

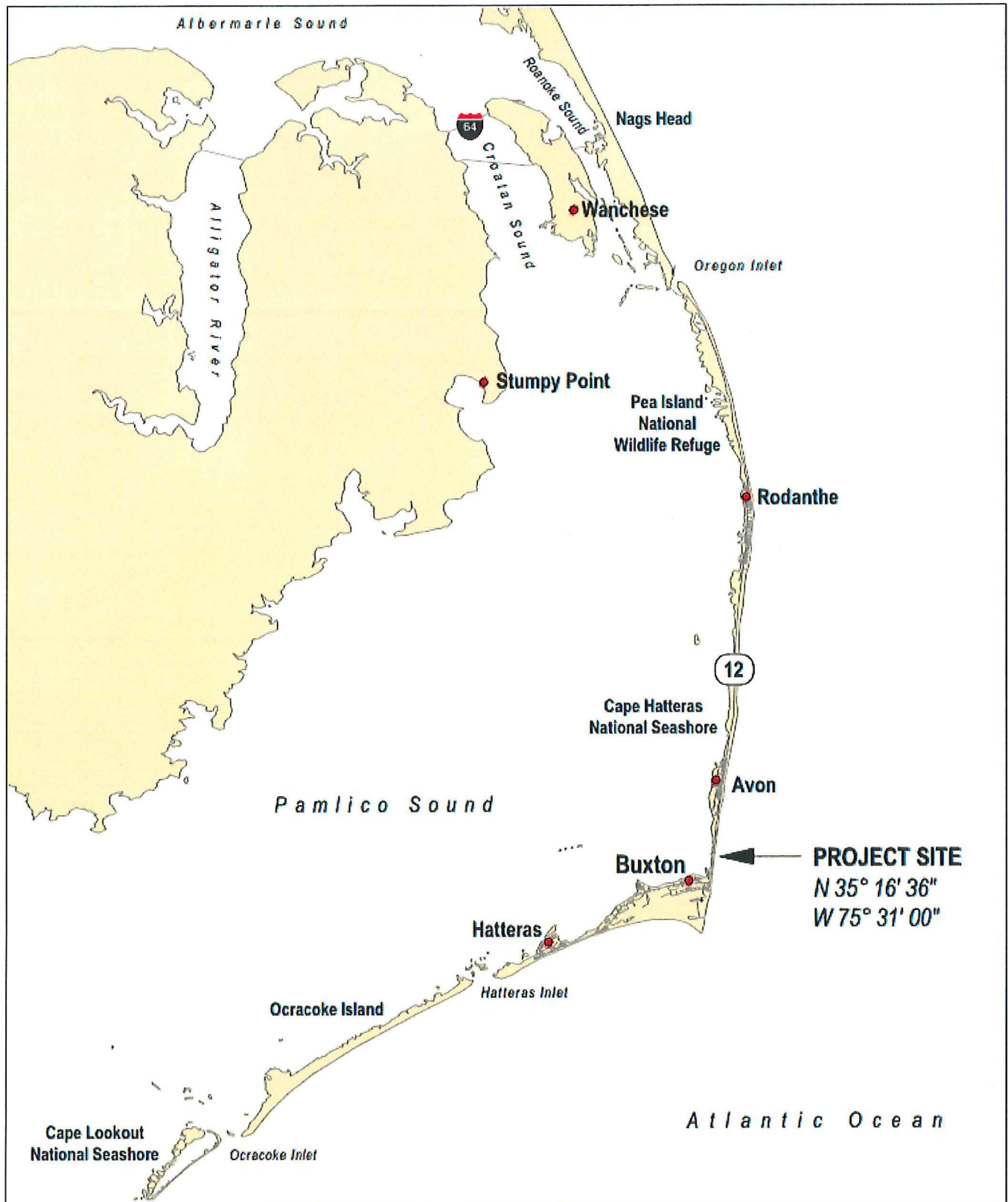


Figure 1. Location of Buxton and Cape Hatteras National Seashore, Dare County, North Carolina.

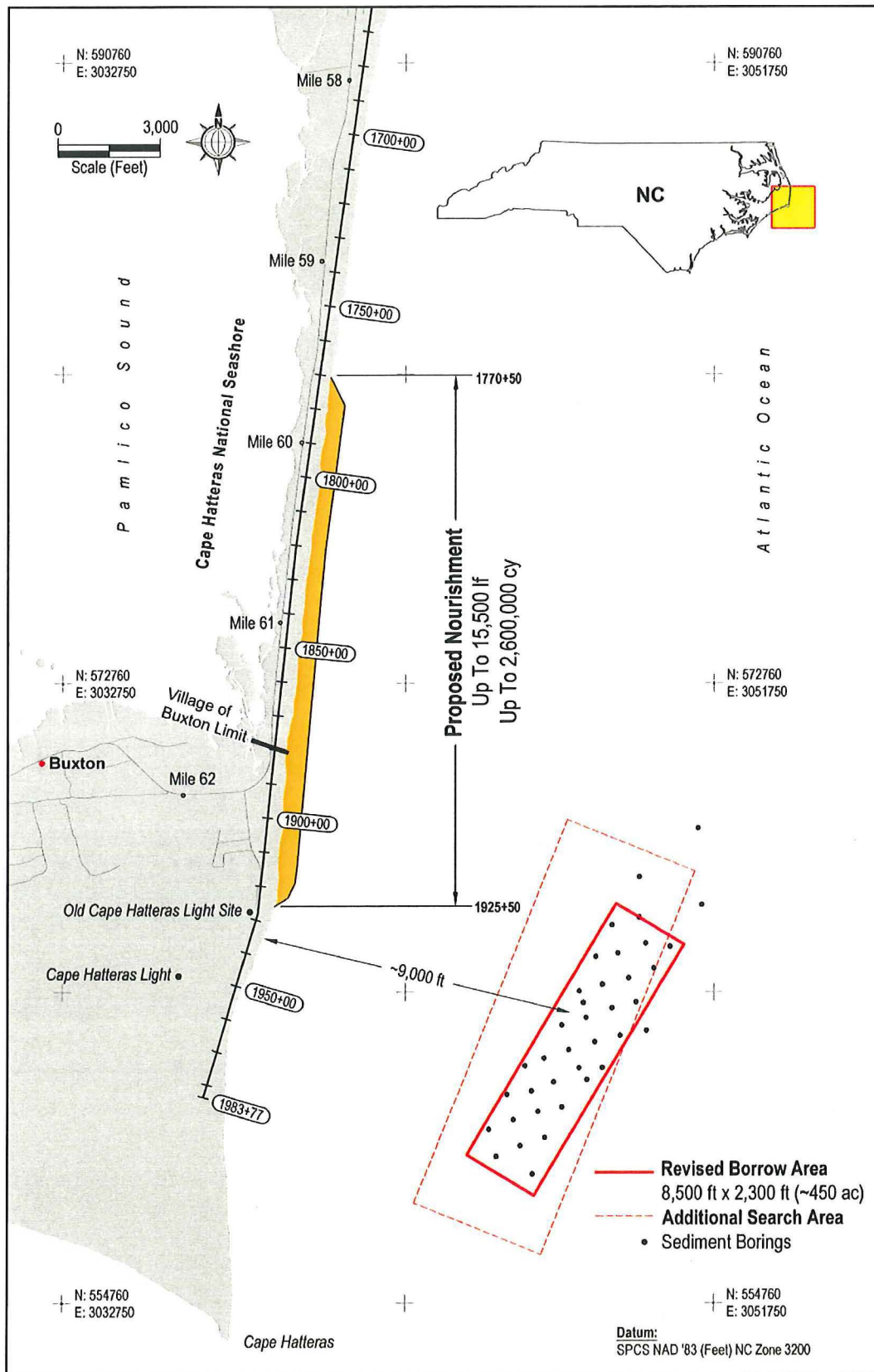


Figure 2. Proposed beach restoration for NC 12 at Buxton showing anticipated maximum project limits and offshore borrow area (after CSE/CZR 2013).



Figure 3 (1 of 2). Aerial image taken by the project team on 11 September 2014 – looking southwest. The maximum project area is shown on the photo.



Figure 3 (2 of 2). Aerial image taken by the project team on 11 September 2014 – looking north. The Village of Buxton north limit is located approximately at the end of the northernmost building showing in the photo.

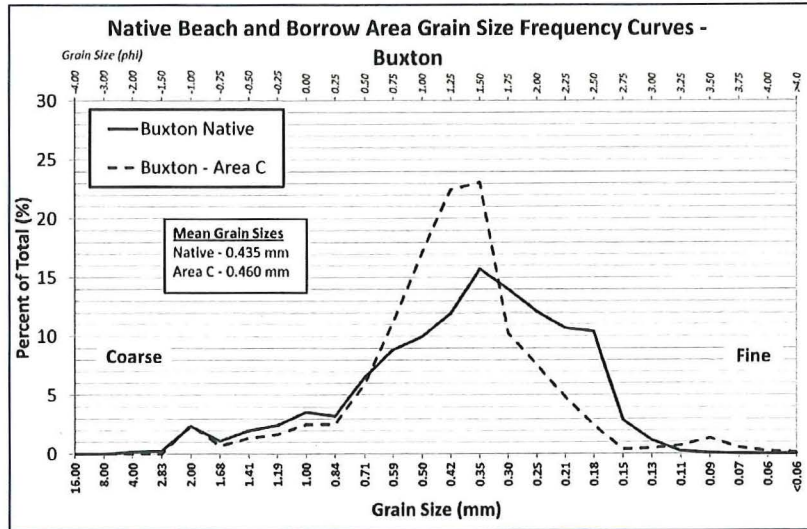


Figure 4.

Sediment grain-size distribution along the proposed project area (composited beach samples) and sediment quality for the proposed offshore borrow area showing similar mean grain size and sorting (composited from available cores).

[Note: Area "C" (dashed line in the graph) refers to the solid red-line box in Figure 2.]

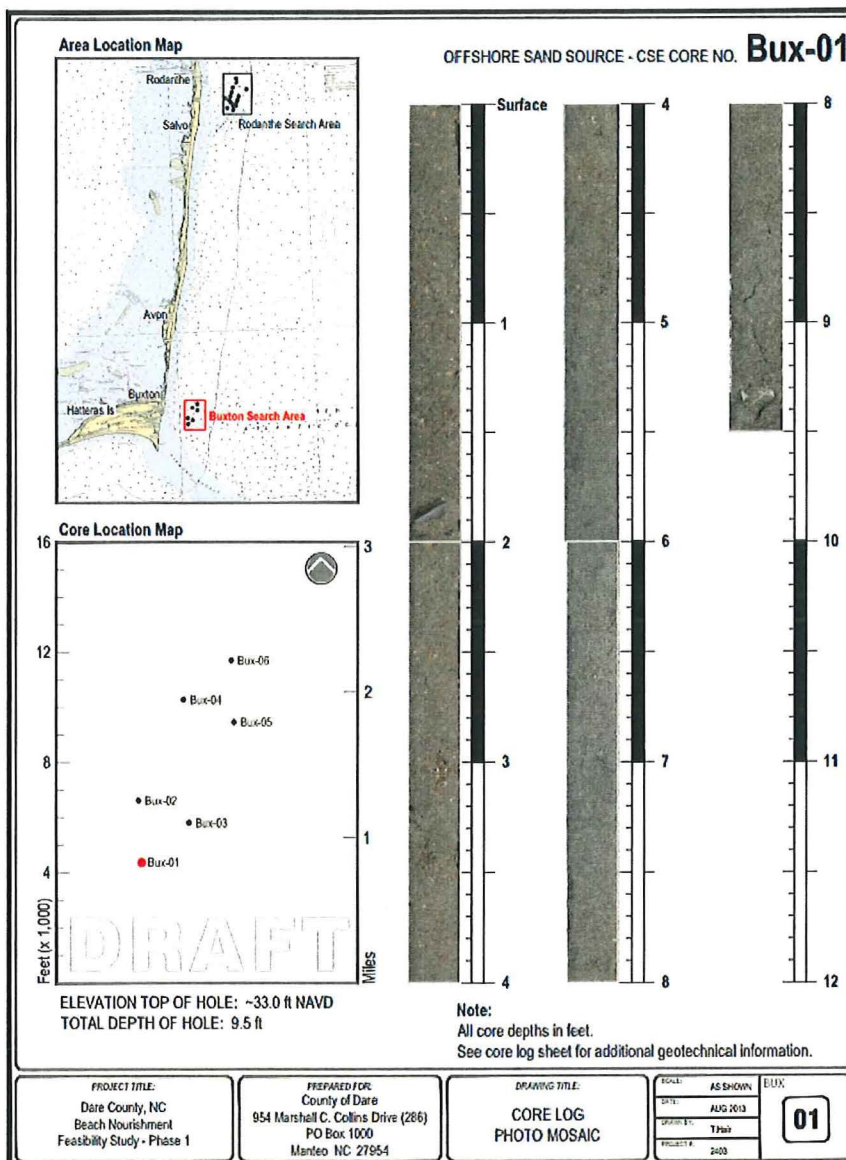
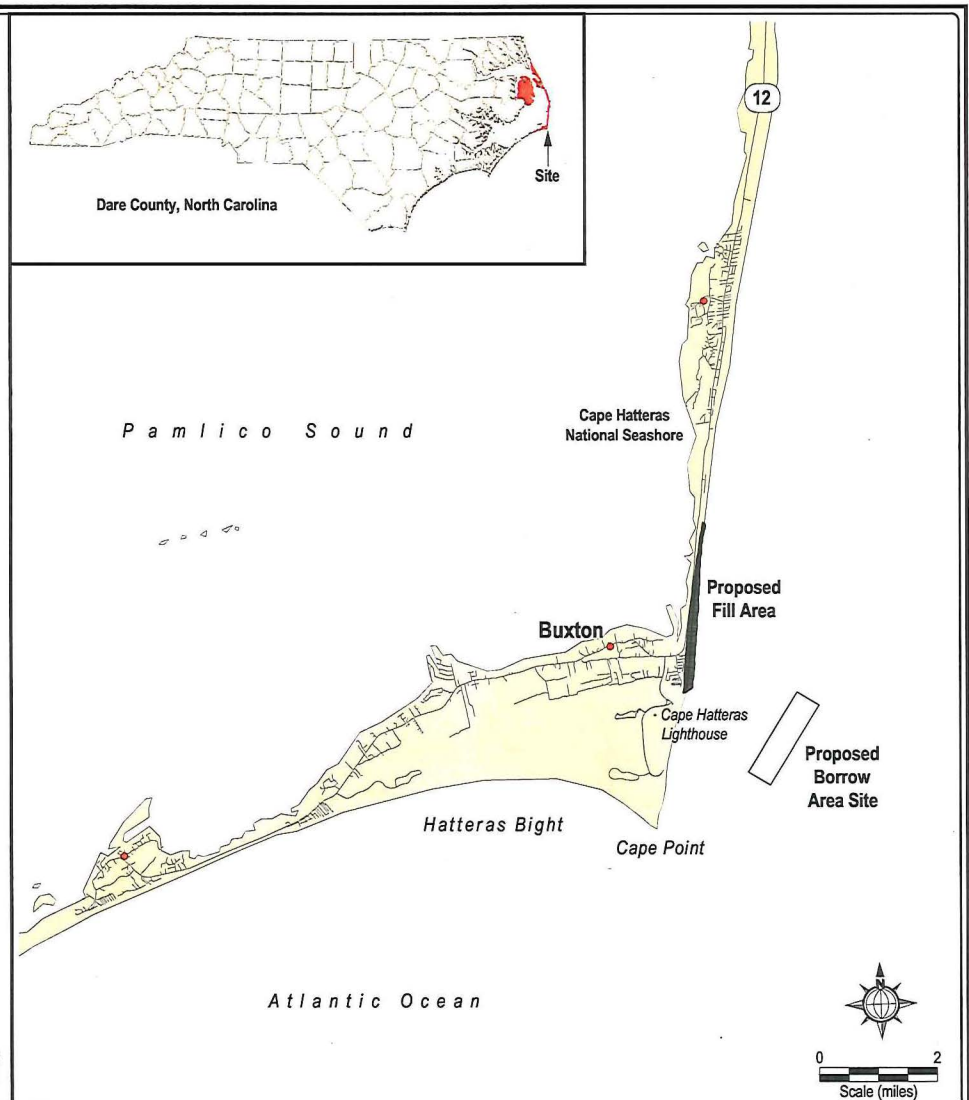
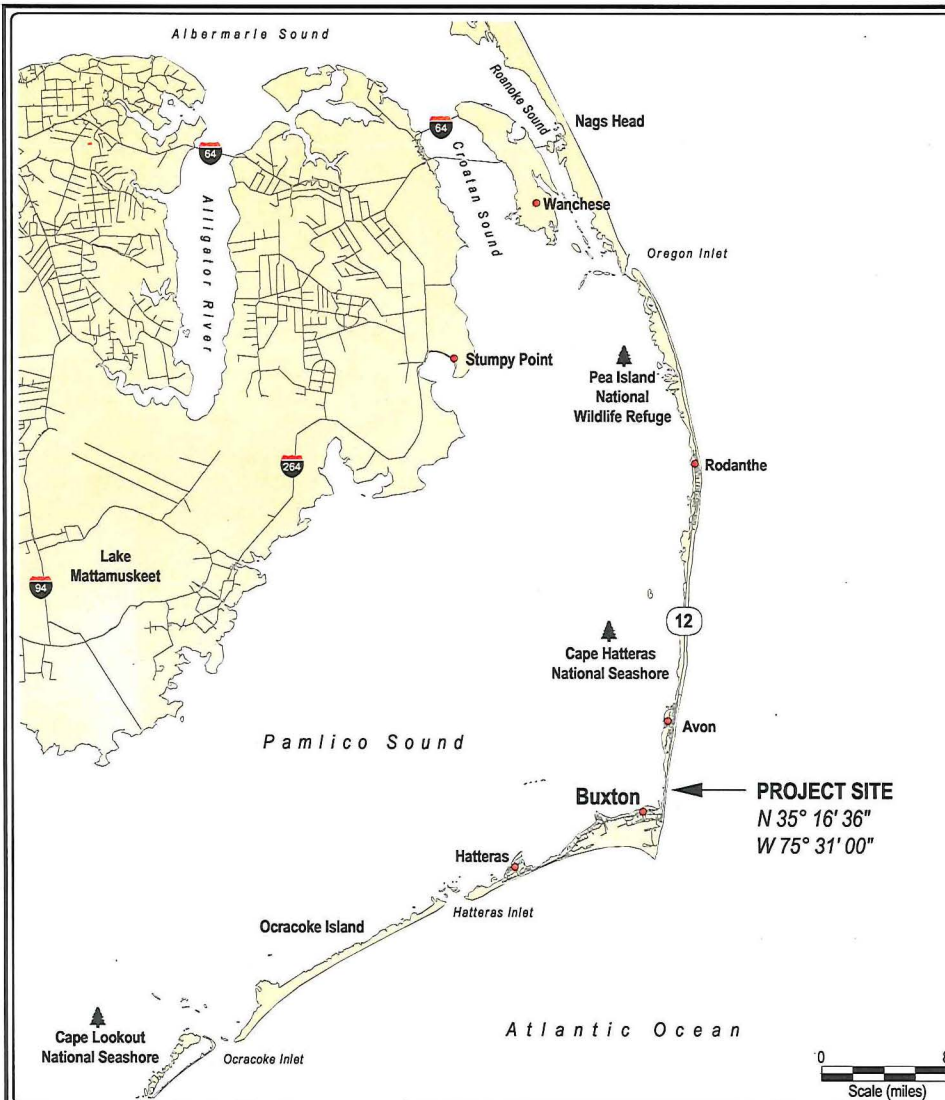


Figure 5.

Representative core photo log for the proposed offshore borrow area (from CSE/CZR 2013).



Project site directions, from Nags Head, NC:
Follow NC-12 S/Cape Hatteras National Park Hwy South.
Continue to follow NC-12 S for 44.3 miles to Haulover public beach access parking area.
North project limit is on beach side of NC-12 (National Park Service Beach) and extends 15,500 feet South toward Buxton, NC. South project limit is in the vicinity of the old Cape Hatteras Lighthouse location.

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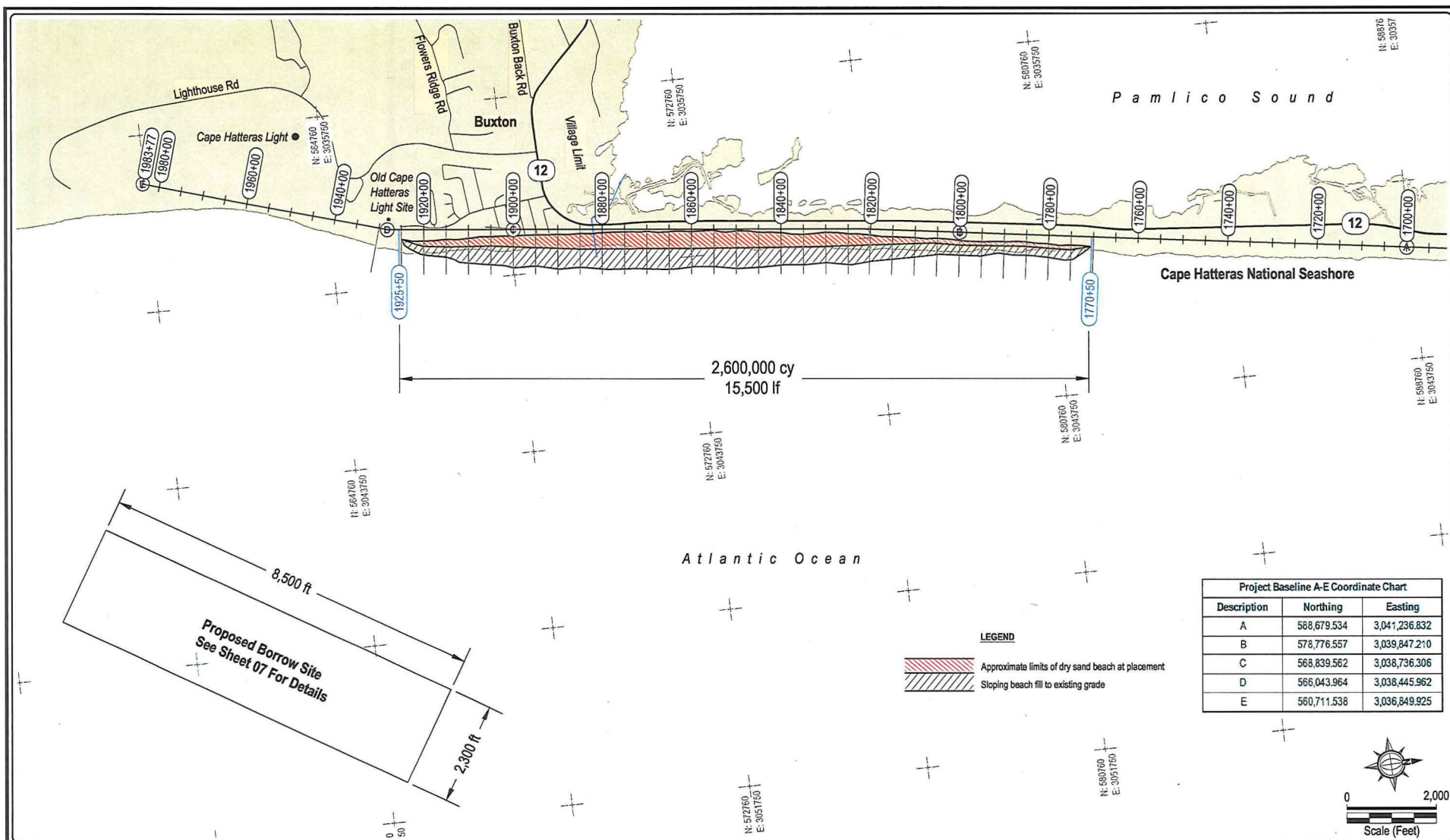
Project:
Beach Restoration To Protect
NC Highway 12 At Buxton
Dare County, NC

DRAWING TITLE:
Project Location
& Vicinity Map



SCALE: AS SHOWN
DATE: 14 July 2015
DRAWN BY: LJH
APPROVED BY:
PROJECT #: 2403

01



Survey Datum: MHW (+1.05 ft NAVD)
Horizontal: SPCS NAD '83 (Feet) NC Zone 3200
 MLW (-1.94 ft NAVD)
 Project Baseline after CSE / CZR (2013)
 Shoreline erosion assessment and plan for beach restoration: Feasibility report to Dare County board of commissioners, Coastal Science & Engineering, Inc. and CZR Inc.

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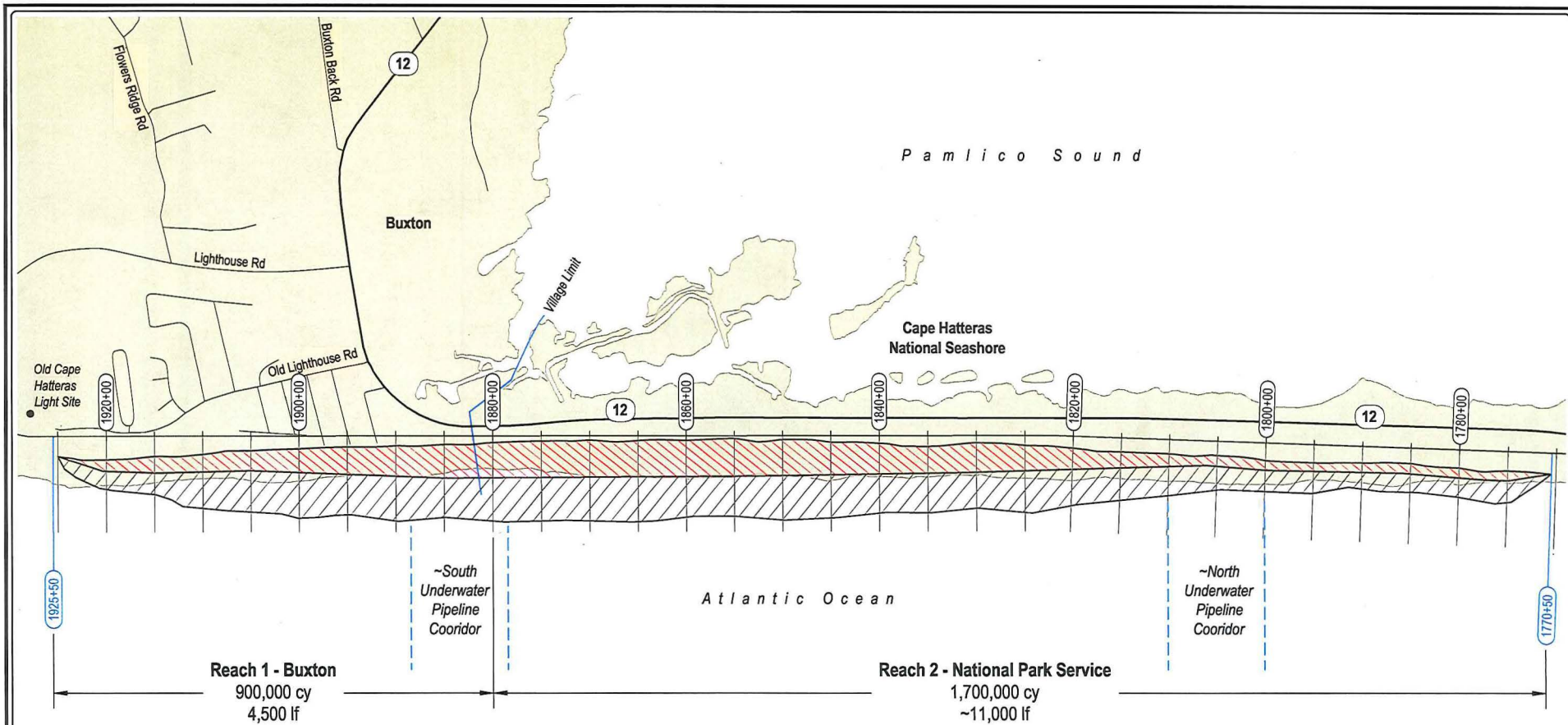
Project:
 Beach Restoration To Protect
 NC Highway 12 At Buxton
 Dare County, NC

DRAWING TITLE:
 OVERALL PROJECT PLAN

SEAL
 NORTH CAROLINA
 REGISTERED PROFESSIONAL ENGINEER
 37281
 12/12/20
 HUONG LIU KACHANG

SCALE: AS SHOWN
DATE: 14 July 2015
DRAWN BY: JLM
APPROVED BY:
PROJECT #: 2403

02



Note:
The landward limit of fill is indicated based on approximate location of escarpments in October 2014. The landward limit of fill will be the +7 ft NAVD contour at the time of construction. (i.e. seaward of the foredune)

The final configuration and limits of beach construction will be determined based on conditions at the time of construction and the aggregate total fill volume that can be accomplished within the available budget for the project. The indicated quantities are maximum amounts to be permitted.

The project will not fill or cover any emergency shore protection structures such as sandbags. Buffers (no work areas) alongshore will be maintained around areas of active bird nesting at the time of construction in consultation with NPS biologists. To extent practicable, the construction berm will shift seaward of Mean Low Water at sites of nests then reenter the existing beach outside of the buffer zone.

Note:
A minimum of two underwater pipeline corridors will be used for transport of the sand slurry. From those points, land based pipes will run along the constructed berm.

The order of beach filling alongshore will be determined in consultation with the National Park Service (NPS) biologists so as to avoid areas of active nesting by colonial water birds to the extent practicable.

Survey Datum:
Horizontal: SPCS NAD '83 (Feet) NC Zone 3200
Vertical: NAVD '88 (Feet)
Notes: Data collected by Coastal Science & Engineering, Inc via RTK GPS:
Data collected: October 2014

MHW (+1.05 ft NAVD)
MLW (-1.94 ft NAVD)

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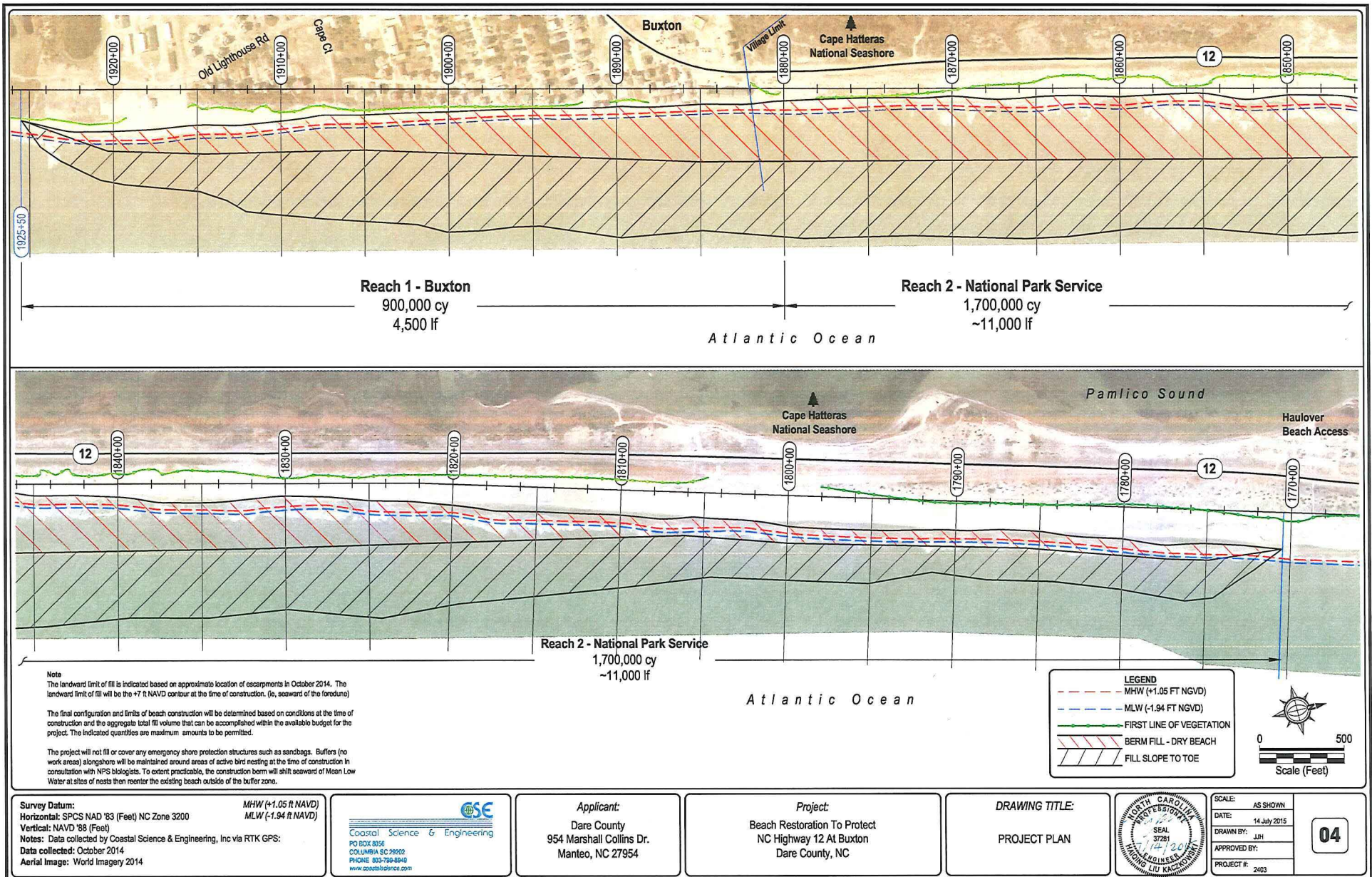
Project:
Beach Restoration To Protect
NC Highway 12 At Buxton
Dare County, NC

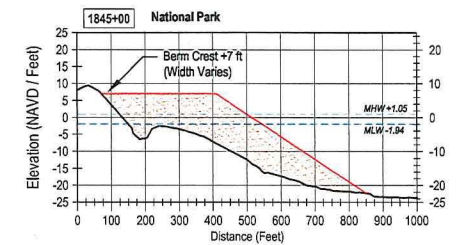
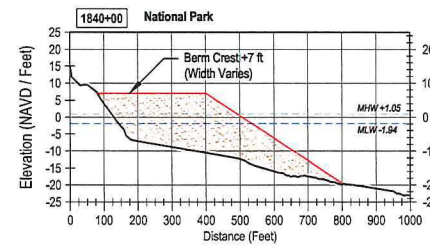
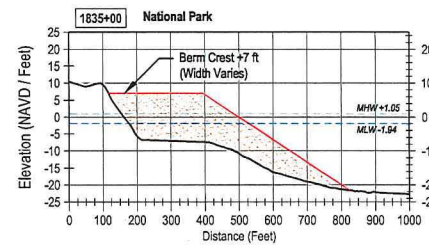
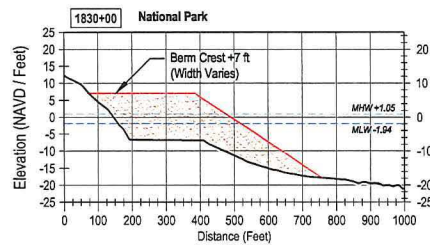
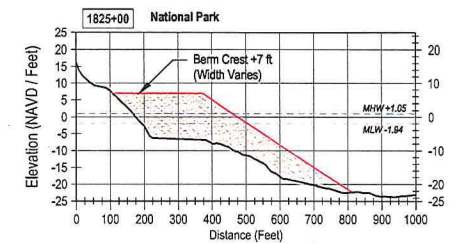
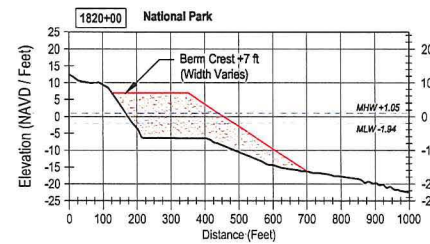
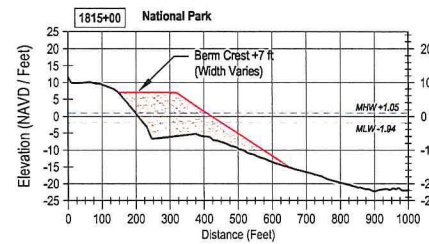
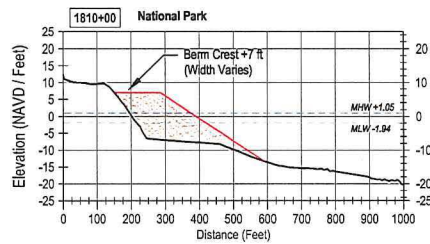
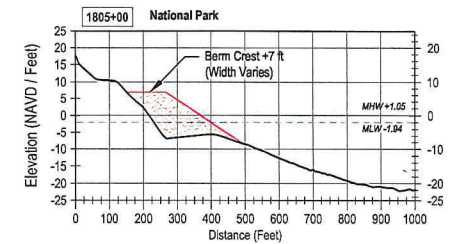
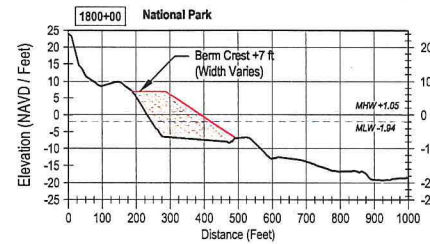
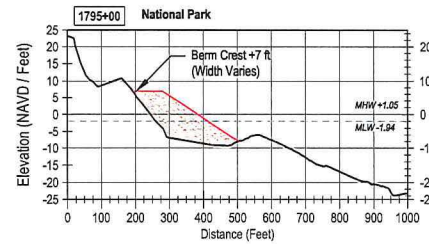
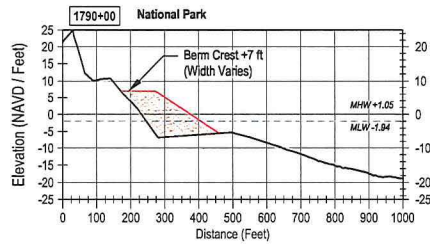
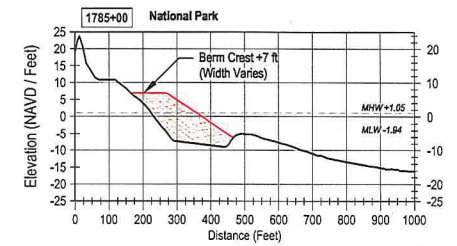
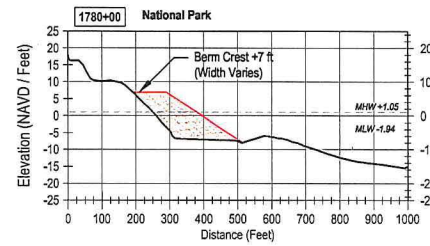
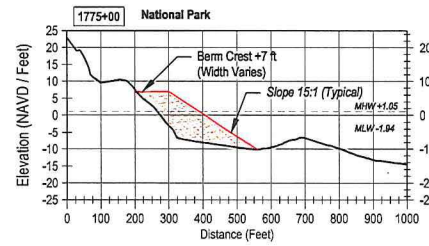
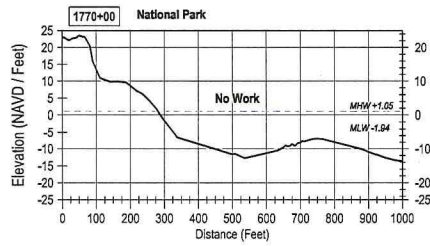
DRAWING TITLE:
OVERALL PROJECT PLAN



SCALE: AS SHOWN
DATE: 14 July 2015
DRAWN BY: JH
APPROVED BY:
PROJECT #: 2403

03





Survey Datum:
Horizontal: SPCS NAD '83 (Feet) NC Zone 3200
Vertical: NAVD '88 (Feet)
Vertical Exaggeration: 10:1
Notes: Data collected by Coastal Science & Engineering, Inc via RTK GPS:
Data collected: October 2014

MHW (+1.05 ft)
MLW (-1.94 ft)

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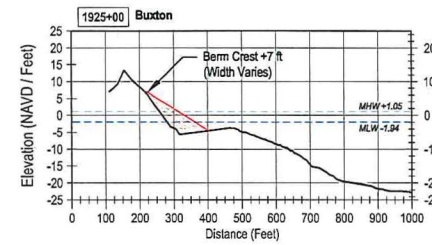
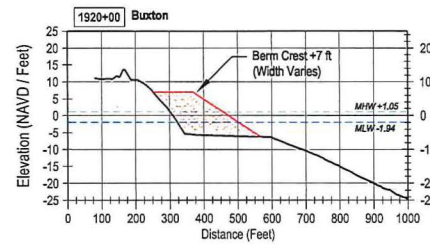
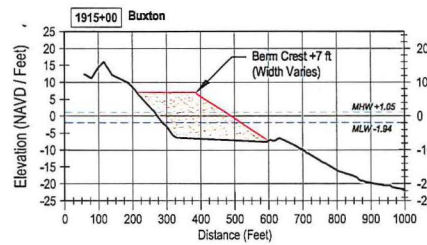
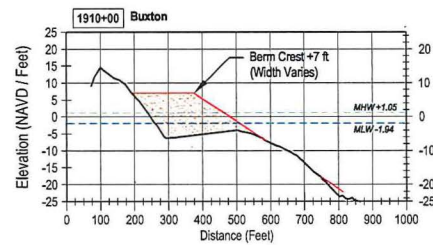
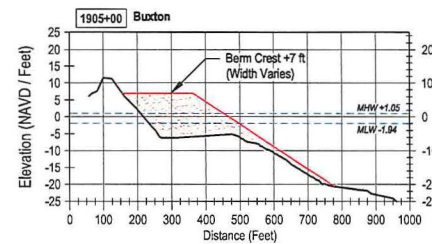
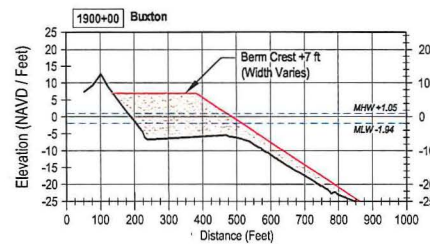
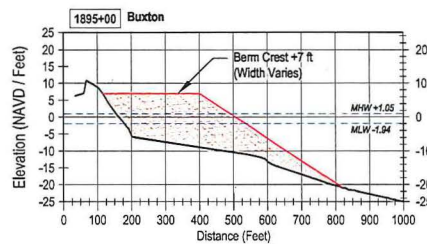
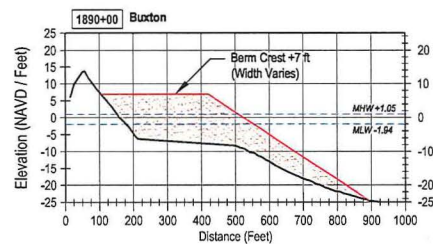
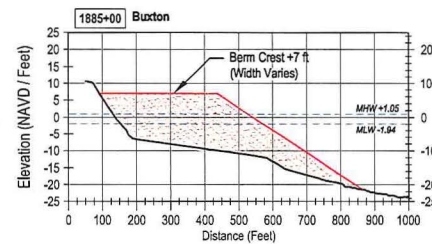
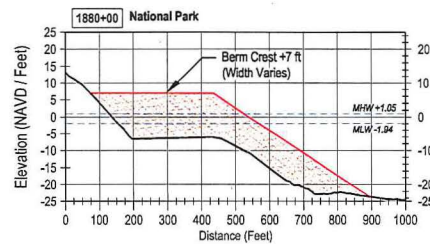
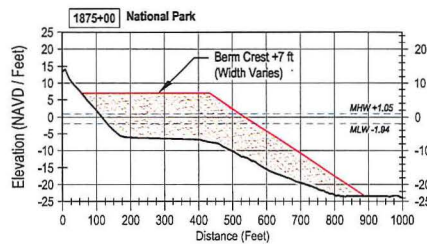
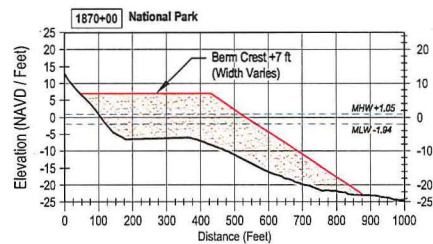
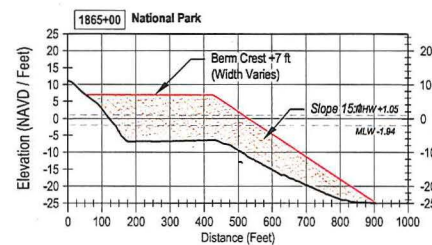
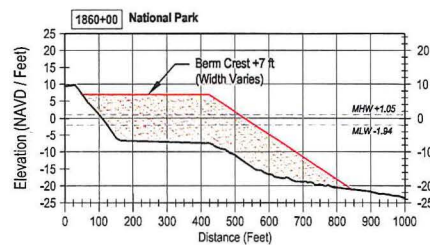
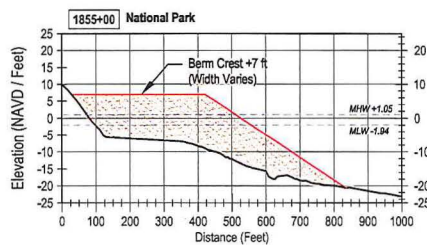
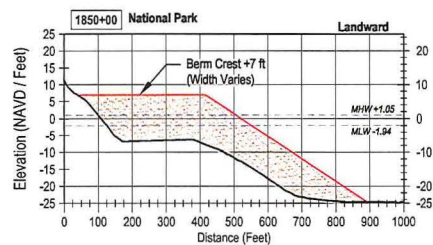
Project:
Beach Restoration To Protect
NC Highway 12 At Buxton
Dare County, NC

DRAWING TITLE:
PLAN FILL SECTIONS
STA 1770+00 TO 1845+00

NORTH CAROLINA
REGISTERED PROFESSIONAL
SEAL
37281
7/14/2015
ENGINEER
HANG LUO KACHONG

SCALE: AS SHOWN
DATE: 14 July 2015
DRAWN BY: JSH
APPROVED BY:
PROJECT #: 2403

05



Survey Datum:
Horizontal: SPCS NAD '83 (Feet) NC Zone 3200
Vertical: NAVD '88 (Feet)
Vertical Exaggeration: 10:1
Notes: Data collected by Coastal Science & Engineering, Inc via RTK GPS:
Data collected: October 2014

MHW (+1.05 ft)
MLW (-1.94 ft)

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Project:
Beach Restoration To Protect
NC Highway 12 At Buxton
Dare County, NC

DRAWING TITLE:
PLAN FILL SECTIONS
STA 1850+00 to 1925+00

NORTH CAROLINA
PROFESSIONAL
SEAL
7281
4/14/2015
ENGINEER
HONG LIU KACHIN

SCALE: AS SHOWN
DATE: 14 July 2015
DRAWN BY: JH
APPROVED BY:
PROJECT #: 2403

06

Borrow Area Coordinate Chart		
Description	Northing	Easting
A	566,343.069	3,048,897.678
B	565,158.522	3,050,869.152
C	557,872.581	3,046,491.338
D	559,057.111	3,044,519.888

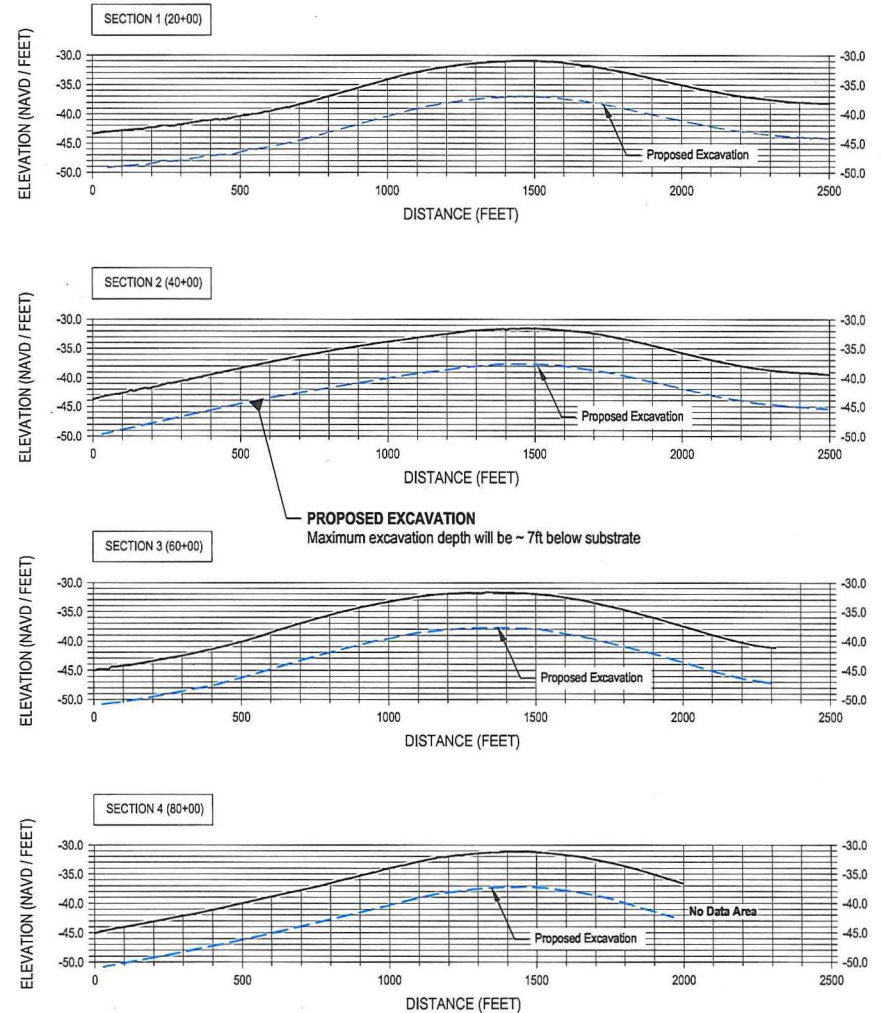
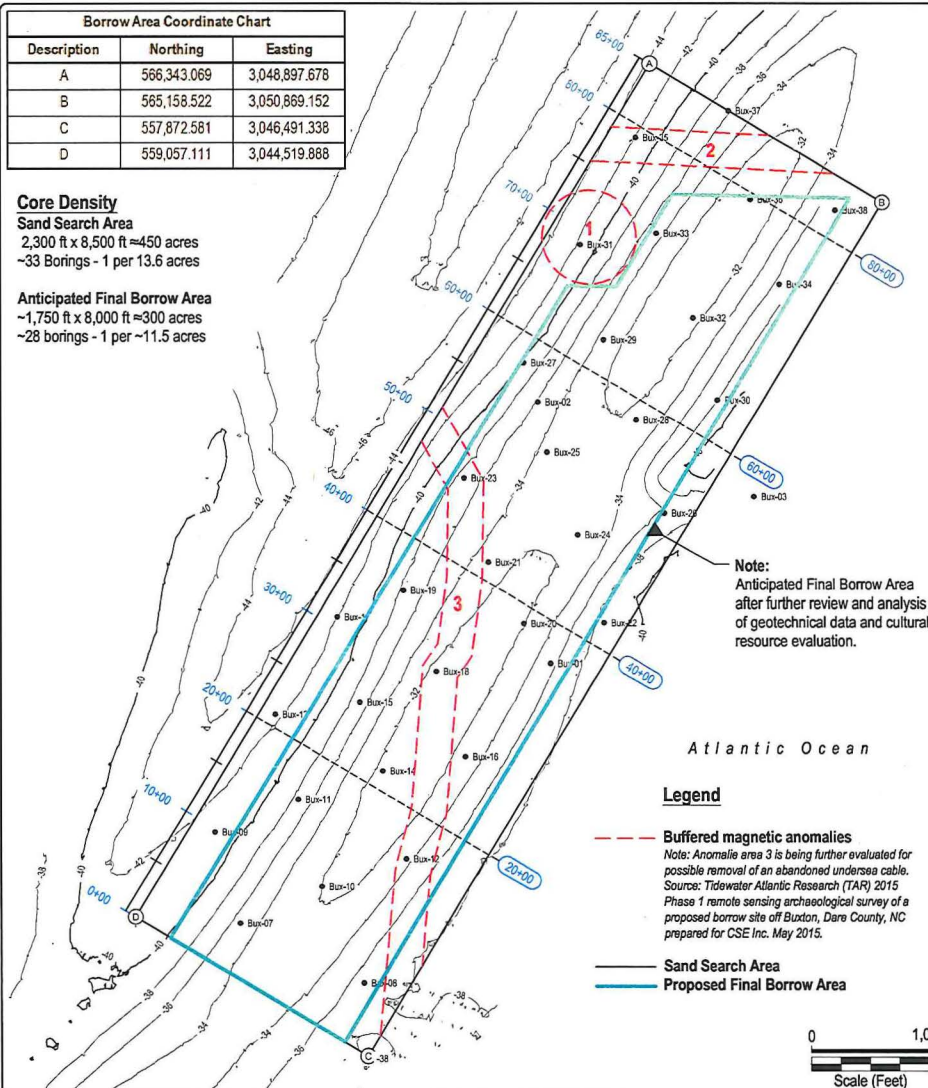
Core Density

Sand Search Area

2,300 ft x 8,500 ft ≈ 450 acres
~33 Borings - 1 per 13.6 acres

Anticipated Final Borrow Area

~1,750 ft x 8,000 ft ≈ 300 acres
~28 borings - 1 per ~11.5 acres



Survey Datum:
Horizontal: SPCS NAD '83 (Feet) NC Zone 3200
Vertical: NAVD '88 (Feet)
Notes: Data collected by Coastal Science & Engineering, Inc via RTK GPS:
Data collected: October 2014

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Project:
Beach Restoration To Protect
NC Highway 12 At Buxton
Dare County, NC

DRAWING TITLE:
BORROW AREA PLAN
& SECTIONS

SEAL
37281
11/14/20
HUIJING LIU KACHONG
ENGINEER

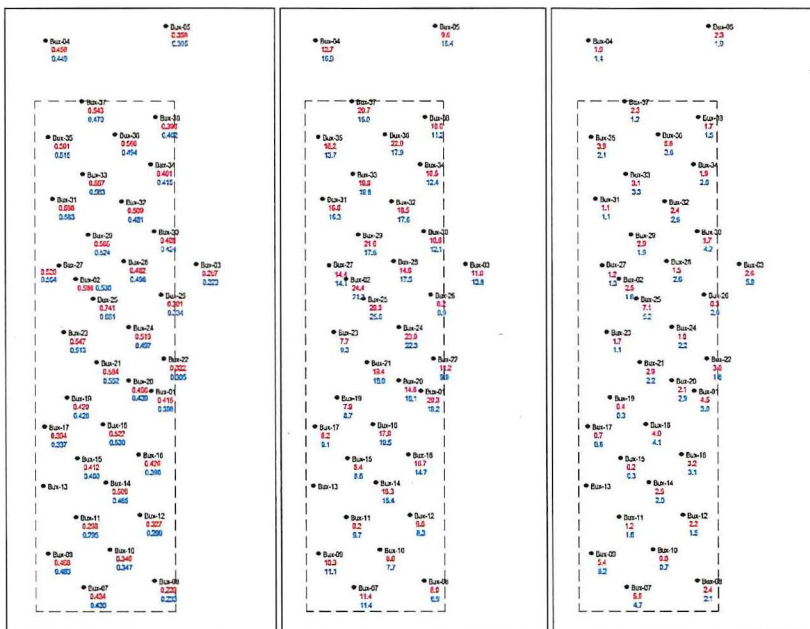
SCALE: AS SHOWN
DATE: 14 July 2016
DRAWN BY: JKH
APPROVED BY:
PROJECT #: 2493

07

OFFSHORE SEDIMENT SAMPLES

Core Samples	Mean Size (mm)	Std Deviation (mm)	Shell (%)	Gravel (%)
All Samples	0.446	0.615	15.1 (7.5)	2.8 (5.2)
Comp 4 ft	0.466	0.609	14.8 (5.9)	2.5 (1.7)
Comp 6 ft	0.455	0.604	14.2 (4.8)	2.3 (1.4)
Comp 8 ft	0.447	0.605	14.5 (5.1)	2.5 (1.5)

Average arithmetic mean grain size, standard deviation, shell percentage, and gravel percentage for 37 borings (135 samples) off Buxton ("All Samples"). Composites are weighted by applicable length of individual samples for the upper 4 ft of core (Comp 4), the upper 6 ft of core (Comp 6), and the upper 8 ft of core (Comp 8). Composite statistics are based on 33 cores within the box shown on sheet 07. Standard deviation for shell and gravel percentages is given in parentheses.



Mean Grain Size

4 ft Composite (mm)
8 ft Composite (mm)

Shell Content

4 ft Composite (% shell)
8 ft Composite (% shell)

% Gravel (> 2mm)

4 ft Composite (% gravel)
8 ft Composite (% gravel)

Mean grain size, percent shell, and percent gravel for core composite samples to 4 ft and 8 ft in the Buxton offshore sand search area based on borings obtained in October 2014. Bux-13 was attempted but not recovered. Composite results to 6 ft (not shown) fall between the results for 4 ft and 8 ft.

BEACH SEDIMENT SAMPLES

Station Average - All Samples - October 2014				
	Mean	STD	Shell	Gravel
	mm	mm	%	%
1760+00	0.524	0.589	5.3	4.8
1790+00	0.600	0.608	5.4	5.1
1820+00	0.704	0.623	6.9	8.1
1840+00	0.749	0.621	7.4	8.5
1870+00	0.709	0.610	6.6	9.6
1890+00	0.586	0.638	5.7	5.3
1900+00	0.626	0.608	6.0	7.1
1920+00	0.674	0.637	6.7	6.5
1940+00	0.583	0.617	6.3	5.4
1980+00	0.548	0.619	5.5	5.5
Average	0.630	0.617	6.2	6.6

Station Average Excluding Trough				
	Mean	STD	Shell	Gravel
	mm	mm	%	(w/o Trough)
1760+00	0.519	0.612	4.9	2.9
1790+00	0.515	0.597	5.6	4.1
1820+00	0.569	0.631	5.7	4.2
1840+00	0.627	0.630	6.2	5.4
1870+00	0.552	0.617	5.1	5.4
1890+00	0.461	0.645	4.7	1.6
1900+00	0.459	0.618	4.5	2.6
1920+00	0.502	0.648	5.7	1.9
1940+00	0.439	0.623	4.7	1.2
1980+00	0.399	0.626	4.3	1.3
Average	0.504	0.625	5.1	3.1

Arithmetic mean grain size and related statistics based on 14 samples per transect (n=140). Lower table gives results omitting the 10 trough samples.

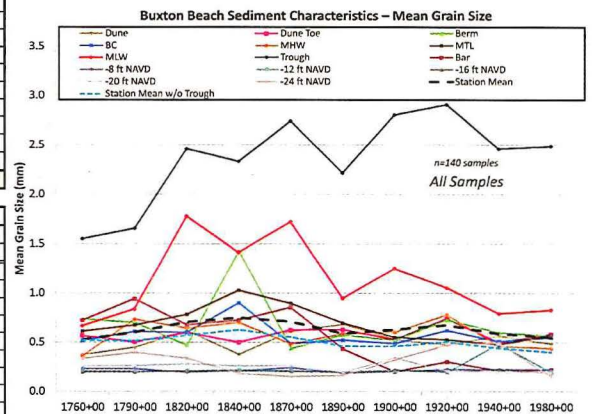
Buxton Beach Sediment Characteristics		Method of Moments					
		Mean	STD	Mean	STD	Skew	Kurt
		mm	mm	phi			
All Sta-Comp140	All X-Shore Samples	0.465	0.413	1.104	1.277	-0.612	3.164
All Sta-Comp130	Exclude Trough	0.411	0.464	1.284	1.108	-0.393	2.807
All Sta-Comp120	Exclude MLW & Trough	0.380	0.485	1.395	1.043	-0.344	2.672
All Sta-Comp60	Exclude All UW Samples	0.582	0.598	0.780	0.743	-0.256	3.349

Buxton Beach Sediment Characteristics		Folk Graphical Method				
		Mean	STD	ISTD	Skew	Kurt
				phi		
All Sta-Comp140	All X-Shore Samples	1.028	1.273	1.280	-0.146	0.949
All Sta-Comp130	Exclude Trough	1.190	1.118	1.093	-0.076	0.842
All Sta-Comp120	Exclude MLW & Trough	1.288	1.050	1.026	-0.084	0.826
All Sta-Comp60	Exclude All UW Samples	0.655	0.723	0.730	-0.025	1.029

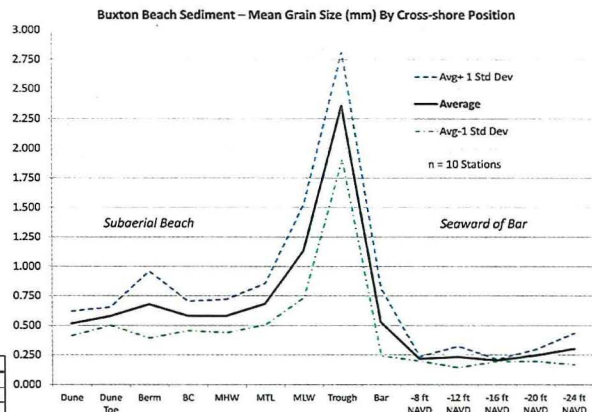
Sample	Interval	USCS Description			
All Sta-Comp140	All X-Shore Samples	SP	Medium Sand	Poorly Graded	
All Sta-Comp130	Exclude Trough	SP	Fine Sand	Poorly Graded	
All Sta-Comp120	Exclude MLW & Trough	SP	Fine Sand	Poorly Graded	
All Sta-Comp60	Exclude All UW Samples	SP	Medium Sand	Poorly Graded	

Sample	Interval	Wentworth Description			
All Sta-Comp140	All X-Shore Samples	Medium Sand	Poorly Sorted	Coarse Skewed	Mesokurtic
All Sta-Comp130	Exclude Trough	Medium Sand	Poorly Sorted	Symmetrical	Mesokurtic
All Sta-Comp120	Exclude MLW & Trough	Medium Sand	Poorly Sorted	Symmetrical	Mesokurtic
All Sta-Comp60	Exclude All UW Samples	Coarse Sand	Moderately Sorted	Symmetrical	Mesokurtic

"Native" mean grain size for Buxton. Results for selected groups of samples. The results in bold are considered most representative of the beach, consistent with size distributions for other Outer Banks localities (Birkemeier et al 1985, USACE 2010). [UW = underwater samples]



Mean grain size by station and sample position in October 2014.



Arithmetic mean grain size by sample position based on fourteen samples per station.

Notes:
Beach sediment samples (n=140) obtained and analyzed by Coastal Science & Engineering, Inc. October 2014.

Offshore borings obtained in July 2013 and October 2014 (3 inch Aluminum tubes). Grain size distributions based on dry sieving at 0.25 phi intervals.

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Manteo, NC 27954

Project:
Beach Restoration To Protect
NC Highway 12 At Buxton
Dare County, NC

DRAWING TITLE:
BORROW AREA
GEOTECHNICAL DATA

SEAL
7/14/2015
LIU KACZOVITZ
ENGINEER

SCALE: AS SHOWN
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