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Approach channel analysis : field report, Belle Isle State Park and Deep Creek, Lancaster County, Virginia

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et al

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Shoreline Studies Program
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Field Report

Belle Isle State Park/Deep Creek
Lancaster County, Virginia

Approach Channel Analysis

by

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Virginia Department of Conservation and Recreation
Division of State Parks

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1.0 Introduction

1.1 Site Setting

Belle Isle State Park is located at the confluence of Deep Creek and the Rappahannock River in Lancaster County, Virginia (Figure 1). The 733 acre site has seven miles of frontage on the north shore of the Rappahannock, and it borders both Deep Creek and Mulberry Creek. It features diverse tidal and nontidal wetlands, lowland marshes, tidal coves and upland forests. It is a relatively new state park with a new boat ramp, picnic amenities, and restrooms. The park is slated for further recreational and historic development including a "deep" water access from the Rappahannock River into the mouth of Deep Creek and then to the boat ramp area.

1.2 Purpose and Scope

The Department of Conservation and Recreation (DCR) and the Kilmarnock-Irvington-White Stone Rotary Foundation are in the planning stages to deepen the approach channel in Deep Creek to -6 ft MLW by dredging. If the dredge material is beach quality sand, it could be used as nourishment along the adjacent eroding shoreline on the Rappahannock River. When dredging a new channel through a creek entrance, it is recommended that the design channel depth be limited to the same depth contour both inside and outside the creek. The 6-foot depth contour in Deep Creek, if there, would be connected to the 6-foot depth contour in the Rappahannock River. A one foot over-dredge (to -7 ft MLW) is generally acceptable.

In order to determine the suitability of sand for beach nourishment and the overall nature of the proposed dredge material, personnel from VIMS performed the following tasks:

- located and surveyed the existing tidal channel in Deep Creek to the boat ramp
- vibra-cored the subsurface of the channel and analyzed sediment samples from the cores

1.3 Data Collection Methods

A bathymetric survey of the Deep Creek channel was performed by Waterway Surveys & Engineering, Ltd. in 1997 was used to locate the channel for the initial effort. Four channel markers designate the natural channel. Aerial imagery (Figure 2) and the VIMS survey confirms that the position of the channel is approximately in the same location as the 1997 survey.

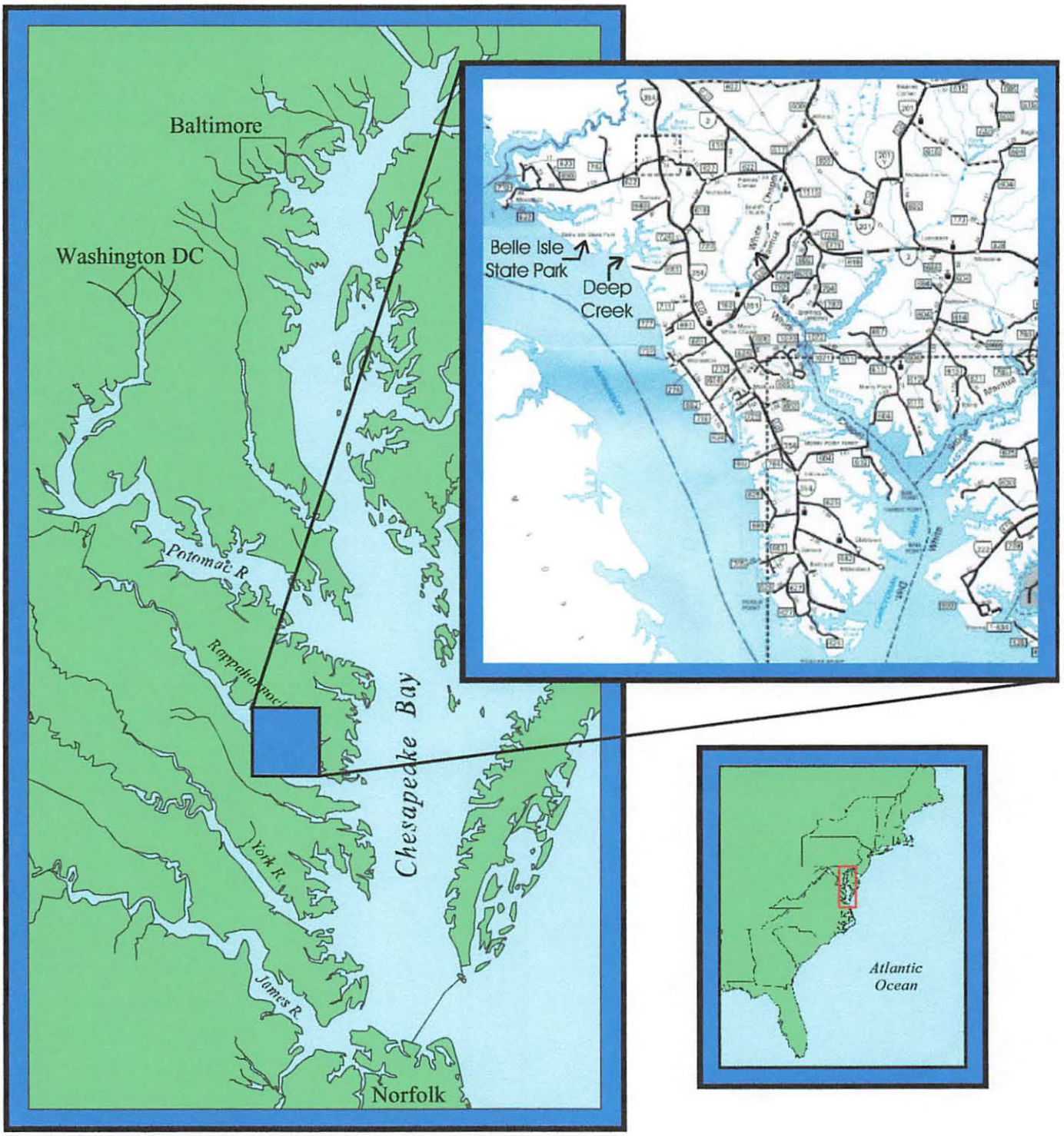


Figure 1. Location of Belle Isle State Park and Deep Creek on the Rappahannock River.

Figure 2. Aerial photo of Belle Isle and Deep Creek on June 9, 1997. Scale app. 1"=500 ft.

1.3.1 Supplemental Channel Survey

The existing channel was surveyed by cross-sections using a Topcon infrared total station from fixed land benchmarks to "dead stick" positions across the channel. The survey was tied to the MLW datum as determined by VIMS for vertical control utilizing National Ocean Service data from Urbanna and Bay Port to establish the tide range at Deep Creek (1.5 ft) and tide gage data from Windmill Point to determine tidal elevations on the survey date for time of tide calculations. For horizontal control, the survey was tied into existing nearby Park survey monuments (Table 1). In addition, VIMS established two temporary benchmarks for the survey. The benchmark information is shown in Appendix A. A new base map was created showing the proposed channel limits using our bathymetry and 1997 aerial photos (Figure 2). In order to plot our cross-sections with the proposed channel cut, a mid-channel baseline was drawn on the base map from the boat ramp (0+00) to the -6 ft MLW contour (31+10) in the Rappahannock River (Figure 3). The cross-section stations are measured in feet along this line. Surveyor designation of feet is used (*i.e.* 31+10 = 3,110 ft)

Table 1. Location of benchmarks and channel markers. Location of "A", "B", and the channel markers were determined by VIMS site survey.

Benchmark	Date	Type	State Plane Coordinates*	
			Northing	Easting
"A"	13 June 2001	Temporary	3,811,019.58	12,037,118.84
"B"	13 June 2001	Temporary	3,811,029.33	12,036,642.70
"7"	22 November 1997	Permanent	3,811,460.60	12,036,304.16
"8"	22 November 1997	Permanent	3,811,222.90	12,036,595.32
C.M. 7		Permanent	3,810,750.81	12,037,088.28
C.M. 6		Permanent	3,810,024.45	12,036,630.52
C.M. 4		Permanent	3,809,461.33	12,036,563.84
C.M. 2		Permanent	3,808,718.96	12,036,194.65

*Virginia grid south zone NAD 83(93) U.S. survey foot units

1.3.2 Sub-bottom Analysis

Twelve cores were obtained using a vibra-core that drives a 3-inch aluminum tube into the bottom. The work was performed from a 20-foot power skiff with hydraulic davit for core removal. Eight cores were taken on 13 June 2001. After they were opened, it was decided that more cores were necessary to further evaluate the channel sub-bottom material particularly beach quality sand. On 27 June 2001, four more cores were taken to complete the sub-bottom data acquisition. Depth of penetration into the sub-bottom for the cores ranged from 2 to 5 ft to depths of almost -9 ft MLW. The locations of the cores are listed in Table 2 and shown in Figure 3.

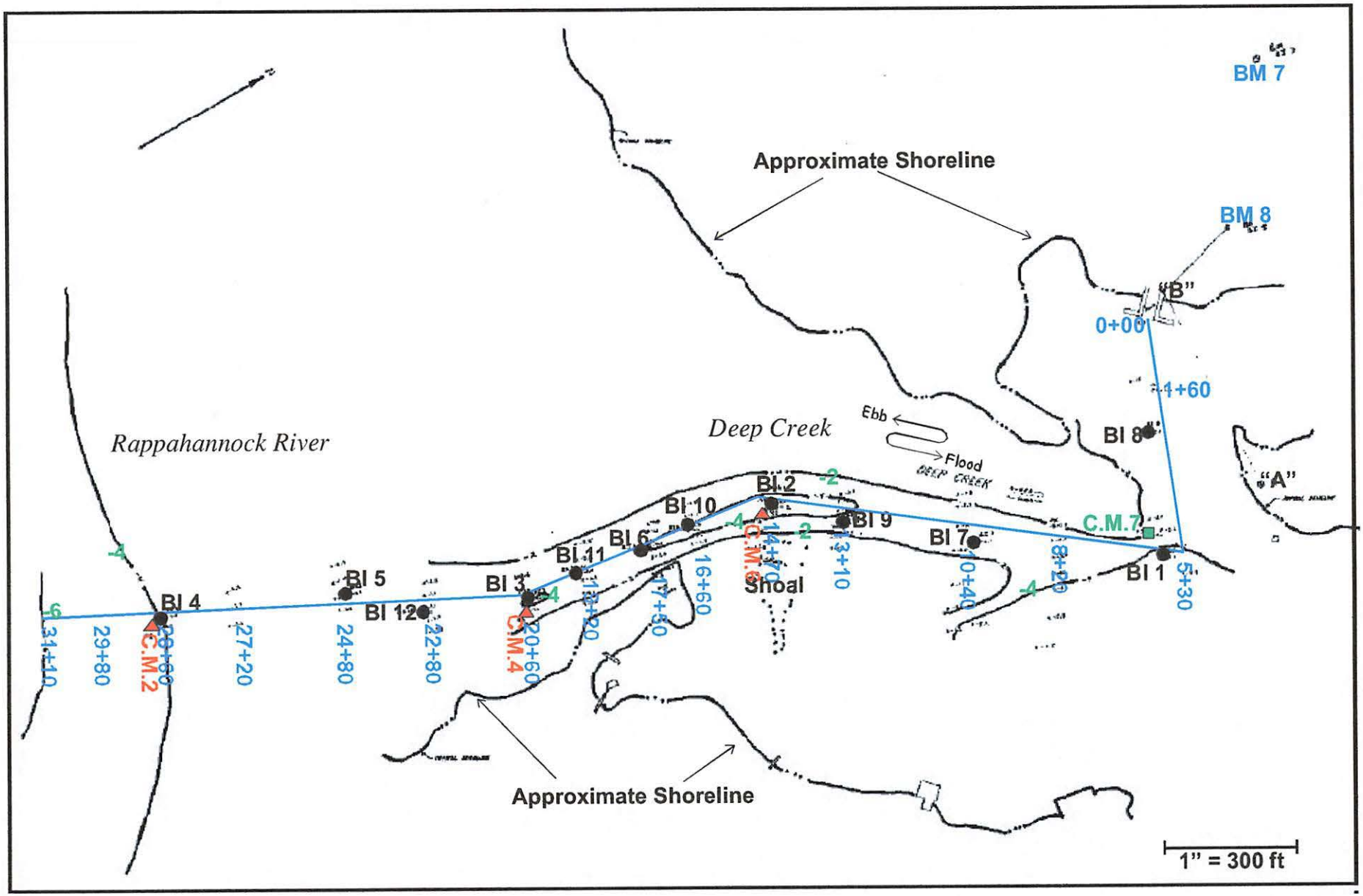


Figure 3. Location of Belle Isle cores and cross-sections.

Table 2. Location, length, and penetration depth of cores taken in the Deep Creek Channel.

Core Name	Date	State Plane Coordinates*		Core	
		Northing	Easting	Length (ft)	Penetration (ft MLW)
BI 1	13 June 2001	3,810,754.68	12,037,137.28	4.7	-8.8
BI 2	13 June 2001	3,810,045.71	12,036,628.62	2.3	–7.3
BI 3	13 June 2001	3,809,475.64	12,036,547.12	3.3	-7.4
BI 4	13 June 2001	3,808,743.46	12,036,186.75	4.2	-8.3
BI 5	13 June 2001	3,809,129.42	12,036,342.83	3.9	-7.1
BI 6	13 June 2001	3,809,744.71	12,036,570.27	4.1	-8.0
BI 7	13 June 2001	3,810,403.89	12,036,917.10	5.1	-7.8
BI 8	13 June 2001	3,810,849.19	12,036,894.24	4.0	-7.4
BI 9	27 June 2001	3,810,170.58	12,036,736.17	3.3	-6.8
BI 10	27 June 2001	3,809,852.77	12,036,578.05	3.6	-7.6
BI 11	27 June 2001	3,809,595.69	12,036,542.39	5.4	-8.4
BI 12	27 June 2001	3,809,254.64	12,036,446.35	3.4	-7.1

*Virginia grid south zone NAD 83(93), U.S. survey foot units

1.4 Laboratory Testing

The cores were split in two, logged, photographed, and sampled. One half of each core was placed in a plastic sleeve and archived. The description of the core used the Unified Soil Classification System (USCS). Individual samples were taken at several locations within selected cores to determine changes in sand composition down the core. Overall samples were taken from the length of the sand portion of the core in order to describe the quality of the sand for beach nourishment. Where the overlying sand did not extend to -7 ft MLW (Cores BI 5 and BI 12), a second overall sample (5a and 12a) included both sand and clay to indicate the type of material that would be dredged. Cores 1, 3, 4, and 8 were not analyzed because they were determined by visual inspection to be mostly silts and clays with less than 50% sand. Individual and overall samples were subjected to grain-size distribution. Samples were analyzed for percent gravel, sand, silt, clay. The sand fraction was analyzed using the Rapid Sand Analyzer (RSA). Core logs are in Appendix B, core photos are in Appendix C, and sediment grain size analysis results are in Appendix D.

2.0 Results

2.1 Subsurface Conditions

Sediment in the subsurface of the study area varies by location. Utilizing information from the cores, we concluded that the entrance channel from the Rappahannock River generally is a sandy layer overlaying a muddy layer (BI 4, 5, and 12). As the channel enters Deep Creek, the substrate is mostly clean sand (BI 6, 10, 2, 9). Farther along the channel to the boat ramp, mud occurs (BI 1 and 8). Cores BI 11 and 7 are transitional with sand overlaying a deep layer of clay (deeper than -7 ft MLW). Core 3 is an isolated area of mud along the channel. The average mean grain size of the samples taken along the full length of the sand portion of the cores is 0.9 mm (Table 3). The median grain size of these same samples is 0.4 mm.

Table 3. Overall sample analysis results. Percent coarse includes the gravel and sand fraction of the sample (greater than 0.0625 mm). Samples from cores containing mostly mud were not analyzed for grain size.

Core Number	Material Sampled	% Coarse	Mean (mm)	Median (mm)
1	Mud*			
2	Sand	95	1.0	0.5
3	Mud*			
4	Mud*			
5	Sand Only	100	1.0	0.5
5a	Sand&Mud	90	2.5	0.5
6	Sand	93	0.4	0.3
7	Sand	100	0.7	0.5
8	Mud*			
9	Sand	100	0.8	0.5
10	Sand	100	0.6	0.4
11	Sand	100	0.4	0.3
12	Sand Only	100	0.7	0.4
12a	Sand&Mud	65	0.4	0.3
AVERAGE			**0.9**	**0.4**

*mostly mud as determined by visual inspection of the core (see Appendix C).

2.2 Channel Survey

The entrance channel into Deep Creek was evaluated to determine the nature of the sub-bottom material and the present dimensions of the channel. The supplemental channel survey showed that the present channel is properly marked by the channel markers. However, between channel marker 7 and cross-section 8+20, the -2 ft MLW contour must be crossed when traveling directly between channel marker 7 and channel marker 6. At the time of the 2001 survey, a PVC pipe marked the location of this shallow area. Overall, the channel has similar dimensions as shown in the 1997 survey by Waterway.

Cross-sections of the channel were plotted and used in conjunction with the cores to calculate the amount and type of material that would be dredged to -7 ft MLW (Figure 4). Table 4 lists the approximate amount of dredge cut and type of material for each cross-section as shown on Figure 3. In order to determine the total dredge cut volume, assumptions are made regarding the transitional areas between sand and mud substrates. When calculating total volume, the cross-sectional volume is multiplied by the distance along the mid-channel baseline. The type of sub-bottom material is confirmed at the core locations; the type of material is inferred between cores. Table 5 indicates the total amount of material that would be dredged in the proposed project.

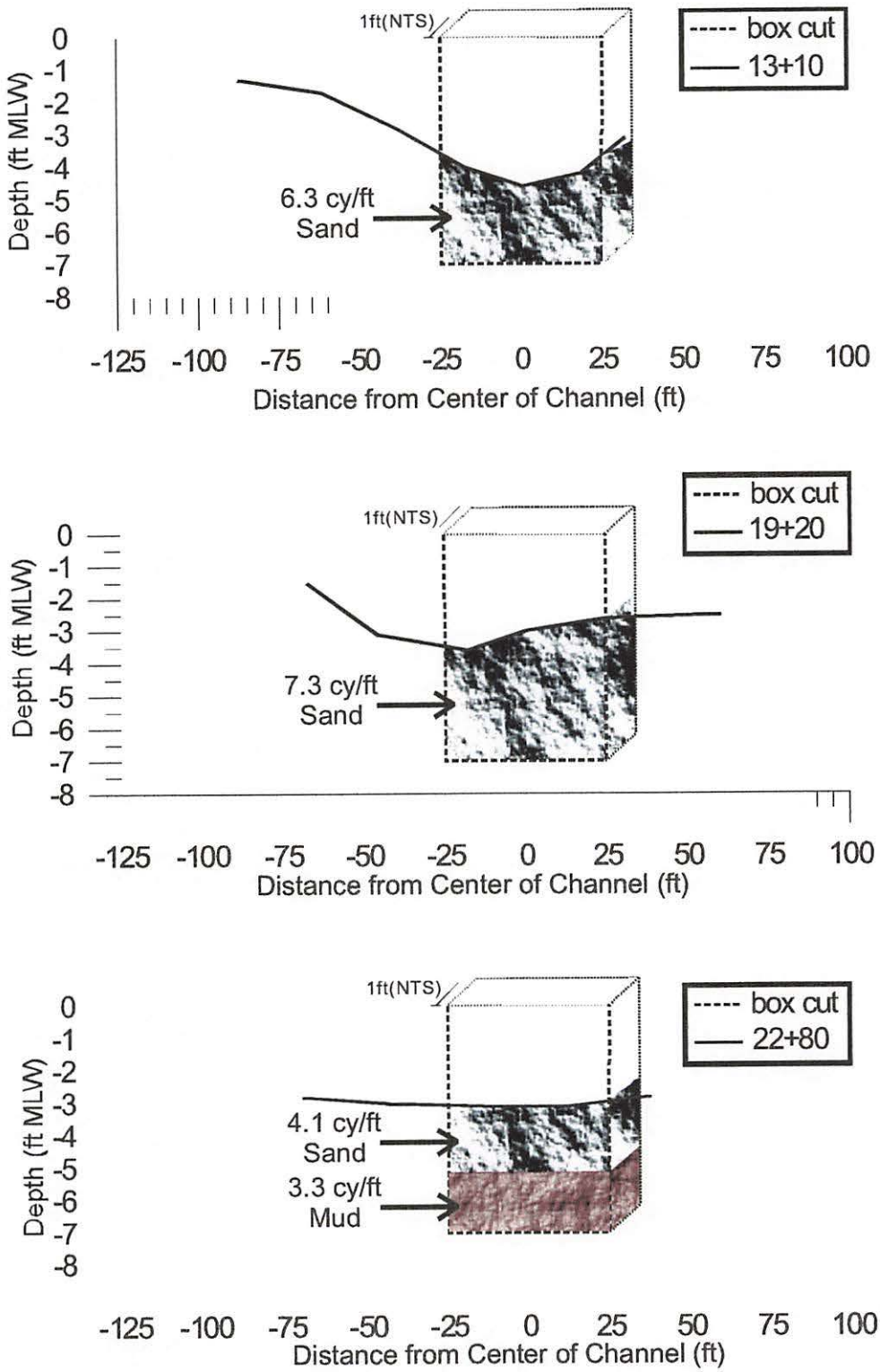


Figure 4. Typical bathymetric cross-sections obtained by VIMS survey crew and approximate dredge channel cut indicating sub-bottom material volume calculations in cubic yards per foot (cy/ft). NTS = Not to scale.

Table 4. Calculation of amount and type of material to be dredged at each cross-section.

Name	Mid-Channel Distance from Boat Ramp (ft)	Amount of Material that will be dredged to -7 ft MLW (cy/ft)^	Type of Material that will be dredged to -7 ft MLW	Depth of Sand (ft MLW)	C=Core Site X=Cross-section only
BI 8	1+60	6.1	mud		C
BI 1	5+30	5.2	mud		C
BI 7.5	8+20	8.6	Assumed mix		X
BI 7	10+40	7.7	sand	- 7 ft	C
BI 9	13+10	6.3	sand	*BOC -6.8 ft	C
BI 2	14+70	5.1	sand	BOC -7.3 ft	C
BI 10	16+60	7.2	sand	BOC -7.6 ft	C
BI 6	17+50	5.9	sand	BOC -8.0 ft	C
BI 11	19+20	7.3	sand	-7.5 ft	C
BI 3	20+60	6.6	mud		C
BI 12	22+80	7.4	mix	stiff clay below -5.2 ft	C
BI 5	24+80	7.0	mix	soft clay below -5.8 ft	C
BI 4.5	27+20	6.9	Assumed mud		X
BI 4	28+60	5.4	mud		C
5 ft contour	29+80	3.7	Assumed mud		from Waterway survey
6 ft contour	31+10	1.9	Assumed mud		from Waterway survey

*BOC = Bottom of Core (*i.e.* sand extends to the bottom of the core)
^(cy/ft) = cubic yards per foot

Table 5. Calculation of types of material to be dredged from the length of the channel.

Location along Channel	Amount of Sand (cy)	Amount of Mud (cy)	Amount of Mixed Material Sand & Mud (cy)
0+00 to 1+60		980	
1+60 to 5+30		2,090	
5+30 to 8+20		(Assumed) 2,000	
8+20 to 10+40	(Assumed) 1,790		
10+40 to 13+10	1,890		
13+10 to 14+70	910		
14+70 to 16+60	2,340		
16+60 to 17+50	590		
17+50 to 19+20	1,120		
19+20 to 19+90	(Assumed) 510		
19+90 to 20+60		460	
20+60 to 21+60		660	
21+60 to 22+80			890
22+80 to 24+80			1,440
24+80 to 27+20			1,680
27+20 to 28+60		860	
28+60 to 29+80		(Assumed) 550	
29+80 to 31+10		(Assumed) 360	
Total	**9,150**	**7,960**	**4,010**

3.0 Conclusions

The entrance channel into Deep Creek was evaluated to determine the nature of the sub-bottom material and the present dimensions of the channel. The type of sub-bottom material is confirmed at the core locations; the type of material is inferred between cores. The sub-bottom down to -7 ft MLW is mostly mud from 0+00 to about 8+20, and there is about 5,000 cubic yards (cy) of material. From 8+20 to about 19+90 the potential channel cut material is predominantly sand, approximately 9,150 cy. Mud exists in the channel and sub-bottom between 19+90 and 21+60, a cut volume of about 1,120 cy. Between 21+60 and 27+20, sand overlies finer silts and clays, a total cut volume of approximately 4,000 cy. The outboard section from 27+20 to 31+10 with 1,770 cy of cut material is assumed to be predominantly mud.

Using the core data, we determined that beach quality material resides primarily between section 10+40 and 19+20 and can be dredged to -7 ft MLW for a total sand volume of 6,850 cy. The main areas of mud are from section 0+00 to 5+30, 20+60, and from 28+60 to 31+10. Once again this material can be expected down to -7 ft MLW. Areas of mixed sand and mud occur from 22+80 to 24+80 in this subreach. The upper core material is still beach quality sand, but the lower mud unit causes a dredge cut to -7 ft MLW to have finer material. Core 5 is actually at 10% mud which makes this material marginal for beach placement. Core 12 is 35% mud to -7 MLW. The mixed material and the mud material generally are not considered appropriate for beach nourishment.

Acknowledgments

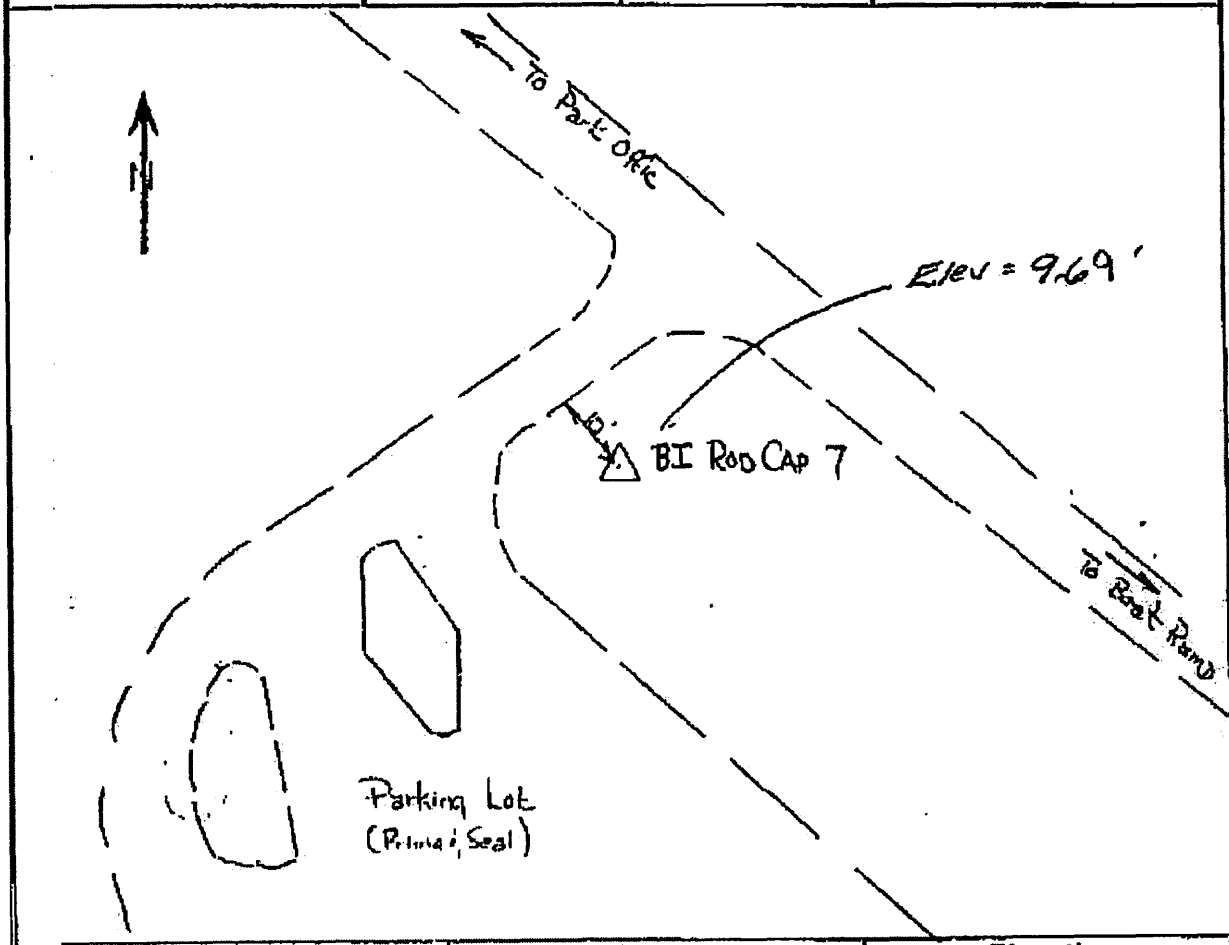
Thanks to Wayne Reisner for his help with the field work associated with this project. Thanks also to Carl H. Hobbs, C. Lee Hill, and Thomas A. Barnard, Jr. for their editorial review.

Appendix A
Benchmark Information

Log Sheet

Observer: HOWELL	Project: BELLE ISLE STATE PARK
System #:: B	Date: November 22, 1997
	Weather: Mostly Sunny

Point ID	Height Meters:	Height Feet	Height Feet and Inches
BI ROD CAP 7	1.184 ✓	3.89 ✓	3' 10 7/16" ✓



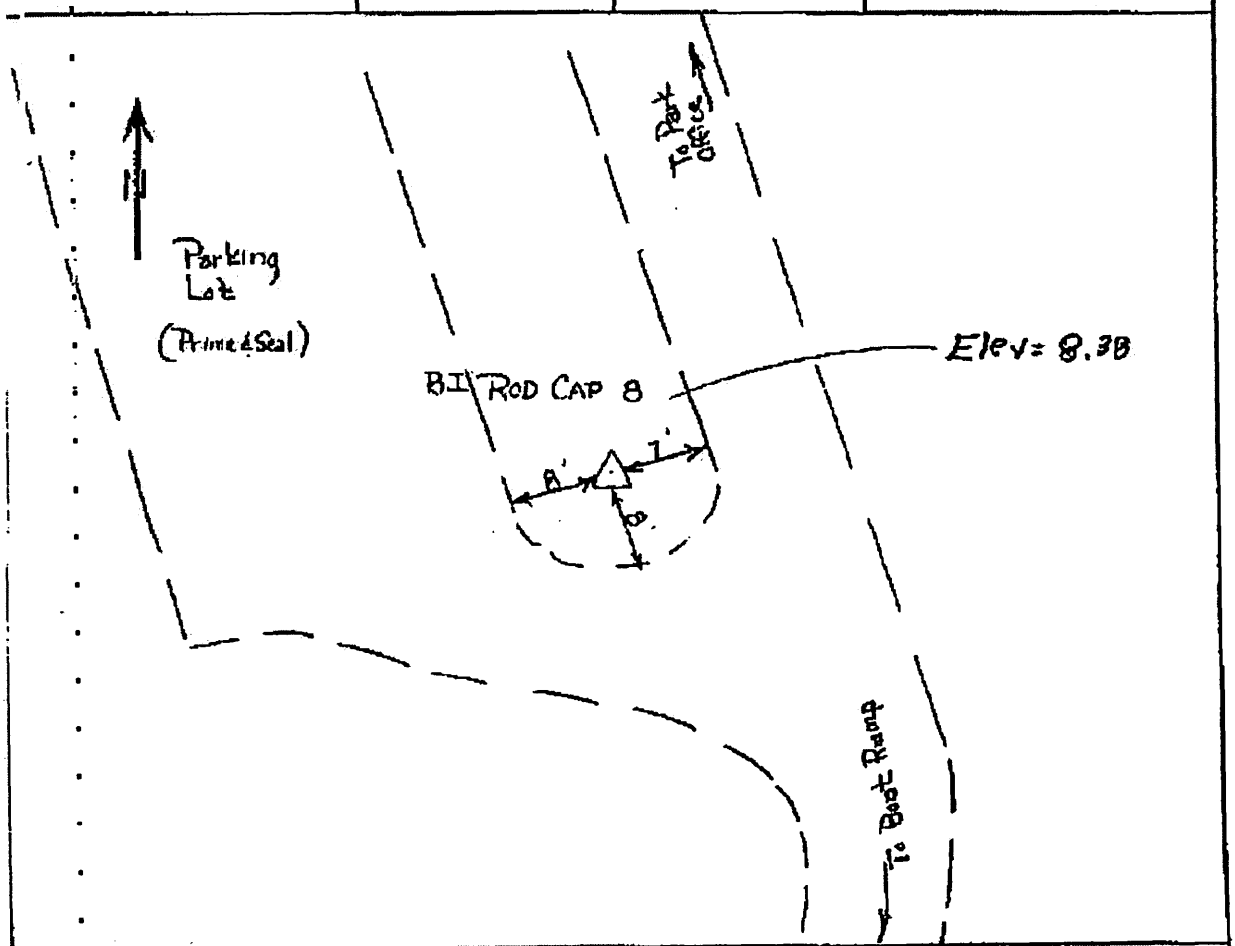
Northing	Easting	Elevation
3811460.6039	12036304.1566	9.69

Marsh & Legge
Land Surveyors, P.L.C.
139 North Cameron Street
Winchester, Virginia 22601
Telephone: (540) 667-0468

Log Sheet

Observer: Howell	Project: Belle Isle State Park
System #:: B	Date: November 22, 1997
	Weather: Mostly Sunny

Point ID	Height Meters:	Height Feet	Height Feet and Inches
BI: Rod Cap 8	1.238 ✓	4.06 ✓	4' 0 5/8" ✓



Northing	Easting	Elevation
3811222.9009	12036595.3242	8.38

Marsh & Legge
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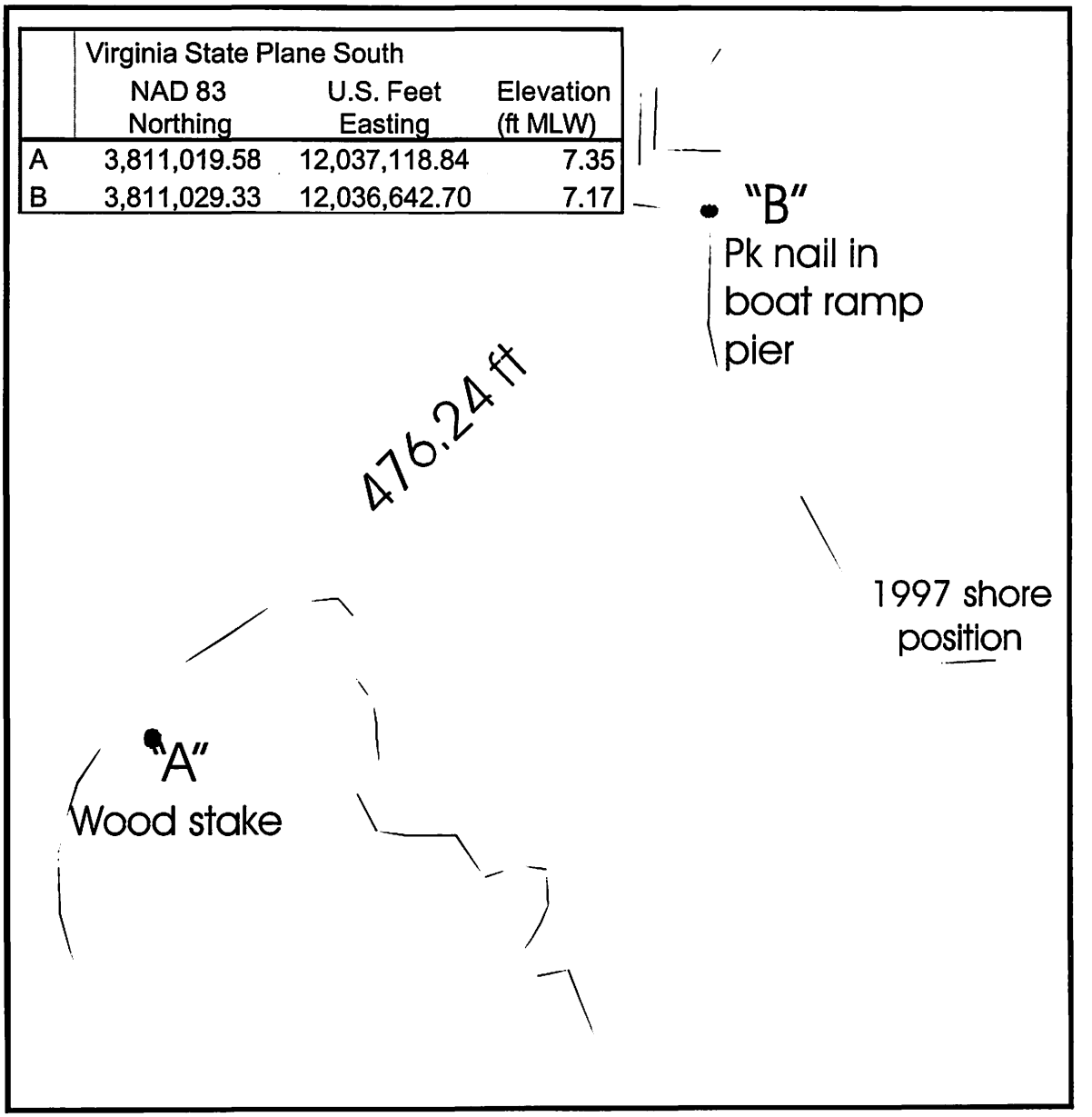
139 North Cameron Street
Winchester, Virginia 22601
Telephone: (540) 667-0468

	Virginia State Plane South NAD 83 Northing	U.S. Feet Easting	Elevation (ft MLW)
A	3,811,019.58	12,037,118.84	7.35
B	3,811,029.33	12,036,642.70	7.17



Established 13 June 2001. State plane coordinates are based on BI rod cap 7 & 8 from Marsh & Legge Land Surveyors.

Appendix B
Core Logs

CLIENT: Belle Isle State Park				DATE: 13 June 2001			
SUBJECT: Deep Creek and Ramp Approach Channel Dredging Project							
BORING #: BI-1	Total Depth -8.8 ft MLW	Elev: -4.1 ft MLW	Location: Deep Creek				
Type of Boring: Vibracore	Started:	Completed:	Driller:				

Elevation MLW	Depth	Description of Materials (classification)	Sample Blows	Sample Depth (ft)	Moisture Content (%)	Remarks
-4.1	0					
-4.6	-0.5	Olive soft fines with little fine sand and shell frags (ML)				
-5.1	-1.0					
-5.6	-1.5					
-6.1	-2.0	Dark olive spongy fines (ML)				
-6.6	-2.5	Olive soft fines with little fine sand (ML)				
-7.1	-3.0	Olive soft fines with shell frags (ML)				
-7.6	-3.5					
-8.1	-4.0					
-8.6	-4.5					
-9.1	-5.0	End				

CLIENT: Belle Isle State Park DATE: 13 June 2001

SUBJECT: Deep Creek and Ramp Approach Channel Dredging Project

BORING #: BI-2 | Total Depth: -7.3 ft MLW | Elev: -5.0 ft MLW | Location: Deep Creek

Type of Boring: Vibracore | Started: | Completed: | Driller:

Elevation MLW	Depth	Description of Materials (classification)	Sample Blows	Sample Depth (ft)	Moisture Content (%)	Remarks
-5.0	0					
-5.2	-0.2	Light gray Fine Sand with trace silt on top (SW)				
-5.4	-0.4					
-5.6	-0.6					
-5.8	-0.8					
-6.0	-1.0	Light gray with dark olive mottling Fine to Coarse Sand (SP) Shell Frags				Overall Sample
-6.2	-1.2					
-6.4	-1.4					
-6.6	-1.6					
-6.8	-1.8					
-7.0	-2.0					
-7.2	-2.2					
-7.4	-2.4	End				

CLIENT: Belle Isle State Park			DATE: 13 June 2001
SUBJECT: Deep Creek and Ramp Approach Channel Dredging Project			
BORING #: BI-3	Total Depth -7.4 ft MLW	Elev: -4.1 ft MLW	Location: Deep Creek
Type of Boring: Vibracore	Started:	Completed:	Driller:

Elevation MLW	Depth	Description of Materials (classification)	Sample Blows	Sample Depth (ft)	Moisture Content (%)	Remarks
-4.1	0					
-4.6	-0.5	Med olive fines with trace fine sand and shells and shell frags (ML)				
-5.1	-1.0					
-5.6	-1.5	Olive soft fines (ML)				
-6.1	-2.0					
-6.6	-2.5					
-7.1	-3.0					
-7.6	-3.5	End				

CLIENT: Belle Isle State Park				DATE: 13 June 2001
SUBJECT: Deep Creek and Ramp Approach Channel Dredging Project				
BORING #: BI-4	Total Depth -8.3 ft MLW	Elev: -4.1 ft MLW	Location: Deep Creek	
Type of Boring: Vibracore	Started:	Completed:	Driller:	

Elevation MLW	Depth	Description of Materials (classification)	Sample Blows	Sample Depth (ft)	Moisture Content (%)	Remarks
-4.1	0					
-4.6	-0.5	Gray with orange mottling Fine Sand and silt (SM)				
-5.1	-1.0					
-5.6	-1.5	Gray to olive silt with some fine sand (ML)				
-6.1	-2.0					
-6.6	-2.5					
-7.1	-3.0	Med gray fines with wood and shell frags (ML)				
	-3.5					
-8.1	-4.0					
-8.6	-4.5	End				

CLIENT: Belle Isle State Park DATE: 13 June 2001

SUBJECT: Deep Creek and Ramp Approach Channel Dredging Project

BORING #: BI-5 | Total Depth -7.1 ft MLW | Elev: -3.2 ft MLW | Location: Deep Creek

Type of Boring: Vibracore | Started: | Completed: | Driller:

Elevation MLW	Depth	Description of Materials (classification)	Sample Blows	Sample Depth (ft)	Moisture Content (%)	Remarks
-3.2	0					
-3.7	-0.5	5-1 Light gray-yellowish orange Fine to Med Sand (SP)				Overall Sample
-4.2	-1.0	Light gray with olive mottling Coarse Sand with trace Gravel (SW) Shell Frags				
-4.7	-1.5	5-2 Light gray with olive mottling Fine to Coarse Sand with trace Gravel (SW)				
-5.2	-2.0	Light gray with olive mottleing Layered fine sand, fine gravel, med sand (SP)				
-5.7	-2.5	Dark olive with light gray mottling Fine to Med Sand (SW)				
-6.2	-3.0	Dark olive very soft Clay mixed with fine sand (CL)				Overall Sample 5a
-6.7	-3.5					
-7.2	-4.0	End				

CLIENT: Belle Isle State Park			DATE: 13 June 2001
SUBJECT: Deep Creek and Ramp Approach Channel Dredging Project			
BORING #: BI-6	Total Depth -8.0 ft MLW	Elev: -3.9 ft MLW	Location: Deep Creek
Type of Boring: Vibracore	Started:	Completed:	Driller:

Elevation MLW	Depth		Description of Materials (classification)	Sample Blows	Sample Depth (ft)	Moisture Content (%)	Remarks
-3.9	0						
-4.4	-0.5		Light gray-yellowish orange Fine Sand with trace silt (SP)				Overall Sample
			Peat with Wood Frags (PT)				
-4.9	-1.0	6-1	Light gray to olive Fine Sand with trace silt and shell frags (SP)				
-5.4	-1.5		Olive gray Fine Sand with some silt (SP)				
-5.9	-2.0	6-2	Light to olive gray Fine to Med Sand with trace silt and shell frags (SW)				
-6.4	-2.5		Dark olive Fine Sand (SP)				
-6.9	-3.0	6-3	Olive to dark olive Fine Sand with trace silt and shell frags (SP)				
-7.4	-3.5						
-7.9	-4.0						
-8.4	-4.5		End				

CLIENT: Belle Isle State Park DATE: 13 June 2001

SUBJECT: Deep Creek and Ramp Approach Channel Dredging Project

BORING #: BI-7 | Total Depth -7.8 ft MLW | Elev: -2.7 ft MLW | Location: Deep Creek

Type of Boring: Vibracore | Started: | Completed: | Driller:

Elevation MLW	Depth	Description of Materials (classification)	Sample Blows	Sample Depth (ft)	Moisture Content (%)	Remarks
-3.9	0					
-4.4	-0.5	Light gray to olive gray Fine to Med Sand with trace silt (SW)				Overall Sample
-4.9	-1.0					
-5.4	-1.5					
		Olive to dark gray Fine to Med Sand with trace silt and oyster shell (SW)				
-5.9	-2.0	Olive Fine Sand with little silt (SP)				
-6.4	-2.5	Light gray and olive mottled Fine to Med Sand with trace silt (SW)				
-6.9	-3.0					
-7.4	-3.5					
-7.9	-4.0					
		Greenish-light gray Fine Sand with little silt (SP)				
-8.4	-4.5	Dark olive gray very soft clay (CL)				
-8.9	-5.0					
		End				

CLIENT: Belle Isle State Park				DATE: 13 June 2001			
SUBJECT: Deep Creek and Ramp Approach Channel Dredging Project							
BORING #: BI-8	Total Depth -7.4 ft MLW	Elev: -3.4 ft MLW	Location: Deep Creek				
Type of Boring: Vibracore	Started:	Completed:	Driller:				

Elevation MLW	Depth	Description of Materials (classification)	Sample Blows	Sample Depth (ft)	Moisture Content (%)	Remarks
-3.4	0					
-3.9	-0.5	Olive very soft Clay (CL)				
-4.4	-1.0					
-4.9	-1.5					
-5.4	-2.0					
-5.9	-2.5					
-6.4	-3.0					
-6.9	-3.5					
-7.4	-4.0					
-7.9	-4.5	End				

CLIENT: Belle Isle State Park				DATE: 27 June 2001
SUBJECT: Deep Creek and Ramp Approach Channel Dredging Project				
BORING #: BI-9	Total Depth -6.8 ft MLW	Elev: -3.5 ft MLW	Location: Deep Creek	
Type of Boring: Vibracore	Started:	Completed:	Driller:	

Elevation MLW	Depth		Description of Materials (classification)	Sample Blows	Sample Depth (ft)	Moisture Content (%)	Remarks
-3.5	0						
-4.0	-0.5	9-1	Light gray to yellowish orange Fine Sand (SP)				Overall Sample
-4.5	-1.0		Light graytoolive Med Sand (SP)				
		9-2	Light gray Fine to Med Sand(SW)				
-5.0	-1.5		Med gray with olive striping Fine Sand with little med sand and trace shell frag (SP)				
-5.5	-2.0						
-6.0	-2.5	9-3	Light to med gray Fine to med Sand (SP)				
-6.5	-3.0		Light gray Fine Sand with a small wood fragment (SP)				
			Light to med gray Fine to Med Sand (SP)				
-7.0	-3.5		End				

CLIENT: Belle Isle State Park				DATE: 27 June 2001
SUBJECT: Deep Creek and Ramp Approach Channel Dredging Project				
BORING #: BI-10	Total Depth -7.6 ft MLW	Elev: -4.0 ft MLW	Location: Deep Creek	
Type of Boring: Vibracore	Started:	Completed:	Driller:	

Elevation MLW	Depth		Description of Materials (classification)	Sample Blows	Sample Depth (ft)	Moisture Content (%)	Remarks
-4.0	0						
-4.5	-0.5	10-1	Light brown-yellowish orange Fine Sand (SP)				Overall Sample
-5.0	-1.0	10-2	Olive with light gray patches of Fine Sand (SP)				
-5.5	-1.5	10-3	Dark olive Fine Sand with trace silt (SP)				
-6.0	-2.0		Med gray and olive mottled Fine to Med Sand with shell and wood frags (SW)				
-6.5	-2.5	10-4	Light gray and olive mottled Med Sand with fine sand stripes (SP)				
-7.0	-3.0						
-7.5	-3.5		Med olive gray Fine Sand (SP)				
-8.0	-4.0		End				

CLIENT: Belle Isle State Park DATE: 27 June 2001

SUBJECT: Deep Creek and Ramp Approach Channel Dredging Project

BORING #: BI-11 | Total Depth -8.4 ft MLW | Elev: -3.0 ft MLW | Location: Deep Creek

Type of Boring: Vibracore | Started: | Completed: | Driller:

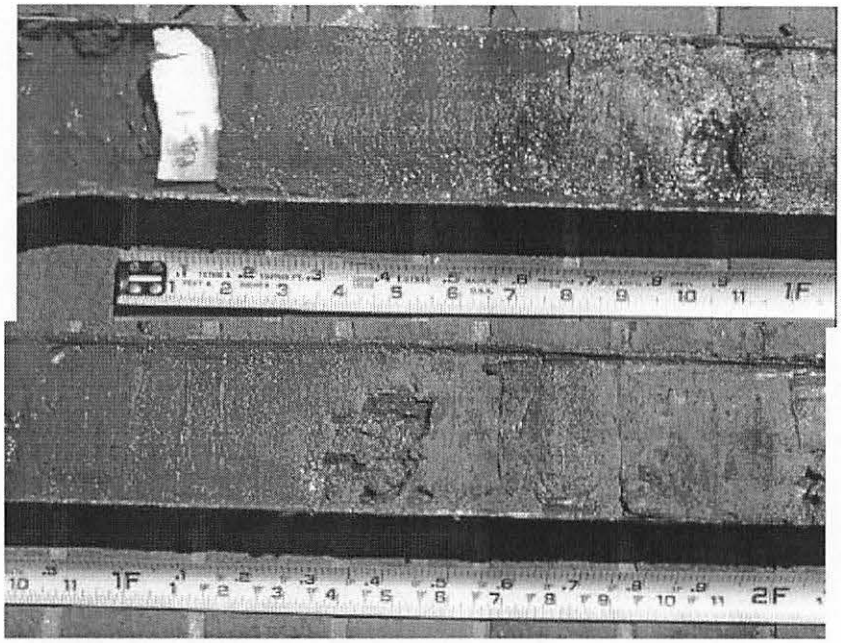
Elevation MLW	Depth	Description of Materials (classification)	Sample Blows	Sample Depth (ft)	Moisture Content (%)	Remarks
-3.0	0					
		Light gray to olive mottled Fine Sand with trace silt (SP)				Overall Sample
-3.5	-0.5	11-1 Dark olive to med gray Fine Sand with little silt (SP)				
-4.0	-1.0					
-4.5	-1.5	Dark olive with light gray mottled Fine to Med Sand with trace silt (SP)				
		Shell layer				
-5.0	-2.0	11-2 Dark olive with light gray mottled Fine to Med Sand with trace silt (SP)				
-5.5	-2.5					
-6.0	-3.0	11-3 Light gray with olive gray striping Fine to Med Sand with a 1 cm shell layer (SP)				
-6.5	-3.5					
-7.0	-4.0	Olive fine sand and silt (SP)				
-7.5	-4.5					
-8.0	-5.0	Olive to dark olive med stiff Clay with little silt (CL)				
-8.5	-5.5	End				

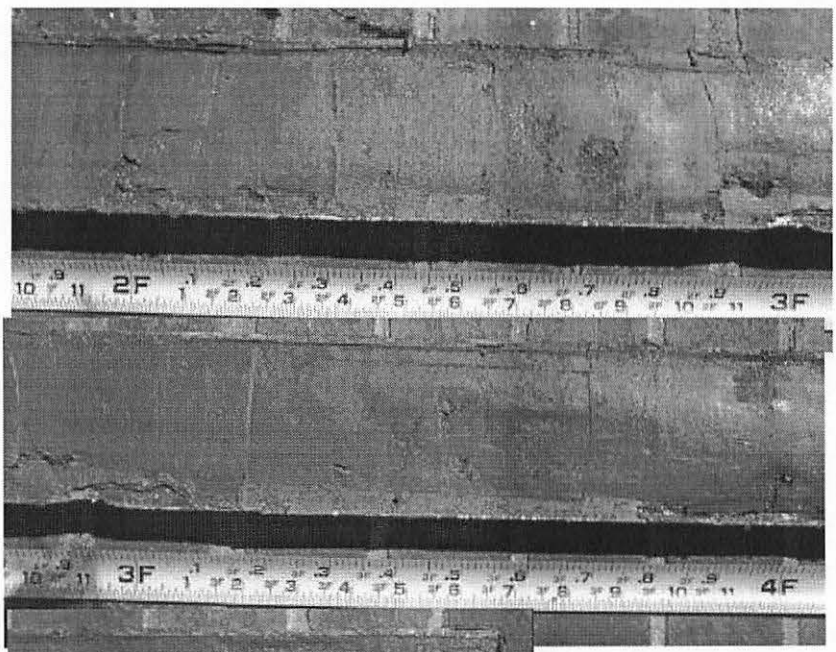
CLIENT: Belle Isle State Park				DATE: 27 June 2001			
SUBJECT: Deep Creek and Ramp Approach Channel Dredging Project							
BORING #: BI-12	Total Depth -7.1 ft MLW	Elev: -3.2 ft MLW	Location: Deep Creek				
Type of Boring: Vibracore	Started:	Completed:	Driller:				

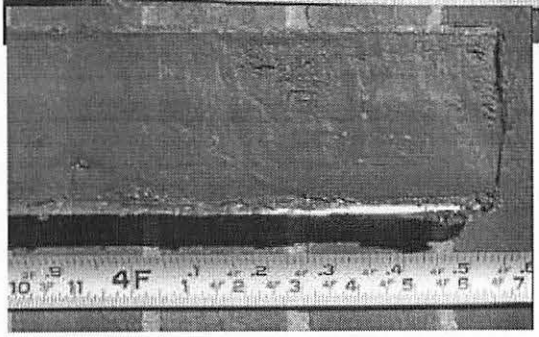
Elevation MLW	Depth	Description of Materials (classification)	Sample Blows	Sample Depth (ft)	Moisture Content (%)	Remarks
-3.2	0					
-3.7	-0.5	Shell and light gray Fine Sand / Olive Fine Sand with trace silt (SP)				Overall Sample
-4.2	-1.0	12-1 Med olive with dark olive mottled Fine to Med Sand with trace silt (SP)				
-4.7	-1.5	12-2 Light olive with light gray streaked Fine to Med Sand with trace silt (SP)				
-5.2	-2.0					
-5.7	-2.5	Greenish-gray with yellowish orange patches stiff - very stiff Clay (CH)				Overall Sample 12a
-6.2	-3.0					
-6.7	-3.5					
-7.2	-4.0	End				

Appendix C
Core Photos

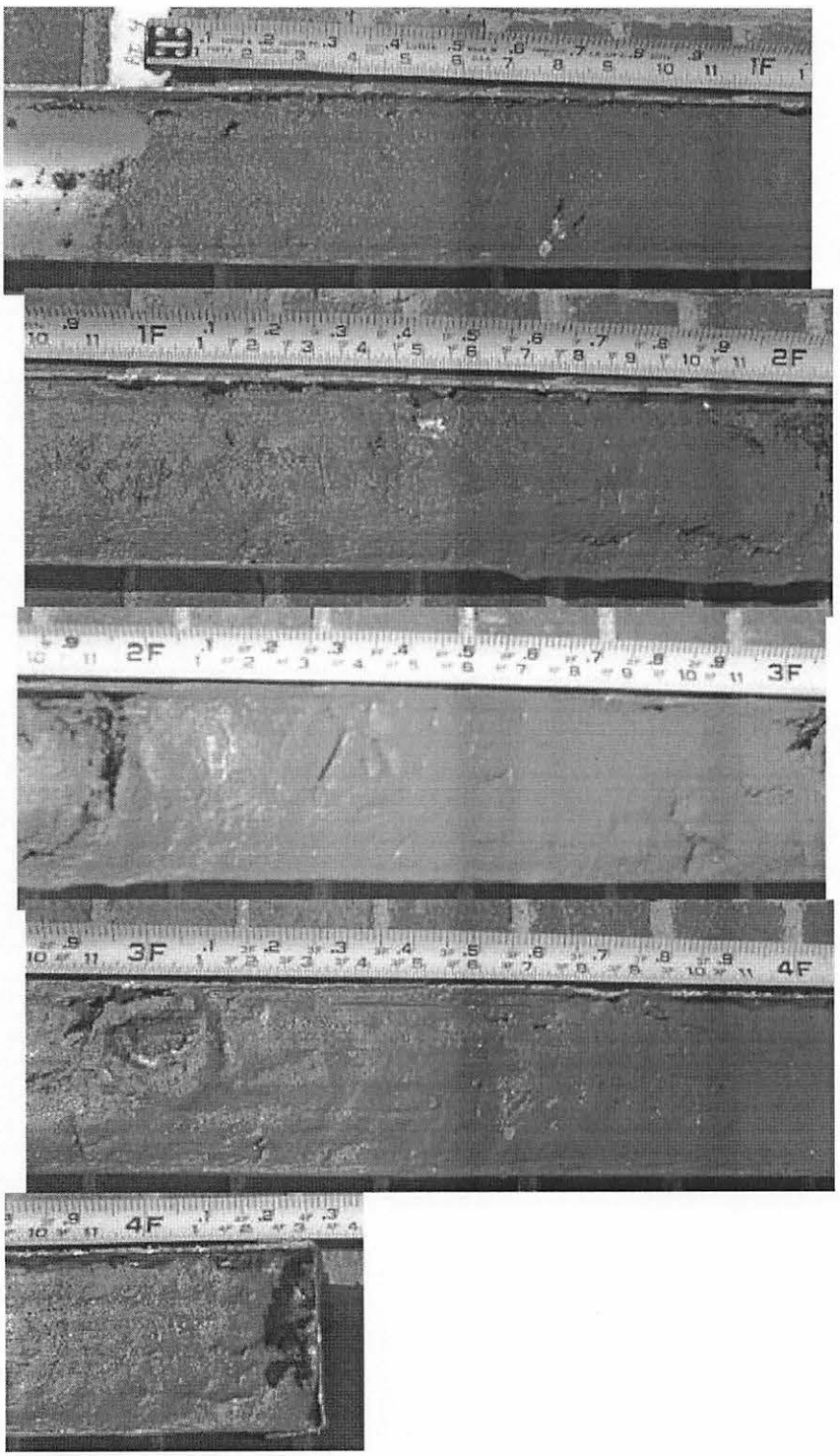
Belle Isle
Core 1



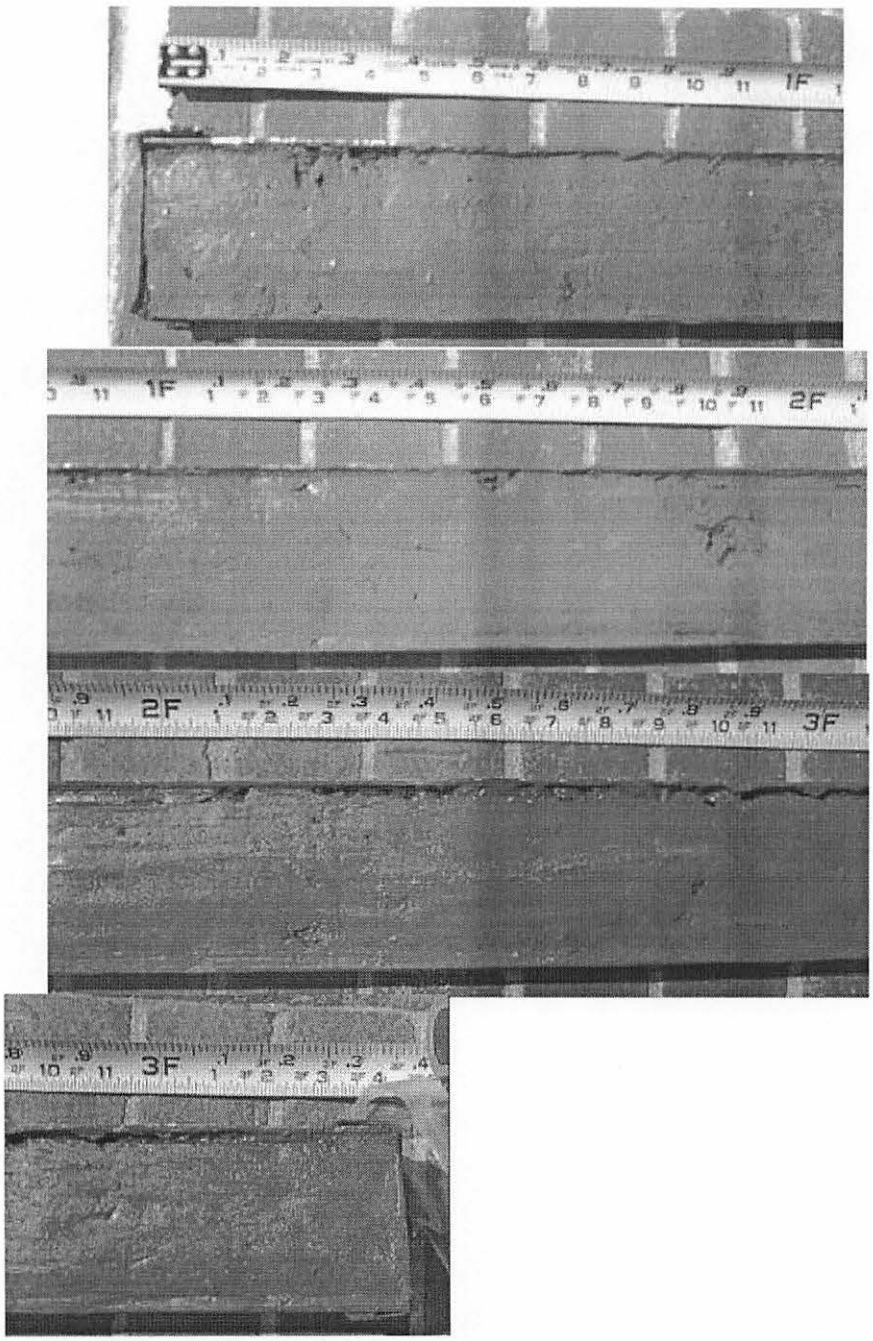




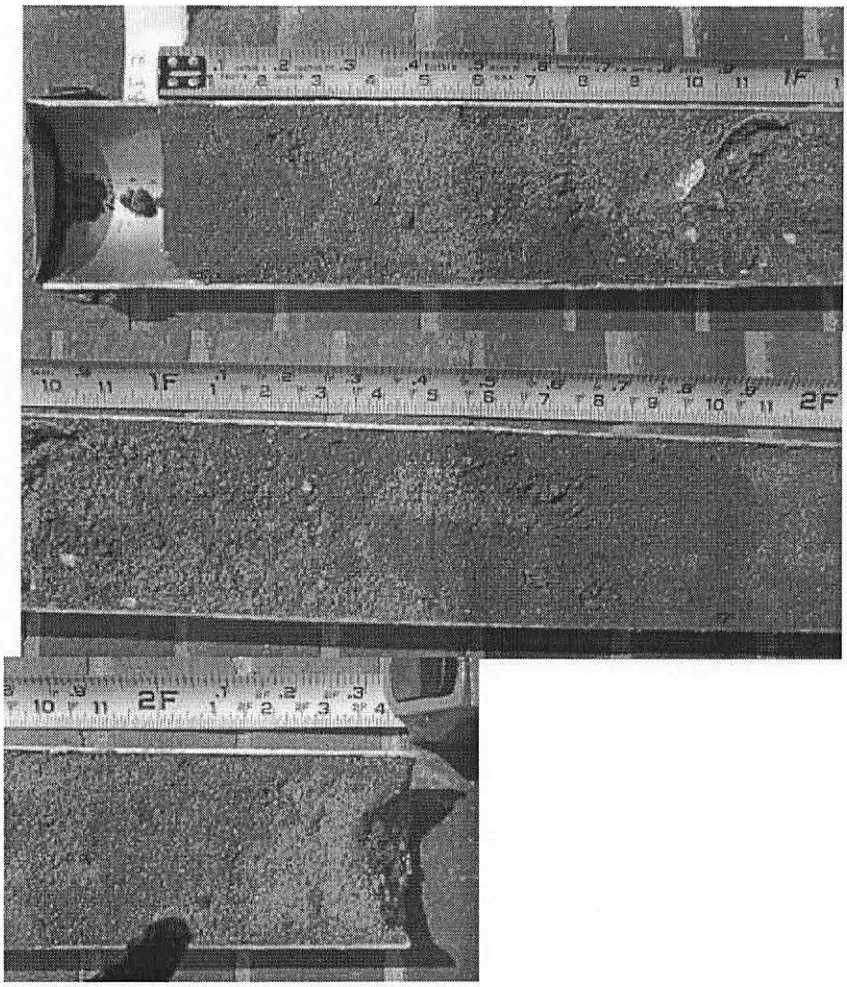
Belle Isle
Core 4



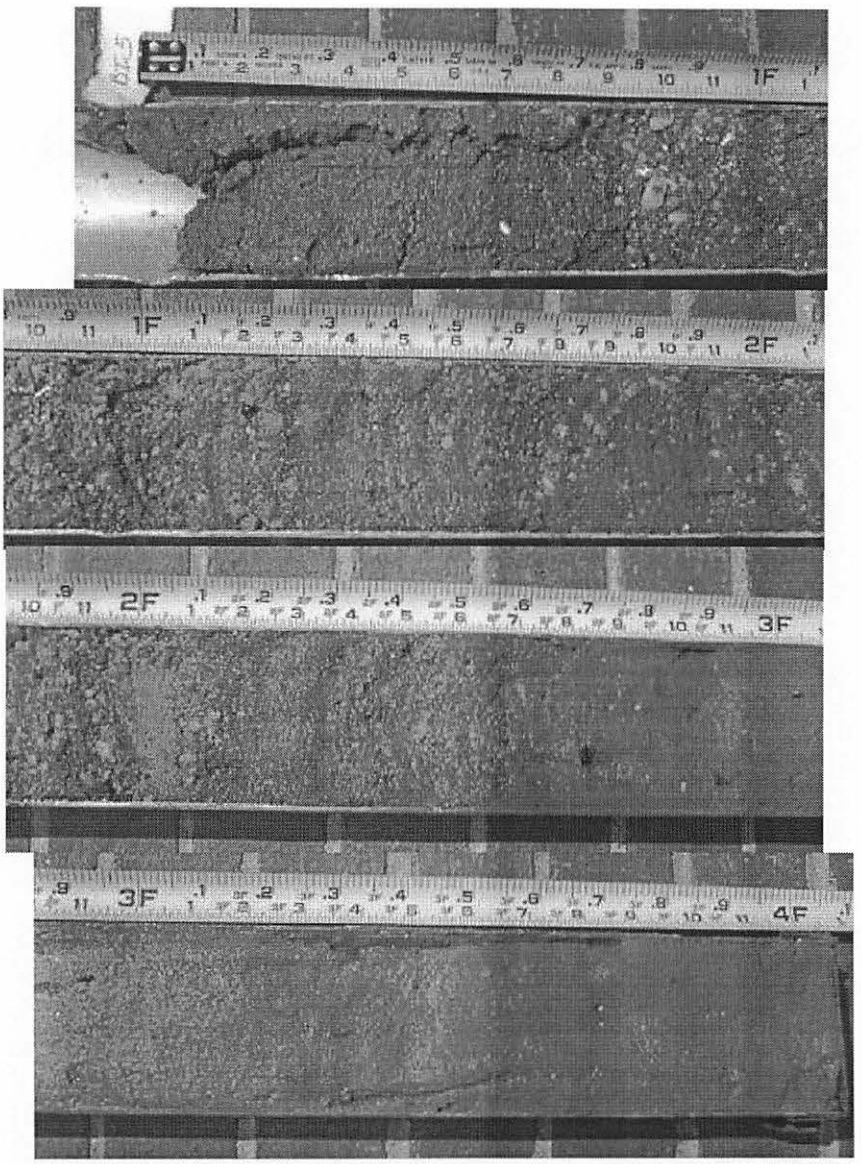
Belle Isle
Core 3



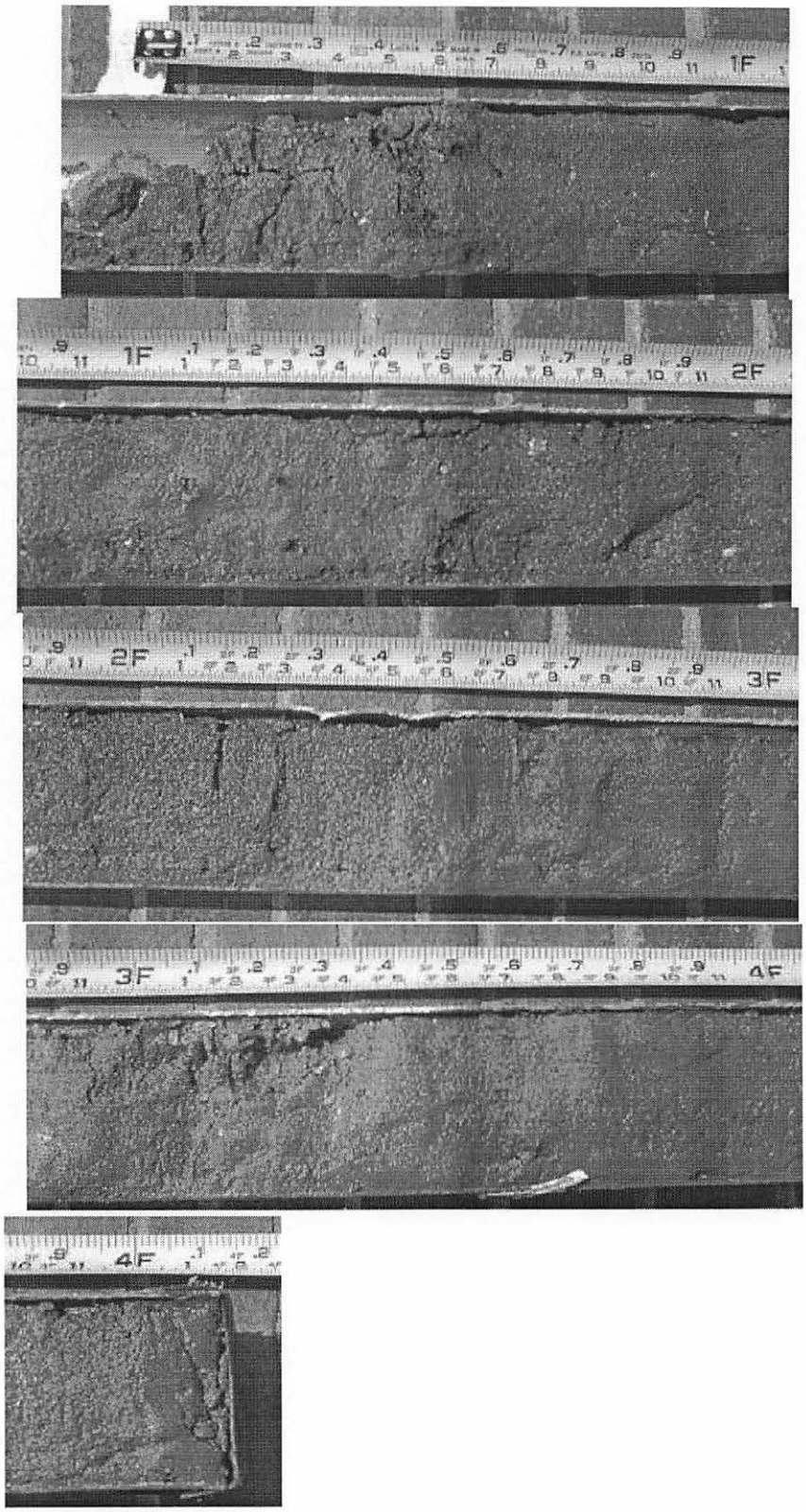
Belle Isle
Core 2



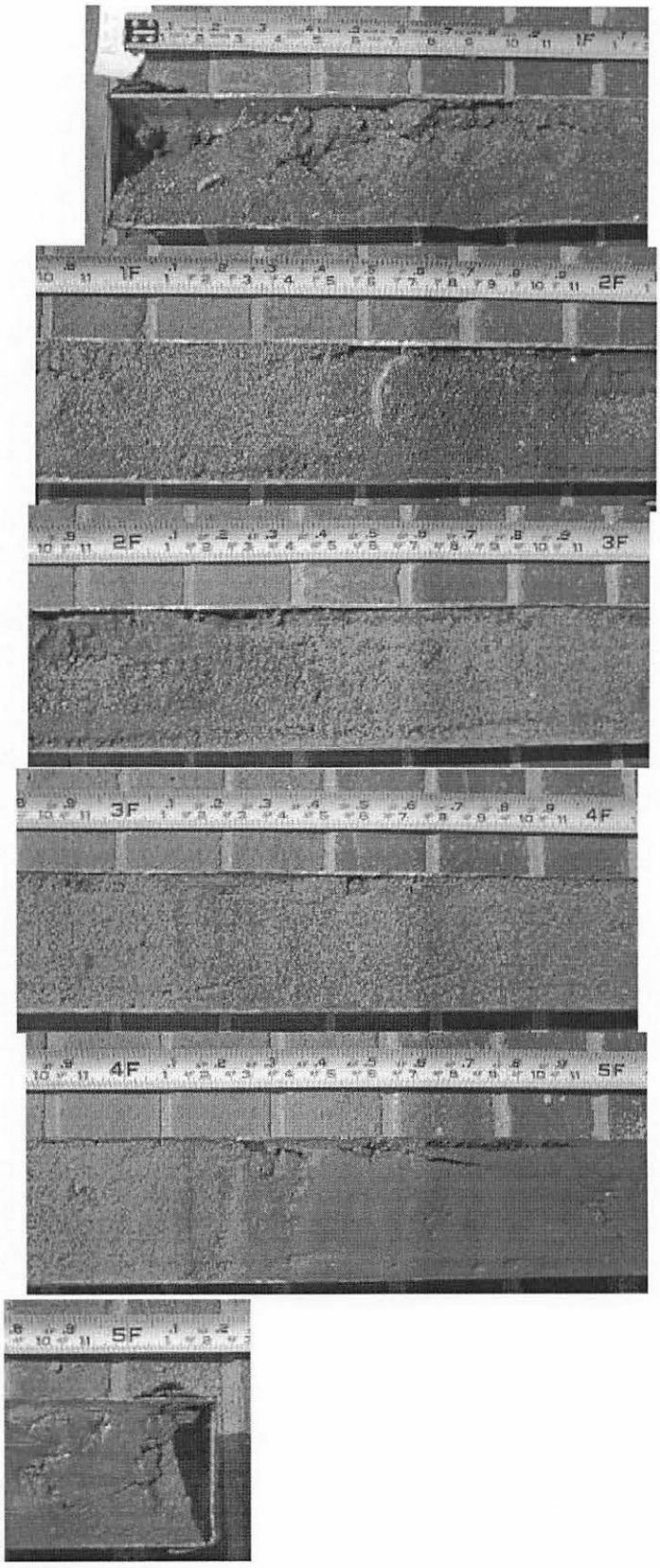
Belle Isle
Core 5



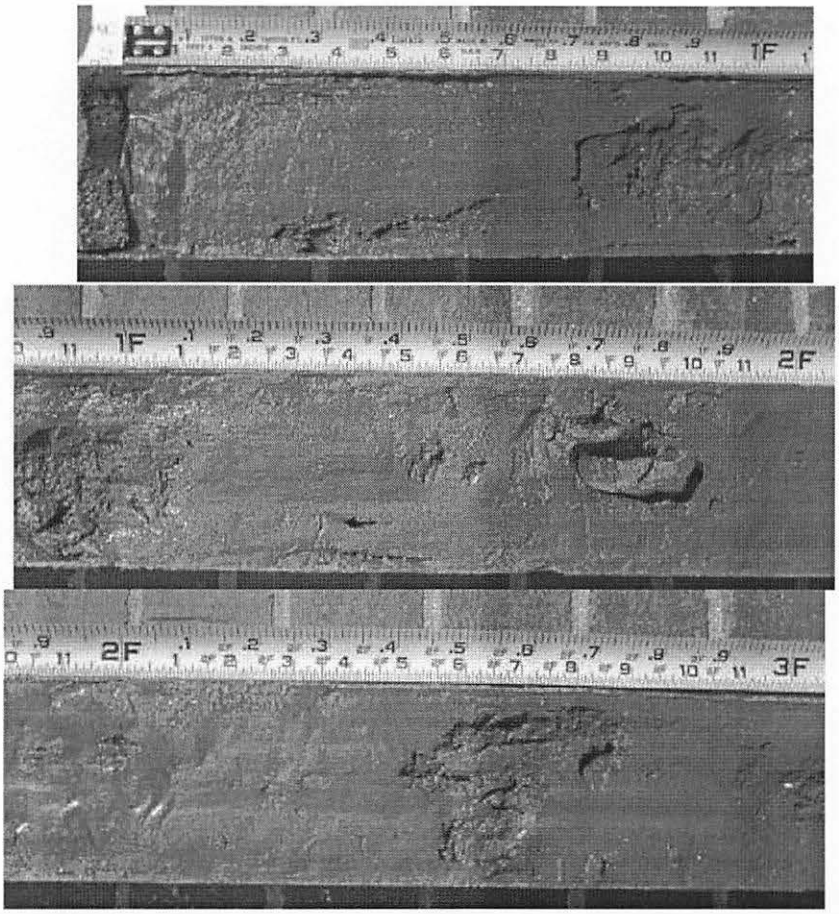
Belle Isle
Core 6



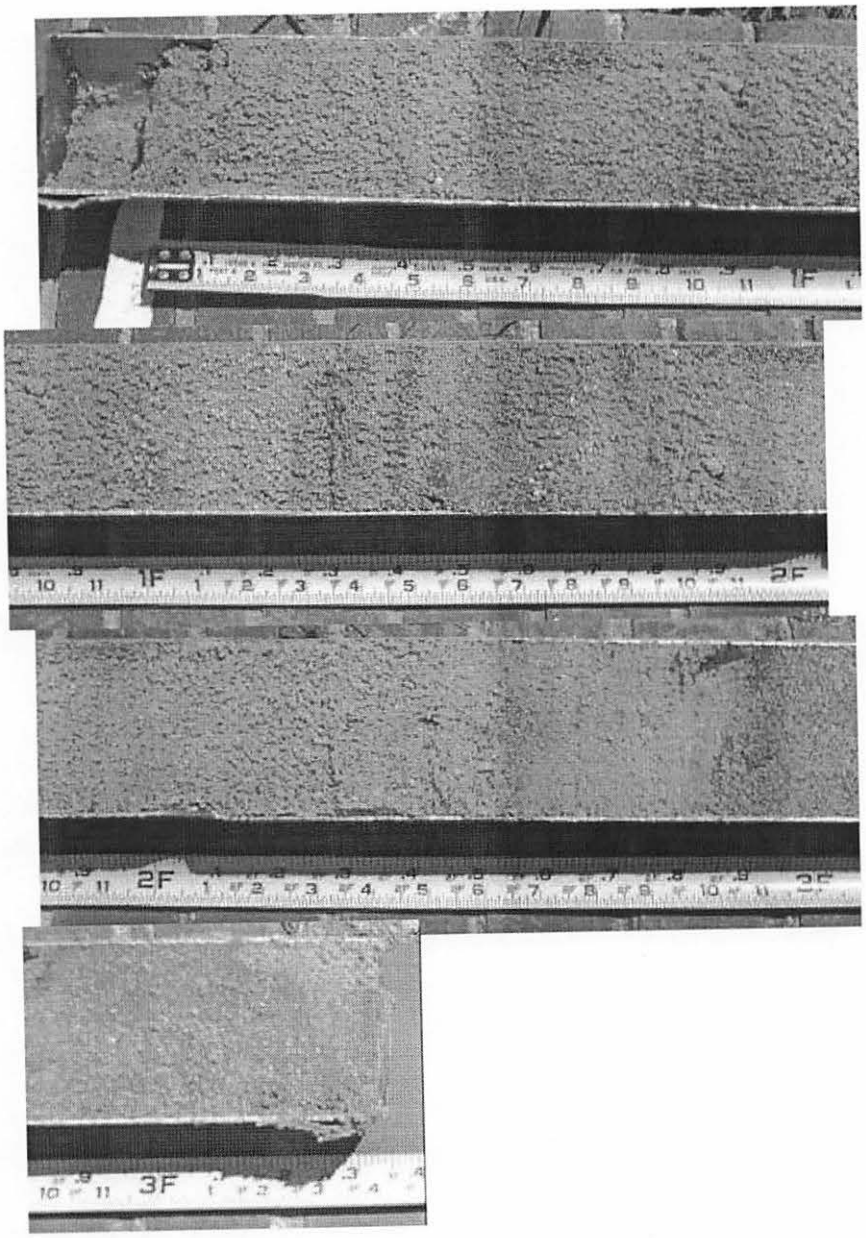
Belle Isle
Core 7



Belle Isle
Core 8

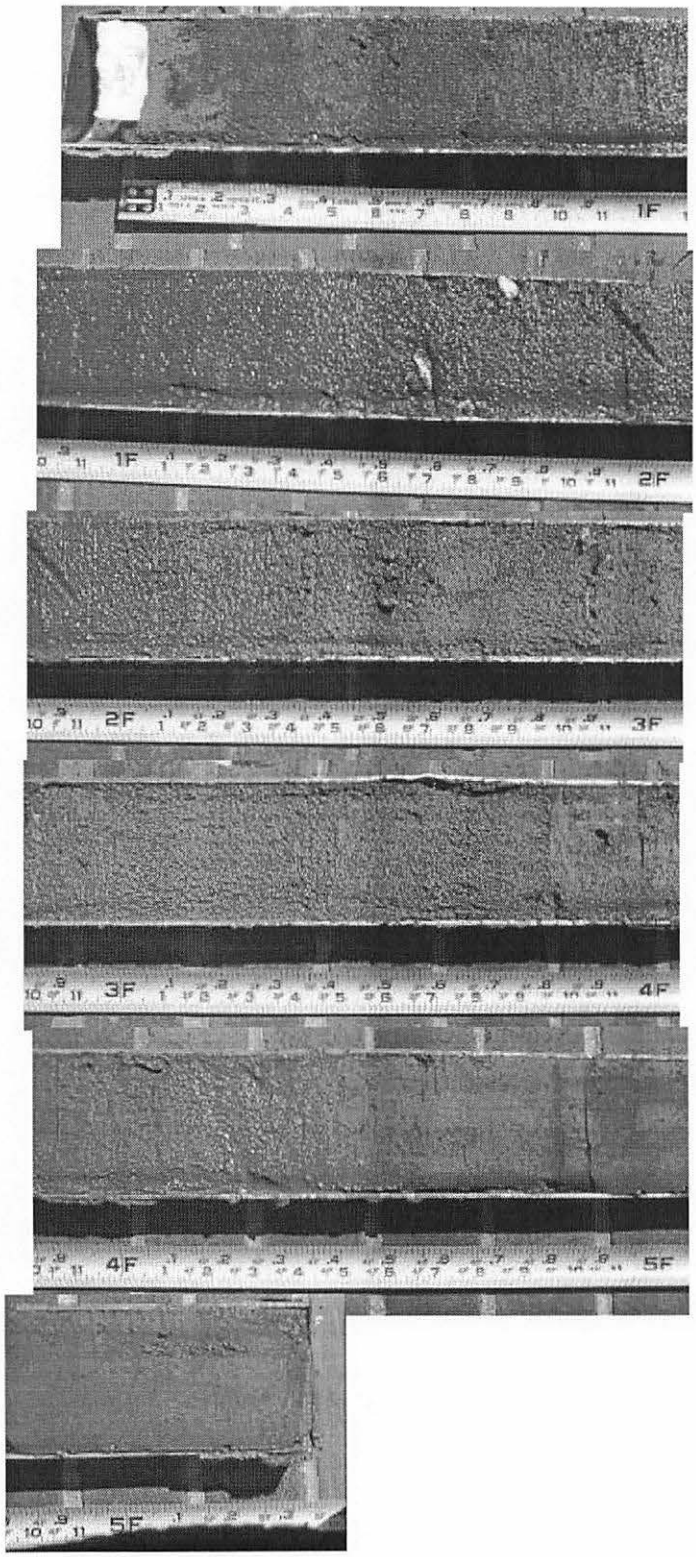


Belle Isle
Core 9

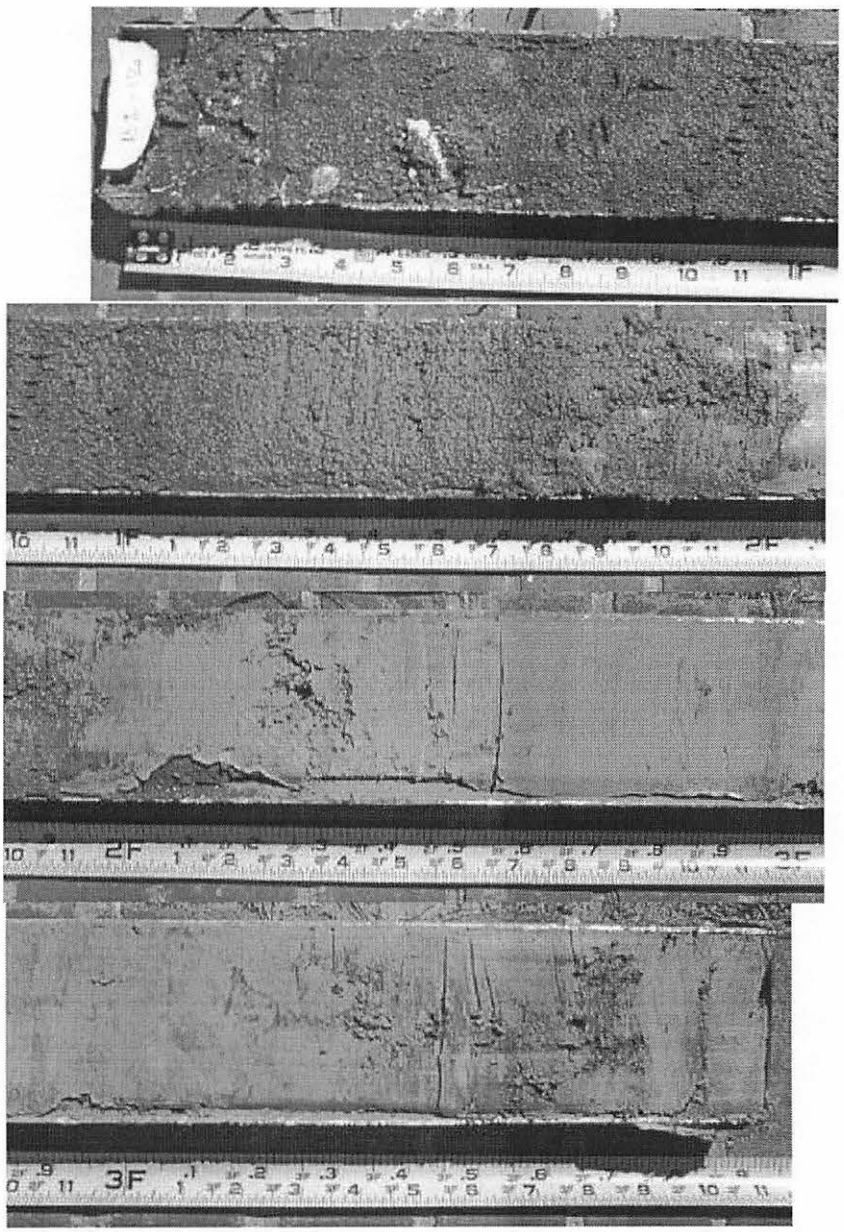


Belle Isle
Core 10

Belle Isle
Core 11



Belle Isle
Core 12



Appendix D
Core Sediment Sample Analysis Results

												Total Sample Statistics		
													Graphic Measures	
					Sample Depth			% Gravel		% Sand	% Silt	% Clay	Mean	Median
					from top of core		Caught on Sieve No.*			Caught on			(mm)	(mm)
Location	Date	Type	Core #	Name	(ft)	>0.5 in.	4	10	Total	Sieve #230				
Belle Isle	13-Jun-2001	Core	2	overall	to 2.3 ft	0.00	1.19	3.57	4.76	90.53	2.47	2.23	1.02	0.52
Belle Isle	13-Jun-2001	Core	5	overall	to 2.6 ft	0.00	9.76	12.60	22.36	77.64	0.00	0.00	1.04	0.48
Belle Isle	13-Jun-2001	Core	5	overall 5a	to 3.9 ft	0.00	8.77	11.32	20.09	69.76	6.48	3.67	2.48	0.52
Belle Isle	13-Jun-2001	Core	5	5-1	0.4 ft	0.00	0.00	0.58	0.58	99.42	0.00	0.00	0.36	0.20
Belle Isle	13-Jun-2001	Core	5	5-2	1.3 ft	0.00	0.00	5.76	5.76	94.24	0.00	0.00	1.05	0.48
Belle Isle	13-Jun-2001	Core	6	overall	to 4.2 ft	0.00	0.00	0.60	0.60	92.51	4.63	2.27	0.42	0.31
Belle Isle	13-Jun-2001	Core	6	6-1	0.8 ft	0.00	0.00	0.00	0.00	99.74	0.26	0.00	0.31	0.24
Belle Isle	13-Jun-2001	Core	6	6-2	2.2 ft	0.00	0.00	1.09	1.09	98.91	0.00	0.00	0.83	0.62
Belle Isle	13-Jun-2001	Core	6	6-3	3.0 ft	0.00	0.00	0.00	0.00	97.53	0.00	2.47	0.24	0.20
Belle Isle	13-Jun-2001	Core	7	overall	to 4.3 ft	0.00	0.00	1.22	1.22	98.78	0.00	0.00	0.73	0.52
Belle Isle	27-Jun-2001	Core	9	overall	to 3.3 ft	0.00	0.00	2.95	2.95	97.05	0.00	0.00	0.84	0.52
Belle Isle	27-Jun-2001	Core	9	9-1	0.3 ft	0.00	0.00	1.84	1.84	98.16	0.00	0.00	0.82	0.57
Belle Isle	27-Jun-2001	Core	9	9-2	1.2 ft	0.00	0.63	4.43	5.06	94.94	0.00	0.00	1.22	0.81
Belle Isle	27-Jun-2001	Core	9	9-3	2.3 ft	0.00	0.00	3.12	3.12	96.87	0.00	0.00	0.96	0.62
Belle Isle	27-Jun-2001	Core	10	overall	to 3.6 ft	0.00	0.00	1.14	1.14	98.86	0.00	0.00	0.64	0.40
Belle Isle	27-Jun-2001	Core	10	10-1	0.2 ft	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.37	0.34
Belle Isle	27-Jun-2001	Core	10	10-2	0.9 ft	0.00	0.00	0.00	0.00	96.33	2.47	1.20	0.31	0.28
Belle Isle	27-Jun-2001	Core	10	10-3	1.5 ft	0.00	0.00	0.00	0.00	94.89	3.34	1.77	0.32	0.26
Belle Isle	27-Jun-2001	Core	10	10-4	2.7 ft	0.00	0.00	2.16	2.16	97.84	0.00	0.00	0.86	0.57
Belle Isle	27-Jun-2001	Core	11	overall	to 4.5 ft	0.00	0.00	0.48	0.48	99.52	0.00	0.00	0.41	0.34
Belle Isle	27-Jun-2001	Core	11	11-1	0.4 ft	0.00	0.00	0.00	0.00	97.97	0.00	2.03	0.18	0.14
Belle Isle	27-Jun-2001	Core	11	11-2	2.0 ft	0.00	0.00	0.00	0.00	96.80	0.00	3.20	0.41	0.34
Belle Isle	27-Jun-2001	Core	11	11-3	3.1 ft	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.41	0.37
Belle Isle	27-Jun-2001	Core	12	overall	to 2.0 ft	0.00	0.00	0.63	0.63	99.37	0.00	0.00	0.67	0.44
Belle Isle	27-Jun-2001	Core	12	overall 12a	to 3.9 ft	0.00	0.00	0.41	0.41	64.21	9.47	25.91	0.44	0.28
Belle Isle	27-Jun-2001	Core	12	12-1	0.7 ft	0.00	10.19	1.77	11.96	81.97	0.00	6.07	1.75	0.34
Belle Isle	27-Jun-2001	Core	12	12-2	1.7 ft	0.00	5.45	1.82	7.27	90.25	0.00	2.48	1.10	0.26

*Sieve #	>0.5 in	4	10	230
	equals	equals	equals	equals
Phi	-3.64	-2.25	-1.00	4
mm	12.5	4.75	2	0.0625
inch	0.50	0.19	0.08	0.0025

August 7, 2001

NOTE:

TO: Carol Hartgen Chief Division of International Activities and Marine Minerals (INTERMAR)

FROM: John Rowland, Geologist, INTERMAR

SUBJECT: Meeting Summary and Comments

Sandbridge Shoal and Regional Beach Restoration Projects

Meeting at the U.S. Army Corps of Engineers (USACE) Norfolk District (NAO) in Norfolk, Virginia on August 1, 2001 from 0900 to 1130 AM. The meeting was convened to discuss mutual interests and inter-related topics related to sand resources and beach nourishment and hurricane protection projects along the coast of southeastern Virginia. The Minerals Management Service (MMS) has management responsibilities pertinent to the sand resource and environment of Sandbridge Shoal located in Federal waters off the coast of southeastern Virginia. Approximately 800,000 cubic yards (cy) of the Sandbridge Shoal shoal sand for the 1996 berm construction and hurricane protection at the U.S. Navy (USN) Damneck Training Facility. The USN facility is located along the coast adjacent to Sandbridge Beach, Virginia. In 1998, Sandbridge Shoal was used as source of 1,100,000 cy of sand to restore of the Sandbridge Beach portion of Virginia Beach. In 2002, the USACE NAO has requested the MMS for access to the Sandbridge Shoal to obtain use of approximately 1,500,000 cy of sand for the second application to the beach along the 5- mile reach of Sandbridge Beach. Consequently, the MMS and others at the meeting are interested in the future of Sandbridge Shoal as a source of sand for subsequent projects. In 2004, the City of Virginia Beach and the USACE NAO are also planning to use 1,500,000 cy in a subsequent cycle of beach nourishment on Sandbridge Beach. The USN expects to request the MMS for access and use of additional Sandbridge Shoal sand for another cycle of renourishment along the beach of the USN Damneck Training Facility located adjacent to Sandbridge Beach. The sand volume request by the USN is anticipated to be within the range of 600,000 to 1,500,000 cy. The sand source for the U.S. Navy is also Sandbridge Shoal. However, initial indications are that the USACE and the USN will attempt to synchronize the schedules of the anticipated 2004 operations. Such cooperation would be expected to generate cost savings for the sponsors related to mobilization, the operations, and administration.

Hobbs (personal communication, 2000) estimated that the Sandbridge Shoal contains about 40,000,000 cy of sand and discussed the shoals' physiography and offered an explanation for its' probable origin. However, the estimate is based on sand body geometry, dimensions and a limited number of cores. Consequently, the estimate was not intended to be a volumetric estimate of usable sand for local beach nourishment projects. Based on subsequent survey work, the USACE NAO states that a reasonable estimate for the volume of usable sand remaining is 7,000,000 cy. This sand volume is located on the northern portion of the shoal (defined by the USACE NAO as Section B) from the surface to the –50 ft isopach. The southern portion of the shoal could be expected to contain a similar volume. If Section BB is included the volume of usable sand may increase to about 9, 000,000 cy. The most recent map developed by the USACE NAO showing the shoal surface is available from the USACE NAO and the MMS. The renourishment cycles for Damneck and Sandbridge Beach projects is about 4 years assuming no instances of catastrophic damage incurred from impacts of nor'easters or hurricanes between planned cycles. Based on that cycle frequency (~4 years) and volume estimates (3,000,000 cy), Sandbridge Shoal Section B & BB could be the sand source for those sites until about 2016. The sand for future beach nourishment along the Virginia Beach resort strip will probably be

with the Office of Naval Research obtained 10 vibracores and high-resolution shallow seismic data from the area offshore False Capes, Virginia. Analyses of the vibra-core material will be accomplished during 2001/2002 at George Mason University. The results and related interpretation can be expected to be helpful determining the quality and the quantity of beach quality sand located offshore False Cape, Virginia.

The USACE stated that administrative work is proceeding on schedule for the 2002 Beach Replenishment Project at the Sandbridge Beach. The 2002 and 1998 Sandbridge Beach Projects Designs are essentially identical. The USACE inquired the MMS about the status of the proposed Memorandum of Agreement (MOA) with the MMS. The proposed MOA forwarded by MMS was forward to the U.S. Department of the Interior Solicitor's Office for review in early 2001. The USACE indicated that another copy of the MOA would be sent to assist in the process. The MOA along with a lease agreement, an Environmental Assessment, and Project Cooperation Agreement (PCA) are crucial segments of the multi-agency administrative process for projects such as for beach restoration and hurricane protection.

The USACE and the MMS discussed the progress of the Environmental Assessment (EA) underway by MMS Headquarters. The MMS anticipates that the EA will be completed as scheduled on or before October 1, 2001. The USACE indicated that a Virginia Marine Resource Commission (VMRC) permit was obtained for the Sandbridge Beach Restoration & Hurricane Protection Project. The VMRC, USACE, and City of Virginia Beach worked cooperatively to formulate the permit that would be effective and valid for a 5-year period. The 5- year duration covers an anticipated beach replenishment at Sandbridge Beach and is designed to reduce the efforts associated with VMRC repetitive permitting for repetitive projects while maintaining the high standards of marine resource management standards. Informal discussion continued about the potential to explore a more regional approach to the cyclic renourishment of Sandbridge Beach and the Damneck Facility beaches. The MMS would examine a more regional approach to the Sandbridge Shoal sand resource management and the USACE, City of Virginia Beach, USN, and MMS would increase planning and coordination related to the beach renourishment project cycles at the USN Damneck Facility and at Sandbridge Beach. Significant benefits would be realized by coordination of these adjacent beach restoration projects. Benefits would include efficiencies gained economies of scale; mobilization costs, and streamlined administrative and planning and designs tasks. Attendees agreed to explore the potential within their agencies for developing and implementing a regional approach to marine sand resource and coastal restoration along the coast of southeastern Virginia. Further discussion relating to a regional approach is anticipated to be an agenda item at another meeting in early 2002.

After the meeting adjourned, Carol Hartgen, John Rowland accompanied Tom Felvey, Virginia's Department of Environmental Quality to the resort strip oceanfront in vicinity of 25th Street to observe the beach nourishment operations by Weeks Marine Inc., dredging contractor for the City of Virginia Beach. The operation is part of the federally funded Beach Nourishment and Hurricane Protection project for the City. Sand for the beach widening operation is obtained by Weeks Marine from the Chesapeake Bay Shipping channel offshore of Cape Henry and extending into the Chesapeake Bay. The sand source is about 3- miles north of the present widening area at 25th Street.

In summary, the meeting provided opportunity for Federal, State and local agencies involved with the regional beach restoration and hurricane protection projects along the southeastern coast of Virginia to review their past, present and anticipated activities. The meeting further provided opportunities for the represented agencies to ensure and increase coordination with future projects.

The sand in cy required for beach nourishment projects and the dates of the projects are projected values and are subject to change. The values are intended only as projections for internal planning exercises. Below is the list of the participants and their phone numbers:

Brian Rheinhart, USACE NAO (757/425-6503)
Phil Roehrs, City of Virginia Beach, (757/427-4167)
Carol Hartgen, MMS (703/787-1300)
John Rowland, MMS (703/787-1297)
Woody Hobbs, VIMS (804/684/7271)
Andy Porter, US Navy Oceana/Damneck (757/433-226)
Jim Haluska, US Navy LANT DIV Norfolk (757/322-4889)
Michele Cleland, USACE NAO (757/441-7766)
Tom Felvey, Commonwealth of Virginia DEQ (804/698-4315)
Jerry Swean, USACE NAO (757/441-7101)
Jim Creighton, USACE NAO (757/441-7724)
Larry Holland, USACE NAO (757/441-7774)
Mike Petro, USACE NAO (757/441-7152)