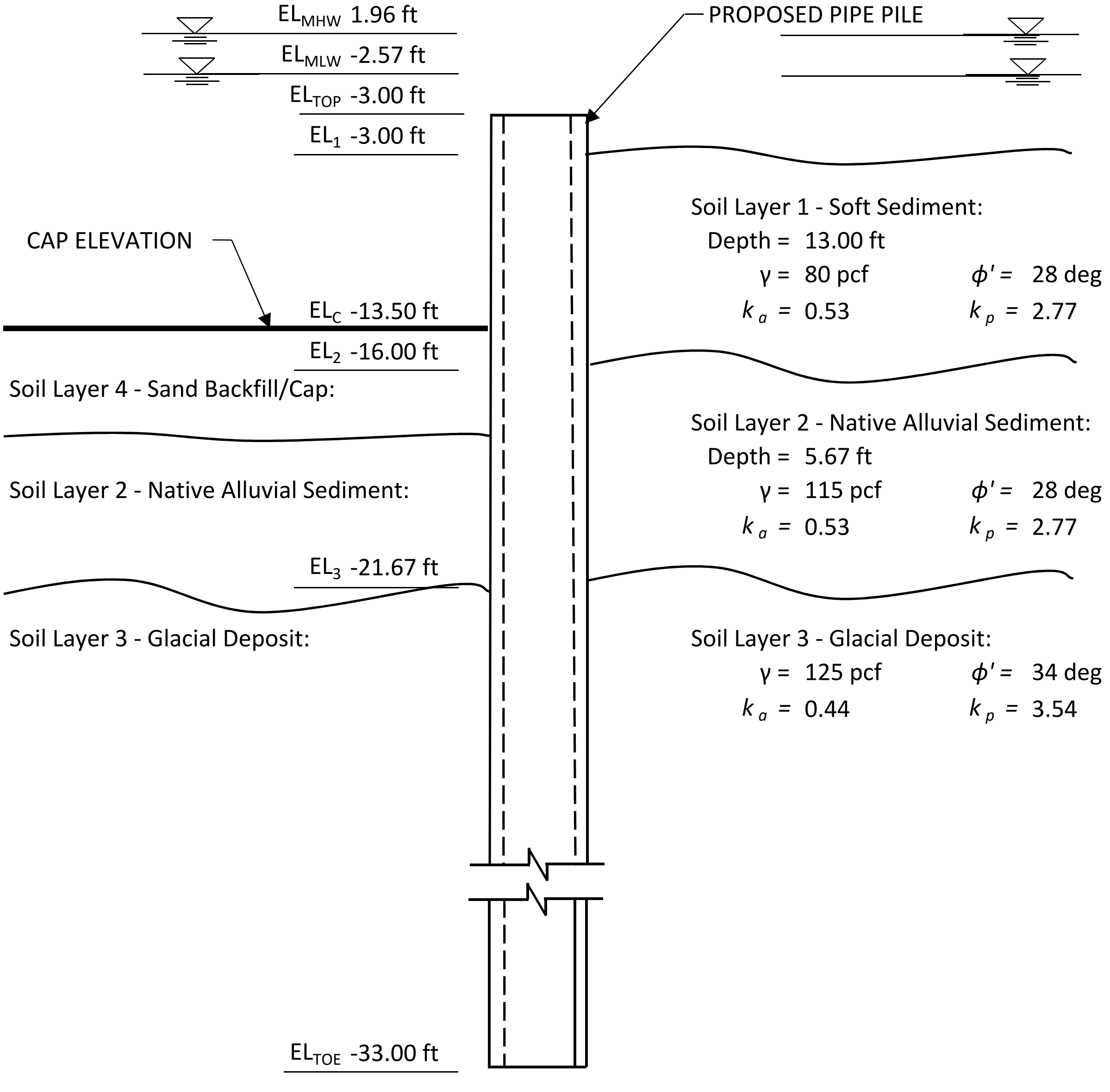
PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case IV	CHECKED BY:	JRA	DATE:	6/4/19

RTA 1 - Carroll Street Pipe Pile Design Case IV - CSDL06

Sheet Pile Cross-Section (Not to Scale):



DESIGN CASE V

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: OF
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case V CHECKED BY: JRA DATE: 6/4/19

RTA 1 - Carroll Street Design Case V - Summary of Results

References:

1. NYSDOT Geotechnical Design Procedure for Flexible Wall Systems - Aug 2015
2. NYSDOT Bridge Manual - 2017
3. AASHTO Standard Specifications for Highway Bridges, 17th Edition - 2002
4. USS Sheet Piling Design Manual - 1984
5. AASHTO LRFD Bridge Design Specifications - Seventh Edition with 2016 Iterim Revisions
6. NYSDOT Standard Specifications
7. Hsieh, Pio-Go and Ou, Chang-Yu. "Shape of Ground Surface Settlement Profiles Caused by Excavation." *Canadian Geotechnical Journal 35(6):1004-1017* (1998)

Appendices:

Appendix A - RTA 1 Bridge Soil Design Parameters by GZA GeoEnvironmental, Inc.
Appendix B - O-Pile Datasheet
Appendix C - Summary of Geotechnical Design Parameters by Geosyntec Consultants

Purpose & Assumptions:

This design case represents a final condition where the bridge is in the closed position (open to traffic). For full list of assumptions, see design summary.

- Factory of safety of 1.5 will be applied to the coefficient of passive earth pressure as per Reference 1 Section II.B.2.

Summary of Results:

The results of the verification are summarized in the table below:

Design Checks									
Design Location	**Load Group**	**Moment Capacity**				**Settlement (in)**			
		Z_{req} (in^3)	Z (in^3)	**D/C**	**Check**	δ_v	$\delta_{v, allow}$	**D/C**	**Check**
CSDL02	I	2.32	95.56	0.02	OK	0.05	0.25	0.20	OK
CSDL02	VII	0.17	95.56	0.02	OK	0.04	0.25	0.17	OK
CSDL03	I	5.77	95.56	0.06	OK	0.09	0.25	0.35	OK
CSDL03	VII	2.67	95.56	0.06	OK	0.10	0.25	0.38	OK

Pipe Pile Information						
Design Location	**Elevations (ft)**			**Section**	**Wall Height**	**Pile Length**
	Top	Min. Tip	Dredge			
CSDL02	-8.77	-28.00	-18.00	O-Pile 20"_0.625"	4.50	20.00
SDL03	-3.00	-30.00	-17.75	O-Pile 20"_0.625"	11.00	27.00

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PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case V	CHECKED BY:	JRA	DATE:	6/4/19

RTA 1 - Carroll Street Design Case V - Inputs

Pipe Pile Material:

ASTM A 572 Gr. 50 Steel:

F_y = 50 *ksi*

E = 29000 *ksi* *Ref. 5 Section 6.4.1*

Soil Parameters:

Constants:

γ_w = 62.4 *pcf* (Unit weight of water)

Soil Layer 1 - Soft Sediment:

γ = 80 *pcf* (Total unit weight) *Appendix A - Page AP-1*

φ' = 28 *deg* (Effective Friction Angle) *Appendix A - Page AP-1*

$\gamma' = \gamma - \gamma_w$ (Effective unit weight)

γ' = 17.6 *pcf*

$K_o = 1 - \sin \emptyset'$ (At-rest pressure coefficient) *Ref. 5 Eq. 3.11.5.2-1*

k_o = 0.53

$$K_p = \frac{1 + \sin \emptyset'}{1 - \sin \emptyset'}$$ (Passive pressure coefficient) *Ref. 1 Appendix A - Page A-1*

k_p = 2.77

$F.S.$ = 1.5 (Factor of Safety) *Ref. 1 Section II.B.2*

$K_p' = K_p/F.S.$ (Effective Passive Pressure Coefficient)

K_p' = 1.85

Soil Layer 2 - Native Alluvial Sediment:

γ = 115 *pcf* (Total unit weight) *Appendix A - Page AP-1*

φ' = 28 *deg* (Effective Friction Angle) *Appendix A - Page AP-1*

$\gamma' = \gamma - \gamma_w$ (Effective unit weight)

γ' = 52.6 *pcf*

$K_o = 1 - \sin \emptyset'$ (At-rest pressure coefficient) *Ref. 5 Eq. 3.11.5.2-1*

k_o = 0.53

$$K_p = \frac{1 + \sin \emptyset'}{1 - \sin \emptyset'}$$ (Passive pressure coefficient) *Ref. 1 Appendix A - Page A-1*

k_p = 2.77

$F.S.$ = 1.5 (Factor of Safety) *Ref. 1 Section II.B.2*

$K_p' = K_p/F.S.$ (Effective Passive Pressure Coefficient)

K_p' = 1.85

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case V CHECKED BY: JRA DATE: 6/4/19

Soil Layer 3 - Glacial Deposit:

γ =	125 *pcf*	(Total unit weight)	*Appendix A - Page AP-1*
φ' =	34 *deg*	(Effective Friction Angle)	*Appendix A - Page AP-1*
γ' =	$\gamma - \gamma_w$	(Effective unit weight)	
			γ' = 62.6 *pcf*
$K_o = 1 - \sin \emptyset'$		(At-rest pressure coefficient)	*Ref. 5 Eq. 3.11.5.2-1*
			k_o = 0.44
$K_p = \dfrac{1 + \sin \emptyset'}{1 - \sin \emptyset'}$		(Passive pressure coefficient)	*Ref. 1 Appendix A - Page A-1*
			k_p = 3.54
F.S. =	1.5	(Factor of Safety)	*Ref. 1 Section II.B.2*
$K_p' = K_p/F.S.$		(Effective Passive Pressure Coefficient)	
			K_p' = 2.36

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PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case V	CHECKED BY:	JRA	DATE:	6/4/19

Carroll Street Design Case V - Area Load Surcharge

Dead Load of Bridge:

Calculate the reaction at the south fascia interior support on the rail concrete cap beam:

Material Weights:

wt_s =	490	*pcf*	(Unit weight of steel)	*Ref. 5 Table 3.5.1-1*
wt_w =	60	*pcf*	(Unit weight of hard wood)	*Ref. 5 Table 3.5.1-1*
wt_C =	150	*pcf*	(Unit weight of concrete)	*Ref. 5 C3.5.1-1*

Geometry:

S =	105	*ft*	(Combined span length of bridge)
S_1 =	61	*ft*	(Length of span 1)
S_2 =	44	*ft*	(Length of span 2)
L_{sg} =	120	*ft*	(Length of s. fascia girder)
L_{sg1} =	75	*ft*	(Length of s. fascia girder span 1)
L_{sg2} =	45	*ft*	(Length of s. fascia girder span 2)
t_d =	8	*in*	(Thickness of timber deck)
W_d =	19	*ft*	(Width of deck)
W_r =	15	*ft*	(Width of Roadway)
W_s =	4.5	*ft*	(Width of sidewalk)
t_s =	2	*in*	(Thickness of timber sidewalk deck)
s_g =	19	*ft*	(Spacing of girders)

Built-up Girders:

South Fascia Girder (Controls):

Top & Bottom Flange:

n_{af} =	2		(Number of Angles per flange)
Angles =	L5x3-1/2x7/16		
Wt_{af} =	12	*lb/ft*	(wt. per foot per angle)
n_{covf} =	3		(Number of cover plates per flange)
w_{cov} =	12	*in*	(Width of cover plate)
t_{cov} =	0.375	*in*	(Thickness of cover plate)

Web:

t_{web} =	0.38	*in*	(Thickness of web plate)
h_{web} =	60	*in*	(Height of web plate)

Transverse Stiffener Angles:

n_{ats} =	112		(Number of transverse stiffener angles)
Angles =	L3-1/2x3-1/2x3/8		
Wt_{ats} =	8.5		
L_{ats} =	5	*ft*	(Lenth of transverse stiffener angles)
wt_g =	256.10	*lb/ft*	(Wt./ft of s. fascia girder)
wt/ft =	294.52	*lb/ft*	(Total weight per ft w/ 15% added for rivits)

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: OF
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case V CHECKED BY: JRA DATE: 6/4/19

Stringers:

n_{s} =	7		(Number of longitudinal stringers)
size =	W8x48		(Size of member)
wt_{st} =	48	*lb/ft*	(Wt. per ft)
Total wt/ft =	336	*lb/ft*	(Total weight per ft of bridge)

Floor Beam:

n_{fb} =	8		(Number of floor beams on bridge)
size =	W21x83		(Size of member)
wt_{fb} =	83	*lb/ft*	(Wt. per ft)
Total wt/ft =	120	*lb/ft*	(Total weight per ft of bridge)

Deck:

Total wt/ft =	760	*lb/ft*	(Total weight per ft of bridge)

S. Fascia Sidewalk deck:

Total wt/ft =	45	*lb/ft*	(Total weight per ft of girder)

Sidewalk Longitudinal Joists:

n_{sj} =	3		(Number of joists)
b_{ds} =	2	*in*	(Assume 2"x8" timber deck supports)
d_{ds} =	8	*in*	
Total wt/ft =	20	*lb/ft*	(Total weight per ft of bridge)

Sidewalk Transverse deck supports:

n_{sss} =	18		(Number of sidewalk supports on south fascia)
size =	2L3x3x3/8		(Size of angle sidwalk supports)
wt_{ss} =	14.36	*lb/ft*	(wt. per ft of angle)
Total wt/ft =	21	*lb/ft*	(Total weight per ft of bridge)

Railing:

Total wt/ft =	200	*lb/ft*	(Assume 200lb/ft)

Curb:

size =	1'x1'	*ft*	(Size of timber curb)
Total wt/ft =	60	*lb/ft*	(Total weight per ft of bridge)

GPI

PROJECT: RTA 1 Bridge Stability Final Design — SHEET: ____ OF ____
JOB NO.: BAB-2017020.01 — MADE BY: PLT — DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case V — CHECKED BY: JRA — DATE: 6/4/19

Overhead Steel Frame:

n_c = 4 (Number of channels in steel frame)
size = C6x40 (Size of channel)
wt_c = 40 *lb/ft*
L_c = 16 *ft* (Length of channels)
Total wt= *2560* *lb* (Total wt. of channels)
n_{ta} = 12 (number of truss angles)
size = L2-1/2x2-1/2x3/8 (Size of truss angles)
wt_{ss} = 5.90 *lb/ft* (wt. per ft of truss angle)
L_{ta} = 3 *ft* (Length of truss angles)
Total wt= 212 *lb/ft* (Total weight of truss angles)
n_{sa} = 2 (Number of top and bottom angle struts)
size = L3x3x3/8 (size of top and bottom angle struts)
wt_{ss} = 7.20 *lb/ft* (wt. per foot of top and bottom angle struts)
L_{ta} = 19 *ft* (Top and bottom angle struts)
Total wt= 274 *lb* (Total wt. of top and bottom angle struts)
Total wt = 3046 *lb/ft* (Total weight of overhead steel frame)

Total DL per ft. of S. Fascia Girder:

w_{DL} = 1498 *lb/ft* (20% Added to account for DL of Connections and assumptions)
P_{DL} = 1904 *lb* (Dead load from Overhead Steel Frame 20% added)

GPI

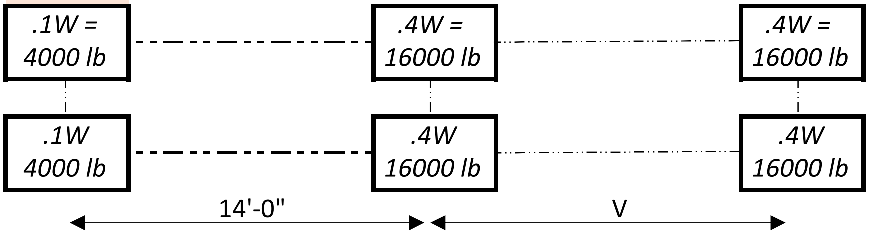
PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case V CHECKED BY: JRA DATE: 6/4/19

Live Load:

Vehicular Live Load:

Standard HS-20 Truck:

W_{HS-20} = 40000 *lb* Stand H Truck: *Ref. 3 Figure 3.7.7A*



Standard HS-20 Lane Loading: *Ref. 3 Figure 3.7.6B*

w_{LL} = 0.64 *klf* (Uniform lane load per linear foot of lane load

$P_{LL,S}$ = 26 kip (Concentrated load for shear)

$P_{LL,m}$ = 18 kip (Concentrated load for moment)

Sidewalk Loading:

P_s = 85 *psf* *Ref. 3 Section 3.14.1.3*

w_{sw} = 383 *lb/ft* (Live load sidewalk loading per ft of bridge)

Distribution Factor:

DF = 1.00

Combinations of Loads: *Ref. 3 Table 3.22.1A*

AASHTO Loading	
Group	Factors Used
I	$\gamma (D + LL + \beta_E E)$
VII	$\gamma (D + E)$

**No impact included for substructures or retaining walls* Ref. 3 Section 3.8.1.2

γ = *1.0* *Ref. 3 Table 3.22.1A*

β_E = *1.0* *for vertical and lateral earth pressure on retaining walls*

Calculate Rail Reaction (R_2) due to DL&LL of Bridge:

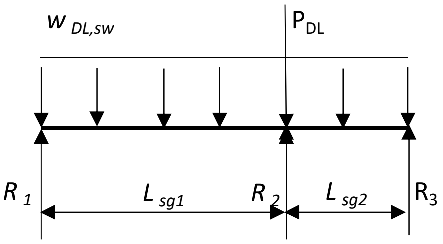
LEAP CONSYS was used to calculate the rail reaction due to DL, HS-20 LL and Sidewalk LL

R_{2DL} = 120246 *lb* *Attachment B Page B-1*

R_{2HS-20} = 73042 *lb* *Attachment B Page B-2*

R_{2LANE} = 77665 *lb*

R_{2SW} = 30257 *lb* *Attachment B Page B-3*



GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: OF
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case V CHECKED BY: JRA DATE: 6/4/19

Calculation of Area Surcharge due to Bridge DL&LL:

Calculate Total Vertical Load on rectangular footing:

$b_f =$ 4.5 ft (Width of rail cap beam footing)
$L_c =$ 54 ft (Length of rail cap beam footing)
$t_f =$ 2.50 ft (Thickness of rail cap footing)
$b_s =$ 2.00 ft (Thickness of rail cap stem)
$h_s =$ 3.00 ft (Height of rail cap stem)

GROUP I Total Vertical Load (P_{vI}')

$P_{vI}' = R_{2DL} + Max(R_{2HS\text{-}20}, R_{2LANE}) + R_{2SW} + (h_s b_s + t_f b_f) L_c w_c$

$P_{vI}' =$ 367893 lb (Total Vertical Load on Footing Group I)

GROUP VII Total Vertical Load (P_{vVII}')

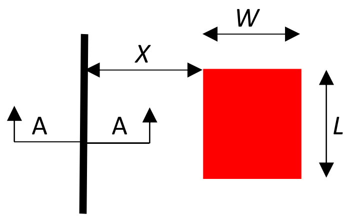
$P_{vVII}' = R_{2DL} + (h_s b_s + t_f b_f) L_c w_c$

$P_{vVII}' =$ 259971 lb (Total Vertical Load on Footing Group VII)

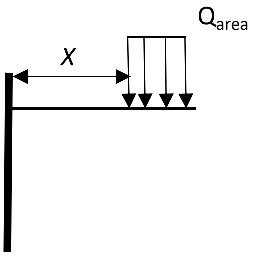
Calculate Magnitude of Area Load input into CivilTech:

				Group I	Group VII
Design Location	*L (ft)*	*W (ft)*	*X (ft)*	Q_{area} *(ksf)*	Q_{area} *(ksf)*
CSDL02	*4.5*	*54*	*2*	*1.51*	*1.07*
CSDL03	*54*	*4.5*	*12*	*1.51*	*1.07*

**See diagram for definition of L, W, X and* Q_{area}



Wall Plan View



Section A-A

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case V	CHECKED BY:	JRA	DATE:	6/4/19

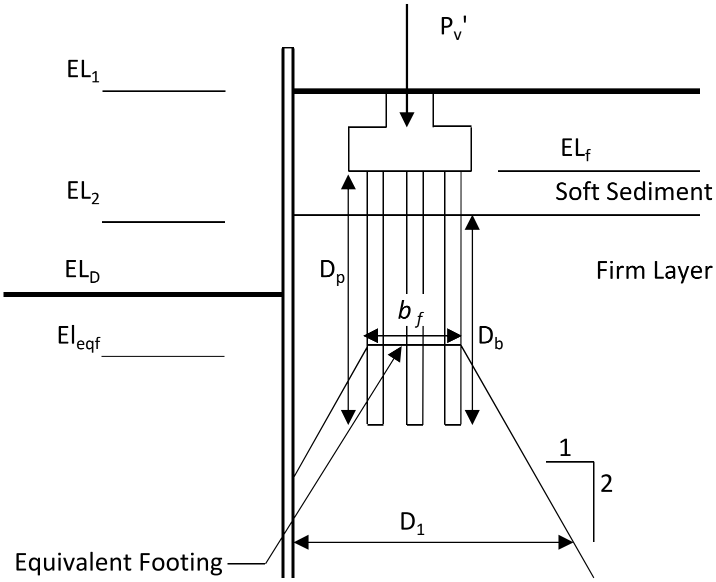
Calculation of Depth of Applied Surcharge Loading:

Calculate Location of Equivalent Footing: *Ref. 5 Figure 10.7.2.3.1-1*

D_b = D_p-(EL_f-EL_2) (Total depth of pile in firm soil layer)

EL_{eqf} = EL_f-D_p+1/3D_b (Elevation of equivalent footing) *Ref. 5 Figure 10.7.2.3.1-1*

Design Location	EL_f	EL_1	EL_2	D_p	D_b	El_{eqf}
CSDL02	-2.41	-10.50	-17.50	20.00	4.91	-20.7733
CSDL03	-2.41	-3.75	-17.50	20.00	4.91	-20.7733



GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case V	CHECKED BY:	JRA	DATE:	6/4/19

RTA 1 - Carroll Street Design Case V - CSDL02

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88)

EL_1 = -10.50 *ft* (Minimum existing bathmetry elevation)

EL_2 = -17.50 *ft* (Minimum el. of soft-native interface) *Appendix C Table 1d*

EL_3 = -18.00 *ft* (Minimum el. of native-glacial interface) *Appendix C Table 1d*

EL_D = -18.00 *ft* (Dredge elevation)

EL_C = -15.00 *ft* (Environmental Cap Elevation)

H = 4.50 *ft* (Wall height)

EL_{TOP} = -8.77 *ft* (Top of wall elevation)

EL_{TOE} = -28.00 *ft* (Toe of wall elevation)

H_w = 19.23 *ft* (Total length of pile, 20% Additional Embedment included)

MHW EL = 1.96 *ft* (Mean high water elevation)

MLW EL = -2.57 *ft* (Mean low water elevation)

Design of Pile (using CivilTech Shoring Suite):

Pipe Pile Section Properties: *Appendix B*

Pile: O-Pile 20"_0.625"

Wt = 74.51 lb/ft (Wt of pipe pile)

b = 22.44 *in* (Width of pipe pile)

I = 955.56 in^4/ft (Moment of inertia of pipe pile)

Z = 95.56 in^3/ft (Plastic section modulus of pipe pile)

GPI

PROJECT: RTA 1 Bridge Stability Final Design — SHEET: ___ OF ___
JOB NO.: BAB-2017020.01 — MADE BY: PLT — DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case V — CHECKED BY: JRA — DATE: 6/4/19

RTA 1 - Carroll Street Design Case V - CSDL02

Load Combination Group I:

Surcharge Loading:

q = 85 *psf* (Applied Surcharge) *Ref. 3 Section 3.14.1.3*

Q_{area} = 1513.96 *psf* (Surcharge from bridge structure)

Check Pile Section:

M_{max} = 5.79 *k-ft* (Maximum moment on wall) *Attachment A - Page A-59*

$\sigma_{allow} = 0.6f_y$ (Allowable stress in pipe pile)

σ_{allow} = 30 *ksi*

$Z_{min} = M_{max} / \sigma_{allow}$ (Minimum section modulus)

Z_{min} = 2.32 in^3

D/C* = 0.02** ***OK

Calculate Settlement Behind Wall:

See "Attachment C - Procedure for Estimating Ground Settlement"

δ_{hm} = 0.07 *in* (Calc. Deflection @ top of soil layer 1) *Attachment A - Page A-59*

$\delta_{vm} = R\delta_{hm}$ (Maximum ground settlement) δ_{vm} = 0.07 *in*

R = 1.0 (Ratio between ground settlement and wall deflection)

$$\delta_v = \left(-0.636\sqrt{\frac{d}{H_e}} + 1\right)\delta_{vm}\ if\ \frac{d}{H_e} \leq 2;\ and$$

$$\delta_v = \left(-0.171\sqrt{\frac{d}{H_e}} + 0.342\right)\delta_{vm}\ if\ 2 < \frac{d}{H_e} \leq 4$$

d = 1 *ft* (Distance behind the wall)

H_e = 4.50 *ft* (Height of excavation)

δ_v = *0.05 in* (Ground Settlement at distance d behind the wall)

$\delta_{v,\ allow}$ = 0.25 *in* (Allowable ground settlement)

D/C* = 0.20** ***OK

Depth of Sheeting:

D = 16.99 *ft* (Top of Soil Layer 1 to Toe of Pile) *Attachment A - Page A-59*
(20% additional embedment included)

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case V CHECKED BY: JRA DATE: 6/4/19

RTA 1 - Carroll Street Design Case V - CSDL02

Load Combination Group VII:

Seismic Loading:

k_h = 0.29 (Horizontal acceleration coefficient) *Attachment D - Page D-2*
k_v = 0 (Vertical acceleration coefficient) *Attachment D - Page D-1*

Surcharge Loading:

Q_{area} = 1069.84 *psf* (Surcharge from bridge structure)

Check Pile Section:

M_{max} = 0.43 *k-ft* (Maximum moment on wall) *Attachment A - Page A-65*
$\sigma_{allow} = 0.6f_y$ (Allowable stress in pipe pile)
σ_{allow} = 30 *ksi*
$Z_{min} = M_{max} / \sigma_{allow}$ (Minimum section modulus)
Z_{min} = 0.17 in^3
D/C* = 0.00** ***OK

Calculate Settlement Behind Wall:

See "Attachment C - Procedure for Estimating Ground Settlement"

δ_{hm} = 0.06 *in* (Calc. Deflection @ top of soil layer 1) *Attachment A - Page A-65*
$\delta_{vm} = R\delta_{hm}$ (Maximum ground settlement) δ_{vm} = 0.06 *in*
R = 1.0 (Ratio between ground settlement and wall deflection)

$$\delta_v = \left(-0.636\sqrt{\frac{d}{H_e}} + 1\right)\delta_{vm}\ if\ \frac{d}{H_e} \le 2; and$$

$$\delta_v = \left(-0.171\sqrt{\frac{d}{H_e}} + 0.342\right)\delta_{vm}\ if\ 2 < \frac{d}{H_e} \le 4$$

d = 1 *ft* (Distance behind the wall)
H_e = 4.50 *ft* (Height of excavation)
δ_v = *0.04 in* (Ground Settlement at distance d behind the wall)
$\delta_{v,\ allow}$ = 0.25 *in* (Allowable ground settlement)
D/C* = 0.17** ***OK

Depth of Sheeting:

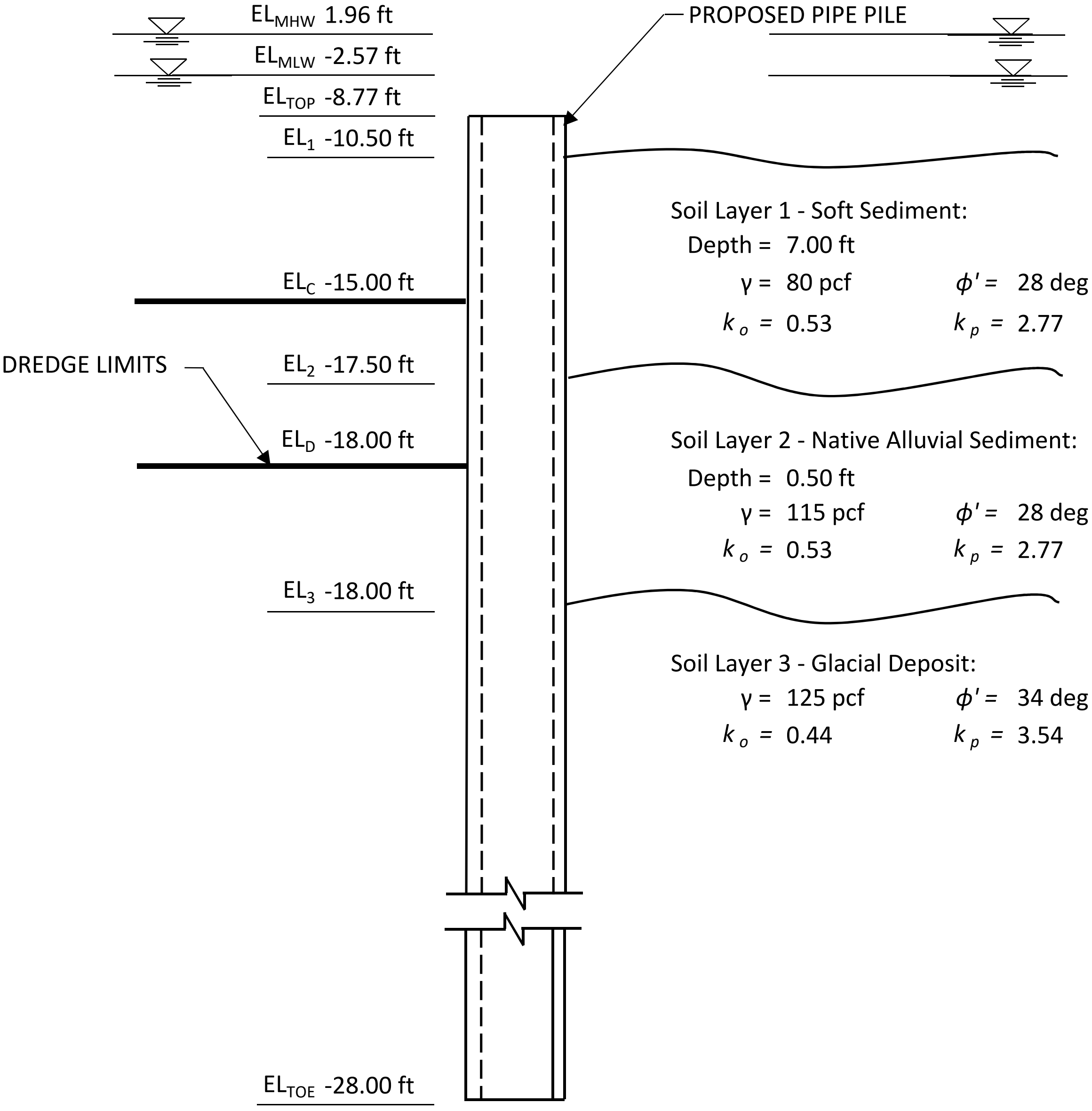
D = 9.79 *ft* (Top of Soil Layer 1 to Toe of Pile) *Attachment A - Page A-65*
(20% additional embedment included)

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case V CHECKED BY: JRA DATE: 6/4/19

RTA 1 - Carroll Street Design Case V - CSDL02

Sheet Pile Cross-Section (Not to Scale):



RTA 1 - Carroll Street Design Case V - CSDL03

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88)

EL_1 =	-3.75	*ft*	(Minimum existing bathmetry elevation)	
EL_2 =	-17.25	*ft*	(Minimum el. of soft-native interface)	*Appendix C Table 1d*
EL_3 =	-21.00	*ft*	(Minimum el. of native-glacial interface)	*Appendix C Table 1d*
EL_D =	-17.75	*ft*	(Dredge elevation)	
EL_C =	-14.75	*ft*	(Environmental Cap Elevation)	
H =	11.00	*ft*	(Wall height)	
EL_{TOP} =	-3.00	*ft*	(Top of wall elevation)	
EL_{TOE} =	-30.00	*ft*	(Toe of wall elevation)	
H_w =	27.00	*ft*	(Total length of pile, 20% Additional Embedment included)	
MHW EL =	1.96	*ft*	(Mean high water elevation)	
MLW EL =	-2.57	*ft*	(Mean low water elevation)	

Design of Pile (using CivilTech Shoring Suite):

Pipe Pile Section Properties: *Appendix B*

Pile:	O-Pile 20"_0.625"		
Wt =	74.51	lb/ft	(Wt of pipe pile)
b =	22.44	*in*	(Width of pipe pile)
I =	955.56	in^4/ft	(Moment of inertia of pipe pile)
Z =	95.56	in^3/ft	(Plastic section modulus of pipe pile)

GPI

PROJECT: RTA 1 Bridge Stability Final Design | SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 | MADE BY: PLT | DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case V | CHECKED BY: JRA | DATE: 6/4/19

RTA 1 - Carroll Street Design Case V - CSDL03

Load Combination Group I:

Surcharge Loading:

q = 85 *psf* (Applied Surcharge) *Ref. 3 Section 3.14.1.3*

Q_{area} = 1513.96 *psf* (Surcharge from bridge structure)

Check Pile Section:

M_{max} = 14.42 *k-ft* (Maximum moment on wall) *Attachment A - Page A-69*

$\sigma_{allow} = 0.6f_y$ (Allowable stress in pipe pile)

σ_{allow} = 30 *ksi*

$Z_{min} = M_{max} / \sigma_{allow}$ (Minimum section modulus)

Z_{min} = 5.77 in^3

D/C* =** **0.06** ***OK

Calculate Settlement Behind Wall:

See "Attachment C - Procedure for Estimating Ground Settlement"

δ_{hm} = 0.1 *in* (Calc. Deflection @ top of soil layer 1) *Attachment A - Page A-69*

$\delta_{vm} = R\delta_{hm}$ (Maximum ground settlement) δ_{vm} = 0.10 *in*

R = 1.0 (Ratio between ground settlement and wall deflection)

$$\delta_v = \left(-0.636\sqrt{\frac{d}{H_e}} + 1\right)\delta_{vm}\ if\ \frac{d}{H_e} \leq 2; and$$

$$\delta_v = \left(-0.171\sqrt{\frac{d}{H_e}} + 0.342\right)\delta_{vm}\ if\ 2 < \frac{d}{H_e} \leq 4$$

d = 0.5 *ft* (Distance behind the wall)

H_e = 11.00 *ft* (Height of excavation)

δ_v = 0.09 *in* (Ground Settlement at distance d behind the wall)

$\delta_{v,\ allow}$ = 0.25 *in* (Allowable ground settlement)

D/C* =** **0.35** ***OK

Depth of Sheeting:

D = 25.42 *ft* (Top of Soil Layer 1 to Toe of Pile) *Attachment A - Page A-69*

(20% additional embedment included)

GPI

PROJECT: RTA 1 Bridge Stability Final Design | SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 | MADE BY: PLT | DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case V | CHECKED BY: JRA | DATE: 6/4/19

RTA 1 - Carroll Street Design Case V - CSDL03

Load Combination Group VII:

Seismic Loading:

k_h = 0.29 (Horizontal acceleration coefficient) *Attachment D - Page D-2*

k_v = 0 (Vertical acceleration coefficient) *Attachment D - Page D-1*

Surcharge Loading:

Q_{area} = 1069.84 *psf* (Surcharge from bridge structure)

Check Pile Section:

M_{max} = 6.68 *k-ft* (Maximum moment on wall) *Attachment A - Page A-75*

$\sigma_{allow} = 0.6f_y$ (Allowable stress in pipe pile)

σ_{allow} = 30 *ksi*

$Z_{min} = M_{max} / \sigma_{allow}$ (Minimum section modulus)

Z_{min} = 2.67 in^3

D/C* = 0.03** ***OK

Calculate Settlement Behind Wall:

See "Attachment C - Procedure for Estimating Ground Settlement"

δ_{hm} = 0.11 *in* (Calc. Deflection @ top of soil layer 1) *Attachment A - Page A-75*

$\delta_{vm} = R\delta_{hm}$ (Maximum ground settlement) δ_{vm} = 0.11 *in*

R = 1.0 (Ratio between ground settlement and wall deflection)

$$\delta_v = \left(-0.636\sqrt{\frac{d}{H_e}}+1\right)\delta_{vm}\ if\ \frac{d}{H_e} \leq 2; and$$

$$\delta_v = \left(-0.171\sqrt{\frac{d}{H_e}}+0.342\right)\delta_{vm}\ if\ 2 < \frac{d}{H_e} \leq 4$$

d = *0.5* *ft* (Distance behind the wall)

H_e = 11.00 *ft* (Height of excavation)

δ_v = *0.10* *in* (Ground Settlement at distance d behind the wall)

$\delta_{v,\ allow}$ = 0.25 *in* (Allowable ground settlement)

D/C* = 0.38** ***OK

Depth of Sheeting:

D = 24.64 *ft* (Top of Soil Layer 1 to Toe of Pile) *Attachment A - Page A-75*

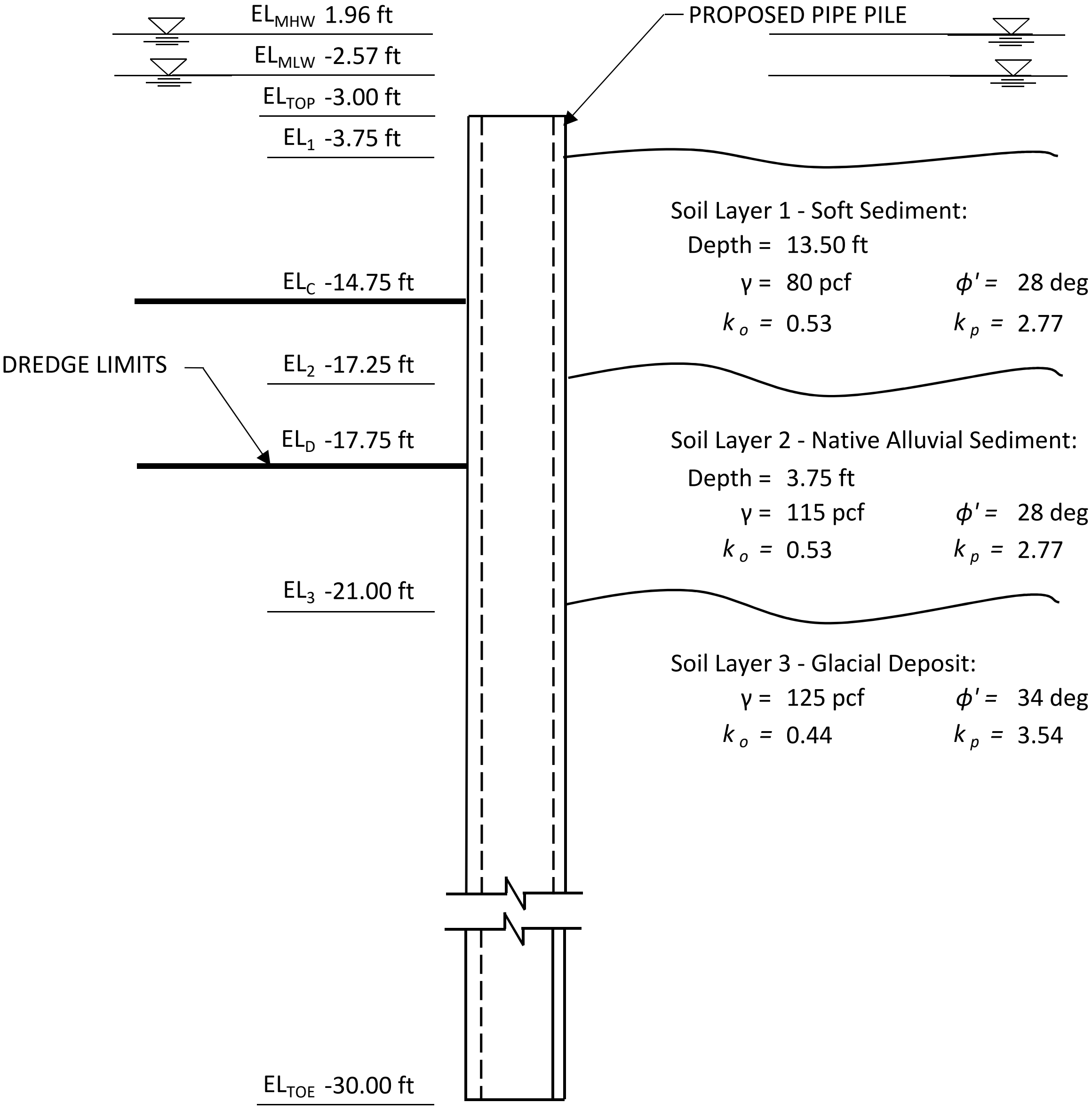
(20% additional embedment included)

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case V CHECKED BY: JRA DATE: 6/4/19

RTA 1 - Carroll Street Design Case V - CSDL03

Sheet Pile Cross-Section (Not to Scale):



DESIGN CASE VI

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: OF
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case VI CHECKED BY: JRA DATE: 6/6/19

RTA 1 - Carroll Street Design Case VI - Summary of Results

References:

1. NYSDOT Geotechnical Design Procedure for Flexible Wall Systems - Aug 2015
2. NYSDOT Bridge Manual - 2017
3. AASHTO Standard Specifications for Highway Bridges, 17th Edition - 2002
4. USS Sheet Piling Design Manual - 1984
5. AASHTO LRFD Bridge Design Specifications - Seventh Edition with 2016 Iterim Revisions
6. NYSDOT Standard Specifications
7. Hsieh, Pio-Go and Ou, Chang-Yu. "Shape of Ground Surface Settlement Profiles Caused by Excavation." *Canadian Geotechnical Journal 35(6):1004-1017* (1998)

Appendices:

Appendix A - RTA 1 Bridge Soil Design Parameters by GZA GeoEnvironmental, Inc.
Appendix B - O-Pile Datasheet
Appendix C - Summary of Geotechnical Design Parameters by Geosyntec Consultants

Purpose & Assumptions:

This design case represents a final condition where the bridge is in the closed position (open to traffic). For full list of assumptions, see design summary.

- Factory of safety of 1.5 will be applied to the coefficient of passive earth pressure as per Reference 1 Section II.B.2.

Summary of Results:

The results of the verification are summarized in the table below:

Design Checks									
Design Location	**Load Group**	**Moment Capacity**				**Settlement (in)**			
		Z_{req} **(in^3)**	Z **(in^3)**	**D/C**	**Check**	δ_v	$\delta_{v, allow}$	**D/C**	**Check**
CSDL05	I	2.86	95.56	0.03	OK	0.05	0.25	0.20	OK
	VII	0.32	95.56	0.00	OK	0.06	0.25	0.23	OK

Pipe Pile Information						
Design Location	**Elevations (ft)**			**Section**	**Wall Height**	**Pile Length**
	Top	Min. Tip	Dredge			
CSDL05	-8.77	-29.00	-17.50	O-Pile 20"_0.625"	5.50	21.00

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case VI CHECKED BY: JRA DATE: 6/6/19

RTA 1 - Carroll Street Design Case VI - Inputs

Pipe Pile Material:

ASTM A 572 Gr. 50 Steel: *Ref. 6 Section 715-17*

F_y = 50 *ksi*

E = 29000 *ksi* *Ref. 5 Section 6.4.1*

Soil Parameters:

Constants:

γ_w = 62.4 *pcf* (Unit weight of water)

Soil Layer 1 - Soft Sediment:

γ = 80 *pcf* (Total unit weight) *Appendix A - Page AP-1*

φ' = 28 *deg* (Effective Friction Angle) *Appendix A - Page AP-1*

$\gamma' = \gamma - \gamma_w$ (Effective unit weight)

γ' = 17.6 *pcf*

$K_o = 1 - \sin \emptyset'$ (At-rest pressure coefficient) *Ref. 5 Eq. 3.11.5.2-1*

k_o = 0.53

$$K_p = \frac{1 + \sin \emptyset'}{1 - \sin \emptyset'}$$ (Passive pressure coefficient) *Ref. 1 Appendix A - Page A-1*

k_p = 2.77

$F.S.$ = 1.5 (Factor of Safety) *Ref. 1 Section II.B.2*

$K_p' = K_p/F.S.$ (Effective Passive Pressure Coefficient)

K_p' = 1.85

Soil Layer 2 - Native Alluvial Sediment:

γ = 115 *pcf* (Total unit weight) *Appendix A - Page AP-1*

φ' = 28 *deg* (Effective Friction Angle) *Appendix A - Page AP-1*

$\gamma' = \gamma - \gamma_w$ (Effective unit weight)

γ' = 52.6 *pcf*

$K_o = 1 - \sin \emptyset'$ (At-rest pressure coefficient) *Ref. 5 Eq. 3.11.5.2-1*

k_o = 0.53

$$K_p = \frac{1 + \sin \emptyset'}{1 - \sin \emptyset'}$$ (Passive pressure coefficient) *Ref. 1 Appendix A - Page A-1*

k_p = 2.77

$F.S.$ = 1.5 (Factor of Safety) *Ref. 1 Section II.B.2*

$K_p' = K_p/F.S.$ (Effective Passive Pressure Coefficient)

K_p' = 1.85

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case VI CHECKED BY: JRA DATE: 6/6/19

Soil Layer 3 - Glacial Deposit:

γ = 125 *pcf* (Total unit weight) *Appendix A - Page AP-1*

φ' = 34 *deg* (Effective Friction Angle) *Appendix A - Page AP-1*

$\gamma' = \gamma - \gamma_w$ (Effective unit weight)

γ' = 62.6 *pcf*

$K_o = 1 - \sin \emptyset'$ (At-rest pressure coefficient) *Ref. 5 Eq. 3.11.5.2-1*

k_o = 0.44

$K_p = \frac{1 + \sin \emptyset'}{1 - \sin \emptyset'}$ (Passive pressure coefficient) *Ref. 1 Appendix A - Page A-1*

k_p = 3.54

F.S. = 1.5 (Factor of Safety) *Ref. 1 Section II.B.2*

$K_p' = K_p/F.S.$ (Effective Passive Pressure Coefficient)

K_p' = 2.36

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case VI	CHECKED BY:	JRA	DATE:	6/6/19

Carroll Street Design Case VI - Area Load Surcharge

Dead Load of Bridge:

Calculate the reaction at the south fascia interior support on the rail concrete cap beam:

<u>Material Weights:</u>

wt_s =	490	*pcf*	(Unit weight of steel)	*Ref. 5 Table 3.5.1-1*
wt_w =	60	*pcf*	(Unit weight of wood)	*Ref. 5 Table 3.5.1-1*
wt_C =	150	*pcf*	(Unit weight of concrete)	*Ref. 5 C3.5.1-1*

<u>Geometry:</u>

S =	105	*ft*	(Combined span length of bridge)
S_1 =	61	*ft*	(Length of span 1)
S_2 =	44	*ft*	(Length of span 2)
L_{sg} =	120	*ft*	(Length of s. fascia girder)
L_{sg1} =	75	*ft*	(Length of s. fascia girder span 1)
L_{sg2} =	45	*ft*	(Length of s. fascia girder span 2)
t_d =	8	*in*	(Thickness of timber deck)
W_d =	19	*ft*	(Width of deck)
W_r =	15	*ft*	(Width of Roadway)
W_s =	4.5	*ft*	(Width of sidewalk)
t_s =	2	*in*	(Thickness of timber sidewalk deck)
s_g =	19	*ft*	(Spacing of girders)

<u>Built-up Girders:</u>

<u>South Fascia Girder (Controls):</u>

Top & Bottom Flange:

n_{af} =	2		(Number of Angles per flange)
Angles =	L5x3-1/2x7/16		
Wt_{af} =	12	*lb/ft*	(wt. per foot per angle)
n_{covf} =	3		(Number of cover plates per flange)
w_{cov} =	12	*in*	(Width of cover plate)
t_{cov} =	0.375	*in*	(Thickness of cover plate)

Web:

t_{web} =	0.38	*in*	(Thickness of web plate)
h_{web} =	60	*in*	(Height of web plate)

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case VI	CHECKED BY:	JRA	DATE:	6/6/19

Carroll Street Design Case VI - Area Load Surcharge

Transverse Stiffener Angles:

n_{ats} = 112 (Number of transverse stiffener angles)

Angles = L3-1/2x3-1/2x3/8

Wt_{ats} = 8.5

L_{ats} = 5 *ft* (Lenth of transverse stiffener angles)

wt_g = 256.10 *lb/ft* (Wt./ft of s. fascia girder)

wt/ft = 294.52 *lb/ft* (Total weight per ft w/ 15% added for rivits)

Stringers:

n_s = 7 (Number of longitudinal stringers)

size = W8x48 (Size of member)

wt_{st} = 48 *lb/ft* (Wt. per ft)

Total wt/ft = 336 *lb/ft* (Total weight per ft of bridge)

Floor Beam:

n_{fb} = 8 (Number of floor beams on bridge)

size = W21x83 (Size of member)

wt_{fb} = 83 *lb/ft* (Wt. per ft)

Total wt/ft = 120 *lb/ft* (Total weight per ft of bridge)

Deck:

Total wt/ft = 760 *lb/ft* (Total weight per ft of bridge)

S. Fascia Sidewalk deck:

Total wt/ft = 45 *lb/ft* (Total weight per ft of girder)

Sidewalk Longitudinal Joists:

n_{sj} = 3 (Number of joists)

b_{ds} = 2 *in* (Assume 2"x8" timber deck supports)

d_{ds} = 8 *in*

Total wt/ft = 20 *lb/ft* (Total weight per ft of bridge)

Sidewalk Transverse deck supports:

n_{sss} = 18 (Number of sidewalk supports on south fascia)

size = 2L3x3x3/8 (Size of angle sidwalk supports)

wt_{ss} = 14.36 *lb/ft* (wt. per ft of angle)

Total wt/ft = 21 *lb/ft* (Total weight per ft of bridge)

Railing:

Total wt/ft = 200 *lb/ft* (Assume 200lb/ft)

Curb:

size = 1'x1' *ft* (Size of timber curb)

Total wt/ft = 60 *lb/ft* (Total weight per ft of bridge)

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case VI	CHECKED BY:	JRA	DATE:	6/6/19

Carroll Street Design Case VI - Area Load Surcharge

Overhead Steel Frame:

n_c =	4		(Number of channels in steel frame)
size =	C6x40		(Size of channel)
wt_c =	40	*lb/ft*	
L_c =	16	*ft*	(Length of channels)
Total wt=	*2560*	*lb*	(Total wt. of channels)
n_{ta} =	12		(number of truss angles)
size =	L2-1/2x2-1/2x3/8		(Size of truss angles)
wt_{ss} =	5.90	*lb/ft*	(wt. per ft of truss angle)
L_{ta} =	3	*ft*	(Length of truss angles)
Total wt=	212	*lb/ft*	(Total weight of truss angles)
n_{sa} =	2		(Number of top and bottom angle struts)
size =	L3x3x3/8		(size of top and bottom angle struts)
wt_{ss} =	7.20	*lb/ft*	(wt. per foot of top and bottom angle struts)
L_{ta} =	19	*ft*	(Top and bottom angle struts)
Total wt=	274	*lb*	(Total wt. of top and bottom angle struts)
Total wt =	3046	*lb/ft*	(Total weight of overhead steel frame)

Total DL per ft. of S. Fascia Girder:

w_{DL} =	1498	*lb/ft*	(20% Added to account for DL of Connections and assumptions)
P_{DL} =	1904	*lb*	(Dead load from Overhead Steel Frame 20% added)

Live Load:

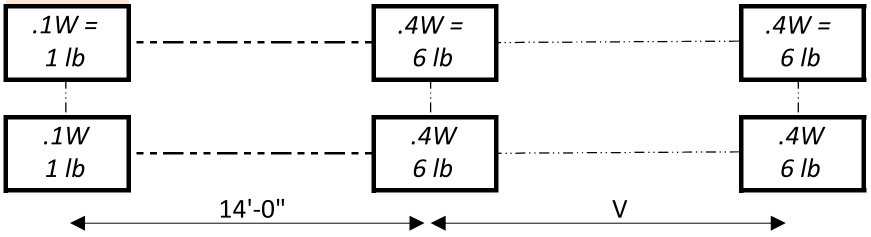
Vehicular Live Load:

Standard HS-20 Truck:

$W_{HS\text{-}20}$ = 40000 *lb*

Stand H Truck:

Ref. 3 Figure 3.7.7A



Standard HS-20 Lane Loading:

Ref. 3 Figure 3.7.6B

w_{LL} =	0.64	*klf*	(Uniform lane load per linear foot of lane load
$P_{LL,S}$ =	26	kip	(Concentrated load for shear)
$P_{LL,m}$ =	18	kip	(Concentrated load for moment)

Sidewalk Loading:

P_s =	85	*psf*	*Ref. 3 Section 3.14.1.3*
w_{sw} =	383	*lb/ft*	(Live load sidewalk loading per ft of bridge)

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ____ OF ____
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case VI CHECKED BY: JRA DATE: 6/6/19

Carroll Street Design Case VI - Area Load Surcharge

Distribution Factor:

DF = 1.00

Combinations of Loads: *Ref. 5 Table 3.22.1A*

AASHTO Loading	
Group	Factors Used
I	$\gamma\,(D + LL + \beta_E E)$
VII	$\gamma\,(D + E)$

**No impact included for substructures or retaining walls* Ref. 5 Section 3.8.1.2

γ = 1.0 *Ref. 5 Table 3.22.1A*

β_E = 1.0 *for vertical and lateral earth pressure on retaining walls*

Calculate Rail Reaction (R_3) due to DL&LL of Bridge:

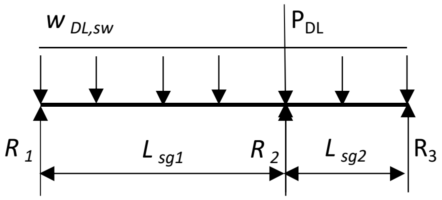
LEAP CONSYS was used to calculate the rail reaction due to DL, H-10 Truck and Sidewalk LL

R_{3DL} = 15916 *lb* *Attachment B Page B-1*

$R_{3HS\text{-}20}$ = 54809 *lb* *Attachment B Page B-2*

R_{3LANE} = 39019 *lb* *Attachment B Page B-3*

R_{3SW} = 4069 *lb*



GROUP I Total Vertical Load (P_{vI}')

$P_{vI}' = (R_{3DL} + Max(R_{3HS\text{-}20}, R_{3LANE}) + R_{3SW})$*2bearings

P_{vI}' = 149588 *lb* (Total Vertical Load on Footing)

GROUP VII Total Vertical Load (P_{vVII}')

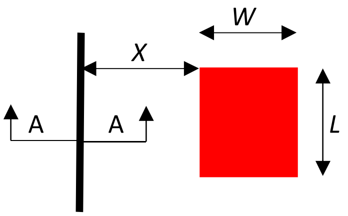
$P_{vVII}' = R_{3DL}$ *2bearings

P_{vVII}' = 31832 *lb*

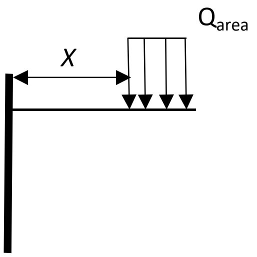
Calculate Magnitude of Area Load input into CivilTech:

				Group I	Group VII
Design Location	*L (ft)*	*W (ft)*	*X (ft)*	*Q_{area} (ksf)*	*Q_{area} (ksf)*
CSDL02	*32.58*	*6*	*1*	*0.77*	0.16

**See diagram for definition of L, W, X and Q_{area}*



Wall Plan View



Section A-A

Carroll Street Design Case VI - Area Load Surcharge

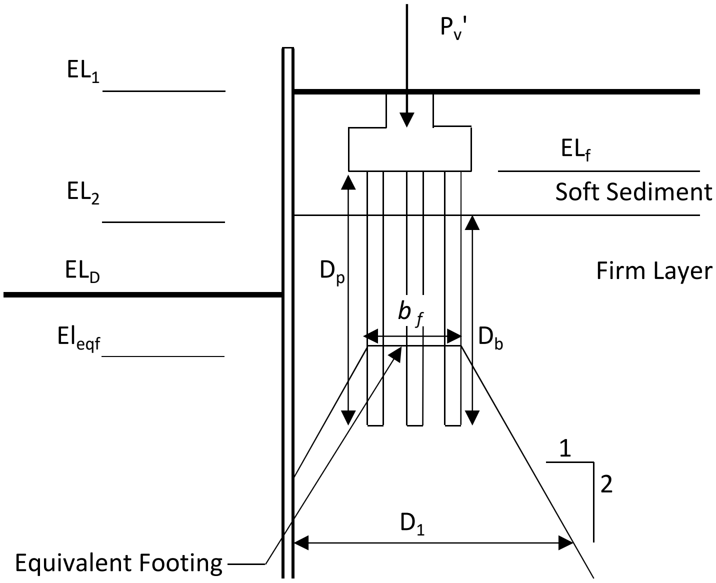
Calculation of Depth of Applied Surcharge Loading:

Calculate Location of Equivalent Footing: *Ref. 5 Figure 10.7.2.3.1-1*

$D_b = D_p-(EL_f-EL_2)$ (Total depth of pile in firm soil layer)

$EL_{eqf} = EL_f-D_p+1/3D_b$ (Elevation of equivalent footing) *Ref. 5 Figure 10.7.2.3.1-1*

Design Location	EL_f	EL_1	EL_2	D_p	D_b	El_{eqf}
CSDL05	-2.41	-9.00	-16.00	20.00	6.41	-20.27



GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	PLT	DATE:	5/28/19
SUBJECT:	RTA 1 - Carroll Street Design Case VI	CHECKED BY:	JRA	DATE:	6/6/19

RTA 1 - Carroll Street Design Case VI - CSDL05

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88)

EL_1 = -9.00 *ft* (Minimum existing bathmetry elevation)

EL_2 = -16.00 *ft* (Minimum el. of soft-native interface) *Appendix C Table 1d*

EL_3 = -19.00 *ft* (Minimum el. of native-glacial interface) *Appendix C Table 1d*

El_D = -17.50 *ft* (Dredge elevation)

El_C = -14.50 *ft* (Environmental cap elevation)

H = 5.50 *ft* (Dredge height)

EL_{TOP} = -8.77 *ft* (Top of wall elevation)

EL_{TOE} = -29.00 *ft* (Toe of wall elevation)

H_w = 20.23 *ft* (Total length of pile, 20% Additional Embedment included)

MHW EL = 1.96 *ft* (Mean high water elevation)

MLW EL = -2.57 *ft* (Mean low water elevation)

Design of Pile Wall (using CivilTech Shoring Suite):

PIpe Pile Section Properties: *Appendix B*

Pipe: O-Pile 20"_0.625"

Wt = 74.51 lb/ft (Wt of Pipe pile)

b = 22.44 *in* (Width of Pipe pile)

I = 955.56 in^4/ft (Moment of inertia of Pipe pile)

Z = 95.56 in^3/ft (Plastic section modulus of Pipe pile)

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ____ OF ____
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case VI CHECKED BY: JRA DATE: 6/6/19

RTA 1 - Carroll Street Design Case VI - CSDL05

Load Combination Group I:

Surcharge Loading:

$q =$ 250 *psf* (Applied Surcharge) *Ref. 1 Section II.A.2*
$Q_{area} =$ 765.16 *psf* (Surcharge from bridge superstructure)

Check Piping Section:

$M_{max} =$ 7.15 *k-ft* (Maximum moment on wall) *Attachment A - Page A-80*
$\sigma_{allow} = 0.6f_y$ (Allowable stress in Pipe pile)
$\sigma_{allow} =$ 30 *ksi*
$Z_{min} = M_{max} / \sigma_{allow}$ (Minimum section modulus)
$Z_{min} =$ 2.86 in^3
D/C* =** **0.03** ***OK

Calculate Settlement Behind Wall:

See "Attachment C - Procedure for Estimating Ground Settlement"

$\delta_{hm} =$ 0.07 *in* (Calc. Deflection @ top of soil layer 1) *Attachment A - Page A-80*
$\delta_{vm} = R\delta_{hm}$ (Maximum ground settlement) $\delta_{vm} =$ 0.07 *in*
$R =$ 1.0 (Ratio between ground settlement and wall deflection)

$$\delta_v = \left(-0.636\sqrt{\frac{d}{H_e}} + 1\right)\delta_{vm}\ if\ \frac{d}{H_e} \le 2; and$$

$$\delta_v = \left(-0.171\sqrt{\frac{d}{H_e}} + 0.342\right)\delta_{vm}\ if\ 2 < \frac{d}{H_e} \le 4$$

$d =$ 1 *ft* (Distance behind the wall)
$H_e =$ 5.50 *ft* (Height of excavation)
$\delta_v =$ 0.05 *in* (Ground Settlement at distance d behind the wall)
$\delta_{v,\ allow} =$ 0.25 *in* (Allowable ground settlement)
D/C* =** **0.20** ***OK

Depth of Pipe Pile Wall

$D =$ 19.92 *ft* (Top of Soil Layer 1 to Toe of Pile) *Attachment A - Page A-80*
(20% additional embedment included)

RTA 1 - Carroll Street Design Case VI - CSDL05

Load Combination Group VII:

Surcharge Loading:

Q_{area} = 162.82 *psf* (Surcharge from bridge superstructure)

Seismic Loading:

k_h = 0.29 (Horizontal acceleration coefficient) *Attachment D - Page D-2*

k_v = 0 (Vertical acceleration coefficient) *Attachment D - Page D-1*

Check Piping Section:

M_{max} = 0.79 *k-ft* (Maximum moment on wall) *Attachment A - Page A-85*

$\sigma_{allow} = 0.6f_y$ (Allowable stress in Pipe pile)

σ_{allow} = 30 *ksi*

$Z_{min} = M_{max}/\sigma_{allow}$ (Minimum section modulus)

Z_{min} = 0.32 in^3

D/C* =** **0.00** ***OK

Calculate Settlement Behind Wall:

See "Attachment C - Procedure for Estimating Ground Settlement"

δ_{hm} = 0.08 *in* (Calc. Deflection @ top of soil layer 1) *Attachment A - Page A-85*

$\delta_{vm} = R\delta_{hm}$ (Maximum ground settlement) δ_{vm} = 0.08 *in*

R = 1.0 (Ratio between ground settlement and wall deflection)

$$\delta_v = \left(-0.636\sqrt{\frac{d}{H_e}}+1\right)\delta_{vm}\ if\ \frac{d}{H_e} \leq 2;\ and$$

$$\delta_v = \left(-0.171\sqrt{\frac{d}{H_e}}+0.342\right)\delta_{vm}\ if\ 2 < \frac{d}{H_e} \leq 4$$

d = 1 *ft* (Distance behind the wall)

H_e = 5.50 *ft* (Height of excavation)

δ_v = *0.06 in* (Ground Settlement at distance d behind the wall)

$\delta_{v,\ allow}$ = 0.25 *in* (Allowable ground settlement)

D/C* =** **0.23** ***OK

Depth of Pipe Pile Wall

D = 12.61 *ft* (Top of Soil Layer 1 to Toe of Pile) *Attachment A - Page A-85*

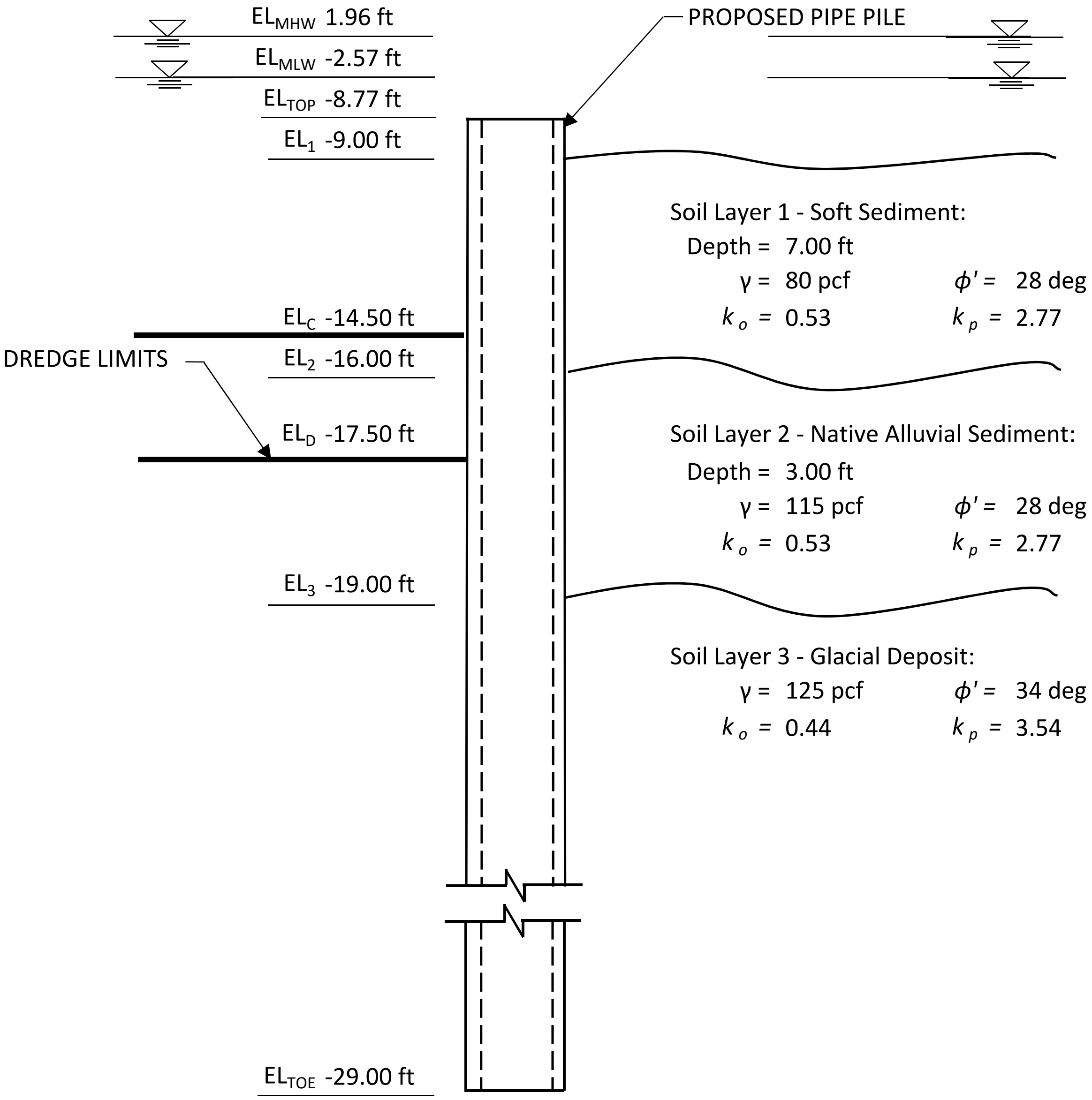
(20% additional embedment included)

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: OF
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA 1 - Carroll Street Design Case VI CHECKED BY: JRA DATE: 6/6/19

RTA 1 - Carroll Street Design Case VI - CSDL05

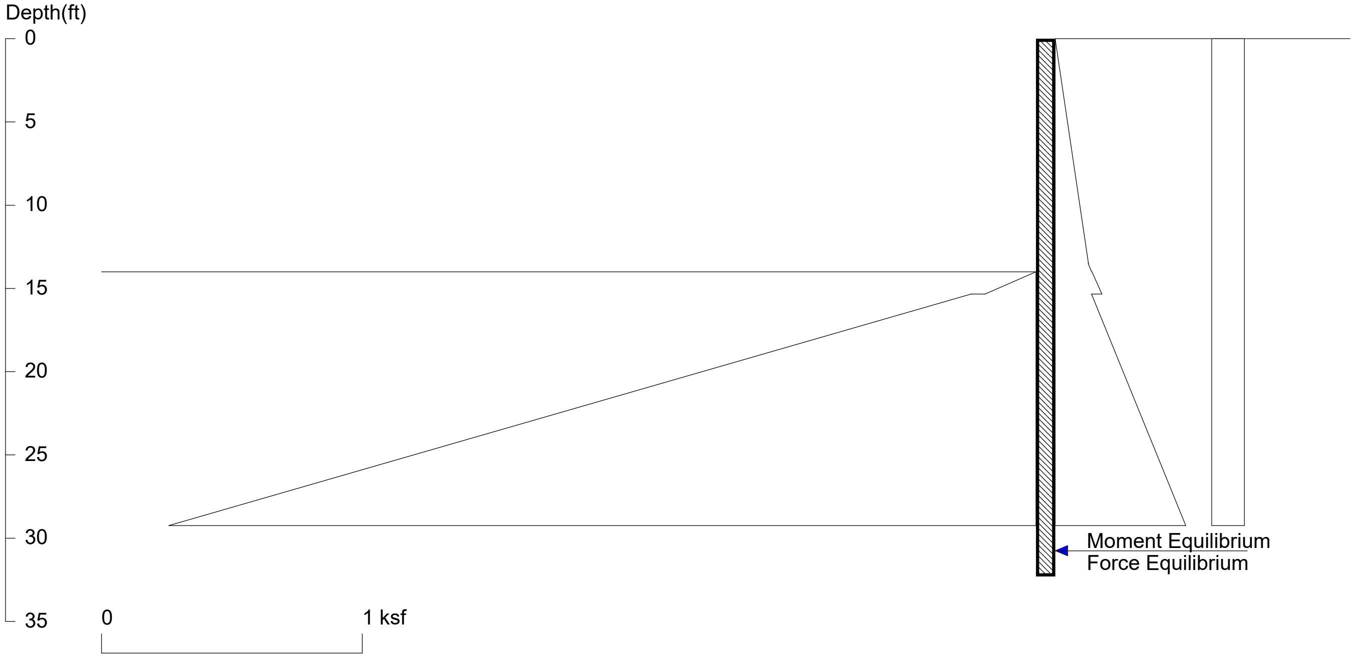
Pipe Pile Cross-Section (Not to Scale):



ATTACHMENT A – CIVILTECH SHORING SUITE OUTPUT

Carroll Street Case I_CSDL01

Case I_CSDL01_EP



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File: O:\2017\BAB-2017020.00 GOWANUS CANAL SUPERFUND SITE\Design\Structures\Carroll Street\Pipe Pile Wall\C

Wall Height=14.0   Pile Diameter=1.0   Pile Spacing=1.0   Wall Type: 1. Sheet Pile

PILE LENGTH: Min. Embedment=18.29   Min. Pile Length=32.29
MOMENT IN PILE: Max. Moment=34.02 per Pile Spacing=1.0 at Depth=22.02

PILE SELECTION:
Request Min. Section Modulus = 13.6 in3/ft=731.56 cm3/m, Fy= 50 ksi = 345 MPa, Fb/Fy=0.60
User Input I (Moment of Inertia):
Top Deflection = 0.25(in) based on E (ksi)=29000.00 and I (in4)/foot=881.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
*	Above	Base		
0.000	0.000	13.500	0.127	0.009434
13.500	0.126	14.000	0.140	0.027906
*	Below	Base		
14.000	0.141	15.340	0.179	0.028196
15.340	0.139	126.000	3.017	0.026009
*	Sur-	charge		
0.000	0.125	0.700	0.125	0.000000
0.700	0.125	1.400	0.125	0.000000
1.400	0.125	2.100	0.125	0.000000
2.100	0.125	2.800	0.125	0.000000
2.800	0.125	3.500	0.125	0.000000
3.500	0.125	4.200	0.125	0.000000
4.200	0.125	4.900	0.125	0.000000
4.900	0.125	5.600	0.125	0.000000
5.600	0.125	6.300	0.125	0.000000
6.300	0.125	7.000	0.125	0.000000
7.000	0.125	7.700	0.125	0.000000

```
               7.700       0.125       8.400       0.125     0.000000
               8.400       0.125       9.100       0.125     0.000000
               9.100       0.125       9.800       0.125     0.000000
               9.800       0.125      10.500       0.125     0.000000
              10.500       0.125      11.200       0.125     0.000000
              11.200       0.125      11.900       0.125     0.000000
              11.900       0.125      12.600       0.125     0.000000
              12.600       0.125      13.300       0.125     0.000000
              13.300       0.125      14.000       0.125     0.000000
              14.000       0.125      15.400       0.125     0.000000
              15.400       0.125      16.800       0.125     0.000000
              16.800       0.125      18.200       0.125     0.000000
              18.200       0.125      19.600       0.125     0.000000
              19.600       0.125      21.000       0.125     0.000000
              21.000       0.125      22.400       0.125     0.000000
              22.400       0.125      23.800       0.125     0.000000
              23.800       0.125      25.200       0.125     0.000000
              25.200       0.125      26.600       0.125     0.000000
              26.600       0.125      28.000       0.125     0.000000
              28.000       0.125      30.800       0.125     0.000000
              30.800       0.125      33.600       0.125     0.000000

PASSIVE PRESSURES:   Pressures below will be divided by a Factor of Safety =1.25
                  Z1          P1          Z2          P2         Slope
--------------------------------------------------------------------------------
                   *        Below        Base
              14.000       0.000      15.340       0.195     0.145693
              15.340       0.249     126.000      24.752     0.221426

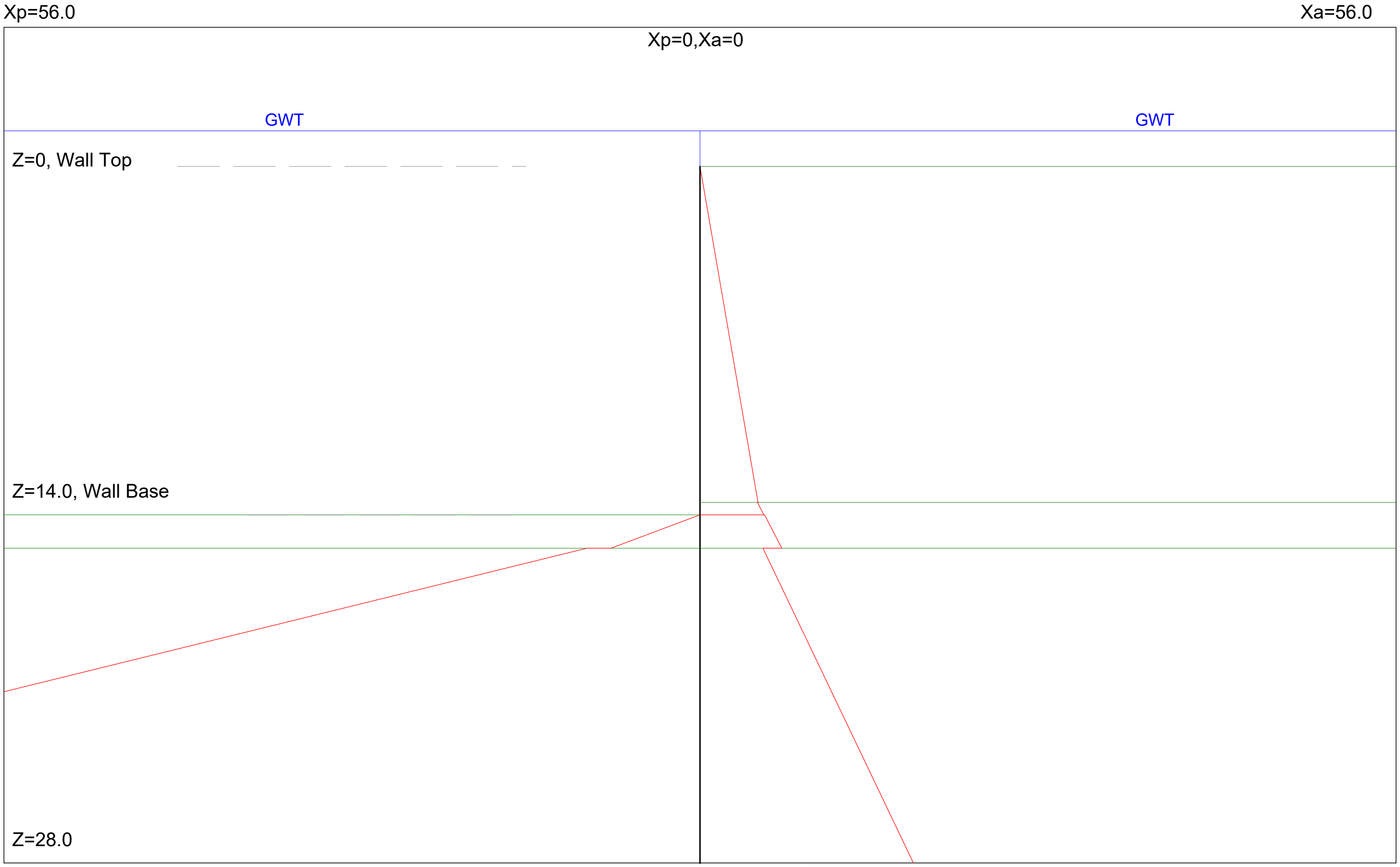
ACTIVE SPACING:
                  No.                  Z depth                  Spacing
--------------------------------------------------------------------------------
                   1                     0.00                     1.00
                   2                    14.00                     1.00

PASSIVE SPACING:
                  No.                  Z depth                  Spacing
--------------------------------------------------------------------------------
                   1                     0.00                     1.00

--------------------------------------------------------------------------------
UNITS:   Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
         Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in
```

Carroll Street Case I_CSDL01

Case I_CSDL01_EP



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UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

29/2019   File: O:\2017\BAB-2017020.00 GOWANUS CANAL SUPERFUND SITE\Design\Structures\Carroll Street\Pipe Pile Wall\Case I\CSDL01\Carroll Street_CSDL01_

* INPUT DATA *

Wall Height=14.0   Total Soil Types= 4

Soil No.	Weight	Saturate	Phi	Cohesion	Nspt	Type	Description
1	80.0	80.0	28.00	0.0	0	3	Soft Sedimen
2	115.0	115.0	28	0.0	0	4	Native Alluv
3	125.0	125.0	34	0.0	0	4	Glacial Depo
4	115.0	115.0	30	0.0	0	4	Sand Backfil

Ground Surface at Active Side:

Line	Z1	Xa1	Z2	Xa2	Soil No.	Description
1	0.0	0.0	0.0	800.0	1	Soft Sedimen
2	13.5	0.0	13.5	800.0	2	Native Alluv
3	15.3	0.0	15.3	800.0	3	Glacial Depo

Water Table at Active Side:

Point	Z-water	X-water
1	-1.4	0.0
2	-1.4	800.0

Ground Surface at Passive Side:

Line	Z1	Xp1	Z2	Xp2	Soil No.	Description
1	14.0	0.0	14.0	800.0	2	Native Alluv
2	15.3	0.0	15.3	800.0	3	Glacial Depo

Water Table at Passive Side:

Point	Z-water	X-water
1	-1.4	0.0
2	-1.4	800.0

Wall Friction Options: 1.* No wall friction

Wall Batter Angle = 0

Apparent Pressure Conversion: 1.* Default (Terzaghi and Peck)*

Water Density = 62.4

Water Pressure: 1.* No seepage at wall tip

* OUTPUT RESULTS *

Total Force above Base= 0.93 per one linear foot (or meter) width along wall height

Total Static Force above Base= 0.93

Driving Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Coef.
0.00	0.00	13.50	0.13	0.0094	0.5360
13.50	0.13	14.00	0.14	0.0279	0.5305

Driving Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Ka or Ko
14.00	0.14	15.34	0.18	0.0282	0.5360
15.34	0.14	28.00	0.47	0.0261	0.4164

Passive Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

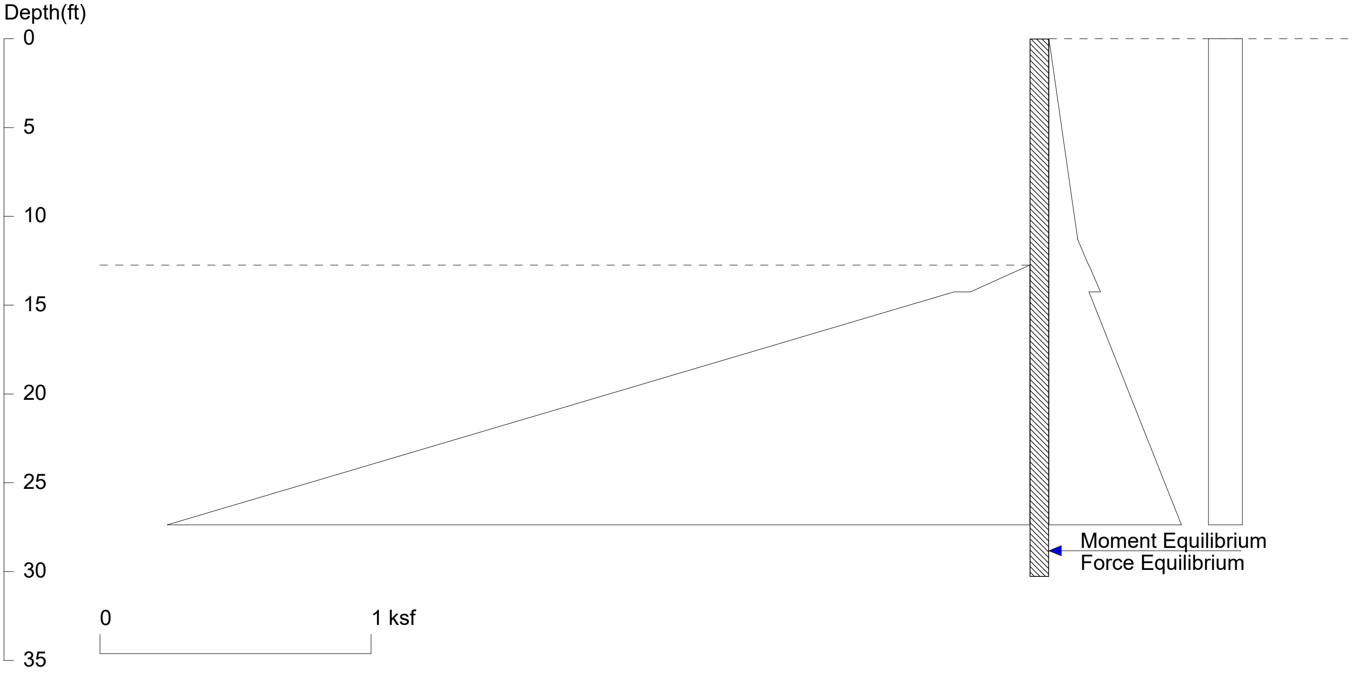
Z1	Pp1	Z2	Pp2	Slope	Kp
14.00	0.00	15.34	0.20	0.146	2.7698
15.34	0.25	28.00	3.05	0.222	3.5392

UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

Date: 5/29/2019   File Name: O:\2017\BAB-2017020.00 GOWANUS CANAL SUPERFUND SITE\Design\Structures\Carroll Street\Pipe Pile Wall\Case I\C

Carroll Street Case I_CSDL04

Case I_CSDL04_EP



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File: O:\2017\BAB-2017020.00 GOWANUS CANAL SUPERFUND SITE\Design\Structures\Carroll Street\Pipe Pile Wall\Ca

Wall Height=12.8   Pile Diameter=1.0   Pile Spacing=1.0   Wall Type: 1. Sheet Pile

PILE LENGTH: Min. Embedment=17.54   Min. Pile Length=30.29
MOMENT IN PILE: Max. Moment=28.89 per Pile Spacing=1.0 at Depth=20.55

PILE SELECTION:
Request Min. Section Modulus = 11.6 in3/ft=621.26 cm3/m, Fy= 50 ksi = 345 MPa, Fb/Fy=0.60
User Input I (Moment of Inertia):
Top Deflection = 0.18(in) based on E (ksi)=29000.00 and I (in4)/foot=955.6

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
*	Above	Base		
0.000	0.000	11.250	0.106	0.009434
11.250	0.105	12.750	0.147	0.027906
*	Below	Base		
12.750	0.148	14.250	0.191	0.028196
14.250	0.148	114.750	2.762	0.026009
*	Sur-	charge		
0.000	0.125	0.637	0.125	0.000000
0.637	0.125	1.275	0.125	0.000000
1.275	0.125	1.913	0.125	0.000000
1.913	0.125	2.550	0.125	0.000000
2.550	0.125	3.188	0.125	0.000000
3.188	0.125	3.825	0.125	0.000000
3.825	0.125	4.463	0.125	0.000000
4.463	0.125	5.100	0.125	0.000000
5.100	0.125	5.737	0.125	0.000000
5.737	0.125	6.375	0.125	0.000000
6.375	0.125	7.012	0.125	0.000000

7.012	0.125	7.650	0.125	0.000000
7.650	0.125	8.287	0.125	0.000000
8.287	0.125	8.925	0.125	0.000000
8.925	0.125	9.562	0.125	0.000000
9.562	0.125	10.200	0.125	0.000000
10.200	0.125	10.837	0.125	0.000000
10.837	0.125	11.475	0.125	0.000000
11.475	0.125	12.112	0.125	0.000000
12.112	0.125	12.750	0.125	0.000000
12.750	0.125	14.025	0.125	0.000000
14.025	0.125	15.300	0.125	0.000000
15.300	0.125	16.575	0.125	0.000000
16.575	0.125	17.850	0.125	0.000000
17.850	0.125	19.125	0.125	0.000000
19.125	0.125	20.400	0.125	0.000000
20.400	0.125	21.675	0.125	0.000000
21.675	0.125	22.950	0.125	0.000000
22.950	0.125	24.225	0.125	0.000000
24.225	0.125	25.500	0.125	0.000000
25.500	0.125	28.050	0.125	0.000000
28.050	0.125	30.600	0.125	0.000000

PASSIVE PRESSURES: Pressures below will be divided by a Factor of Safety =1.25

Z1	P1	Z2	P2	Slope
*	Below	Base		
12.750	0.000	14.250	0.219	0.145693
14.250	0.279	114.750	22.532	0.221427

ACTIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00
2	12.75	1.00

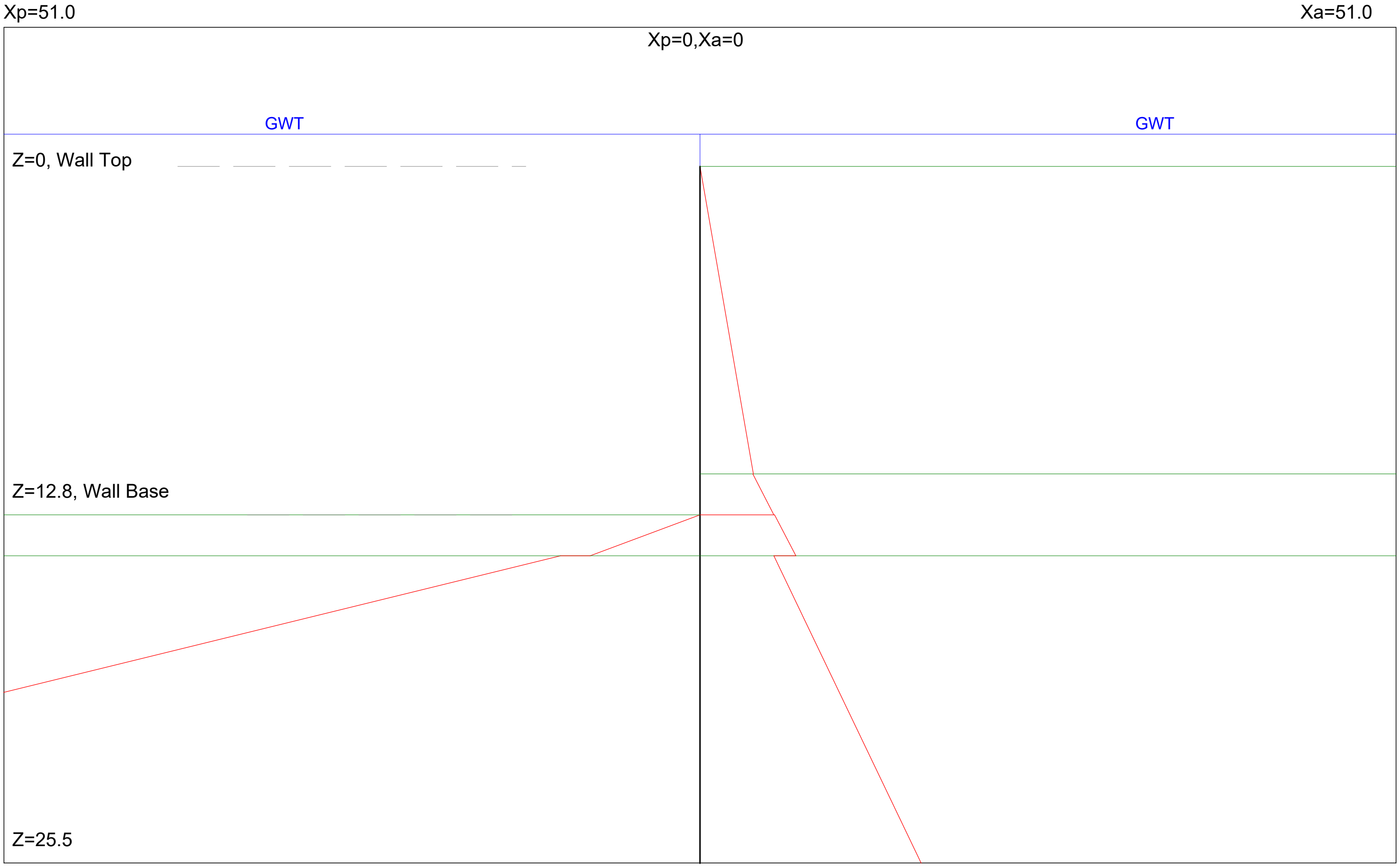
PASSIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in

Carroll Street Case I_CSDL04

Case I_CSDL04_EP



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UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

29/2019 File: O:\2017\BAB-2017020.00 GOWANUS CANAL SUPERFUND SITE\Design\Structures\Carroll Street\Pipe Pile Wall\Case I\CSDL04\Carroll Street_CSDL04_

* INPUT DATA *

Wall Height=12.8 Total Soil Types= 4

Soil No.	Weight	Saturate	Phi	Cohesion	Nspt	Type	Description
1	80.0	80.0	28.00	0.0	0	3	Soft Sedimen
2	115.0	115.0	28	0.0	0	4	Native Alluv
3	125.0	125.0	34	0.0	0	4	Glacial Depo
4	115.0	115.0	30	0.0	0	4	Sand Backfil

Ground Surface at Active Side:

Line	Z1	Xa1	Z2	Xa2	Soil No.	Description
1	0.0	0.0	0.0	800.0	1	Soft Sedimen
2	11.3	0.0	11.3	800.0	2	Native Alluv
3	14.3	0.0	14.3	800.0	3	Glacial Depo

Water Table at Active Side:

Point	Z-water	X-water
1	-1.2	0.0
2	-1.2	800.0

Ground Surface at Passive Side:

Line	Z1	Xp1	Z2	Xp2	Soil No.	Description
1	12.8	0.0	12.8	800.0	2	Native Alluv
2	14.3	0.0	14.3	800.0	3	Glacial Depo

Water Table at Passive Side:

Point	Z-water	X-water
1	-1.2	0.0
2	-1.2	800.0

Wall Friction Options: 1.* No wall friction

Wall Batter Angle = 0

Apparent Pressure Conversion: 1.* Default (Terzaghi and Peck)*

Water Density = 62.4

Water Pressure: 1.* No seepage at wall tip

* OUTPUT RESULTS *

Total Force above Base= 0.79 per one linear foot (or meter) width along wall height

Total Static Force above Base= 0.79

Driving Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Coef.
0.00	0.00	11.25	0.11	0.0094	0.5360
11.25	0.11	12.75	0.15	0.0279	0.5305

Driving Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Ka or Ko
12.75	0.15	14.25	0.19	0.0282	0.5360
14.25	0.15	25.50	0.44	0.0261	0.4166

Passive Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

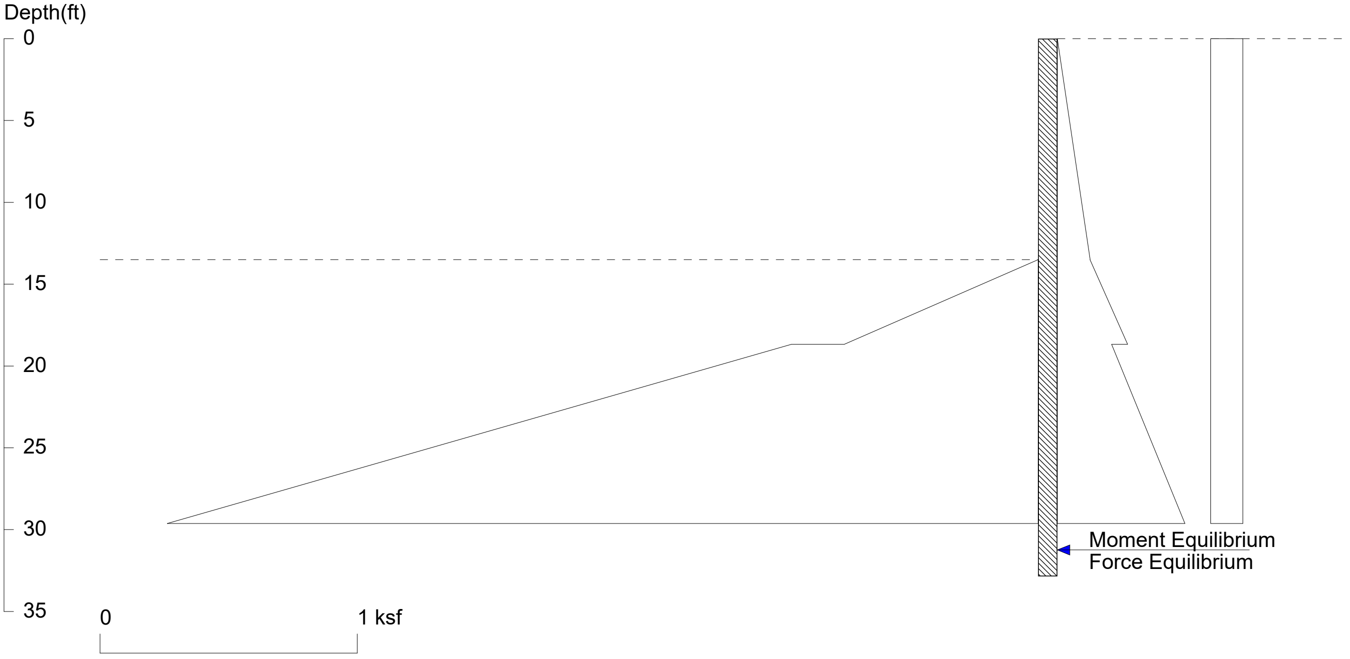
Z1	Pp1	Z2	Pp2	Slope	Kp
12.75	0.00	14.25	0.22	0.146	2.7698
14.25	0.28	25.50	2.77	0.222	3.5404

UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

Date: 5/29/2019   File Name: O:\2017\BAB-2017020.00 GOWANUS CANAL SUPERFUND SITE\Design\Structures\Carroll Street\Pipe Pile Wall\Case I\C

Carroll Street Case I_CSDL06

Case I_CSDL06_EP



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File: O:\2017\BAB-2017020.00 GOWANUS CANAL SUPERFUND SITE\Design\Structures\Carroll Street\Pipe Pile Wall\Ca

Wall Height=13.5 Pile Diameter=1.0 Pile Spacing=1.0 Wall Type: 1. Sheet Pile

PILE LENGTH: Min. Embedment=19.35 Min. Pile Length=32.85
MOMENT IN PILE: Max. Moment=35.41 per Pile Spacing=1.0 at Depth=22.41

PILE SELECTION:
Request Min. Section Modulus = 14.2 in3/ft=761.45 cm3/m, Fy= 50 ksi = 345 MPa, Fb/Fy=0.60
User Input I (Moment of Inertia):
Top Deflection = 0.23(in) based on E (ksi)=29000.00 and I (in4)/foot=955.6

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
*	Above	Base		
0.000	0.000	13.500	0.127	0.009434
*	Below	Base		
13.500	0.127	18.670	0.273	0.028196
18.670	0.211	121.500	2.886	0.026011
*	Sur-	charge		
0.000	0.125	0.675	0.125	0.000000
0.675	0.125	1.350	0.125	0.000000
1.350	0.125	2.025	0.125	0.000000
2.025	0.125	2.700	0.125	0.000000
2.700	0.125	3.375	0.125	0.000000
3.375	0.125	4.050	0.125	0.000000
4.050	0.125	4.725	0.125	0.000000
4.725	0.125	5.400	0.125	0.000000
5.400	0.125	6.075	0.125	0.000000
6.075	0.125	6.750	0.125	0.000000
6.750	0.125	7.425	0.125	0.000000
7.425	0.125	8.100	0.125	0.000000

```
                8.100        0.125        8.775        0.125        0.000000
                8.775        0.125        9.450        0.125        0.000000
                9.450        0.125       10.125        0.125        0.000000
               10.125        0.125       10.800        0.125        0.000000
               10.800        0.125       11.475        0.125        0.000000
               11.475        0.125       12.150        0.125        0.000000
               12.150        0.125       12.825        0.125        0.000000
               12.825        0.125       13.500        0.125        0.000000
               13.500        0.125       14.850        0.125        0.000000
               14.850        0.125       16.200        0.125        0.000000
               16.200        0.125       17.550        0.125        0.000000
               17.550        0.125       18.900        0.125        0.000000
               18.900        0.125       20.250        0.125        0.000000
               20.250        0.125       21.600        0.125        0.000000
               21.600        0.125       22.950        0.125        0.000000
               22.950        0.125       24.300        0.125        0.000000
               24.300        0.125       25.650        0.125        0.000000
               25.650        0.125       27.000        0.125        0.000000
               27.000        0.125       29.700        0.125        0.000000
               29.700        0.125       32.400        0.125        0.000000
               32.400        0.125       35.100        0.125        0.000000

PASSIVE PRESSURES:   Pressures below will be divided by a Factor of Safety =1.25
                  Z1          P1           Z2           P2          Slope
------------------------------------------------------------------------------------
                  *          Below        Base
               13.500        0.000       18.670        0.753        0.145693
               18.670        0.959      121.500       23.732        0.221456

ACTIVE SPACING:
                  No.                    Z depth                   Spacing
------------------------------------------------------------------------------------
                  1                       0.00                      1.00
                  2                      13.50                      1.00

PASSIVE SPACING:
                  No.                    Z depth                   Spacing
------------------------------------------------------------------------------------
                  1                       0.00                      1.00

------------------------------------------------------------------------------------
UNITS:   Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
         Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in
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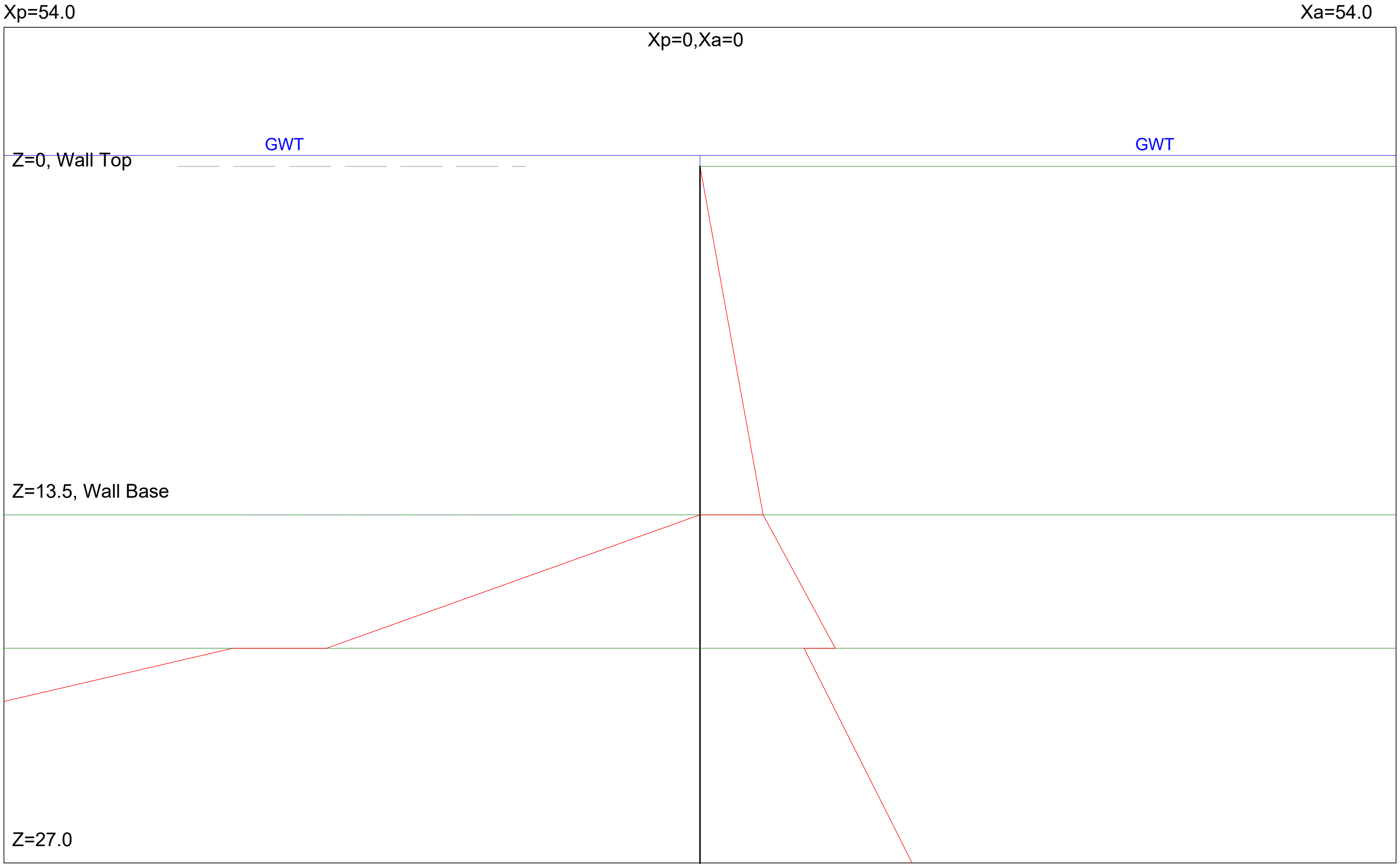
Carroll Street Case I_CSDL06

Case I_CSDL06_EP



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* INPUT DATA *

Wall Height=13.5 Total Soil Types= 4

Soil No.	Weight	Saturate	Phi	Cohesion	Nspt	Type	Description
1	80.0	80.0	28.00	0.0	0	3	Soft Sedimen
2	115.0	115.0	28	0.0	0	4	Native Alluv
3	125.0	125.0	34	0.0	0	4	Glacial Depo
4	115.0	115.0	30	0.0	0	4	Sand Backfil

Ground Surface at Active Side:

Line	Z1	Xa1	Z2	Xa2	Soil No.	Description
1	0.0	0.0	0.0	800.0	1	Soft Sedimen
2	13.5	0.0	13.5	800.0	2	Native Alluv
3	18.7	0.0	18.7	800.0	3	Glacial Depo

Water Table at Active Side:

Point	Z-water	X-water
1	-0.4	0.0
2	-0.4	800.0

Ground Surface at Passive Side:

Line	Z1	Xp1	Z2	Xp2	Soil No.	Description
1	13.5	0.0	13.5	800.0	2	Native Alluv
2	18.7	0.0	18.7	800.0	3	Glacial Depo

Water Table at Passive Side:

Point	Z-water	X-water
1	-0.4	0.0
2	-0.4	800.0

Wall Friction Options: 1.* No wall friction

Wall Batter Angle = 0

Apparent Pressure Conversion: 1.* Default (Terzaghi and Peck)*

Water Density = 62.4

Water Pressure: 1.* No seepage at wall tip

* OUTPUT RESULTS *

Total Force above Base= 1.46 per one linear foot (or meter) width along wall height

Total Static Force above Base= 1.46

Driving Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Coef.
0.00	0.00	13.50	0.13	0.0094	0.5360

Driving Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Ka or Ko
13.50	0.13	18.67	0.27	0.0282	0.5360
18.67	0.21	27.00	0.43	0.0262	0.4186

Passive Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

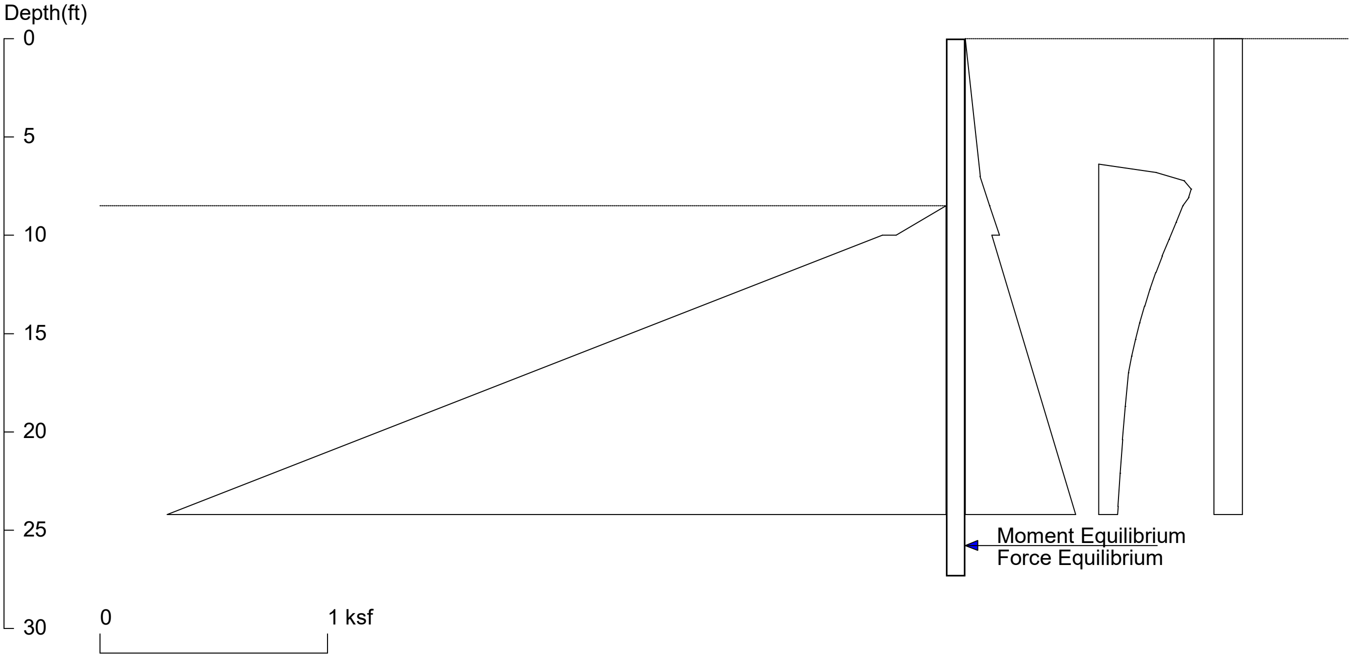
Z1	Pp1	Z2	Pp2	Slope	Kp
13.50	0.00	18.67	0.75	0.146	2.7698
18.67	0.94	27.00	2.81	0.224	3.5808

UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

Date: 5/29/2019   File Name: O:\2017\BAB-2017020.00 GOWANUS CANAL SUPERFUND SITE\Design\Structures\Carroll Street\Pipe Pile Wall\Case I\C

Carroll Street Case II_CSDL05

Case II_CSDL05_EP



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Wall Height=8.5 Pile Diameter=1.0 Pile Spacing=1.0 Wall Type: 1. Sheet Pile

PILE LENGTH: Min. Embedment=18.85 Min. Pile Length=27.35
MOMENT IN PILE: Max. Moment=28.11 per Pile Spacing=1.0 at Depth=17.80

PILE SELECTION:
Request Min. Section Modulus = 11.2 in3/ft=604.48 cm3/m, Fy= 50 ksi = 345 MPa, Fb/Fy=0.60
User Input I (Moment of Inertia):
Top Deflection = 0.13(in) based on E (ksi)=29000.00 and I (in4)/foot=955.6

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
*	Above	Base		
0.000	0.000	7.000	0.066	0.009434
7.000	0.065	8.500	0.107	0.027906
*	Below	Base		
8.500	0.108	10.000	0.151	0.028196
10.000	0.117	76.500	1.846	0.026010
*	Sur-	charge		
6.375	0.000	6.800	0.252	0.593319
6.800	0.252	7.225	0.377	0.293311
7.225	0.377	7.650	0.407	0.071645
7.650	0.407	8.075	0.397	-0.024369
8.075	0.397	8.500	0.371	-0.060171
8.500	0.371	9.350	0.341	-0.035898
9.350	0.341	10.200	0.310	-0.036724
10.200	0.310	11.050	0.280	-0.035372
11.050	0.280	11.900	0.251	-0.033052
11.900	0.251	12.750	0.226	-0.030338
12.750	0.226	13.600	0.202	-0.027528

13.600	0.202	14.450	0.181	-0.024781
14.450	0.181	15.300	0.162	-0.022184
15.300	0.162	16.150	0.146	-0.019783
16.150	0.146	17.000	0.131	-0.017594
17.000	0.131	18.700	0.117	-0.007811
18.700	0.117	20.400	0.106	-0.006929
20.400	0.106	22.100	0.095	-0.006144
22.100	0.095	23.800	0.086	-0.005450
23.800	0.086	25.500	0.078	-0.004836
25.500	0.078	27.200	0.064	-0.008115
27.200	0.064	28.900	0.053	-0.006434
*	Sur-	charge		
0.000	0.125	0.425	0.125	0.000000
0.425	0.125	0.850	0.125	0.000000
0.850	0.125	1.275	0.125	0.000000
1.275	0.125	1.700	0.125	0.000000
1.700	0.125	2.125	0.125	0.000000
2.125	0.125	2.550	0.125	0.000000
2.550	0.125	2.975	0.125	0.000000
2.975	0.125	3.400	0.125	0.000000
3.400	0.125	3.825	0.125	0.000000
3.825	0.125	4.250	0.125	0.000000
4.250	0.125	4.675	0.125	0.000000
4.675	0.125	5.100	0.125	0.000000
5.100	0.125	5.525	0.125	0.000000
5.525	0.125	5.950	0.125	0.000000
5.950	0.125	6.375	0.125	0.000000
6.375	0.125	6.800	0.125	0.000000
6.800	0.125	7.225	0.125	0.000000
7.225	0.125	7.650	0.125	0.000000
7.650	0.125	8.075	0.125	0.000000
8.075	0.125	8.500	0.125	0.000000
8.500	0.125	9.350	0.125	0.000000
9.350	0.125	10.200	0.125	0.000000
10.200	0.125	11.050	0.125	0.000000
11.050	0.125	11.900	0.125	0.000000
11.900	0.125	12.750	0.125	0.000000
12.750	0.125	13.600	0.125	0.000000
13.600	0.125	14.450	0.125	0.000000
14.450	0.125	15.300	0.125	0.000000
15.300	0.125	16.150	0.125	0.000000
16.150	0.125	17.000	0.125	0.000000
17.000	0.125	18.700	0.125	0.000000
18.700	0.125	20.400	0.125	0.000000
20.400	0.125	22.100	0.125	0.000000
22.100	0.125	23.800	0.125	0.000000
23.800	0.125	25.500	0.125	0.000000
25.500	0.125	27.200	0.125	0.000000
27.200	0.125	28.900	0.125	0.000000

PASSIVE PRESSURES: Pressures below will be divided by a Factor of Safety =1.25

Z1	P1	Z2	P2	Slope
*	Below	Base		
8.500	0.000	10.000	0.219	0.145693
10.000	0.279	76.500	15.004	0.221431

ACTIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00
2	8.50	1.00

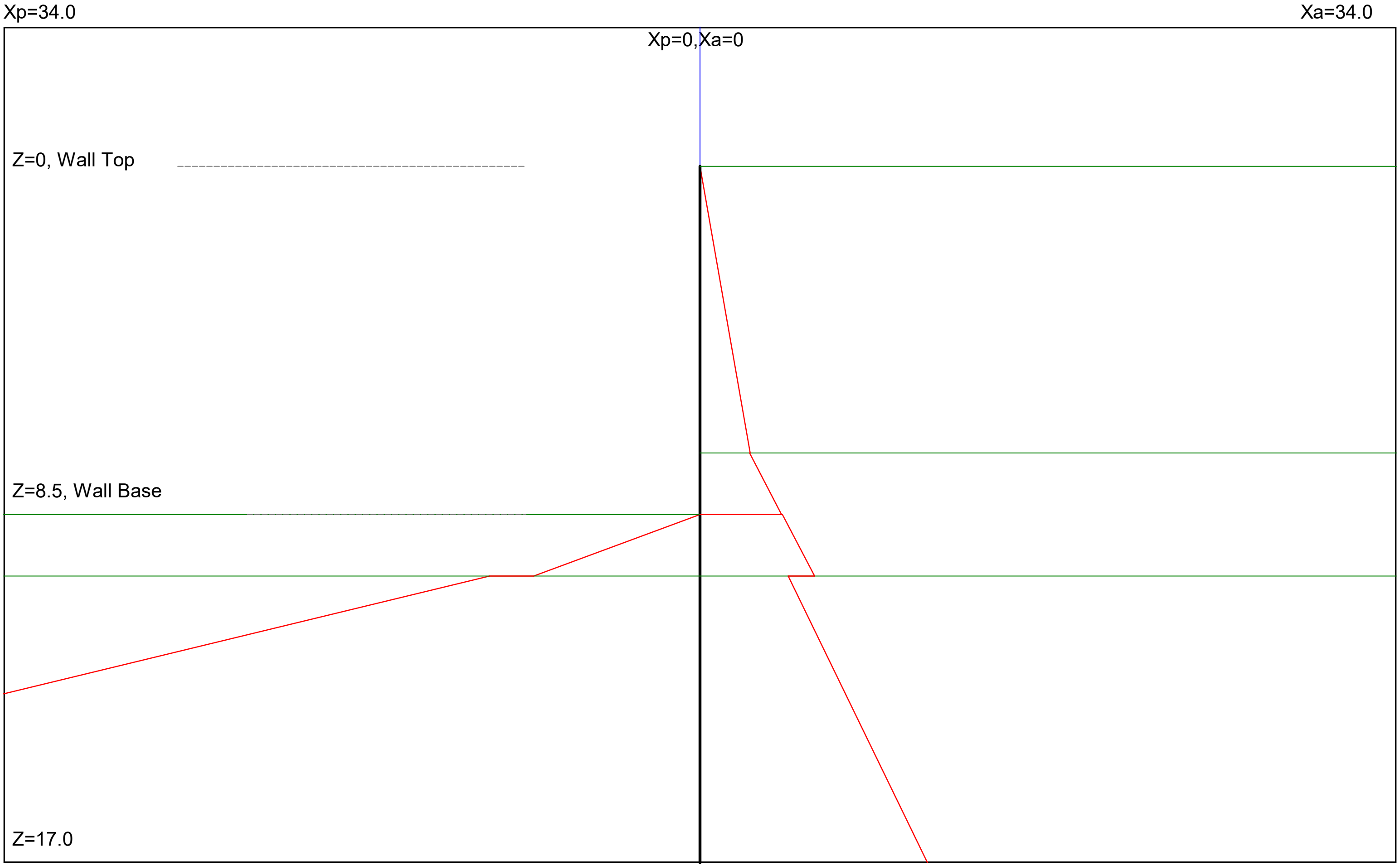
PASSIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in

Carroll Street Case II_CSDL05

Case II_CSDL05_EP



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UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

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* INPUT DATA *

Wall Height=8.5   Total Soil Types= 4

Soil No.	Weight	Saturate	Phi	Cohesion	Nspt	Type	Description
1	80.0	80.0	28.00	0.0	0	3	Soft Sedimen
2	115.0	115.0	28	0.0	0	4	Native Alluv
3	125.0	125.0	34	0.0	0	4	Glacial Depo
4	115.0	115.0	30	0.0	0	4	Sand Backfil

Ground Surface at Active Side:

Line	Z1	Xa1	Z2	Xa2	Soil No.	Description
1	0.0	0.0	0.0	800.0	1	Soft Sedimen
2	7.0	0.0	7.0	800.0	2	Native Alluv
3	10.0	0.0	10.0	800.0	3	Glacial Depo

Water Table at Active Side:

Point	Z-water	X-water
1	-6.4	0.0
2	-6.4	800.0

Ground Surface at Passive Side:

Line	Z1	Xp1	Z2	Xp2	Soil No.	Description
1	8.5	0.0	8.5	800.0	2	Native Alluv
2	10.0	0.0	10.0	800.0	3	Glacial Depo

Water Table at Passive Side:

Point	Z-water	X-water
1	-6.4	0.0
2	-6.4	800.0

Wall Friction Options: 1.* No wall friction

Wall Batter Angle = 0

Apparent Pressure Conversion: 1.* Default (Terzaghi and Peck)*

Water Density = 62.4

Water Pressure: 1.* No seepage at wall tip

* OUTPUT RESULTS *

Total Force above Base= 0.36 per one linear foot (or meter) width along wall height

Total Static Force above Base= 0.36

Driving Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Coef.
0.00	0.00	7.00	0.07	0.0094	0.5360
7.00	0.07	8.50	0.11	0.0279	0.5305

Driving Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

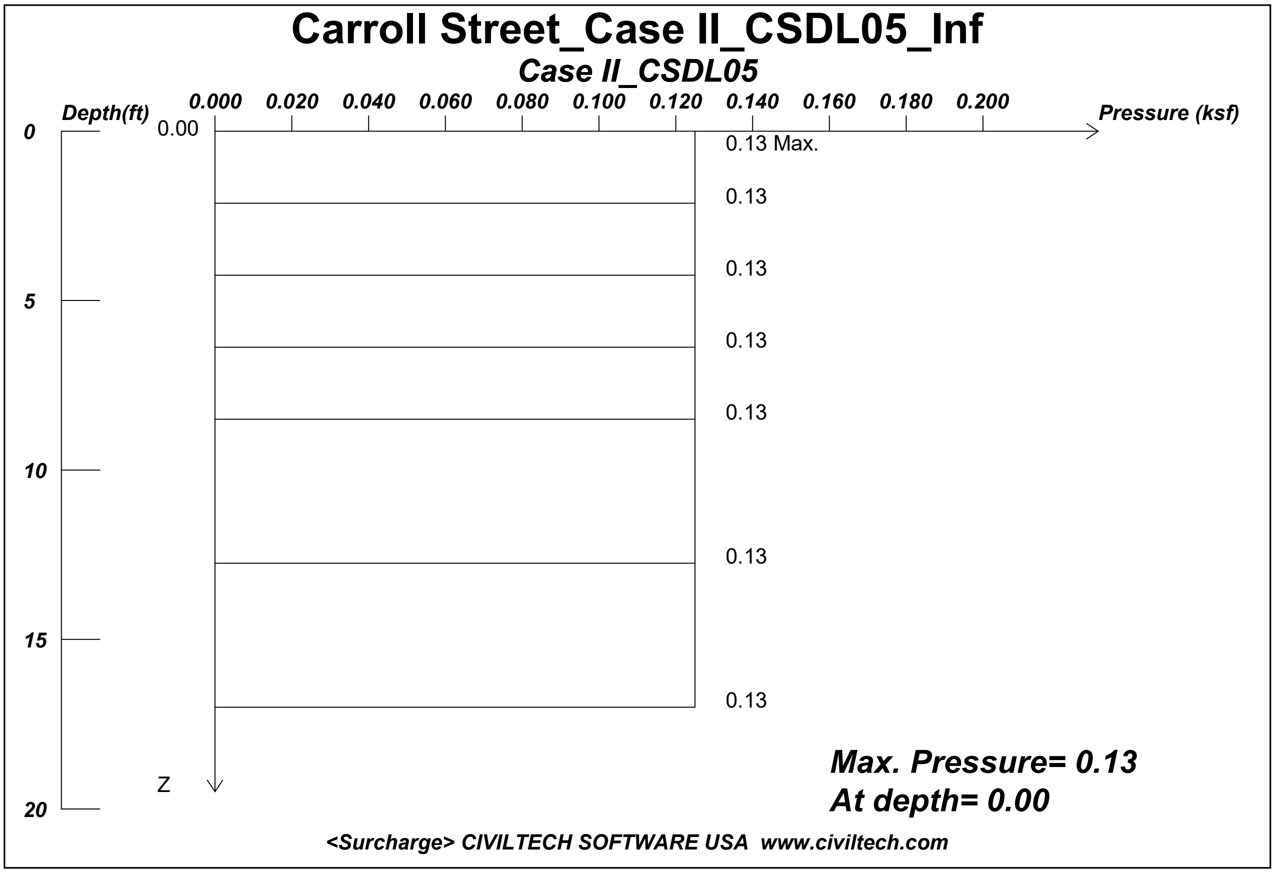
Z1	Pa1	Z2	Pa2	Slope	Ka or Ko
8.50	0.11	10.00	0.15	0.0282	0.5360
10.00	0.12	17.00	0.30	0.0261	0.4171

Passive Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pp1	Z2	Pp2	Slope	Kp
8.50	0.00	10.00	0.22	0.146	2.7698
10.00	0.28	17.00	1.83	0.222	3.5447

UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

Date: 8/7/2019   File Name: O:\2017\BAB-2017020.00 GOWANUS CANAL SUPERFUND SITE\Design\Structures\Carroll Street\Pipe Pile Wall\Case II\



Carroll Street_Case II_CSDL05_Inf

Case II_CSDL05

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Wall Height, H= 8.5 Load Depth, D= 0

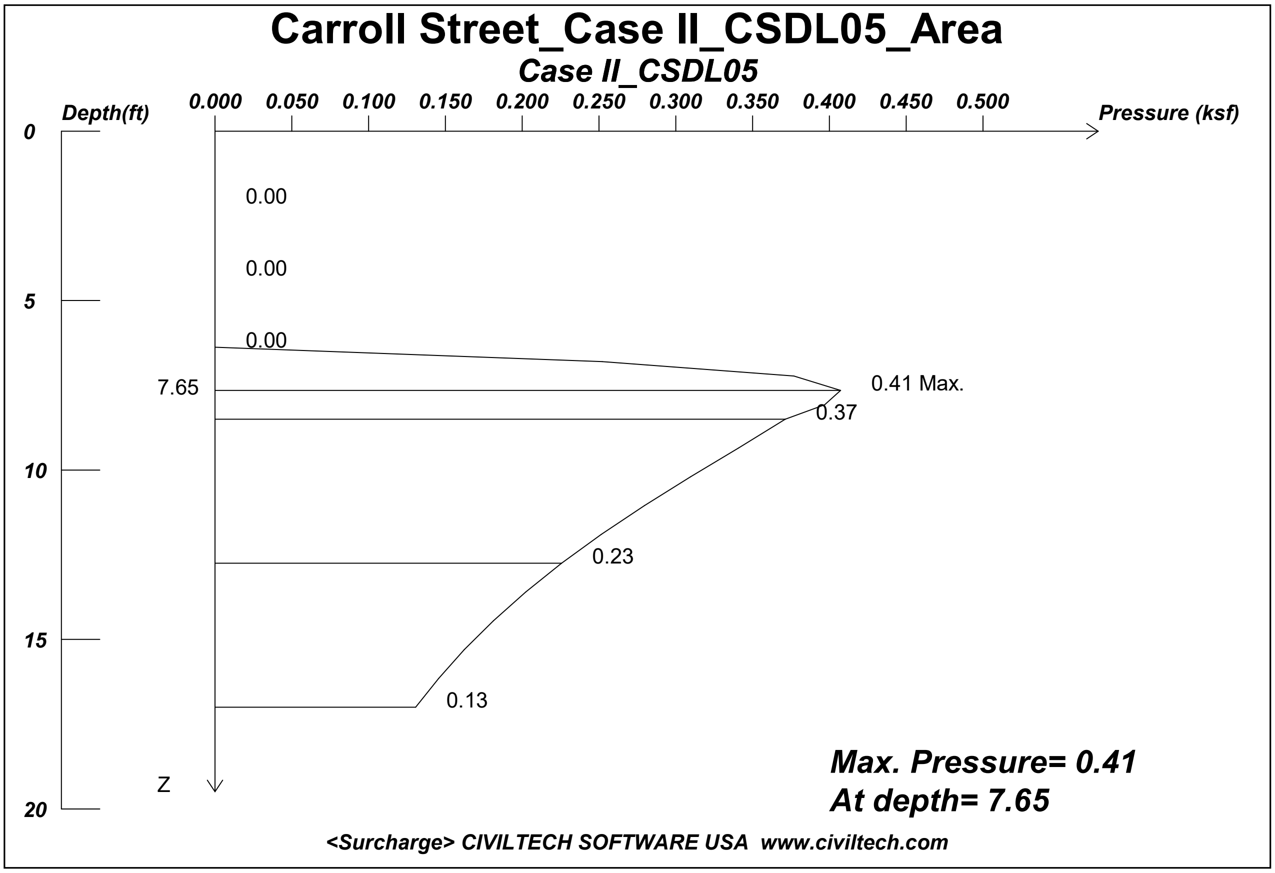
Load Factor of Surcharge Loading = 1

Rigid Wall Condition -- No movement or deflection of the wall are allowed.

Max. Pressure = 0.125 at depth = 0.00

Infinite Surcharge, Q=.250 Active Wedge Approach * (recommend)

UNITS: LENGTH/DEPTH: ft, Qpoint: kip, Qline: kip/ft, Qstrip/Qarea/PRESSURE: ksf



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Wall Height, H= 8.5 Load Depth, D= 6.61

Load Factor of Surcharge Loading = 1

Rigid Wall Condition -- No movement or deflection of the wall are allowed.

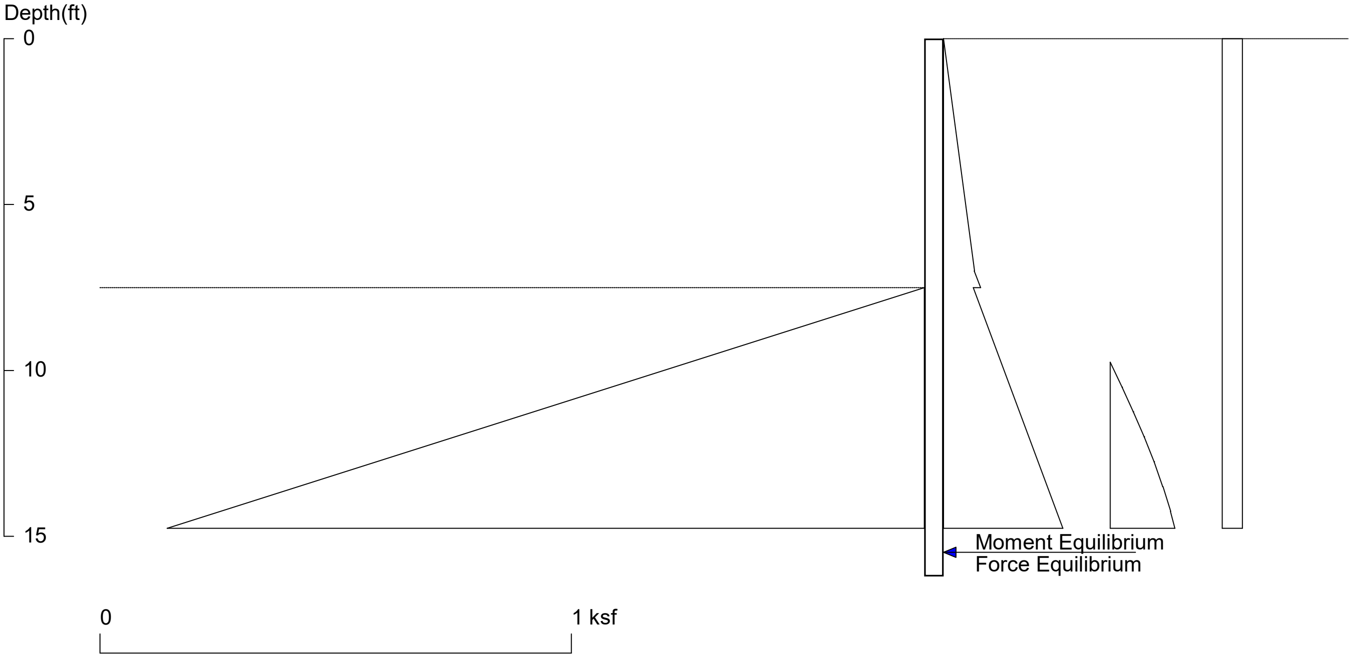
Max. Pressure = 0.407 at depth = 7.65

X	Width	Length	Area Load
1.0	6.0	32.6	.77

UNITS: LENGTH/DEPTH: ft, Qpoint: kip, Qline: kip/ft, Qstrip/Qarea/PRESSURE: ksf

Carroll Street Case III_CSDL02

Case III_CSDL02_EP



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Wall Height=7.5   Pile Diameter=1.0   Pile Spacing=1.0   Wall Type: 1. Sheet Pile

PILE LENGTH: Min. Embedment=8.70   Min. Pile Length=16.20
MOMENT IN PILE: Max. Moment=3.52 per Pile Spacing=1.0 at Depth=11.16

PILE SELECTION:
Request Min. Section Modulus = 1.4 in3/ft=75.77 cm3/m, Fy= 50 ksi = 345 MPa, Fb/Fy=0.60
User Input I (Moment of Inertia):
Top Deflection = 0.04(in) based on E (ksi)=29000.00 and I (in4)/foot=955.6

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
*	Above	Base		
0.000	0.000	7.000	0.066	0.009434
7.000	0.065	7.500	0.079	0.027906
*	Below	Base		
7.500	0.063	67.500	1.639	0.026279
*	Sur-	charge		
9.750	0.000	10.500	0.025	0.033318
10.500	0.025	11.250	0.049	0.032342
11.250	0.049	12.000	0.072	0.030503
12.000	0.072	12.750	0.093	0.028005
12.750	0.093	13.500	0.112	0.025089
13.500	0.112	14.250	0.128	0.021991
14.250	0.128	15.000	0.143	0.018910
15.000	0.143	16.500	0.155	0.007996
*	Sur-	charge		
0.000	0.043	0.375	0.043	0.000000
0.375	0.043	0.750	0.043	0.000000
0.750	0.043	1.125	0.043	0.000000

```
              1.125       0.043       1.500       0.043       0.000000
              1.500       0.043       1.875       0.043       0.000000
              1.875       0.043       2.250       0.043       0.000000
              2.250       0.043       2.625       0.043       0.000000
              2.625       0.043       3.000       0.043       0.000000
              3.000       0.043       3.375       0.043       0.000000
              3.375       0.043       3.750       0.043       0.000000
              3.750       0.043       4.125       0.043       0.000000
              4.125       0.043       4.500       0.043       0.000000
              4.500       0.043       4.875       0.043       0.000000
              4.875       0.043       5.250       0.043       0.000000
              5.250       0.043       5.625       0.043       0.000000
              5.625       0.043       6.000       0.043       0.000000
              6.000       0.043       6.375       0.043       0.000000
              6.375       0.043       6.750       0.043       0.000000
              6.750       0.043       7.125       0.043       0.000000
              7.125       0.043       7.500       0.043       0.000000
              7.500       0.043       8.250       0.043       0.000000
              8.250       0.043       9.000       0.043       0.000000
              9.000       0.043       9.750       0.043       0.000000
              9.750       0.043      10.500       0.043       0.000000
             10.500       0.043      11.250       0.043       0.000000
             11.250       0.043      12.000       0.043       0.000000
             12.000       0.043      12.750       0.043       0.000000
             12.750       0.043      13.500       0.043       0.000000
             13.500       0.043      14.250       0.043       0.000000
             14.250       0.043      15.000       0.043       0.000000
             15.000       0.043      16.500       0.043       0.000000

PASSIVE PRESSURES:   Pressures below will be divided by a Factor of Safety =1.25
                Z1          P1          Z2          P2         Slope
--------------------------------------------------------------------------------
                 *        Below        Base
              7.500       0.000      67.500      13.285       0.221424

ACTIVE SPACING:
                No.                   Z depth                  Spacing
--------------------------------------------------------------------------------
                 1                     0.00                      1.00
                 2                     7.50                      1.00

PASSIVE SPACING:
                No.                   Z depth                  Spacing
--------------------------------------------------------------------------------
                 1                     0.00                      1.00

--------------------------------------------------------------------------------
UNITS:   Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
         Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in
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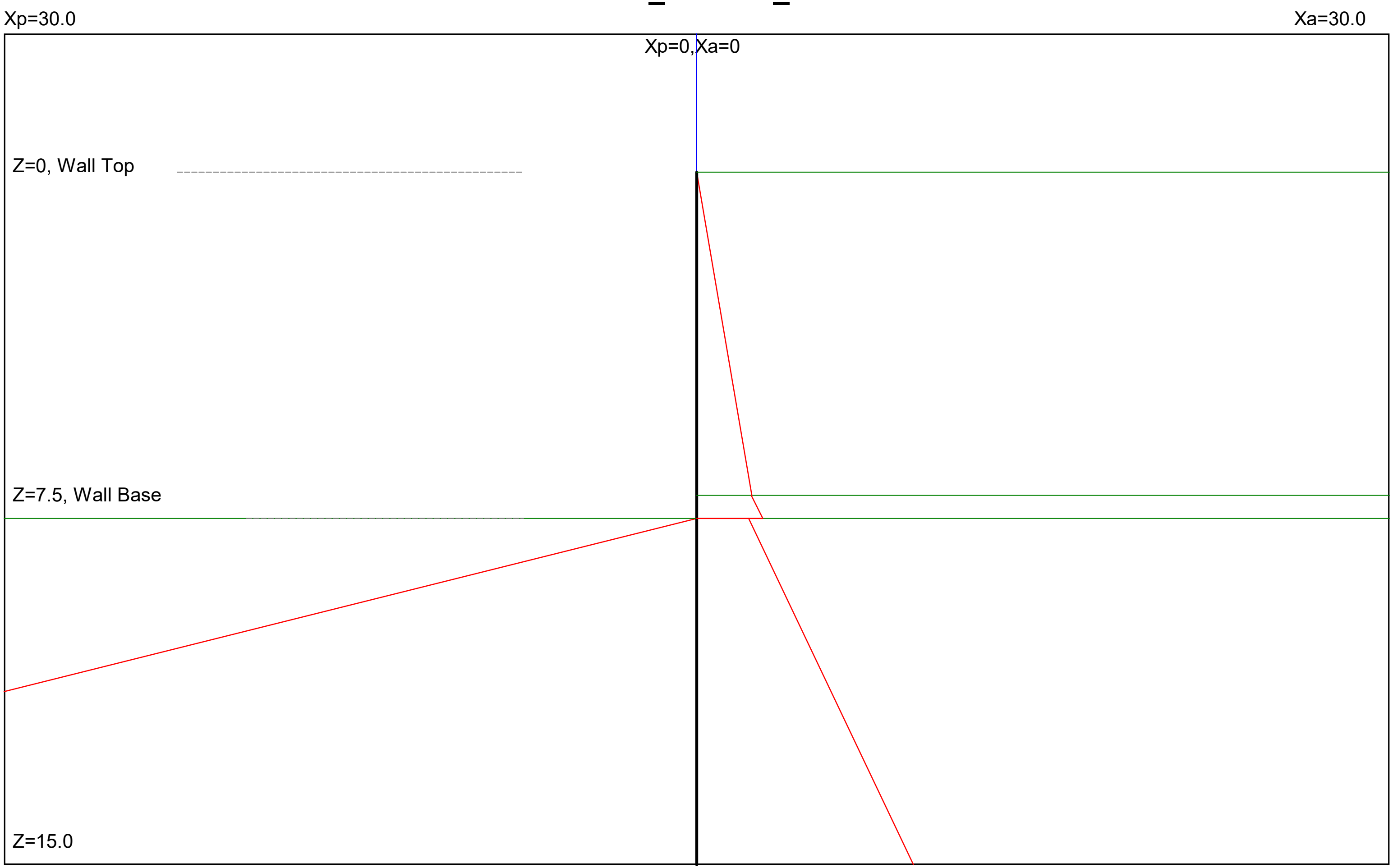
Carroll Street Case III_CSDL02

Case III_CSDL02_EP



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UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

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* INPUT DATA *

Wall Height=7.5   Total Soil Types= 4

Soil No.	Weight	Saturate	Phi	Cohesion	Nspt	Type	Description
1	80.0	80.0	28.00	0.0	0	3	Soft Sedimen
2	115.0	115.0	28	0.0	0	4	Native Alluv
3	125.0	125.0	34	0.0	0	4	Glacial Depo
4	115.0	115.0	30	0.0	0	4	Sand Backfil

Ground Surface at Active Side:

Line	Z1	Xa1	Z2	Xa2	Soil No.	Description
1	0.0	0.0	0.0	800.0	1	Soft Sedimen
2	7.0	0.0	7.0	800.0	2	Native Alluv
3	7.5	0.0	7.5	800.0	3	Glacial Depo

Water Table at Active Side:

Point	Z-water	X-water
1	-7.9	0.0
2	-7.9	800.0

Ground Surface at Passive Side:

Line	Z1	Xp1	Z2	Xp2	Soil No.	Description
1	7.5	0.0	7.5	800.0	3	Glacial Depo

Water Table at Passive Side:

Point	Z-water	X-water
1	-7.9	0.0
2	-7.9	800.0

Wall Friction Options: 1.* No wall friction
Wall Batter Angle = 0
Apparent Pressure Conversion: 1.* Default (Terzaghi and Peck)*
Water Density = 62.4
Water Pressure: 1.* No seepage at wall tip

* OUTPUT RESULTS *

Total Force above Base= 0.27 per one linear foot (or meter) width along wall height
Total Static Force above Base= 0.27

Driving Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Coef.
0.00	0.00	7.00	0.07	0.0094	0.5360
7.00	0.07	7.50	0.08	0.0279	0.5305

Driving Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Ka or Ko
7.50	0.06	15.00	0.26	0.0263	0.4205

Passive Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pp1	Z2	Pp2	Slope	Kp
7.50	0.00	15.00	1.66	0.221	3.5371

UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

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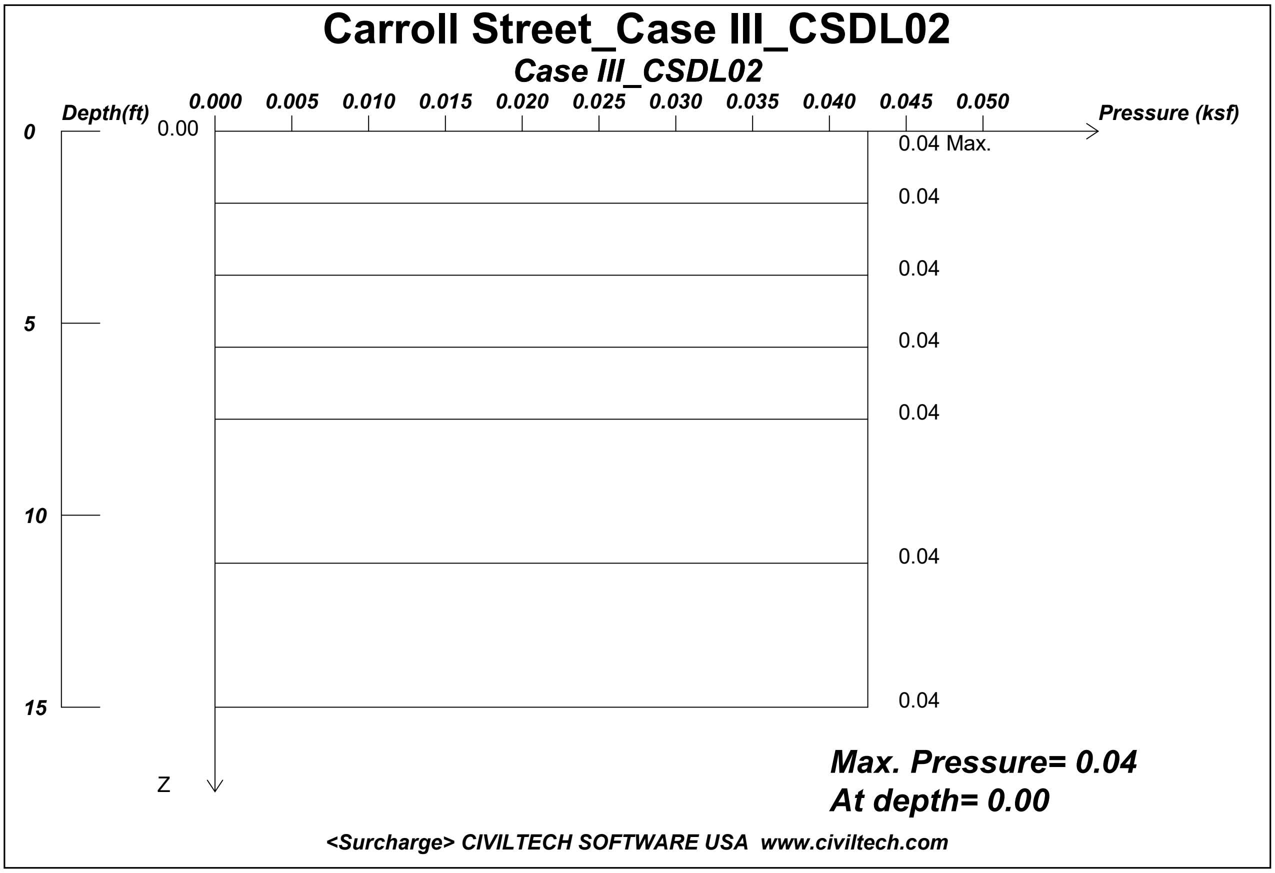

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Wall Height, H= 7.5 Load Depth, D= 0

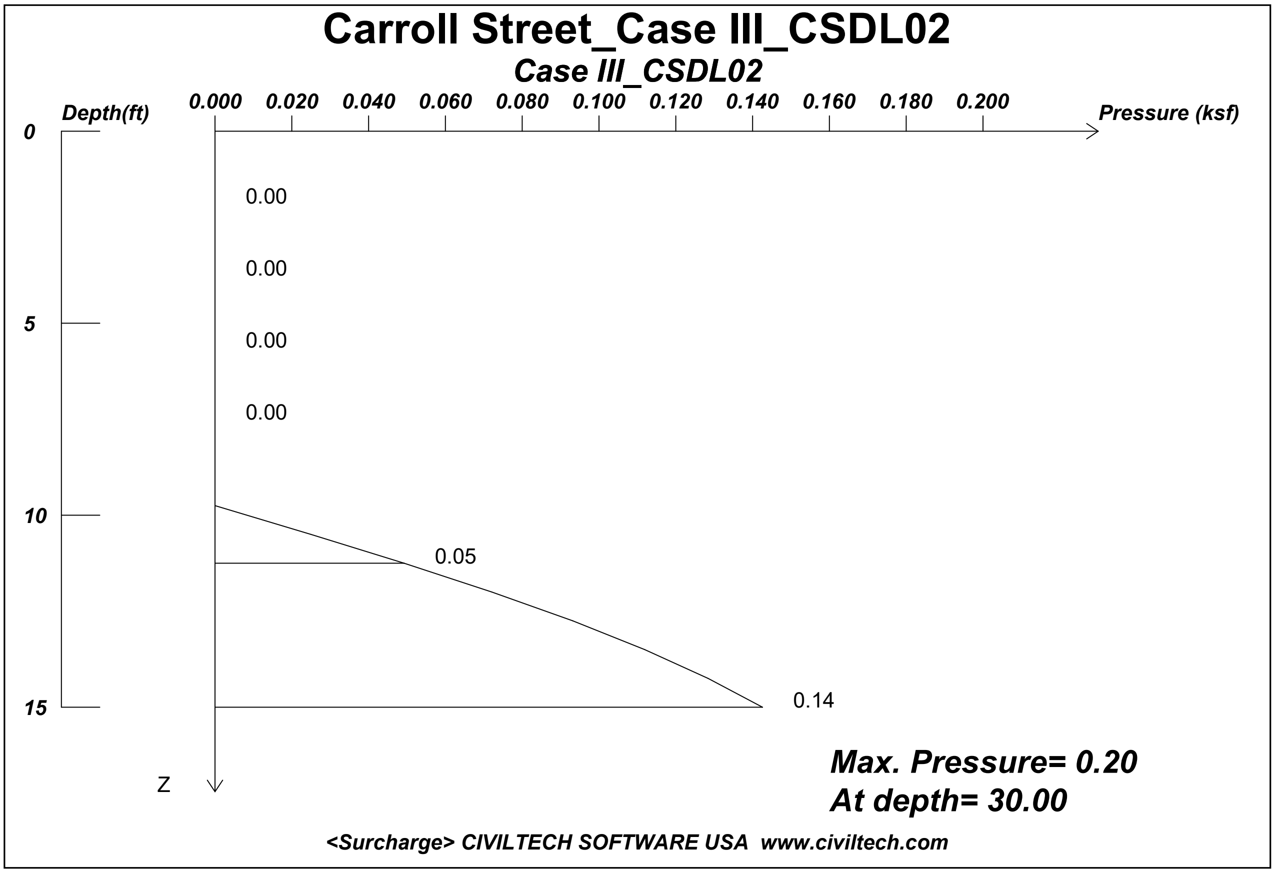
Load Factor of Surcharge Loading = 1

Rigid Wall Condition -- No movement or deflection of the wall are allowed.

Max. Pressure = 0.043 at depth = 0.00

Infinite Surcharge, Q=.085 Active Wedge Approach * (recommend)

UNITS: LENGTH/DEPTH: ft, Qpoint: kip, Qline: kip/ft, Qstrip/Qarea/PRESSURE: ksf



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Wall Height, H= 7.5 Load Depth, D= 10.27

Load Factor of Surcharge Loading = 1

Rigid Wall Condition -- No movement or deflection of the wall are allowed.

Max. Pressure = 0.198 at depth = 30.00

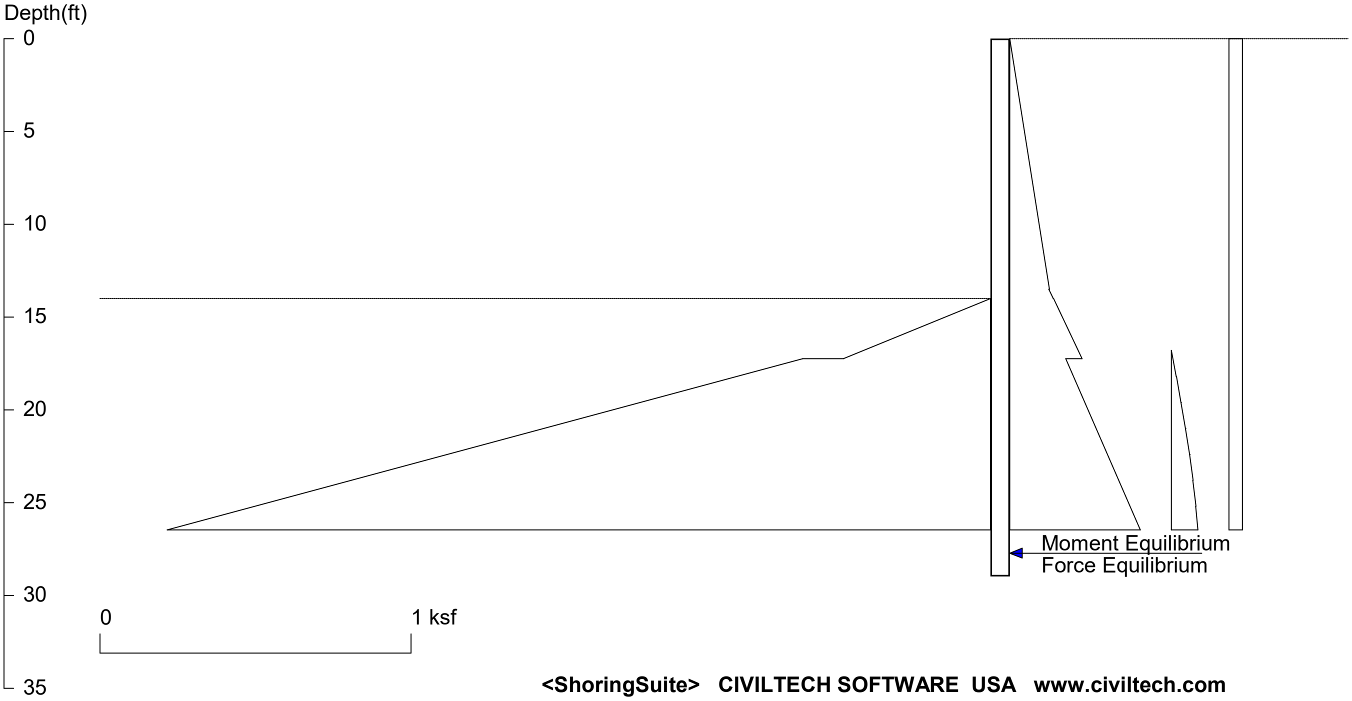
X	Width	Length	Area Load
4.5	54.0	4.5	1.51

30.00 0.20 Max.

UNITS: LENGTH/DEPTH: ft, Qpoint: kip, Qline: kip/ft, Qstrip/Qarea/PRESSURE: ksf

Carroll Street Case III_CSDL03

Case III_CSDL03_EP



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Wall Height=14.0 Pile Diameter=1.0 Pile Spacing=1.0 Wall Type: 1. Sheet Pile

PILE LENGTH: Min. Embedment=14.97 Min. Pile Length=28.97
MOMENT IN PILE: Max. Moment=17.22 per Pile Spacing=1.0 at Depth=20.62

PILE SELECTION:
Request Min. Section Modulus = 6.9 in3/ft=370.21 cm3/m, Fy= 50 ksi = 345 MPa, Fb/Fy=0.60
User Input I (Moment of Inertia):
Top Deflection = 0.14(in) based on E (ksi)=29000.00 and I (in4)/foot=955.6

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
*	Above	Base		
0.000	0.000	13.500	0.127	0.009434
13.500	0.126	14.000	0.140	0.027906
*	Below	Base		
14.000	0.141	17.250	0.233	0.028196
17.250	0.180	126.000	3.009	0.026010
*	Sur-	charge		
16.800	0.000	18.200	0.016	0.011073
18.200	0.016	19.600	0.031	0.010738
19.600	0.031	21.000	0.045	0.010094
21.000	0.045	22.400	0.058	0.009188
22.400	0.058	23.800	0.069	0.008083
23.800	0.069	25.200	0.078	0.006851
25.200	0.078	26.600	0.086	0.005562
26.600	0.086	28.000	0.092	0.004279
28.000	0.092	30.800	0.096	0.001527
*	Sur-	charge		
0.000	0.043	0.700	0.043	0.000000

0.700	0.043	1.400	0.043	0.000000
1.400	0.043	2.100	0.043	0.000000
2.100	0.043	2.800	0.043	0.000000
2.800	0.043	3.500	0.043	0.000000
3.500	0.043	4.200	0.043	0.000000
4.200	0.043	4.900	0.043	0.000000
4.900	0.043	5.600	0.043	0.000000
5.600	0.043	6.300	0.043	0.000000
6.300	0.043	7.000	0.043	0.000000
7.000	0.043	7.700	0.043	0.000000
7.700	0.043	8.400	0.043	0.000000
8.400	0.043	9.100	0.043	0.000000
9.100	0.043	9.800	0.043	0.000000
9.800	0.043	10.500	0.043	0.000000
10.500	0.043	11.200	0.043	0.000000
11.200	0.043	11.900	0.043	0.000000
11.900	0.043	12.600	0.043	0.000000
12.600	0.043	13.300	0.043	0.000000
13.300	0.043	14.000	0.043	0.000000
14.000	0.043	15.400	0.043	0.000000
15.400	0.043	16.800	0.043	0.000000
16.800	0.043	18.200	0.043	0.000000
18.200	0.043	19.600	0.043	0.000000
19.600	0.043	21.000	0.043	0.000000
21.000	0.043	22.400	0.043	0.000000
22.400	0.043	23.800	0.043	0.000000
23.800	0.043	25.200	0.043	0.000000
25.200	0.043	26.600	0.043	0.000000
26.600	0.043	28.000	0.043	0.000000
28.000	0.043	30.800	0.043	0.000000

PASSIVE PRESSURES: Pressures below will be divided by a Factor of Safety =1.25

Z1	P1	Z2	P2	Slope
*	Below	Base		
14.000	0.000	17.250	0.474	0.145693
17.250	0.604	126.000	24.685	0.221436

ACTIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00
2	14.00	1.00

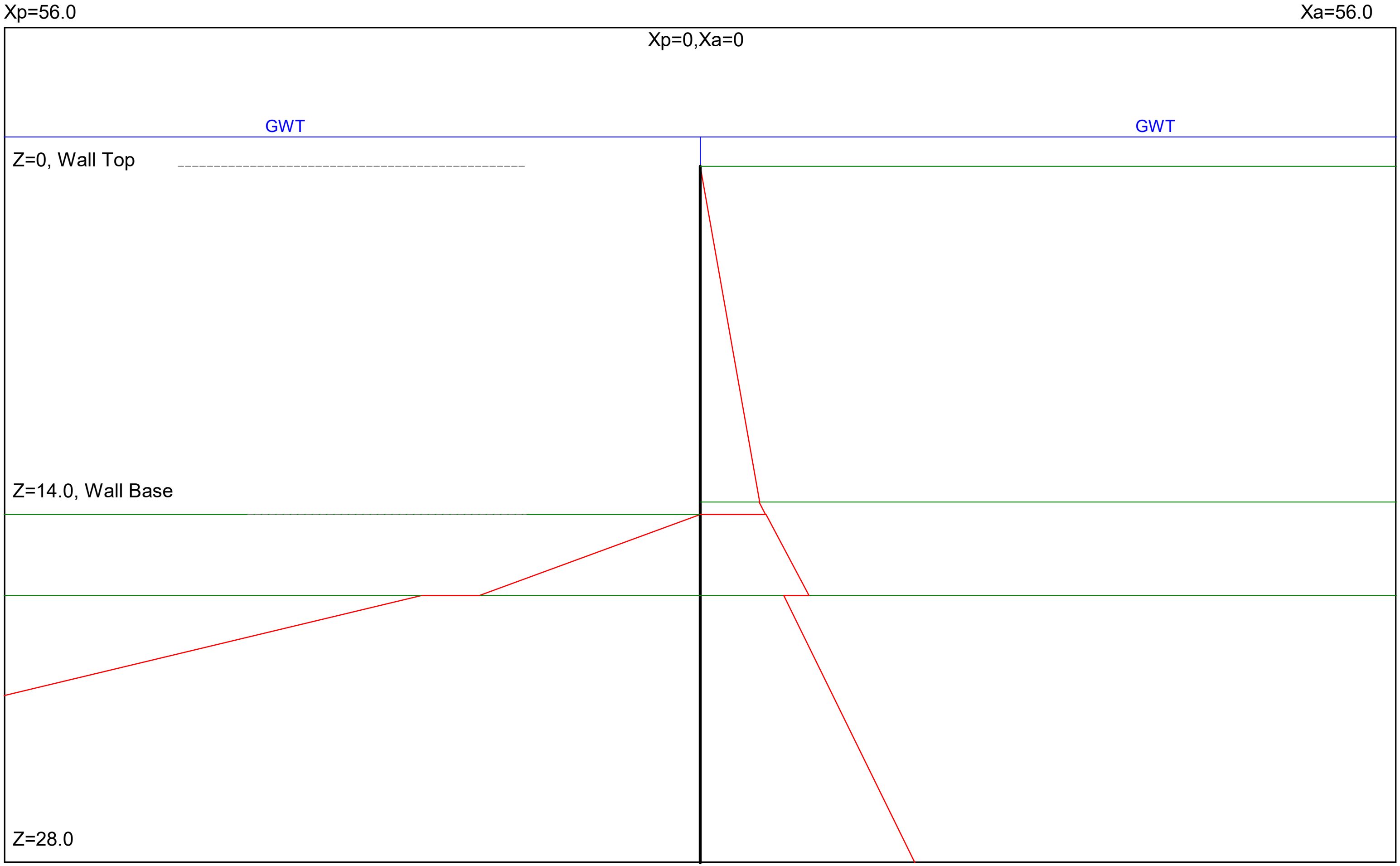
PASSIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in

Carroll Street Case III_CSDL03

Case III_CSDL03_EP



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* INPUT DATA *

Wall Height=14.0 Total Soil Types= 4

Soil No.	Weight	Saturate	Phi	Cohesion	Nspt	Type	Description
1	80.0	80.0	28.00	0.0	0	3	Soft Sedimen
2	115.0	115.0	28	0.0	0	4	Native Alluv
3	125.0	125.0	34	0.0	0	4	Glacial Depo
4	115.0	115.0	30	0.0	0	4	Sand Backfil

Ground Surface at Active Side:

Line	Z1	Xa1	Z2	Xa2	Soil No.	Description
1	0.0	0.0	0.0	800.0	1	Soft Sedimen
2	13.5	0.0	13.5	800.0	2	Native Alluv
3	17.3	0.0	17.3	800.0	3	Glacial Depo

Water Table at Active Side:

Point	Z-water	X-water
1	-1.2	0.0
2	-1.2	800.0

Ground Surface at Passive Side:

Line	Z1	Xp1	Z2	Xp2	Soil No.	Description
1	14.0	0.0	14.0	800.0	2	Native Alluv
2	17.3	0.0	17.3	800.0	3	Glacial Depo

Water Table at Passive Side:

Point	Z-water	X-water
1	-1.2	0.0
2	-1.2	800.0

Wall Friction Options: 1.* No wall friction

Wall Batter Angle = 0

Apparent Pressure Conversion: 1.* Default (Terzaghi and Peck)*

Water Density = 62.4

Water Pressure: 1.* No seepage at wall tip

* OUTPUT RESULTS *

Total Force above Base= 0.93 per one linear foot (or meter) width along wall height

Total Static Force above Base= 0.93

Driving Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Coef.
0.00	0.00	13.50	0.13	0.0094	0.5360
13.50	0.13	14.00	0.14	0.0279	0.5305

Driving Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Ka or Ko
14.00	0.14	17.25	0.23	0.0282	0.5360
17.25	0.18	28.00	0.46	0.0261	0.4175

Passive Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pp1	Z2	Pp2	Slope	Kp
14.00	0.00	17.25	0.47	0.146	2.7698
17.25	0.60	28.00	2.99	0.222	3.5502

UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

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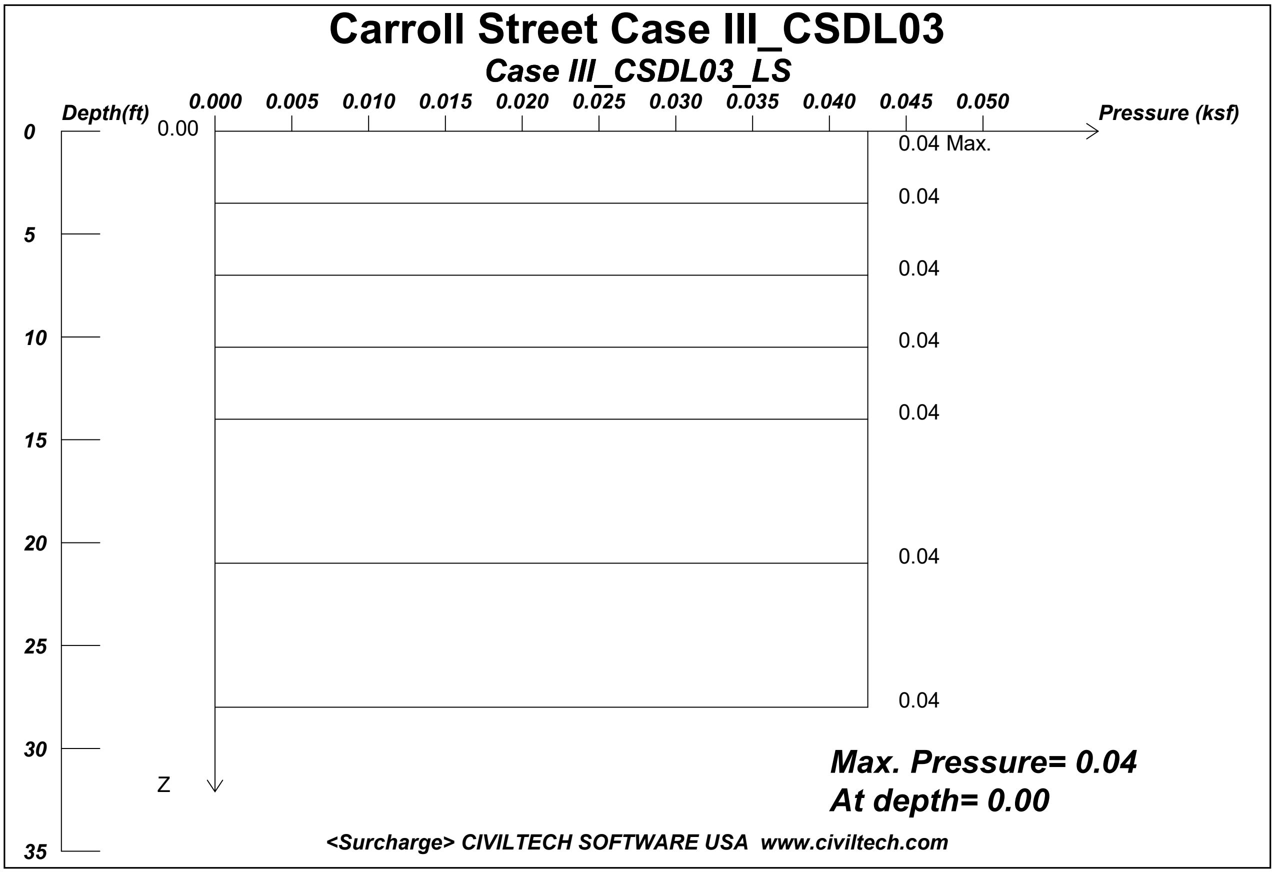

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Wall Height, H= 14 Load Depth, D= 0

Load Factor of Surcharge Loading = 1

Rigid Wall Condition -- No movement or deflection of the wall are allowed.

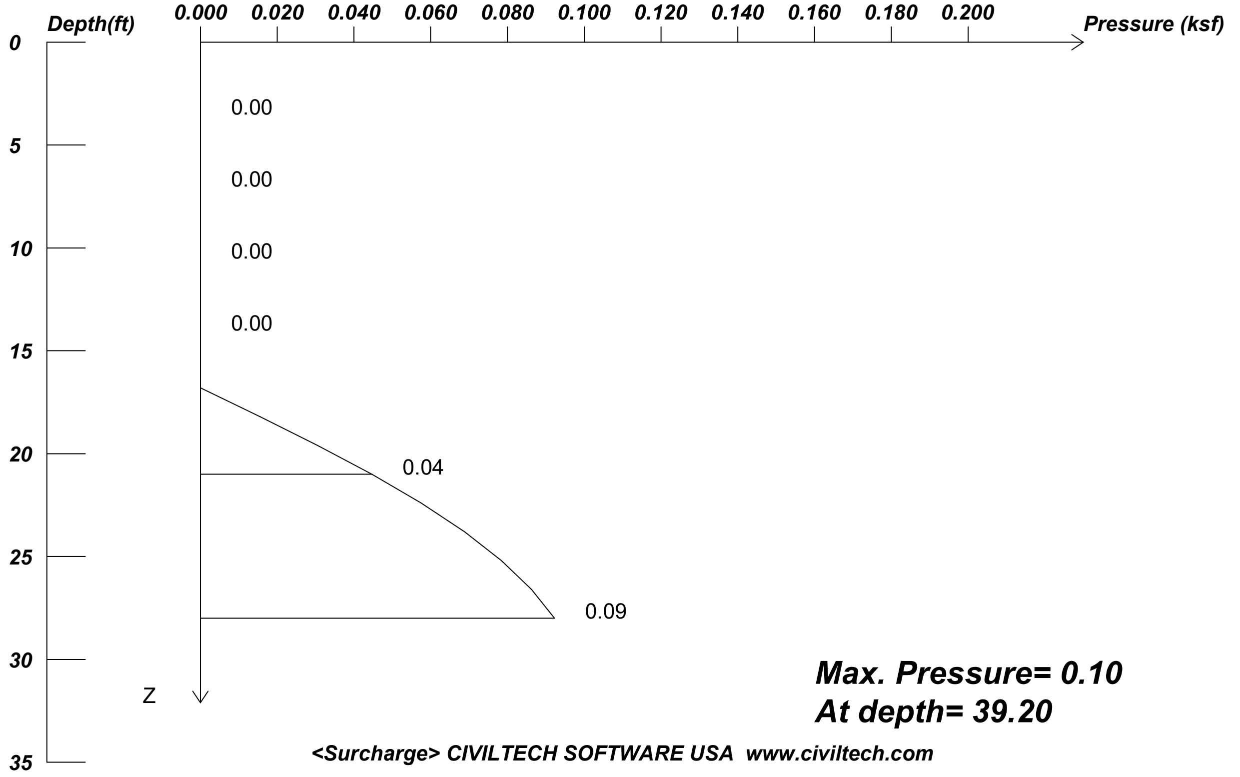
Max. Pressure = 0.043 at depth = 0.00

Infinite Surcharge, Q=0.085 Active Wedge Approach * (recommend)

UNITS: LENGTH/DEPTH: ft, Qpoint: kip, Qline: kip/ft, Qstrip/Qarea/PRESSURE: ksf

Carroll Street Case III_CSDL03

Case III_CSDL03_LS



Max. Pressure= 0.10
At depth= 39.20

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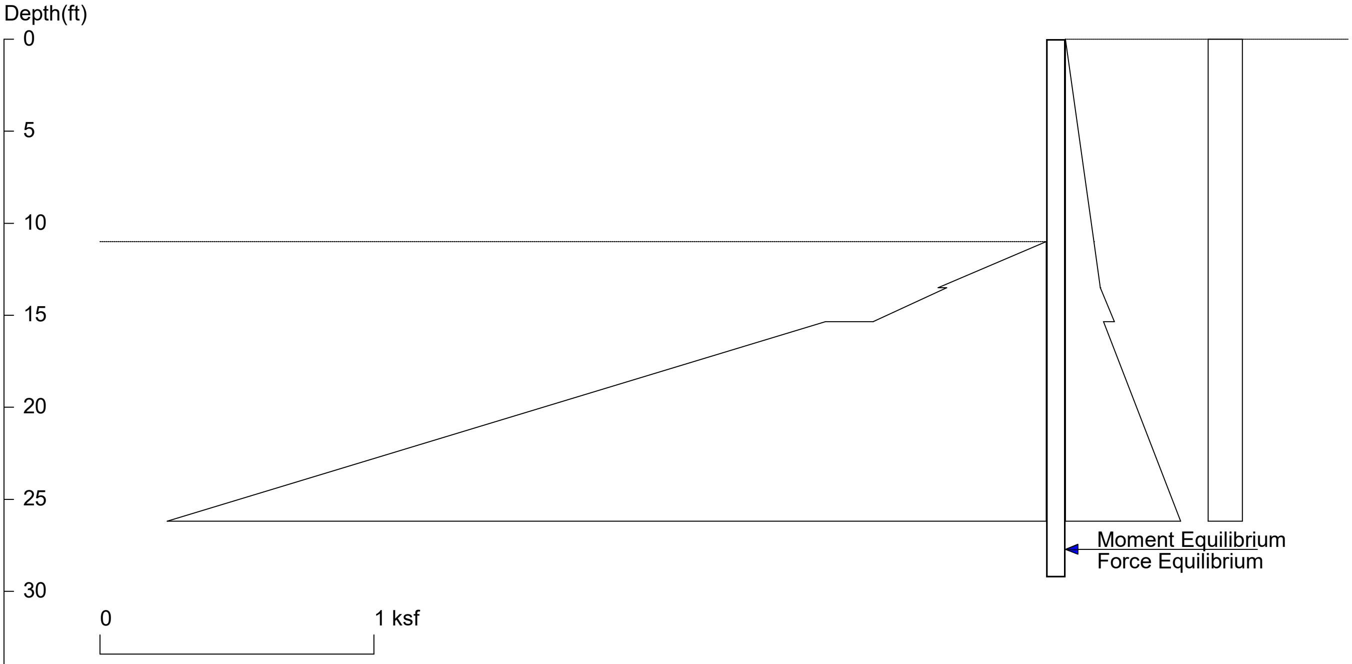
Wall Height, H= 14 Load Depth, D= 17
Load Factor of Surcharge Loading = 1
Rigid Wall Condition -- No movement or deflection of the wall are allowed.
Max. Pressure = 0.101 at depth = 39.20

X	Width	Length	Area Load
12.0	4.5	54.0	1.51

UNITS: LENGTH/DEPTH: ft, Qpoint: kip, Qline: kip/ft, Qstrip/Qarea/PRESSURE: ksf

Carroll Street Case IV_CSDL01_Group I

Case IV_CSDL01_EP



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Wall Height=11.0 Pile Diameter=1.0 Pile Spacing=1.0 Wall Type: 1. Sheet Pile

PILE LENGTH: Min. Embedment=18.23 Min. Pile Length=29.23
MOMENT IN PILE: Max. Moment=24.01 per Pile Spacing=1.0 at Depth=19.41

PILE SELECTION:
Request Min. Section Modulus = 9.6 in3/ft=516.38 cm3/m, Fy= 50 ksi = 345 MPa, Fb/Fy=0.60
User Input I (Moment of Inertia):
Top Deflection = 0.14(in) based on E (ksi)=29000.00 and I (in4)/foot=955.6

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
*	Above	Base		
0.000	0.000	11.000	0.104	0.009434
*	Below	Base		
11.000	0.104	13.500	0.127	0.009434
13.500	0.127	15.340	0.179	0.028196
15.340	0.139	99.000	2.315	0.026011
*	Sur-	charge		
0.000	0.125	0.550	0.125	0.000000
0.550	0.125	1.100	0.125	0.000000
1.100	0.125	1.650	0.125	0.000000
1.650	0.125	2.200	0.125	0.000000
2.200	0.125	2.750	0.125	0.000000
2.750	0.125	3.300	0.125	0.000000
3.300	0.125	3.850	0.125	0.000000
3.850	0.125	4.400	0.125	0.000000
4.400	0.125	4.950	0.125	0.000000
4.950	0.125	5.500	0.125	0.000000
5.500	0.125	6.050	0.125	0.000000

6.050	0.125	6.600	0.125	0.000000
6.600	0.125	7.150	0.125	0.000000
7.150	0.125	7.700	0.125	0.000000
7.700	0.125	8.250	0.125	0.000000
8.250	0.125	8.800	0.125	0.000000
8.800	0.125	9.350	0.125	0.000000
9.350	0.125	9.900	0.125	0.000000
9.900	0.125	10.450	0.125	0.000000
10.450	0.125	11.000	0.125	0.000000
11.000	0.125	12.100	0.125	0.000000
12.100	0.125	13.200	0.125	0.000000
13.200	0.125	14.300	0.125	0.000000
14.300	0.125	15.400	0.125	0.000000
15.400	0.125	16.500	0.125	0.000000
16.500	0.125	17.600	0.125	0.000000
17.600	0.125	18.700	0.125	0.000000
18.700	0.125	19.800	0.125	0.000000
19.800	0.125	20.900	0.125	0.000000
20.900	0.125	22.000	0.125	0.000000
22.000	0.125	24.200	0.125	0.000000
24.200	0.125	26.400	0.125	0.000000
26.400	0.125	28.600	0.125	0.000000
28.600	0.125	30.800	0.125	0.000000

PASSIVE PRESSURES: Pressures below will be divided by a Factor of Safety =1.5

Z1	P1	Z2	P2	Slope
*	Below	Base		
11.000	0.000	13.500	0.395	0.157800
13.500	0.363	15.340	0.632	0.146063
15.340	0.806	99.000	19.332	0.221451

ACTIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00
2	11.00	1.00

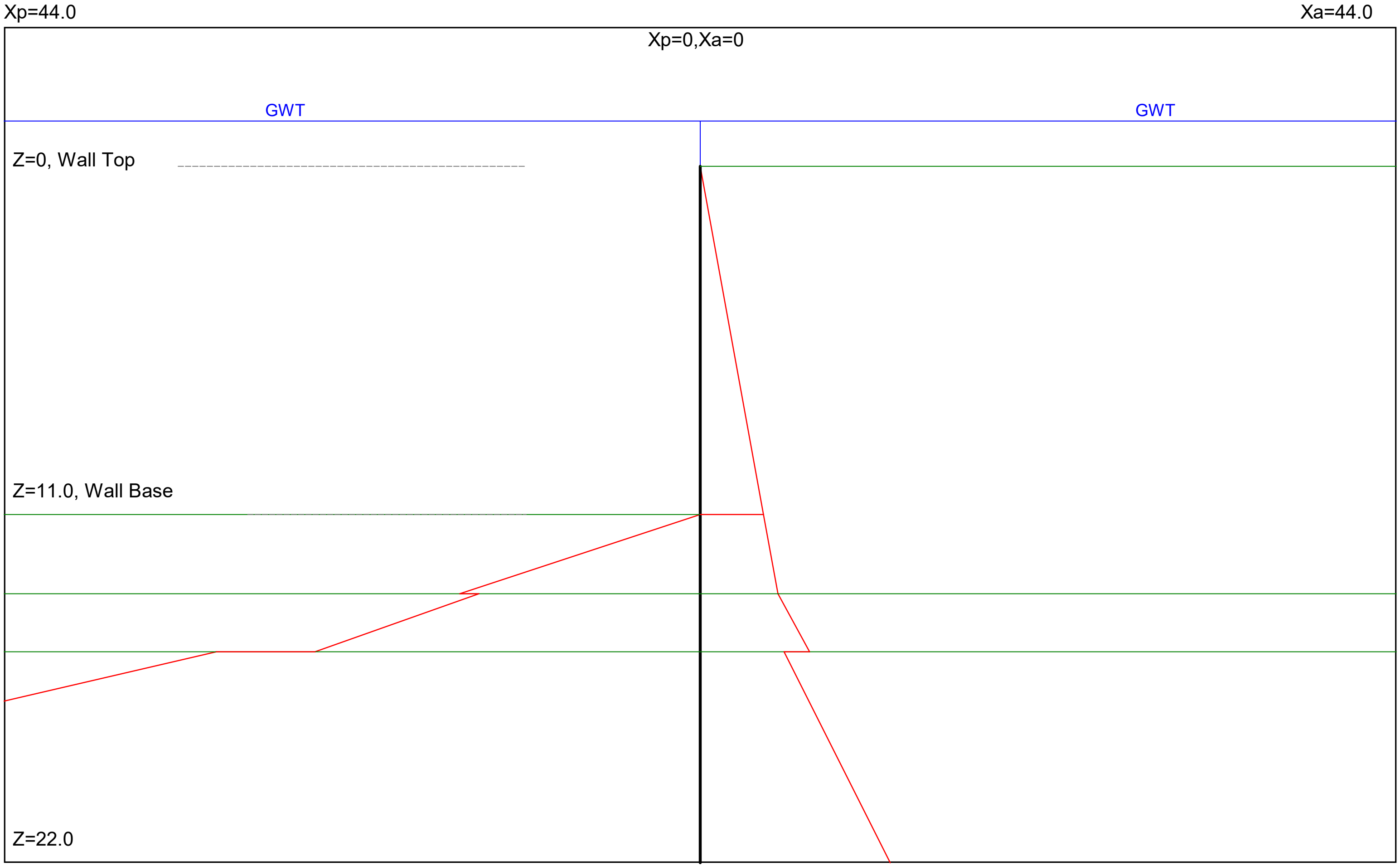
PASSIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in

Carroll Street Case IV_CSDL01_Group I

Case IV_CSDL01_EP



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UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

File: O:\2017\BAB-2017020.00 GOWANUS CANAL SUPERFUND SITE\Design\Structures\Carroll Street\Pipe Pile Wall\Case IV\Group I\CSDL01\Carroll Street_Case IV

* INPUT DATA *

Wall Height=11.0   Total Soil Types= 4

Soil No.	Weight	Saturate	Phi	Cohesion	Nspt	Type	Description
1	80.0	80.0	28.00	0.0	0	3	Soft Sedimen
2	115.0	115.0	28	0.0	0	4	Native Alluv
3	125.0	125.0	34	0.0	0	4	Glacial Depo
4	115.0	115.0	30	0.0	0	4	Sand Backfil

Ground Surface at Active Side:

Line	Z1	Xa1	Z2	Xa2	Soil No.	Description
1	0.0	0.0	0.0	800.0	1	Soft Sedimen
2	13.5	0.0	13.5	800.0	2	Native Alluv
3	15.3	0.0	15.3	800.0	3	Glacial Depo

Water Table at Active Side:

Point	Z-water	X-water
1	-1.4	0.0
2	-1.4	800.0

Ground Surface at Passive Side:

Line	Z1	Xp1	Z2	Xp2	Soil No.	Description
1	11.0	0.0	11.0	800.0	4	Sand Backfil
2	13.5	0.0	13.5	800.0	2	Native Alluv

3	15.3	0.0	15.3	800.0	3	Glacial Depo

Water Table at Passive Side:

Point	Z-water	X-water
1	-1.4	0.0
2	-1.4	800.0

Wall Friction Options: 1.* No wall friction
Wall Batter Angle = 0
Apparent Pressure Conversion: 1.* Default (Terzaghi and Peck)*
Water Density = 62.4
Water Pressure: 1.* No seepage at wall tip

* OUTPUT RESULTS *

Total Force above Base= 0.57 per one linear foot (or meter) width along wall height
Total Static Force above Base= 0.57

Driving Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Coef.
0.00	0.00	11.00	0.10	0.0094	0.5360

Driving Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Ka or Ko
11.00	0.10	13.50	0.13	0.0094	0.5360
13.50	0.13	15.34	0.18	0.0282	0.5360
15.34	0.14	22.00	0.31	0.0262	0.4178

Passive Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pp1	Z2	Pp2	Slope	Kp
11.00	0.00	13.50	0.39	0.158	3.0000
13.50	0.36	15.34	0.63	0.146	2.7769
15.34	0.79	22.00	2.28	0.224	3.5746

UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

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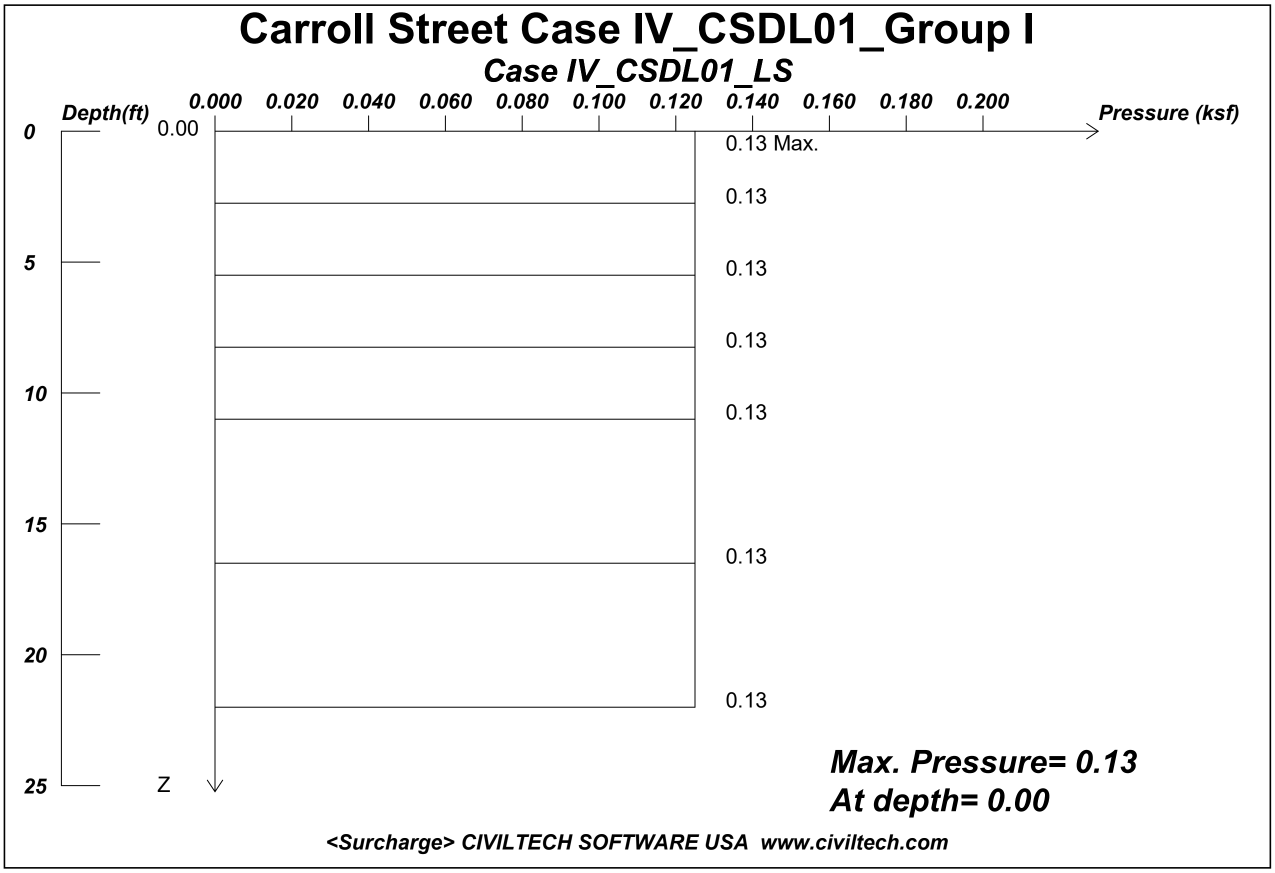

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Wall Height, H= 11 Load Depth, D= 0

Load Factor of Surcharge Loading = 1

Rigid Wall Condition -- No movement or deflection of the wall are allowed.

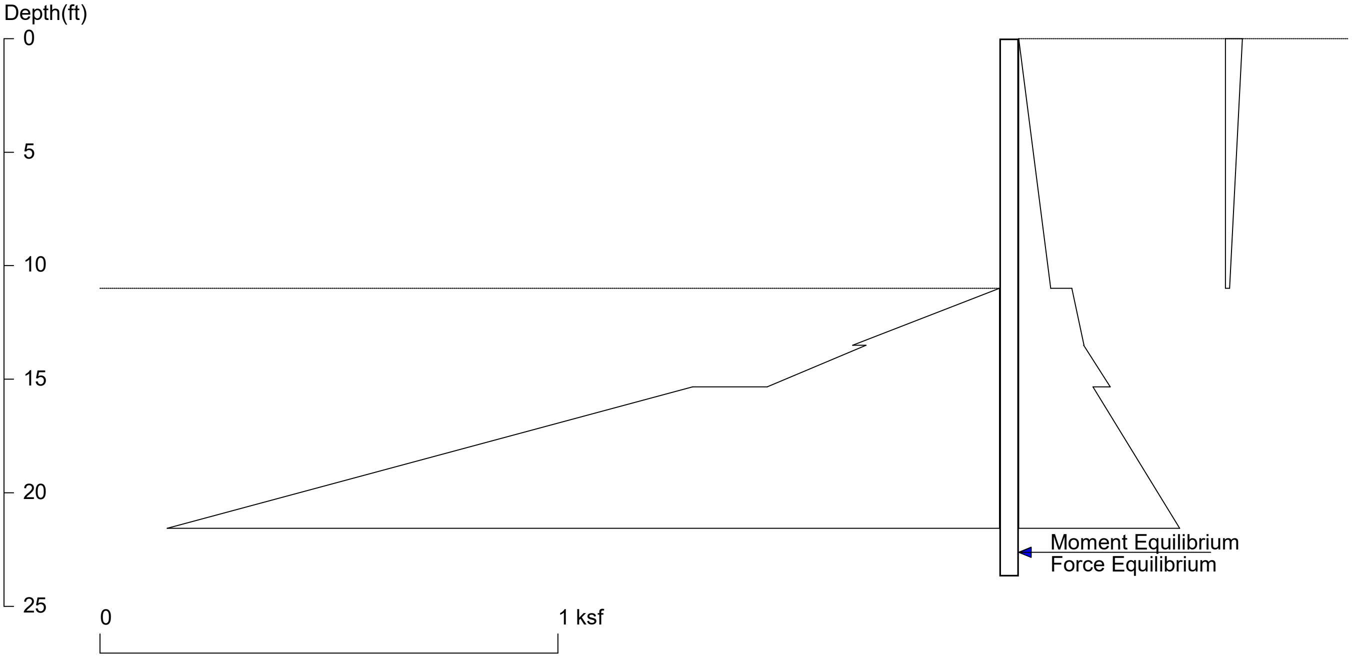
Max. Pressure = 0.125 at depth = 0.00

Infinite Surcharge, Q=.250 Active Wedge Approach * (recommend)

UNITS: LENGTH/DEPTH: ft, Qpoint: kip, Qline: kip/ft, Qstrip/Qarea/PRESSURE: ksf

Carroll Street Case IV_CSDL01_Group VII

Case IV_CSDL01_EP



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Wall Height=11.0 Pile Diameter=1.0 Pile Spacing=1.0 Wall Type: 1. Sheet Pile

PILE LENGTH: Min. Embedment=12.68 Min. Pile Length=23.68
MOMENT IN PILE: Max. Moment=6.41 per Pile Spacing=1.0 at Depth=16.82

PILE SELECTION:
Request Min. Section Modulus = 2.6 in3/ft=137.74 cm3/m, Fy= 50 ksi = 345 MPa, Fb/Fy=0.60
User Input I (Moment of Inertia):
Top Deflection = 0.10(in) based on E (ksi)=29000.00 and I (in4)/foot=955.6

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
*	Above	Base		
0.000	0.000	11.000	0.070	0.006354
*	Below	Base		
11.000	0.116	13.500	0.142	0.010546
13.500	0.142	15.340	0.200	0.031517
15.340	0.162	99.000	2.706	0.030415
*	Earth	Queck		
0.000	0.037	11.000	0.009	-0.002515

PASSIVE PRESSURES: Pressures below will be divided by a Factor of Safety =1.5

Z1	P1	Z2	P2	Slope
*	Below	Base		
11.000	0.000	13.500	0.321	0.128347
13.500	0.291	15.340	0.507	0.117444
15.340	0.670	99.000	16.085	0.184259

ACTIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00
2	11.00	1.00

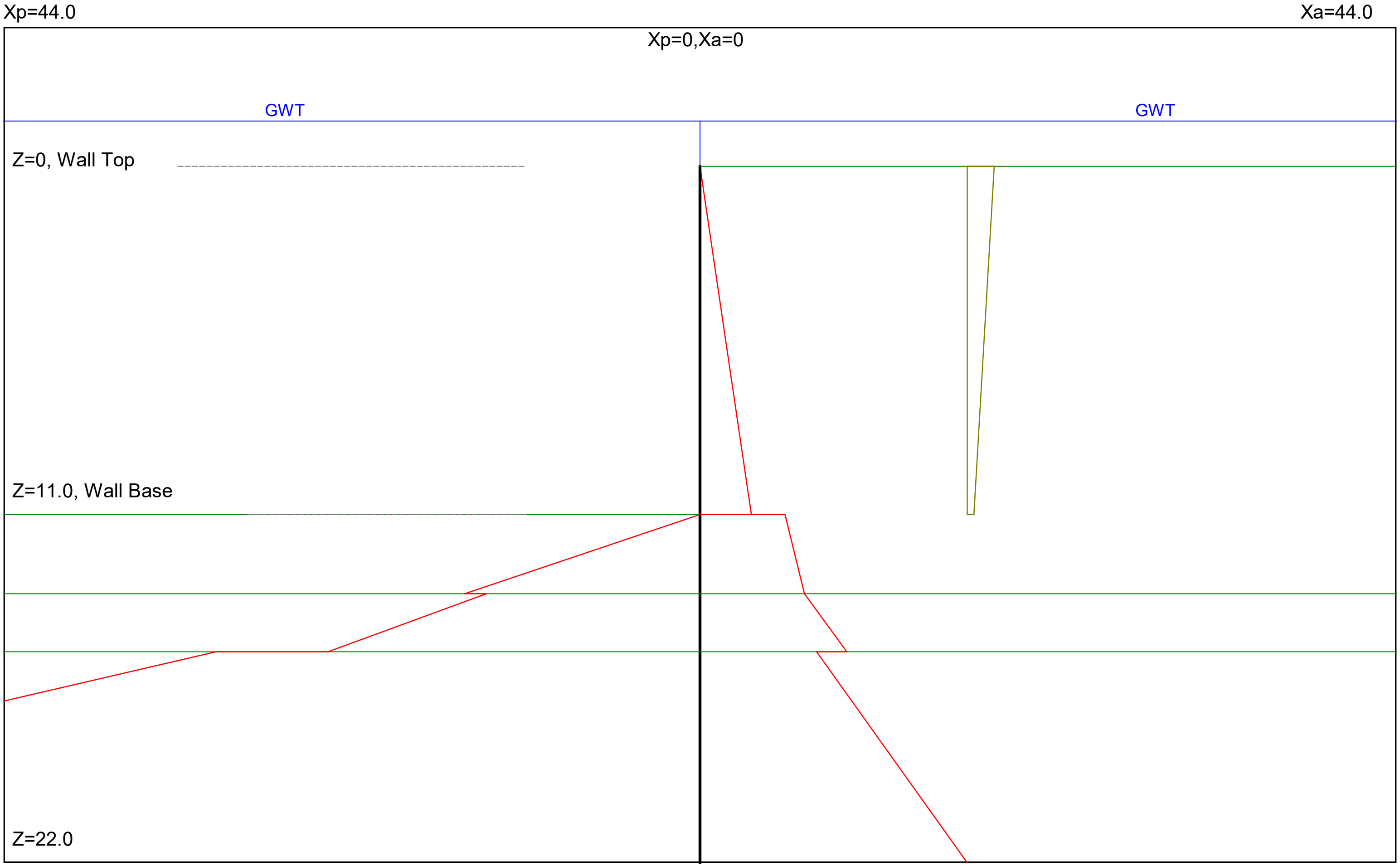
PASSIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in

Carroll Street Case IV_CSDL01_Group VII

Case IV_CSDL01_EP



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* INPUT DATA *

Wall Height=11.0 Total Soil Types= 4

Soil No.	Weight	Saturate	Phi	Cohesion	Nspt	Type	Description
1	80.0	80.0	28.00	0.0	0	3	Soft Sedimen
2	115.0	115.0	28	0.0	0	4	Native Alluv
3	125.0	125.0	34	0.0	0	4	Glacial Depo
4	115.0	115.0	30	0.0	0	4	Sand Backfil

Ground Surface at Active Side:

Line	Z1	Xa1	Z2	Xa2	Soil No.	Description
1	0.0	0.0	0.0	800.0	1	Soft Sedimen
2	13.5	0.0	13.5	800.0	2	Native Alluv
3	15.3	0.0	15.3	800.0	3	Glacial Depo

Water Table at Active Side:

Point	Z-water	X-water
1	-1.4	0.0
2	-1.4	800.0

Ground Surface at Passive Side:

Line	Z1	Xp1	Z2	Xp2	Soil No.	Description
1	11.0	0.0	11.0	800.0	4	Sand Backfil
2	13.5	0.0	13.5	800.0	2	Native Alluv

3	15.3	0.0	15.3	800.0	3	Glacial Depo

Water Table at Passive Side:

Point	Z-water	X-water
1	-1.4	0.0
2	-1.4	800.0

Wall Friction Options: 1.* No wall friction

Wall Batter Angle = 0

Apparent Pressure Conversion: 1.* Default (Terzaghi and Peck)*

Water Density = 62.4

Water Pressure: 1.* No seepage at wall tip

* OUTPUT RESULTS *

Total Force above Base= 0.64 per one linear foot (or meter) width along wall height

Total Static Force above Base= 0.38

Total Earthquake Force above Base= 0.25. Distributed in trapezoid. Total earthquake force acting at 0.4H below wall top.

Driving Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Coef.
0.00	0.00	11.00	0.07	0.0064	0.3610

Driving Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Ka or Ko
11.00	0.12	13.50	0.14	0.0105	0.5992
13.50	0.14	15.34	0.20	0.0315	0.5992
15.34	0.16	22.00	0.36	0.0308	0.4920

Passive Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pp1	Z2	Pp2	Slope	Kp
11.00	0.00	13.50	0.32	0.128	2.4401
13.50	0.29	15.34	0.51	0.117	2.2328
15.34	0.66	22.00	1.90	0.186	2.9728

Output Earthquake Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Total Earthq. Force, Ee = 0.25

No	Zq1	Pq1	Zq2	Pq2	Slope
0	0.00	0.037	11.00	0.009	-0.003

UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

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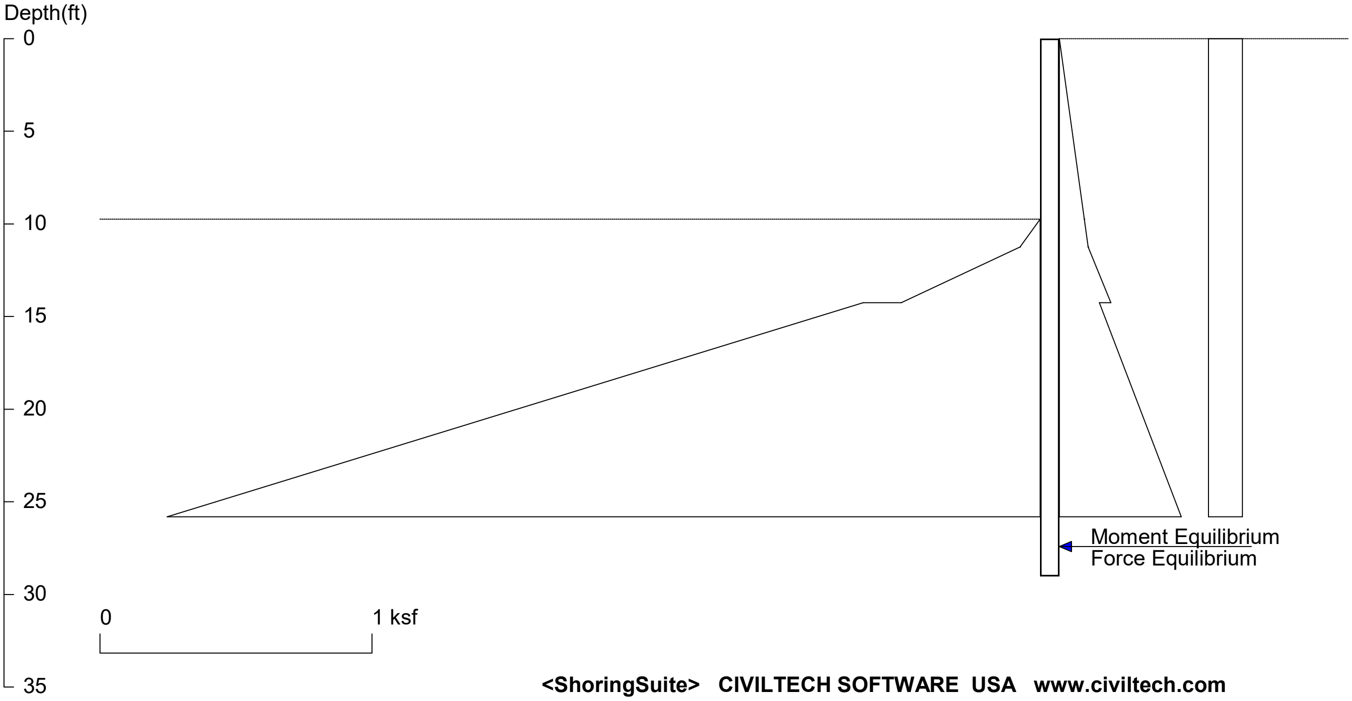
Carroll Street Case IV_CSDL04_Group I

Case IV_CSDL04_EP



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Wall Height=9.8 Pile Diameter=1.0 Pile Spacing=1.0 Wall Type: 1. Sheet Pile

PILE LENGTH: Min. Embedment=19.27 Min. Pile Length=29.02
MOMENT IN PILE: Max. Moment=23.03 per Pile Spacing=1.0 at Depth=19.09

PILE SELECTION:
Request Min. Section Modulus = 9.2 in3/ft=495.23 cm3/m, Fy= 50 ksi = 345 MPa, Fb/Fy=0.60
User Input I (Moment of Inertia):
Top Deflection = 0.14(in) based on E (ksi)=29000.00 and I (in4)/foot=955.6

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
*	Above	Base		
0.000	0.000	9.750	0.092	0.009434
*	Below	Base		
9.750	0.092	11.250	0.106	0.009434
11.250	0.106	14.250	0.191	0.028196
14.250	0.148	87.750	2.059	0.026012
*	Sur-	charge		
0.000	0.125	0.488	0.125	0.000000
0.488	0.125	0.975	0.125	0.000000
0.975	0.125	1.462	0.125	0.000000
1.462	0.125	1.950	0.125	0.000000
1.950	0.125	2.438	0.125	0.000000
2.438	0.125	2.925	0.125	0.000000
2.925	0.125	3.412	0.125	0.000000
3.412	0.125	3.900	0.125	0.000000
3.900	0.125	4.387	0.125	0.000000
4.387	0.125	4.875	0.125	0.000000
4.875	0.125	5.363	0.125	0.000000

5.363	0.125	5.850	0.125	0.000000
5.850	0.125	6.338	0.125	0.000000
6.338	0.125	6.825	0.125	0.000000
6.825	0.125	7.313	0.125	0.000000
7.313	0.125	7.800	0.125	0.000000
7.800	0.125	8.288	0.125	0.000000
8.288	0.125	8.775	0.125	0.000000
8.775	0.125	9.263	0.125	0.000000
9.263	0.125	9.750	0.125	0.000000
9.750	0.125	10.725	0.125	0.000000
10.725	0.125	11.700	0.125	0.000000
11.700	0.125	12.675	0.125	0.000000
12.675	0.125	13.650	0.125	0.000000
13.650	0.125	14.625	0.125	0.000000
14.625	0.125	15.600	0.125	0.000000
15.600	0.125	16.575	0.125	0.000000
16.575	0.125	17.550	0.125	0.000000
17.550	0.125	18.525	0.125	0.000000
18.525	0.125	19.500	0.125	0.000000
19.500	0.125	21.450	0.125	0.000000
21.450	0.125	23.400	0.125	0.000000
23.400	0.125	25.350	0.125	0.000000
25.350	0.125	27.300	0.125	0.000000
27.300	0.125	29.250	0.125	0.000000

PASSIVE PRESSURES: Pressures below will be divided by a Factor of Safety =1.5

Z1	P1	Z2	P2	Slope
*	Below	Base		
9.750	0.000	11.250	0.073	0.048749
11.250	0.073	14.250	0.510	0.145693
14.250	0.650	87.750	16.927	0.221454

ACTIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00
2	9.75	1.00

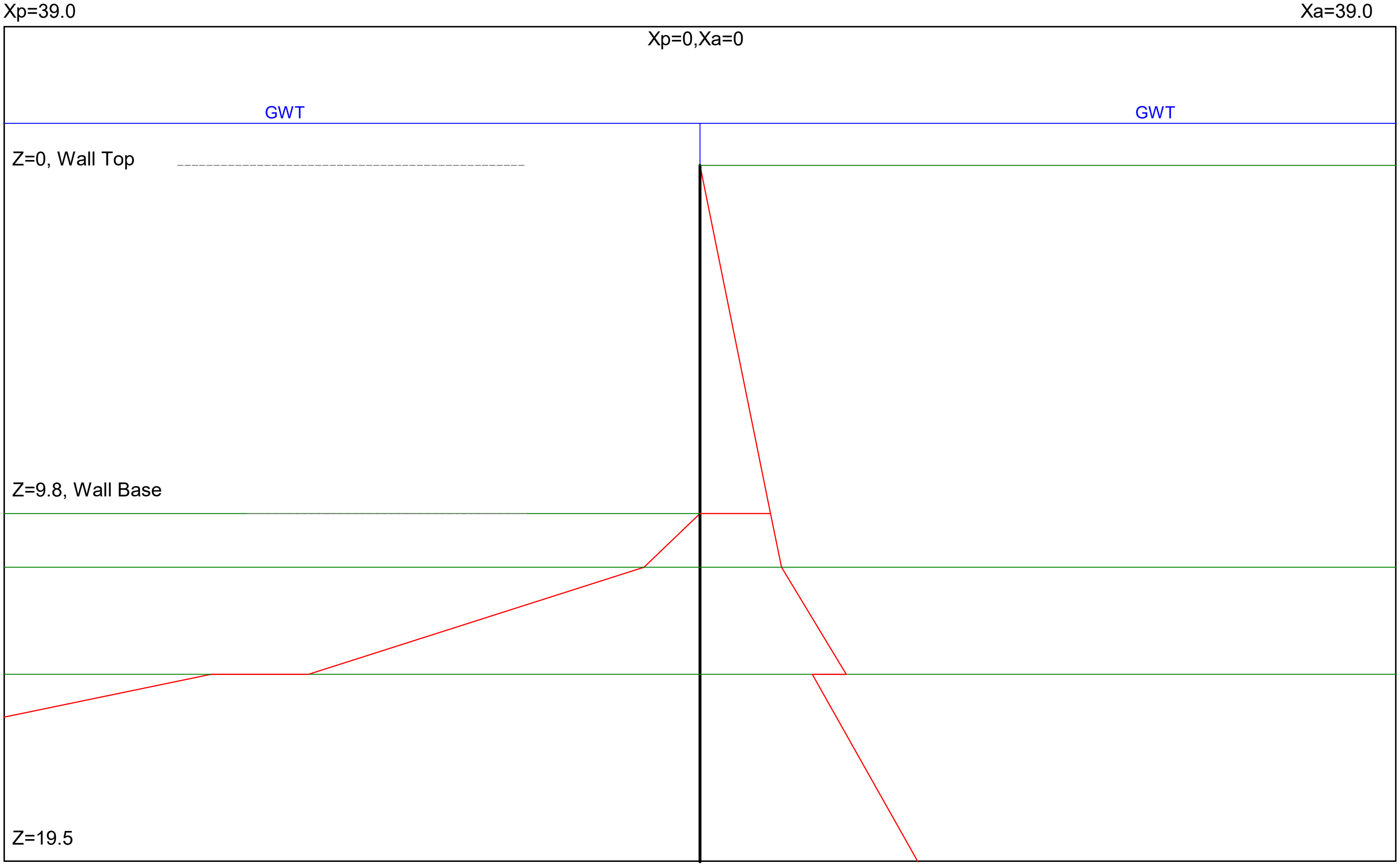
PASSIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in

Carroll Street Case IV_CSDL04_Group I

Case IV_CSDL04_EP



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* INPUT DATA *

Wall Height=9.8   Total Soil Types= 4

Soil No.	Weight	Saturate	Phi	Cohesion	Nspt	Type	Description
1	80.0	80.0	28.00	0.0	0	3	Soft Sedimen
2	115.0	115.0	28	0.0	0	4	Native Alluv
3	125.0	125.0	34	0.0	0	4	Glacial Depo
4	115.0	115.0	30	0.0	0	4	Sand Backfil

Ground Surface at Active Side:

Line	Z1	Xa1	Z2	Xa2	Soil No.	Description
1	0.0	0.0	0.0	800.0	1	Soft Sedimen
2	11.3	0.0	11.3	800.0	2	Native Alluv
3	14.3	0.0	14.3	800.0	3	Glacial Depo

Water Table at Active Side:

Point	Z-water	X-water
1	-1.2	0.0
2	-1.2	800.0

Ground Surface at Passive Side:

Line	Z1	Xp1	Z2	Xp2	Soil No.	Description
1	9.8	0.0	9.8	800.0	1	Soft Sedimen
2	11.3	0.0	11.3	800.0	2	Native Alluv

3	14.3	0.0	14.3	800.0	3	Glacial Depo

Water Table at Passive Side:

Point	Z-water	X-water
1	-1.2	0.0
2	-1.2	800.0

Wall Friction Options: 1.* No wall friction

Wall Batter Angle = 0

Apparent Pressure Conversion: 1.* Default (Terzaghi and Peck)*

Water Density = 62.4

Water Pressure: 1.* No seepage at wall tip

* OUTPUT RESULTS *

Total Force above Base= 0.45 per one linear foot (or meter) width along wall height

Total Static Force above Base= 0.45

Driving Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Coef.
0.00	0.00	9.75	0.09	0.0094	0.5360

Driving Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Ka or Ko
9.75	0.09	11.25	0.11	0.0094	0.5360
11.25	0.11	14.25	0.19	0.0282	0.5360
14.25	0.15	19.50	0.28	0.0262	0.4181

Passive Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pp1	Z2	Pp2	Slope	Kp
9.75	0.00	11.25	0.07	0.049	2.7698
11.25	0.07	14.25	0.51	0.146	2.7698
14.25	0.64	19.50	1.82	0.225	3.5863

UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

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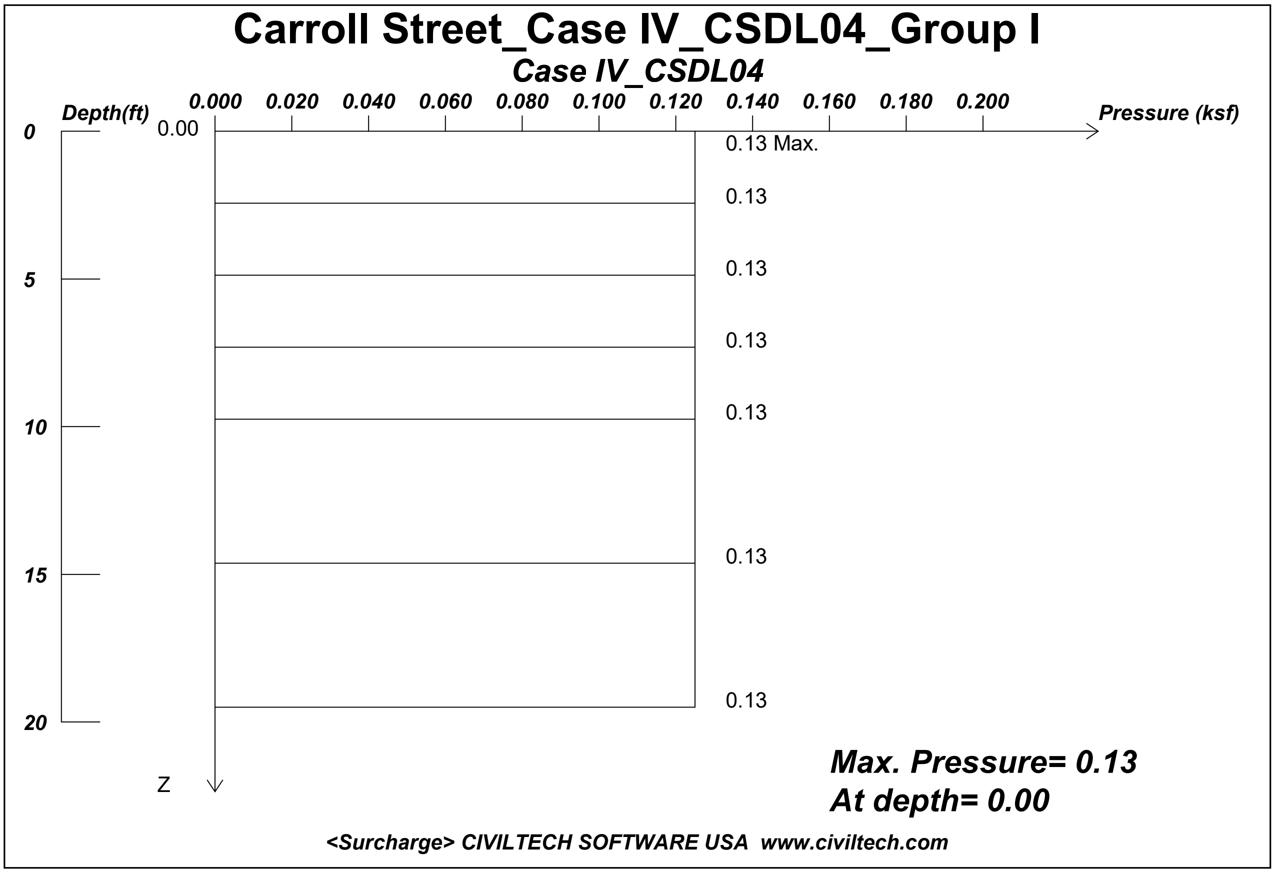

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Wall Height, H= 9.75 Load Depth, D= 0

Load Factor of Surcharge Loading = 1

Rigid Wall Condition -- No movement or deflection of the wall are allowed.

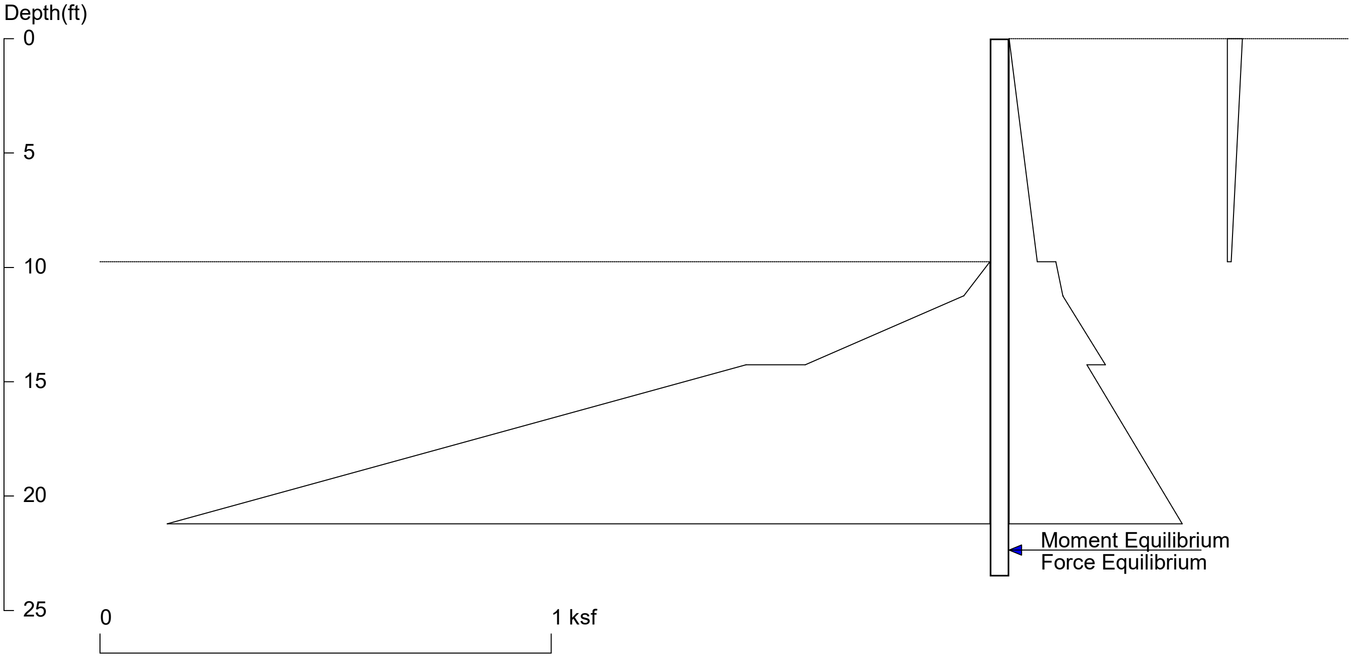
Max. Pressure = 0.125 at depth = 0.00

Infinite Surcharge, Q=0.250 Active Wedge Approach * (recommend)

UNITS: LENGTH/DEPTH: ft, Qpoint: kip, Qline: kip/ft, Qstrip/Qarea/PRESSURE: ksf

Carroll Street Case IV_CSDL04_Group VII

Case IV_CSDL04_EP



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Wall Height=9.8 Pile Diameter=1.0 Pile Spacing=1.0 Wall Type: 1. Sheet Pile

PILE LENGTH: Min. Embedment=13.75 Min. Pile Length=23.50
MOMENT IN PILE: Max. Moment=5.96 per Pile Spacing=1.0 at Depth=16.52

PILE SELECTION:
Request Min. Section Modulus = 2.4 in3/ft=128.07 cm3/m, Fy= 50 ksi = 345 MPa, Fb/Fy=0.60
User Input I (Moment of Inertia):
Top Deflection = 0.12(in) based on E (ksi)=29000.00 and I (in4)/foot=955.6

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
*	Above	Base		
0.000	0.000	9.750	0.062	0.006354
*	Below	Base		
9.750	0.103	11.250	0.119	0.010546
11.250	0.119	14.250	0.213	0.031517
14.250	0.172	87.750	2.408	0.030417
*	Earth	Queck		
0.000	0.033	9.750	0.008	-0.002515

PASSIVE PRESSURES: Pressures below will be divided by a Factor of Safety =1.5

Z1	P1	Z2	P2	Slope
*	Below	Base		
9.750	0.000	11.250	0.059	0.039133
11.250	0.059	14.250	0.410	0.116953
14.250	0.541	87.750	14.084	0.184261

ACTIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00
2	9.75	1.00

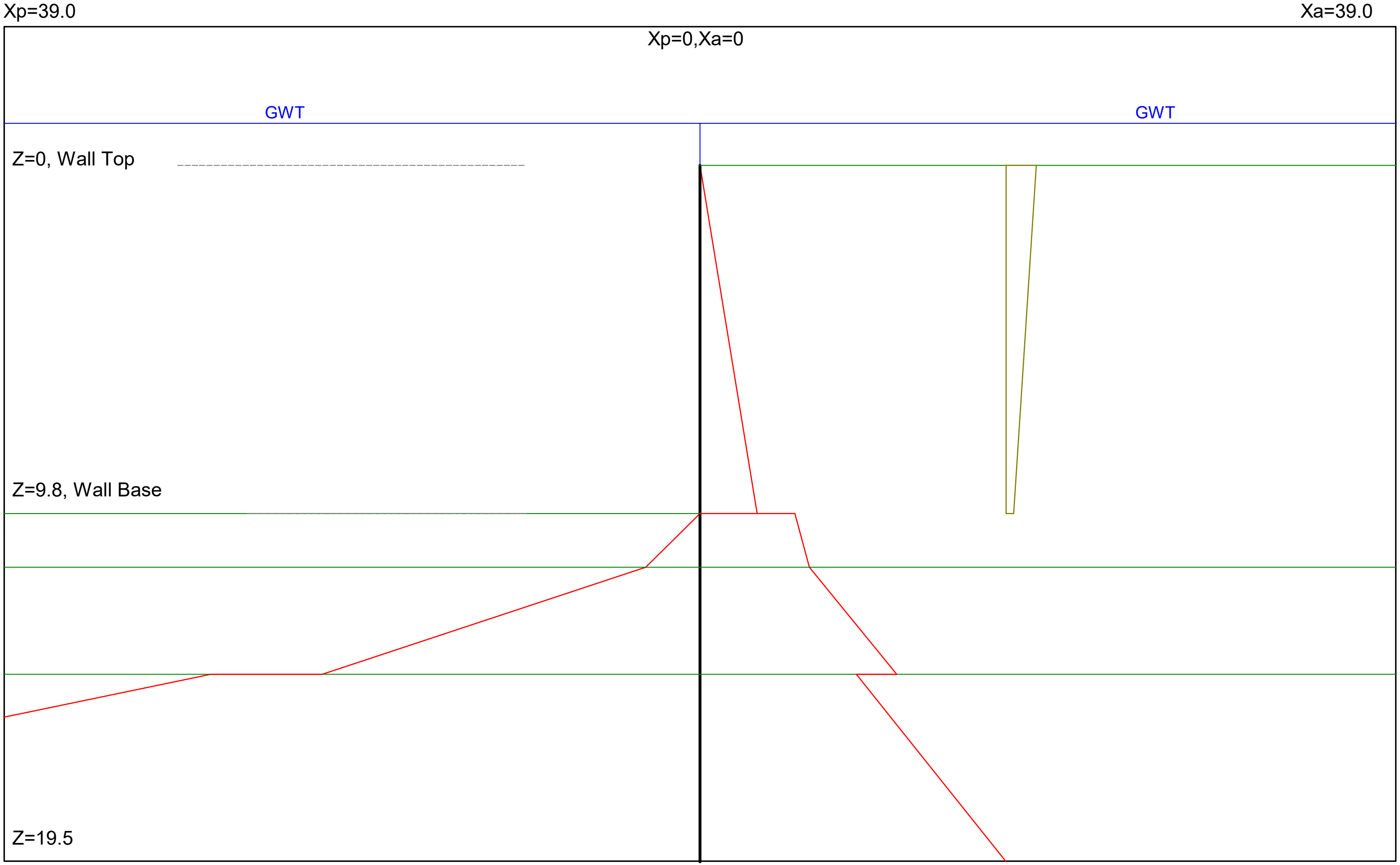
PASSIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in

Carroll Street Case IV_CSDL04_Group VII

Case IV_CSDL04_EP



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UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

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* INPUT DATA *

Wall Height=9.8   Total Soil Types= 4

Soil No.	Weight	Saturate	Phi	Cohesion	Nspt	Type	Description
1	80.0	80.0	28.00	0.0	0	3	Soft Sedimen
2	115.0	115.0	28	0.0	0	4	Native Alluv
3	125.0	125.0	34	0.0	0	4	Glacial Depo
4	115.0	115.0	30	0.0	0	4	Sand Backfil

Ground Surface at Active Side:

Line	Z1	Xa1	Z2	Xa2	Soil No.	Description
1	0.0	0.0	0.0	800.0	1	Soft Sedimen
2	11.3	0.0	11.3	800.0	2	Native Alluv
3	14.3	0.0	14.3	800.0	3	Glacial Depo

Water Table at Active Side:

Point	Z-water	X-water
1	-1.2	0.0
2	-1.2	800.0

Ground Surface at Passive Side:

Line	Z1	Xp1	Z2	Xp2	Soil No.	Description
1	9.8	0.0	9.8	800.0	1	Soft Sedimen
2	11.3	0.0	11.3	800.0	2	Native Alluv

3	14.3	0.0	14.3	800.0	3	Glacial Depo

Water Table at Passive Side:

Point	Z-water	X-water
1	-1.2	0.0
2	-1.2	800.0

Wall Friction Options: 1.* No wall friction
Wall Batter Angle = 0
Apparent Pressure Conversion: 1.* Default (Terzaghi and Peck)*
Water Density = 62.4
Water Pressure: 1.* No seepage at wall tip

* OUTPUT RESULTS *

Total Force above Base= 0.50 per one linear foot (or meter) width along wall height
Total Static Force above Base= 0.30
Total Earthquake Force above Base= 0.20. Distributed in trapezoid. Total earthquake force acting at 0.4H below wall top.

Driving Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Coef.
0.00	0.00	9.75	0.06	0.0064	0.3610

Driving Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Ka or Ko
9.75	0.10	11.25	0.12	0.0105	0.5992
11.25	0.12	14.25	0.21	0.0315	0.5992
14.25	0.17	19.50	0.33	0.0309	0.4943

Passive Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pp1	Z2	Pp2	Slope	Kp
9.75	0.00	11.25	0.06	0.039	2.2234
11.25	0.06	14.25	0.41	0.117	2.2234
14.25	0.53	19.50	1.51	0.187	2.9812

Output Earthquake Pressure above Base - Output to Shoring - Multiplier of Pressure = 1
Total Earthq. Force, Ee = 0.20

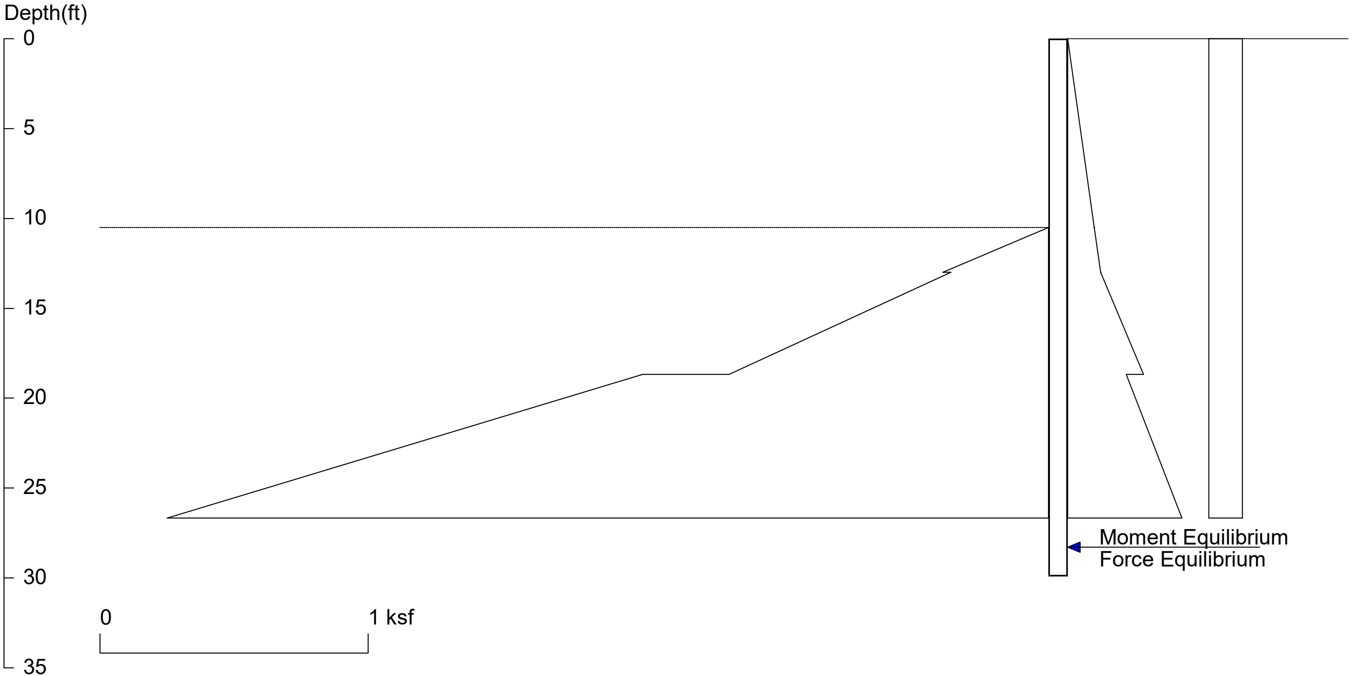
No	Zq1	Pq1	Zq2	Pq2	Slope
0	0.00	0.033	9.75	0.008	-0.003

UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

Date: 8/13/2019   File Name: O:\2017\BAB-2017020.00 GOWANUS CANAL SUPERFUND SITE\Design\Structures\Carroll Street\Pipe Pile Wall\Case I'

Carroll Street Case IV_CSDL06_Group I

Case IV_CSDL06_EP



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Wall Height=10.5   Pile Diameter=1.0   Pile Spacing=1.0   Wall Type: 1. Sheet Pile

PILE LENGTH: Min. Embedment=19.41   Min. Pile Length=29.91
MOMENT IN PILE: Max. Moment=24.31 per Pile Spacing=1.0 at Depth=20.03

PILE SELECTION:
Request Min. Section Modulus = 9.7 in3/ft=522.82 cm3/m, Fy= 50 ksi = 345 MPa, Fb/Fy=0.60
User Input I (Moment of Inertia):
Top Deflection = 0.15(in) based on E (ksi)=29000.00 and I (in4)/foot=955.6

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
*	Above	Base		
0.000	0.000	10.500	0.099	0.009434
*	Below	Base		
10.500	0.099	13.000	0.123	0.009434
13.000	0.123	18.670	0.283	0.028196
18.670	0.218	94.500	2.191	0.026016
*	Sur-	charge		
0.000	0.125	0.525	0.125	0.000000
0.525	0.125	1.050	0.125	0.000000
1.050	0.125	1.575	0.125	0.000000
1.575	0.125	2.100	0.125	0.000000
2.100	0.125	2.625	0.125	0.000000
2.625	0.125	3.150	0.125	0.000000
3.150	0.125	3.675	0.125	0.000000
3.675	0.125	4.200	0.125	0.000000
4.200	0.125	4.725	0.125	0.000000
4.725	0.125	5.250	0.125	0.000000
5.250	0.125	5.775	0.125	0.000000

5.775	0.125	6.300	0.125	0.000000
6.300	0.125	6.825	0.125	0.000000
6.825	0.125	7.350	0.125	0.000000
7.350	0.125	7.875	0.125	0.000000
7.875	0.125	8.400	0.125	0.000000
8.400	0.125	8.925	0.125	0.000000
8.925	0.125	9.450	0.125	0.000000
9.450	0.125	9.975	0.125	0.000000
9.975	0.125	10.500	0.125	0.000000
10.500	0.125	11.550	0.125	0.000000
11.550	0.125	12.600	0.125	0.000000
12.600	0.125	13.650	0.125	0.000000
13.650	0.125	14.700	0.125	0.000000
14.700	0.125	15.750	0.125	0.000000
15.750	0.125	16.800	0.125	0.000000
16.800	0.125	17.850	0.125	0.000000
17.850	0.125	18.900	0.125	0.000000
18.900	0.125	19.950	0.125	0.000000
19.950	0.125	21.000	0.125	0.000000
21.000	0.125	23.100	0.125	0.000000
23.100	0.125	25.200	0.125	0.000000
25.200	0.125	27.300	0.125	0.000000
27.300	0.125	29.400	0.125	0.000000
29.400	0.125	31.500	0.125	0.000000

PASSIVE PRESSURES: Pressures below will be divided by a Factor of Safety =1.5

Z1	P1	Z2	P2	Slope
*	Below	Base		
10.500	0.000	13.000	0.395	0.157800
13.000	0.364	18.670	1.190	0.145834
18.670	1.513	94.500	18.313	0.221553

ACTIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00
2	10.50	1.00

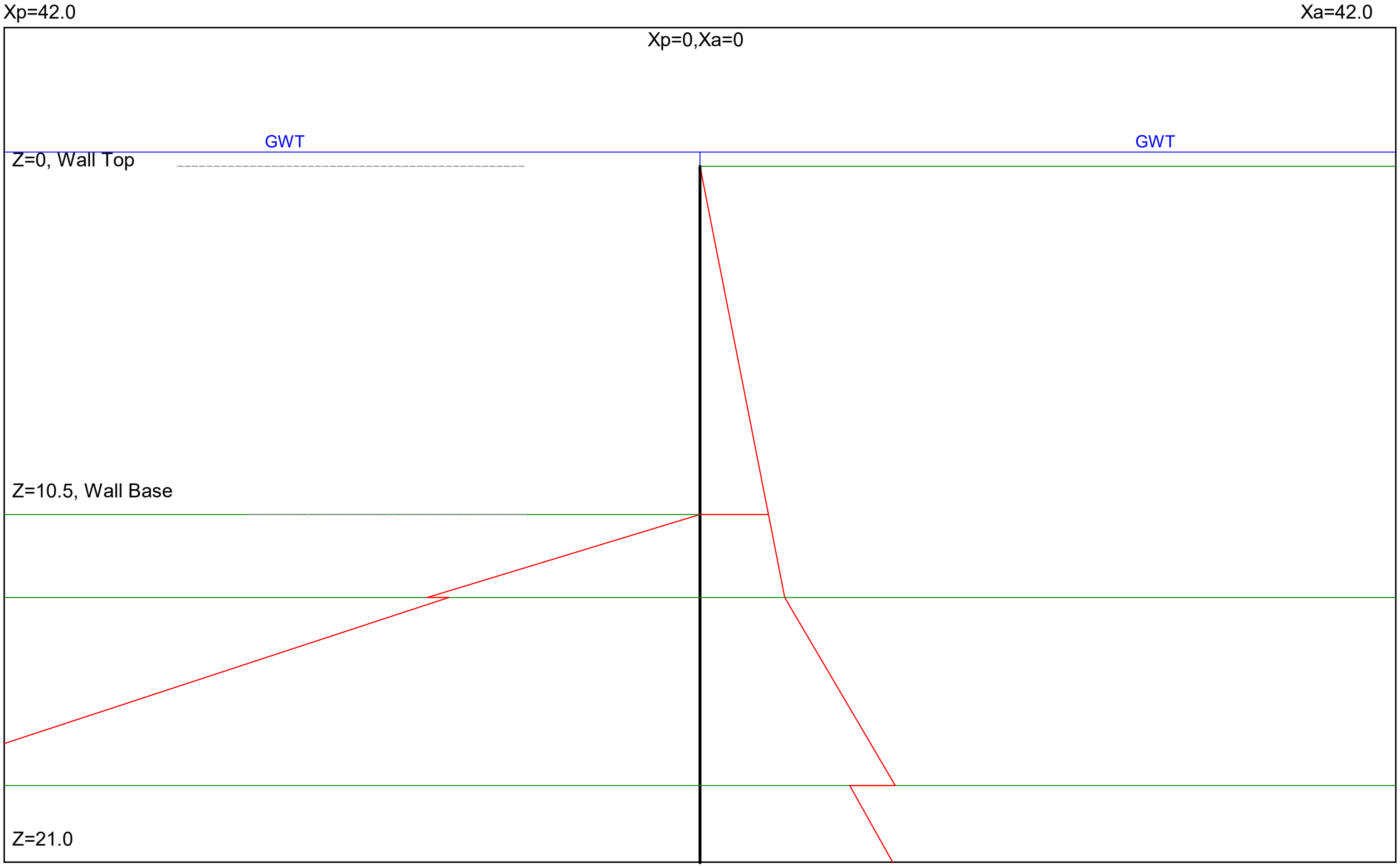
PASSIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in

Carroll Street Case IV_CSDL06_Group I

Case IV_CSDL06_EP



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UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

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* INPUT DATA *

Wall Height=10.5 Total Soil Types= 4

Soil No.	Weight	Saturate	Phi	Cohesion	Nspt	Type	Description
1	80.0	80.0	28.00	0.0	0	3	Soft Sedimen
2	115.0	115.0	28	0.0	0	4	Native Alluv
3	125.0	125.0	34	0.0	0	4	Glacial Depo
4	115.0	115.0	30	0.0	0	4	Sand Backfil

Ground Surface at Active Side:

Line	Z1	Xa1	Z2	Xa2	Soil No.	Description
1	0.0	0.0	0.0	800.0	1	Soft Sedimen
2	13.0	0.0	13.0	800.0	2	Native Alluv
3	18.7	0.0	18.7	800.0	3	Glacial Depo

Water Table at Active Side:

Point	Z-water	X-water
1	-0.4	0.0
2	-0.4	800.0

Ground Surface at Passive Side:

Line	Z1	Xp1	Z2	Xp2	Soil No.	Description
1	10.5	0.0	10.5	800.0	4	Sand Backfil
2	13.0	0.0	13.0	800.0	2	Native Alluv

3	18.7	0.0	18.7	800.0	3	Glacial Depo

Water Table at Passive Side:

Point	Z-water	X-water
1	-0.4	0.0
2	-0.4	800.0

Wall Friction Options: 1.* No wall friction

Wall Batter Angle = 0

Apparent Pressure Conversion: 1.* Default (Terzaghi and Peck)*

Water Density = 62.4

Water Pressure: 1.* No seepage at wall tip

* OUTPUT RESULTS *

Total Force above Base= 0.52 per one linear foot (or meter) width along wall height

Total Static Force above Base= 0.52

Driving Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Coef.
0.00	0.00	10.50	0.10	0.0094	0.5360

Driving Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Ka or Ko
10.50	0.10	13.00	0.12	0.0094	0.5360
13.00	0.12	18.67	0.28	0.0282	0.5360
18.67	0.22	21.00	0.28	0.0269	0.4291

Passive Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pp1	Z2	Pp2	Slope	Kp
10.50	0.00	13.00	0.39	0.158	3.0000
13.00	0.36	18.67	1.19	0.146	2.7725
18.67	1.48	21.00	2.01	0.230	3.6815

UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

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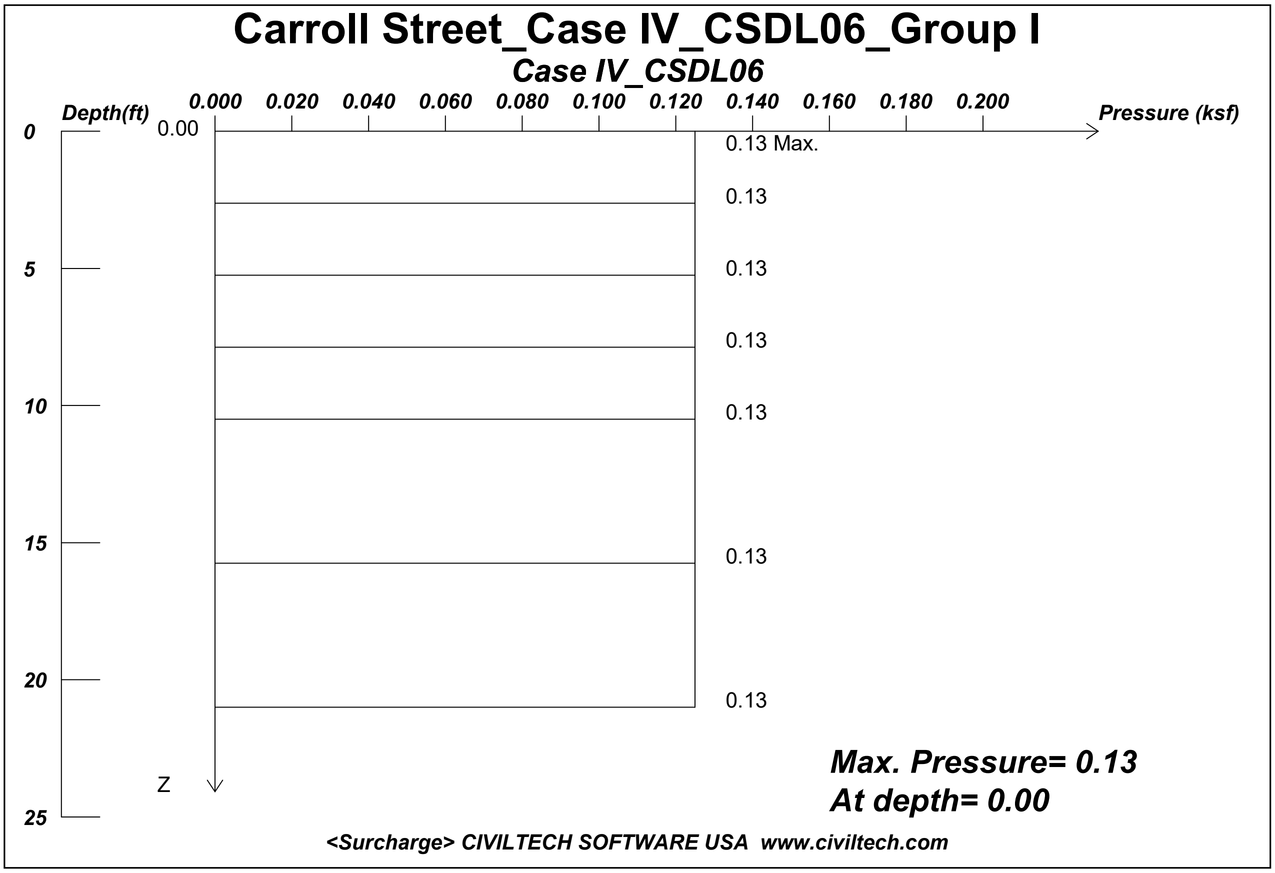

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Wall Height, H= 10.5 Load Depth, D= 0

Load Factor of Surcharge Loading = 1

Rigid Wall Condition -- No movement or deflection of the wall are allowed.

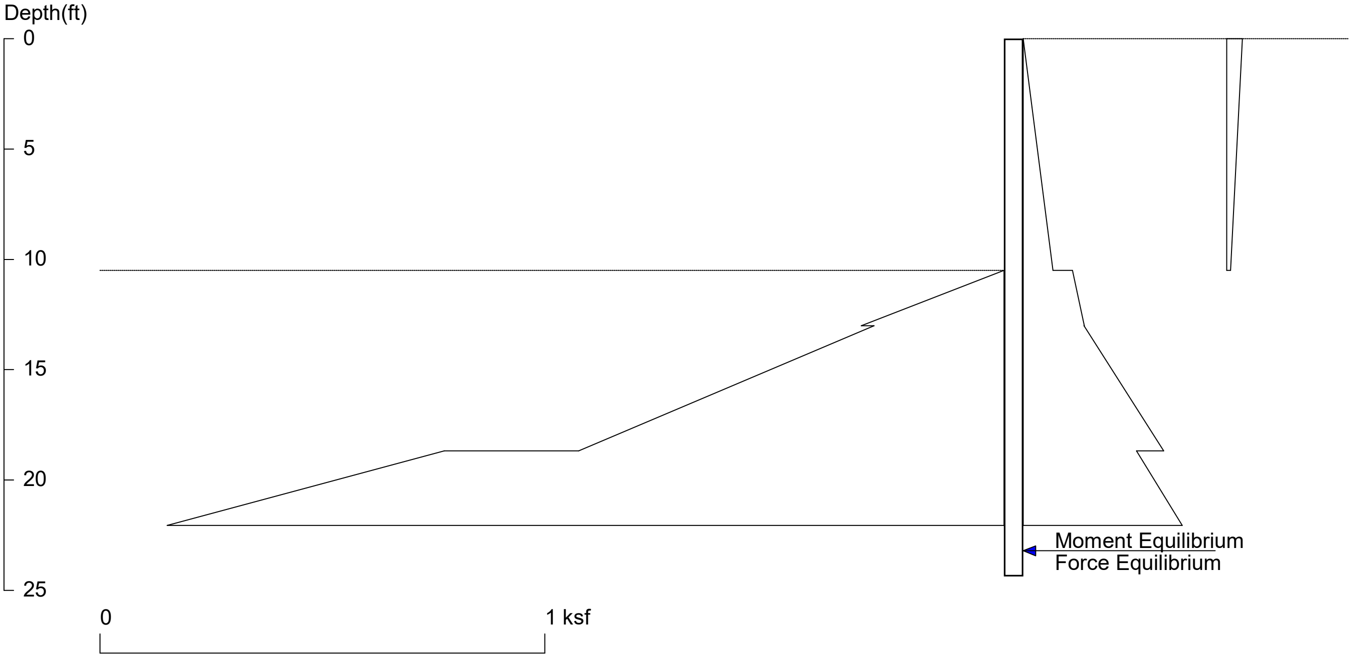
Max. Pressure = 0.125 at depth = 0.00

Infinite Surcharge, Q=0.250 Active Wedge Approach * (recommend)

UNITS: LENGTH/DEPTH: ft, Qpoint: kip, Qline: kip/ft, Qstrip/Qarea/PRESSURE: ksf

Carroll Street Case IV_CSDL06_Group VII

Case IV_CSDL06_EP



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Wall Height=10.5 Pile Diameter=1.0 Pile Spacing=1.0 Wall Type: 1. Sheet Pile

PILE LENGTH: Min. Embedment=13.86 Min. Pile Length=24.36
MOMENT IN PILE: Max. Moment=5.80 per Pile Spacing=1.0 at Depth=17.07

PILE SELECTION:
Request Min. Section Modulus = 2.3 in3/ft=124.75 cm3/m, Fy= 50 ksi = 345 MPa, Fb/Fy=0.60
User Input I (Moment of Inertia):
Top Deflection = 0.12(in) based on E (ksi)=29000.00 and I (in4)/foot=955.6

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
*	Above	Base		
0.000	0.000	10.500	0.067	0.006354
*	Below	Base		
10.500	0.111	13.000	0.137	0.010546
13.000	0.137	18.670	0.316	0.031517
18.670	0.255	94.500	2.562	0.030425
*	Earth	Queck		
0.000	0.035	10.500	0.009	-0.002515

PASSIVE PRESSURES: Pressures below will be divided by a Factor of Safety =1.5

Z1	P1	Z2	P2	Slope
*	Below	Base		
10.500	0.000	13.000	0.321	0.128347
13.000	0.292	18.670	0.956	0.117078
18.670	1.258	94.500	15.237	0.184351

ACTIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00
2	10.50	1.00

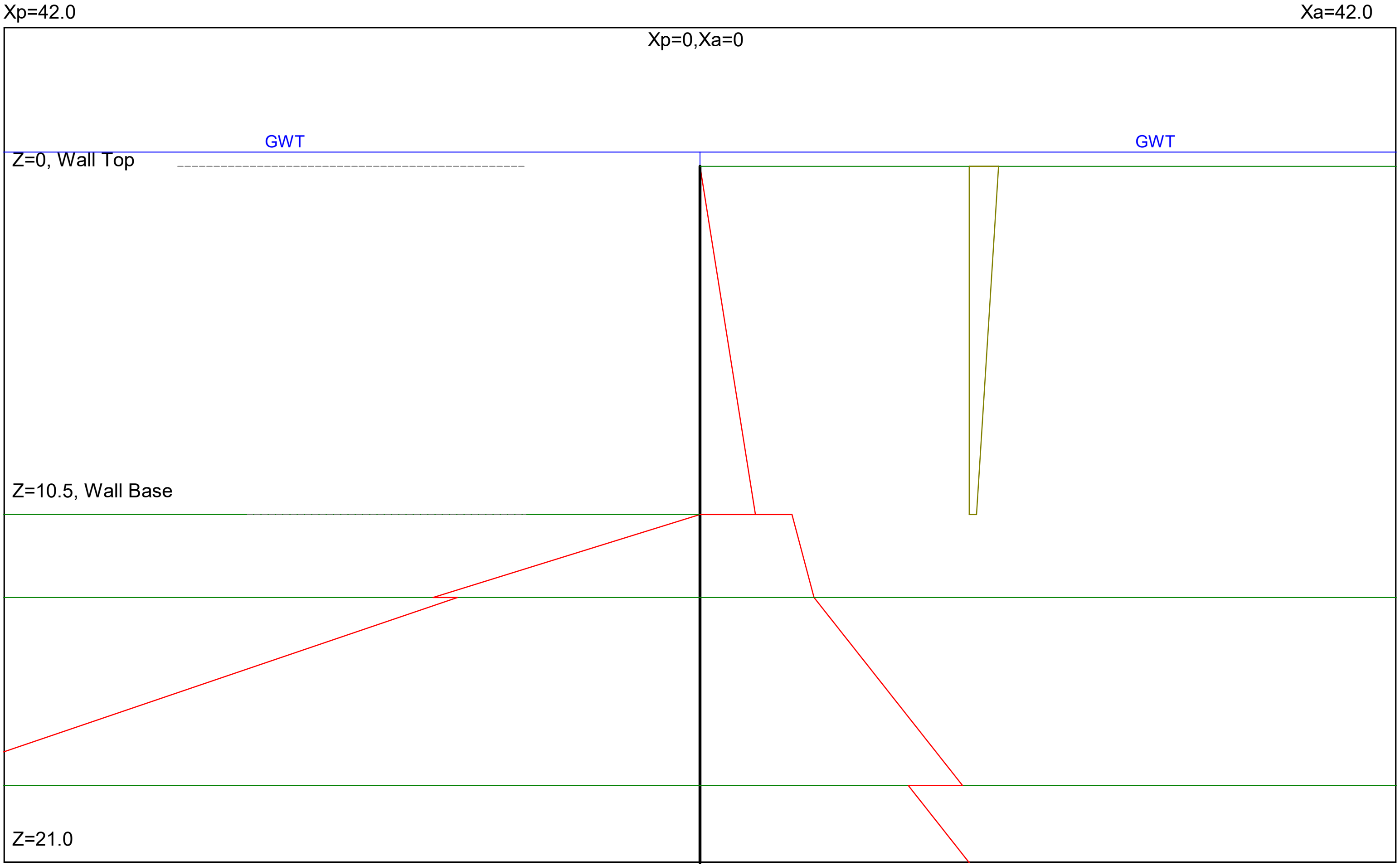
PASSIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in

Carroll Street Case IV_CSDL06_Group VII

Case IV_CSDL06_EP



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* INPUT DATA *

Wall Height=10.5   Total Soil Types= 4

Soil No.	Weight	Saturate	Phi	Cohesion	Nspt	Type	Description
1	80.0	80.0	28.00	0.0	0	3	Soft Sedimen
2	115.0	115.0	28	0.0	0	4	Native Alluv
3	125.0	125.0	34	0.0	0	4	Glacial Depo
4	115.0	115.0	30	0.0	0	4	Sand Backfil

Ground Surface at Active Side:

Line	Z1	Xa1	Z2	Xa2	Soil No.	Description
1	0.0	0.0	0.0	800.0	1	Soft Sedimen
2	13.0	0.0	13.0	800.0	2	Native Alluv
3	18.7	0.0	18.7	800.0	3	Glacial Depo

Water Table at Active Side:

Point	Z-water	X-water
1	-0.4	0.0
2	-0.4	800.0

Ground Surface at Passive Side:

Line	Z1	Xp1	Z2	Xp2	Soil No.	Description
1	10.5	0.0	10.5	800.0	4	Sand Backfil
2	13.0	0.0	13.0	800.0	2	Native Alluv

3	18.7	0.0	18.7	800.0	3	Glacial Depo

Water Table at Passive Side:

Point	Z-water	X-water
1	-0.4	0.0
2	-0.4	800.0

Wall Friction Options: 1.* No wall friction

Wall Batter Angle = 0

Apparent Pressure Conversion: 1.* Default (Terzaghi and Peck)*

Water Density = 62.4

Water Pressure: 1.* No seepage at wall tip

* OUTPUT RESULTS *

Total Force above Base= 0.58 per one linear foot (or meter) width along wall height

Total Static Force above Base= 0.35

Total Earthquake Force above Base= 0.23. Distributed in trapezoid. Total earthquake force acting at 0.4H below wall top.

Driving Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Coef.
0.00	0.00	10.50	0.07	0.0064	0.3610

Driving Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Ka or Ko
10.50	0.11	13.00	0.14	0.0105	0.5992
13.00	0.14	18.67	0.32	0.0315	0.5992
18.67	0.25	21.00	0.32	0.0315	0.5028

Passive Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pp1	Z2	Pp2	Slope	Kp
10.50	0.00	13.00	0.32	0.128	2.4401
13.00	0.29	18.67	0.96	0.117	2.2258
18.67	1.23	21.00	1.67	0.192	3.0616

Output Earthquake Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Total Earthq. Force, Ee = 0.23

No	Zq1	Pq1	Zq2	Pq2	Slope
0	0.00	0.035	10.50	0.009	-0.003

UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

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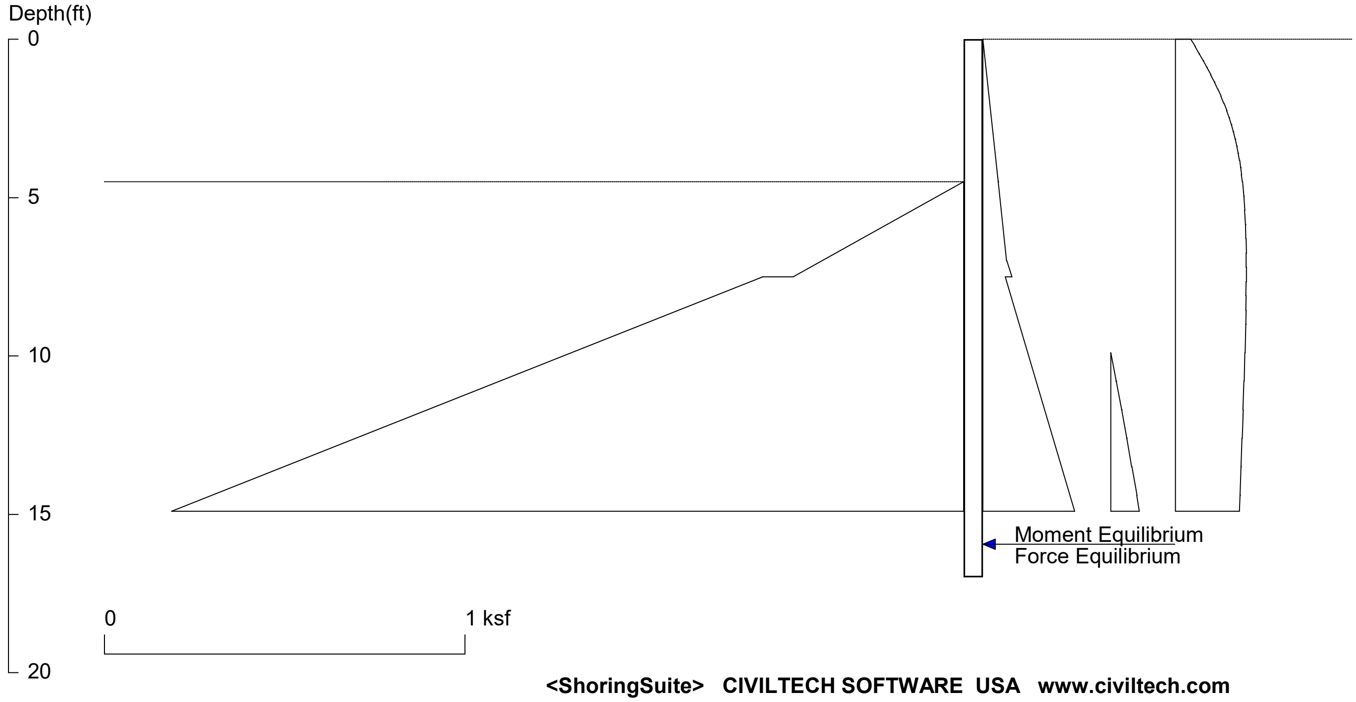
Carroll Street Case V_CSDL02_Group I

Case V_CSDL02_EP



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Wall Height=4.5   Pile Diameter=1.0   Pile Spacing=1.0   Wall Type: 1. Sheet Pile

PILE LENGTH: Min. Embedment=12.49   Min. Pile Length=16.99
MOMENT IN PILE: Max. Moment=5.79 per Pile Spacing=1.0 at Depth=10.66

PILE SELECTION:
Request Min. Section Modulus = 2.3 in3/ft=124.42 cm3/m, Fy= 50 ksi = 345 MPa, Fb/Fy=0.60
User Input I (Moment of Inertia):
Top Deflection = 0.07(in) based on E (ksi)=29000.00 and I (in4)/foot=955.6

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
*	Above	Base		
0.000	0.000	4.500	0.042	0.009434
*	Below	Base		
4.500	0.042	7.000	0.066	0.009434
7.000	0.066	7.500	0.080	0.028196
7.500	0.062	45.000	1.037	0.026012
*	Sur-	charge		
9.900	0.000	10.800	0.015	0.016712
10.800	0.015	11.700	0.030	0.016533
11.700	0.030	12.600	0.044	0.016182
12.600	0.044	13.500	0.059	0.015675
13.500	0.059	14.400	0.072	0.015033
14.400	0.072	15.300	0.085	0.014279
15.300	0.085	16.200	0.097	0.013442
16.200	0.097	17.100	0.108	0.012547
*	Sur-	charge		
0.000	0.043	0.225	0.054	0.051797
0.225	0.054	0.450	0.066	0.051241

0.450	0.066	0.675	0.077	0.050155
0.675	0.077	0.900	0.088	0.048583
0.900	0.088	1.125	0.098	0.046592
1.125	0.098	1.350	0.108	0.044257
1.350	0.108	1.575	0.118	0.041661
1.575	0.118	1.800	0.126	0.038887
1.800	0.126	2.025	0.135	0.036014
2.025	0.135	2.250	0.142	0.033111
2.250	0.142	2.475	0.149	0.030240
2.475	0.149	2.700	0.155	0.027447
2.700	0.155	2.925	0.161	0.024771
2.925	0.161	3.150	0.166	0.022236
3.150	0.166	3.375	0.170	0.019862
3.375	0.170	3.600	0.174	0.017655
3.600	0.174	3.825	0.178	0.015620
3.825	0.178	4.050	0.181	0.013754
4.050	0.181	4.275	0.183	0.012051
4.275	0.183	4.500	0.186	0.010504
4.500	0.186	4.950	0.190	0.008470
4.950	0.190	5.400	0.192	0.006182
5.400	0.192	5.850	0.194	0.004330
5.850	0.194	6.300	0.196	0.002836
6.300	0.196	6.750	0.196	0.001631
6.750	0.196	7.200	0.197	0.000660
7.200	0.197	7.650	0.196	-0.000125
7.650	0.196	8.100	0.196	-0.000760
8.100	0.196	8.550	0.196	-0.001276
8.550	0.196	9.000	0.195	-0.001695
9.000	0.195	9.900	0.193	-0.002177
9.900	0.193	10.800	0.190	-0.002639
10.800	0.190	11.700	0.188	-0.002948
11.700	0.188	12.600	0.185	-0.003153
12.600	0.185	13.500	0.182	-0.003287
13.500	0.182	14.400	0.179	-0.003371
14.400	0.179	15.300	0.176	-0.003418
15.300	0.176	16.200	0.173	-0.003438
16.200	0.173	17.100	0.170	-0.003439

PASSIVE PRESSURES: Pressures below will be divided by a Factor of Safety =1.5

Z1	P1	Z2	P2	Slope
*	Below	Base		
4.500	0.000	7.500	0.473	0.157800
7.500	0.557	45.000	8.862	0.221460

ACTIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00
2	4.50	1.00

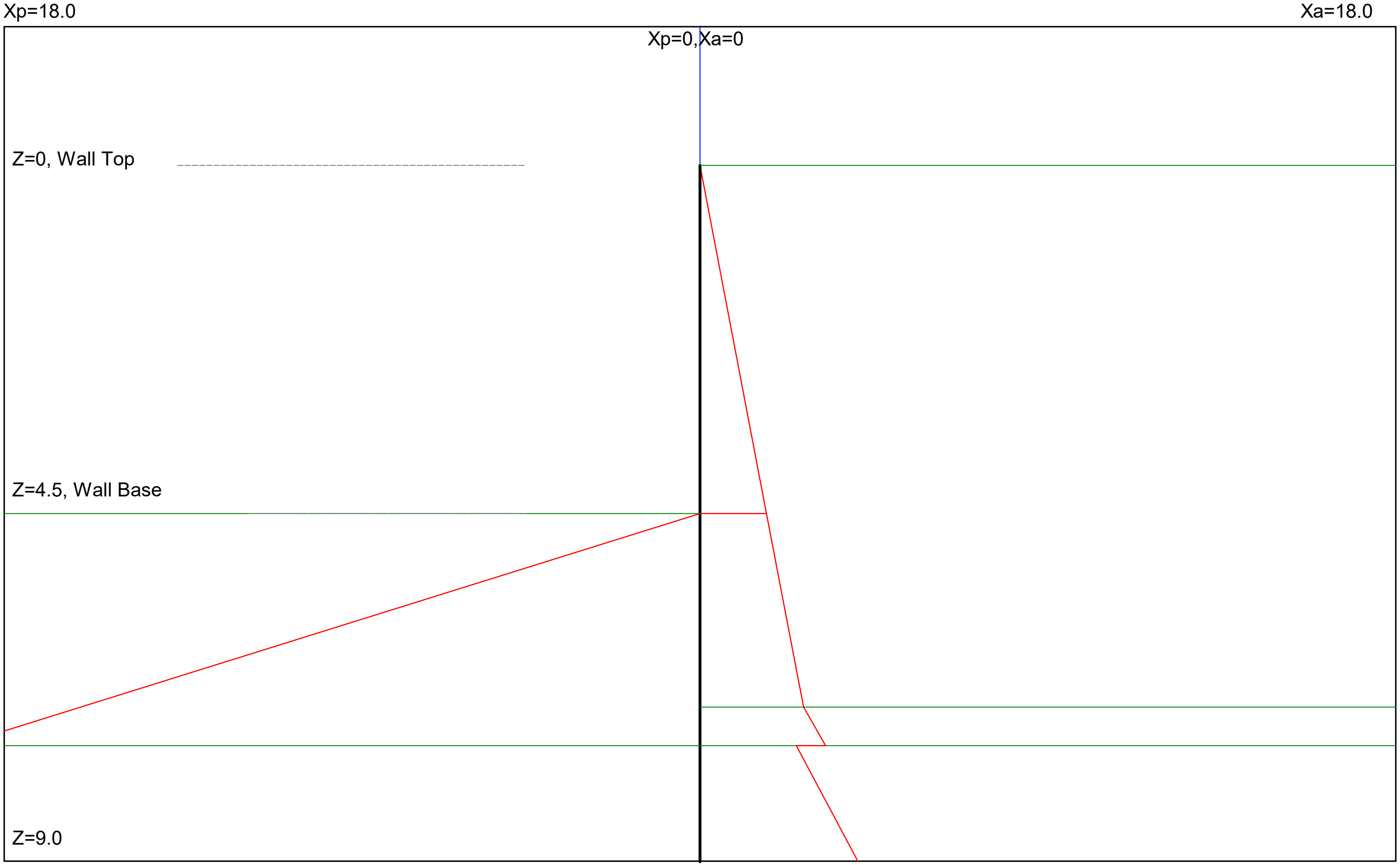
PASSIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in

Carroll Street Case V_CSDL02_Group I

Case V_CSDL02_EP



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* INPUT DATA *

Wall Height=4.5   Total Soil Types= 4

Soil No.	Weight	Saturate	Phi	Cohesion	Nspt	Type	Description
1	80.0	80.0	28.00	0.0	0	3	Soft Sedimen
2	115.0	115.0	28	0.0	0	4	Native Alluv
3	125.0	125.0	34	0.0	0	4	Glacial Depo
4	115.0	115.0	30	0.0	0	4	Sand Backfil

Ground Surface at Active Side:

Line	Z1	Xa1	Z2	Xa2	Soil No.	Description
1	0.0	0.0	0.0	800.0	1	Soft Sedimen
2	7.0	0.0	7.0	800.0	2	Native Alluv
3	7.5	0.0	7.5	800.0	3	Glacial Depo

Water Table at Active Side:

Point	Z-water	X-water
1	-7.9	0.0
2	-7.9	800.0

Ground Surface at Passive Side:

Line	Z1	Xp1	Z2	Xp2	Soil No.	Description
1	4.5	0.0	4.5	800.0	4	Sand Backfil
2	7.5	0.0	7.5	800.0	3	Glacial Depo

Water Table at Passive Side:

Point	Z-water	X-water
1	-7.9	0.0
2	-7.9	800.0

Wall Friction Options: 1.* No wall friction

Wall Batter Angle = 0

Apparent Pressure Conversion: 1.* Default (Terzaghi and Peck)*

Water Density = 62.4

Water Pressure: 1.* No seepage at wall tip

* OUTPUT RESULTS *

Total Force above Base= 0.10 per one linear foot (or meter) width along wall height

Total Static Force above Base= 0.10

Driving Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Coef.
0.00	0.00	4.50	0.04	0.0094	0.5360

Driving Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Ka or Ko
4.50	0.04	7.00	0.07	0.0094	0.5360
7.00	0.07	7.50	0.08	0.0282	0.5360
7.50	0.06	9.00	0.10	0.0262	0.4193

Passive Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pp1	Z2	Pp2	Slope	Kp
4.50	0.00	7.50	0.47	0.158	3.0000
7.50	0.55	9.00	0.89	0.225	3.5900

UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

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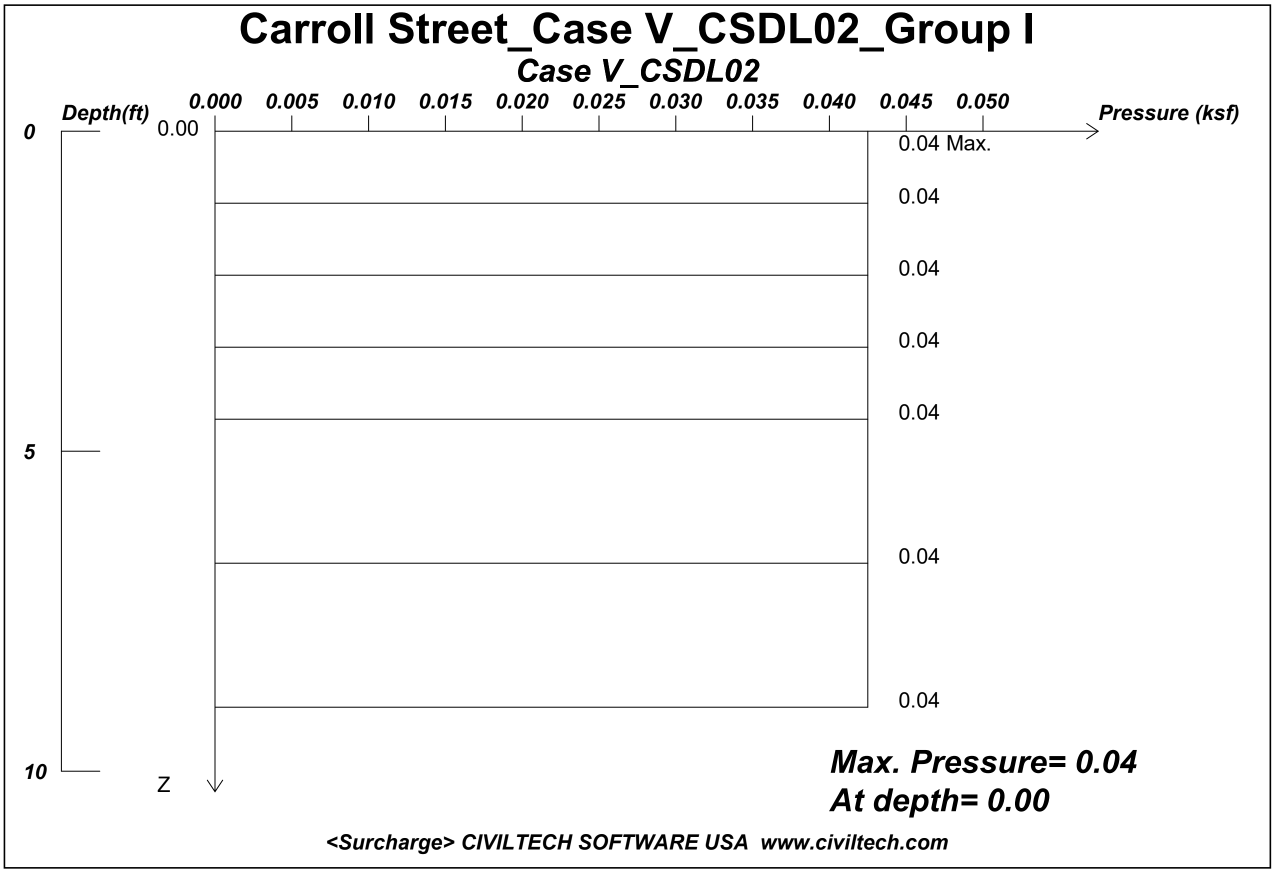

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Wall Height, H= 4.5 Load Depth, D= 0

Load Factor of Surcharge Loading = 1

Rigid Wall Condition -- No movement or deflection of the wall are allowed.

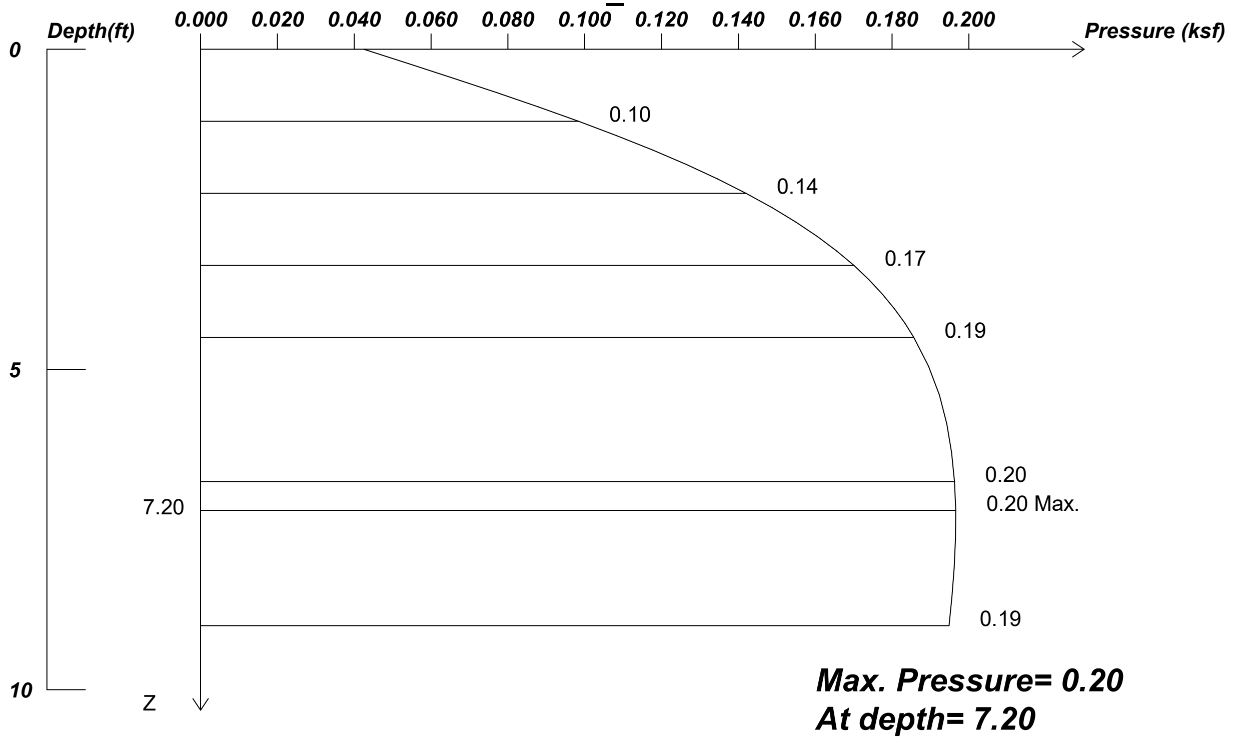
Max. Pressure = 0.043 at depth = 0.00

Infinite Surcharge, Q=.085 Active Wedge Approach * (recommend)

UNITS: LENGTH/DEPTH: ft, Qpoint: kip, Qline: kip/ft, Qstrip/Qarea/PRESSURE: ksf

Carroll Street_Case V_CSDL02_Group I

Case V_CSDL02



Max. Pressure= 0.20
At depth= 7.20

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Wall Height, H= 4.5   Load Depth, D= 0
Load Factor of Surcharge Loading = 1
Rigid Wall Condition -- No movement or deflection of the wall are allowed.
Max. Pressure = 0.197   at depth = 7.20

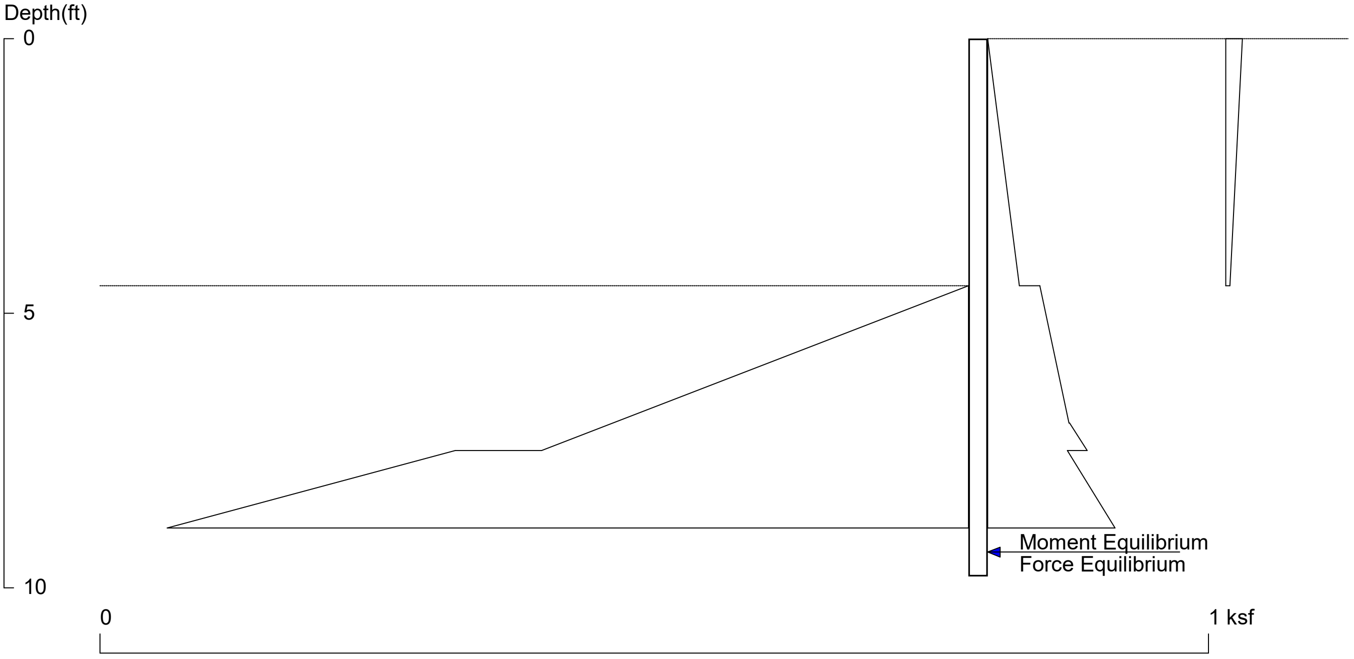
X	Width	Length	Area Load
4.5	54.0	4.5	1.17

Infinite Surcharge, Q=.085   Active Wedge Approach * (recommend)

UNITS: LENGTH/DEPTH: ft, Qpoint: kip, Qline: kip/ft, Qstrip/Qarea/PRESSURE: ksf

Carroll Street Case V_CSDL02_Group VII

Case V_CSDL02_EP



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Wall Height=4.5   Pile Diameter=1.0   Pile Spacing=1.0   Wall Type: 1. Sheet Pile

PILE LENGTH: Min. Embedment=5.29   Min. Pile Length=9.79
MOMENT IN PILE: Max. Moment=0.43 per Pile Spacing=1.0 at Depth=6.92

PILE SELECTION:
Request Min. Section Modulus = 0.2 in3/ft=9.20 cm3/m, Fy= 50 ksi = 345 MPa, Fb/Fy=0.60
User Input I (Moment of Inertia):
Top Deflection = 0.06(in) based on E (ksi)=29000.00 and I (in4)/foot=955.6

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
*	Above	Base		
0.000	0.000	4.500	0.029	0.006354
*	Below	Base		
4.500	0.047	7.000	0.074	0.010546
7.000	0.074	7.500	0.090	0.031517
7.500	0.072	45.000	1.213	0.030417
*	Earth	Queck		
0.000	0.015	4.500	0.004	-0.002515
*	Sur-	charge		

PASSIVE PRESSURES: Pressures below will be divided by a Factor of Safety =1.5

Z1	P1	Z2	P2	Slope
*	Below	Base		
4.500	0.000	7.500	0.385	0.128347
7.500	0.463	45.000	7.374	0.184268

ACTIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00
2	4.50	1.00

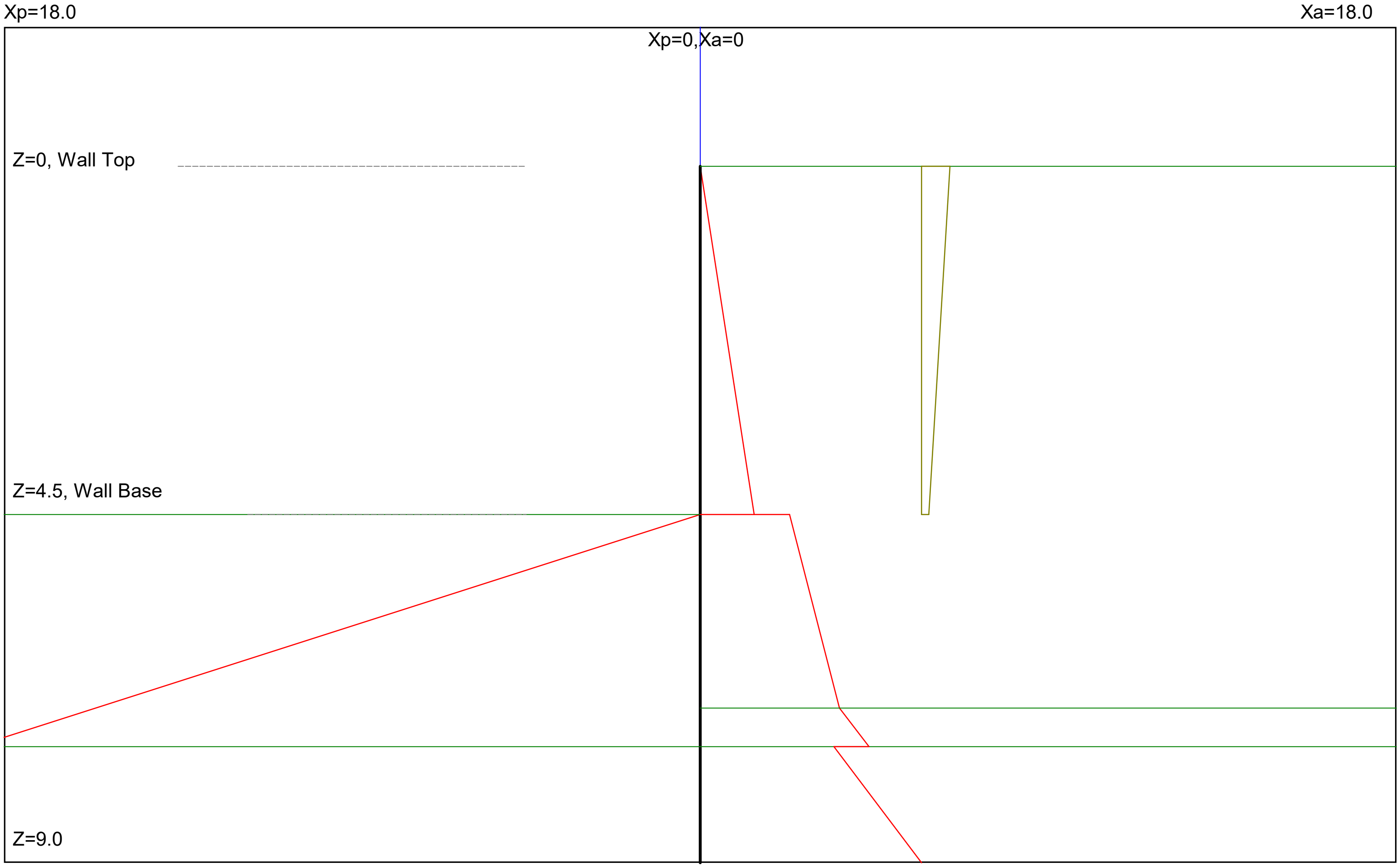
PASSIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in

Carroll Street Case V_CSDL02_Group VII

Case V_CSDL02_EP



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UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

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* INPUT DATA *

Wall Height=4.5 Total Soil Types= 4

Soil No.	Weight	Saturate	Phi	Cohesion	Nspt	Type	Description
1	80.0	80.0	28.00	0.0	0	3	Soft Sedimen
2	115.0	115.0	28	0.0	0	4	Native Alluv
3	125.0	125.0	34	0.0	0	4	Glacial Depo
4	115.0	115.0	30	0.0	0	4	Sand Backfil

Ground Surface at Active Side:

Line	Z1	Xa1	Z2	Xa2	Soil No.	Description
1	0.0	0.0	0.0	800.0	1	Soft Sedimen
2	7.0	0.0	7.0	800.0	2	Native Alluv
3	7.5	0.0	7.5	800.0	3	Glacial Depo

Water Table at Active Side:

Point	Z-water	X-water
1	-7.9	0.0
2	-7.9	800.0

Ground Surface at Passive Side:

Line	Z1	Xp1	Z2	Xp2	Soil No.	Description
1	4.5	0.0	4.5	800.0	4	Sand Backfil
2	7.5	0.0	7.5	800.0	3	Glacial Depo

Water Table at Passive Side:

Point	Z-water	X-water
1	-7.9	0.0
2	-7.9	800.0

Wall Friction Options: 1.* No wall friction

Wall Batter Angle = 0

Apparent Pressure Conversion: 1.* Default (Terzaghi and Peck)*

Water Density = 62.4

Water Pressure: 1.* No seepage at wall tip

* OUTPUT RESULTS *

Total Force above Base= 0.11 per one linear foot (or meter) width along wall height

Total Static Force above Base= 0.06

Total Earthquake Force above Base= 0.04. Distributed in trapezoid. Total earthquake force acting at 0.4H below wall top.

Driving Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Coef.
0.00	0.00	4.50	0.03	0.0064	0.3610

Driving Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Ka or Ko
4.50	0.05	7.00	0.07	0.0105	0.5992
7.00	0.07	7.50	0.09	0.0315	0.5992
7.50	0.07	9.00	0.12	0.0310	0.4949

Passive Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pp1	Z2	Pp2	Slope	Kp
4.50	0.00	7.50	0.39	0.128	2.4401
7.50	0.46	9.00	0.74	0.187	2.9913

Output Earthquake Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Total Earthq. Force, Ee = 0.04

No	Zq1	Pq1	Zq2	Pq2	Slope
0	0.00	0.015	4.50	0.004	-0.003

UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

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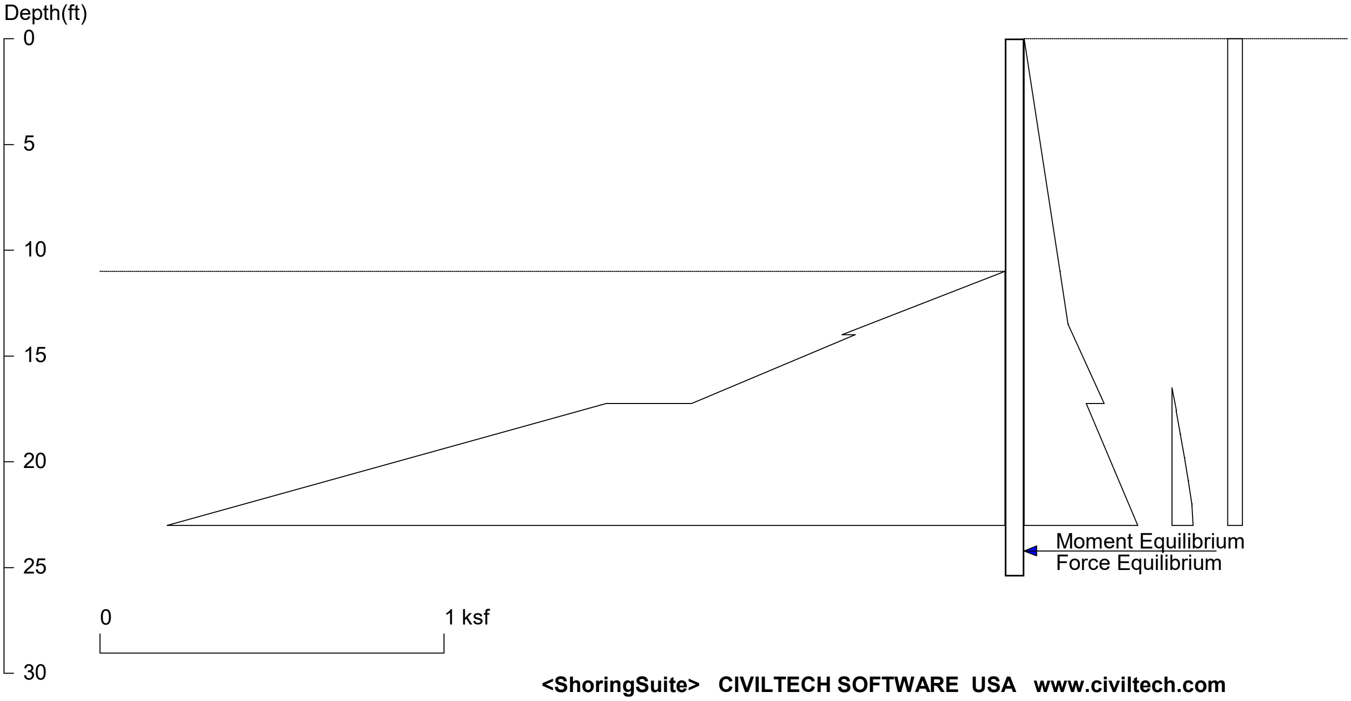
Carroll Street Case V_CSDL03_Group I

Case V_CSDL03_EP



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Wall Height=11.0 Pile Diameter=1.0 Pile Spacing=1.0 Wall Type: 1. Sheet Pile

PILE LENGTH: Min. Embedment=14.42 Min. Pile Length=25.42
MOMENT IN PILE: Max. Moment=10.64 per Pile Spacing=1.0 at Depth=17.85

PILE SELECTION:
Request Min. Section Modulus = 4.3 in3/ft=228.75 cm3/m, Fy= 50 ksi = 345 MPa, Fb/Fy=0.60
User Input I (Moment of Inertia):
Top Deflection = 0.10(in) based on E (ksi)=29000.00 and I (in4)/foot=955.6

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
*	Above	Base		
0.000	0.000	11.000	0.104	0.009434
*	Below	Base		
11.000	0.104	13.500	0.127	0.009434
13.500	0.127	17.250	0.233	0.028196
17.250	0.180	99.000	2.307	0.026013
*	Sur-	charge		
16.500	0.000	17.600	0.012	0.011095
17.600	0.012	18.700	0.024	0.010886
18.700	0.024	19.800	0.036	0.010479
19.800	0.036	20.900	0.047	0.009893
20.900	0.047	22.000	0.057	0.009154
22.000	0.057	24.200	0.066	0.004147
24.200	0.066	26.400	0.074	0.003674
*	Sur-	charge		
0.000	0.043	0.550	0.043	0.000000
0.550	0.043	1.100	0.043	0.000000
1.100	0.043	1.650	0.043	0.000000

1.650	0.043	2.200	0.043	0.000000
2.200	0.043	2.750	0.043	0.000000
2.750	0.043	3.300	0.043	0.000000
3.300	0.043	3.850	0.043	0.000000
3.850	0.043	4.400	0.043	0.000000
4.400	0.043	4.950	0.043	0.000000
4.950	0.043	5.500	0.043	0.000000
5.500	0.043	6.050	0.043	0.000000
6.050	0.043	6.600	0.043	0.000000
6.600	0.043	7.150	0.043	0.000000
7.150	0.043	7.700	0.043	0.000000
7.700	0.043	8.250	0.043	0.000000
8.250	0.043	8.800	0.043	0.000000
8.800	0.043	9.350	0.043	0.000000
9.350	0.043	9.900	0.043	0.000000
9.900	0.043	10.450	0.043	0.000000
10.450	0.043	11.000	0.043	0.000000
11.000	0.043	12.100	0.043	0.000000
12.100	0.043	13.200	0.043	0.000000
13.200	0.043	14.300	0.043	0.000000
14.300	0.043	15.400	0.043	0.000000
15.400	0.043	16.500	0.043	0.000000
16.500	0.043	17.600	0.043	0.000000
17.600	0.043	18.700	0.043	0.000000
18.700	0.043	19.800	0.043	0.000000
19.800	0.043	20.900	0.043	0.000000
20.900	0.043	22.000	0.043	0.000000
22.000	0.043	24.200	0.043	0.000000
24.200	0.043	26.400	0.043	0.000000

PASSIVE PRESSURES: Pressures below will be divided by a Factor of Safety =1.5

Z1	P1	Z2	P2	Slope
*	Below	Base		
11.000	0.000	14.000	0.473	0.157800
14.000	0.436	17.250	0.910	0.145983
17.250	1.159	99.000	19.265	0.221486

ACTIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00
2	11.00	1.00

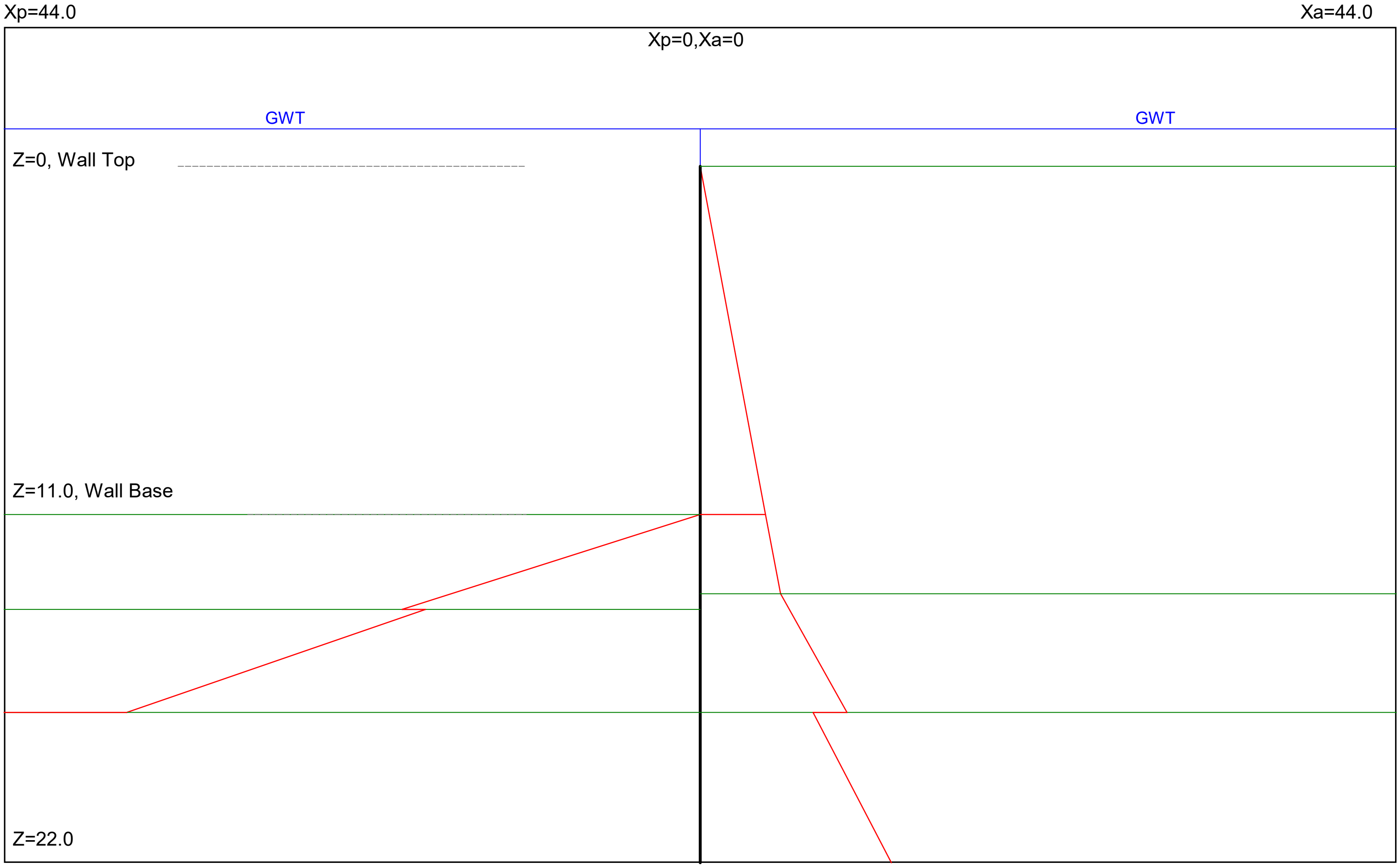
PASSIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in

Carroll Street Case V_CSDL03_Group I

Case V_CSDL03_EP



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UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

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* INPUT DATA *

Wall Height=11.0   Total Soil Types= 4

Soil No.	Weight	Saturate	Phi	Cohesion	Nspt	Type	Description
1	80.0	80.0	28.00	0.0	0	3	Soft Sedimen
2	115.0	115.0	28	0.0	0	4	Native Alluv
3	125.0	125.0	34	0.0	0	4	Glacial Depo
4	115.0	115.0	30	0.0	0	4	Sand Backfil

Ground Surface at Active Side:

Line	Z1	Xa1	Z2	Xa2	Soil No.	Description
1	0.0	0.0	0.0	800.0	1	Soft Sedimen
2	13.5	0.0	13.5	800.0	2	Native Alluv
3	17.3	0.0	17.3	800.0	3	Glacial Depo

Water Table at Active Side:

Point	Z-water	X-water
1	-1.2	0.0
2	-1.2	800.0

Ground Surface at Passive Side:

Line	Z1	Xp1	Z2	Xp2	Soil No.	Description
1	11.0	0.0	11.0	800.0	4	Sand Backfil
2	14.0	0.0	14.0	800.0	2	Native Alluv

3	17.3	0.0	17.3	800.0	3	Glacial Depo

Water Table at Passive Side:

Point	Z-water	X-water
1	-1.2	0.0
2	-1.2	800.0

Wall Friction Options: 1.* No wall friction

Wall Batter Angle = 0

Apparent Pressure Conversion: 1.* Default (Terzaghi and Peck)*

Water Density = 62.4

Water Pressure: 1.* No seepage at wall tip

* OUTPUT RESULTS *

Total Force above Base= 0.57 per one linear foot (or meter) width along wall height

Total Static Force above Base= 0.57

Driving Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Coef.
0.00	0.00	11.00	0.10	0.0094	0.5360

Driving Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Ka or Ko
11.00	0.10	13.50	0.13	0.0094	0.5360
13.50	0.13	17.25	0.23	0.0282	0.5360
17.25	0.18	22.00	0.30	0.0261	0.4172

Passive Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pp1	Z2	Pp2	Slope	Kp
11.00	0.00	14.00	0.47	0.158	3.0000
14.00	0.44	17.25	0.91	0.146	2.7753
17.25	1.14	22.00	2.21	0.226	3.6078

UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

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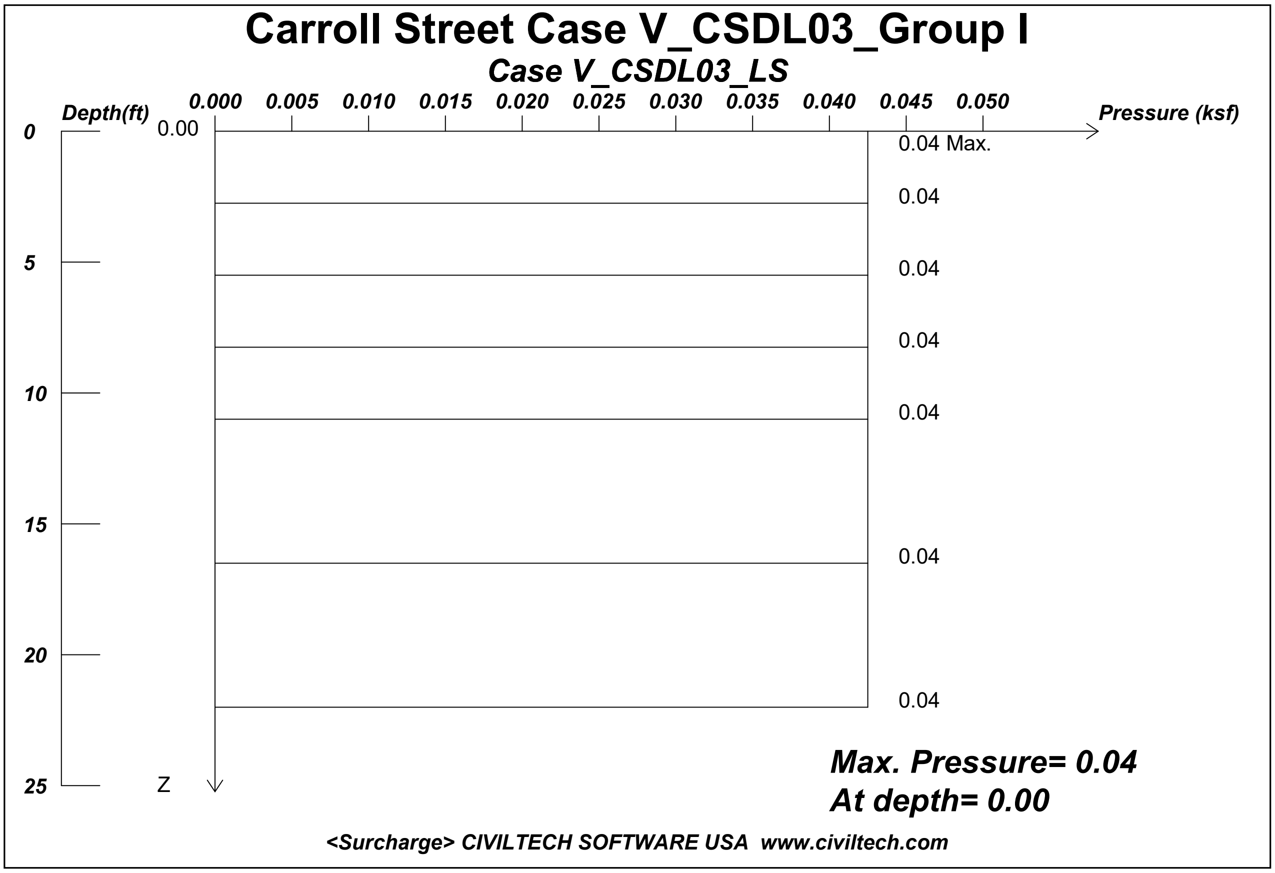

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Wall Height, H= 11 Load Depth, D= 0

Load Factor of Surcharge Loading = 1

Rigid Wall Condition -- No movement or deflection of the wall are allowed.

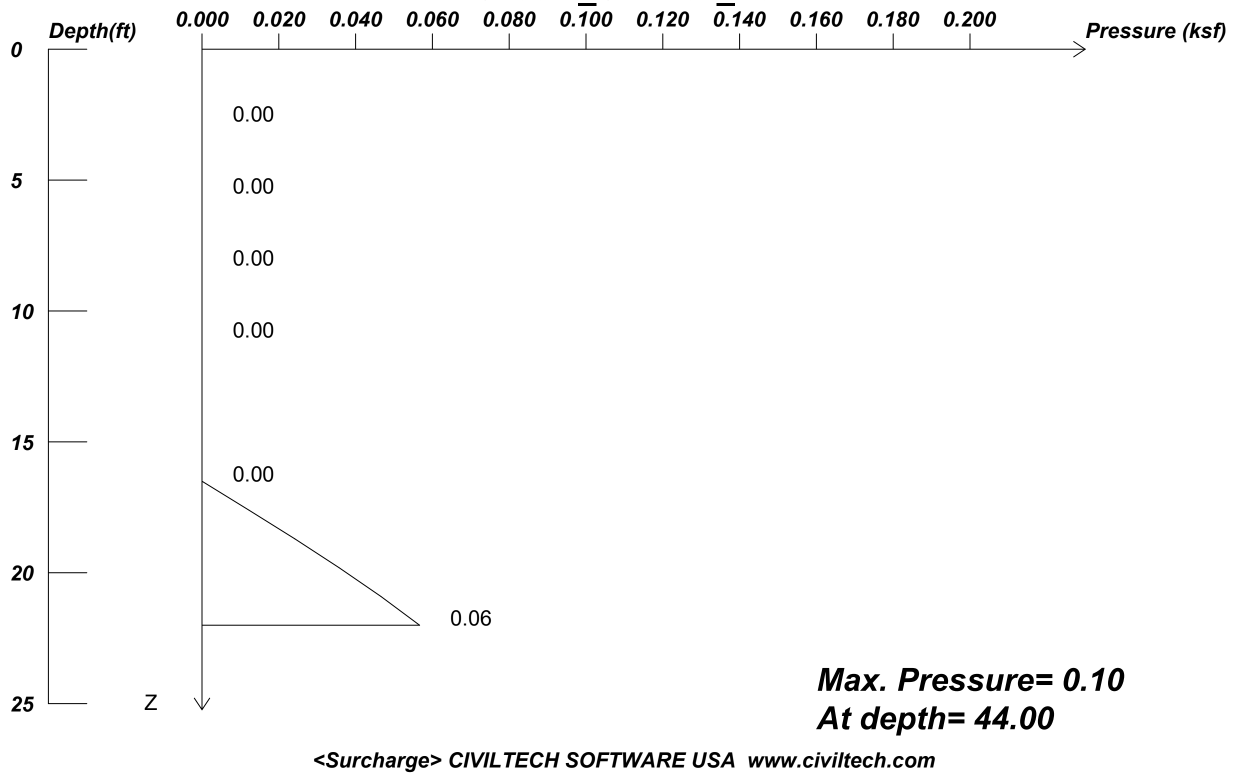
Max. Pressure = 0.043 at depth = 0.00

Infinite Surcharge, Q=0.085 Active Wedge Approach * (recommend)

UNITS: LENGTH/DEPTH: ft, Qpoint: kip, Qline: kip/ft, Qstrip/Qarea/PRESSURE: ksf

Carroll Street Case V_CSDL03_Group I

Case V_CSDL03_LS



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Wall Height, H= 11 Load Depth, D= 17

Load Factor of Surcharge Loading = 1

Rigid Wall Condition -- No movement or deflection of the wall are allowed.

Max. Pressure = 0.101 at depth = 44.00

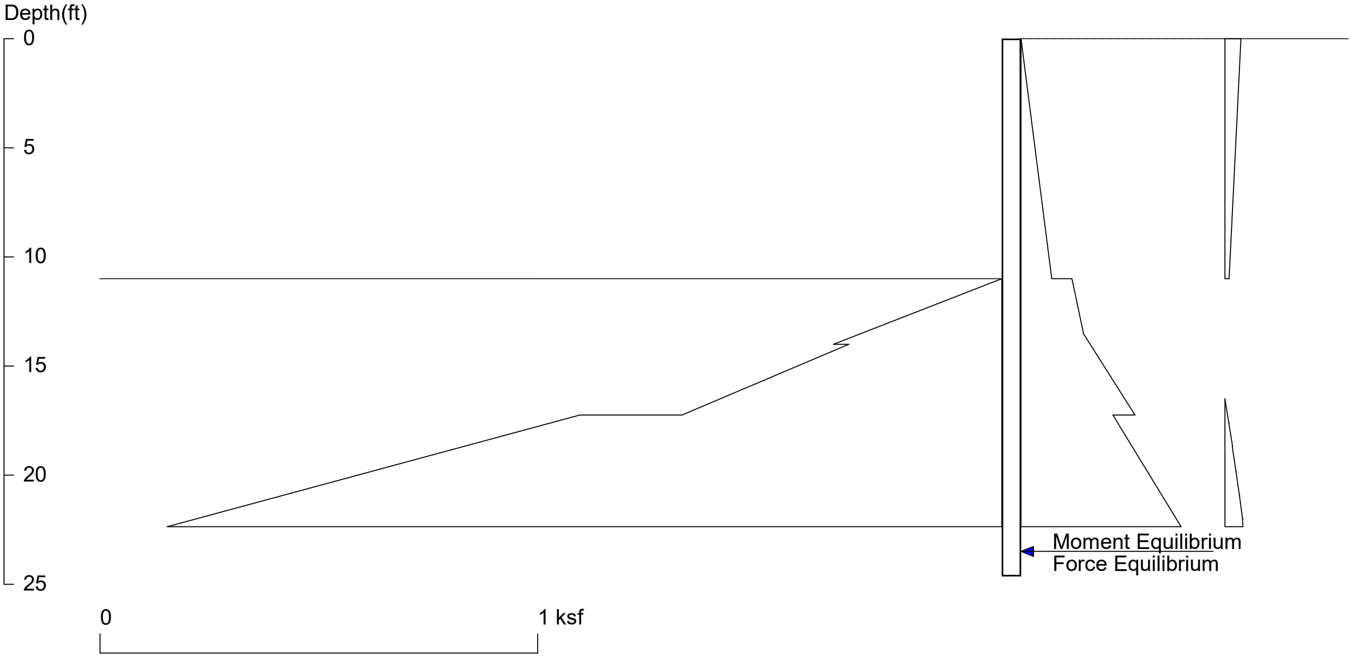
44.00 0.10 Max.

X	Width	Length	Area Load
12.0	4.5	54.0	1.51

UNITS: LENGTH/DEPTH: ft, Qpoint: kip, Qline: kip/ft, Qstrip/Qarea/PRESSURE: ksf

Carroll Street Case V_CSDL03_Group VII

Case V_CSDL03_EP



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Wall Height=11.0 Pile Diameter=1.0 Pile Spacing=1.0 Wall Type: 1. Sheet Pile

PILE LENGTH: Min. Embedment=13.64 Min. Pile Length=24.64
MOMENT IN PILE: Max. Moment=6.68 per Pile Spacing=1.0 at Depth=17.62

PILE SELECTION:
Request Min. Section Modulus = 2.7 in3/ft=143.57 cm3/m, Fy= 50 ksi = 345 MPa, Fb/Fy=0.60
User Input I (Moment of Inertia):
Top Deflection = 0.11(in) based on E (ksi)=29000.00 and I (in4)/foot=955.6

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
*	Above	Base		
0.000	0.000	11.000	0.070	0.006354
*	Below	Base		
11.000	0.116	13.500	0.142	0.010546
13.500	0.142	17.250	0.261	0.031517
17.250	0.210	99.000	2.697	0.030419
*	Earth	Queck		
0.000	0.037	11.000	0.009	-0.002515
*	Sur-	charge		
16.500	0.000	17.600	0.009	0.007862
17.600	0.009	18.700	0.017	0.007714
18.700	0.017	19.800	0.025	0.007426
19.800	0.025	20.900	0.033	0.007011
20.900	0.033	22.000	0.040	0.006487
22.000	0.040	24.200	0.047	0.002939
24.200	0.047	26.400	0.052	0.002603

PASSIVE PRESSURES: Pressures below will be divided by a Factor of Safety =1.5

Z1	P1	Z2	P2	Slope
*	Below	Base		

```
        11.000     0.000     14.000      0.385    0.128347
        14.000     0.350     17.250      0.731    0.117284
        17.250     0.964     99.000     16.030    0.184290

ACTIVE SPACING:
             No.                Z depth               Spacing
-----------------------------------------------------------------------
              1                   0.00                  1.00
              2                  11.00                  1.00

PASSIVE SPACING:
             No.                Z depth               Spacing
-----------------------------------------------------------------------
              1                   0.00                  1.00

-----------------------------------------------------------------------
UNITS:   Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
         Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in
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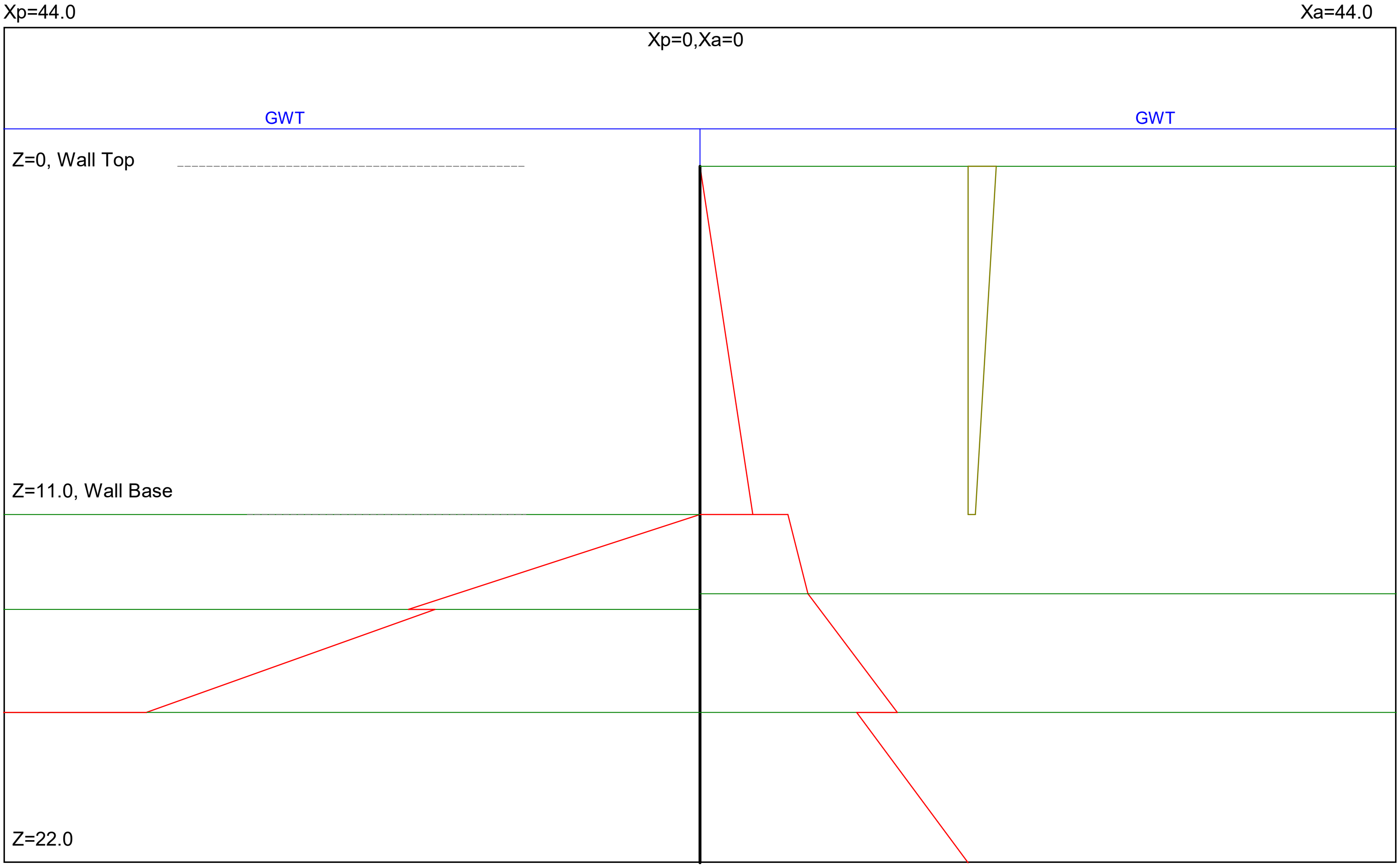
Carroll Street Case V_CSDL03_Group VII

Case V_CSDL03_EP



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UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

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* INPUT DATA *

Wall Height=11.0 Total Soil Types= 4

Soil No.	Weight	Saturate	Phi	Cohesion	Nspt	Type	Description
1	80.0	80.0	28.00	0.0	0	3	Soft Sedimen
2	115.0	115.0	28	0.0	0	4	Native Alluv
3	125.0	125.0	34	0.0	0	4	Glacial Depo
4	115.0	115.0	30	0.0	0	4	Sand Backfil

Ground Surface at Active Side:

Line	Z1	Xa1	Z2	Xa2	Soil No.	Description
1	0.0	0.0	0.0	800.0	1	Soft Sedimen
2	13.5	0.0	13.5	800.0	2	Native Alluv
3	17.3	0.0	17.3	800.0	3	Glacial Depo

Water Table at Active Side:

Point	Z-water	X-water
1	-1.2	0.0
2	-1.2	800.0

Ground Surface at Passive Side:

Line	Z1	Xp1	Z2	Xp2	Soil No.	Description
1	11.0	0.0	11.0	800.0	4	Sand Backfil
2	14.0	0.0	14.0	800.0	2	Native Alluv

3	17.3	0.0	17.3	800.0	3	Glacial Depo

Water Table at Passive Side:

Point	Z-water	X-water
1	-1.2	0.0
2	-1.2	800.0

Wall Friction Options: 1.* No wall friction

Wall Batter Angle = 0

Apparent Pressure Conversion: 1.* Default (Terzaghi and Peck)*

Water Density = 62.4

Water Pressure: 1.* No seepage at wall tip

* OUTPUT RESULTS *

Total Force above Base= 0.64 per one linear foot (or meter) width along wall height

Total Static Force above Base= 0.38

Total Earthquake Force above Base= 0.25. Distributed in trapezoid. Total earthquake force acting at 0.4H below wall top.

Driving Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Coef.
0.00	0.00	11.00	0.07	0.0064	0.3610

Driving Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Ka or Ko
11.00	0.12	13.50	0.14	0.0105	0.5992
13.50	0.14	17.25	0.26	0.0315	0.5992
17.25	0.21	22.00	0.35	0.0310	0.4952

Passive Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pp1	Z2	Pp2	Slope	Kp
11.00	0.00	14.00	0.39	0.128	2.4401
14.00	0.35	17.25	0.73	0.117	2.2297
17.25	0.95	22.00	1.84	0.188	3.0070

Output Earthquake Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Total Earthq. Force, Ee = 0.25

No	Zq1	Pq1	Zq2	Pq2	Slope
0	0.00	0.037	11.00	0.009	-0.003

UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

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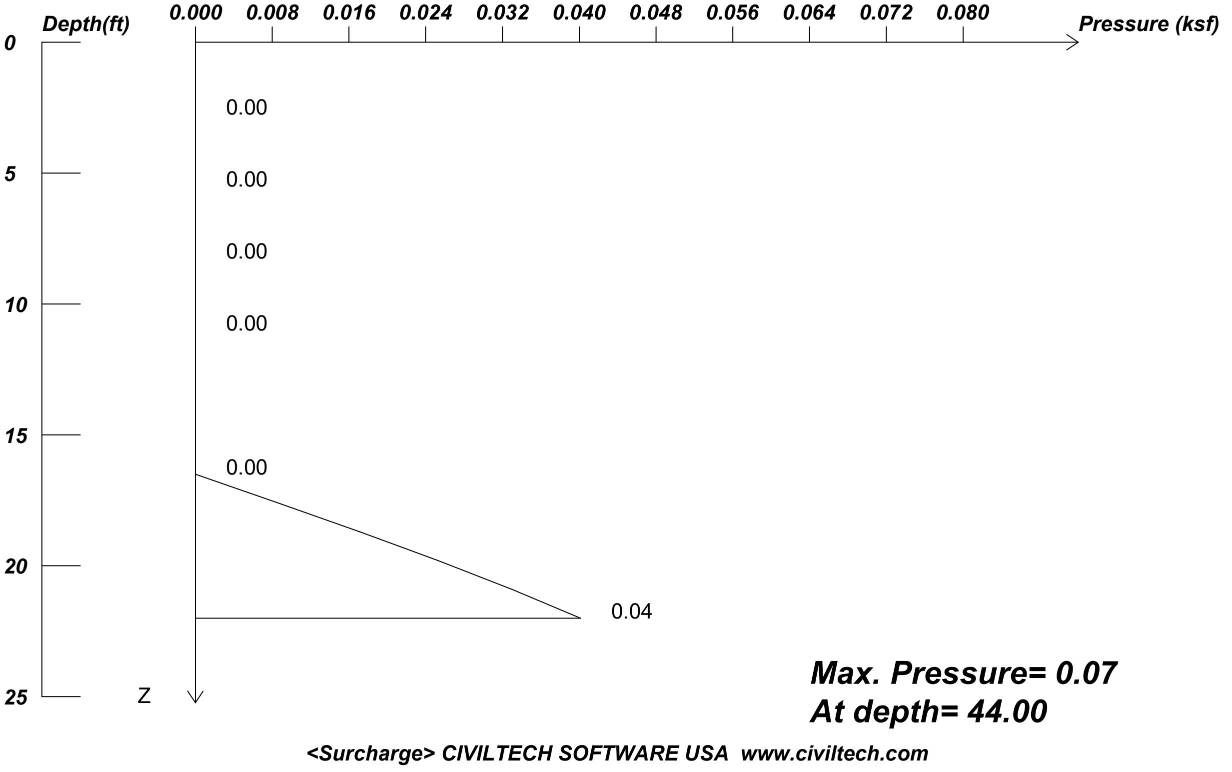
Carroll Street Case V_CSDL03_Group VII

Case V_CSDL03_LS



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Wall Height, H= 11 Load Depth, D= 17

Load Factor of Surcharge Loading = 1

Rigid Wall Condition -- No movement or deflection of the wall are allowed.

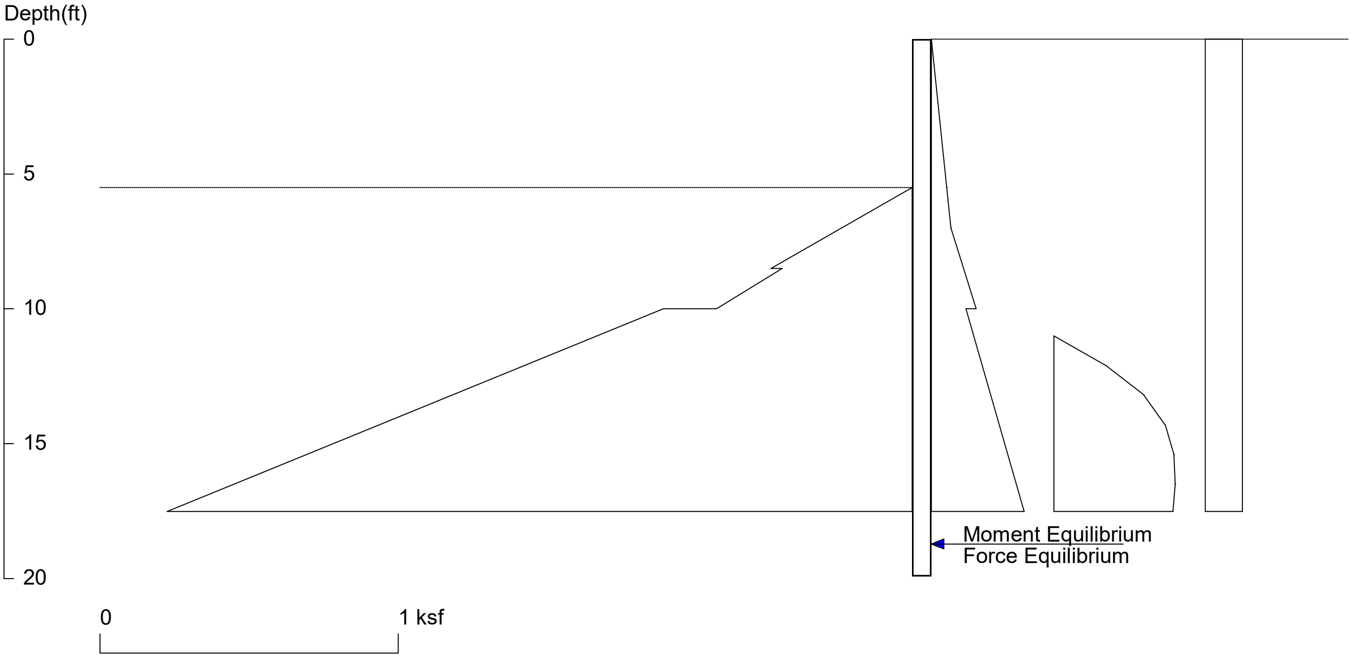
Max. Pressure = 0.071 at depth = 44.00

X	Width	Length	Area Load
44.00			0.07 Max.
12.0	4.5	54.0	1.07

UNITS: LENGTH/DEPTH: ft, Qpoint: kip, Qline: kip/ft, Qstrip/Qarea/PRESSURE: ksf

Carroll Street Case IV_CSDL05_Group I

Case IV_CSDL05_EP



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Wall Height=5.5 Pile Diameter=1.0 Pile Spacing=1.0 Wall Type: 1. Sheet Pile

PILE LENGTH: Min. Embedment=14.42 Min. Pile Length=19.92
MOMENT IN PILE: Max. Moment=7.15 per Pile Spacing=1.0 at Depth=11.99

PILE SELECTION:
Request Min. Section Modulus = 2.9 in3/ft=153.75 cm3/m, Fy= 50 ksi = 345 MPa, Fb/Fy=0.60
User Input I (Moment of Inertia):
Top Deflection = 0.07(in) based on E (ksi)=29000.00 and I (in4)/foot=955.6

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
*	Above	Base		
0.000	0.000	5.500	0.052	0.009434
*	Below	Base		
5.500	0.052	7.000	0.066	0.009434
7.000	0.066	10.000	0.151	0.028196
10.000	0.116	55.000	1.287	0.026014
*	Sur-	charge		
11.000	0.000	12.100	0.175	0.159406
12.100	0.175	13.200	0.302	0.115587
13.200	0.302	14.300	0.373	0.063872
14.300	0.373	15.400	0.402	0.026606
15.400	0.402	16.500	0.407	0.004684
16.500	0.407	17.600	0.399	-0.007227
17.600	0.399	18.700	0.384	-0.013470
18.700	0.384	19.800	0.366	-0.016602
19.800	0.366	20.900	0.346	-0.018005
*	Sur-	charge		
0.000	0.125	0.275	0.125	0.000000

0.275	0.125	0.550	0.125	0.000000
0.550	0.125	0.825	0.125	0.000000
0.825	0.125	1.100	0.125	0.000000
1.100	0.125	1.375	0.125	0.000000
1.375	0.125	1.650	0.125	0.000000
1.650	0.125	1.925	0.125	0.000000
1.925	0.125	2.200	0.125	0.000000
2.200	0.125	2.475	0.125	0.000000
2.475	0.125	2.750	0.125	0.000000
2.750	0.125	3.025	0.125	0.000000
3.025	0.125	3.300	0.125	0.000000
3.300	0.125	3.575	0.125	0.000000
3.575	0.125	3.850	0.125	0.000000
3.850	0.125	4.125	0.125	0.000000
4.125	0.125	4.400	0.125	0.000000
4.400	0.125	4.675	0.125	0.000000
4.675	0.125	4.950	0.125	0.000000
4.950	0.125	5.225	0.125	0.000000
5.225	0.125	5.500	0.125	0.000000
5.500	0.125	6.050	0.125	0.000000
6.050	0.125	6.600	0.125	0.000000
6.600	0.125	7.150	0.125	0.000000
7.150	0.125	7.700	0.125	0.000000
7.700	0.125	8.250	0.125	0.000000
8.250	0.125	8.800	0.125	0.000000
8.800	0.125	9.350	0.125	0.000000
9.350	0.125	9.900	0.125	0.000000
9.900	0.125	10.450	0.125	0.000000
10.450	0.125	11.000	0.125	0.000000
11.000	0.125	12.100	0.125	0.000000
12.100	0.125	13.200	0.125	0.000000
13.200	0.125	14.300	0.125	0.000000
14.300	0.125	15.400	0.125	0.000000
15.400	0.125	16.500	0.125	0.000000
16.500	0.125	17.600	0.125	0.000000
17.600	0.125	18.700	0.125	0.000000
18.700	0.125	19.800	0.125	0.000000
19.800	0.125	20.900	0.125	0.000000

PASSIVE PRESSURES: Pressures below will be divided by a Factor of Safety =1.5

Z1	P1	Z2	P2	Slope
*	Below	Base		
5.500	0.000	8.500	0.473	0.157800
8.500	0.436	10.000	0.655	0.146505
10.000	0.834	55.000	10.802	0.221512

ACTIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00
2	5.50	1.00

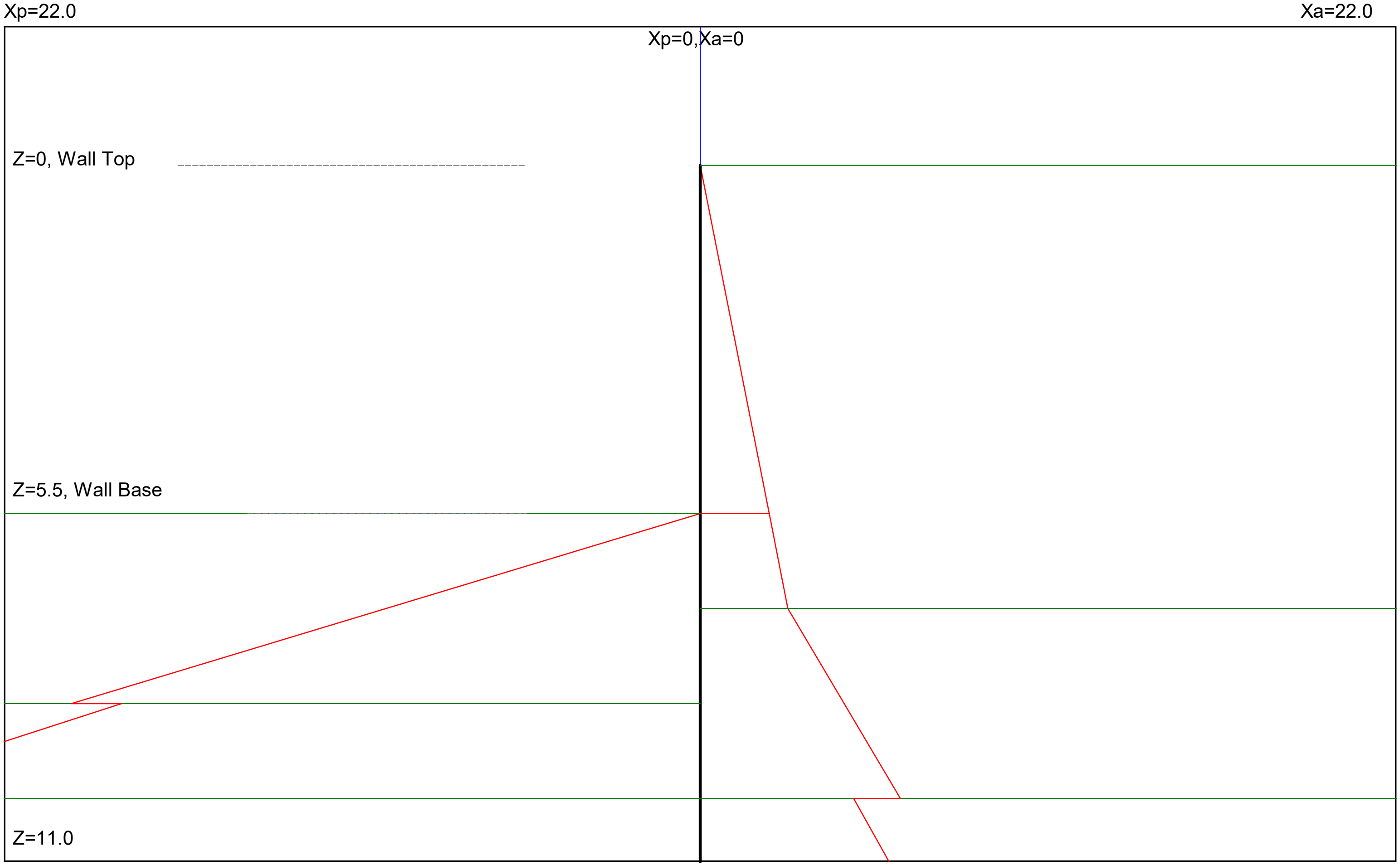
PASSIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in

Carroll Street Case IV_CSDL05_Group I

Case IV_CSDL05_EP



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* INPUT DATA *

Wall Height=5.5 Total Soil Types= 4

Soil No.	Weight	Saturate	Phi	Cohesion	Nspt	Type	Description
1	80.0	80.0	28.00	0.0	0	3	Soft Sedimen
2	115.0	115.0	28	0.0	0	4	Native Alluv
3	125.0	125.0	34	0.0	0	4	Glacial Depo
4	115.0	115.0	30	0.0	0	4	Sand Backfil

Ground Surface at Active Side:

Line	Z1	Xa1	Z2	Xa2	Soil No.	Description
1	0.0	0.0	0.0	800.0	1	Soft Sedimen
2	7.0	0.0	7.0	800.0	2	Native Alluv
3	10.0	0.0	10.0	800.0	3	Glacial Depo

Water Table at Active Side:

Point	Z-water	X-water
1	-6.4	0.0
2	-6.4	800.0

Ground Surface at Passive Side:

Line	Z1	Xp1	Z2	Xp2	Soil No.	Description
1	5.5	0.0	5.5	800.0	4	Sand Backfil
2	8.5	0.0	8.5	800.0	2	Native Alluv

3	10.0	0.0	10.0	800.0	3	Glacial Depo

Water Table at Passive Side:

Point	Z-water	X-water
1	-6.4	0.0
2	-6.4	800.0

Wall Friction Options: 1.* No wall friction
Wall Batter Angle = 0
Apparent Pressure Conversion: 1.* Default (Terzaghi and Peck)*
Water Density = 62.4
Water Pressure: 1.* No seepage at wall tip

* OUTPUT RESULTS *

Total Force above Base= 0.14 per one linear foot (or meter) width along wall height
Total Static Force above Base= 0.14

Driving Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Coef.
0.00	0.00	5.50	0.05	0.0094	0.5360

Driving Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Ka or Ko
5.50	0.05	7.00	0.07	0.0094	0.5360
7.00	0.07	10.00	0.15	0.0282	0.5360
10.00	0.12	11.00	0.14	0.0267	0.4272

Passive Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pp1	Z2	Pp2	Slope	Kp
5.50	0.00	8.50	0.47	0.158	3.0000
8.50	0.44	10.00	0.66	0.147	2.7853
10.00	0.82	11.00	1.05	0.231	3.6873

UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

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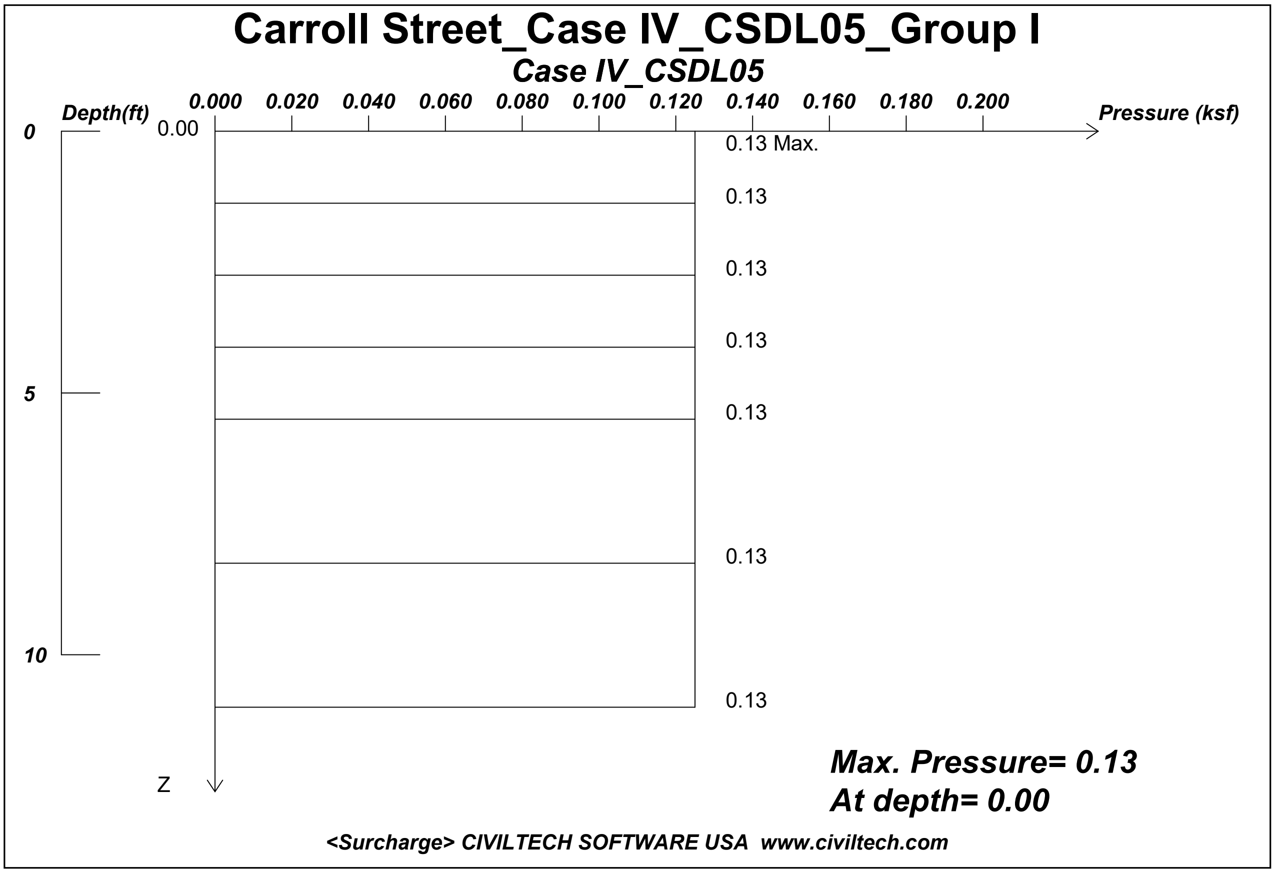

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Wall Height, H= 5.5 Load Depth, D= 0

Load Factor of Surcharge Loading = 1

Rigid Wall Condition -- No movement or deflection of the wall are allowed.

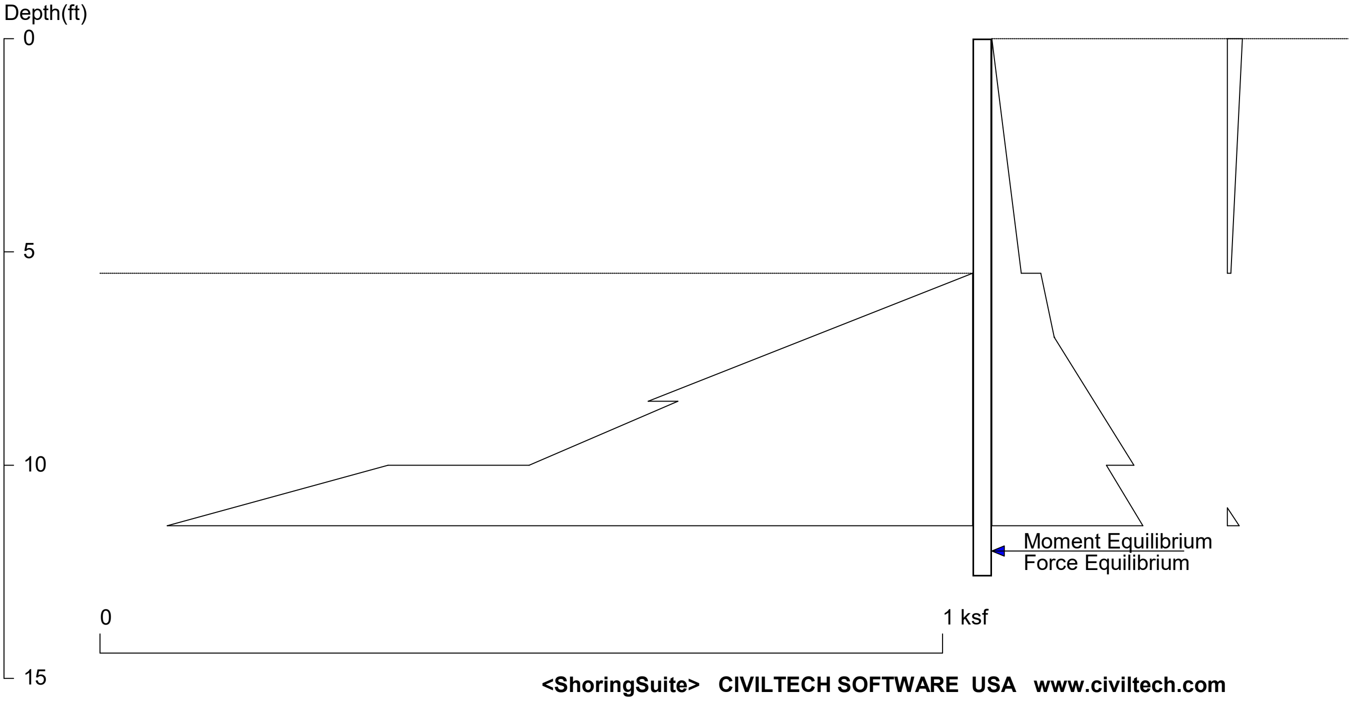
Max. Pressure = 0.125 at depth = 0.00

Infinite Surcharge, Q=0.250 Active Wedge Approach * (recommend)

UNITS: LENGTH/DEPTH: ft, Qpoint: kip, Qline: kip/ft, Qstrip/Qarea/PRESSURE: ksf

Carroll Street Case IV_CSDL05_Group VII

Case IV_CSDL05_EP



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Wall Height=5.5   Pile Diameter=1.0   Pile Spacing=1.0   Wall Type: 1. Sheet Pile

PILE LENGTH: Min. Embedment=7.11   Min. Pile Length=12.61
MOMENT IN PILE: Max. Moment=0.79 per Pile Spacing=1.0 at Depth=8.66

PILE SELECTION:
Request Min. Section Modulus = 0.3 in3/ft=16.92 cm3/m, Fy= 50 ksi = 345 MPa, Fb/Fy=0.60
User Input I (Moment of Inertia):
Top Deflection = 0.08(in) based on E (ksi)=29000.00 and I (in4)/foot=955.6

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
*	Above	Base		
0.000	0.000	5.500	0.035	0.006354
*	Below	Base		
5.500	0.058	7.000	0.074	0.010546
7.000	0.074	10.000	0.168	0.031517
10.000	0.136	55.000	1.505	0.030422
*	Earth	Queck		
0.000	0.018	5.500	0.005	-0.002515
*	Sur-	charge		
11.000	0.000	12.100	0.037	0.033744
12.100	0.037	13.200	0.064	0.024469

PASSIVE PRESSURES: Pressures below will be divided by a Factor of Safety =1.5

Z1	P1	Z2	P2	Slope
*	Below	Base		
5.500	0.000	8.500	0.385	0.128347
8.500	0.350	10.000	0.526	0.117624
10.000	0.694	55.000	8.988	0.184314

ACTIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00
2	5.50	1.00

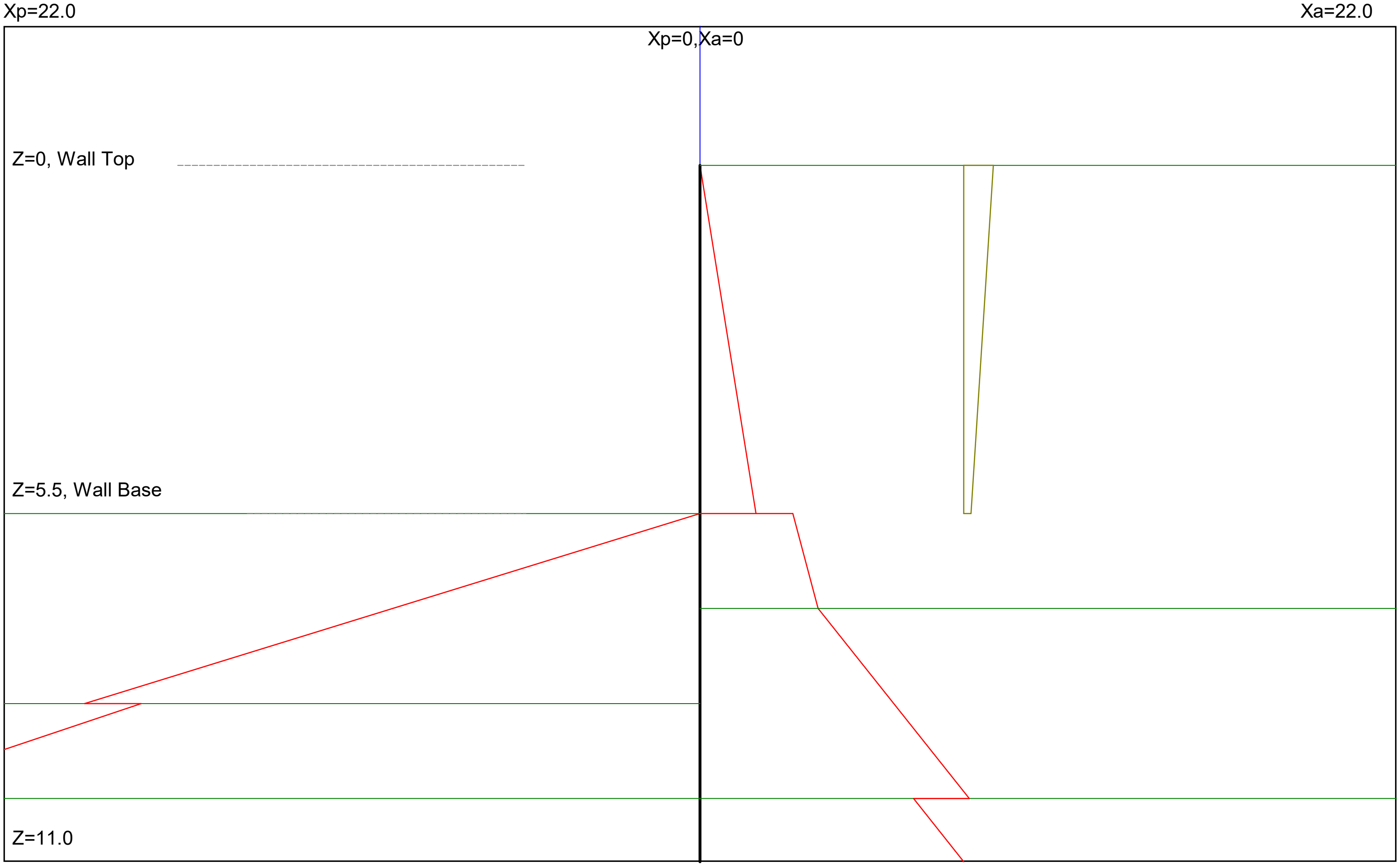
PASSIVE SPACING:

No.	Z depth	Spacing
1	0.00	1.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in

Carroll Street Case IV_CSDL05_Group VII

Case IV_CSDL05_EP



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UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

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* INPUT DATA *

Wall Height=5.5   Total Soil Types= 4

Soil No.	Weight	Saturate	Phi	Cohesion	Nspt	Type	Description
1	80.0	80.0	28.00	0.0	0	3	Soft Sedimen
2	115.0	115.0	28	0.0	0	4	Native Alluv
3	125.0	125.0	34	0.0	0	4	Glacial Depo
4	115.0	115.0	30	0.0	0	4	Sand Backfil

Ground Surface at Active Side:

Line	Z1	Xa1	Z2	Xa2	Soil No.	Description
1	0.0	0.0	0.0	800.0	1	Soft Sedimen
2	7.0	0.0	7.0	800.0	2	Native Alluv
3	10.0	0.0	10.0	800.0	3	Glacial Depo

Water Table at Active Side:

Point	Z-water	X-water
1	-6.4	0.0
2	-6.4	800.0

Ground Surface at Passive Side:

Line	Z1	Xp1	Z2	Xp2	Soil No.	Description
1	5.5	0.0	5.5	800.0	4	Sand Backfil
2	8.5	0.0	8.5	800.0	2	Native Alluv

3	10.0	0.0	10.0	800.0	3	Glacial Depo

Water Table at Passive Side:

Point	Z-water	X-water
1	-6.4	0.0
2	-6.4	800.0

Wall Friction Options: 1.* No wall friction

Wall Batter Angle = 0

Apparent Pressure Conversion: 1.* Default (Terzaghi and Peck)*

Water Density = 62.4

Water Pressure: 1.* No seepage at wall tip

* OUTPUT RESULTS *

Total Force above Base= 0.16 per one linear foot (or meter) width along wall height

Total Static Force above Base= 0.10

Total Earthquake Force above Base= 0.06. Distributed in trapezoid. Total earthquake force acting at 0.4H below wall top.

Driving Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Coef.
0.00	0.00	5.50	0.03	0.0064	0.3610

Driving Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pa1	Z2	Pa2	Slope	Ka or Ko
5.50	0.06	7.00	0.07	0.0105	0.5992
7.00	0.07	10.00	0.17	0.0315	0.5992
10.00	0.13	11.00	0.16	0.0314	0.5015

Passive Pressure below Base - Output to Shoring - Multiplier of Pressure = 1

Z1	Pp1	Z2	Pp2	Slope	Kp
5.50	0.00	8.50	0.39	0.128	2.4401
8.50	0.35	10.00	0.53	0.118	2.2362
10.00	0.68	11.00	0.87	0.191	3.0467

Output Earthquake Pressure above Base - Output to Shoring - Multiplier of Pressure = 1

Total Earthq. Force, Ee = 0.06

No	Zq1	Pq1	Zq2	Pq2	Slope
0	0.00	0.018	5.50	0.005	-0.003

UNITS: DEPTH/DISTANCE: ft, UNIT WEIGHT: pcf, FORCE: kip/ft, PRESSURE: ksf, SLOPE: kcf

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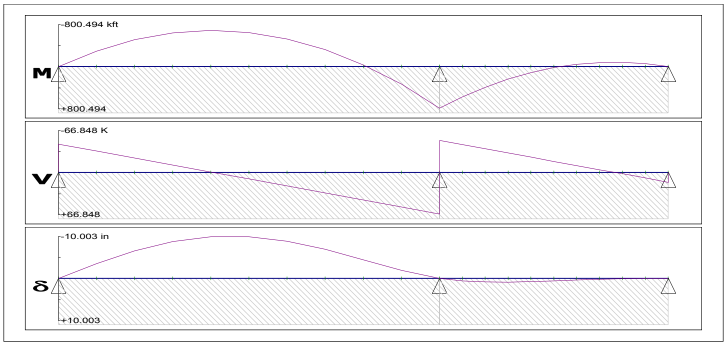
ATTACHMENT B – CONSYS OUTPUT

ID: DL
Type: Static

Factor: 1.000

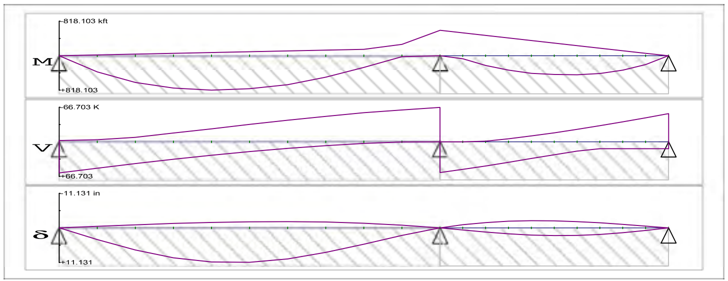


Span	Location (ft)	Moment (kft)	Shear (K)	Deflect (in)	Reaction (K)
1	0.000	+0.000/ -0.000	+0.000/ -45.502	+0.00	45.502
	7.500	-299.132	-34.267	-3.56	
	15.000	-514.001	-23.032	-6.63	
	22.500	-644.608	-11.797	-8.85	
	30.000	-690.952	-0.562	-10.00	
	37.500	-653.034	+10.673	-10.00	
	45.000	-530.854	+21.908	-8.92	
	52.500	-324.411	+33.143	-6.97	
	60.000	-33.705	+44.378	-4.48	
	67.500	+341.263	+55.613	-1.95	
	75.000				
2	0.000	+800.494	+66.848/ -51.494	+0.00	120.246
	4.500	+583.939	-44.753	+0.63	
	9.000	+397.719	-38.012	+0.90	
	13.500	+241.833	-31.271	+0.94	
	18.000	+116.282	-24.530	+0.82	
	22.500	+21.066	-17.789	+0.64	
	27.000	-43.817	-11.048	+0.44	
	31.500	-78.364	-4.307	+0.26	
	36.000	-82.577	+2.434	+0.13	
	40.500	-56.456	+9.175	+0.05	
	45.000	-0.000/ +0.000	+15.916/ +0.000	+0.00	15.916

Moment causing bottom tension and Shear causing left-up/right-down are positive. Deflection down is positive. Reaction down is positive.

ID: HS20
Type: Truck

Factors:
Moment: 1.000
Shear: 1.000
Deflection: 1.000



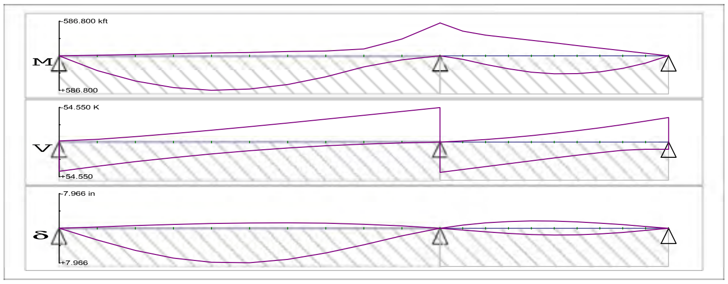
Span	Location (ft)	MOMENT (max) (min) (kft)	Corresponding Shear(+) (K)	Shear(-) (K)	SHEAR (max) (min) (K)	Corresponding Moment(+) (kft)	Moment(-) (kft)	DEFLECT (max) (min) (in)
1	0.000	0.000	60.343	-2.563	60.343	0.000	0.000	0.00
		-0.000	60.343	-2.563	-2.563	0.000	-0.000	0.00
	7.500	384.755	51.301	0.000	51.301	384.755	0.000	3.80
		-19.221	0.000	-2.563	-4.190	208.575	0.000	-0.53
	15.000	637.039	42.469	0.000	42.469	637.039	0.000	7.18
		-38.442	0.000	-2.563	-8.880	378.800	0.000	-1.03
	22.500	769.916	31.196	-0.804	34.076	766.706	0.000	9.69
		-57.663	0.000	-2.563	-17.075	607.802	0.000	-1.47
	30.000	818.103	23.003	-8.997	26.255	787.662	0.000	11.04
		-76.884	0.000	-2.563	-25.303	728.914	0.000	-1.80
	37.500	789.389	0.997	-31.003	19.143	717.861	0.000	11.13
		-96.105	0.000	-2.563	-33.927	755.726	0.000	-2.01
	45.000	688.845	0.000	-38.737	12.874	579.309	0.000	10.06
		-115.325	0.000	-2.563	-42.045	675.987	0.000	-2.06
	52.500	510.408	0.000	-45.745	7.579	397.922	0.000	7.97
		-134.546	0.000	-2.563	-49.520	508.191	0.000	-1.92
	60.000	278.513	0.000	-51.891	3.369	202.137	0.000	5.29
		-153.767	0.000	-2.563	-56.219	274.884	0.000	-1.55
	67.500	28.530	0.000	-37.918	0.320	21.582	0.000	2.44
		-271.766	0.000	-39.937	-62.005	2.661	0.000	-0.92
	75.000							
2	0.000	0.000	0.000	0.000	59.666	0.000	-120.205	0.00
		-606.404	13.476	-48.565	-66.703	0.000	-280.102	0.00
	4.500	73.800	53.585	0.000	53.585	73.800	0.000	0.68
		-545.763	13.476	0.000	0.000	0.000	0.000	-1.04
	9.000	232.135	46.885	0.000	46.885	232.135	0.000	1.37
		-485.123	13.476	0.000	-1.290	46.455	0.000	-1.76
	13.500	345.290	39.705	0.000	39.705	345.290	0.000	1.95
		-424.483	13.476	0.000	-6.064	191.016	0.000	-2.18
	18.000	419.829	31.858	-0.142	32.337	406.898	0.000	2.34
		-363.842	13.476	0.000	-11.513	310.851	0.000	-2.34
	22.500	445.420	24.292	-7.708	25.387	420.785	0.000	2.52
		-303.202	13.476	0.000	-17.584	395.641	0.000	-2.29
	27.000	454.567	8.524	-23.476	18.190	376.588	0.000	2.45
		-242.561	13.476	0.000	-24.210	435.788	0.000	-2.05
	31.500	422.881	0.675	-31.325	13.476	0.000	-181.921	2.13
		-181.921	13.476	0.000	-31.325	422.881	0.000	-1.66
	36.000	349.646	0.000	-38.850	13.476	0.000	-121.281	1.57
		-121.281	13.476	0.000	-38.850	349.646	0.000	-1.17
	40.500	210.171	0.000	-46.705	13.476	0.000	-60.640	0.83
		-60.640	13.476	0.000	-46.705	210.171	0.000	-0.60
	45.000	0.000	13.476	-54.727	13.476	0.000	0.000	0.00
		-0.000	13.476	-54.727	-54.727	0.000	0.000	0.00

Support	Reaction Positive	Negative
1	2.563	-60.435
2	0.000	-73.042
3	13.476	-54.809

Moment causing bottom tension and Shear causing left-up/right-down are positive. Deflection down is positive. Reaction down is positive.

ID: HS20 Lane Load
Type: Lane Load

Factors:
Moment: 1.000
Shear: 1.000
Deflection: 1.000



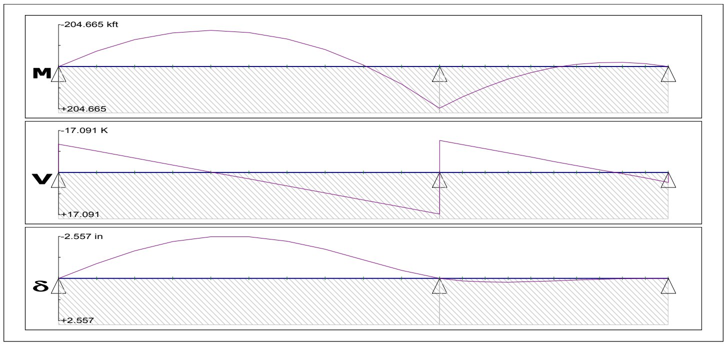
Span	Location (ft)	MOMENT (max) (min) (kft)	Corresponding Shear(+) (K)	Corresponding Shear(-) (K)	SHEAR (max) (min) (K)	Corresponding Moment(+) (kft)	Corresponding Moment(-) (kft)	DEFLECT (max) (min) (in)
1	0.000	0.000	46.216	-1.933	46.216	0.000	-0.000	0.00
		-0.000	46.216	-1.933	-1.933	0.000	-0.000	0.00
	7.500	251.199	31.093	0.000	38.360	287.702	0.000	2.72
		-11.907	0.000	-1.588	-4.529	179.031	0.000	-0.33
	15.000	431.550	23.970	0.000	31.144	467.160	0.000	5.11
		-23.814	0.000	-1.588	-8.824	329.639	0.000	-0.64
	22.500	542.574	16.914	-1.086	24.636	554.321	0.000	6.90
		-35.721	0.000	-1.588	-13.633	440.262	0.000	-0.91
	30.000	586.800	9.960	-8.040	18.864	565.920	0.000	7.86
		-47.628	0.000	-1.588	-18.884	501.479	0.000	-1.12
	37.500	567.774	3.141	-14.859	13.844	519.140	0.000	7.97
		-59.535	0.000	-1.588	-24.497	506.343	0.000	-1.25
	45.000	490.050	0.000	-21.510	9.584	431.280	0.000	7.22
		-71.442	0.000	-1.588	-30.384	450.720	0.000	-1.28
	52.500	359.199	0.000	-27.958	6.084	319.409	0.000	5.74
		-83.349	0.000	-1.588	-36.445	333.624	0.000	-1.19
	60.000	190.440	0.000	-29.226	3.334	200.039	0.000	3.81
		-115.033	0.000	-13.467	-42.574	157.560	-14.040	-0.96
	67.500	70.568	0.000	-21.488	1.315	88.779	0.000	1.77
		-287.166	0.000	-31.321	-48.654	0.000	-152.862	-0.57
	75.000							
2	0.000	0.000	0.000	0.000	47.984	0.000	-342.436	0.00
		-562.320	37.696	-42.298	-54.550	0.000	-343.216	0.00
	4.500	62.124	23.666	0.000	43.449	0.000	-253.337	0.42
		-421.404	24.165	0.000	-1.862	75.396	0.000	-0.76
	9.000	149.688	25.362	0.000	38.845	0.000	-184.356	0.85
		-354.600	9.850	0.000	-4.197	151.093	0.000	-1.28
	13.500	225.702	20.915	0.000	34.245	57.796	-133.082	1.21
		-310.275	9.850	0.000	-7.004	220.641	0.000	-1.59
	18.000	278.478	16.326	-1.674	29.703	133.299	-96.957	1.48
		-265.950	9.850	0.000	-10.279	277.534	0.000	-1.71
	22.500	305.649	11.616	-6.384	25.269	178.454	-72.914	1.59
		-221.625	9.850	0.000	-14.012	315.281	0.000	-1.67
	27.000	305.208	6.804	-11.196	20.989	193.870	-57.446	1.53
		-177.300	9.850	0.000	-18.193	327.482	0.000	-1.50
	31.500	275.517	1.911	-16.089	16.909	181.049	-46.684	1.33
		-132.975	9.850	0.000	-22.807	307.897	0.000	-1.22
	36.000	215.298	0.000	-21.042	13.068	142.309	-36.467	0.98
		-88.650	9.850	0.000	-27.836	250.522	0.000	-0.86
	40.500	123.641	0.000	-26.036	11.621	0.000	-45.814	0.52
		-44.325	9.850	0.000	-33.258	149.662	0.000	-0.44
	45.000	0.000	11.450	-39.019	11.450	0.000	-0.000	0.00
		-0.000	11.450	-39.019	-39.019	0.000	-0.000	0.00

Support	Reaction Positive	Reaction Negative
1	1.933	-46.250
2	0.000	-77.665
3	11.450	-39.019

Moment causing bottom tension and Shear causing left-up/right-down are positive. Deflection down is positive. Reaction down is positive.

ID: LL-SW
Type: Static

Factor: 1.000



Span	Location (ft)	Moment (kft)	Shear (K)	Deflect (in)	Reaction (K)
1	0.000	+0.000/ -0.000	+0.000/ -11.634	+0.00	11.634
	7.500	-76.480	-8.761	-0.91	
	15.000	-131.417	-5.889	-1.69	
	22.500	-164.810	-3.016	-2.26	
	30.000	-176.659	-0.144	-2.56	
	37.500	-166.964	+2.729	-2.56	
	45.000	-135.726	+5.601	-2.28	
	52.500	-82.943	+8.474	-1.78	
	60.000	-8.617	+11.346	-1.15	
	67.500	+87.252	+14.219	-0.50	
	75.000				
2	0.000	+204.665	+17.091/ -13.166	+0.00	30.257
	4.500	+149.298	-11.442	+0.16	
	9.000	+101.686	-9.719	+0.23	
	13.500	+61.831	-7.995	+0.24	
	18.000	+29.730	-6.272	+0.21	
	22.500	+5.386	-4.548	+0.16	
	27.000	-11.203	-2.825	+0.11	
	31.500	-20.036	-1.101	+0.07	
	36.000	-21.113	+0.622	+0.03	
	40.500	-14.434	+2.346	+0.01	
	45.000	+0.000/ +0.000	+4.069/ +0.000	+0.00	4.069

Moment causing bottom tension and Shear causing left-up/right-down
are positive. Deflection down is positive. Reaction down is positive.

ATTACHMENT C – PROCEDURE FOR ESTIMATING GROUND SETTLEMENT

RTA 1 - Carroll Street Pipe Pile Design - Procedure for Estimating Ground Settlement

The analysis of excavation-induced ground settlements follows the following procedure found in "Shape of Ground Surface Settlement Profiles Caused by Excavation" by Hsieh and Ou (1998) (pages 1009-1010):

1. Predict the maximum lateral wall deflection (δ_{hm}).
2. Determine the type of settlement profile.
3. Estimate the maximum ground surface settlement (δ_{hm}) using the relationship shown by Hsieh and Ou (1998).
4. Calculate the surface settlement at various distances behind the wall using the relationship shown by Hsieh and Ou (1998).

Results of the procedure by Hsieh and Ou (1998):

1. The maximum lateral wall deflection has been calculated for each design case and location using the design software CivilTech Shoring Suite and the method found in the USS Steel Sheet Piling Design Manual.
2. The settlement profile is spandrel due to the free head condition of the cantilever wall.
3. Hsieh and Ou (1998) developed a relationship between maximum lateral wall deflection (δ_{hm}) and maximum ground settlement (δ_{vm}) using excavation case-history data. "In most cases δ_{vm} is equal to (0.5-0.75)δ_{hm}, and the upper limit is $\delta_{vm} = \delta_{hm}$." Conservatively, the relationship between δ_{hm} and δ_{vm} will be considered equal.
4. The ground settlement is predicted using the following equations by Hsieh and Ou (1998):

$$\delta_v = \left(-0.636\sqrt{\frac{d}{H_e}}+1\right)\delta_{vm}\ if\ \frac{d}{H_e} \leq 2;\ and$$

$$\delta_v = \left(-0.171\sqrt{\frac{d}{H_e}}+0.342\right)\delta_{vm}\ if\ 2 < \frac{d}{H_e} \leq 4$$

Where:

δ_v = *Ground surface settlement*
d = *Distance behind the wall*
H_e = *Wall height*

ATTACHMENT D – SEISMIC DESIGN PARAMETERS

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: OF
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA1 - Bridge Support Design CHECKED BY: JRA DATE: 6/4/19

Attachment D - Seismic Design Parameters

References:

1. NYSDOT Geotechnical Design Procedure for Flexible Wall Systems - Aug 2015
2. NYSDOT Bridge Manual - 2017
3. AASHTO Standard Specifications for Highway Bridges, 17th Edition - 2002
4. USS Sheet Piling Design Manual - 1984
5. AASHTO LRFD Bridge Design Specifications - Seventh Edition with 2016 Iterim Revisions
6. NYSDOT Standard Specifications
7. Hsieh, Pio-Go and Ou, Chang-Yu. "Shape of Ground Surface Settlement Profiles Caused by Excavation." *Canadian Geotechnical Journal 35(6):1004-1017* (1998)
8. NYCDOT Seismic Design Guidelines for Bridges in Downstate Region - May 2016

Appendices:

Appendix A - RTA 1 Bridge Soil Design Parameters by GZA GeoEnvironmental, Inc.
Appendix B - Skyline Steel AZ Sheet Pile Datasheet
Appendix C - Summary of Geotechnical Design Parameters by Geosyntec Consultants

Seismic Design of Pipe Pile Walls:

Seismic design of the pipe pile walls is completed in CivilTech Shoring Suite. The additional earthquake forces are applied using the wedge analysis described in Ref. 5 Section A11.3.2. Seismic loading is only considered for the final design condition. Since 1.0 to 2.0 in of permanent ground deformation is not strictly permitted, the reduction of the horizontal seismic acceleration cofficient (k_h) can not be used. Instead, the peak ground acceleration coefficient will be used as per Ref. 5 Section A11.3.2. The vertical seismic acceleration cofficient (k_v) = 0 as per Ref. 5 Section A11.3.2.

Calculation of Horizontal Seismic Acceleration Coefficient, k_h:

Bridge Classification & Preformance Criteria:

Carroll Street bridge classification is assumed to be Other based on Ref. 8 Table 1.

Wall designs will be analyzed for a single earthquake hazard level having 7% probability of being exceeded in 75 years (1000 years Return Period).

Site Classification:

As per Ref. 8 Section 6.3.1, since rock is greater than 10 feet below the surface, this is a soil site.

Soil Site Classification:

As per Ref. 8 Section 6.3.1, for non-critical bridges, soil site classes shall be characterized on the basis of average soil properties. For cohsionless soils, the SPT resistance N may be used. For cohesive soils, the undrained shear strength (s_u) may be used. Since there are muliple soil types at this location, both soil parameters will be considered.

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: PLT DATE: 5/28/19
SUBJECT: RTA1 - Bridge Support Design CHECKED BY: JRA DATE: 6/4/19

Cohesive Soils Layers:

Soft Sediment:

$s_u = 0.3\sigma'_v$ *Appendix A*

$s_u =$ *73.92 pcf*

Max. depth = 14 *ft* (Maximum soft sediment layer depth)

$\gamma =$ 80 *pcf* (Total unit weight)

$\sigma'_v =$ 246.4 *psf* (Effective vertical stress)

Native Alluvial:

$s_u =$ *250 if > EL. -20 ft* *Appendix A*

$s_u =$ *500 if < EL. -20 ft*

Ref. 8 Table 11:

$s_u <$ *1000 pcf for Soil Class E*

Cohesionless Soil Layers:

Glacial Deposits:

$N_{60} =$ 16 *bpf* (SPT for Glacial Deposits) *Appendix C Table 6*

Ref. 8 Table 11:

$N <$ *15 pcf for Soil Class E*

Since the soft sediment and Native Alluvial Sediments are within the limits of soil class E and the Glacial Deposits are on the very low end of Soil Class D, Soil Class E has been selected for this site.

Soil Class = E (based on undrained shear strength) *Ref. 8 Table 11*

Calculation of Seismic Design Spectra and PGA:

As per Ref. 8 Section 7.2, soil on top of rock class B will be assumed when determining the PGA.

PGA = 0.29 *Ref. 8 Table 13*

Calculation of k_h:

$k_h =$ PGA *Ref. 5 Section A11.3.2*

$k_h =$ 0.29

ATTACHMENT E – CORROSION DURABILITY

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: JRA DATE: 6/20/19
SUBJECT: RTA1 - Bridge Support Design CHECKED BY: PLT DATE: 6/21/19

Attachment E - Pipe Pile Corrosion Durability

References:

1. Arcelor Mittal Piling Handbook 8th Edition, Reprint 2008
2. AISC Steel Construction Manual 14th Edition

Corrosion Durability Pipe Pile Walls:

Corrosion Durability of the pipe pile walls is completed in accordance with the procedure set forth in the Arcelor Mittal Piling Handbook. The corrosion durability is checked for a 50 year timeline. To be conservative, the maximum moment determined for all design cases and locations shall be used, which is Carroll Street Design Case I Location CSDL06, maximum moment = 35.41 kip-ft.

Assumptions*:*

Polluted Natural Soils and industrial grounds.
Seawater

RTA 1 - Carroll Street Pipe Pile Wall Design Case I - CSDL06

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88)

EL_1 = -3.00 *ft* (Minimum existing bathmetry elevation)
EL_2 = -16.00 *ft* (Minimum el. of soft-native interface) *Appendix C Table 1d*
EL_3 = -21.67 *ft* (Minimum el. of native-glacial interface) *Appendix C Table 1d*
El_D = -16.50 *ft* (Dredge elevation)
H = 13.50 *ft* (Dredge height)
EL_{TOP} = -3.00 *ft* (Top of wall elevation)
EL_{TOE} = -36.00 *ft* (Toe of wall elevation)
H_w = 33.00 *ft* (Total length of pile, 20% Additional Embedment included)
MHW EL = 1.96 *ft* (Mean high water elevation)

Corrosion Loss Rates:

Soil and Water Corrosion thicknesses below taken from Ref 1. Table 3.3.1 and 3.3.2 for 50 year timeline

Step 1:

Depth	Inshore Face Thickness Loss (mm)	Outshore Face Thickness Loss (mm)	Total Thickness Loss Over 50 Year Life
0 - 13.5 ft	Contam. Soil (1.5)	Immersed (1.75)	6.5 mm (0.256 in)
13.5-33 ft	Contam. Soil (1.5)	Contam. Soil (1.5)	6.0 mm (0.236 in)

Note:

1. Depth of zero feet is equivalent to the top of pile at EL. 3.00
2. Corrosion accounted for on exterior face of pile inshore and outshore, as well as interior face of pile.

Step 2:

Depth	Maximum Bending Moment (k-ft)
0 - 13.5 ft	14.06
13.5-33 ft	35.41

Note:

Bending Moments taken from Civil Tech Shoring Suite Output for Case I CSDL06.

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	6/20/19
SUBJECT:	RTA1 - Bridge Support Design	CHECKED BY:	PLT	DATE:	6/21/19

Step 3:

Depth	Min. Section Modulus (in^3)
0 - 13.5 ft	6.14
13.5-33 ft	15.45

Section modulus = M_{max} / (.55*F_y)

F_y = 50 ksi

Step 4:

Section Modulus of Hollow Circle S= .098175(D^4-d^4)/D (Ref. 2. Table 17-27)

D= Outside Diameter

d= Inside Diameter

O-Pile Manufacturer's Cutsheet 20" dia. Pile S= 95.56 in^3/ft

Adjusted Section Modulus After Corrosion Loss

Depth	Pile Dia. (in)	Pile Thickness (in)	Corrosion Loss (in)	Adjusted S_x (in^3)	Check
0 - 13.5 ft	20	0.625	0.256	83.6	OK
13.5-33 ft	20	0.625	0.236	85.4	OK

APPENDIX A – PAGES FROM RTA 1 BRIDGE SOIL DESIGN PARAMETERS BY GZA GEOENVIRONMENTAL, INC.

GZA
Proactive by Design

GEOTECHNICAL
ENVIRONMENTAL
ECOLOGICAL
WATER
CONSTRUCTION MANAGEMENT

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www.gza.com

MEMORANDUM

To: Jason Stern, P.E. (GPI)

From: Russell Morgan, P.E.; Andrew Rizk, P.E. (GZA)

CC Michael Shaw (GZA);

Date: June 28, 2019

File No.: 14.0079527.00

Re: Geotechnical Soil Design Parameters for RTA1 Bridges Stabilization Design Gowanus Canal Superfund Site Remediation Project

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GZA is pleased to provide GPI with this technical memorandum summarizing geotechnical design parameters to support GPI's design of stabilization measures for the three bridges: Union Street, Carroll Street, and Third Street Bridges, which are located within the Remediation Target Area (RTA) 1 portion of the Gowanus Canal Superfund Site Remediation project.

The basis of these soil parameters is based on data collected by Geosyntec and presented in Geosyntec's Summary of Geotechnical Design Parameters document dated October 28, 2016 (Report). Data from selected borings and cone penetrometer test soundings (CPTs) as well as laboratory testing data located near or around the referenced bridges were evaluated by GZA. The design parameters provided by Geosyntec in their Report were reviewed by GZA and deemed acceptable to be used for the design of the bridge stabilization measures. The selected explorations were overlaid by GZA on the existing bathymetry plan and profile between station 8+00 to 24+00on drawing number DR-2 and DR-3 of 22 prepared by Geosyntec and dated October 2017.

The soil design parameters including total unit weight, effective friction angle, undrained shear strength, and thickness of each strata for canal and upland subsurface materials are summarized and tabulated in the two attached tables. The approximate locations of the selected explorations which were evaluated are shown on the existing bathymetry survey and profile in Attachment A. The logs of the selected borings and the graphical data from the selected CPTs are shown in Appendix B.

Should you have any questions or comments, please do not hesitate to reach Andrew Rizk, P.E. at 732-356-3400 or Russell Morgan , P.E. at 401.427.2708.

TABLES

GZA GeoEnvironmental of New York
RTA 1 Bridge Soil Design Parameters
July 11, 2018

Summary of Design Parameters for Canal Soils

Soil Unit	Total Unit Weight, γ (pcf)	Effective Friction Angle, ϕ' (degrees)	Undrained Shear Strength, S_u (psf), See Note 1	Stratum Thickness Union Street (feet)	Stratum Thickness Carroll Street (feet)	Stratum Thickness 3rd Street (feet)
Soft Sediment	80	28	$0.3\sigma'_v$	6	5	7
Native Alluvial Sediment	115	28	250 if > El. -20 ft 500 if < El. -20 ft	4	4	7
Glacial Deposit	125	34	-	See Note 2	See Note 2	See Note 2

1. $\sigma'v$ = (total unit weight of soil - 62.4 pcf)*depth
2. Explorations were terminated in this stratum and it is expected that the stabilization design for the bridges will also terminate here.

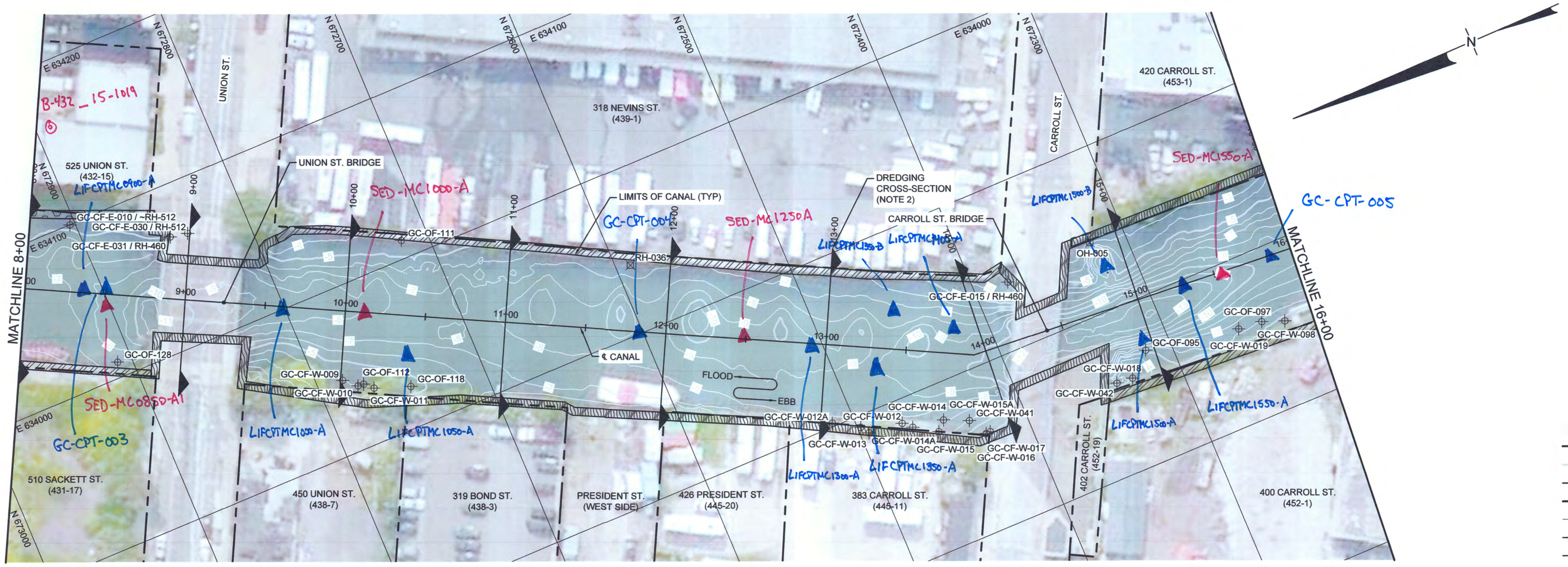
Summary of Design Parameters for Upland Soils

Soil Unit	Total Unit Weight, γ (pcf)	Effective Friction Angle, ϕ' (degrees)	Undrained Shear Strength, S_u (psf), See Note 1
Fill	120	32	-
Organic Sediment	95	23	$0.25\sigma'_v$ min. 250 psf
Native Alluvial Sediment	115	28	$0.35\sigma'_v$ min. 250 psf
Glacial Deposit w/ Fines	125	28	$0.5\sigma'_v$ min. 500 psf
Glacial Deposit w/ Sands	125	34	-

1. $\sigma'v$ = total unit weight of soil*depth above the water table and $\sigma'v$ = (total unit weight of soil - 62.4 pcf)*depth below the water table.

ATTACHMENT A

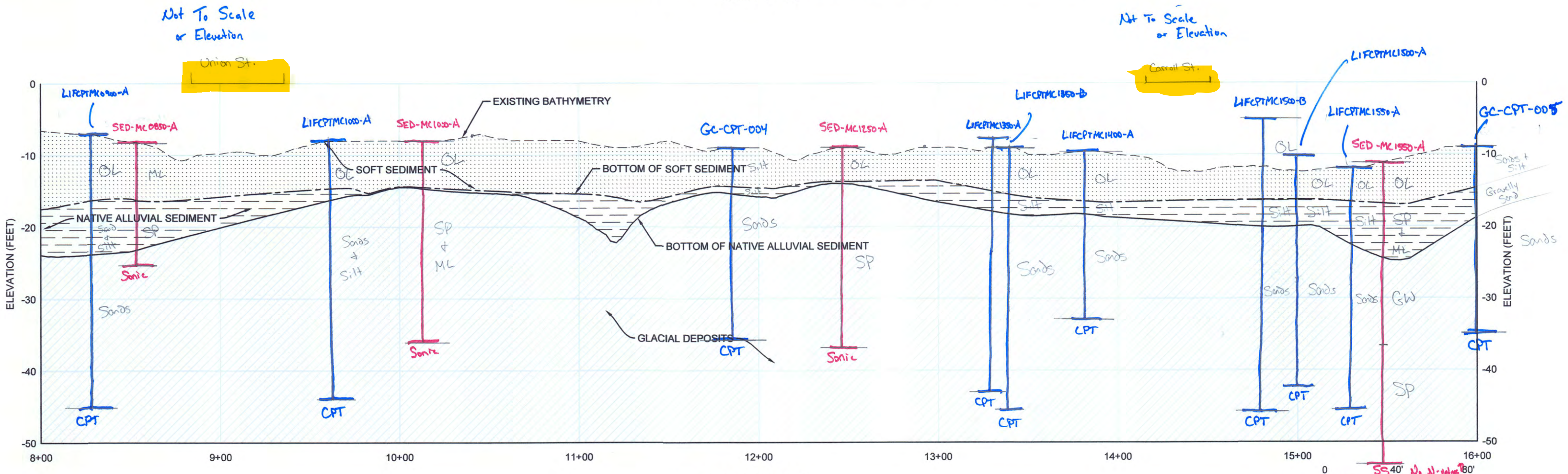
EXISTING BATHYMETRY PLAN AND PROFILE (STATIONS 8+00 TO 24+00) WITH SELECTED EXPLORATIONS



6
G-3

PLAN
EXISTING BATHYMETRY (STA. 8+00 TO 16+00)

SCALE: 1" = 40'



DISTANCE (FEET)

7
DR-2

PROFILE
EXISTING BATHYMETRY (STA. 8+00 TO 16+00)

SCALE: 1" = 40' (HORIZONTAL); 1" = 10' (VERTICAL)

LEGEND

─	BATHYMETRY ELEVATION
─	CANAL BOUNDARY
— — —	PROPERTY LINE
- - -	EXISTING BATHYMETRY
- · - ·	BOTTOM OF SOFT SEDIMENT
— · · —	BOTTOM OF NATIVE ALLUVIAL SEDIMENT
10+00	CANAL STATIONING
▨	STEEL SHEET PILE BULKHEAD
▨	TIMBER CRIB BULKHEAD
○○○	TIMBER PILE BULKHEAD
░	SOFT SEDIMENT
☰	NATIVE ALLUVIAL SEDIMENT
☐	GLACIAL DEPOSITS
⌖	OUTFALL (NOTE 4)
☒	CSO (NOTE 4)
(417-21)	BLOCK AND LOT
▲	Boring
▲	CPT

NOTES:

1. DEBRIS IN RTA1 IS PRESENTED ON DRAWINGS DR-6 TO DR-8.
2. DREDGE CROSS-SECTIONS ARE PRESENTED ON DRAWINGS DR-17 AND DR-18.
3. THE BULKHEAD TYPE FOR EACH PROPERTY IS PRIMARILY BASED ON A PRELIMINARY DESKTOP STUDY COMPLETED BY GEOSYNTEC (2014) TITLED "CONDITION ASSESSMENT OF EXISTING BULKHEADS" ALONG WITH MORE RECENT SUPPLEMENTARY INFORMATION (E.G., SITE WALKS, ENGINEERING DRAWINGS).
4. CONTRACTOR IS RESPONSIBLE FOR DOCUMENTING AND VERIFYING THE LOCATION AND DESCRIPTION OF OUTFALLS. ONLY RTA1 OUTFALLS DATA ARE PRESENTED ON THE DRAWING. OUTFALL DATA IS PROVIDED AS TABLE 1 ON DRAWING G-2 AND DESCRIBED WITHIN THE ASSOCIATED NOTES.

REV	DATE	DESCRIPTION	DRN	APP
C2	10.31.17	RTA1 65% REMEDIAL DESIGN TO RD GROUP	SRN	JFB
B	12.23.16	RTA1 35% REMEDIAL DESIGN - CAPPING AND ISS	SRN	JFB
A	10.31.16	RTA1 35% REMEDIAL DESIGN – DREDGING AND TREATMENT	SRN	JFB

Gowanus Canal
Remedial Design
Group

Geosyntec
consultants
7 GRAPHICS DRIVE, SUITE 106
EWING, NEW JERSEY 08628, USA
PHONE: 609.895.1400

Beech and Bonaparte
engineering p.c.
an affiliate of Geosyntec Consultants

TITLE:
EXISTING BATHYMETRY PLAN (STA. 8+00 TO 16+00)

PROJECT:
REMEDIATION TARGET AREA (RTA) 1
65% REMEDIAL DESIGN

SITE:
GOWANUS CANAL SUPERFUND SITE, BROOKLYN, NEW YORK

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

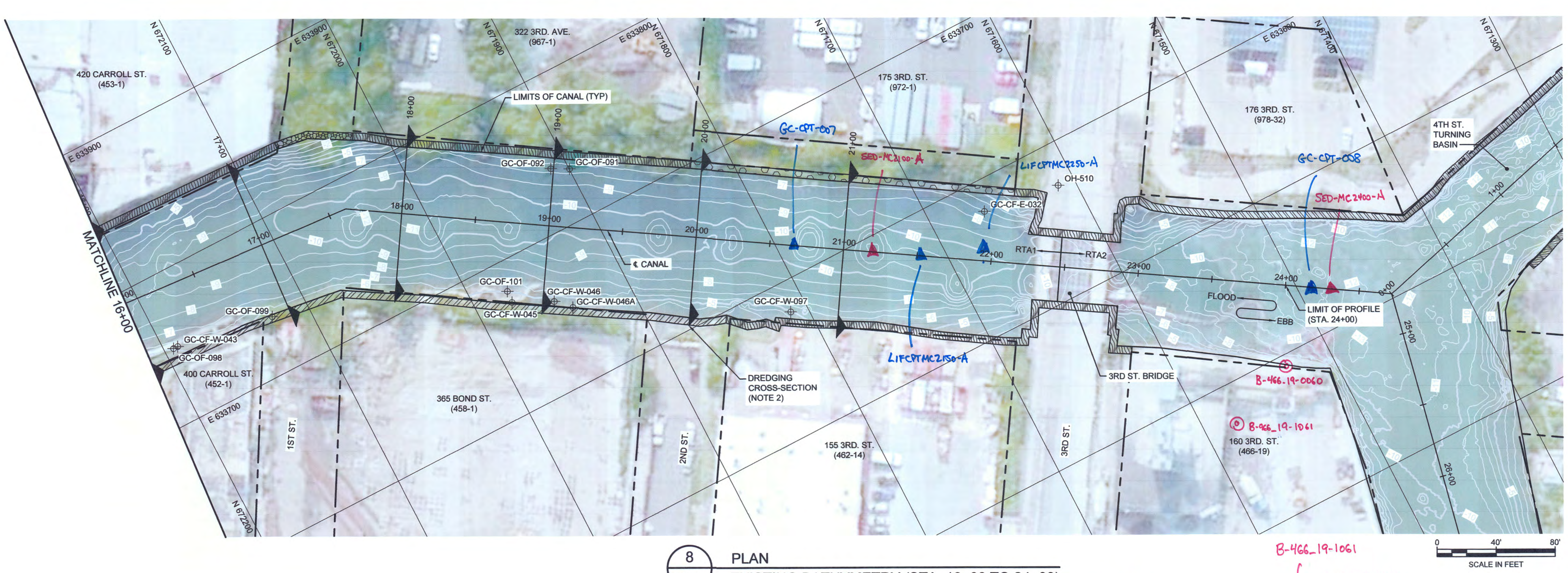
SIGNATURE

DATE

DESIGN BY:	JMG	DATE:	OCTOBER 2017
DRAWN BY:	SRN	PROJECT NO.:	HPH106A
CHECKED BY:	JMG	FILE:	HPH106A-DR006
REVIEWED BY:	MWS	DRAWING NO.:	DR-2 OF 22
APPROVED BY:	JFB		

NOT ISSUED FOR CONSTRUCTION

X:\00_CADD\DREDGING DESIGN\RTA1\DRAWINGS\HPH106A-DR006

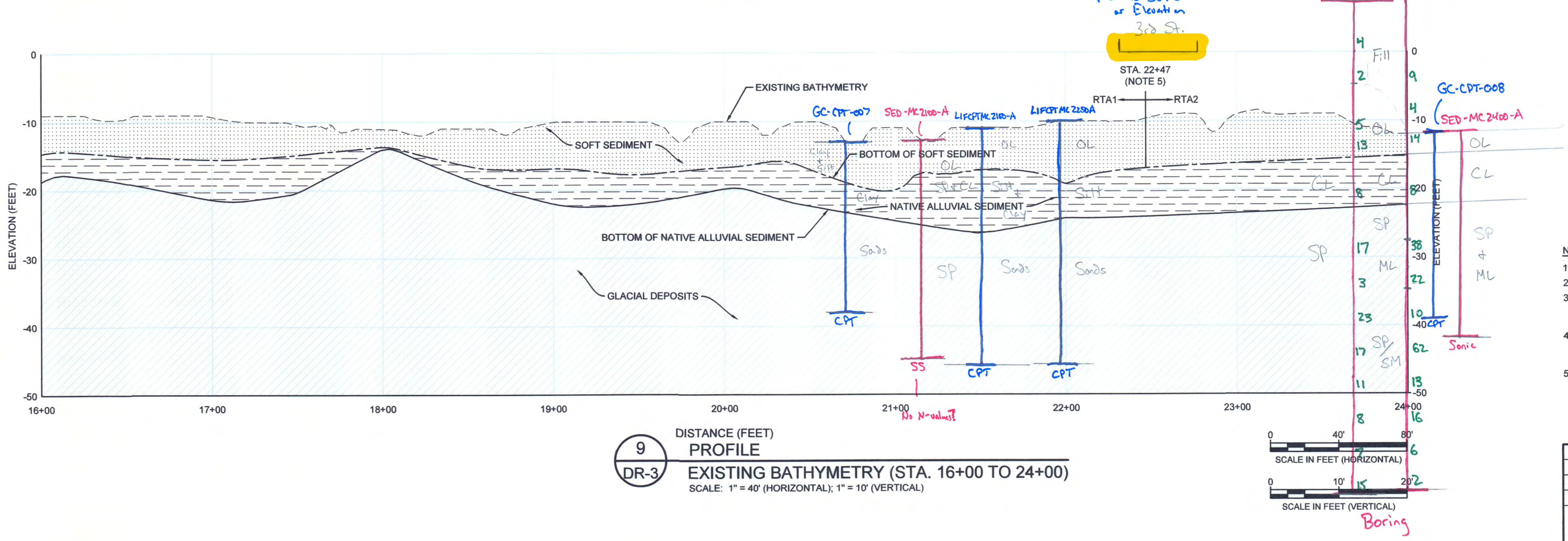


8
G-3

PLAN

EXISTING BATHYMETRY (STA. 16+00 TO 24+00)

SCALE: 1" = 40'



9
DR-3

PROFILE

EXISTING BATHYMETRY (STA. 16+00 TO 24+00)

SCALE: 1" = 40' (HORIZONTAL); 1" = 10' (VERTICAL)

LEGEND

—10—	BATHYMETRY ELEVATION
——	CANAL BOUNDARY
— — —	PROPERTY LINE
- - - -	EXISTING BATHYMETRY
—·—·—	BOTTOM OF SOFT SEDIMENT
——	BOTTOM OF NATIVE ALLUVIAL SEDIMENT
20+00	CANAL STATIONING
▨	STEEL SHEET PILE BULKHEAD
▨	TIMBER CRIB BULKHEAD
○○○	TIMBER PILE BULKHEAD
░	SOFT SEDIMENT
▤	NATIVE ALLUVIAL SEDIMENT
▨	GLACIAL DEPOSITS
⌖	OUTFALL (NOTE 4)
⊠	CSO (NOTE 4)
(417-21)	BLOCK AND LOT
▲	Boring
▲	CPT

NOTES:

1. DEBRIS IN RTA1 IS PRESENTED ON DRAWINGS DR-6 TO DR-8.
2. DREDGE CROSS-SECTIONS ARE PRESENTED ON DRAWINGS DR-17 AND DR-18.
3. THE BULKHEAD TYPE FOR EACH PROPERTY IS PRIMARILY BASED ON A PRELIMINARY DESKTOP STUDY COMPLETED BY GEOSYNTEC (2014) TITLED "CONDITION ASSESSMENT OF EXISTING BULKHEADS" ALONG WITH MORE RECENT SUPPLEMENTARY INFORMATION (E.G., SITE WALKS, ENGINEERING DRAWINGS).
4. CONTRACTOR IS RESPONSIBLE FOR DOCUMENTING AND VERIFYING THE LOCATION AND DESCRIPTION OF OUTFALLS. ONLY RTA1 OUTFALLS ARE PRESENTED ON THE DRAWING. OUTFALL DATA IS PROVIDED AS TABLE 1 ON DRAWING G-2 AND DESCRIBED WITHIN THE ASSOCIATED DREDGING NOTES.
5. THE BOUNDARY BETWEEN RTA1 AND RTA2 PRESENTED IS BASED ON A FIGURE IDENTIFIED IN THE EPA FEASIBILITY STUDY (2011).

REV	DATE	DESCRIPTION	DRN	APP
C2	10.31.17	RTA1 65% REMEDIAL DESIGN TO RD GROUP	SRN	JFB
B	12.23.16	RTA1 35% REMEDIAL DESIGN - CAPPING AND ISS	SRN	JFB
A	10.31.16	RTA1 35% REMEDIAL DESIGN – DREDGING AND TREATMENT	SRN	JFB

Gowanus Canal
Remedial Design
Group

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EWING, NEW JERSEY 08628, USA
PHONE: 609.895.1400

Beech and Bonaparte
engineering p.c.
an affiliate of Geosyntec Consultants

TITLE:
EXISTING BATHYMETRY PLAN (STA. 16+00 TO 24+00)

PROJECT:
REMEDIATION TARGET AREA (RTA) 1
65% REMEDIAL DESIGN

SITE:
GOWANUS CANAL SUPERFUND SITE, BROOKLYN, NEW YORK

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY:	JMG	DATE:	OCTOBER 2017
DRAWN BY:	SRN	PROJECT NO.:	HPH106A
CHECKED BY:	JMG	FILE:	HPH106A-DR007
REVIEWED BY:	MWS	DRAWING NO.:	
APPROVED BY:	JFB	DR-3 OF 22	

NOT ISSUED FOR CONSTRUCTION

ATTACHMENT B

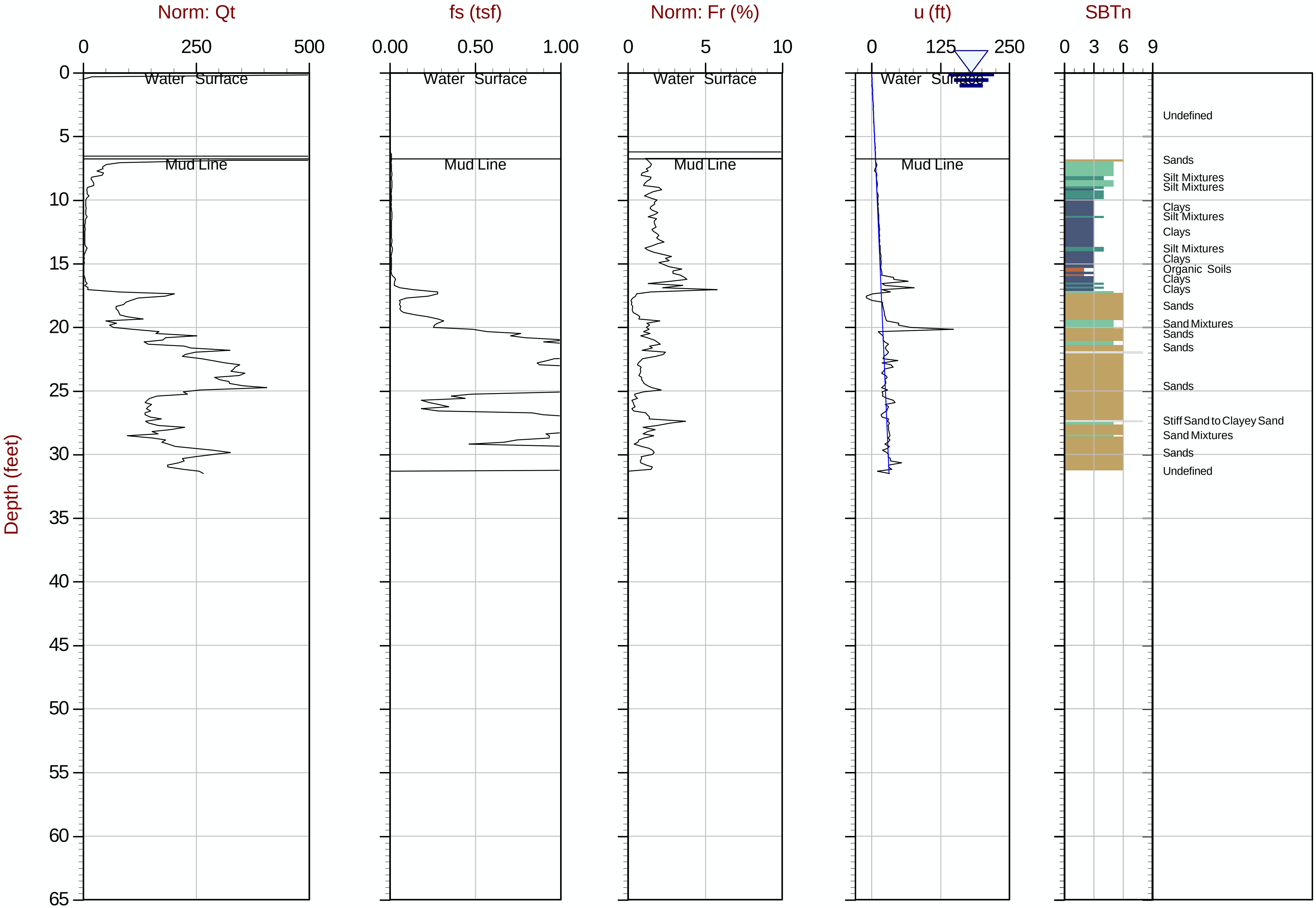
LOGS OF SELECTED BORINGS AND GRAPHICAL DATA OF SELECTED CPTS

CONETEC

GEI Consultants

Job No: 12-748
Date: 08:22:12 08:11
Site: Gowanus Canal

Sounding: GC-CPT-003
Cone: 366:T1500F15U500



Max Depth: 9.600 m / 31.50 ft
Depth Inc: 0.050 m / 0.164 ft

File: 748CP03.COR

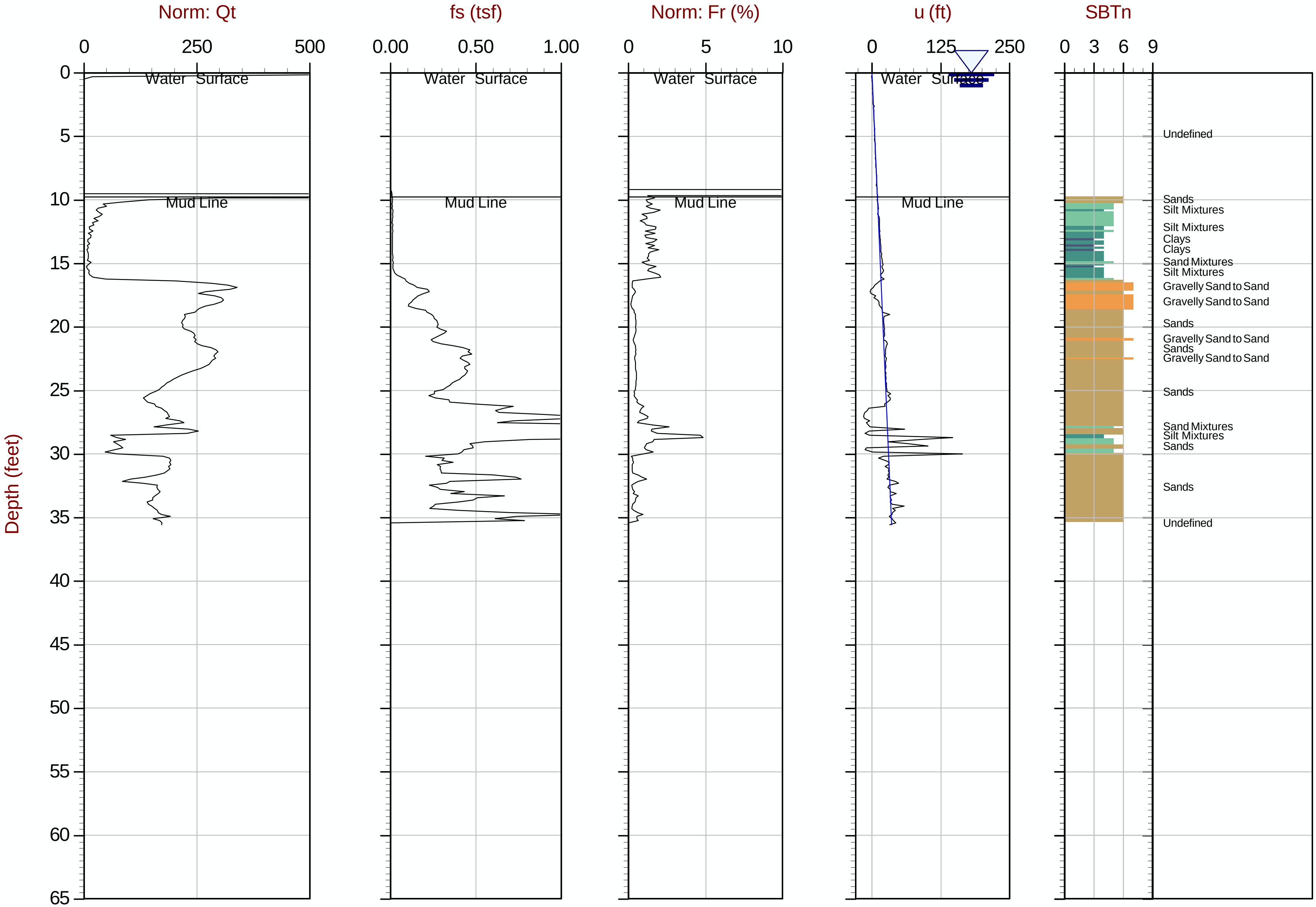
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4503692 E: 585502

CONETEC

GEI Consultants

Job No: 12-748
Date: 08:22:12 09:27
Site: Gowanus Canal

Sounding: GC-CPT-004
Cone: 366:T1500F15U500



Max Depth: 10.850 m / 35.60 ft
Depth Inc: 0.050 m / 0.164 ft

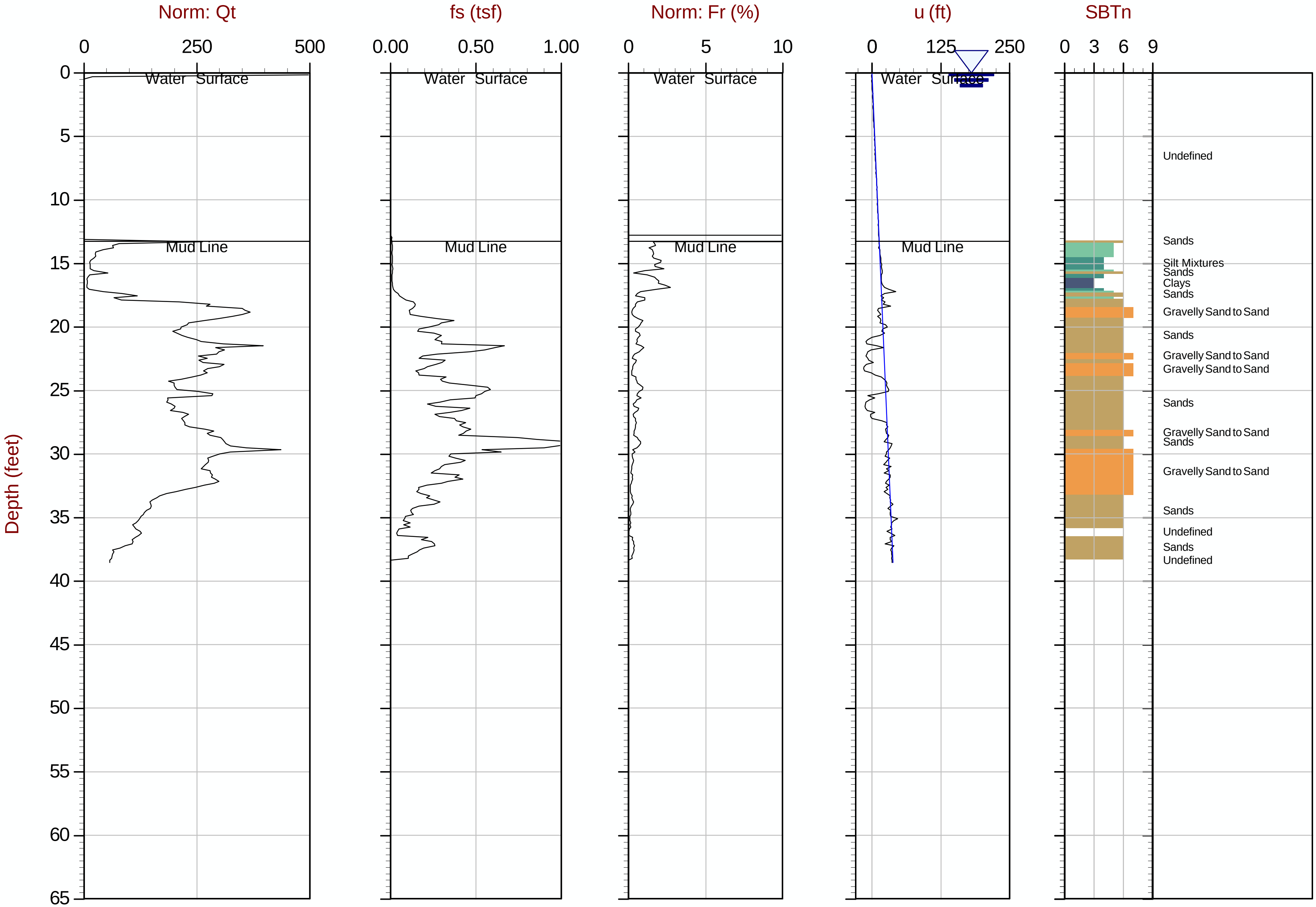
File: 748CP04.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4503601 E: 585466

GEI Consultants

Job No: 12-748
Date: 08:22:12 12:24
Site: Gowanus Canal

Sounding: GC-CPT-005
Cone: 366:T1500F15U500



Max Depth: 11.750 m / 38.55 ft
Depth Inc: 0.050 m / 0.164 ft

File: 748CP05.COR

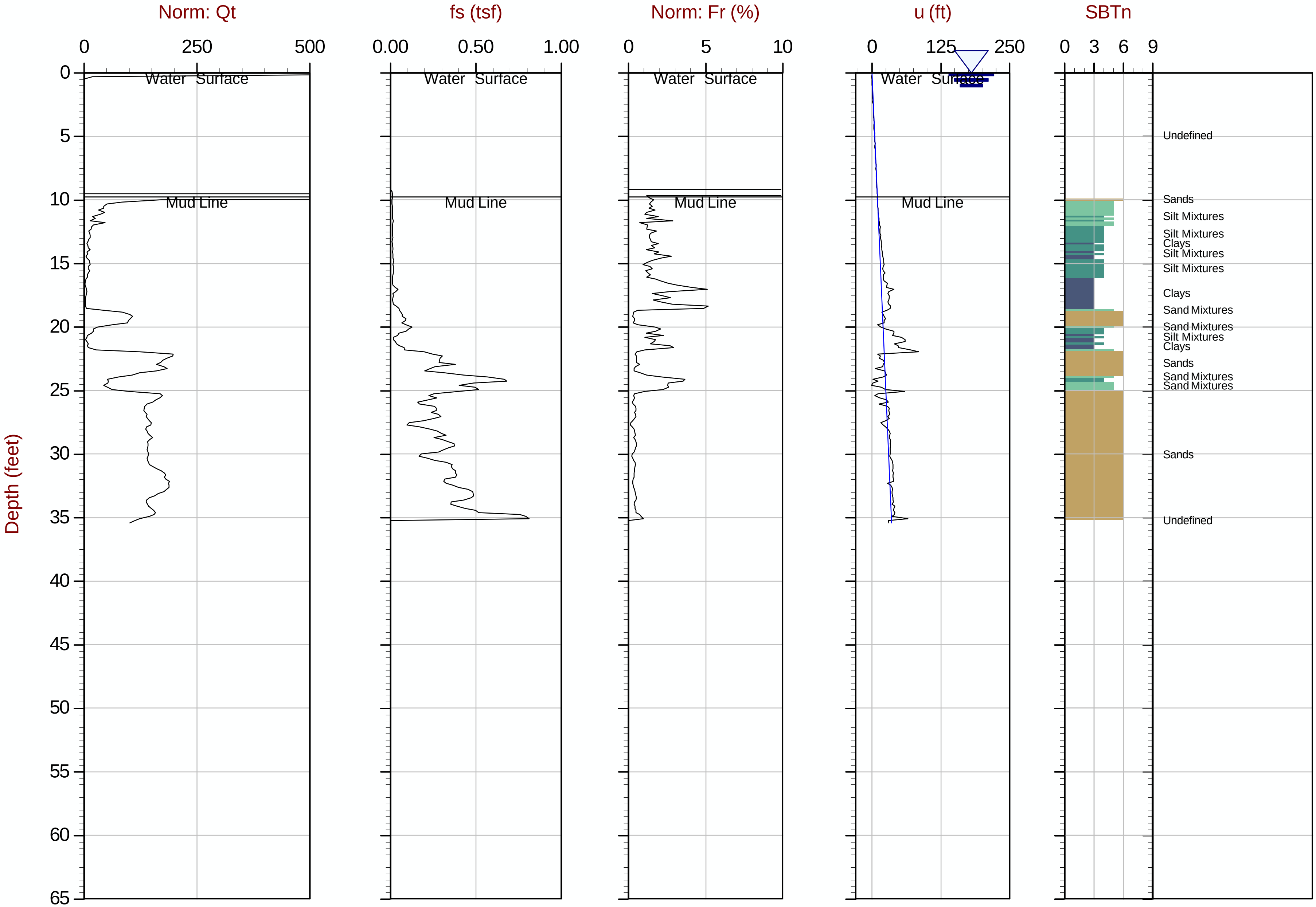
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4503479 E: 585431

ConeTec

GEI Consultants

Job No: 12-748
Date: 08:23:12 09:23
Site: Gowanus Canal

Sounding: GC-CPT-007
Cone: 366:T1500F15U500



Max Depth: 10.800 m / 35.43 ft
Depth Inc: 0.050 m / 0.164 ft

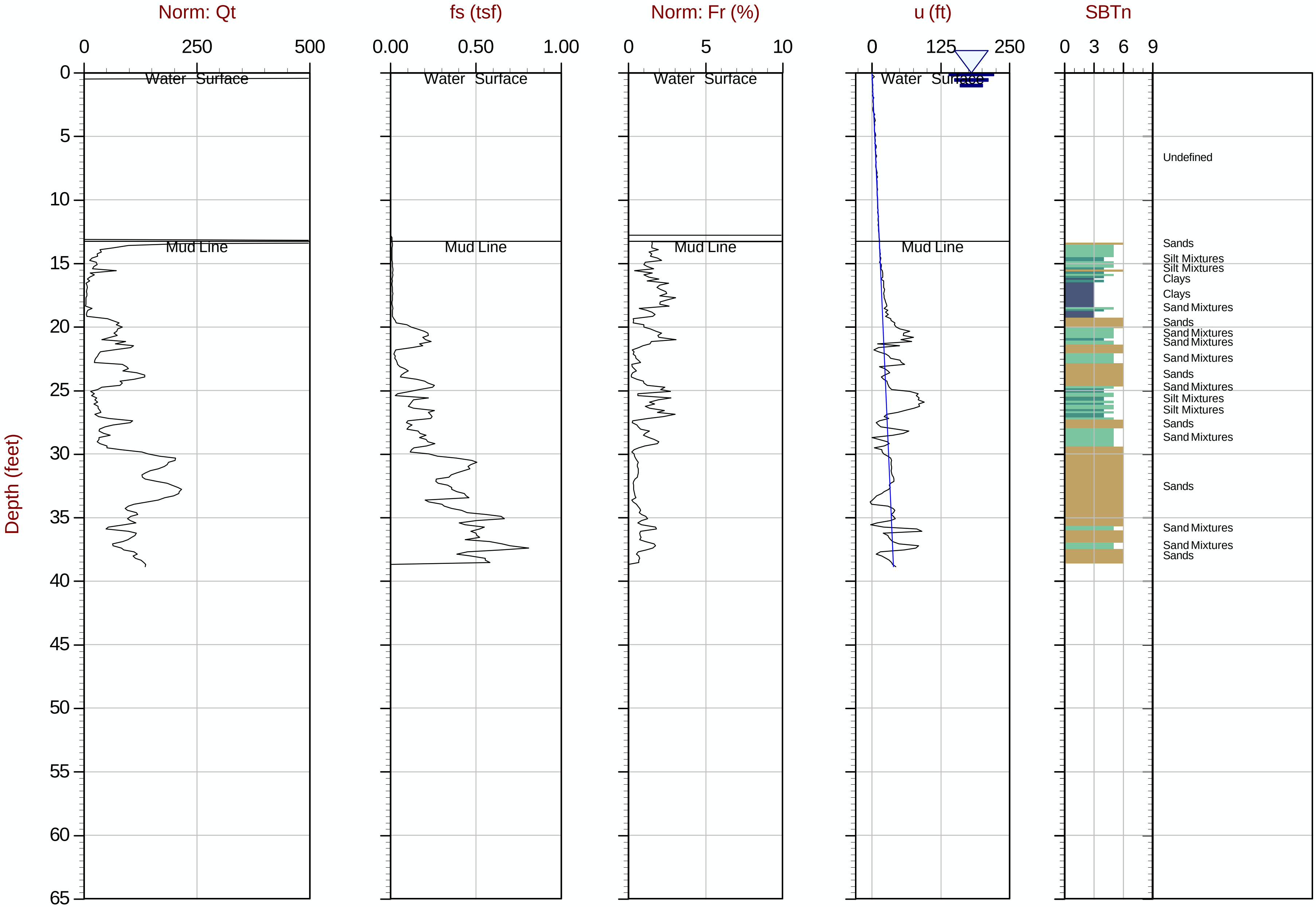
File: 748CP07.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4503356 E: 585374

GEI Consultants

Job No: 12-748
Date: 08:23:12 11:40
Site: Gowanus Canal

Sounding: GC-CPT-008
Cone: 366:T1500F15U500



Max Depth: 11.850 m / 38.88 ft
Depth Inc: 0.050 m / 0.164 ft

File: 748CP08.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4503252 E: 585323

BORING NUMBER SED-MC1000-A

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal Superfund
PROJECT NUMBER HPH106
PROJECT LOCATION Gowanus Brooklyn, NY
DATE STARTED 5/1/15 **COMPLETED** 5/1/15
MUDLINE ELEVATION -7.91 ft NAVD88
DRILLING CONTRACTOR Cascade
BOREHOLE DIAMETER 6 inches
DRILLING METHOD Sonic Drilling
SAMPLER 3.5 in. Sonic Core - Lexan Liner
LOGGED BY PS, MM **CHECKED BY** PS

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	LABORATORY SAMPLES	COMMENTS
0.0	60/60	OL		1.8	black, very soft, wet SILT, little clay, sheen, strong odor	-9.7		
2.5		OL		4.0	black, soft, wet SILT, little clay, organic debris, sheen, strong odor	-11.9		
5.0				5.0		-12.9	SED-MC1000-A-4-5	
	60/58.8	OL		6.2	black, soft, wet SILT, little clay, organic debris, sheen, strong odor	-14.1		Soft Sediments/ Glacial Deposits Interface [Elevation of -14.11 ft NAVD88]
7.5 10.0	60/60	SP		11.1	brown/tan, loose, wet, fine SAND, little silt, sheen, some stain, strong odor	-19.0		
		ML		11.9	brown, tan, medium stiff, moist, micaceous SILT, some fine sand, sheen, odor	-19.8		
12.5		SM		12.0	gray, medium stiff, moist SILT and fine SAND	-19.9		
				13.0		-20.9	SED-MC1000-A-12-13	
				14.0		-21.9	SED-MC1000-A-13-14	
		GW		14.3	gray, loose, wet, medium GRAVEL and coarse SAND, trace silt, heavy staining, sheen, strong odor	-22.2		
15.0		ML		15.0	black, medium stiff, moist SILT, trace fine sand, heavily stained,	-22.9		

NOTES

(Continued Next Page)

Geosyntec consultants

BORING NUMBER SED-MC1000-A

PAGE 2 OF 2

CLIENT Gowanus Canal Remedial Design Group

PROJECT NAME Gowanus Canal Superfund

PROJECT NUMBER HPH106

PROJECT LOCATION Gowanus Brooklyn, NY

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	LABORATORY SAMPLES	COMMENTS
15.0	36/33.6	SP		15.5	sheen, strong odor (linear path of stain/NAPL)	-23.4		
		GW		16.0	brown to gray, loose, damp, fine to medium SAND, trace silt, trace fine gravel	-23.9		
				17.0	brown to gray, loose, damp, medium SAND and GRAVEL, some staining, sheen, strong odor	-24.9	SED-MC1000-A-16-17	
		SC		17.3	brown, loose to medium stiff, damp, medium SAND and silty CLAY, heavily stained in sand, sheen, strong odor	-25.2		
17.5		SP		17.6		-25.5		
		CL-ML		17.8	black, loose, moist, medium SAND, trace gravel, heavy staining, sheen, strong odor	-25.7		
	18/10.8			18.5	brown, medium stiff, moist, clayey SILT, trace fine sand, sheen, odor	-26.4		
		SM		18.9	NO CORE COLLECTED	-26.8	SED-MC1000-A-18.5-20	Blow count: 2/2/4 [Elevations: -26.41 to -26.91/ -26.91 to -27.41/-27.41 to -27.91 ft NAVD88]
		SP		19.2	gray, loose, wet, fine SAND with SILT, sheen	-27.1		
		CL-ML		19.9	gray, loose, wet, fine to medium SAND, little silt, heavily stained, strong odor, sheen	-27.8		
20.0				22.5	black, medium stiff, wet CLAY, some silt, trace gravel, heavily stained, strong odor, sheen NO CORE COLLECTED	-30.4		
22.5	18/19.2	SP		22.6	gray, loose, wet, medium SAND, little silt, heavy staining, strong odor, free product	-30.5	SED-MC1000-A-22.5-24	Blow count: 2.5/4/6 [Elevations: -30.41 to -30.91/ -30.91 to -31.41/-31.41 to -31.91 ft NAVD88]
		CL		24.1	tan, stiff, damp CLAY, little silt, trace gravel	-32.0		
25.0				26.5	NO CORE COLLECTED	-34.4		
	18/18	SP		27.3	brown, medium stiff, wet, fine SAND, some silt, little clay, sheen, little stain, odor	-35.2	SED-MC1000-A-26.5-28	Blow count: 2/2/2 [Elevations: -34.41 to -34.91/ -34.91 to -35.41/-35.41 to -35.91 ft NAVD88]
27.5		CL		28.0	brown, stiff, moist to wet CLAY, some silt, little fine sand	-35.9		
30.0					Bottom of borehole at 28.0 feet.			

ENVIRONMENTAL BH - 3 - NO - PID2 - GEOSYNTECNJ_STD.GDT - 12/22/15 16:47 - T:\DATABASE\GINT\PROJECTS\HPH106 - GOWANUS\PD-7 SEDIMENT BORING LOGS.GPJ

BORING NUMBER SED-MC1250-A

PAGE 1 OF 2

CLIENT Gowanus Canal Remedial Design Group

PROJECT NAME Gowanus Canal Superfund

PROJECT NUMBER HPH106

PROJECT LOCATION Gowanus Brooklyn, NY

DATE STARTED 5/4/15 **COMPLETED** 5/5/15

MUDLINE ELEVATION -8.88 ft NAVD88

DRILLING CONTRACTOR Cascade

BOREHOLE DIAMETER 6 inches

DRILLING METHOD Sonic Drilling

SAMPLER 3.5 in. Sonic Core - Lexan Liner

LOGGED BY GB, MM **CHECKED BY** PS

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	LABORATORY SAMPLES	COMMENTS
0.0	60/39.6	OL			black, soft, wet SILT, trace clay, detritus, strong odor, sheen			
2.5								
				3.3		-12.2	SED-MC1250-A-2.3-3.3	
5.0	60/44.4	SP			gray, loose, wet, fine SAND, trace silt, native sediment content; (3" glass bottle fragment)			Soft Sediments/ Glacial Deposits Interface [Elevation of -13.88 ft NAVD88]
7.5								
				8.7		-17.6		
10.0	60/60							
				11.0		-19.9	SED-MC1250-A-10-11	
				12.0		-20.9	SED-MC1250-A-11-12	
12.5		SP			gray, medium dense, fine SAND, little medium sand, little gravel at 14.1', slight odor			
15.0				15.0		-23.9		

NOTES 15 to 18 ft below mudline was heavily stained cause 5 ft of recovery. After pulling rods, sample loss at bottom and only 2 ft of recovery. Likely. The first native sediment was observed in 5-10 ft. No soft sediment was observed in 5-10 ft interval.

ENVIRONMENTAL BH - 3 - NO - PID2 - GEOSYNTECNJ_STD.GDT - 12/22/15 16:47 - T:\DATABASE\GINT\PROJECTS\HPH106 - GOWANUS\PD-7 SEDIMENT BORING LOGS.GPJ

(Continued Next Page)

Geosyntec consultants

BORING NUMBER SED-MC1250-A

CLIENT Gowanus Canal Remedial Design Group

PROJECT NAME Gowanus Canal Superfund

PROJECT NUMBER HPH106

PROJECT LOCATION Gowanus Brooklyn, NY

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	LABORATORY SAMPLES	COMMENTS
15.0	36/20.4	SP	▨	16.7	gray, medium dense, fine SAND, little medium sand, slight odor	-25.6		
17.5	60/46.8			19.0		-27.9	SED-MC1250-A-18-19	
20.0 22.5		SP	▨	22.9	dark gray, medium dense, moist fine to medium SAND, trace gravel, some staining, sheen, odor	-31.8		
	60/56.4			24.0		-32.9	SED-MC1250-A-23-24	
25.0 27.5		SP	▨	27.7	dark gray, medium dense, moist fine to medium SAND, trace gravel, some staining, sheen, odor	-36.6	SED-MC1250-A-26.5-27.5	Staining was observed throughout the core and followed the coarser grained material.

Bottom of borehole at 28.0 feet.

30.0

BORING NUMBER SED-MC1550-A

PAGE 1 OF 2

CLIENT Gowanus Canal Remedial Design Group

PROJECT NAME Gowanus Canal Superfund

PROJECT NUMBER HPH106

PROJECT LOCATION Gowanus Brooklyn, NY

DATE STARTED 6/3/15 **COMPLETED** 6/4/15

MUDLINE ELEVATION -11.78 ft NAVD88

DRILLING CONTRACTOR Aquifer Drilling and Testing

BOREHOLE DIAMETER 4 inches

DRILLING METHOD Split Spoon

SAMPLER 3 in. Split Spoon

LOGGED BY AW **CHECKED BY** PS

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	LABORATORY SAMPLES	COMMENTS
0					NO CORE COLLECTED			
5	24/20.4			5.0		-16.8		Soft Sediments/ Native Alluvial Sediments Interface [Elevation of -17.08 ft NAVD88]
		OL		5.3	black, very soft, wet SILT, little fine sand, little gravel, trace organic debris	-17.1		
		SP		5.7	dark gray, dense, wet, fine SAND, sheen	-17.5		
		SP		6.7	dark brown to black, medium dense, wet, fine SAND, heavy staining, sheen, strong odor	-18.5	SED-MC1550-A-5.7-6.7	
					NO CORE COLLECTED			
10	24/19.2			10.0		-21.8		
		ML		10.3	dark gray, stiff, moist SILT, some fine sand, little clay, some organic debris, hairs, and fibers, some gravel	-22.1		
		SP		10.5	black, medium dense, wet, fine SAND, heavy staining, sheen, strong odor	-22.3		
		ML		11.1	dark gray, stiff, moist SILT, trace fine sand, trace clay	-22.9		
		SP		11.6	grayish brown, medium stiff, wet, fine SAND with SILT, trace clay, sheen	-23.4	SED-MC1550-A-10-11.6	
					NO CORE COLLECTED			Native Alluvial Sediments/ Glacial Deposits Interface [Elevation of > -26.78 ft NAVD88]
15	24/10.8	GW		15.0	dark brown, loose, wet, coarse SAND with medium GRAVEL	-26.8		
				15.9		-27.7	SED-MC1550-A-15-15.9	
	24/12	GW		17.3	dark brown, loose, wet, coarse SAND with medium GRAVEL	-29.1	SED-MC1550-A-17.3-18.3	
					NO CORE COLLECTED			
20	24/12	GW		20.0	dark brown, loose, wet, coarse SAND with medium GRAVEL, some large gravel, wet	-31.8		
				21.0		-32.8	SED-MC1550-A-20-21	
					NO CORE COLLECTED			
25				25.0		-36.8		

NOTES

(Continued Next Page)

BORING NUMBER SED-MC1550-A

PAGE 2 OF 2

CLIENT Gowanus Canal Remedial Design Group

PROJECT NAME Gowanus Canal Superfund

PROJECT NUMBER HPH106

PROJECT LOCATION Gowanus Brooklyn, NY

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	LABORATORY SAMPLES	COMMENTS
25	24/16.8	SP	▒	25.2	grayish brown, loose, wet, medium to coarse SAND, some medium gravel	-37.0	SED-MC1550-A-25-26.4	
		SP	▒	25.8	black, medium dense, wet, medium to coarse SAND, some medium gravel, heavily stained, strong odor, sheen, very sticky	-37.6		
		SP	▒	26.0	black, medium dense, wet, fine SAND, some medium gravel, heavily stained, strong odor, sheen, very sticky	-37.8		
		SP	▒	26.4	brown, medium dense, wet, fine to medium SAND, no staining, no odor	-38.2		
					NO CORE COLLECTED			
30	24/18			30.0		-41.8		
		SP	▒	30.5	black, dense, wet, fine SAND, no staining, no odor	-42.3	SED-MC1550-A-30-31.5	
		SP	▒	31.5	brown, dense, wet, fine to medium SAND, no staining, no odor	-43.3		
					NO CORE COLLECTED			
35	24/13.2			35.0		-46.8		
		SP	▒	35.5	brown, dense, wet, medium to coarse SAND, no staining, no odor	-47.3	SED-MC1550-A-35-36.1	
		GW	○	36.1	brown, dense, wet, medium to coarse SAND with medium GRAVEL, no staining, no odor	-47.9		
					NO CORE COLLECTED			
40	24/15.6			40.0		-51.8		
		GW	○	40.7	brown, medium dense, wet, coarse SAND and medium to coarse GRAVEL	-52.5	SED-MC1550-A-40-41.3	
		SP	▒	41.3	brown, dense, wet, fine SAND, little medium gravel, trace silt	-53.1		

Bottom of borehole at 42.0 feet.

45

50

BORING NUMBER SED-MC2100-A

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal Superfund
PROJECT NUMBER HPH106
PROJECT LOCATION Gowanus Brooklyn, NY
DATE STARTED 6/4/15 **COMPLETED** 6/5/15
MUDLINE ELEVATION -11.81 ft NAVD88
DRILLING CONTRACTOR Aquifer Drilling and Testing
BOREHOLE DIAMETER 4 inches
DRILLING METHOD Split Spoon
SAMPLER 3 in. Split Spoon
LOGGED BY AW **CHECKED BY** PS

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	LABORATORY SAMPLES	COMMENTS
0.0 2.5					NO CORE COLLECTED			
5.0	24/24	OL		5.0	dark gray to black, soft, wet, little clay, slight staining	-16.8	SED-MC2100-A-6-7	Soft Sediments/ Native Alluvial Sediments Interface [Elevation of -17.01 ft NAVD88]; Blow Count: 7 [Elevation: -16.81 to -18.81 ft NAVD88]
		CL		5.2	dark gray, very stiff, damp CLAY, little silt, trace organic debris	-17.0		
		SP		6.1	dark brown, loose, wet, fine SAND, sheen, heavy staining, strong odor	-17.9		
		CL		6.2	dark gray, very stiff, damp CLAY, little silt, trace organic debris	-18.0		
		SP		6.3	dark brown, loose, wet, fine SAND, sheen, heavy staining, strong odor	-18.1		
		CL		6.4	dark gray, very stiff, damp CLAY, little silt, trace organic debris	-18.2		
		SP		6.6	dark brown, loose, wet, fine SAND, sheen, heavy staining, strong odor	-18.4		
		CL		6.7	dark gray, very stiff, damp CLAY, little silt, trace organic debris	-18.5		
7.5 10.0				7.0	NO CORE COLLECTED	-18.8		
	24/24	CL-ML		12.0	black, very stiff, damp SILT with CLAY, sheen, staining, odor	-23.8	SED-MC2100-A-12-14	[Elevation: -23.81 to -25.81 ft NAVD88] Native Alluvial Sediments/ Glacial Deposits Interface [Elevation of -25.11 ft NAVD88]
12.5		CL		12.3	dark gray, very stiff, damp CLAY, some silt, staining, odor	-24.1		
		SP		13.3	dark brown, dense, wet, medium SAND, some silt, heavy staining, strong odor, trace medium gravel	-25.1		
		SP		13.7	brown, dense, wet, fine SAND, staining, odor	-25.5		
15.0				14.0	NO CORE COLLECTED	-25.8		
				16.0		-27.8		

NOTES

(Continued Next Page)

BORING NUMBER SED-MC2100-A

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal Superfund
PROJECT NUMBER HPH106
PROJECT LOCATION Gowanus Brooklyn, NY

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	LABORATORY SAMPLES	COMMENTS
	24/20.4	SC		16.1	black, stiff, moist, CLAY with fine SAND, sheen, staining	-27.9	SED-MC2100-A-16-17.7	[Elevation: -27.81 to -29.81 ft NAVD88]
		SM		16.6	grayish brown, stiff, wet SILT with fine SAND, sheen	-28.4		
		CL		16.9	brown, hard, damp CLAY, sheen	-28.7		
		SP		17.0	dark brown, loose, wet, fine SAND, some silt, sheen	-28.8		
17.5		SP		17.7	brown to dark brown, loose, wet, fine SAND, some silt, sheen	-29.5		
				18.2		-30.0		
	24/24	ML		18.5	brown, very soft, saturated SILT, some fine sand, sheen	-30.3		[Elevation: -29.81 to -31.81 ft NAVD88]
		SP			brown, medium dense, saturated, fine SAND, trace gravel			
		SP		19.0	brown, medium dense, wet, fine SAND, trace medium gravel	-30.8		
		SP		19.6 19.7	brown, very dense, wet, fine SAND, trace medium gravel, slight staining	-31.4 -31.5	SED-MC2100-A-19-20	
20.0		SP		20.0	greenish brown, dense, wet, fine SAND, heavy sheen	-31.8		
	24/24	SP			dark brown to black, medium dense, wet, fine to medium SAND			[Elevation: -31.81 to -33.81 ft NAVD88]
		SP		20.6	black, medium dense, wet, medium SAND, some fine gravel, heavy staining, sheen, strong odor	-32.4		
		SP		21.6	black, dense, wet, fine SAND, some fine gravel, heavy staining, sheen, strong odor, large cobble at 21.2 ft	-33.4	SED-MC2100-A-20-22	
		SP		22.0	dark gray, dense, wet, fine SAND, sheen, no staining, no odor	-33.8		
					NO CORE COLLECTED`			
22.5								
25.0				25.0		-36.8		
	24/19.2	SP		25.2	dark gray, medium dense, wet, medium SAND, trace fine gravel, no staining, no odor	-37.0		[Elevation: -36.81 to -38.81 ft NAVD88]
		SP		26.3	black, very dense, wet, fine SAND, trace fine gravel, trace coarse sand, no staining, no odor	-38.1	SED-MC2100-A-25-26.6	
		GW		26.6	brown, medium dense, wet, coarse SAND with fine GRAVEL, little medium gravel, no staining, no odor	-38.4		
					NO CORE COLLECTED			
27.5								
30.0				30.0		-41.8		
	24/15.6	SP		30.3	dark brown, loose, wet, medium to coarse SAND, no staining, no odor	-42.1		[Elevation: -41.81 to -43.81 ft NAVD88]
		ML		30.4	black, stiff, wet SILT, no staining, no odor	-42.2		
		SP		31.1	brown, dense, wet, fine to medium SAND, no staining, no odor	-42.9	SED-MC2100-A-30-31.3	
		SP		31.3	light brown, dense, wet, fine to medium SAND, no staining, no odor	-43.1		

Bottom of borehole at 32.0 feet.

32.5

BORING NUMBER SED-MC2400-A

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal Superfund
PROJECT NUMBER HPH106
PROJECT LOCATION Gowanus Brooklyn, NY
DATE STARTED 5/19/15 **COMPLETED** 5/19/15
MUDLINE ELEVATION -12.04 ft NAVD88
DRILLING CONTRACTOR Cascade
BOREHOLE DIAMETER 6 inches
DRILLING METHOD Sonic Drilling
SAMPLER 3.5 in. Sonic Core - Lexan Liner
LOGGED BY PS, LC **CHECKED BY** PS

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	LABORATORY SAMPLES	COMMENTS
0.0	60/48	OL		2.0	black, wet, very soft SILT, some clay, organic debris, hair, trash, lots of sheen, odor	-14.0		
		OL		2.2	black, wet, soft SILT and CLAY, organic debris, hair, trash, little sheen, odor	-14.2		
2.5		OL		2.7	black, wet, very soft, SILT, some clay, lots of organic debris, hair, trash, lots of sheen, odor	-14.7		Soft Sediments/ Native Alluvial Sediments Interface [Elevation of -14.74 ft NAVD88]
		CL		3.0	bluish gray, moist, medium stiff CLAY, some silt, little fine sand, trace root material, sheen is heavily concentrated in root traces	-15.0		
				4.0		-16.0	SED-MC2400-A-3-4	
5.0 7.5	60/60	CL		7.7	gray, wet, stiff CLAY, some silt, little fine sand, lots of sheen, sheen is concentrated in vertically oriented fine sand units, root/plant material found, very strong odor	-19.7		
		ML		8.9	brownish gray, stiff, wet SILT, some fine sand, trace clay, plant material, lots of sheen concentrated in fine sand in horizontal and vertically oriented units, strong odor	-20.9		
		SP		9.6	brownish gray, wet, medium dense, fine SAND, little silt, plant material, very heavy sheen and brown staining, strong odor	-21.6		
10.0		CL-ML		10.0	gray, moist, stiff CLAY with SILT, some fine sand, some sheen concentrated in fine sand units, fine sand units are horizontal	-22.0		Native Alluvial Sediments/ Glacial Deposits Interface [Elevation of -22.04 ft NAVD88]
	60/60	SP		10.4	brown, wet, loose, fine SAND, little silt, trace gravel, some sheen, strong odor	-22.4		
		ML		12.0	brown, moist, stiff SILT, little clay, little fine sand, trace, medium sand, little sheen, odor	-24.0		
12.5				13.0		-25.0	SED-MC2400-A-12-13	
		ML		13.4	brown, moist, stiff SILT, little clay, little fine sand, trace, medium sand, little sheen, odor	-25.4		
		SP		13.9	brown, wet, medium dense, fine SAND, some silt, some medium sand, little staining, odor	-25.9		
15.0		SP		15.0	black with stratified brown units, wet, medium dense, fine SAND, some silt, little medium sand, heavy sheen /staining, strong odor	-27.0		

NOTES

(Continued Next Page)

CLIENT Gowanus Canal Remedial Design Group

PROJECT NAME Gowanus Canal Superfund

PROJECT NUMBER HPH106

PROJECT LOCATION Gowanus Brooklyn, NY

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	LABORATORY SAMPLES	COMMENTS
15.0	60/56	SP		16.1	dark gray and brown, wet, loose, fine SAND, some silt, little medium sand, heavy sheen/staining, very strong odor	-28.1		
		ML		16.7	brown, wet, medium stiff SILT, some fine sand, little clay, lot of sheen, strong odor	-28.7		
17.5				17.7		-29.7	SED-MC2400-A-17-18	
				18.7		-30.7	SED-MC2400-A-18-19	
		SM		19.7	greenish brown, from 18.7-18.8 and redish brown from 18.8-19.7, wet, medium stiff, SILT with fine SAND, generally finer texture upward, slight odor, little sheen	-31.7		
20.0	60/60			21.0		-33.0	SED-MC2400-A-20-21	
22.5		SW		24.0	brown with black staining, wet, medium dense, fine to medium SAND, some silt, macro pore structures, sheen, staining, and very strong odor	-36.0		
				25.0		-37.0	SED-MC2400-A-24-25	
25.0 27.5	60/54	SP		28.0	brown, medium dense, wet, fine to medium SAND, little silt, isolated pockets of sheen, odor	-40.0		
				29.0		-41.0	SED-MC2400-A-28-29	
		SP		29.6	brown, medium dense, wet, fine to medium SAND, little silt, isolated pockets of sheen, odor	-41.6		
30.0								

Bottom of borehole at 30.0 feet.

Geosyntec consultants
Beech and Bonaparte engineering p.c.
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BORING NUMBER B-432_15-1019

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal PD-5 Phase 1
PROJECT NUMBER HPH106-17
PROJECT LOCATION Brooklyn, NY
DATE STARTED 7/15/15 2:30 pm **COMPLETED** 7/16/15 10:00 am
GROUND ELEVATION 8.59 ft. NAVD88 **HOLE SIZE** 6"
DRILLING CONTRACTOR Aquifer Drilling & Testing
COORDINATES N: 672878.8, E: 634173.0 NAD 83 NY EAST 3101
DRILLING EQUIPMENT XL Max 362 (FRASTE)
∇ **GWL AT TIME OF DRILLING DRILLING** 6.5 ft. bgs 7/16/15 7:00 am
DRILLING METHOD Sonic, ASTM D6914
GWL AT END OF DRILLING ---
LOGGED BY D. Woeste **CHECKED BY** P. Andonyadis
GWL AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		
											LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
5	0		**SANDY GRAVEL** (GW) [FILL]: dark brown (10YR 4/2); small to large sized gravel; fine to coarse grained sand; trace asphalt and brick fragments; moist NOTE: Material description based on soft excavation completed on 7/15/15.		0/				0.0				
	5		∇ **SANDY SILT** (ML) [FILL]: brown (10YR 4/3); low plasticity; fine grained sand; medium stiff; wet [NYCBC class 7]	SS 5-7	18/ 24	6-4-2-3 (6)			0.0	14.7	NP	NP	NP
0			Some small sized gravel from 7 to 10 ft.	SC 7-10	30/ 36				0.0	19.7			
	10		**WELL GRADED GRAVEL** (GW) [FILL]: brown (10YR 4/3); small sized gravel; some fine to coarse grained sand; trace silt; dense; wet [NYCBC class 7] Oxidation staining at 11 ft.	SS 10-12	16/ 24	21-19-20-13 (39)			0.0				
-5			**SANDY GRAVEL** (GW) [FILL]: brown (10YR 4/3); small to large sized rounded and subrounded gravel; fine to coarse grained sand; trace silt; wet	SC 12-15	14/ 36				0.0				
	15		Subtle sheen in Split Spoon sampler at 15 ft. Medium dense [NYCBC class 7]	SS 15-17	8/ 24	6-6-5-5 (11)			0.5				
-10			**POORLY GRADED SAND** (SP) [GLACIAL DEPOSITS]: dark gray (7.5YR 4/1); fine to medium grained sand; some coarse grained sand; trace small sized gravel; wet; sheen present	SC 17-20	24/ 36				7.4				
	20		**SANDY GRAVEL** (GW) [GLACIAL DEPOSITS]: dark gray (7.5YR 4/1): small to large sized subangular gravel; fine to coarse grained sand; sheen present; medium dense; wet; small pocket of silt [NYCBC class 2b]	SS 20-22	9/ 24	5-6-14-15 (20)			14.6				
-15	25		Same as above Sheen and slight staining present	SC 22-25	20/ 36								

(Continued Next Page)

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
	25		**SANDY GRAVEL** (GW) [GLACIAL DEPOSITS]: dark gray (7.5YR 4/1): small to large sized subangular gravel; fine to coarse grained sand; sheen present; medium dense; wet; small pocket of silt [NYCBC class 2b] *(continued)*	SS 25-27	11/ 24	12-13-7-4 (20)			40.4				
-20			Same as above without silt pocket Note: Casing dropped during driving of split spoon (approx. 6") **WELL GRADED SAND** (SW) [GLACIAL DEPOSITS]: dark gray (7.5YR 4/1): fine to coarse grained sand; some small to large sized gravel; sheen and odor present; wet	SC 27-30	24/ 36				43.3				
	30		**POORLY GRADED GRAVEL** (GP) [GLACIAL DEPOSITS]: dark gray (7.5YR 4/1); small sized subangular gravel; some medium to coarse grained gravel; little fine grained sand; medium dense; wet; sheen and odor present [NYCBC class 2b]	SS 30-32	11/ 24	6-9-8-5 (17)			14.8	9.3			
-25													
	35		No Recovery Angular rock in shoe	SS 35-37	0/24	24-10-10-12 (20)							
-30													
	40		No Recovery **WELL GRADED SAND** (SW) [WASH] in shoe	SS 40-42	0/24	17-15-9-6 (24)							
-35													
	45		**WELL GRADED SAND** (SW) [GLACIAL DEPOSITS]: grayish brown (10YR 5/2): medium to coarse grained sand; some fine sand; little small sized gravel; trace large subangular gravel; medium dense; wet [NYCBC class 3b]	SS 45-47	7/ 24	17-7-3-3 (10)			0.0	15.2			
-40													
	50		No Recovery	SS 50-52	0/24	15-7-3-4 (10)							
			Thin layer of large sized subrounded gravel and small cobbles at 53 ft.	SC									

(Continued Next Page)

BORING NUMBER B-432_15-1019

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal PD-5 Phase 1
PROJECT NUMBER HPH106-17
PROJECT LOCATION Brooklyn, NY

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	ATTERBERG LIMITS PLASTIC LIMIT	ATTERBERG LIMITS PLASTICITY INDEX
-45			**WELL GRADED SAND** (SW) [GLACIAL DEPOSITS]: grayish brown (10YR 5/2): medium to coarse grained sand; some fine sand; little small sized gravel; trace large subangular gravel; medium dense; wet [NYCBC class 3b] *(continued)*	52-55	0/36				0.0	11.3			
	55			SS 55-57	9/ 24	8-6-7-6 (13)			0.0				
-50	60												
			POORLY GRADED GRAVEL (GP) [GLACIAL DEPOSITS]: dark gray (10YR 4/1): small to large sized subangular and subrounded gravel; little fine to coarse grained sand; medium dense; wet [NYCBC class 2b]	SS 60-62	7/ 24	17-10-12-15 (22)			0.0	8.7			
-55	65												
			POORLY GRADED GRAVEL (GP) [GLACIAL DEPOSITS]: gray (10YR 5/1); large sized subangular gravel; very dense; wet [NYCBC class 2a]	SS 65-67	1/ 6	50/6"			0.0				
-60	70												
			SANDY GRAVEL (GW) [GLACIAL DEPOSITS]: brown (10YR 4/3): small to large sized subrounded gravel; fine to medium grained sand; some coarse sand; trace fractured siltstone; red (10R 4/3) [NYCBC class 2b]	SS 70-72	10/ 24	24-13-8-13 (21)			0.0				
-65	75		Bottom of borehole at 72.0 ft. NOTE (1): PID readings with samples enclosed in jars. Breathing zone PID monitoring did not exceed 0 ppm. NOTE (2): 7/16/15: Tremie grout hole with mixture: 376 lbs cement; 10 lbs bentonite; 35 gallons water.										
-70	80												

BORING NUMBER B-466_19-1061

PAGE 1 OF 3

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal PD-5 Phase 2
PROJECT NUMBER HPH106A
PROJECT LOCATION Brooklyn, NY
DATE STARTED 1/20/16 9:30 am **COMPLETED** 1/21/16 9:30 am
GROUND ELEVATION 7.45 ft. NAVD88 **HOLE SIZE** 3.5"
DRILLING CONTRACTOR Cascade Drilling
COORDINATES N: 633375.72, E: 671562.58 NAD 83 NY EAST 3101
DRILLING EQUIPMENT 100c mini-sonic (B&L)
GWL AT TIME OF DRILLING ---
DRILLING METHOD Sonic, ASTM D6914
GWL AT END OF DRILLING ---
LOGGED BY R. Fischer **CHECKED BY** P. Andonyadis
GWL AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
5	0		**<u>CONCRETE</u>** [FILL] **<u>SILTY SAND WITH GRAVEL</u>** (SM) [FILL]: black (Gley 2 2.5/10G); fine to coarse sand; some concrete pieces; moist	BULK 0-5	0/60				0.4				
	5		Same as above. Grades to SAND (SP); brown (7.5YR 4/2); fine to medium; very loose; wet	SS 5-7	16/ 24	3-WOH-4-2			0.2				
0			Same as above. Little cobbles; timber and organics present; organic odor present	SC 7-10	36/ 36				7.3	13.6			
	10		Same as above. Trace brick; organic clay in shoe.	SS 10-12	6/ 24	1-1-1-9 (2)			19.2				
-5			**<u>ORGANIC SILT</u>** (OH) [NATIVE ALLUVIAL SEDIMENTS]: dark greenish gray (Gley 1 4/5GY); high plasticity; bedded with plant fiber; little brick; trace shells; wet; organic odor present	SC 12-15	36/ 36		0.5 0.75	0.3 0.3	0.3	54.8			
	15		Same as above	ST 15-17	27/ 24		0.5 0.5	0.3 0.3		69.8	82	39	43
-10			Same as above. Medium stiff.	SS 17-19	24/ 24	2-2-3-2 (5)			0.0	84.4			
			Same as above	SC 17-20	36/ 36				0.2				
	20		**<u>LEAN CLAY WITH SAND</u>** (CL) [NATIVE ALLUVIAL SEDIMENTS]: dark greenish gray (Gley 1 4/5GY); low plasticity; trace organics; mottling; stiff; wet	SS 20-22	24/ 24	3-4-9-10 (13)			0.0	21.2	26	14	12
-15	25		Same as above	SC 22-25	36/ 36		3.75 2.5	0.625 0.65	0.2	24.4	34	17	17

(Continued Next Page)

BORING NUMBER B-466_19-1061

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal PD-5 Phase 2
PROJECT NUMBER HPH106A
PROJECT LOCATION Brooklyn, NY

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
	25	▨	**LEAN CLAY WITH SAND** (CL) [NATIVE ALLUVIAL SEDIMENTS]: dark greenish gray (Gley 1 4/5GY); low plasticity; trace organics; mottling; stiff; wet *(continued)*	ST 25-27	24/ 24					27.4	31	17	14
-20		░	**POORLY GRADED SAND** (SP) [GLACIAL DEPOSITS]; at bottom of tube; black (10YR 2/1); fine grained sand; staining and odor present; wet Same as above. Grades to very fine to fine sand; some clay; loose; wet	SS 27-29	24/ 24	2-2-6-7 (8)			31.2				
-25	30	░	* Note: Driller missed split spoon sample from 30 to 32 ft. Sonic core drilling straight down to 35 ft. bgs.										
	35	░	**POORLY GRADED SAND** (SP) [GLACIAL DEPOSITS]: brown (7.5YR 4/2); very fine to fine grained sand; trace clay; staining present; medium dense; wet	SS 35-37	12/ 24	6-7-10-7 (17)			6.6				
-30		░											
	40	░	**POORLY GRADED SAND** (SP) [GLACIAL DEPOSITS]: dark grayish brown (10YR 4/2); fine to medium grained sand; trace clay; trace coarse sand; very loose; wet	SS 40-42	3/ 24	4-3-WOH- 1			1.9				
-35		░											
	45	░	No Recovery. Medium dense.	SS 45-47	0/24	6-10-13-16 (23)							
-40		░											
	50	░	No Recovery. Medium dense.	SS 50-52	0/24	7-8-9-10 (17)							
-45		░	**POORLY GRADED SAND** (SP) [GLACIAL DEPOSITS]: brown (7.5YR 4/2); very fine to fine grained sand										

(Continued Next Page)

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BORING NUMBER B-466_19-1061

PAGE 3 OF 3

CLIENT Gowanus Canal Remedial Design Group

PROJECT NAME Gowanus Canal PD-5 Phase 2

PROJECT NUMBER HPH106A

PROJECT LOCATION Brooklyn, NY

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		
											LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
			POORLY GRADED SAND (SP) [GLACIAL DEPOSITS]: brown (7.5YR 4/2); very fine to fine grained sand *(continued)* 1" thick clay layer at 54.5 ft. bgs.	SC 52-55	36/ 34				4.1				
	55		Same as above. Trace clay; medium dense; wet	SS 55-57	8/ 24	7-6-5-10 (11)			0.6				
-50													
	60		**SILTY SAND** (SM): dark grayish brown (10YR 4/2); very fine to fine grained sand; loose; wet	SS 60-62	11/ 24	3-5-3-2 (8)			0.5				
-55													
	65		Same as above. Trace clay.	SS 65-67	18/ 24	4-3-4-6 (7)			0.4				
-60													
	70		Same as above. Medium dense.	SS 70-72	20/ 24	6-6-9-10 (15)			0.3	24.2			
-65			Bottom of borehole at 72 ft. bgs NOTE (1): PID readings with samples enclosed in jars. Breathing zone PID monitoring did not exceed 0 ppm. NOTE (2): Borehole abandonment: Tremie grout hole with mixture: 1600 lbs cement; 60 lbs bentonite; 100 gallons water.										
	75												
-70													
	80												

BORING NUMBER B-466_19-0060

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal PD-5 Phase 2
PROJECT NUMBER HPH106A
PROJECT LOCATION Brooklyn, NY
DATE STARTED 1/15/16 12:00 pm **COMPLETED** 1/19/16 9:30 am
GROUND ELEVATION 7.74 ft. NAVD88 **HOLE SIZE** 7"
DRILLING CONTRACTOR Cascade Drilling
COORDINATES N: 633397.98, E: 671540.01 NAD 83 NY EAST 3101
DRILLING EQUIPMENT 100c mini-sonic (B&L)
GWL AT TIME OF DRILLING ---
DRILLING METHOD Sonic, ASTM D6914
GWL AT END OF DRILLING ---
LOGGED BY R. Fischer **CHECKED BY** P. Andonyadis
GWL AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
5	0 5		**CONCRETE** [FILL]	BULK 0-5					0.0				
			No Recovery	SS 5-7	0/3	70/3"							
0	10		**POORLY GRADED GRAVEL WITH SILT AND SAND** (GP-GM) [FILL]: black (5Y 2.5/1); wet; strong organic odor Wood at 9.5 ft.	SC 7-10	36/ 36				0.6	18.1			
			SILT (ML) [FILL]: dark gray (5Y 4/1): low plasticity; some subangular gravel; little timber bulkhead; loose; wet; organic odor present	SS 10-12	4/ 24	4-3-6-4 (9)			0.4				
-5	15		Same as above. Cobbles.	SC 12-15	6/ 36				1.0				
			Same as above. Trace brick. Becomes very loose.	SS 15-17	6/ 24	2-3-1-12 (4)			0.4				
-10	20		Same as above. Some cobbles. No recoverable-sized samples.	SC 17-20	3/ 36								
			TIMBER (bulkhead): black (5Y 2.5/1); wet; organic odor present	SS 20-22	4/ 24	16-8-6-7 (14)			279.2				
-15	25		Same as above. Decaying timber; odor present. **LEAN CLAY** (CL) [NATIVE ALLUVIAL SEDIMENTS]: dark gray (Gley 1 4/N); low plasticity; stiff; wet	SC 22-25	36/ 36		1.75 1.25	0.6 0.6	0.6				

(Continued Next Page)

BORING NUMBER B-466_19-0060

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal PD-5 Phase 2
PROJECT NUMBER HPH106A
PROJECT LOCATION Brooklyn, NY

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
	25		**LEAN CLAY** (CL) [NATIVE ALLUVIAL SEDIMENTS]: dark gray (Gley 1 4/N); low plasticity; stiff; wet *(continued)* No Recovery.	ST 25-27	0/24								
-20			Same as above **POORLY GRADED SAND** (SP) [GLACIAL DEPOSITS]: very dark gray (2.5Y 3/1); fine to very fine grained sand; little clay; loose; wet; staining and odor present; clean out to 30 ft. bgs.	SC 25-30 SS 27-29	60/ 60 24/ 24	4-3-5-4 (8)			23.2				
	30		Same as above	SS 30-32	16/ 24	5-4-4-6 (8)			23.2				
-25			Same as above. Trace gravel. **POORLY GRADED SAND** (SP) [GLACIAL DEPOSITS]: brown (7.5YR 4/2); very fine to fine grained sand; little clay; wet; staining present	SC 32-35	36/ 36				23.5				
	35		**SILT WITH SAND** (ML) [GLACIAL DEPOSITS]: brown (7.5 YR 4/2); non-plastic; very fine to fine grained sand; laminated with little clay; dense; wet; staining and mottling present	SS 35-37	14/ 24	13-18-20-12 (38)			4.7	20.3	NP	NP	
-30			Same as above. Little medium grained sand; trace gravel.	SC 37-40	36/ 36				4.4	20.0			
	40		No Recovery. Medium dense.	SS 40-42	0/24	2-2-20-30 (22)							
-35			**POORLY GRADED SAND** (SP) [GLACIAL DEPOSITS]: brown (7.5YR 4/2); fine grained sand; some medium to coarse sand; wet; no visible staining	SC 42-45	36/ 36				0.9				
	45		No Recovery. Loose.	SS 45-47	0/24	2-3-7-7 (10)							
-40			No Recovery	SC 47-50	0/36								
	50		**POORLY GRADED SAND WITH SILT** (SP-SM) [GLACIAL DEPOSITS]: brown (7.5YR 4/2); fine grained sand; very dense; wet; staining present	SS 50-52	14/ 24	18-36-26-30 (62)			1.7	20.4			
-45													

(Continued Next Page)

CLIENT Gowanus Canal Remedial Design Group
PROJECT NAME Gowanus Canal PD-5 Phase 2
PROJECT NUMBER HPH106A
PROJECT LOCATION Brooklyn, NY

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY/ ATTEMPTED (in)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	TORVANE (tsf)	PID (ppm)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		
											LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
	55		Same as above. 1.5 ft. layer of staining and odor present. **POORLY GRADED SAND WITH SILT** (SP-SM) [GLACIAL DEPOSITS]: brown (7.5YR 4/2); fine grained sand; very dense; wet; staining present *(continued)*	SC 52-55	36/ 36				71.2				
			Same as above. Medium dense.	SS 55-57	21/ 24	3-6-7-5 (13)			7.5				
-50	60		Same as above. Trace layers of clayey sand.	SC 57-60	36/ 36				0.9				
			Same as above. Medium dense.	SS 60-62	10/ 24	3-8-8-12 (16)			1.0				
-55	65		Same as above	SC 62-65	36/ 36				0.0				
			Same as above. Loose. 1" layer of clay at 65.5 ft.; dark greenish gray (Gley 2 4/1); high plasticity; medium stiff; wet	SS 65-67	19/ 24	1-3-3-2 (6)			0.2				
-60	70		Same as above	SC 67-70	24/ 36				0.1				
			Same as above. Very loose.	SS 70-72	16/ 24	1-WOH-2-3			0.2				
-65	75		Bottom of borehole at 72 ft. bgs NOTE (1): PID readings with samples enclosed in jars. Breathing zone PID monitoring did not exceed 0 ppm. NOTE (2): Set 70 ft. long 3"-ID Schedule 40 PVC casing to bottom of hole with grout mixture: 1200 lbs cement; 45 lbs bentonite; 75 gallons water.										
-70	80												

BORING NUMBER SED-MC0850-A

CLIENT Gowanus Canal Remedial Design Group

PROJECT NAME Gowanus Canal Superfund

PROJECT NUMBER HPH106

PROJECT LOCATION Gowanus Brooklyn, NY

DATE STARTED 9/21/15 **COMPLETED** 9/21/15

MUDLINE ELEVATION -8.2 ft NAVD88

DRILLING CONTRACTOR Cascade

BOREHOLE DIAMETER 6 inches

DRILLING METHOD Sonic Rig

SAMPLER 3.5 in. Sonic Core - Lexan Liner

LOGGED BY JC **CHECKED BY** DWT

DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	PID (ppm)	LABORATORY SAMPLES	COMMENTS
0.0	60/18	ML		1.5	black, very soft, wet SILT, some organic debris, odor, slight sheen	-9.7	0 0.9 0 0		
2.5				5.0		-13.2			
5.0	60/30	ML		7.3	black, very soft, wet SILT, some organic debris, odor, slight sheen	-15.5	1 1.4 1.9 2.7 4.3		
7.5		SP		7.5	grayish brown, loose, wet, fine to medium SAND, little silt, staining and sheen	-15.7	86.4		Soft Sediments/ Native Alluvial Sediments Interface [Elevation of -15.5 ft NAVD88]
		SP			grayish brown, loose, wet, fine to medium SAND, little silt, staining and sheen				
10.0									

NOTES No recovery from 12-17 ft - team mob to SED-MC0850-A1 for continuous coring

(Continued Next Page)

Geosyntec consultants

BORING NUMBER SED-MC0850-A

CLIENT Gowanus Canal Remedial Design Group

PROJECT NAME Gowanus Canal Superfund

PROJECT NUMBER HPH106

PROJECT LOCATION Gowanus Brooklyn, NY

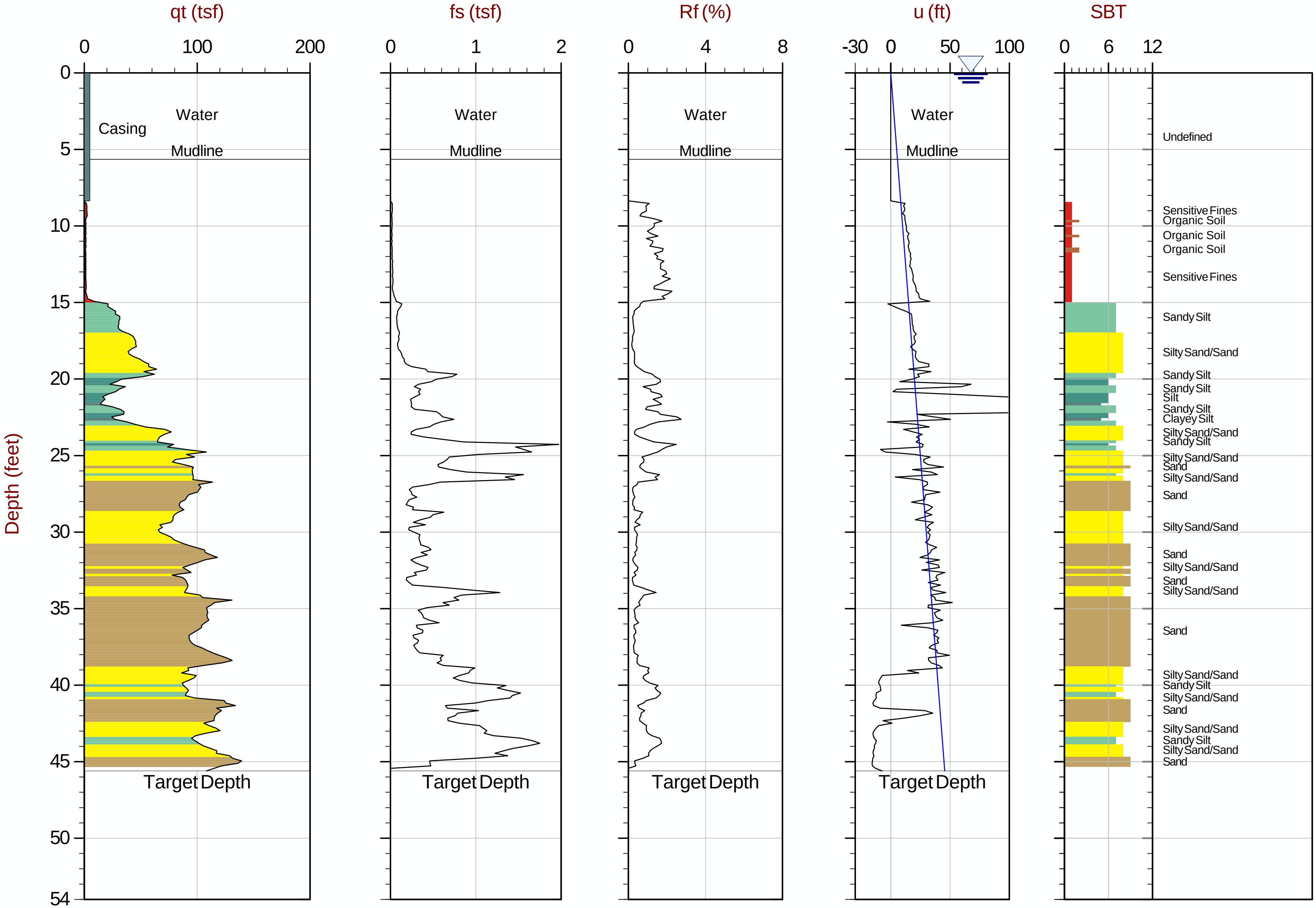
DEPTH (ft below mudline)	REC. (Dr/Rec) (in)	U.S.C.S CODE	GRAPHIC LOG	LOG INTERVAL (ft Below Mudline)	MATERIAL DESCRIPTION	LOG ELEVATION (ft NAVD88)	PID (ppm)	LABORATORY SAMPLES	COMMENTS
10.0	24/18	SP	▒	10.7	grayish brown, loose, wet, fine to medium SAND, little silt, staining and sheen *(continued)*	-18.9	6.7 234.4		
		SP	▒	11.5	grayish brown, loose, wet, medium SAND, little silt, staining and sheen	-19.7	264.2 278.8		
12.5	60/0								
15.0									
					Bottom of borehole at 17 feet				
17.5									
20.0									

CONETEC

Geosyntec Consultants

Job No: 15-53060
Date: 08:24:15 10:41
Site: Gowanus Canal

Sounding: LIF-MC0900-A
Cone: 236:T1500F15U500



Max Depth: 13.900 m / 45.60 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53060_LIFCPTMC0900-A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 18 N: 4503687m E: 585501m

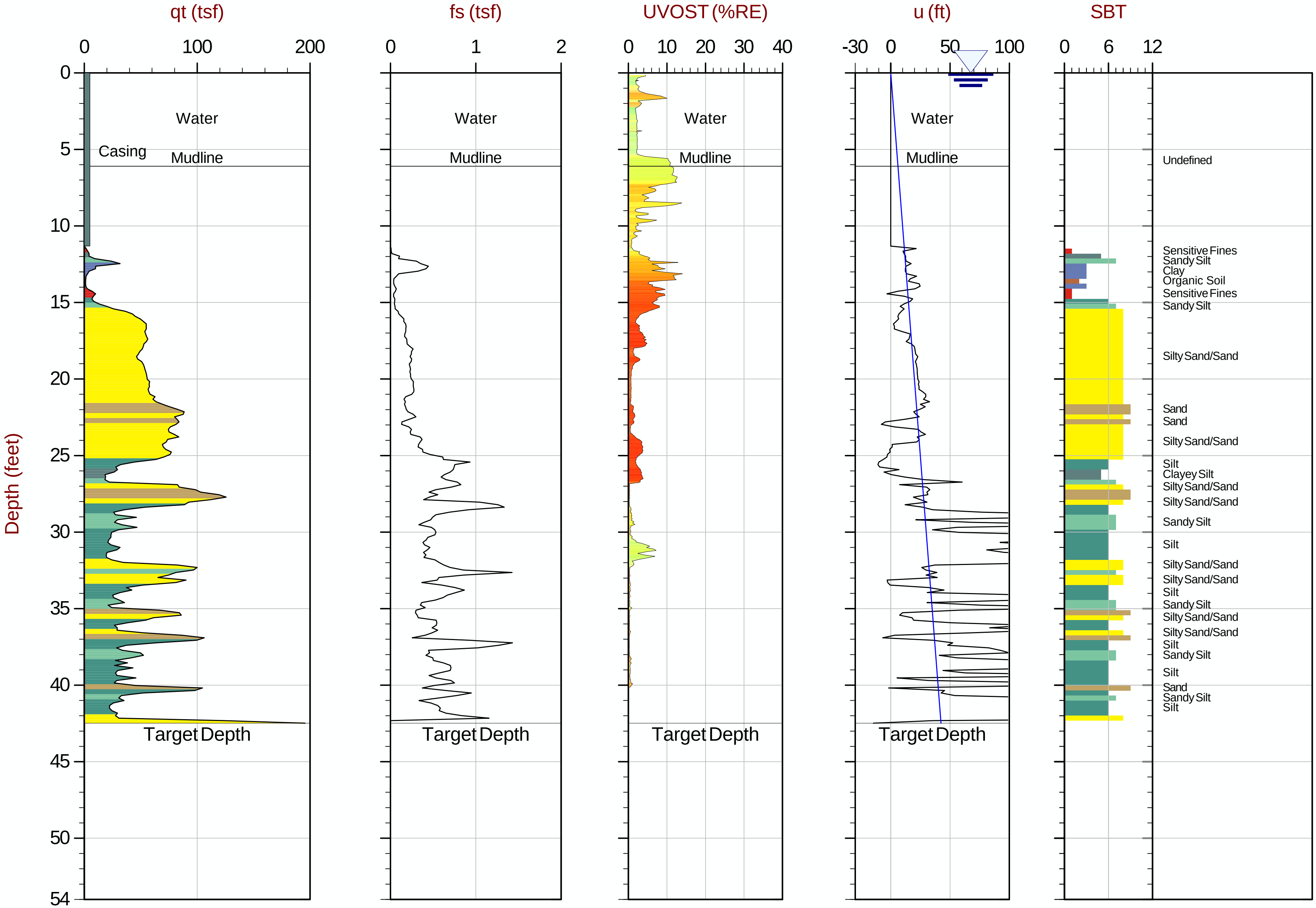
— Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Geosyntec Consultants

Job No: 15-53060
Date: 08:14:15 13:15
Site: Gowanus Canal

Sounding: LIF-MC1000-A
Cone: 406:T1500F15U500



Max Depth: 12.950 m / 42.49 ft
Depth Inc: 0.050 m / 0.164 ft

File: 15-53060_LIFCPTMC1000-A.COR

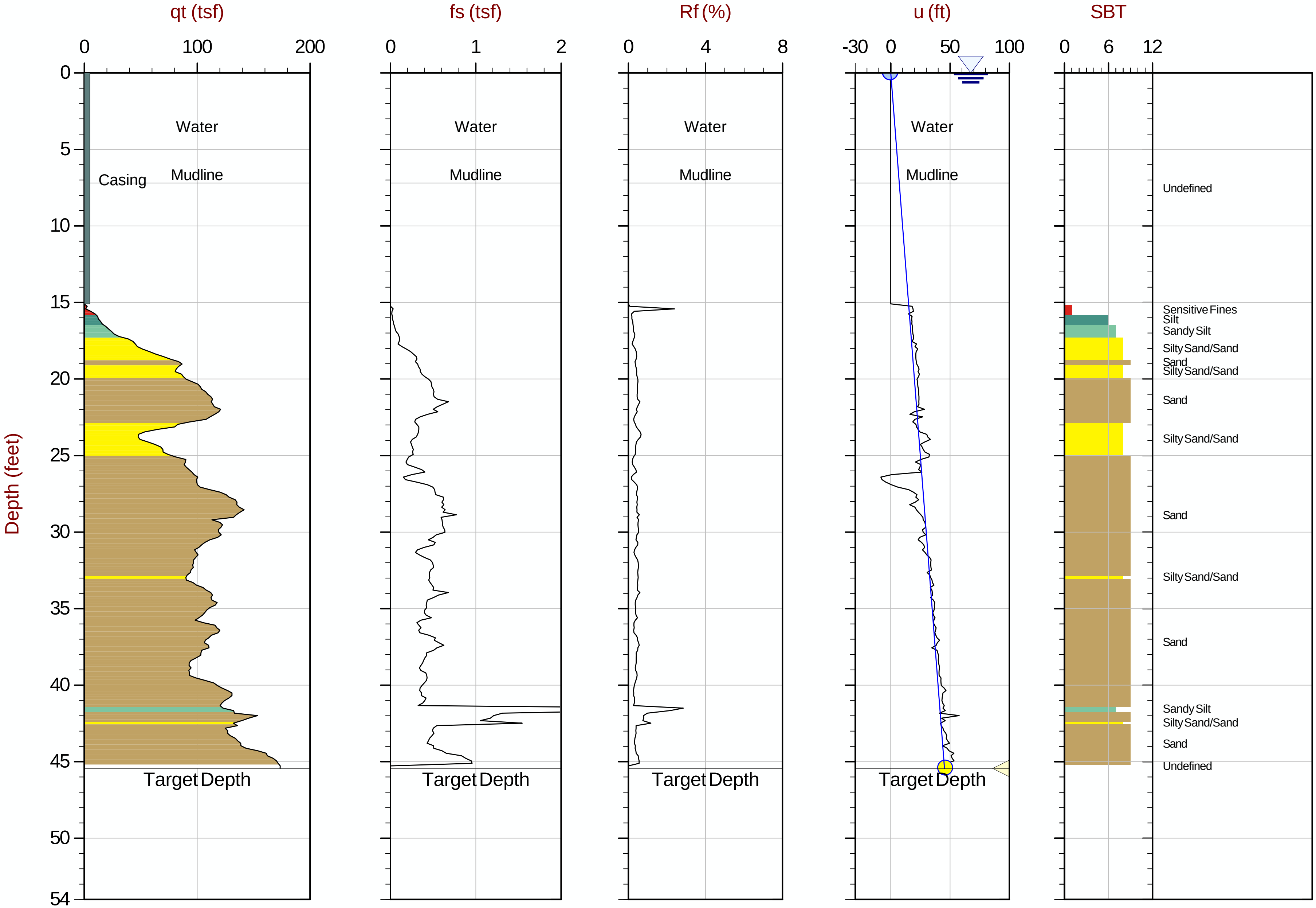
SBT: Robertson and Campanella, 1986
Coords: UTM Zone 18 N: 4503652m E: 585479m

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Geosyntec Consultants

Job No: 15-53060
Date: 08:12:15 15:19
Site: Gowanus Canal

Sounding: LIF-MC1350-A
Cone: 406:T1500F15U500



Max Depth: 13.850 m / 45.44 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53060_LIFCPTMC1350-A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 18 N: 4503503m E: 585416m

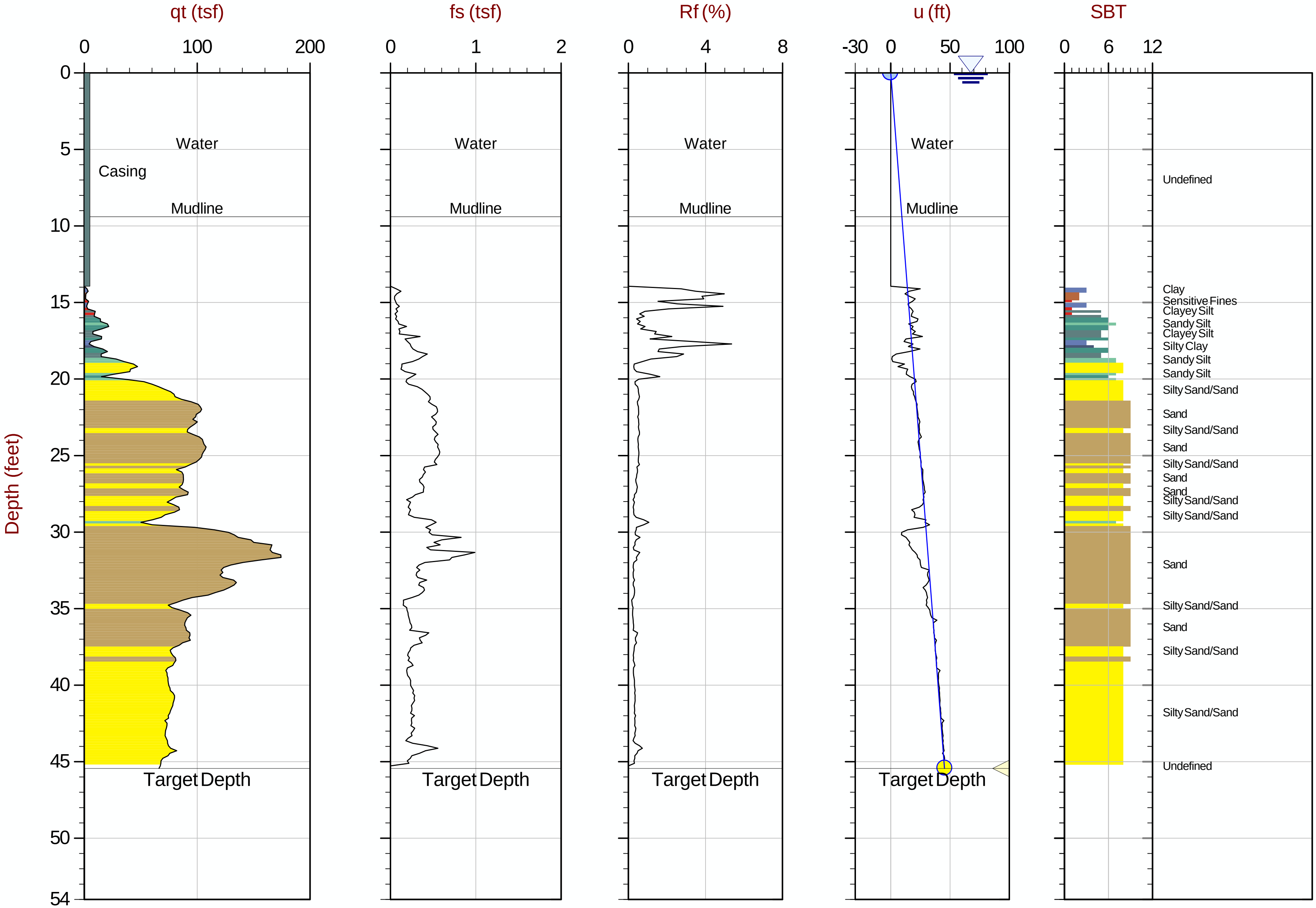
— Hydrostatic Line ○ Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Geosyntec Consultants

Job No: 15-53060
Date: 08:13:15 09:12
Site: Gowanus Canal

Sounding: LIF-MC1350-B
Cone: 406:T1500F15U500



Max Depth: 13.850 m / 45.44 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53060_LIFCPTMC1350-B.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 18 N: 4503548m E: 585439m

Hydrostatic Line ○ Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved

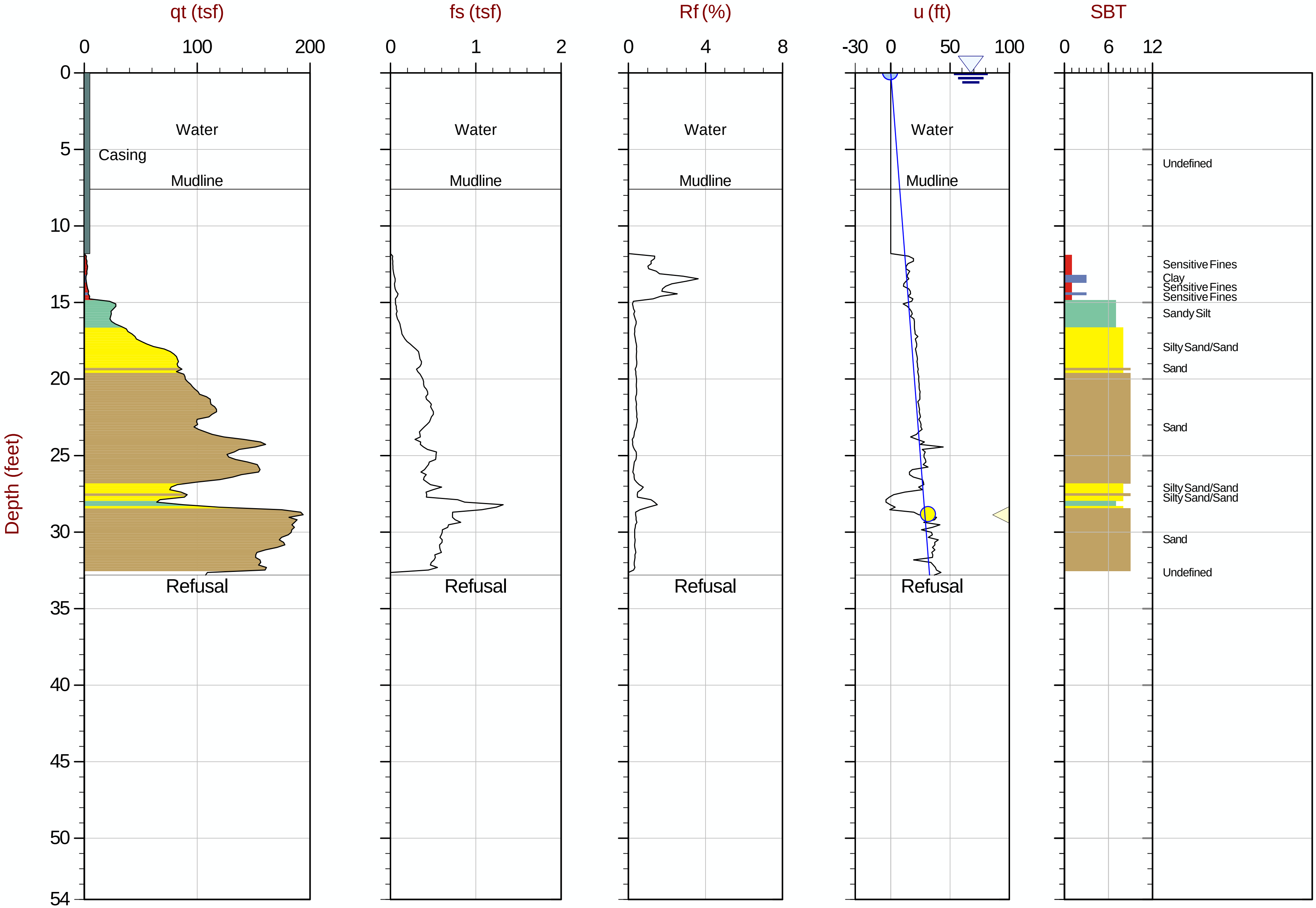
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Geosyntec Consultants

Job No: 15-53060
Date: 08:25:15 10:34
Site: Gowanus Canal

Sounding: LIF-MC1400-A
Cone: 236:T1500F15U500



Max Depth: 10.000 m / 32.81 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53060_LIFCPTMC1400-A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 18 N: 4503541m E: 585429m

Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved

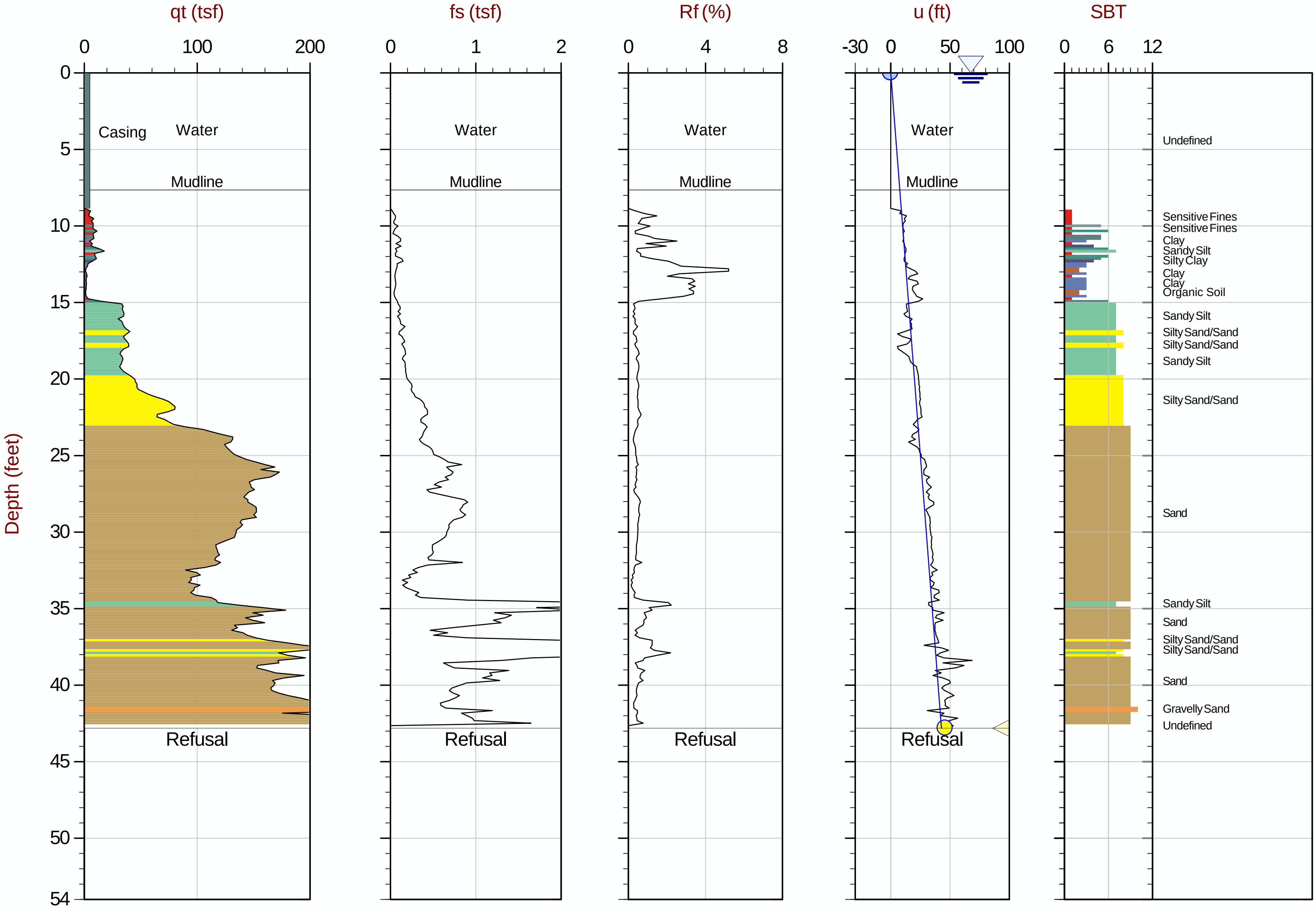
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Geosyntec Consultants

Job No: 15-53060
Date: 08:12:15 13:43
Site: Gowanus Canal

Sounding: LIF-MC1500-A
Cone: 406:T1500F15U500



Max Depth: 13.050 m / 42.81 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53060_LIFCPTMC1500-A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 18 N: 4503503m E: 585416m

Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved

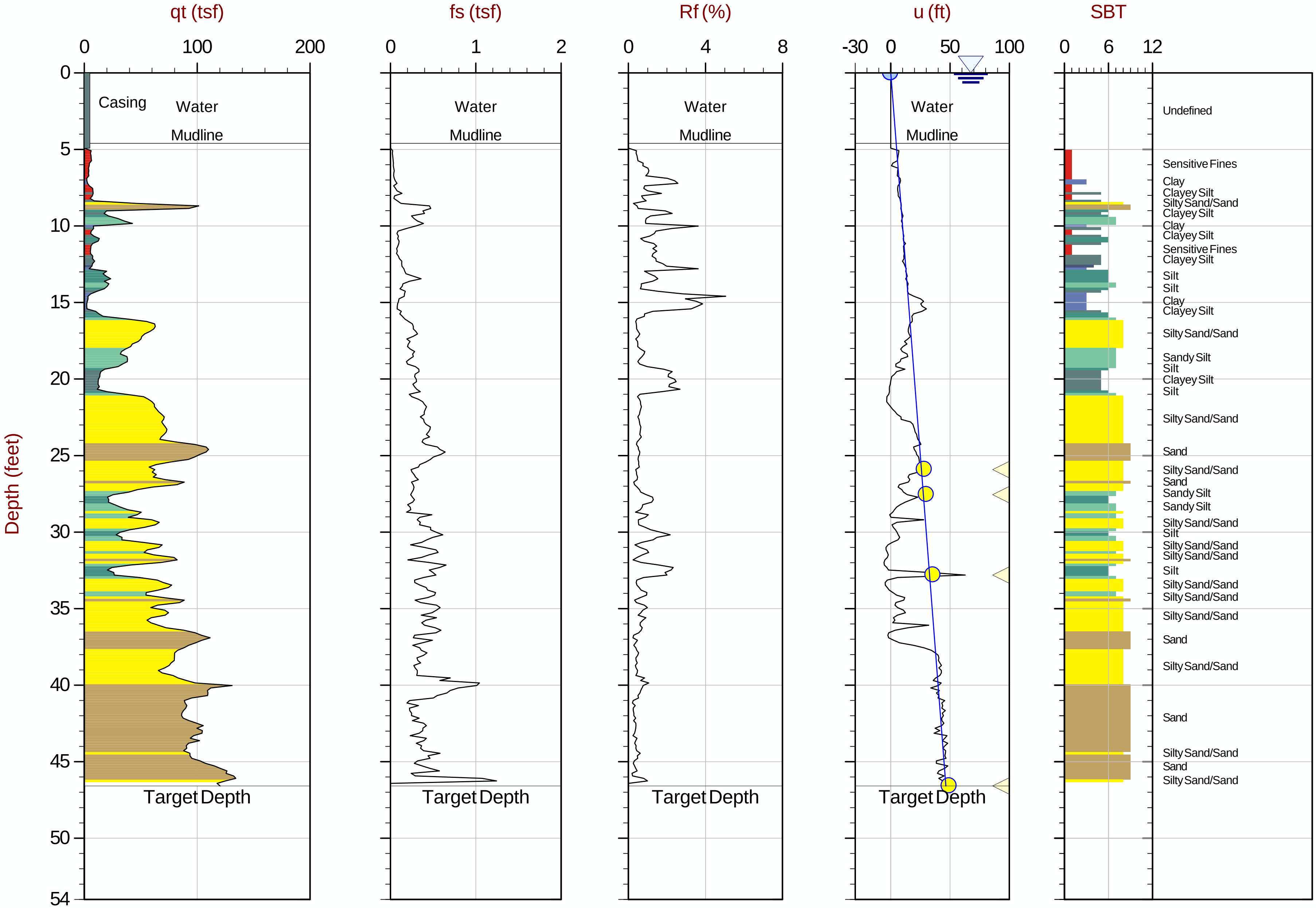
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

ConeTec

Geosyntec Consultants

Job No: 15-53060
Date: 08:12:15 11:31
Site: Gowanus Canal

Sounding: LIF-MC1500-B
Cone: 406:T1500F15U500



Max Depth: 14.200 m / 46.59 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53060_LIFCPTMC1500-B.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 18 N: 4503505m E: 585432m

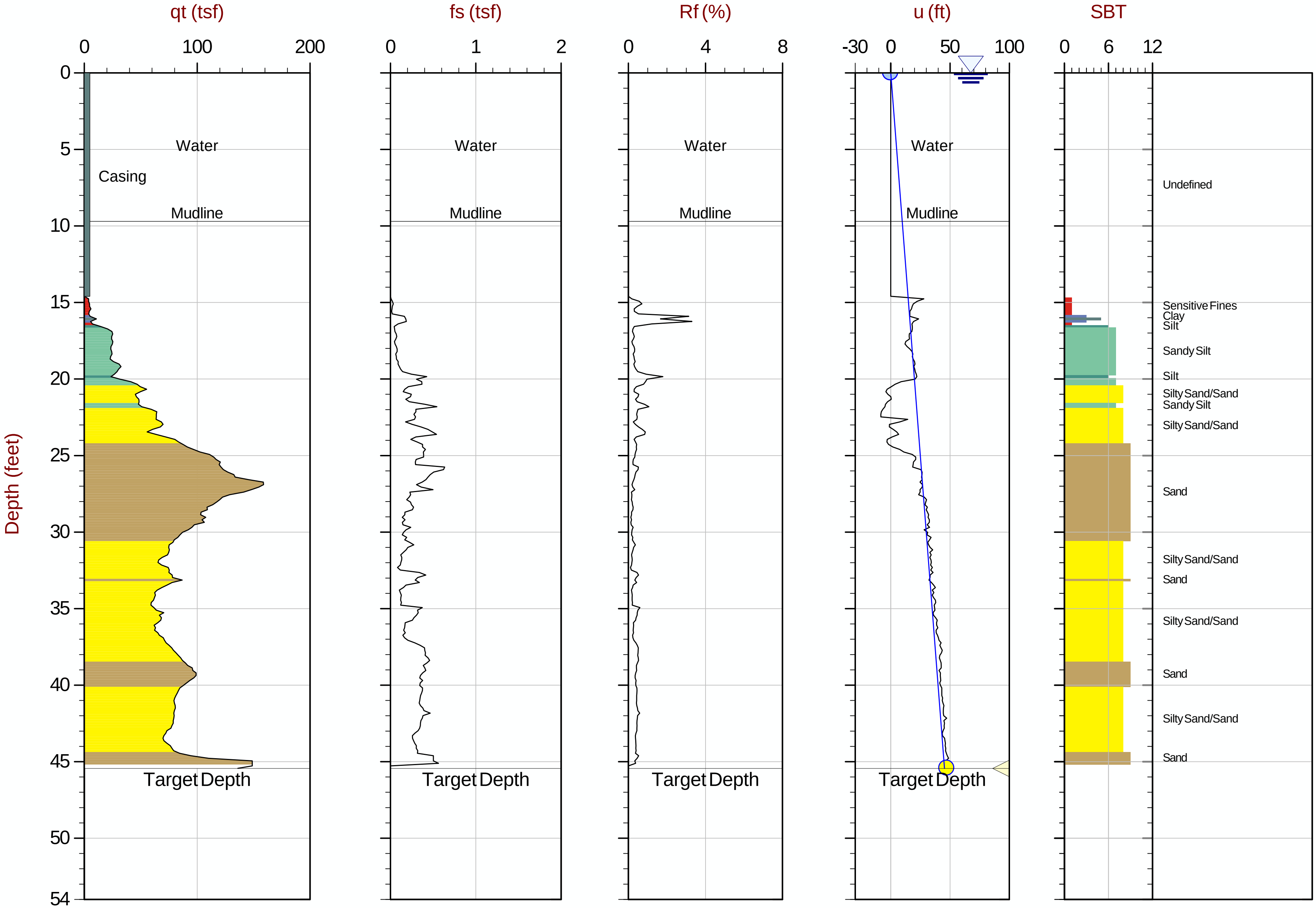
— Hydrostatic Line ○ Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Geosyntec Consultants

Job No: 15-53060
Date: 08:12:15 10:15
Site: Gowanus Canal

Sounding: LIF-MC1550-A
Cone: 406:T1500F15U500



Max Depth: 13.850 m / 45.44 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53060_LIFCPTMC1550-A.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 18 N: 4503487m E: 585425m

Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Geosyntec Consultants

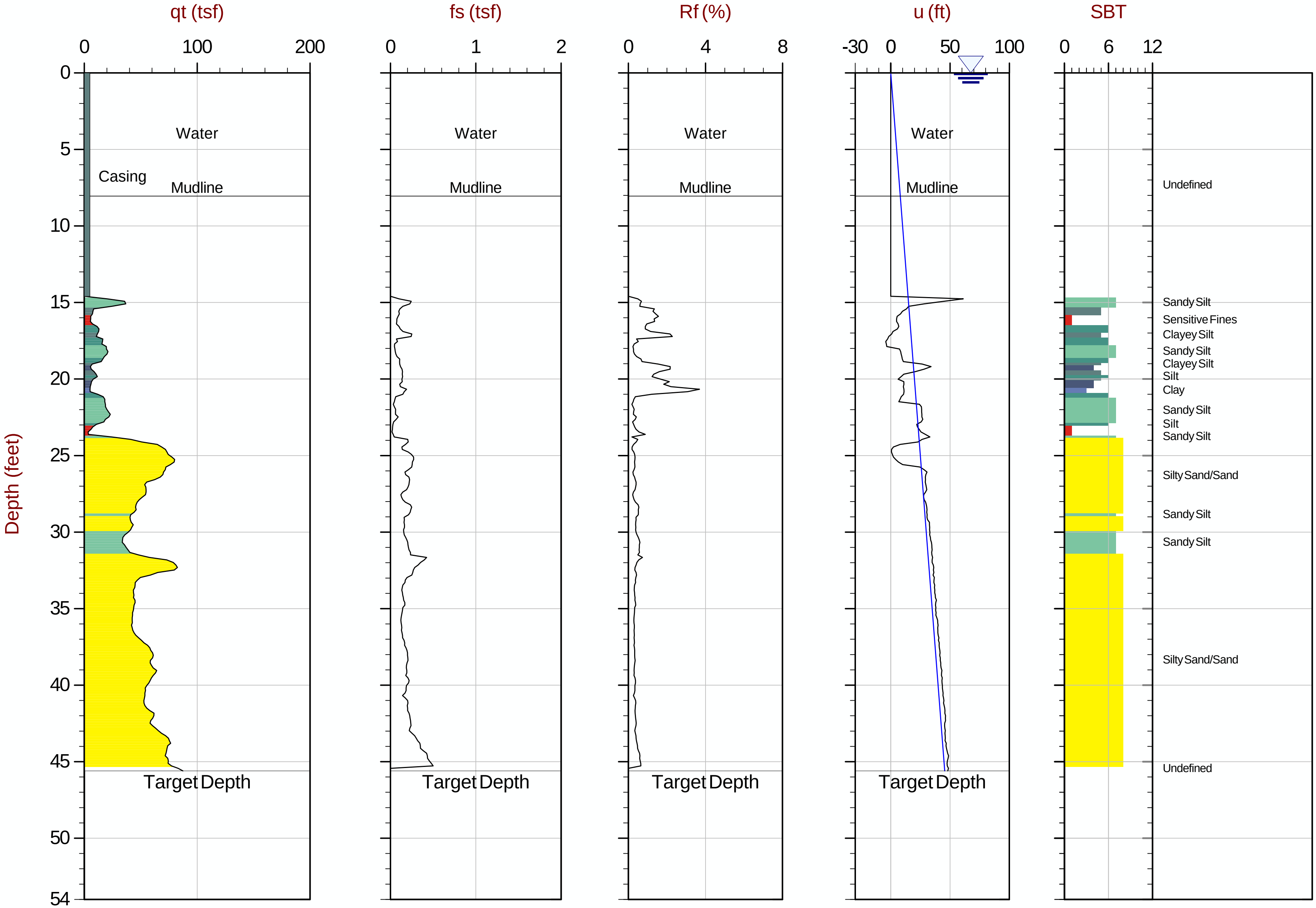
Job No: 15-53060

Date: 07:30:15 14:35

Site: Gowanus Canal

Sounding: LIF-MC2150-A

Cone: 406:T1500F15U500



Max Depth: 13.900 m / 45.60 ft

Depth Inc: 0.050 m / 0.164 ft

Avg Int: Every Point

File: 15-53060_LIFCPTMC2150-A.COR

SBT: Robertson and Campanella, 1986

Coords: UTM Zone 18 N: 4503327m E: 585358m

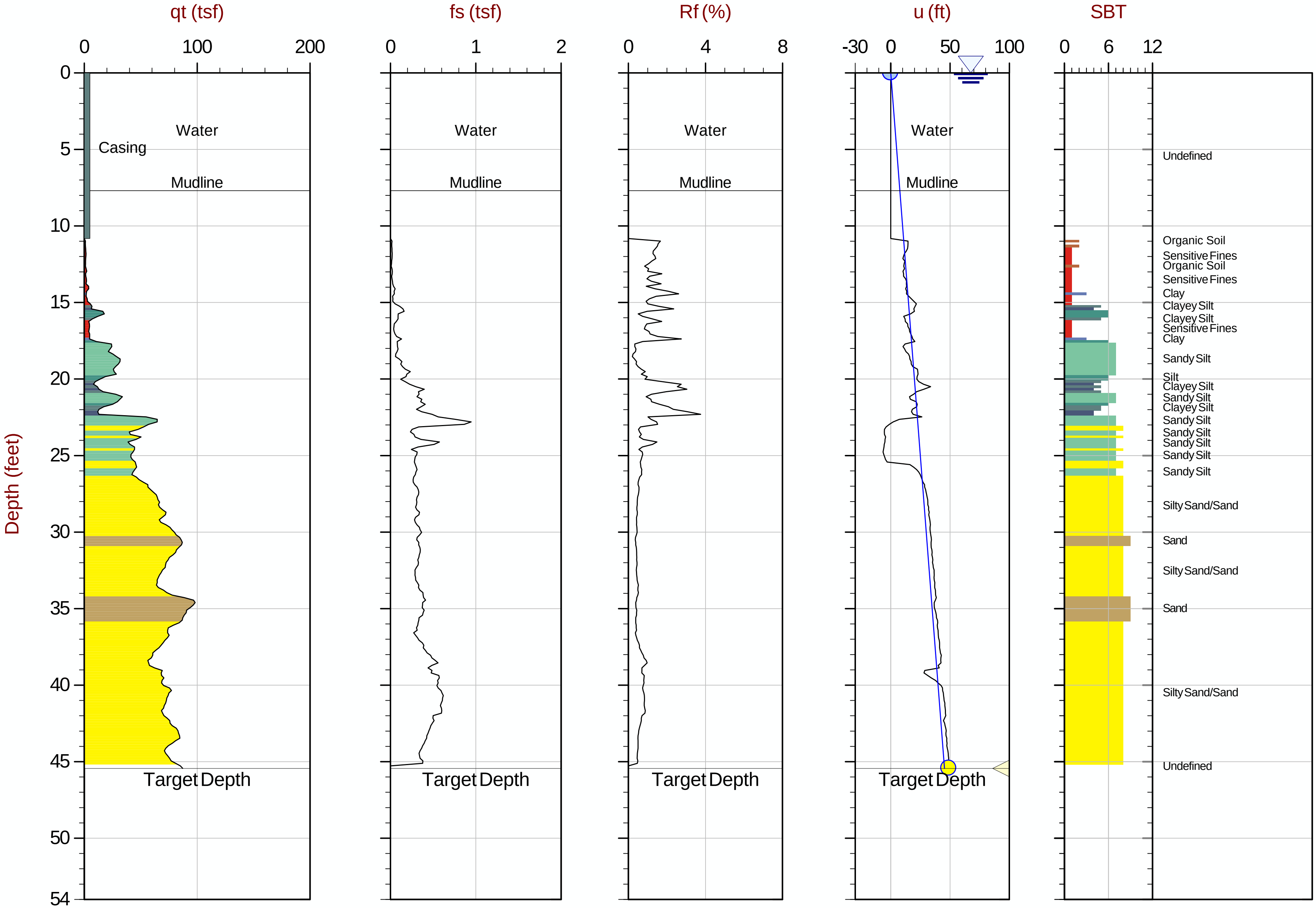
Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Geosyntec Consultants

Job No: 15-53060
Date: 07:30:15 13:28
Site: Gowanus Canal

Sounding: LIF-MC2250-A
Cone: 406:T1500F15U500



Max Depth: 13.850 m / 45.44 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53060_LIFCPTMC2250-A.COR

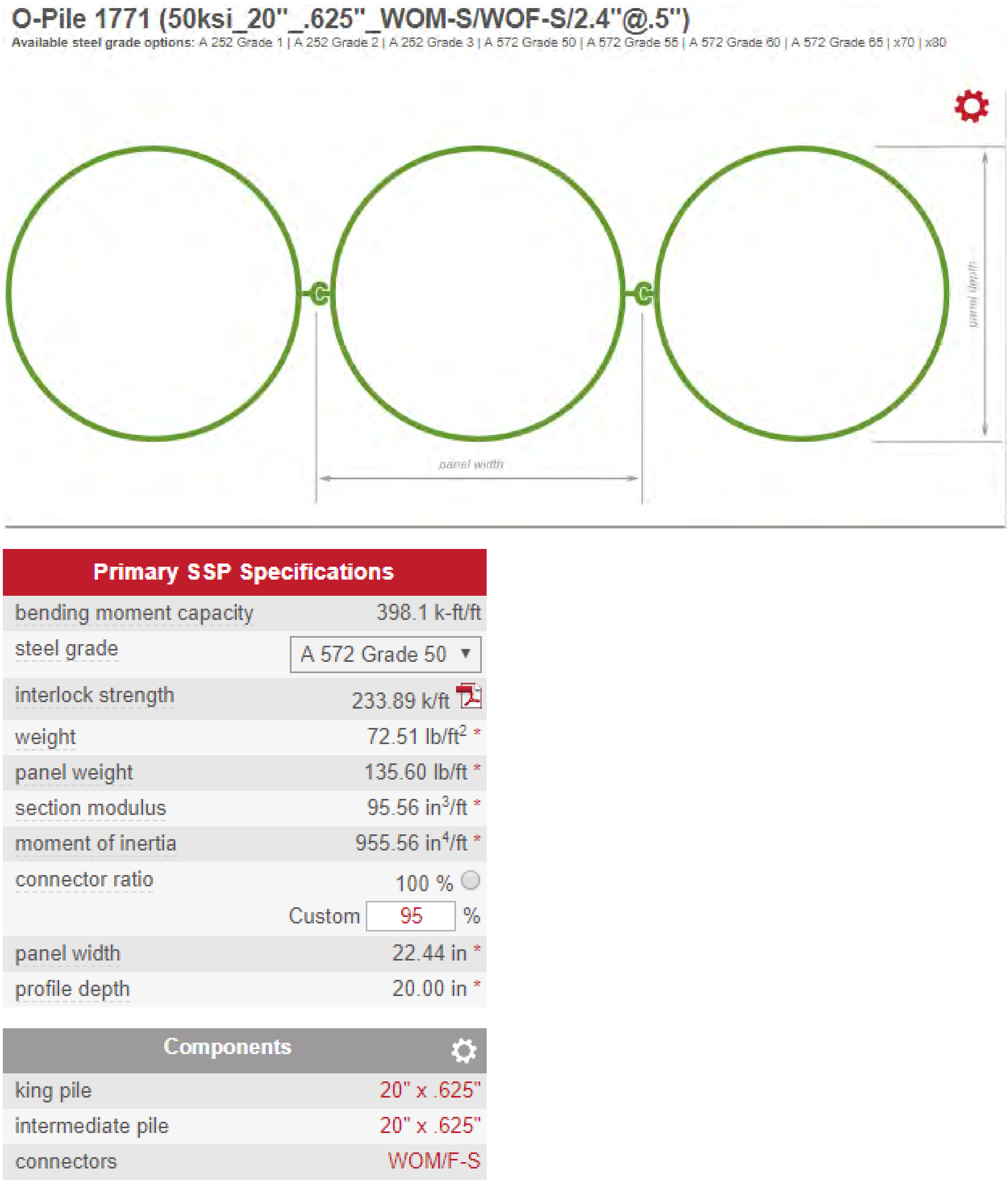
SBT: Robertson and Campanella, 1986
Coords: UTM Zone 18 N: 4503315m E: 585395m

Hydrostatic Line ○ Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

APPENDIX B – O-PILE DATA SHEET

O-Pile 20” Diameter – 0.625” Wall Thickness:



O-Pile 1771 (50ksi_20"_.625"_WOM-S/WOF-S/2.4"@.5")

Available steel grade options: A 252 Grade 1 | A 252 Grade 2 | A 252 Grade 3 | A 572 Grade 50 | A 572 Grade 55 | A 572 Grade 60 | A 572 Grade 65 | x70 | x80

Primary SSP Specifications	
bending moment capacity	398.1 k-ft/ft
steel grade	A 572 Grade 50 ▼
interlock strength	233.89 k/ft
weight	72.51 lb/ft^2 *
panel weight	135.60 lb/ft *
section modulus	95.56 in^3/ft *
moment of inertia	955.56 in^4/ft *
connector ratio	100 % ○
	Custom 95 %
panel width	22.44 in *
profile depth	20.00 in *

Components	
king pile	20" x .625"
intermediate pile	20" x .625"
connectors	WOM/F-S

APPENDIX C – PAGES FROM SUMMARY OF GEOTECHNICAL DESIGN PARAMETERS BY GEOSYNTEC CONSULTANTS

X:\03_GIS\mxd\geotech\geotech_parameters_report\Figure05a_CPT_Borings_Locations_PD-8.mxd; 5/19/2016

Legend

🟦	CPT Location
▭	Gowanus Canal
▨	RTA1
▨	RTA2
▨	RTA3A
▨	RTA3B

200 100 0 200 Feet

Locations of CPTs in RTA1 and TB4 From the Geosyntec PD-8 (2015c) Investigation Report

Gowanus Canal Superfund Site, Brooklyn, NY

Gowanus Canal Remedial Design Group

Geosyntec consultants

Beech and Bonaparte engineering p.c.

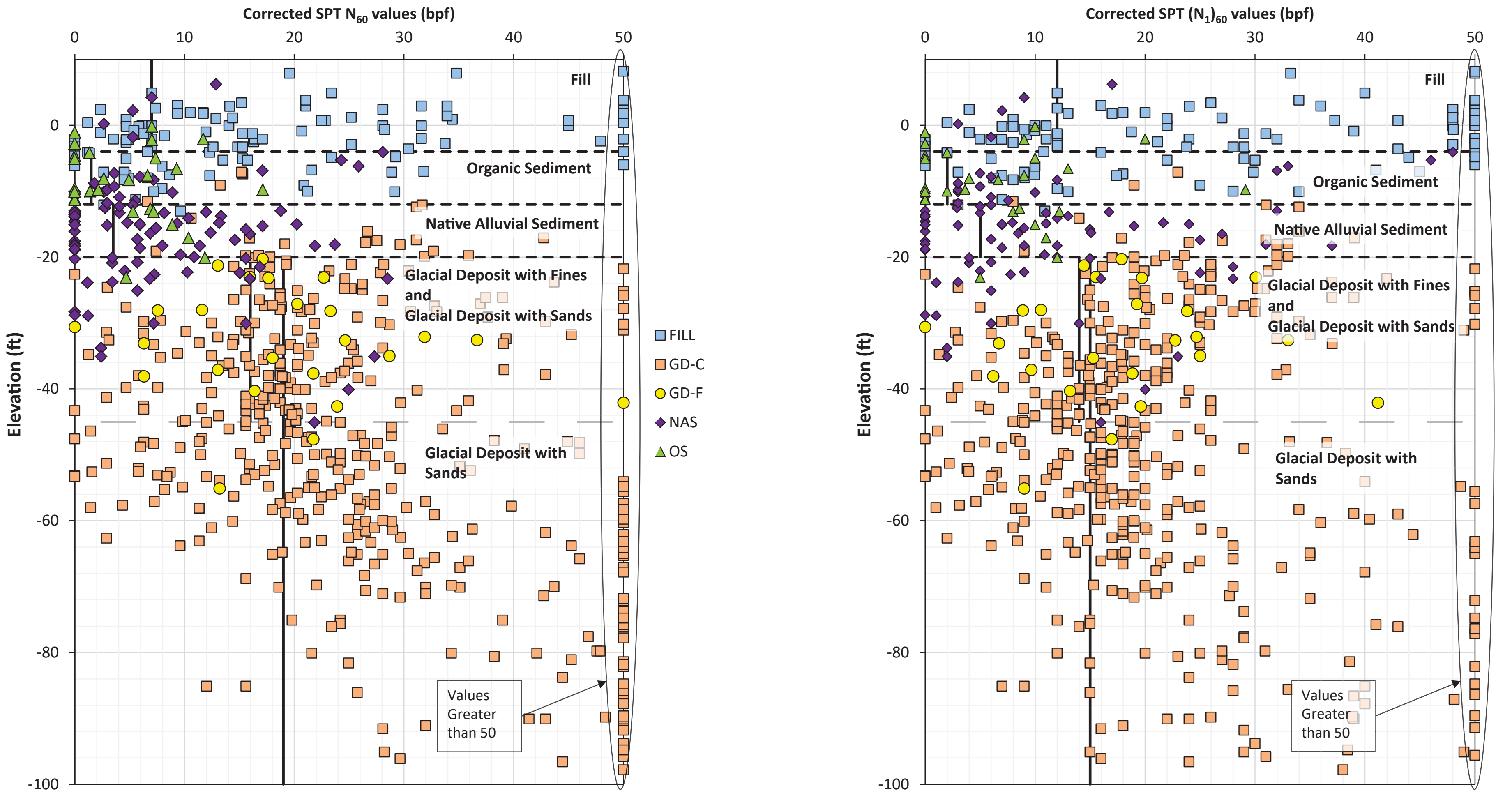
Figure 5a

Ewing, NJ

August 2016

Table 1d. Geosyntec (2015c) PD-8 CPT Locations

Location	CPT Name	As Built Northing	As Built Easting	Elevation Mudline/Ground (ft)	Elevation of Soft-Native Interface (ft)	Elevation of Native-Glacial Interface (ft)
RTA1	15-53060_LIFCPTMC1350-A	672471.44	633808.56	-8.64	-17.74	-19.34
	15-53060_LIFCPTMC1350-B	672449.34	633847.72	-7.62	-14.62	-18.12
	15-53060_LIFCPTMC1400-A	672424.91	633818.08	-9.00	-16.25	-18.00
	15-53060_LIFCPTMC1500-A	672296.14	633773.22	-9.72	-16.97	-20.97
	15-53060_LIFCPTMC1500-B	672307.29	633826.07	-5.37	-15.67	-21.67
	15-53060_LIFCPTMC1550-A	672252.13	633797.73	-10.37	-17.07	-24.97
	15-53060_LIFCPTMC1600-A	672205.73	633773.24	-7.85	NA	NA
	15-53060_LIFCPTMC1600-A1	672203.35	633779.75	-8.05	-13.95	-16.95
	15-53060_LIFCPTMC1600-B	672207.26	633819.28	-6.62	-14.52	-18.52
	15-53060_LIFCPTMC1650-A	672162.65	633795.88	-9.33	-15.03	-19.03
	15-53060_LIFCPTMC1700-A	672104.66	633758.52	-8.35	-15.95	-21.35
	15-53060_LIFCPTMC1700-B	672103.15	633811.16	-8.46	-15.36	-22.36
	15-53060_LIFCPTMC1750-A	672063.65	633784.90	-10.13	-14.88	-20.63
	15-53060_LIFCPTMC1800-A	672034.39	633736.61	-9.37	NA	-14.62
	15-53060_LIFCPTMC1800-B	672004.77	633787.93	-8.99	NA	-13.19
	15-53060_LIFCPTMC1850-A	671972.27	633728.24	-10.43	-17.13	-19.43
	15-53060_LIFCPTMC1900-A	671946.06	633691.28	-8.20	-15.85	-22.35
	15-53060_LIFCPTMC1900-B	671904.89	633722.41	-9.42	-17.82	-22.82
	15-53060_LIFCPTMC1950-A	671888.47	633663.35	-9.17	-18.32	-22.02
	15-53060_LIFCPTMC2000-A	671858.17	633632.70	-7.72	-14.24	-18.54
	15-53060_LIFCPTMC2000-B	671833.06	633668.24	-8.63	-15.33	-19.23
	15-53060_LIFCPTMC2050-A	671817.54	633633.40	-9.85	-25.75	-22.00
	15-53060_LIFCPTMC2100-A	671777.40	633579.73	-8.63	-23.53	-24.53
	15-53060_LIFCPTMC2100-B	671746.67	633623.22	-9.27	-23.07	-25.07
	15-53060_LIFCPTMC2150-A	671722.76	633577.46	-10.64	-16.99	-26.59
	15-53060_LIFCPTMC2200-A	671705.59	633530.93	-8.25	-16.25	-24.55
	15-53060_LIFCPTMC2200-B	671676.01	633569.03	-8.84	-17.09	-24.79
	15-53060_LIFCPTMC2250-A	671678.89	633550.88	-9.81	-19.56	-24.11
TB4	15-53060_LIFCPT0000-A	671449.45	633405.09	-11.85	-17.85	-29.43
	15-53060_LIFCPT0000-A1	671451.86	633403.89	-12.03	-17.63	-22.13
	15-53060_LIFCPT0050-A	671381.86	633391.68	-10.49	-15.14	-21.24
	15-53060_LIFCPT0050-B	671406.98	633430.67	-11.01	-14.11	-21.91
	15-53060_LIFCPT0100-A	671363.62	633425.59	-11.74	-18.59	-25.89
	15-53060_LIFCPT0150-A	671301.26	633424.24	-10.33	-15.93	-24.03
	15-53060_LIFCPT0150-B	671304.23	633457.79	-8.48	-16.78	-28.28
	15-53060_LIFCPT0200-A	671250.95	633457.93	-6.38	-14.83	-22.13
	15-53060_LIFCPT0250-A	671243.40	633441.94	-4.71	-13.51	-20.51
	15-53060_LIFCPT0250-B	671209.87	633490.88	-4.09	-15.59	-23.59
	15-53060_LIFCPT0275-A	671170.09	633477.85	-5.70	-13.90	-21.40
	15-53060_LIFCPT0300-A	671183.30	633500.76	-5.16	-14.11	-24.61
	15-53060_LIFCPT0350-A	671125.89	633540.90	-6.07	-14.62	-23.82
	15-53060_LIFCPT0350-B	671169.04	633555.83	-4.68	-14.31	-26.11
	15-53060_LIFCPT0400-A	671102.65	633600.65	-6.31	-16.11	-30.51
	15-53060_LIFCPT0450-A	671090.18	633591.81	-4.38	-14.83	-27.83
	15-53060_LIFCPT0450-B	671123.26	633641.77	-4.21	-12.61	-27.31
	15-53060_LIFCPT0500-A	671055.05	633670.13	-6.49	-14.99	-27.05
	15-53060_LIFCPT0550-A	671014.10	633688.97	-6.28	-13.28	-22.78
	15-53060_LIFCPT0550-B	671055.66	633723.14	-6.49	-16.49	-24.99
	15-53060_LIFCPT0600-A	671012.36	633752.28	-6.68	-15.38	-19.48
	15-53060_LIFCPT0650-A	670976.08	633765.78	-5.29	-15.74	-17.84
	15-53060_LIFCPT0650-B	671007.92	633795.14	-5.09	-15.79	-18.09
	15-53060_LIFCPT0700-A	670953.15	633825.72	-4.62	-13.90	-17.42



Notes:

1. Dash lines represent general boundaries between material layers defined for the upland side of the bulkheads
2. The subsurface stratigraphy is not identical at all boring locations; therefore, some blow count values shown within a material may not be representative of that material.

Legend:

bpf = blows per foot

Soil Unit	Representative N-values (bpf)	
	N_{60}	$(N_1)_{60}$
Fill	7	12
Organic Sediment (OS)	1.5	2
Native Alluvial Sediment (NAS)	3.5	5
Glacial Deposit with Fines (GD-F)	16	14
Glacial Deposit with Sands (GD-S)	19	15

Compilation Plots of Calculated N_{60} and $(N_1)_{60}$ Values with Depth for the Upland Side of the Canal

Gowanus Canal Superfund Site, Brooklyn, NY

Gowanus Canal Remedial Design Group

Geosyntec consultants

Beech and Bonaparte engineering p.c.
an affiliate of Geosyntec Consultants

Ewing, NJ

October 2016

Figure
6

APPENDIX D – NYC DOT DIVISION OF BRIDGES REVIEW PROCEDURE FOR PRIVATE DEVELOPMENT PROJECT NEAR BRIDGE STRUCTURE

NYCDOT – Division of Bridges Review Procedure for Private Development Project near Bridge Structure

Please be aware that section 2-11(d) of DOT's Highway Rules requires that street opening and excavation permit applications state "whether the proposed work will be within 100 feet on, above or below or in either direction of any portion of a bridge, tunnel, underpass or overpass (if so, approval from the Division of Bridges shall be obtained)". For purposes of this section "portion" shall include, but not be limited to, approach slabs, retaining walls, and support columns. The method of excavation and final restoration shall be reviewed and approved by the Division of Bridges."

Also, as further described in section 3.5.1 of DOT's Street Works Manual, if the Project will be within 100 feet of a bridge, the project owner or its consultant must submit a scaled drawing showing the work to be performed and its exact location relative to the bridge, in order for DOT to consider its construction activity permit application. The drawing shall be reviewed and approved by the DOT's Division of Bridges before such permit will be issued.

Therefore, no construction activity shall take place within the 100 feet of the Bridge before the required information has been submitted (as stated below) and DOT's Division of Bridges' approval has been obtained. **All Private developers' projects will be submitted for CDOT – Division of Bridges, Division of Bridge's approval if granted does not constitute approval from NYCDOT. General requirements for the submission to Division of Bridges are as follows:**

A. **General Scope:**
A description of the general scope of the project, and the specific nature of the work that will be performed in closest proximity to the bridge. It should include a location map (Google map, etc.), Block and Lot numbers, address of the property, developers name, address, key contact person details include phone number.

B. **Design documents:**
Plans and sectional elevations of the proposed work near the bridge; horizontal and vertical clearances between the bridge's superstructure, foundation, and the closest proposed building lines or property lines. Support of excavations, foundation plans and design calculations showing the foundation loads due to the proposed construction does not impose any additional loads on to the existing bridge foundation structure.

C. Pre and Post Construction Reports and Bridge Monitoring Plan:

In order to protect the bridge's integrity, DOT will require that an approved monitoring plan to observe cracking, vibration and settlement, be in place prior to commencement of any construction activity within 100 ft. of the bridge. Submission of pre-construction and post-construction survey reports (including photographs of existing condition prior to the project start and after competition of the project) of the bridge structure will be required. In accordance with the Division of Bridges standards, the threshold limit for vibration (PPV) is 0.5 inches/sec and settlement is 0.25 inches. A preconstruction report must be submitted to the Division at least 10 working days prior to commence of the project.

Note: The access to the bridge to perform pre and post construction survey shall be obtained by contacting Mr. George Klein, P.E., deputy Chief Engineer, Bureau of Maintenance, Inspection and Operations at (212)839-4846 or gklein@dot.nyc.gov .

a) The Pre-construction report shall clearly specify the existing condition of the bridge structure adjacent to the project limits, offsets from the bridge structure to the actual work, and any preexisting conditions such as cracks, spalls, and deterioration shall be pointed out in the report with photographs. Copies of all documents shall be sent to the Division of Bridges before construction begins. Any damage that was not documented to have existed before construction (including cracks that have expanded) will be deemed to have occurred as a result of construction activities and shall be repaired by the developer, to Division of Bridges satisfaction, and at no cost to the City.

b) The Bridge Monitoring Plan shall contain a general description of the project, project limits, project schedule, period of monitoring plan in place, location and number of monitoring points provided for measuring movement, settlements, vibration monitoring, and crack monitoring. It shall also contain the type of monitoring instruments used, monitoring procedures, reporting system and threshold limits for monitoring.

If the construction activity is in very close proximity to the bridge structure, as determined by the Division of Bridges, the monitoring reports shall be submitted on a weekly basis to the designated Engineer at the Division of Bridges. As the construction work progresses away from the bridge structure then the reports shall be submitted on Bi-weekly after getting approval from Division of Bridges. The report shall include but not limited to the monitoring values observed, nature of the contractor's activity, work location with respect to the bridge structure, day time/night time activity, and weather condition, etc. The Division of Bridges may require more frequent reports if deemed necessary.

c) The Post-Construction report shall contain the pre/post conditions of the structure, with photographs. Any deviation from pre-construction report shall be highlighted and any damage that may have occurred due to construction activity shall be repaired and brought to its original condition, as per the Division of Bridges' direction and at no cost to the City.

D. Land Use:
If the private development projects require temporary easements/land use related issues of CDOT properties as part of their construction, such requests shall be clearly mentioned in the drawings.

E. Truck Permit Program Unit:
The Construction Manager of the private development project shall familiarize himself/herself with all NYC regulations with respect to overweight and overdimensional permits and shall document that all trucks working on the project have the required permits. The Division of Bridges' review and approval is limited to the review of the subject plans. However, Overweight/Over dimensional trucks and cranes, that move in and out of New York City, are required to submit permit applications to the CDOT-Permit Unit. The contact person is Mr. Kevin Lobat, Director of Truck Permit Program Unit and he can be reached at (212)839-6335.

F. Bridge Hold: Any planned work requiring a Building Operations/ Construction Activity Permit that may potentially be within 100 feet of a bridge structure will be placed on a Bridge hold. If any proposed work is within 100 feet of a bridge or structure, applicants must submit a scaled drawing showing the work and exact location. If the work is more than 100 feet away from the bridge structure, applicants must send a certification by e-mail stating so. Either response must be sent to NYC DOT's Division of Bridges at bridgeshold@dot.nyc.gov for review and release prior to commencing work.

In general should you have any questions regarding our review and approval process, please contact Mr. Uday Dommaraju, P.E., Director of Engineering Review Section at (212)839-4029 or udommaraju@dot.nyc.gov.

CALCULATIONS
FOR
STEEL MONOPILE DOLPHINS

STRUCTURE

CARROLL STREET BRIDGE
B.I.N. 2-24026-0

PREPARED FOR

GOWANUS ENVIRONMENTAL
REMEDIATION TRUST

RTA1 BRIDGE STABILITY FINAL DESIGN

PREPARED BY

Greenman-Pedersen, Inc.

FEBURARY 2020

DESIGN SUMMARY

Design Criteria:

Manuals & Specifications References

1. AASHTO LRFD Bridge Design Specifications – Eighth Edition
2. AWPI Timber Pile Design and Construction Manual - 2002
3. Coastal Engineering Research Council of the COPRI of ASCE, “Concepts in Design of Coastal Structures” - 1976
4. NYSDOT Standard Specifications

Other References:

- Department of Civil Engineering at Princeton University, “Analysis and Design of Dolphins, Final Report to the Bureau of Yards and Docks Department of the Navy.” April 1, 1963.
- Arcelor Mittal Piling Handbook 8th Edition Revised 2008

Software Used:

- Civiltech AllPile – Version 7
- Microsoft Excel

Design Approach:

The existing timber pile cluster dolphins that protect the bridge structures from vessel collisions are to be removed and replaced following the dredging and backfill of the Gowanus Canal for RTA 1 proposed by Geosyntec. The deflection of the replacement dolphins at the mudline must be determined in order for the remediation team to design their environmental concrete cap, which is also included in Geosyntec's plan for RTA 1.

The design of the pipe pile dolphins is split into four locations notated as follows:

- CSDL01 – Northwest corner of the bridge
- CSDL02 – Northeast corner of the bridge
- CSDL03 – Southeast corner of the bridge
- CSDL04 – Southwest corner of the bridge

The steel pipe pile dolphins were designed using a two-step approach. First, the vessel collision force was determined using the procedure set forth in LRFD Bridge Design Specifications (AASHTO). Once the design load was calculated, the ultimate load capacity and the maximum allowable deflection of the pile at the mudline were determined using the Broms’ Method for Laterally Loaded Piles following the procedure in the Timber Pile Design and Construction Manual (AWPI).

The design of the pile stops followed the procedure set forth in LRFD Bridge Design Specifications (AASHTO).

The mudline after dredging is completed is taken as the minimum mudline elevation. The mudline falls at a lower elevation at the northwest corner than at any of the other three corners of the bridge. This means that the vertical distance between the mudline and the lateral load is greatest at design location CSDL01, as are the length of the pile and the lateral deflection at the mudline. Therefore, design location CSDL01 controls the design due to the elevation of the mudline after dredging is completed.

Analysis Methods and Design Assumptions:

General Assumptions:

- All soil information including soil design properties and soil layer thicknesses were obtained from the RTA 1 Bridge Soil Design Parameters prepared by GZA GeoEnvironmental, Inc. dated July 11, 2018 (*Appendix A*). Soil layer thicknesses have been modified for certain design locations per the Summary of Geotechnical Design Parameters prepared by Geosyntec Consultants (*Appendix B*).
- Verification of pipe pile design deflections was performed using the program CivilTech AllPile – Version 7.
- Dredge depths were obtained from the bottom of soft sediment surface provided by Geosyntec Consultants.

Vessel Collision Force:

- The structural limit state that governs this design is Extreme Event II, for which the vessel collision force is the only load considered.
- An empty standard hopper barge was chosen as the design vessel per recommendations made in Article 3.14 of Reference 1. Ships were not considered due to their relatively infrequent use of the channel.
- The design vessel collision force is assumed to be the collision impact force on a pier for a standard hopper barge and is applied as an equivalent static force at a point along the length of the pile equal in elevation to that of the bow/rake of the design barge.

Broms' Method for Laterally Loaded Piles:

- The embedded end of each pile is assumed to be fixed at the critical depth "CD" below the mudline.
- The soil type within the critical depth is cohesionless.
- Each pile is analyzed assuming perfect rigidity.
- Axial loads on the pile are ignored.

Corrosion Durability of Dolphin Piles:

- All steel monopile dolphins shall be protected by applying coal tar epoxy.
- Coal tar epoxy has an assumed design life of 10 years.
- Corrosion durability is checked for a 50 year timeline.
- Thickness loss due to corrosion was accounted for on the interior and exterior faces of the piles in accordance with the corrosion rates provided in the Arcelor Mittal Piling handbook.

Summary of Results:

Dolphin Design Values	
Steel Pipe Pile	
Diameter, in	24
Wall Thickness, in	0.438
Depth of Embedment, ft	32.56
Ultimate Lateral Capacity, k	20.37
Max. Allowable Load, k	8.15
Collision Force, k	6.52
Steel Plate Pile Stop	
Diameter, in	37
Thickness, in	1
Welded Connection	
Weld size, in	5/16
Shear Resistance, kips	448.38

Dolphin Pile Elevations				
Location	**Top of Pile**	**Approx. Channel Bed**	**Min. Tip of Pile**	**Pile Length (ft)**
CSDL01	10.00	-17.44	-50.00	60.00
CSDL02	10.00	-15.68	-48.24	59.00
CSDL03	10.00	-15.75	-48.31	59.00
CSDL04	10.00	-16.91	-49.47	60.00

Deflection of Dolphin Piles at the Mudline Following a Vessel Collision		
Location	**Elevation of Mudline (ft)**	**Deflection (in)**
CSDL01	-17.44	0.233
CSDL02	-15.68	0.172
CSDL03	-15.75	0.220
CSDL04	-16.91	0.205

All dolphin piles met the minimum required design section strength after a 50 year period of thickness loss due to corrosion. Results are shown in Attachment C.

TABLE OF CONTENTS

SUMMARY OF RESULTS

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	11/21/19
SUBJECT:	RTA 1 - Carroll Street Dolphin Design	CHECKED BY:	PLT	DATE:	12/18/19

RTA 1 - Carroll Street Dolphin Design - Summary of Results

References:

1. AASHTO LRFD Bridge Design Specifications - Eighth Edition
2. AWPI Timber Pile Design and Construction Manual, 2002
3. Coastal Engineering Research Council of the COPRI of ASCE, "Concepts in Design of Coastal Structures", 1976
4. NYSDOT Standard Specifications
5. Department of Civil Engineering at Princeton University, "Analysis and Design of Dolphins, Final Report to the Bureau of Yards and Docks Department of the Navy", April 1, 1963
6. AISC Steel Comnstruction Manual, 14th Ed.

Appendices:

Appendix A - Pages from RTA 1 Bridge Soil Design Parameters by GZA GeoEnvironmental, Inc.
Appendix B - Pages from Summary of Geotechnical Design Parameters by Geosyntec Consultants
Appendix C - O-Pile Datasheet
Appendix D - Configuration and Performance of Donut Marine Fender by Trelleborg Marine Systems

Purpose & Assumptions:

The existing timber pile cluster dolphins that protect the bridge structures from vessel collisions are to be removed and replaced prior to the dredging and backfill of the Gowanus Canal for RTA 1 proposed by Geosyntec. The deflection of the replacement dolphins at the mudline must be determined in order for the remediation team to design their environmental concrete cap, which is also included in Geosyntec's plan for RTA 1. The assumptions are as follows:

- The structural limit state that governs this design is Extreme Event II, for which the vessel collision force is the only load considered. Axial loads on the pile are ignored.
- An empty standard hopper barge was chosen as the design vessel per recommendations made in Article 3.14 of Reference 1. Ships were not considered due to their relatively infrequent use of the channel.
- The design vessel collision force is assumed to be the collision impact force on a pier for a standard hopper barge, and is applied as an equivalent static force at a point along the length of the pile equal in elevation to that of the bow/rake of the design barge.
- The embedded end of each pile is assumed to be fixed at the critical depth "CD" below the mudline.
- The soil type within the critical depth is cohesionless.
- Each pile is analyzed assuming perfect rigidity.
- To be conservative, the mudline elevation used for design will be the bottom of the dredge surface. This temporary condition represents the worst case condition. The mudline falls at a lower elevation at the northwest corner than at any of the other three corners of the bridge. This means that the vertical distance between the mudline and the lateral load is greatest at design location CSDL01, as are the length of the pile and the lateral deflection at the mudline. Therefore, design location CSDL01 controls the design due to the elevation of the mudline after dredging is completed.

Summary of Results:

The design results are summarized in the tables below:

Dolphin Design Values	
Steel Pipe Pile	
Diameter, in	24
Wall Thickness, in	0.438
Depth of Embedment, ft	32.56
Ultimate Lateral Capacity, k	20.37
Max. Allowable Load, k	8.15
Collision Force, k	6.52

8.15 > 6.52 ***OK***

Steel Plate Pile Stop	
Diameter, in	37
Thickness, in	1.0
Welded Connection	
Weld size, in	5/16
Shear Resistance, kips	448.38

Deflections of 24" x 0.438" Pipe Pile Following Vessel Collision (AllPile)				
Design Location CSDL01				
	Elevation (ft)	**Pile Depth (ft)**	**Collision Force (k)**	**Deflection (in)**
Top of Pile	10.00	0	6.52	1.480
Dredge Limit	-17.44	27.44	6.40	0.233
Critical Depth	-26.44	36.44	-3.20	-0.005
Tip	-50.00	60.00	0	0

Dolphin Pile Elevations				
Location	**Top of Pile**	**Approx. Dredge Limit EL.**	**Min. Tip of Pile**	**Pile Length (ft)**
CSDL01	10.00	-17.44	-50.00	60.00
CSDL02	10.00	-15.68	-48.24	59.00
CSDL03	10.00	-15.75	-48.31	59.00
CSDL04	10.00	-16.91	-49.47	60.00

Deflection of Dolphin Piles at the Mudline Following a Vessel Collision		
Location	**Dredge Limit EL. (ft)**	**Deflection (in)**
CSDL01	-17.44	0.233
CSDL02	-15.68	0.172
CSDL03	-15.75	0.220
CSDL04	-16.91	0.205

INPUTS

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	11/21/19
SUBJECT:	RTA 1 - Carroll Street Dolphin Design	CHECKED BY:	PLT	DATE:	12/18/19

RTA 1 - Carroll Street Dolphin Design - Inputs

Pipe Pile Material:

ASTM A 572 Steel:

F_y = 50 *ksi* (Yield stress)

E = 29000 *ksi* = 4176000 *ksf* (Modulus of elasticity)

Pile Stop Material:

ASTM A 36 Steel:

F_y = 36 *ksi* (Yield stress)

F_u = 58 *ksi* (Tensile stress)

E = 29000 *ksi* = 4176000 *ksf* (Modulus of elasticity)

Donut Fender Properties:

WD = 3054 *lbs* (Nominal weight of donut fender) *Appendix D - Page 1*

OD_f = 5.83 *ft* (Outside diameter of donut fender) *Appendix D - Page 1*

r_o = 2.92 *ft* (Radius of donut fender)

CD_f = 2.56 *ft* (Diameter of donut fender core) *Appendix D - Page 1*

r_c = 1.28 *ft* (Radius of donut fender core)

Assume donut fender completely submerged (conservative)

h_{BMHW} = 119 *in* (Submerged height of donut fender) *Appendix D - Page 1*

Approx. $V_{O,SDF} = \pi r_O^2 h_{SDF}$ (Approximate submerged volume of donut fender)

Approx. $V_{O,SDF}$ = 265.03 ft^3

Approx. $V_{C,SDF} = \pi r_c^2 h_{SDF}$ (Approximate submerged volume of donut fender core)

Approx. $V_{O,SDF}$ = 51.14 ft^3

Approx. $V_{SDF} = V_{O,SDF} - V_{C,SDF}$

Approx. V_{SDF} = 213.88 ft^3

$WD_B = \gamma_w V_{SDF}$ (Buoyant weight of donut fender)

WD_B = 13346.35 *lbs*

$F_B = WD_B$ (Buoyant force on the donut fender)

F_B = 13346.3 *lbs*

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: JRA DATE: 11/21/19
SUBJECT: RTA 1 - Carroll Street Dolphin Design CHECKED BY: PLT DATE: 12/18/19

Soil Parameters:

Constants:

γ_w = 62.4 *pcf* (Unit weight of water)

Soil Layer 1 - Native Alluvial Sediment:

γ_2 = 115 *pcf* (Total unit weight) *Appendix A - Page 1*
φ'_2 = 28 *deg* (Effective Friction Angle) *Appendix A - Page 1*
$\gamma'_2 = \gamma_2 - \gamma_w$ (Effective unit weight)
γ'_2 = 52.6 *pcf*
N_{60} = 3.5 *bpf* *Appendix B - Figure 6*
$(N_1)_{60}$ = 5 *bpf* *Appendix B - Figure 6*
Soil Density = Loose
Soil Type = Cohesionless *Assumed*
$K_{p2} = \tan^2(45 + \varphi'_2/2)$ (Rankine passive earth pressure coefficient)
K_{p2} = 2.77
K_{h2} = 7 *kcf* (Coefficient of horizontal subgrade reaction) *Ref. 2 Table 7-2*
$K_{h2,\,adj} = 0.25 * K_{h2}$ (Adjusted for cyclic loading conditions) *Ref. 2 Section 7.2*
$K_{h2,\,adj}$ = 1.75 *kcf*
OCR_2 = 1 *Appendix B - Table 9*

Soil Layer 2 - Glacial Deposit:

γ_3 = 125 *pcf* (Total unit weight) *Appendix A - Page 1*
φ'_3 = 34 *deg* (Effective Friction Angle) *Appendix A - Page 1*
$\gamma'_3 = \gamma_3 - \gamma_w$ (Effective unit weight)
γ'_3 = 62.6 *pcf*
N_{60} = 19 *bpf* *Appendix B - Figure 6*
$(N_1)_{60}$ = 15 *bpf* *Appendix B - Figure 6*
Soil Density = Medium to Dense
Soil Type = Cohesionless *Appendix A - Drawing DR-2*
$K_{p3} = \tan^2(45 + \varphi'_3/2)$ (Rankine passive earth pressure coefficient)
K_{p3} = 3.54
K_{h3} = 35 *kcf* (Coefficient of horizontal subgrade reaction) *Ref. 2 Table 7-2*
$K_{h3,\,adj} = 0.5 * K_{h3}$ (Adjusted for cyclic loading conditions) *Ref. 2 Section 7.2*
$K_{h3,\,adj}$ = 17.5 *kcf*
OCR_3 = 1 *Appendix B - Table 9*

VESSEL COLLISION FORCE

RTA 1 - Carroll Street Dolphin Design - Vessel Collision Force

Design Barge:

Standard Hopper Barge: *Ref. 1 Article 3.14.11*

B_W = 35 *ft* (Barge width)

B_L = 195 *ft* (Barge length)

B_D = 12 *ft* (Barge depth)

B_{ED} = 1.7 *ft* (Barge empty draft)

B_{LD} = 8.7 *ft* (Barge loaded draft)

$B_{DL,top} = B_D - B_{LD}$ (Depth of loaded barge above MHW)

$B_{DL,top}$ = 3.3 *ft*

$EL_{BDL} = EL_{MHW} + B_{DL,top}$ (Barge deck elevation, loaded)

EL_{BDL} = 5.26 *ft*

$B_{DE,top} = B_D - B_{ED}$ (Depth of empty barge above MHW)

$B_{DE,top}$ = 10.3 *ft*

$EL_{BDE} = EL_{MHW} + B_{DE,top}$ (Barge deck elevation, unloaded)

EL_{BDE} = 12.26 *ft*

DWT = 1700 *tons* (Deadweight tonnage) *Ref. 1 Article 3.14.11*

LOA = 195 *ft* (Length overall)

W_E = 200 *tons* (Empty displacement) *Ref. 1 Article 3.14.1*

Annual Frequency of Collapse:

Probability of Aberrancy, *PA*: *Ref. 1 Article 3.14.5.2.3*

BR = 0.00012 (Aberrancy base rate for barges)

θ = 27 *deg* (Angle of the turn in channel at bridge location, measured in CAD)

$$R_B = \left(1 + \frac{\theta}{45°}\right)$$

(Correction factor for bridge location in a turn region)

R_B = 1.6

V_C = 0.308 *knots* (Current velocity component parallel to the vessel transit path, provided by Geosyntec)

$$R_C = \left(1 + \frac{V_C}{10}\right)$$

(Correction factor for current acting parallel to vessel transit path)

R_C = 1.031

V_{XC} = 0.000 *knots* (Current velocity component perpendicular to the vessel transit path)

$R_{XC} = (1+V_{XC})$ (Correction factor for cross-currents acting perpendicular to vessel transit path)

R_{XC} = 1.000

R_D = 1.0 (Correction factor for vessel traffic density)

$PA = (BR)(R_B)(R_C)(R_{XC})(R_D)$ *Ref. 1 Equation 3.14.5.2.3-1*

PA = 0.000198

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	11/21/19
SUBJECT:	RTA 1 - Carroll Street Dolphin Design	CHECKED BY:	PLT	DATE:	12/18/19

Geometric Probability, *PG* : *Ref. 1 Article 3.14.5.3*

$B_M = B_W$ (Width of the design vessel)

B_M = 35 *ft*

$B_{P+Fender}$ = 31.14 *ft* (Width of the pier with fender system)

σ = 195 *ft* (Standard deviation of the normal distribution)

Impact Zone = 66.14 *ft*

X = 34.43 *ft* (Distance from centerline of vessel sailing path to centerline of pier)

PG_1 = 1.36 *ft* (Lower boundary of the geometric probability)

PG_2 = 67.5 *ft* (Upper boundary of the geometric probability)

PG = *the area under the normal distribution bounded by* PG_1 *and* PG_2

PG = 0.023189

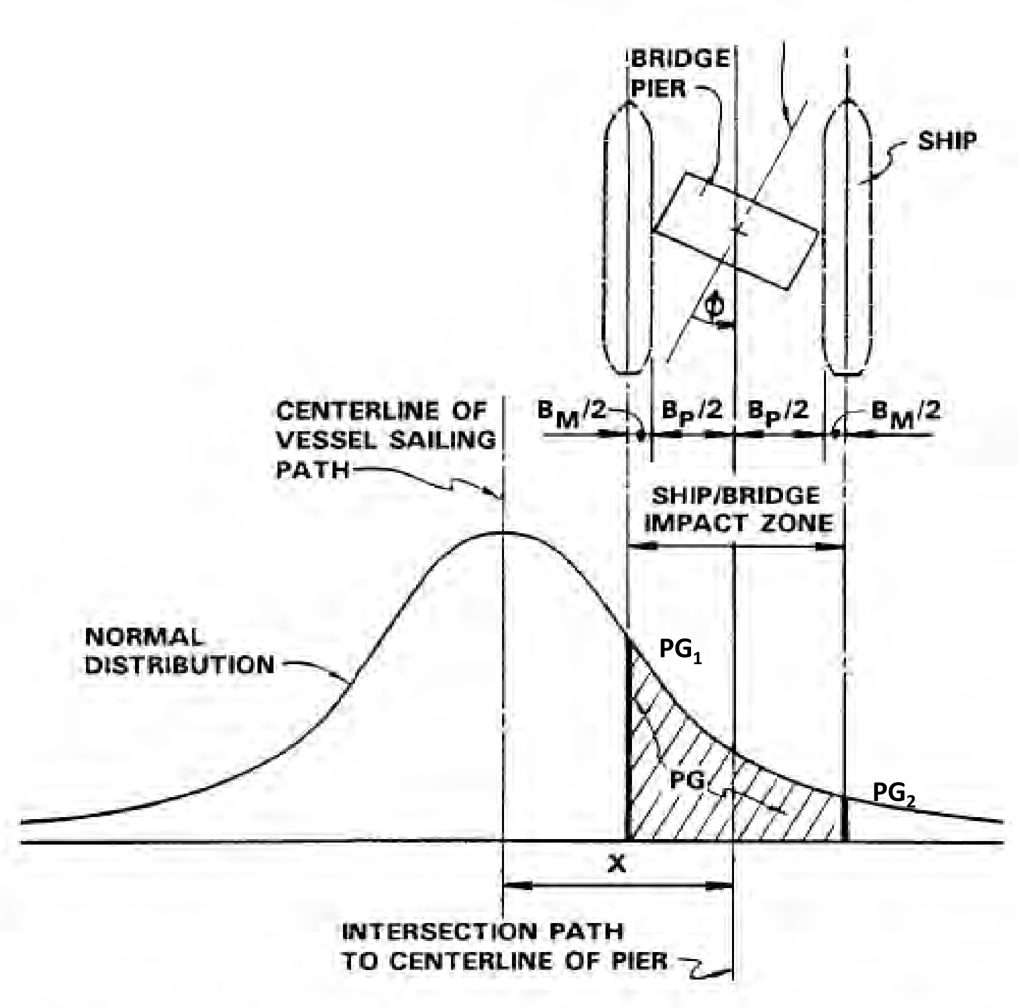


Figure 3.14.5.3-1—Geometric Probability of Pier Collision

Probability of Collapse, *PC* : *Ref. 1 Article 3.14.5.4*

According to Article 3.14.5.4 of Reference 1, the probability of bridge collapse, *PC* , is based on the ratio *H/P* , where:

H = Resistance of bridge component to a horizontal force expressed as pier resistance, H_P, or superstructure resistance, H_S
P = Vessel impact force, P_S, P_{BH}, P_{DH}, or P_{MT}
P_S = Ship collision force on pier *Ref. 1 Article 3.14.8*
P_{BH} = Bow collision impact force on a superstructure *Ref. 1 Article 3.14.10.1*
P_{BH} = Deck house collision impact force on a superstructure *Ref. 1 Article 3.14.10.2*
P_{MT} = Mast collision impact force on a superstructure *Ref. 1 Article 3.14.10.3*

A standard hopper barge was selected as the design vessel for each of the piers at this location. The barge impact force on a pier, P_B, is not considered in the calculation of the ratio *H/P* presented above. For this reason, the probability of collapse, *PC* , is neglected for this design.

Protection Factor, *PF* : *Ref. 1 Article 3.14.5.5*

B_P = 24.14 *ft* (Width of the pier)
L_{WA} = 63 *ft* (Length of the west abutment)
L_{EA} = 32 *ft* (Length of the east abutment)
B_C = 100 *ft* (Width of the channel)
θ = 24.14 *deg* (Protection angle provided by dolphin)

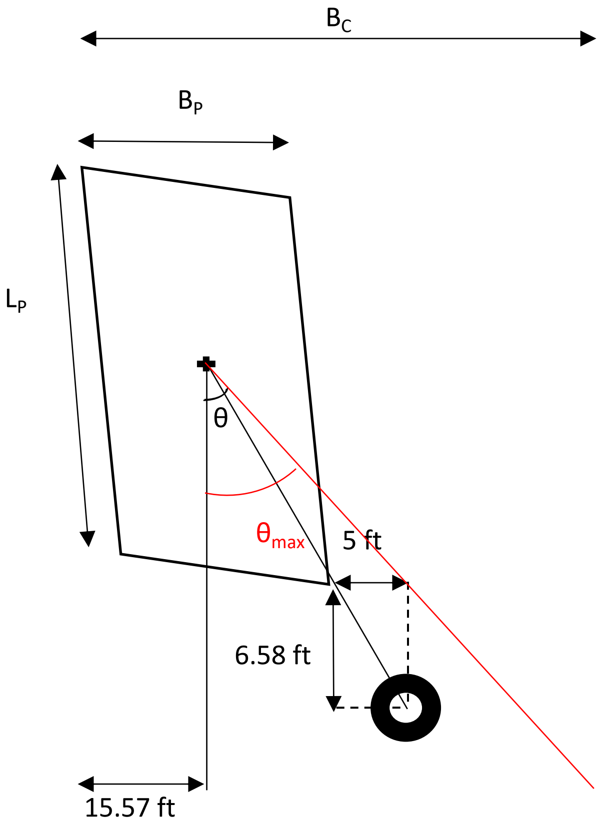
$$\theta_{max} = \sin^{-1}\frac{B_C - {}^{B_P}/_2}{LOA + {}^{B_P}/_2}$$

(Max. possible protection angle allowed by channel geometry)

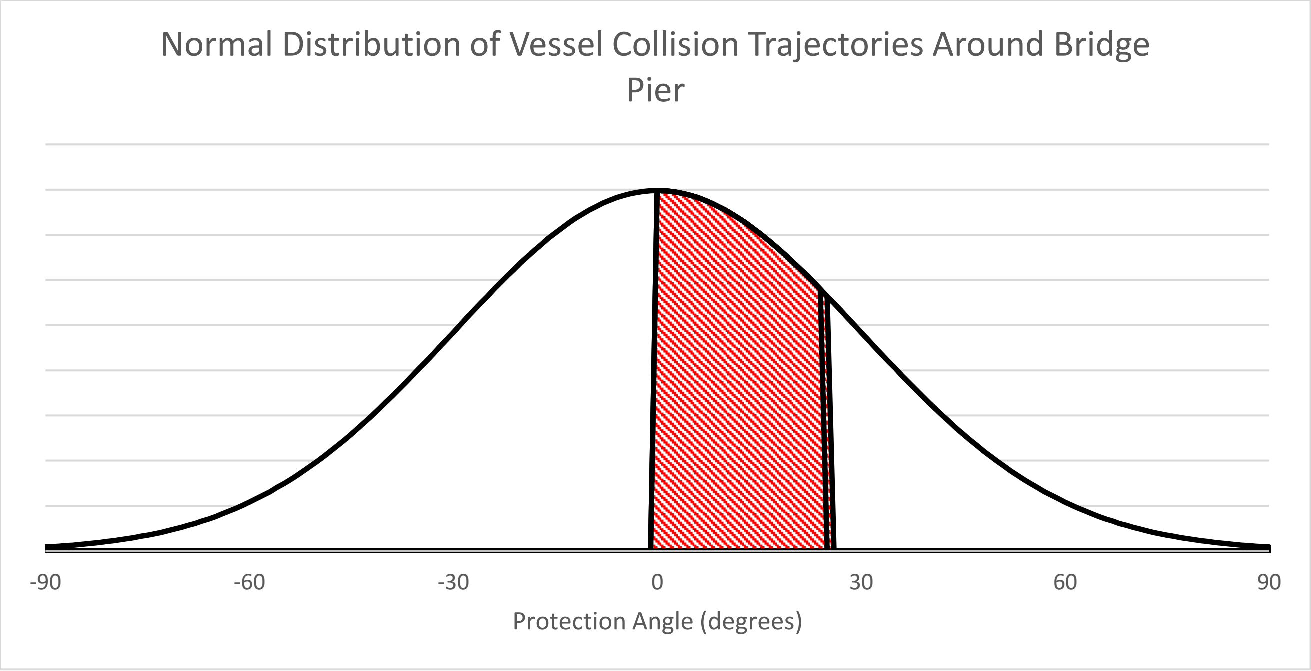
θ_{max} = 25.13 *deg*

σ = 30 *deg* (Standard deviation of the normal distribution, assumed)
θ *Protection* = *the area in the density function between 0 and* θ *(in %)*
θ *Protection* = 11.04 %
θ_{max} *Protection* = *the area in the density function between 0 and* θ_{max} *(in %)*
θ_{max} *Protection* = 11.80 *%*
rotection Provided = 93.49 *%* (Protection provided by dolphin, adjusted per max. protection angle)
PF = 1 - (% Protection Provided/100) *Ref. 1 Equation 3.14.5.5-1*
PF = 0.065141

Plan of Dolphin Protection (Not to Scale):



Illustrative Model of the Protection Factor (PF) of Dolphin Protection around a Bridge Pier:



Annual Frequency of Collapse, *AF* : *Ref. 1 Article 3.14.5*

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: JRA DATE: 11/21/19
SUBJECT: RTA 1 - Carroll Street Dolphin Design CHECKED BY: PLT DATE: 12/18/19

$N =$ 3 (Annual number of vessels that utilize the channel, assumed)
$AF =$ $(N)\ (PA)\ (PG)\ (PC)\ (PF)$ *Ref. 1 Equation 3.14.5-1*
$AF =$ 8.97E-07

$AF_{MAX} =$ 0.001 (Maximum annual frequency of collapse for typical bridges)
$AF \leq AF_{MAX}$ ***OK***

Vessel Collision Force:

Design Collision Velocity, *V* : *Ref. 1 Article 3.14.6*

$V_{MIN} =$ 0.52 *ft/s* (Minimum design impact velocity = yearly mean current velocity for the bridge location) *Provided by Geosyntec*

$V_T =$ V_{MIN} (Typical vessel transit velocity in the channel under normal environmental conditions)
$V_T =$ 0.52 *ft/s*

$X =$ 22.36 *ft* (Distance to face of pier from centerline of channel, measured in CAD)
$X_C =$ 50 *ft* (Distance from centerline to edge of channel, measured in CAD)
$X_L =$ 585 *ft* (Distance equal to 3.0 times the length overall of the design vessel)
$V =$ 0.52 *ft/s* (Design impact velocity)

Vessel Collision Energy, *KE* : *Ref. 1 Article 3.14.7*

$W =$ 181.44 *tonnes* (Vessel displacement tonnage)
$UC =$ 11.05 *ft* (Underkeel clearance)
$C_H =$ 1.05 (Hydrodynamic mass coefficient) *Ref. 1 Equations 3.14.7-2,3*
$KE = (C_H\ W\ V^2)\ /\ 29.2$ (Vessel collision energy) *Ref. 1 Equation 3.14.7-1*
$KE =$ 1.76 *k-ft*

Barge Bow Damage Length, a_B : *Ref. 1 Article 3.14.12*

$$a_B = 10.2\left(\sqrt{1+\frac{KE}{5{,}672}}-1\right)$$

Ref. 1 Equation 3.14.12-1

$a_B =$ 0.0016 *ft*

Barge Collision Force on the Pier, P_B: *Ref. 1 Article 3.14.11*

$P_B =$ $4{,}112\ a_B$ (Equivalent static barge impact force) *Ref. 1 Equation 3.14.11-1*
$P_B =$ 6.522 *kips*

Vessel Collision Force, *CV* :

Load Factor = 1.00 *Ref. 1 Table 3.4.1-1*
$CV =$ P_B * *Load Factor*

CV =* 6.52 *kips

BROMS' METHOD FOR LATERALLY LOADED PILES

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	11/21/19
SUBJECT:	RTA 1 - Carroll Street Dolphin Design	CHECKED BY:	PLT	DATE:	12/18/19

RTA 1 - Carroll Street Dolphin Design - Broms' Method for Laterally Loaded Piles

(These calculations follow the procedure set forth in Ref. 2, Section 7.2)

Soil Parameters within the Critical Depth at Location CSDL01 (Controls):

Assumed soil layer =	Soil Layer 2 - Glacial Deposit		
Soil type =	Cohesionless		
Soil density =	Medium to Dense		
K_{h3} =	35	*kcf*	(Coefficient of horizontal subgrade reaction for soil layer 2)
$K_{h3,\ adj}$ =	17.5	*kcf*	(Adjusted for cyclic loading conditions)
K_{p3} =	3.537		(Rankine passive earth pressure coefficient for soil layer 2)

Load Combination

1. Extreme Event II - Collision by Vessels — *Ref. 1 Sect. 3.4.1*

2. Water Load and Stream Pressure (WA) and Vessel Collision Forces (VC) have load factors of 1 for Extreme Event II. — *Ref. 1 Table 3.4.1-1*

3. All resistance factors for the extreme limit event state shall be taken to be 1. — *Ref. 1 Sect. 6.5.5*

Pile Parameters:

Section Parameters:

D =	2.00	*ft*	(Diameter of pile, outside)
t =	0.438	*in*	(Thickness of pile)
D_i =	1.927	*ft*	(Diameter of pile, inside)
C =	75.40	*in*	(Circumference of pile)
I =	2251	in^4	(Moment of inertia of the pile section)
S =	187.6	in^3	(Section modulus of the pile)
w =	110.3	*lb/ft*	(Weight of pile per unit length)
A_g =	32.42	in^2	(Cross sectional area of steel)
Z=	243.2	in^3	(Plastic section modulus of pile)

Circular Tubes — *Ref. 1 Sect. 6.12.2.2.3*

D/t= 54.79

$.07E/F_y$= 40.60

D/t > $.07E/F_y$ — ***CHECK LOCAL BUCKLING***

Moment Capacity

$0.31E/F_y$= 179.80

D/t < $0.31E/F_y$

M_n= 955 *k-ft* (Nom. Flex. Resistance Local Buckling) — *Ref. 1 Eq. 6.12.2.2.3-3*

M_{max} = 202.50 *k-ft*

M_n > M_{max} — ***OK***

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	11/21/19
SUBJECT:	RTA 1 - Carroll Street Dolphin Design	CHECKED BY:	PLT	DATE:	12/18/19

Shear Capacity

L_v= 102.0 *in* (Distance between point of max and zero shear)

F_{cr1}= (1.60*E)/(sqrt(L_v/D)*(D/t)$^{(5/4)}$) *Ref. 1 Eq. 6.12.1.2.3c-2*

F_{cr1}= 151.0 *ksi*

F_{cr2}= (0.78*E)/(D/t)^(3/2) *Ref. 1 Eq. 6.12.1.2.3c-3*

F_{cr2}= 55.8 *ksi* (Shear Buckling Resistance)

F_{cr2} < F_{cr1} Use Fcr1 Value

V_n= 0.5*A_g*F_{cr} (Nominal Shear Resistance) *Ref. 1 Eq. 6.12.1.2.3c-1*

V_n= 2447 *k*

V_u= 20.8 *k* (max. shear applied)

V_n > V_u ***OK***

Member Parameters:

$T = \sqrt[5]{EI/K_{h3,adj}}$ (Characteristic length of the pile for cohesionless soil) *Ref. 3 Figure 3*

T = 7.63 *ft*

h $_{T,MIN}$ = *3T* (Minimum depth of embedment of the pile for cohesionless soil) *Ref. 3 Figure 3*

h $_{T,MIN}$ = 22.90 *ft*

h $_T$ = 32.56 *ft* (Design depth of embedment)

L = 60.00 *ft* (Total length of pile)

e $_c$ = 27.44 *ft* (Vertical distance between mudline and lateral load)

W = *wL* (Weight of pile)

W = 6619.436 *lb*

Critical Depth:

CD = 4 to 5 pile diameters *Ref. 2 Sect. 7.2*

CD = 9.00 *ft*

EL $_{CD}$ = *EL* $_2$ - *CD* (Elevation of the critical depth)

EL $_{CD}$ = -26.44 *ft*

Preliminary Design Checks:

Does the elevation of the critical depth fall within the assumed soil layer?

$|EL_{CD}| \geq |EL_2|$ ***OK***

Assumed soil layer is correct; OK to continue with design

Is the length of the pile above MHW adequate to protect against design vessel?

L $_{top}$ = 8.04 *ft* (Length of pile above MHW)

B $_{DL,top}$ = *B* $_D$ - *B* $_{LD}$ (Depth of loaded barge above MHW)

B $_{DL,top}$ = 3.3 *ft*

L $_{top}$ ≥ *B* $_{DL,top}$ ***OK***

Maximum Allowable Deflection of a Single Pipe Pile - Free Head Condition:

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	11/21/19
SUBJECT:	RTA 1 - Carroll Street Dolphin Design	CHECKED BY:	PLT	DATE:	12/18/19

Dimensionless Length Factor, ηh_T:

$\eta = (K_{h3,adj}/EI)^{1/5}$

$\eta =$ 0.131 *ft*

$\eta h_T =$ 4.266 ***LONG***

Ultimate Lateral Load Capacity of the Pile, Q_u:

$M_n/\gamma'_3 D^4 K_{p3} =$ #REF!

$e_c/D =$ 13.72

$Q_u/K_{p3} D^3 \gamma'_3 =$ 11.5 (Approximate value based on graph) *Ref. 2 Figure 7-4*

$Q_u =$ 20.37 *kips* (Ultimate lateral load for a single pile)

Maximum Allowable Working Load, Q_m:

$Q_m = Q_u / 2.5$

$Q_m =$ 8.15 *kips*

Lateral Deflection at the Mudline:

$\eta h_T =$ 4.266

$e_c/h_T =$ 0.843

$\frac{y_m (EI)^{3/5} K_{h3,adj}{}^{2/5}}{Q_m h_T} =$ 1.79 (Approximate value based on graph) *Ref. 2 Figure 7-6*

$y_m =$ 0.732 *in* (Lateral deflection of the pile at the mudline)

DESIGN ELEVATIONS

RTA 1 - Carroll Street Dolphin Design - CSDL01

(Using CPT Location LIFCPTMC1400-A from Appendix B - Figure 5a)

Design Elevations:

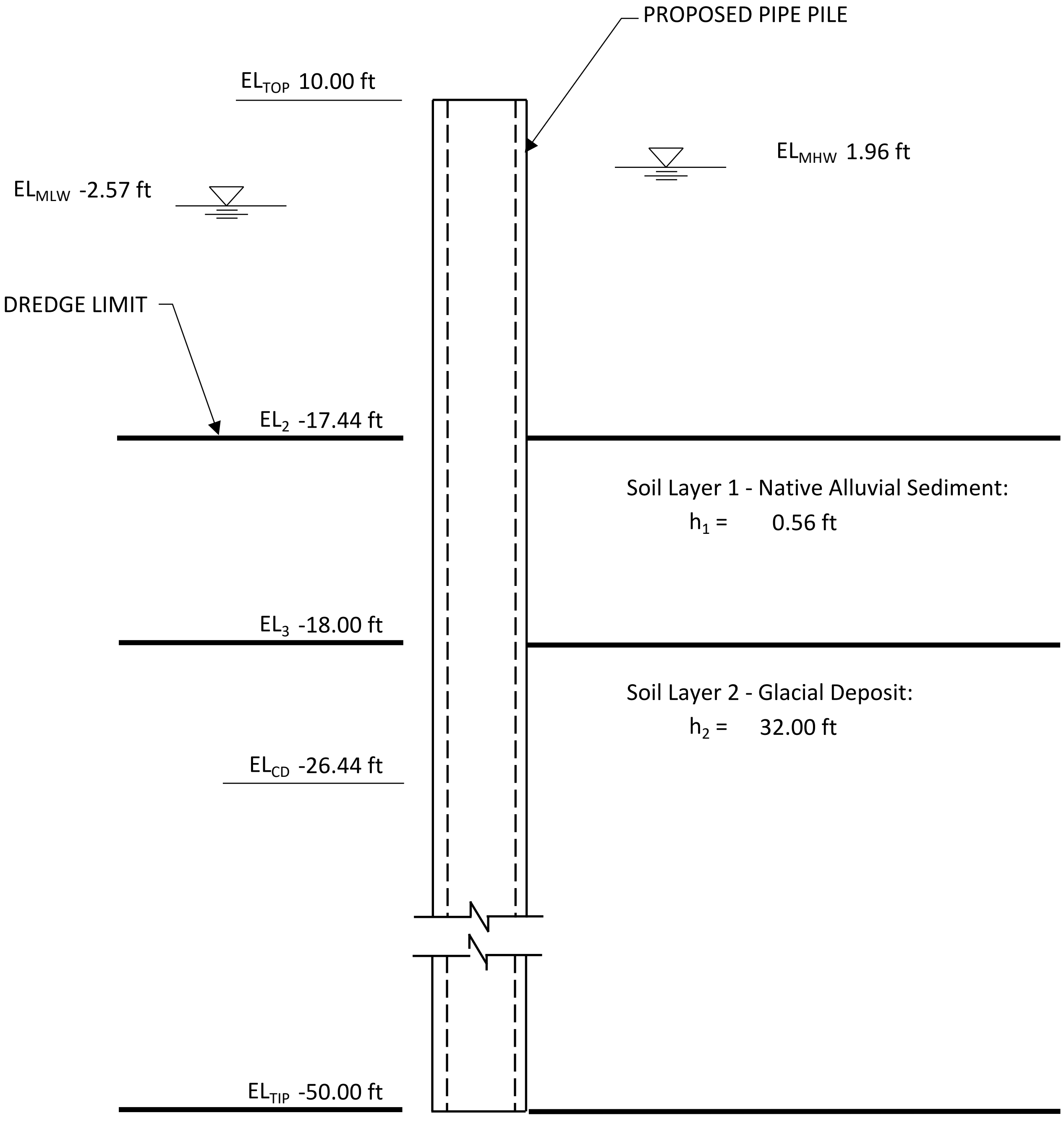
(All elevations are based on the North American Vertical Datum of 1988 (NAVD88))

EL_1 =	-14.44	ft	(Minimum top of cap and fill elevation)
EL_2 =	-17.44	ft	(Minimum el. of fill-native interface = dredge elevation)
EL_3 =	-18.00	ft	(Minimum el. of native-glacial interface)
EL_{CD} =	-26.44	ft	(Elevation of the critical depth)
EL_{TOP} =	10.00	ft	(Top of pile elevation)
EL_{TIP} =	-50.00	ft	(Tip of pile elevation)
MHW EL =	1.96	ft	(Mean high water elevation)
MLW EL =	-2.57	ft	(Mean low water elevation)

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: JRA DATE: 11/21/19
SUBJECT: RTA 1 - Carroll Street Dolphin Design CHECKED BY: PLT DATE: 12/18/19

Pipe Pile Cross-Section (Not to Scale):



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PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	11/21/19
SUBJECT:	RTA 1 - Carroll Street Dolphin Design	CHECKED BY:	PLT	DATE:	12/18/19

RTA 1 - Carroll Street Dolphin Design - CSDL02

(Using CPT Location LIFCPTMC1400-A from Appendix B - Figure 5a)

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88))

$EL_1 =$ -12.68 *ft* (Minimum top of cap and fill elevation)

$EL_2 =$ -15.68 *ft* (Minimum el. of fill-native interface = dredge elevation)

$EL_3 =$ -18.00 *ft* (Minimum el. of native-glacial interface)

$EL_{CD} =$ -24.68 *ft* (Elevation of the critical depth)

$EL_{TOP} =$ 10.00 *ft* (Top of pile elevation)

$EL_{TIP} =$ -48.24 *ft* (Tip of pile elevation)

MHW EL = 1.96 *ft* (Mean high water elevation)

MLW EL = -2.57 *ft* (Mean low water elevation)

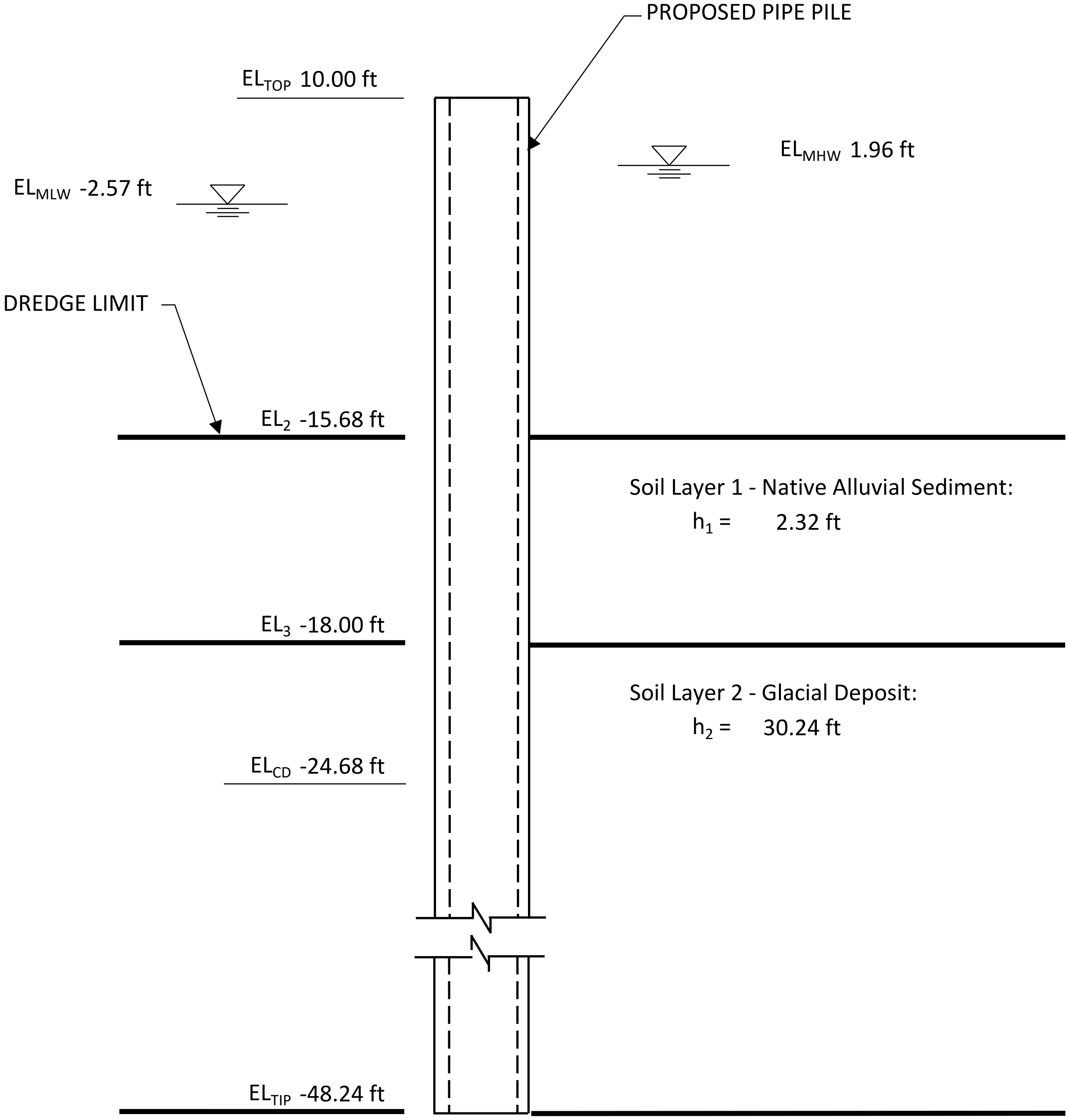
GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______

JOB NO.: BAB-2017020.01 MADE BY: JRA DATE: 11/21/19

SUBJECT: RTA 1 - Carroll Street Dolphin Design CHECKED BY: PLT DATE: 12/18/19

Pipe Pile Cross-Section (Not to Scale):



GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______

JOB NO.: BAB-2017020.01 MADE BY: JRA DATE: 11/21/19

SUBJECT: RTA 1 - Carroll Street Dolphin Design CHECKED BY: PLT DATE: 12/18/19

RTA 1 - Carroll Street Dolphin Design - CSDL03

(Using CPT Location LIFCPTMC1500-B from Appendix B - Figure 5a)

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88))

EL_1 = -12.75 *ft* (Minimum top of cap and fill elevation)

EL_2 = -15.75 *ft* (Minimum el. of fill-native interface = dredge elevation)

EL_3 = -21.67 *ft* (Minimum el. of native-glacial interface)

EL_{CD} = -24.75 *ft* (Elevation of the critical depth)

EL_{TOP} = 10.00 *ft* (Top of pile elevation)

EL_{TIP} = -48.31 *ft* (Tip of pile elevation)

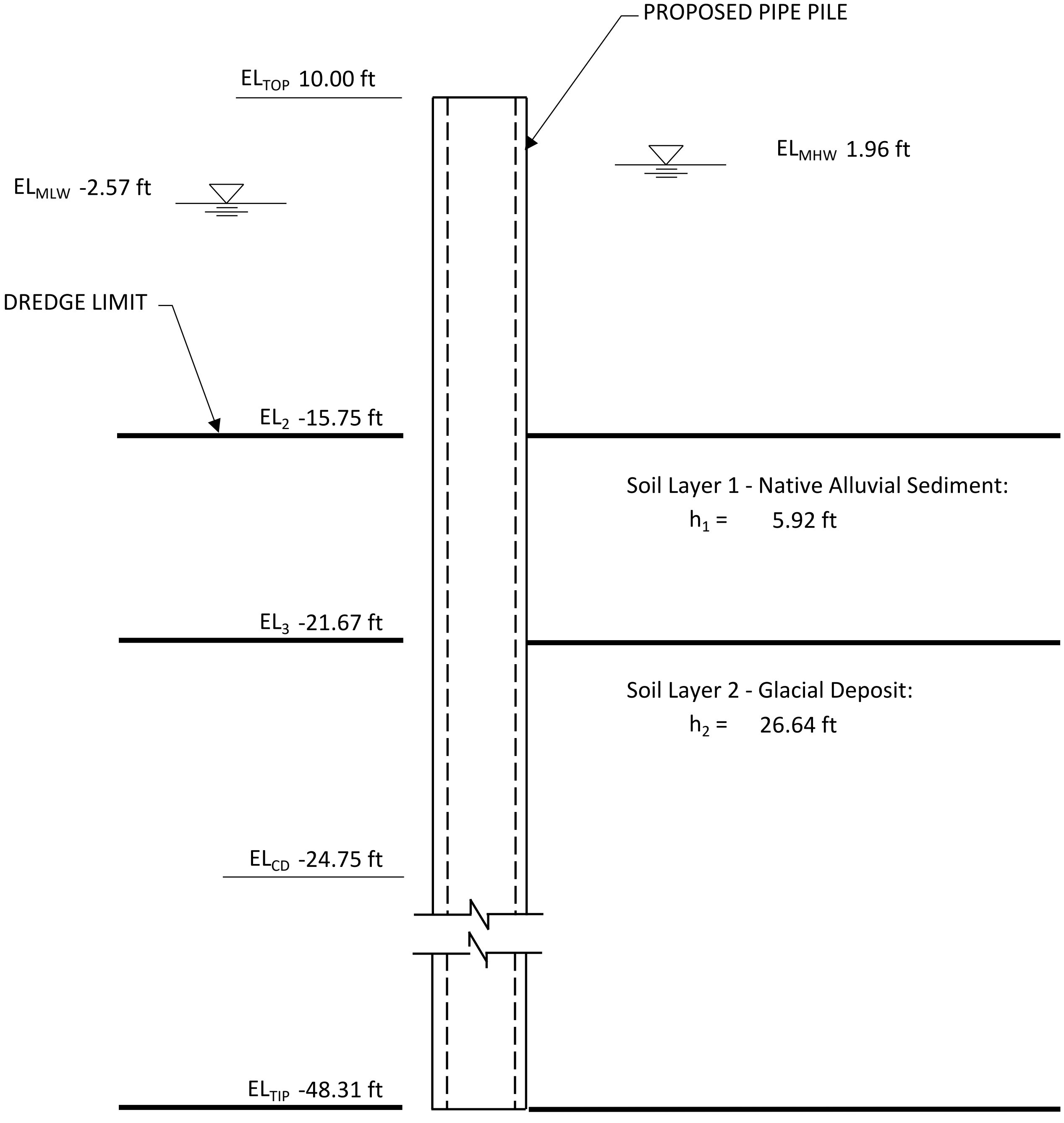
MHW EL = 1.96 *ft* (Mean high water elevation)

MLW EL = -2.57 *ft* (Mean low water elevation)

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: JRA DATE: 11/21/19
SUBJECT: RTA 1 - Carroll Street Dolphin Design CHECKED BY: PLT DATE: 12/18/19

Pipe Pile Cross-Section (Not to Scale):



GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: JRA DATE: 11/21/19
SUBJECT: RTA 1 - Carroll Street Dolphin Design CHECKED BY: PLT DATE: 12/18/19

RTA 1 - Carroll Street Dolphin Design - CSDL04

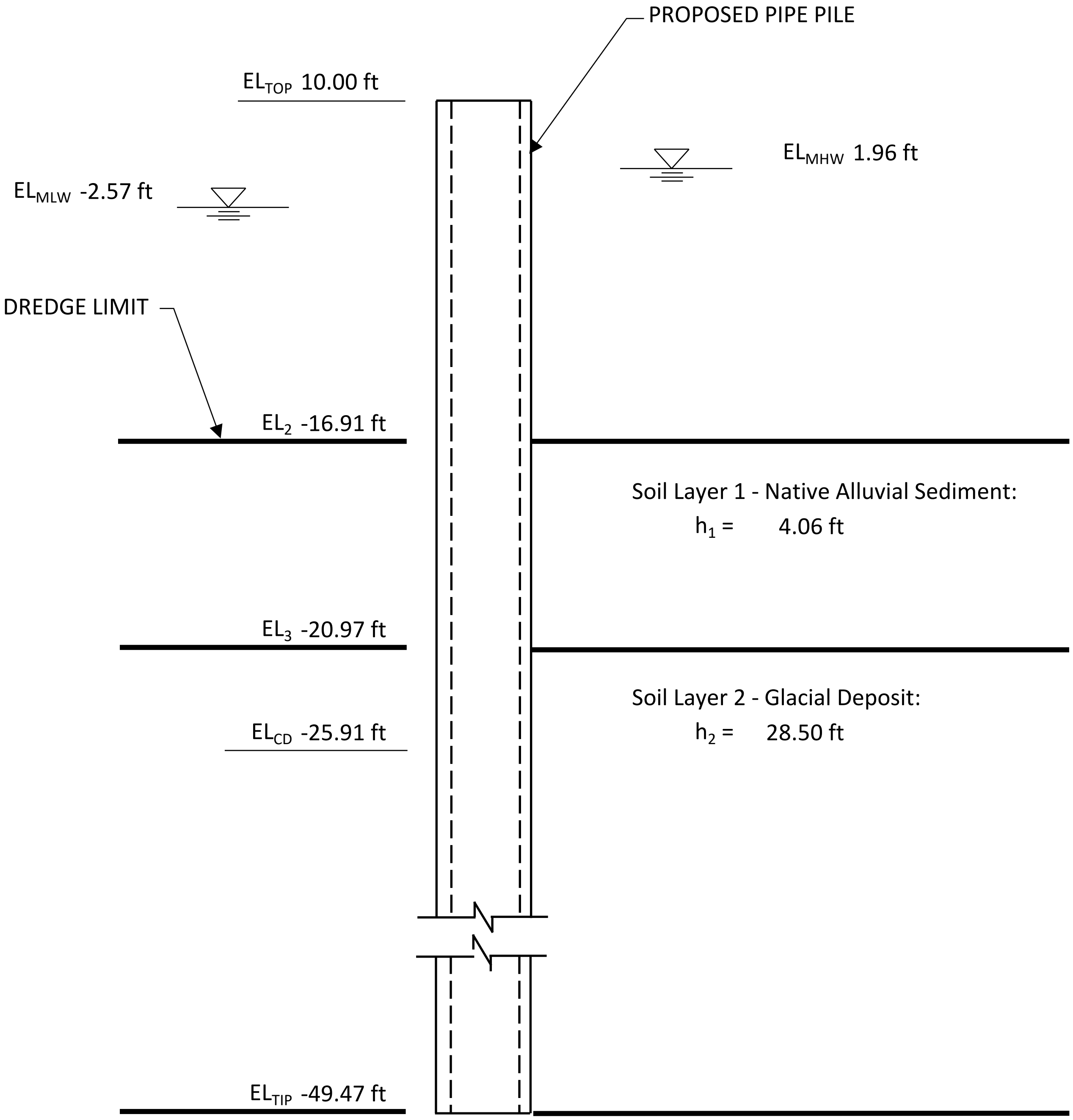
(Using CPT Location LIFCPTMC1500-A from Appendix B - Figure 5a)

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88))

EL_1 = -13.91 *ft* (Minimum top of cap and fill elevation)
EL_2 = -16.91 *ft* (Minimum el. of fill-native interface = dredge elevation)
EL_3 = -20.97 *ft* (Minimum el. of native-glacial interface)
EL_{CD} = -25.91 *ft* (Elevation of the critical depth)
EL_{TOP} = 10.00 *ft* (Top of pile elevation)
EL_{TIP} = -49.47 *ft* (Tip of pile elevation)
MHW EL = 1.96 *ft* (Mean high water elevation)
MLW EL = -2.57 *ft* (Mean low water elevation)

Pipe Pile Cross-Section (Not to Scale):



PILE STOP DESIGN

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	11/21/19
SUBJECT:	RTA 1 - Carroll Street Dolphin Design	CHECKED BY:	PLT	DATE:	12/18/19

RTA 1 - Carroll Street Dolphin Design - Pile Stop Design

Fillet Weld Design:

Factored Shear Resistance of the Weld Metal, R_r: *Ref. 1 Article 6.13.3.2.4*

F_{exx} = 70 *ksi* (Classification strength of the weld metal)

φ_{e2} = 0.80 (Resistance factor for weld metal in fillet welds) *Ref. 1 Article 6.5.4.2*

$R_r = 0.6\,\varphi_{e2}\,F_{exx}$ *Ref. 1 Equation 6.13.3.2.4-1*

R_r = 33.6 *ksi*

Effective Area of the Weld, A_{ew}: *Ref. 1 Article 6.13.3.3*

$L_w = C$ (Length of the weld = circumference of the pile)

L_w = 75.40 *in*

w = 5/16 *in* (Weld size, maximum for a single pass)

$t_e = w\cos(45^\circ)$ (Effective throat)

t_e = 0.221 *in*

$A_{ew} = L_w\,t_e$

A_{ew} = 16.66 in^2

Factored Shear Rupture Resistance, R_r:

$A_{vn} = A_{ew}$ (Net area of the plate subject to shear)

A_{vn} = 16.66 in^2

F_u = 58 *ksi* (Tensile strength of the plate)

R_p = *neglected*

no bolt holes (Reduction factor for holes taken equal to 0.90 for bolt holes punched full size and 1.0 for bolt holes drilled full size or subpunched and reamed to size)

φ_{vu} = 0.80 (Resistance factor for shear rupture of connection elements) *Ref. 1 Article 6.5.4.2*

Factored Shear Resistance of the Weld Metal, R_w: *Ref. 1 Article 6.13.3.2.4*

$R_r\,A_{ew}$ = 559.80 *kips*

$\varphi_{vu}\,0.58R_p\,F_u\,A_{vn}$ = 448.38 *kips* *Ref. 1 Equation 6.13.5.3-2*

R_w = 448.38 *kips*

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ____ OF ____
JOB NO.: BAB-2017020.01 MADE BY: JRA DATE: 11/21/19
SUBJECT: RTA 1 - Carroll Street Dolphin Design CHECKED BY: PLT DATE: 12/18/19

Pile Stop Design:

Plate Section Parameters:

CD_f = 2.90 *ft* (Diameter of donut fender core) *Appendix D - Page 1*

$D_P = CD_f + 2$ *in* (Diameter of the plate)

D_P = 37 *in*

T_P = 1 *in* (Thickness of the plate)

C_P = 116.24 *in* (Circumference of the plate)

F_y = 36 *ksi* (Specified minimum yield strength)

F_u = 58 *ksi* (Tensile strength)

Plate Design Checks

l= 6.50 *in* (cantilever length of pile stop beyond pile diameter)

$P_{D,up}$ = 13346 *lbs* (point load from uplift)

Assume point load at end of cantilevered plate (conservative)

Check Bending

M_{max} = 7 *kip-ft* *Ref. 6 Table 3-23, 22*

Z= 4.71 in^3 (assume 1/4 of pile circumference for width)

M_n = 14 *kip-ft*

ΦM_n = 12.7 *kip-ft*

$\Phi M_n > M_{max}$ **OK**

Check Shear

V_{max} = 13.35 *kip* *Ref. 6 Table 3-23, 23*

V_n = 36.00 *kip*

ΦV_n = 32.40 *kip*

$V_n > V_{max}$ **OK**

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PROJECT: RTA 1 Bridge Stability Final Design SHEET: _____ OF _____
JOB NO.: BAB-2017020.01 MADE BY: JRA DATE: 11/21/19
SUBJECT: RTA 1 - Carroll Street Dolphin Design CHECKED BY: PLT DATE: 12/18/19

Weld Design Checks

Can the weld resist the impact of a vessel collision on the pile stop?

$CV =$ 6.522 *kips* (Vessel collision force)

$R_w \geq CV$ **OK**

Is the thickness of the plate adequate for the weld size chosen?

$T = T_P$ (Thickness of the plate) *Ref. 1 Table 6.13.3.4-1*

$T =$ 1 *in*

$T >$ *3/4* **OK** *Ref. 1 Table 6.13.3.4-1*

Can the connection resist the uplift force of the donut fender?

$F_B =$ 13346.3 *lbs* (Buoyant weight of the donut fender)

$WD_B =$ 13346.3 *lbs* (Nominal weight of the donut fender)

$P_{D,up} = F_B$ (Equivalent uplift force on the plate)

$P_{D,up} =$ 13346 *lbs*

$p_{D,up} = P_{D,up} / C$ (Uplift force, distributed around the circumference of the pile)

$p_{D,up} =$ 0.18 *kips/in*

$r_w = R_w / C$

(Shear resistance of the weld, distributed around the circumference of the pile) $r_w =$ 5.95 *kips/in*

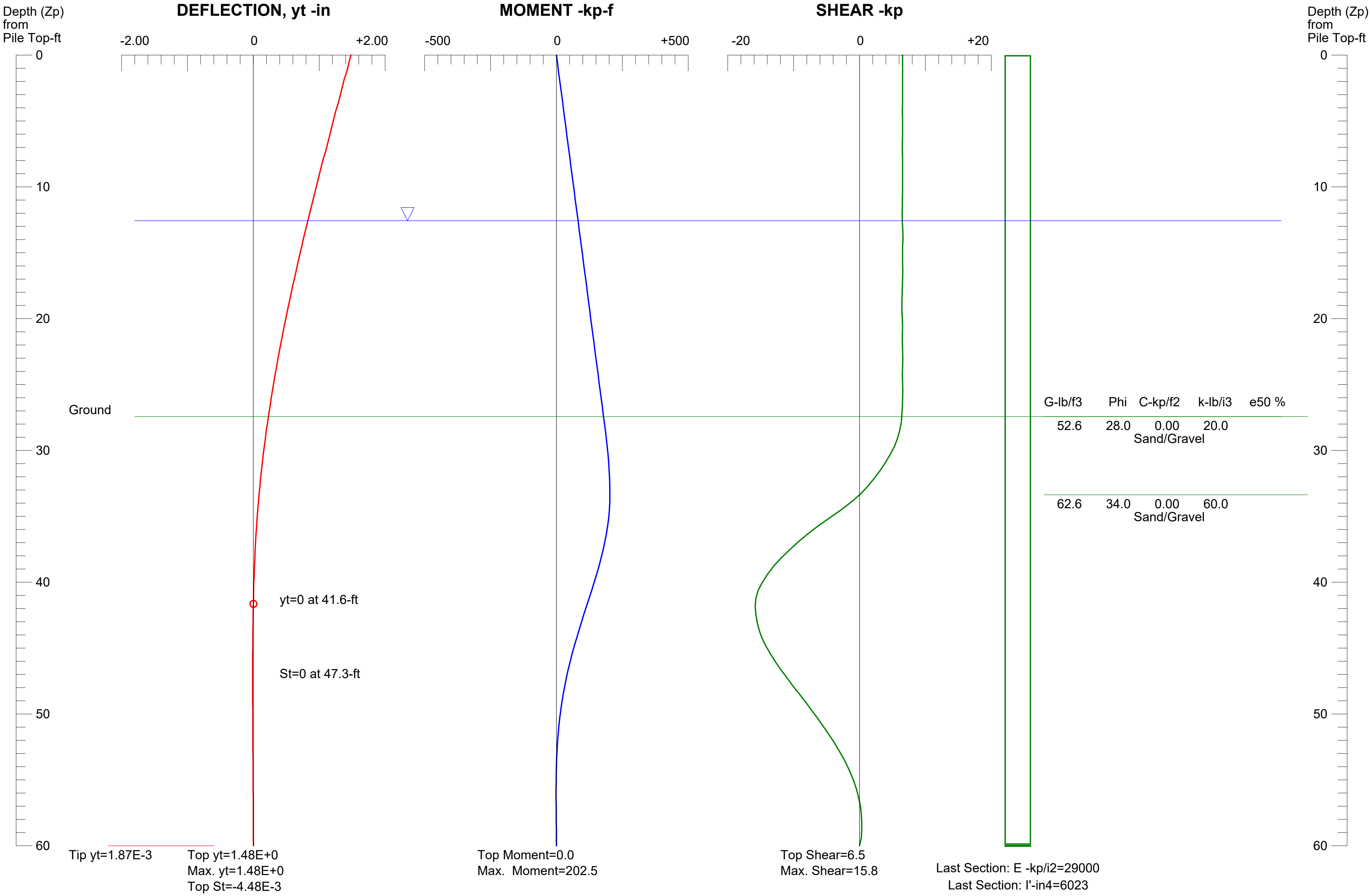
$r_w \geq p_{D,up}$ **OK**

ATTACHMENT A – CIVILTECH ALLPILE OUTPUT

CSDL01 - VESSEL COLLISION FORCE

PILE DEFLECTION & FORCE vs DEPTH

Single Pile, Khead=2, Kbc=1



CivilTech Software

Gowanus Canal Superfund Site
Carroll Street Dolphin Design

Figure 1

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Depth vs. Deflection, Moment, Shear, and Slope in Single Pile:

****************************************************************************


Zp      yt      Moment  Shear   Pressure        Slope
-ft     -in     -kp-f   -kp     -kp/f2

0.0     1.480   0.0     6.5     0.0             -0.00448
0.6     1.450   4.0     6.5     0.0             -0.00413
1.2     1.420   7.9     6.5     0.0             -0.00412
1.8     1.380   11.8    6.5     0.0             -0.00550
2.4     1.350   15.8    6.5     0.0             -0.00413
3.0     1.320   19.8    6.5     0.0             -0.00413
3.6     1.290   23.8    6.5     0.0             -0.00412
4.2     1.250   27.7    6.5     0.0             -0.00550
4.8     1.220   31.6    6.5     0.0             -0.00413
5.5     1.190   35.6    6.5     0.0             -0.00413
6.1     1.160   39.5    6.5     0.0             -0.00412
6.7     1.130   43.5    6.5     0.0             -0.00413
7.3     1.100   47.4    6.5     0.0             -0.00413
7.9     1.060   51.3    6.5     0.0             -0.00549
8.5     1.030   55.3    6.5     0.0             -0.00413
9.1     1.000   59.3    6.5     0.0             -0.00413
9.7     0.970   63.3    6.5     0.0             -0.00413
10.3    0.940   67.2    6.5     0.0             -0.00412
10.9    0.909   71.2    6.5     0.0             -0.00426
11.5    0.879   75.1    6.5     0.0             -0.00413
12.1    0.849   79.0    6.5     0.0             -0.00413
12.7    0.820   83.0    6.5     0.0             -0.00398
13.3    0.790   86.7    6.6     0.0             -0.00413
13.9    0.761   90.8    6.6     0.0             -0.00399
14.5    0.733   95.0    6.5     0.0             -0.00385
15.2    0.705   99.2    6.5     0.0             -0.00385
15.8    0.677   102.5   6.5     0.0             -0.00385
16.4    0.649   106.7   6.6     0.0             -0.00385
17.0    0.622   110.8   6.5     0.0             -0.00371
17.6    0.595   115.0   6.5     0.0             -0.00371
18.2    0.569   118.3   6.5     0.0             -0.00358
18.8    0.543   122.5   6.4     0.0             -0.00358
19.4    0.517   126.7   6.4     0.0             -0.00357
20.0    0.492   130.0   6.5     0.0             -0.00344
20.6    0.468   134.2   6.5     0.0             -0.00330
21.2    0.444   138.3   6.5     0.0             -0.00330
21.8    0.420   142.5   6.5     0.0             -0.00330
22.4    0.397   145.8   6.5     0.0             -0.00316
23.0    0.375   150.0   6.6     0.0             -0.00303
```

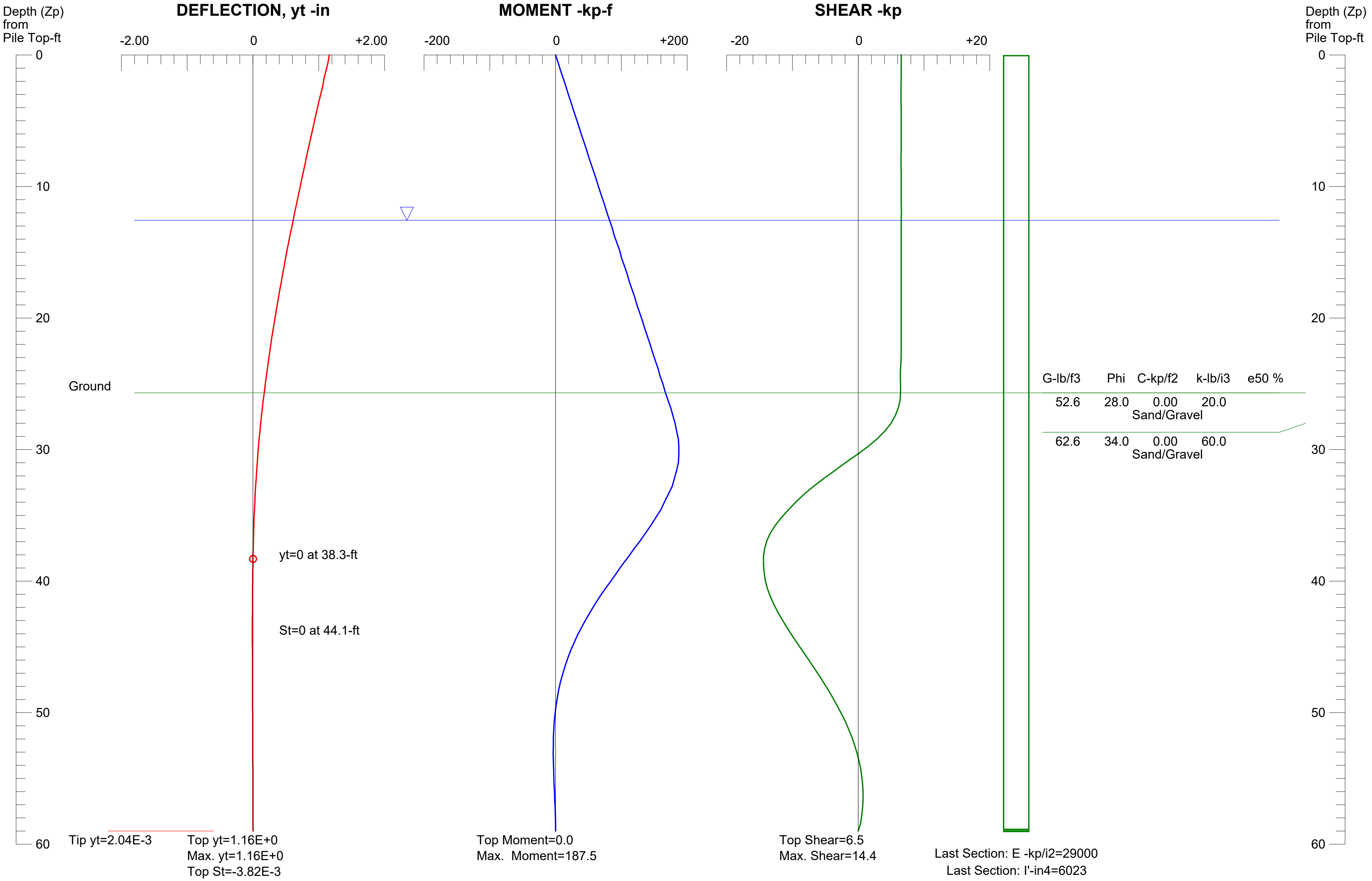
```
23.6    0.353   154.2   6.5     0.0             -0.00302
24.2    0.331   158.3   6.5     0.0             -0.00303
24.8    0.311   161.7   6.5     0.0             -0.00275
25.5    0.290   165.8   6.6     0.0             -0.00289
26.1    0.271   170.0   6.5     0.0             -0.00261
26.7    0.252   174.2   6.5     0.0             -0.00261
27.3    0.233   177.5   6.4     0.0             -0.00261
27.9    0.216   181.7   6.3     0.0             -0.00234
28.5    0.198   185.8   6.1     -0.1            -0.00248
29.1    0.182   189.2   5.8     -0.1            -0.00220
29.7    0.166   192.5   5.3     -0.1            -0.00220
30.3    0.151   195.8   4.7     -0.1            -0.00206
30.9    0.137   198.3   3.9     -0.1            -0.00193
31.5    0.123   200.0   3.1     -0.2            -0.00193
32.1    0.111   201.7   2.2     -0.2            -0.00165
32.7    0.098   202.5   1.2     -0.2            -0.00172
33.3    0.087   202.5   0.1     -0.2            -0.00157
33.9    0.076   202.5   -1.3    -0.3            -0.00146
34.5    0.067   200.8   -2.9    -0.3            -0.00136
35.2    0.057   198.3   -4.6    -0.3            -0.00127
35.8    0.049   194.2   -6.3    -0.3            -0.00117
36.4    0.041   189.2   -7.9    -0.3            -0.00106
37.0    0.034   183.3   -9.4    -0.2            -0.00098
37.6    0.028   176.7   -10.7   -0.2            -0.00088
38.2    0.022   169.2   -11.9   -0.2            -0.00080
38.8    0.017   161.7   -13.0   -0.2            -0.00070
39.4    0.012   152.5   -14.0   -0.1            -0.00063
40.0    0.008   143.3   -14.7   -0.1            -0.00054
40.6    0.005   134.2   -15.4   -0.1            -0.00048
41.2    0.002   124.2   -15.7   0.0             -0.00041
41.8    -0.001  114.2   -15.8   0.0             -0.00035
42.4    -0.003  104.2   -15.7   0.0             -0.00029
43.0    -0.005  95.0    -15.5   0.1             -0.00024
43.6    -0.006  85.8    -15.2   0.1             -0.00019
44.2    -0.007  76.3    -14.8   0.1             -0.00015
44.8    -0.008  67.6    -14.2   0.1             -0.00011
45.5    -0.009  59.3    -13.5   0.1             -0.00008
46.1    -0.009  51.6    -12.7   0.2             -0.00005
46.7    -0.009  44.3    -11.9   0.2             -0.00002
47.3    -0.009  37.6    -11.0   0.2             0.00000
47.9    -0.009  31.4    -10.1   0.2             0.00002
48.5    -0.009  25.8    -9.1    0.2             0.00003
49.1    -0.008  20.9    -8.2    0.2             0.00005
49.7    -0.008  16.5    -7.3    0.2             0.00006
50.3    -0.007  12.7    -6.4    0.2             0.00007
50.9    -0.007  9.3     -5.5    0.1             0.00007
51.5    -0.006  6.5     -4.7    0.1             0.00008
52.1    -0.006  4.2     -3.9    0.1             0.00008
```

```
52.7    -0.005  2.4     -3.2    0.1             0.00008
53.3    -0.005  0.9     -2.5    0.1             0.00008
53.9    -0.004  -0.1    -1.9    0.1             0.00008
54.5    -0.003  -0.8    -1.3    0.1             0.00008
55.2    -0.003  -1.2    -0.8    0.1             0.00008
55.8    -0.002  -1.4    -0.4    0.1             0.00008
56.4    -0.002  -1.4    -0.1    0.0             0.00008
57.0    -0.001  -1.2    0.1     0.0             0.00008
57.6    0.000   -0.9    0.3     0.0             0.00008
58.2    0.000   -0.6    0.3     0.0             0.00008
58.8    0.001   -0.3    0.3     0.0             0.00008
59.4    0.001   -0.1    0.3     0.0             0.00008
60.0    0.002   0.0     0.0     -0.1            0.00008
________________________________________________
Zp - Depth from pile Top
yt - Pile top deflection
Moment - Internal moment in pile shaft
Shear - Internal shear force in pile shaft
Pressure - Soil-Pile interactive pressure (Arching is considered)
Slope - Deflection slope at pile top
```

CSDL02 - VESSEL COLLISION FORCE

PILE DEFLECTION & FORCE vs DEPTH

Single Pile, Khead=2, Kbc=1



CivilTech Software

Gowanus Canal Superfund Site
Carroll Street Dolphin Design

Figure 2

```
Depth vs. Deflection, Moment, Shear, and Slope in Single Pile:

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Zp      yt      Moment  Shear   Pressure        Slope
-ft     -in     -kp-f   -kp     -kp/f2
_______________________________________________________________
0.0     1.160   0.0     6.5     0.0             -0.00382
0.6     1.140   3.9     6.5     0.0             -0.00280
1.2     1.110   7.8     6.5     0.0             -0.00420
1.8     1.080   11.7    6.5     0.0             -0.00420
2.4     1.060   15.6    6.5     0.0             -0.00279
3.0     1.030   19.4    6.5     0.0             -0.00420
3.6     1.000   23.3    6.5     0.0             -0.00420
4.2     0.975   27.2    6.5     0.0             -0.00350
4.8     0.948   31.1    6.5     0.0             -0.00378
5.4     0.921   35.0    6.5     0.0             -0.00378
6.0     0.894   38.8    6.5     0.0             -0.00377
6.6     0.868   42.8    6.5     0.0             -0.00364
7.2     0.841   46.7    6.5     0.0             -0.00378
7.7     0.815   50.5    6.5     0.0             -0.00364
8.3     0.789   54.4    6.5     0.0             -0.00364
8.9     0.763   58.3    6.5     0.0             -0.00364
9.5     0.737   62.2    6.5     0.0             -0.00364
10.1    0.712   66.1    6.5     0.0             -0.00349
10.7    0.687   69.9    6.5     0.0             -0.00350
11.3    0.662   73.8    6.5     0.0             -0.00350
11.9    0.637   77.8    6.6     0.0             -0.00350
12.5    0.613   81.6    6.5     0.0             -0.00336
13.1    0.589   85.8    6.5     0.0             -0.00336
13.7    0.565   89.2    6.5     0.0             -0.00336
14.3    0.541   93.3    6.5     0.0             -0.00335
14.9    0.518   97.5    6.5     0.0             -0.00322
15.5    0.495   100.8   6.5     0.0             -0.00322
16.1    0.473   105.0   6.5     0.0             -0.00308
16.7    0.450   109.2   6.5     0.0             -0.00322
17.3    0.429   112.5   6.5     0.0             -0.00294
17.9    0.407   116.7   6.5     0.0             -0.00307
18.5    0.386   120.8   6.5     0.0             -0.00294
19.1    0.366   124.2   6.5     0.0             -0.00280
19.7    0.346   128.3   6.5     0.0             -0.00280
20.3    0.326   132.5   6.5     0.0             -0.00280
20.9    0.307   135.8   6.5     0.0             -0.00266
21.5    0.288   140.0   6.5     0.0             -0.00266
22.1    0.270   144.2   6.5     0.0             -0.00251
22.6    0.252   147.5   6.5     0.0             -0.00252
```

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23.2    0.235   151.7   6.5     0.0               -0.00238
23.8    0.219   155.8   6.4     0.0               -0.00224
24.4    0.202   159.2   6.4     0.0               -0.00238
25.0    0.187   163.3   6.4     0.0               -0.00210
25.6    0.172   166.7   6.4     0.0               -0.00209
26.2    0.158   170.8   6.4     0.0               -0.00196
26.8    0.144   175.0   6.1     -0.1              -0.00196
27.4    0.131   178.3   5.6     -0.1              -0.00182
28.0    0.118   181.7   5.0     -0.2              -0.00182
28.6    0.106   184.2   4.0     -0.2              -0.00168
29.2    0.095   186.7   2.8     -0.3              -0.00154
29.8    0.084   187.5   1.4     -0.3              -0.00148
30.4    0.074   187.5   -0.2    -0.3              -0.00140
31.0    0.065   186.7   -1.9    -0.3              -0.00129
31.6    0.057   184.2   -3.5    -0.3              -0.00120
32.2    0.049   180.8   -5.2    -0.3              -0.00112
32.8    0.041   177.5   -6.8    -0.3              -0.00103
33.4    0.034   171.7   -8.2    -0.2              -0.00094
34.0    0.028   165.8   -9.4    -0.2              -0.00085
34.6    0.023   160.0   -10.6   -0.2              -0.00077
35.2    0.018   152.5   -11.7   -0.2              -0.00070
35.8    0.014   145.0   -12.6   -0.1              -0.00062
36.4    0.010   136.7   -13.4   -0.1              -0.00055
36.9    0.006   128.3   -13.9   -0.1              -0.00048
37.5    0.003   119.2   -14.2   0.0               -0.00042
38.1    0.001   110.8   -14.4   0.0               -0.00036
38.7    -0.002  101.7   -14.4   0.0               -0.00031
39.3    -0.003  93.3    -14.3   0.0               -0.00025
39.9    -0.005  85.0    -14.1   0.1               -0.00021
40.5    -0.006  76.3    -13.8   0.1               -0.00017
41.1    -0.007  68.2    -13.4   0.1               -0.00013
41.7    -0.008  60.4    -12.9   0.1               -0.00010
42.3    -0.008  53.0    -12.3   0.1               -0.00007
42.9    -0.008  46.1    -11.6   0.1               -0.00004
43.5    -0.009  39.6    -10.9   0.1               -0.00002
44.1    -0.009  33.5    -10.1   0.1               0.00000
44.7    -0.008  27.9    -9.3    0.1               0.00002
45.3    -0.008  22.8    -8.5    0.1               0.00003
45.9    -0.008  18.3    -7.7    0.1               0.00004
46.5    -0.008  14.3    -6.9    0.1               0.00005
47.1    -0.007  10.6    -6.1    0.1               0.00006
47.7    -0.007  7.5     -5.3    0.1               0.00006
48.3    -0.006  4.8     -4.6    0.1               0.00007
48.9    -0.006  2.5     -3.9    0.1               0.00007
49.5    -0.005  0.7     -3.2    0.1               0.00007
50.1    -0.005  -0.8    -2.6    0.1               0.00007
50.7    -0.004  -1.9    -2.0    0.1               0.00007
51.3    -0.004  -2.7    -1.5    0.1               0.00007
```

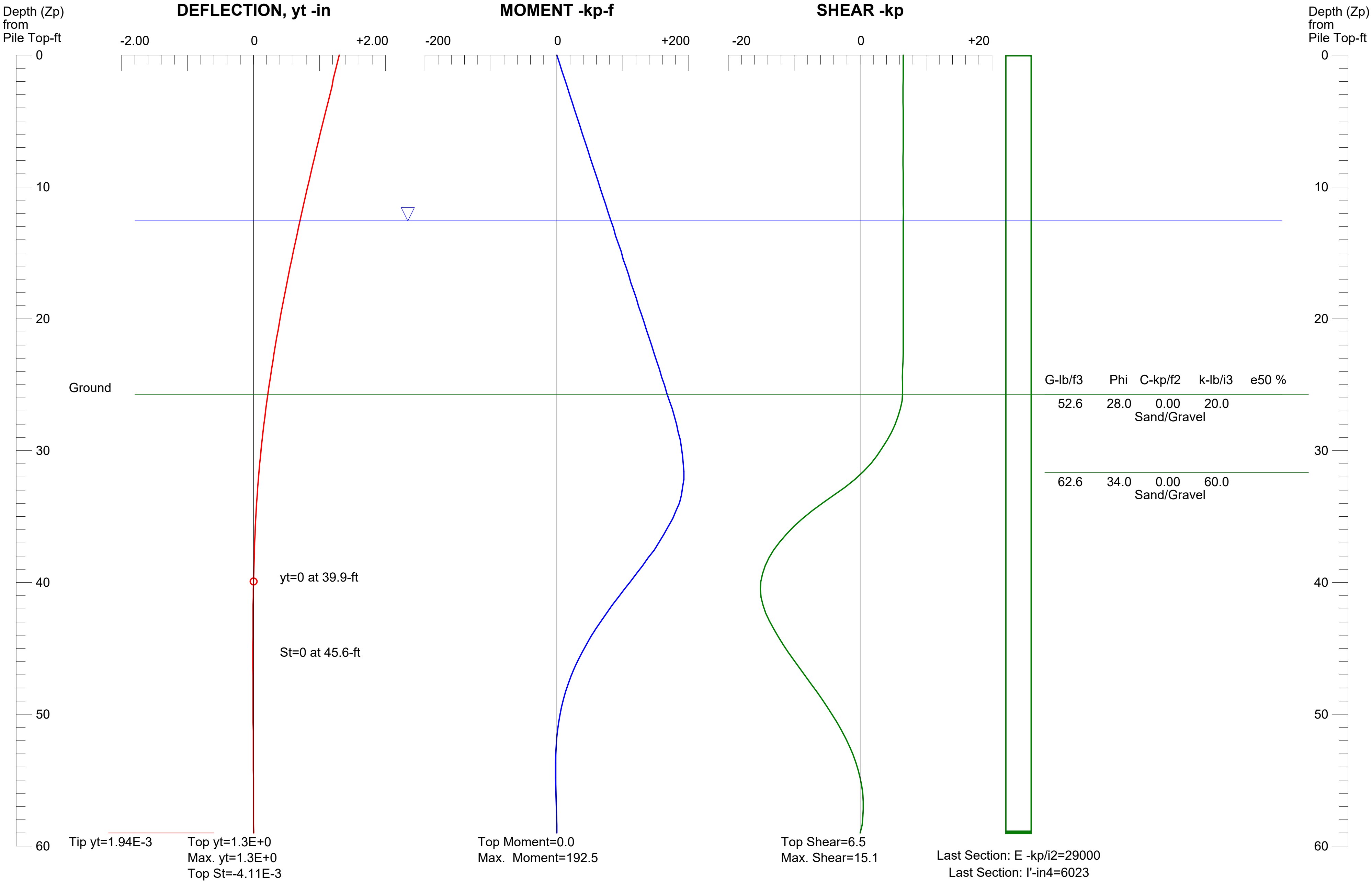
```
51.8    -0.003  -3.2    -1.0    0.1             0.00007
52.4    -0.003  -3.5    -0.6    0.1             0.00007
53.0    -0.002  -3.5    -0.2    0.1             0.00007
53.6    -0.002  -3.4    0.1     0.0             0.00006
54.2    -0.001  -3.1    0.4     0.0             0.00006
54.8    -0.001  -2.7    0.5     0.0             0.00006
55.4    0.000   -2.3    0.7     0.0             0.00006
56.0    0.000   -1.7    0.7     0.0             0.00006
56.6    0.000   -1.2    0.7     0.0             0.00006
57.2    0.001   -0.8    0.7     0.0             0.00006
57.8    0.001   -0.4    0.5     0.0             0.00006
58.4    0.002   -0.1    0.4     0.0             0.00006
59.0    0.002   0.0     0.0     -0.1            0.00006
```

Zp - Depth from pile Top
yt - Pile top deflection
Moment - Internal moment in pile shaft
Shear - Internal shear force in pile shaft
Pressure - Soil-Pile interactive pressure (Arching is considered)
Slope - Deflection slope at pile top

CSDL03 - VESSEL COLLISION FORCE

PILE DEFLECTION & FORCE vs DEPTH

Single Pile, Khead=2, Kbc=1



CivilTech Software

Page A-9

Gowanus Canal Superfund Site
Carroll Street Dolphin Design

Figure 3

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Depth vs. Deflection, Moment, Shear, and Slope in Single Pile:

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Zp      yt      Moment  Shear   Pressure        Slope
-ft     -in     -kp-f   -kp     -kp/f2
_______________________________________________________________
0.0     1.300   0.0     6.5     0.0             -0.00411
0.6     1.270   3.9     6.5     0.0             -0.00420
1.2     1.240   7.8     6.5     0.0             -0.00420
1.8     1.210   11.7    6.5     0.0             -0.00420
2.4     1.190   15.6    6.5     0.0             -0.00279
3.0     1.160   19.4    6.5     0.0             -0.00420
3.6     1.130   23.3    6.5     0.0             -0.00420
4.2     1.100   27.2    6.5     0.0             -0.00420
4.8     1.070   31.1    6.5     0.0             -0.00420
5.4     1.040   35.0    6.5     0.0             -0.00420
6.0     1.010   38.8    6.5     0.0             -0.00419
6.6     0.983   42.8    6.5     0.0             -0.00378
7.2     0.954   46.7    6.5     0.0             -0.00406
7.7     0.926   50.5    6.5     0.0             -0.00392
8.3     0.898   54.4    6.5     0.0             -0.00392
8.9     0.870   58.3    6.5     0.0             -0.00392
9.5     0.842   62.2    6.5     0.0             -0.00392
10.1    0.814   66.1    6.5     0.0             -0.00391
10.7    0.787   69.9    6.5     0.0             -0.00378
11.3    0.760   73.8    6.5     0.0             -0.00378
11.9    0.733   77.8    6.6     0.0             -0.00378
12.5    0.707   81.6    6.5     0.0             -0.00364
13.1    0.681   85.8    6.5     0.0             -0.00364
13.7    0.655   89.2    6.5     0.0             -0.00364
14.3    0.629   93.3    6.5     0.0             -0.00363
14.9    0.604   97.5    6.5     0.0             -0.00350
15.5    0.579   100.8   6.5     0.0             -0.00350
16.1    0.554   105.0   6.5     0.0             -0.00350
16.7    0.530   109.2   6.5     0.0             -0.00336
17.3    0.506   112.5   6.5     0.0             -0.00336
17.9    0.483   116.7   6.5     0.0             -0.00321
18.5    0.460   120.8   6.5     0.0             -0.00322
19.1    0.437   124.2   6.5     0.0             -0.00322
19.7    0.415   128.3   6.5     0.0             -0.00308
20.3    0.393   132.5   6.5     0.0             -0.00308
20.9    0.372   135.8   6.5     0.0             -0.00294
21.5    0.351   140.0   6.5     0.0             -0.00294
22.1    0.331   144.2   6.5     0.0             -0.00279
22.6    0.311   147.5   6.5     0.0             -0.00280
```

```
23.2    0.292   151.7   6.5     0.0             -0.00266
23.8    0.273   155.8   6.4     0.0             -0.00266
24.4    0.255   159.2   6.4     0.0             -0.00252
25.0    0.237   163.3   6.4     0.0             -0.00252
25.6    0.220   166.7   6.4     0.0             -0.00237
26.2    0.203   170.8   6.4     0.0             -0.00238
26.8    0.188   175.0   6.1     -0.1            -0.00210
27.4    0.172   178.3   5.7     -0.1            -0.00224
28.0    0.158   181.7   5.3     -0.1            -0.00196
28.6    0.144   184.2   4.8     -0.1            -0.00196
29.2    0.130   187.5   4.1     -0.1            -0.00196
29.8    0.118   189.2   3.3     -0.1            -0.00168
30.4    0.106   190.8   2.5     -0.1            -0.00168
31.0    0.094   191.7   1.6     -0.2            -0.00165
31.6    0.083   192.5   0.5     -0.2            -0.00150
32.2    0.073   192.5   -0.8    -0.3            -0.00140
32.8    0.064   190.8   -2.3    -0.3            -0.00130
33.4    0.056   189.2   -4.0    -0.3            -0.00122
34.0    0.047   185.8   -5.7    -0.3            -0.00112
34.6    0.040   180.8   -7.3    -0.3            -0.00102
35.2    0.034   175.8   -8.8    -0.2            -0.00094
35.8    0.027   169.2   -10.1   -0.2            -0.00085
36.4    0.022   162.5   -11.2   -0.2            -0.00077
36.9    0.017   155.0   -12.2   -0.2            -0.00069
37.5    0.013   147.5   -13.1   -0.1            -0.00061
38.1    0.009   138.3   -13.8   -0.1            -0.00054
38.7    0.005   130.0   -14.4   -0.1            -0.00047
39.3    0.002   120.8   -14.8   0.0             -0.00041
39.9    0.000   111.7   -15.1   0.0             -0.00035
40.5    -0.002  102.5   -15.1   0.0             -0.00029
41.1    -0.004  93.3    -15.0   0.1             -0.00024
41.7    -0.005  84.2    -14.7   0.1             -0.00020
42.3    -0.006  75.6    -14.3   0.1             -0.00016
42.9    -0.007  67.3    -13.8   0.1             -0.00012
43.5    -0.008  59.3    -13.1   0.1             -0.00009
44.1    -0.008  51.8    -12.4   0.1             -0.00006
44.7    -0.009  44.8    -11.7   0.1             -0.00003
45.3    -0.009  38.3    -10.9   0.2             -0.00001
45.9    -0.009  32.3    -10.1   0.2             0.00001
46.5    -0.008  26.8    -9.2    0.2             0.00003
47.1    -0.008  21.8    -8.3    0.2             0.00004
47.7    -0.008  17.3    -7.5    0.2             0.00005
48.3    -0.007  13.4    -6.6    0.2             0.00006
48.9    -0.007  10.0    -5.8    0.1             0.00006
49.5    -0.006  7.1     -5.0    0.1             0.00007
50.1    -0.006  4.7     -4.2    0.1             0.00007
50.7    -0.005  2.7     -3.5    0.1             0.00007
51.3    -0.005  1.0     -2.8    0.1             0.00008
```

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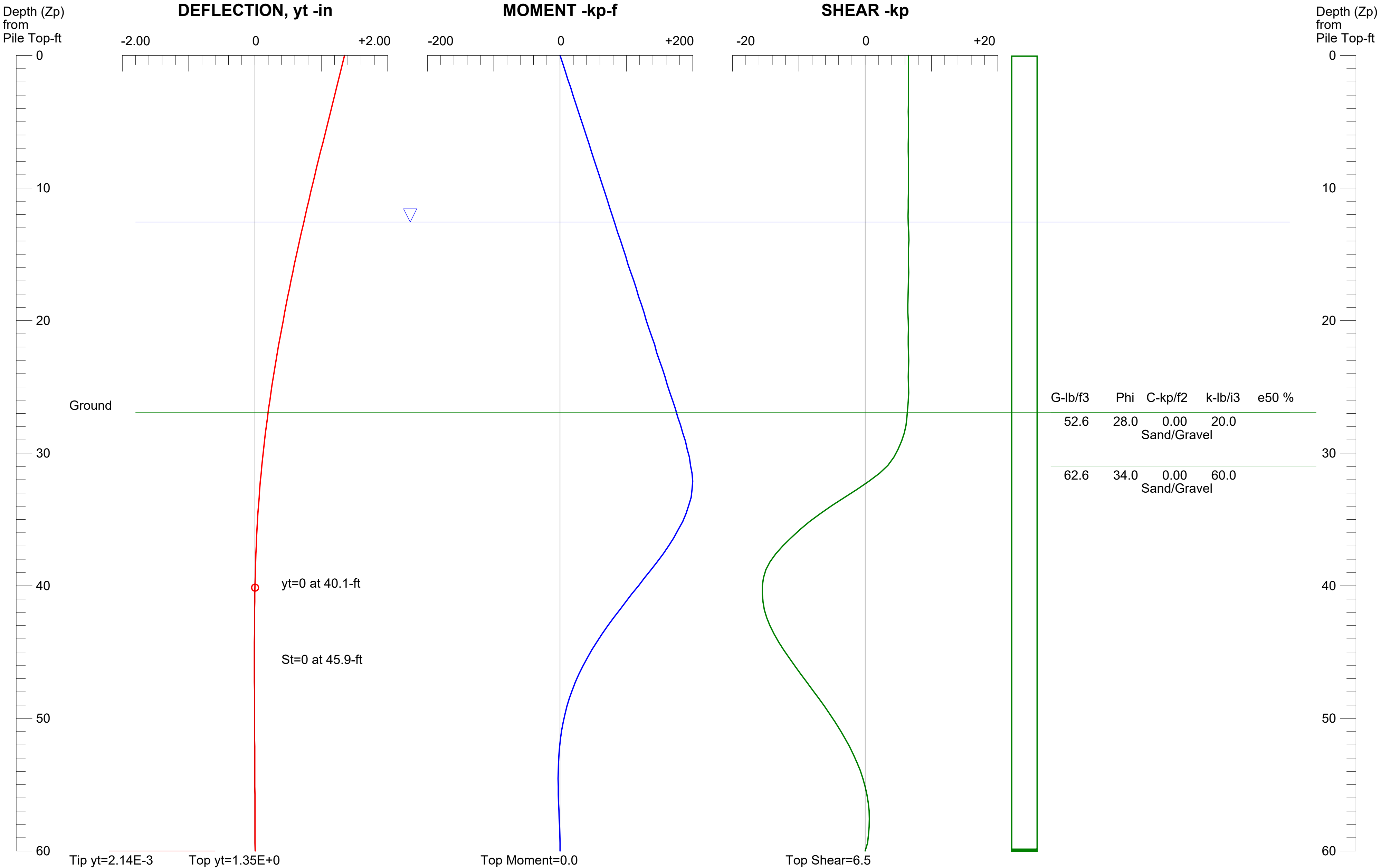
51.8    -0.004  -0.2    -2.2    0.1             0.00008
52.4    -0.004  -1.1    -1.6    0.1             0.00008
53.0    -0.003  -1.7    -1.1    0.1             0.00008
53.6    -0.003  -2.0    -0.7    0.1             0.00007
54.2    -0.002  -2.1    -0.3    0.1             0.00007
54.8    -0.002  -2.0    0.0     0.0             0.00007
55.4    -0.001  -1.8    0.2     0.0             0.00007
56.0    -0.001  -1.4    0.4     0.0             0.00007
56.6    0.000   -1.1    0.5     0.0             0.00007
57.2    0.000   -0.7    0.5     0.0             0.00007
57.8    0.001   -0.3    0.4     0.0             0.00007
58.4    0.001   -0.1    0.3     0.0             0.00007
59.0    0.002   0.0     0.0     -0.1            0.00007
________________________________________________
Zp - Depth from pile Top
yt - Pile top deflection
Moment - Internal moment in pile shaft
Shear - Internal shear force in pile shaft
Pressure - Soil-Pile interactive pressure (Arching is considered)
Slope - Deflection slope at pile top
```

CSDL04 - VESSEL COLLISION FORCE

PILE DEFLECTION & FORCE vs DEPTH

Single Pile, Khead=2, Kbc=1



Tip yt=2.14E-3

Top yt=1.35E+0
Max. yt=1.35E+0
Top St=-4.22E-3

Top Moment=0.0
Max. Moment=200.0

Top Shear=6.5
Max. Shear=15.5

Last Section: E -kp/i2=29000
Last Section: I'-in4=6023

CivilTech Software

Gowanus Canal Superfund Site
Carroll Street Dolphin Design

Figure 4

```
Depth vs. Deflection, Moment, Shear, and Slope in Single Pile:

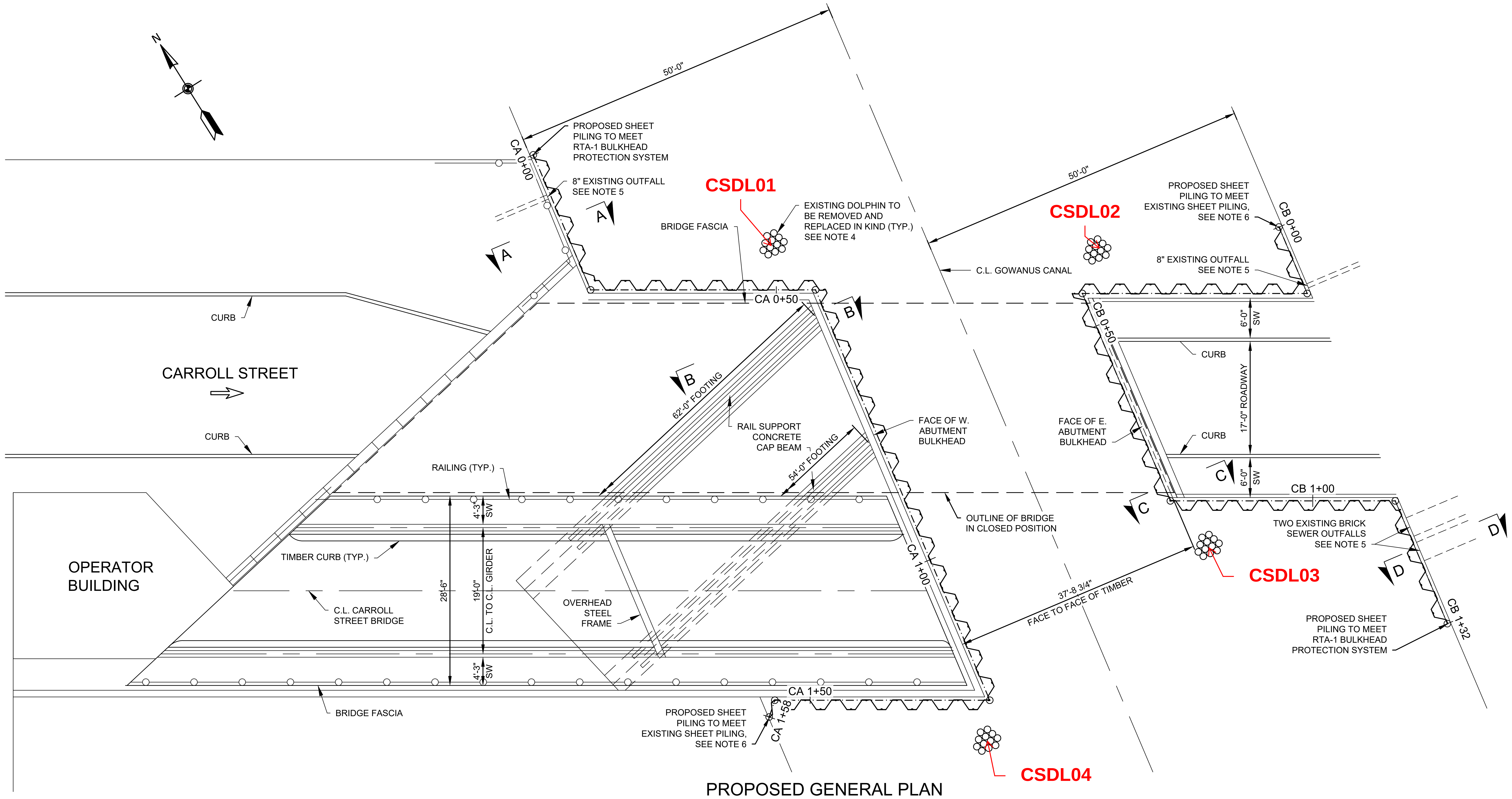
*****************************************************************************


Zp      yt      Moment  Shear   Pressure        Slope
-ft     -in     -kp-f   -kp     -kp/f2
_______________________________________________________________
0.0     1.350   0.0     6.5     0.0             -0.00422
0.6     1.320   4.0     6.5     0.0             -0.00413
1.2     1.290   7.9     6.5     0.0             -0.00412
1.8     1.260   11.8    6.5     0.0             -0.00413
2.4     1.230   15.8    6.5     0.0             -0.00413
3.0     1.200   19.8    6.5     0.0             -0.00413
3.6     1.170   23.8    6.5     0.0             -0.00412
4.2     1.140   27.7    6.5     0.0             -0.00413
4.8     1.110   31.6    6.5     0.0             -0.00413
5.5     1.080   35.6    6.5     0.0             -0.00413
6.1     1.050   39.5    6.5     0.0             -0.00412
6.7     1.020   43.5    6.5     0.0             -0.00413
7.3     0.987   47.4    6.5     0.0             -0.00454
7.9     0.957   51.3    6.5     0.0             -0.00412
8.5     0.928   55.3    6.5     0.0             -0.00399
9.1     0.899   59.3    6.5     0.0             -0.00399
9.7     0.870   63.3    6.5     0.0             -0.00399
10.3    0.841   67.2    6.5     0.0             -0.00398
10.9    0.812   71.2    6.5     0.0             -0.00399
11.5    0.784   75.1    6.5     0.0             -0.00385
12.1    0.756   79.0    6.5     0.0             -0.00385
12.7    0.729   83.0    6.5     0.0             -0.00371
13.3    0.701   86.7    6.6     0.0             -0.00385
13.9    0.674   90.8    6.6     0.0             -0.00371
14.5    0.648   95.0    6.5     0.0             -0.00357
15.2    0.621   99.2    6.5     0.0             -0.00371
15.8    0.595   102.5   6.5     0.0             -0.00358
16.4    0.570   106.7   6.6     0.0             -0.00344
17.0    0.544   110.8   6.5     0.0             -0.00357
17.6    0.520   115.0   6.5     0.0             -0.00330
18.2    0.495   118.3   6.5     0.0             -0.00344
18.8    0.471   122.5   6.4     0.0             -0.00330
19.4    0.448   126.7   6.4     0.0             -0.00316
20.0    0.425   130.0   6.5     0.0             -0.00316
20.6    0.402   134.2   6.5     0.0             -0.00316
21.2    0.380   138.3   6.5     0.0             -0.00302
21.8    0.358   142.5   6.5     0.0             -0.00303
22.4    0.337   145.8   6.5     0.0             -0.00289
23.0    0.317   150.0   6.6     0.0             -0.00275
```

23.6	0.297	154.2	6.5	0.0		-0.00275
24.2	0.277	158.3	6.5	0.0		-0.00275
24.8	0.258	161.7	6.5	0.0		-0.00261
25.5	0.240	165.8	6.6	0.0		-0.00248
26.1	0.222	170.0	6.5	0.0		-0.00247
26.7	0.205	174.2	6.4	0.0		-0.00234
27.3	0.189	177.5	6.3	0.0		-0.00220
27.9	0.173	181.7	6.2	-0.1		-0.00220
28.5	0.158	185.0	5.9	-0.1		-0.00206
29.1	0.143	189.2	5.5	-0.1		-0.00206
29.7	0.129	191.7	5.0	-0.1		-0.00193
30.3	0.116	195.0	4.3	-0.1		-0.00179
30.9	0.104	196.7	3.4	-0.2		-0.00165
31.5	0.092	199.2	2.2	-0.3		-0.00160
32.1	0.081	200.0	0.6	-0.3		-0.00151
32.7	0.071	199.2	-1.2	-0.3		-0.00140
33.3	0.062	197.5	-3.1	-0.3		-0.00131
33.9	0.053	194.2	-5.0	-0.3		-0.00120
34.5	0.045	190.0	-6.7	-0.3		-0.00111
35.2	0.038	185.0	-8.4	-0.3		-0.00102
35.8	0.031	178.3	-9.8	-0.2		-0.00092
36.4	0.025	171.7	-11.1	-0.2		-0.00083
37.0	0.019	164.2	-12.4	-0.2		-0.00074
37.6	0.014	155.8	-13.5	-0.1		-0.00067
38.2	0.010	146.7	-14.3	-0.1		-0.00058
38.8	0.007	137.5	-15.0	-0.1		-0.00052
39.4	0.003	127.5	-15.3	0.0		-0.00045
40.0	0.001	118.3	-15.5	0.0		-0.00038
40.6	-0.002	108.3	-15.5	0.0		-0.00032
41.2	-0.004	99.2	-15.4	0.0		-0.00027
41.8	-0.005	90.0	-15.2	0.1		-0.00022
42.4	-0.007	80.5	-14.8	0.1		-0.00017
43.0	-0.008	71.8	-14.3	0.1		-0.00013
43.6	-0.008	63.3	-13.7	0.1		-0.00010
44.2	-0.009	55.3	-13.0	0.1		-0.00006
44.8	-0.009	47.8	-12.3	0.1		-0.00004
45.5	-0.009	40.8	-11.4	0.2		-0.00001
46.1	-0.009	34.4	-10.6	0.2		0.00001
46.7	-0.009	28.5	-9.7	0.2		0.00002
47.3	-0.009	23.2	-8.8	0.2		0.00004
47.9	-0.008	18.3	-7.9	0.2		0.00005
48.5	-0.008	14.2	-7.0	0.2		0.00006
49.1	-0.007	10.4	-6.1	0.1		0.00007
49.7	-0.007	7.3	-5.3	0.1		0.00007
50.3	-0.006	4.6	-4.5	0.1		0.00007
50.9	-0.006	2.4	-3.7	0.1		0.00008
51.5	-0.005	0.6	-3.0	0.1		0.00008
52.1	-0.005	-0.8	-2.4	0.1		0.00008

```
52.7    -0.004  -1.8    -1.8    0.1             0.00008
53.3    -0.003  -2.4    -1.2    0.1             0.00008
53.9    -0.003  -2.8    -0.7    0.1             0.00008
54.5    -0.002  -2.9    -0.3    0.1             0.00007
55.2    -0.002  -2.8    0.0     0.0             0.00007
55.8    -0.001  -2.6    0.3     0.0             0.00007
56.4    -0.001  -2.2    0.5     0.0             0.00007
57.0    0.000   -1.7    0.6     0.0             0.00007
57.6    0.000   -1.3    0.6     0.0             0.00007
58.2    0.001   -0.8    0.6     0.0             0.00007
58.8    0.001   -0.4    0.5     0.0             0.00007
59.4    0.002   -0.1    0.4     -0.1            0.00007
60.0    0.002   0.0     0.0     -0.1            0.00007
________________________________________________
Zp - Depth from pile Top
yt - Pile top deflection
Moment - Internal moment in pile shaft
Shear - Internal shear force in pile shaft
Pressure - Soil-Pile interactive pressure (Arching is considered)
Slope - Deflection slope at pile top
```

ATTACHMENT B – DESIGN LOCATIONS



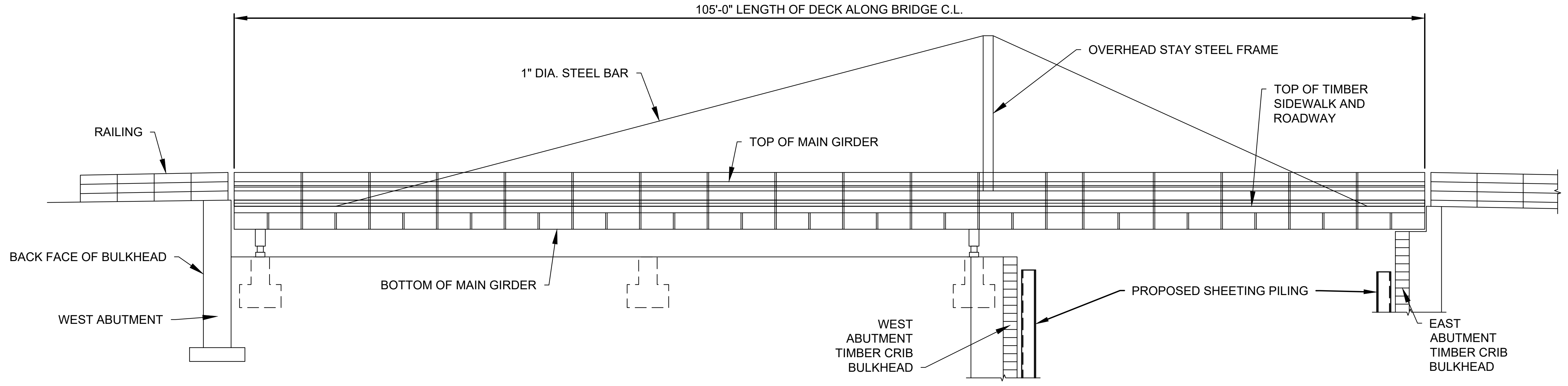
PROPOSED GENERAL PLAN

(OPEN TO MARINE TRAFFIC)

SCALE: 1' = 10'-0"

0 10' 20'

SCALE IN FEET



SOUTH ELEVATION

(CLOSED TO MARINE TRAFFIC)

SCALE: 1' = 10'-0"

0 10' 20'

SCALE IN FEET

WALL STATIONING			LOCATION	SHEET PILE NO.	MIN. SECTION MODULUS (IN3)	SECTION	TOP OF PILE EL. (FT.)*	MIN. TIP EL. (FT.)*	SHEET PILE LENGTH (FT.)*
CA 0+00	TO	CA 0+56	NW CORNER	SP066-SP089	99.5	AZ 46-700N	12.00	-35.00	47.00
CA 0+56	TO	CA 1+23	WEST ABUT.	SP090-SP118	57.1	AZ 26-700	4.50	-30.00	34.50
CA 1+23	TO	CA 1+58	SW CORNER	SP119-SP133	99.5	AZ 46-700N	4.50	-36.00	40.50
CB 0+00	TO	CB 0+45	NE CORNER	SP134-SP152	99.5	AZ 46-700N	13.50	-35.00	48.50
CB 0+45	TO	CB 0+79	EAST ABUT.	SP153-SP167	57.1	AZ 26-700	6.50	-32.00	38.50
CB 0+79	TO	CB 1+32	SE CORNER	SP168-SP190	99.5	AZ 46-700N	13.50	-36.00	49.50

SHEET PILE SCHEDULE

*ALL ELEVATIONS AND LENGTHS ARE APPROXIMATE, SEE NOTE 7.

NOT FOR CONSTRUCTION

NOTES:

1. CONTRACTOR TO FIELD VERIFY ALL DIMENSIONS.
2. STEEL SHEET PILING TO BE INSTALLED USING PRESS-IN METHOD.
3. FOR SECTIONS A-A, B-B, C-C AND D-D, SEE DWG. NO. B-5.
4. EXISTING DOLPHINS TO BE REMOVED PRIOR TO INSTALLATION OF SHEETING. PROPOSED DOLPHIN REPLACEMENT TO BE COORDINATED WITH RTA 1 CAP INSTALLATION.
3. OUTFALLS SHALL BE CLEARED OF ANY OBSTRUCTIONS AND ALLOWED TO FLOW FREELY INTO THE CANAL. OUTFALLS SHALL BE FIT WITH EXTENSIONS AND CUT THROUGH THE PROPOSED SHEET PILE WALL. FOR DETAILS, SEE DWG. NO. B-5.
4. CONTRACTOR SHALL IDENTIFY THE TYPE OF SHEET PILE SHAPE AND SIZE OF THE EXISTING STEEL SHEET PILE BULKHEAD AT PROPERTIES 439-1 AND 452-1 AND USE THE NECESSARY CONNECTION REQUIRED TO CREATE A CONTINUOUS INTERLOCKING WALL BETWEEN THE EXISTING SHEET PILE WALL AND THE BULKHEAD SUPPORT SHEET PILES.
5. THE CARROLL STREET BRIDGE WILL REMAIN IN THE OPEN POSITION (CLOSED TO TRAFFIC, AS SHOWN) FOR THE DURATION OF CONSTRUCTION UNTIL REMEDIAL CAP CONSTRUCTION IS COMPLETE AND ACCEPTED.
6. ALL ELEVATIONS ARE IN FEET UNLESS OTHERWISE NOTED.
7. ALL ELEVATIONS AND LENGTHS SHOWN ARE APPROXIMATE BASED ON AS-BUILT INFORMATION. ELEVATIONS AND LENGTHS SHALL BE VERIFIED BY SURVEY AND ADJUSTED DURING FINAL DESIGN.

LOCATION	ELEVATION (FT)			UNIT WEIGHT (LBS/FT3)	FRICTION ANGLE (DEGREES)	COHESION (LB/IN2)	WALL FRICTION ANGLE (DEGREES)
NW CORNER	-3.90	TO	-17.75	80	28	0	0
	-17.75	TO	-19.34	115	28	0	0
	-19.34	TO	TOE	125	34	0	0
WEST ABUT.	-10.50	TO	-16.25	80	28	0	0
	-16.25	TO	-18.00	115	28	0	0
	-18.00	TO	TOE	125	34	0	0
SW CORNER	-3.75	TO	-16.25	80	28	0	0
	-16.25	TO	-21.00	115	28	0	0
	-21.00	TO	TOE	125	34	0	0
NE CORNER	-3.75	TO	-15.00	80	28	0	0
	-15.00	TO	-18.00	115	28	0	0
	-18.00	TO	TOE	125	34	0	0
EAST ABUT.	-7.75	TO	-16.00	80	28	0	0
	-16.00	TO	-19.00	115	28	0	0
	-19.00	TO	TOE	125	34	0	0
SE CORNER	-3.00	TO	-17.00	80	28	0	0
	-17.00	TO	-21.67	115	28	0	0
	-21.67	TO	TOE	125	34	0	0

SOIL PARAMETERS

NOTES:

1. DIVIDE THE PASSIVE EARTH PRESSURE COEFFICIENT (K_P) BY 1.25 FOR TEMPORARY CONDITION OR 1.5 FOR PERMANENT CONDITION.
2. GROUNDWATER IS ASSUMED AT ELEVATION -2.57 FT.
3. FOR LIMITS OF LOCATION, SEE SHEET PILE SCHEDULE TABLE.

REV	DATE	DESCRIPTION	DRN	APP

Gowanus Canal
Remedial Design
Group

GPI
Greenman-Pedersen, Inc.
Engineering and Construction Services
325 West Main Street, Babylon, NY 11702
Tel: (631) 587-5060 Fax: (631) 422-3479

TITLE:
CARROLL STREET BRIDGE GENERAL PLAN AND ELEVATION

PROJECT:
RTA 1 - DREDGING, SEDIMENT AND WATER TREATMENT, ISS,
CAPPING, AND STAGING AND SUPPORT SITE DESIGN

SITE:
GOWANUS CANAL SUPERFUND SITE, BROOKLYN, NEW YORK

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DRAFT

DESIGN BY: PLT
DRAWN BY: PLT
CHECKED BY:
REVIEWED BY:
APPROVED BY:
DATE: JULY 2018
PROJECT NO.: HPH106A
FILE:
DRAWING NO.: B-4 OF 5

O:\2017\BAB-2017020.00 GOWANUS CANAL SUPERFUND SITE\CADD\CONTRACT PLANS\CARROLL STREET BRIDGE\B-1 GENERAL PLAN AND ELEVATION

ATTACHMENT C – CORROSION DURABILITY

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:	1	OF	2
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	11/21/19
SUBJECT:	RTA1 - Bridge Support Design	CHECKED BY:	PLT	DATE:	12/18/19

Attachment C - Corrosion Durability

References:

1. Arcelor Mittal Piling Handbook 8th Edition, Reprint 2008
2. AISC LRFD Steel Construction Manual 14th Edition

Corrosion Durability Pipe Pile:

Corrosion Durability of the steel monopile dolphin is completed in accordance with the procedure set forth in the Arcelor Mittal Piling Handbook. The corrosion durability is checked for a 50 year timeline. To be conservative, the design location with the longest pile length and the maximum moment determined from a vessel collision force was used. This design location was CSDL01. To be conservative, checks were performed using loading in the temporary condition after dredging operations and prior to remedial cap installation.

Assumptions*:*

Polluted Natural Soils and industrial grounds.

Seawater

RTA 1 - Carroll Street Dolphin Monopile - CSDL01

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88)

EL_1 =	-14.44	*ft*	(Minimum existing bathmetry elevation)	
EL_2 =	-17.44	*ft*	(Minimum el. of soft-native interface)	*Appendix C Table 1d*
EL_3 =	-18.00	*ft*	(Minimum el. of native-glacial interface)	*Appendix C Table 1d*
El_D =	-17.44	*ft*	(Dredge elevation)	
H =	3.00	*ft*	(Dredge height)	
EL_{TOP} =	10.00	*ft*	(Top of dolphin pile elevation)	
EL_{TOE} =	-50.00	*ft*	(Tip of dolphin pile elevation)	
H_w =	60.00	*ft*	(Total length of dolphin pile)	
MHW EL =	1.96	*ft*	(Mean high water elevation)	
MLW EL =	-2.57	*ft*	(Mean low water elevation)	

Corrosion Loss Rates:

Soil and Water Corrosion thicknesses below taken from Ref 1. Table 3.3.1 and 3.3.2 for 50 year timeline

Step 1:

Depth	Exterior Face Thickness Loss (mm)	Interior Face Thickness Loss (mm)	Total Thickness Loss Over 50 Year Life
0 - 8 ft	Splash Zone (7.5)	-	7.5 mm (0.295 in)
8 - 12.6 ft	Tidal (7.5)	Tidal (7.5)	15.0 mm (0.590 in)
12.6 - 24.4 ft	Immersed (3.5)	Immersed (3.5)	7.0 mm (0.276 in)
24.4 - 60 ft	Contam. Soil (3.0)	Contam. Soil (3.0)	6.0 mm (0.236 in)

Note:

1. Depth of zero feet is equivalent to the top of pile at EL. 10.0
2. Corrosion values from Reference 1 were doubled to account for both faces of pile in cross sectional view.
3. Thickness loss in the splash zone on the interior face was assumed to be zero.

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: 1 OF 2
JOB NO.: BAB-2017020.01 MADE BY: JRA DATE: 11/21/19
SUBJECT: RTA1 - Bridge Support Design CHECKED BY: PLT DATE: 12/18/19

Step 2:

Depth	Maximum Bending Moment (k-ft)
0 - 8 ft	51.3
8 - 12.6 ft	83.00
12.6 - 24.4 ft	158.3
24.4 - 60 ft	202.5

Note:

Bending Moments taken from Carroll Street Dolphin Design Spreadsheet for location CSDL01.

Step 3:

Depth	Min. Section Modulus (in^3)
0 - 8 ft	20.52
8 - 12.6 ft	33.20
12.6 - 24.4 ft	63.32
24.4 - 60 ft	81.00

Section modulus = $M_{max} / (0.6*F_y)$

F_y = 50 ksi

Step 4:

Section Modulus of Hollow Circle $S= .098175(D^4-d^4)/D$ (Ref. 2. Table 17-27)

D= 24 in (Outside Diameter)

d= 23.124 in (Inside Diameter)

Adjusted Section Modulus After Corrosion Loss

Depth	Pile Dia. (in)	Pile Thickness (in)	Corrosion Loss (in)	Adjusted S_x (in^3)	Check
0 - 8 ft	24	0.438	0.295	123.6	OK
8 - 12.6 ft	24	0.438	0.59	62.8	OK
12.6 - 24.4 ft	24	0.438	0.276	129.9	OK
24.4 - 60 ft	24	0.438	0.236	138.4	OK

APPENDIX A – PAGES FROM RTA 1 BRIDGE SOIL DESIGN PARAMETERS BY GZA GEOENVIRONMENTAL, INC.

GZA GeoEnvironmental, Inc.
RTA 1 Bridge Soil Design Parameters
July 11, 2018

Summary of Design Parameters for Canal Soils

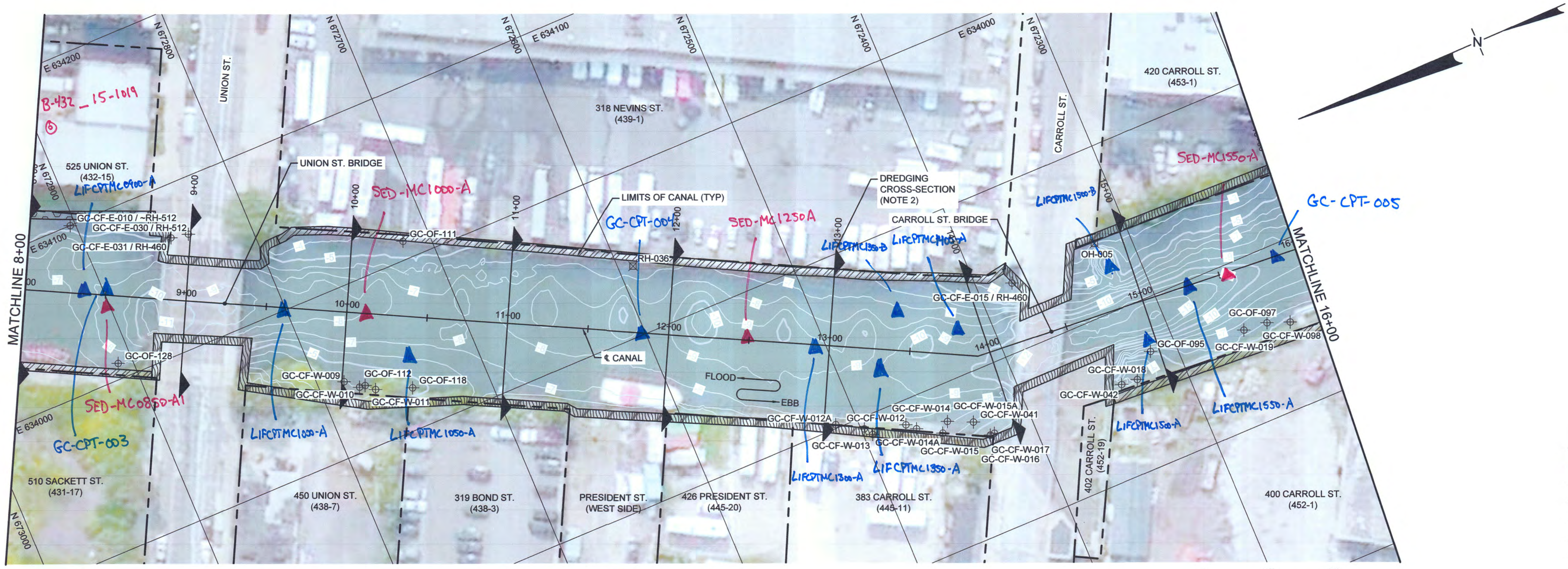
Soil Unit	**Total Unit Weight, γ (pcf)**	**Effective Friction Angle, ϕ' (degrees)**	**Undrained Shear Strength, S_u (psf), See Note 1**	**Stratum Thickness Union Street (feet)**	**Stratum Thickness Carroll Street (feet)**	**Stratum Thickness 3rd Street (feet)**
Soft Sediment	80	28	$0.3\sigma'_v$	6	5	7
Native Alluvial Sediment	115	28	250 if > El. -20 ft 500 if < El. -20 ft	4	4	7
Glacial Deposit	125	34	-	See Note 2	See Note 2	See Note 2

1. σ'v = (total unit weight of soil - 62.4 pcf)*depth
2. Explorations were terminated in this stratum and it is expected that the stabilization design for the bridges will also terminate here.

Summary of Design Parameters for Upland Soils

Soil Unit	**Total Unit Weight, γ (pcf)**	**Effective Friction Angle, ϕ' (degrees)**	**Undrained Shear Strength, S_u (psf), See Note 1**
Fill	120	32	-
Organic Sediment	95	23	$0.25\sigma'_v$ min. 250 psf
Native Alluvial Sediment	115	28	$0.35\sigma'_v$ min. 250 psf
Glacial Deposit w/ Fines	125	28	$0.5\sigma'_v$ min. 500 psf
Glacial Deposit w/ Sands	125	34	-

1. σ'v = total unit weight of soil*depth above the water table and σ'v = (total unit weight of soil - 62.4 pcf)*depth below the water table.

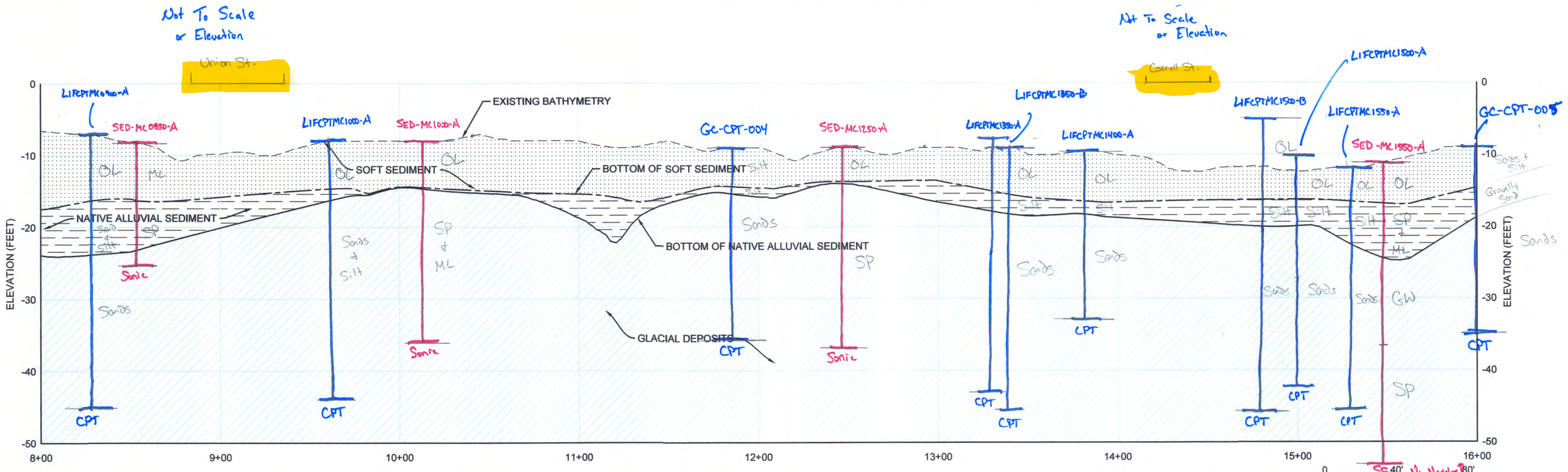


6
G-3

PLAN

EXISTING BATHYMETRY (STA. 8+00 TO 16+00)

SCALE: 1" = 40'



7
DR-2

PROFILE

EXISTING BATHYMETRY (STA. 8+00 TO 16+00)

SCALE: 1" = 40' (HORIZONTAL); 1" = 10' (VERTICAL)

LEGEND

─ ─	BATHYMETRY ELEVATION
──	CANAL BOUNDARY
─ ─ ─	PROPERTY LINE
- - - -	EXISTING BATHYMETRY
─ · ─	BOTTOM OF SOFT SEDIMENT
─ · · ─	BOTTOM OF NATIVE ALLUVIAL SEDIMENT
10+00	CANAL STATIONING
▨	STEEL SHEET PILE BULKHEAD
▩	TIMBER CRIB BULKHEAD
○○○	TIMBER PILE BULKHEAD
░	SOFT SEDIMENT
☰	NATIVE ALLUVIAL SEDIMENT
☐	GLACIAL DEPOSITS
⌖	OUTFALL (NOTE 4)
☒	CSO (NOTE 4)
(417-21)	BLOCK AND LOT
▲	Boring
▲	CPT

NOTES:

1. DEBRIS IN RTA1 IS PRESENTED ON DRAWINGS DR-6 TO DR-8.
2. DREDGE CROSS-SECTIONS ARE PRESENTED ON DRAWINGS DR-17 AND DR-18.
3. THE BULKHEAD TYPE FOR EACH PROPERTY IS PRIMARILY BASED ON A PRELIMINARY DESKTOP STUDY COMPLETED BY GEOSYNTEC (2014) TITLED "CONDITION ASSESSMENT OF EXISTING BULKHEADS" ALONG WITH MORE RECENT SUPPLEMENTARY INFORMATION (E.G., SITE WALKS, ENGINEERING DRAWINGS).
4. CONTRACTOR IS RESPONSIBLE FOR DOCUMENTING AND VERIFYING THE LOCATION AND DESCRIPTION OF OUTFALLS. ONLY RTA1 OUTFALLS DATA ARE PRESENTED ON THE DRAWING. OUTFALL DATA IS PROVIDED AS TABLE 1 ON DRAWING G-2 AND DESCRIBED WITHIN THE ASSOCIATED NOTES.

REV	DATE	DESCRIPTION	DRN	APP
C2	10.31.17	RTA1 65% REMEDIAL DESIGN TO RD GROUP	SRN	JFB
B	12.23.16	RTA1 35% REMEDIAL DESIGN - CAPPING AND ISS	SRN	JFB
A	10.31.16	RTA1 35% REMEDIAL DESIGN – DREDGING AND TREATMENT	SRN	JFB

Gowanus Canal
Remedial Design
Group

Geosyntec
consultants
7 GRAPHICS DRIVE, SUITE 106
EWING, NEW JERSEY 08628, USA
PHONE: 609.895.1400

Beech and Bonaparte
engineering p.c.
an affiliate of Geosyntec Consultants

TITLE:
EXISTING BATHYMETRY PLAN (STA. 8+00 TO 16+00)

PROJECT:
REMEDIATION TARGET AREA (RTA) 1
65% REMEDIAL DESIGN

SITE:
GOWANUS CANAL SUPERFUND SITE, BROOKLYN, NEW YORK

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY:	JMG	DATE:	OCTOBER 2017
DRAWN BY:	SRN	PROJECT NO.:	HPH106A
CHECKED BY:	JMG	FILE:	HPH106A-DR006
REVIEWED BY:	MWS	DRAWING NO.:	DR-2 OF 22
APPROVED BY:	JFB		

NOT ISSUED FOR CONSTRUCTION

APPENDIX B – PAGES FROM SUMMARY OF GEOTECHNICAL DESIGN PARAMETERS BY GEOSYNTEC CONSULTANTS

X:\03_GIS\mxd\geotech\geotech_parameters_report\Figure05a_CPT_Borings_Locations_PD-8.mxd; 5/19/2016

Legend

🟦	CPT Location
☐	Gowanus Canal
▨	RTA1
▨	RTA2
▨	RTA3A
▨	RTA3B

200 100 0 200 Feet

Locations of CPTs in RTA1 and TB4 From the Geosyntec PD-8 (2015c) Investigation Report

Gowanus Canal Superfund Site, Brooklyn, NY

Gowanus Canal Remedial Design Group

Geosyntec consultants

Beech and Bonaparte engineering p.c.

Figure

5a

Ewing, NJ

August 2016

Table 1d. Geosyntec (2015c) PD-8 CPT Locations

Location	CPT Name	As Built Northing	As Built Easting	Elevation Mudline/Ground (ft)	Elevation of Soft-Native Interface (ft)	Elevation of Native-Glacial Interface (ft)
RTA1	15-53060_LIFCPTMC1350-A	672471.44	633808.56	-8.64	-17.74	-19.34
	15-53060_LIFCPTMC1350-B	672449.34	633847.72	-7.62	-14.62	-18.12
	15-53060_LIFCPTMC1400-A	672424.91	633818.08	-9.00	-16.25	-18.00
	15-53060_LIFCPTMC1500-A	672296.14	633773.22	-9.72	-16.97	-20.97
	15-53060_LIFCPTMC1500-B	672307.29	633826.07	-5.37	-15.67	-21.67
	15-53060_LIFCPTMC1550-A	672252.13	633797.73	-10.37	-17.07	-24.97
	15-53060_LIFCPTMC1600-A	672205.73	633773.24	-7.85	NA	NA
	15-53060_LIFCPTMC1600-A1	672203.35	633779.75	-8.05	-13.95	-16.95
	15-53060_LIFCPTMC1600-B	672207.26	633819.28	-6.62	-14.52	-18.52
	15-53060_LIFCPTMC1650-A	672162.65	633795.88	-9.33	-15.03	-19.03
	15-53060_LIFCPTMC1700-A	672104.66	633758.52	-8.35	-15.95	-21.35
	15-53060_LIFCPTMC1700-B	672103.15	633811.16	-8.46	-15.36	-22.36
	15-53060_LIFCPTMC1750-A	672063.65	633784.90	-10.13	-14.88	-20.63
	15-53060_LIFCPTMC1800-A	672034.39	633736.61	-9.37	NA	-14.62
	15-53060_LIFCPTMC1800-B	672004.77	633787.93	-8.99	NA	-13.19
	15-53060_LIFCPTMC1850-A	671972.27	633728.24	-10.43	-17.13	-19.43
	15-53060_LIFCPTMC1900-A	671946.06	633691.28	-8.20	-15.85	-22.35
	15-53060_LIFCPTMC1900-B	671904.89	633722.41	-9.42	-17.82	-22.82
	15-53060_LIFCPTMC1950-A	671888.47	633663.35	-9.17	-18.32	-22.02
	15-53060_LIFCPTMC2000-A	671858.17	633632.70	-7.72	-14.24	-18.54
	15-53060_LIFCPTMC2000-B	671833.06	633668.24	-8.63	-15.33	-19.23
	15-53060_LIFCPTMC2050-A	671817.54	633633.40	-9.85	-25.75	-22.00
	15-53060_LIFCPTMC2100-A	671777.40	633579.73	-8.63	-23.53	-24.53
	15-53060_LIFCPTMC2100-B	671746.67	633623.22	-9.27	-23.07	-25.07
	15-53060_LIFCPTMC2150-A	671722.76	633577.46	-10.64	-16.99	-26.59
	15-53060_LIFCPTMC2200-A	671705.59	633530.93	-8.25	-16.25	-24.55
	15-53060_LIFCPTMC2200-B	671676.01	633569.03	-8.84	-17.09	-24.79
	15-53060_LIFCPTMC2250-A	671678.89	633550.88	-9.81	-19.56	-24.11
TB4	15-53060_LIFCPT0000-A	671449.45	633405.09	-11.85	-17.85	-29.43
	15-53060_LIFCPT0000-A1	671451.86	633403.89	-12.03	-17.63	-22.13
	15-53060_LIFCPT0050-A	671381.86	633391.68	-10.49	-15.14	-21.24
	15-53060_LIFCPT0050-B	671406.98	633430.67	-11.01	-14.11	-21.91
	15-53060_LIFCPT0100-A	671363.62	633425.59	-11.74	-18.59	-25.89
	15-53060_LIFCPT0150-A	671301.26	633424.24	-10.33	-15.93	-24.03
	15-53060_LIFCPT0150-B	671304.23	633457.79	-8.48	-16.78	-28.28
	15-53060_LIFCPT0200-A	671250.95	633457.93	-6.38	-14.83	-22.13
	15-53060_LIFCPT0250-A	671243.40	633441.94	-4.71	-13.51	-20.51
	15-53060_LIFCPT0250-B	671209.87	633490.88	-4.09	-15.59	-23.59
	15-53060_LIFCPT0275-A	671170.09	633477.85	-5.70	-13.90	-21.40
	15-53060_LIFCPT0300-A	671183.30	633500.76	-5.16	-14.11	-24.61
	15-53060_LIFCPT0350-A	671125.89	633540.90	-6.07	-14.62	-23.82
	15-53060_LIFCPT0350-B	671169.04	633555.83	-4.68	-14.31	-26.11
	15-53060_LIFCPT0400-A	671102.65	633600.65	-6.31	-16.11	-30.51
	15-53060_LIFCPT0450-A	671090.18	633591.81	-4.38	-14.83	-27.83
	15-53060_LIFCPT0450-B	671123.26	633641.77	-4.21	-12.61	-27.31
	15-53060_LIFCPT0500-A	671055.05	633670.13	-6.49	-14.99	-27.05
	15-53060_LIFCPT0550-A	671014.10	633688.97	-6.28	-13.28	-22.78
	15-53060_LIFCPT0550-B	671055.66	633723.14	-6.49	-16.49	-24.99
	15-53060_LIFCPT0600-A	671012.36	633752.28	-6.68	-15.38	-19.48
	15-53060_LIFCPT0650-A	670976.08	633765.78	-5.29	-15.74	-17.84
	15-53060_LIFCPT0650-B	671007.92	633795.14	-5.09	-15.79	-18.09
	15-53060_LIFCPT0700-A	670953.15	633825.72	-4.62	-13.90	-17.42

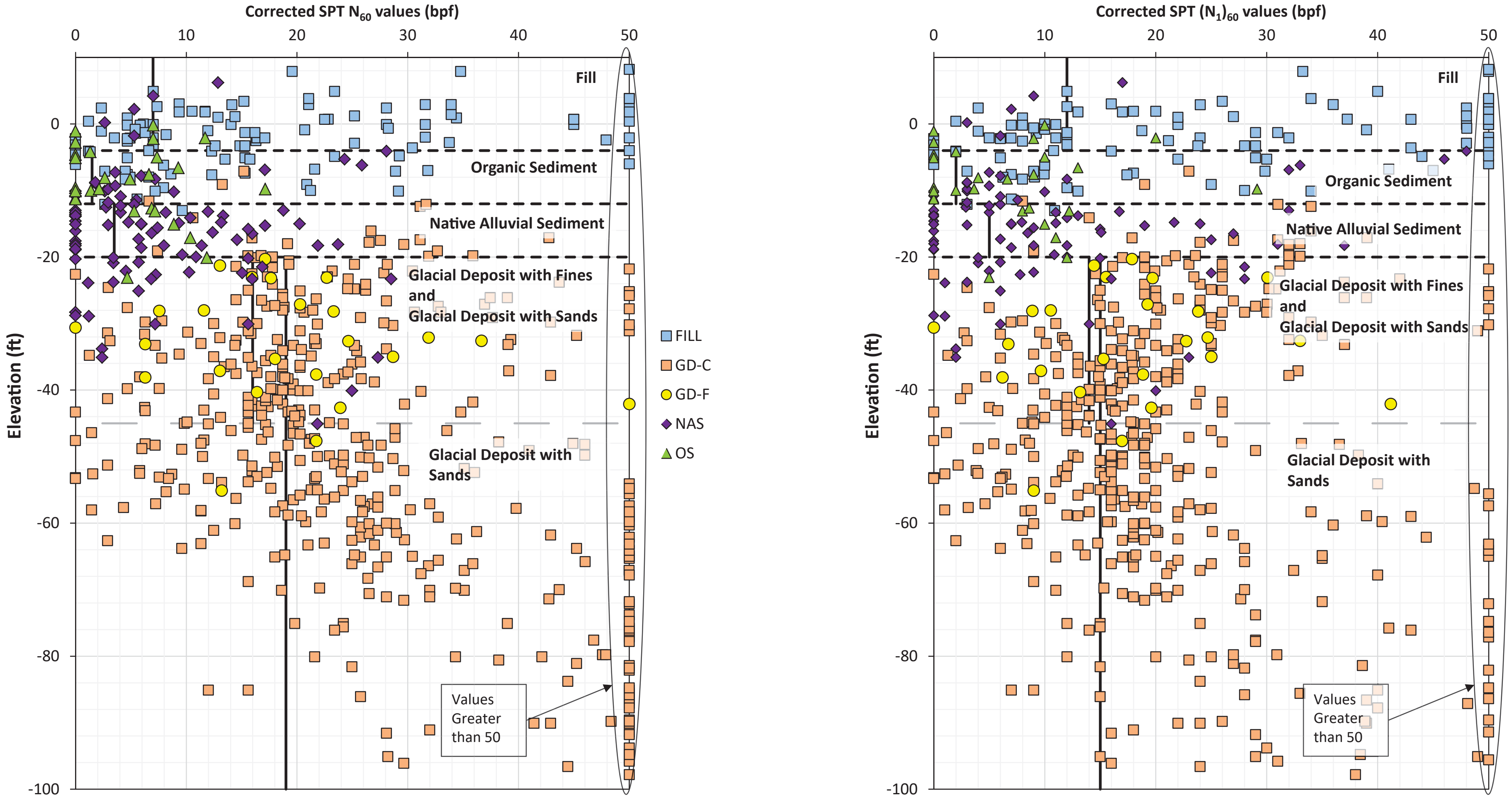
Table 9. Recommended Material Parameters for Canal Soils for Dredge and Cap Geotechnical Evaluation

Soil Unit	Total Unit Weight (pcf)	Drained Shear Strength - Effective Stress Friction Angle, ϕ'(degrees)	Undrained Shear Strength, S_u (psf)	Undrained Shear Strength Ratio (S_u/σ'_v)	Over Consolidation Ratio (OCR)[1]	Modified Compression Index, $C_{c\varepsilon}$	Modified Recompression Index, $C_{r\varepsilon}$	Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	Coefficient of Consolidation, C_v (cm^2/s)	Young's Modulus (tsf)
		Fully Softened Shear Strength[2]								
Soft Sediment	80	28°	-	0.3	1	0.23	0.028	0.015	1 x 10^{-4}	-
Native Alluvial Sediment	115	28°	RTA1: 250 psf [> El. -20 ft] 500 psf [< El. -20 ft] TB4: 500 psf [> El. -19 ft and < El. -26 ft] 250 psf [in-between El. -19 ft and -26 ft]	-	1	0.075	0.028	0.002	2 x 10^{-3}	-
Glacial Deposit	125	34° (effective friction angle in drained and undrained conditions)[3]			1					400

Notes:

1. The soils are assumed to be normally consolidated under the existing conditions.
2. The fully softened shear strength is recommended as the drained shear strength for soft sediment and native alluvial sediment if these soils have not undergone failure.
3. For the glacial deposit, the selected drained and undrained shear strengths are the same as this material is assumed to be freely draining.

Legend:
S_u – Undrained Shear Strength
σ'_v – In-Situ Effective Vertical Stress
pcf – Pounds per Cubic Foot
cm^2/s – Square Centimeter per Second
tsf – Tons per Square Foot
El. – Elevation
ft – Foot
RTA – Remediation Target Area
TB4 – 4th Turning Basin



Notes:

1. Dash lines represent general boundaries between material layers defined for the upland side of the bulkheads
2. The subsurface stratigraphy is not identical at all boring locations; therefore, some blow count values shown within a material may not be representative of that material.

Legend:

bpf = blows per foot

Soil Unit	Representative N-values (bpf)	
	N_{60}	$(N_1)_{60}$
Fill	7	12
Organic Sediment (OS)	1.5	2
Native Alluvial Sediment (NAS)	3.5	5
Glacial Deposit with Fines (GD-F)	16	14
Glacial Deposit with Sands (GD-S)	19	15

Compilation Plots of Calculated N_{60} and $(N_1)_{60}$ Values with Depth for the Upland Side of the Canal

Gowanus Canal Superfund Site, Brooklyn, NY

Gowanus Canal Remedial Design Group

Geosyntec consultants

Beech and Bonaparte engineering p.c.
an affiliate of Geosyntec Consultants

Ewing, NJ

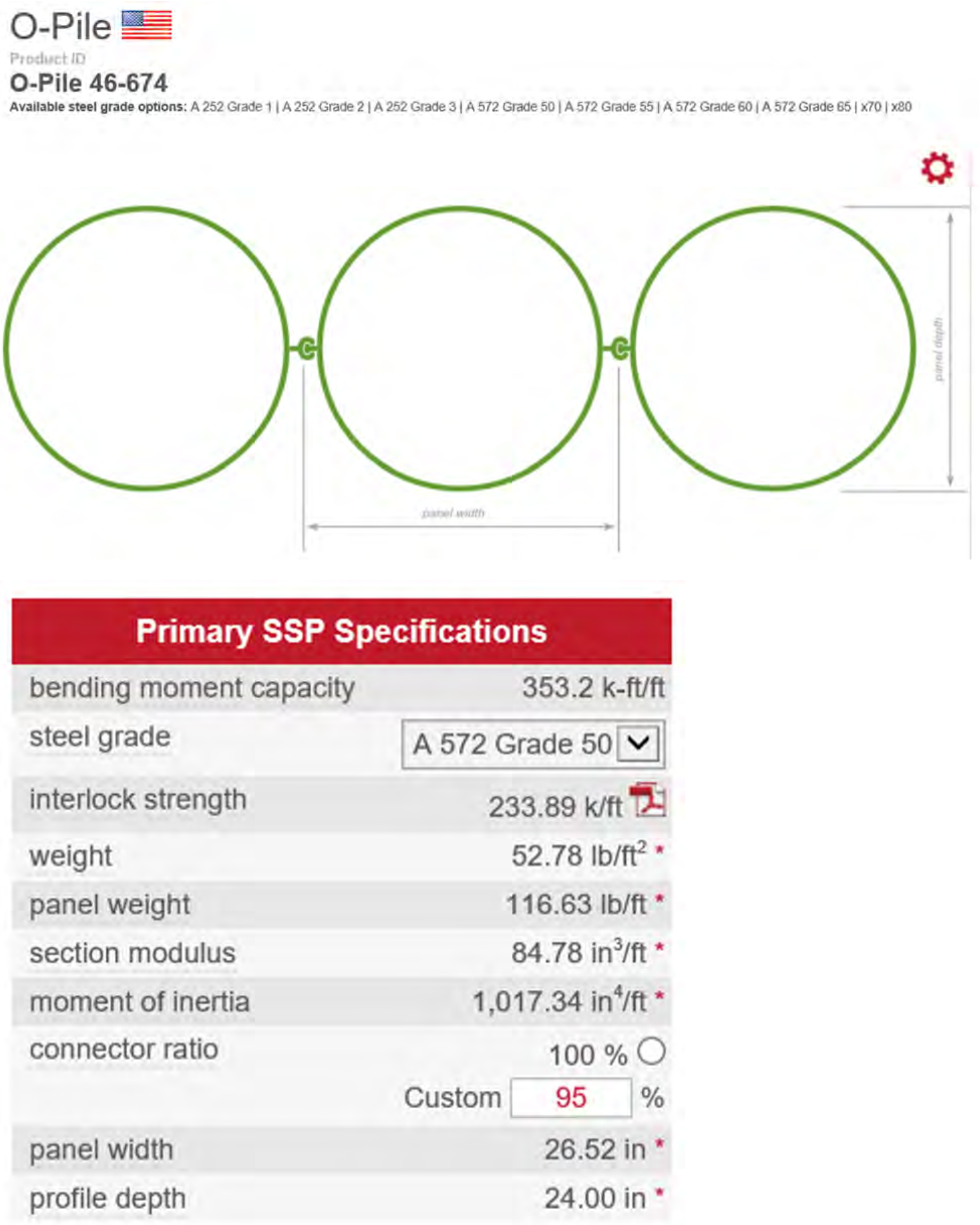
October 2016

Figure

6

APPENDIX C – O-PILE DATASHEET

O-Pile 24” Diameter – 0.438” Wall Thickness:



O-Pile

Product ID

O-Pile 46-674

Available steel grade options: A 252 Grade 1 | A 252 Grade 2 | A 252 Grade 3 | A 572 Grade 50 | A 572 Grade 55 | A 572 Grade 60 | A 572 Grade 65 | x70 | x80

Primary SSP Specifications

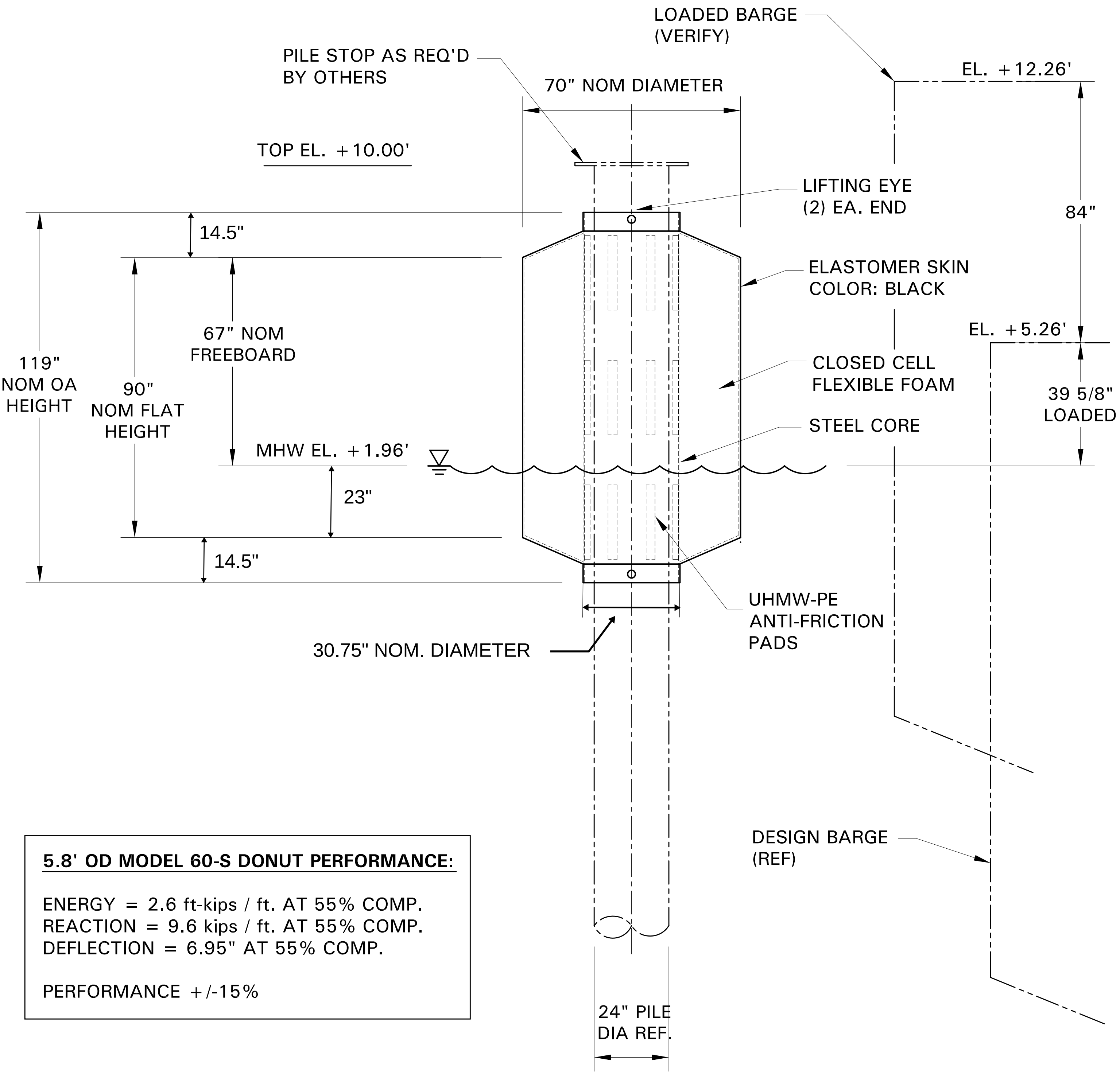
bending moment capacity	353.2 k-ft/ft
steel grade	A 572 Grade 50
interlock strength	233.89 k/ft
weight	52.78 lb/ft^2 *
panel weight	116.63 lb/ft *
section modulus	84.78 in^3/ft *
moment of inertia	1,017.34 in^4/ft *
connector ratio	100 % ○ Custom 95 %
panel width	26.52 in *
profile depth	24.00 in *

APPENDIX D – CONFIGURATION AND PERFORMANCE OF DONUT MARINE FENDER BY TRELLEBORG MARINE SYSTEMS

DONUT MARINE FENDER

Model 60-S Fender Configuration
5.8' OD x 7.5' Flat Ht. for 24" Pile

NOT TO SCALE



5.8' OD MODEL 60-S DONUT PERFORMANCE:

ENERGY = 2.6 ft-kips / ft. AT 55% COMP.
REACTION = 9.6 kips / ft. AT 55% COMP.
DEFLECTION = 6.95" AT 55% COMP.

PERFORMANCE +/-15%

DONUT WEIGHT ~3054 lbs

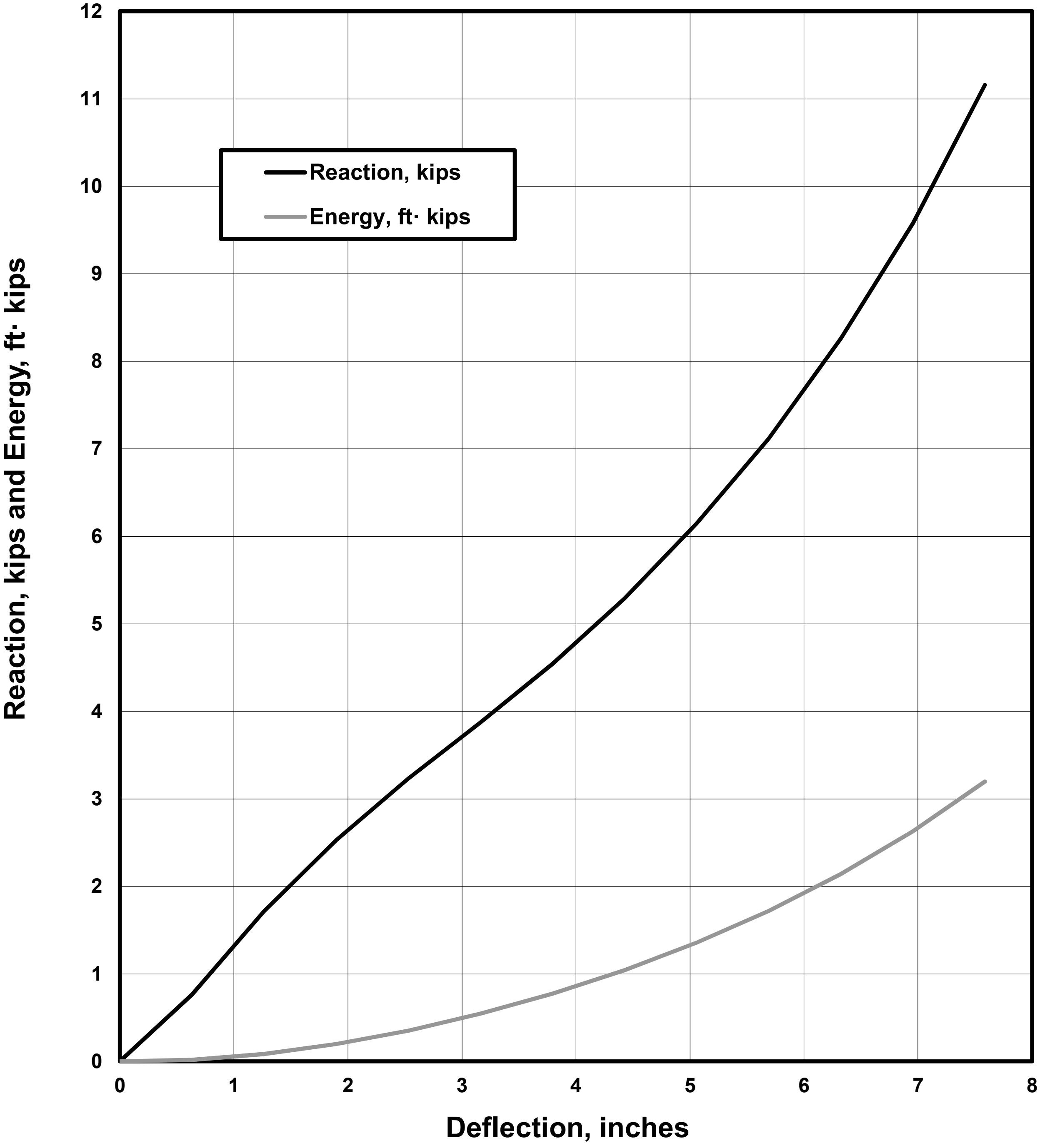
190114 Gowanus Dolphin Donut.dwg 14Jun19

TO ACCOMMODATE MANUFACTURING PROCESSES, TRELLEBORG MARINE SYSTEMS RESERVES THE RIGHT TO CHANGE, WITHOUT SPECIFIC CUSTOMER APPROVAL, DETAILS WHICH DO NOT IN TRELLEBORG'S OPINION AFFECT INTENDED FORM, FIT AND FUNCTION OF THE PRODUCT.	THIS DOCUMENT CONTAINS INFORMATION WHICH IS PROPRIETARY TO TRELLEBORG MARINE SYSTEMS. THE INFORMATION CONTAINED HEREIN SHALL NOT BE DISCLOSED OR DUPLICATED, USED OR DISCLOSED IN WHOLE OR IN PART FOR ANY PURPOSE OTHER THAN TO EVALUATE THE DOCUMENT.

Trelleborg Marine Systems - 532 Jack Enders Blvd.
Berryville, VA 22611 Phone (540) 667-5191 Fax (540) 667-7987

TRELLEBORG

Performance Curves
5.8 ft OD x 1.0 ft. Effective Flat-Side Height
Model 60-S DONUT Fender



Performance +/-15%

6/7/2019

CALCULATIONS
FOR
STEEL MONOPILE DOLPHINS

STRUCTURE

UNION STREET BRIDGE
B.I.N. 2-24027-0

PREPARED FOR

GOWANUS ENVIRONMENTAL REMEDIATION TRUST

RTA1 BRIDGE STABILITY FINAL DESIGN

PREPARED BY

Greenman-Pedersen, Inc.

FEBURARY 2020

DESIGN SUMMARY

Design Criteria:

Manuals & Specifications References

1. AASHTO LRFD Bridge Design Specifications – Eighth Edition
2. AWPI Timber Pile Design and Construction Manual - 2002
3. Coastal Engineering Research Council of the COPRI of ASCE, “Concepts in Design of Coastal Structures” - 1976
4. NYSDOT Standard Specifications

Other References:

- Department of Civil Engineering at Princeton University, “Analysis and Design of Dolphins, Final Report to the Bureau of Yards and Docks Department of the Navy.” April 1, 1963.
- Arcelor Mittal Piling Handbook 8th Edition Revised 2008

Software Used:

- Civiltech AllPile – Version 7
- Microsoft Excel

Design Approach:

The existing timber pile cluster dolphins that protect the bridge structures from vessel collisions are to be removed and replaced following the dredging and backfill of the Gowanus Canal for RTA 1 proposed by Geosyntec. The deflection of the replacement dolphins at the mudline must be determined in order for the remediation team to design their environmental concrete cap, which is also included in Geosyntec's plan for RTA 1.

The design of the pipe pile dolphins is split into four locations notated as follows:

- USDL01 – Northwest corner of the bridge
- USDL02 – Northeast corner of the bridge
- USDL03 – Southeast corner of the bridge
- USDL04 – Southwest corner of the bridge

The steel pipe pile dolphins were designed using a two-step approach. First, the vessel collision force was determined using the procedure set forth in LRFD Bridge Design Specifications (AASHTO). Once the design load was calculated, the ultimate load capacity and the maximum allowable deflection of the pile at the mudline were determined using the Broms’ Method for Laterally Loaded Piles following the procedure in the Timber Pile Design and Construction Manual (AWPI).

The design of the pile stops followed the procedure set forth in LRFD Bridge Design Specifications (AASHTO).

The mudline elevation used is the elevation after dredging is completed. The mudline falls at a lower elevation at the northwest corner than at any of the other three corners of the bridge. This means that the vertical distance between the mudline and the lateral load is greatest at design location USDL01, as are the length of the pile and the lateral deflection at the mudline. Therefore, design location USDL01 controls the design due to the elevation of the mudline after dredging is completed.

Analysis Methods and Design Assumptions:

General Assumptions:

- All soil information including soil design properties and soil layer thicknesses were obtained from the RTA 1 Bridge Soil Design Parameters prepared by GZA GeoEnvironmental, Inc. dated July 11, 2018 (*Appendix A*). Soil layer thicknesses have been modified for certain design locations per the Summary of Geotechnical Design Parameters prepared by Geosyntec Consultants (*Appendix B*).
- Verification of pipe pile design deflections was performed using the program CivilTech AllPile – Version 7.
- Dredge depths were obtained from the bottom of soft sediment surface provided by Geosyntec Consultants.

Vessel Collision Force:

- The structural limit state that governs this design is Extreme Event II, for which the vessel collision force is the only load considered.
- An empty standard hopper barge was chosen as the design vessel per recommendations made in Article 3.14 of Reference 1. Ships were not considered due to their relatively infrequent use of the channel.
- The design vessel collision force is assumed to be the collision impact force on a pier for a standard hopper barge, and is applied as an equivalent static force at a point along the length of the pile equal in elevation to that of the bow/rake of the design barge.

Broms' Method for Laterally Loaded Piles:

- The embedded end of each pile is assumed to be fixed at the critical depth "CD" below the mudline.
- The soil type within the critical depth is cohesionless.
- Each pile is analyzed assuming perfect rigidity.
- Axial loads on the pile are ignored.

Corrosion Durability of Dolphin Piles:

- All steel monopile dolphins shall be protected by applying coal tar epoxy.
- Coal tar epoxy has an assumed design life of 10 years.
- Corrosion durability is checked for a 50 year timeline.
- Thickness loss due to corrosion was accounted for on the interior and exterior faces of the piles in accordance with the corrosion rates provided in the Arcelor Mittal Piling handbook.

Summary of Results:

Dolphin Design Values	
Steel Pipe Pile	
Diameter, in	28
Wall Thickness, in	0.750
Depth of Embedment, ft	37.50
Ultimate Lateral Capacity, k	30.94
Max. Allowable Load, k	12.38
Collision Force, k	9.57
Steel Plate Pile Stop	
Diameter, in	37
Thickness, in	1
Welded Connection	
Weld size, in	5/16
Shear Resistance, kips	523.11

Dolphin Pile Elevations				
Location	**Top of Pile**	**Approx. Channel Bed**	**Min. Tip of Pile**	**Pile Length (ft)**
USDL01	10.00	-17.50	-55.00	65.00
USDL02	10.00	-14.60	-52.10	63.00
USDL03	10.00	-15.00	-52.50	63.00
USDL04	10.00	-14.00	-51.50	62.00

Deflection of Dolphin Piles at the Mudline Following a Vessel Collision		
Location	**Elevation of Mudline (ft)**	**Deflection (in)**
USDL01	-17.50	0.388
USDL02	-14.60	0.328
USDL03	-15.00	0.258
USDL04	-14.00	0.232

All dolphin piles met the minimum required design section strength after a 50 year period of thickness loss due to corrosion. Results are shown in Attachment C.

TABLE OF CONTENTS

SUMMARY OF RESULTS

References:

1. AASHTO LRFD Bridge Design Specifications - Eighth Edition
2. AWPI Timber Pile Design and Construction Manual, 2002
3. Coastal Engineering Research Council of the COPRI of ASCE, "Concepts in Design of Coastal Structures", 1976
4. NYSDOT Standard Specifications
5. Department of Civil Engineering at Princeton University, "Analysis and Design of Dolphins, Final Report to the Bureau of Yards and Docks Department of the Navy", April 1, 1963
6. AISC Steel Construction Manual, 14th Ed.

Appendices:

Appendix A - Pages from RTA 1 Bridge Soil Design Parameters by GZA GeoEnvironmental, Inc.
Appendix B - Pages from Summary of Geotechnical Design Parameters by Geosyntec Consultants
Appendix C - O-Pile Datasheet
Appendix D - Configuration and Performance of Donut Marine Fender by Trelleborg Marine Systems

Purpose & Assumptions:

The existing timber pile cluster dolphins that protect the bridge structures from vessel collisions are to be removed and replaced prior to the dredging and backfill of the Gowanus Canal for RTA 1 proposed by Geosyntec. The deflection of the replacement dolphins at the mudline must be determined in order for the remediation team to design their environmental concrete cap, which is also included in Geosyntec's plan for RTA 1. The assumptions are as follows:

- The structural limit state that governs this design is Extreme Event II, for which the vessel collision force is the only load considered. Axial loads on the pile are ignored.
- An empty standard hopper barge was chosen as the design vessel per recommendations made in Article 3.14 of Reference 1. Ships were not considered due to their relatively infrequent use of the channel.
- The design vessel collision force is assumed to be the collision impact force on a pier for a standard hopper barge, and is applied as an equivalent static force at a point along the length of the pile equal in elevation to that of the bow/rake of the design barge.
- The embedded end of each pile is assumed to be fixed at the critical depth "CD" below the mudline.
- The soil type within the critical depth is cohesionless.
- Each pile is analyzed assuming perfect rigidity.
- To be conservative, the mudline elevation used for design will be the bottom of the dredge surface. This temporary condition represents the worst case condition. The mudline falls at a lower elevation at the northwest corner than at any of the other three corners of the bridge. This means that the vertical distance between the mudline and the lateral load is greatest at design location USDL01, as are the length of the pile and the lateral deflection at the mudline. Therefore, design location USDL01 controls the design due to the elevation of the mudline after dredging is completed.

Summary of Results:

The design results are summarized in the tables below:

Pile Design Values	
Diameter, in	28
Wall Thickness, in	0.75
Depth of Embedment, ft	37.50
Ultimate Lateral Capacity, k	30.94
Max. Allowable Load, k	12.38
Collision Force, k	9.57

12.38 > 9.57 ***OK***

Steel Plate Pile Stop	
Diameter, in	37
Thickness, in	1.0
Welded Connection	
Weld size, in	5/16
Shear Resistance, kips	523.11

Deflections of 28" x 0.75" Pipe Pile Following Vessel Collision (AllPile)				
Design Location USDL01				
	Elevation (ft)	**Pile Depth (ft)**	**Collision Force (k)**	**Deflection (in)**
Top of Pile	10.00	0	9.57	2.330
Dredge Limit	-17.50	27.50	9.30	0.388
Critical Depth	-28.00	38.00	-2.60	-0.004
Tip	-55.00	65.00	0.00	0.003

Dolphin Pile Elevations				
Location	**Top of Pile**	**Approx. Dredge Limit EL.**	**Min. Tip of Pile**	**Pile Length (ft)**
USDL01	10.00	-17.50	-55.00	65.00
USDL02	10.00	-14.60	-52.10	63.00
USDL03	10.00	-15.00	-52.50	63.00
USDL04	10.00	-14.00	-51.50	62.00

Deflection of Dolphin Piles at the Mudline Following a Vessel Collision		
Location	**Dredge Limit EL. (ft)**	**Deflection (in)**
USDL01	-17.50	0.388
USDL02	-14.60	0.328
USDL03	-15.00	0.258
USDL04	-14.00	0.232

INPUTS

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	11/21/19
SUBJECT:	RTA 1 - Union Street Dolphin Design	CHECKED BY:	PLT	DATE:	12/18/19

RTA 1 - Union Street Dolphin Design - Inputs

Pipe Pile Material:

ASTM A 572 Steel:

F_y = 50 *ksi* (Yield stress)

E = 29000 *ksi* = 4176000 *ksf* (Modulus of elasticity)

Pile Stop Material:

ASTM A 36 Steel:

F_y = 36 *ksi* (Yield stress)

F_u = 58 *ksi* (Tensile stress)

E = 29000 *ksi* = 4176000 *ksf* (Modulus of elasticity)

Donut Fender Properties:

WD = 3054 *lbs* (Nominal weight of donut fender) *Appendix D - Page 1*

OD_f = 5.83 *ft* (Outside diameter of donut fender) *Appendix D - Page 1*

r_o = 2.92 *ft* (Radius of donut fender)

CD_f = 2.56 *ft* (Diameter of donut fender core) *Appendix D - Page 1*

r_c = 1.28 *ft* (Radius of donut fender core)

Assume donut fender completely submerged (conservative)

h_{SDF} = 119 *in* (Submerged height of donut fender)

Approx. $V_{O,SDF} = \pi r_O^2 h_{SDF}$ (Approximate submerged volume of donut fender)

Approx. $V_{O,SDF}$ = 265.03 ft^3

Approx. $V_{C,SDF} = \pi r_c^2 h_{SDF}$ (Approximate submerged volume of donut fender core)

Approx. $V_{O,SDF}$ = 51.14 ft^3

Approx. $V_{SDF} = V_{O,SDF} - V_{C,SDF}$

Approx. V_{SDF} = 213.88 ft^3

$WD_B = \gamma_w V_{SDF}$ (Buoyant weight of donut fender)

WD_B = 13346.35 *lbs*

$F_B = WD_B$ (Buoyant force on the donut fender)

F_B = 13346.35 *lbs*

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PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	11/21/19
SUBJECT:	RTA 1 - Union Street Dolphin Design	CHECKED BY:	PLT	DATE:	12/18/19

Soil Parameters:

Constants:

γ_w = 62.4 *pcf* (Unit weight of water)

Soil Layer 1 - Native Alluvial Sediment:

γ_2 = 115 *pcf* (Total unit weight) *Appendix A - Page 1*

φ'_2 = 28 *deg* (Effective Friction Angle) *Appendix A - Page 1*

$\gamma'_2 = \gamma_2 - \gamma_w$ (Effective unit weight)

γ'_2 = 52.6 *pcf*

N_{60} = 3.5 *bpf* *Appendix B - Figure 6*

$(N_1)_{60}$ = 5 *bpf* *Appendix B - Figure 6*

Soil Density = Loose

Soil Type = Cohesionless *Assumed*

$K_{p2} = \tan^2 (45 + \varphi'_2/2)$ (Rankine passive earth pressure coefficient)

K_{p2} = 2.77

K_{h2} = 7 *kcf* (Coefficient of horizontal subgrade reaction) *Ref. 2 Table 7-2*

$K_{h2, adj} = 0.25 * K_{h2}$ (Adjusted for cyclic loading conditions) *Ref. 2 Section 7.2*

$K_{h2, adj}$ = 1.75 *kcf*

OCR_2 = 1 *Appendix B - Table 9*

Soil Layer 2 - Glacial Deposit:

γ_3 = 125 *pcf* (Total unit weight) *Appendix A - Page 1*

φ'_3 = 34 *deg* (Effective Friction Angle) *Appendix A - Page 1*

$\gamma'_3 = \gamma_3 - \gamma_w$ (Effective unit weight)

γ'_3 = 62.6 *pcf*

N_{60} = 19 *bpf* *Appendix B - Figure 6*

$(N_1)_{60}$ = 15 *bpf* *Appendix B - Figure 6*

Soil Density = Medium to Dense

Soil Type = Cohesionless *Appendix A - Drawing DR-2*

$K_{p3} = \tan^2 (45 + \varphi'_3/2)$ (Rankine passive earth pressure coefficient)

K_{p3} = 3.54

K_{h3} = 35 *kcf* (Coefficient of horizontal subgrade reaction) *Ref. 2 Table 7-2*

$K_{h3, adj} = 0.5 * K_{h3}$ (Adjusted for cyclic loading conditions) *Ref. 2 Section 7.2*

$K_{h3, adj}$ = 17.5 *kcf*

OCR_3 = 1 *Appendix B - Table 9*

VESSEL COLLISION FORCE

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 MADE BY: JRA DATE: 11/21/19
SUBJECT: RTA 1 - Union Street Dolphin Design CHECKED BY: PLT DATE: 12/18/19

RTA 1 - Union Street Dolphin Design - Vessel Collision Force

Design Barge:

Standard Hopper Barge: *Ref. 1 Article 3.14.11*

B_W = 35 *ft* (Barge width)

B_L = 195 *ft* (Barge length)

B_D = 12 *ft* (Barge depth)

B_{ED} = 1.7 *ft* (Barge empty draft)

B_{LD} = 8.7 *ft* (Barge loaded draft)

$B_{DL,top} = B_D - B_{LD}$ (Depth of loaded barge above MHW)

$B_{DL,top}$ = 3.3 *ft*

$EL_{BDL} = EL_{MHW} + B_{DL,top}$ (Barge deck elevation, loaded)

EL_{BDL} = 5.26 *ft*

$B_{DE,top} = B_D - B_{ED}$ (Depth of empty barge above MHW)

$B_{DE,top}$ = 10.3 *ft*

$EL_{BDE} = EL_{MHW} + B_{DE,top}$ (Barge deck elevation, unloaded)

EL_{BDE} = 12.26 *ft*

DWT = 1700 *tons* (Deadweight tonnage) *Ref. 1 Article 3.14.11*

LOA = 195 *ft* (Length overall)

W_E = 200 *tons* (Empty displacement) *Ref. 1 Article 3.14.1*

Annual Frequency of Collapse:

Probability of Aberrancy, *PA* : *Ref. 1 Article 3.14.5.2.3*

BR = 0.00012 (Aberrancy base rate for barges)

R_B = 1.0 (Correction factor for bridge location in a straight region)

V_C = 0.373 *knots* (Current velocity component parallel to the vessel transit path, provided by Geosyntec)

$$R_C = \left(1 + \frac{V_C}{10}\right)$$

(Correction factor for current acting parallel to vessel transit path)

R_C = 1.037

V_{XC} = 0.000 *knots* (Current velocity component perpendicular to the vessel transit path)

$R_{XC} = (1+V_{XC})$ (Correction factor for cross-currents acting perpendicular to vessel transit path)

R_{XC} = 1.000

R_D = 1.0 (Correction factor for vessel traffic density)

$PA = (BR)\,(R_B)\,(R_C)\,(R_{XC})\,(R_D)$ *Ref. 1 Equation 3.14.5.2.3-1*

PA = 0.000124

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	11/21/19
SUBJECT:	RTA 1 - Union Street Dolphin Design	CHECKED BY:	PLT	DATE:	12/18/19

Geometric Probability, *PG* : *Ref. 1 Article 3.14.5.3*

$B_M = B_W$ (Width of the design vessel)

$B_M =$ 35 *ft*

$B_{P+Fender} =$ 17 *ft* (Width of the pier with fender system)

$\sigma =$ 195 *ft* (Standard deviation of the normal distribution)

Impact Zone = 52 *ft*

$X =$ 34.5 *ft* (Distance from centerline of vessel sailing path to centerline of pier)

$PG_1 =$ 8.5 *ft* (Lower boundary of the geometric probability)

$PG_2 =$ 60.5 *ft* (Lower boundary of the geometric probability)

PG = *the area under the normal distribution bounded by* PG_1 *and* PG_2

PG = 0.0184

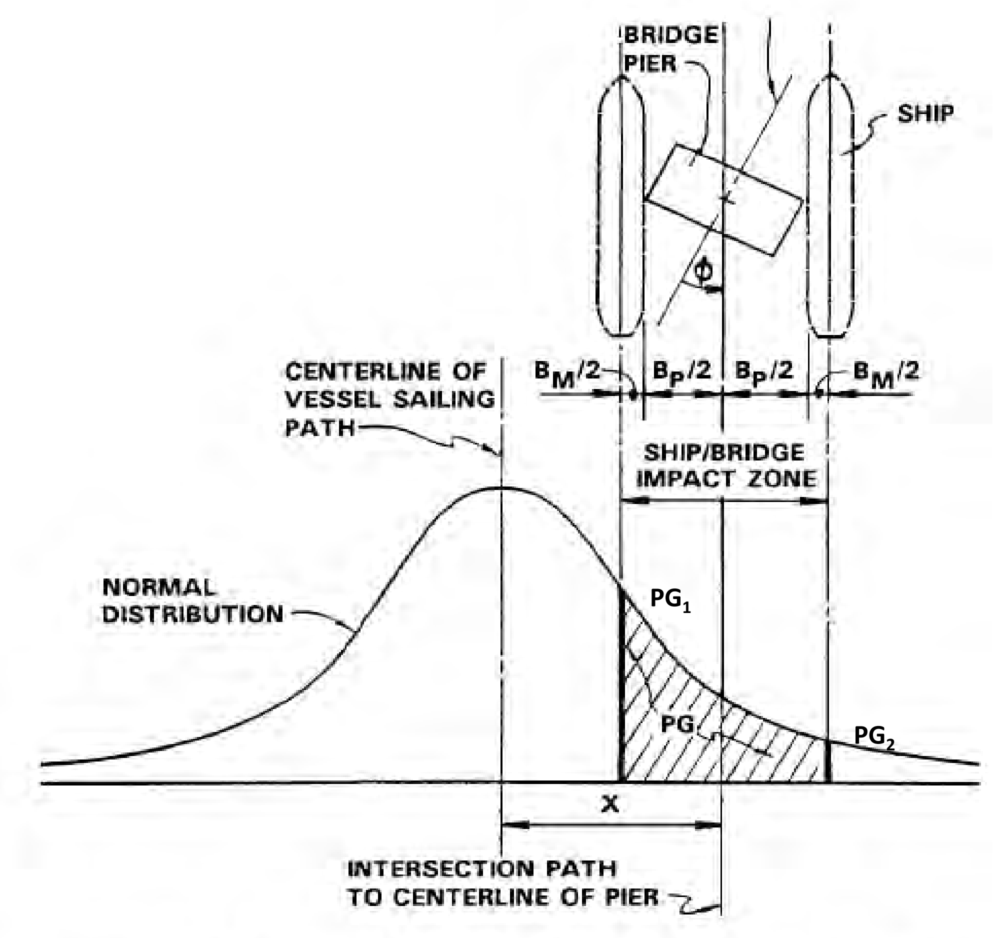

Figure 3.14.5.3-1—Geometric Probability of Pier Collision

Probability of Collapse, *PC* : *Ref. 1 Article 3.14.5.4*

According to Article 3.14.5.4 of Reference 1, the probability of bridge collapse, *PC* , is based on the ratio *H/P* , where:

H = Resistance of bridge component to a horizontal force expressed as pier resistance, H_P, or superstructure resistance, H_S

P = Vessel impact force, P_S, P_{BH}, P_{DH}, or P_{MT}

P_S	=	Ship collision force on pier	*Ref. 1 Article 3.14.8*
P_{BH}	=	Bow collision impact force on a superstructure	*Ref. 1 Article 3.14.10.1*
P_{BH}	=	Deck house collision impact force on a superstructure	*Ref. 1 Article 3.14.10.2*
P_{MT}	=	Mast collision impact force on a superstructure	*Ref. 1 Article 3.14.10.3*

A standard hopper barge was selected as the design vessel for each of the piers at this location. The barge impact force on a pier, P_B, is not considered in the calculation of the ratio *H/P* presented above. For this reason, the probability of collapse, *PC* , is neglected for this design.

Protection Factor, *PF* : *Ref. 1 Article 3.14.5.5*

B_P =	10	*ft*	(Width of the pier)
L_P =	56	*ft*	(Length of the pier)
B_C =	106	*ft*	(Width of the channel)
θ =	7.21	*deg*	(Protection angle provided by dolphin)

$$\theta_{max} = \sin^{-1}\frac{B_C - 18.5\,ft}{LOA + {}^{B_P}/_2}$$ (Max. possible protection angle allowed by channel geometry)

θ_{max} = 25.94 *deg*

σ = 30 *deg* (Standard deviation of the normal distribution, assumed)

θ *Protection* = *the area in the density function between 0 and* θ *(in %)*

θ *Protection* = 1.14 %

θ_{max} *Protection* = *the area in the density function between 0 and* θ_{max} *(in %)*

θ_{max} *Protection* = 12.45 *%*

Protection Provided = 9.13 *%* (Protection provided by dolphin, adjusted per max. protection angle)

PF = 1 - (% Protection Provided/100)

PF = 0.9087

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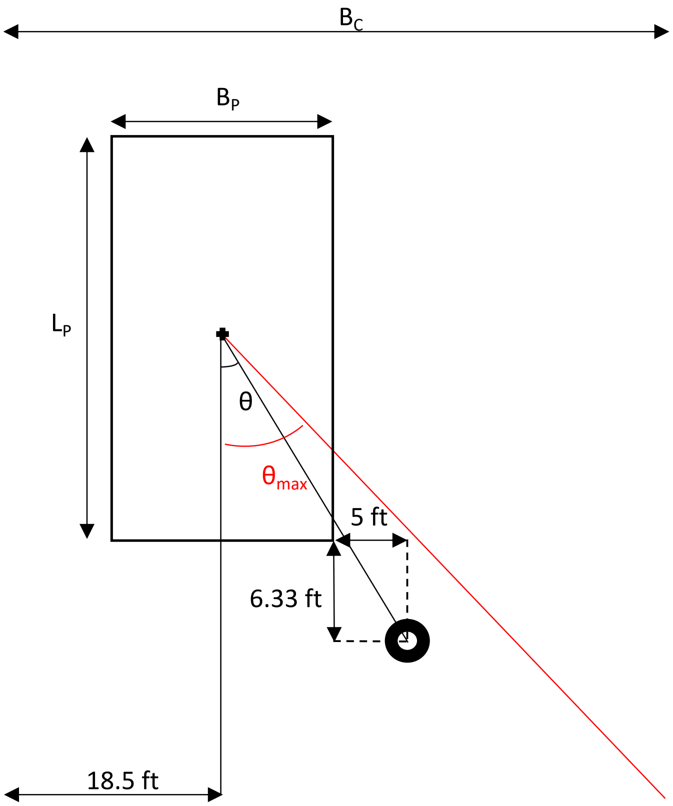
PROJECT: RTA 1 Bridge Stability Final Design SHEET: ______ OF ______

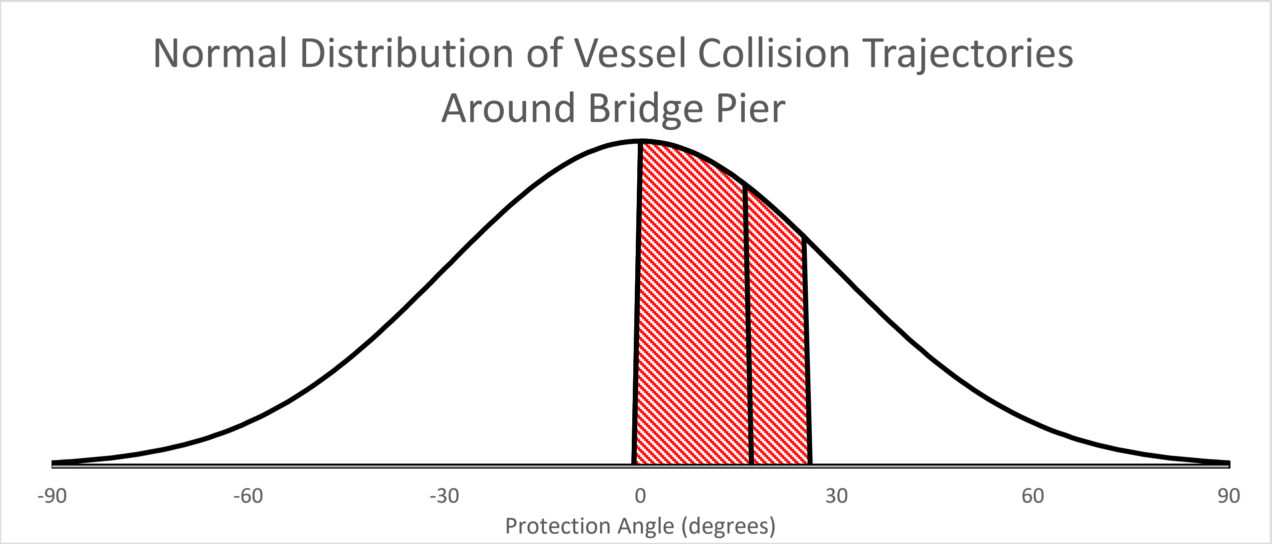
JOB NO.: BAB-2017020.01 MADE BY: JRA DATE: 11/21/19

SUBJECT: RTA 1 - Union Street Dolphin Design CHECKED BY: PLT DATE: 12/18/19

Plan of Dolphin Protection (Not to Scale):



Illustrative Model of the Protection Factor (PF) of Dolphin Protection around a Bridge Pier:



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PROJECT: RTA 1 Bridge Stability Final Design — SHEET: ____ OF ____
JOB NO.: BAB-2017020.01 — MADE BY: JRA — DATE: 11/21/19
SUBJECT: RTA 1 - Union Street Dolphin Design — CHECKED BY: PLT — DATE: 12/18/19

Annual Frequency of Collapse, *AF* : — *Ref. 1 Article 3.14.5*

N = 3 (Annual number of vessels that utilize the channel, assumed)

AF = *(N) (PA) (PG) (PC) (PF)* — *Ref. 1 Equation 3.14.5-1*

AF = 6.23E-06

AF_{MAX} = 0.001 (Maximum annual frequency of collapse for typical bridges)

$AF \leq AF_{MAX}$ — ***OK***

Vessel Collision Force:

Design Collision Velocity, *V* : — *Ref. 1 Article 3.14.6*

V_{MIN} = 0.63 *ft/s* (Minimum design impact velocity = yearly mean current velocity for the bridge location) — *Provided by Geosyntec*

V_T = V_{MIN} (Typical vessel transit velocity in the channel under normal environmental conditions)

V_T = 0.63 *ft/s*

X = 29.5 *ft* (Distance to face of pier from centerline of channel, measured in CAD)

X_C = 53 *ft* (Distance from centerline to edge of channel, measured in CAD)

X_L = 585 *ft* (Distance equal to 3.0 times the length overall of the design vessel)

V = 0.63 *ft/s* (Design impact velocity)

Vessel Collision Energy, *KE* : — *Ref. 1 Article 3.14.7*

W = 181.44 *tonnes* (Vessel displacement tonnage)

UC = 12.80 *ft* (Underkeel clearance)

C_H = 1.05 (Hydrodynamic mass coefficient) — *Ref. 1 Equations 3.14.7-2,3*

$KE = (C_H\ W\ V^2) / 29.2$ (Vessel collision energy) — *Ref. 1 Equation 3.14.7-1*

KE = 2.59 *k-ft*

Barge Bow Damage Length, a_B : — *Ref. 1 Article 3.14.12*

$$a_B = 10.2\left(\sqrt{1+\frac{KE}{5{,}672}}-1\right)$$

Ref. 1 Equation 3.14.12-1

a_B = 0.0023 *ft*

Barge Collision Force on the Pier, P_B : — *Ref. 1 Article 3.14.11*

$P_B = 4{,}112\ a_B$ (Equivalent static barge impact force) — *Ref. 1 Equation 3.14.11-1*

P_B = 9.57 *kips*

Vessel Collision Force, *CV* :

Load Factor = 1.00 — *Ref. 1 Table 3.4.1-1*

CV = P_B * *Load Factor*

CV* = 9.57 *kips

BROMS' METHOD FOR LATERALLY LOADED PILES

GPI

PROJECT: RTA 1 Bridge Stability Final Design — SHEET: ______ OF ______
JOB NO.: BAB-2017020.01 — MADE BY: JRA — DATE: 11/21/19
SUBJECT: RTA 1 - Union Street Dolphin Design — CHECKED BY: PLT — DATE: 12/18/19

RTA 1 - Union Street Dolphin Design - Broms' Method for Laterally Loaded Piles

(These calculations follow the procedure set forth in Ref. 2, Section 7.2)

Soil Parameters within the Critical Depth at Location USDL01 (Controls):

Assumed soil layer =	Soil Layer 2 - Glacial Deposit		
Soil type =	Cohesionless		
Soil density =	Medium to Dense		
K_{h3} =	35	*kcf*	(Coefficient of horizontal subgrade reaction for soil layer 2)
$K_{h3,\,adj}$ =	17.5	*kcf*	(Adjusted for cyclic loading conditions)
K_{p3} =	3.537		(Rankine passive earth pressure coefficient for soil layer 2)

Load Combination

1. Extreme Event II - Collision by Vessels	*Ref. 1 Sect. 3.4.1*
2. Water Load and Stream Pressure (WA) and Vessel Collision Forces (VC) have load factors of 1 for Extreme Event II.	*Ref. 1 Table 3.4.1-1*
3. All resistance factors for the extreme limit event state shall be taken to be 1.	*Ref. 1 Sect. 6.5.5*

Pile Parameters:

Section Parameters:

D =	2.33	*ft*	(Diameter of pile, outside)
t =	0.75	*in*	(Thickness of pile)
D_i =	2.208	*ft*	(Diameter of pile, inside)
C =	87.96	*in*	(Circumference of pile)
I =	5964	in^4	(Moment of inertia of the pile section)
S =	426.0	in^3	(Section modulus of the pile)
w =	218.5	*lb/ft*	(Weight of pile per unit length)
A_g =	64.21	in^2	(Cross sectional area of steel)
Z=	557.1	in^3	(Plastic section modulus of pile)

Circular Tubes — *Ref. 1 Sect. 6.12.2.2.3*

D/t= 37.33

$.07E/F_y$= 40.60

D/t < $.07E/F_y$ — ***NO LOCAL BUCKLING CHECK REQUIRED***

Moment Capacity

M_n= fy*Z — (Resisting moment of the pile) — *Ref. 1 Eq. 6.12.2.2.3-1*

M_n= 2321 *k-ft*

M_{max} = 298.3 *k-ft*

M_n = > M_{max} — ***OK***

GPI

PROJECT: RTA 1 Bridge Stability Final Design — SHEET: ____ OF ____

JOB NO.: BAB-2017020.01 — MADE BY: JRA — DATE: 11/21/19

SUBJECT: RTA 1 - Union Street Dolphin Design — CHECKED BY: PLT — DATE: 12/18/19

Shear Capacity

L_v= 117.6 *in* (Distance between point of max and zero shear)

F_{cr1}= (1.60*E)/(sqrt(L_v/D)*(D/t)$^{(5/4)}$) *Ref. 1 Eq. 6.12.1.2.3c-2*

F_{cr1}= 0.42 *ksi*

F_{cr2}= (0.78*E)/(D/t)^(3/2) *Ref. 1 Eq. 6.12.1.2.3c-3*

F_{cr2}= 99.2 *ksi* (Shear Buckling Resistance)

F_{cr2} > F_{cr1} Use Fcr2 Value

V_n= 0.5*A_g*F_{cr} (Nominal Shear Resistance) *Ref. 1 Eq. 6.12.1.2.3c-1*

V_n= 3183 *k*

V_u= 22.8 *k* (max. shear applied)

V_n > V_u ***OK***

Member Parameters:

$T = \sqrt[5]{EI/K_{h3,adj}}$ (Characteristic length of the pile for cohesionless soil) *Ref. 3 Figure 3*

T = 9.27 *ft*

h $_{T,MIN}$ = 3*T* (Minimum depth of embedment of the pile for cohesionless soil) *Ref. 3 Figure 3*

h $_{T,MIN}$ = 27.82 *ft*

h $_T$ = 37.50 *ft* (Design depth of embedment)

L = 65.00 *ft* (Total length of pile)

e $_c$ = 27.50 *ft* (Vertical distance between mudline and lateral load)

W $_p$ = *wL* (Weight of pile)

W $_p$ = 14201.19 *lb*

Critical Depth:

CD = 4 to 5 pile diameters *Ref. 2 Sect. 7.2*

CD = 10.50 *ft*

EL $_{CD}$ = *EL* $_2$ -*CD* (Elevation of the critical depth)

EL $_{CD}$ = -28.00 *ft*

Preliminary Design Checks:

Does the elevation of the critical depth fall within the assumed soil layer?

$|EL_{CD}| \geq |EL_2|$ ***OK***

Assumed soil layer is correct; OK to continue with design

Is the length of the pile above MHW adequate to protect against design vessel?

L $_{top}$ = 8.04 *ft* (Length of pile above MHW)

B $_{DL,top}$ = *B* $_D$ - *B* $_{LD}$ (Depth of loaded barge above MHW)

B $_{DL,top}$ = 3.3 *ft*

L $_{top}$ ≥ *B* $_{DL,top}$ ***OK***

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PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	11/21/19
SUBJECT:	RTA 1 - Union Street Dolphin Design	CHECKED BY:	PLT	DATE:	12/18/19

Maximum Allowable Deflection of a Single Pipe Pile - Free Head Condition:

Dimensionless Length Factor, ηh_T:

$\eta = (K_{h3,adj}/EI)^{1/5}$

$\eta =$ 0.108 *ft*

$\eta h_T =$ 4.043 **LONG**

Ultimate Lateral Load Capacity of the Pile, Q_u:

$M_n/\gamma'_3 D^4 K_{p3} =$ 354

$e_c/D =$ 11.79

$Q_u/K_{p3} D^3 \gamma'_3 =$ 11 (Approximate value based on graph) *Ref. 2 Figure 7-4*

$Q_u =$ 30.9 *kips* (Ultimate lateral load for a single pile)

Maximum Allowable Working Load, Q_m:

$Q_m = Q_u / 2.5$

$Q_m =$ 12.38 *kips*

Lateral Deflection at the Mudline:

$\eta h_T =$ 4.043

$e_c/h_T =$ 0.733

$\frac{y_m\,(EI)^{3/5} K_{h3,adj}{}^{2/5}}{Q_m h_T} =$ 1.9 (Approximate value based on graph) *Ref. 2 Figure 7-6*

$y_m =$ 0.758 *in* (Lateral deflection of the pile at the mudline)

DESIGN ELEVATIONS

RTA 1 - Union Street Dolphin Design - USDL01

(Using CPT Location LIFCPTMC0850-A from Appendix B - Figure 5a)

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88))

EL_1 = -14.50 *ft* (Minimum top of cap and fill elevation)

EL_2 = -17.50 *ft* (Minimum el. of fill-native interface = dredge elevation)

EL_3 = -26.33 *ft* (Minimum el. of native-glacial interface)

EL_{CD} = -28.00 *ft* (Elevation of the critical depth)

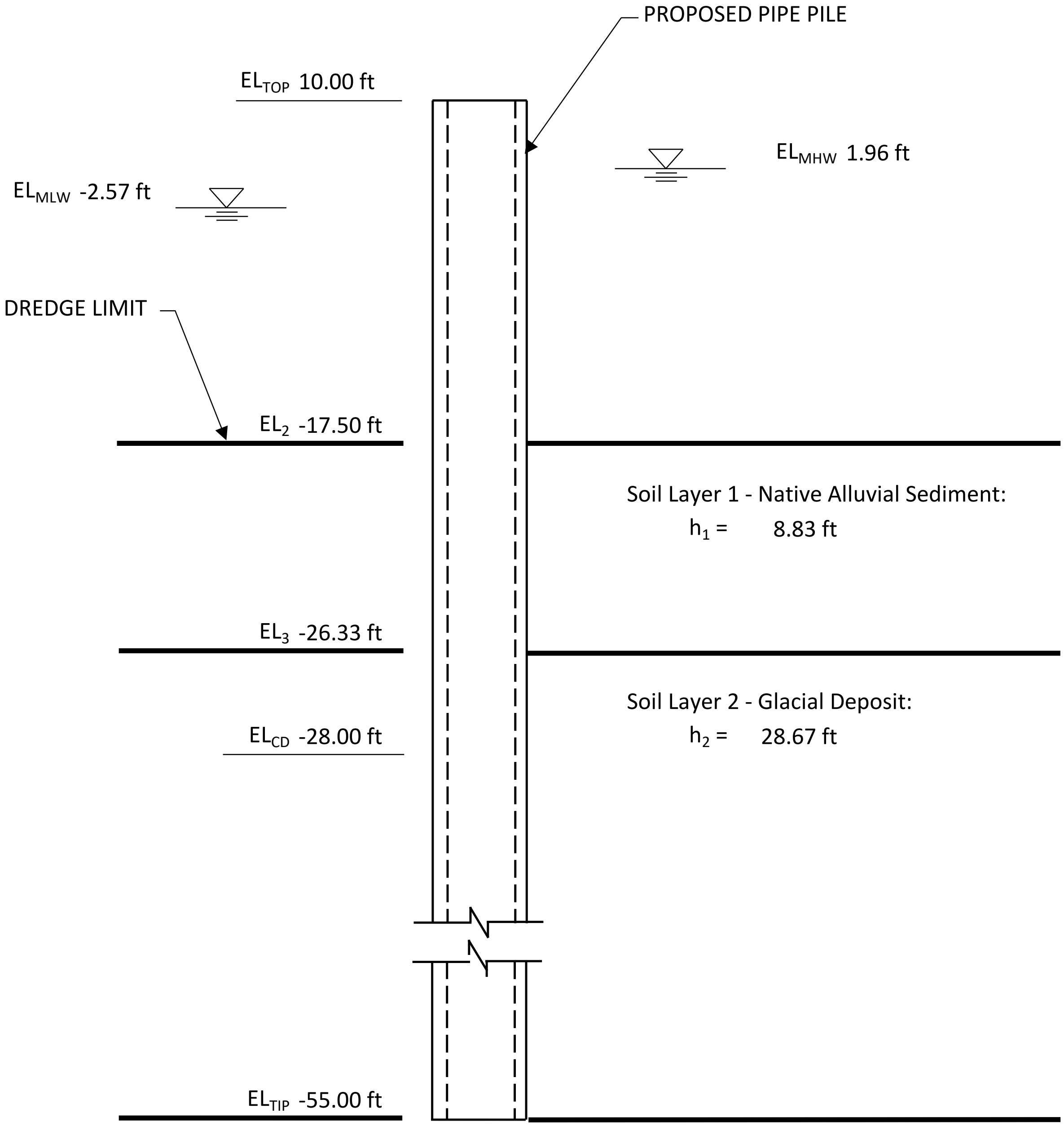
EL_{TOP} = 10.00 *ft* (Top of pile elevation)

EL_{TIP} = -55.00 *ft* (Tip of pile elevation)

MHW EL = 1.96 *ft* (Mean high water elevation)

MLW EL = -2.57 *ft* (Mean low water elevation)

Pipe Pile Cross-Section (Not to Scale):



RTA 1 - Union Street Dolphin Design - USDL02

(Using CPT Location LIFCPTMC0850-B from Appendix B - Figure 5a)

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88))

EL_1 = -11.60 ft (Minimum top of cap and fill elevation)

EL_2 = -14.60 ft (Minimum el. of fill-native interface = dredge elevation)

EL_3 = -21.30 ft (Minimum el. of native-glacial interface)

EL_{CD} = -25.10 ft (Elevation of the critical depth)

EL_{TOP} = 10.00 ft (Top of pile elevation)

EL_{TIP} = -52.10 ft (Toe of pile elevation)

MHW EL = 1.96 ft (Mean high water elevation)

MLW EL = -2.57 ft (Mean low water elevation)

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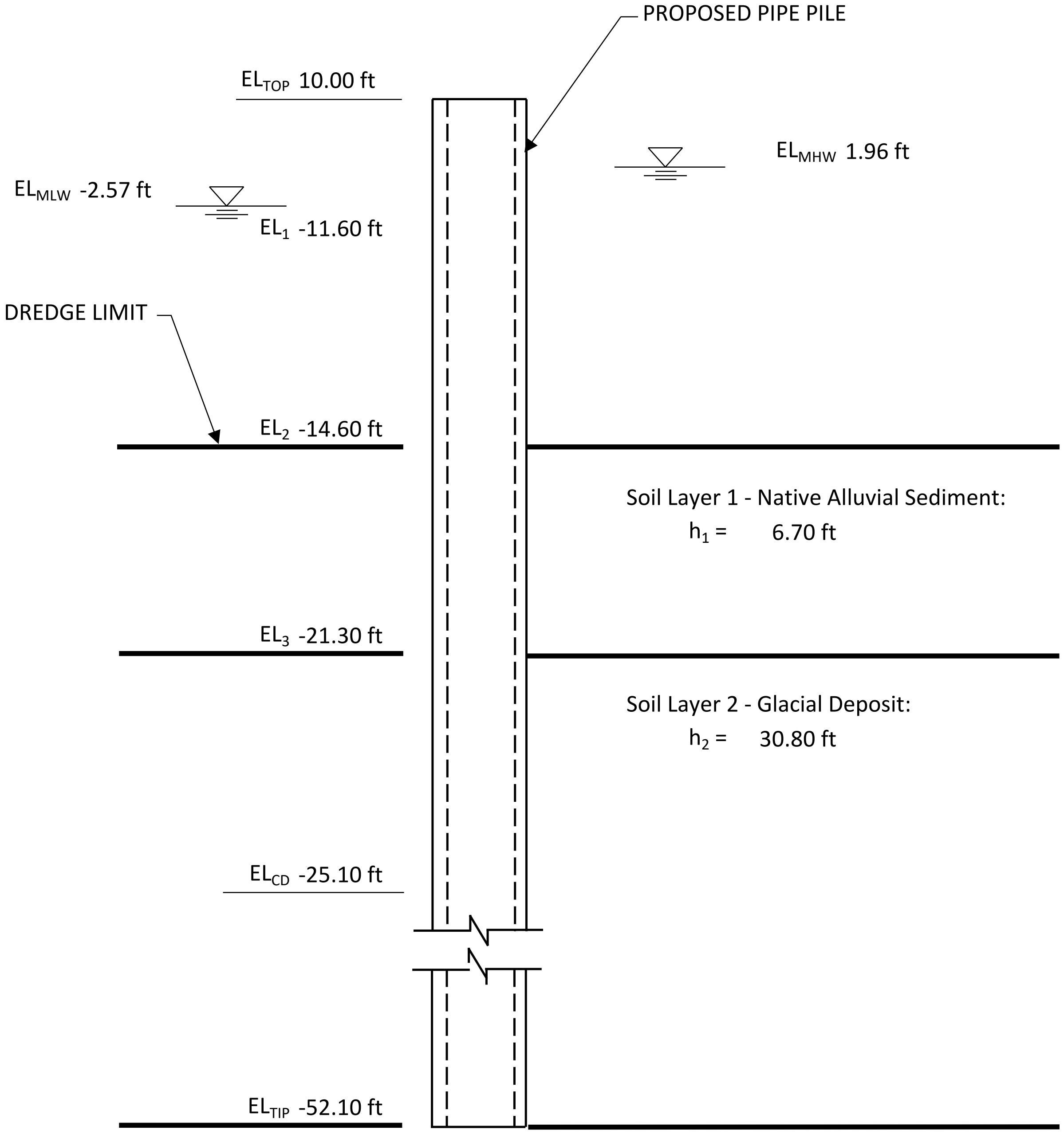
PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	11/21/19
SUBJECT:	RTA 1 - Union Street Dolphin Design	CHECKED BY:	PLT	DATE:	12/18/19

Pipe Pile Cross-Section (Not to Scale):



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PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	11/21/19
SUBJECT:	RTA 1 - Union Street Dolphin Design	CHECKED BY:	PLT	DATE:	12/18/19

RTA 1 - Union Street Dolphin Design - USDL03

(Using CPT Location LIFCPTMC0950-B from Appendix B - Figure 5a)

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88))

EL_1 = -12.00 *ft* (Minimum top of cap and fill elevation)

EL_2 = -15.00 *ft* (Minimum el. of fill-native interface = dredge elevation)

EL_3 = -15.39 *ft* (Minimum el. of native-glacial interface)

EL_{CD} = -25.50 *ft* (Elevation of the critical depth)

EL_{TOP} = 10.00 *ft* (Top of pile elevation)

EL_{TIP} = -52.50 *ft* (Toe of pile elevation)

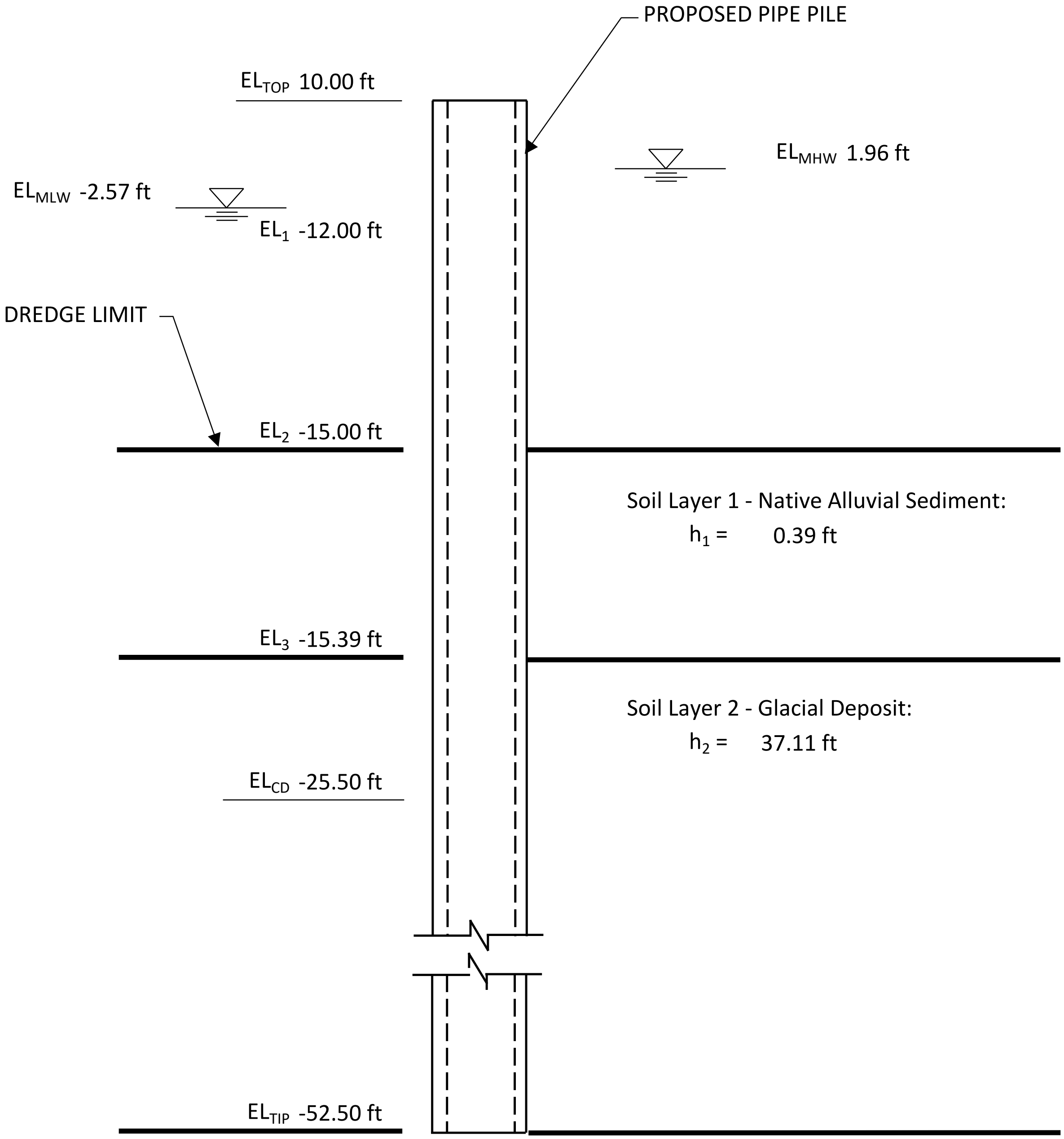
MHW EL = 1.96 *ft* (Mean high water elevation)

MLW EL = -2.57 *ft* (Mean low water elevation)

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: OF
JOB NO.: BAB-2017020.01 MADE BY: JRA DATE: 11/21/19
SUBJECT: RTA 1 - Union Street Dolphin Design CHECKED BY: PLT DATE: 12/18/19

Pipe Pile Cross-Section (Not to Scale):



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PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	11/21/19
SUBJECT:	RTA 1 - Union Street Dolphin Design	CHECKED BY:	PLT	DATE:	12/18/19

RTA 1 - Union Street Dolphin Design - USDL04

(Using CPT Location LIFCPTMC0950-A from Appendix B - Figure 5a)

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88))

EL_1 = -11.00 *ft* (Minimum top of cap and fill elevation)

EL_2 = -14.00 *ft* (Minimum el. of fill-native interface = dredge elevation)

EL_3 = -14.99 *ft* (Minimum el. of native-glacial interface)

EL_{CD} = -24.50 *ft* (Elevation of the critical depth)

EL_{TOP} = 10.00 *ft* (Top of pile elevation)

EL_{TIP} = -51.50 *ft* (Toe of pile elevation)

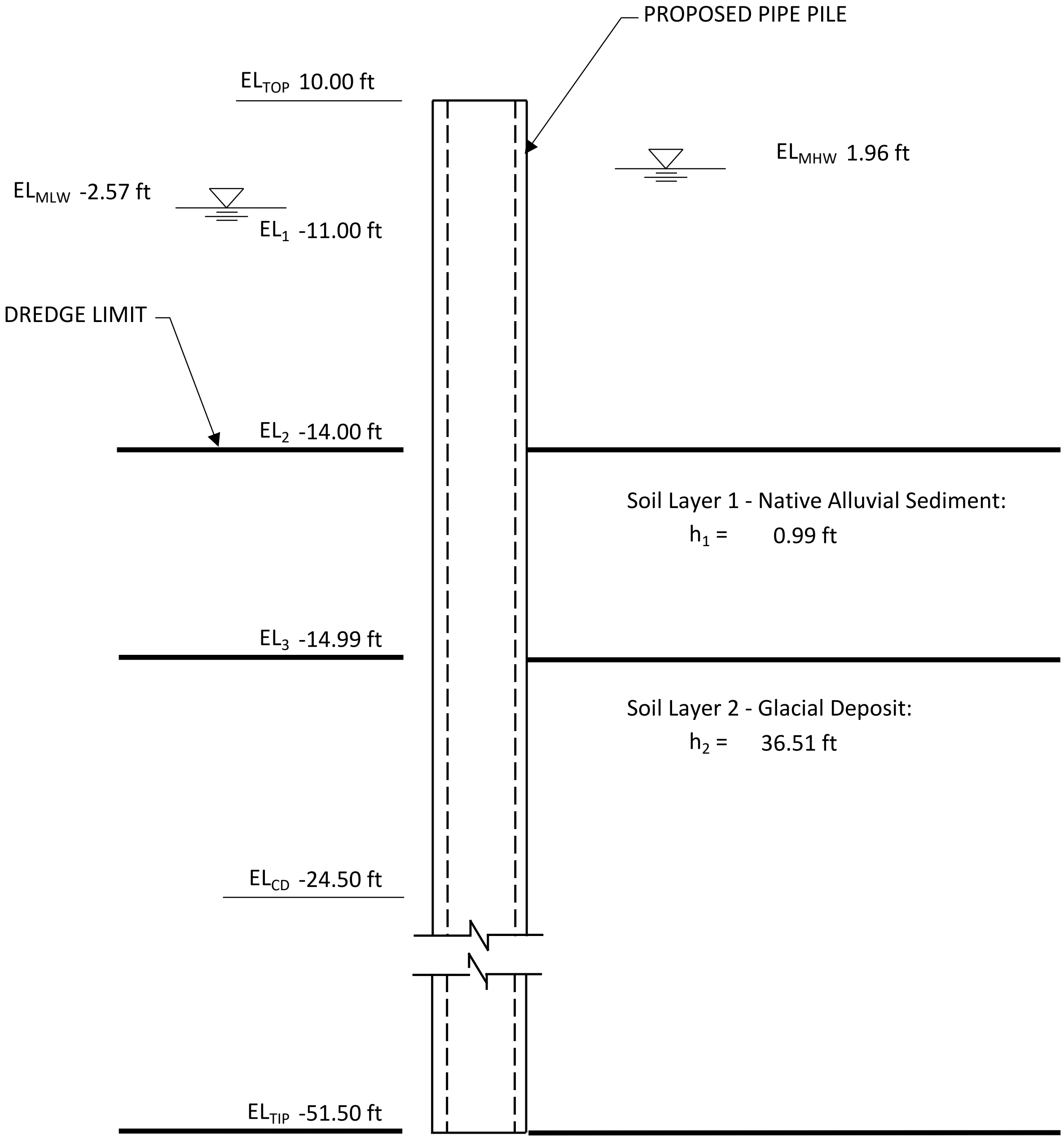
MHW EL = 1.96 *ft* (Mean high water elevation)

MLW EL = -2.57 *ft* (Mean low water elevation)

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	11/21/19
SUBJECT:	RTA 1 - Union Street Dolphin Design	CHECKED BY:	PLT	DATE:	12/18/19

Pipe Pile Cross-Section (Not to Scale):



PILE STOP DESIGN

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	11/21/19
SUBJECT:	RTA 1 - Union Street Dolphin Design	CHECKED BY:	PLT	DATE:	12/18/19

RTA 1 - Union Street Dolphin Design - Pile Stop Design

Fillet Weld Design:

Factored Shear Resistance of the Weld Metal, R_r: *Ref. 1 Article 6.13.3.2.4*

F_{exx} = 70 *ksi* (Classification strength of the weld metal)

φ_{e2} = 0.80 (Resistance factor for weld metal in fillet welds) *Ref. 1 Article 6.5.4.2*

$R_r = 0.6\,\varphi_{e2}\,F_{exx}$ *Ref. 1 Equation 6.13.3.2.4-1*

R_r = 33.6 *ksi*

Effective Area of the Weld, A_{ew}: *Ref. 1 Article 6.13.3.3*

$L_w = C$ (Length of the weld = circumference of the pile)

L_w = 87.96 *in*

w = 5/16 *in* (Weld size, maximum for a single pass)

$t_e = w\cos(45^\circ)$ (Effective throat)

t_e = 0.221 *in*

$A_{ew} = L_w\,t_e$

A_{ew} = 19.44 in^2

Factored Shear Rupture Resistance, R_r:

$A_{vn} = A_{ew}$ (Net area of the plate subject to shear)

A_{vn} = 19.44 in^2

F_u = 58 *ksi* (Tensile strength of the plate)

R_p = *neglected*

no bolt holes (Reduction factor for holes taken equal to 0.90 for bolt holes punched full size and 1.0 for bolt holes drilled full size or subpunched and reamed to size)

φ_{vu} = 0.80 (Resistance factor for shear rupture of connection elements) *Ref. 1 Article 6.5.4.2*

Factored Shear Resistance of the Weld Metal, R_w: *Ref. 1 Article 6.13.3.2.4*

$R_r\,A_{ew}$ = 653.10 *kips*

$\varphi_{vu}\,0.58R_p\,F_u\,A_{vn}$ = 523.11 *kips* *Ref. 1 Equation 6.13.5.3-2*

R_w = 523.11 *kips*

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	11/21/19
SUBJECT:	RTA 1 - Union Street Dolphin Design	CHECKED BY:	PLT	DATE:	12/18/19

Pile Stop Design:

Plate Section Parameters:

CD_f = 2.90 *ft* (Diameter of donut fender core) *Appendix D - Page 1*

D_P = $CD_f + 2$ *in.* (Diameter of the plate)

D_P = 37 *in*

T_P = 1 *in* (Thickness of the plate)

C_P = 116.24 *in* (Circumference of the plate)

F_y = 36 *ksi* (Specified minimum yield strength)

F_u = 58 *ksi* (Tensile strength)

Plate Design Check

l= 4.50 *in* (cantilever length of pile stop beyond pile diameter)

$P_{D,up}$ = 13346 *lbs* (point load from uplift)

Assume point load at end of cantilevered plate (conservative)

Check Bending

M_{max} = 5 *kip-ft* *Ref. 6 Table 3-23, 22*

Z= 5.50 in^3 (assume 1/4 of pile circumference for width)

M_n = 16 *kip-ft*

ΦM_n = 14.8 *kip-ft*

$\Phi M_n > M_{max}$ **OK**

Check Shear

V_{max} = 13.35 *kip* *Ref. 6 Table 3-23, 23*

V_n = 36.00 *kip*

ΦV_n = 32.40 *kip*

$V_n > V_{max}$ **OK**

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:		OF	
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	11/21/19
SUBJECT:	RTA 1 - Union Street Dolphin Design	CHECKED BY:	PLT	DATE:	12/18/19

Weld Design Checks

Can the weld resist the impact of a vessel collision on the pile stop?

$CV =$ 9.573 *kips* (Vessel collision force)

$R_w \geq CV$ **OK**

Is the thickness of the plate adequate for the weld size chosen?

$T = T_P$ (Thickness of the plate) *Ref. 1 Table 6.13.3.4-1*

$T =$ 1 *in*

$T >$ *3/4* **OK** *Ref. 1 Table 6.13.3.4-1*

Can the connection resist the uplift force of the donut fender?

$F_B =$ 13346.3 *lbs* (Buoyant weight of the donut fender)

$P_{D,up} = F_B$ (Equivalent uplift force on the plate)

$P_{D,up} =$ 13346 *lbs*

$p_{D,up} = P_{D,up} / C$ (Uplift force, distributed around the circumference of the pile)

$p_{D,up} =$ 0.15 *kips/in*

$r_w = R_w / C$

(Shear resistance of the weld, distributed around the circumference of the pile) $r_w =$ 5.95 *kips/in*

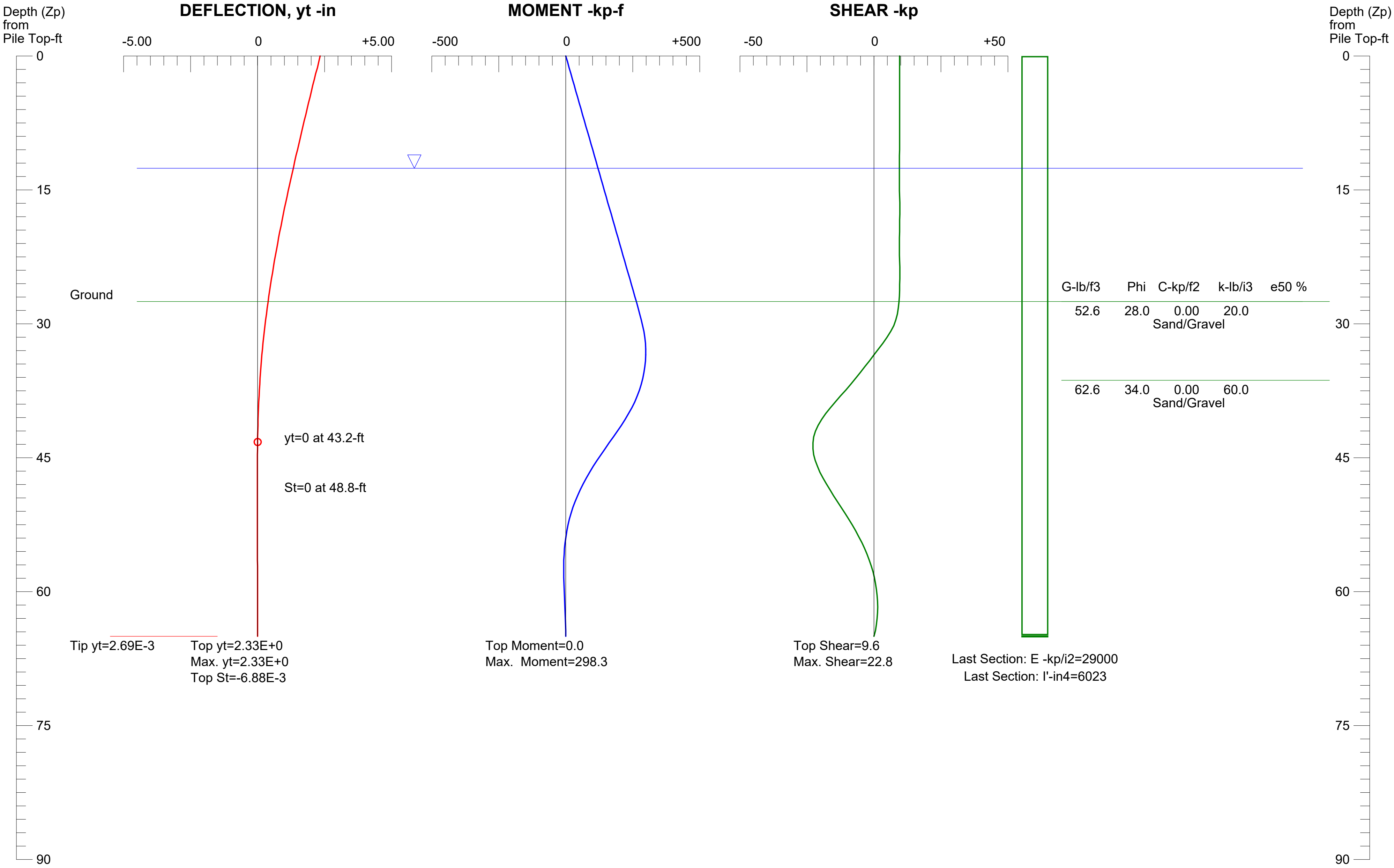
$r_w \geq p_{D,up}$ **OK**

ATTACHMENT A – CIVILTECH ALLPILE OUTPUT

USDL01 - VESSEL COLLISION FORCE

PILE DEFLECTION & FORCE vs DEPTH

Single Pile, Khead=2, Kbc=1



CivilTech Software

Page A-1

Gowanus Canal Superfund Site
Union Street Dolphin Design

Figure 1

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Depth vs. Deflection, Moment, Shear, and Slope in Single Pile:

*****************************************************************************


Zp      yt      Moment  Shear   Pressure        Slope
-ft     -in     -kp-f   -kp     -kp/f2
_______________________________________________________________
0.0     2.330   0.0     9.6     0.0             -0.00688
0.7     2.280   6.3     9.6     0.0             -0.00635
1.3     2.230   12.6    9.6     0.0             -0.00635
2.0     2.170   18.8    9.6     0.0             -0.00761
2.6     2.120   25.2    9.6     0.0             -0.00635
3.3     2.060   31.4    9.6     0.0             -0.00762
3.9     2.010   37.7    9.6     0.0             -0.00635
4.6     1.960   44.0    9.6     0.0             -0.00635
5.3     1.900   50.3    9.6     0.0             -0.00761
5.9     1.850   56.6    9.6     0.0             -0.00635
6.6     1.800   62.8    9.6     0.0             -0.00635
7.2     1.740   69.1    9.6     0.0             -0.00761
7.9     1.690   75.4    9.6     0.0             -0.00635
8.5     1.640   81.7    9.6     0.0             -0.00635
9.2     1.590   88.3    9.6     0.0             -0.00635
9.8     1.540   94.2    9.6     0.0             -0.00635
10.5    1.490   100.8   9.5     0.0             -0.00635
11.2    1.430   106.7   9.5     0.0             -0.00761
11.8    1.380   113.3   9.5     0.0             -0.00635
12.5    1.340   119.2   9.5     0.0             -0.00508
13.1    1.290   125.8   9.5     0.0             -0.00635
13.8    1.240   131.7   9.5     0.0             -0.00635
14.4    1.190   138.3   9.5     0.0             -0.00635
15.1    1.140   144.2   9.5     0.0             -0.00635
15.8    1.100   150.8   9.6     0.0             -0.00508
16.4    1.050   156.7   9.6     0.0             -0.00635
17.1    1.000   163.3   9.7     0.0             -0.00635
17.7    0.959   170.0   9.6     0.0             -0.00520
18.4    0.915   175.8   9.6     0.0             -0.00558
19.0    0.871   182.5   9.6     0.0             -0.00559
19.7    0.829   188.3   9.5     0.0             -0.00533
20.4    0.787   195.0   9.5     0.0             -0.00533
21.0    0.746   200.8   9.5     0.0             -0.00520
21.7    0.706   207.5   9.5     0.0             -0.00508
22.3    0.667   213.3   9.5     0.0             -0.00495
23.0    0.629   220.0   9.6     0.0             -0.00482
23.6    0.591   225.8   9.6     0.0             -0.00482
24.3    0.555   232.5   9.7     0.0             -0.00457
24.9    0.519   239.2   9.6     0.0             -0.00457
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25.6    0.485   245.0   9.6     0.0             -0.00431
26.3    0.452   251.7   9.5     0.0             -0.00419
26.9    0.420   257.5   9.5     0.0             -0.00406
27.6    0.388   264.2   9.3     0.0             -0.00406
28.2    0.358   270.0   9.1     -0.1            -0.00381
28.9    0.330   275.8   8.7     -0.1            -0.00355
29.5    0.302   281.7   8.2     -0.1            -0.00355
30.2    0.275   286.7   7.4     -0.2            -0.00343
30.9    0.250   291.7   6.3     -0.2            -0.00317
31.5    0.226   295.0   4.9     -0.2            -0.00305
32.2    0.203   297.5   3.3     -0.3            -0.00292
32.8    0.182   298.3   1.7     -0.3            -0.00266
33.5    0.162   298.3   0.0     -0.3            -0.00254
34.1    0.143   297.5   -1.7    -0.3            -0.00241
34.8    0.125   295.0   -3.4    -0.3            -0.00228
35.5    0.109   291.7   -5.1    -0.3            -0.00203
36.1    0.093   287.5   -6.9    -0.3            -0.00198
36.8    0.079   281.7   -8.7    -0.3            -0.00178
37.4    0.067   275.0   -10.5   -0.3            -0.00161
38.1    0.055   266.7   -12.5   -0.3            -0.00147
38.7    0.045   257.5   -14.4   -0.3            -0.00133
39.4    0.035   246.7   -16.2   -0.3            -0.00118
40.1    0.027   234.2   -18.0   -0.3            -0.00105
40.7    0.020   221.7   -19.5   -0.2            -0.00093
41.4    0.013   207.5   -20.8   -0.2            -0.00080
42.0    0.008   192.5   -21.8   -0.1            -0.00070
42.7    0.003   177.5   -22.5   0.0             -0.00059
43.3    -0.001  161.7   -22.8   0.0             -0.00049
44.0    -0.004  146.7   -22.8   0.1             -0.00040
44.6    -0.006  131.7   -22.5   0.1             -0.00033
45.3    -0.008  116.7   -21.9   0.1             -0.00026
46.0    -0.010  102.5   -21.1   0.2             -0.00019
46.6    -0.011  89.2    -20.1   0.2             -0.00013
47.3    -0.012  76.6    -19.0   0.2             -0.00009
47.9    -0.012  64.8    -17.8   0.2             -0.00005
48.6    -0.012  53.8    -16.5   0.2             -0.00001
49.2    -0.012  43.9    -15.1   0.2             0.00003
49.9    -0.012  34.9    -13.7   0.2             0.00004
50.6    -0.011  26.8    -12.2   0.2             0.00006
51.2    -0.010  19.8    -10.8   0.2             0.00008
51.9    -0.010  13.7    -9.4    0.2             0.00008
52.5    -0.009  8.4     -8.1    0.2             0.00009
53.2    -0.008  4.0     -6.8    0.2             0.00010
53.8    -0.008  0.4     -5.6    0.2             0.00010
54.5    -0.007  -2.4    -4.5    0.2             0.00010
55.2    -0.006  -4.6    -3.5    0.2             0.00010
55.8    -0.005  -6.2    -2.6    0.1             0.00010
56.5    -0.004  -7.2    -1.7    0.1             0.00009
```

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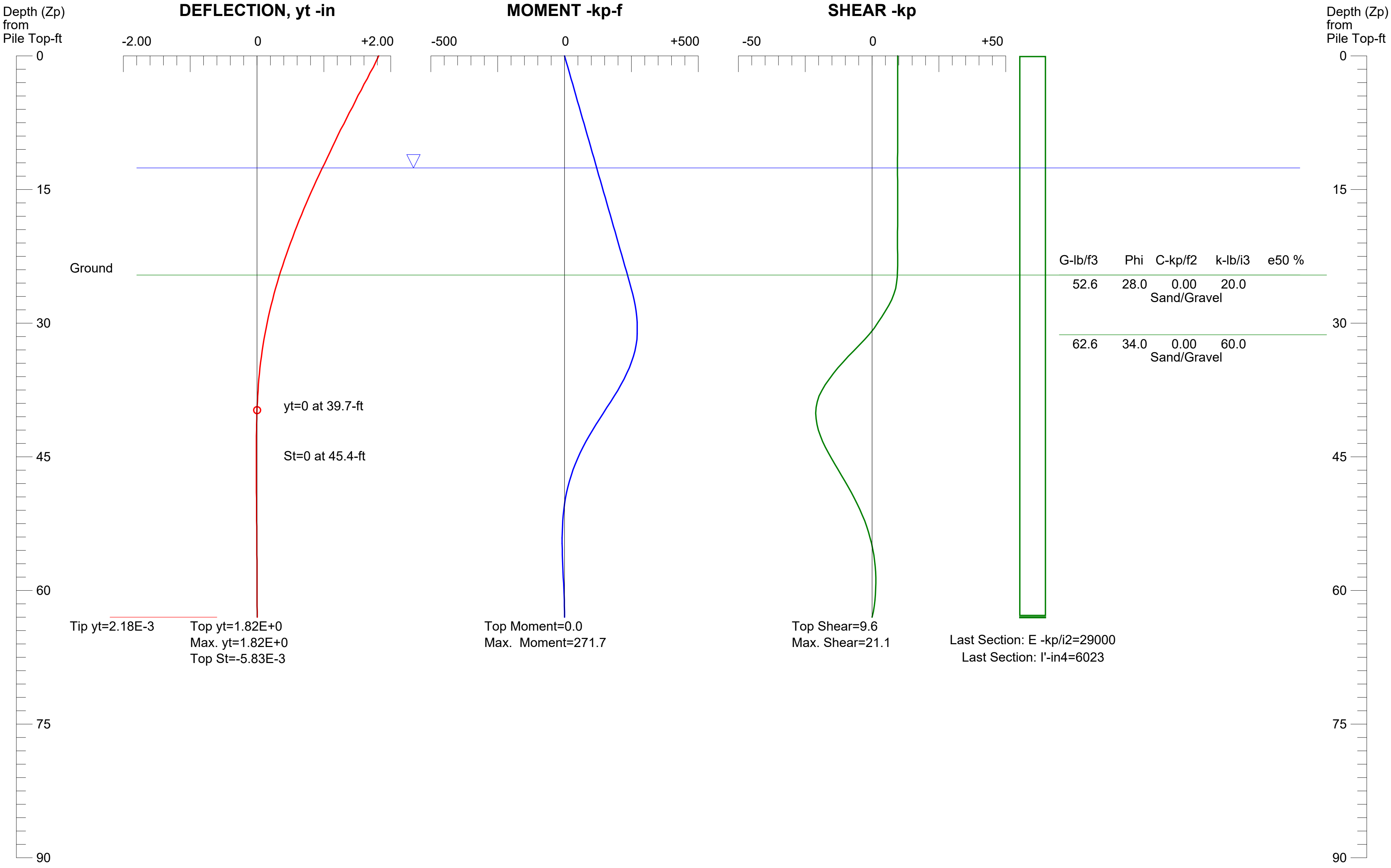
57.1    -0.004  -7.7    -1.0    0.1             0.00009
57.8    -0.003  -7.8    -0.4    0.1             0.00009
58.4    -0.002  -7.5    0.2     0.1             0.00008
59.1    -0.002  -7.0    0.6     0.1             0.00008
59.7    -0.001  -6.3    1.0     0.0             0.00007
60.4    -0.001  -5.3    1.2     0.0             0.00007
61.1    0.000   -4.3    1.3     0.0             0.00007
61.7    0.000   -3.3    1.4     0.0             0.00006
62.4    0.001   -2.3    1.3     0.0             0.00006
63.0    0.001   -1.4    1.2     0.0             0.00006
63.7    0.002   -0.7    0.9     -0.1            0.00006
64.3    0.002   -0.2    0.6     -0.1            0.00006
65.0    0.003   0.0     0.0     -0.1            0.00006
________________________________________________
Zp - Depth from pile Top
yt - Pile top deflection
Moment - Internal moment in pile shaft
Shear - Internal shear force in pile shaft
Pressure - Soil-Pile interactive pressure (Arching is considered)
Slope - Deflection slope at pile top
```

USDL02 - VESSEL COLLISION FORCE

PILE DEFLECTION & FORCE vs DEPTH

Single Pile, Khead=2, Kbc=1



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Gowanus Canal Superfund Site
Union Street Dolphin Design

Figure 2

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Depth vs. Deflection, Moment, Shear, and Slope in Single Pile:

******************************************************************************


Zp      yt      Moment  Shear   Pressure        Slope
-ft     -in     -kp-f   -kp     -kp/f2
_______________________________________________________________
0.0     1.820   0.0     9.6     0.0             -0.00583
0.6     1.780   6.1     9.6     0.0             -0.00524
1.3     1.740   12.2    9.6     0.0             -0.00524
1.9     1.690   18.3    9.6     0.0             -0.00654
2.5     1.650   24.3    9.6     0.0             -0.00524
3.2     1.600   30.4    9.6     0.0             -0.00655
3.8     1.560   36.5    9.6     0.0             -0.00524
4.5     1.510   42.7    9.6     0.0             -0.00655
5.1     1.470   48.8    9.6     0.0             -0.00524
5.7     1.430   54.8    9.6     0.0             -0.00524
6.4     1.380   60.9    9.6     0.0             -0.00655
7.0     1.340   67.0    9.5     0.0             -0.00524
7.6     1.300   73.1    9.6     0.0             -0.00524
8.3     1.250   79.2    9.6     0.0             -0.00655
8.9     1.210   85.0    9.6     0.0             -0.00524
9.5     1.170   91.7    9.6     0.0             -0.00524
10.2    1.130   97.5    9.6     0.0             -0.00524
10.8    1.090   103.3   9.6     0.0             -0.00524
11.5    1.050   110.0   9.5     0.0             -0.00524
12.1    1.010   115.8   9.5     0.0             -0.00524
12.7    0.966   121.7   9.5     0.0             -0.00576
13.4    0.926   127.5   9.5     0.0             -0.00524
14.0    0.887   134.2   9.6     0.0             -0.00510
14.6    0.849   140.0   9.6     0.0             -0.00497
15.3    0.811   145.8   9.6     0.0             -0.00498
15.9    0.774   152.5   9.6     0.0             -0.00484
16.5    0.737   158.3   9.6     0.0             -0.00484
17.2    0.701   164.2   9.6     0.0             -0.00472
17.8    0.666   170.8   9.6     0.0             -0.00458
18.5    0.631   176.7   9.6     0.0             -0.00459
19.1    0.597   182.5   9.6     0.0             -0.00445
19.7    0.564   189.2   9.5     0.0             -0.00432
20.4    0.532   195.0   9.5     0.0             -0.00419
21.0    0.500   200.8   9.5     0.0             -0.00419
21.6    0.469   206.7   9.5     0.0             -0.00406
22.3    0.439   213.3   9.6     0.0             -0.00393
22.9    0.410   219.2   9.6     0.0             -0.00380
23.5    0.382   225.0   9.6     0.0             -0.00366
24.2    0.354   231.7   9.5     0.0             -0.00367
```

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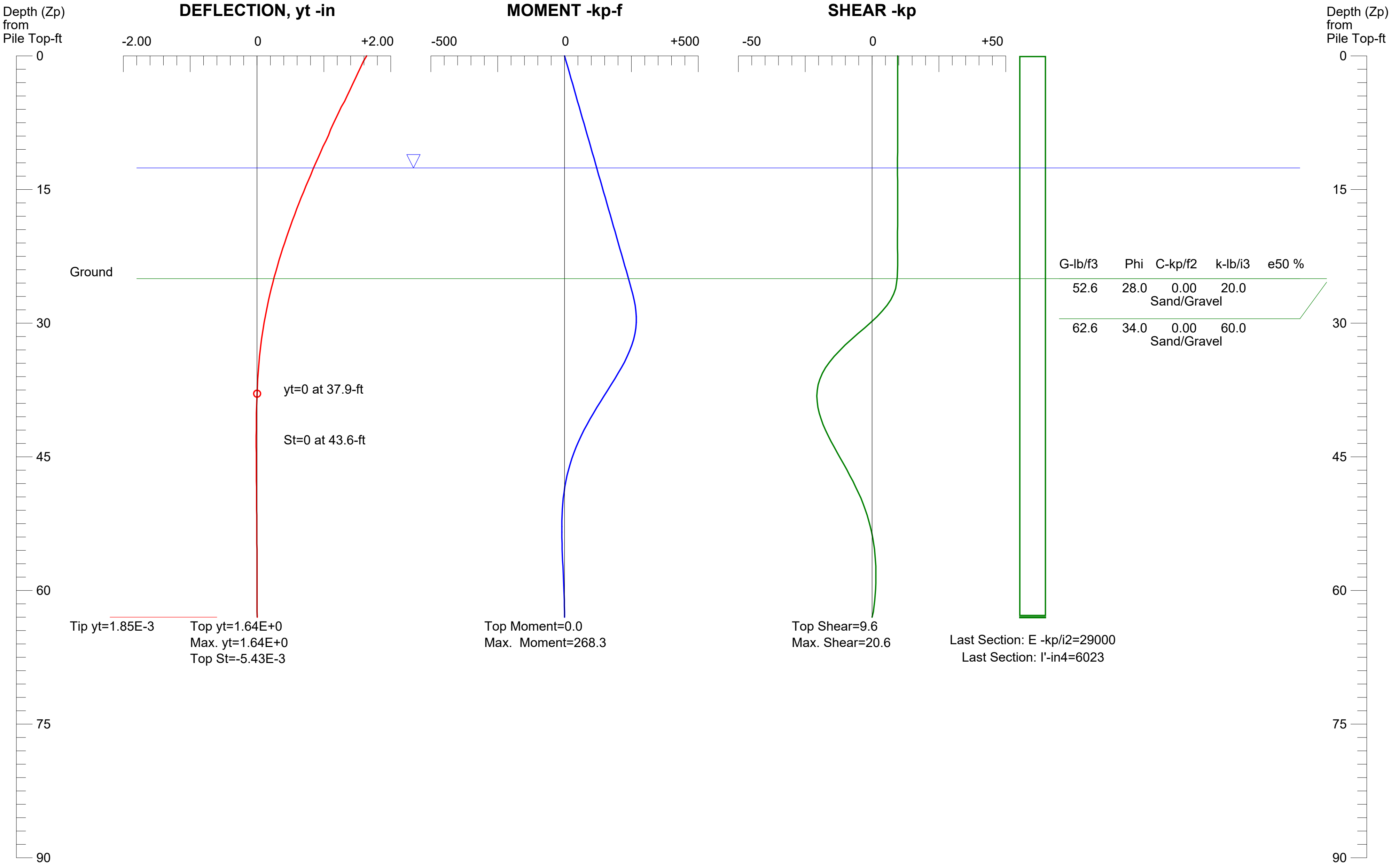
24.8    0.328   237.5   9.4     0.0             -0.00340
25.5    0.302   243.3   9.2     -0.1            -0.00341
26.1    0.278   249.2   8.8     -0.1            -0.00314
26.7    0.254   255.0   8.2     -0.1            -0.00314
27.4    0.232   260.0   7.3     -0.2            -0.00288
28.0    0.210   264.2   6.3     -0.2            -0.00288
28.6    0.190   267.5   5.0     -0.2            -0.00262
29.3    0.171   270.0   3.7     -0.2            -0.00249
29.9    0.152   271.7   2.3     -0.2            -0.00249
30.5    0.135   271.7   0.8     -0.3            -0.00223
31.2    0.119   271.7   -0.8    -0.3            -0.00210
31.8    0.104   270.8   -2.7    -0.4            -0.00196
32.5    0.090   267.5   -4.8    -0.4            -0.00182
33.1    0.077   263.3   -6.9    -0.4            -0.00168
33.7    0.065   257.5   -8.9    -0.3            -0.00154
34.4    0.055   250.0   -10.9   -0.3            -0.00142
35.0    0.045   242.5   -12.7   -0.3            -0.00127
35.6    0.036   232.5   -14.4   -0.3            -0.00115
36.3    0.028   222.5   -16.0   -0.3            -0.00104
36.9    0.021   210.8   -17.5   -0.2            -0.00090
37.5    0.015   199.2   -18.8   -0.2            -0.00081
38.2    0.010   185.8   -19.8   -0.1            -0.00069
38.8    0.005   172.5   -20.5   -0.1            -0.00060
39.5    0.001   158.3   -20.9   0.0             -0.00051
40.1    -0.002  145.0   -21.1   0.0             -0.00043
40.7    -0.004  131.7   -21.0   0.1             -0.00035
41.4    -0.007  117.5   -20.6   0.1             -0.00028
42.0    -0.008  105.0   -20.1   0.1             -0.00022
42.6    -0.010  92.5    -19.3   0.2             -0.00016
43.3    -0.010  80.4    -18.5   0.2             -0.00012
43.9    -0.011  69.2    -17.5   0.2             -0.00008
44.5    -0.011  58.7    -16.4   0.2             -0.00003
45.2    -0.011  48.9    -15.2   0.2             -0.00001
45.8    -0.011  40.0    -13.9   0.2             0.00003
46.5    -0.011  31.9    -12.7   0.2             0.00004
47.1    -0.010  24.7    -11.4   0.2             0.00005
47.7    -0.010  18.3    -10.2   0.2             0.00007
48.4    -0.009  12.6    -8.9    0.2             0.00008
49.0    -0.009  7.7     -7.8    0.2             0.00009
49.6    -0.008  3.6     -6.6    0.2             0.00009
50.3    -0.007  0.1     -5.6    0.2             0.00009
50.9    -0.006  -2.7    -4.6    0.2             0.00009
51.5    -0.006  -4.9    -3.6    0.1             0.00009
52.2    -0.005  -6.6    -2.8    0.1             0.00009
52.8    -0.004  -7.8    -2.0    0.1             0.00009
53.5    -0.004  -8.5    -1.3    0.1             0.00008
54.1    -0.003  -8.8    -0.7    0.1             0.00008
54.7    -0.003  -8.8    -0.2    0.1             0.00007
```

```
55.4    -0.002  -8.6    0.3     0.1             0.00007
56.0    -0.002  -8.1    0.6     0.0             0.00006
56.6    -0.001  -7.4    0.9     0.0             0.00006
57.3    -0.001  -6.6    1.2     0.0             0.00005
57.9    0.000   -5.7    1.3     0.0             0.00005
58.5    0.000   -4.7    1.4     0.0             0.00005
59.2    0.000   -3.7    1.4     0.0             0.00005
59.8    0.001   -2.8    1.4     0.0             0.00004
60.5    0.001   -1.9    1.2     0.0             0.00004
61.1    0.001   -1.1    1.1     0.0             0.00004
61.7    0.002   -0.5    0.8     -0.1            0.00004
62.4    0.002   -0.1    0.5     -0.1            0.00004
63.0    0.002   0.0     0.0     -0.1            0.00004
________________________________________________
Zp - Depth from pile Top
yt - Pile top deflection
Moment - Internal moment in pile shaft
Shear - Internal shear force in pile shaft
Pressure - Soil-Pile interactive pressure (Arching is considered)
Slope - Deflection slope at pile top
```

USDL03 - VESSEL COLLISION FORCE

PILE DEFLECTION & FORCE vs DEPTH

Single Pile, Khead=2, Kbc=1



CivilTech Software

Gowanus Canal Superfund Site
Union Street Dolphin Design

Figure 3

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Depth vs. Deflection, Moment, Shear, and Slope in Single Pile:

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Zp      yt      Moment  Shear   Pressure        Slope
-ft     -in     -kp-f   -kp     -kp/f2
_______________________________________________________________
0.0     1.640   0.0     9.6     0.0             -0.00543
0.6     1.590   6.1     9.6     0.0             -0.00654
1.3     1.550   12.2    9.6     0.0             -0.00524
1.9     1.510   18.3    9.6     0.0             -0.00524
2.5     1.470   24.3    9.6     0.0             -0.00524
3.2     1.430   30.4    9.6     0.0             -0.00524
3.8     1.390   36.5    9.6     0.0             -0.00524
4.5     1.350   42.7    9.6     0.0             -0.00524
5.1     1.310   48.8    9.6     0.0             -0.00524
5.7     1.260   54.8    9.6     0.0             -0.00654
6.4     1.220   60.9    9.6     0.0             -0.00524
7.0     1.180   67.0    9.5     0.0             -0.00524
7.6     1.140   73.1    9.6     0.0             -0.00524
8.3     1.100   79.2    9.6     0.0             -0.00524
8.9     1.070   85.0    9.6     0.0             -0.00393
9.5     1.030   91.7    9.6     0.0             -0.00524
10.2    0.988   97.5    9.6     0.0             -0.00550
10.8    0.950   103.3   9.6     0.0             -0.00497
11.5    0.912   110.0   9.5     0.0             -0.00498
12.1    0.875   115.8   9.5     0.0             -0.00484
12.7    0.838   121.7   9.5     0.0             -0.00484
13.4    0.802   127.5   9.5     0.0             -0.00472
14.0    0.766   134.2   9.6     0.0             -0.00471
14.6    0.730   140.0   9.6     0.0             -0.00471
15.3    0.696   145.8   9.6     0.0             -0.00446
15.9    0.661   152.5   9.6     0.0             -0.00458
16.5    0.628   158.3   9.6     0.0             -0.00432
17.2    0.595   164.2   9.6     0.0             -0.00433
17.8    0.563   170.8   9.6     0.0             -0.00419
18.5    0.531   176.7   9.6     0.0             -0.00419
19.1    0.500   182.5   9.6     0.0             -0.00406
19.7    0.470   189.2   9.5     0.0             -0.00393
20.4    0.441   195.0   9.5     0.0             -0.00380
21.0    0.412   200.8   9.5     0.0             -0.00380
21.6    0.384   206.7   9.5     0.0             -0.00366
22.3    0.357   213.3   9.6     0.0             -0.00354
22.9    0.331   219.2   9.6     0.0             -0.00340
23.5    0.306   225.0   9.6     0.0             -0.00327
24.2    0.282   231.7   9.5     0.0             -0.00315
```

```
24.8    0.258   237.5   9.4     0.0             -0.00314
25.5    0.236   243.3   9.2     -0.1            -0.00288
26.1    0.214   249.2   8.8     -0.1            -0.00288
26.7    0.194   255.0   8.1     -0.2            -0.00262
27.4    0.174   260.0   7.0     -0.2            -0.00262
28.0    0.156   264.2   5.6     -0.3            -0.00236
28.6    0.139   266.7   3.8     -0.3            -0.00223
29.3    0.122   268.3   1.8     -0.4            -0.00223
29.9    0.107   268.3   -0.4    -0.4            -0.00196
30.5    0.093   266.7   -2.8    -0.4            -0.00185
31.2    0.080   263.3   -5.3    -0.4            -0.00172
31.8    0.068   258.3   -7.8    -0.4            -0.00157
32.5    0.057   251.7   -10.1   -0.4            -0.00144
33.1    0.047   243.3   -12.2   -0.3            -0.00131
33.7    0.038   234.2   -14.2   -0.3            -0.00118
34.4    0.030   224.2   -15.9   -0.2            -0.00105
35.0    0.023   212.5   -17.4   -0.2            -0.00094
35.6    0.016   200.0   -18.6   -0.2            -0.00082
36.3    0.011   187.5   -19.5   -0.1            -0.00072
36.9    0.006   174.2   -20.1   -0.1            -0.00063
37.5    0.002   160.8   -20.5   0.0             -0.00053
38.2    -0.001  147.5   -20.6   0.0             -0.00045
38.8    -0.004  134.2   -20.5   0.1             -0.00037
39.5    -0.007  120.8   -20.2   0.1             -0.00030
40.1    -0.008  108.3   -19.7   0.1             -0.00024
40.7    -0.010  95.8    -19.1   0.1             -0.00018
41.4    -0.011  84.2    -18.3   0.2             -0.00013
42.0    -0.011  72.8    -17.4   0.2             -0.00008
42.6    -0.012  62.3    -16.4   0.2             -0.00005
43.3    -0.012  52.4    -15.3   0.2             -0.00001
43.9    -0.012  43.3    -14.2   0.2             0.00001
44.5    -0.012  35.0    -13.0   0.2             0.00004
45.2    -0.011  27.5    -11.8   0.2             0.00005
45.8    -0.011  20.8    -10.6   0.2             0.00007
46.5    -0.010  14.8    -9.4    0.2             0.00009
47.1    -0.009  9.5     -8.3    0.2             0.00009
47.7    -0.009  5.0     -7.2    0.2             0.00009
48.4    -0.008  1.2     -6.1    0.2             0.00010
49.0    -0.007  -2.0    -5.1    0.2             0.00010
49.6    -0.006  -4.6    -4.2    0.1             0.00010
50.3    -0.006  -6.6    -3.3    0.1             0.00009
50.9    -0.005  -8.1    -2.6    0.1             0.00009
51.5    -0.004  -9.3    -1.9    0.1             0.00009
52.2    -0.004  -9.9    -1.2    0.1             0.00008
52.8    -0.003  -10.3   -0.7    0.1             0.00007
53.5    -0.003  -10.3   -0.2    0.1             0.00007
54.1    -0.002  -10.0   0.3     0.1             0.00006
54.7    -0.002  -9.5    0.6     0.0             0.00006
```

```
55.4    -0.001  -8.9    0.9     0.0             0.00005
56.0    -0.001  -8.1    1.1     0.0             0.00005
56.6    -0.001  -7.2    1.3     0.0             0.00004
57.3    0.000   -6.3    1.4     0.0             0.00004
57.9    0.000   -5.3    1.4     0.0             0.00004
58.5    0.000   -4.3    1.4     0.0             0.00003
59.2    0.001   -3.3    1.4     0.0             0.00003
59.8    0.001   -2.4    1.3     0.0             0.00003
60.5    0.001   -1.6    1.2     0.0             0.00003
61.1    0.001   -1.0    1.0     0.0             0.00003
61.7    0.001   -0.5    0.7     0.0             0.00003
62.4    0.002   -0.1    0.5     -0.1            0.00003
63.0    0.002   0.0     0.0     -0.1            0.00003
________________________________________________
Zp - Depth from pile Top
yt - Pile top deflection
Moment - Internal moment in pile shaft
Shear - Internal shear force in pile shaft
Pressure - Soil-Pile interactive pressure (Arching is considered)
Slope - Deflection slope at pile top
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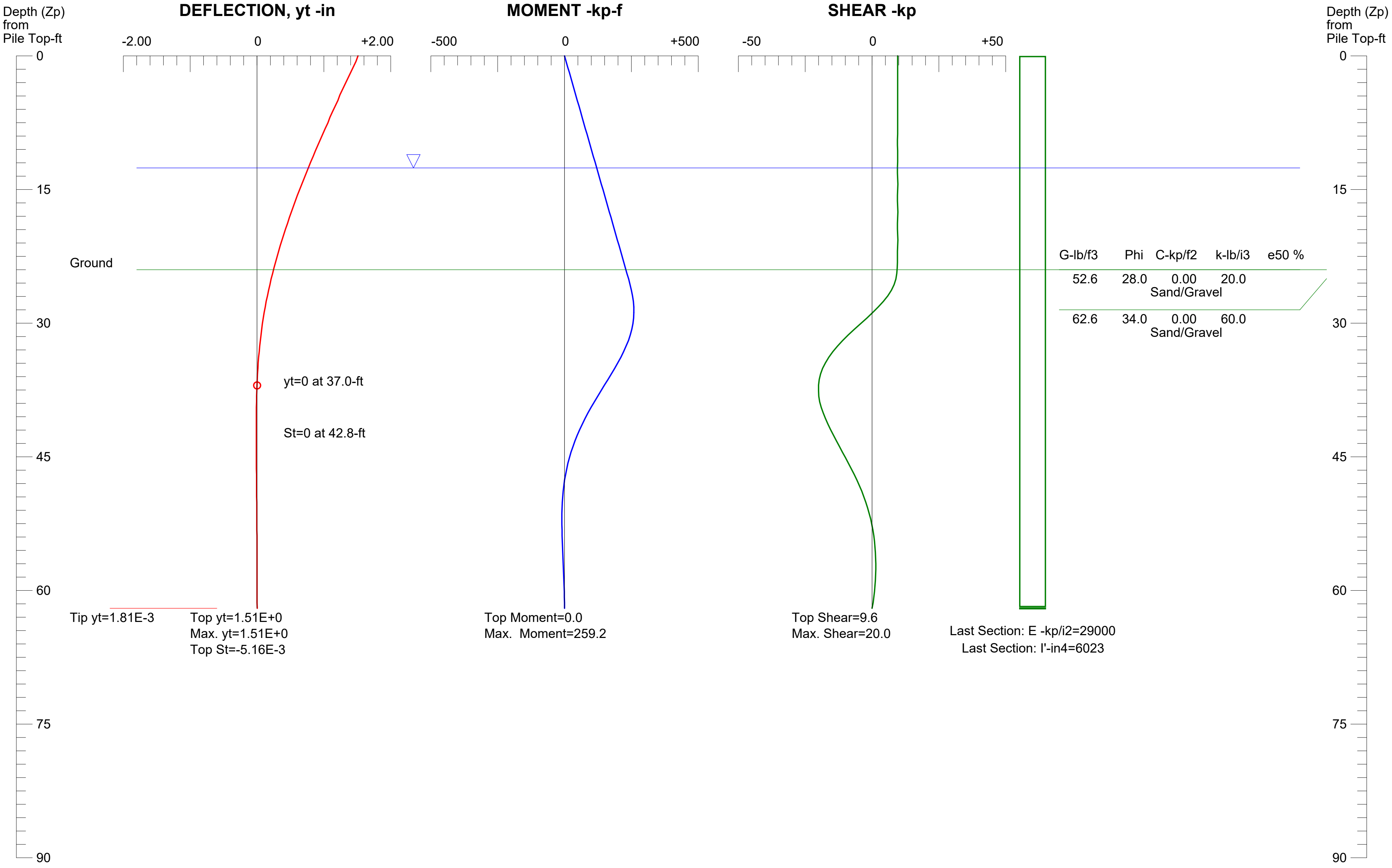
USDL04 - VESSEL COLLISION FORCE

PILE DEFLECTION & FORCE vs DEPTH

Single Pile, Khead=2, Kbc=1



CivilTech Software

Gowanus Canal Superfund Site
Union Street Dolphin Design

Figure 4

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Depth vs. Deflection, Moment, Shear, and Slope in Single Pile:

*******************************************************************************


Zp      yt      Moment  Shear   Pressure        Slope
-ft     -in     -kp-f   -kp     -kp/f2
_______________________________________________________________
0.0     1.510   0.0     9.6     0.0             -0.00516
0.6     1.480   6.0     9.6     0.0             -0.00399
1.3     1.440   12.0    9.6     0.0             -0.00533
1.9     1.400   18.0    9.6     0.0             -0.00532
2.5     1.360   24.0    9.6     0.0             -0.00533
3.1     1.320   30.0    9.6     0.0             -0.00532
3.8     1.280   36.0    9.6     0.0             -0.00533
4.4     1.240   41.9    9.6     0.0             -0.00532
5.0     1.210   47.9    9.6     0.0             -0.00399
5.6     1.170   53.9    9.6     0.0             -0.00532
6.3     1.130   59.9    9.6     0.0             -0.00533
6.9     1.090   65.9    9.6     0.0             -0.00532
7.5     1.060   71.9    9.6     0.0             -0.00399
8.1     1.020   77.9    9.6     0.0             -0.00532
8.8     0.982   84.2    9.5     0.0             -0.00506
9.4     0.946   90.0    9.5     0.0             -0.00479
10.0    0.910   95.8    9.5     0.0             -0.00479
10.6    0.874   101.7   9.6     0.0             -0.00479
11.3    0.839   107.5   9.6     0.0             -0.00466
11.9    0.804   114.2   9.6     0.0             -0.00465
12.5    0.770   120.0   9.5     0.0             -0.00453
13.2    0.736   125.8   9.5     0.0             -0.00452
13.8    0.702   131.7   9.6     0.0             -0.00453
14.4    0.670   137.5   9.6     0.0             -0.00426
15.0    0.637   144.2   9.6     0.0             -0.00439
15.7    0.605   150.0   9.5     0.0             -0.00426
16.3    0.574   155.8   9.5     0.0             -0.00413
16.9    0.544   161.7   9.6     0.0             -0.00399
17.5    0.514   167.5   9.6     0.0             -0.00399
18.2    0.484   174.2   9.6     0.0             -0.00399
18.8    0.456   180.0   9.5     0.0             -0.00373
19.4    0.428   185.8   9.5     0.0             -0.00372
20.0    0.400   191.7   9.6     0.0             -0.00373
20.7    0.374   197.5   9.6     0.0             -0.00346
21.3    0.348   204.2   9.6     0.0             -0.00346
21.9    0.323   210.0   9.5     0.0             -0.00333
22.5    0.299   215.8   9.5     0.0             -0.00319
23.2    0.276   221.7   9.5     0.0             -0.00306
23.8    0.253   227.5   9.5     0.0             -0.00306
```

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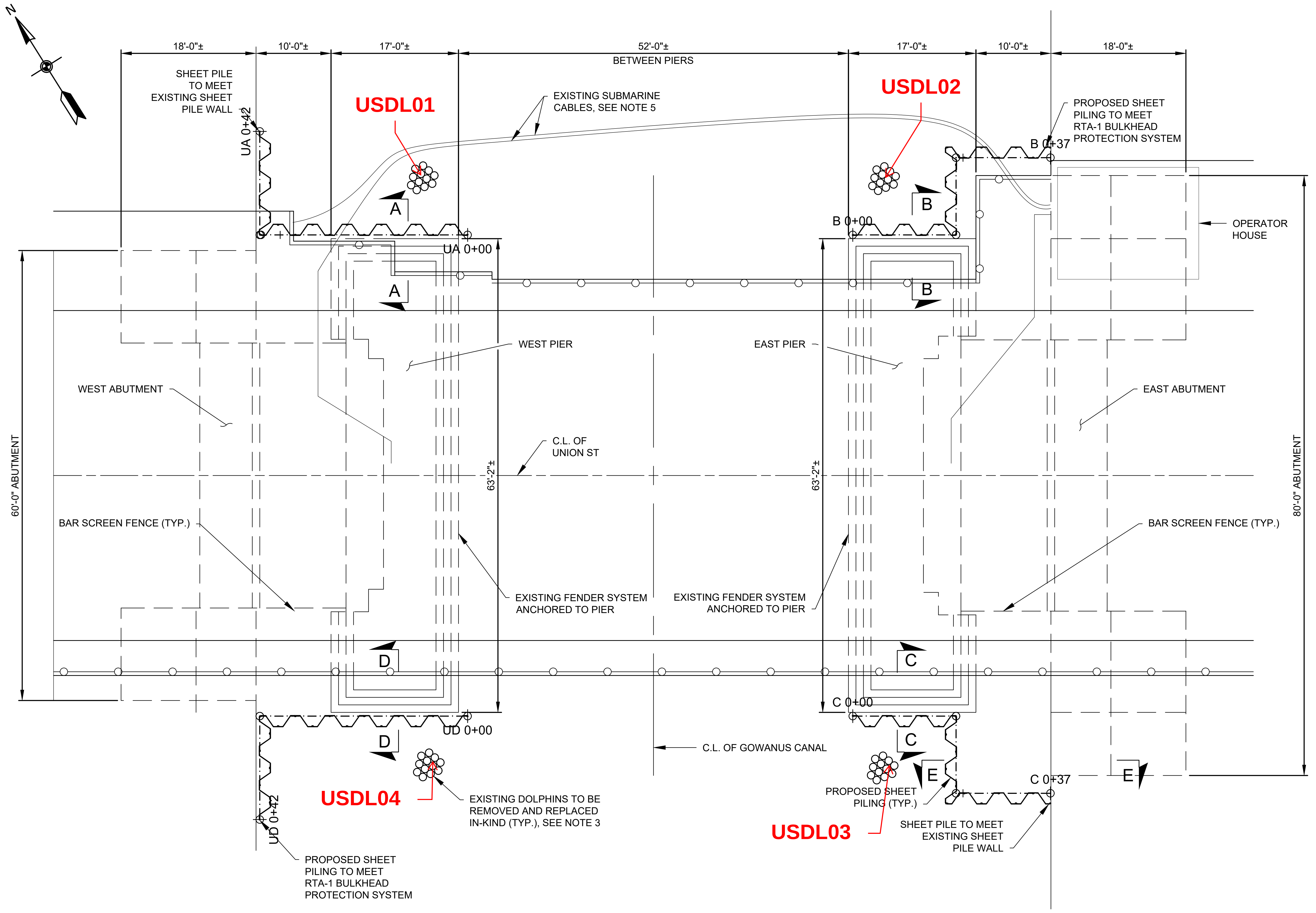
24.4    0.232   233.3   9.3     -0.1            -0.00280
25.1    0.211   240.0   8.9     -0.1            -0.00279
25.7    0.192   245.0   8.2     -0.2            -0.00253
26.3    0.173   250.0   7.2     -0.2            -0.00253
26.9    0.155   254.2   5.9     -0.3            -0.00240
27.6    0.138   257.5   4.2     -0.3            -0.00226
28.2    0.123   259.2   2.3     -0.4            -0.00200
28.8    0.108   259.2   0.3     -0.4            -0.00199
29.4    0.094   258.3   -1.9    -0.4            -0.00186
30.1    0.081   255.8   -4.2    -0.4            -0.00170
30.7    0.069   251.7   -6.6    -0.4            -0.00157
31.3    0.059   245.8   -8.9    -0.4            -0.00144
31.9    0.049   239.2   -11.0   -0.3            -0.00130
32.6    0.040   230.0   -12.9   -0.3            -0.00120
33.2    0.032   220.8   -14.6   -0.3            -0.00107
33.8    0.025   210.8   -16.2   -0.2            -0.00096
34.4    0.018   199.2   -17.4   -0.2            -0.00084
35.1    0.013   187.5   -18.5   -0.1            -0.00074
35.7    0.008   175.0   -19.3   -0.1            -0.00065
36.3    0.004   162.5   -19.8   0.0             -0.00056
36.9    0.000   149.2   -20.0   0.0             -0.00047
37.6    -0.003  136.7   -20.0   0.0             -0.00039
38.2    -0.005  124.2   -19.9   0.1             -0.00032
38.8    -0.007  111.7   -19.6   0.1             -0.00026
39.5    -0.009  99.2    -19.0   0.1             -0.00020
40.1    -0.010  87.5    -18.3   0.1             -0.00015
40.7    -0.011  76.8    -17.4   0.2             -0.00011
41.3    -0.011  66.3    -16.5   0.2             -0.00007
42.0    -0.011  56.5    -15.5   0.2             -0.00003
42.6    -0.012  47.3    -14.4   0.2             -0.00001
43.2    -0.011  38.9    -13.3   0.2             0.00003
43.8    -0.011  31.3    -12.2   0.2             0.00004
44.5    -0.011  24.4    -11.0   0.2             0.00005
45.1    -0.010  18.2    -9.9    0.2             0.00008
45.7    -0.009  12.8    -8.8    0.2             0.00008
46.3    -0.009  7.9     -7.7    0.2             0.00009
47.0    -0.008  3.8     -6.7    0.2             0.00009
47.6    -0.007  0.3     -5.7    0.2             0.00009
48.2    -0.007  -2.5    -4.7    0.1             0.00009
48.8    -0.006  -4.9    -3.9    0.1             0.00009
49.5    -0.005  -6.7    -3.1    0.1             0.00009
50.1    -0.005  -8.1    -2.3    0.1             0.00009
50.7    -0.004  -9.1    -1.7    0.1             0.00008
51.4    -0.004  -9.7    -1.1    0.1             0.00008
52.0    -0.003  -9.9    -0.5    0.1             0.00007
52.6    -0.002  -9.8    -0.1    0.1             0.00007
53.2    -0.002  -9.6    0.3     0.1             0.00006
53.9    -0.002  -9.1    0.6     0.0             0.00006
```

```
54.5    -0.001  -8.5    0.9     0.0             0.00005
55.1    -0.001  -7.7    1.1     0.0             0.00005
55.7    -0.001  -6.9    1.3     0.0             0.00004
56.4    0.000   -5.9    1.4     0.0             0.00004
57.0    0.000   -5.0    1.4     0.0             0.00004
57.6    0.000   -4.1    1.4     0.0             0.00003
58.2    0.001   -3.2    1.4     0.0             0.00003
58.9    0.001   -2.3    1.3     0.0             0.00003
59.5    0.001   -1.6    1.1     0.0             0.00003
60.1    0.001   -0.9    0.9     0.0             0.00003
60.7    0.001   -0.4    0.7     0.0             0.00003
61.4    0.002   -0.1    0.4     -0.1            0.00003
62.0    0.002   0.0     0.0     -0.1            0.00003
________________________________________________
Zp - Depth from pile Top
yt - Pile top deflection
Moment - Internal moment in pile shaft
Shear - Internal shear force in pile shaft
Pressure - Soil-Pile interactive pressure (Arching is considered)
Slope - Deflection slope at pile top
```

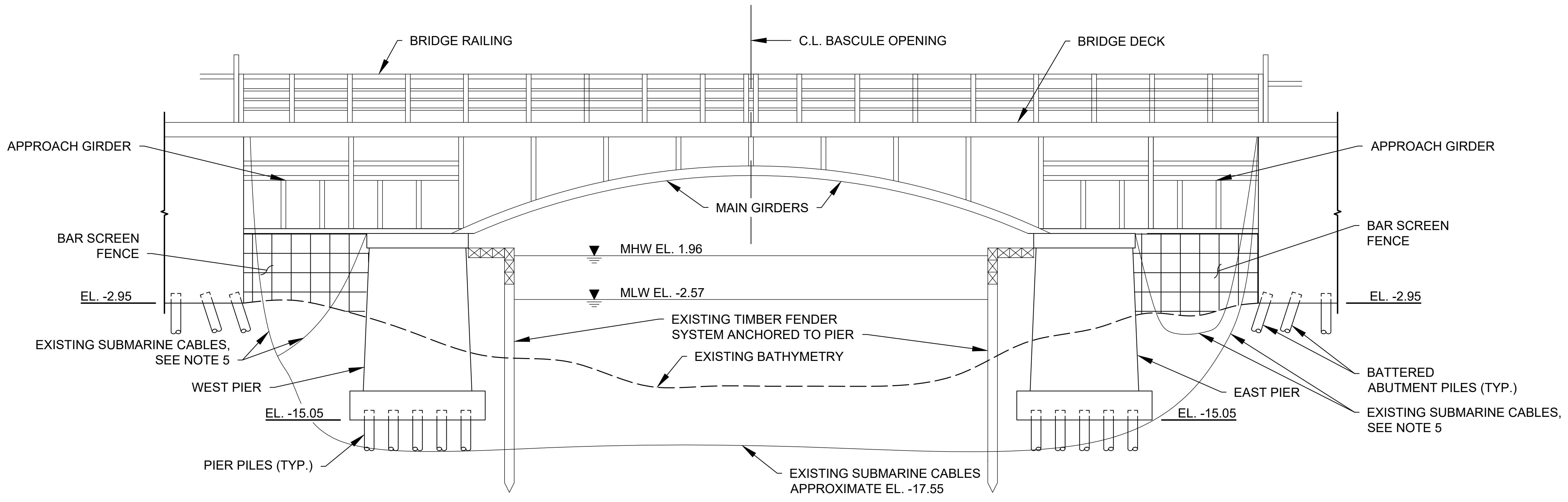
ATTACHMENT B – DESIGN LOCATIONS



PROPOSED GENERAL PLAN

SCALE: 1" = 10'-0"

0 10' 20'
SCALE IN FEET



ELEVATION
(LOOKING NORTH)

SCALE: 1" = 10'-0"

0 10' 20'
SCALE IN FEET

NOTES:

1. CONTRACTOR TO FIELD VERIFY ALL DIMENSIONS.
2. STEEL SHEET PILING TO BE INSTALLED USING PRESS-IN METHOD.
3. EXISTING DOLPHINS TO BE REMOVED PRIOR TO INSTALLATION OF SHEETING. PROPOSED DOLPHIN REPLACEMENT TO BE COORDINATED WITH RTA 1 CAP INSTALLATION.
4. CONTRACTOR SHALL IDENTIFY THE TYPE OF SHEET PILE SHAPE AND SIZE OF THE EXISTING STEEL SHEET PILE BULKHEAD AT PROPERTIES 431-17 AND 439-1 AND USE THE NECESSARY CONNECTION REQUIRED TO CREATE A CONTINUOUS INTERLOCKING WALL BETWEEN THE EXISTING SHEET PILE WALL AND THE BULKHEAD SUPPORT SHEET PILES.
5. THE CONTRACTOR SHALL VERIFY THE LOCATION OF SUBMARINE CABLES THAT PASS THROUGH THE AREA IN WHICH SHEET PILING IS TO BE DRIVEN. THE CONTRACTOR WILL MAINTAIN AND PROTECT THE CABLES DURING INSTALLATION.
6. FOR SECTIONS A-A, B-B, C-C AND D-D, SEE DWG. NO. B-3.
7. ALL ELEVATIONS ARE IN FEET UNLESS OTHERWISE NOTED.
8. ALL ELEVATIONS AND LENGTHS SHOWN ARE APPROXIMATE BASED ON AS-BUILT INFORMATION. ELEVATIONS AND LENGTHS SHALL BE VERIFIED BY SURVEY AND ADJUSTED DURING FINAL DESIGN.

LOCATION	ELEVATION (FT)			UNIT WEIGHT (LBS/FT3)	FRICTION ANGLE (DEGREES)	COHESION (LB/IN2)	WALL FRICTION ANGLE (DEGREES)
NW CORNER	-5.70	TO	-14.53	80	28	0	0
	-14.53	TO	-26.33	115	28	0	0
	-26.33	TO	TOE	125	34	0	0
NE CORNER	-4.40	TO	-14.55	80	28	0	0
	-14.55	TO	-21.30	115	28	0	0
	-21.30	TO	TOE	125	34	0	0
SE CORNER	-4.00	TO	-14.89	80	28	0	0
	-14.89	TO	-15.39	115	28	0	0
	-15.39	TO	TOE	125	34	0	0
SW CORNER	-1.00	TO	-12.79	80	28	0	0
	-12.79	TO	-15.00	115	28	0	0
	-15.00	TO	TOE	125	34	0	0

SOIL PARAMETERS

NOTES:

1. DIVIDE THE PASSIVE EARTH PRESSURE COEFFICIENT (K_P) BY 1.25 FOR TEMPORARY CONDITION OR 1.5 FOR PERMANENT CONDITION.
2. GROUNDWATER IS ASSUMED AT ELEVATION -2.57 FT.
3. FOR LIMITS OF LOCATION, SEE SHEET PILE SCHEDULE TABLE.

WALL STATIONING			LOCATION	SHEET PILE NO.	MIN. SECTION MODULUS (IN3)	SECTION	TOP OF PILE EL. (FT.)*	MIN. TIP EL. (FT.)*	SHEET PILE LENGTH (FT.)*	NO. PILES
UA 0+00	TO	UA 0+42	NW CORNER	SP001-SP013	99.5	AZ 46-700N	8.50	-38.00	46.50	18
UB 0+00	TO	UB 0+37	NE CORNER	SP014-SP029	57.1	AZ 26-700	8.50	-38.00	46.50	17
UC 0+00	TO	UC 0+37	SE CORNER	SP030-SP047	99.5	AZ 46-700N	13.50	-29.00	42.50	17
UD 0+00	TO	UD 0+42	SW CORNER	SP048-SP065	99.5	AZ 46-700N	13.50	-32.00	45.50	18

SHEET PILE SCHEDULE

*ELEVATIONS AND LENGTHS ARE APPROXIMATE, SEE NOTE 8.

NOT FOR CONSTRUCTION

REV	DATE	DESCRIPTION	DRN	APP

Gowanus Canal
Remedial Design
Group

GPI
Greenman-Pedersen, Inc.
Engineering and Construction Services
325 West Main Street, Babylon, NY 11702
Tel: (631) 587-5060 Fax: (631) 422-3479

TITLE:
UNION STREET BRIDGE GENERAL PLAN AND ELEVATION

PROJECT:
RTA 1 - DREDGING, SEDIMENT AND WATER TREATMENT, ISS,
CAPPING, AND STAGING AND SUPPORT SITE DESIGN

SITE:
GOWANUS CANAL SUPERFUND SITE, BROOKLYN, NEW YORK

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DRAFT

DESIGN BY: PLT
DRAWN BY: PLT
CHECKED BY:
REVIEWED BY:
APPROVED BY:
DATE: JULY 2018
PROJECT NO.: HPH106A
FILE:
DRAWING NO.: B-2 OF 5

ATTACHMENT C – CORROSION DURABILITY

GPI

PROJECT: RTA 1 Bridge Stability Final Design SHEET: 1 OF 2
JOB NO.: BAB-2017020.01 MADE BY: JRA DATE: 11/21/19
SUBJECT: RTA1 - Bridge Support Design CHECKED BY: PLT DATE: 12/18/19

Attachment C - Corrosion Durability

References:

1. Arcelor Mittal Piling Handbook 8th Edition, Reprint 2008
2. AISC Steel Construction Manual 14th Edition
3. AASHTO Standard Specifications for Highway Bridges 17th Ed.

Corrosion Durability Pipe Pile:

Corrosion Durability of the steel monopile dolphin is completed in accordance with the procedure set forth in the Arcelor Mittal Piling Handbook. The corrosion durability is checked for a 50 year timeline. To be conservative, the design location with the longest pile length and the maximum moment determined from a vessel collision force was used. This design location was USDL01. To be conservative, checks were performed using loading in the temporary condition after dredging operations and prior to remedial cap installation.

Assumptions*:*

Polluted Natural Soils and industrial grounds below elevation of clean backfill and concrete cap.
Seawater

RTA 1 - Union Street Dolphin Monopile - USDL01

Design Elevations:

(All elevations are based on the North American Vertical Datum of 1988 (NAVD88)

EL_1 = -14.50 *ft* (Minimum existing bathymetry elevation)
EL_2 = -17.50 *ft* (Minimum el. of soft-native interface) *Appendix C Table 1d*
EL_3 = -26.33 *ft* (Minimum el. of native-glacial interface) *Appendix C Table 1d*
El_D = -17.50 *ft* (Dredge elevation)
EL_{CAP} = -15.67 *ft* (Environmental Cap Elevation)
H = 1.17 *ft* (Dredge height)
EL_{TOP} = 10.00 *ft* (Top of dolphin pile elevation)
EL_{TOE} = -55.00 *ft* (Tip of dolphin pile, add additional 20%)
H_w = 65.00 *ft* (Length of pile)
MHW EL = 1.96 *ft* (Mean high water elevation)
MLW EL = -2.57 *ft* (Mean low water elevation)

Corrosion Loss Rates:

Soil and Water Corrosion thicknesses below taken from Ref 1. Table 3.3.1 and 3.3.2 for 50 year timeline

Step 1:

Depth	Exterior Face Thickness Loss (mm)	Interior Face Thickness Loss (mm)	Total Thickness Loss Over 50 Year Life
0 - 8 ft	Splash Zone (7.5)	-	7.5 mm (0.295 in)
8 - 12.6 ft	Tidal (7.5)	Tidal (7.5)	15.0 mm (0.590 in)
12.6 - 24.5 ft	Immersed (3.5)	Immersed (3.5)	7.0 mm (0.276 in)
24.5 - 65 ft	Contam. Soil (3.0)	Contam. Soil (3.0)	6.0 mm (0.236 in)

Note:

1. Depth of zero feet is equivalent to the top of pile at EL. 10.0
2. Corrosion values from Reference 1 were doubled to account for both faces of pile in cross sectional view.
3. Thickness loss in the splash zone on the interior face was assumed to be zero.

GPI

PROJECT:	RTA 1 Bridge Stability Final Design	SHEET:	1	OF	2
JOB NO.:	BAB-2017020.01	MADE BY:	JRA	DATE:	11/21/19
SUBJECT:	RTA1 - Bridge Support Design	CHECKED BY:	PLT	DATE:	12/18/19

Step 2:

Depth	Maximum Bending Moment (k-ft)
0 - 8 ft	75.4
8 - 12.6 ft	119.2
12.6 - 24.5 ft	232.5
24.5 - 65 ft	298.3

Note:

Bending Moments taken from Union Street Dolphin Design Spreadsheet for location USDL01.

Step 3:

Depth	Min. Section Modulus (in^3)
0 - 8 ft	30.16
8 - 12.6 ft	47.68
12.6 - 24.5 ft	93.00
24.5 - 65 ft	119.32

Section modulus = M_{max} / (0.6*F_y)

F_y = 50 ksi

Step 4:

Section Modulus of Hollow Circle S= .098175(D^4-d^4)/D (Ref. 2. Table 17-27)

D= 28 in (Outside Diameter)

d= 26.5 in (Inside Diameter)

Adjusted Section Modulus After Corrosion Loss

Depth	Pile Dia. (in)	Pile Thickness (in)	Corrosion Loss (in)	Adjusted S_x (in^3)	Check
0 - 8 ft	28	0.750	0.236	357.3	OK
8 - 12.6 ft	28	0.750	0.536	279.0	OK
12.6 - 24.5 ft	28	0.750	0.248	358.7	OK
24.5 - 65 ft	28	0.750	0.213	368.2	OK

APPENDIX A – PAGES FROM RTA 1 BRIDGE SOIL DESIGN PARAMETERS BY GZA GEOENVIRONMENTAL, INC.

GZA GeoEnvironmental, Inc.
RTA 1 Bridge Soil Design Parameters
July 11, 2018

Summary of Design Parameters for Canal Soils

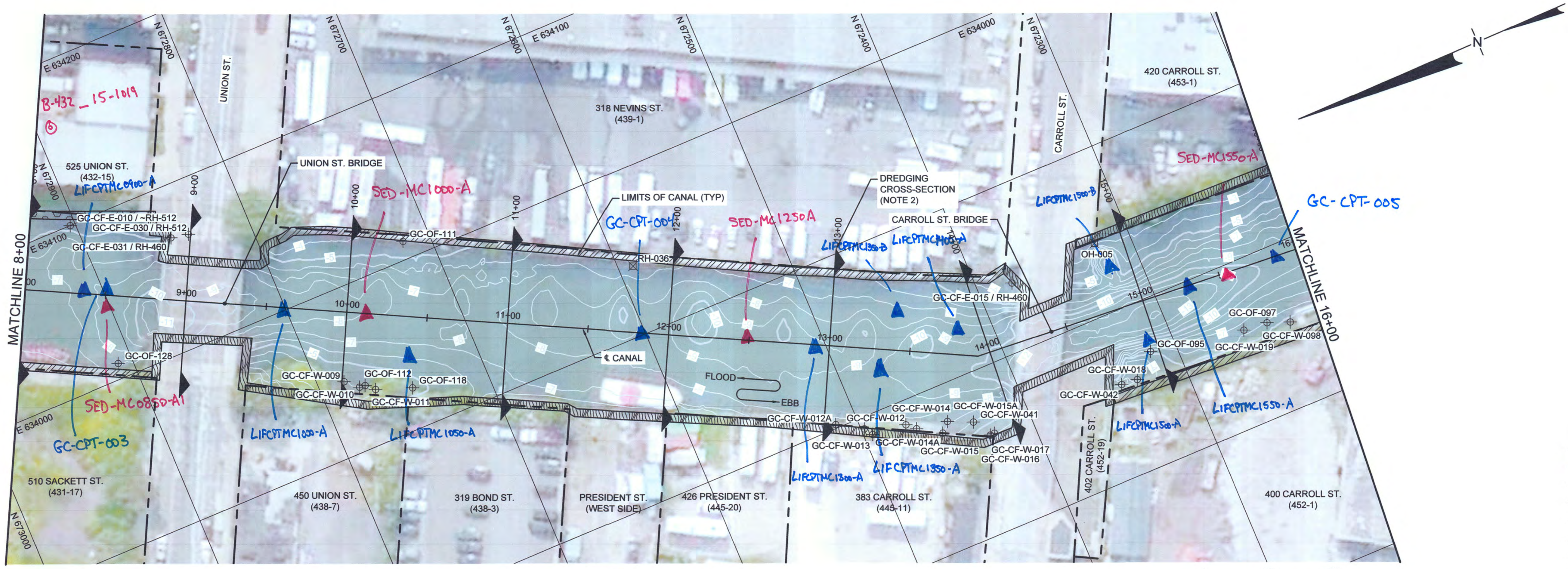
Soil Unit	Total Unit Weight, γ (pcf)	Effective Friction Angle, ϕ' (degrees)	Undrained Shear Strength, S_u (psf), See Note 1	Stratum Thickness Union Street (feet)	Stratum Thickness Carroll Street (feet)	Stratum Thickness 3rd Street (feet)
Soft Sediment	80	28	$0.3\sigma'_v$	6	5	7
Native Alluvial Sediment	115	28	250 if > El. -20 ft 500 if < El. -20 ft	4	4	7
Glacial Deposit	125	34	-	See Note 2	See Note 2	See Note 2

1. σ'v = (total unit weight of soil - 62.4 pcf)*depth
2. Explorations were terminated in this stratum and it is expected that the stabilization design for the bridges will also terminate here.

Summary of Design Parameters for Upland Soils

Soil Unit	Total Unit Weight, γ (pcf)	Effective Friction Angle, ϕ' (degrees)	Undrained Shear Strength, S_u (psf), See Note 1
Fill	120	32	-
Organic Sediment	95	23	$0.25\sigma'_v$ min. 250 psf
Native Alluvial Sediment	115	28	$0.35\sigma'_v$ min. 250 psf
Glacial Deposit w/ Fines	125	28	$0.5\sigma'_v$ min. 500 psf
Glacial Deposit w/ Sands	125	34	-

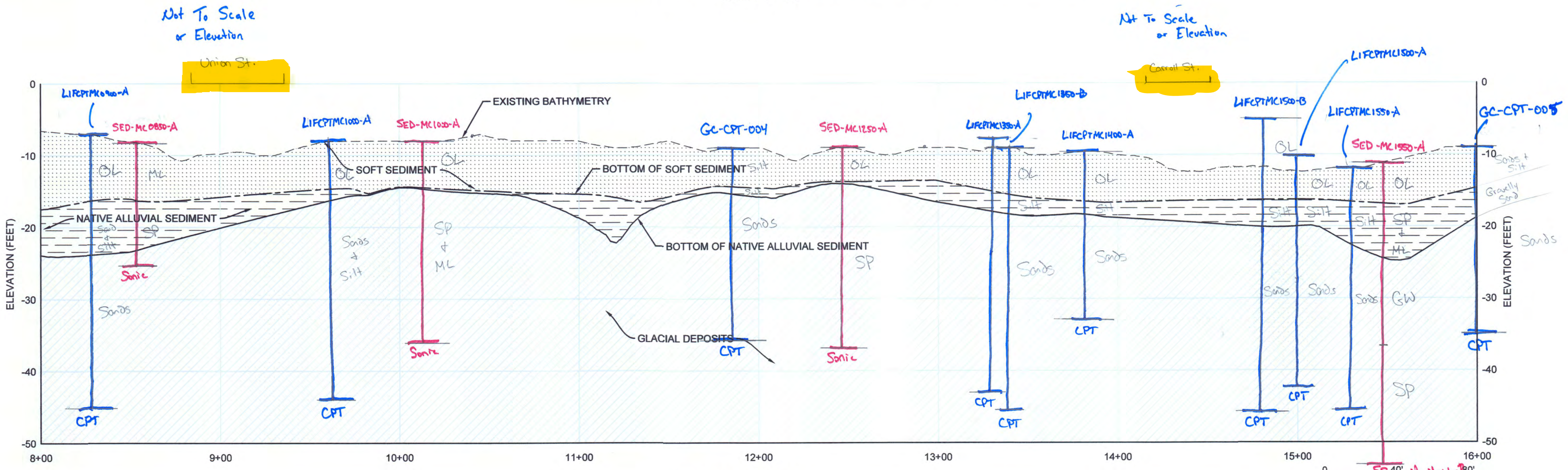
1. σ'v = total unit weight of soil*depth above the water table and σ'v = (total unit weight of soil - 62.4 pcf)*depth below the water table.



6
G-3

PLAN

EXISTING BATHYMETRY (STA. 8+00 TO 16+00)
SCALE: 1" = 40'



7
DR-2

PROFILE

EXISTING BATHYMETRY (STA. 8+00 TO 16+00)
SCALE: 1" = 40' (HORIZONTAL); 1" = 10' (VERTICAL)

0 40' 80'
SCALE IN FEET (HORIZONTAL)

0 10' 20'
SCALE IN FEET (VERTICAL)

LEGEND

─	BATHYMETRY ELEVATION
──	CANAL BOUNDARY
── ─ ─ ──	PROPERTY LINE
- - - -	EXISTING BATHYMETRY
─ · ─ · ─	BOTTOM OF SOFT SEDIMENT
─ ·· ─ ·· ─	BOTTOM OF NATIVE ALLUVIAL SEDIMENT
10+00	CANAL STATIONING
▨	STEEL SHEET PILE BULKHEAD
▨	TIMBER CRIB BULKHEAD
○○○	TIMBER PILE BULKHEAD
░	SOFT SEDIMENT
═	NATIVE ALLUVIAL SEDIMENT
▨	GLACIAL DEPOSITS
⌖	OUTFALL (NOTE 4)
⊠	CSO (NOTE 4)
(417-21)	BLOCK AND LOT
▲	Boring
▲	CPT

NOTES:

1. DEBRIS IN RTA1 IS PRESENTED ON DRAWINGS DR-6 TO DR-8.
2. DREDGE CROSS-SECTIONS ARE PRESENTED ON DRAWINGS DR-17 AND DR-18.
3. THE BULKHEAD TYPE FOR EACH PROPERTY IS PRIMARILY BASED ON A PRELIMINARY DESKTOP STUDY COMPLETED BY GEOSYNTEC (2014) TITLED "CONDITION ASSESSMENT OF EXISTING BULKHEADS" ALONG WITH MORE RECENT SUPPLEMENTARY INFORMATION (E.G., SITE WALKS, ENGINEERING DRAWINGS).
4. CONTRACTOR IS RESPONSIBLE FOR DOCUMENTING AND VERIFYING THE LOCATION AND DESCRIPTION OF OUTFALLS. ONLY RTA1 OUTFALLS DATA ARE PRESENTED ON THE DRAWING. OUTFALL DATA IS PROVIDED AS TABLE 1 ON DRAWING G-2 AND DESCRIBED WITHIN THE ASSOCIATED NOTES.

REV	DATE	DESCRIPTION	DRN	APP
C2	10.31.17	RTA1 65% REMEDIAL DESIGN TO RD GROUP	SRN	JFB
B	12.23.16	RTA1 35% REMEDIAL DESIGN - CAPPING AND ISS	SRN	JFB
A	10.31.16	RTA1 35% REMEDIAL DESIGN – DREDGING AND TREATMENT	SRN	JFB

Gowanus Canal
Remedial Design
Group

Geosyntec
consultants
7 GRAPHICS DRIVE, SUITE 106
EWING, NEW JERSEY 08628, USA
PHONE: 609.895.1400

Beech and Bonaparte
engineering p.c.
an affiliate of Geosyntec Consultants

TITLE:
EXISTING BATHYMETRY PLAN (STA. 8+00 TO 16+00)

PROJECT:
REMEDIATION TARGET AREA (RTA) 1
65% REMEDIAL DESIGN

SITE:
GOWANUS CANAL SUPERFUND SITE, BROOKLYN, NEW YORK

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY: JMG		DATE:	OCTOBER 2017
DRAWN BY: SRN		PROJECT NO.:	HPH106A
CHECKED BY: JMG		FILE:	HPH106A-DR006
REVIEWED BY: MWS		DRAWING NO.:	DR-2 OF 22
APPROVED BY: JFB			

NOT ISSUED FOR CONSTRUCTION

X:\09_CADD\DREDGING DESIGN\RTA1\DRAWINGS\HPH106A-DR006

APPENDIX B – PAGES FROM SUMMARY OF GEOTECHNICAL DESIGN PARAMETERS BY GEOSYNTEC CONSULTANTS

X:\03_GIS\mxd\geotech\geotech_parameters_report\Figure05a_CPT_Borings_Locations_PD-8.mxd; 5/19/2016

Legend

■ CPT Location

□ Gowanus Canal

▨ RTA1

▨ RTA2

▨ RTA3A

▨ RTA3B

200 100 0 200 Feet

Locations of CPTs in RTA1 and TB4 From the Geosyntec PD-8 (2015c) Investigation Report

Gowanus Canal Superfund Site, Brooklyn, NY

Gowanus Canal Remedial Design Group

Geosyntec consultants

Beech and Bonaparte engineering p.c.

Figure

5a

Ewing, NJ

August 2016

Table 1d. Geosyntec (2015c) PD-8 CPT Locations

Location	CPT Name	As Built Northing	As Built Easting	Elevation Mudline/Ground (ft)	Elevation of Soft-Native Interface (ft)	Elevation of Native-Glacial Interface (ft)
RTA1	15-53060_LIFCPTMC0000-A	673625.99	634418.54	-4.43	-18.13	-22.13
	15-53060_LIFCPTMC0000-A1	673617.43	634411.53	-4.16	-17.86	-21.86
	15-53060_LIFCPTMC0050-A	673635.74	634396.37	-3.57	-14.27	-19.77
	15-53060_LIFCPTMC0050-B	673602.82	634441.17	-2.39	-15.69	-20.69
	15-53060_LIFCPTMC0100-A	673565.95	634398.12	-3.70	-18.20	-21.70
	15-53060_LIFCPTMC0150-A	673532.23	634351.93	-6.30	-20.75	-23.05
	15-53060_LIFCPTMC0150-B	673514.39	634394.77	-3.16	-17.21	-19.91
	15-53060_LIFCPTMC0200-A	673477.58	634359.95	-4.00	-15.80	-18.30
	15-53060_LIFCPTMC0250-A	673443.39	634295.19	-6.46	-17.08	-19.08
	15-53060_LIFCPTMC0250-B	673433.36	634350.07	-4.76	-18.21	-24.21
	15-53060_LIFCPTMC0300-A	673391.05	634302.85	-4.76	-15.76	-17.51
	15-53060_LIFCPTMC0350-A	673363.12	634264.67	-5.79	-17.54	NA
	15-53060_LIFCPTMC0350-A1	673363.12	634264.67	-5.58	-17.58	NA
	15-53060_LIFCPTMC0350-B	673340.09	634309.00	-3.77	-16.52	-17.92
	15-53060_LIFCPTMC0400-A	673300.56	634252.44	-5.21	-15.21	-18.21
	15-53060_LIFCPTMC0450-A	673270.50	634212.47	-5.37	-16.37	-17.37
	15-53060_LIFCPTMC0450-A1	673265.08	634220.93	-6.07	-17.82	-18.32
	15-53060_LIFCPTMC0450-B	673241.33	634254.85	-3.59	-15.34	-18.09
	15-53060_LIFCPTMC0450-B1	673245.57	634255.70	-4.18	-15.98	-18.98
	15-53060_LIFCPTMC0500-A	673213.42	634212.79	-4.75	-12.85	-14.25
	15-53060_LIFCPTMC0500-A1	673214.67	634210.65	-4.98	-12.53	-13.53
	15-53060_LIFCPTMC0550-A	673178.16	634164.03	-5.64	-13.09	-18.09
	15-53060_LIFCPTMC0550-B	673155.88	634218.13	-3.00	-11.65	-14.25
	15-53060_LIFCPTMC0600-A	673131.34	634161.27	-6.33	-13.58	-18.78
	15-53060_LIFCPTMC0650-A	673089.02	634119.77	-8.93	-17.43	NA
	15-53060_LIFCPTMC0650-A1	673083.36	634111.64	-8.98	-17.73	-19.23
	15-53060_LIFCPTMC0650-A2	673079.26	634118.67	-9.12	-19.12	-20.87
	15-53060_LIFCPTMC0650-B	673071.98	634155.82	-6.36	-17.36	-18.71
	15-53060_LIFCPTMC0650-B1	673078.07	634156.54	-6.54	-17.54	-19.24
	15-53060_LIFCPTMC0700-A	673038.19	634117.64	-8.10	-16.60	NA
	15-53060_LIFCPTMC0700-A1	673042.26	634116.51	-8.16	-18.16	NA
	15-53060_LIFCPTMC0750-A	673010.23	634075.26	-6.29	-15.29	-17.64
	15-53060_LIFCPTMC0750-A1	673004.27	634073.07	-6.06	-16.51	-18.91
	15-53060_LIFCPTMC0750-B	672983.28	634113.17	-6.18	-16.80	NA
	15-53060_LIFCPTMC0750-B1	672982.74	634108.13	-5.88	-17.23	NA
	15-53060_LIFCPTMC0800-A	672946.38	634078.38	-6.86	-17.61	-24.11
	15-53060_LIFCPTMC0850-A	672920.46	634027.16	-7.38	-14.53	-26.33
	15-53060_LIFCPTMC0850-B	672895.53	634081.06	-5.85	-14.55	-21.30
	15-53060_LIFCPTMC0850-B1	672899.36	634083.25	-6.25	-14.30	-21.80
	15-53060_LIFCPTMC0900-A	672901.29	634056.80	-6.92	-16.17	-23.17
	15-53060_LIFCPTMC0950-A	672801.52	633975.76	-6.19	-12.79	-14.99
	15-53060_LIFCPTMC0950-B	672786.44	634013.37	-7.14	-14.89	-15.39
	15-53060_LIFCPTMC1000-A	672790.27	633984.71	-7.45	-16.25	-16.25
	15-53060_LIFCPTMC1050-A	672735.43	633939.09	-6.56	-14.56	-18.06
	15-53060_LIFCPTMC1050-B	672705.04	633959.45	-7.75	-15.30	-15.30
	15-53060_LIFCPTMC1100-A	672670.01	633943.49	-8.74	-15.64	-17.14
	15-53060_LIFCPTMC1150-A	672644.46	633894.04	-7.53	-14.53	-16.53
	15-53060_LIFCPTMC1150-B	672606.63	633913.10	-8.63	-14.18	-14.68
	15-53060_LIFCPTMC1200-A	672583.90	633893.11	-9.33	-14.83	-16.33
	15-53060_LIFCPTMC1250-A	672558.55	633846.25	-8.52	-13.77	-16.47
	15-53060_LIFCPTMC1250-B	672561.76	633889.47	-9.63	-13.63	-13.63
	15-53060_LIFCPTMC1300-A	672504.89	633854.32	-8.80	-13.45	-16.41

Table 9. Recommended Material Parameters for Canal Soils for Dredge and Cap Geotechnical Evaluation

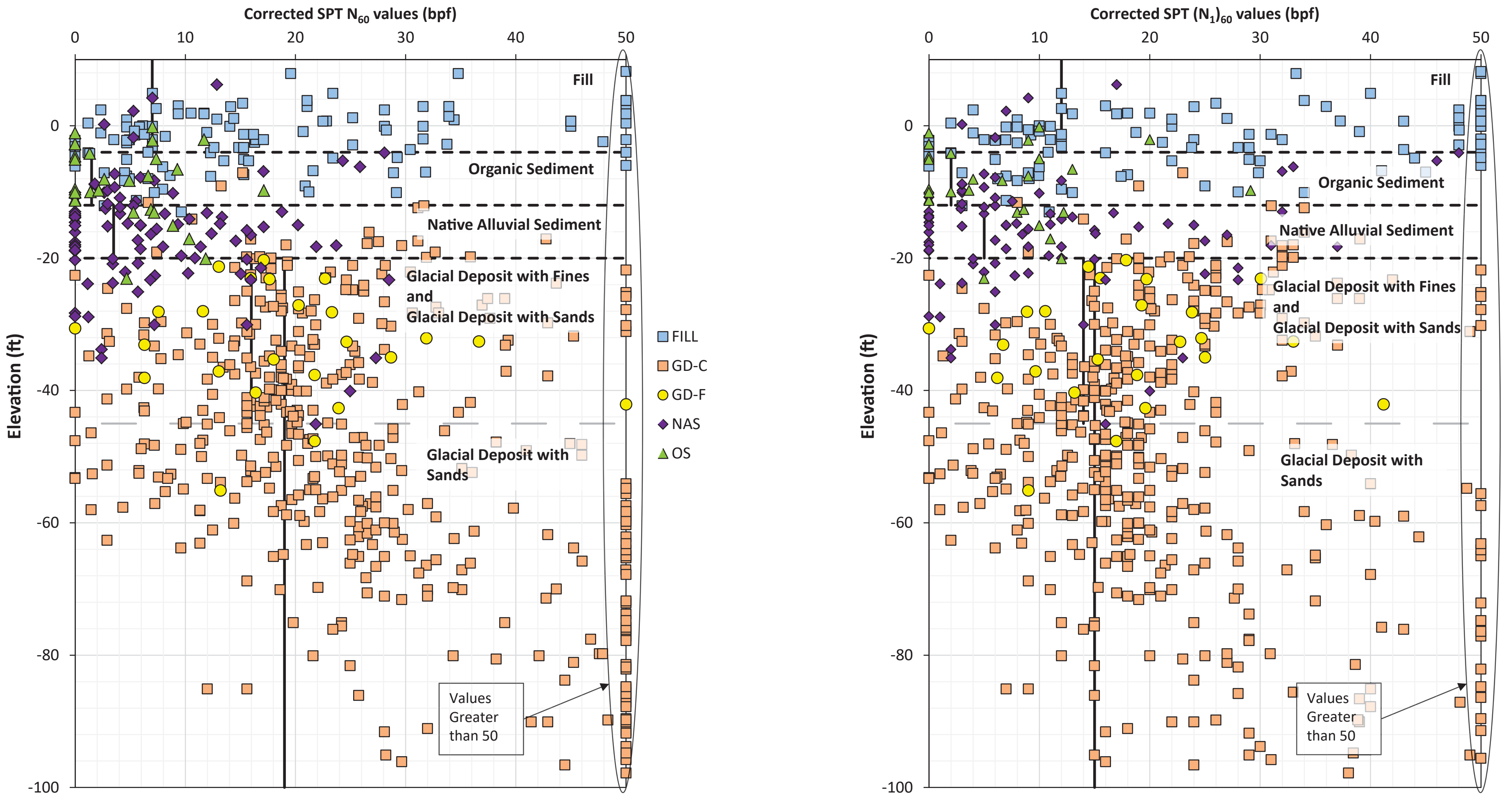
Soil Unit	Total Unit Weight (pcf)	Drained Shear Strength - Effective Stress Friction Angle, ϕ'(degrees)	Undrained Shear Strength, S_u (psf)	Undrained Shear Strength Ratio (S_u/σ'_v)	Over Consolidation Ratio (OCR)[1]	Modified Compression Index, $C_{c\varepsilon}$	Modified Recompression Index, $C_{r\varepsilon}$	Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	Coefficient of Consolidation, C_v (cm^2/s)	Young's Modulus (tsf)
		Fully Softened Shear Strength[2]								
Soft Sediment	80	28°	-	0.3	1	0.23	0.028	0.015	1×10^{-4}	-
Native Alluvial Sediment	115	28°	RTA1: 250 psf [> El. -20 ft] 500 psf [< El. -20 ft] TB4: 500 psf [> El. -19 ft and < El. -26 ft] 250 psf [in-between El. -19 ft and -26 ft]	-	1	0.075	0.028	0.002	2×10^{-3}	-
Glacial Deposit	125	34° (effective friction angle in drained and undrained conditions)[3]			1					400

Notes:

1. The soils are assumed to be normally consolidated under the existing conditions.
2. The fully softened shear strength is recommended as the drained shear strength for soft sediment and native alluvial sediment if these soils have not undergone failure.
3. For the glacial deposit, the selected drained and undrained shear strengths are the same as this material is assumed to be freely draining.

Legend:

S_u – Undrained Shear Strength
σ'_v – In-Situ Effective Vertical Stress
pcf – Pounds per Cubic Foot
cm^2/s – Square Centimeter per Second
tsf – Tons per Square Foot
El. – Elevation
ft – Foot
RTA – Remediation Target Area
TB4 – 4th Turning Basin



Notes:

1. Dash lines represent general boundaries between material layers defined for the upland side of the bulkheads
2. The subsurface stratigraphy is not identical at all boring locations; therefore, some blow count values shown within a material may not be representative of that material.

Legend:

bpf = blows per foot

Soil Unit	Representative N-values (bpf)	
	N_{60}	$(N_1)_{60}$
Fill	7	12
Organic Sediment (OS)	1.5	2
Native Alluvial Sediment (NAS)	3.5	5
Glacial Deposit with Fines (GD-F)	16	14
Glacial Deposit with Sands (GD-S)	19	15

Compilation Plots of Calculated N_{60} and $(N_1)_{60}$ Values with Depth for the Upland Side of the Canal

Gowanus Canal Superfund Site, Brooklyn, NY

Gowanus Canal Remedial Design Group

Geosyntec consultants

Beech and Bonaparte engineering p.c.
an affiliate of Geosyntec Consultants

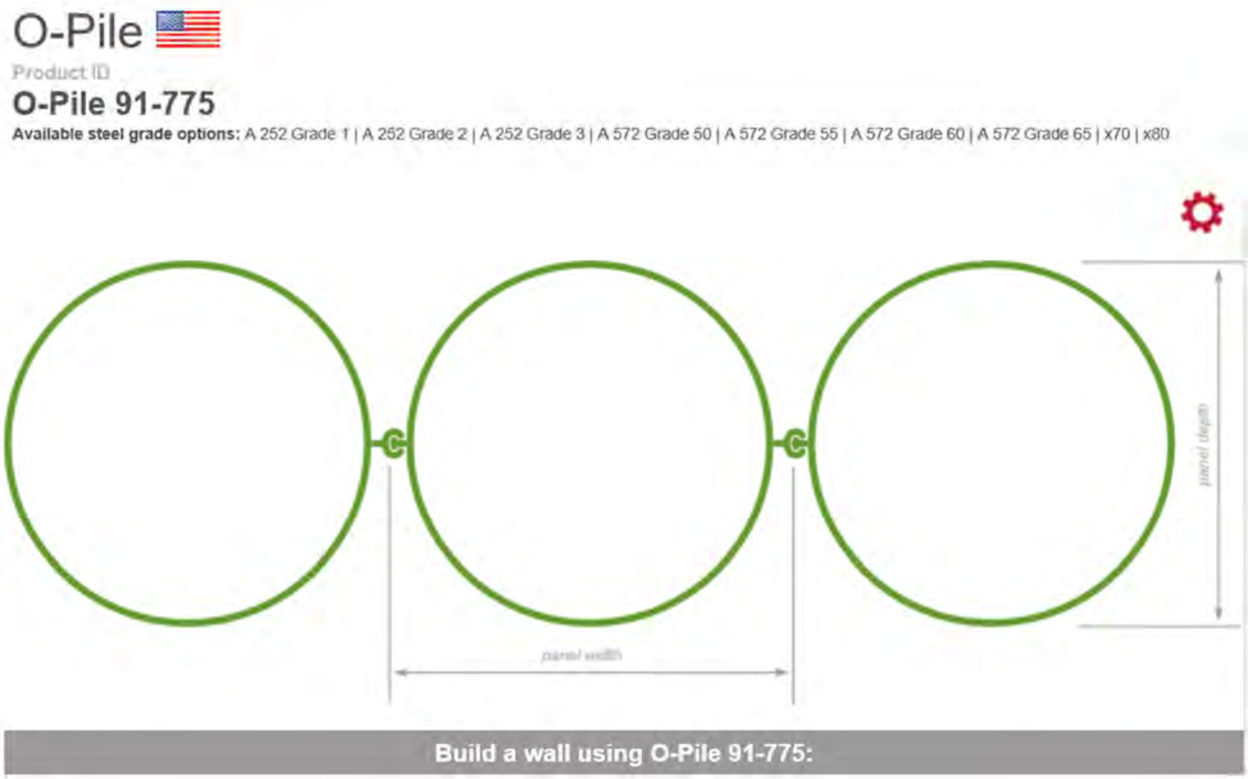
Ewing, NJ

October 2016

Figure 6

APPENDIX C – O-PILE DATASHEET

O-Pile 28” Diameter – 0.750” Wall Thickness:



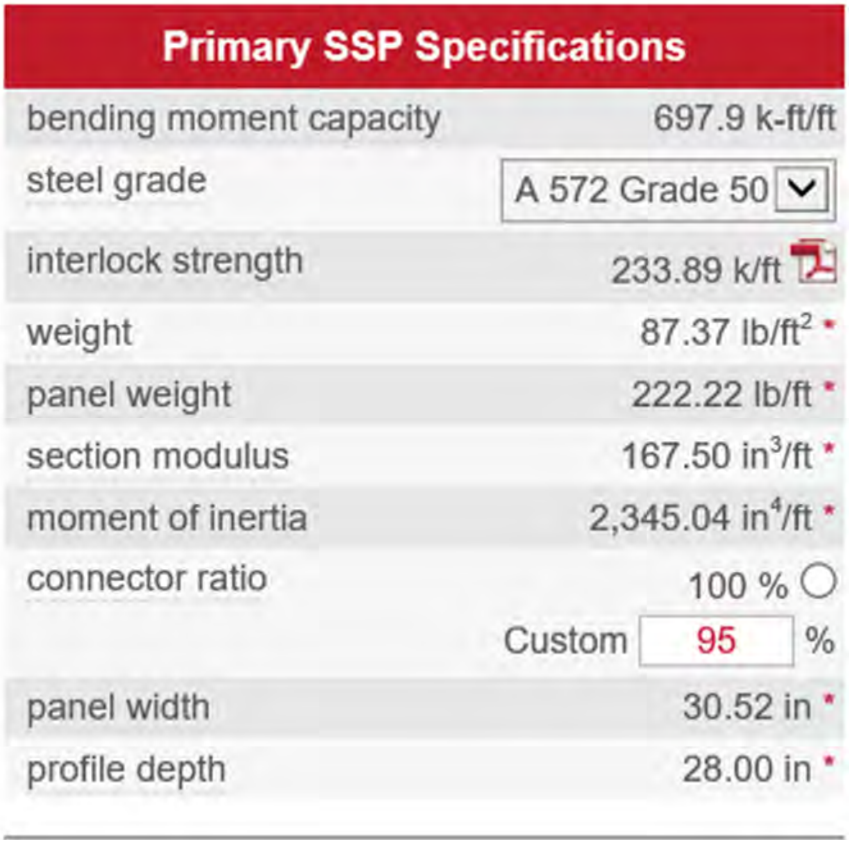
O-Pile

Product ID

O-Pile 91-775

Available steel grade options: A 252 Grade 1 | A 252 Grade 2 | A 252 Grade 3 | A 572 Grade 50 | A 572 Grade 55 | A 572 Grade 60 | A 572 Grade 65 | x70 | x80

Build a wall using O-Pile 91-775:



Primary SSP Specifications

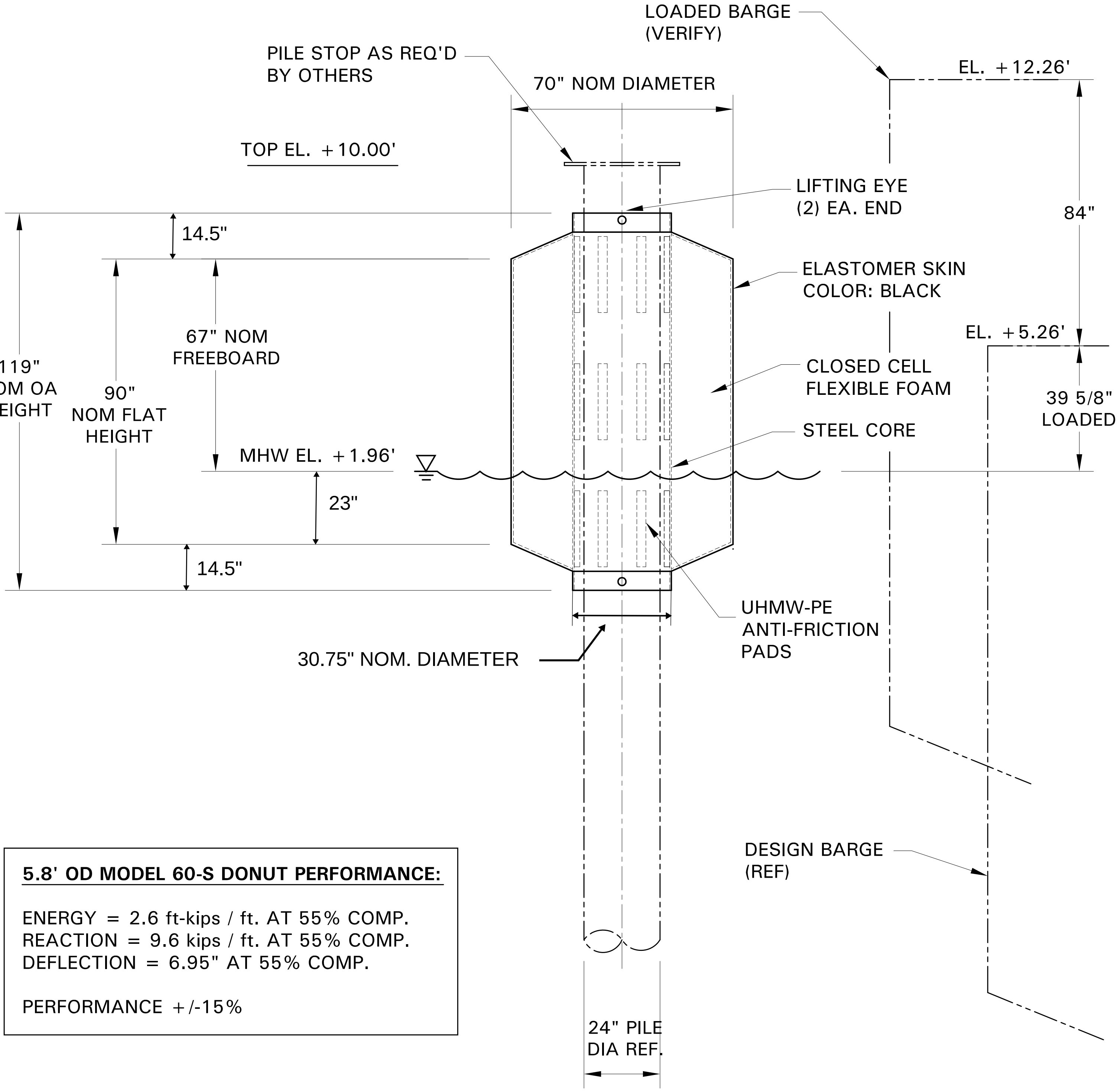
bending moment capacity	697.9 k-ft/ft
steel grade	A 572 Grade 50
interlock strength	233.89 k/ft
weight	87.37 lb/ft^2 *
panel weight	222.22 lb/ft *
section modulus	167.50 in^3/ft *
moment of inertia	2,345.04 in^4/ft *
connector ratio	100 % ○ Custom 95 %
panel width	30.52 in *
profile depth	28.00 in *

APPENDIX D – CONFIGURATION AND PERFORMANCE OF DONUT MARINE FENDER BY TRELLEBORG MARINE SYSTEMS

DONUT MARINE FENDER

Model 60-S Fender Configuration
5.8' OD x 7.5' Flat Ht. for 24" Pile

NOT TO SCALE



5.8' OD MODEL 60-S DONUT PERFORMANCE:

ENERGY = 2.6 ft-kips / ft. AT 55% COMP.
REACTION = 9.6 kips / ft. AT 55% COMP.
DEFLECTION = 6.95" AT 55% COMP.

PERFORMANCE +/-15%

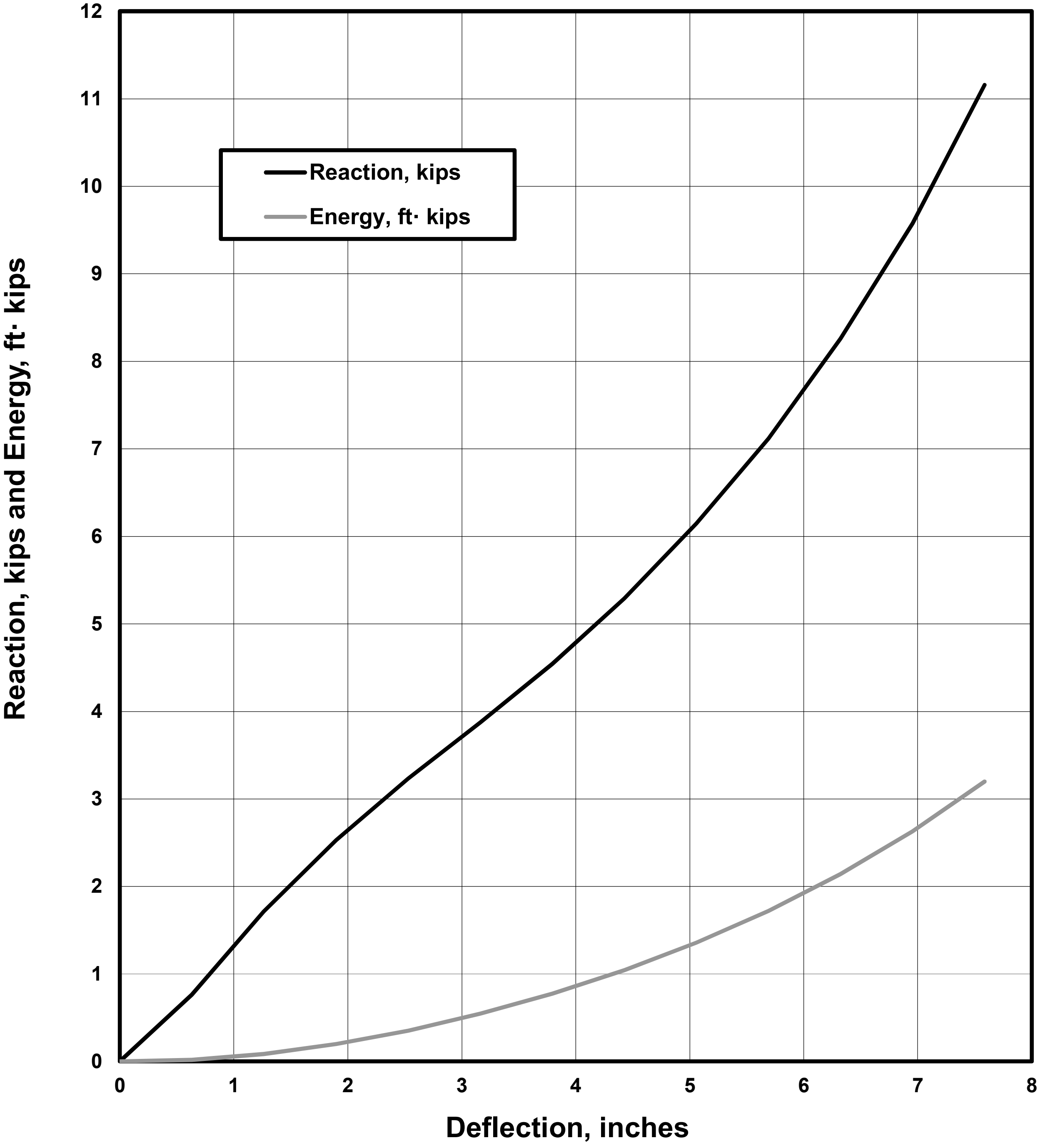
DONUT WEIGHT ~3054 lbs

190114 Gowanus Dolphin Donut.dwg 14Jun19

TO ACCOMMODATE MANUFACTURING PROCESSES, TRELLEBORG MARINE SYSTEMS RESERVES THE RIGHT TO CHANGE, WITHOUT SPECIFIC CUSTOMER APPROVAL, DETAILS WHICH DO NOT IN TRELLEBORG'S OPINION AFFECT INTENDED FORM, FIT AND FUNCTION OF THE PRODUCT.	THIS DOCUMENT CONTAINS INFORMATION WHICH IS PROPRIETARY TO TRELLEBORG MARINE SYSTEMS. THE INFORMATION CONTAINED HEREIN SHALL NOT BE DISCLOSED OR DUPLICATED, USED OR DISCLOSED IN WHOLE OR IN PART FOR ANY PURPOSE OTHER THAN TO EVALUATE THE DOCUMENT.

Trelleborg Marine Systems - 532 Jack Enders Blvd.
Berryville, VA 22611 Phone (540) 667-5191 Fax (540) 667-7987

Performance Curves
5.8 ft OD x 1.0 ft. Effective Flat-Side Height
Model 60-S DONUT Fender



Performance +/-15%

6/7/2019

CALCULATIONS
FOR
FENDER SYSTEM ANALYSIS

STRUCTURE

UNION STREET
B.I.N. 2-24027-0

PREPARED FOR

GOWANUS ENVIRONMENTAL REMEDIATION TRUST

RTA1 BRIDGE STABILITY FINAL DESIGN

PREPARED BY

Greenman-Pedersen, Inc.

FEBURARY 2020

GPI

CALCULATIONS FOR THE FENDER ANALYSIS AT UNION STREET BRIDGE

RTA1 BRIDGE STABILITY FINAL DESIGN
B.I.N # 2-24027

DESIGN SUMMARY

Design Criteria:

Manuals & Specifications

- NYSDOT Geotechnical Design Procedure for Flexible Wall Systems - Aug 2015
- NYSDOT Bridge Manual, 2017 Edition, updated August 2017
- AASHTO Standard Specifications for Highway Bridges, 17th Edition - 2002
- USS Sheet Piling Design Manual – 1984
- NYSDOT Standard Specifications
- Manual for Bridge Evaluation 3rd Edition

References:

- Geotechnical References prepared by Geosyntec Consultants

Software Used:

- SPW-11 V2.40 Sheet Piling
- Mathcad

Design Approach:

The dredging of the Gowanus Canal for RTA 1 proposed by Geosyntec will increase the exposed height of the Fender System which is composed of timber Sheet pile walls surrounding the concrete abutment which is supported on piles. The sheeting analysis was done in ASD following the procedure in the NYSDOT Geotechnical Design Procedure for Flexible Wall Systems (GDP-11). The Fender Analysis was developed utilizing geotechnical data from RTA1, LIFCPTMC0850-A, LIFCPTMC0850-B, LIFCPTMC0850-B1, LIFCPTMC0950-A, LIFCPTMC0950-B, and LIFCPTMC1000-A, (Figure 5A, Summary of Geotechnical Design Parameters, Revision A, August 2016).

There will not be an applied Live load surcharge behind the fender and the fender system was not analyzed for vessel impact because this is an unlikely occurrence during construction

Below are the various analysis cases that have been performed and it was determined that the existing fender system is not stable when dredging the canal to Elevation -16.00ft, without performing remedial measures to the fender system.

Design Case I:

This is the base condition representing the effects on the Fender System during dredging the canal, The dredge elevation varies, however the elevation assumed for the calculations is -16.00 ft. The Fender System is composed of timber sheeting with cylindrical rubber fenders attached to the pier in 9-foot increments. There is no positive attachment between the fender and the timber sheeting thus the sheeting is assumed unbraced.

Results-Case 1

The analysis revealed that the embedment depth was not adequate during dredged loading conditions. 14.9 feet embedment is required and only 6.56 feet embedment will exist after dredging.

Design Case II:

This case represents the base system except as a remedial measure, the fill behind the fender system will be dredged to an elevation of -12.55 feet. This will result in a decreased active pressure thus decreased embedment depth.

Results-Case II

The analysis revealed a required embedment depth of 4.22 feet, which is less than the 6.56 feet embedment depth exhibited with this case. The timber section capacity was checked assuming a 20 percent loss and the section was found adequate.

Design Case III:

This case represents the final condition. The cap will be added to the canal. An elevation of -13.0 is assumed. Fill will be added back behind the fender system to an elevation -9.55 feet .

Results-Case III

20% loss of timber section was assumed. The section capacity of the timber was adequate as well as the required embedment of 4.95 feet which is less than the 9.56 provided.

Analysis Methods and Design Assumptions:

All Design Cases:

- All soil information including soil design properties and soil layer thicknesses were obtained from the RTA 1 Bridge Soil Design Parameters prepared by GZA GeoEnvironmental, Inc. dated July 11, 2018 (*Appendix A*). Soil layer thicknesses have been modified for certain design locations per the Summary of Geotechnical Design Parameters prepared by Geosyntec Consultants (*Appendix B*)..
- Fender Analysis System was performed using the program SPW-11 Software Civil Suite.
- Dredge depths were obtained from the RTA 1 65% Design Package provided by Geosyntec Consultants.
- It was assumed that settlements of the fill between the fender and the pier will not be an issue due to fact that the pier is pile supported.

GPI

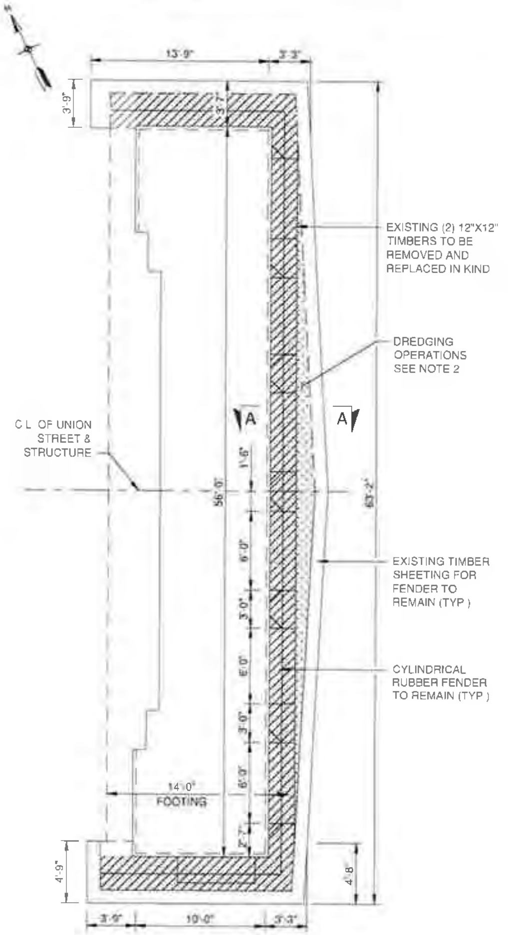
CALCULATIONS FOR PROTECTION OF UNION STREET BRIDGE

RTA 1 BRIDGE STABILITY FINAL
DESIGN B.I.N # 2-24027-0

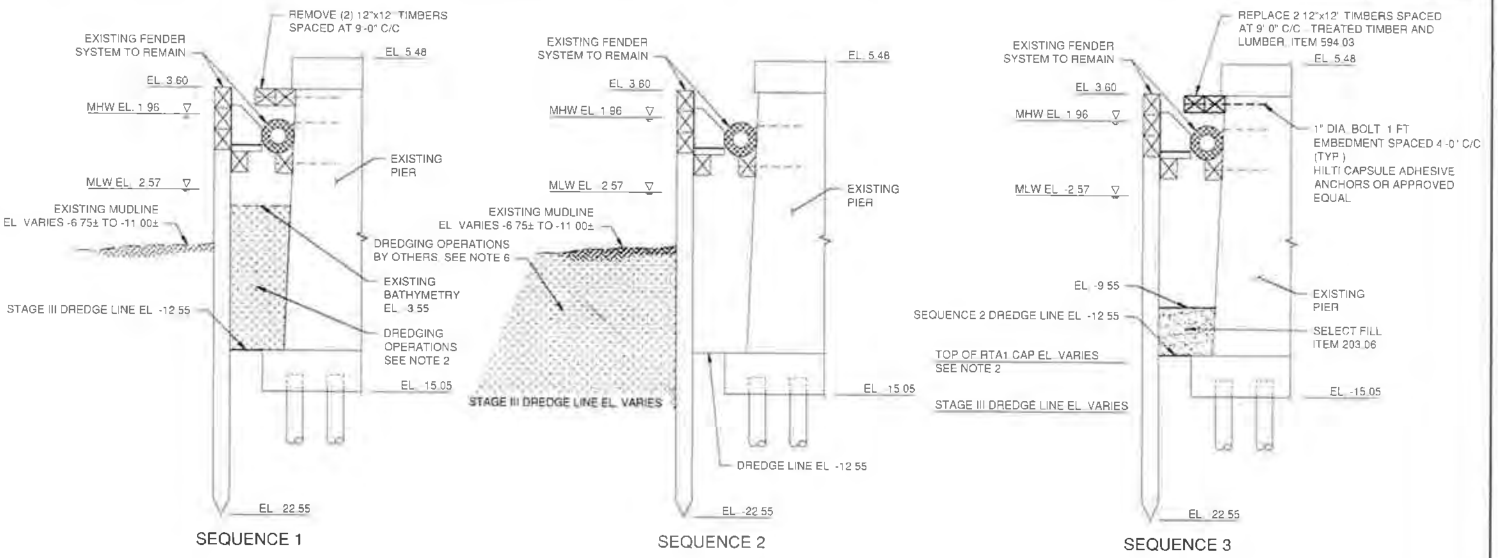
TABLE OF CONTENTS

ATTACHMENTS:

SHEET NO	TOTAL SHEETS
15	22



PLAN
WEST PIER SHOWN, EAST PIER SIMILAR
SCALE: 1" = 10'-0"



SECTION A-A
SCALE: 1/8" = 1' 0"

SUGGESTED SEQUENCE OF DREDGING

THE FOLLOWING DREDGING SEQUENCE ALLOWS FOR STABILITY OF THE EXISTING FENDER SYSTEM WHILE MAINTAINING DREDGING OPERATION

STAGE 1
1 REMOVE 2 HORIZONTAL 12"x12" TIMBER SECTIONS
2 DREDGE BEHIND THE FENDER SYSTEM TO ELEVATION -12.55
3 DISCHARGE TO BE PUMPED DIRECTLY TO A HOPPER BARGE

STAGE 2
1 DREDGE IN CANAL TO ELEVATION -16.00

STAGE 3
1 FILL BEHIND FENDER WITH SELECT FILL TO EL -9.55, ITEM 203.06
2 REPLACE 2 12'x12' TIMBER SECTIONS

NOTES:
1 CONTRACTOR TO FIELD VERIFY ALL DIMENSIONS
2 FOR SEDIMENT CONTROL AND WASTE MANAGEMENT DETAILS REFER TO REMEDIATION TARGET AREA (RTA) 1 DESIGN PACKAGE
3 FOR UNION STREET GENERAL PLAN AND ELEVATION, SEE DWG NO U 2
4 CARE SHALL BE TAKEN THROUGHOUT DREDGING OPERATIONS ANY DAMAGE TO THE FENDER SYSTEM SHALL BE REPAIRED BY THE CONTRACTOR AT THE CONTRACTOR'S EXPENSE
5 CANAL DREDGING ADJACENT TO THE EXISTING FENDER SYSTEMS AND CONCRETE PIERS SHALL BE DONE IN SLOTS USING BEST MANAGMENT PRACTICES
6 DREDGING OF CANAL SEDIMENTS BY OTHERS FOR DREDGING LIMITS, OPERATIONS, DETAILS AND SPECFICATIONS SEE REMEDIATION TARGET AREA (RTA) 1 DESIGN PACKAGE
7 DURING DREDGING OPERATIONS HYDRAULIC HEAD ON BOTH SIDES OF THE FENDER TO BE MAINTAINED AT THE SAME ELEVATION

LEGEND:
▨	VOLUME TO BE DREDGED
▨	SELECT FILL ITEM 203.02

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DESIGNER L DESIMONE CHECKER J. STERN

0 1 2 3 4
ORIGINAL SIZE IN INCHES

IT IS A VIOLATION OF LAW FOR ANY PERSON, UNLESS THEY ARE ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, ARCHITECT, LANDSCAPE ARCHITECT, OR LAND SURVEYOR, TO ALTER AN ITEM IN ANY WAY. IF AN ITEM BEARING THE STAMP OF A LICENSED PROFESSIONAL IS ALTERED THE ALTERING ENGINEER, ARCHITECT, LANDSCAPE ARCHITECT, OR LAND SURVEYOR SHALL STAMP THE DOCUMENT AND INCLUDE THE NOTATION "ALTERED BY" FOLLOWED BY THEIR SIGNATURE THE DATE OF SUCH ALTERATION, AND A SPECIFIC DESCRIPTION OF THE ALTERATION.

CITY OF NEW YORK
DEPARTMENT OF TRANSPORTATION
DIVISION OF BRIDGES

NYS P.I.N. NO
FED. AID PROJ. NO
NYC P.I.N. NO
CONTRACT NO HPH106A
CD NO

RTA 1 - DREDGING SEDIMENT AND WATER TREATMENT ISS CAPPING AND STAGING AND SUPPORT SITE DESIGN
UNION STREET BRIDGE OVER THE GOWANUS CANAL
BOROUGH OF BROOKLYN B.I.N. 2 24027 0

DREDGING DETAILS AT EXISTING PIER FENDER

DWG NO	SCALE	DATE	SHEET NO
U-5	AS NOTED	JULY 2019	15

DESIGN CASE 1

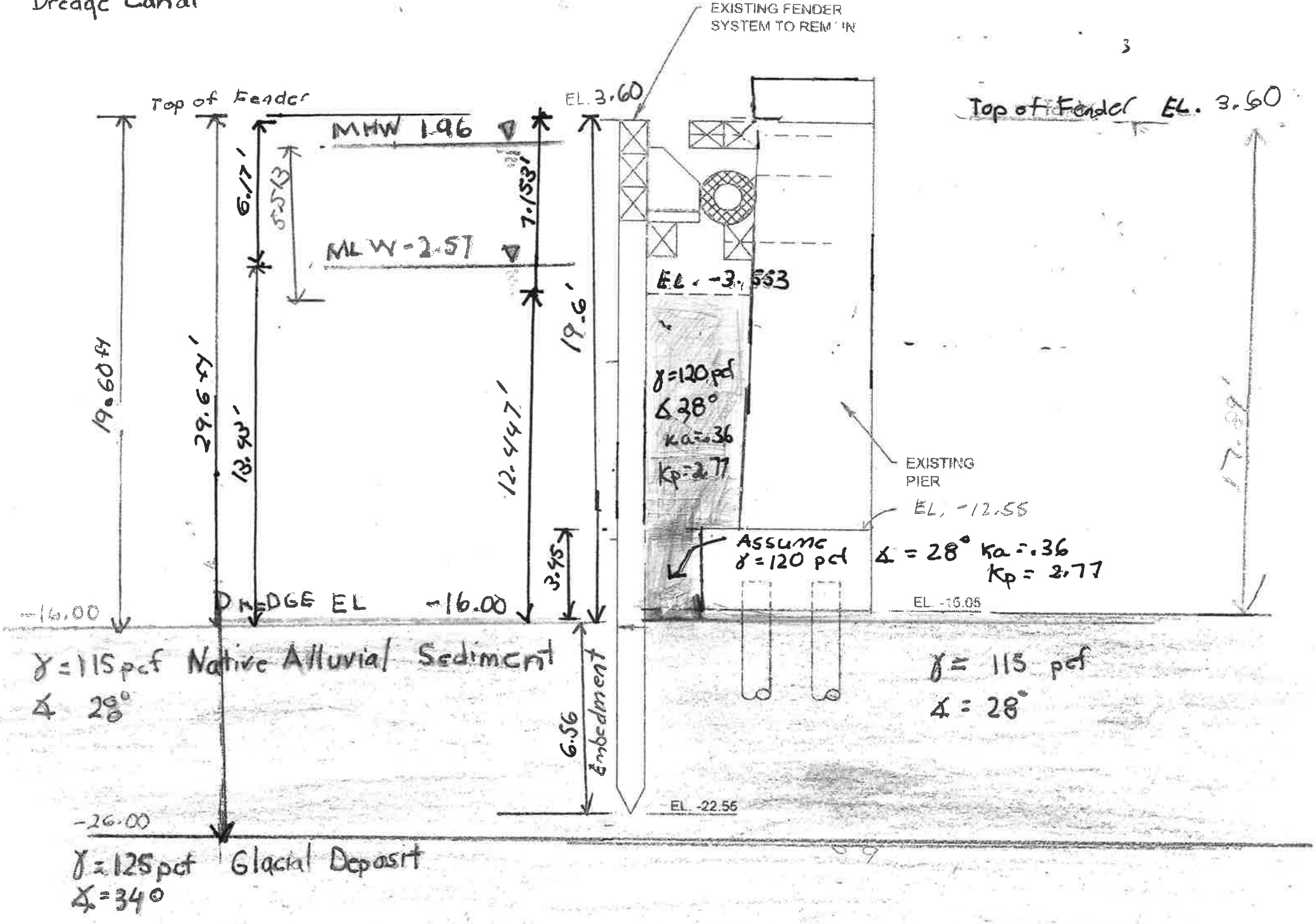
Design Case I:

This is the base condition representing the effects on the Fender System during dredging the canal, The dredge elevation varies, however the elevation assumed for the calculations is -16.00 ft. The Fender System is composed of timber sheeting with cylindrical rubber fenders attached to the pier in 9-foot increments. There is no positive attachment between the fender and the timber sheeting thus the sheeting is assumed unbraced.

Results-Case 1

The analysis revealed that the embedment depth was not adequate during dredged loading conditions. 14.9 feet embedment is required and only 6.56 feet embedment will exist after dredging.

CASE I
Dredge Canal



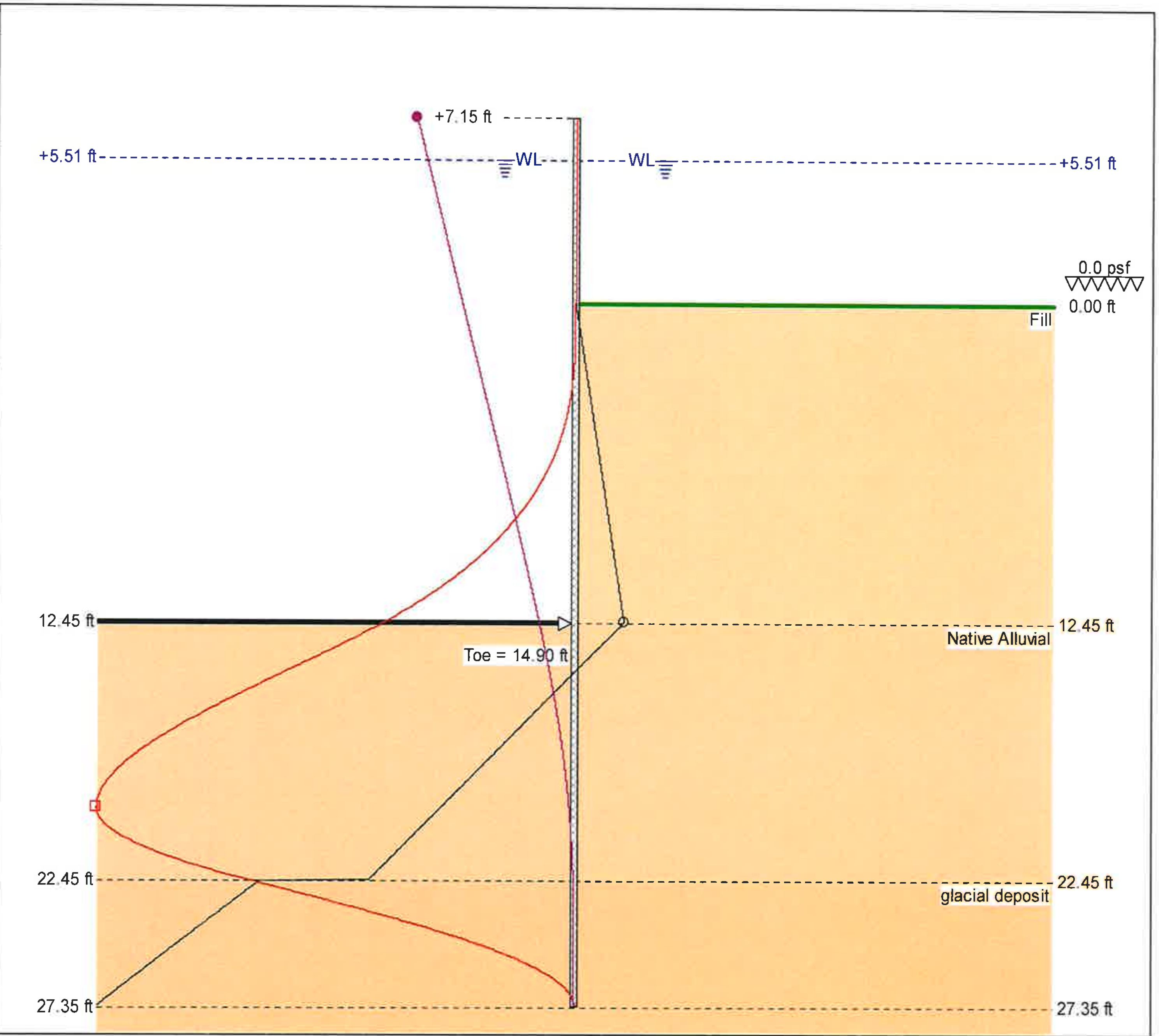
Client: GPI

Title: Gowanus Superfund Union
Street, Case I, Dredge in Canal,
Fender System left as is
Page: 1
Date: 6.20.19

Sheet: timber section
Pressure: Rankine
FOS: 1.0 (K_p÷1.3)
Toe: Cantilever

Maximum		d (ft)
○	235.7 psf	12.45
☐	15186.2 ftlb/ft	19.67
●	9.0 in	-7.15

The timber section sized represent net sizes w/o losses assumed.



Your Company Name

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Client: GPI

Title: Gowanus Superfund Union Street, Case I, Dredge in Canal, Fender System left as is
Page: 2
Date: 6.20.19

Sheet: timber section
Pressure: Rankine
FOS: 1.0 (K_p÷1.3)
Toe: Cantilever

The timber section sized represent net sizes w/o losses assumed

Input Data

Depth Of Excavation = 12.45 ft
Surcharge = 0.0 psf

Depth Of Active Water = +5.51 ft
Depth Of Passive Water = +5.51 ft

Water Density = 62.43 pcf
Minimum Fluid Density = 31.82 pcf

Soil Profile

Depth (ft)	Soil Name	γ (pcf)	γ' (pcf)	C (psf)	C_a (psf)	ϕ(°)	δ(°)	K_a	K_{ac}	K_p	K_{pc}
0.00	Fill	120.00	52.60	0.0	0.0	28.0	0.0	0.36	0.00	2.77 (2.13)	0.00 (0.00)
12.45	Native Alluvial	115.00	68.73	0.0	0.0	28.0	0.0	0.36	0.00	2.77 (2.13)	0.00 (0.00)
22.45	glacial deposit	125.00	65.55	0.0	0.0	34.0	0.0	0.28	0.00	3.54 (2.72)	0.00 (0.00)

( ) indicates factored value used in calculations. Factor(s): K_p÷1.3

Solution

Sheet

Sheet Name	I (in⁴/ft)	E (psi)	Z (in³/ft)	f (psi)	Maximum Bending Moment (ftlb/ft)	Upstand (ft)	Toe (ft)	Pile Length (ft)
timber section	791.45	9.6E+05	171.25	680.0	9704.2	7.15	14.90	34.50

Maxima

	Maximum	Depth
Bending Moment	15186.2 ftlb/ft	19.67 ft
Deflection	9.0 in	-7.15 ft
Pressure	235.7 psf	12.45 ft
Shear Force	1904.1 lb/ft	22.46 ft

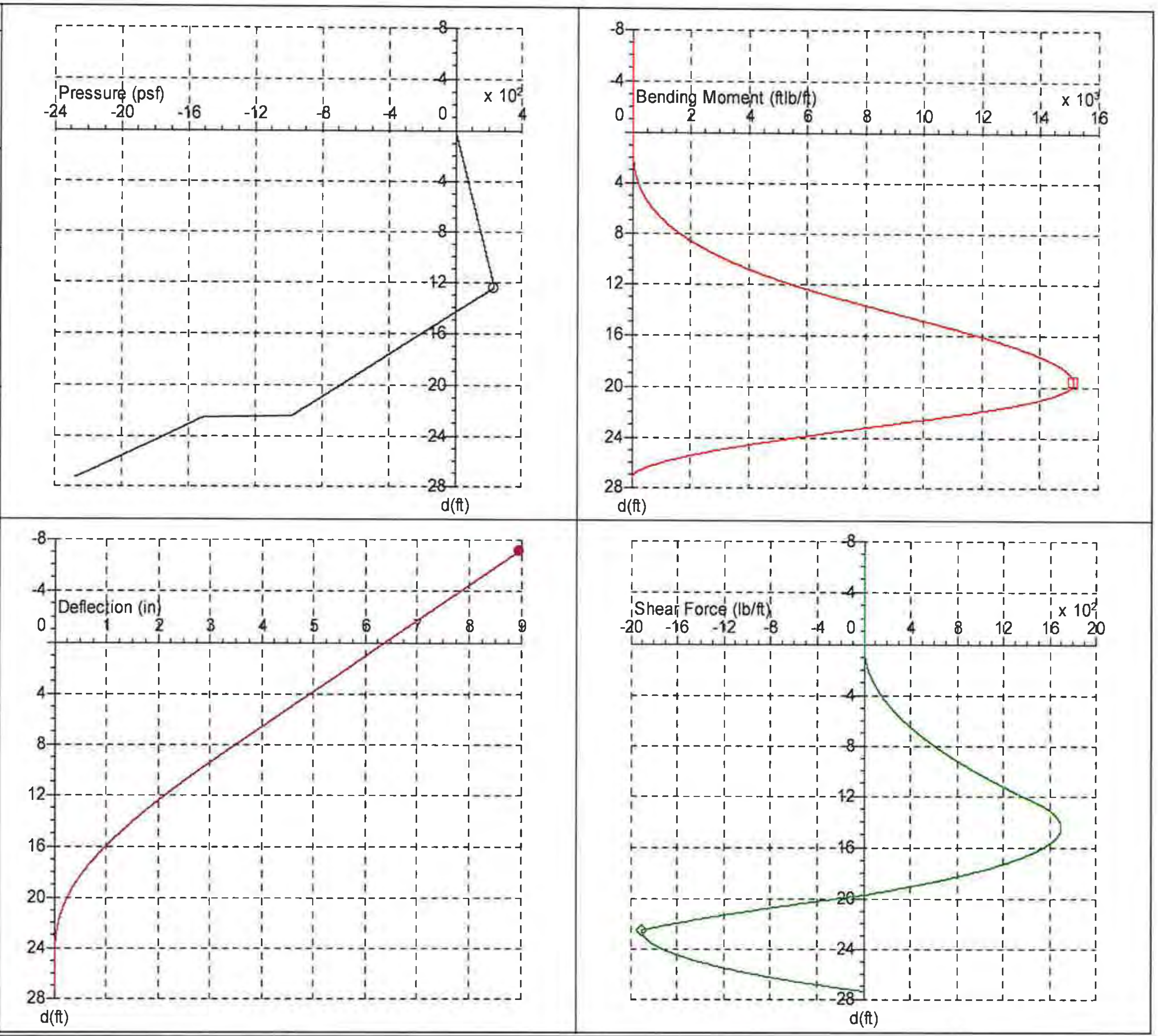
Client: GPI

Title: Gowanus Superfund Union Street, Case I, Dredge in Canal, Fender System left as is
Page: 3
Date: 6.20.19

Sheet: timber section
Pressure: Rankine
FOS: 1.0 (K_p÷1.3)
Toe: Cantilever

	Maximum	d (ft)
○	235.7 psf	12.45
□	15186.2 ftlb/ft	19.67
◇	1904.1 lb/ft	22.46
●	9.0 in	-7.15

The timber section sized represent net sizes w/o losses assumed.



Your Company Name

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Client: GPI

Title: Gowanus Superfund Union
Street, Case I, Dredge in Canal,
Fender System left as is
Page: 4
Date: 6.20.19

Sheet: timber section
Pressure: Rankine
FOS: 1.0 ($K_p \div 1.3$)
Toe: Cantilever

The timber section sized represent net sizes w/o losses assumed.

depth (ft)	P (psf)	M (ftlb/ft)	D (in)	F (lb/ft)
0.00	0.0	0.0	6.4	0.0
0.24	5.0	0.1	6.3	0.7
0.48	9.4	0.4	6.2	2.5
0.73	14.3	1.3	6.1	5.6
0.97	18.6	3.0	6.0	9.4
1.21	23.0	5.6	5.9	14.3
1.45	27.9	10.1	5.8	20.9
1.69	32.3	15.5	5.8	27.9
1.94	37.2	23.8	5.7	37.0
2.18	41.5	33.1	5.6	46.1
2.42	45.9	44.7	5.5	56.2
2.66	50.8	60.6	5.4	68.8
2.90	55.1	77.6	5.3	81.0
3.15	60.0	100.2	5.2	96.0
3.39	64.4	123.6	5.2	110.4
3.63	69.3	154.0	5.1	127.7
3.87	73.6	185.0	5.0	144.2
4.11	78.0	219.8	4.9	161.7
4.36	82.9	263.9	4.8	182.6
4.60	87.2	307.7	4.7	202.2
4.84	92.1	362.5	4.6	225.5
5.08	96.5	416.4	4.5	247.3
5.33	100.9	475.3	4.5	270.0
5.57	105.8	548.0	4.4	296.8
5.81	110.1	618.6	4.3	321.7
6.05	115.0	704.9	4.2	350.9
6.29	119.4	788.1	4.1	378.0
6.54	124.3	889.2	4.0	409.5
6.78	128.6	986.0	3.9	438.7
7.02	133.0	1089.6	3.9	468.8
7.26	137.9	1214.6	3.8	504.0
7.50	142.2	1333.3	3.7	536.2
7.75	147.1	1475.9	3.6	573.8
7.99	151.5	1611.0	3.5	608.2
8.23	155.9	1753.9	3.4	643.6
8.47	160.8	1924.7	3.3	684.6
8.71	165.1	2085.4	3.3	722.2
8.96	170.0	2276.6	3.2	765.6
9.20	174.4	2456.2	3.1	805.3
9.44	179.3	2669.1	3.0	851.1
9.68	183.6	2868.5	2.9	892.9
9.92	188.0	3077.5	2.8	935.7
10.17	192.9	3324.5	2.7	985.0
10.41	197.2	3554.9	2.7	1030.0
10.65	202.1	3826.5	2.6	1081.7
10.89	206.5	4079.2	2.5	1128.8
11.13	210.8	4342.9	2.4	1176.8
11.38	215.7	4652.8	2.3	1232.1
11.62	220.1	4940.3	2.3	1282.3
11.86	225.0	5277.7	2.2	1339.9
12.10	229.4	5590.2	2.1	1392.3
12.34	234.3	5956.3	2.0	1452.3
12.59	217.0	6294.7	1.9	1504.9
12.83	189.0	6644.5	1.9	1551.2
13.07	157.5	7050.0	1.8	1595.6
13.31	129.5	7419.3	1.7	1628.2
13.55	98.0	7842.8	1.6	1657.2
13.80	70.0	8224.8	1.6	1676.1
14.04	38.5	8658.9	1.5	1689.7
14.28	10.5	9047.0	1.4	1694.9
14.52	-17.5	9435.7	1.4	1694.1
14.77	-49.0	9872.0	1.3	1685.9
15.01	-77.0	10257.3	1.2	1671.9
15.25	-108.5	10686.1	1.2	1648.3
15.49	-136.5	11061.4	1.1	1620.5
15.73	-164.5	11429.7	1.0	1586.3
15.98	-196.0	11833.8	1.0	1540.1
16.22	-224.0	12182.3	0.9	1492.3
16.46	-255.5	12560.4	0.9	1430.7
16.70	-283.5	12882.4	0.8	1369.1
16.94	-315.0	13227.0	0.8	1292.1
17.19	-343.0	13515.8	0.7	1216.8
17.43	-370.9	13786.8	0.7	1135.1
17.67	-402.4	14068.4	0.6	1035.5
17.91	-430.4	14296.4	0.6	940.1
18.15	-461.9	14525.9	0.5	825.1
18.40	-489.9	14704.3	0.5	716.1
18.64	-517.9	14857.0	0.4	600.5
18.88	-549.4	14996.4	0.4	462.9
19.12	-577.4	15089.7	0.4	333.7
19.36	-608.9	15158.4	0.3	180.6
19.61	-636.9	15185.6	0.3	37.8
19.85	-668.4	15161.5	0.3	-169.1
20.09	-696.4	15064.2	0.2	-356.3
20.33	-724.4	14895.7	0.2	-537.1
20.57	-755.9	14623.9	0.2	-732.8
20.82	-783.9	14312.0	0.2	-899.9
21.06	-815.4	13885.4	0.1	-1080.2
21.30	-843.4	13441.5	0.1	-1233.6
21.54	-871.4	12939.5	0.1	-1380.5
21.78	-902.9	12308.1	0.1	-1538.2
22.03	-930.9	11690.5	0.1	-1671.5
22.27	-962.4	10935.6	0.1	-1813.7
22.51	-1503.1	10214.5	0.1	-1903.8
22.75	-1549.1	9387.5	0.0	-1895.3
22.99	-1586.0	8657.1	0.0	-1878.8
23.24	-1622.8	7934.5	0.0	-1853.8
23.48	-1664.3	7135.1	0.0	-1815.6
23.72	-1701.1	6440.0	0.0	-1772.6
23.96	-1742.5	5679.8	0.0	-1714.1
24.20	-1779.4	5027.0	0.0	-1653.1
24.45	-1816.2	4399.2	0.0	-1583.6
24.69	-1857.7	3727.0	0.0	-1495.3
24.93	-1894.5	3163.3	0.0	-1407.8
25.17	-1935.9	2571.4	0.0	-1299.3
25.42	-1972.8	2086.6	0.0	-1193.8
25.66	-2014.2	1591.8	0.0	-1065.0
25.90	-2051.1	1200.6	0.0	-941.5
26.14	-2087.9	858.6	0.0	-809.5
26.38	-2129.3	536.7	0.0	-650.9
26.63	-2166.2	310.1	0.0	-500.9
26.87	-2207.6	126.4	0.0	-322.1
27.11	-2244.5	30.0	0.0	-154.1
27.35	-2281.3	0.0	0.0	0.0

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Union Street Timber Fender Analysis-Case I

Notes & References:

1. *Manual for Bridge Evaluation, 3rd Edition:*
2. *AASHTO Standard Specifications; 17th Ed..*
3. *The design method is: Allowable Stress Method.*

Design of Timber Sheeting:

Properties of Timber Sheeting:

Reference: AASHTO Std. Specs. 17th Ed.
Article 8.4.1.1.2

$d_{nominal} := 10in$ Nominal Depth of Sheeting from As-Builts

$w_{Nominal} := 12in$ Nominal Width of Sheeing from As-Builts

$d_{net} := d_{nominal} - .75in = 9.25 \cdot in$ Net Depth used in Calculations

$w_{net} := w_{Nominal} - .75in = 11.25 \cdot in$ Net Width used in Calculations

$S_x := \frac{1}{6} \cdot w_{net} \cdot d_{net}^{\,2} = 160.43 \cdot in^3$ Section Modulus

$A_x := d_{net} \cdot w_{net} = 104.062 \cdot in^2$ Section Area

$I_x := \frac{1}{12} \cdot w_{net} \cdot d_{net}^{\,3} = 741.987 \cdot in^4$ Moment of Inertia

$I_{xperFootWidth} := I_x \cdot 12 \frac{in}{w_{net}} = 791.453 \cdot in^4$ Moment of Inertia per foot width to be used in SPW-911 Program

Unfactored Allowable Stresses:

Reference: AASHTO Std. Specs. 17th Ed.
Table 10.32.1A

WOOD SPECIES: Southern Pine No.2 is used per Ref.1 6-86

$F_b := 850psi$ Allowable Bending Stress w/o factors

$F_{cp} := 375psi$ Allowable Compression Stress perpendicular to grain w/o factors

$F_v := 100psi$ Allowable Shear Stress Parallel to grain w/o factors

$E := 1200ksi$ Modulus of Elasticity

Adjustment Factors for Allowable Stresses:

$C_m := 0.8$ Wet Service Factor Ref 2; Article 13.5.5.1

$C_D := 0.9$ Load Duration Factor. Article 13.5.5.2

$C_F := 1$ Bending Size Factor. Ref 2; Article 13.6.4.2

$C_V := 1$ Volume Factor for Glue Laminated - N.A.

$C_L := 1$ Beam Stability Factor Ref 2; Article 13.6.6.4

$C_f := 1.1$ Form Factor. Ref 2; Article 13.6.4.5

$C_{fu} := 1$ Flat Use Factor Ref 2; Article 13.5.1A & 13.5.1B

$C_r := 1$ Bending Size Factor. Ref 2; Article 13.5.1A

Factored Allowable Stresses:

$F_{b.allow} := F_b \cdot C_m \cdot C_D \cdot C_F \cdot C_V \cdot C_L \cdot C_f \cdot C_{fu} \cdot C_r$ $F_{b.allow} = 673.2 \cdot psi$ Adjusted Allowable Bending Stress; Ref 2; Article 13.6.4.1; (13-2)

$F_{v.allow} := F_v \cdot C_m \cdot C_D = 72 \cdot psi$ $F_{v.allow} = 72 \cdot psi$ Adjusted Allowable Shear Stress; Ref 2; Article 13.6.5.3; (13-11)

$F_{cp.allow} := F_{cp} \cdot C_m \cdot C_D = 270 \cdot psi$ $F_{cp.allow} = 270 \cdot psi$ Adjusted Allowable Compressive Stress; Ref 2; Article 13.6.6.2; (13-12)

$E_{allowed} := E \cdot C_m = 9.6 \times 10^5 \cdot psi$ $E_{allowed} = 9.6 \times 10^5 \cdot psi$ Adjusted Modulus of Elasticity to be used in SPW-911 Program

DESIGN CASE II

Design Case II:

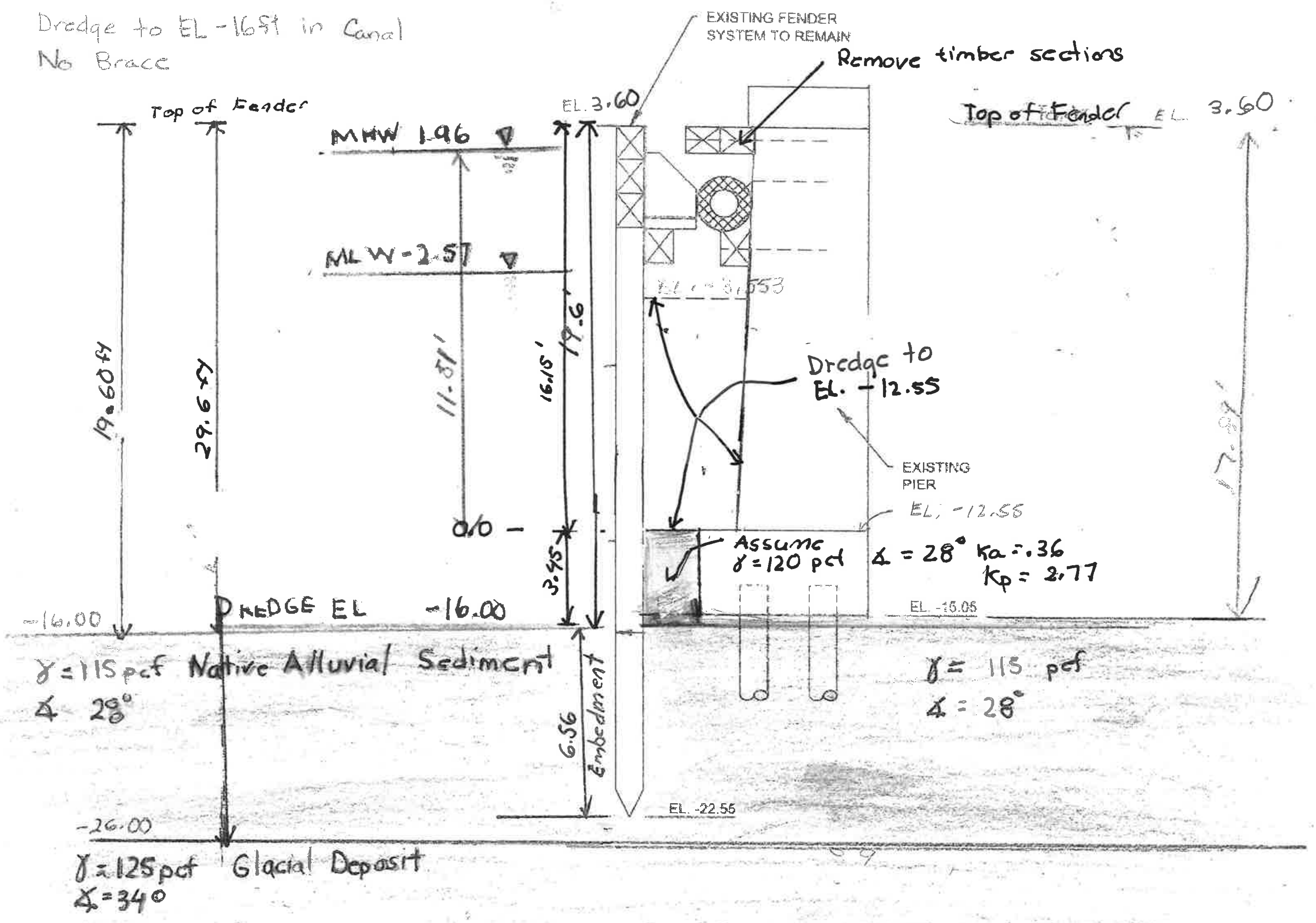
This case represents the base system except as a remedial measure, the fill behind the fender system will be dredged to an elevation of -12.55 feet. This will result in a decreased active pressure thus decreased embedment depth.

Results-Case II

The analysis revealed a required embedment depth of 4.22 feet, which is less than the 6.56 feet embedment depth exhibited with this case. The timber section capacity was checked assuming a 20 percent loss and the section was found adequate.

CASE II

Dredge to EL -16ft in Canal
No Brace



Client: GPI

Title: Gowanus Superfund Union Street, Case II, Dredge in Canal, Dredge behind fender

Page: 1

Date: 6.20.19

Sheet: timber section

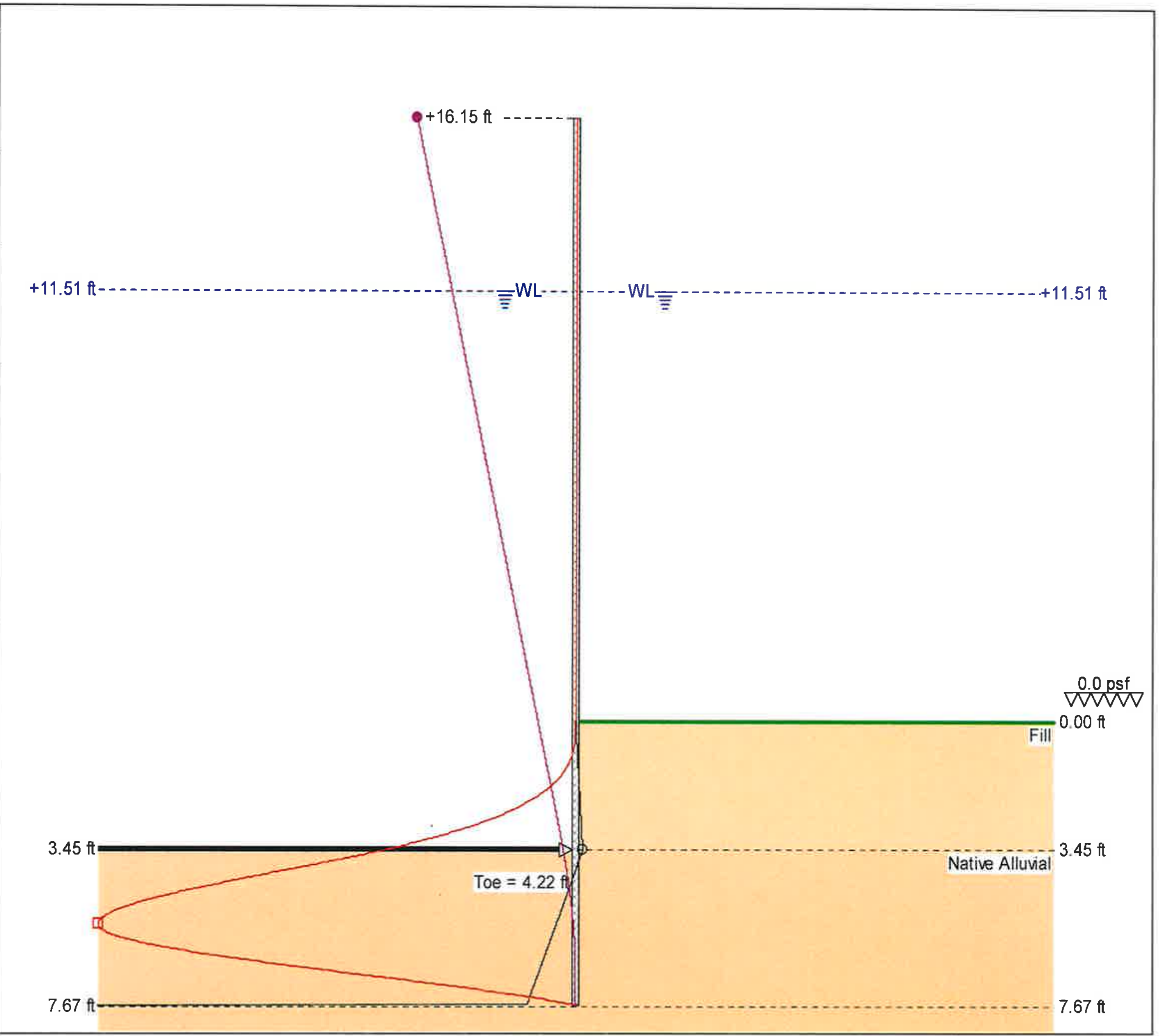
Pressure: Rankine

FOS: 1.0 ($K_p \div 1.3$)

Toe: Cantilever

	Maximum	d (ft)
○	65.3 psf	3.45
☐	323.5 ftlb/ft	5.45
●	0.0 in	-16.15

The timber section sized represent net sizes w/o losses assumed.



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Client: GPI

Title: Gowanus Superfund Union Street, Case II, Dredge in Canal, Dredge behind fender
Page: 2
Date: 6.20.19

Sheet: timber section
Pressure: Rankine
FOS: 1.0 (K_p÷1.3)
Toe: Cantilever

The timber section sized represent net sizes w/o losses assumed.

Input Data

Depth Of Excavation = 3.45 ft
Surcharge = 0.0 psf
Depth Of Active Water = +11.51 ft
Depth Of Passive Water = +11.51 ft
Water Density = 62.43 pcf
Minimum Fluid Density = 31.82 pcf

Soil Profile

Depth (ft)	Soil Name	γ (pcf)	γ' (pcf)	C (psf)	C_a (psf)	ϕ(°)	δ(°)	K_a	K_{ac}	K_p	K_{pc}
0.00	Fill	120.00	52.60	0.0	0.0	28.0	0.0	0.36	0.00	2.77 (2.13)	0.00 (0.00)
3.45	Native Alluvial	115.00	68.73	0.0	0.0	28.0	0.0	0.36	0.00	2.77 (2.13)	0.00 (0.00)
22.45	glacial deposit	125.00	65.55	0.0	0.0	34.0	0.0	0.28	0.00	3.54 (2.72)	0.00 (0.00)
40.00	Dense Coarse Sand	125.00	68.73	0.0	0.0	34.0	0.0	0.28	0.00	2.54 (1.95)	0.00 (0.00)

( ) indicates factored value used in calculations. Factor(s): K_p÷1.3

Solution

Sheet

Sheet Name	I (in⁴/ft)	E (psi)	Z (in³/ft)	f (psi)	Maximum Bending Moment (ftlb/ft)	Upstand (ft)	Toe (ft)	Pile Length (ft)
timber section	791.45	9.6E+05	171.25	680.0	9704.2	16.15	4.22	23.82

Maxima

	Maximum	Depth
Bending Moment	323.5 ftlb/ft	5.45 ft
Deflection	0.0 in	-16.15 ft
Pressure	65.3 psf	3.45 ft
Shear Force	130.3 lb/ft	3.98 ft

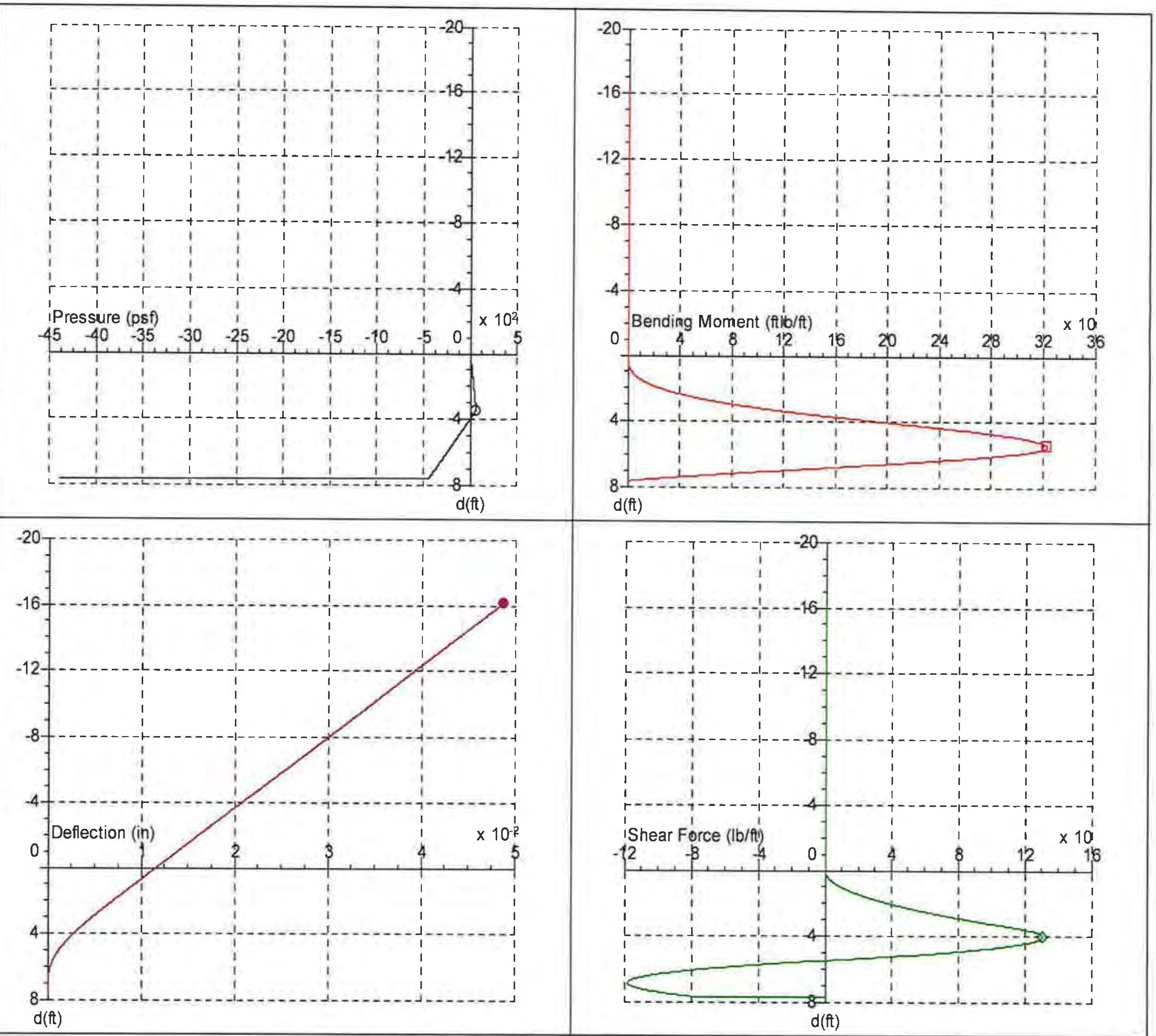
Client: GPI

Title: Gowanus Superfund Union
Street, Case II, Dredge in Canal,
Dredge behind fender
Page: 3
Date: 6.20.19

Sheet: timber section
Pressure: Rankine
FOS: 1.0 (K_p÷1.3)
Toe: Cantilever

Maximum		d (ft)
○	65.3 psf	3.45
□	323.5 ftlb/ft	5.45
◇	130.3 lb/ft	3.98
●	0.0 in	-16.15

The timber section sized represent net sizes w/o losses assumed.



Your Company Name

SPW911, v2.40

Client: GPI

Title: Gowanus Superfund Union Street, Case II, Dredge in Canal, Dredge behind fender
Page: 4
Date: 6.20.19

Sheet: timber section
Pressure: Rankine
FOS: 1.0 (K_p÷1.3)
Toe: Cantilever

The timber section sized represent net sizes w/o losses assumed.

depth (ft)	P (psf)	M (ftlb/ft)	D (in)	F (lb/ft)
0.00	0.0	0.0	0.0	0.0
0.07	1.3	0.0	0.0	0.1
0.14	2.8	0.0	0.0	0.2
0.20	4.0	0.0	0.0	0.5
0.27	5.5	0.1	0.0	0.8
0.34	6.6	0.1	0.0	1.2
0.41	7.7	0.2	0.0	1.7
0.48	9.2	0.4	0.0	2.3
0.54	10.4	0.5	0.0	2.9
0.61	11.9	0.8	0.0	3.8
0.68	13.0	1.0	0.0	4.6
0.75	14.5	1.4	0.0	5.7
0.82	15.6	1.8	0.0	6.6
0.88	16.8	2.2	0.0	7.6
0.95	18.3	2.8	0.0	9.0
1.02	19.4	3.4	0.0	10.1
1.09	20.9	4.2	0.0	11.7
1.15	22.0	4.9	0.0	13.0
1.22	23.5	6.0	0.0	14.8
1.29	24.7	6.9	0.0	16.3
1.36	25.8	7.9	0.0	17.8
1.43	27.3	9.4	0.0	19.9
1.49	28.4	10.6	0.0	21.6
1.56	29.9	12.3	0.0	23.9
1.63	31.0	13.8	0.0	25.7
1.70	32.2	15.4	0.0	27.6
1.77	33.7	17.6	0.0	30.3
1.83	34.8	19.4	0.0	32.3
1.90	36.3	22.1	0.0	35.2
1.97	37.4	24.2	0.0	37.4
2.04	38.9	27.2	0.0	40.4
2.11	40.1	29.7	0.0	42.8
2.17	41.2	32.2	0.0	45.2
2.24	42.7	35.9	0.0	48.6
2.31	43.8	38.8	0.0	51.1
2.38	45.3	43.0	0.0	54.7
2.45	46.5	46.3	0.0	57.4
2.51	48.0	50.9	0.0	61.2
2.58	49.1	54.6	0.0	64.1
2.65	50.2	58.4	0.0	67.1
2.72	51.7	63.8	0.0	71.1
2.78	52.8	68.1	0.0	74.3
2.85	54.4	74.1	0.0	78.5
2.92	55.5	78.8	0.0	81.8
2.99	56.6	83.7	0.0	85.2
3.06	58.1	90.5	0.0	89.7
3.12	59.2	95.9	0.0	93.2
3.19	60.7	103.4	0.0	98.0
3.26	61.9	109.3	0.0	101.7
3.33	63.4	117.4	0.0	106.7
3.40	64.5	123.8	0.0	110.5
3.46	65.3	130.4	0.0	114.4
3.53	53.7	139.6	0.0	119.0
3.60	46.5	146.7	0.0	121.9
3.67	36.8	156.4	0.0	125.1
3.74	29.6	163.8	0.0	127.0
3.80	19.9	173.9	0.0	128.9
3.87	12.6	181.5	0.0	129.8
3.94	5.4	189.2	0.0	130.2
4.01	-4.3	199.5	0.0	130.2
4.08	-11.5	207.2	0.0	129.8
4.14	-21.2	217.4	0.0	128.6
4.21	-28.4	225.0	0.0	127.2
4.28	-35.7	232.5	0.0	125.4
4.35	-45.3	242.3	0.0	122.3
4.41	-52.6	249.4	0.0	119.4
4.48	-62.3	258.7	0.0	115.0
4.55	-69.5	265.4	0.0	111.1
4.62	-79.2	274.0	0.0	105.3
4.69	-86.4	280.2	0.0	100.4
4.75	-93.7	286.0	0.0	95.2
4.82	-103.3	293.3	0.0	87.4
4.89	-110.6	298.3	0.0	81.1
4.96	-120.3	304.5	0.0	72.1
5.03	-127.5	308.6	0.0	64.7
5.09	-137.2	313.4	0.0	54.3
5.16	-144.4	316.4	0.0	46.0
5.23	-151.7	319.0	0.0	37.3
5.30	-161.3	321.6	0.0	24.9
5.37	-168.6	322.8	0.0	15.2
5.43	-178.2	323.5	0.0	0.0
5.50	-185.5	323.2	0.0	-9.9
5.57	-192.7	321.9	0.0	-19.3
5.64	-202.4	318.7	0.0	-31.3
5.71	-209.7	315.3	0.0	-39.7
5.77	-219.3	309.5	0.0	-50.3
5.84	-226.6	304.3	0.0	-57.7
5.91	-236.2	296.2	0.0	-67.0
5.98	-243.5	289.3	0.0	-73.4
6.04	-250.7	281.8	0.0	-79.4
6.11	-260.4	270.9	0.0	-86.7
6.18	-267.7	262.1	0.0	-91.7
6.25	-277.3	249.6	0.0	-97.7
6.32	-284.6	239.8	0.0	-101.7
6.38	-294.2	226.1	0.0	-106.3
6.45	-301.5	215.4	0.0	-109.3
6.52	-308.7	204.5	0.0	-111.9
6.59	-318.4	189.5	0.0	-114.6
6.66	-325.6	178.1	0.0	-116.1
6.72	-335.3	162.6	0.0	-117.5
6.79	-342.6	150.9	0.0	-118.0
6.86	-349.8	139.2	0.0	-118.1
6.93	-359.5	123.5	0.0	-117.6
7.00	-366.7	111.9	0.0	-116.7
7.06	-376.4	96.5	0.0	-114.8
7.13	-383.6	85.2	0.0	-112.9
7.20	-393.3	70.4	0.0	-109.6
7.27	-400.6	59.6	0.0	-106.7
7.34	-407.8	49.1	0.0	-103.4
7.40	-417.5	35.6	0.0	-98.2
7.47	-424.7	26.0	0.0	-93.8
7.54	-434.4	13.9	0.0	-87.3
7.61	-441.6	5.4	0.0	-82.0
7.67	-4383.1	0.0	0.0	0.0

Your Company Name

SPW911, v2.40

Union Street Timber Fender Analysis-Case II

Notes & References:

1. *Manual for Bridge Evaluation, 3rd Edition:*
2. *AASHTO Standard Specifications; 17th Ed..*
3. *The design method is: Allowable Stress Method.*

Design of Timber Sheeting:

Properties of Timber Sheeting:

Reference: AASHTO Std. Specs. 17th Ed.
Article 8.4.1.1.2

$d_{nominal} := 10in$ Nominal Depth of Sheeting from As-Builts

$w_{Nominal} := 12in$ Nominal Width of Sheeing from As-Builts

$d_{net} := d_{nominal} - .75in = 9.25 \cdot in$ Net Depth used in Calculations

$w_{net} := w_{Nominal} - .75in = 11.25 \cdot in$ Net Width used in Calculations

$S_x := \frac{1}{6} \cdot w_{net} \cdot d_{net}^2 = 160.43 \cdot in^3$ Section Modulus

$S_{xperfootwidth} := S_x \cdot \frac{12in}{w_{net}} = 171.125 \cdot in^3$ Section Modulus per foot width used in SPW-911 Program

$A_x := d_{net} \cdot w_{net} = 104.062 \cdot in^2$ Section Area

$I_x := \frac{1}{12} \cdot w_{net} \cdot d_{net}^3 = 741.987 \cdot in^4$ Moment of Inertia

$I_{xperFootWidth} := I_x \cdot 12 \frac{in}{w_{net}} = 791.453 \cdot in^4$ Moment of Inertia per foot width to be used in SPW-911 Program

Unfactored Allowable Stresses:

Reference: AASHTO Std. Specs. 17th Ed.
Table 10.32.1A

WOOD SPECIES: Southern Pine No.2 is used per Ref.1 6-86

$F_b := 850\text{psi}$	Allowable Bending Stress w/o factors
$F_v := 100\text{psi}$	Allowable Shear Stress Parallel to grain w/o factors
$E := 1200\text{ksi}$	Modulus of Elasticity

Adjustment Factors for Allowable Stresses:

$C_m := 0.8$	Wet Service Factor Ref 2; Article 13.5.5.1
$C_D := 0.9$	Load Duration Factor. Article 13.5.5.2
$C_F := 1$	Bending Size Factor. Ref 2; Article 13.6.4.2
$C_V := 1$	Volume Factor for Glue Laminated - N.A.
$C_L := 1$	Beam Stability Factor Ref 2; Article 13.6.6.4
$C_f := 1.1$	Form Factor. Ref 2; Article 13.6.4.5
$C_{fu} := 1$	Flat Use Factor Ref 2; Article 13.5.1A & 13.5.1B
$C_r := 1$	Bending Size Factor. Ref 2; Article 13.5.1A

Factored Allowable Stresses:

$F_{b.allow} := F_b \cdot C_m \cdot C_D \cdot C_F \cdot C_V \cdot C_L \cdot C_f \cdot C_{fu} \cdot C_r$ $F_{b.allow} = 673.2 \cdot psi$ Adjusted Allowable Bending Stress; Ref 2; Article 13.6.4.1; (13-2)

$F_{v.allow} := F_v \cdot C_m \cdot C_D = 72 \cdot psi$ $F_{v.allow} = 72 \cdot psi$ Adjusted Allowable Shear Stress; Ref 2; Article 13.6.5.3; (13-11)

$E_{allowed} := E \cdot C_m = 9.6 \times 10^5 \cdot psi$ $E_{allowed} = 9.6 \times 10^5 \cdot psi$ Adjusted Modulus of Elasticity to be used in SPW-911 Program

Design Forces for Timber Sheeting:

$M_{max} := .400 \cdot kip \cdot ft$ Design Moment per unit length(rounded)

$V_{max} := 1 \cdot kip$ Design Shear per unit length(rounded)

Case 2 : Temporary Wale and Anchor Added

Check of Flexural Bending: 20% loss assumed

$$M_{board} := M_{max} \cdot \frac{w_{net}}{12 \cdot in} = 0.375 \cdot kip \cdot ft$$

Actual Moment per board width

$$f_{b.board} := \frac{M_{board}}{\frac{S_x}{1.20}} = 33.66 \cdot psi$$

Actual Bending Stress in Timber Lagging

$$Flexure_{check} := \left(\begin{array}{|ll} \text{"OK"} & \text{if } f_{b.board} \le F_{b.allow} \\ \text{"FAILS"} & \text{otherwise} \end{array} \right)$$

$Flexure_{check} = \text{"OK"}$

Check of Shear:20% loss assumed

$$V_{board} := V_{max} \cdot \frac{w_{net}}{12 \cdot in} = 0.938 \cdot kip$$

Actual Shear per board width

$$f_{v.board} := \frac{3 \cdot V_{board}}{2 \cdot \frac{A_x}{1.20}} = 16.216 \cdot psi$$

Actual Shear Stress in Timber Lagging

$$Shear_{check} := \left(\begin{array}{|ll} \text{"OK"} & \text{if } f_{v.board} \le F_{v.allow} \\ \text{"FAILS"} & \text{otherwise} \end{array} \right)$$

$Shear_{check} = \text{"OK"}$

DESIGN CASE III

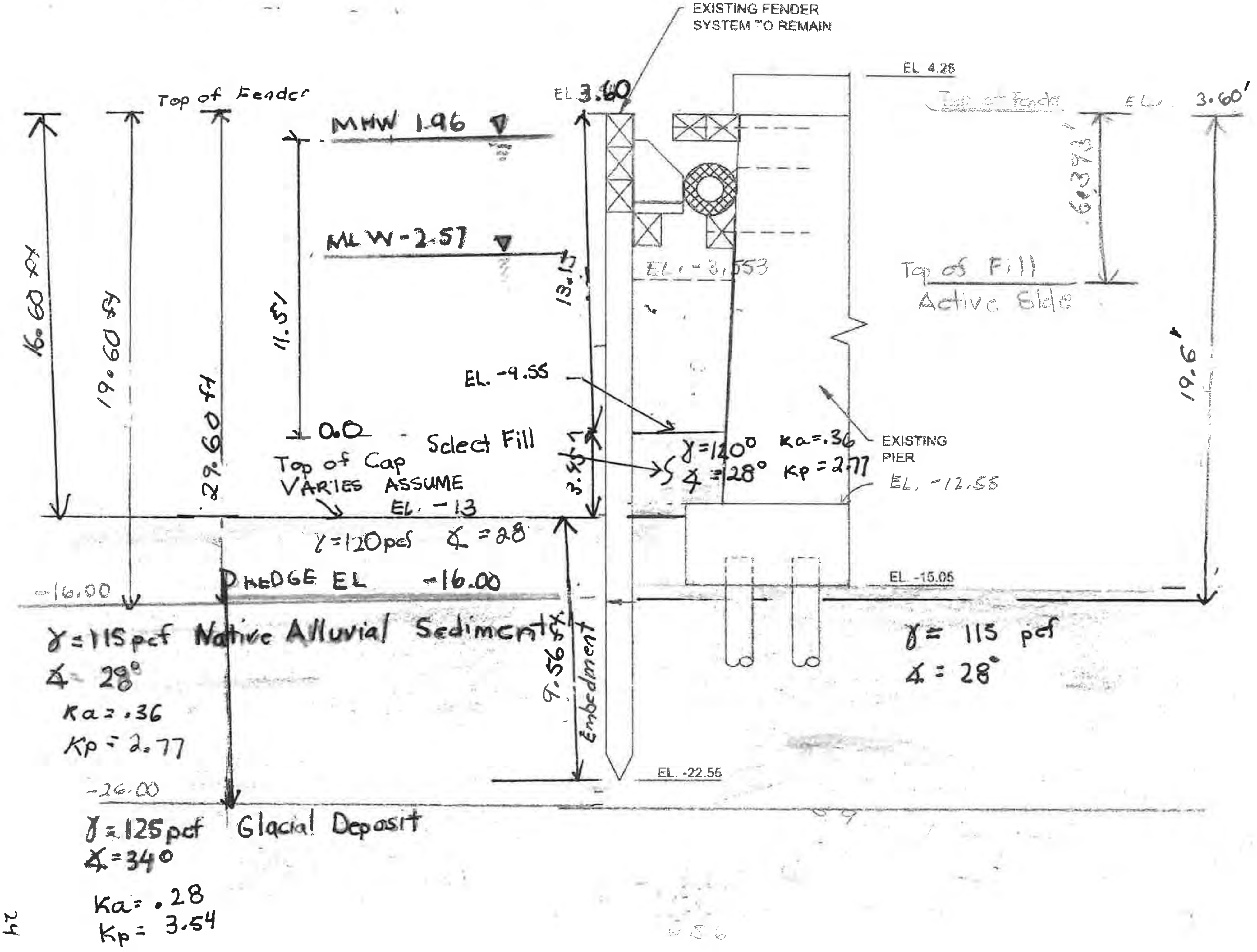
Design Case III:

This case represents the final condition. The cap will be added to the canal. An elevation of -16.0 is assumed. Fill will be added back behind the fender system to an elevation -9.55 feet .

Results-Case III

20% loss of timber section was assumed within this Mathcad sheet.. The section capacity of the timber was adequate as well as the required embedment of 4.95 feet which is less than the 9.56 provided.

CASE III


EXISTING FENDER SYSTEM TO REMAIN
EL 3.60
Top of Fender
MHW 1.96
MLW -2.57
0.0
Top of Cap VARIES ASSUME EL. -13
Select Fill
EL. -9.55
16.60 ft
19.60 ft
29.60 ft
11.57
13.15
3.45
EL. -8.553
γ=120° Ka=.36
∡=28° Kp=2.77
EXISTING PIER
EL. -12.55
EL. 4.28
Top of Fender
EL. 3.60'
6.373'
Top of Fill
Active Side
19.6'
γ=120pcf ∡=28
DREDGE EL -16.00
-16.00
EL. -15.05
γ=115pcf Native Alluvial Sediments
∡=28°
Ka=.36
Kp=2.77
9.56 ft
Embedment
γ= 115 pcf
∡= 28°
EL. -22.55
-26.00
γ=125pcf Glacial Deposit
∡=34°
Ka=.28
Kp=3.54

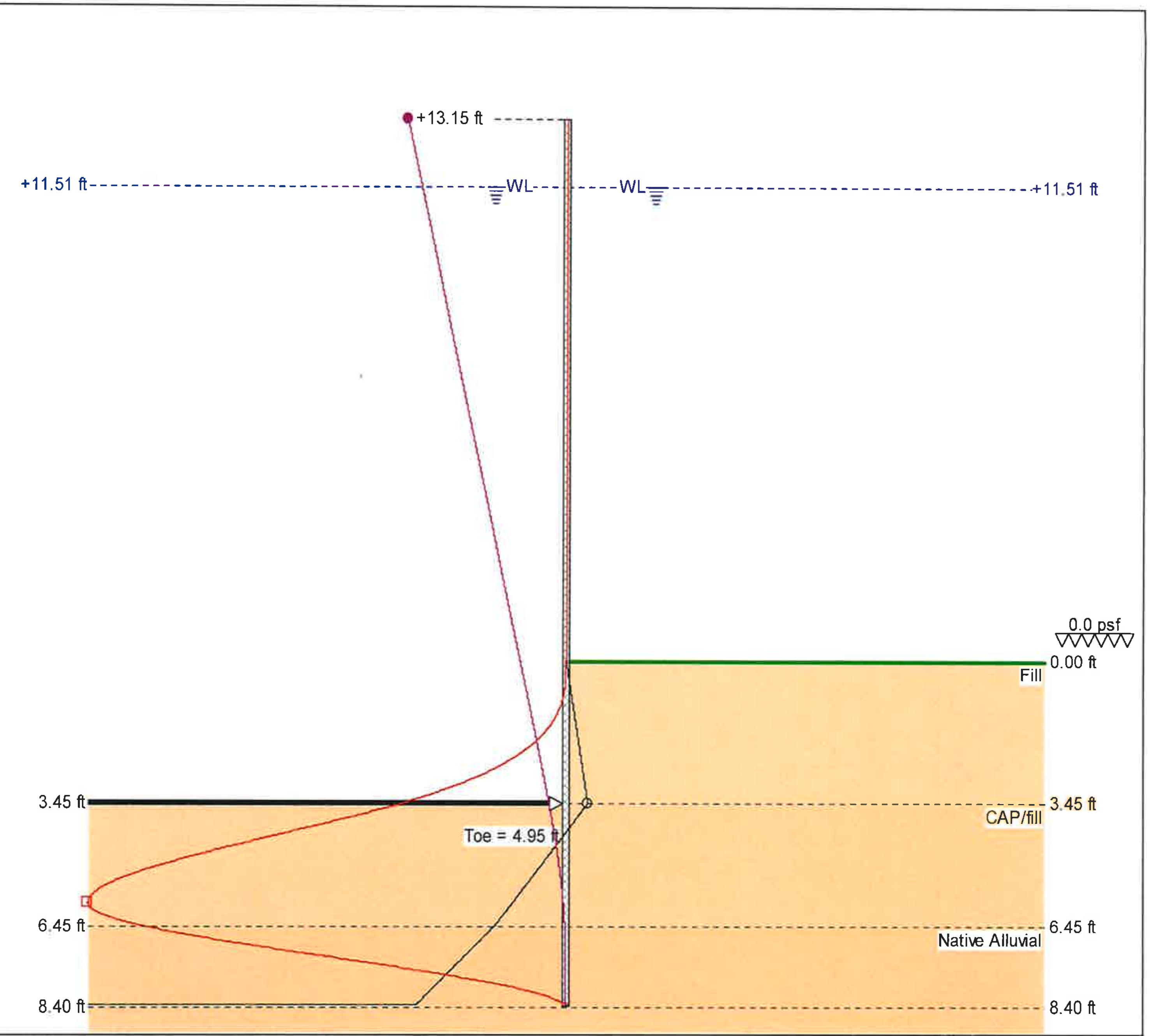
Client: GPI

Title: Gowanus Superfund Union
Street, Case III,add fill behind
fender, Dredge in Canal
Page: 1
Date: 6.20.19

Sheet: timber section
Pressure: Rankine
FOS: 1.0 $(K_p \div 1.3)$
Toe: Cantilever

	Maximum	d (ft)
○	65.3 psf	3.45
□	373.8 ftlb/ft	5.87
●	0.1 in	-13.15

The timber section sized represent net sizes w/o losses assumed. Assumed Losses checked in MathCad Calculations.



Your Company Name

SPW911, v2.40

Client: GPI

Title: Gowanus Superfund Union Street, Case III,add fill behind fender, Dredge in Canal
Page: 2
Date: 6.20.19

Sheet: timber section
Pressure: Rankine
FOS: 1.0 (K_p÷1.3)
Toe: Cantilever

The timber section sized represent net sizes w/o losses assumed. Assumed Losses checked in MathCad Calculations.

Input Data

Depth Of Excavation = 3.45 ft
Surcharge = 0.0 psf

Depth Of Active Water = +11.51 ft
Depth Of Passive Water = +11.51 ft

Water Density = 62.43 pcf
Minimum Fluid Density = 31.82 pcf

Soil Profile

Depth (ft)	Soil Name	γ (pcf)	γ' (pcf)	C (psf)	C_a (psf)	ϕ(°)	δ(°)	K_a	K_{ac}	K_p	K_{pc}
0.00	Fill	120.00	52.60	0.0	0.0	28.0	0.0	0.36	0.00	2.77 (2.13)	0.00 (0.00)
3.45	CAP/fill	120.00	52.60	0.0	0.0	28.0	0.0	0.36	0.00	2.77 (2.13)	0.00 (0.00)
6.45	Native Alluvial	120.00	68.73	0.0	0.0	28.0	0.0	0.36	0.00	2.77 (2.13)	0.00 (0.00)
16.45	glacial deposit	125.00	65.55	0.0	0.0	34.0	0.0	0.28	0.00	3.54 (2.72)	0.00 (0.00)

( ) indicates factored value used in calculations. Factor(s): K_p÷1.3

Solution

Sheet

Sheet Name	I (in⁴/ft)	E (psi)	Z (in³/ft)	f (psi)	Maximum Bending Moment (ftlb/ft)	Upstand (ft)	Toe (ft)	Pile Length (ft)
timber section	791.45	9.6E+05	171.25	680.0	9704.2	13.15	4.95	21.55

Maxima

	Maximum	Depth
Bending Moment	373.8 ftlb/ft	5.87 ft
Deflection	0.1 in	-13.15 ft
Pressure	65.3 psf	3.45 ft
Shear Force	135.6 lb/ft	4.14 ft

Your Company Name

SPW911, v2.40

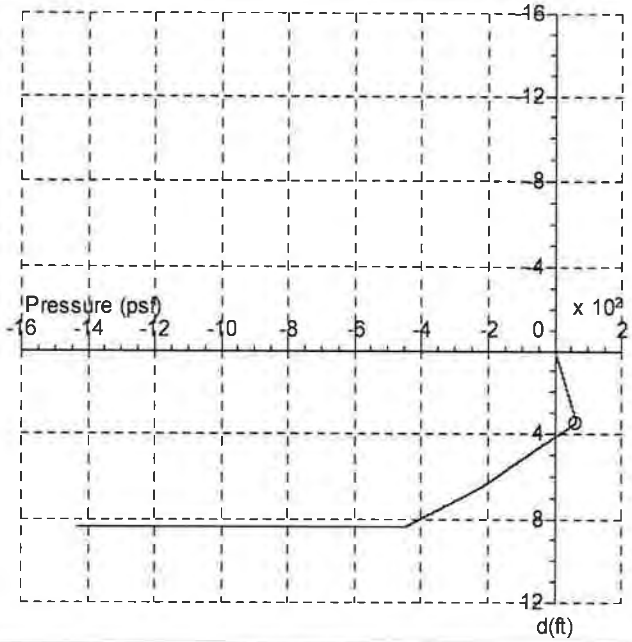
Client: GPI

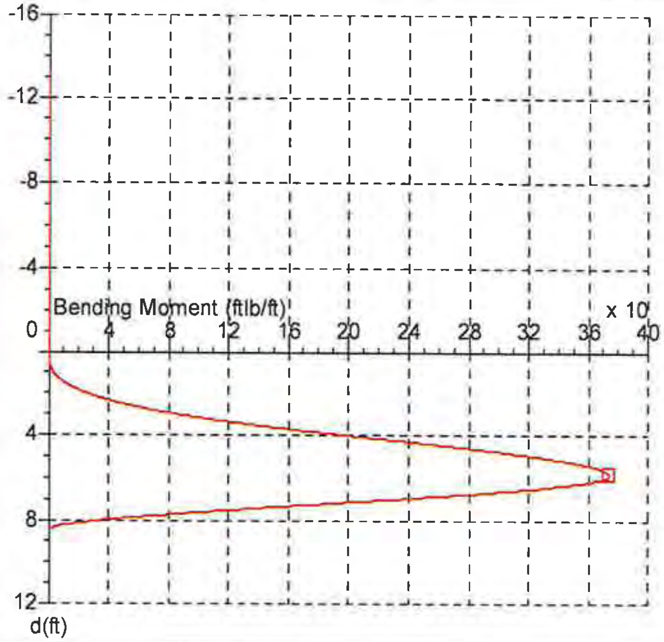
Title: Gowanus Superfund Union
Street, Case III,add fill behind
fender, Dredge in Canal
Page: 3
Date: 6.20.19

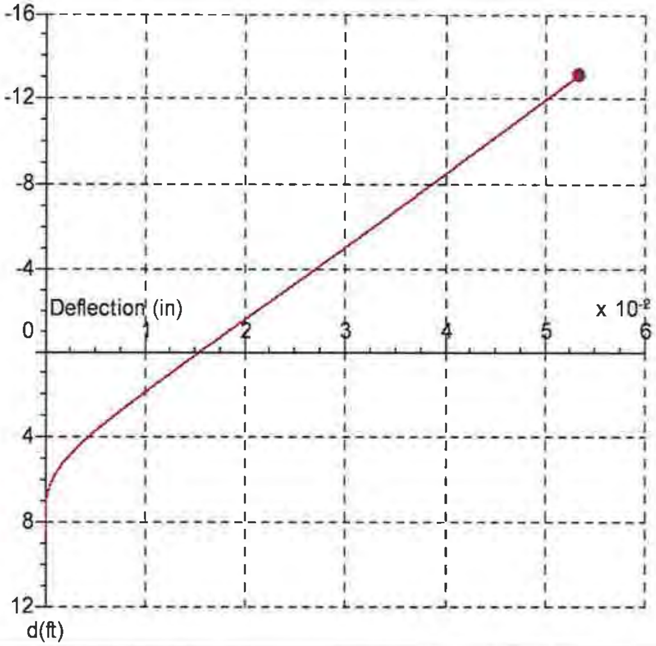
Sheet: timber section
Pressure: Rankine
FOS: 1.0 (K_p÷1.3)
Toe: Cantilever

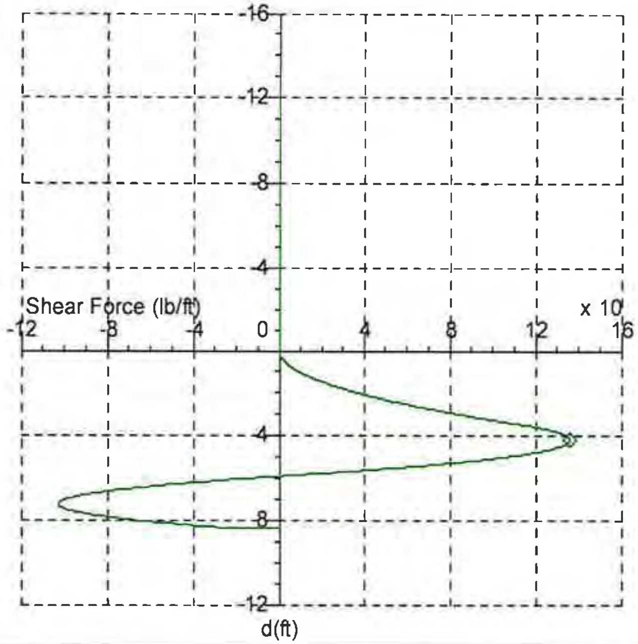
	Maximum	d (ft)
○	65.3 psf	3.45
□	373.8 ftlb/ft	5.87
◇	135.6 lb/ft	4.14
●	0.1 in	-13.15

The timber section sized represent net sizes w/o losses assumed. Assumed Losses checked in MathCad Calculations.









Your Company Name

SPW911, v2.40

Client: GPI

Title: Gowanus Superfund Union Street, Case III,add fill behind fender, Dredge in Canal
Page: 4
Date: 6.20.19

Sheet: timber section
Pressure: Rankine
FOS: 1.0 $(K_p \div 1.3)$
Toe: Cantilever

The timber section sized represent net sizes w/o losses assumed. Assumed Losses checked in MathCad Calculations.

depth (ft)	P (psf)	M (ftlb/ft)	D (in)	F (lb/ft)
0.00	0.0	0.0	0.0	0.0
0.07	1.6	0.0	0.0	0.1
0.15	3.0	0.0	0.0	0.3
0.22	4.3	0.0	0.0	0.5
0.30	5.7	0.1	0.0	0.9
0.37	7.1	0.2	0.0	1.4
0.45	8.8	0.3	0.0	2.1
0.52	10.1	0.5	0.0	2.8
0.59	11.5	0.7	0.0	3.6
0.67	12.8	1.0	0.0	4.5
0.74	14.2	1.3	0.0	5.5
0.82	15.6	1.7	0.0	6.5
0.89	16.9	2.2	0.0	7.7
0.97	18.6	3.0	0.0	9.3
1.04	20.0	3.7	0.0	10.7
1.12	21.3	4.5	0.0	12.2
1.19	22.7	5.4	0.0	13.8
1.26	24.1	6.4	0.0	15.5
1.34	25.4	7.6	0.0	17.3
1.41	26.8	8.9	0.0	19.2
1.49	28.5	10.7	0.0	21.7
1.56	29.9	12.3	0.0	23.8
1.64	31.2	14.0	0.0	26.0
1.71	32.6	16.0	0.0	28.3
1.78	33.9	18.0	0.0	30.7
1.86	35.3	20.3	0.0	33.2
1.93	36.7	22.7	0.0	35.8
2.01	38.0	25.4	0.0	38.5
2.08	39.7	28.9	0.0	42.0
2.16	41.1	32.0	0.0	44.9
2.23	42.4	35.3	0.0	47.9
2.30	43.8	38.8	0.0	51.0
2.38	45.2	42.5	0.0	54.2
2.45	46.5	46.5	0.0	57.5
2.53	47.9	50.7	0.0	60.9
2.60	49.6	56.3	0.0	65.3
2.68	50.9	61.0	0.0	69.0
2.75	52.3	66.1	0.0	72.7
2.83	53.7	71.4	0.0	76.5
2.90	55.0	76.9	0.0	80.4
2.97	56.4	82.8	0.0	84.4
3.05	57.7	88.9	0.0	88.5
3.12	59.4	97.0	0.0	93.8
3.20	60.8	103.8	0.0	98.1
3.27	62.2	110.9	0.0	102.6
3.35	63.5	118.4	0.0	107.1
3.42	64.9	126.2	0.0	111.7
3.49	62.5	134.3	0.0	116.3
3.57	54.2	142.7	0.0	120.4
3.64	45.8	153.6	0.0	124.8
3.72	39.1	162.6	0.0	127.8
3.79	32.4	171.8	0.0	130.3
3.87	25.7	181.1	0.0	132.3
3.94	19.0	190.6	0.0	133.9
4.01	12.3	200.2	0.0	134.9
4.09	5.7	209.9	0.0	135.5
4.16	-2.7	222.0	0.0	135.6
4.24	-9.4	231.6	0.0	135.2
4.31	-16.1	241.3	0.0	134.4
4.39	-22.8	250.8	0.0	133.0
4.46	-29.5	260.3	0.0	131.2
4.53	-36.2	269.6	0.0	128.9
4.61	-42.9	278.7	0.0	126.2
4.68	-51.2	289.9	0.0	122.0
4.76	-57.9	298.5	0.0	118.1
4.83	-64.6	306.8	0.0	113.8
4.91	-71.3	314.8	0.0	109.0
4.98	-78.0	322.4	0.0	103.7
5.06	-84.7	329.7	0.0	97.9
5.13	-91.4	336.5	0.0	91.6
5.20	-98.1	342.9	0.0	84.9
5.28	-106.4	350.1	0.0	75.8
5.35	-113.1	355.3	0.0	68.0
5.43	-119.8	360.0	0.0	59.7
5.50	-126.5	364.0	0.0	50.9
5.58	-133.2	367.4	0.0	41.6
5.65	-139.9	370.1	0.0	31.9
5.72	-146.6	372.1	0.0	21.6
5.80	-154.9	373.6	0.0	8.2
5.87	-161.6	373.8	0.0	-2.6
5.95	-168.3	372.8	0.0	-12.7
6.02	-175.0	370.4	0.0	-22.3
6.10	-181.7	366.5	0.0	-31.4
6.17	-188.4	361.3	0.0	-40.1
6.24	-195.1	354.7	0.0	-48.2
6.32	-203.4	344.9	0.0	-57.8
6.39	-210.1	335.8	0.0	-64.9
6.47	-217.7	325.7	0.0	-71.5
6.54	-226.4	314.6	0.0	-77.5
6.62	-235.1	302.6	0.0	-82.8
6.69	-243.9	289.8	0.0	-87.6
6.77	-252.6	276.4	0.0	-91.6
6.84	-263.6	258.8	0.0	-95.9
6.91	-272.3	244.2	0.0	-98.6
6.99	-281.0	229.2	0.0	-100.6
7.06	-289.8	214.0	0.0	-102.0
7.14	-298.5	198.6	0.0	-102.8
7.21	-307.3	183.1	0.0	-103.0
7.29	-316.0	167.6	0.0	-102.5
7.36	-326.9	148.4	0.0	-101.1
7.43	-335.7	133.2	0.0	-99.2
7.51	-344.4	118.4	0.0	-96.7
7.58	-353.2	104.0	0.0	-93.5
7.66	-361.9	90.1	0.0	-89.8
7.73	-370.7	76.9	0.0	-85.4
7.81	-379.4	64.3	0.0	-80.4
7.88	-390.3	49.7	0.0	-73.2
7.95	-399.1	39.0	0.0	-66.8
8.03	-407.8	29.3	0.0	-59.7
8.10	-416.6	20.7	0.0	-52.0
8.18	-425.3	13.4	0.0	-43.7
8.25	-434.0	7.3	0.0	-34.8
8.33	-442.8	2.6	0.0	-25.2
8.40	-1431.2	0.0	0.0	0.0

Your Company Name

SPW911, v2.40

Email: pilebuck@pilebuck.com
Web: www.pilebuck.com

Union Street Timber Fender Analysis-Case III

Notes & References:

1. *Manual for Bridge Evaluation, 3rd Edition:*
2. *AASHTO Standard Specifications; 17th Ed..*
3. *The design method is: Allowable Stress Method.*

Design of Timber Sheeting:

Properties of Timber Sheeting:

Reference: AASHTO Std. Specs. 17th Ed.
Article 8.4.1.1.2

$d_{nominal} := 10in$ — Nominal Depth of Sheeting from As-Builts

$w_{Nominal} := 12in$ — Nominal Width of Sheeing from As-Builts

$d_{net} := d_{nominal} - .75in = 9.25 \cdot in$ — Net Depth used in Calculations

$w_{net} := w_{Nominal} - .75in = 11.25 \cdot in$ — Net Width used in Calculations

$S_x := \frac{1}{6} \cdot w_{net} \cdot d_{net}^2 = 160.43 \cdot in^3$ — Section Modulus

$S_{xperfootwidth} := S_x \cdot \frac{12in}{w_{net}} = 171.125 \cdot in^3$ — Section Modulus per foot width used in SPW-911 Program

$A_x := d_{net} \cdot w_{net} = 104.062 \cdot in^2$ — Section Area

$I_x := \frac{1}{12} \cdot w_{net} \cdot d_{net}^3 = 741.987 \cdot in^4$ — Moment of Inertia

$I_{xperFootWidth} := I_x \cdot 12 \frac{in}{w_{net}} = 791.453 \cdot in^4$ — Moment of Inertia per foot width to be used in SPW-911 Program

Unfactored Allowable Stresses:

Reference: AASHTO Std. Specs. 17th Ed.
Table 10.32.1A

WOOD SPECIES: Southern Pine No.2 is used per Ref.1 6-86

$F_b := 850\text{psi}$ Allowable Bending Stress w/o factors

$F_v := 100\text{psi}$ Allowable Shear Stress Parallel to grain w/o factors

$E := 1200\text{ksi}$ Modulus of Elasticity

Adjustment Factors for Allowable Stresses:

$C_m := 0.8$ Wet Service Factor Ref 2; Article 13.5.5.1

$C_D := 0.9$ Load Duration Factor. Article 13.5.5.2

$C_F := 1$ Bending Size Factor. Ref 2; Article 13.6.4.2

$C_V := 1$ Volume Factor for Glue Laminated - N.A.

$C_L := 1$ Beam Stability Factor Ref 2; Article 13.6.6.4

$C_f := 1.1$ Form Factor. Ref 2; Article 13.6.4.5

$C_{fu} := 1$ Flat Use Factor Ref 2; Article 13.5.1A & 13.5.1B

$C_r := 1$ Bending Size Factor. Ref 2; Article 13.5.1A

Factored Allowable Stresses:

$F_{b.allow} := F_b \cdot C_m \cdot C_D \cdot C_F \cdot C_V \cdot C_L \cdot C_f \cdot C_{fu} \cdot C_t$ $F_{b.allow} = 673.2 \cdot \mathbf{psi}$ Adjusted Allowable Bending Stress; Ref 2; Article 13.6.4.1; (13-2)

$F_{v.allow} := F_v \cdot C_m \cdot C_D = 72 \cdot \mathbf{psi}$ $F_{v.allow} = 72 \cdot \mathbf{psi}$ Adjusted Allowable Shear Stress; Ref 2; Article 13.6.5.3; (13-11)

$E_{allowed} := E \cdot C_m = 9.6 \times 10^5 \cdot \mathbf{psi}$ $\mathbf{E_{allowed}} = 9.6 \times 10^5 \cdot \mathbf{psi}$ Adjusted Modulus of Elasticity to be used in SPW-911 Program

Design Forces for Timber Sheeting: Reference: **Actual stresses calculated by spw-911 Program**

$\mathbf{M_{max}} := .400 \cdot \mathbf{kip \cdot ft}$ Design Moment per unit length(rounded)

$\mathbf{V_{max}} := 1 \cdot \mathbf{kip}$ Design Shear per unit length(rounded)

Case 2 : Temporary Wale and Anchor Added

Check of Flexural Bending: 20% loss assumed

$\mathbf{M_{board}} := \mathbf{M_{max}} \cdot \frac{\mathbf{w_{net}}}{12 \cdot \mathbf{in}} = 0.375 \cdot \mathbf{kip \cdot ft}$ Actual Moment per board width

$f_{b.board} := \frac{\mathbf{M_{board}}}{\frac{S_x}{1.20}} = 33.66 \cdot \mathbf{psi}$ Actual Bending Stress in Timber Lagging

$$\mathbf{Flexure_{check}} := \left(\begin{array}{|ll} \text{"OK"} & \textbf{if } f_{b.board} \le F_{b.allow} \\ \text{"FAILS"} & \textbf{otherwise} \end{array} \right)$$

$\mathbf{Flexure_{check}} = \text{"OK"}$

Check of Shear:20% loss assumed

$$V_{board} := V_{max} \cdot \frac{w_{net}}{12 \cdot in} = 0.938 \cdot kip$$

Actual Shear per board width

$$f_{v.board} := \frac{3 \cdot V_{board}}{2 \cdot \frac{A_x}{1.20}} = 16.216 \cdot psi$$

Actual Shear Stress in Timber Lagging

$$Shear_{check} := \left(\begin{array}{|l} \text{"OK"} \quad \textbf{if} \quad f_{v.board} \le F_{v.allow} \\ \text{"FAILS"} \quad \textbf{otherwise} \end{array} \right)$$

$$Shear_{check} = \text{"OK"}$$

GPI **GREENMAN - PEDERSEN, INC.**
ENGINEERING AND CONSTRUCTION SERVICES

(DESIGN ASSUMPTIONS, IF ANY, LISTED BELOW)

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Sheet 1 **of** 4

Gowanus Canal / Union Street / Bolt Embedment

Assumptions:

1) The 2-12x12 timbers provide a protective shelf over the rubber fender
It is assumed that a maintenance person may step on this shelf.

The anchor bolts are spaced at 4ft

Since this is acting like a slender maintenance platform, a Live Load of 90 psf is assumed to act on it. This would be a 90 psf x 4 ft = 360 # concentrated Load which is conservative.

This high concentrated Load and the deadweight of the timber are assumed to act on these planks and from observation will be the governing loads.

Ref: AASHTO LRFD Guide to Pedestrian Bridge;
use 90 psf for pedestrian Load when that is the sole purpose of the structural element (3.6.1.6)

2. 2 continuous 4 ft spans assumed to develop reaction.

(DESIGN ASSUMPTIONS, IF ANY, LISTED BELOW)

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Sheet 2 **of** 9

Determine Reactions at Anchor Bolt

Ref: Steel Constuction Manual
2 Continuous span Reaction

Maximum R at Center Support = $\frac{10}{8}$ (Factor) × w

PL - Pedestrian Load

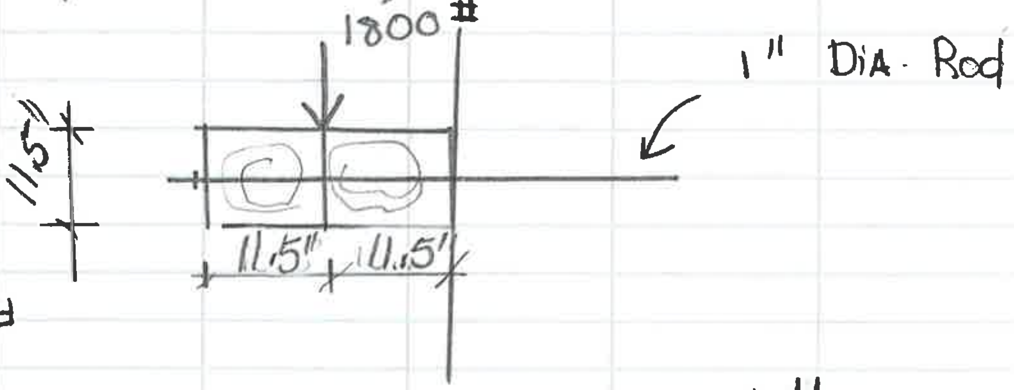
$R_{PL} = \frac{10}{8} \times 90\text{ psf} \times 2\text{ft} \times 4\text{ft} = 900^{\#}$

DL = Dead Load

$R_{DL} = 10/8 \times 45\text{ psf} \times 2\text{ft} \times 4\text{ft} = 450^{\#}$

$U = 1.2D + 1.6L$

$V_u = 1.2 \times (900) + 1.6(450) = 1800^{\#}$



$V_u = 1860^{\#}$

$M_u = 1800^{\#} \times 11.5'' = 20,700$ #11

(DESIGN ASSUMPTIONS, IF ANY, LISTED BELOW)

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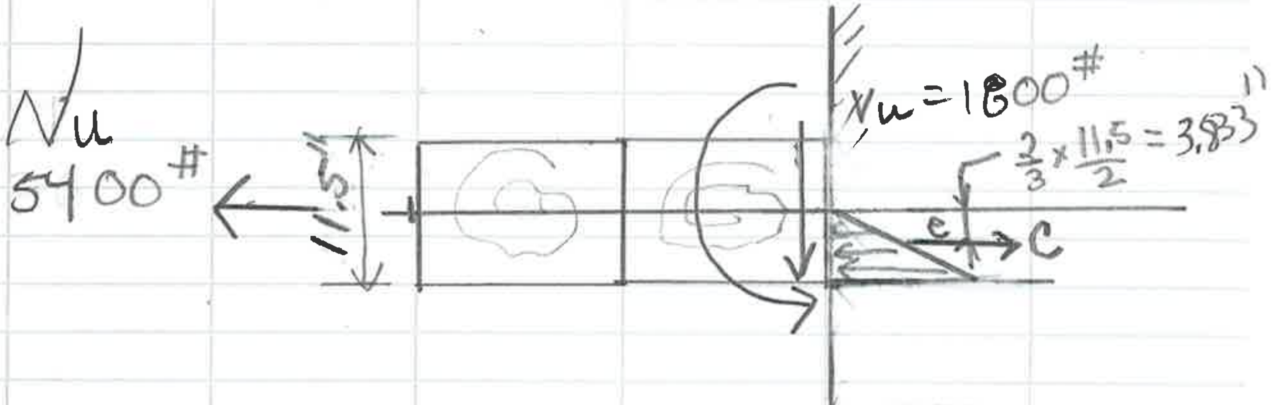
Sheet 3 of 4

Determine Nu



Conservatively assume rotation will occur about x.

$$T_u = \frac{19350''\#}{(3.833'')} = 5{,}400^{\#}$$

Reference alternative short method (Design of Welded Structures 3.3-10)

The center of gravity of the triangular representing the triangle is assumed to be fixed at the force acting with the concentrated compressive force of the ledge end

(DESIGN ASSUMPTIONS, IF ANY, LISTED BELOW)

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Sheet 4 **of** 4

All minimum properties assumed

Anchor Rod $F_y = 36$ ksi

Nominal Bond Strength of Capsule 1,08 ksi

Anchor Edge Distance (used in program) = c

Top of Abutment Elevation − Approx. Elev. of Bolt (sheet 15 of Contract plans)

$c = 5{,}48\text{ ft} - 3.6\text{ ft} = 1{,}88\text{ ft} = 22.56\text{ in}$

SINGLE ADHESIVE ANCHOR SYSTEM DESIGN PROGRAM

$MPa := 10^6 Pa$ $\quad$ $kip := 1000 lbf$ $\quad$ $ksi := 1 kip \cdot in^{-2}$ $\quad$ $N := \frac{1}{4.448} lbf$

$kN := 1000N$

Anchorage and Adhesive Notation

A_e = effective tensile stress area of steel anchor (may be taken as 75% of the gross area for threaded anchors). [in²]

A_{n0} = 16d², effective area of a single Adhesive Anchor in tension; used in calculating Ψ_{gn} (See Figure 1-6). [in²]

A_n = effective area of a group of Adhesive Anchors in tension; used in calculating Ψ_{gn}, defined as the rectangular area bounded by a perimeter spaced 8d from the center of the anchors and limited by free edges of concrete (See Figure 1-6). [in²]

A_{v0} = 4.5c², effective breakout area of a single Adhesive Anchor in shear; used in calculating Ψ_{gv} (See Figure 1-7). [in²]

A_v = effective area of a group of Adhesive Anchors in shear and/or loaded in shear where the member thickness, h, is less than 1.5c; used in calculating Ψ_{gv}, (See Figure 1-7). [in²]

c = anchor edge distance from free edge to centerline of the anchor. [in]

d = nominal diameter of Adhesive Anchor. [in]

f'_c = minimum specified concrete strength. [ksi]

f_y = minimum specified yield strength of Adhesive Anchor steel. [ksi]

f_u = minimum specified ultimate strength of Adhesive Anchor steel. [ksi]

h = concrete member thickness. [in]

h_e = embedment depth of anchor. [in]

N_c = tensile design strength as controlled by bond for Adhesive Anchors. [kips]

N_n = nominal tensile strength of Adhesive Anchor. [kips]

N_o = nominal tensile strength as controlled by concrete embedment for a single Adhesive Anchor. [kips]

N_s = design strength as controlled by Adhesive Anchor steel. [kips]

N_u = factored tension load. [kips]

s = Adhesive Anchor spacing (measured from centerlines of anchors). [in] When using Type HSHV adhesives, the minimum anchor spacing is 12d, unless approved by the State Structures Engineer.

V_c = shear design strength as controlled by the concrete embedment for Adhesive Anchors. [kips]

V_s = design shear strength as controlled by Adhesive Anchor steel. [kips]

V_u = factored shear load. [kips]

T' = 1.08 ksi nominal bond strength for general use products on the QPL (Type V and Type HV). 1.83 ksi nominal bond strength for Type HSHV adhesive products on the QPL for traffic railing barrier retrofits only.

$\varnothing_c$ = 0.85, capacity reduction factor for adhesive anchor controlled by the concrete embedment, ($\varnothing_c$ =1.00 for extreme event load case).

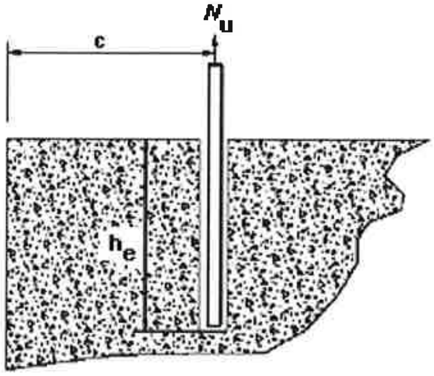
$\varnothing_s$ = 0.90, capacity reduction factor for adhesive anchor controlled by anchor steel.

Ψ_e = modification factor, for strength in tension, to account for anchor edge distance less than 8d (1.0 when c ≥ 8d).

Ψ_{gn} = strength reduction factor for Adhesive Anchor groups in tension (1.0 when s ≥ 16d).

Ψ_{gv} = strength reduction factor for Adhesive Anchor groups in shear and single Adhesive Anchors in shear influenced by member thickness (1.0 when s ≥ 3.0c and h ≥ 1.5c).

USER INPUTS: Anchorage and Adhesive Properties



This program is for the design of a single adhesive anchor system given a factored tension and shear load (*Nu and Vu*) and anchor edge distance (*c*). User shall input all the values, highlighted in blue, for the properties below. If no shear load is present, use $V_u = 0$.

Threaded Rod or Reinforcing Dowel

RodType := Threaded Rod or Bolt ▾

Capacity Reduction Factor of Anchor Steel = $\phi_s := 0.9$

Capacity Reduction Factor of Concrete = $\phi_c := 0.85$

Concrete Strength = $f'_c := 2 \cdot ksi$

Yield Strength of Steel (Anchor) = $f_y := 36 \cdot ksi$

Ultimate Strength of Steel (Anchor) = $f_u := 58 \cdot ksi$

Anchor Edge Distance = $c := 22 \cdot in$

Nominal Bond Strength = T' := 1.08 ksi - General Use products on QPL, Type V and Type H' ▾

Factored Tension Load (Total Load) = $N_u := 5.4 \cdot kip$

Factored Shear Load (Total Load) = $V_u := 1.8 \cdot kip$

Concrete Member Thickness = $h := 120 \cdot in$

Designer's Anchor Diameter Preference =
(set d=0, if no preference) $d := 1 \cdot in$

STEP 1 - Determine Required Rod Diameter

==

Determine the required diameter of the rod/bar by setting the factored tension load equal to the design steel strength:

$$N_u = N_s$$

As with reinforcing bars, the minimum specified yield strength of the rod/bar is used to determine the required diameter:

$$N_s = \phi_s A_e f_y$$

$\phi_s = 0.9$

$f_y = 36\cdot ksi$

$A_e = 0.75(\pi)(d^2/4)$ (Threaded)

or

$A_e = (\pi)(d^2/4)$ (Non-Threaded)

Substituting and solve for *d*:

$$d_{reqd} := \left\| \begin{array}{l} \left[\sqrt{\frac{[(N_u)\cdot(4)]}{0.75\cdot(\phi_s)\cdot(\pi)\cdot(f_y)}}\right]\cdot\left(\frac{1}{in}\right) \text{ if } \mathrm{RodType} = 0 \\ \left[\sqrt{\frac{[(N_u)\cdot(4)]}{(\phi_s)\cdot(\pi)\cdot(f_y)}}\right]\cdot\left(\frac{1}{in}\right) \text{ if } \mathrm{RodType} = 1 \end{array}\right.$$

$$d_{reqd} = 0.532$$

Determine nominal rod diameter:

(Rounded up to the nearest 1/8" or specified diameter preference, min 5/8")

$$d_{reqd} := \mathrm{if}\left(d_{reqd} \geq \frac{d}{in}, d_{reqd}, \frac{d}{in}\right)$$

$$\mathrm{ROUND}(d_{reqd}) := \frac{\mathrm{floor}(d_{reqd}\cdot 8 - 0.0001) + 1}{8}$$

$$\mathrm{ROUND}(d_{reqd}) = 1$$

$$d_{provided} := \mathrm{if}(\mathrm{ROUND}(d_{reqd}) \geq 0.625, \mathrm{ROUND}(d_{reqd})\cdot in, 0.625\cdot in)$$

$d_{provided} = 1\cdot in$

Check design steel strength:

$$A_e := \begin{cases} 0.75\cdot\left(\pi\cdot\dfrac{d_{provided}^{\ 2}}{4}\right) & \text{if RodType} = 0 \\ \left(\pi\cdot\dfrac{d_{provided}^{\ 2}}{4}\right) & \text{if RodType} = 1 \end{cases}$$

$A_e = 0.589\cdot in^2$

$N_s := \phi_s\cdot A_e\cdot f_y$

$N_s = 19.085\cdot kip$

$$\text{CheckSteelStrength} := \begin{cases} \text{"GOOD...Continue to Step 2"} & \text{if } N_s > N_u \\ \text{"STOP...Ns<Nu"} & \text{if } N_u \geq N_s \end{cases}$$

CheckSteelStrength = "GOOD...Continue to Step 2"

STEP 2 - Determine Required Embedment Depth

==

Basic equation for embedment length calulation.

$N_c = \phi_c \Psi_e \Psi_{gn} N_o$ (tensile design strength as controlled by bond for Adhesive Anchors)

$N_o = T \pi d h_e$ (nominal tensile strength as controlled by concrete embedment for a single Adhesive Anchor)

Since there are no spacing concerns for single adhesive anchors, *Ψgn* may be taken as 1.0. Edge effect factor, *Ψe*, will need to be calculated for an anchorage edge distance (*c*) less than (*8*d*). *(For 'c' greater than or equal to '8*d', use Ψe = 1).*

$d_{provided} = 1 \cdot in \qquad c = 22 \cdot in$

$$\Psi_e := \begin{array}{|l} \left[0.70 + 0.30\left(\frac{c}{8 \cdot d_{provided}}\right)\right] \text{ if } \left(3.0 \cdot d_{provided} \le c < 8.0 \cdot d_{provided}\right) \\ \text{"STOP...Special Testing required if necessary"} \text{ if } \left(3.0 \cdot d_{provided} > c\right) \\ 1 \text{ if } \left(c \ge 8.0 \cdot d_{provided}\right) \end{array}$$

$\Psi_e = 1$

For ductile behavior it is necessary to embed the anchor sufficiently to develop 125% of the yield strength or 100% of the ultimate strength, whichever is less. Determine the required tension force, *N_{c_req}*, to ensure ductile behavior.

$A_e = 0.589 \cdot in^2$

$$N_{c\_req} := \begin{array}{|l} \left(1.25 \cdot A_e \cdot f_y\right) \text{ if } \left[\left(1.25 \cdot A_e \cdot f_y\right) \le \left(A_e \cdot f_u\right)\right] \\ \left(A_e \cdot f_u\right) \text{ if } \left(A_e \cdot f_u < 1.25 \cdot A_e \cdot f_y\right) \end{array}$$

$N_{c\_req} = 26.507 \cdot kip$

Substituting and solve for *h_e*:

$$N_{c\_req} = \phi_c \Psi_e \Psi_{gn} (T \pi d h_e)$$

$\Psi_{gn} := 1.0 \qquad T' = 1.08 \cdot ksi$

$\phi_c = 0.85 \qquad d_{provided} = 1 \cdot in$

$\Psi_e = 1 \qquad N_{c\_req} = 26.507 \cdot kip$

41

$$h_e := \left[\frac{N_{c\_req}}{\phi_c \cdot \Psi_e \cdot \Psi_{gn} \cdot \left(T' \cdot \pi \cdot d_{provided}\right)}\right] \cdot \left(\frac{1}{in}\right)$$

$h_e = 9.191$

Determine nominal rod/bar embedment depth:

(Rounded up to the nearest 1/2")

$$ROUND(h_e) := \frac{\text{floor}\left(h_e \cdot 2 - 0.0001\right) + 1}{2}$$

$ROUND(h_e) = 9.5$

$h_e := ROUND(h_e) \cdot in$

$h_e = 9.5 \cdot in$

Check = "Continue ... Sufficient Depth Available"

Allows for minimum 3" cover

Check design adhesive bond strength:

$N_c := \phi_c \cdot \Psi_e \cdot \Psi_{gn} \cdot \left(T' \cdot \pi \cdot d_{provided} \cdot h_e\right)$

$\Psi_{gn} = 1$

$N_c = 27.398 \cdot kip$

$$CheckBondStrength := \begin{cases} \text{"GOOD"} & \text{if } N_c > N_u \\ \text{"STOP...Nc<Nu"} & \text{if } N_u \geq N_c \end{cases}$$

CheckBondStrength = "GOOD"

Check for Failure Type (Ductile vs. Brittle):

$FailureType_{tension} := \text{if}\left(N_s > N_c, \text{"Adhesive (brittle)"}, \text{"Steel (ductile)"}\right)$

$FailureType_{tension}$ = "Steel (ductile)"

STEP 3 - Determine Interaction of Tensile and Shear Loading (when $V_u > 0$)

==

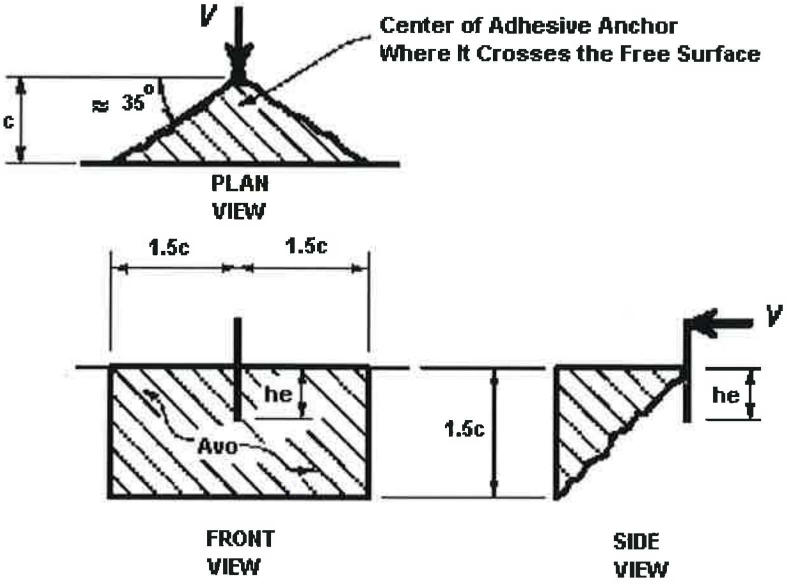
Adhesive Anchors loaded in shear shall be embedded a distance of not less than *6*d*. For Adhesive Anchors loaded in shear, the design shear strength controlled by anchor steel (*V_s*) is determined below:

$$\text{EmbeddedDepthForShear} := \left| \begin{array}{l} \text{"GOOD"} \quad \text{if } h_e > 6 \cdot d_{provided} \\ \text{"NO\_GOOD"} \quad \text{if } h_e \le 6 \cdot d_{provided} \end{array} \right.$$

$$\text{EmbeddedDepthForShear} = \text{"GOOD"}$$

$$V_s := \phi_s \cdot 0.7 \cdot A_e \cdot f_y \qquad V_s = 13.36 \cdot kip$$

For Adhesive Anchors loaded in shear, the design shear strength controlled by anchor concrete breakout for shear directed toward a free edge of concrete (*V_c*) is determined below. For concrete member thickness, h, less than 1.5*c, a reduction factor, *Ψ_{gv}*, is calculated in accordance to the figures below. (*When concrete member thickness, h, is greater than 1.5*c, Ψ_{gv} shall be taken as 1.0*)

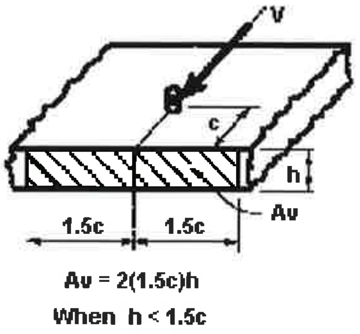


For Calculation of A_{vo}:

$$A_{v0} := 4.5 \cdot \left(c^2\right)$$

$$A_{v0} = 2.178 \times 10^3 \cdot in^2$$

43



For Calculation of A_v:

$$A_v := \begin{cases} 2\cdot(1.5\cdot c)\cdot h & \text{if } (h < 1.5\cdot c) \\ A_{v0} & \text{if } (h \ge 1.5\cdot c) \end{cases}$$

$A_v = 2.178 \times 10^3 \cdot in^2$

$$\Psi_{gv} := \frac{A_v}{A_{v0}}$$

$\Psi_{gv} = 1$

$\phi_c = 0.85$ $f'_c = 2\cdot ksi$ $c = 22\cdot in$

$$V_c := \phi_c\cdot\Psi_{gv}\cdot 0.4534\cdot\left(\frac{c}{in}\right)^{1.5}\cdot\sqrt{\frac{f'_c}{ksi}}\cdot kip$$

$V_c = 56.241\cdot kip$

The following linear interaction between tension and shear loadings shall be evaluated unless special testing is performed. *ϕN_n* is the smaller of *N_s* and *N_c*. *ϕV_n* is the smaller of *V_s* and *V_c*.

$N_s = 19.085\cdot kip$ $N_c = 27.398\cdot kip$

$$\phi N_n := \begin{cases} N_s & \text{if } N_s \le N_c \\ N_c & \text{if } N_c < N_s \end{cases}$$

$\phi N_n = 19.085\cdot kip$

$V_s = 13.36\cdot kip$ $V_c = 56.241\cdot kip$

$$\phi V_n := \begin{cases} V_s & \text{if } V_s \le V_c \\ V_c & \text{if } V_c < V_s \end{cases}$$

$\phi V_n = 13.36\cdot kip$

$$\text{TensionShearInteraction} := \begin{cases} \text{"GOOD"} & \text{if } \left[\left(\frac{N_u}{\phi N_n}\right) + \left(\frac{V_u}{\phi V_n}\right)\right] \le 1.0 \\ \text{"NO\_GOOD"} & \text{if } \left[\left(\frac{N_u}{\phi N_n}\right) + \left(\frac{V_u}{\phi V_n}\right)\right] > 1.0 \end{cases}$$

TensionShearInteraction = "GOOD"

Check for Failure Type (Ductile vs. Brittle):

$\text{FailureType}_{shear} := \text{if}(V_s > V_c, \text{"Adhesive (brittle)"}, \text{"Steel (ductile)"})$

$\text{FailureType}_{shear} = \text{"Steel (ductile)"}$

SUMMARY OF RESULTS

==

Diameter of Rod/Bar = $d_{provided} = 1\cdot in$

Anchor Embedment Depth = $h_e = 9.5\cdot in$

Effective Area of Steel (Anchor) = $A_e = 0.589\cdot in^2$

Edge Effect Factor = $\Psi_e = 1$

Group Effect Factor = $\Psi_{gn} = 1$

Factored Tension Load = $N_u = 5.40\cdot kip$

Design Tension Strength of Steel Anchor = $N_s = 19.09\cdot kip$

Design Tension Strength of Adhesive Bond = $N_c = 27.40\cdot kip$

Factored Shear Load = $V_u = 1.80\cdot kip$

Design Shear Strength of Steel Anchor = $V_s = 13.36\cdot kip$

Design Shear Strength of Adhesive Bond = $V_c = 56.24\cdot kip$

Failure Type Under Tension Loading = $FailureType_{tension}$ = "Steel (ductile)"

Failure Type Under Shear Loading = $FailureType_{shear}$ = "Steel (ductile)"

HVU Capsule Adhesive Anchoring System 3.2.8

Table 4 - HVU allowable and ultimate bond/concrete capacity for HAS rods in normal weight concrete[1, 2]

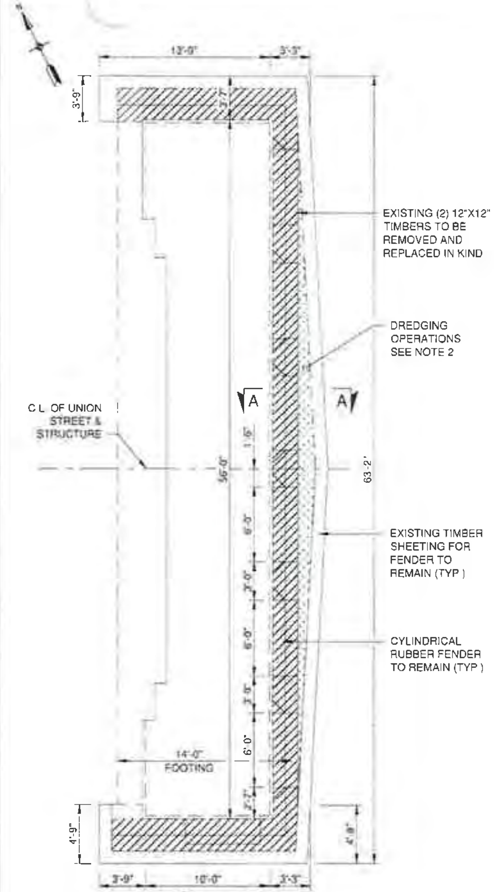
Nominal anchor diameter	Embed. depth[3] in.	Adhesive capsule(s) required	HVU allowable bond/concrete capacity				HVU ultimate bond/concrete capacity			
			Tensile		Shear		Tensile		Shear	
			f'_c = 2000 psi lb (kN)	f'_c = 4000 psi lb (kN)	f'_c = 2000 psi lb (kN)	f'_c = 4000 psi lb (kN)	f'_c = 2000 psi lb (kN)	f'_c = 4000 psi lb (kN)	f'_c = 2000 psi lb (kN)	f'_c = 4000 psi lb (kN)
3/8	3-1/2 (90)	(1) 3/8 x 3-1/2	2,085 (9.3)	2,595 (11.5)	3,335 (14.8)	4,710 (21.0)	8,345 (37.1)	10,380 (46.2)	10,000 (44.5)	14,120 (62.8)
	5-1/4 (133)	(2) 3/8 x 3-1/2	2,325 (10.3)	4,185 (18.6)	6,120 (27.2)	8,655 (38.5)	9,295 (41.3)	16,730 (74.4)	18,360 (81.7)	25,960 (115.5)
	7 (178)	(2) 3/8 x 3-1/2	4,405 (19.6)	4,895 (21.8)	9,420 (41.9)	13,330 (59.3)	17,630 (78.4)	19,590 (87.1)	28,260 (125.7)	39,980 (177.8)
1/2	4-1/4 (110)	(1) 1/2 x 4-1/4	3,250 (14.5)	4,735 (21.1)	5,450 (24.2)	7,280 (32.4)	12,990 (57.8)	18,940 (84.2)	15,440 (68.7)	21,840 (97.1)
	6-3/8 (162)	(1) 1/2 x 4-1/4 & (1) 3/8 x 3-1/2	4,890 (21.8)	5,455 (24.3)	9,455 (42.1)	13,375 (59.5)	19,565 (87.0)	21,815 (97.0)	28,360 (126.2)	40,120 (178.5)
	8-1/2 (216)	(2) 1/2 x 4-1/4	6,700 (29.8)	7,545 (33.6)	14,560 (64.8)	20,590 (91.6)	26,810 (119.3)	30,190 (134.3)	43,680 (194.3)	61,760 (274.7)
5/8	5 (125)	(1) 5/8 x 5	3,970 (17.7)	5,245 (23.3)	7,350 (32.7)	10,390 (46.2)	15,890 (70.7)	20,970 (93.3)	22,040 (98.0)	31,160 (138.6)
	7-1/2 (184)	(1) 5/8 x 5 & (1) 1/2 x 4-1/4	5,770 (25.7)	10,465 (46.6)	13,495 (60.0)	19,080 (84.9)	23,080 (102.7)	41,865 (186.2)	40,480 (180.1)	57,240 (254.6)
	10 (254)	(2) 5/8 x 5	11,700 (52.0)	12,835 (57.1)	20,775 (92.4)	29,375 (130.7)	46,795 (208.2)	51,340 (228.4)	62,320 (277.2)	88,120 (392.0)
3/4	6-5/8 (170)	(1) 3/4 x 6-5/8	6,080 (27.0)	8,615 (38.3)	12,270 (54.6)	17,355 (77.2)	24,330 (108.2)	34,470 (153.3)	36,800 (163.7)	52,060 (231.6)
	10 (254)	(1) 3/4 x 6-5/8 & (1) 1/2 x 4-1/4	9,110 (40.5)	14,835 (66.0)	22,755 (101.2)	32,180 (143.1)	36,445 (162.1)	59,350 (264.0)	68,260 (303.6)	96,540 (429.4)
	13-1/4 (337)	(2) 3/4 x 6-5/8	15,220 (67.7)	15,310 (68.1)	34,700 (154.4)	49,080 (218.3)	60,875 (270.8)	61,230 (272.4)	104,100 (463.1)	147,240 (655.0)
7/8	6-5/8 (170)	(1) 7/8 x 6-5/8	7,145 (31.8)	9,130 (40.6)	13,110 (58.3)	18,535 (82.4)	28,580 (127.1)	36,525 (162.5)	39,320 (174.9)	55,600 (247.3)
	10 (254)	(2) 3/4 x 6-5/8	10,475 (46.6)	18,970 (84.4)	24,575 (109.3)	34,755 (154.6)	41,905 (186.4)	75,870 (337.5)	73,720 (327.9)	104,260 (463.8)
	13-1/4 (337)	(2) 7/8 x 6-5/8	16,475 (73.3)	23,055 (102.6)	34,780 (154.7)	53,010 (235.8)	65,895 (293.1)	92,220 (410.2)	112,440 (500.2)	159,020 (707.4)
1	8-1/4 (210)	(1) 1 x 8-1/4	8,640 (38.4)	13,425 (59.7)	19,690 (87.6)	27,840 (123.8)	34,560 (153.7)	53,695 (238.8)	59,060 (262.7)	83,520 (371.5)
	12-3/8 (314)	(2) 7/8 x 6-5/8	14,665 (65.2)	23,450 (104.3)	36,170 (160.9)	51,150 (227.5)	58,665 (261.0)	93,800 (417.2)	108,500 (482.6)	153,440 (682.5)
	16-1/2 (419)	(2) 1 x 8-1/4	26,645 (118.5)	30,805 (137.0)	55,690 (247.7)	78,750 (350.3)	106,580 (474.1)	123,220 (548.1)	167,060 (743.1)	236,240 (1050.8)
1-1/4	12 (305)	(1) 1-1/4 x 12	19,175 (85.3)	23,920 (106.4)	38,615 (171.8)	54,610 (242.9)	76,740 (341.4)	95,680 (425.6)	115,840 (515.3)	163,820 (728.7)
	15 (381)	(1) 1-1/4 x 12 & (1) 1 x 8-1/4	24,750 (110.1)	26,855 (119.5)	53,960 (240.0)	76,315 (339.5)	99,000 (440.4)	107,420 (477.8)	161,880 (720.1)	228,940 (1018.4)
	18 (457)	(1) 1-1/4 x 12 & (2) 1 x 8-1/4	29,535 (131.4)	37,920 (168.7)	70,935 (315.5)	100,320 (446.2)	118,140 (525.5)	151,680 (674.7)	212,800 (946.6)	300,960 (1338.7)

1 Influence factors for spacing and/or edge distance are applied to concrete/bond values above, and then compared to the steel value. The lesser of the values is to be used for the design.

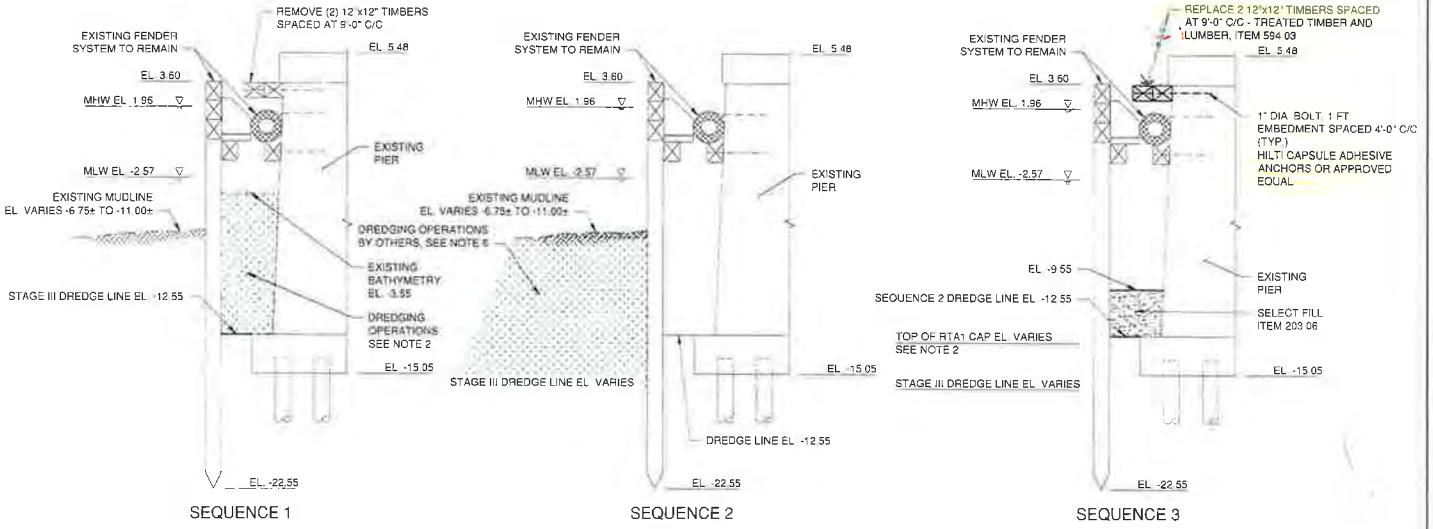
2 Average ultimate concrete shear capacity based on Strength Design method.

3 Contact Hilti for the use of alternate embedment other than those tested and listed above.

SHEET NO	TOTAL SHEETS
15	22



PLAN
WEST PIER SHOWN, EAST PIER SIMILAR
SCALE: 1" = 10'-0"



SECTION A-A
SCALE: 1/8" = 1'-0"

NOTES:

1. CONTRACTOR TO FIELD VERIFY ALL DIMENSIONS
2. FOR SEDIMENT CONTROL AND WASTE MANAGEMENT DETAILS, REFER TO REMEDIATION TARGET AREA (RTA) 1 DESIGN PACKAGE
3. FOR UNION STREET GENERAL PLAN AND ELEVATION, SEE DWG NO U-2
4. CARE SHALL BE TAKEN THROUGHOUT DREDGING OPERATIONS ANY DAMAGE TO THE FENDER SYSTEM SHALL BE REPAIRED BY THE CONTRACTOR AT THE CONTRACTOR'S EXPENSE
5. CANAL DREDGING ADJACENT TO THE EXISTING FENDER SYSTEMS AND CONCRETE PIERS SHALL BE DONE IN SLOTS USING BEST MANAGMENT PRACTICES
6. DREDGING OF CANAL SEDIMENTS BY OTHERS FOR DREDGING LIMITS OPERATIONS DETAILS AND SPECFICATIONS, SEE REMEDIATION TARGET AREA (RTA) 1 DESIGN PACKAGE
7. DURING DREDGING OPERATIONS HYDRAULIC HEAD ON BOTH SIDES OF THE FENDER TO BE MAINTAINED AT THE SAME ELEVATION

SUGGESTED SEQUENCE OF DREDGING:

THE FOLLOWING DREDGING SEQUENCE ALLOWS FOR STABILITY OF THE EXISTING FENDER SYSTEM WHILE MAINTAINING DREDGING OPERATION

STAGE 1
1. REMOVE 2 HORIZONTAL 12'x12' TIMBER SECTIONS
2. DREDGE BEHIND THE FENDER SYSTEM TO ELEVATION -12.55
3. DISCHARGE TO BE PUMPED DIRECTLY TO A HOPPER BARGE

STAGE 2
1. DREDGE IN CANAL TO ELEVATION -16.00

STAGE 3
1. FILL BEHIND FENDER WITH SELECT FILL TO EL -9.55, ITEM 203 06
2. REPLACE 2 12"x12" TIMBER SECTIONS

LEGEND:

▨	VOLUME TO BE DREDGED
▨	SELECT FILL, ITEM 203 02

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ALTERED BY:

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PREPARED BY:
IN CHARGE D CHASE DRAFTER D CASILLAS
DESIGNER L DESIMONE CHECKER J STERN

0 1 2 3 4
ORIGINAL SIZE IN INCHES

IT IS A VIOLATION OF LAW FOR ANY PERSON, UNLESS THEY ARE ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, ARCHITECT, LANDSCAPE ARCHITECT, OR LAND SURVEYOR, TO ALTER AN ITEM IN ANY WAY IF AN ITEM BEARING THE STAMP OF A LICENSED PROFESSIONAL IS ALTERED THE ALTERING ENGINEER, ARCHITECT, LANDSCAPE ARCHITECT, OR LAND SURVEYOR SHALL STAMP THE DOCUMENT AND INCLUDE THE NOTATION "ALTERED BY" FOLLOWED BY THEIR SIGNATURE THE DATE OF SUCH ALTERATION, AND A SPECIFIC DESCRIPTION OF THE ALTERATION

CITY OF NEW YORK
DEPARTMENT OF TRANSPORTATION
DIVISION OF BRIDGES

NYS P.I.N. NO
FED AID PROJ NO
NYC P.I.N. NO
CONTRACT NO HPH106A
CD NO

RTA 1 - DREDGING, SEDIMENT AND WATER TREATMENT, ISS, CAPPING, AND STAGING AND SUPPORT SITE DESIGN
UNION STREET BRIDGE OVER THE GOWANUS CANAL
BOROUGH OF BROOKLYN B.I.N. 2-24027-0

DREDGING DETAILS AT EXISTING PIER FENDER

DWG NO	SCALE	DATE	SHEET NO
U-5	AS NOTED	JULY 2019	15

ATTACHMENT A

GZA GeoEnvironmental, Inc.
RTA 1 Bridge Soil Design Parameters
July 11, 2018

Summary of Design Parameters for Canal Soils

Soil Unit	Total Unit Weight, γ (pcf)	Effective Friction Angle, ϕ' (degrees)	Undrained Shear Strength, S_u (psf), See Note 1	Stratum Thickness Union Street (feet)	Stratum Thickness Carroll Street (feet)	Stratum Thickness 3rd Street (feet)
Soft Sediment	80	28	$0.3\sigma'_v$	6	5	7
Native Alluvial Sediment	115	28	250 if > El. -20 ft 500 if < El. -20 ft	4	4	7
Glacial Deposit	125	34	-	See Note 2	See Note 2	See Note 2

1. σ'v = (total unit weight of soil - 62.4 pcf)*depth
2. Explorations were terminated in this stratum and it is expected that the stabilization design for the bridges will also terminate here.

Summary of Design Parameters for Upland Soils

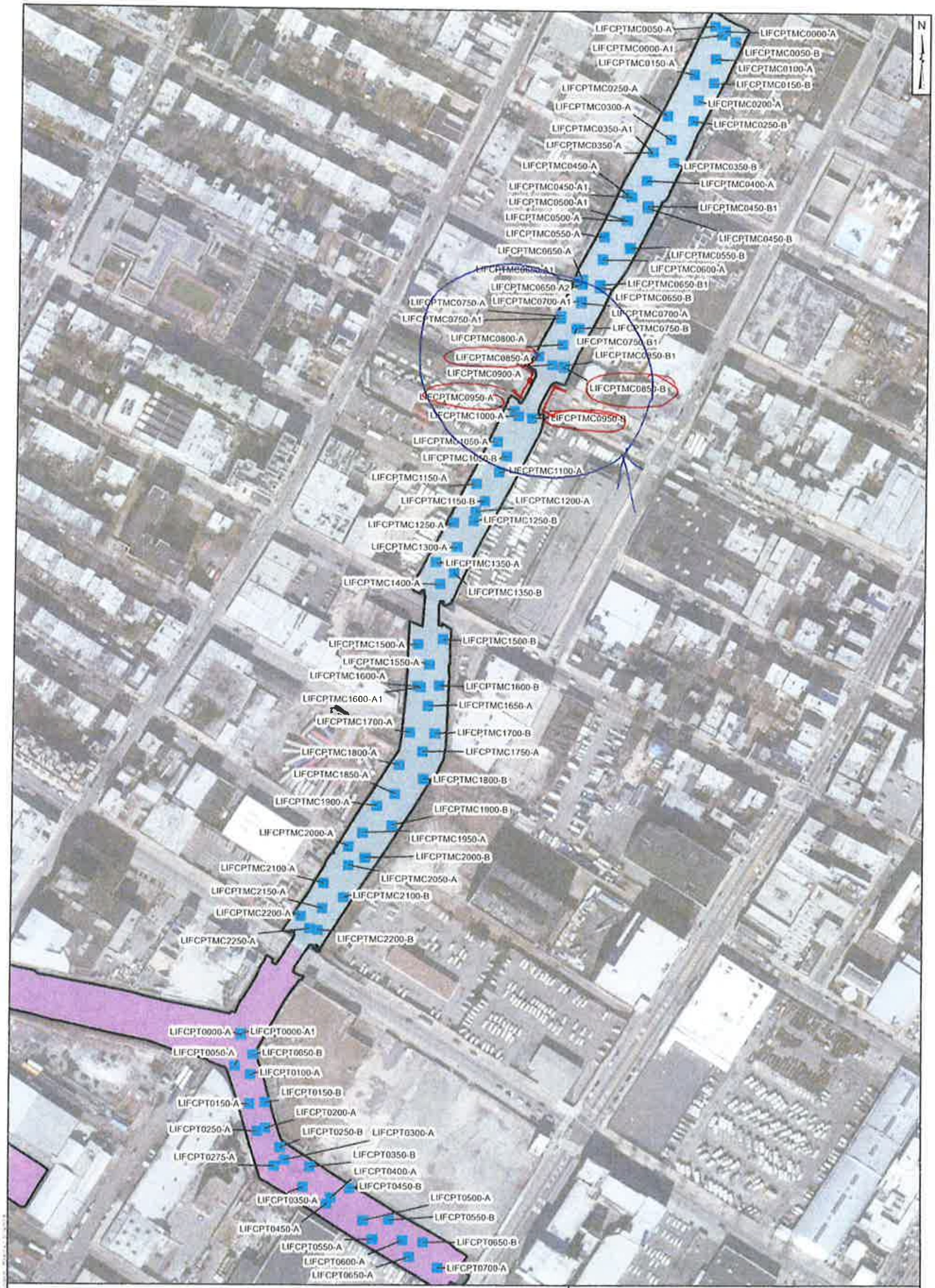
Soil Unit	Total Unit Weight, γ (pcf)	Effective Friction Angle, ϕ' (degrees)	Undrained Shear Strength, S_u (psf), See Note 1
Fill	120	32	-
Organic Sediment	95	23	$0.25\sigma'_v$ min. 250 psf
Native Alluvial Sediment	115	28	$0.35\sigma'_v$ min. 250 psf
Glacial Deposit w/ Fines	125	28	$0.5\sigma'_v$ min. 500 psf
Glacial Deposit w/ Sands	125	34	-

1. σ'v = total unit weight of soil*depth above the water table and σ'v = (total unit weight of soil - 62.4 pcf)*depth below the water table.

A1

Table 1d. Geosyntec (2015c) PD-8 CPT Locations

Location	CPT Name	As Built Northing	As Built Easting	Elevation Mudline/Ground (ft)	Elevation of Soft-Native Interface (ft)	Elevation of Native-Glacial Interface (ft)
RTA1	15-53060_LIFCPTMC0000-A	673625.99	634418.54	-4.43	-18.13	-22.13
	15-53060_LIFCPTMC0000-A1	673617.43	634411.53	-4.16	-17.86	-21.86
	15-53060_LIFCPTMC0050-A	673635.74	634396.37	-3.57	-14.27	-19.77
	15-53060_LIFCPTMC0050-B	673602.82	634441.17	-2.39	-15.69	-20.69
	15-53060_LIFCPTMC0100-A	673565.95	634398.12	-3.70	-18.20	-21.70
	15-53060_LIFCPTMC0150-A	673532.23	634351.93	-6.30	-20.75	-23.05
	15-53060_LIFCPTMC0150-B	673514.39	634394.77	-3.16	-17.21	-19.91
	15-53060_LIFCPTMC0200-A	673477.58	634359.95	-4.00	-15.80	-18.30
	15-53060_LIFCPTMC0250-A	673443.39	634295.19	-6.46	-17.08	-19.08
	15-53060_LIFCPTMC0250-B	673433.36	634350.07	-4.76	-18.21	-24.21
	15-53060_LIFCPTMC0300-A	673391.05	634302.85	-4.76	-15.76	-17.51
	15-53060_LIFCPTMC0350-A	673363.12	634264.67	-5.79	-17.54	NA
	15-53060_LIFCPTMC0350-A1	673363.12	634264.67	-5.58	-17.58	NA
	15-53060_LIFCPTMC0350-B	673340.09	634309.00	-3.77	-16.52	-17.92
	15-53060_LIFCPTMC0400-A	673300.56	634252.44	-5.21	-15.21	-18.21
	15-53060_LIFCPTMC0450-A	673270.50	634212.47	-5.37	-16.37	-17.37
	15-53060_LIFCPTMC0450-A1	673265.08	634220.93	-6.07	-17.82	-18.32
	15-53060_LIFCPTMC0450-B	673241.33	634254.85	-3.59	-15.34	-18.09
	15-53060_LIFCPTMC0450-B1	673245.57	634255.70	-4.18	-15.98	-18.98
	15-53060_LIFCPTMC0500-A	673213.42	634212.79	-4.75	-12.85	-14.25
	15-53060_LIFCPTMC0500-A1	673214.67	634210.65	-4.98	-12.53	-13.53
	15-53060_LIFCPTMC0550-A	673178.16	634164.03	-5.64	-13.09	-18.09
	15-53060_LIFCPTMC0550-B	673155.88	634218.13	-3.00	-11.65	-14.25
	15-53060_LIFCPTMC0600-A	673131.34	634161.27	-6.33	-13.58	-18.78
	15-53060_LIFCPTMC0650-A	673089.02	634119.77	-8.93	-17.43	NA
	15-53060_LIFCPTMC0650-A1	673083.36	634111.64	-8.98	-17.73	-19.23
	15-53060_LIFCPTMC0650-A2	673079.26	634118.67	-9.12	-19.12	-20.87
	15-53060_LIFCPTMC0650-B	673071.98	634155.82	-6.36	-17.36	-18.71
	15-53060_LIFCPTMC0650-B1	673078.07	634156.54	-6.54	-17.54	-19.24
	15-53060_LIFCPTMC0700-A	673038.19	634117.64	-8.10	-16.60	NA
	15-53060_LIFCPTMC0700-A1	673042.26	634116.51	-8.16	-18.16	NA
	15-53060_LIFCPTMC0750-A	673010.23	634075.26	-6.29	-15.29	-17.64
	15-53060_LIFCPTMC0750-A1	673004.27	634073.07	-6.06	-16.51	-18.91
	15-53060_LIFCPTMC0750-B	672983.28	634113.17	-6.18	-16.80	NA
	15-53060_LIFCPTMC0750-B1	672982.74	634108.13	-5.88	-17.23	NA
	15-53060_LIFCPTMC0800-A	672946.38	634078.38	-6.86	-17.61	-24.11
	15-53060_LIFCPTMC0850-A	672920.46	634027.16	-7.38	-14.53	-26.33
	15-53060_LIFCPTMC0850-B	672895.53	634081.06	-5.85 ←	-14.55	-21.30
	15-53060_LIFCPTMC0850-B1	672899.36	634083.25	-6.25	-14.30	-21.80
	15-53060_LIFCPTMC0900-A	672901.29	634056.80	-6.92	-16.17	-23.17
	15-53060_LIFCPTMC0950-A	672801.52	633975.76	-6.19	-12.79	-14.99
	15-53060_LIFCPTMC0950-B	672786.44	634013.37	-7.14 ←	-14.89	-15.39
	15-53060_LIFCPTMC1000-A	672790.27	633984.71	-7.45	-16.25	-16.25
	15-53060_LIFCPTMC1050-A	672735.43	633939.09	-6.56	-14.56	-18.06
	15-53060_LIFCPTMC1050-B	672705.04	633959.45	-7.75	-15.30	-15.30
	15-53060_LIFCPTMC1100-A	672670.01	633943.49	-8.74	-15.64	-17.14
	15-53060_LIFCPTMC1150-A	672644.46	633894.04	-7.53	-14.53	-16.53
	15-53060_LIFCPTMC1150-B	672606.63	633913.10	-8.63	-14.18	-14.68
	15-53060_LIFCPTMC1200-A	672583.90	633893.11	-9.33	-14.83	-16.33
	15-53060_LIFCPTMC1250-A	672558.55	633846.25	-8.52	-13.77	-16.47
	15-53060_LIFCPTMC1250-B	672561.76	633889.47	-9.63	-13.63	-13.63
	15-53060_LIFCPTMC1300-A	672504.89	633854.32	-8.80	-13.45	-16.41



Legend

- 🟦 CPT Location
- ▭ Gowanus Canal
- RTA1
- RTA2
- RTA3A
- RTA3B

200 100 0 200 Feet

Locations of CPTs in RTA1 and TB4 From the Geosyntec PD-8 (2015c) Investigation Report

Gowanus Canal Superfund Site, Brooklyn, NY

Gowanus Canal Remedial Design Group

Geosyntec consultants

Hirsch and Bonaparte

Figure 5a

Ewing, NJ

August 2016

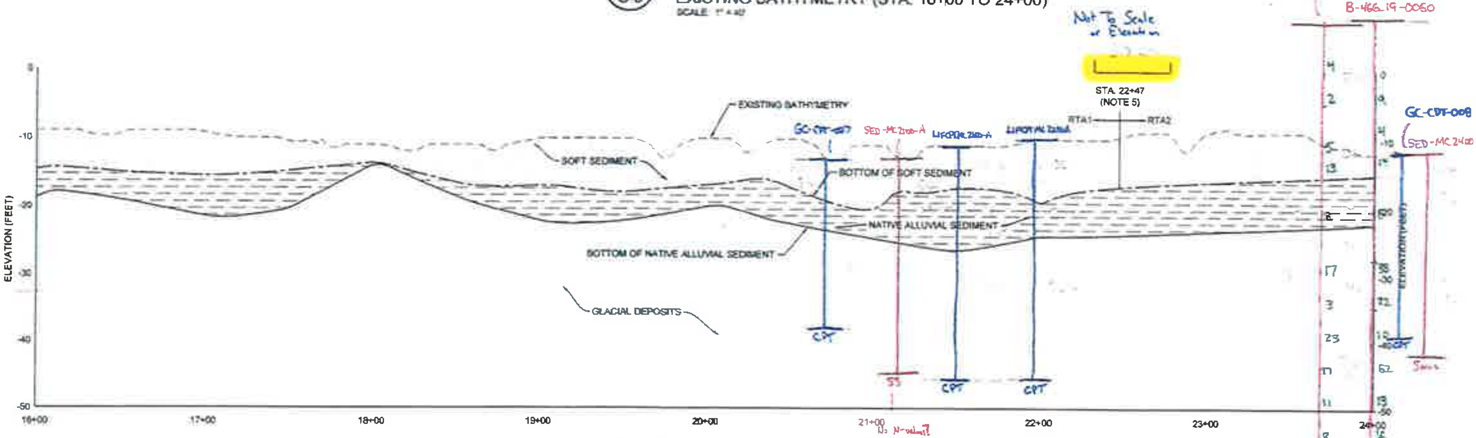
A3

8
G-3

PLAN

EXISTING BATHYMETRY (STA. 16+00 TO 24+00)

SCALE: 1" = 40'



DISTANCE (FEET)

9
DR-3

PROFILE

EXISTING BATHYMETRY (STA. 16+00 TO 24+00)

SCALE: 1" = 40' (HORIZONTAL); 1" = 10' (VERTICAL)

LEGEND

	BATHYMETRY ELEVATION
———	CANAL BOUNDARY
— - —	PROPERTY LINE
- - - -	EXISTING BATHYMETRY
- · - ·	BOTTOM OF SOFT SEDIMENT
———	BOTTOM OF NATIVE ALLUVIAL SEDIMENT
20+00	CANAL STATIONING
▨	STEEL SHEET PILE BULKHEAD
▨	TIMBER CRIB BULKHEAD
▨	TIMBER PILE BULKHEAD
☐	SOFT SEDIMENT
☐	NATIVE ALLUVIAL SEDIMENT
☐	GLACIAL DEPOSITS
⌖	OUTFALL (NOTE 4)
⊠	CSO (NOTE 4)
(417-21)	BLOCK AND LOT
▲	Boring
▲	CPT

NOTES:

1. DEBRIS IN RTA1 IS PRESENTED ON DRAWINGS DR-8 TO DR-8
2. DREDGE CROSS-SECTIONS ARE PRESENTED ON DRAWINGS DR-17 AND DR-18.
3. THE BULKHEAD TYPE FOR EACH PROPERTY IS PRIMARILY BASED ON A PRELIMINARY DESKTOP STUDY COMPLETED BY GEOSYNTEC (2014) TITLED "CONDITION ASSESSMENT OF EXISTING BULKHEADS" ALONG WITH MORE RECENT SUPPLEMENTARY INFORMATION (E.G. SITE WALKS, ENGINEERING DRAWINGS).
4. CONTRACTOR IS RESPONSIBLE FOR DOCUMENTING AND VERIFYING THE LOCATION AND DESCRIPTION OF OUTFALLS. ONLY RTA1 OUTFALLS ARE PRESENTED ON THE DRAWING. OUTFALL DATA IS PROVIDED AS TABLE 1 ON DRAWING G-2 AND DESCRIBED WITHIN THE ASSOCIATED DREDGING NOTES
5. THE BOUNDARY BETWEEN RTA1 AND RTA2 PRESENTED IS BASED ON A FIGURE IDENTIFIED IN THE EPA FEASIBILITY STUDY (2011).

REV	DATE	DESCRIPTION	DRN
C2	10.31.17	RTA1 65% REMEDIAL DESIGN TO RD GROUP	SRN
B	12.21.16	RTA1 35% REMEDIAL DESIGN - CAPPING AND ISS	SRN
A	10.31.16	RTA1 35% REMEDIAL DESIGN - DREDGING AND TREATMENT	SRN

Gowanus Canal
Remedial Design
Group

Geosyntec consultants
7 GRAPHICS DRIVE, SUITE 106
EWING, NEW JERSEY 08628, USA
PHONE: 609.895.1400

Beech and Bonaparte
engineering p.c.
an affiliate of Geosyntec Consultants

TITLE
EXISTING BATHYMETRY PLAN (STA. 16+00 TO 24+00)

PROJECT
REMEDIATION TARGET AREA (RTA) 1
65% REMEDIAL DESIGN

SITE
GOWANUS CANAL SUPERFUND SITE, BROOKLYN, NEW YORK

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY	JMG	DATE	OCTOBER 201
DRAWN BY	SRN	PROJECT NO.	HPH106A
CHECKED BY	JMG	FILE	HPH106A-DR0
REVIEWED BY	MWS	DRAWING NO.	
APPROVED BY	JFB	DR-3 OF 22	

NOT ISSUED FOR CONSTRUCTION

A4