PRELIMINARY GEOTECHNICAL SERVICES

SOUTH CAPITOL STREET BRIDGE

WASHINGTON, D. C.

- Prepared for -

HNTB, Inc.
Arlington, Virginia

- Prepared by -

MACTEC ENGINEERING AND CONSULTING, Inc.
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MACTEC Project Number 3551-05-0587
May 25, 2005

MACTEC

May 25, 2005

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Subject: **Preliminary Geotechnical Services**
South Capitol Street Bridge
Washington, D.C.
MACTEC Project No. 3551-05-0587

Dear Mr. Clark:

MACTEC Engineering and Consulting, Inc. (MACTEC) is pleased to submit this report of our preliminary geotechnical services for the South Capitol Street Bridge project in Southeast Washington, D.C. Our services were provided in accordance with MACTEC Proposal No. PROP04WASH.237B dated December 6, 2004 and authorized by you on February 28, 2005. This report presents a review of the information provided to us, a discussion of the site and subsurface conditions encountered based on data available, and our preliminary geotechnical recommendations. The appendices contain site location plan, an estimated subsurface profile, and tables and graphic presentations that summarize the data analyzed and the results of our calculations.

We would be pleased to discuss our recommendations with you. We look forward to serving as your geotechnical engineer on the remainder of this project and on future projects.

Very truly yours,

MACTEC ENGINEERING AND CONSULTING, INC.

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Project Engineer

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Chief Engineer
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1.0 PROJECT INFORMATION

1.1 Project Overview

Replacement of the Fredrick Douglas Memorial Bridge (aka South Capitol Street Bridge) will be part of the South Capitol Street Corridor Street Improvements. The study corridor extends south from the U.S. Capitol Building to the Anacostia River. The corridor extends across the river and connects with north- and southbound I-295 and southwest bound Suitland Parkway. The improvements will necessitate the replacement of the exiting South Capitol Street Bridge, which is an aging structure. The new bridge type has not been developed, but it is recognized that the new bridge should be architecturally distinguished.

The location and type of the new bridge is yet to be determined. The north approach location will depend on the height of the bridge. The existing approach begins at "O" Street, but the prevailing thought is that the new bridge can be lowered, which will enable the approach to begin in the vicinity of Potomac Street. Several north approach options being considered include at-grade, circle and oval intersections with Potomac Avenue. Potomac Avenue is located about 500 feet north of the river's edge.

The existing bridge crosses the Anacostia River on a heading of about S 70^{o} E. The new bridge alignment places the bridge location south of the existing bridge on a heading of about S 45^{o} E. The approximate new bridge length would be about 2,500 feet. The planned south approach location is expected to be located in the vicinity of the intersection of South Capitol Street and the Suitland Parkway. Several south approach options are being considered including at-grade and traffic circle intersections.

As noted the bridge type is yet to be developed. The number of substructures, type, and location will be a function of the bridge type selected and corresponding span lengths. A central bascule pier will be constructed as a movable span that will permit two-way river traffic. The bridge is expected to have at least six travel lanes centrally divided by a raised median or a low barrier wall. Pedestrian and bicycle paths will be included.

Drawing 1 in Appendix A shows South Capitol Street Corridor Study Area and includes the general location of the new bridge crossing the Anacostia River.

1.2 Information Provided

The essential information provided to us includes:

1. As-Built plans for the existing South Capitol Street Bridge. These plans include the soil borings that were performed. The plans were prepare by Mojesky and Masters and dated December 1943.

1.3 Scope of Work

MACTEC's scope of work is defined by its proposal dated December 6, 2004. Specifically, the scope was limited to developing preliminary geotechnical engineering recommendations for the replacement bridge. The scope of work did not include any sampling or testing; rather the recommendations to be provided were to be based on available data and subsequent analyses. The scope of services does not include assessment of site surface, subsurface, or ground-water conditions for the presence of pollutants, hazardous substances, or contaminants or the delineation of wetlands.

1.4 Authorization

Authorization for providing preliminary geotechnical services was provided to MACTEC via the Agreement between HNTB and Consultant dated February 28, 2005. MACTEC is also under separate contract to evaluate environmental concerns in the study corridor.

2.0 SITE CHARACTERIZATION

2.1 General

This section reviews the site surface, geologic, and available boring and laboratory test data. Based on this review a generalized statigraphic section has been developed and is presented in Appendix A as Drawing 3. Engineering properties have been developed for the various major stratigraphic and substatigraphic units. These properties were used for engineering analyses to determine probable foundation types and other pertinent project considerations.

2.2 Site Conditions

A reconnaissance of the site was made by Mr. J. Christopher Giese, P.E. of MACTEC on May 24, 2005. The purpose of the site visit was to document conditions that could affect our recommendations. The project site is located in Washington DC, SE about 1.5 miles south of the U.S. Capitol Building as noted on Drawing 1 in Appendix A. Photographs were taken during the site visit and are included in Appendix B.

2.1.1 West Approach

Photographs Nos. 1 to 4 represent site conditions in this area. The west approach consists of a stone-faced abutment that is about 20 feet high descending to local grades within a distance of about one city block. The general area in the west approach is level at elevations of about +15 feet. South of Q Street, a few buildings and a fuel/oil storage depot is present to the south of the existing bridge. The new alignment will pass through this depot. A concrete preparation plant is located just south of the fuel depot. Also south of Q Street, another concrete preparation plant is located just north of the bridge.

2.1.2 River Environment

Photograph No. 5 represents conditions in the river area. There are several loading docks present along the west bank of the river that serve the fuel depot and the concrete preparation plants. The river bottom gradually slopes towards the middle of the river from each side to a dredged channel that is about 20 feet deep and 400 feet wide. A single bascule pier serves the existing bridge. This movable span permits two-way river traffic. A single unloading dock for fuel is present on the east bank of the river in the vicinity of the new bridge alignment. A levy about 8 feet above the west approach area elevation lines the west river bank.

2.1.3 East Approach

The east approach appears to be a continuation of fill that was used to develop the Anacostia Naval Air Station (ANAS). Presently this area is roughly level, gravel-covered, and used as a bus parking lot as noted in Photographs 6, 7, and 9. A mound of fill about 30 feet high (seen in the right side of Photograph No. 10) is present at the north end of the ANAS, but the new alignment will probably be located just up to its edge. The new traffic circle for the west approach will be constructed in an area with several roads and one three-story building (noted in the left side of Photograph No. 10). Photograph 8 shows the existing bridge Middle Ramp and Ramp A abutments

2.2 Geologic Conditions

The South Capitol Street Bridge Corridor is located in the Coastal Plain Physiographic Province. The Coastal Plain consists mainly of marine sediments which were deposited during successive periods of fluctuating sea level and moving shoreline. The formations dip slightly seaward and several are exposed at the surface in bands paralleling the coast. Many beds exist only as fragmental erosion remnants sandwiched between more continuous strata above and below.

The soils in this province are typical of those laid down in a shallow sloping sea bottom: sands, silts, and clays with irregular deposits of shells. Some of the existing formations contain predominantly plastic clays interbedded with strata of sands and poorly consolidated limestones. Others contain predominantly sands and chalky or porous limestones with local lenticular deposits of highly plastic clays.

Locally the South Capitol Bridge site is characterized by the Pamlico formation of recent Pleistocene Age. It is entirely fluvial and estuarine and consists chiefly of sand, gravel, and silt, with organic silts encountered in estuarine environments. Artificial fill has been used to develop land in the vicinity of estuarine environments. The Pamilco formation is characterized by alluvial deposits underlain by terrace deposits that extend to about -40 to -60 feet in elevation. The Potomac Group is present beneath the Pamlico formation and consists of gray to pink silty to clayey feldspathic sands that overlie greenish-gray, mottled red and brown silts and clay that are moderately to highly plastic and montmorillonite and illite rich.

2.3 Available Data Sources

The following data sources have been reviewed to characterize the site and subsurface conditions:

1. Existing South Capitol Street Plans by Mojesky and Masters, 1943
2. Washington Metro Green Tunnel under Anacostia River Geotechnical Borings
3. Anacostia River Bridge (Barney Circle Freeway) MACTEC Project No. (MPN) 482-8409
4. Pennsylvania Avenue Bridge widening MPN 482-8433B
5. BAFB VMF and RDS Sites, MPN 482-9460
6. Barney Circle Freeway East, MON W1-8628B
7. Pennsylvania Oil/Grit Separators, MPN 482-1901
8. Barney Circle Freeway West, MPN-8628A
9. New Main Terminal Regan National Airport; MPN
10. Anacostia Freeway Bridge 505 Widening, MPN 482-10727
11. BAFB White House Communication Authority, MPN W7-5972
12. ANAS HMX-1, MPN W0-8046
13. SE/SW Freeway over South Capitol Street MPN W8-6821

Relevant information from the above-noted sources is presented in Table 2.1. This table lists the engineering properties and characteristics according to strata type as defined in Section 2.4. The purpose of developing Table 2.1 was to take advantage of MACTEC's knowledge of engineering properties in the vicinity of the alignment such that the representative values of each geologic stratum could be determined for analysis purposed. A map that indicates the locations of these projects (as numbered above) relative to the subject bridge is presented in Appendix A as Drawing 2.

Table 2.1 Field and Laboratory Test Data from the Sources Cited in Section 2.3

Map No	Project/ Boring No.	Stratum F						Stratum A1						Stratum A2						T1						T2						P2					
		USCS Type	N avg. bpf	Γ pcf	Em ksf	Su psf	Φ deg	USCS Type	N avg. bpf	Γ pcf	Em ksf	Su psf	Φ deg	USCS Type	N avg. bpf	Γ pcf	Em ksf	Su psf	Φ deg	USCS Type	N avg. bpf	Γ pcf	Em ksf	Su psf	Φ deg	USCS Type	N avg. bpf	Γ pcf	Em ksf	Su psf	Φ deg	USCS Type	N avg. bpf	Γ pcf	Em ksf	Su psf	Φ deg
1	**Existing South Capitol Street Bridge**																																				
	BORING E	CL	10	128.6	201	2500																				CL,SC	35	140.0	454	8000	37						
	BORING F	SC	40	135.0	495		39													CL	19	134.0	305	4750		SC	11	130.0	214		31						
	PIER-A							OH/OL	5	100.0	128	150								CL	17	134.0	284	1817								SC	47	140	551	1920	41
	PIER-B							OH/OL	10	120.0	201	15																				SC	50	140	570	2090	41
	PIER-C							OH/OL	0	100.0	50	15		SP, SC	31	135.0	419	1850	36													SC	45	140	530	1925	41
	REST PIER-D							OH/OL	0	100.0	50	100		SC	40	135.0	495		39							SC	31	135.0	417		36	SC, CL	46	140	545	2063	41
	PIVOT PIER-E													OH/SP	6	115.0	144	1000	29	CL	8	128.6	174	1275								SC	40	140	497	1883	39
	PIER-H													CL	16	139.4	273	600		CL	33	134.0	440	1638								SC, CL	69	140	704	687	43
	BORING C /PIER-J							OH/OL	11	120.0	218	1600		SP, SC, CL	16	130.0	273	4000	31	CL	33	134.0	440	8000								SC	56	140	612		43
	BORING J							OH/OL	8	120.0	167	300		SP	17	130.0	284	300	31	CL	58	140.0	630	1292													
	BORING M							ML	2	80.6	71	730		SP	7	115.0	159		29	CL	28	134.0	393	1317													
2	**Washington Metropolitan Anacostia Green Line Crossing**																																				
	FPS 54U							OH	0	100.0	50	100		SM	5	115.0	128		29													SM, SC	80	140	777	5300	43
	FPS 56U							OH	0	100.0	50	100		SM	31	135.0	419		36													SP, SC	50	140	572		43
	FPS 16U	CL	6	120.6	144	1500		OH	2	100.0	71	625		PT	6	97.2	144	500														SC, CL	60	140	644	8000	43
	FPS 20U	CL, OH, SM	13	134.0	241	1625		OH	2	100.0	71	700																				SC, CH	42	140	511	8000	43
	FPS 1U	SM, SC	23	130.0	342		35	OH	5	100.0	128	1000		SM, SC, OH	19	125.0	300	1000	33													CL, GP, S	111	140	961	8000	43
	FPS 4U	SC, SM, OL	24	130.0	352		35	OH	4	100.0	111	725		OL, SM	10	120.0	201	1000	30													SC, SM, C	113	140	969	8000	43
	FPS 48U	OH	0	100.5	50	100		OH	0	100.0	50	100		SM	0	100.0		300	28													SP, SC, S	65	140	679	3500	43
	FPS 50	OH	0	100.5	50	100		OH	0	100.0	50	200		SM	13	125.0	238		31													CL, CH, S	55	140	609	3100	43
	FPS 51							OH	0	100.0	50	100		SM, OH	5	115.0	128	1000	29													SC	50	140	572	2750	43
	FPS 53							OH, SM	0	100.0	50	100	20	SM, OH	5	115.0	128	200	29													SC	46	140	542	4000	43
3	**Anacostia River Bridge (WO-4809) / Contract No.2**																																				
	B-3													OH	11	111.6	214	1000																			
	B-8							OH	3	103.6	92	400		SM	7	115.0	159	2000	29																		
	B-9							OH	5	108.6	128	2000																									
4	**Pennsylvania Ave. River Bridge widening (W1-8433-B)**																																				
	CB-1	CL, SC	9	125.0	188	2500	27																														
	CB-2	SM, SC	19	130.0	301		33																														
	B-3							OH	1	106.7	54	200																									
	B-8							OH		102.9	50	325																									
	B-9													CL, SC		110.1		650																			
	B-10A							OH		94.0	50	870																									
5	**Vehicle Maintenance Facility and Remote Delivery Site, Anacostia Naval Air Station (482-9460-01)**																																				
	B-13	ML	7	117.9	163	1750		OH	2	100.0	77	250		MH	8	114.1	177	600	31.5																		
	B-9	ML	17	140.7	278	4250		OH	7	110.0	153	1000		SC	21	130.0	326	1400	33																		
	B-10	CL, GC, SC	18	139.4	290	4500	31	OH	5	108.6	130	1400		SC	50	140.0	572		41																		
	B-11	SM	12	135.0	226		31	OH	4	100.0	103	550		SM, SP	21	130.0	328		33																		
	B-7	ML	11	134.0	216	2750		OH	0	100.0	50	100		SC	11	125.0	214	4850	30																		
	B-3	ML	50	140.7	572	8000		OH, MH	9	106.2	184	800	31.5	SC	52	140.0	588		41																		
	B-4	CL	13	134.0	241	3250		OH	9	115.3	185	700																									
6	**Barney Circle contract No. 3 (W1-8628B)**																																				
	SB-3.2	SM, SC	6	115.0	144		29	OH, PT	2	94.7	71	250		SP-GP, SM	4	100.0	111		28																		
	SB-3.4				0																																
	SB-3.6	SM-SC, CH	10	120.0	194	2500	30	OH, PT	4	100.0	111	550																									
	SB-3.8	SM, SP, SC	11	120.0	210		30	OH, PT	2	95.6	71	250																									
	SB-3.11	SM	14	125.0	250		31																														
	SB-3.15	SC, SM, OH CL	13	125.0	238	3250	31	OH	3	100.0	92	400																									
	SB-3.19	OH, SM, CH	30	130.0	411	8000	36	OH	2	100.0	71	250																									
	CB-1	SC	13	122.3	238		31																														
7	**Pennsylvania Avenue Oil Grit Separators (482-9101-01)**																			CH	25	139.4	365	6250													
	B-1	SM	16	130.0	268		31																														
	B-3	ML, SM	8	120.0	174	2000	29	MH	5	100.0	128	700								CH	22	139.4	336	5000													
	B-4	CL, SM	10	134.0	201	2500	30	OH	5	100.0	128	700																									
8	**Barney Circle contract No. 1 (W1-8628A)**																																				
	SB1.1	SC	10	120.0	197	2500	30	OH	8	120.0	174	1150	23																								
	SB1.3	SC, CL	12	118.9	230	3000	31	OH, PT	7	100.0	164	1000																									
	SB1.5	CL, SC, CH	10	134.0	201	2500	30	OH	9	110.0	191	1300																									
	SB1.10	CL, SC	8	128.6	174	2000	29	OH	9	110.0	191	1300																									
	SB1.14	SC, CL	12	125.0	230	3000	31	OH	5	110.0	128	700																									
	SB1.17	CL, SC, SM	14	130.0	250	3500	31																														
	SB-51																																				
9	**New Main Terminal - Washington National Airport**																																				

Table 2.1 Field and Laboratory Test Data from the Sources Cited in Section 2.3

Map No	Project/ Boring No.	Stratum F						Stratum A1						Stratum A2					
		USCS Type	N avg. bpf	Γ pcf	Em ksf	Su psf	Φ deg	USCS Type	N avg. bpf	Γ pcf	Em ksf	Su psf	Φ deg	USCS Type	N avg. bpf	Γ pcf	Em ksf	Su psf	Φ deg
	PB-1	SP	15	130.0	259		31	OL	2	100.0	71	250		CH	6	120.6	148	1500	
	PB-5	GP	10	125.0	206		30												
	PB-7	CL	10	134.0	198	2500		ML	1	100.0	50	100		SM, SC	28	125.0	394		36
	B-3	SP	7	115.0	159		29												
	B-5	SP	9	115.0	188		29												
10	Anacostia River Bridge 505 Widening (482-1027-07)																		
	B-4							OH	3	82.9	92	4000		CH	8	128.6	174	2000	
11	White House Communication Authority																		
12	HMX-1 (W6-5280)																		
	CFB-1	SP	5					OH, SM	1	104.3	50	100		SC,SM,GM	16	130.0	273		36
	CFD-1	ML, CL			431.6	500		OH		102.87	20	150							
13	SE/SW Freeway Over South Captol Street (W8-6821)																		
	B-1													SM, SC, CL	13	125.0	236	3250	31
	B-3																		
	AVERAGE		**13**	**126**	**241**	**3060**	**31**		**4**	**103**	**101**	**638**	**25**		**17**	**123**	**272**	**1450**	**32**

Map No	Project/ Boring No.	T1						T2						P2					
		USCS Type	N avg. bpf	Γ pcf	Em ksf	Su psf	Φ deg	USCS Type	N avg. bpf	Γ pcf	Em ksf	Su psf	Φ deg	USCS Type	N avg. bpf	Γ pcf	Em ksf	Su psf	Φ deg
	PB-1							SC, SM	36	135.0	466		38						
	PB-5							SM	24	125.0	352		35						
	PB-7	CH	27	134.0	383	6750													
	B-3																		
	B-5																		
10	Anacostia River Bridge 505 Widening (482-1027-07)																		
	B-4																		
11	White House Communication Authority																		
12	HMX-1 (W6-5280)																		
	CFB-1	CH	58	140.0	630	8000													
	CFD-1	CL		103.0	100	250								CL		140	600		
13	SE/SW Freeway Over South Captol Street (W8-6821)																		
	B-1	CL, CH	37	140.0	470									SM, SC	77	140	758		43
	B-3	CL, ML	19	139.4	300									SM, SC	79	140	770		43
	AVERAGE		**30**	**133**	**378**	**3861**			**27**	**133**	**380**	**8000**	**35**		**62**	**140**	**649**	**4081**	**42**

Green — Su Values from FHWA H1-88-009
RED — $Em = 22.5 (N)^{0.65}$ $t/ft^{2,}$ Schmertman
BLUE — Φ, γ, Correlation Peck Hanson &Thornburn
PURPLE — Excluded form average

2.4 Washington Area Generalized Stratigraphic Descriptions

The stratigraphic units described herein and presented in the drawings correspond to the system used by several consultants that work in the Washington metropolitan area. Table 2.2 presents an overview of this system for describing stratgraphic units in the region.

Table 2.2 Generalized Strata Descriptions

Symbol	Description	Unified Soil Classification		Source
		Primary	Secondary	
F1	FILL: Derrived from Coastal Plain or Piedmont Souces. Might contain man-made products, generally non-organic.	SC SM	CL ML	Borrrow in historic times
A1	Very soft to medium stiff gray and brown organic clay & silt. Often highly organic under water.	CL, ML CH, MH, OH	OL PT	Post-glacial river alluvium
A2	Loose to firm gray to dark brown silty fine to mediun sand. Might contain lenses of fine gravel; might contain organics.	SM	SP	
T1	Stiff to medium stiff gray, brown, or mottled silty clay or clayey silt with lenses of brown silty fine sand	CL, ML MH	Lenses SM, SC	Terrace deposits by rivers in Pliestocene times
T0	Medium stiff to stiff dark gray organic clay with wood fragments. Often interlensed with T4.	CL OL	CH OH	
T2	Firm to dense brown to red-brown silty to clayey fine to medium sand with trace gravels & occasional cobbles.	SM SC	SP SW	
T3	Firm to very dense brown to red-brown fine to coarse sand with some silt and gravel, occasional cobbles.	SM SW	SP GM	
T4	Firm to dense gray to gray-brown fine to medium sand, with some silt, fine gravel, lenses of gray clay. Occ. sl. organic.	SM SP	SW	
T5	Firm to very dense gray to gray-borwn fine to coarse sand with some gravel, some to tr. silt, var. cobbles at base.	SW SM	SP BM	
P1	Hard mottled red-brown and gray, gray-green, tan highly plastic clay or silt, little to trace fine sand	CH MH	CL ML	Potomac fomation of Cretaceous age
P2	Firm to very dense light gray to tan silty or clayey fine to medium sand, with pockets of silty clay & trace gravels.	SM SP	SP	
P3	Hard gray-green or blue-green silty or sandy clay, clayey fine to medium sand, occassional fine gravel	CL SC	ML SM	
P4	Dense light gray, tan, buff, white silty or clayey fine to mediun sand with some gravel	ML SM	MH	
D	Residual soil or saprolite (decomposed rock). Fine sandy silts with rock fragments, trace mica	SM GP		Weathered fr. crystalline rock
WR	Weathered and jointed bedrock. RQD 0 to 50%			Metamorphic schist and gneiss bedrock
R	Bedrock, weathering and jointing increasing with depth. RQD depends jointing; sound rock can be > 75%.			

2.5 Generalized Stratigraphic Subsurface Profile along the New South Capitol Street Bridge

2.5.1 Development of the Subsurface Profile

The information provided on the 1943 drawings was used to develop an estimated subsurface profile along the existing South Capitol Street Bridge. This information represents the best available geotechnical information. Interpretation of the previous boring data considered the available data sources cited in Section 2.3 as well as the methodology currently used regionally by consultants to describe Washington area subsurface area subsurface stratigraphy as noted in Section 2.4.

The profile developed includes ground surface, water surface, and sounding elevations based on the topographic plans provided to us. The intention of the report is to use this profile as the basis for providing preliminary recommendations for the new bridge. It is recognized that the new alignment is not fixed and that the new bridge will be slightly skewed in relation to the exiting bridge's alignment. This is not a problem. Once the new alignment is determined, the approximate subsurface conditions at any specific location of the new bridge can be considered equivalent to that at a specific station of the existing bridge by projection directly north from the new alignment.

Drawing 3 in Appendix A is a plan drawing of the existing South Capitol Street Bridge that indicates the locations of the specific sections evaluated. Drawing 4 represents an estimated subsurface profile along the existing South Capitol Street Bridge.

2.5.2 Subsurface Stratigraphy Review South Capitol Street Bridge Area.

Five fairly distinct subsurface strata exist in the vicinity of the new South Capitol Bridge alignment. These include:

FILL - Its source and type are not known and it is expected to vary, but our experience is that they would likely be sandy clays with possible construction debris. On the west approach side it is nominally thick but up to about 20 feet thick near the river. On the east approach side is about 10 feet thick.

Soft Alluvium (A1) - It consists of very soft, gray, fine sandy organic silt, (aka river mud). It is present in the river environment and is about 20 to 30 feet thick, extending to about -50 feet in elevation in the center of the river channel. It is about 15 feet thick on the east side extending to about elevation -22 feet. This stratum is covered by fill on the east side.

Alluvial Sand and Gravel (A2) - This is recent river fluvial deposits of mostly firm, occasionally dense, clayey sands and gravel. It generally underlies the A1 stratum and is about 10 to 15 feet thick. The bottom of this stratum is near about -25 feet in elevation, but is depressed to about -60 feet in the river channel area.

Terrace Deposit Clayey Sands and Gravel (T2) - Consists of gray and yellow clayey and silty sands with clay and silt lenses and occasional gravel. This stratum was encountered under the A1 stratum on the west approach side and extends to elevation about -20 feet.

Terrace Deposit Clays (T1) - This stratum typically consists of gray, blue, and red hard to very hard clays with sandy clay lenses. It is typically 10 feet thick, except in the east approach area where it is estimated to be over 40 feet thick. The bottom of this stratum ranges from about -40 to -60 to -70 feet for the west approach, river channel, and east approach respectively.

Potomac Group Clayey Sands (P2) - This stratum consists of gray, blue, and green, dense to very dense clayey sands. It extends to elevations deeper than -200 feet.

2.5.3 Foundation Types for the Existing South Capitol Street Bridge

The existing bridge is supported mainly by spread footing type foundations. In the west approach area the footings bear at nominal depths (<8 feet) in the fill or near the top of the A2 stratum. In the river environment the footings bear from -45 feet in elevation on the west side of the river, descend to -90 feet at the bascule pier, and ascend to -35 feet on the east side of the river. The river footings typically bear in the P2 stratum but also bear in the T1 stratum on the east side of the river. Ramp and Bridge piers on the east side of the river are supported by piles below cap that are located in the fill about 6 to 8 feet fellow the ground surface. Concrete piles of unknown size and number were designed to carry 25 tons and extended to about -22 feet in elevation, which would place the tips in the A2 or T1 strata.

2.6 Engineering Properties for the Subsurface Stratigraphic Units

Engineering properties for the various stratagraphic units at select locations have been developed for the purpose of performing analyses on which the preliminary recommendations are based. Field and laboratory test data from the sources cited in Section 2.3 are presented in Table 2.1. These sources were used to develop engineering properties for analysis. Engineering correlations and calculations, as well as engineering judgment, were used to develop the engineering properties presented in Table 2.3

Five sections have been selected for foundation analysis. These sections represent different but typical sections for the site. These include the bridge approach areas, the west and east sections of the river, and the central bascule area. The locations of these sections are shown on Drawing 2.

Table 2.3 - Properties for the Subsurface Stratigraphic Units

Stratum	Thickness t ft	Typical SPT N bpf	Density γ pcf	El. Modulus E_m ksf	Unconf. Comp. Strength, U_c psf	Internal Friction Angle, ϕ deg
Section A - West Approach						
F	7	12	126	236	3176	31
A1	-	-	-	-	-	-
A2	15	25	123	272	-	32
T1	13	36	136	380	3809	-
T2	21	37	133	380	-	35
P2	200+	82	140	651	-	40
Section B - River West						
F	-	-	-	-	-	-
A1	29	14	103	103	662	25
A2	16	32	123	272	-	32
T1	18	26	136	380	3809	-
T2	18	31	133	380	-	35
P2	200+	47	140	651	-	40
Section C - Central Bascule						
F	-	-	-	-	3176	31
A1	18	10	103	103	662	25
A2	5	18	123	272	-	32
T1	13	15	136	380	2000	-
T2	18	31	133	380	-	35
P2	200+	47	140	651	-	40
Section D - Rvier East						
F	-	-	-	-	-	-
A1	22	20	103	103	662	25
A2	14	17	123	272	-	32
T1	20	26	136	380	3809	-
T2	-	-	-	-	-	-
P2	200+	44	140	651	-	40
Section E - East Approach						
F	-	-	-	-	-	-
A1	20	1	103	103	662	25
A2	13	15	123	272	-	32
T1	64	67	136	380	3809	-
T2	-	-	-	-	-	-
P2	200+	-	140	651	-	40

3.0 PRELIMINARY RECOMMENDATIONS

3.1 General

The principal focus of the preliminary recommendation is to review several foundation types for support of the new bridge as well as possible site ground improvements that might be required for the walls, abutments, and fills required for the approaches. Several foundation types and sizes were considered for the selected sections. Discussions are included that review the merits of the various foundation alternatives. A review of the ground improvement options at the approach locations is included.

Support of the bridge substructures is possible be several foundation types. Reviews of these alternatives are presented in Section 3.2. For this preliminary evaluation we considered the following foundation types:

- shallow foundations with applied bearing pressures of 8.0 ksf
- Grade 36, driven steel HP piles, HP 12x 53, HP 12x74, and 12x84
- driven, prestressed concrete piles 12, 18, and 24 inches square
- drilled shafts 5 and 7 feet in diameter

3.2 Foundation Analyses and Results

3.2.1 Shallow Foundations

Support of the bridge by shallow foundations is generally feasible as the existing South Capitol Street Bridge is supported mostly on shallow foundations. It will not be possible to use shallow foundations in the east approach because of the soft alluvial soils that are present beneath the surficial fill. The footings in the west approach should be able to be constructed at relatively moderate depths, which reduce the need for extensive sheeting and shoring. Also, it is likely that some of the footings on the west approach could be constructed at elevations above the water table.

Construction of footings in the river, such as indicated by Sections B, C, and D, will require the use of cofferdams to construct. It would be necessary to drive sheeting to depths of about 70 to 100 feet or more and excavations to about -40 to -85 feet in elevation. The construction of bridge piers using piles for support will likely require similar construction techniques. However, the extent of dewatering, excavation, and bracing would be less as the bottom of the cap could be higher, around 30 to -40 feet in elevation.

The estimated settlements were determined for the shallow foundations. Settlement estimates of shallow foundations were made using the Schmertman 1978 method. Assumed footing sizes are 25 by 100 feet and the estimated bearing pressure is 8.0 ksf, except for Section C where the footing was assumed to be 250 by 60 feet. Bearing elevations selected were similar to the same elevations at which foundations for the present South Capitol Street Bridge were constructed. These elevations generally represent the highest practical elevation for foundation construction given consideration to subsurface conditions and scour protection. The results of these analyses are presented in Table 3.1.

Table 3.1 Estimated Settlements for Shallow Foundations

Section	Footing Elevation ft, msl	Estimated Settlement in
A	+10	4.6
B	-70	3.5
C	-85	3.3
D	-70	2.3
E	Not Recommended	

The expected settlements should be tolerable. It is recognized that a portion of the settlement will occur during construction as the substructure is constructed.

3.2.3 Deep Foundations

The estimated driving depths of several pile types to reach the 100 and 75 percent of the structural capacities of the piles were determined. The estimated depths to reach 500 and 750 each tons were determined for drilled shafts. We assumed typical lateral and moment loads to determine the deflections and associated resulting moment and shear forces for the two sizes of drilled shafts and for one of the pile types.

The structural capacities of steel piles were limited to $0.33F_y$, assuming grade 36 steel. The structural capacities of the prestressed concrete piles were limited to be $0.33f'_c$, assuming 4,000- psi concrete.

Scour was considered at locations B, C, and D. The depth of scour was assumed to be to the bottom of the A1 stratum, which is essentially soft river mud. Consequently, no pile capacity is expected to be developed within this stratum. The pile capacities were determined using the computer software DRIVEN in accordance with the Design and Construction of Driven Pile Foundations Manual by Hannigan, 1997. The capacities of drilled shafts were determined following using Ensoft Drilled Shaft Analysis Program in accordance with FHWA 1999 Drilled Shaft Manual.

The soil property input data is presented in Table 2.3. Charts appear on the following pages, one for each section analyzed, that present the allowable deep foundation capacities of the various foundation types versus elevation. A factor of safety of 2.5 and 3.0 was used to determine the allowable capacities of piles and drilled shafts, respectively. The estimated required deep foundation lengths to achieve particular axial capacities for various types are summarized in Table 3.2.

Figure 1. Driven Piles Allowable Capacities – Section A

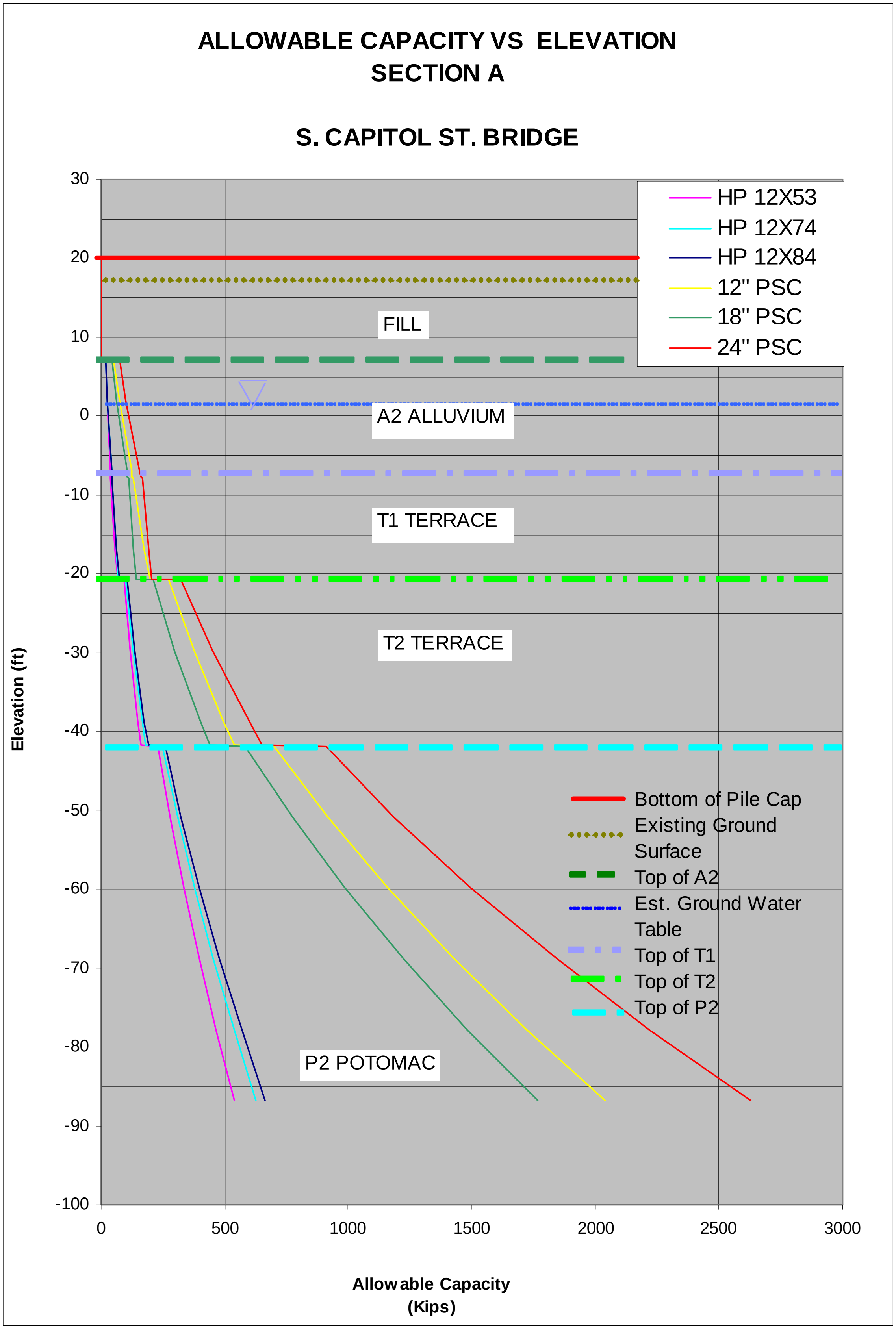


Figure 2. Driven Piles Allowable Capacities – Section B

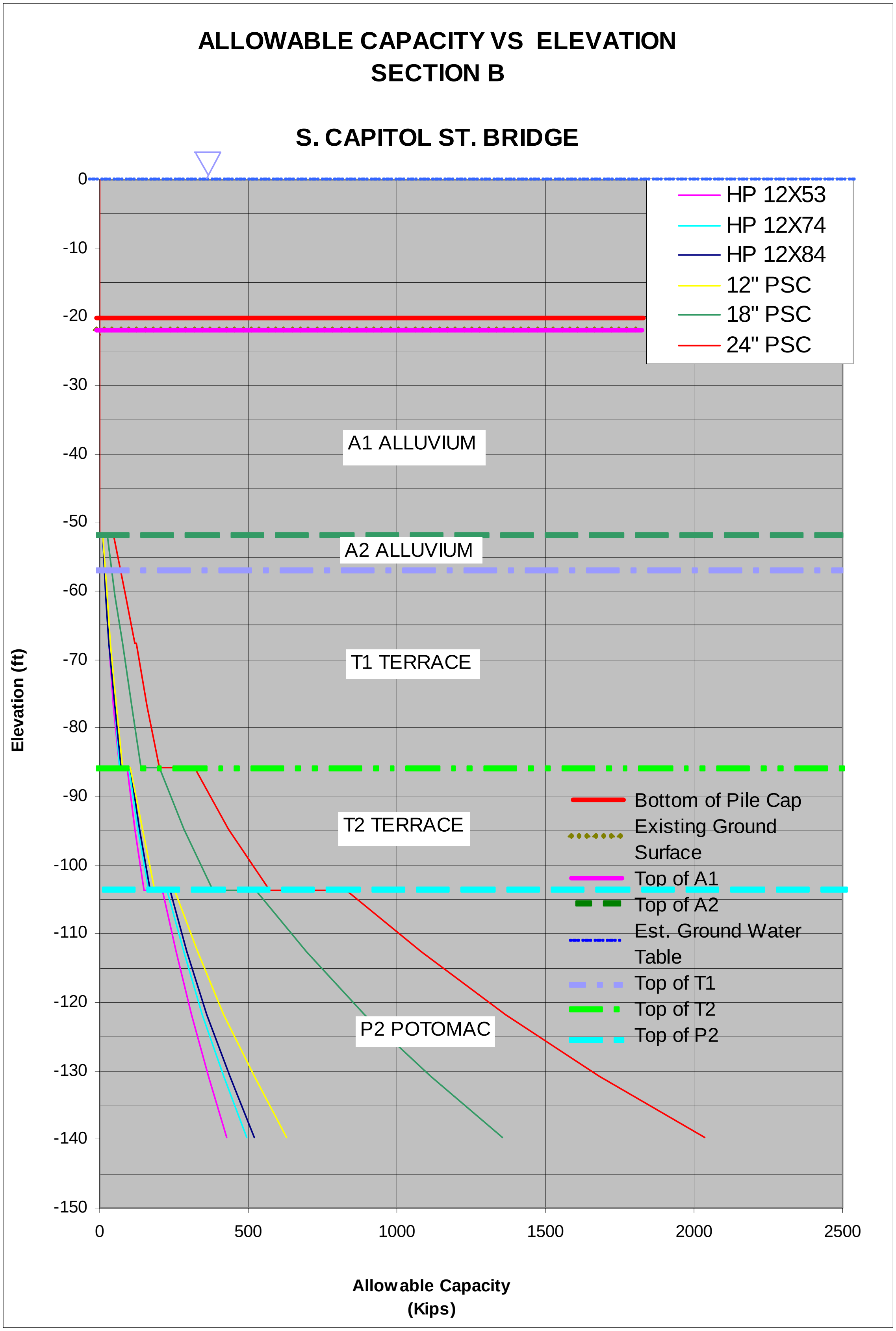


Figure 3. Driven Piles Allowable Capacities – Section C

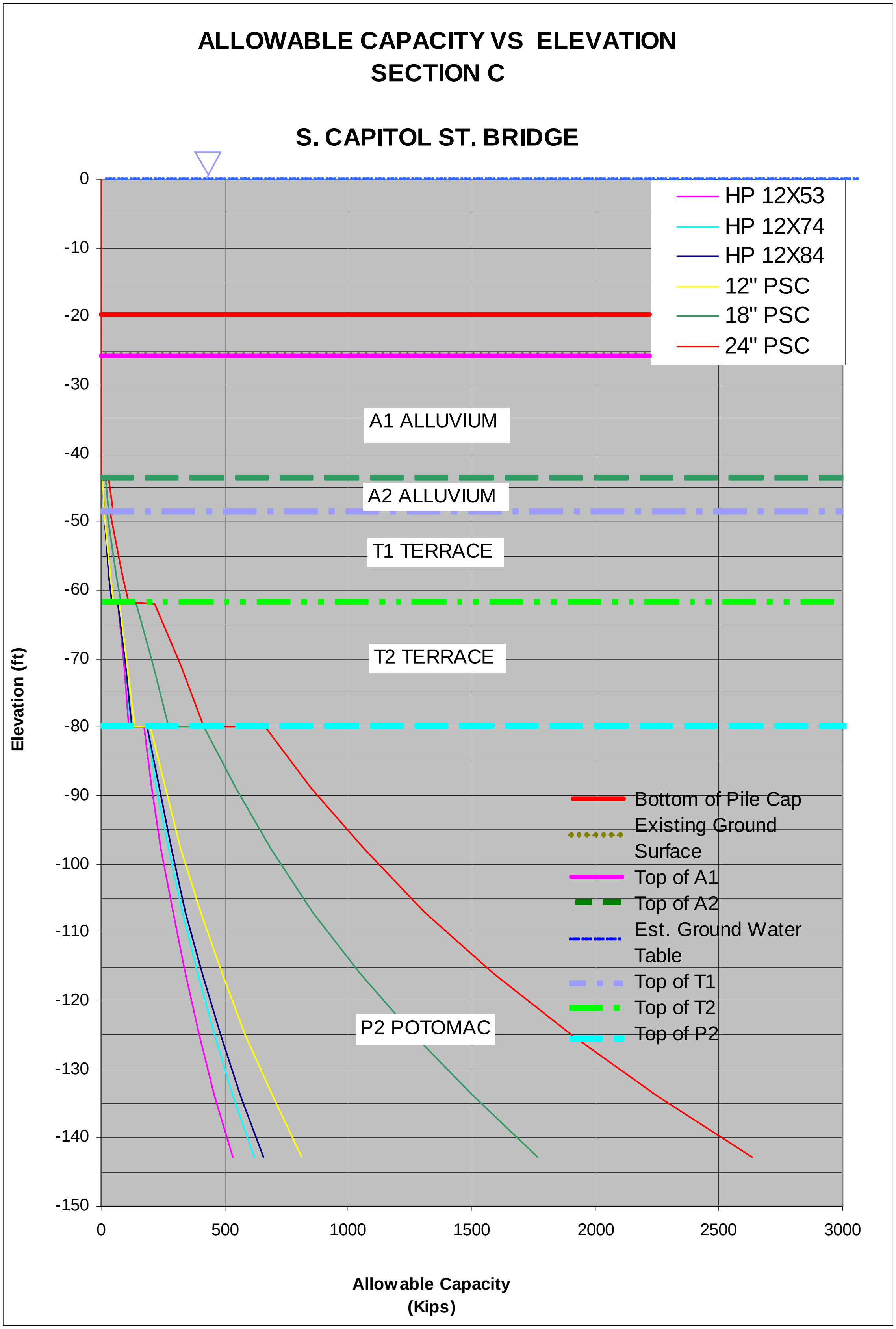


Figure 4. Driven Piles Allowable Capacities – Section D

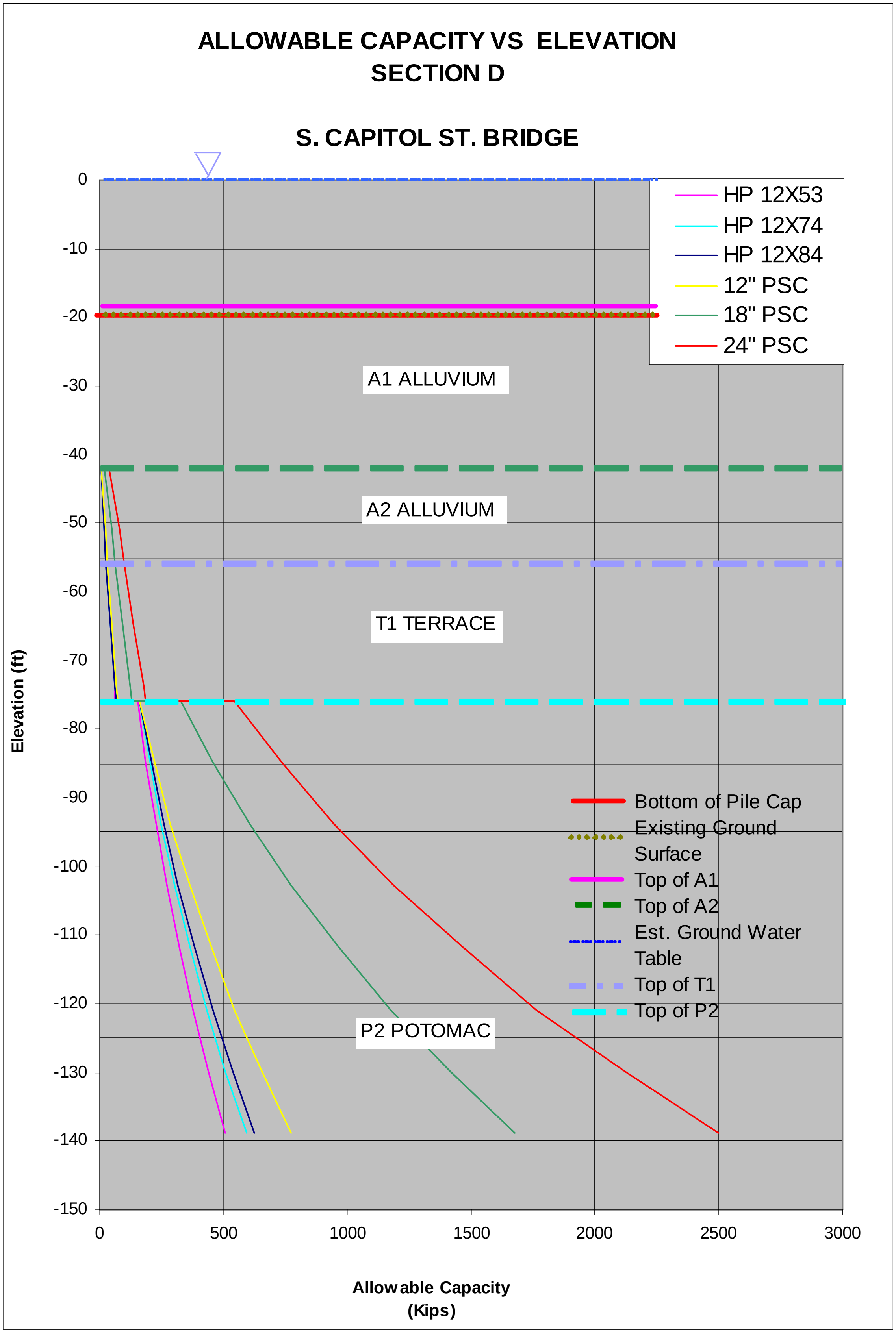


Figure 5. Driven Piles Allowable Capacities – Section E

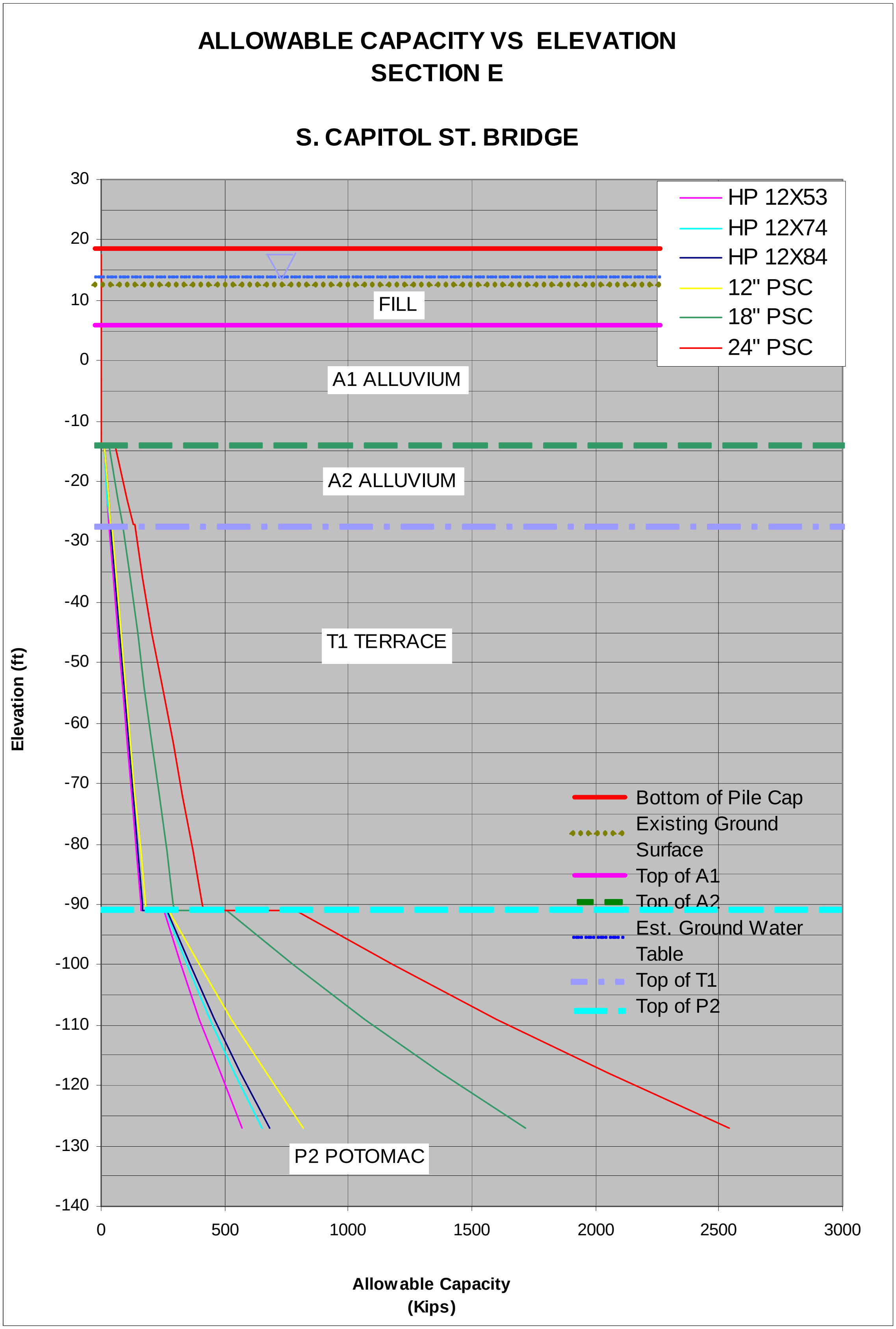


Figure 6. Drilled Shafts Allowable Capacities – Section A

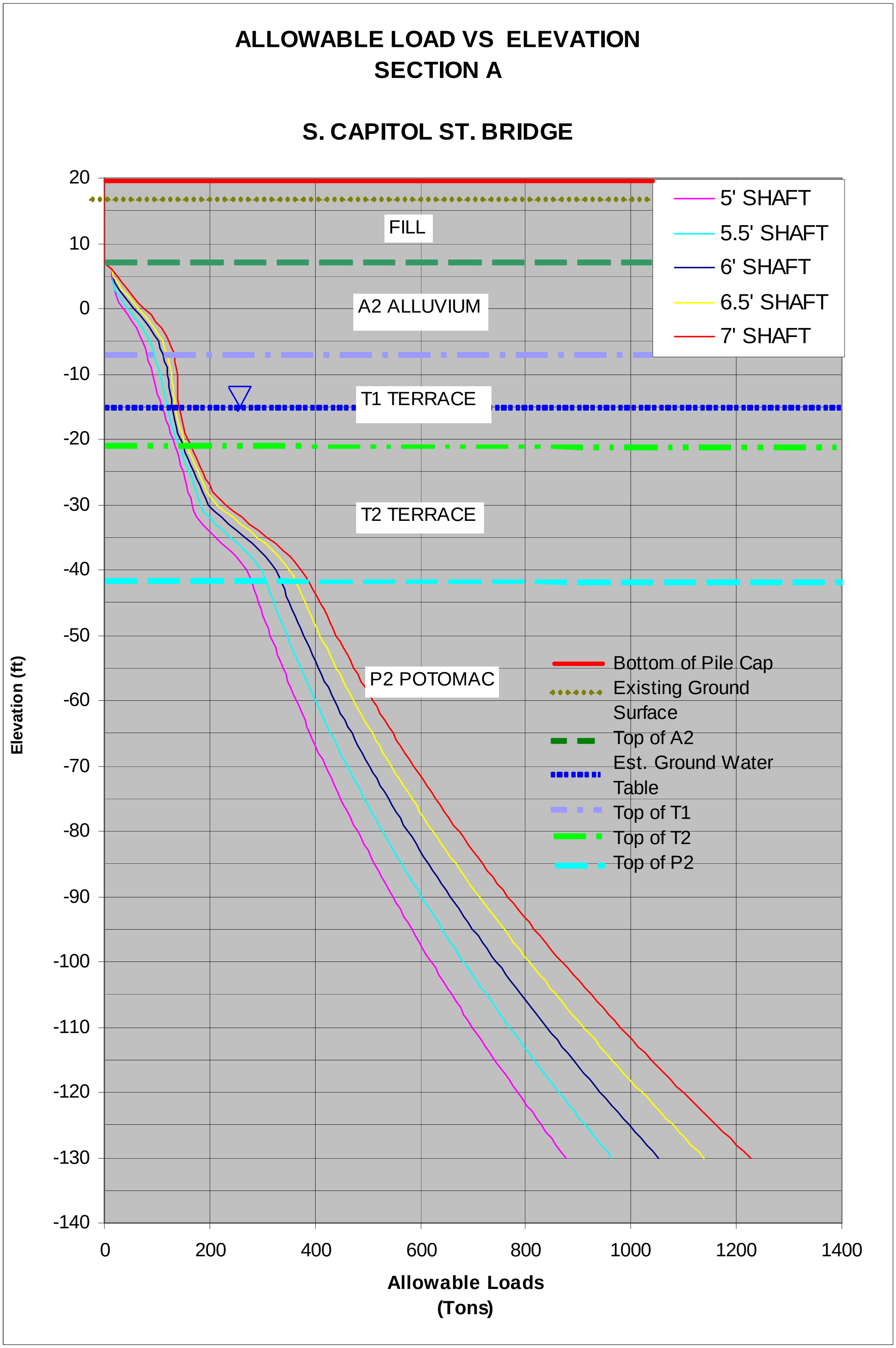


Figure 7. Drilled Shafts Allowable Capacities – Section B

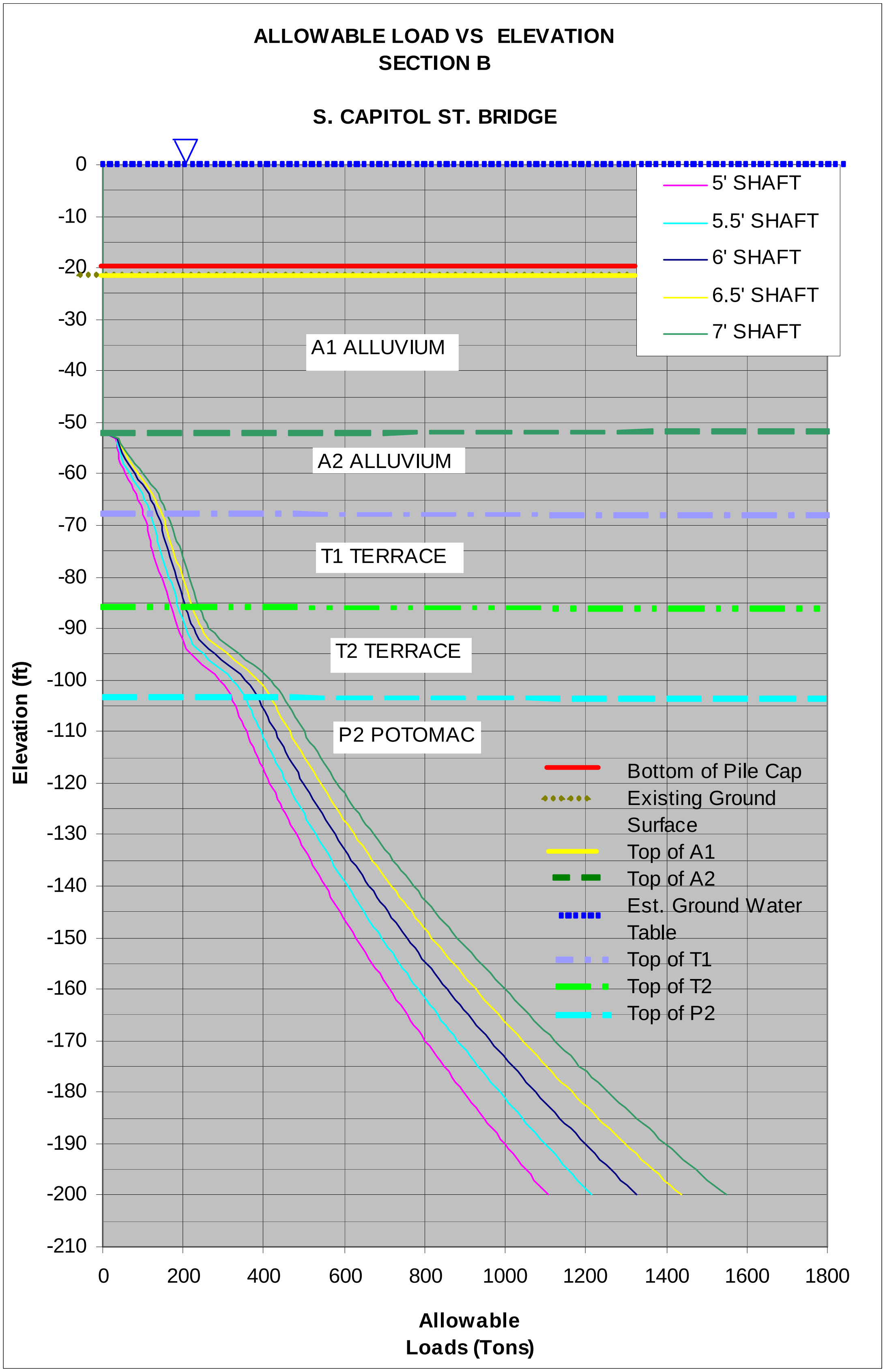


Figure 8. Drilled Shafts Allowable Capacities – Section C

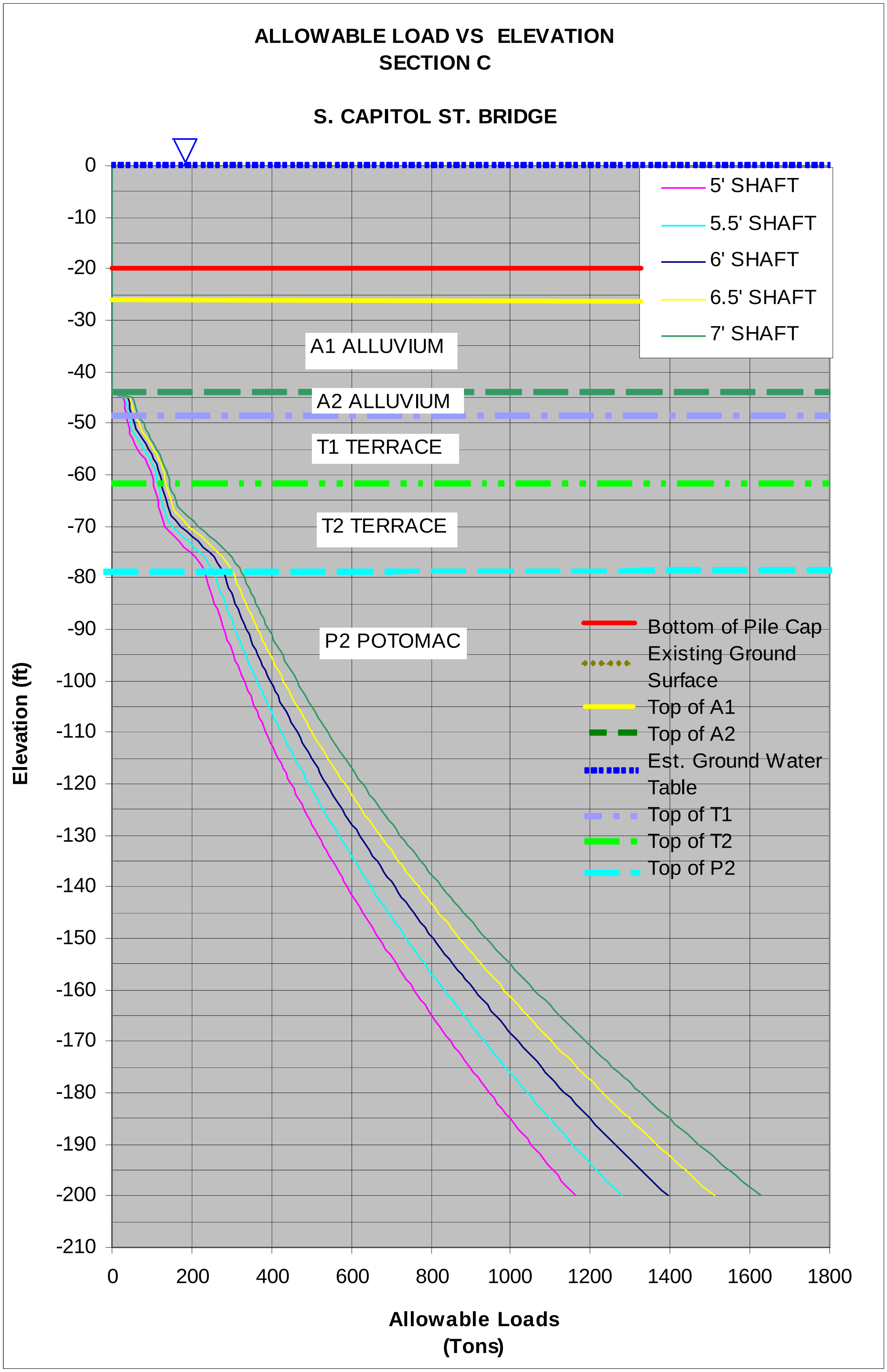


Figure 9. Drilled Shafts Allowable Capacities – Section D

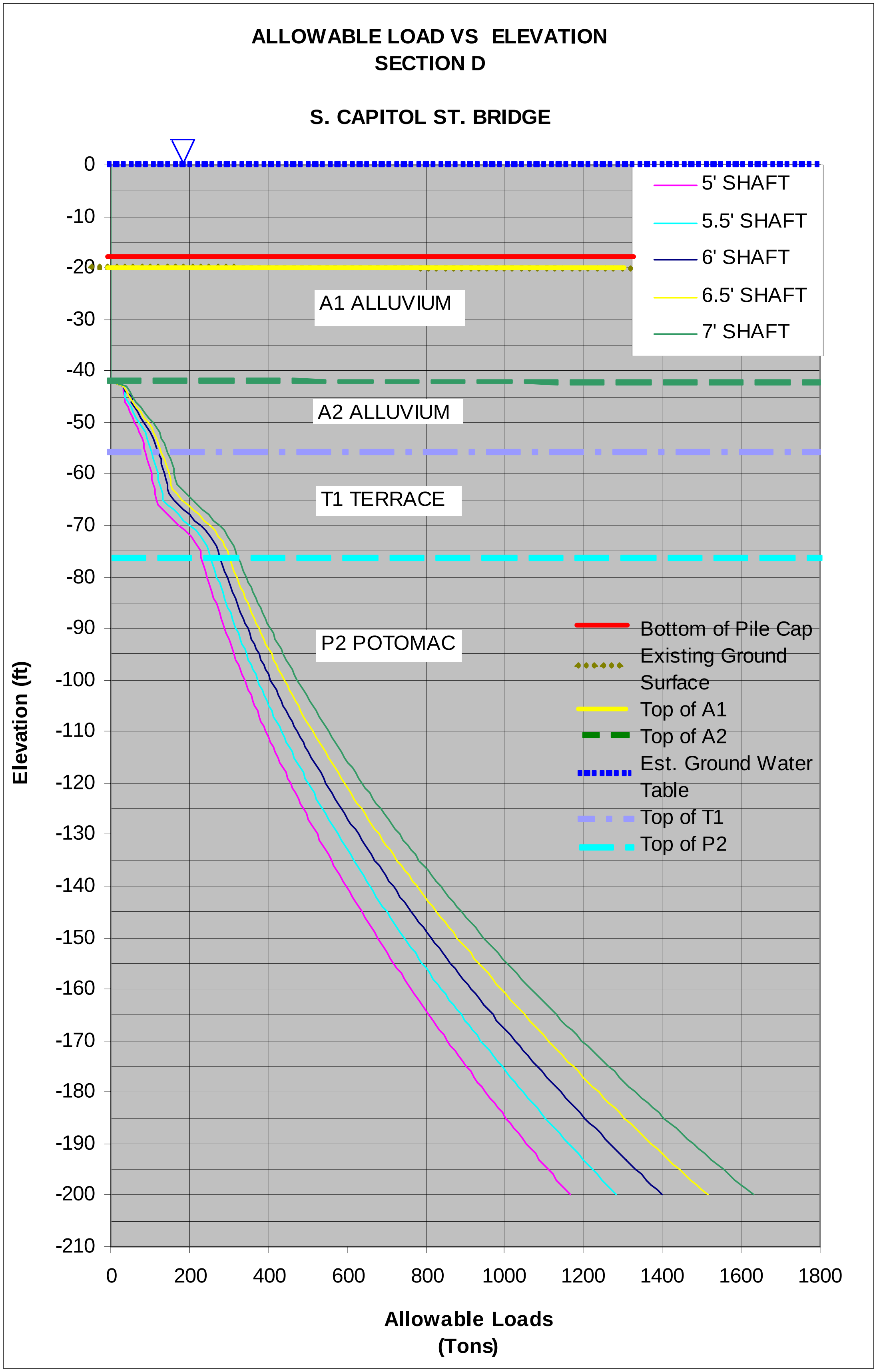


Figure 10. Drilled Shafts Allowable Capacities – Section E

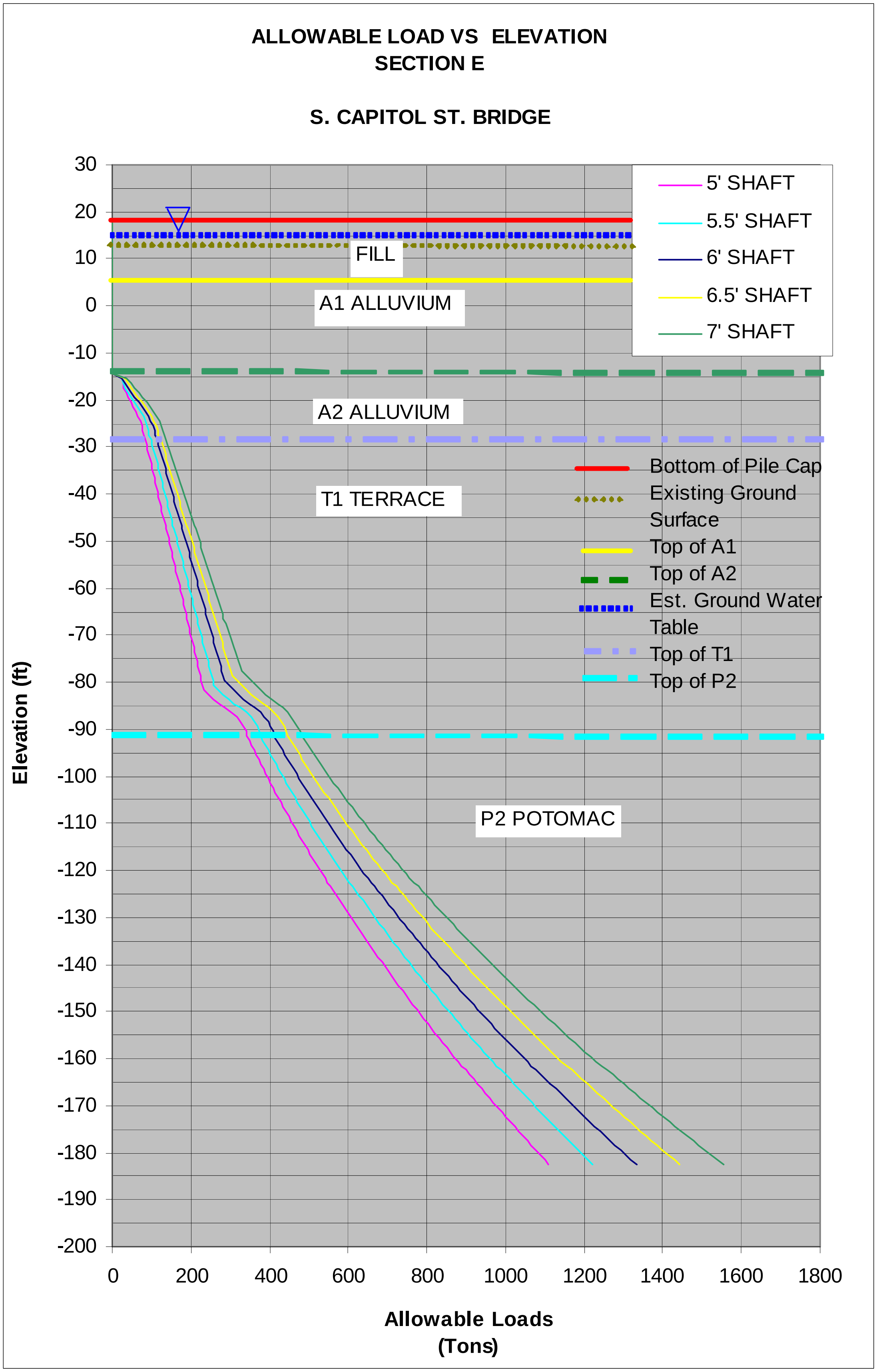


Table 3.2 Estimated Deep Foundation Capacities and Required Lengths

Location	Assumed El. Bottom of Cap, ft.	Estimated Pile Length Required, feet					
		100% of Structural Capacity, tons					
		HP 12x53	**HP 12x74**	**HP 12x84**	**12-in. Conc**	**18-in. Conc**	**24-in. Conc.**
		90	**130**	**155**	**90**	**200**	**350**
A	20	41	50	55	41	41	43
B	-20	66	66	80	66	66	69
C	-20	50	60	60	50	50	53
D	-20	56	56	56	56	56	56
E	18	74	91	103	68	79	94
		75% of Structural Capacity, tons					
		HP 12x53	**HP 12x74**	**HP 12x84**	**12-in. Conc**	**18-in. Conc**	**24-in. Conc.**
		70	**100**	**120**	**70**	**150**	**260**
A	20	41	41	46	37	41	41
B	-20	66	66	70	63	66	66
C	-20	45	52	60	45	45	45
D	-20	56	56	56	56	56	56
E	18	63	76	85	58	64	74
		Estmated Drilled Shaft Lengths, feet					
		5-foot Dia.	**7-foot Dia.**				
		500 tons	**750 tons**				
A	20	103	108				
B	-20	112	117				
C	-20	100	113				
D	-20	106	113				
E	18	134	139				

Notes:
1. The pile capacities in this table include a F.S. of 2.5.
2. The shaft capacacties in this table incluse a F.S. of 3.0.

Typical lateral capacities of deep foundations were determined by the software LPILE. We assumed fixed head conditions since each cap will be supported by multiple piles. We assumed typical lateral and moment loads to determine the deflections and associated resulting moment and shear forces for the two sizes of drilled shafts and for one of the pile types. The results of the analyses for drilled shafts are presented in Table 3.3. We only analyzed one pile type, HP 12x74, to determine typical pile responses. The assumed applied moments and shear forces are about one-fifth or less than the force applied to the shafts. The results of the analyses for the selected pile are presented in Table 3.4. Some reduction in lateral capacity should be expected for group reduction effects.

Table 3.3 Results of L-PILE Analyses of Drilled Shafts

APPLIED LOADS AND MOMENTS

Diameter	5'			7'		
Case \ Loads	Moment (ft-kips)	Lateral Force (kips)	Axial Load (tons)	Moment (ft-kips)	Lateral Force (kips)	Axial Load (kips)
I	4000	100	500	4000	100	750
II	4000	100	750	4000	100	1000
III	2000	50	500	2000	50	750
IV	2000	50	750	2000	50	1000
V	1000	25	750	1000	25	1000

SUMMARY OF MAXIMUM MOMENT, SHEAR AND DEFLECTION

Diameter		5'			7'		
Section	Case	Moment (ft-kips)	Shear (kips)	Deflection (in)	Moment (ft-kips)	Shear (kips)	Deflection (in)
A	I	4703	266	0.87	4724	191	0.31
	II	4725	268	0.87	4732	191	0.31
	III	1462	83	0.22	1494	61	0.10
	IV	1468	83	0.22	1497	61	0.10
B	I	5648	272	4.00	5781	219	1.18
	II	5785	278	4.11	5820	220	1.19
	III	1796	97	1.06	1882	83	0.31
	IV	1828	99	1.08	1892	84	0.31
	V	825	44	0.39	843	35	0.12
C	I	5633	256	3.31	5676	215	0.97
	II	5741	262	3.39	5705	217	0.98
	III	1830	88	0.87	1898	75	0.25
	IV	1859	90	0.88	1906	76	0.25
	V	837	41	0.33	858	35	0.10
D	I	5647	263	3.16	5702	215	0.89
	II	5754	268	3.23	5731	217	0.90
	III	1837	94	0.85	1906	79	0.24
	IV	1865	95	0.86	1914	79	0.24
	V	838	47	0.33	860	36	0.10
E	I	4850	204	2.96	4922	189	0.92
	II	4912	208	3.03	4944	191	0.92
	III	1524	60	0.55	1537	52	0.19
	IV	1535	61	0.56	1540	52	0.19
	V	739	32	0.14	743	27	0.06

Table 3.4 Results of L-PILE Analyses of HP 12x74 Pile

APPLIED LOADS AND MOMENTS

Size	HP12X74		
Case \ Loads	Moment (ft-kips)	Lateral Force (kips)	Axial Load (tons)
I	200	5	100
II	100	5	100
III	50	2.5	100

SUMMARY OF MAXIMUM MOMENT, SHEAR AND DEFLECTION

Size		HP12X74		
Section	Case	Moment (ft-kips)	Shear (kips)	Deflection (in)
A	I	221	32	1.11
	II	117	17	0.52
	III	59	9	0.19
B	I	213	15	2.98
	II	115	10	1.43
	III	55	5	0.48
C	I	246	21	3.98
	II	129	12	1.71
	III	60	6	0.55
D	I	234	19	2.87
	II	126	11	1.32
	III	59	6	0.43
E	I	233	22	1.85
	II	124	13	0.86
	III	59	8	0.31

3.3 Preliminary Foundation Recommendations

Based on the information available, the analyses presented herein, and available construction practice, it would appear that the following foundation types should be considered:

- Use shallow foundations for the west approach that are designed for 8.0 ksf.
- Use either pile or drilled shaft foundations for the river environment.
- If steel piles are used, use piles designed for 75 percent of structural capacity to account of possible corrosion.
- Drilled shafts offer superior performance in terms of lateral resistance.
- First, place the fill needed to build the west approaches. Drive piles after the settlement period.

3.4 Approach Fill Construction Considerations

3.4.1 West Approach

Based on the information at hand, it does not appear that ground improvement techniques will be required for the west approach. It appears that this area is represented by about nominal amounts to 20 feet of sandy clay fills that are underlain by the sand and gravel A2 stratum. This should be confirmed by borings during the final investigation

3.4.2 East Approach

General site subsurface conditions in the vicinity of the east approach are represented by 10 feet of fill situated over soft alluvial stratum A1 soils. Placement of new fill for roadways, ramps, and abutments above the existing elevations will cause large settlements, about 2 inches for each foot of new fill.

It appears that about 11 feet of fill might be needed to reach required grades. The time to reach about 95 percent settlement would be about 300 days without surcharging. The time to reach the same settlement using wick drains, spaced on 5-foot centers, would be about 60 days. The settlement time period can also be reduced by surcharging.

The use of wick drains alone is considered to be the best option at this moment. The length of the drains would be relatively short and on the order of about 30 to 35 feet, which minimizes the cost. Eliminating surcharging avoids additional construction steps and costs.

To minimize downdrag on the piles, the piles should be installed after the settlement period. Even with the ground improvement program indicated above, some post-construction settlement will occur. However, the effect on pile drown drag (piles driven after the settlement period) should be minimal since the settlement zone is a low-strength material. It will likely be necessary to use friction reducers or place cans around the piles in the new fill zone.

3.5 Retaining Walls

It is expected that most types of retaining walls can be supported by shallow foundations. The use of mechanically stabilized earth (MSE) walls is more common today and this type of walls does not require the use of concrete foundations. The soils on the west approach side should be suitable for supporting walls on most types with design bearing pressures of 4 ksf. Walls planned for the east approach will need to be constructed after the settlement period described in Section 3.4.2. Additionally, some undercutting and replacement with compacted fill might be needed prior to the placing fill for the settlement induction in order to enhance global stability of the wall. Similar bearing pressures for the east approach should be available for design provided the foundation area is treated appropriately.

3.6 Seismic Site Class Coefficient

The Site Coefficient, S, for the soil type at the site is 1.5. The Acceleration Coefficient, g, for the area is 0.75.

3.7 Preliminary Unit Costs

Estimated preliminary unit costs related to foundation construction are provided in Table 3.5 below.

Table 3.5 Estimated Foundation-Related Unit Cost Data

Item	Unit	Est. Unit Cost	Remarks
HP 12x 53 Land	lf	$24	
HP 12x53 Water	lf	$30	
HP 12x74 Land	lf	$32	
HP 12x74 Water	lf	$40	
HP 12x84 Land	lf	$40	
HP 12x84 Water	lf	$50	
12-in PSC Land	lf	$24	
12-in PSC Water	lf	$30	
18-in PSC Land	lf	$56	
18-in PSC Water	lf	$70	
24-in PSC Land	lf	$80	
24-in PSC Water	lf	$100	
Sheet Piling Land	lf	$15	
Sheet Piling Water	lf	$25	
5-ft Shaft Land	lf	$400	
5-ft Shaft Water	lf	$450	
7-ft Shaft Land	lf	$500	
7-ft Shaft Water	lf	$600	
Structural Concrete	cy	$350	
Soil Excavation Land	cy	$10	
Soil Excavation Water	cy	$25	
Load Test Shafts	ea	$75,000	
Load Test Piles	ea	$25,000	
CSL Tubes	lf	$6	Minimum six tubes per shaft
Mobilization Land	ls	8%	Percentage of total land-related foundation costs
Mobilization Water	ls	25%	Percentage of total water-related foundation costs
CSL Monitoring	ls	$25,000	
PDA Monitoring	ls	$50,000	
Retaining Wall	sf	$35	Not including backfill
Wick Drains	lf	$2.50	Includes mobilization

4.0 BASIS FOR RECOMMENDATIONS

The preliminary recommendations provided are based in part on project information provided to us and they only apply to the specific project and the bridge alignment discussed in this report. If the project information section in this report contains incorrect information or if additional information is available, you should convey the correct or additional information to us and retain us to review our recommendations. We can then modify our recommendations, as necessary, for the proposed project.

It is understood that the estimated geologic profile developed for this report is based in part on data by others and does not accurately represent subsurface conditions along the new bridge alignment. There is always a possibility that conditions between might have changed as a result of a fluctuating river environment.

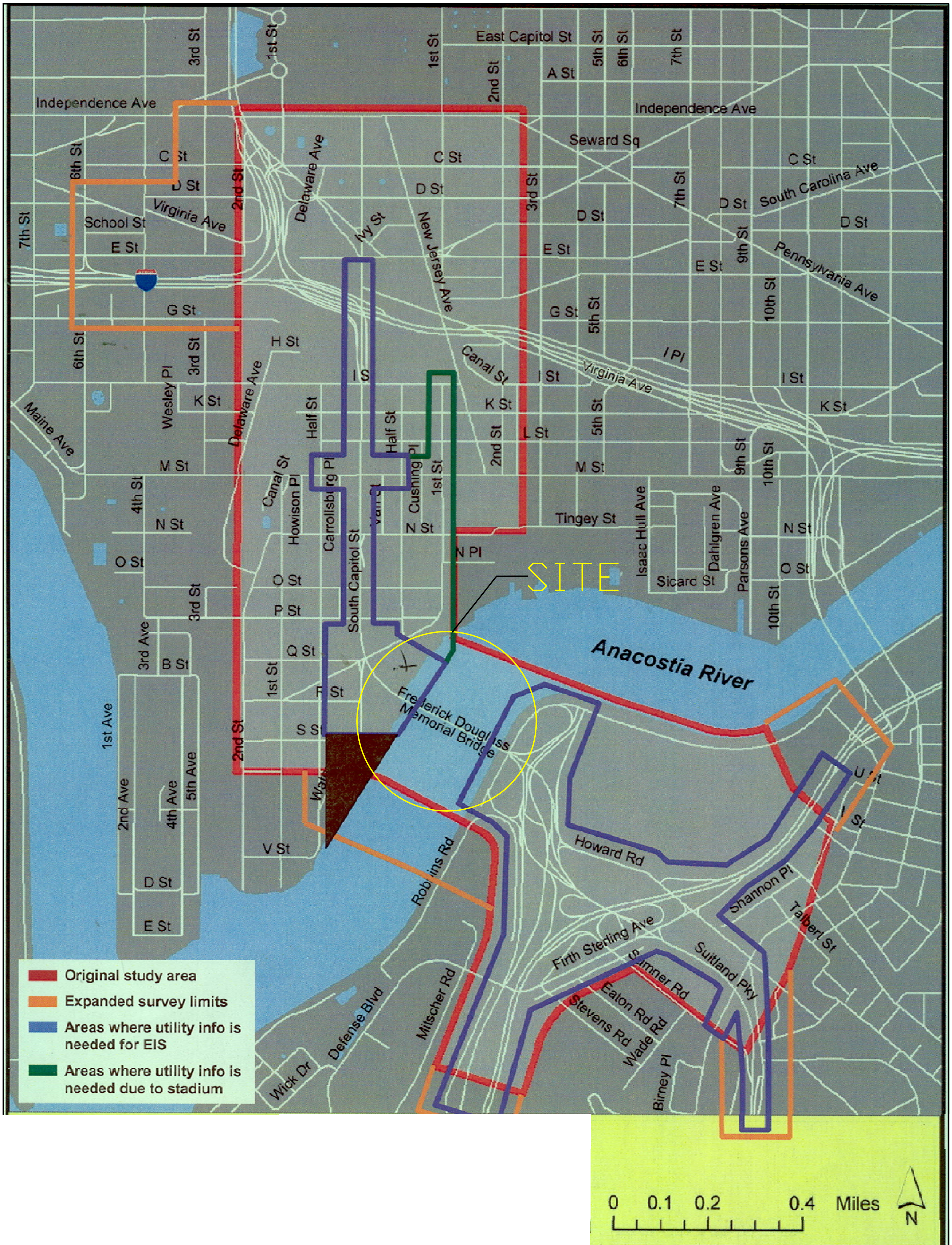
It is recommended detailed boring program be performed to determine the subsurface conditions along the new bridge alignment. The information herein, is based on existing information and might not reflect the actual conditions along the new bridge alignment. The recommendations and conclusions herein are intended to be of general assistance for preliminary engineering. They should not be used for cost or quantity estimates or design. We recommend that MACTEC be retained to perform the final investigation based upon our familiarity with the project, the subsurface conditions, and the intent of the recommendations and design.

APPENDIX A

DRAWINGS

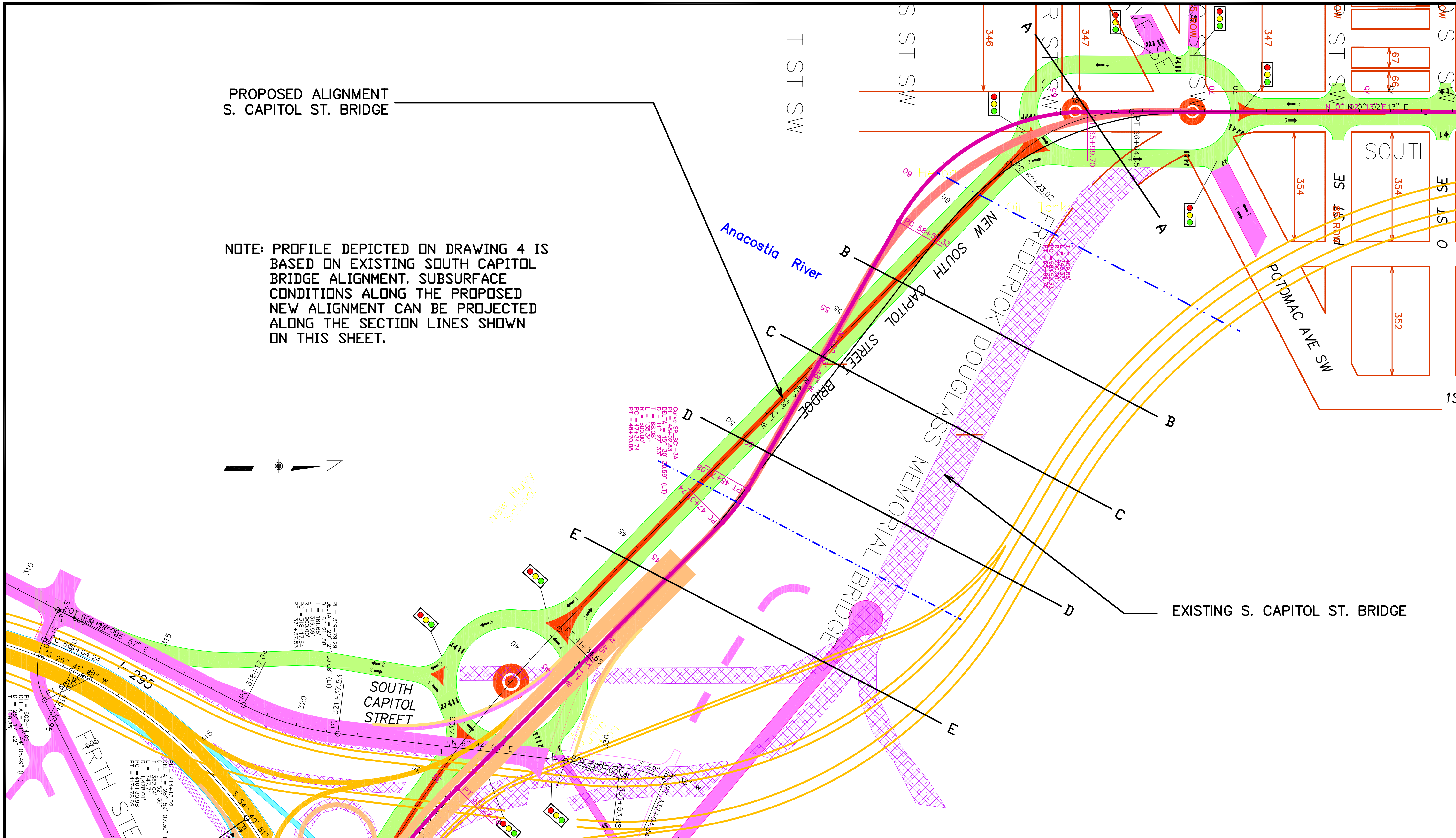
FILE: P:\2005 Projects\3551\0567 – South Capital St. Bridge\ACAD\DWG 1 – SITE LOCATION PLAN.dwg

CHECKED BY/DATE: APPROVED–BY



SOUTH CAPITAL St. BRIDGE	MACTEC MACTEC Engineering and Consulting, Inc. 22455 Davis Drive, Suite 100 Sterling, Virginia 20164	SITE LOCATION PLAN PROJECT NO. 3551–05–0567 DRAWING 1

FILE :P:\2005 PROJECTS\3551\0567-SOUTH CAPITAL St. BRIDGE\CAD\DWG 3- EXISTING AND PROPOSED PLAN.DWG



MACTEC
MACTEC Engineering and Consulting, Inc.
22455 Davis Drive, Suite 100
Sterling, Virginia 20164

DRAWN BY: NM	CHECKED BY: MIH
DATE: 5/24/05	DATE: 5/24/05
DESIGNED BY:	APPROVED BY: JCG
DATE:	DATE: 5/24/05

REVISIONS

NO.	DESCRIPTION	DATE

PROJECT: **SOUTH CAPITAL ST. BRIDGE**

TITLE: PLAN ON EXISTING & NEW ALIGNMENTS

DATE: 5/24/05
SCALE: 1" = 300'
PROJECT NO.: 3551-05-0567
DRAWING NO.: 3

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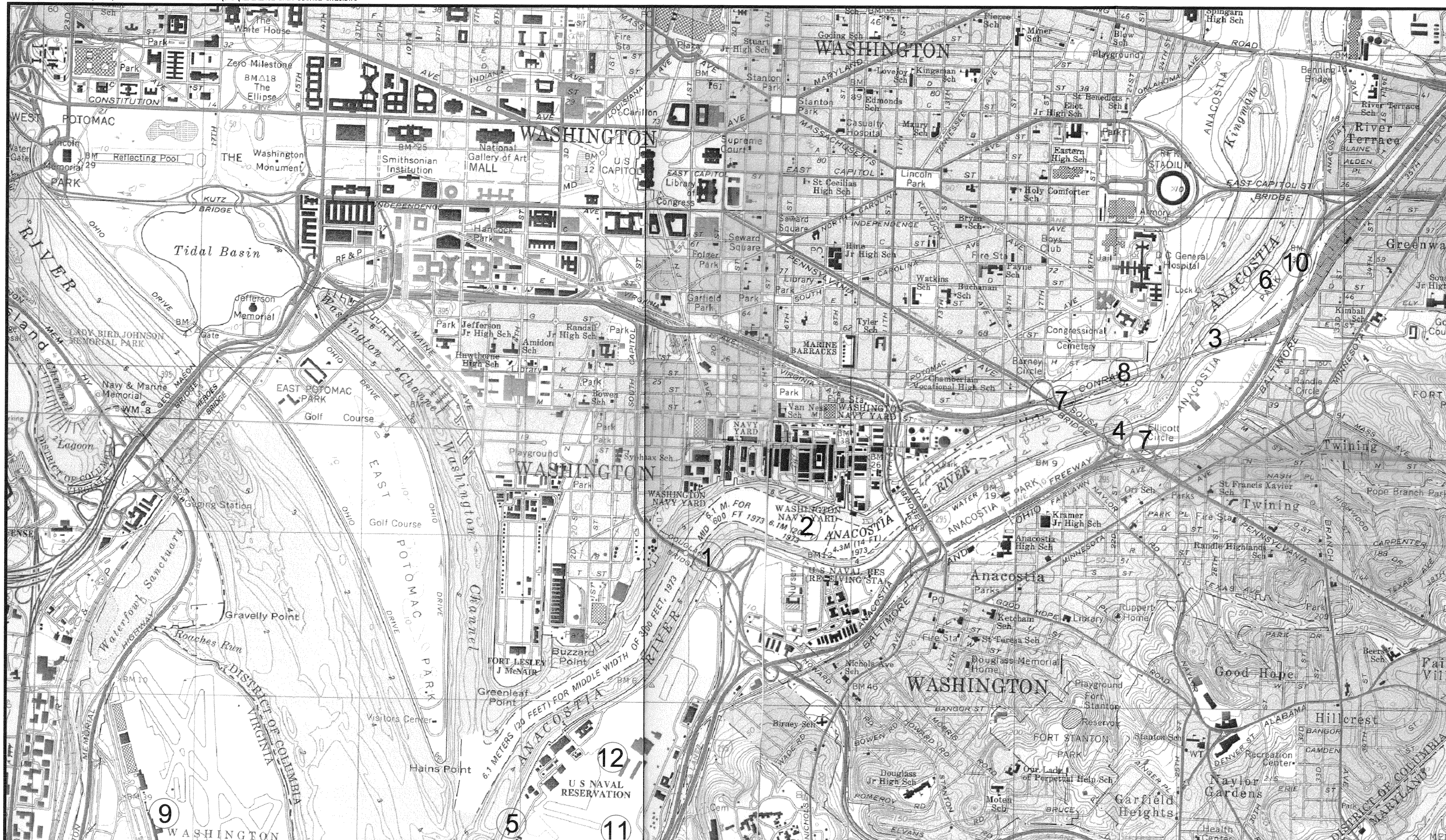

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22455 Davis Drive, Suite 100
Sterling, Virginia 20164

NOTE:
SEE REPORT SECTION 2.3 FOR DESCRIPTION & REFERENCE SITES.

DRAWN BY:	CHECKED BY:
DATE: 4/28/05	DATE: 04/28/05
DESIGNED BY:	APPROVED BY:
DATE: 4/28/05	DATE: 4/28/05

REVISIONS

NO.	DESCRIPTION	DATE

PROJECT: **SOUTH CAPITAL ST. BRIDGE**

TITLE: REFERENCE DATA SOURCE SITES

DATE:
SCALE:
PROJECT NO.: 3551-05-0567
DRAWING NO.: 2

SCALE: AS SHOWN

MATERIAL LAYERING CODES

- FILL
- Low Plasticity Inorganic Clays (CL)
- High Plasticity Inorganic Clays (CH)
- Low Plasticity Inorganic Silts (ML)
- Topsoil
- Poorly Graded Sand (SP)
- Well Graded Sand (SW)
- Silty Sand (SM)
- High Plasticity Inorganic Silts (MH)
- Peat/Organic Muck
- Poorly Graded Sand with Clay (SP-SC)
- Silty Clayey Sand (SC-SM)
- High Plasticity Organic Soils (OH)
- Clayey Sand (SC)
- Hard Zone
- Poorly Graded Sand with Silt (SP-SM)
- Low Plasticity Organic Soils (OL)
- Very Hard Zone

SOUTH CAPITOL STREET BRIDGE
OVER THE ANACOSTIA RIVER
WASHINGTON, D. C.

PROJECT NO: 3551-05-0567

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PRELIMINARY

DRAWING 4

ESTIMATED SUBSURFACE PROFILE
ALONG THE PROPOSED BRIDGE ALIGNMENT

APPENDIX B

PHOTOGRAPHS