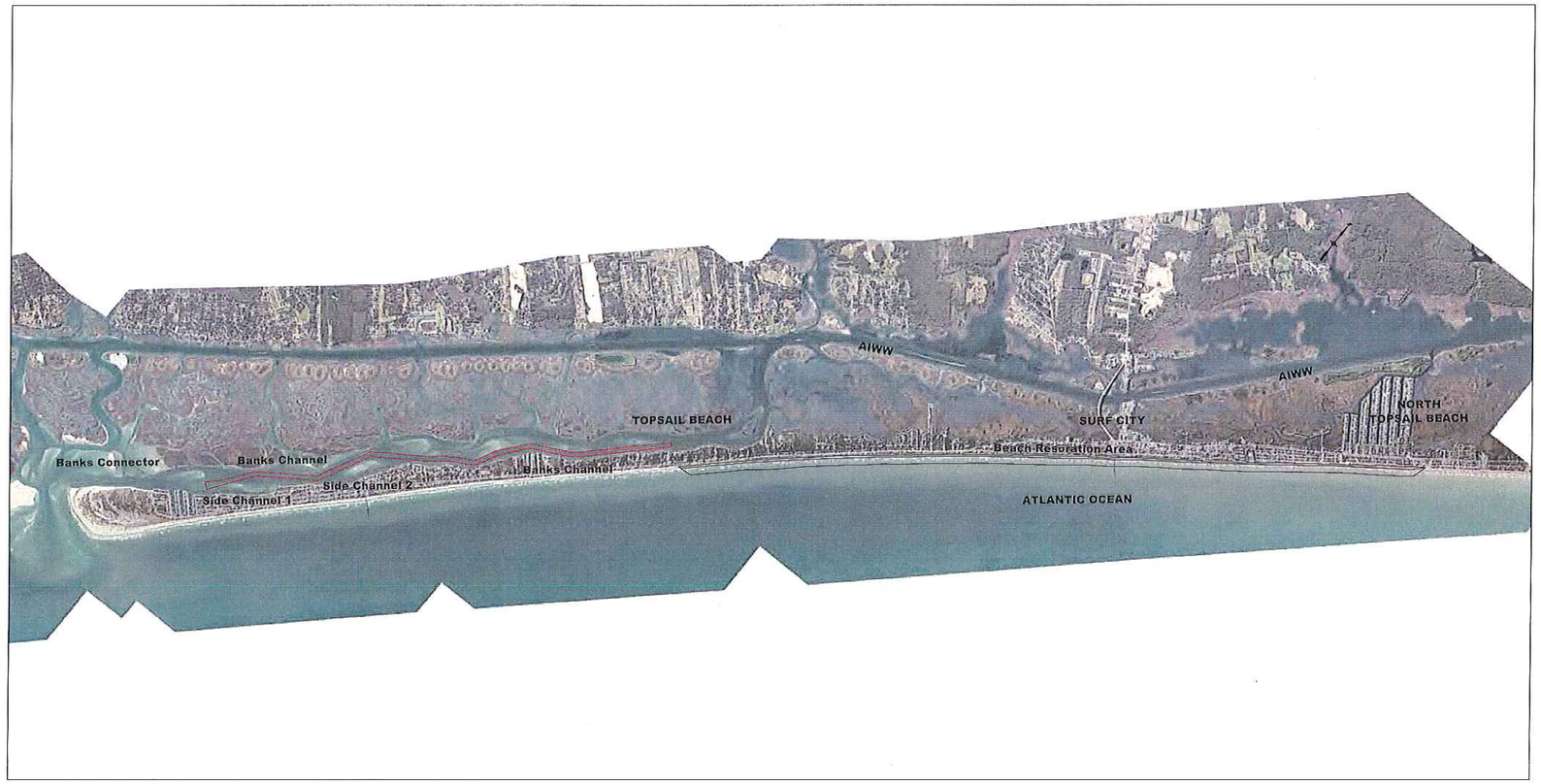
SURF CITY BEACH NOURISHMENT
PROJECT PERMIT DRAWING

OCTOBER 2019

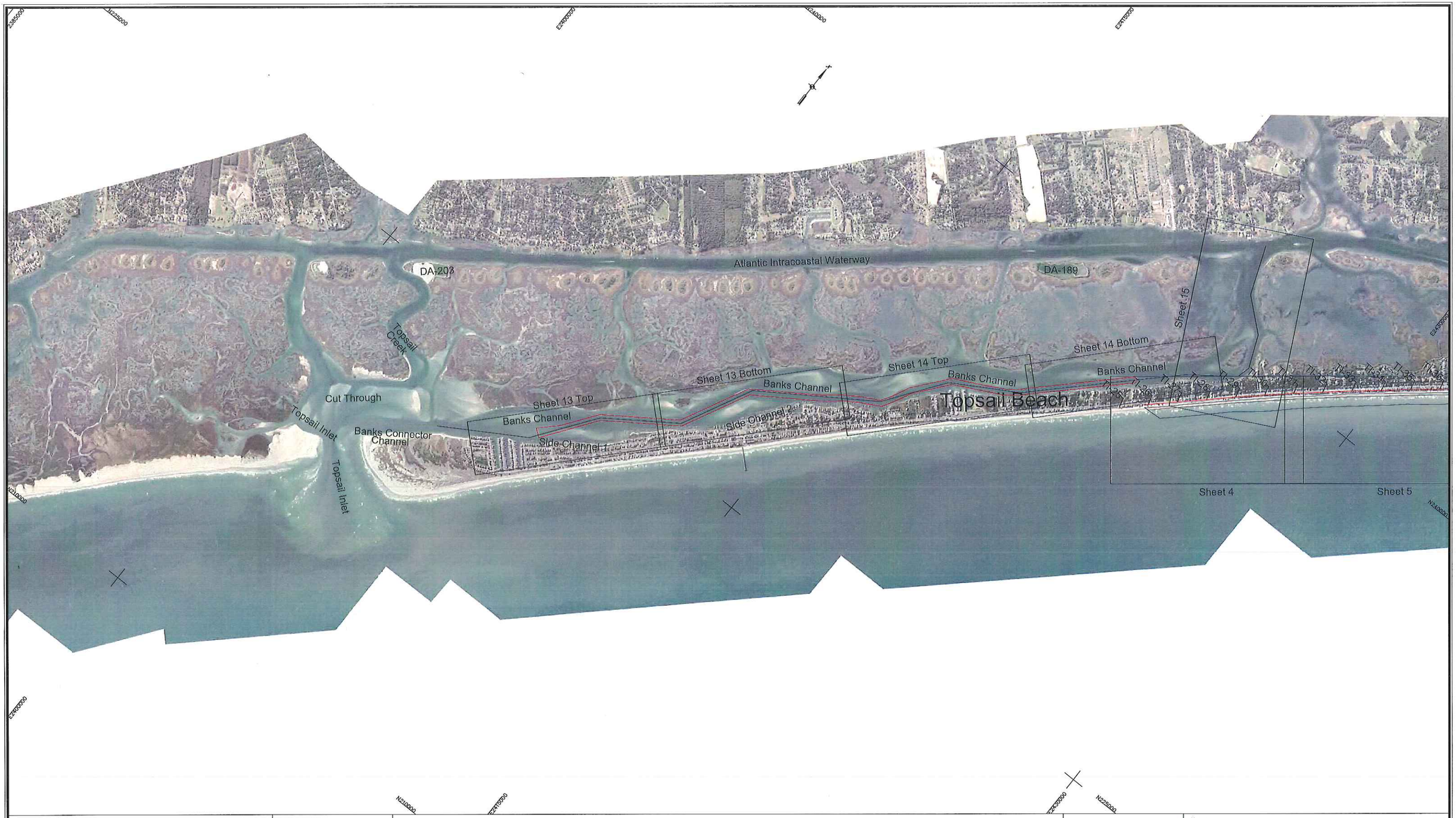


TOWN OF SURF CITY
PENDER & ONLSOW COUNTY
NORTH CAROLINA

TI Coastal

TI Coastal Services, Inc.
387-B N. Green Meadows Drive
Wilmington, NC 28405
910.821.1358

11x17 = Half Scale



TI Coastal

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Wilmington, NC 28405
910.821.1358

11x17 = Half Scale

Vertical Datum Conversion

Mean High Water
1.20'
3.74'
NAVD 1988
2.54'
Mean Low Water

Graphic Scale

750' 1,500' 3,000'
Scale: 1" = 1,500'

SURF CITY BEACH NOURISHMENT

SURF CITY
PENDER & ONSLOW COUNTIES, NORTH CAROLINA

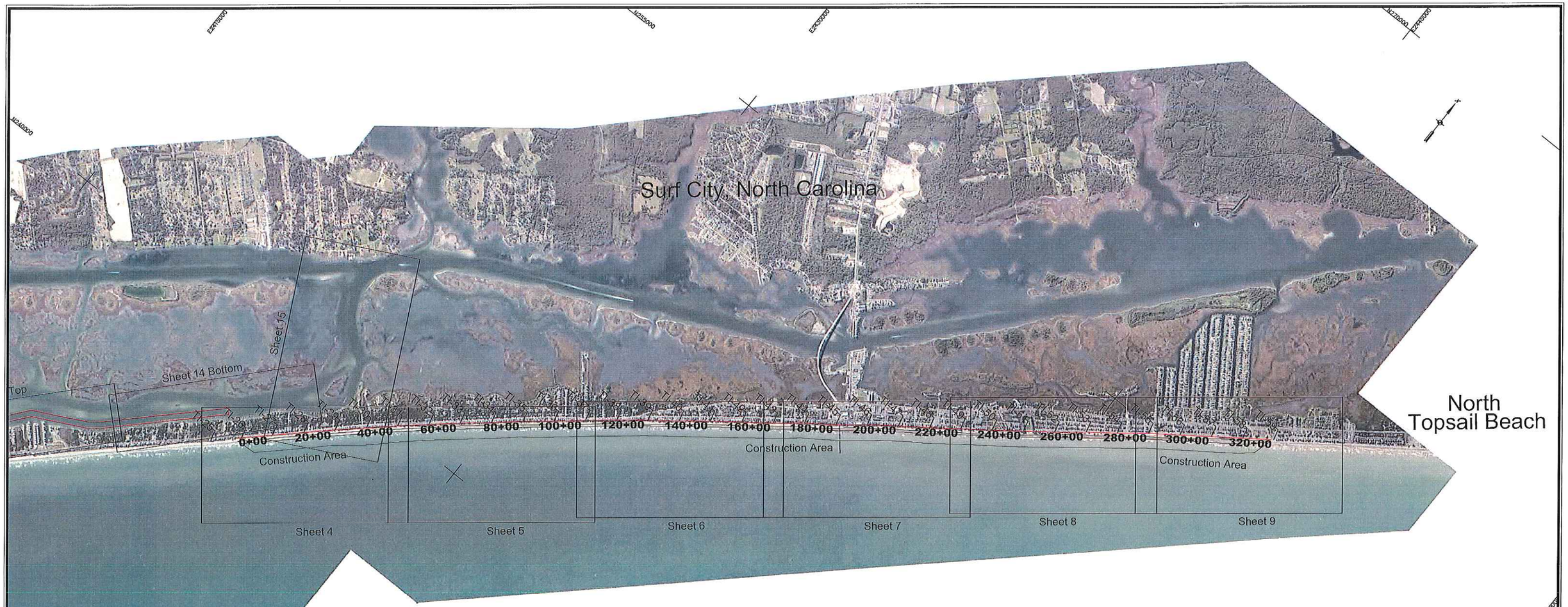
Permit Drawing - October 2019

Project Control and Sheet Layout

Christian L. Gibson, P.E. No. 026273

Notes:
1. Horizontal Datum: NC State Plane - Zone 3200, NAD83, Feet
2. Vertical Datum: NAVD 88
3. Data collected by TI Coastal in July 10-17, 2019 and represent conditions at that time.
4. Soundings are expressed in feet and tenths.
5. Aerial flown on June 17, 2019 by TerraLina Mapping Consultants.

DWG NAME: 2018 Surf City Beachfill.dwg	
DWG DATE: October 8, 2019	SURVEY DATE: July 10-17, 2019
SCALE: 1" = 1,500'	SHEET: 2 OF 18



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11x17 = Half Scale

Vertical Datum Conversion

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3.74'
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2.54'
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Graphic Scale
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SURF CITY BEACH NOURISHMENT

SURF CITY
PENDER & ONSLOW COUNTIES, NORTH CAROLINA

Permit Drawing - October 2019

Project Control and Sheet Layout

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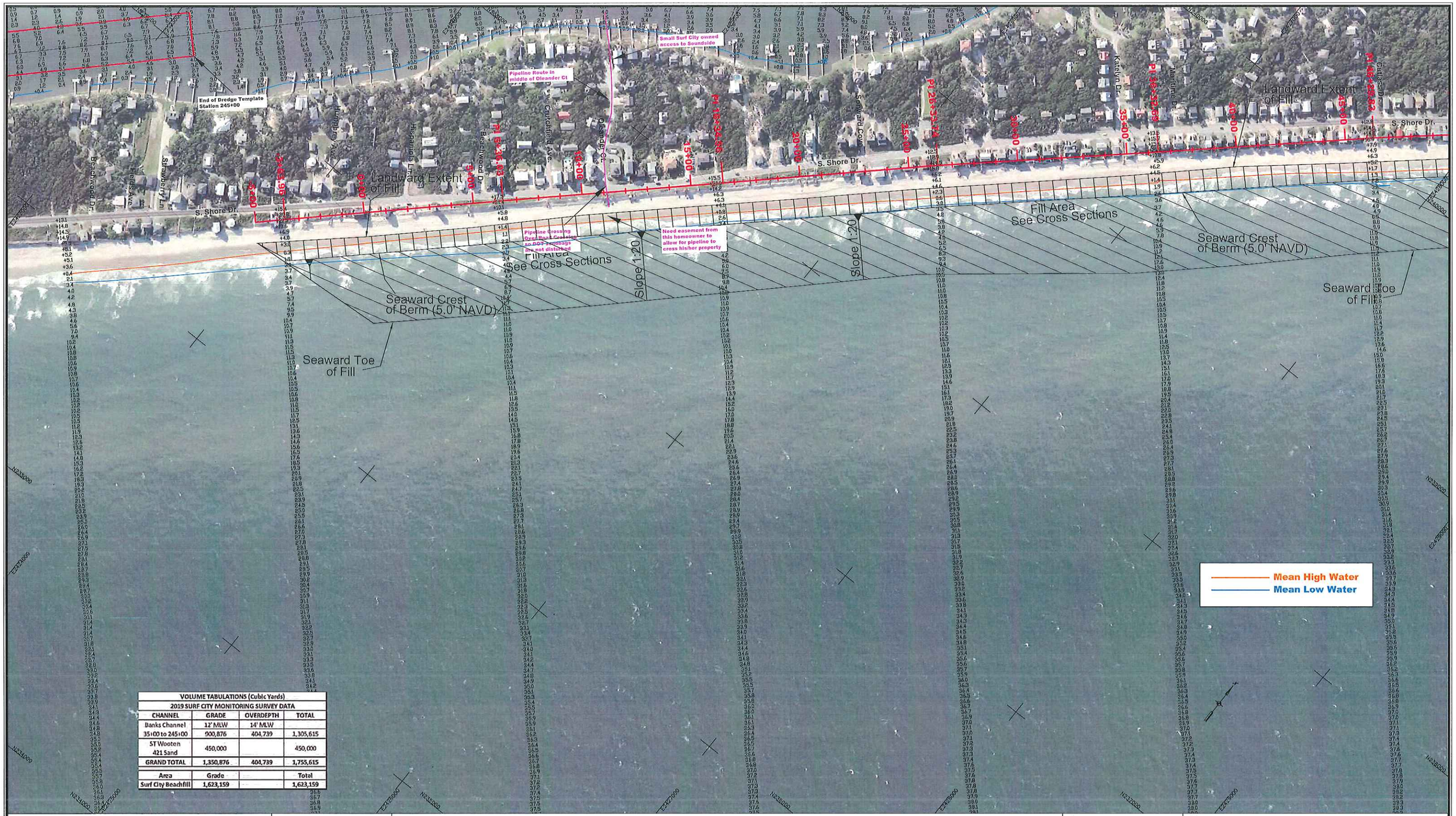
DWG NAME: 2018 Surf City Beachfill.dwg
DWG DATE: October 8, 2019 | SURVEY DATE: July 10-17, 2019
SCALE: 1" = 1,500' | SHEET: 3 OF 18



VOLUME TABULATIONS (Cubic Yards)			
2019 SURF CITY MONITORING SURVEY DATA			
CHANNEL	GRADE	OVERDEPTH	TOTAL
Banks Channel 35+00 to 245+00	12' MLW 900,876	14' MLW 404,739	1,305,615
ST Wooten 421 Sand	450,000		450,000
GRAND TOTAL	1,350,876	404,739	1,755,615
Area	Grade		Total
Surf City Beachfill	1,623,159		1,623,159

TI Coastal

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910.821.1358

11x17 = Half Scale

Vertical Datum Conversion

Mean High Water
1.20'
3.74'
NAVD 1988
2.54'
Mean Low Water

Graphic Scale
100' 200' 400'
Scale: 1" = 200'

SURF CITY BEACH NOURISHMENT

SURF CITY
PENDER & ONSLOW COUNTIES, NORTH CAROLINA

Permit Drawing - October 2019

Plan View - Beach Layout and Bathymetry

Christian L. Gibson, P.E. No. 026273

Notes:
1. Horizontal Datum: NC State Plane - Zone 3200, NAD83, Feet
2. Vertical Datum: NAVD 88
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DWG NAME: 2018 Surf City Beachfill.dwg
DWG DATE: November 25, 2019 | SURVEY DATE: July 10-17, 2019
SCALE: 1" = 200' | SHEET: 4 OF 18

VOLUME TABULATIONS (Cubic Yards)			
2019 SURF CITY MONITORING SURVEY DATA			
CHANNEL	GRADE	OVERDEPTH	TOTAL
Banks Channel	12' MLW	14' MLW	
35+00 to 245+00	900,876	404,739	1,305,615
ST Wooten 421 Sand	450,000		450,000
GRAND TOTAL	1,350,876	404,739	1,755,615
Area	Grade		Total
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TI Coastal Services, Inc.
387-B N. Green Meadows Drive
Wilmington, NC 28405
910.821.1358

11x17 = Half Scale

Vertical Datum Conversion

Mean High Water
1.20'
3.74'
NAVD 1988
2.54'
Mean Low Water

Graphic Scale

100' 200' 400'
Scale: 1" = 200'

SURF CITY BEACH NOURISHMENT

SURF CITY
PENDER & ONSLOW COUNTIES, NORTH CAROLINA

Permit Drawing - October 2019

Plan View - Beach Layout and Bathymetry

Christian L. Gibson, P.E. No. 026273

Notes:
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DWG NAME: 2018 Surf City Beachfill.dwg	
DWG DATE: November 25, 2019	SURVEY DATE: July 10-17, 2019
SCALE: 1" = 200'	SHEET: 5 OF 18

VOLUME TABULATIONS (Cubic Yards)			
2019 SURF CITY MONITORING SURVEY DATA			
CHANNEL	GRADE	OVERDEPTH	TOTAL
Banks Channel	12' MLW	14' MLW	
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Area	Grade		Total
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Wilmington, NC 28405
910.821.1358

11x17 = Half Scale

Vertical Datum Conversion

Mean High Water
1.20'
3.74' NAVD 1988
2.54'
Mean Low Water

Graphic Scale

100' 200' 400'

Scale: 1" = 200'

SURF CITY BEACH NOURISHMENT

SURF CITY

PENDER & ONSLOW COUNTIES, NORTH CAROLINA

Permit Drawing - October 2019

Plan View - Beach Layout and Bathymetry

Christian L. Gibson, P.E. No. 026273

Notes:
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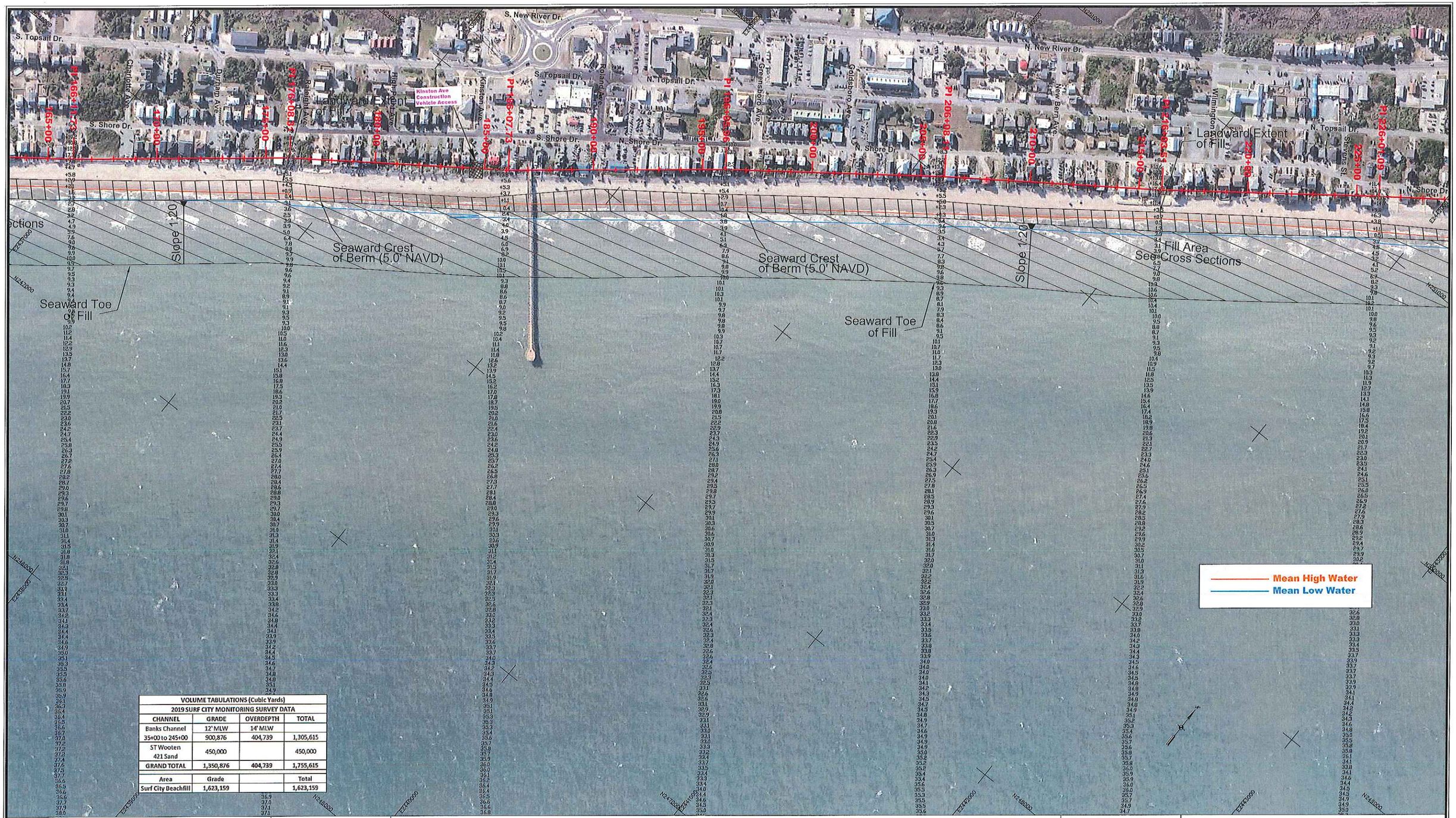
DWG NAME: 2018 Surf City Beachfill.dwg	
DWG DATE: November 25, 2019	SURVEY DATE: July 10-17, 2019
SCALE: 1" = 200'	SHEET: 6 OF 18



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Vertical Datum Conversion

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3.74'
NAVD 1988
2.54'
Mean Low Water

Graphic Scale
100' 200' 400'
Scale: 1" = 200'

SURF CITY BEACH NOURISHMENT

SURF CITY
PENDER & ONSLOW COUNTIES, NORTH CAROLINA

Permit Drawing - October 2019

Plan View - Beach Layout and Bathymetry

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Christian L. Gibson, P.E. No. 026273

DWG NAME: 2018 Surf City Beachfill.dwg	
DWG DATE: November 25, 2019	SURVEY DATE: July 10-17, 2019
SCALE: 1" = 200'	SHEET: 7 OF 18

N. New River Dr.
N. Topsail Dr.
Shell Rd.
Pelican Watch
Stevens St.
Dolphin St.
Sunrise Ct.
N. Shore Dr.
Mecklenburg Ave.
Craven Ave.
Lenoir Ave.
Pender Ave.
Easy St.
Broadway St.
Broadway Ave Construction Vehicle Access
PI 236+01.09
PI 235+99.57
PI 245+97.13
PI 255+95.23
PI 265+95.28
PI 275+94.55
PI 285+95.23
235+00
240+00
250+00
260+00
270+00
280+00
290+00
Landward Extent of Fill
Seaward Crest of Berm (5.0' NAVD)
Seaward Toe of Fill
Slope 1:20
Fill Area See Cross Sections
Mean High Water
Mean Low Water

VOLUME TABULATIONS (Cubic Yards)			
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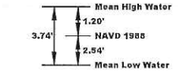
Vertical Datum Conversion



Graphic Scale

100' 200' 400'

Scale: 1" = 200'

SURF CITY BEACH NOURISHMENT

SURF CITY

PENDER & ONSLOW COUNTIES, NORTH CAROLINA

Permit Drawing - October 2019

Plan View - Beach Layout and Bathymetry

Notes:
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DWG NAME: 2018 Surf City Beachfill.dwg	
DWG DATE: November 25, 2019	SURVEY DATE: July 10-17, 2019
SCALE: 1" = 200'	SHEET: 8 OF 18

VOLUME TABULATIONS (Cubic Yards)			
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Banks Channel 35+00 to 245+00	12' MLW	14' MLW	
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Area	Grade		Total
Surf City Beachfill	1,623,159		1,623,159

Mean High Water
Mean Low Water

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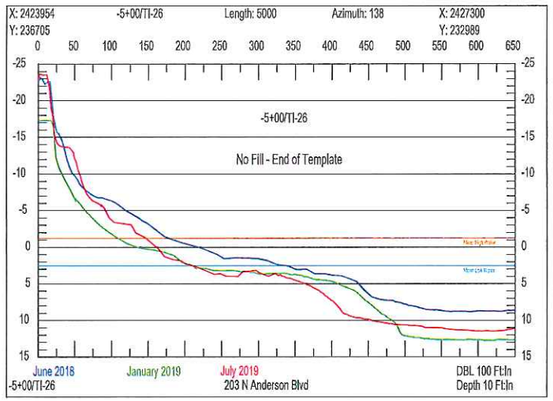
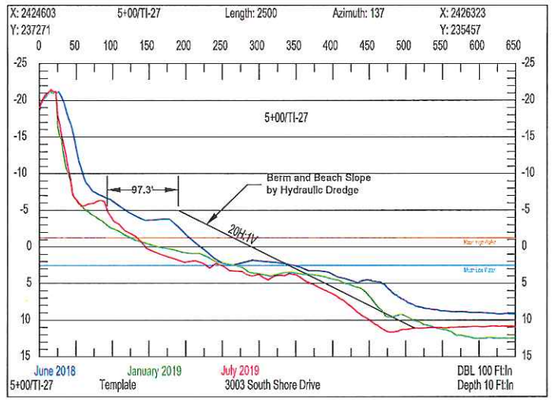
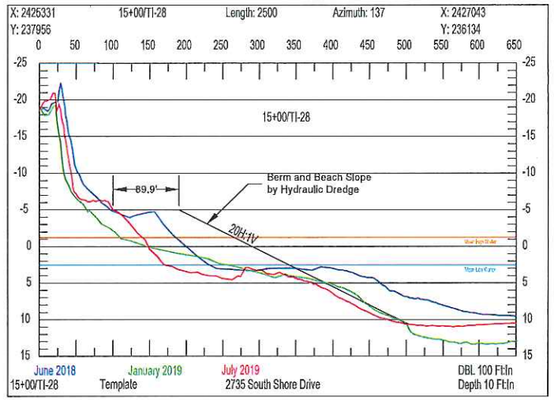
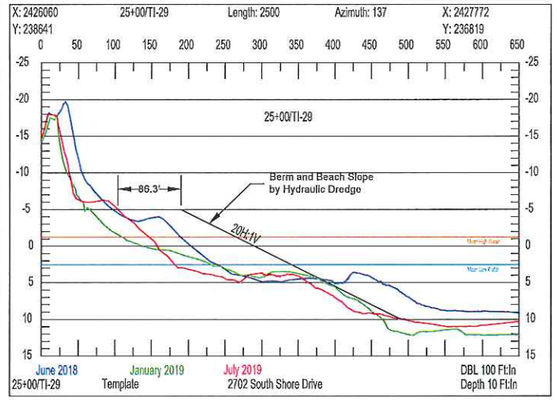
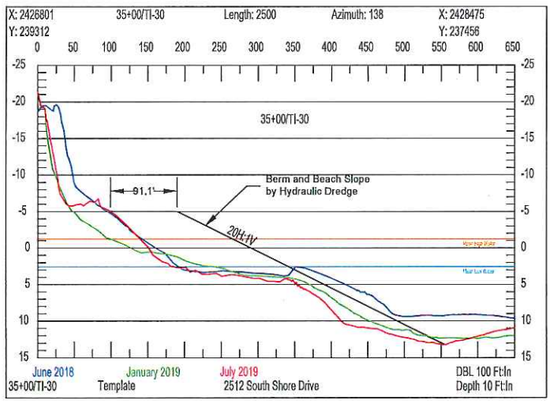
DWG DATE: November 25, 2019 | SURVEY DATE: July 10-17, 2019
SCALE: 1" = 200' | SHEET: 9 OF 18

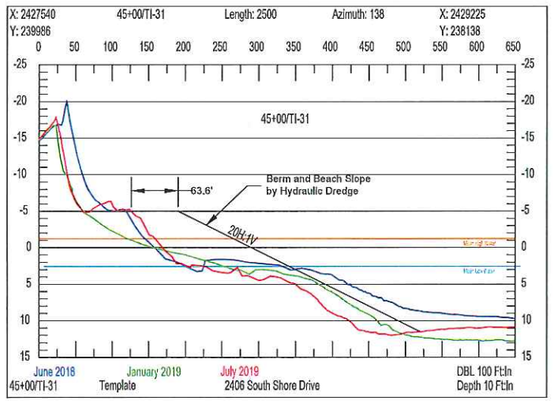


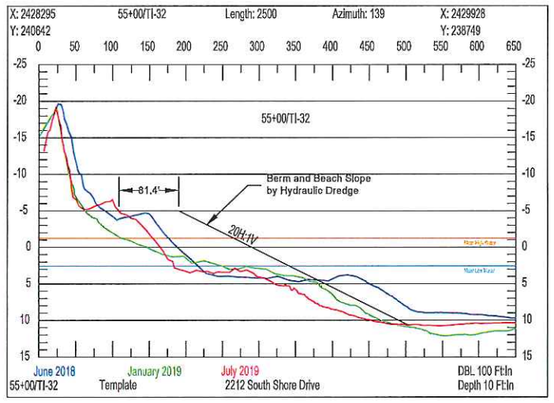


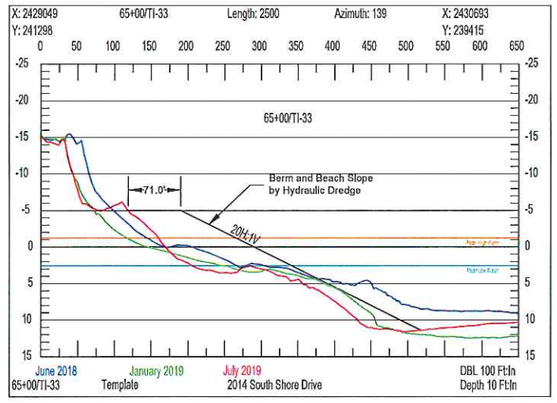


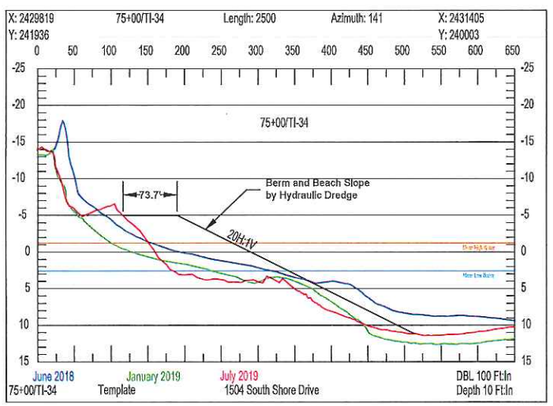


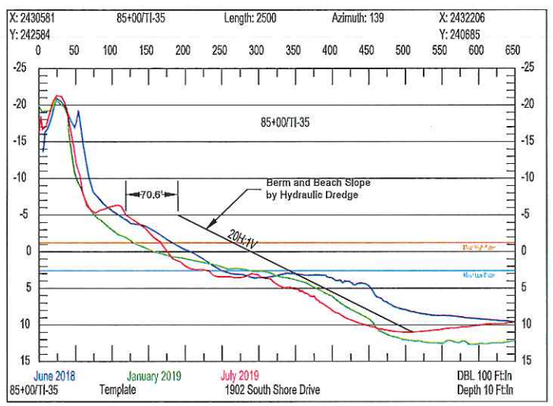


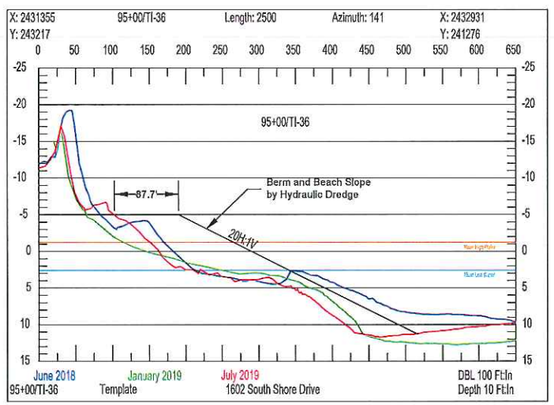


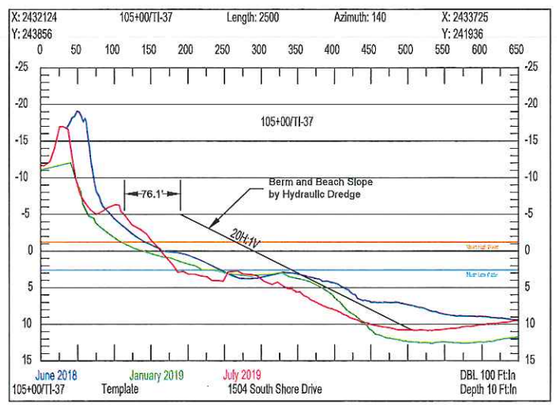












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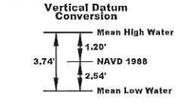
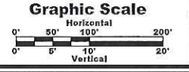
910.821.1358

11x17 = Half Scale

Vertical Datum Conversion



Graphic Scale



SURF CITY BEACH NOURISHMENT

SURF CITY
PENDER & ONSLOW COUNTIES, NORTH CAROLINA

Permit Drawing - October 2019

CROSS SECTION PROFILES -5+00 TO 105+00

Notes:
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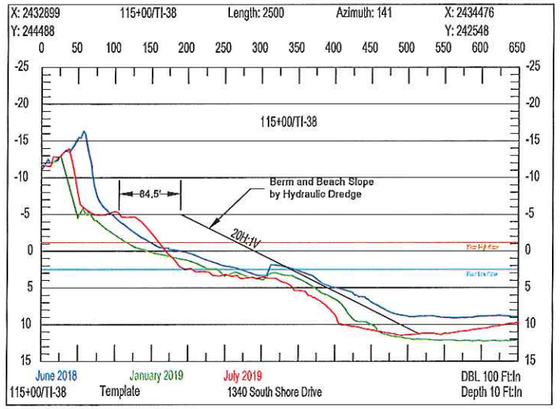
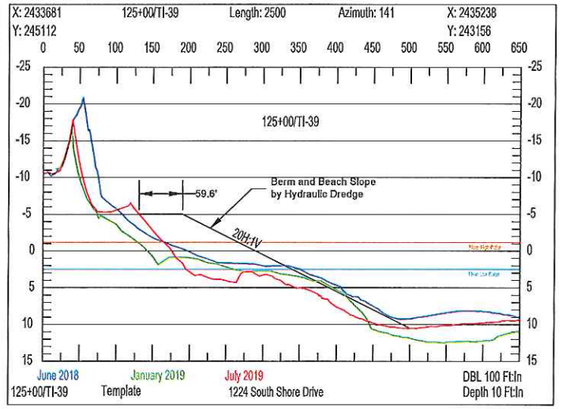
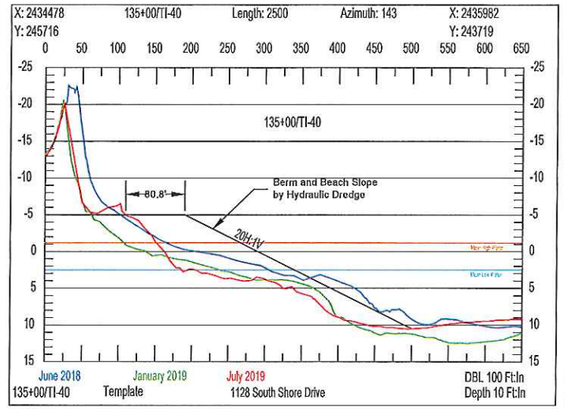
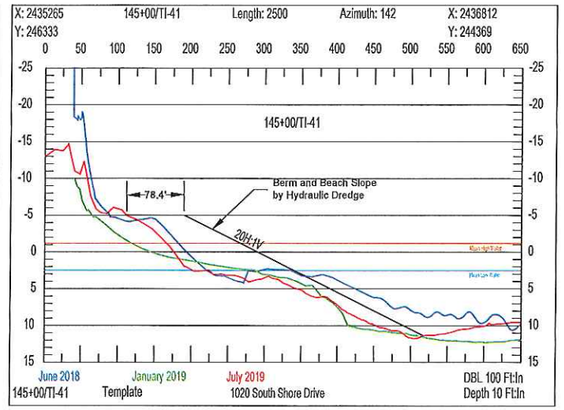
Christian L. Gibson, P.E. No. 026273

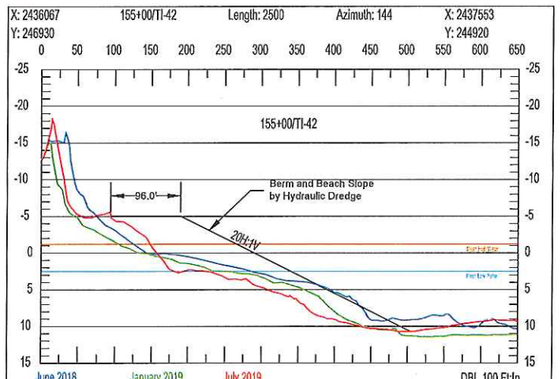
DWG NAME: 2018 Surf City Beachfill.dwg	
DWG DATE: October 8, 2019	SURVEY DATE: July 10-17, 2019
SCALE: AS SHOWN	SHEET: 10 OF 18

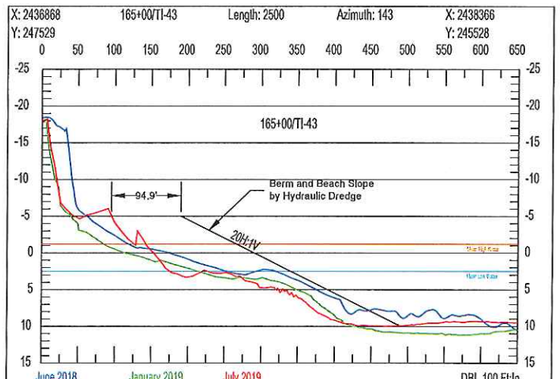


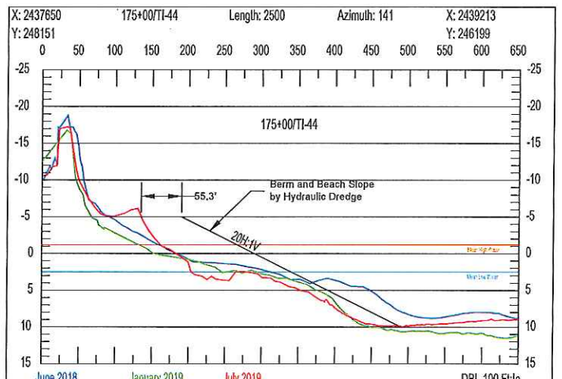


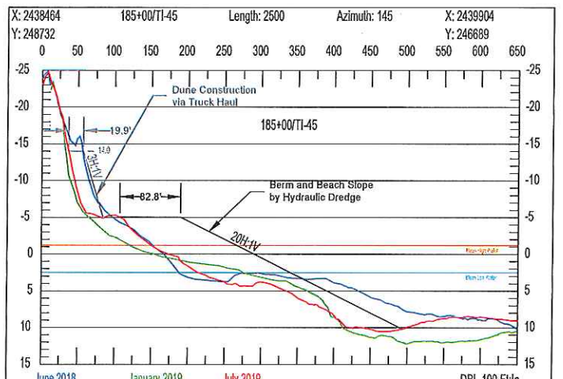


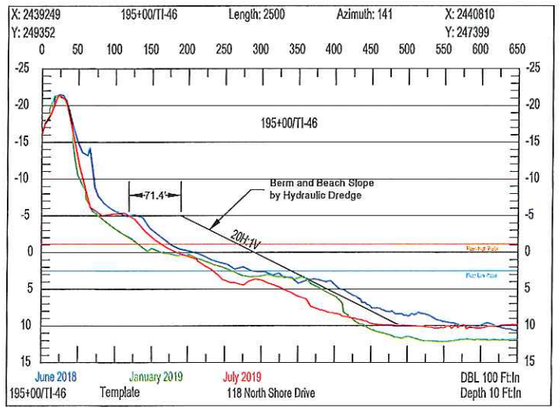


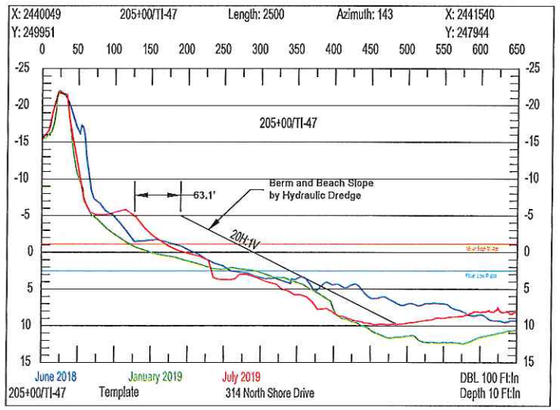


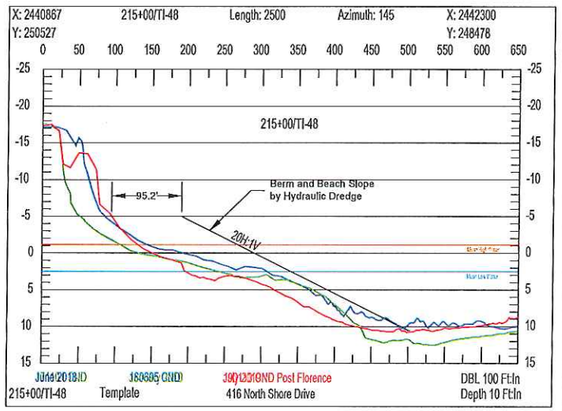


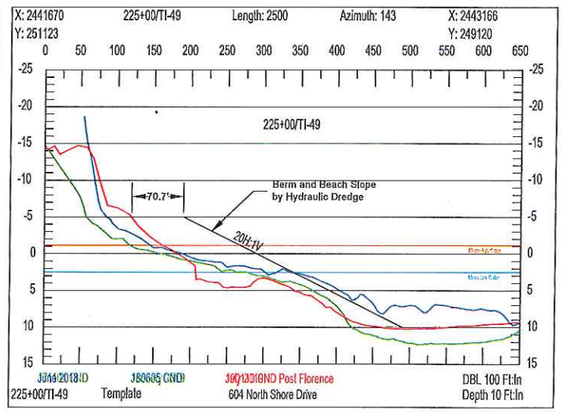












TI Coastal
TI Coastal Services, Inc.
387-B N. Green Meadows Drive
Wilmington, NC 28405
910.821.1358

11x17 = Half Scale

Vertical Datum Conversion
Mean High Water
1.20'
3.74'
NAVD 1988
2.54'
Mean Low Water

Graphic Scale
Horizontal
0' 50' 100' 200'
0' 5' 10' 20'
Vertical

SURF CITY BEACH NOURISHMENT

SURF CITY
PENDER & ONSLOW COUNTIES, NORTH CAROLINA

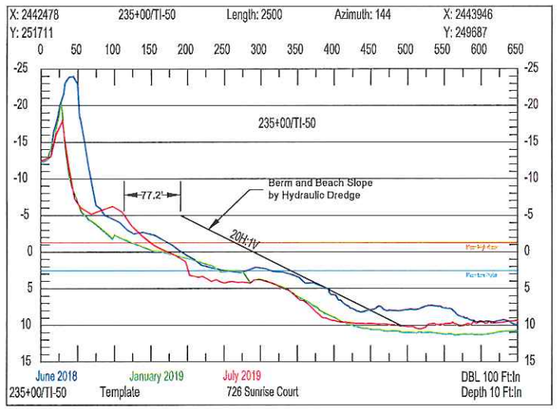
Permit Drawing - October 2019

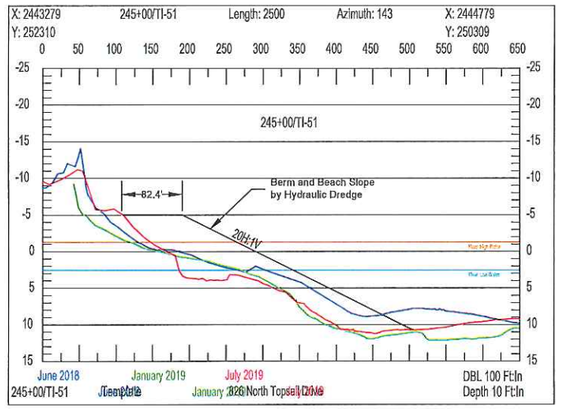
CROSS SECTION PROFILES 115+00 TO 225+00

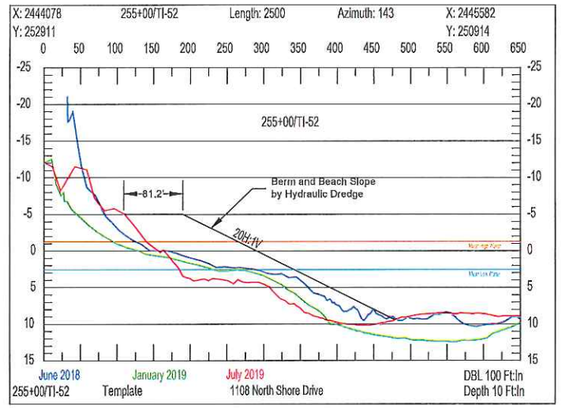
Christian L. Gibson, P.E. No. 026273

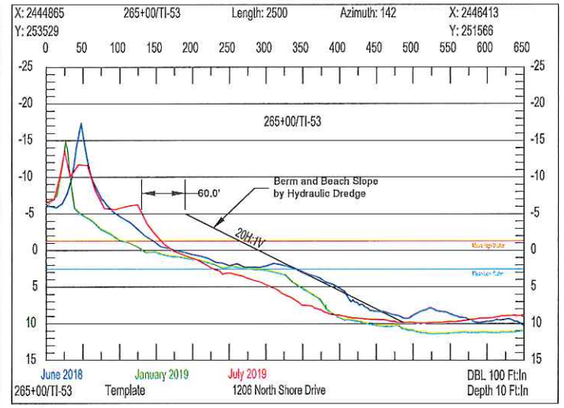
Notes:
1. Horizontal Datum: NC State Plane - Zone 3200, NAD83, Feet
2. Vertical Datum: NAVD 88
3. Data collected by TI Coastal in July 10-17, 2019 and represent conditions at that time.
4. Soundings are expressed in feet and tenths.
5. Aerial flown on June 17, 2019 by TerraLina Mapping Consultants.

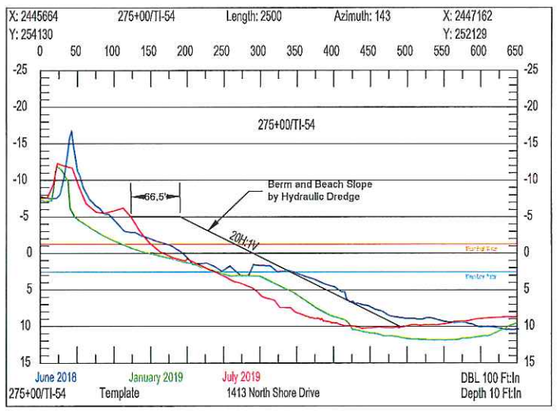
DWG NAME: 2018 Surf City Beachfill.dwg
DWG DATE: October 8, 2019 | SURVEY DATE: July 10-17, 2019
SCALE: AS SHOWN | SHEET: 11 OF 18

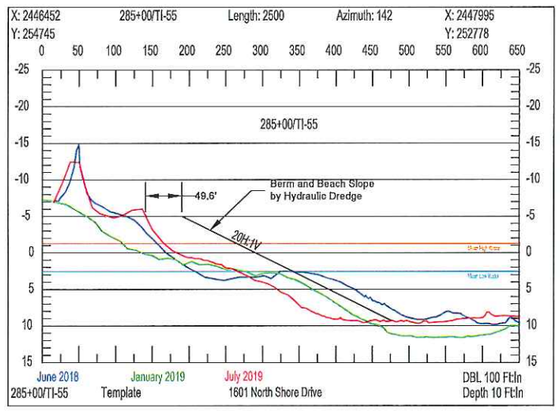


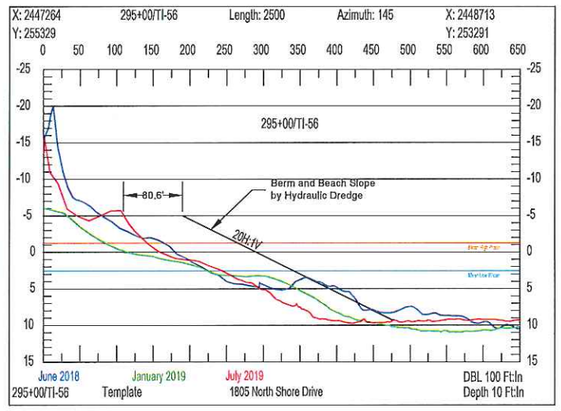


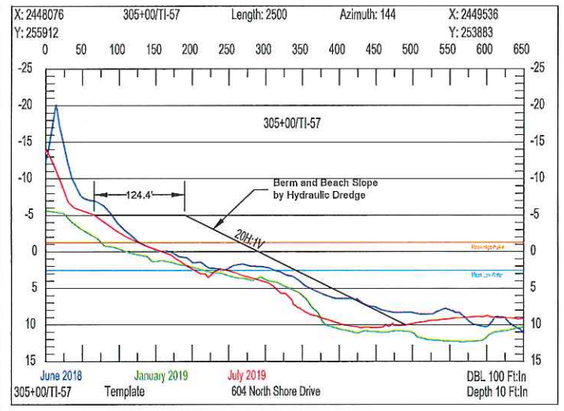


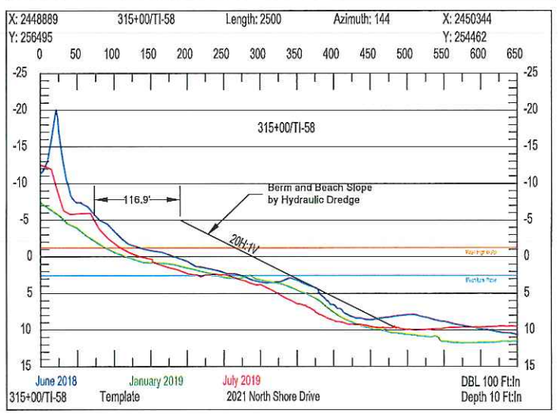


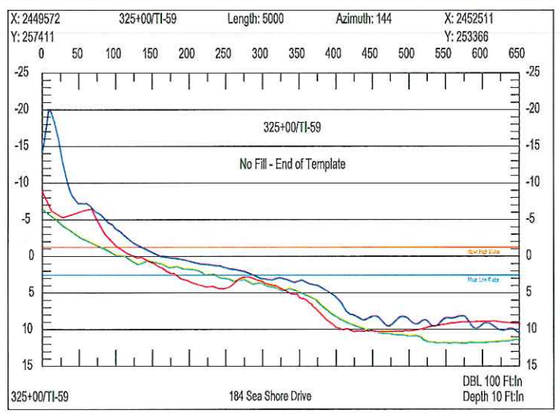








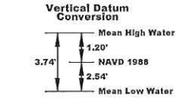




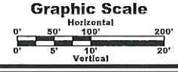
TI Coastal
TI Coastal Services, Inc.
387-B N. Green Meadows Drive
Wilmington, NC 28405
910.821.1358

11x17 = Half Scale

Vertical Datum Conversion



Graphic Scale



SURF CITY BEACH NOURISHMENT

SURF CITY
PENDER & ONSLOW COUNTIES, NORTH CAROLINA

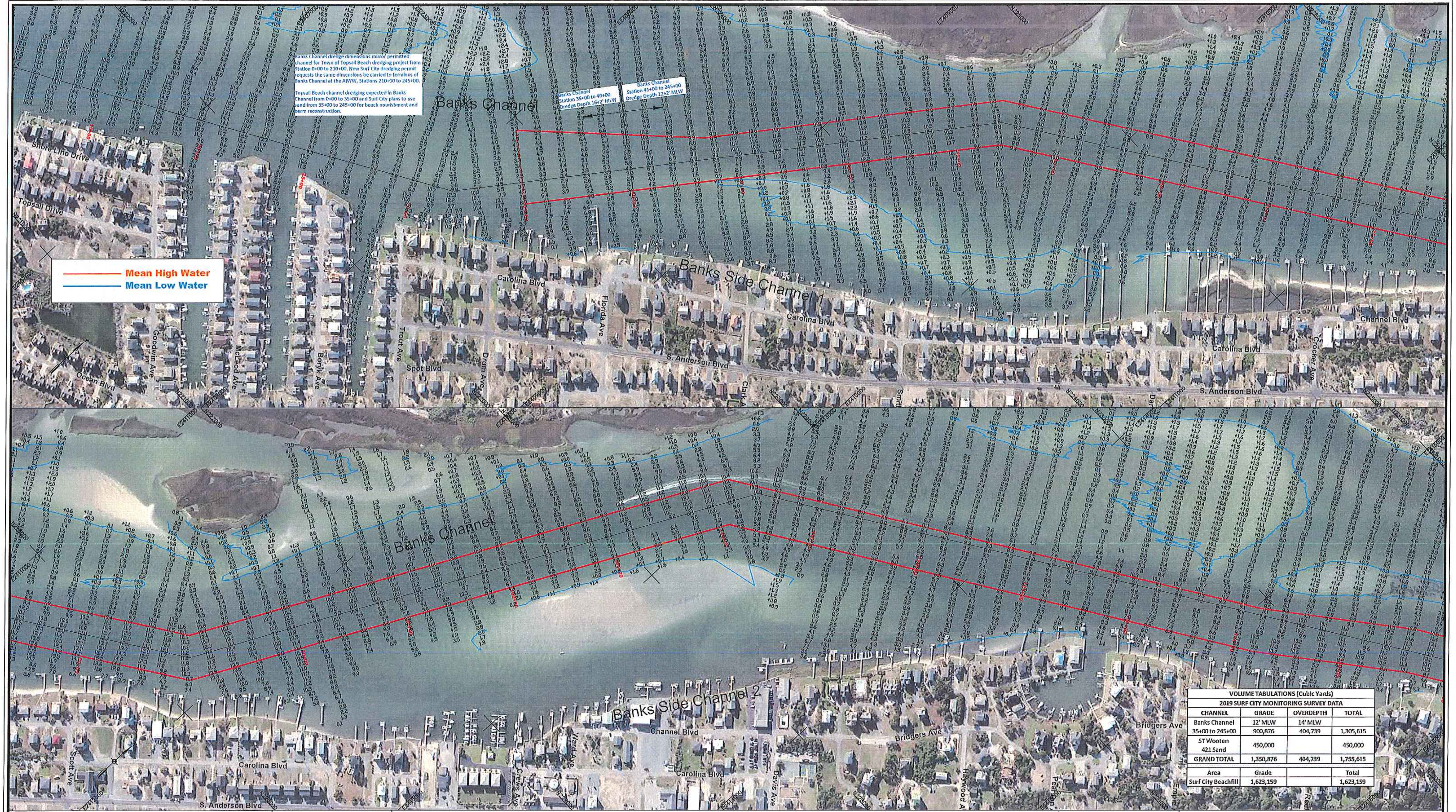
Permit Drawing - October 2019

CROSS SECTION PROFILES 235+00 TO 325+00

Christian L. Gibson, P.E. No. 026273

Notes:
1. Horizontal Datum: NC State Plane - Zone 3200, NAD83, Feet
2. Vertical Datum: NAVD 88
3. Data collected by TI Coastal in July 10-17, 2019 and represent conditions at that time.
4. Soundings are expressed in feet and tenths.
5. Aerial flown on June 17, 2019 by TerraLina Mapping Consultants.

DWG NAME: 2018 Surf City Beachfill.dwg
DWG DATE: October 8, 2019 | SURVEY DATE: July 10-17, 2019
SCALE: AS SHOWN | SHEET: 12 OF 18

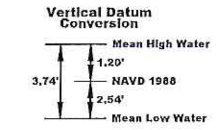


VOLUME TABULATIONS (Cubic Yards)			
2019 SURF CITY MONITORING SURVEY DATA			
CHANNEL	**GRADE**	**OVERDEPTH**	**TOTAL**
Banks Channel	12' MLW	14' MLW	
35+00 to 245+00	900,876	404,739	1,305,615
ST Wooten 421 Sand	450,000		450,000
GRAND TOTAL	1,350,876	404,739	1,755,615
Area	**Grade**		**Total**
Surf City Beachfill	1,623,159		1,623,159

TI Coastal

TI Coastal Services, Inc.
387-B N. Green Meadows Dr.
Wilmington, NC 28405
910.821.1358

11x17 = Half Scale



Graphic Scale

100' 200' 400'

Scale: 1" = 200'

SURF CITY BEACH NOURISHMENT

SURF CITY

PENDER & ONSLOW COUNTIES, NORTH CAROLINA

Permit Drawing - October 2019

Plan View - Banks Channel and Side Channels Layout and Bathymetry

Christian L. Gibson, P.E. No. 026273

Notes:

1. Horizontal Datum: NC State Plane - Zone 3200, NAD83, Feet
2. Vertical Datum: Mean Low Water
3. Data collected by TI Coastal in July 10-17, 2019 and represent conditions at that time.
4. Soundings are expressed in feet and tenths.
5. Aerial flown on June 17, 2019 by TerraLina Mapping Consultants.

DWG NAME: 2018 Surf City Beachfill.dwg

DWG DATE: November 25, 2019 | **SURVEY DATE: July 10-17, 2019**

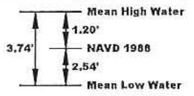
SCALE: 1" = 200' |

VOLUME TABULATIONS (Cubic Yards)			
2019 SURF CITY MONITORING SURVEY DATA			
CHANNEL	GRADE	OVERDEPTH	TOTAL
Banks Channel	12' MLW	14' MLW	
35+00 to 245+00	900,876	404,739	1,305,615
ST Wooten 421 Sand	450,000		450,000
GRAND TOTAL	1,350,876	404,739	1,755,615
Area	Grade		Total
Surf City Beachfill	1,623,159		1,623,159

TI Coastal Services, Inc.
387-B N. Green Meadows Dr.
Wilmington, NC 28405
910.821.1358

11x17 = Half Scale

Vertical Datum Conversion



Graphic Scale

100' 200' 400'

Scale: 1" = 200'

SURF CITY BEACH NOURISHMENT

SURF CITY
PENDER & ONSLOW COUNTIES, NORTH CAROLINA

Permit Drawing - October 2019

Plan View - Banks Channel Layout and Bathymetry

Christian L. Gibson, P.E. No. 026273

Notes:

1. Horizontal Datum: NC State Plane - Zone 3200, NAD83, Feet
2. Vertical Datum: Mean Low Water
3. Data collected by TI Coastal in July 10-17, 2019 and represent conditions at that time.
4. Soundings are expressed in feet and tenths.
5. Aerial flown on June 17, 2019 by TerraLina Mapping Consultants.

DWG NAME: 2018 Surf City Beachfill.dwg	
DWG DATE: November 25, 2019	SURVEY DATE: July 10-17, 2019
SCALE: 1" = 200'	SHEET: 14 OF 18

VOLUME TABULATIONS (Cubic Yards)			
2019 SURF CITY MONITORING SURVEY DATA			
CHANNEL	GRADE	OVERDEPTH	TOTAL
Banks Channel	12' MLW	14' MLW	
35+00 to 245+00	900,876	404,739	1,305,615
ST Wooten 421 Sand	450,000		450,000
GRAND TOTAL	1,350,876	404,739	1,755,615
Area	Grade		Total
Surf City Beachfill	1,623,159		1,623,159

TI Coastal

TI Coastal Services, Inc.
387-B N. Green Meadows Drive
Wilmington, NC 28405
910.821.1358

11x17 = Half Scale

Vertical Datum Conversion

Mean High Water
1.20'
3.74'
NAVD 1988
2.54'
Mean Low Water

Graphic Scale

100' 200' 400'
Scale: 1" = 200'

SURF CITY BEACH NOURISHMENT

SURF CITY
PENDER & ONSLOW COUNTIES, NORTH CAROLINA

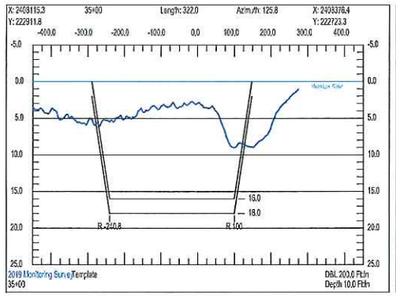
Permit Drawing - October 2019

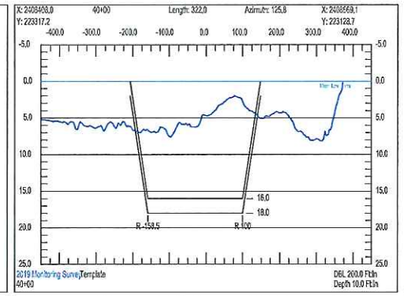
Plan View - Banks Channel Layout and Bathymetry

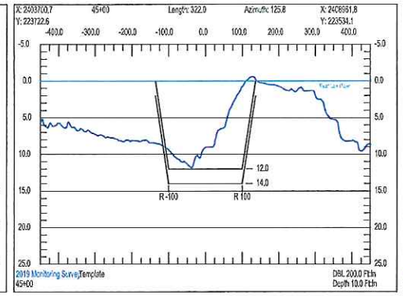
Notes:
1. Horizontal Datum: NC State Plane - Zone 3200, NAD83, Feet
2. Vertical Datum: Mean Low Water
3. Data collected by TI Coastal in July 10-17, 2019 and represent conditions at that time.
4. Soundings are expressed in feet and tenths.
5. Aerial flown on June 17, 2019 by TerraTna Mapping Consultants.

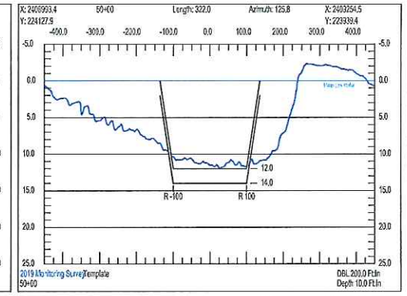
Christian L. Gibson, P.E. No. 026273

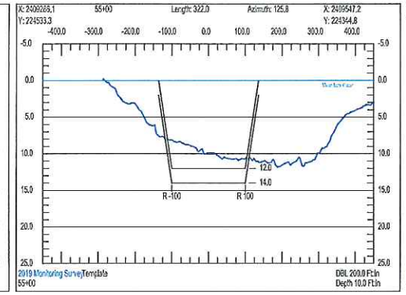
DWG NAME: 2018 Surf City Beachfill.dwg
DWG DATE: November 25, 2019 | SURVEY DATE: July 10-17, 2019
SCALE: 1" = 200' | SHEET: 15 OF 18

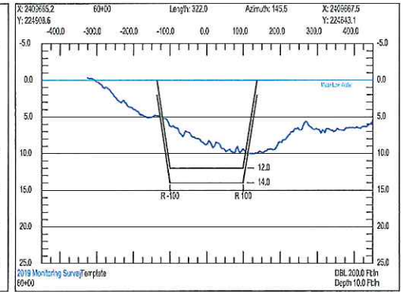


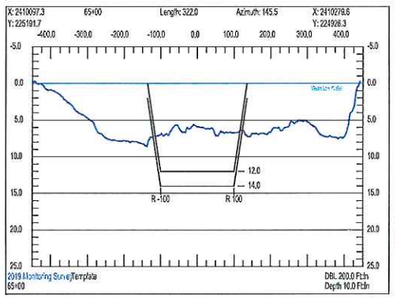


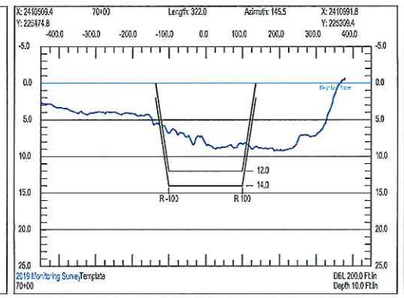


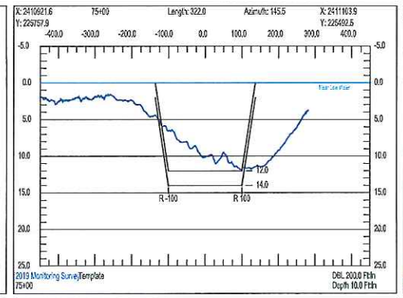


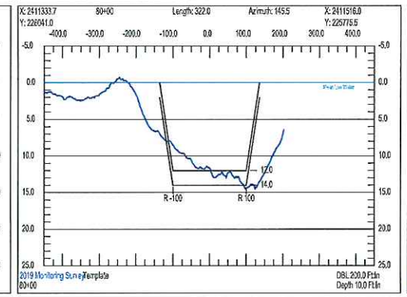


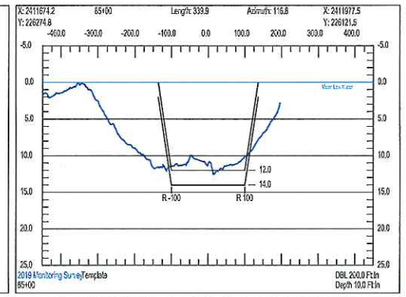


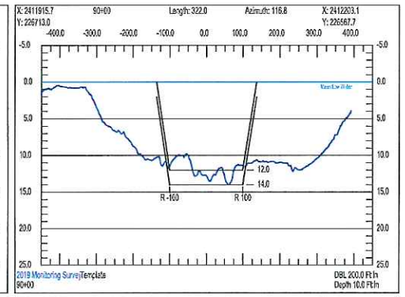


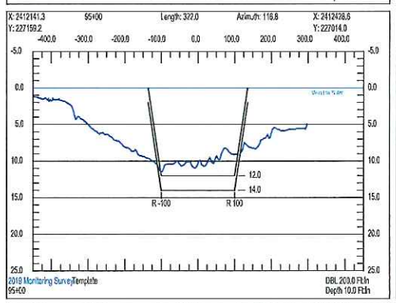


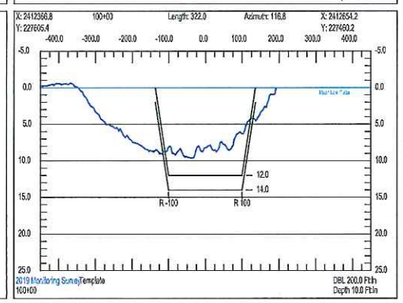


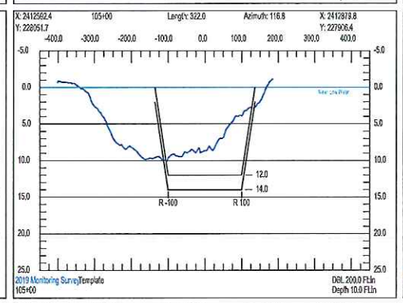


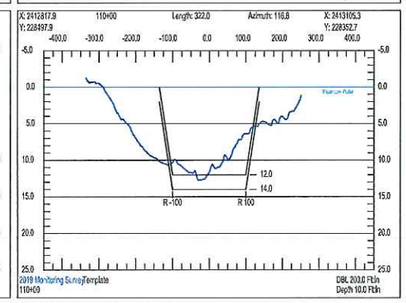


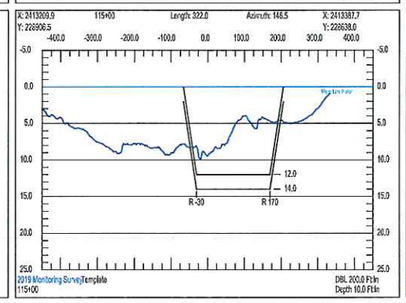


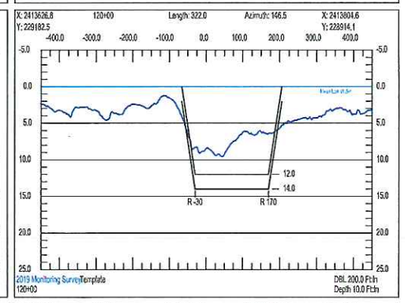


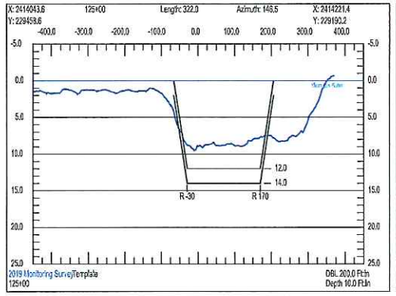


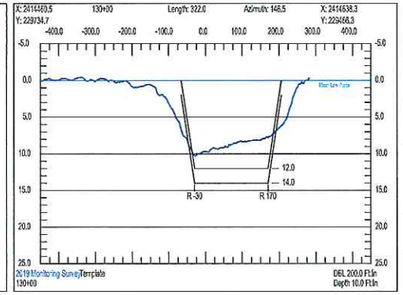


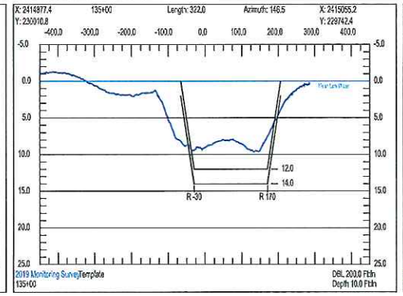


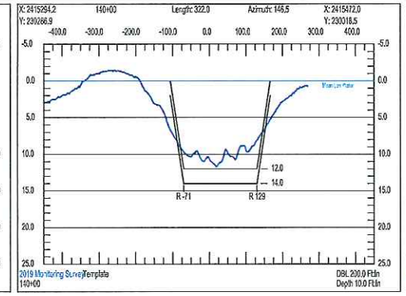


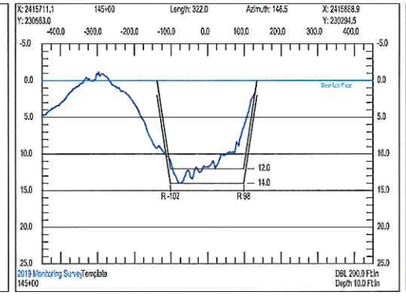


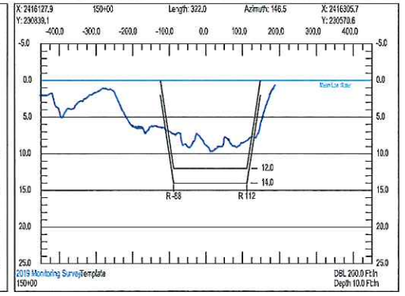












TI Coastal Services, Inc.
387-B N. Green Meadows Dr.
Wilmington, NC 28405
910.821.1358

11x17 = Half Scale

Vertical Datum Conversion

3.74'
Mean High Water
1.20'
NAVD 1988
2.54'
Mean Low Water

Graphic Scale

Horizontal
0' 100' 200' 400'
Vertical
0' 5' 10' 20'

SURF CITY BEACH NOURISHMENT

SURF CITY
PENDER & ONSLOW COUNTIES, NORTH CAROLINA

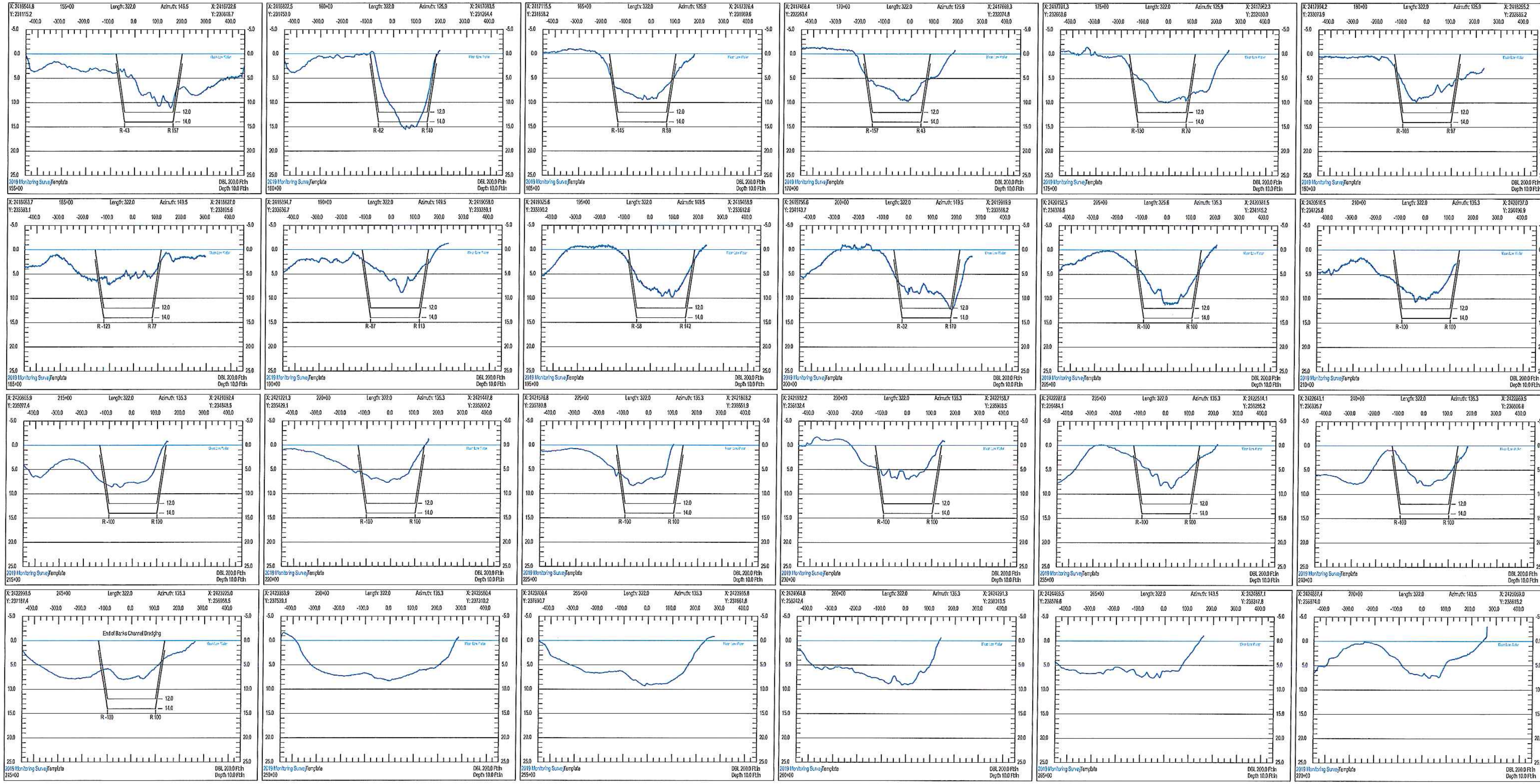
Permit Drawing - October 2019

Station 35+00 to 150+00 - Banks Channel Cross Sections

Notes:
1. Horizontal Datum: NC State Plane - Zone 3200, NAD83, Feet
2. Vertical Datum: Mean Low Water
3. Data collected by TI Coastal in July 10-17, 2019 and represent conditions at that time.
4. Soundings are expressed in feet and tenths.
5. Aerial flown on June 17, 2019 by TerraLina Mapping Consultants.

Christian L. Gibson, P.E. No. 026273

DWG NAME: 2018 Surf City Beachfill.dwg
DWG DATE: November 25, 2019 | SURVEY DATE: July 10-17, 2019
SCALE: As Shown | SHEET: 16 OF 18



TI Coastal

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387-B N. Green Meadows Dr.
Wilmington, NC 28405
910.821.1358

11x17 = Half Scale

Vertical Datum Conversion

Mean High Water
1.20'
3.74' — NAVD 1988
2.54'
Mean Low Water

Graphic Scale
Horizontal
0' 100' 200' 400'
0' 5' 10' 20'
Vertical

SURF CITY BEACH NOURISHMENT

SURF CITY
PENDER & ONSLOW COUNTIES, NORTH CAROLINA

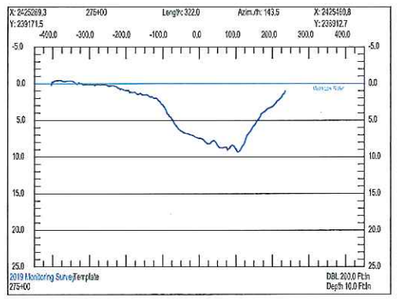
Permit Drawing - October 2019

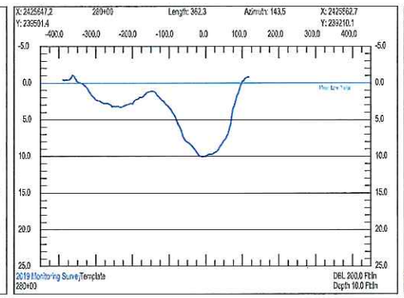
Station 155+00 to 270+00 - Banks Channel Cross Sections

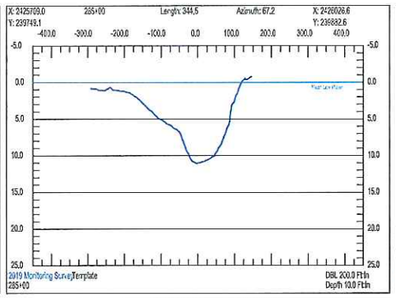
Christian L. Gibson, P.E. No. 026273

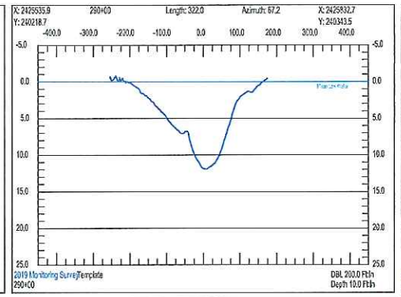
Notes:
1. Horizontal Datum: NC State Plane - Zone 3200, NAD83, Feet
2. Vertical Datum: Mean Low Water
3. Data collected by TI Coastal in July 10-17, 2019 and represent conditions at that time.
4. Soundings are expressed in feet and tenths.
5. Aerial flown on June 17, 2019 by TerraLina Mapping Consultants.

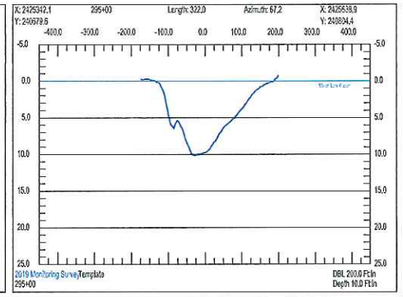
DWG NAME: 2018 Surf City Beachfill.dwg
DWG DATE: November 25, 2019
SURVEY DATE: July 10-17, 2019
SCALE: As Shown
SHEET: 17 OF 18

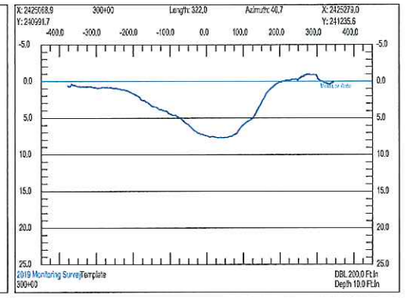


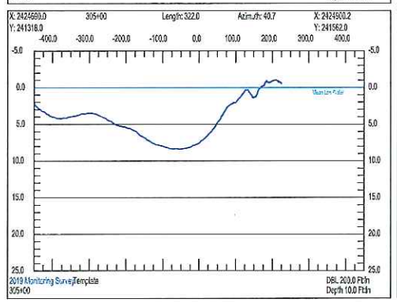


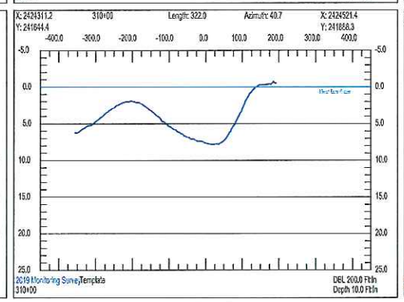


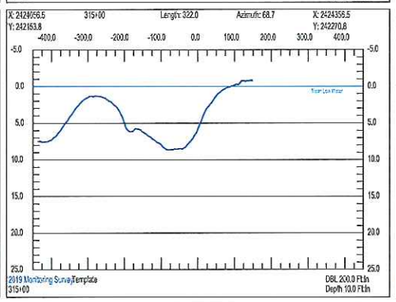


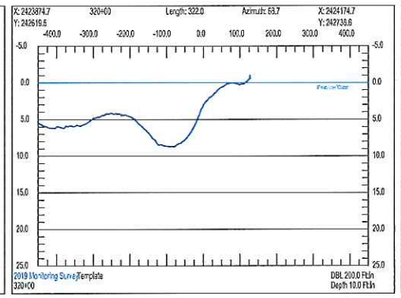


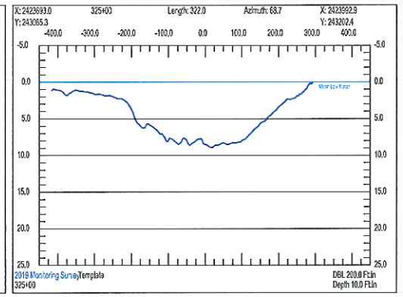


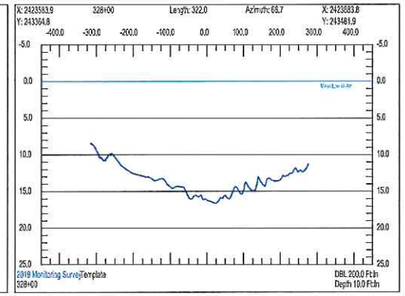










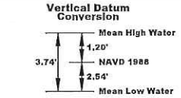


TI Coastal

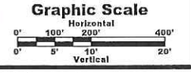
TI Coastal Services, Inc.
387-B N. Green Meadows Dr.
Wilmington, NC 28405
910.821.1358

11x17 = Half Scale

Vertical Datum Conversion



Graphic Scale



SURF CITY BEACH NOURISHMENT

SURF CITY
PENDER & ONSLOW COUNTIES, NORTH CAROLINA

Permit Drawing - October 2019

Station 275+00 to 328+00 - Banks Channel Cross Sections

Christian L. Gibson, P.E. No. 026273

Notes:
1. Horizontal Datum: NC State Plane - Zone 3200, NAD83, Feet
2. Vertical Datum: Mean Low Water
3. Data collected by TI Coastal in July 10-17, 2019 and represent conditions at that time.
4. Soundings are expressed in feet and tenths.
5. Aerial flown on June 17, 2019 by TerraLina Mapping Consultants.

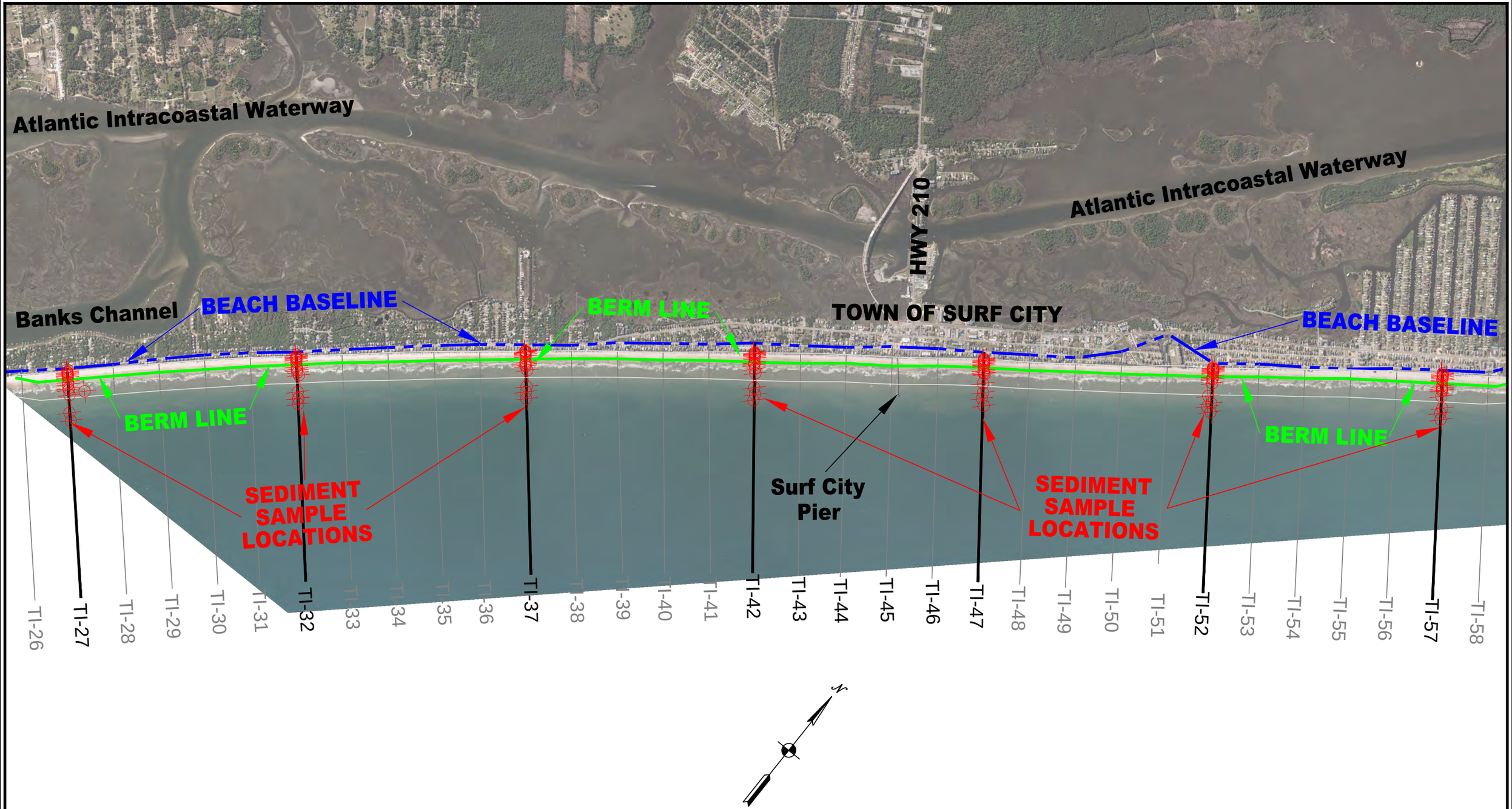
DWG NAME: 2018 Surf City Beachfill.dwg

DWG DATE: November 25, 2019	**SURVEY DATE: July 10-17, 2019**
SCALE: As Shown	**SHEET: 18 OF 18**

CAMA Permit Application

Geotechnical Information

-Native Grain Size Analysis
-Vibracore Location Maps
-Composite Tables, Statistics and Graphs



TI Coastal Services, Inc.
387-B N. Green Meadows Drive
Wilmington, NC 28405
910.821.1358

Vertical Datum Conversion
NAVD88
X.XX
MLW

Surf City Nourishment Project

Surf City
Pender & Onslow County, NC

Native Grain Size Sampling Locations

PLAN VIEW

Graphic Scale
0' 500' 1,000' 2,000'
Scale: 1" = 2,000'

Notes:
1. Horizontal Datum: NC State Plane - Zone 3200, NAD83, Feet
2. Vertical Datum: NAVD88, Feet
3. Data collected by TI Coastal in April and May 2018, and represent conditions at that time.
4. Soundings are expressed in depths and in feet and tenths.

DWG NAME: Surf City Native Grain Size Samples.dwg
DWG DATE: June 15, 2018
SURVEY DATE: April and May, 2018
SCALE: 1" = 2000'
SHEET: 1 OF 1

Granularmetric Report

Depths and elevations based on measured values

TI Coastal SERVICES, INC.

TI Coastal Services, Inc.

ph
fax

Project Name: Surf City Beach Nourishment Project 2018
Sample Name: Composite TB-27
Analysis Date: 05-24-18
Analyzed By: SJF

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		North Carolina State Plane	

USCS:	Munsell:	Comments:
SP		

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
100.00	100.00	0.10	0.20	#200 - 0.30 #230 - 0.30		6.90	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3"	-6.25	76.11	0.00	0.00	0.00	0.00
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
3/8"	-3.25	9.51	0.20	0.20	0.20	0.20
4	-2.25	4.76	0.10	0.10	0.30	0.30
5	-2.00	4.00	0.10	0.10	0.40	0.40
7	-1.50	2.83	0.10	0.10	0.50	0.50
10	-1.00	2.00	0.20	0.20	0.70	0.70
14	-0.50	1.41	0.50	0.50	1.20	1.20
18	0.00	1.00	0.80	0.80	2.00	2.00
25	0.50	0.71	1.50	1.50	3.50	3.50
35	1.00	0.50	2.70	2.70	6.20	6.20
45	1.50	0.35	7.40	7.40	13.60	13.60
60	2.00	0.25	23.60	23.60	37.20	37.20
70	2.25	0.21	19.00	19.00	56.20	56.20
80	2.50	0.18	22.30	22.30	78.50	78.50
100	2.75	0.15	15.30	15.30	93.80	93.80
120	3.00	0.13	3.70	3.70	97.50	97.50
170	3.50	0.09	2.10	2.10	99.60	99.60
200	3.75	0.07	0.10	0.10	99.70	99.70
230	4.00	0.06	0.00	0.00	99.70	99.70

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.83	2.59	2.46	2.17	1.74	1.55	0.78

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	2.03	0.24	0.72	-2.56	15.93

GRANULARMETRIC REPORT SURF CITY NATIVE GRAIN SIZE ANALYSIS.GPJ FL DEP ROSS.GDT 5/31/18

Granularmetric Report

Depths and elevations based on measured values

TI Coastal SERVICES, INC.

TI Coastal Services, Inc.

ph
fax

Project Name: Surf City Beach Nourishment Project 2018

Sample Name: Composite TB-32

Analysis Date: 05-24-18

Analyzed By: SJF

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		North Carolina State Plane	

USCS:	Munsell:	Comments:
SP		

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
99.90	99.90	0.00	0.00	#200 - 0.00 #230 - 0.00		4.40	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3"	-6.25	76.11	0.00	0.00	0.00	0.00
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
3/8"	-3.25	9.51	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.10	0.10	0.10	0.10
5	-2.00	4.00	0.10	0.10	0.20	0.20
7	-1.50	2.83	0.10	0.10	0.30	0.30
10	-1.00	2.00	0.30	0.30	0.60	0.60
14	-0.50	1.41	0.60	0.60	1.20	1.20
18	0.00	1.00	0.80	0.80	2.00	2.00
25	0.50	0.71	1.50	1.50	3.50	3.50
35	1.00	0.50	2.80	2.80	6.30	6.31
45	1.50	0.35	8.20	8.21	14.50	14.51
60	2.00	0.25	26.70	26.73	41.20	41.24
70	2.25	0.21	23.80	23.82	65.00	65.07
80	2.50	0.18	20.70	20.72	85.70	85.79
100	2.75	0.15	10.30	10.31	96.00	96.10
120	3.00	0.13	2.40	2.40	98.40	98.50
170	3.50	0.09	1.40	1.40	99.80	99.90
200	3.75	0.07	0.10	0.10	99.90	100.00
230	4.00	0.06	0.00	0.00	99.90	100.00

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.72	2.48	2.37	2.09	1.70	1.53	0.77

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	1.97	0.26	0.66	-2.04	10.94

GRANULARMETRIC REPORT SURF CITY NATIVE GRAIN SIZE ANALYSIS.GPJ FL DEP ROSS.GDT 5/31/18

Granularmetric Report

Depths and elevations based on measured values

TI Coastal SERVICES, INC.
TI Coastal Services, Inc.
ph
fax

Project Name: Surf City Beach Nourishment Project 2018
Sample Name: Composite TB-37
Analysis Date: 05-24-18
Analyzed By: SJF

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		North Carolina State Plane	

USCS:	Munsell:	Comments:
SP		

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
99.80	99.80	0.00	0.10	#200 - 0.10 #230 - 0.10		5.70	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3"	-6.25	76.11	0.00	0.00	0.00	0.00
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
3/8"	-3.25	9.51	0.10	0.10	0.10	0.10
4	-2.25	4.76	0.10	0.10	0.20	0.20
5	-2.00	4.00	0.10	0.10	0.30	0.30
7	-1.50	2.83	0.10	0.10	0.40	0.40
10	-1.00	2.00	0.20	0.20	0.60	0.60
14	-0.50	1.41	0.50	0.50	1.10	1.10
18	0.00	1.00	0.70	0.70	1.80	1.80
25	0.50	0.71	1.20	1.20	3.00	3.01
35	1.00	0.50	2.00	2.00	5.00	5.01
45	1.50	0.35	6.30	6.31	11.30	11.32
60	2.00	0.25	26.00	26.05	37.30	37.37
70	2.25	0.21	24.00	24.05	61.30	61.42
80	2.50	0.18	24.30	24.35	85.60	85.77
100	2.75	0.15	10.00	10.02	95.60	95.79
120	3.00	0.13	2.30	2.30	97.90	98.10
170	3.50	0.09	1.70	1.70	99.60	99.80
200	3.75	0.07	0.10	0.10	99.70	99.90
230	4.00	0.06	0.00	0.00	99.70	99.90

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.73	2.48	2.39	2.13	1.76	1.59	1.00

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	2.01	0.25	0.65	-2.65	17.07

GRANULARMETRIC REPORT SURF CITY NATIVE GRAIN SIZE ANALYSIS.GPJ FL DEP ROSS.GDT 5/31/18

Granularmetric Report

Depths and elevations based on measured values

TI Coastal SERVICES, INC.
TI Coastal Services, Inc.
ph
fax

Project Name: Surf City Beach Nourishment Project 2018
Sample Name: Composite TB-42
Analysis Date: 05-24-18
Analyzed By: SJF

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		North Carolina State Plane	

USCS:	Munsell:	Comments:
SP		

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
99.90	99.90	0.00	0.00	#200 - 0.10 #230 - 0.00		5.20	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3"	-6.25	76.11	0.00	0.00	0.00	0.00
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
3/8"	-3.25	9.51	0.20	0.20	0.20	0.20
4	-2.25	4.76	0.00	0.00	0.20	0.20
5	-2.00	4.00	0.00	0.00	0.20	0.20
7	-1.50	2.83	0.10	0.10	0.30	0.30
10	-1.00	2.00	0.10	0.10	0.40	0.40
14	-0.50	1.41	0.30	0.30	0.70	0.70
18	0.00	1.00	0.40	0.40	1.10	1.10
25	0.50	0.71	0.90	0.90	2.00	2.00
35	1.00	0.50	1.90	1.90	3.90	3.90
45	1.50	0.35	5.40	5.41	9.30	9.31
60	2.00	0.25	17.70	17.72	27.00	27.03
70	2.25	0.21	20.60	20.62	47.60	47.65
80	2.50	0.18	27.50	27.53	75.10	75.18
100	2.75	0.15	17.00	17.02	92.10	92.19
120	3.00	0.13	4.30	4.30	96.40	96.50
170	3.50	0.09	3.20	3.20	99.60	99.70
200	3.75	0.07	0.20	0.20	99.80	99.90
230	4.00	0.06	0.10	0.10	99.90	100.00

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.91	2.63	2.50	2.27	1.94	1.69	1.10

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	2.16	0.22	0.64	-2.77	20.9

GRANULARMETRIC REPORT SURF CITY NATIVE GRAIN SIZE ANALYSIS.GPJ FL DEP ROSS.GDT 5/31/18

Granularmetric Report

Depths and elevations based on measured values

TI Coastal SERVICES, INC.
TI Coastal Services, Inc.
ph
fax

Project Name: Surf City Beach Nourishment Project 2018
Sample Name: Composite TB-47
Analysis Date: 05-24-18
Analyzed By: SJF

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		North Carolina State Plane	

USCS:	Munsell:	Comments:
SP		

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
99.70	99.70	0.00	0.10	#200 - 0.20 #230 - 0.10		8.00	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3"	-6.25	76.11	0.00	0.00	0.00	0.00
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
3/8"	-3.25	9.51	0.20	0.20	0.20	0.20
4	-2.25	4.76	0.10	0.10	0.30	0.30
5	-2.00	4.00	0.10	0.10	0.40	0.40
7	-1.50	2.83	0.10	0.10	0.50	0.50
10	-1.00	2.00	0.30	0.30	0.80	0.80
14	-0.50	1.41	0.70	0.70	1.50	1.50
18	0.00	1.00	1.00	1.00	2.50	2.51
25	0.50	0.71	2.10	2.11	4.60	4.61
35	1.00	0.50	3.60	3.61	8.20	8.22
45	1.50	0.35	6.90	6.92	15.10	15.15
60	2.00	0.25	22.20	22.27	37.30	37.41
70	2.25	0.21	20.70	20.76	58.00	58.17
80	2.50	0.18	21.60	21.66	79.60	79.84
100	2.75	0.15	12.90	12.94	92.50	92.78
120	3.00	0.13	3.80	3.81	96.30	96.59
170	3.50	0.09	3.00	3.01	99.30	99.60
200	3.75	0.07	0.20	0.20	99.50	99.80
230	4.00	0.06	0.10	0.10	99.60	99.90

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.90	2.58	2.44	2.15	1.72	1.52	0.55

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	2	0.25	0.77	-2.26	12.92

GRANULARMETRIC REPORT SURF CITY NATIVE GRAIN SIZE ANALYSIS.GPJ FL DEP ROSS.GDT 5/31/18

Granularmetric Report

Depths and elevations based on measured values

TI Coastal SERVICES, INC.

TI Coastal Services, Inc.

ph
fax

Project Name: Surf City Beach Nourishment Project 2018
Sample Name: Composite TB-52
Analysis Date: 05-24-18
Analyzed By: SJF

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		North Carolina State Plane	

USCS:	Munsell:	Comments:
SP		

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
99.80	99.80	0.00	0.20	#200 - 0.30 #230 - 0.20		7.40	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3"	-6.25	76.11	0.00	0.00	0.00	0.00
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
3/8"	-3.25	9.51	0.40	0.40	0.40	0.40
4	-2.25	4.76	0.20	0.20	0.60	0.60
5	-2.00	4.00	0.00	0.00	0.60	0.60
7	-1.50	2.83	0.20	0.20	0.80	0.80
10	-1.00	2.00	0.40	0.40	1.20	1.20
14	-0.50	1.41	0.70	0.70	1.90	1.90
18	0.00	1.00	0.90	0.90	2.80	2.81
25	0.50	0.71	1.80	1.80	4.60	4.61
35	1.00	0.50	4.20	4.21	8.80	8.82
45	1.50	0.35	9.50	9.52	18.30	18.34
60	2.00	0.25	21.60	21.64	39.90	39.98
70	2.25	0.21	18.40	18.44	58.30	58.42
80	2.50	0.18	20.80	20.84	79.10	79.26
100	2.75	0.15	13.90	13.93	93.00	93.19
120	3.00	0.13	3.70	3.71	96.70	96.89
170	3.50	0.09	2.60	2.61	99.30	99.50
200	3.75	0.07	0.20	0.20	99.50	99.70
230	4.00	0.06	0.10	0.10	99.60	99.80

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.87	2.59	2.45	2.14	1.65	1.38	0.55

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	1.96	0.26	0.84	-2.51	14.46

GRANULARMETRIC REPORT SURF CITY NATIVE GRAIN SIZE ANALYSIS.GPJ FL DEP ROSS.GDT 5/31/18

Granularmetric Report

Depths and elevations based on measured values

TI Coastal SERVICES, INC.
TI Coastal Services, Inc.
ph
fax

Project Name: Surf City Beach Nourishment Project 2018
Sample Name: Composite TB-57
Analysis Date: 05-24-18
Analyzed By: SJF

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		North Carolina State Plane	

USCS:	Munsell:	Comments:
SP		

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
99.80	99.80	0.10	0.00	#200 - 0.30 #230 - 0.10		8.90	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3"	-6.25	76.11	0.00	0.00	0.00	0.00
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
3/8"	-3.25	9.51	0.20	0.20	0.20	0.20
4	-2.25	4.76	0.20	0.20	0.40	0.40
5	-2.00	4.00	0.10	0.10	0.50	0.50
7	-1.50	2.83	0.20	0.20	0.70	0.70
10	-1.00	2.00	0.50	0.50	1.20	1.20
14	-0.50	1.41	0.80	0.80	2.00	2.00
18	0.00	1.00	1.10	1.10	3.10	3.11
25	0.50	0.71	2.40	2.40	5.50	5.51
35	1.00	0.50	4.40	4.41	9.90	9.92
45	1.50	0.35	9.30	9.32	19.20	19.24
60	2.00	0.25	20.70	20.74	39.90	39.98
70	2.25	0.21	18.40	18.44	58.30	58.42
80	2.50	0.18	22.10	22.14	80.40	80.56
100	2.75	0.15	12.30	12.32	92.70	92.89
120	3.00	0.13	3.40	3.41	96.10	96.29
170	3.50	0.09	3.10	3.11	99.20	99.40
200	3.75	0.07	0.30	0.30	99.50	99.70
230	4.00	0.06	0.20	0.20	99.70	99.90

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.91	2.57	2.44	2.14	1.64	1.33	0.39

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	1.95	0.26	0.84	-2.08	11.02

GRANULARMETRIC REPORT SURF CITY NATIVE GRAIN SIZE ANALYSIS.GPJ FL DEP ROSS.GDT 5/31/18

Granularmetric Report

Depths and elevations based on measured values

TI Coastal SERVICES, INC.
TI Coastal Services, Inc.
ph
fax

Project Name: Surf City Beach Nourishment Project 2018
Sample Name: Surf City Native Composite
Analysis Date: 05-24-18
Analyzed By: SJF

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		North Carolina State Plane	

USCS:	Munsell:	Comments:
SP		

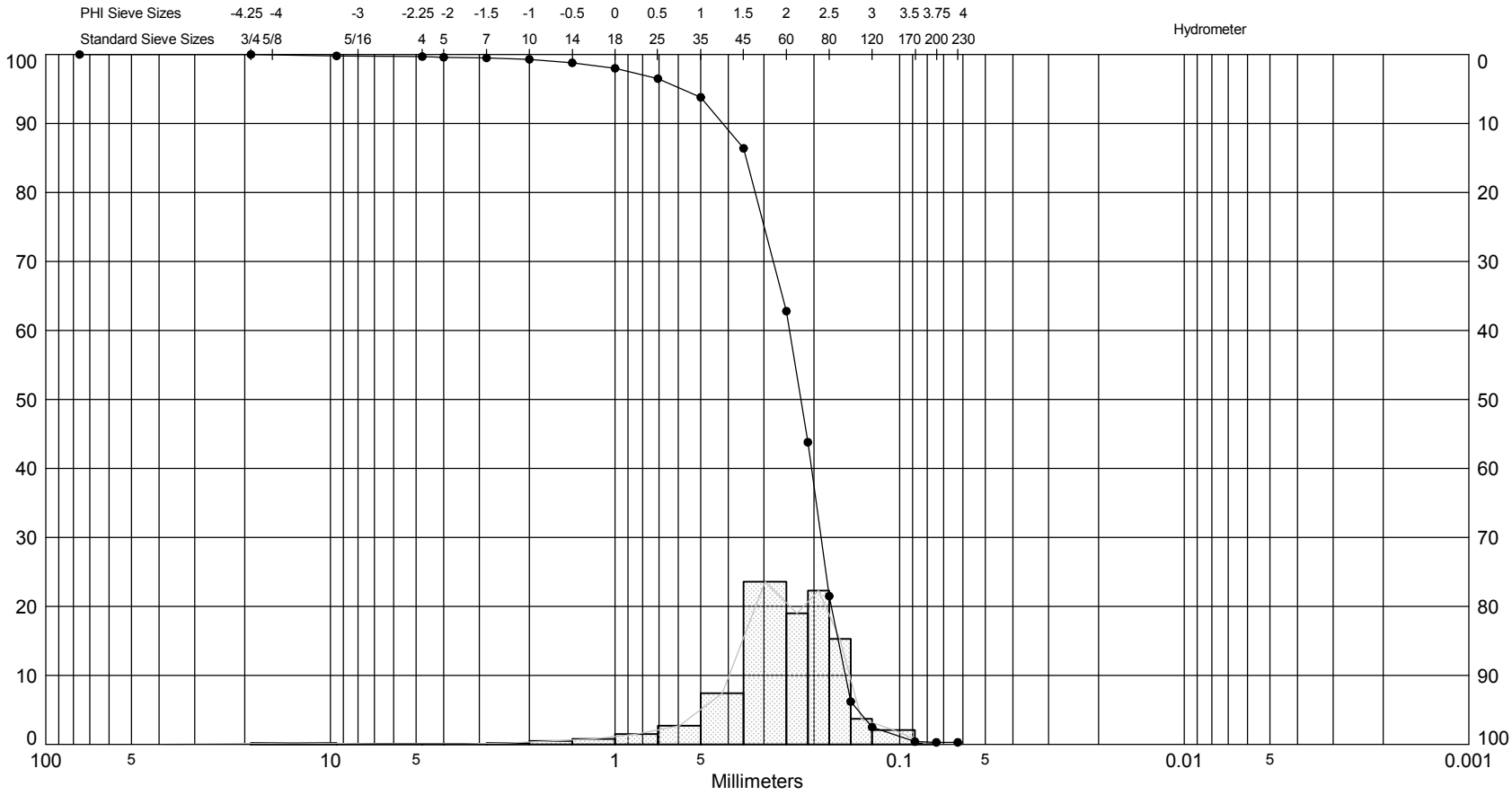
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
99.90	99.90	0.00	0.00	#200 - 0.10 #230 - 0.00		6.60	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3"	-6.25	76.11	0.00	0.00	0.00	0.00
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
3/8"	-3.25	9.51	0.20	0.20	0.20	0.20
4	-2.25	4.76	0.10	0.10	0.30	0.30
5	-2.00	4.00	0.10	0.10	0.40	0.40
7	-1.50	2.83	0.10	0.10	0.50	0.50
10	-1.00	2.00	0.30	0.30	0.80	0.80
14	-0.50	1.41	0.60	0.60	1.40	1.40
18	0.00	1.00	0.80	0.80	2.20	2.20
25	0.50	0.71	1.60	1.60	3.80	3.80
35	1.00	0.50	3.10	3.10	6.90	6.91
45	1.50	0.35	7.60	7.61	14.50	14.51
60	2.00	0.25	22.60	22.62	37.10	37.14
70	2.25	0.21	20.70	20.72	57.80	57.86
80	2.50	0.18	22.80	22.82	80.60	80.68
100	2.75	0.15	13.10	13.11	93.70	93.79
120	3.00	0.13	3.40	3.40	97.10	97.20
170	3.50	0.09	2.50	2.50	99.60	99.70
200	3.75	0.07	0.20	0.20	99.80	99.90
230	4.00	0.06	0.10	0.10	99.90	100.00

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.84	2.56	2.44	2.16	1.73	1.53	0.69

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	2.01	0.25	0.74	-2.43	14.73

GRANULARMETRIC REPORT SURF CITY NATIVE GRAIN SIZE ANALYSIS.GPJ FL DEP ROSS.GDT 5/31/18



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Composite TB-27	—●—		SP	#200 - 0.30 #230 - 0.30		6.90	2.17	2.03	-2.56	15.93	0.72

Comments:

Depths and elevations based on measured values

Sample Information	
Project Name:	Surf City Beach Nourishment Project 2018
Analysis Date:	05-24-18
Analyzed By:	SJF
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	NAD 1983
Vertical System:	NAVD 88

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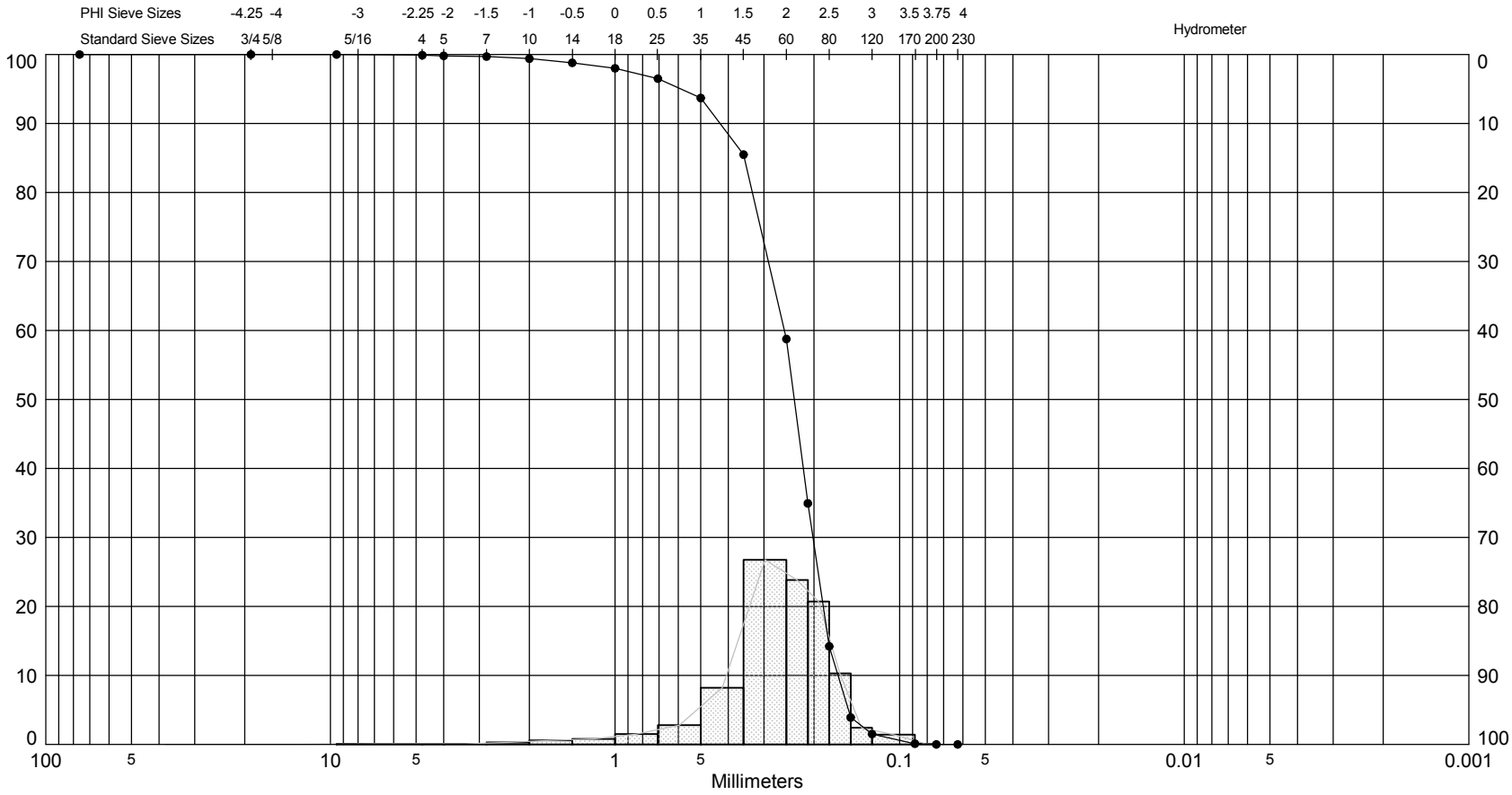
SIEVE ANALYSIS SURF CITY NATIVE GRAIN SIZE ANALYSIS.GPJ FL DEP ROSS.GDT 5/31/18



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Composite TB-32	—●—		SP	#200 - 0.00 #230 - 0.00		4.40	2.09	1.97	-2.04	10.94	0.66

Comments:

Depths and elevations based on measured values

TI Coastal SERVICES, INC.

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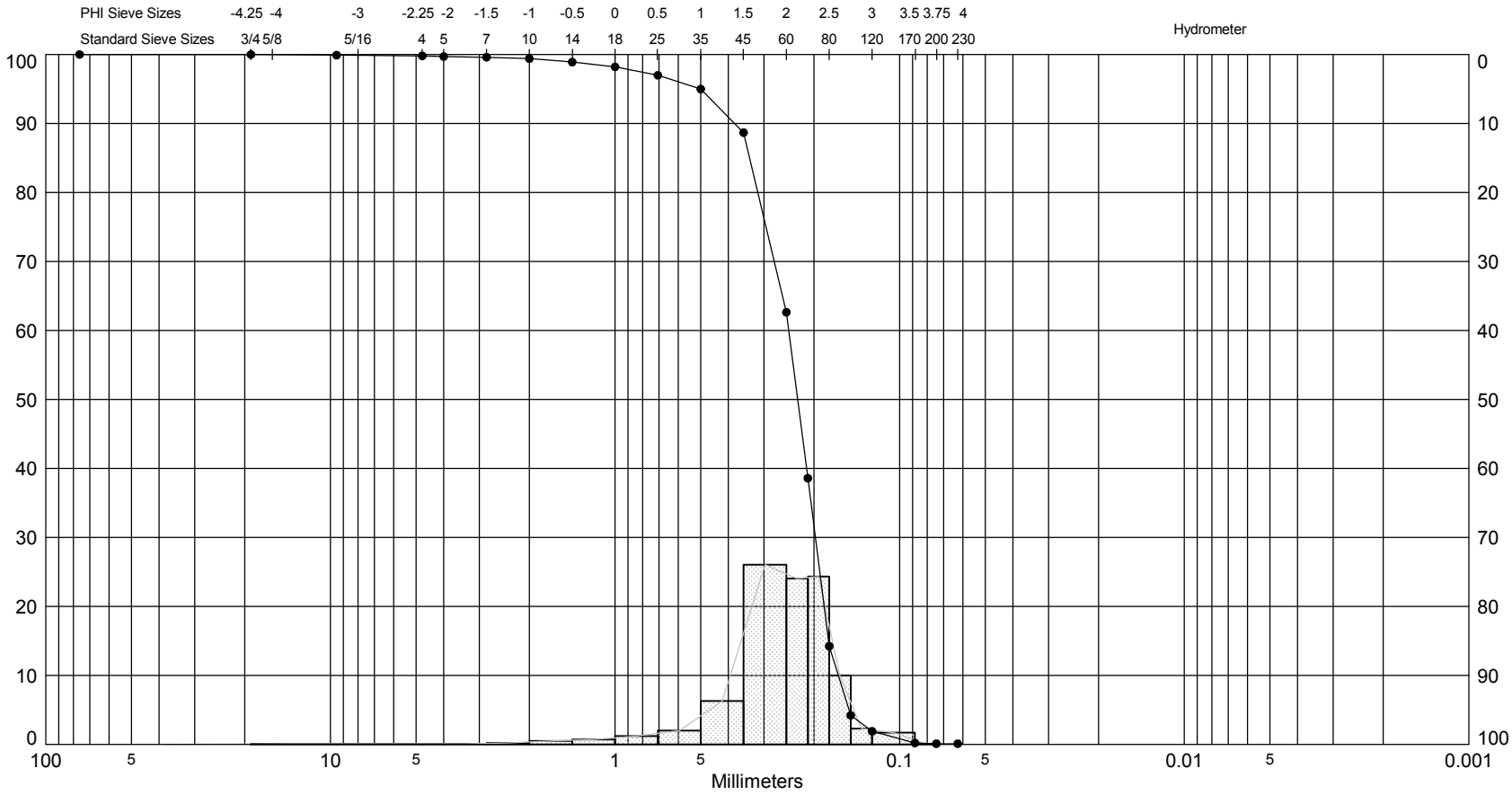
Sample Information	
Project Name:	Surf City Beach Nourishment Project 2018
Analysis Date:	05-24-18
Analyzed By:	SJF
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	NAD 1983
Vertical System:	NAVD 88

SIEVE ANALYSIS SURF CITY NATIVE GRAIN SIZE ANALYSIS.GPJ FL DEP ROSS.GDT 5/31/18



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Composite TB-37	—●—		SP	#200 - 0.10 #230 - 0.10		5.70	2.13	2.01	-2.65	17.07	0.65

Comments:

Depths and elevations based on measured values

TI Coastal SERVICES, INC.

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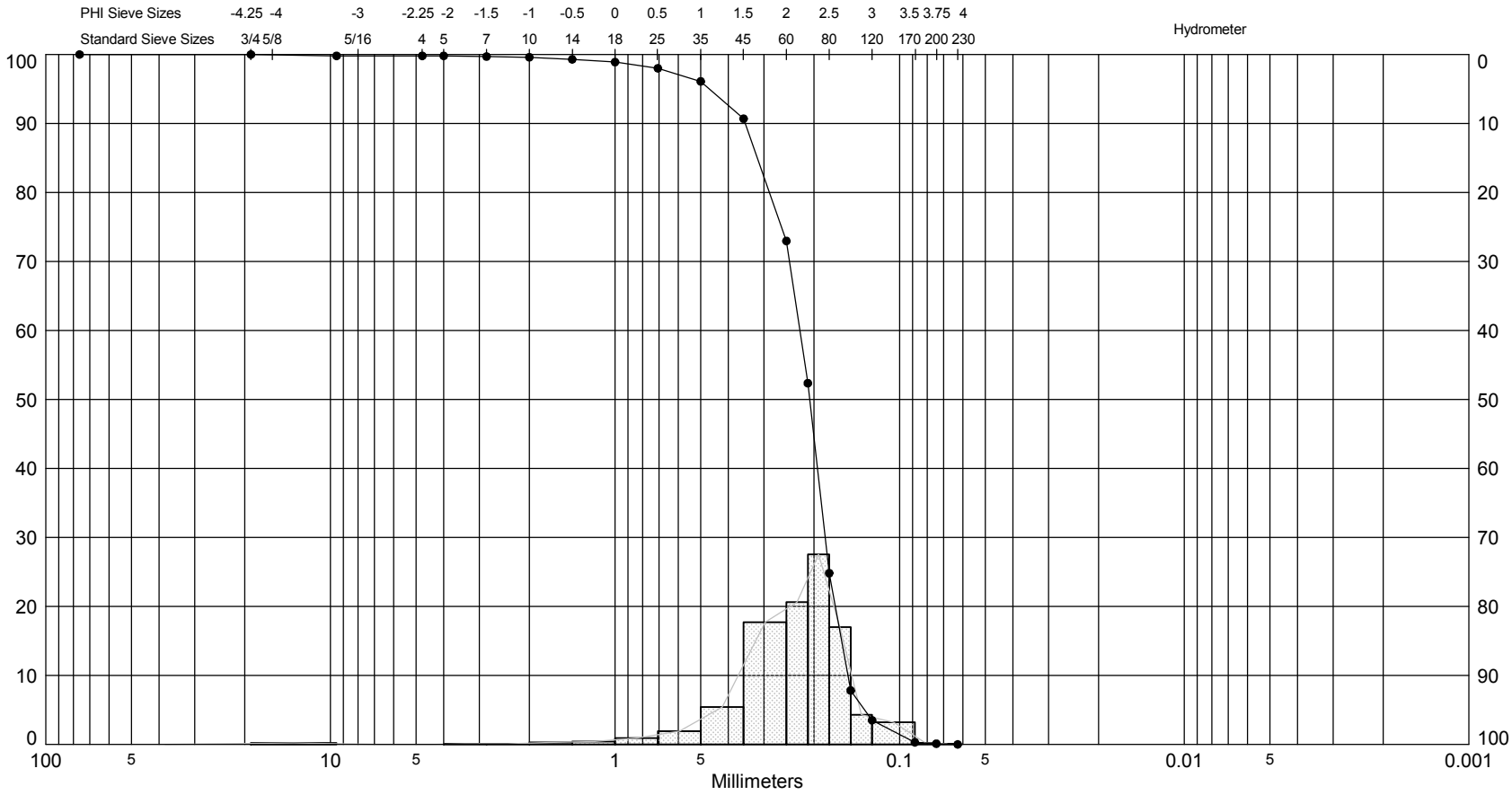
Sample Information	
Project Name:	Surf City Beach Nourishment Project 2018
Analysis Date:	05-24-18
Analyzed By:	SJF
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	NAD 1983
Vertical System:	NAVD 88

SIEVE ANALYSIS SURF CITY NATIVE GRAIN SIZE ANALYSIS.GPJ FL DEP ROSS.GDT 5/31/18



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Composite TB-42	—●—		SP	#200 - 0.10 #230 - 0.00		5.20	2.27	2.16	-2.77	20.9	0.64

Sample Information	
Project Name:	Surf City Beach Nourishment Project 2018
Analysis Date:	05-24-18
Analyzed By:	SJF
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	NAD 1983
Vertical System:	NAVD 88

Comments:

Depths and elevations based on measured values

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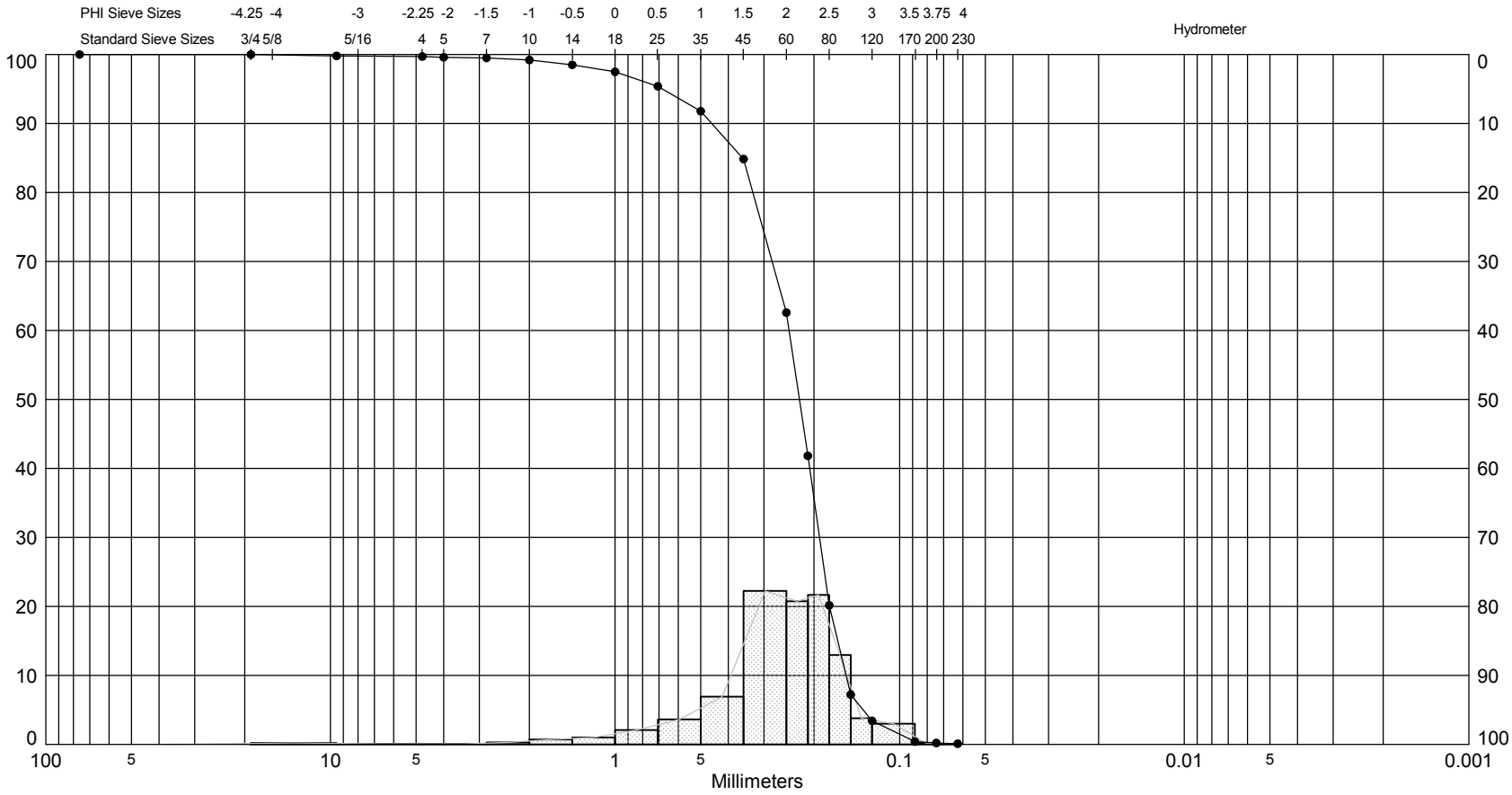
SIEVE ANALYSIS SURF CITY NATIVE GRAIN SIZE ANALYSIS.GPJ FL DEP ROSS.GDT 5/31/18



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Composite TB-47	—●—		SP	#200 - 0.20 #230 - 0.10		8.00	2.15	2	-2.26	12.92	0.77

Comments:

Depths and elevations based on measured values

Sample Information	
Project Name:	Surf City Beach Nourishment Project 2018
Analysis Date:	05-24-18
Analyzed By:	SJF
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	NAD 1983
Vertical System:	NAVD 88

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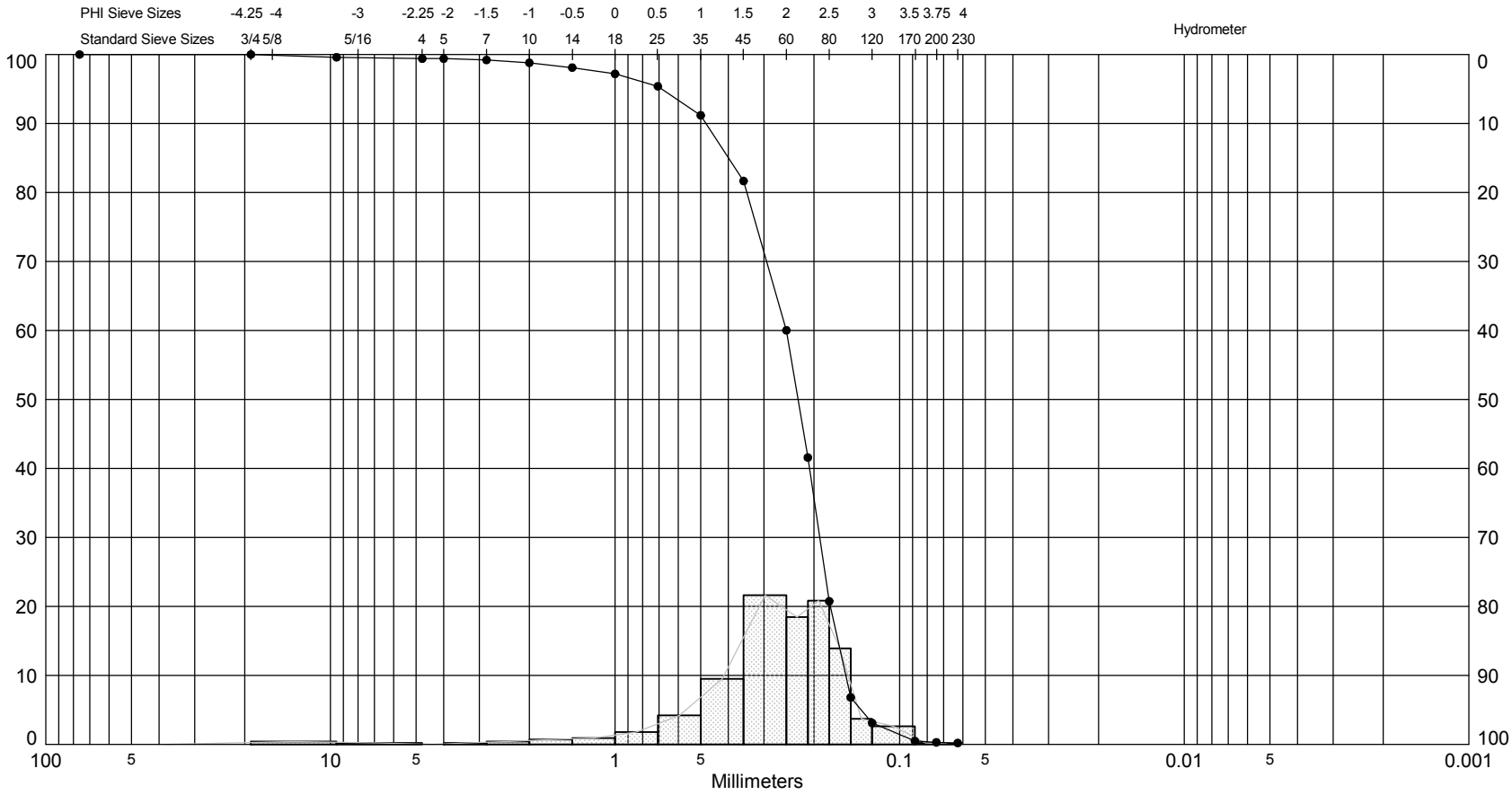
SIEVE ANALYSIS SURF CITY NATIVE GRAIN SIZE ANALYSIS.GPJ FL DEP ROSS.GDT 5/31/18



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Composite TB-52	—●—		SP	#200 - 0.30 #230 - 0.20		7.40	2.14	1.96	-2.51	14.46	0.84

Comments:

Depths and elevations based on measured values

Sample Information	
Project Name:	Surf City Beach Nourishment Project 2018
Analysis Date:	05-24-18
Analyzed By:	SJF
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	NAD 1983
Vertical System:	NAVD 88

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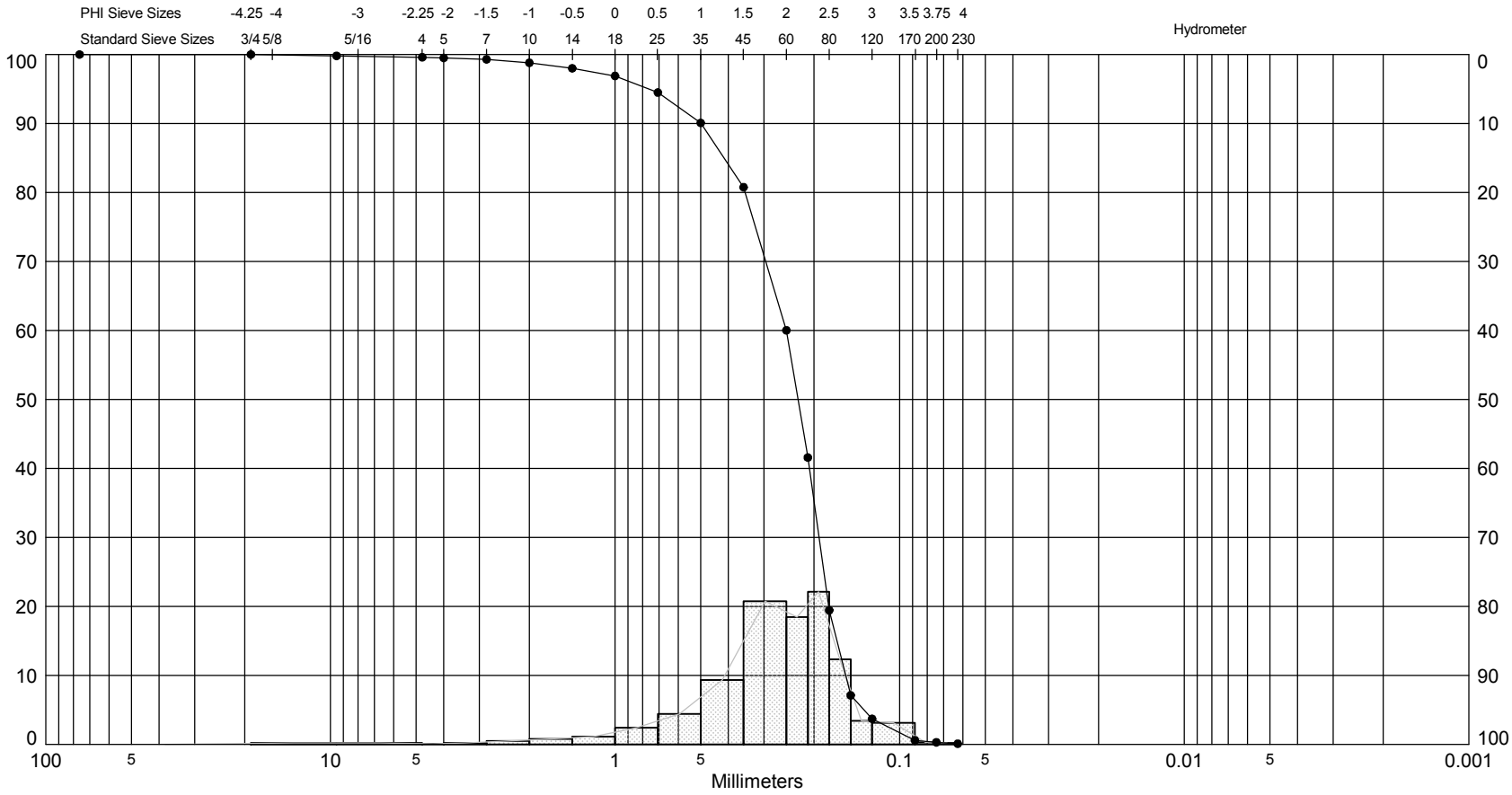
SIEVE ANALYSIS SURF CITY NATIVE GRAIN SIZE ANALYSIS.GPJ FL DEP ROSS.GDT 5/31/18



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Composite TB-57	—●—		SP	#200 - 0.30 #230 - 0.10		8.90	2.14	1.95	-2.08	11.02	0.84

Comments:

Depths and elevations based on measured values

Sample Information	
Project Name:	Surf City Beach Nourishment Project 2018
Analysis Date:	05-24-18
Analyzed By:	SJF
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	NAD 1983
Vertical System:	NAVD 88

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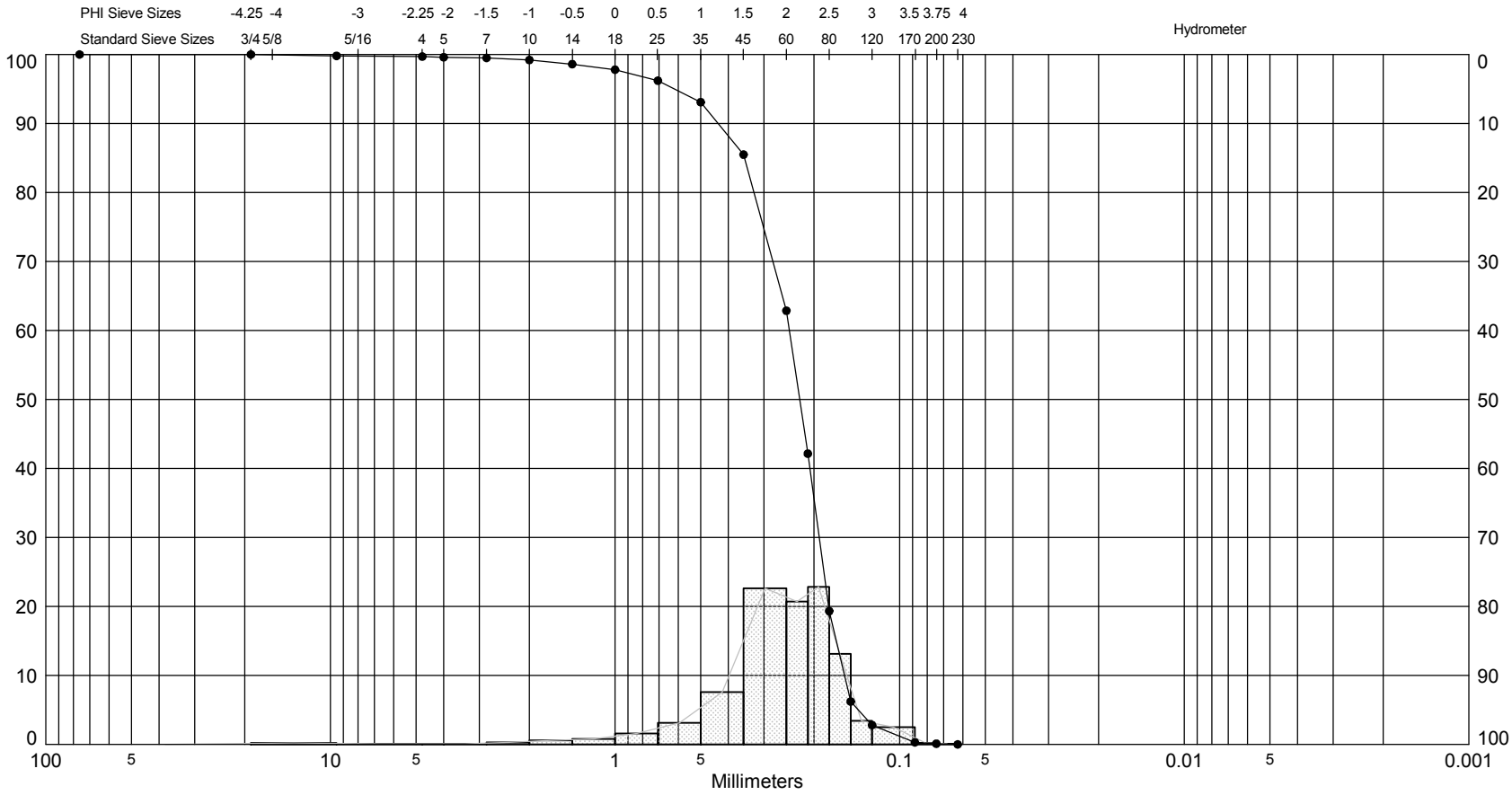
SIEVE ANALYSIS SURF CITY NATIVE GRAIN SIZE ANALYSIS.GPJ FL DEP ROSS.GDT 5/31/18



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Surf City Native Composite			SP	#200 - 0.10 #230 - 0.00		6.60	2.16	2.01	-2.43	14.73	0.74

Sample Information	
Project Name:	Surf City Beach Nourishment Project 2018
Analysis Date:	05-24-18
Analyzed By:	SJF
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	NAD 1983
Vertical System:	NAVD 88

Comments:

Depths and elevations based on measured values

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SIEVE ANALYSIS SURF CITY NATIVE GRAIN SIZE ANALYSIS.GPJ FL DEP ROSS.GDT 5/31/18

TB-27 GRAIN SIZE ANALYSIS (INCREMENTAL RETAINED %)																		
Millimeters	PHI Size	Dune Crest	Dune Toe	Mid Berm	MHW	Foreshore	Mid Tide	0' NAVD	MLW	Trough	Bar Crest	-6' NAVD	-8' NAVD	-10' NAVD	16' NAVD	-20' NAVD	Average	
>75.00	-6.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	COBBLES
19.05	-4.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	PEBBLES
9.53	-3.25	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.1	0.2	
4.75	-2.25	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.3	0.0	0.0	0.1	0.0	0.1	
4.00	-2	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	GRAVEL
2.80	-1.5	0.0	0.0	0.0	0.0	0.0	0.2	0.7	0.2	0.0	0.2	0.3	0.0	0.2	0.0	0.0	0.1	
2	-1	0.1	0.0	0.0	0.0	0.0	0.6	1.0	0.4	0.1	0.2	0.5	0.1	0.2	0.1	0.1	0.2	
1.4	-0.5	0.3	0.0	0.0	0.0	0.0	2.7	1.2	0.6	0.3	0.7	0.9	0.1	0.1	0.4	0.1	0.5	SAND
1	0	0.7	0.0	0.0	0.1	0.1	4.5	1.4	0.9	0.5	1.0	1.8	0.4	0.6	0.4	0.1	0.8	
0.71	0.5	1.5	0.1	0.1	0.3	0.5	7.0	2.1	2.1	0.9	2.4	2.5	1.2	1.2	0.8	0.1	1.5	
0.5	1	3.9	0.2	0.5	1.6	2.6	6.2	4.6	4.0	2.0	4.6	4.6	2.3	2.2	0.8	0.4	2.7	
0.36	1.5	8.6	2.8	7.3	14.6	12.6	9.8	11.6	8.8	2.8	9.2	9.8	6.2	3.3	2.1	1.3	7.4	
0.25	2	22.3	34.4	40.1	52.2	34.3	26.0	20.8	18.9	7.5	18.4	21.3	40.8	7.0	8.2	2.1	23.6	
0.21	2.25	22.8	28.2	30.9	18.2	23.4	18.8	16.5	18.5	19.7	16.7	18.8	23.5	11.6	13.0	4.4	19.0	
0.18	2.5	21.1	19.0	14.7	8.6	18.1	14.3	22.1	22.3	40.4	22.7	23.5	16.4	42.1	27.4	22.5	22.3	
0.15	2.75	12.7	10.0	4.9	3.7	7.2	8.3	12.5	17.1	20.9	17.1	13.1	5.8	21.4	31.4	43.8	15.3	
0.13	3	2.8	2.1	0.8	0.5	0.9	1.1	2.1	4.1	3.7	4.6	2.0	1.6	5.8	9.1	14.0	3.7	
0.09	3.5	2.5	3.0	0.6	0.3	0.3	0.3	0.6	1.7	1.2	2.2	0.5	1.1	3.6	4.9	9.2	2.1	
0.08	3.75	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.9	0.1	
0.06	4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.0	
Pan		0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.2	0.1	SILT
	Totals	100.0	100.0	100.0	100.0	100.0	99.9	100.0	99.7	100.0	99.8	99.8	100.0	99.5	99.7	99.5	100.0	
	$CaCO_3$%	2.6	3.2	5.4	6.6	6.8	17.8	10.5	9.7	5.2	10.8	12.5	3.6	2.8	5.4	1	6.9	

TB-32 GRAIN SIZE ANALYSIS (INCREMENTAL RETAINED %)																		
Millimeters	PHI Size	Dune Crest	Dune Toe	Mid Berm	MHW	Foreshore	Mid Tide	0' NAVD	MLW	Trough	Bar Crest	-6' NAVD	-8' NAVD	-12' NAVD	16' NAVD	-20' NAVD	Average	
>75.00	-6.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	COBBLES
19.05	-4.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	PEBBLES
9.53	-3.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4.75	-2.25	0.0	0.0	0.3	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.7	0.0	0.0	0.1	
4.00	-2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	GRAVEL
2.80	-1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4	0.1	0.2	0.1	0.0	0.6	0.0	0.0	0.1	
2	-1	0.0	0.0	0.1	0.0	0.0	0.0	0.6	0.8	0.5	0.5	0.1	0.0	1.2	0.1	0.2	0.3	
1.4	-0.5	0.1	0.0	0.1	0.0	0.0	0.5	0.7	1.6	0.8	1.0	0.2	0.0	2.7	0.3	0.4	0.6	SAND
1	0	0.2	0.0	0.1	0.0	0.0	0.8	0.7	1.9	1.4	1.8	0.5	0.3	3.9	0.5	0.7	0.8	
0.71	0.5	0.3	0.0	0.3	0.1	0.1	1.0	1.1	2.7	2.4	4.3	1.8	0.5	7.1	0.7	1.0	1.5	
0.5	1	0.5	0.4	0.6	0.1	0.2	1.0	3.3	3.4	5.4	10.4	2.6	1.4	10.7	0.9	1.6	2.8	
0.36	1.5	4.6	3.9	4.3	1.7	1.0	3.1	12.5	10.9	14.5	30.5	7.0	13.2	11.9	2.1	2.3	8.2	
0.25	2	36.0	30.7	44.3	30.3	15.4	26.4	23.9	33.2	28.7	28.4	20.5	46.1	12.0	18.8	5.3	26.7	
0.21	2.25	28.1	32.9	26.7	48.1	33.4	25.5	20.3	20.8	17.5	10.1	20.5	29.8	9.6	22.2	11.1	23.8	
0.18	2.5	18.9	21.5	15.1	14.8	33.7	24.3	22.7	13.9	19.8	7.6	32.3	5.6	17.7	25.3	38.0	20.7	
0.15	2.75	8.6	7.8	5.7	3.6	13.1	14.0	10.8	7.5	6.9	4.1	11.4	1.8	14.7	18.4	25.8	10.3	
0.13	3	1.6	1.4	1.3	0.7	2.2	2.6	2.1	1.7	1.3	0.8	2.2	0.6	4.3	5.5	7.8	2.4	
0.09	3.5	0.8	1.0	1.2	0.6	0.8	0.9	0.7	0.6	0.6	0.2	0.7	0.5	2.5	4.9	5.3	1.4	
0.08	3.75	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.1	
0.06	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	
Pan		0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	SILT
	Totals	99.8	99.7	100.0	100.0	99.9	100.0	99.8	99.7	99.9	99.9	99.8	99.8	100.0	99.8	99.8	99.9	
	$CaCO_3$%	0.8	0.1	1.9	0.5	0.3	2.0	3.4	6.9	6.5	14.8	1.8	2.5	21.8	2.7	2.6	4.5	

TB-37 GRAIN SIZE ANALYSIS (INCREMENTAL RETAINED %)																		
Millimeters	PHI Size	Dune Crest	Dune Toe	Mid Berm	MHW	Foreshore	Mid Tide	0' NAVD	MLW	Trough	Bar Crest	-6' NAVD	-8' NAVD	-12' NAVD	16' NAVD	-20' NAVD	Totals	
>75.00	-6.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	COBBLES
19.05	-4.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
9.53	-3.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.1	PEBBLES
4.75	-2.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.1	0.1	0.0	0.0	0.2	0.3	0.1	
4.00	-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.1	0.0	0.0	0.1	0.1	0.1	
2.80	-1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.5	0.1	0.0	0.0	0.1	0.1	0.1	GRAVEL
2	-1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.1	0.8	0.4	0.1	0.4	0.3	0.5	0.2	
1.4	-0.5	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.7	1.4	1.8	0.9	0.4	0.9	0.8	0.7	0.5	
1	0	0.1	0.1	0.1	0.0	0.1	0.4	0.2	1.0	1.6	2.1	1.3	0.4	1.2	0.8	0.7	0.7	
0.71	0.5	0.1	0.5	0.0	0.0	0.1	0.6	1.4	2.0	2.5	4.0	2.0	0.7	2.6	0.8	0.7	1.2	
0.5	1	0.1	1.2	0.1	0.2	0.1	1.1	1.8	3.7	3.7	6.7	3.3	1.1	4.9	1.3	0.7	2.0	
0.36	1.5	0.5	3.5	2.6	4.2	1.1	7.0	9.3	15.0	7.4	18.7	8.4	3.4	9.5	2.3	1.7	6.3	
0.25	2	19.3	24.1	45.0	37.1	22.3	38.4	27.8	36.4	15.1	30.8	25.5	22.2	19.2	22.1	5.2	26.0	
0.21	2.25	28.1	28.7	23.9	25.9	32.3	27.1	20.8	18.2	15.6	16.2	23.0	27.8	28.7	23.4	20.1	24.0	SAND
0.18	2.5	31.4	32.4	15.8	22.0	30.9	17.0	27.3	12.2	33.0	9.8	27.2	18.4	19.8	23.7	44.0	24.3	
0.15	2.75	14.9	6.5	8.5	7.2	9.3	6.6	9.0	7.6	13.6	5.7	6.5	15.6	8.6	14.1	17.0	10.0	
0.13	3	3.3	1.4	1.8	1.5	1.9	1.1	1.7	1.7	2.8	1.3	1.0	5.4	2.3	4.8	3.3	2.3	
0.09	3.5	2.2	1.4	1.9	1.7	1.8	0.4	0.5	0.7	1.2	0.5	0.2	3.9	1.6	4.2	3.6	1.7	
0.08	3.75	0.1	0.1	0.1	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.3	0.5	0.1	
0.06	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.0	
Pan		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	SILT
	Totals	99.9	99.8	99.8	99.9	99.8	99.8	99.9	99.8	99.8	100.0	99.9	99.6	99.6	99.5	99.4	99.8	
	$CaCO_3$%	1.9	4.2	5.7	6.1	3.9	4.1	5.4	6.8	9.1	7.9	6.2	3.4	9.3	5.9	5.6	5.7	

TB-42 GRAIN SIZE ANALYSIS (INCREMENTAL RETAINED %)																		
Millimeters	PHI Size	Dune Crest	Dune Toe	Mid Berm	MHW	Foreshore	Mid Tide	0' NAVD	MLW	Trough	Bar Crest	-6' NAVD	-8' NAVD	-12' NAVD	16' NAVD	-20' NAVD	Average	
>75.00	-6.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	COBBLES
19.05	-4.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	PEBBLES
9.53	-3.25	0.0	0.0	0.0	0.0	0.0	0.0	1.1	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
4.75	-2.25	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	
4.00	-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	GRAVEL
2.80	-1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.1	
2	-1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.7	0.2	0.1	0.1	0.0	0.5	0.1	0.1	0.1	
1.4	-0.5	0.0	0.0	0.1	0.0	0.0	0.1	0.2	1.1	0.3	0.4	0.3	0.2	1.0	0.2	0.1	0.3	SAND
1	0	0.1	0.0	0.1	0.0	0.0	0.2	0.2	1.6	0.6	0.7	0.6	0.5	1.6	0.3	0.1	0.4	
0.71	0.5	0.1	0.1	0.1	0.0	0.0	0.3	0.4	3.7	1.1	1.7	1.1	0.9	3.7	0.7	0.2	0.9	
0.5	1	0.1	0.3	0.6	0.0	0.0	0.3	0.7	8.2	2.8	3.6	2.5	2.2	4.6	2.1	0.3	1.9	
0.36	1.5	0.3	1.9	4.5	1.3	0.6	1.5	4.1	22.4	7.9	12.6	7.6	3.6	8.9	3.3	1.2	5.4	
0.25	2	14.1	19.3	32.9	21.6	16.2	13.3	20.4	26.0	17.0	27.1	20.3	6.8	17.8	8.5	4.1	17.7	
0.21	2.25	37.7	29.0	28.3	28.5	23.7	22.0	19.6	13.0	16.5	19.1	19.3	8.3	18.5	17.1	8.4	20.6	
0.18	2.5	26.2	35.1	19.0	32.7	34.2	41.6	23.1	11.0	34.7	17.5	32.9	23.8	22.1	32.3	26.2	27.5	
0.15	2.75	14.8	9.7	10.6	9.6	19.1	17.0	21.4	6.9	14.0	12.8	11.3	33.8	14.9	25.7	32.8	17.0	
0.13	3	3.4	2.0	1.9	2.3	4.2	2.7	5.2	1.7	3.2	2.9	2.4	11.0	3.9	6.3	11.4	4.3	
0.09	3.5	3.3	2.3	1.9	3.6	2.0	0.8	3.0	0.9	1.5	1.2	1.4	7.9	2.1	3.0	12.7	3.2	
0.08	3.75	0.2	0.2	0.1	0.4	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.8	0.1	0.3	1.1	0.2	
0.06	4	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.2	0.0	0.1	0.7	0.1	
Pan		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.0	SILT
	Totals	100.0	99.8	100.0	99.9	99.9	99.8	99.8	99.8	99.8	99.7	99.9	100.0	100.0	100.0	99.8	99.9	
	$CaCO_3$%	1.5	2.2	3.1	2.0	1.6	3.1	3.4	14.1	5.6	8.1	5.0	4.9	12.3	5.8	4.7	5.2	

TB-47 GRAIN SIZE ANALYSIS (INCREMENTAL RETAINED %)																		
Millimeters	PHI Size	Dune Crest	Dune Toe	Mid Berm	MHW	Foreshore	Mid Tide	0' NAVD	MLW	Trough	Bar Crest	-6' NAVD	-8' NAVD	-12' NAVD	16' NAVD	-20' NAVD	Average	
>75.00	-6.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	COBBLES
19.05	-4.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	PEBBLES
9.53	-3.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.7	0.0	0.0	0.0	0.0	0.0	0.2	
4.75	-2.25	0.1	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.4	0.5	0.0	0.0	0.1	0.5	0.0	0.1	
4.00	-2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.1	0.1	0.0	0.1	GRAVEL
2.80	-1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.8	0.1	0.0	0.0	0.3	0.3	0.2	0.1	
2	-1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.8	1.4	0.3	0.2	0.2	0.9	0.4	0.5	0.3	
1.4	-0.5	0.1	0.0	0.0	0.0	0.0	0.2	0.6	1.9	2.5	0.8	0.4	0.3	1.9	0.7	0.6	0.7	SAND
1	0	0.0	0.0	0.0	0.0	0.1	0.7	1.0	3.3	4.2	1.2	0.7	0.6	3.0	0.6	0.4	1.0	
0.71	0.5	0.0	0.0	0.0	0.0	0.2	3.5	1.6	8.3	6.8	2.6	0.9	1.4	5.5	0.9	0.5	2.1	
0.5	1	0.0	0.2	0.1	0.3	0.7	8.4	3.2	15.3	9.4	3.4	1.3	1.6	8.3	1.0	0.6	3.6	
0.36	1.5	0.1	4.1	2.6	4.0	5.5	17.3	8.3	20.6	12.0	9.5	1.8	3.7	10.1	2.5	1.0	6.9	
0.25	2	3.1	35.2	29.3	23.5	28.4	24.6	30.3	28.4	29.5	57.0	11.6	10.5	10.5	7.9	3.1	22.2	
0.21	2.25	20.3	31.4	30.2	25.5	25.1	13.1	32.1	15.5	25.3	15.9	32.2	15.7	9.4	12.5	6.5	20.7	
0.18	2.5	54.3	18.3	19.7	32.3	23.7	18.9	18.6	4.0	6.4	4.2	31.4	28.1	17.2	26.9	20.3	21.6	
0.15	2.75	15.8	8.4	9.2	8.4	10.6	10.1	3.2	0.6	0.3	2.2	14.6	24.4	20.9	28.0	37.1	12.9	
0.13	3	3.3	1.4	3.2	2.1	2.4	2.0	0.0	0.1	0.0	0.6	3.6	7.8	6.8	9.1	15.2	3.8	
0.09	3.5	2.5	0.9	5.2	3.4	3.1	0.9	0.0	0.1	0.0	0.1	1.4	5.2	4.2	7.2	11.3	3.0	
0.08	3.75	0.2	0.0	0.4	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.6	1.4	0.2	
0.06	4	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.4	0.6	0.1	
Pan		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.0	SILT
	Totals	99.8	99.8	99.7	99.7	99.7	99.5	99.2	99.6	100.0	99.6	99.8	99.8	99.6	99.6	99.7	99.7	
	$CaCO_3$%	1.0	2.7	3.1	3.1	3.2	12.0	5.1	16.4	15.7	20.8	4.5	4.4	15.1	8.2	4.8	8.0	

TB-52 GRAIN SIZE ANALYSIS																		
Millimeters	PHI Size	Dune Crest	Dune Toe	Mid Berm	MHW	Foreshore	Mid Tide	0' NAVD	MLW	Trough	Bar Crest	-6' NAVD	-8' NAVD	-12' NAVD	16' NAVD	-20' NAVD	Average	
>75.00	-6.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	COBBLES
19.05	-4.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	PEBBLES
9.53	-3.25	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.3	4.4	0.0	0.0	1.0	0.0	0.0	0.0	0.4	
4.75	-2.25	0.0	0.2	0.0	0.0	0.0	0.0	1.0	0.4	0.1	0.1	0.0	0.3	0.3	0.4	0.0	0.2	
4.00	-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	GRAVEL
2.80	-1.5	0.0	0.1	0.0	0.0	0.0	0.0	0.5	0.8	0.1	0.2	0.1	0.4	0.3	0.4	0.3	0.2	
2	-1	0.0	0.1	0.0	0.0	0.0	0.0	0.4	1.2	0.1	0.4	0.2	1.0	1.2	0.5	0.7	0.4	
1.4	-0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.6	2.2	0.4	0.7	0.4	1.8	2.7	0.7	1.2	0.7	SAND
1	0	0.0	0.1	0.1	0.1	0.0	0.0	0.9	3.0	0.7	1.6	0.5	2.1	3.2	0.5	0.7	0.9	
0.71	0.5	0.1	0.3	0.5	0.1	0.0	0.2	1.9	6.0	1.9	4.7	0.6	4.5	4.8	0.6	0.7	1.8	
0.5	1	0.1	1.7	4.6	0.4	0.3	0.8	4.3	15.6	4.0	15.3	0.9	6.8	6.8	0.9	0.6	4.2	
0.36	1.5	0.2	8.7	18.4	8.6	3.3	6.3	9.3	25.0	11.1	26.1	2.6	11.4	8.6	1.9	1.4	9.5	
0.25	2	6.2	29.5	34.4	41.8	19.8	26.7	14.6	21.6	23.3	32.0	39.5	14.4	11.1	5.0	4.7	21.6	
0.21	2.25	16.6	26.4	18.1	24.5	24.1	25.3	19.5	9.0	22.0	15.5	34.6	12.9	11.5	9.1	7.7	18.4	
0.18	2.5	34.2	22.5	16.0	16.0	31.3	25.1	32.3	10.0	18.6	3.0	14.4	17.5	20.4	28.3	22.5	20.8	
0.15	2.75	27.2	7.1	6.8	6.9	16.7	12.7	11.8	4.0	9.9	0.0	4.9	16.6	18.9	35.3	30.4	13.9	
0.13	3	8.7	1.2	0.8	0.9	2.7	1.8	1.8	0.6	2.2	0.0	0.9	5.1	6.1	9.8	12.5	3.7	
0.09	3.5	6.3	0.8	0.4	0.7	1.6	0.9	0.8	0.0	1.0	0.0	0.3	3.7	3.5	5.5	14.0	2.6	
0.08	3.75	0.4	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.4	0.6	1.5	0.2	
0.06	4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.3	0.7	0.1	
Pan		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.0	SILT
	Totals	99.8	99.6	99.9	99.8	99.7	99.8	99.8	99.7	99.8	99.7	99.7	99.8	99.8	100.0	100.0	99.8	
	$CaCO_3$%	1.7	4.0	6.0	1.7	3.2	3.7	6.3	18.7	8.1	14.6	4.2	13.1	16.8	4.6	4.4	7.4	

TB-57 GRAIN SIZE ANALYSIS (INCREMENTAL RETAINED %)																		
Millimeters	PHI Size	Dune Crest	Dune Toe	Mid Berm	MHW	Foreshore	Mid Tide	0' NAVD	MLW	Trough	Bar Crest	-6' NAVD	-8' NAVD	-12' NAVD	16' NAVD	-20' NAVD	Average	
>75.00	-6.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	COBBLES
19.05	-4.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	PEBBLES
9.53	-3.25	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	1.4	0.0	1.9	0.0	0.0	0.0	0.2	
4.75	-2.25	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.2	0.5	0.1	0.0	0.7	0.0	0.5	0.2	0.2	
4.00	-2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.6	0.3	0.0	0.4	0.0	0.1	0.3	0.1	GRAVEL
2.80	-1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.7	0.2	0.2	0.8	0.2	0.3	0.5	0.2	
2	-1	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.1	1.7	0.5	0.4	2.0	0.6	0.7	0.4	0.5	
1.4	-0.5	0.0	0.0	0.0	0.0	0.0	0.1	0.7	0.3	2.8	1.3	1.2	2.9	0.9	1.1	0.6	0.8	SAND
1	0	0.0	0.0	0.1	0.0	0.0	0.2	1.3	0.3	5.3	2.7	1.1	4.0	1.0	1.0	0.4	1.1	
0.71	0.5	0.0	0.1	0.1	0.2	0.0	0.4	3.0	1.3	10.8	6.8	3.4	6.9	1.3	1.3	0.4	2.4	
0.5	1	0.2	2.4	1.0	1.5	0.1	0.9	6.4	3.7	17.1	13.0	5.0	10.4	1.6	1.9	0.4	4.4	
0.36	1.5	0.3	15.8	9.4	12.9	2.4	4.5	13.0	17.5	17.8	15.2	10.6	12.1	3.5	2.9	0.9	9.3	
0.25	2	2.6	44.0	34.0	33.7	24.0	27.5	18.0	39.1	15.8	17.4	23.6	12.2	10.4	5.8	2.4	20.7	
0.21	2.25	12.0	19.0	24.2	22.1	30.6	32.0	27.8	26.0	10.0	11.8	18.4	10.0	15.8	11.9	4.6	18.4	
0.18	2.5	60.1	12.5	22.0	18.1	33.4	21.6	23.4	8.0	11.5	15.0	19.9	16.2	27.0	29.6	12.6	22.1	
0.15	2.75	17.7	4.7	7.7	9.1	8.0	9.8	3.9	2.5	4.3	10.2	13.2	14.1	22.8	27.2	29.6	12.3	
0.13	3	4.0	0.7	0.9	1.6	1.0	2.1	0.4	0.4	0.7	2.4	1.9	3.7	8.0	8.6	14.5	3.4	
0.09	3.5	2.6	0.4	0.6	0.6	0.5	0.8	0.0	0.2	0.2	1.3	0.8	1.6	6.3	5.7	24.7	3.1	
0.08	3.75	0.2	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.8	3.5	0.3	
0.06	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	2.0	0.2	
Pan		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.2	1.4	0.1	SILT
	Totals	99.8	99.8	99.9	99.8	99.9	99.8	99.8	99.7	99.6	99.7	99.6	99.8	100.0	99.9	99.3	99.8	
	$CaCO_3$%	1.7	4.5	5.1	4.9	2.3	4.2	11.8	8.0	25.0	16.1	7.1	25.0	3.9	7.4	6.8	8.9	

SURF CITY GRAIN SIZE ANALYSIS (INCREMENTAL RETAINED %)										
Millimeters	PHI Size	TB-27	TB-32	TB-37	TB-42	TB-47	TB-52	TB-57	Average	
>75.00	-6.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	COBBLES
19.05	-4.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	PEBBLES
9.53	-3.25	0.2	0.0	0.1	0.2	0.2	0.4	0.2	0.2	
4.75	-2.25	0.1	0.1	0.1	0.0	0.1	0.2	0.2	0.1	
4.00	-2	0.1	0.1	0.1	0.0	0.1	0.0	0.1	0.1	GRAVEL
2.80	-1.5	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	
2	-1	0.2	0.3	0.2	0.1	0.3	0.4	0.5	0.3	
1.4	-0.5	0.5	0.6	0.5	0.3	0.7	0.7	0.8	0.6	SAND
1	0	0.8	0.8	0.7	0.4	1.0	0.9	1.1	0.8	
0.71	0.5	1.5	1.5	1.2	0.9	2.1	1.8	2.4	1.6	
0.5	1	2.7	2.8	2.0	1.9	3.6	4.2	4.4	3.1	
0.36	1.5	7.4	8.2	6.3	5.4	6.9	9.5	9.3	7.6	
0.25	2	23.6	26.7	26.0	17.7	22.2	21.6	20.7	22.6	
0.21	2.25	19.0	23.8	24.0	20.6	20.7	18.4	18.4	20.7	
0.18	2.5	22.3	20.7	24.3	27.5	21.6	20.8	22.1	22.8	
0.15	2.75	15.3	10.3	10.0	17.0	12.9	13.9	12.3	13.1	
0.13	3	3.7	2.4	2.3	4.3	3.8	3.7	3.4	3.4	
0.09	3.5	2.1	1.4	1.7	3.2	3.0	2.6	3.1	2.5	
0.08	3.75	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.2	
0.06	4	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.1	
Pan		0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	SILT
	Totals	100.0	99.9	99.8	99.9	99.7	99.8	99.8	99.8	
	$CaCO_3$%	6.9	4.4	5.7	5.2	8.0	7.4	8.9	6.6	

TI Coastal Services, Inc.
387-B N. Green Meadows Drive
Wilmington, NC 28405
910.821.1358

Vertical Datum Conversion

MHW
1.20'
NAVD88
2.54'
MLW

Surf City Nourishment Project

Surf City
Pender & Onslow County, North Carolina

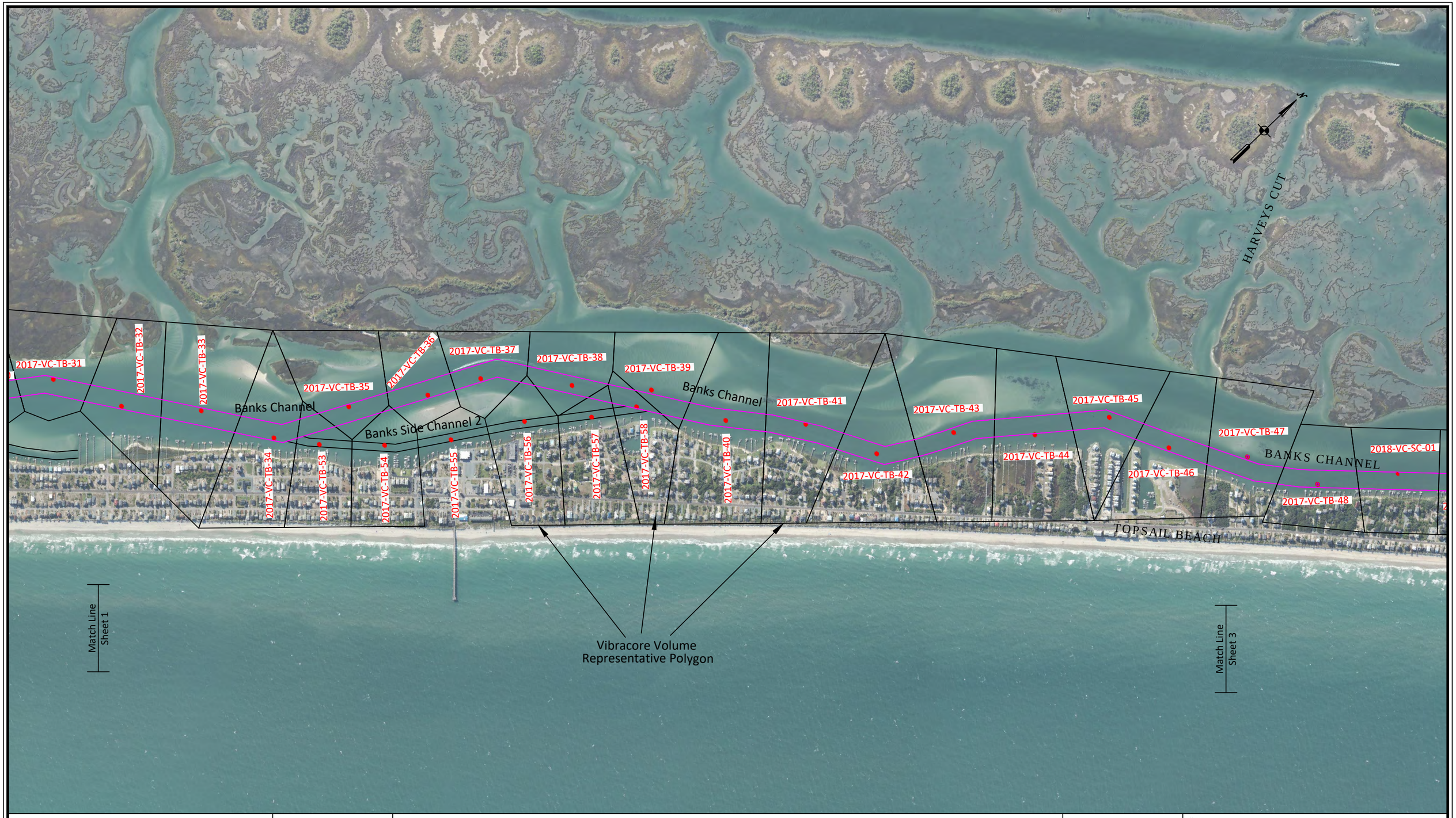
Proposed Channel Design

Vibracore Sampling Locations and Spider Map

Graphic Scale
0' 250' 500' 1,000'
Scale: 1" = 1,000'

Notes:
1. Horizontal Datum: NC State Plane - Zone 3200, NAD83, Feet
2. Vertical Datum: NAVD88
3. Channel layout is preliminary, pending approval by State and Federal Permitting Agencies.
4. Vibracores collected by Athena Technologies between June 5 and June 14, 2017 (Topsail) and on March 29, 2018 and July 11-12, 2019 (Surf City).
5. Positions provided by Athena Technologies and determined by DGPS, tide corrections provided by TI Coastal Services via RTK GPS.
6. Aerial photography performed by TerraLina Mapping Consultants, Inc. on June 17, 2019 and represent conditions at that time.

DWG NAME: Surf City Vibracore Spider Map.dwg
DWG DATE: August 29, 2019 | SURVEY DATE: 6/2017, 3/2018 & 7/2019
SCALE: 1" = 1,000' | SHEET: 1 OF 3



TI Coastal Services, Inc.
387-B N. Green Meadows Drive
Wilmington, NC 28405
910.821.1358

Vertical Datum Conversion

MHW
1.20'
NAVD88
2.54'
MLW

Surf City Nourishment Project

Surf City
Pender & Onslow County, North Carolina

Proposed Channel Design

Vibracore Sampling Locations and Spider Map

Graphic Scale
0' 250' 500' 1,000'
Scale: 1" = 1,000'

Notes:
1. Horizontal Datum: NC State Plane - Zone 3200, NAD83, Feet
2. Vertical Datum: NAVD88
3. Channel layout is preliminary, pending approval by State and Federal Permitting Agencies.
4. Vibracores collected by Athena Technologies between June 5 and June 14, 2017 (Topsail) and on March 29, 2018 and July 11-12, 2019 (Surf City).
5. Positions provided by Athena Technologies and determined by DGPS, tide corrections provided by TI Coastal Services via RTK GPS.
6. Aerial photography performed by TerraLina Mapping Consultants, Inc. on June 17, 2019 and represent conditions at that time.

DWG NAME: Surf City Vibracore Spider Map.dwg
DWG DATE: August 29, 2019 | SURVEY DATE: 6/2017, 3/2018 & 7/2019
SCALE: 1" = 1,000' | SHEET: 2 OF 3

TI Coastal Services, Inc.
387-B N. Green Meadows Drive
Wilmington, NC 28405
910.821.1358

Vertical Datum Conversion

MHW
1.20'
NAVD88
2.54'
MLW

Surf City Nourishment Project

Surf City
Pender & Onslow County, North Carolina

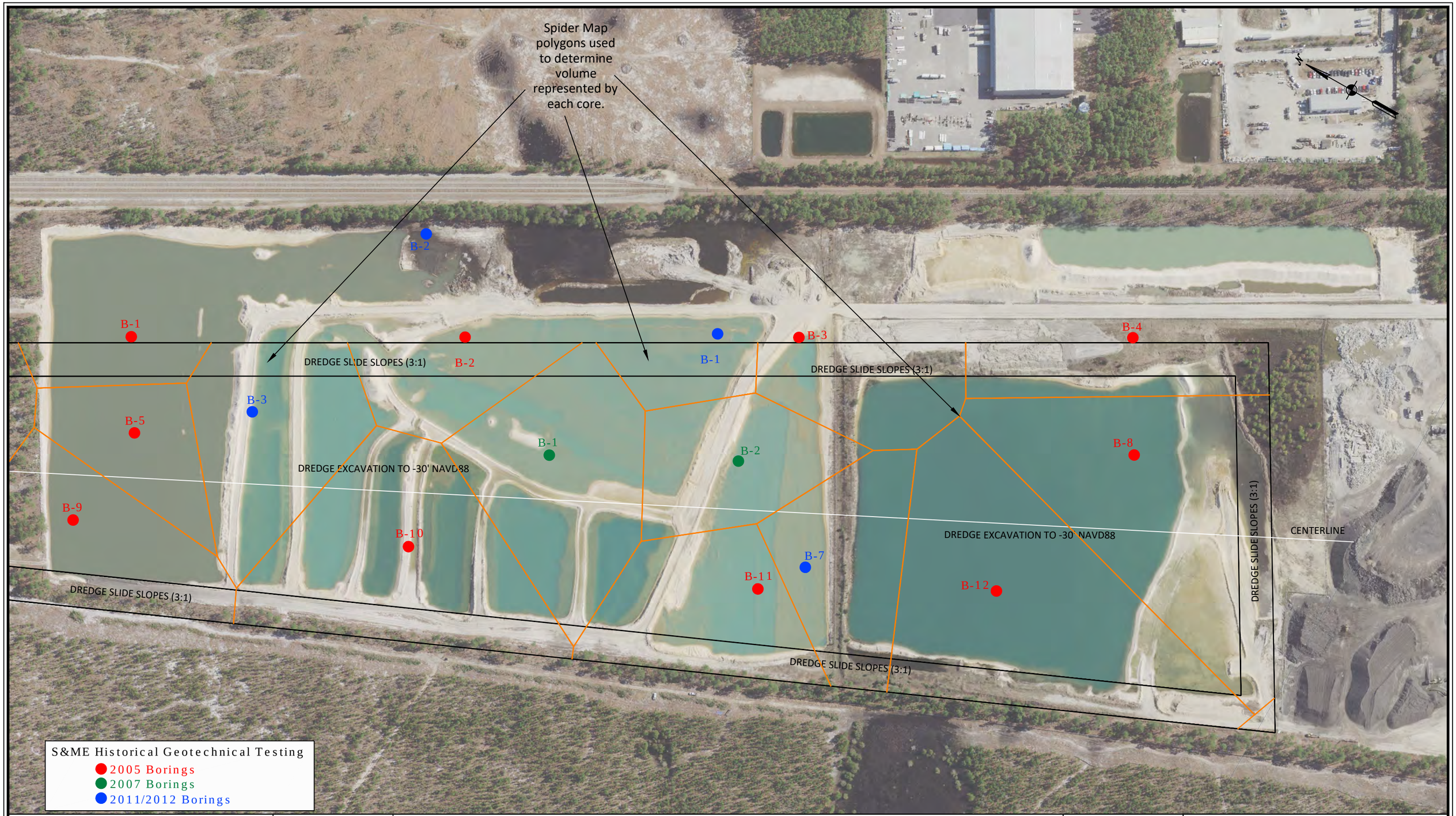
Proposed Channel Design

Vibracore Sampling Locations and Spider Map

Graphic Scale
0' 250' 500' 1,000'
Scale: 1" = 1,000'

Notes:
1. Horizontal Datum: NC State Plane - Zone 3200, NAD83, Feet
2. Vertical Datum: NAVD88
3. Channel layout is preliminary, pending approval by State and Federal Permitting Agencies.
4. Vibracores collected by Athena Technologies between June 5 and June 14, 2017 (Topsail) and on March 29, 2018 and July 11-12, 2019 (Surf City).
5. Positions provided by Athena Technologies and determined by DGPS, tide corrections provided by TI Coastal Services via RTK GPS.
6. Aerial photography performed by TerraLina Mapping Consultants, Inc. on June 17, 2019 and represent conditions at that time.

DWG NAME: Surf City Vibracore Spider Map.dwg
DWG DATE: August 29, 2019 | SURVEY DATE: 6/2017, 3/2018 & 7/2019
SCALE: 1" = 1,000' | SHEET: 3 OF 3



TI Coastal Services, Inc.
387-B N. Green Meadows Drive
Wilmington, NC 28405
910.821.1358

Vertical Datum Conversion
NAVD88
1.00'
NGVD29

Surf City Hurricane Florence Dune Restoration - Phase 2

Town of Surf City
Pender and Onslow County, North Carolina

ST Wooten Geotechnical Survey

Historic Core Locations and Spider Map Layout

Graphic Scale
0' 75' 150' 300'
Scale: 1" = 300'

Notes:
1. Horizontal Datum: NC State Plane - Zone 3200, NAD83, Survey Feet.
2. Vertical Datum: NAVD88
3. Layout designed by TI Coastal on September 27th, 2017.
4. Cores collected in 2005, 2007, and 2011/2012 and represent conditions at that time
5. 2016 Aerial downloaded from NC OneMap GeoSpatial Portal.
6. Core locations and Top of Hole elevations are approximate and scaled off of location maps provided by S&ME.

DWG NAME: ST Wooten Excavation Layout.dwg	
DWG DATE: August 6, 2019	SURVEY DATE: Spring 2017 & 2019
SCALE: 1" = 300'	SHEET: 1 OF 1

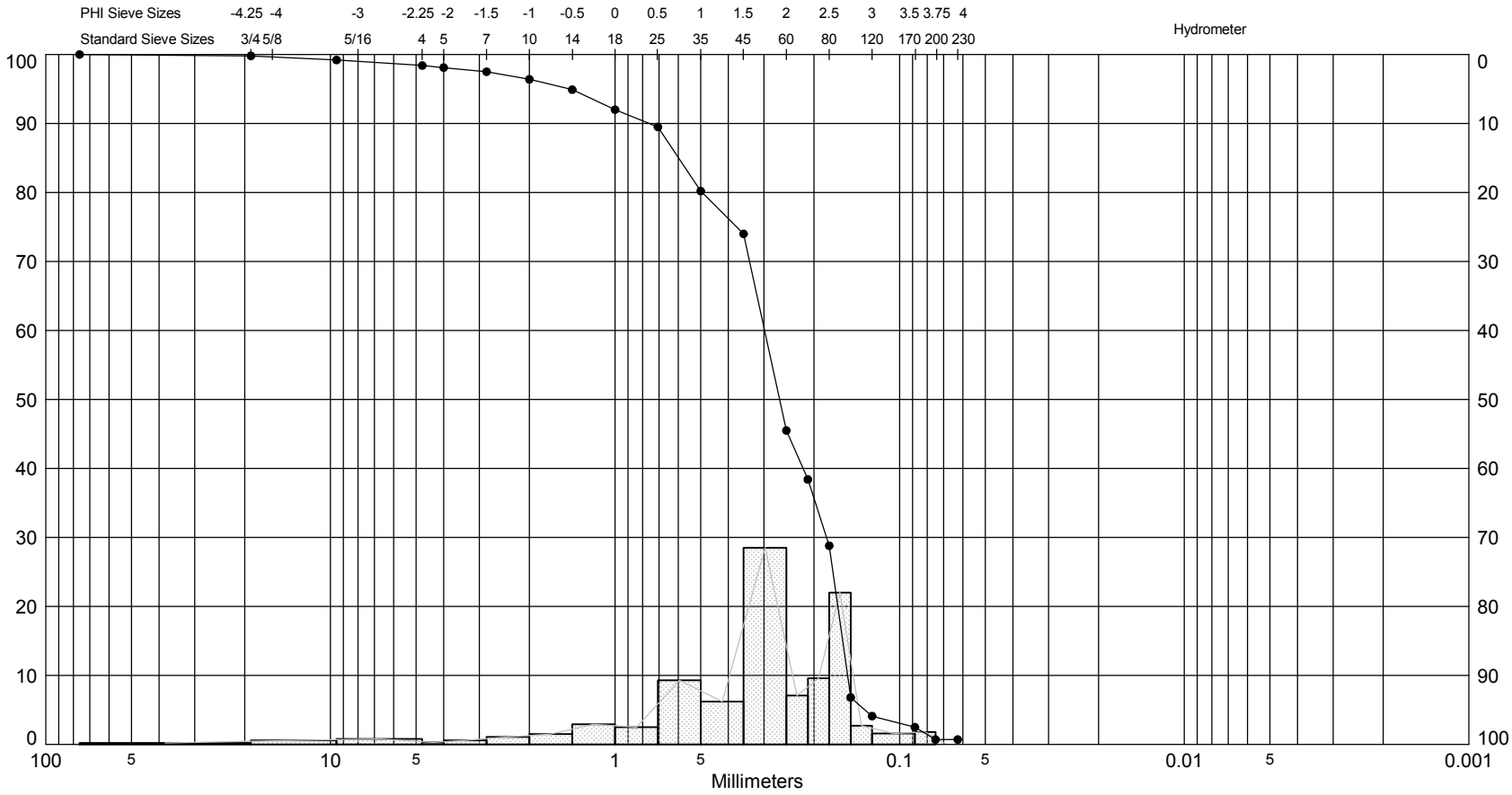
ALL BANKS CHANNEL GRAIN SIZE ANALYSIS (Station 35+00 to 245+00)

Millimeters	PHI Size	2017-VC-TB-28	2017-VC-TB-29	2017-VC-TB-30	2017-VC-TB-31	2017-VC-TB-32	2017-VC-TB-33	2017-VC-TB-34	2017-VC-TB-35	2017-VC-TB-36	2017-VC-TB-37	2017-VC-TB-38	2017-VC-TB-39	2017-VC-TB-40	2017-VC-TB-41	2017-VC-TB-42	2017-VC-TB-43	2017-VC-TB-44	
>75.00	-6.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	COBBLES
19.05	-4.25	0.0	0.0	0.0	1.0	0.0	0.0	7.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	PEBBLES
9.53	-3.25	0.8	0.0	0.0	1.9	0.0	3.1	8.1	0.6	2.5	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.2	
4.75	-2.25	2.5	0.2	0.3	1.5	0.3	1.5	5.1	0.9	3.0	0.7	0.0	1.0	3.3	0.0	0.2	0.0	0.3	
4.00	-2	1.0	0.1	0.1	0.7	0.0	0.6	1.5	0.4	1.1	0.2	0.0	0.2	1.2	0.1	0.2	0.0	0.0	GRAVEL
2.80	-1.5	2.9	0.4	0.6	1.4	0.6	1.3	2.8	1.3	2.3	0.5	0.1	0.9	2.8	0.2	0.1	0.2	0.2	
2.00	-1	4.9	0.5	0.9	2.7	1.0	2.2	6.4	2.6	3.7	0.8	0.6	2.3	3.4	0.7	0.2	0.2	0.7	
1.40	-0.5	7.7	0.8	1.7	4.4	1.8	3.8	11.3	4.8	4.8	1.0	1.0	5.9	3.7	1.5	0.5	0.5	1.5	SAND
1.00	0	9.8	1.0	2.3	5.1	2.2	4.9	6.0	5.1	4.9	0.8	1.3	7.3	3.5	2.5	0.7	0.7	2.0	
0.71	0.5	11.8	1.6	5.2	7.8	3.4	7.2	9.2	7.0	6.1	1.7	2.1	9.6	4.9	4.0	1.8	1.2	3.7	
0.50	1	12.0	3.6	9.5	9.3	5.0	10.0	13.2	7.8	8.2	3.1	3.0	6.1	7.9	7.6	3.1	2.0	5.2	
0.36	1.5	9.7	6.9	23.6	15.0	10.6	16.4	12.5	12.1	16.9	11.1	4.8	3.9	14.4	18.7	7.6	5.7	10.5	
0.25	2	8.5	11.7	29.3	11.2	24.2	19.0	5.1	16.3	18.1	37.3	8.7	3.8	19.2	19.1	16.2	23.4	16.3	
0.21	2.25	5.4	10.2	13.0	2.6	13.7	7.8	4.3	11.7	9.4	21.1	9.4	7.6	9.1	8.6	14.2	34.6	12.4	
0.18	2.5	10.1	25.6	7.5	2.8	15.5	12.1	2.4	13.2	10.3	12.7	31.0	27.0	11.6	15.2	27.0	21.8	19.2	
0.15	2.75	9.5	25.3	4.7	12.9	14.7	8.2	3.0	12.2	6.6	7.4	29.6	18.9	8.5	15.9	22.2	8.3	20.3	
0.13	3	2.3	7.1	0.7	8.8	4.5	1.4	1.0	2.4	1.3	1.1	5.9	4.0	1.6	3.9	4.2	1.1	4.3	
0.09	3.5	0.9	4.6	0.3	9.3	2.3	0.5	0.5	1.2	0.6	0.5	2.3	1.4	0.7	1.8	1.4	0.2	2.7	
0.08	3.75	0.0	0.1	0.0	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.1	
0.06	4	0.0	0.1	0.0	0.3	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Pan		0.1	0.2	0.0	0.7	0.1	0.1	0.1	0.2	0.1	0.0	0.0	0.0	0.2	0.1	0.1	0.0	0.3	SILT
	Totals	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
	$CaCO_3$	33.7	9.4	24.3	20.8	16.0	24.4	35.6	25.1	25.2	9.7	10.7	20.8	26.0	12.5	8.0	6.7	10.5	
	Volume	23,766	73,081	22,817	34,911	44,547	33,909	15,539	33,149	36,961	32,498	66,710	40,963	40,882	32,080	44,156	42,990	41,234	

ALL BANKS CHANNEL GRAIN SIZE ANALYSIS (Station 35+00 to 245+00)

Millimeters	Phi Size	2017-VC-TB-45	2017-VC-TB-46	2017-VC-TB-47	2017-VC-TB-48	2017-VC-TB-49	2017-VC-TB-50	2017-VC-TB-53	2017-VC-TB-54	2017-VC-TB-57	2017-VC-TB-58	2018-VC-SC-01	2018-VC-SC-02	2018-VC-SC-03	2018-VC-SC-04	2019-VC-SC-01	ST Wooten	Totals	
>75.00	-6.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	**0.0**	COBBLES
19.05	-4.25	4.2	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.3	0.0	1.1	0	**0.2**	PEBBLES
9.53	-3.25	2.6	0.0	0.6	0.2	0.0	0.0	5.0	0.0	0.2	0.7	1.0	1.5	1.9	0.4	0.3	0.1	**0.6**	
4.75	-2.25	3.6	0.1	0.7	0.7	0.5	0.3	6.2	0.1	2.0	1.5	1.6	2.1	2.2	0.6	0.8	0	**0.7**	
4.00	-2	1.1	0.0	0.1	0.5	0.2	0.0	2.4	0.0	0.6	0.9	0.4	0.9	0.8	0.4	0.3	0	**0.3**	GRAVEL
2.80	-1.5	3.0	0.1	0.2	0.8	0.8	0.1	4.2	0.3	1.5	2.3	0.6	1.6	1.4	0.6	0.5	0.3	**0.7**	
2.00	-1	3.7	0.1	0.4	1.2	1.6	0.3	4.7	0.6	2.1	3.3	0.8	2.3	1.8	0.8	1.1	0	**1.0**	
1.40	-0.5	4.6	0.4	0.6	1.9	2.9	0.5	4.5	1.5	3.4	4.8	1.1	3.3	2.5	0.9	1.8	3	**2.7**	SAND
1.00	0	4.8	0.5	0.9	2.2	3.8	1.0	3.7	2.6	3.9	4.1	1.3	3.8	2.8	0.8	2.4	0	**1.7**	
0.71	0.5	5.3	0.8	1.6	3.5	5.1	2.0	5.4	4.5	6.5	4.7	2.5	5.7	4.3	1.4	3.9	14.3	**8.3**	
0.50	1	5.3	1.0	2.2	6.2	6.6	3.7	9.2	6.8	8.9	6.6	4.0	8.4	7.4	2.4	6.3	0	**3.4**	
0.36	1.5	6.8	2.5	5.8	17.0	11.6	5.9	17.8	11.3	16.7	6.9	11.3	17.4	14.1	5.9	10.4	44.8	**24.7**	
0.25	2	9.7	13.0	12.5	33.5	27.1	16.4	19.0	22.1	23.2	13.5	25.9	24.9	17.8	13.3	17.8	0	**10.1**	
0.21	2.25	4.4	26.7	5.2	16.2	17.3	23.9	6.9	22.7	12.9	19.7	17.7	10.0	10.3	13.1	12.6	0	**7.1**	
0.18	2.5	5.5	31.3	5.1	11.5	12.1	24.2	5.8	17.8	8.0	21.7	17.5	9.4	10.7	27.6	17.0	31.6	**22.6**	
0.15	2.75	14.9	18.6	32.1	7.6	7.7	15.9	3.4	7.3	7.3	7.2	11.4	6.7	12.4	23.4	15.3	0	**9.0**	
0.13	3	9.7	3.3	18.9	1.4	1.7	4.1	0.7	1.5	1.9	1.6	2.1	1.3	5.6	5.3	5.8	0	**2.7**	
0.09	3.5	9.8	1.3	11.6	0.5	1.0	1.4	0.4	0.7	0.9	0.5	0.8	0.6	3.4	2.8	2.1	4.1	**3.3**	
0.08	3.75	0.6	0.0	0.9	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0	**0.1**	
0.06	4	0.3	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.8	**0.8**	
Pan		0.1	0.0	0.3	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.3	0.1	0.2	0	**0.1**	SILT
	Totals	100.0	100.0	100.0	104.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	**100.0**	
	$CaCO_3$	27.8	5.4	11.9	18.4	7.5	9.7	34.5	18.8	23.0	16.0	15.3	26.0	20.7	10.3	14.8	N/A	**10.1**	
	Volume	48,305	34,948	50,113	7,359	15,420	422	12,783	1,032	3,017	17,072	54,367	61,805	57,465	30,446	27,851	758,671	**1,841,270**	

All numbers represent percent of total core incrementally retained on the sieve. Calcium carbonate is a percentage. Volume is cubic yardage each core represents.



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Banks & ST Wooten #COMPOSITE			SW	#230 - 0.70		10.10	1.92	1.71	-1.99	9	1.18

Sample Information	
Project Name:	Surf City Nourishment 2018-2019
Analysis Date:	10-09-19
Analyzed By:	JCP
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	NAD 1983
Vertical System:	MLW

Comments:

Depths and elevations based on measured values

TI Coastal SERVICES, INC.

TI Coastal Services, Inc.
387-B N. Green Meadows Dr.
Wilmington, NC 28405
ph 910.821.1358
fax 910.821.1359

SIEVE ANALYSIS BANKS CHANNEL CORES.GPJ FL DEP ROSS.GDT 10/9/19

Granularmetric Report

Depths and elevations based on measured values

Project Name: Surf City Nourishment 2018-2019

Sample Name: Banks & ST Wooten #COMPOSITE

Analysis Date: 10-09-19

Analyzed By: JCP

TI Coastal Services, Inc.
387-B N. Green Meadows Dr.
Wilmington, NC 28405
ph 910.821.1358
fax 910.821.1359

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		North Carolina State Plane	

USCS:	Munsell:	Comments:
SW		

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shells (%):
100.00	100.00	0.80	-0.10	#230 - 0.70		10.10	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3"	-6.25	76.11	0.00	0.00	0.00	0.00
0.75"	-4.25	19.03	0.20	0.20	0.20	0.20
0.375"	-3.25	9.51	0.60	0.60	0.80	0.80
4	-2.25	4.76	0.80	0.80	1.60	1.60
5	-2.00	4.00	0.30	0.30	1.90	1.90
7	-1.50	2.83	0.60	0.60	2.50	2.50
10	-1.00	2.00	1.10	1.10	3.60	3.60
14	-0.50	1.41	1.50	1.50	5.10	5.10
18	0.00	1.00	2.90	2.90	8.00	8.00
25	0.50	0.71	2.50	2.50	10.50	10.50
35	1.00	0.50	9.30	9.30	19.80	19.80
45	1.50	0.35	6.20	6.20	26.00	26.00
60	2.00	0.25	28.50	28.50	54.50	54.50
70	2.25	0.21	7.10	7.10	61.60	61.60
80	2.50	0.18	9.60	9.60	71.20	71.20
100	2.75	0.15	22.00	22.00	93.20	93.20
120	3.00	0.13	2.70	2.70	95.90	95.90
170	3.50	0.09	1.60	1.60	97.50	97.50
200	3.74	0.07	1.80	1.80	99.30	99.30
230	4.00	0.06	0.00	0.00	99.30	99.30

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.92	2.65	2.54	1.92	1.42	0.80	-0.53

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	1.71	0.31	1.18	-1.99	9

GRANULARMETRIC REPORT BANKS CHANNEL CORES.GPJ FL DEP ROSS.GDT 10/9/19

Surf City
Beach Nourishment Project

Prepared For:

The Town of Surf City, NC

December 13, 2019

Prepared By:

TI Coastal Services, Inc.
387-B N. Green Meadows Dr.
Wilmington, NC, 28405
910-821-1358
www.ticoastal.com

CAMA Permit Application

Agent Authorization

AGENT AUTHORIZATION FOR CAMA PERMIT APPLICATION

Name of Property Owner Requesting Permit: Town of Surf City

Mailing Address: P.O. Box 2475
Surf City, NC 28445

Phone Number: 910-328-4131

Email Address: aloftis@townofsurfcity.com

I certify that I have authorized Chris Gibson PE,
Agent / Contractor

to act on my behalf, for the purpose of applying for and obtaining all CAMA permits necessary for the following proposed development: Dredging of Banks Channel and nourishment of the Town's beaches.

at my property located at the public beaches within the Town of Surf City, in Pender / Onslow County.

I furthermore certify that I am authorized to grant, and do in fact grant permission to Division of Coastal Management staff, the Local Permit Officer and their agents to enter on the aforementioned lands in connection with evaluating information related to this permit application.

Property Owner Information:

Ashley Loftis
Signature

Ashley Loftis
Print or Type Name

Town Manager
Title

05 / 21 / 2019
Date

This certification is valid through ____/____/____

CAMA Permit Application

MP-1

DCM MP-1

APPLICATION for Major Development Permit

(last revised 12/27/06)

North Carolina DIVISION OF COASTAL MANAGEMENT

1. Primary Applicant/ Landowner Information

Business Name Town Of Surf City		Project Name (if applicable) Surf City Nourishment 2019		
Applicant 1: First Name Ashley	MI	Last Name Loftis		
Applicant 2: First Name	MI	Last Name		
If additional applicants, please attach an additional page(s) with names listed.				
Mailing Address		PO Box 2475	City Surf City	State NC
ZIP 28445	Country USA	Phone No. 910 - 328 - 4131 ext.	FAX No. 910 - 328 - 1746	
Street Address *(if different from above)*		City	State	ZIP -
Email				

2. Agent/Contractor Information

Business Name Ti Coastal Services Inc.				
Agent/ Contractor 1: First Name Jamie	MI C	Last Name Pratt		
Agent/ Contractor 2: First Name Chris	MI L	Last Name Gibson		
Mailing Address		PO Box 11056	City Wilmington	State NC
ZIP 28404		Phone No. 1 910 - 821 - 1358 ext.	Phone No. 2 910 - 508 - 2744 ext.	
FAX No. 910 821 1359		Contractor #		
Street Address *(if different from above)* 387-B N. Green Meadows Dr.		City Wilmington	State NC	ZIP 28405 -
Email jcpratt@ticoastal.com				

<Form continues on back>

3. Project Location

County (can be multiple)	Street Address		State Rd. #
Pender County Onslow County	214 N New River Dr.		
Subdivision Name	**City**	**State**	**Zip**
Town of Surf City	Surf City	NC	28445 -

Phone No.	Lot No.(s) *(if many, attach additional page with list)*
910 - 328 - 4131 ext.	, , , ,
a. In which NC river basin is the project located? Cape Fear River	b. Name of body of water nearest to proposed project: Atlantic Ocean and Atlantic Intercoastal Waterway
c. Is the water body identified in (b) above, natural or manmade? ☒Natural ☒Manmade ☐Unknown	d. Name the closest major water body to the proposed project site. Atlantic Ocean
e. Is proposed work within city limits or planning jurisdiction? ☒Yes ☐No	f. If applicable, list the planning jurisdiction or city limit the proposed work falls within. Town of Surf City, North Carolina

4. Site Description

a. Total length of shoreline on the tract (ft.)	b. Size of entire tract (sq.ft.)
32,500ft of oceanfront beach	19,040,908 sq.ft. (437 acres)
c. Size of individual lot(s) , , , *(If many lot sizes, please attach additional page with a list)*	d. Approximate elevation of tract above NHW *(normal high water)* or NWL *(normal water level)* Highest:9.3ft, Lowest: -10.7ft, Average Elevation: -7.5ft ☐NHW or ☒NWL

e. Vegetation on tract
American Beach Grass, Sea Oats

f. Man-made features and uses now on tract
Public and private dune crossovers and the Surf City Pier

g. Identify and describe the existing land uses adjacent to the proposed project site.
The lands adjacent to the proposed project site include Topsail Beach, N.C. and North Topsail Beach, N.C. North of the proposed project site is North Topsail Beach. North Topsail Beach is a residential beach on Topsail Island. Land uses include recreational boating, fishing, and swimming in the Atlantic Ocean and Intercoastal Waterway. South of the proposed project site, is Topsail Beach, N.C. Topsail Beach is a residential beach on Topsail Island. Similarly to North Topsail Beach land uses include recreational boating, fishing, and swimming in the Atlantic Ocean and Intercoastal Waterway.

h. How does local government zone the tract?	i. Is the proposed project consistent with the applicable zoning? (Attach zoning compliance certificate, if applicable)
Mixed use - residential and light commercial	☒Yes ☐No ☐NA

j. Is the proposed activity part of an urban waterfront redevelopment proposal? ☐Yes ☒No

k. Has a professional archaeological assessment been done for the tract? If yes, attach a copy. ☒Yes ☐No ☐NA

If yes, by whom? Federial FEIS

l. Is the proposed project located in a National Registered Historic District or does it involve a National Register listed or eligible property? ☐Yes ☒No ☐NA

<Form continues on next page>

m. (i) Are there wetlands on the site?	☐Yes ☒No
(ii) Are there coastal wetlands on the site?	☐Yes ☒No
(iii) If yes to either (i) or (ii) above, has a delineation been conducted? *(Attach documentation, if available)*	☐Yes ☐No

n. Describe existing wastewater treatment facilities.

Municipal water is available for all residential and commerical properities with the Town of Surf City.

o. Describe existing drinking water supply source.

Existing drinking water supply comes from town-owned groundwater wells.

p. Describe existing storm water management or treatment systems.

Typical runoff to municiple stormwater drains.

5. Activities and Impacts

a. Will the project be for commercial, public, or private use? ☐Commercial ☒Public/Government ☒Private/Community

b. Give a brief description of purpose, use, and daily operations of the project when complete.

See attached project narrative.

c. Describe the proposed construction methodology, types of construction equipment to be used during construction, the number of each type of equipment and where it is to be stored.

Hydraulic cutterhead dredge with 24-30 inch pipeline, 4-5 pushboats and 1-2 crew boats, 3-4 bulldozers, 2-3 loaders, 1-2 excavators.

d. List all development activities you propose.

Placement of approximately 1.6 million cubic yards of sand on the oceanfront shoreline of Surf City. Material will be dredged from Banks Channel from station 35+00 to 245+00 and supplemented with truck haul sand from the ST Wooten sand mine on highway 421 in Wilmington, NC.

e. Are the proposed activities maintenance of an existing project, new work, or both? New Work

f. What is the approximate total disturbed land area resulting from the proposed project? 437.1 ☐Sq.Ft or ☒Acres

g. Will the proposed project encroach on any public easement, public accessway or other area that the public has established use of? ☒Yes ☐No ☐NA

h. Describe location and type of existing and proposed discharges to waters of the state.

Surface runoff- No proposed changes to runoff

i. Will wastewater or stormwater be discharged into a wetland?	☐Yes ☒No ☐NA
If yes, will this discharged water be of the same salinity as the receiving water?	☐Yes ☐No ☐NA
j. Is there any mitigation proposed? If yes, attach a mitigation proposal.	☐Yes ☒No ☐NA

<Form continues on back>

6. Additional Information

In addition to this completed application form, (MP-1) the following items below, if applicable, must be submitted in order for the application package to be complete. Items (a) – (f) are always applicable to any major development application. Please consult the application instruction booklet on how to properly prepare the required items below.

a. A project narrative.

b. An accurate, dated work plat (including plan view and cross-sectional drawings) drawn to scale. Please give the present status of the proposed project. Is any portion already complete? If previously authorized work, clearly indicate on maps, plats, drawings to distinguish between work completed and proposed.

c. A site or location map that is sufficiently detailed to guide agency personnel unfamiliar with the area to the site.

d. A copy of the deed (with state application only) or other instrument under which the applicant claims title to the affected properties.

e. The appropriate application fee. Check or money order made payable to DENR.

f. A list of the names and complete addresses of the adjacent waterfront (riparian) landowners and signed return receipts as proof that such owners have received a copy of the application and plats by certified mail. Such landowners must be advised that they have 30 days in which to submit comments on the proposed project to the Division of Coastal Management.

Name James C. Gardner	Phone No.
Address 101 N. Anderson Blvd. Topsail Beach, NC 28445	
Name Paul S. and Anne F. Scott	Phone No.
Address 100 Scotch Bonnet Dr. North Topsail Beach, NC 28460	
Name	Phone No.
Address	

g. A list of previous state or federal permits issued for work on the project tract. Include permit numbers, permittee, and issuing dates.

CAMA #190-05, Town of Surf City, 10/28/2019	USACE Action ID No. 200600158 (Dune Scraping/Truck Haul)
CAMA GP 72219, Town of Surf City, 9/28/2019	(Post Florence Emergency Dune Truck Haul)

h. Signed consultant or agent authorization form, if applicable.

i. Wetland delineation, if necessary.

j. A signed AEC hazard notice for projects in oceanfront and inlet areas. *(Must be signed by property owner)*

k. A statement of compliance with the N.C. Environmental Policy Act (N.C.G.S. 113A 1-10), if necessary. If the project involves expenditure of public funds or use of public lands, attach a statement documenting compliance with the North Carolina Environmental Policy Act.

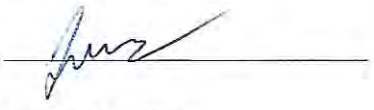
7. Certification and Permission to Enter on Land

I understand that any permit issued in response to this application will allow only the development described in the application. The project will be subject to the conditions and restrictions contained in the permit.

I certify that I am authorized to grant, and do in fact grant permission to representatives of state and federal review agencies to enter on the aforementioned lands in connection with evaluating information related to this permit application and follow-up monitoring of the project.

I further certify that the information provided in this application is truthful to the best of my knowledge.

Date 12/13/2019 Print Name Jamie Pratt

Signature 

Please indicate application attachments pertaining to your proposed project.

☒DCM MP-2 Excavation and Fill Information

☐DCM MP-3 Upland Development

☐DCM MP-4 Structures Information

☐DCM MP-5 Bridges and Culverts

CAMA Permit Application

MP-2

Form DCM MP-2

EXCAVATION and FILL

(Except for bridges and culverts)

Attach this form to Joint Application for CAMA Major Permit, Form DCM MP-1. Be sure to complete all other sections of the Joint Application that relate to this proposed project. Please include all supplemental information.

Describe below the purpose of proposed excavation and/or fill activities**. All values should be given in feet.**

	Access Channel (NLW or NWL)	Canal	Boat Basin	Boat Ramp	Rock Groin	Rock Breakwater	Other (excluding shoreline stabilization)
Length	21,000ft						
Width	200ft						
Avg. Existing Depth	6ft MLW				NA	NA	
Final Project Depth	18-14ft MLW				NA	NA	

1. EXCAVATION

☐ *This section not applicable*

a. Amount of material to be excavated from below NHW or NWL in cubic yards.

1,300,000 CY of material from Banks Channel and 450,000 CY from ST Wooten Sand Mine to be placed on the oceanfront shoreline of Surf City to restore the beach berm and slope

b. Type of material to be excavated.

Beach Quality Sand. Mean grain size: 0.31mm; 0.7% fines. 11.1% CaCO3.

c. (i) Does the area to be excavated include coastal wetlands/marsh (CW), submerged aquatic vegetation (SAV), shell bottom (SB), or other wetlands (WL)? If any boxes are checked, provide the number of square feet affected.

☐CW _____ ☐SAV _____ ☐SB _____

☐WL _____ ☒None

(ii) Describe the purpose of the excavation in these areas:

d. High-ground excavation in cubic yards.

450,000 CY from ST Wooten Sand mine on Hwy 421 in Wilmington, NC

2. DISPOSAL OF EXCAVATED MATERIAL

☐ *This section not applicable*

a. Location of disposal area.

Surf City Oceanfront Beach; Unsuitable material will be stockpiled at the Broadway Ave staging area, then placed on DA-203, outside of USACE right of way, on State owned property after completion of the project

b. Dimensions of disposal area.

Length: 32,500ft, Width: 350ft on average

c. (i) Do you claim title to disposal area?

☐Yes ☒No ☐NA

(ii) If no, attach a letter granting permission from the owner.

d. (i) Will a disposal area be available for future maintenance?

☒Yes ☐No ☐NA

(ii) If yes, where?

Surf City Oceanfront Beach

e. (i) Does the disposal area include any coastal wetlands/marsh (CW), submerged aquatic vegetation (SAV), shell bottom (SB), or other wetlands (WL)? If any boxes are checked, provide the number of square feet affected.

☐CW _____ ☐SAV _____ ☐SB _____

☐WL _____ ☒None

(ii) Describe the purpose of disposal in these areas:

f. (i) Does the disposal include any area in the water?

☒Yes ☐No ☐NA

(ii) If yes, how much water area is affected?

230 acres (10,020,425 sqft) below MLW on the beach

Replace eroded sand from Hurricane Florence and increase coastal protection for property owners in Surf City

3. SHORELINE STABILIZATION

☒ *This section not applicable*

(If development is a wood groin, use MP-4 – Structures)

a. Type of shoreline stabilization:
☐Bulkhead ☐Riprap ☐Breakwater/Sill ☐Other: _____

b. Length: _____
Width: _____

c. Average distance waterward of NHW or NWL:

d. Maximum distance waterward of NHW or NWL:

e. Type of stabilization material:

f. (i) Has there been shoreline erosion during preceding 12 months?
☐Yes ☐No ☐NA
(ii) If yes, state amount of erosion and source of erosion amount information.

g. Number of square feet of fill to be placed below water level.
Bulkhead backfill _____ Riprap _____
Breakwater/Sill _____ Other _____

h. Type of fill material.

i. Source of fill material.

4. OTHER FILL ACTIVITIES

☐ *This section not applicable*

(Excluding Shoreline Stabilization)

a. (i) Will fill material be brought to the site? ☒Yes ☐No ☐NA
If yes,
(ii) Amount of material to be placed in the water 1,127,029 CY below MLW; 1,518,248 CY below MHW
(iii) Dimensions of fill area 32,500' x 350'
(iv) Purpose of fill
Navigation dredging in Banks Channel with beneficial use of material for shoreline protection and habitat restoration.

b. (i) Will fill material be placed in coastal wetlands/marsh (CW), submerged aquatic vegetation (SAV), shell bottom (SB), or other wetlands (WL)? If any boxes are checked, provide the number of square feet affected.
☐CW _____ ☐SAV _____ ☐SB _____
☐WL _____ ☒None
(ii) Describe the purpose of the fill in these areas:

5. GENERAL

a. How will excavated or fill material be kept on site and erosion controlled?
Beach quality sand will be pumped and desposited onto the beach via dredge and piping and also by truck haul from ST Wooten to Surf City; bulldozers will shape the sand into the designed template.

b. What type of construction equipment will be used (e.g., dragline, backhoe, or hydraulic dredge)?
Hydraulic dredge, booster pump, dredge pipe, loader, bulldozer, offroad buggy, on road dump trucks, offroad dump trucks, excavator.

c. (i) Will navigational aids be required as a result of the project?
☐Yes ☒No ☐NA
(ii) If yes, explain what type and how they will be implemented.

d. (i) Will wetlands be crossed in transporting equipment to project site? ☐Yes ☒No ☐NA
(ii) If yes, explain steps that will be taken to avoid or minimize environmental impacts.

Date

December 13, 2019

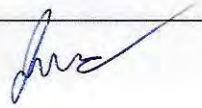
Project Name

Surf City Nourishment 2019

Applicant Name

Jamie Pratt

Applicant Signature



CAMA Permit Application

Project Narrative

1.0 Purpose

1.1 Introduction

The Town of Surf City, N.C. was incorporated in 1949 and is situated along a +/- 6 mile stretch of central Topsail Island. During the 1990s, Surf City endured 5 direct hits by Category 1 or stronger Hurricanes and recently sustained widespread impacts from Hurricane Florence in September 2018. This put much of Surf City's oceanfront in a critical or imminently threatened status. Losses of the beach berm prior to Florence left over 13% of the developed properties imminently threatened and a total of 58% properties endangered and not conforming to state setback regulations for building or re-building. These numbers are even more dire now after a direct landfalling hurricane last season. It is estimated that over 70% of structures were eminently threatened immediately after Hurricane Florence. Even with annual beach bulldozing operations, the shoreline continues to migrate landward as there is no natural influx of sand to rebuild the beach. This lack of sediment introduction along the Town's beachfront is due to its central location on the island 14 miles south and 5 miles north of the inlets at either end of the island. The only major source of sediment influx to the beachfront is the shoreward migration of sediment from nearby hard-bottoms. These very thin, low in volume, nearshore veneer deposits are insufficient to naturally provide the quantity of sediment necessary to keep the shoreline in a non-erosive equilibrium. The landward migration of the shoreline and the absence of new sediment along the beachfront make this region one of the most sediment starved areas on the East Coast of the United States. Additionally, the passing of tropical cyclones and nor'easters make the Town vulnerable to significant beach erosion and property damages at any given time, which brings concern to an already sediment starved environment.

The existing conditions for the Town of Surf City require beach nourishment efforts to preserve this pristine coastline. Management of this coastline will not only benefit the coastal ecosystem but also protect the present real estate and infrastructure which is a primary income for the Town during the summer months. Beach management is a constant and adaptive process. The dynamic coastal environment is in constant movement and mitigation strategies must be implemented to offset beach erosion. By implementing and executing beach nourishment on a programmatic level, the long-term future of the beach for the Town can be secured, protecting valuable environmental resources and local real estate. A beach nourishment program entails adding sand to the beach front multiple times over several decades, not just a "one-and-done" project. The beach nourishment program is not only more feasible financially but allows for additional monitoring surveys for the beach front of Town in order to offset beach front loss over several decades. The monitoring surveys detail the current condition of the beach and assist in placing sand appropriately for each nourishment project. A good program will eventually reduce the rate of erosion and become more economical as time moves forward.

1.2 Project Objectives

As discussed in Section 1.1, the Town of Surf City is proposing to increase the scale of its beach nourishment project. The proposed project's goal is to afford immediate relief from encroaching high tides on the upland beach and dune system, providing sufficient coastal protection from Hurricanes and Nor'easters for a 4-5 year time increment and buy the Town more time for either the Federal (USACE)

CSDR project to become appropriated and go to construction or to develop and implement a long term, locally funded Beach Management Plan.

There are two primary objectives of the proposed project. The first is to protect properties located within the Town of Surf City from future loss due to major coastal storms. The Town of Surf City contains approximately 2,600 homes and about 2,100 year-round residents. Of the 2,600 properties within Town limits, 430 of them are directly oceanfront. During the summer vacation season, the residential population swells to over 19,000, sustaining the Town's motels, restaurant, gift shops, fish pier and local businesses. The primary tourism draw, as with most coastal communities in the United States, is a wide and beautiful recreational sand beach, clean ocean and sound side waters, and boating access. If the Town did not maintain its coastal resources, visitors would likely choose a different beach town to vacation in and patronize businesses in other coastal communities. Widening the dry berm beach also provides habitat for shorebirds as well as nesting areas for sea turtles. Currently, the entire beach is nearly submerged on a normal high tide cycle, significantly reducing the available nesting area for both birds and turtles within Surf City.

The second primary objective of the recommended project is to maintain Banks Channel adjacent to Surf City. The Town of Topsail Beach operates a town owned boat ramp and the North Carolina Wildlife Resources Commission (NCWRC) maintains a state owned boat ramp near the Surf City Bridge, allowing residents and tourists a public access point to its coastal waters. Dredging Banks Channel adjacent to Surf City and beneficially using the beach quality sand for a beach nourishment project provides a clear passageways for boaters to travel to the federally maintained Atlantic Intercoastal Waterway (AIWW), and enjoy the backbarrier channels of Surf City without the worry of navigating through shoaled waterways. It should be noted that the Town of Topsail Beach recently received permits to dredge Banks Channel to the exact proposed dimensions as this project. Banks Channel in its entirety was originally included in the Topsail Beach permit application; however, the existing vibracores at the northern end of Banks Channel were over 5 years old (at the time of permit submission) and therefore no longer valid for the current permit application. As such, the northern portion of Banks Channel was dropped from the Topsail Inlet permit request to expedite permitting and remain on schedule for Topsail Beach. Since that time, additional vibracores for the remaining portion of Banks Channel have been collected and analyzed to continue the proposed 200' width and 12+2' MLW dredge depth, currently permitted for Topsail Beach, for the remainder of Banks Channel.

As mentioned above, the Town of Topsail Beach recently permitted its full 30 year management plan project and is set to begin construction in the fall of 2019. This project utilizes beach quality sand in New Topsail Inlet, Topsail Creek, the Cut-Through Channel, Banks Connector Channel, Banks Channel, and Banks Side Channels 1 and 2 to construct a new primary dune system and a large dry sand beach on their oceanfront beaches. Based upon the most recent survey data, the beachfill template requires approximately 2.1 million cubic yards of sand and the permitted sound-side channel systems contained approximately 3.4 million cubic yards of sand. After Topsail Beach has completed construction in the winter of 2019, Surf City will use the remaining sand in the Banks Channel permitted templates, combined with the continuation of an expanded Banks Channel template (proposed in this application) to place approximate 1.6 million cubic yards of sand on their oceanfront beach. Prior to hydraulic

dredging of Banks Channel, a separate truck haul project, initiated in the spring of 2019, will continue to rebuild the dune system lost to Hurricane Florence while the hydraulic beachfill project from the sound-side channels will construct a dry sand beach and natural slope seaward of the dune system.

The design goals of the proposed project are summarized as follows:

- To provide interim Hurricane and Nor'easter protection to Surf City by increasing the width of the dry sand beach and repair dune scarping until the Federal USACE CSDR Project is appropriated by Congress or the Town can initiate a long term Beach Management Plan.
- Continue to provide a wide recreational beach for local residents and tourists to enjoy (swimming, fishing, etc).
- Maintain safe navigation throughout all interior channels surrounding Surf City that are utilized by both commercial businesses as well as the public for pleasure boating, fishing, and water sports.
- Provide dry sand habitat for shorebird and sea turtle nesting and reduce the probability of overwash during storm events for nests.

2.0 Project Description

2.1 Location

The project site is located in the middle of Topsail Island within the municipal limits of the Town of Surf City. Topsail Island is a barrier island located in southeast North Carolina along the beaches of Onslow Bay. The Town of Surf City is bordered by North Topsail to the north, the Atlantic Ocean to the east, Banks Channel to the west and Topsail Beach to the south. The island is accessible to the public by highways 50 and 210 with Highway 50 being the only main road to the Town of Surf City. The approximate geographic coordinates of Surf City are Latitude 34^{o} 25'40" and longitude 77^{o} 33' 24". The Town consists of mixed use zoning, consisting primarily of residential single family homes, a small downtown business district, and several moderately sized hotels and condominiums. The oceanfront beach is flanked by a vegetated dune system consisting of typical beach vegetation including American Beach Grass (*Ammophila breviligulata*) and Sea Oats *(Uniola paniculata)*.

2.2 Surf City Current Beach Conditions

In fall 2017, a beach monitoring survey was completed for the Town in order to compare the current conditions with previous datasets. Additionally, deliverables were prepared that showed (1) current beach width (Figure 1), (2) current distance from structure to setback line (Figure 2), and (3) current dune retreat rate (Figure 3). (1) The current beach width of the Town indicates that over 50%, nearly 20,000 linear feet (lft) (3.75 miles), of the present shoreline has a current beach width between 10 to 20 ft. The present beach width serves a great importance to not only acting as a buffer from on-coming wave energy, but it also provides essential habitat for nesting turtles and birds. Additionally, the beach width provides an area for recreation for beach-goers in summer and year-round residents. (2) The

current distance from structures to the setback line indicate that nearly 70%, 294 dwelling units fall within the 60 ft setback line. This means that if all property were to be over 50% destroyed from a tropical cyclone close to 300 dwelling units would have be moved from their current position and rebuilt outside of the setback line. (3) The current dune retreat rate varies across the Town. The dunes not only serve an important role in establishing vegetation growth for sea oats, which help keep the dune in place but are the primary defense against storm surge. Just over 50%, nearly 18,000 lft (3.4 miles), of the Town is experiencing a dune retreat of 4 to 9 ft per year. The seaward edge of established vegetation growth serves as the point from which the setback line is measured; therefore, adding a broader beach and dune field can make established vegetation growth be more seaward allowing for non-conforming houses to regain conformity to the 60 ft setback rule.

The current conditions of the Town indicate a beach management program is needed to help with the current beach width, distance from structure to setback line, and current dune retreat rate. Implementing a cost-effective, environmentally friendly, and tourist attractive plan will benefit the Town substantially. A beach nourishment program will allow for continued deliverables of the Town's present beach conditions and contribute to future beach nourishment plans for the Town of Surf City.

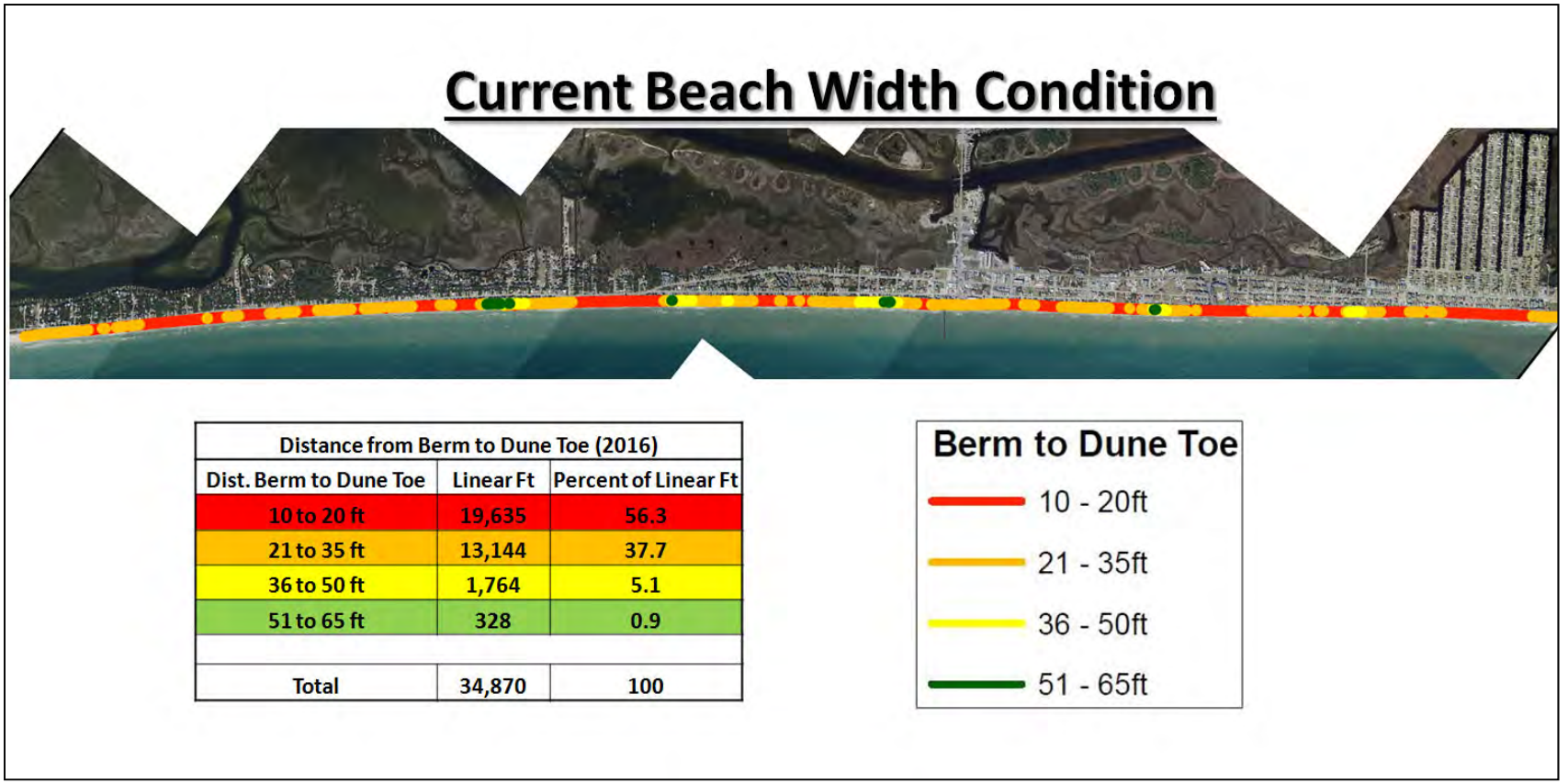
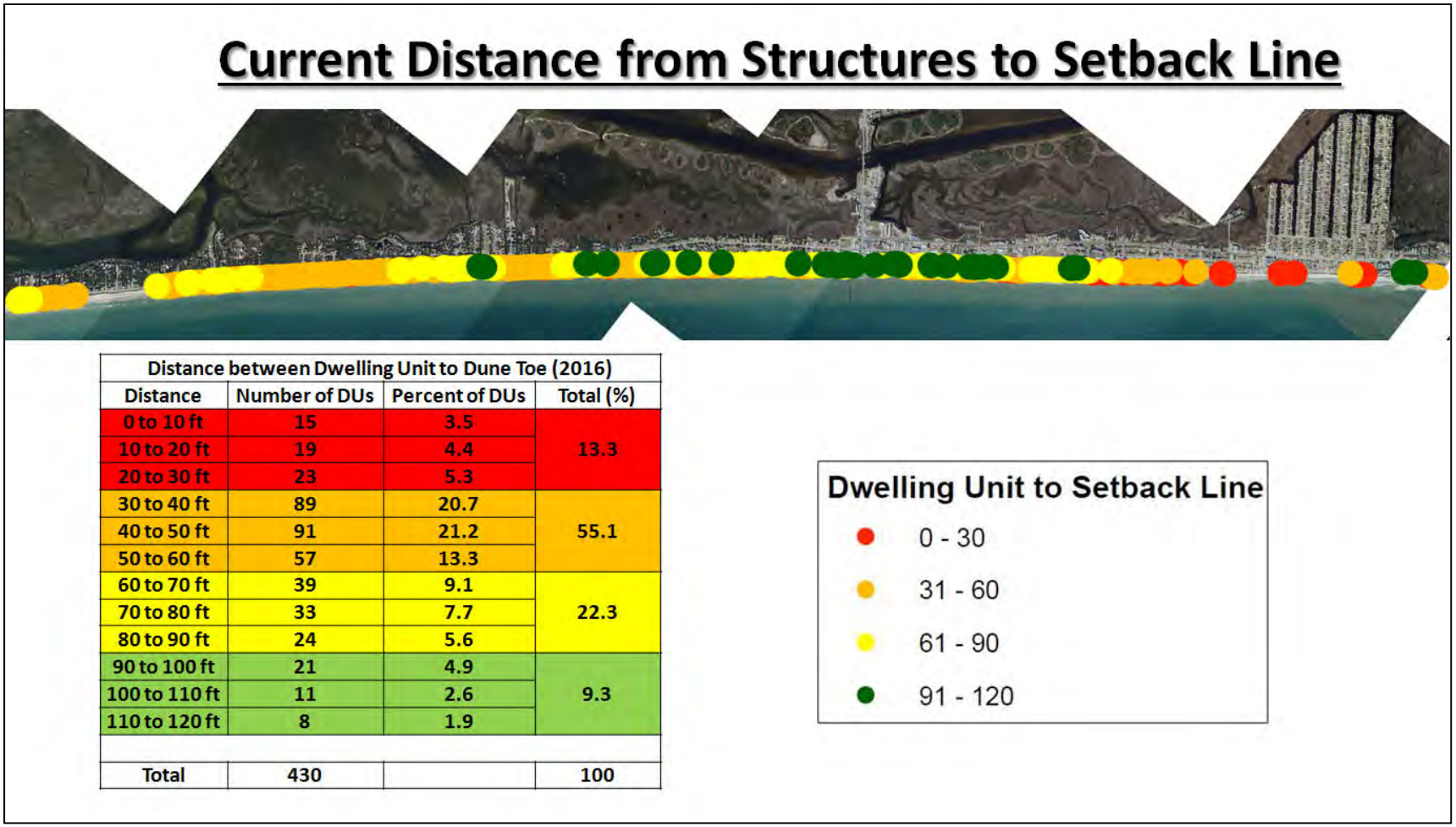
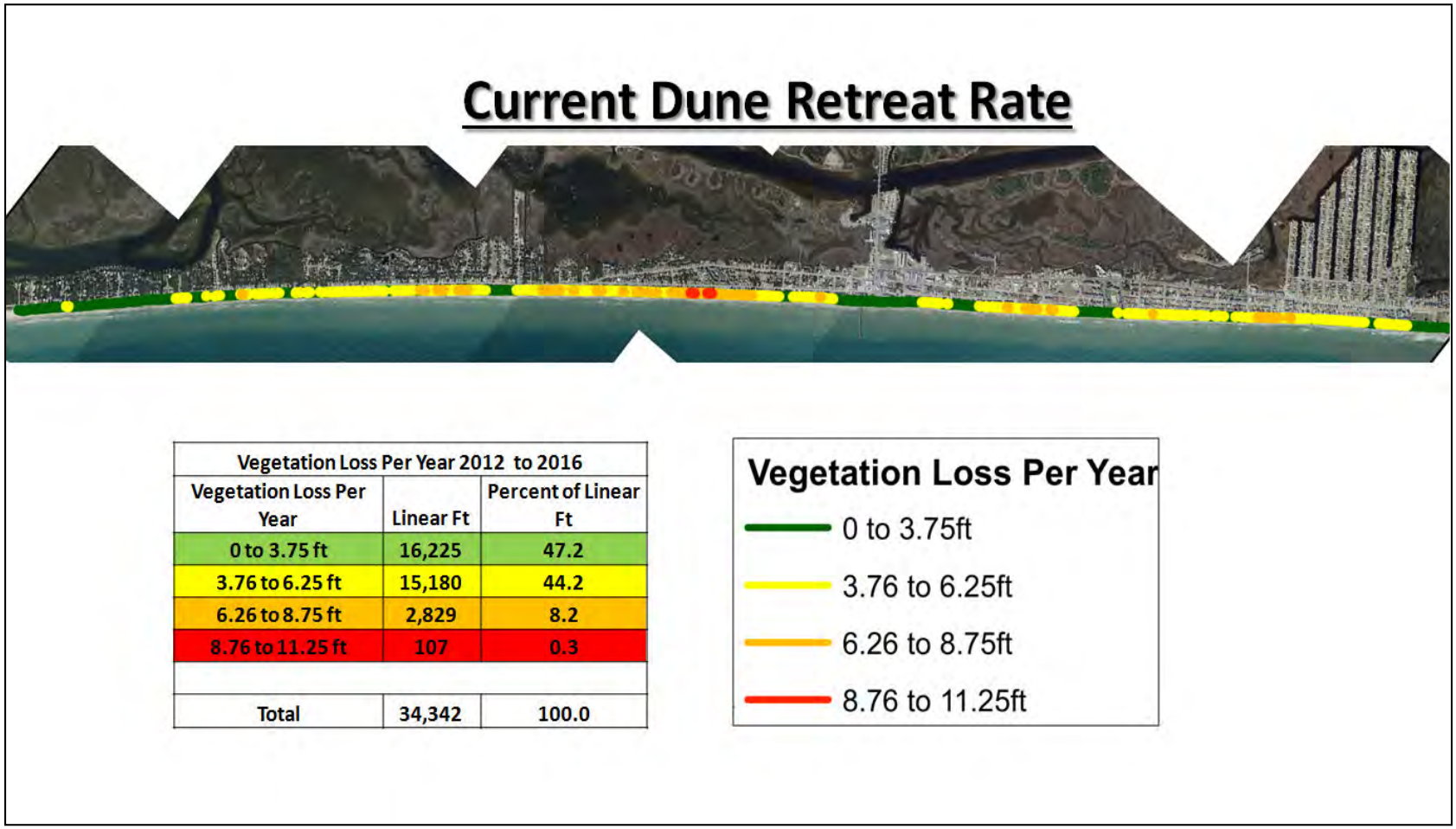


Figure 1. The beach width condition (2017) for the Town of Surf City.



Distance between Dwelling Unit to Dune Toe (2016)			
Distance	Number of DUs	Percent of DUs	Total (%)
0 to 10 ft	15	3.5	13.3
10 to 20 ft	19	4.4	
20 to 30 ft	23	5.3	
30 to 40 ft	89	20.7	55.1
40 to 50 ft	91	21.2	
50 to 60 ft	57	13.3	
60 to 70 ft	39	9.1	22.3
70 to 80 ft	33	7.7	
80 to 90 ft	24	5.6	
90 to 100 ft	21	4.9	9.3
100 to 110 ft	11	2.6	
110 to 120 ft	8	1.9	
Total	430		100

Figure 2. The distance from structure to setback line (2017) for the Town of Surf City.



Vegetation Loss Per Year 2012 to 2016		
Vegetation Loss Per Year	Linear Ft	Percent of Linear Ft
0 to 3.75 ft	16,225	47.2
3.76 to 6.25 ft	15,180	44.2
6.26 to 8.75 ft	2,829	8.2
8.76 to 11.25 ft	107	0.3
Total	34,342	100.0

Figue 3. The dune retreat rate for the Town of Surf City from 2012 to 2017.

2.3 Wave Climate and Littoral Transport

Topsail Island is situated within a mixed-energy hydrodynamic setting. Mean wave height is 3.3 ft and mean tidal range is 3.0 ft (CLEARY, 1994 and USACE, 2006). Annually, the most frequent occurring wave heights range from 1.6 to 3.2 feet. During winter months, the most frequent wave heights range from 1.6 to 4.9 ft due to storms and easterly to northeasterly approaching waves increase in occurrence. Waves during the summer months propagate from a southeasterly direction and often reach 1.0 to 3.0 ft in height. Tropical systems, although infrequent, can generate waves exceeding 15.0 feet (USACE, 2006). The net longshore sediment transport is from north to south in Surf City.

2.4 Storm Events

Storms over the past 65 years have caused extensive damage to the island, destroying infrastructure and transporting sand from the oceanfront beach across the island to the marsh and sound creating overwash fans. Topsail Island is located along major historic storm tracks, and as a result has been repeatedly impacted by tropical and extra-tropical storms. Storm activity between 1944 and 1962 and in the late 1980's was significant and caused extensive damage island-wide. Hurricane Hazel (1954) and the Ash Wednesday Storm of 1962 were significant events causing massive damage. Hurricane Hazel destroyed approximately 90% of the buildings in existence on the island. That storm generated a 9.5 ft storm surge above mean sea level (MSL). The island's average elevation was 8.9 ft above MSL (CLEARY and PILKEY, 1996). Hazel removed 850,000 CY of sand from the oceanfront beaches of Surf City and Topsail Beach. A portion of sand lost from the beach was carried onto and across the island into the sound and marsh in the form of overwash terraces. A large volume of this sand was lost from the oceanfront system as it became trapped beneath grasslands and incorporated into dune fields perched above washover deposits.

Prior to 1996, southeastern North Carolina had not experienced a hurricane stronger than a category 2 since 1954 (Hurricane Hazel) and a single dune, often scarped and sometimes nonexistent, fronted a majority of Topsail Island. However, between 1996 and 1999, four major hurricanes made landfall in the region with two others passing nearby. The southern 2-mile length of Topsail Beach experienced some of the most extensive formation of washover terraces during the hurricanes of the late 1990's. Overwash terraces extended as far as 328-656 ft across the leveled barrier island (CLEARY *et al*., 2006). Bertha and Fran (1996) and Floyd (1999) were among the most destructive and costly storms ever to impact North Carolina. Frequent storm events affecting the region have increased erosion of oceanfront property.

Most recently, in September 2018, Hurricane Florence made landfall near Wrightsville Beach as a strong category 1 storm. The duration of this storm event was extremely long and the cumulative impacts of the lasting hurricane force winds, surf, and tides wreaked havoc on Topsail Island. While total losses of property were limited in Surf City, the dune and beach system were severely eroded leaving the majority of the properties within town limits in imminent danger and fronted by a scarped or nonexistent dune system.

3.0 Project Purpose

3.1 Integration of Navigation and Nourishment

As with most coastal towns, the beach itself is the number one economic resource and driving factor in the local economy. A close second is the surrounding waterways and boating access and as such, both need to be maintained. With a year-round population of approximately 2,100 residents and a summertime population of nearly 19,000, it is easy to see that the draw of the beach, ocean and waterways have a huge impact on the local economy. Ensuring that both of these natural resources remain attractive to visitors, provide storm protection to residents, and protect the Town's infrastructure is the ultimate goal of a successful beach and sound management plan.

In February 2017, the USACE received guidance from headquarters that essentially made all dredge disposal areas off limits. Under these guidelines, disposal on the beach is the only option for a project of this magnitude. By beneficially using material dredged from Banks Channel, combined with remaining sand within the permitted channels for the Town of Topsail Beach, both facets of the project are completed—the beach receives high quality sands to replace eroded sands and maintain the high quality coastal environment that draws summertime visitors to Surf City. In unison with the nourishment of the beach, because the local channel systems are the sources of sand, navigation behind Topsail Beach and Surf City is significantly improved and completed at one time rather than leaving 'speed bumps' or extraneous shoals within the channels. The proposed dredge channel dimensions provide sufficient capacity to allow for the historic shoaling rates to infill the channel while still providing navigation at the federally authorized depths for the designed return period of the project, estimated at 4 to 5 years.

Traditionally, beach nourishment projects and navigation dredging projects have focused on each individual aspect. Offshore borrow sites have been the go-to source for sand used to restore beaches, excavating expansive shoals miles off the beach and placing the material on the beach via pipeline or hydraulic dredge. Due to their spatial size, the offshore borrow sites often provide substantial volumes of beach quality sand and are viable resources for multiple nourishment projects. However because they are outside of the active sediment transport zone, they do not recharge and once the sand supply has been exhausted a new search for sand must occur. Beach quality sand exists in the northern portion of Banks Channel due to overwash fans associated with the string of 1990's hurricanes. The proximity of this channel area to the dynamic inlet zone does not produce tidal currents strong enough to transport beach quality sand within this area. While the volume of sand exists in the channel system to perform an initial construction project for Surf City, future locally funded projects will need to search for an alternative, most likely offshore, borrow source.

3.2 Increased Shoreline Protection

In the early 2000s, the United States Army Corps of Engineers (USACE) completed the feasibility study and approved a Coastal Storm Damage Reduction (CSDR) project for the Town of Surf City, aimed at

protecting coastal properties and infrastructure from major storm events. The federal beach design consists of 2 stages of construction—an initial construction which constructs a large beach in anticipation of equilibrium induced erosion and then maintenance portion for the remaining lifetime of the project. The maintenance portion of the project is a much smaller beach than the initial construction beach. As shown in Figure 4, this federal beach berm design included a 300 ft wide berm for initial construction and then maintains the berm at 50 ft wide maintained at an elevation of 6 ft NAVD with a 1:15 beach slope. The dune would be 25 ft wide at an elevation of 14 ft NAVD with a 1:10 dune slope. The initial construction of this project would consist of 6.6 million cubic yards of beach fill coming from offshore borrow areas.

As mentioned before, this Federal CSDR was authorized by congress for construction in 2014 as a combined project covering both Surf City and North Topsail Beach. No Federal appropriations have been approved to start construction on this project through the FY 2020 budget. Additionally, the original design agreement was executed on August 8, 2011 for the Surf City/North Topsail Beach project and this authorization will expire ten years from enactment unless construction is initiated within this time frame. With no appropriations available through the 2020 fiscal year, the chances of the project starting before the sunset clause is initiated are very slim. The Non-Federal cost share of the initial construction project, split between Surf City and North Topsail Beach, is $49,983,000 and both towns must be ready to contribute their portion of the funds if and when the Federal appropriations are approved by congress. Without both Towns paying their portion, the entire project would remain unfunded.

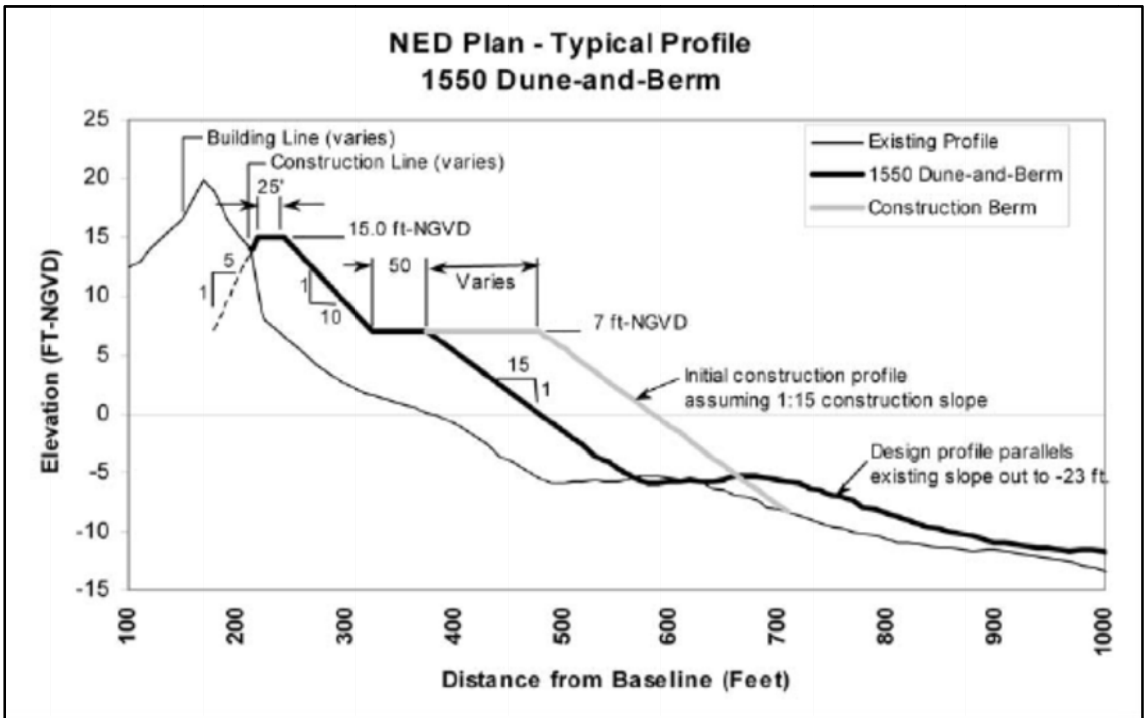


Figure 4. USACE federal beach template design. The initial construction (grey line) would be built for the first cycle of the beach nourishment program. The next cycle of beach replenishment efforts would only be filled to the 1550 Dune-and-Berm bolded line for future projects.

Due to the uncertainty in Federal appropriations and time frame, coupled with the high initial construction costs, the Town has decided to select an alternate interim project that is more feasible and a better long term solution. In fall of 2017, a conditional beach survey was completed in order to determine the best design beach templates for the Town of Surf City. Given the condition of the beach, volume of economical sand, and Surf City's budget, TI Coastal developed a feasible beach nourishment template that would begin a long term beach management plan for Surf City. The template entails an average 85 ft wide berm at an elevation of 5 ft NAVD with a 20H:1V natural beach slope (Figure 5). The initial beach design allows for repair of any scarped dunes by adding a 5H:1V slope. The dune portion of the project will be completed by a separate truck haul project, working to rebuild the pre-Florence primary dune, however if any scarping to that dune is present at the time of hydraulic construction, the dune face will be dressed up to restore a 5H:1V slope. Initial construction of this local project would consist of approximately 1.6 million cubic yards of beach fill, dredged from Banks Channel from the southern terminus of Banks Side Channel 1 to the northern extent of beach compatible material at Station 245+00 in Banks Channel. To supplement the total material needed to complete the beachfill project design, high quality beach sand will be trucked in from the ST Wooten sand mine located on Highway 421 in Wilmington (the same sand mine that has been utilized for the dune restoration project). Final placement areas of hydraulically placed and trucked in sand will depend upon construction logistics at the start of the project, however it is likely that this material will be placed on the northern end of Surf City, from the North Topsail Beach town line to approximately station 220+00 on the beach, where it will meet the hydraulic beach placement area.

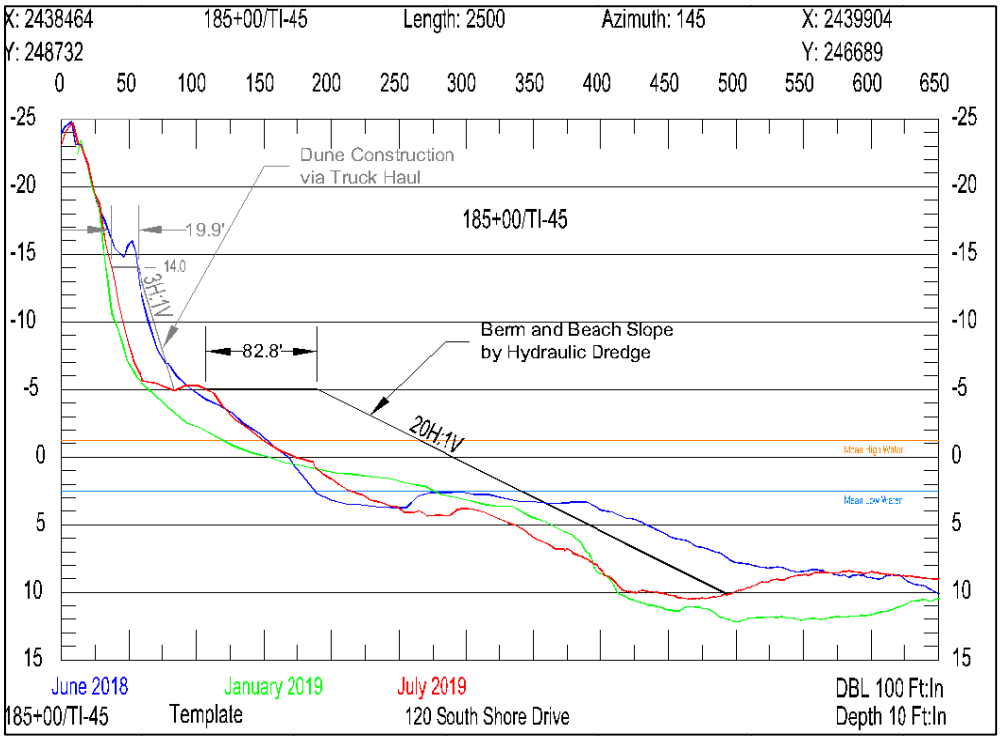


Figure 5. Proposed beachfill template. The colored lines indicate the June 2018, January 2019, and July 2019 beach condition and the black line indicates the proposed template of the beach placement area. Dune construction will be done by truck haul and berm and slope construction by hydraulic dredge.

3.3 Navigational Benefit

As mentioned in the section above a secondary benefit from this project is to provide and maintain navigation at the federally authorized depths over the 4-5 year design cycle of the project. By creating shoaling capacity, the need for intermittent work between beach nourishment projects would be removed. Not only does this reduce the temporal environmental impact to the shallow water channel systems, it also alleviates the burden to the USACE dredge fleet. The sidecast dredges Fry and Merritt have been the USACE dredges to address shoaling and navigation issues in shallow draft inlets along the eastern seaboard. Despite being maintained and managed by the local USACE Wilmington District, these dredges are used in inlet systems from New Jersey to South Carolina. To exacerbate the burden of the sidecast dredges, the Fry was decommissioned in 2011 due to its age. This leaves the aging Merritt, which is over 50 years old, as the only available sidecast dredge to perform work on 25 separate inlet systems along the Atlantic coast. By establishing a navigational dredging plan for the Banks Channel system adjacent to Surf City, the Merritt would be free to address issues in other shallow draft inlets.

As mentioned previously, the initial construction project for Surf City will utilize whatever sand remains within the Topsail Beach Nourishment Projects permitted templates after Topsail completes their project in the fall of 2019. It is anticipated that the Topsail project will require somewhere in the neighborhood of 2.1 million cubic yards of sand to complete their nourishment which leaves approximately 1.3 million yards in template. Dredging within Banks Channel for the Surf City project will begin near Station 35+00 and continue northward to station 245+00. Dredge depths for Banks Channel will follow what is currently permitted for Topsail Beach, with dredge depths of 16+2’ MLW from station 35+00 to 40+00 and 12+2’ MLW from station 41+00 to 245+00. The channel width is 200’ wide for the entire channel, aside from the permitted channel widener’ in Banks Channel near the intersection with Banks Side Channel 1. Approximately 1.3 million CY of high quality sand exists within this section of channel. Piggy backing the Surf City project onto the Topsail project creates a comprehensive cleaning of the channel system and removes all hot spot shoals from the system.

4.0 Proposed Project Description

4.1 Surf City Beachfill

Surf City is proposing to undertake an interim, emergency beach nourishment project until the Federal CSDR Project is appropriated or sunsets in 2021 and a locally funded long term Beach Management Plan can be adapted. Coupled with the truck haul dune restoration project, these projects would begin work to rebuild the primary dune system that was eroded during Hurricane Florence as well as create a dry sand beach in front of the dune to keep wave energy further offshore, reduce dune scarping, and protect dune crossovers. The beach placement would occur along the full length of beach within Surf City, from the town line with Topsail Beach on the south and the town line with North Topsail Beach on the north (Figure 6).

Figure 6. Beach nourishment would occur within the red oceanfront beach areas, from Topsail Beach to North Topsail Beach and include all of Surf City.

Given the condition of the beach as described above in the 2017 analysis and the recent impacts from Hurricane Florence, the initial project for Surf City is triage in nature and seeks to provide immediate relief to the oceanfront homes and Town's infrastructure from future coastal storm events. This project proposes on average a 85 foot wide dry sand berm at elevation 5 ft NAVD88 and repairing the dune scarping/erosion to the truck hauled dune. The front dune slope will be 5H:1V and the beach slope will be 20H:1V. Beach nourishment would cover the entire length of Surf City, from the Town of Topsail Beach to North Topsail Beach lines and is estimated to require approximately 1.6 million cubic yards of sand to fill the proposed template.

Surf City began an emergency Post Florence truck haul project to rebuild sections of dunes lost and badly damaged during the storm. This project was put on hiatus due to environmental moratoriums and, pending permit approval, will begin again on November 16, 2019, completing dune reconstruction along the entire length of Surf City. Areas of dunes that were previously constructed by the truck haul project and have been eroded will be repaired and dressed up during the hydraulic beach fill portion of the project. The condition of the dune system as a whole at the time of this proposed construction project will dictate any additional dune work that is needed to ensure the dune template is full and complete at the time of berm construction. A typical cross section of the completed beachfill template can be seen above in Figure 5, with the dune construction being completed by truck haul prior to the start of this proposed project, and the berm and beach slope being constructed by hydraulic dredging of Banks Channel. Within Banks Channel, the quality of sand degrades north of station 245+00 and therefore dredging under this authorization has been truncated here. Approximately 1.3 million cubic yards of sand exists within this portion of the Banks Channel template (16+2' MLW and 12+2' MLW). In order to complete the beachfill for the full Surf City berm template, trucked in sand from the ST Wooten sand mine, on Highway 421 in Wilmington, NC is proposed to supplement the hydraulic fill from Banks Channel. Approximately 450,000 cubic yards of supplemental sand from the upland sand mine is proposed to be trucked in and placed on the northern portion of Surf City.

4.2 Hydraulic Dredge Areas

Initial renourishment of Surf City proposes to use beach quality shoaled sand within Banks Channel, west of Topsail Beach and Surf City. The Town of Topsail Beach recently permitted dredging within Banks Channel to a width of 200 feet and depths ranging from 16+2' MLW to 12+2' MLW deep. Vibracores collected for Topsail's permitting effort only extended to station 210+00 and therefore the expanded channel dimensions end there. Nourishment of Surf City seeks to utilize this currently permitted portion of Banks Channel. In the time since the Topsail Permit was submitted, additional

cores have been collected to characterize the sediments from Banks Channel station 210+00 to the intersection with the AIWW at station 328+00. Given the quality of sand found in the collected vibracores, the increased width of 200 feet and depth of 12+2' MLW is proposed to continue to Station 245+00 in Banks Channel—thereafter, the quality of sand degrades and is questionable for beach placement. Given the essential timing for this permit application, every attempt has been made to alleviate the concern for any unsuitable material placement on the beach.

The timing and plan for the November 16, 2019 start of dredge season includes Surf City continuing and completing its ongoing truck haul dune reconstruction project, restoring a continuous primary dune system for the entire length of the Town. At the same time, Topsail Beach will begin construction on its beach nourishment project, utilizing permitted sand sources of Topsail Inlet, Topsail Creek, the Cut Through Channel, Banks Connector Channel, Banks Channel, and Banks Side Channels 1 and 2. An estimated 2.1 million cubic yards is required for Topsail Beach to complete their project, leaving nearly 1.3 million cubic yards within the permitted channel templates. After the dune construction in Surf City and Topsail's beachfill project are completed in or around February 2020, hydraulic dredging will begin for Surf City utilizing beach quality sand in Banks Channel (Stations 35+00 to 245+00), proposed within this application. This proposed dredge area for Surf City also places the channel system under the State Programmatic Biological Opinion and remedies the need for a project specific Environmental Analysis and Biological Opinion.

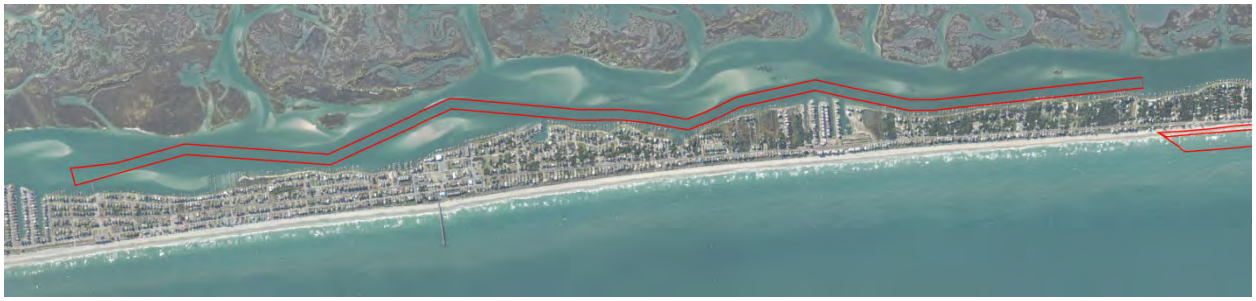


Figure 7. Channel dredging will occur within the red Banks Channel template extending from the southern end of Side Channel 1 to Station 245+00.

4.3 Pipeline Crossings

Pipeline routes for the project will extend from the Banks Channel dredge area to a planned over road crossing at Oleander Drive in the southern end of Surf City and the existing pipeline crossing at Queens Grant in Topsail Beach. The over road crossing at Oleander Court and South Shore Drive allows the dredge pipeline to cross from Banks Channel to the oceanfront beach disposal area while minimizing traffic and environmental impact of pipeline routes through critical dune habitat.

Through verbal coordination with the NCDOT, an over road crossing is preferred to a directional bore under the road due to the sandbagged dunes on the oceanfront shoreline, protecting Route 50. This is the only access road to the southern end of Topsail Island, and the sandbags are in place to ensure the road is not washed out during storm events. A directional bore under the road would disrupt the

sandbag placement and create a potential weak point in the protective dune. As such, an over the road crossing is preferred by the NCDOT. This crossing will involve the dredge pipeline extending down the center of Oleander Ct and then over South Shore Drive (Route 50). The crossing at South Shore drive will be covered by crush and run with 6H:1V slopes leading up to a 30' wide horizontal crest to allow for easy vehicular crossings. Total width will allow for 2 separate 12' roadways. The crossing edges will be on a 2H:1V slope with water barriers along the side to separate the crossing ramp from pedestrian traffic along the roadside.

Dredge pipe will stretch from this location both southward to the Topsail Beach town line and northward on the beach of Surf City until reaching the end of the job at the North Topsail Beach line. Sporadic booster pumps may be needed to assist in pumping the sand but final location of these pumps, both in Banks Channel, along the beach, or slightly offshore will be dictated by the final contractors needs and equipment. The dredging contractor will utilize vehicle crossovers at Kinston Avenue, near the Surf City bridge and Broadway Avenue towards the northern end of town for all ingress and egress from the construction site. All of the proposed gravel fill and water barriers used for the pipeline crossing are temporary in nature. At the conclusion of the beachfill project, the entire pipeline crossing will be returned to its pre-project condition.

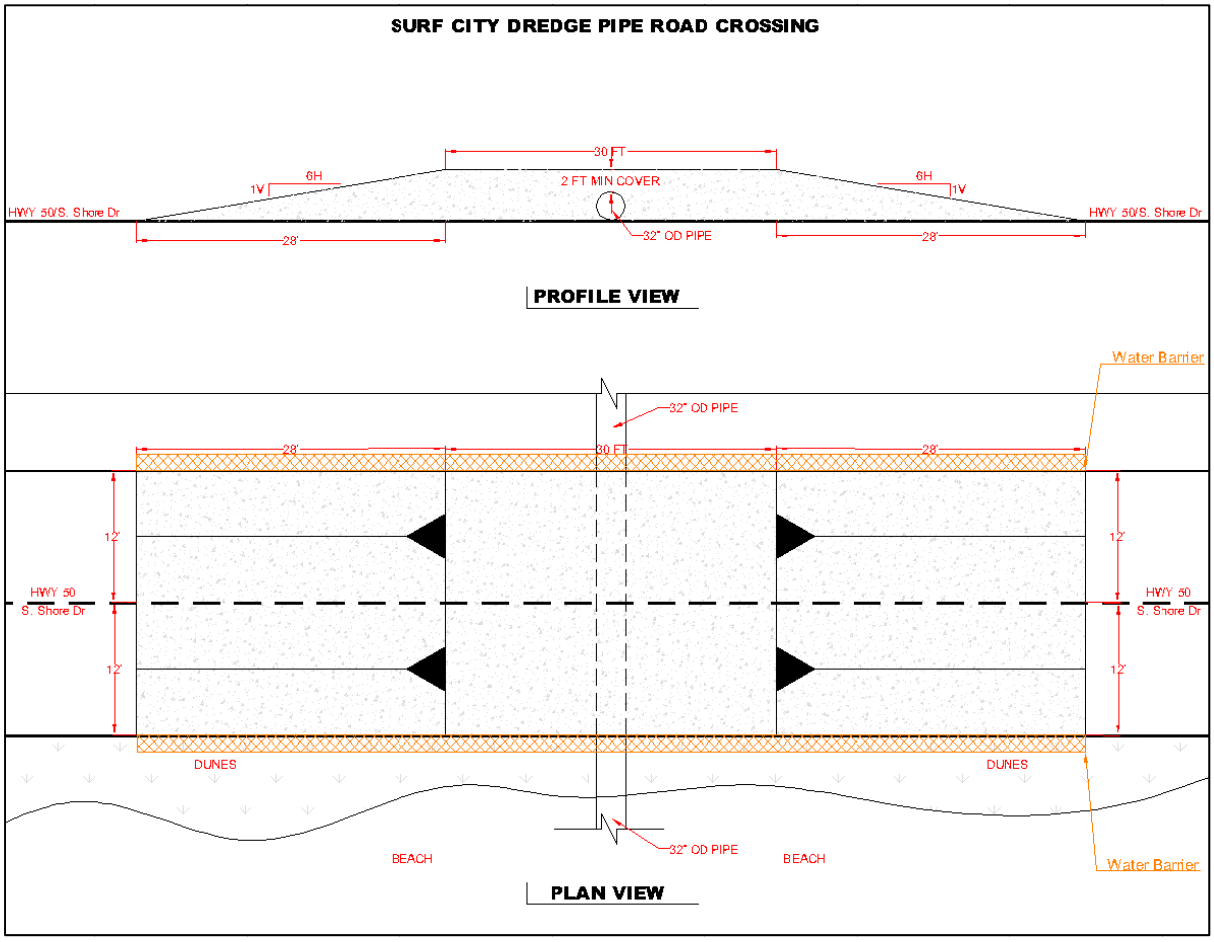


Figure 8. Proposed over road pipeline crossing with vehicular ramp at Oleander Ct. in Surf City.

4.4 Environmental Impacts

Efforts to reduce the overall environmental footprint of the project have been built into the design, from following the azimuths of the Federally authorized navigation channel in Banks Channel to a natural beach design that minimizes scarping and mimics the existing beach profile. All work proposed for Surf City falls within the guidelines of already established Biological Opinions (BOs). Dredging and beachfill associated with the Banks Channel system and Surf City oceanfront beaches should fall under the North Carolina Statewide Programmatic BO (attached in appendices). Additionally, a BO was written for the recently permitted project at Topsail Beach and as these two projects are extremely similar in nature (borrow areas and beachfill design); all work in Surf City should fall within these parameters as well. Finally, the USACE Coastal Storm Damage Reduction Project for Surf City and North Topsail Beach has been approved and permitted and the Federal Environmental Impact Statement/BO for this project blankets beachfill work proposed here within. All work associated with this project and under this permit application will fall within the auspices of these three, previously defined and accepted, Biological Opinions.

5.0 Geotechnical Information

5.1 Vibracore Collection

Core collection began on March 29, 2018 when TI Coastal contracted Athena Technologies, Inc. to collect 13 vibracores from Banks Channel adjacent to the Town of Surf City to investigate and determine if shoaled material in the channels was beach compatible in accordance to the North Carolina Department of Environmental Quality (NCDEQ) Sediment Criteria Rules. All cores were collected with 3 inch diameter aluminum pipes and pneumatically vibrated into the substrate. The cores were taken back to Athena Technologies' shop, where the core barrels were split longitudinally and cut into 5 foot sections, with one half of the core dedicated to descriptions and sampling and the other transferred to 3-inch PVC and wrapped for archiving. The split cores were delivered to TI Coastal's USACE certified Geotechnical Lab on April 5, 2018. An additional vibracore (TB-48) was included in this initial study from a previous project and the same procedure for collection was executed.

The core layout and spacing was created by TI Coastal in accordance with the NCDEQ Sediment Criteria Rules for borrow site characterization, allowing for 1,000 foot spacing between cores and taken on the shallower sides of Banks Channel **(Figure 9 and Figure 10).** Athena Technologies loaded the proposed core locations into their on-board navigation software and used Differential Global Positioning System (DGPS) positioning to navigate to each core location. Water depths on site were collected via survey rod and then tide adjusted by coordinating with TI Coastal personnel who read tide levels from an established tide board at the Surf City Boat Ramp. This information provided the top of hole elevation, in NAVD88, and allowed Athena to calculate their goal penetration depth, which was set at 2 feet below the proposed dredge overdepth (-14' NAVD88). The additional 2 feet of penetration allows for some core loss upon retrieval while still ensuring the total core recovery covered the entire proposed dredge depths.

Initial results of the March 2018 sampling effort and subsequent analysis revealed the potential for unsuitable material residing within the proposed dredge template, near the northwesterly turn of Banks Channel towards the Atlantic Intracoastal Waterway. Significant findings of silt and oyster shells, from relict marsh banks, were found in the cores. In order to better delineate the area of unsuitable material and isolate it for separate disposal methods, additional vibracores were proposed in the questionable area. The supplemental cores were spaced between the March 2018 core locations with the goal of isolating the unsuitable material and maximizing the beach compatible sand. Athena Technologies was again contracted to collect the cores and work was completed on July 11 and 12, 2019 with the same procedures as the first sampling effort. After splitting the cores at their office, Athena delivered the 2019 Surf City vibracores to TI Coastal on July 19, 2019.

5.2 Vibracore Analysis

Core photography and descriptions began on April 5, 2018 and was completed on April 13, 2018. Core descriptions focused on sediment texture and grain size, Munsell sediment color, sorting and visual USCS classification. A total of 43 representative samples, one for each distinct stratigraphic layer in the cores, were collected for grain size and calcium carbonate analysis. Each sample was transferred into a porcelain evaporating dish and dried in a bench oven at 215^{o} Fahrenheit for at least 10 hours and held for testing in a sealed plastic zip lock bag. Grain size statistics were generated by running approximately 200 grams of the dried sediment sample through TI Coastal's stack of sieves on a sieve shaker for 25 minutes (Table 1). The incremental weight retained was recorded and entered into gINT, a geotechnical software that generates data reports based upon user defined sediment statistics. GINT utilized the weight retained on each sieve to determine the critical statistics: mean grain size, median grain size, standard deviations, skewness, kurtosis, sorting, percent fines, and USCS classification. Grain size analysis was completed on April 16, 2018.

Calcium carbonate testing began on April 17, 2018 and was completed on April 19, 2018. Analysis was conducted via acid digestion where 3 molar hydrochloric acid was introduced to approximately 50 grams of the dried sediment sample. The acid was added until the chemical reaction ceased, indicating all of the $CaCO_3$ was dissolved from the sample. The remaining sediment was rinsed with distilled water and then dried in a bench oven at 215^{o} Fahrenheit for at least 10 hours and weighed a second time once dry. The percentage of calcium carbonate was determined by the difference in weight between the original sample and the final sample.

The 2019 core descriptions and photography was completed between July 23 and 25, 2019. Utilizing the same procedures as before, the split vibracores were analyzed by a North Carolina Professional Geologist, describing each individual stratigraphic layer and collecting representative samples for each sedimentary layer for grain size analysis, Munsell colors, and calcium carbonate testing. Geotechnical testing for the 2019 cores was conducted between July 29 and August 9, 2019 thus creating grain size distribution curves, granularmetric tables, and determining Munsell color for the representative samples.

The following week, the vibracore spider map was updated by incorporating the additional cores as well as the 2019 Surf City monitoring data. The spider map breaks the proposed dredge area in Banks Channel into polygons where one vibracore represents the sediment within that segment of channel (map is included in Appendix A). The polygons were delineated by the midpoint of the straight line distance between two adjacent cores. Volume analysis was performed within the channel footprint for each core compartment to determine the amount of sediment each core layer represented. Once the total volume of sediment for the individual core layer was calculated, a weighted average of the sieve analysis was created, multiplying the total volume by the percent of sediment retained on each sieve. Compiling these numbers, an overall composite sample was created for Banks Channel in order to compare the borrow area sediment to the Native sand found on Surf City's oceanfront beach.

Calcium carbonate testing for the 2019 cores was completed on August 20 and 21, 2019 and utilized the same procedure as described for the 2018 vibracore samples. The calcium carbonate percentages were added to the final Surf City Banks Channel statistical analysis.

Because the proposed dredge area of Banks Channel extends southward to Station 35+00 and the Surf City Banks Channel vibracores covered the area from 210+00 to 328+00, the volumetric and geotechnical information completed for the Banks Channel dredging portion of the Topsail Beach Nourishment and Dredging Project were incorporated into the final spreadsheet. Only cores that represented material within the proposed dredge template from 35+00 to 210+00 were used, but this provides a comprehensive geotechnical investigation of the sediment within the entire proposed dredge area. Compiling these numbers, an overall composite sample was created for Banks Channel.

Preliminary comments from regulatory agencies after an initial permit submission on May 23, 2019 indicated potential issues with sediment color. Review of initial procedures indicates that the Munsell colors were taken while the sample was wet and errantly recorded as a dry Munsell color in our geotechnical reports. These color hue, value, and chroma do not accurately represent the final color of dredged sediment after it has been placed on the beach and allowed to oxidize. Virgin material within the template has resided in an anoxic environment for an extended period of time and is therefore very dark in coloration when first removed from the ground. Allowing the material to naturally dry in the sun provides a better interpretation of the final sediment color once placed on the beach. The 2018 vibracore samples were re-evaluated for Munsell color by drying through an open-air, sun drying process, allowing the sediment to oxidize naturally and lighten due to solar radiation as it would naturally on the beach. Between August 4 and August 9, 2019 the 2018 core samples were placed in aluminum pan baking dishes and left in a sunny area near TI Coastal's geotechnical lab until completely dried. These samples were then photographed with the 2.5YR Munsell color classification sheet to provide better insight to the actual sediment colors. Representative samples from the 2019 cores were dried in the oven, but still photographed with the 2.5YR Munsell page for comparison. The sediment coloration was re-evaluated for each 2018 sample and updated in the official sample records and all samples appear to be compatible with the native beach sediment. Photographs of the sun dried (2018) and oven dried (2019) sediments can be found in the digital copy of Appendix A.

Subsequent submittals of the summer 2019 vibracores and associated geotechnical analysis indicate that material in template north of Station 245+00 in Banks Channel degrades in quality as the quantity of clastic material and silt increases. To minimize any influx of unsuitable material for this project, the dredge area has been truncated to Station 245+00 under this permit application.

Table 1. The sieve set used to calculate the grain size statistics (i.e. sorting, mean, median, skewness, and kurtosis). Classification based on the Wentworth grade scale.

TIC Sieve Set			
Sieve Number	**MM**	**Phi**	
3"	>75	>6.27	**COBBLES**
0.75"	19.05	-4.25	**GRAVEL**
0.375"	9.525	-3.252	
4	4.75	-2.25	**GRANULE**
5	4	-2.0	
7	2.8	-1.5	
10	2	-1.0	
14	1.4	-0.5	**SAND**
18	1	0.0	
25	0.71	0.5	
35	0.5	1.0	
45	0.355	1.5	
60	0.25	2.0	
70	0.212	2.24	
80	0.18	2.5	
100	0.15	2.74	
120	0.125	3.0	
170	0.09	3.5	
200	0.075	3.74	
230	0.063	4.0	
PAN			**SILT**

Vibracore Summary
TI Coastal Services, Inc.
Town of Surf City, North Carolina
March 2018

Station ID	Collection Date	Time	East (x)	North (y)	Water Depth (ft)	Tide Elevation (ft MLW) [1]	Sediment Surface Elevation (ft MLW)	Bottom Elevation of Recovered Core (ft MLW)	Penetration Depth (ft bss)	Recovery (ft)	Location Notes
2018-VC-SC-01	3/29/2018	9:35	2,421,003.39	235,099.28	11.8	3.4	-8.4	-14.9	7.0	6.5	
2018-VC-SC-02	3/29/2018	9:51	2,421,681.03	235,764.45	12.6	3.4	-9.2	-16.5	8.0	7.3	
2018-VC-SC-03	3/29/2018	10:07	2,422,294.25	236,364.18	9.2	3.4	-5.8	-16.1	11.0	10.3	
2018-VC-SC-04	3/29/2018	10:23	2,423,041.63	236,908.56	10.6	3.3	-7.3	-16.2	9.5	8.9	
2018-VC-SC-05	3/29/2018	10:36	2,423,586.44	237,648.15	10.7	3.3	-7.4	-14.3	7.5	6.9	
2018-VC-SC-06	3/29/2018	10:51	2,424,331.58	238,190.64	8.8	3.2	-5.6	-15.0	10.0	9.4	
2018-VC-SC-07	3/29/2018	11:03	2,424,972.93	238,848.64	8.0	3.2	-4.9	-14.9	13.0	10.0	Over-penetrated to ensure sediment retention; recovered 12.4' of core; only top 10' of core was opened.
2018-VC-SC-08	3/29/2018	11:36	2,425,715.59	239,399.38	8.0	3.0	-5.0	-14.8	10.5	9.8	
2018-VC-SC-09	3/29/2018	11:53	2,425,662.54	240,149.38	9.0	3.0	-6.1	-15.5	10.0	9.4	Moved sample location approximately 45' to the southwest of original location to reach shallower water.
2018-VC-SC-10	3/29/2018	12:10	2,425,265.64	240,926.40	7.7	2.9	-4.8	-14.8	12.5	10.0	Over-penetrated to ensure sediment retention; recovered 11.7' of core; only top 10' of core was opened.
2018-VC-SC-11	3/29/2018	12:24	2,424,681.27	241,632.28	5.6	2.8	-2.8	*NA*	13.0	0.0	Made 2 attempts; loss of recovery during retrieval for both cores; sediment consists of very soft silt/clay; abandoned location.
		12:44	2,424,700.05	241,599.12	6.4	2.8	-3.7	*NA*	13.0	0.0	Made 2 attempts; loss of recovery during retrieval for both cores; sediment consists of very soft silt/clay; abandoned location.
		12:59	2,424,666.43	241,600.89	7.5	2.8	-4.8	-14.8	22.5	10.0	Over-penetrated to ensure sediment retention; recovered 21.0' of core; only top 10' of core was opened.
2018-VC-SC-12	3/29/2018	13:27	2,424,097.91	242,305.00	10.3	2.6	-7.7	-17.7	16.0	10.0	Over-penetrated to ensure sediment retention; recovered 14.6' of core; only top 10' of core was opened.
2018-VC-SC-13	3/29/2018	13:59	2,423,884.51	243,215.73	11.5	2.5	-9.1	-19.1	14.5	10.0	Over-penetrated to ensure sediment retention; recovered 13.3' of core; only top 10' of core was opened.

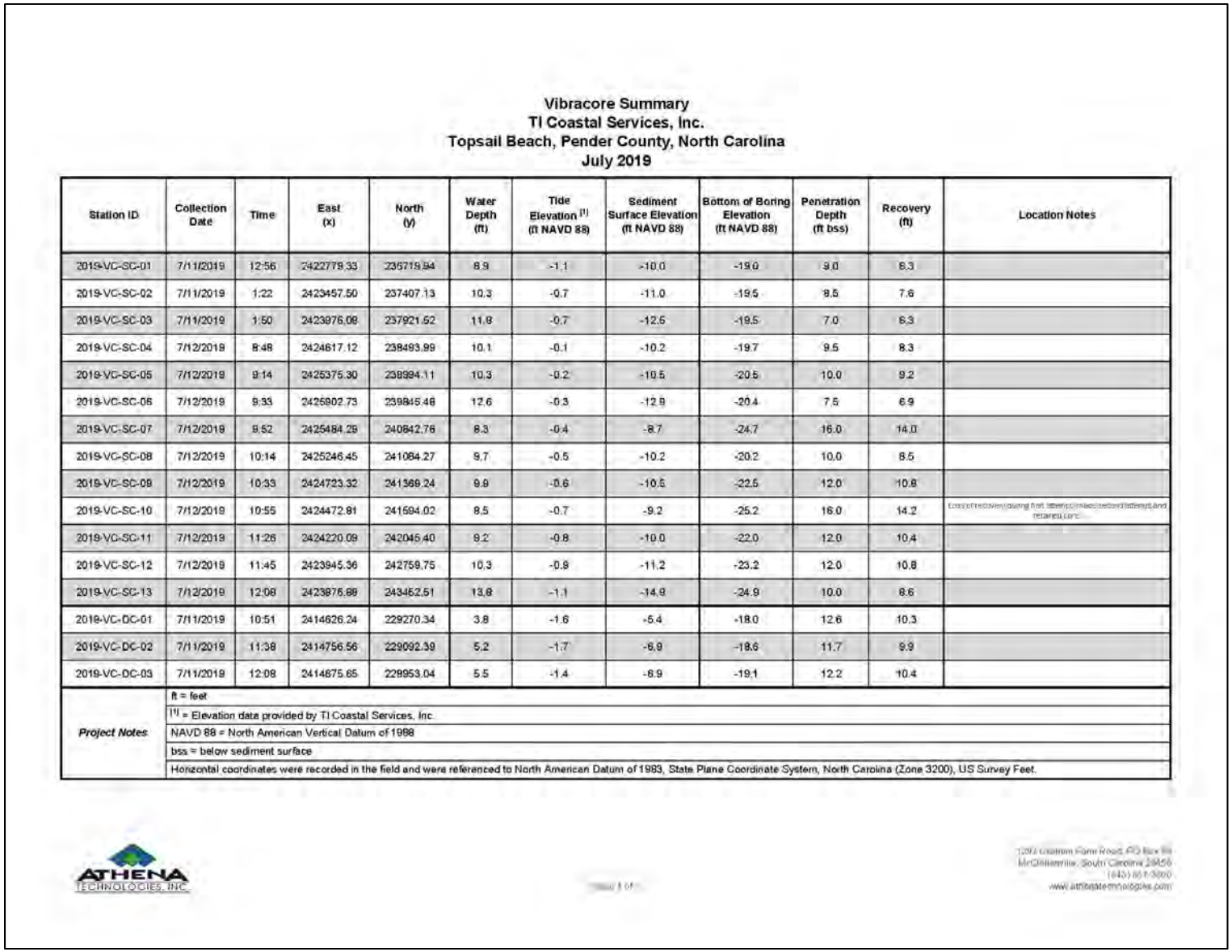
Project Notes

ft = feet
MLW = Mean Low Water
[1] = Elevation data provided by TI Coastal Services, Inc.
bss = below sediment surface
Coordinates were recorded in North American Datum of 1983, State Plane Coordinate System, North Carolina (Zone 3200), US Survey Feet.
NA = Not applicable

ATHENA TECHNOLOGIES, INC.

1293 Graham Farm Road, PO Box 68
McClellanville, South Carolina 29458
(843) 887-3800
www.athenatechnologies.com

Figure 9. Vibracore summary provided by Athena Technologies for March 2018 and July 2019 sampling efforts.



Vibracore Summary
TI Coastal Services, Inc.
Topsail Beach, Pender County, North Carolina
July 2019

Station ID	Collection Date	Time	East (x)	North (y)	Water Depth (ft)	Tide Elevation [1] (ft NAVD 88)	Sediment Surface Elevation (ft NAVD 88)	Bottom of Boring Elevation (ft NAVD 88)	Penetration Depth (ft bss)	Recovery (ft)	Location Notes
2019-VC-SC-01	7/11/2019	12:56	2422778.33	236719.94	8.9	-1.1	-10.0	-19.0	9.0	6.3	
2019-VC-SC-02	7/11/2019	1:22	2423457.50	237407.13	10.3	-0.7	-11.0	-19.5	8.5	7.6	
2019-VC-SC-03	7/11/2019	1:50	2423976.08	237921.52	11.8	-0.7	-12.5	-19.5	7.0	6.3	
2019-VC-SC-04	7/12/2019	8:48	2424617.12	238493.99	10.1	-0.1	-10.2	-19.7	9.5	8.3	
2019-VC-SC-05	7/12/2019	9:14	2425375.30	239994.11	10.3	-0.2	-10.5	-20.5	10.0	9.2	
2019-VC-SC-06	7/12/2019	9:33	2425902.73	239845.48	12.6	-0.3	-12.9	-20.4	7.5	6.9	
2019-VC-SC-07	7/12/2019	9:52	2425484.29	240842.76	8.3	-0.4	-8.7	-24.7	16.0	14.0	
2019-VC-SC-08	7/12/2019	10:14	2425246.45	241084.27	9.7	-0.5	-10.2	-20.2	10.0	8.5	
2019-VC-SC-09	7/12/2019	10:33	2424723.32	241569.24	9.9	-0.6	-10.5	-22.5	12.0	10.8	
2019-VC-SC-10	7/12/2019	10:55	2424472.91	241594.02	8.5	-0.7	-9.2	-25.2	16.0	14.2	Lost core recovery during first attempt; core recovered on second attempt and retained core.
2019-VC-SC-11	7/12/2019	11:26	2424220.09	242045.40	9.2	-0.8	-10.0	-22.0	12.0	10.4	
2019-VC-SC-12	7/12/2019	11:45	2423945.36	242759.75	10.3	-0.9	-11.2	-23.2	12.0	10.8	
2019-VC-SC-13	7/12/2019	12:08	2423876.89	243462.51	13.8	-1.1	-14.9	-24.9	10.0	8.6	
2019-VC-DC-01	7/11/2019	10:51	2414626.24	229270.34	3.8	-1.6	-5.4	-18.0	12.6	10.3	
2019-VC-DC-02	7/11/2019	11:38	2414756.56	229092.39	5.2	-1.7	-6.9	-18.6	11.7	9.9	
2019-VC-DC-03	7/11/2019	12:08	2414675.65	229953.04	5.5	-1.4	-6.9	-19.1	12.2	10.4	

Project Notes

ft = feet
[1] = Elevation data provided by TI Coastal Services, Inc.
NAVD 88 = North American Vertical Datum of 1988
bss = below sediment surface
Horizontal coordinates were recorded in the field and were referenced to North American Datum of 1983, State Plane Coordinate System, North Carolina (Zone 3200), US Survey Feet.

ATHENA TECHNOLOGIES, INC.

1293 Common Farm Road, PO Box 84
McGilliamville, South Carolina 29556
(843) 851-3000
www.athenatechnologies.com

Figure 9. Vibracore summary provided by Athena Technologies for March 2018 and July 2019 sampling efforts.

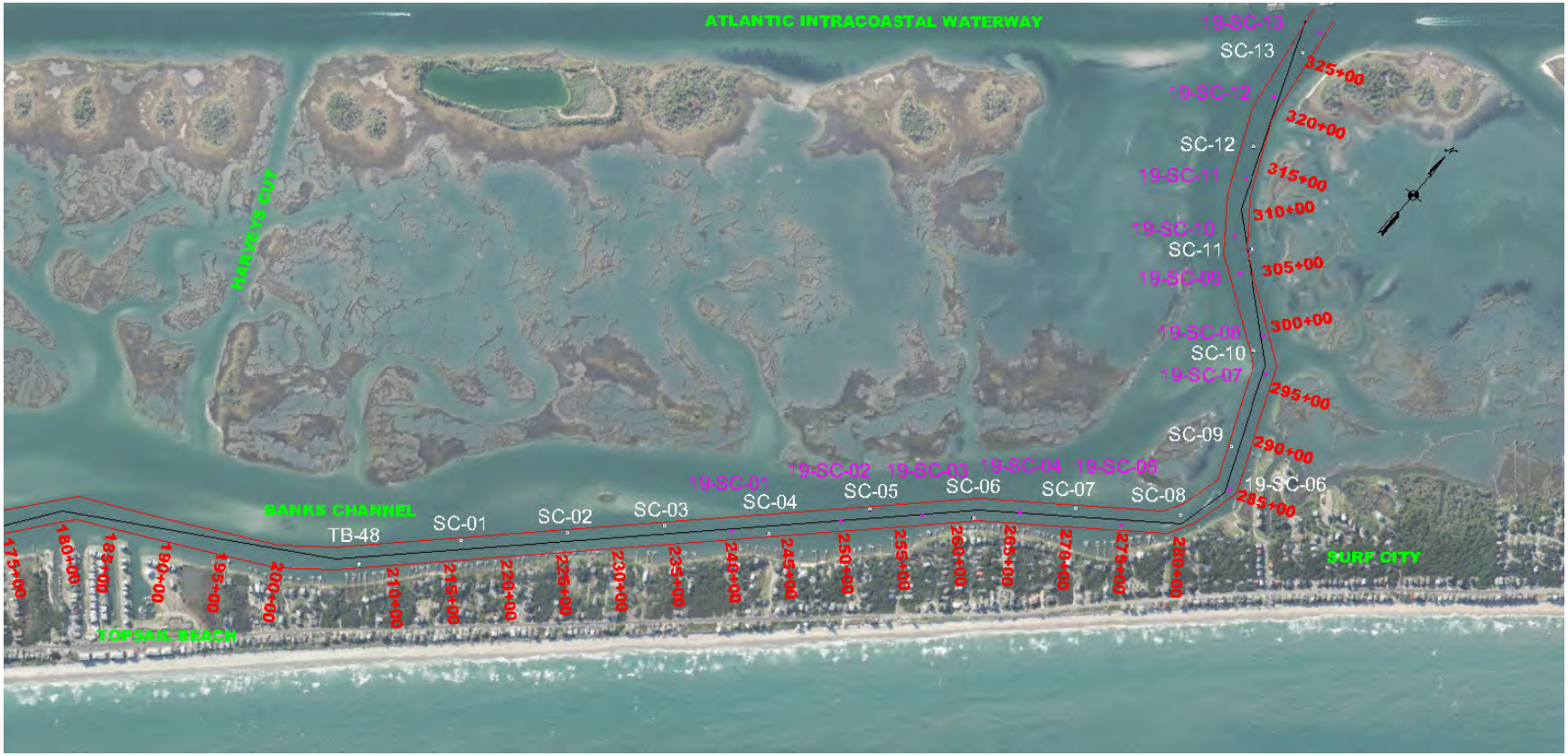


Figure 10. The 27 vibracore locations in Banks Channel adjacent to the Town of Surf City. This permit application truncates the proposed dredge area to Station 245+00 in Banks Channel. As such, Core SC-04 is the last represented vibracore and only 19-SC-01 was used from the 2019 core efforts.

5.3 Surf City Native Grain Size Analysis

According to the CRC guidelines, sediment sampling and analysis was conducted to capture the three-dimensional spatial variability of the sediment characteristic such as grain size, sorting and mineralogy within the natural system; Shore-perpendicular topographic and bathymetric surveying of the beach was conducted to determine the beach profile. Topographic and bathymetric surveying occurred along seven shore-perpendicular transects that were evenly spaced throughout the entire project area. Each transect extended from the frontal dune crest seaward to a depth of -20' NAVD88, and the transect spacing was 5,000' ft in the shore-parallel direction. Elevation data for all transects were referenced to the North American Vertical Datum of 1988 and the North American Datum of 1983. A total of 15 sediment samples were taken along each beach profile transect. At least one sample was taken from the frontal dune, frontal dune toe, mid berm, mean high water (MHW), mid tide (MT), mean low water (MLW), trough, bar crest and at even depth increments from 6' NAVD88 ft to 20' NAVD88 ft. The total number of samples taken landward of MLW were equal to the total number of samples taken seaward of MLW.

A total of 105 samples were collected along 5 transects (15 samples each transect), TB-27, TB-32, TB-37, TB-42, TB-47, TB-52, and TB-57 **(Figure 11)**. For each transect a sample was taken at the dune crest, dune toe, mid-berm, MHW, foreshore, MT, elevation 0' NAVD88, MLW, trough, bar crest, elevation -6' NAVD88, elevation -8' NAVD88, elevation -12' NAVD88, elevation -16' NAVD88, and elevation -20' NAVD88. Samples from the dune crest to -6’ elevation NAVD88 were collected on April 16, 2018 and April 17, 2018 while offshore samples from -8’ elevation NAVD88 to -20' NAVD88 elevation were collected on May 16, 2018. With the exception of TB-27 rather than a sample be taken at elevation -12' NAVD88, a sample was taken at -10' NAVD88 due to rough seas.

After the collection of sediment samples, the samples were taken back to TI Coastal's USACE certified geotechnical laboratory for further analysis. Similar to the vibracore analysis, description of color according to the Munsell Color chart was performed along with grain size analysis of each sample. Each sample was transferred into a porcelain evaporating dish and dried in a bench oven at 215^{o} Fahrenheit for at least 10 hours and held for testing in a sealed plastic zip lock bag. Grain size statistics were generated by running approximately 200 grams of the dried sediment sample through TI Coastal’s stack of sieves on a sieve shaker for 25 minutes (Table 1). The incremental weight retained was recorded and entered into gINT, a geotechnical software that generates data reports based upon user defined sediment statistics. GINT utilized the weight retained on each sieve to determine the critical statistics: mean grain size, median grain size, standard deviations, skewness, kurtosis, sorting, percent fines, and USCS classification. Grain size analysis was completed on May 23, 2018.

Calcium carbonate testing began on May 18, 2018 and was completed on May 29, 2018. Analysis was conducted via acid digestion where 3 molar hydrochloric acid was introduced to approximately 50 grams of the dried sediment sample. The acid was added until the chemical reaction ceased, indicating all of the $CaCO_3$ was dissolved from the sample. The remaining sediment was rinsed with distilled water and then dried in a bench oven at 215^{o} Fahrenheit for at least 10 hours and weighed a second time once dry.

The percentage of calcium carbonate was determined by the difference in weight between the original sample and the final sample.

The USACE completed its own internal grain size analysis for the Town of Surf City and found a mean grain size of 0.22 mm and visually 10% shell fragments (USACE, 2010). While TI Coastal's native grain size analysis for the Town of Surf City was found to have a mean grain size of 0.25 mm and $CaCO_3$ of 6.6%. The proposed borrow area in Banks Channel had a mean grain size of 0.33 mm and $CaCO_3$ of 16.5%. The percentage silt and clay (sediment size ≤0.063 mm), gravel (material with a diameter ≥4.76 mm), and granular sediment (2.0 mm to 4.76 mm) are all under 5% of the native (**Table 4** and **Table 5**).

A 50,000 sqft location of oceanfront beach in Surf City was analyzed for large clastic material - exceeding 3" in diameter- on the existing beach. The summation of large clasts is needed to calculate sand composition and grain size distribution of the existing shoreline environment. The survey location is near the intersection of Craven Ave and N. Shore Dr in Surf City, NC. The area extended from the toe of the dune to the shoreline MLW. For our survey, we made a sample area of 500ft x 100ft. and broke it down into 5, 100ft x 100ft sections. We counted the number of large shells and sediment (clasts) that exceeded 3" in diameter in each 10,000 sqft section using 5ft x 5ft pvc frames as reference tools. We also used an RTK rover to accurately measure the sample area parameters (**Figure 12)**.

The survey began at Station 257+00 and went northward to Station 262+00. A total of 98 clasts were found in the 50,000sqft area. The majority of large clasts and shells were located at or near the toe of the dune, while the rest of the large shells and clasts, were found at or near the low-tide shoreline. During the survey we extended past the 100ft width area in order to survey as close as we could to the MLW line.

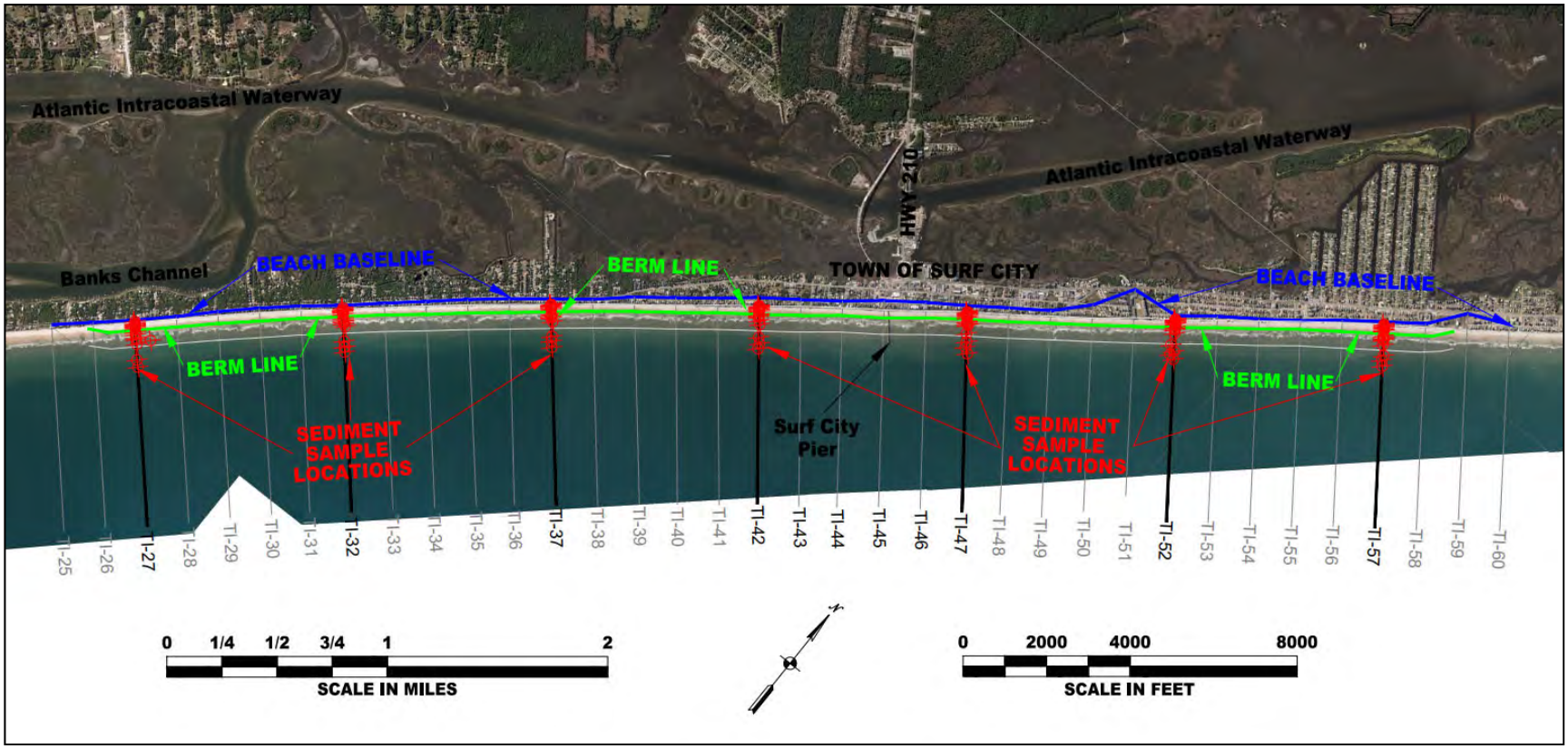


Figure 11. Location of sediment samples taken to determine the native grain size and percentage of calcium carbonate for the Town of Surf City, N.C.

Figure 12: 5’x5’ PVC frames and a RTK rover were used as reference tools to verify clasts exceeding 3” in diameter from a 50,000 sqft sample beach area.

5.4 Banks Channel Vibracore Results

In order to maintain the integrity and quality of the current beach, the North Carolina Coastal Resources Commission (CRC) has established standards to prevent large amounts of coarse material (cobbles, large shells and shell hash) as well as excessive fine grained material (silt and clay) from being placed on the beach. Silt and clay (sediment size ≤0.063 mm), gravel (material with a diameter ≥4.76 mm), and granular sediment (2.0 mm to 4.76 mm) are limited to 5% over the percentage found on the native beach. The calcium carbonate (shell) fraction of the borrow material is limited to no more than 15% over what naturally is found in the fill area. Following within the guidelines of the CRC, TI Coastal determined the native grain size for the Town of Surf City. After completion of all 105 native beach samples the results can be found in Tables 2 to 3 while grain size statistics for the Banks Channel dredge area (Station 35+00 to 245+00) can be found in Table 5.

Dried sediment samples from 2018 were measured under the Munsell Color classification method. Requirements asked that the sediment fall within a Munsell color value of 5/1 or lighter (i.e. 6/1 or 7/1). All sediment samples from the 2018 VC that were air-dried and the 2019 vibracore samples that were oven-dried had a value of 5/1 or lighter in value (6/1 or 7/1). Very few samples indicated any change in chroma from gray to yellow, while the vast majority had a chroma gray to light gray within the 2.5Y hue. The review of the sediment colors can be seen in the photos in the digital version of Appendix A. Volumes were calculated using survey data and drilling log information.

Despite extra vibracoring efforts to isolate the unsuitable material areas within Banks Channel, it was determined that material in the northern portion of the proposed template is questionable enough to warrant it being removed completely from this application. The dredge template has been modified and the proposed dig area ends at Station 245+00, leaving only high quality beach sand within template. Due to the shortened template, the total volume within Banks Channel is no longer sufficient to complete the desired beachfill template. Sand from the ST Wooten Mine on highway 421 in Wilmington, NC, which was previously permitted for the Surf City Dune truck haul project, is proposed to supplement the Banks Channel dredged sand and complete the berm project.

Calcium Carbonate ($CaCO_3$) averages are found in Table 5 of this report and represent weighted averages for all cores from 2017 through 2019 within the Banks Channel dredge area and the supplemental truck haul sand from the ST Wooten sand mine. Additionally, the results of our grain size analysis can be found in Table 5, showing the mean and median grain size, as well as the average percentage of fine, sand, and gravel material from Banks Channel and both upland sand mines. For comparison the CRC thresholds are posted in the table as well. The overall composite of the combined borrow areas falls within the limits set forth by the CRC and proves to be sand source areas for nourishment on Surf City.

Overall grain size statistics tables of the full Banks Channel borrow area (stations 35+00 to 245+00) are included in Appendix A. Accompanying these spreadsheets are the grain size distribution curves and granularmetric tables for both Surf City Banks and the upland borrow areas at the ST Wooten sand mine.

The average percentages (%) for this report fall well within the CRC threshold. Calcium Carbonate ($CaCO_3$) concentration percentages fall within the 21.6% threshold. Gravel concentration percentages are all within 5.3% (Table 5). Fine aggregates fall within the 5.0% threshold. Our results indicate that our overall percentage of sand in the Banks Channel and ST Wooten Composite totals 95.7% (Table 5). A supporting piece of consistency in our analysis is that each sequential aggregation of Banks Channel sediment results averaged resembles the previous individual analyses for this report. In other words, all of the analyses from Table 5 have similar values to one another before and after being merged.

The high percentage of sand in Banks Channel can be partially attributed to a strong incoming tidal current during high tide, carrying and pushing sand into Banks channel (Table 5). However, this only occurs near Topsail Inlet at the entrance of Banks Connector Channel, and Banks Channel. The large percentage of fine to coarse grained sand and granular sediment could be evidence of higher wave action and previous storm activity, where more energy keeps larger, heavier material in suspension before being deposited in the channel. However, because this area of the channel is mostly closed off from the ocean wave energy, the main source of sand in Banks Channel was deposited from overwash fans from previous hurricane and strong storm impacts. Due to the highly infrequent occurrence of overwash fan deposition in this area, navigation maintenance in the upper reaches of Banks Channel is not expected in the foreseeable future. This makes this a one-time project due to the limited sand supply.

Fine sediment found in our vibracore analysis may be from rain runoff and fluvial discharge into the AIWW and Bank Channel and/or biogenous material from past marsh environments. Fine sediment indicates calm water environments. Circling back to Table 5 below, we can see that the weighted average values represented under “Borrow Area Composite” have low quantities of fine sediment and fall within the grain size percentage threshold suggesting that the sand in both Banks Channel and the ST Wooten sand mine are viable sources for beach nourishment.

5.5 ST Wooten Upland Borrow Areas

The material within the proposed template of Banks Channel becomes slightly unsuitable north of station 245+00 and in an effort to greatly reduce the chance that any non-beach quality sand is placed on the beach, the proposed dredging ends at this location. Truncating the dredge area has reduced the overall volume of sand available for beneficial use placement on the oceanfront beach of Surf City and alternative methodologies must not be employed to compensate for the deficit. The upland sand mine at ST Wooten, off of Highway 421 in Wilmington, NC has been used for truck haul dune restoration projects in both Surf City and North Topsail Beach. The ST Wooten site was used last winter for Surf City’s dune project and this it is being used for North Topsail. Material dredged from ST Wooten is run through a 3/4” screen at the dredge pipe, stockpiled and sent directly to the beach as bulk material. Because of these construction methodologies, a complete geotechnical analysis of the borrow pit at ST Wooten was conducted to ensure the dredged material was beach compatible and comparable to the native Surf City Sand. A summary of this analysis can be found below.

ST Wooten's sand mine, located on Highway 421 in Wilmington, NC, has previously been permitted for an emergency Post Hurricane Florence truck haul project and is currently proposed for use under a minor modification of CAMA permit 190-05 to truck in sand from an upland sand mine in order to complete the truck haul dune restoration project. This upland sand pit was also permitted for work at North Topsail Beach in 2017 (work on this truck haul project to begin in November 2019) and the geotechnical information submitted for this project follows. Due to its location and quality of sand, the ST Wooten sand mine located at 226 Sutton Lake Road, Wilmington, NC has been identified as supplemental source of beach quality sand for Surf City's berm construction project. The previous study and permitting efforts determined the material in the mine was beach compatible in accordance to the North Carolina Department of Environmental Equality (NCDEQ) Sediment Criteria. Through collaboration with ST Wooten, TI Coastal was granted access to historical geotechnical work completed by S&ME, who specialize in core collection and geotechnical analysis. Sediment analysis of the mine began development by S&ME, under contract with S.T. Wooten, in 2005 and was able to provide the original core logs, grain size distribution curves, granularmetric tables, and maps showing the location of borings (Appendix A). TI Coastal Services was provided all of the geotechnical work conducted by S&ME from S.T. Wooten for additional analysis.

The study area includes 12 borings from 2005, 2 borings from 2007, and 4 borings from 2011/2012 (see spider map in Geotechnical Section). The borings included in this analysis are all located within the currently active mining area. Review of the core logs reveal that the sediment is very uniform, consisting of tan, fine to medium sand with a thin layer of topsoil capping most cores. The material becomes increasingly grey and clayey around -25' NAVD88, which is below the currently designed dredge depth. Due to ongoing mining operations, some of the material represented by the original core samples has been excavated and is no longer present on site and has removed the sparse clay layers that were originally found in some cores.

Despite use since the original permitting in 2017, the topographic survey completed in September 2017 is included in this application to provide a cohesive correlation between on-site elevations which were reassigned to their respective borings as the new top of hole elevation for the previous analysis. The designed dredge depth for the project is -20 feet; therefore, material that fell between the current top of hole elevation and the designed dredge depth of -20 feet was accounted for in determining the total volume and anything that was deeper than -20 feet was not accounted for in the total volume. Lastly, two grab samples were taken from a stock pile at the study site in September of 2017 and were analyzed at TI Coastal's geotechnical lab. The grain size statistics resemble the material previously documented by S&ME during their geotechnical surveys from 2005 to 2012 and represents the dredge material anticipated to be produced from the sand pit in the future.

The geotechnical data (i.e. core logs, granularmetric tables, etc.) from the 18 borings collected by S&ME was used for statistical analysis of the borrow area and calculating the weighted average parameters of the borrow area sediment currently within the dredge template. Critical statistics generated from this dataset was then compared with the native sand found on Surf City's beach (Table 5) to ensure borrow area compatibility. This analysis was completed by constructing a 'Spider Map', which creates a polygon

where one boring represents the sediment within that polygon (Spider Map in Geotechnical Section). The polygons were delineated by the midpoint of the straight line distance between two adjacent cores. Volume analysis was performed within the borrow footprint for each core compartment to determine the amount of sediment each individual core represented. Once the total volume of sediment for the individual core was calculated, a weighted average of the sieve analysis was created, multiplying the total volume by the percent of sediment retained on each sieve. Compiling these numbers, an overall composite sample was created for the entire sand mine.

Upon completion of the 'Spider Map' the statistics and volumes calculated for each of the cores were entered into gINT, a geotechnical software that generates data reports based upon user defined sediment statistics. GINT utilized the weight retained on each sieve to determine the critical statistics: mean grain size, median grain size, standard deviations, skewness, kurtosis, sorting, percent fines, and USCS classification. The total breakdown of the sand mine, includes 18 polygons and based on the cumulative grain size statistics calculate in gINT the total sand mine yields a volume of 2,466,100 cubic yards of beach compatible sand, of which 760,000 cubic yards are anticipated to be used to supplement the sand dredged from Banks Channel (Table 5).

In order to maintain the integrity and quality of the current beach, the North Carolina Coastal Resources Commission (CRC) has established standards to prevent large amounts of coarse material (cobbles, large shells and shell hash) as well as excessive fine grained material (silt and clay) from being placed on the beach. Silt and clay (sediment size ≤0.063 mm), gravel (material with a diameter ≥4.76 mm), and granular sediment (2.0 mm to 4.76 mm) are limited to 5% over the percentage found on the native beach (Table 2). The calcium carbonate (shell) fraction of the borrow material is limited to no more than 15% over what naturally is found in the fill area.

Native beach sand statistics associated with this permit application have identified the native beach characteristics for the proposed nourishment area to have a mean grain size of 0.25 mm, 0.0% silt, 0.3% gravel, 0.5% granular and 6.6% calcium carbonate. Based on current criteria established by the North Carolina CRC, dredged material being placed on the beach must consist of sediment encompassed within 5.0% of the native material – in this case no more than 5.0% silt, 5.3% gravel, 5.5% granular and 21.6% calcium carbonate. The geotechnical analysis of the grab samples from ST Wooten proves that their quality of sand is a good match for the native material on Surf City and well within the limits established by the CRC (Table 5). There was no calcium carbonate sampling initiated to the samples because the material in the grab sample did not contain any shell fragments.

Historic use of this mine for the dune construction on Surf City shows it produced high quality beach sand with limited amounts of pebbles. Because the pebbles became a source of contention during the dune restoration project, all sand to be used for this beach berm nourishment project will be pumped through a screening basket as it is harvested from the dredge area at ST Wooten. These screening baskets are frequently used on northeastern beachfill project to screen for munitions that were dumped offshore following World Wars 1 and 2. The Munitions and Explosives of Concern (MEC) baskets are

typically steel grate baskets that the dredge discharge is pumped through. Any undesirable material that is greater in size than the screening is retained within the basket while the sand passes through. All sand to be used for the upcoming dune restoration will be screened by a 3/4" MEC basket as it is dredged from the ST Wooten harvest area and stockpiled for the project, thereby removing any unsuitable pebbles or rocks that exist in the native material.

The appendices found at the end of this document contain all the grain size analysis reports for each sample taken from the vibracores and sample taken to determine the native grain size for the Town of Surf City as well as the full set of geotechnical information used to analyze the sand at the ST Wooten plant. Included within these reports are the descriptive vibracore logs, granularmetric reports for each sample and cumulative grain-size distribution curves for each sample. Photographs of the vibracores, taken in 2 foot sections, are also included. Detailed spreadsheets of how the composite samples were formed can be found there, as well as statistical analysis for each compiled sample.

VOLUME TABULATIONS (Cubic Yards)			
2019 SURF CITY MONITORING SURVEY DATA			
CHANNEL	**GRADE**	**OVERDEPTH**	**TOTAL**
Banks Channel 35+00 to 245+00	12' MLW	14' MLW	
	900,876	404,739	1,305,615
ST Wooten	450,000		450,000
GRAND TOTAL	**1,350,876**	**404,739**	**1,755,615**
Area	**Grade**		**Total**
Surf City Beachfill	**1,623,159**		**1,623,159**

Table 2. Breakdown of proposed beachfill cubic yardage, amount of material in Banks Channel, and total quantity of supplemental truck haul sand required. Total dredged/hauled material is higher than required fill to account for typical losses during hydraulic dredging and beachfill.

Table 3. Native sand of Surf City grain size analysis. Individual transect grain size statistics of mean, median, and percentage of calcium carbonate. Each statistic contained samples from the dune crest to -20' NAVD88.

Transect	Mean (mm)	Median (mm)	Fine% (<0.0625 mm)	Sand% (0.0625-2.00 mm)	Granular% (2.00-4.76 mm)	Gravel% (4.76-76.00 mm)	$CaCO_3$%
TB-27	0.24	0.22	0.1	99.2	0.4	0.3	6.9
TB-32	0.26	0.23	0.0	99.3	0.5	0.1	4.4
TB-37	0.25	0.23	0.0	99.2	0.4	0.2	5.7
TB-42	0.22	0.21	0.0	99.4	0.2	0.2	5.2
TB-47	0.25	0.23	0.0	98.8	0.5	0.3	8.0
TB-52	0.26	0.23	0.0	98.5	0.6	0.6	7.4
TB-57	0.26	0.23	0.1	98.4	0.8	0.4	8.9

Table 4. Native sand of Surf City grain size analysis. Composite of mean, median, and percentage of calcium carbonate for all of the transects in the Town of Surf City.

Composite (Native)	Mean (mm)	Median (mm)	Fine% (<0.0625 mm)	Sand% (0.0625-2.00 mm)	Granular% (2.00-4.76 mm)	Gravel% (4.76-76.00 mm)	$CaCO_3$%
Average	0.25	0.22	0.0	99.0	0.5	0.3	6.6

Table 5. Vibracore grain size analysis averages for Banks Channel (35+00 to 245+00), ST Wooten Sand Mine, and the Overall Composite of Borrow Areas. Results are compared to CRC Threshold for viability. Stations are included for location reference.

Channel Area	Mean (mm)	Median (mm)	Fine% (<0.0625 mm)	Sand% (0.0625-2.00 mm)	Granular% (2.00-4.76 mm)	Gravel% (4.76-76.00 mm)	$CaCO_3$%
ST Wooten Sand Mine	0.27	0.28	1.8	97.8	0.3	0.1	N/A
Banks Channel (Sta. 35+00 – 245+00)	0.33	0.25	0.1	94.1	3.1	2.7	16.5
Borrow Area Composite	0.31	0.26	0.7	95.7	2	1.6	10.1
Surf City Native	0.25	0.22	0.0	99.0	0.5	0.3	6.6
CRC Threshold	N/A	N/A	5.00	N/A	5.50	5.30	21.60

5.6 Unsuitable Material Handling

An abundance of vibracores taken from Banks Channel have done a good job of delineating the problematic areas of sediment within the proposed template. In an effort to ensure that it is extremely unlikely for any non-compatible sediment to make its way to the beach during this project, the channel dredging area has been truncated to Station 245+00. Given the appearance of cores south of this terminus point, we are confident that only high quality beach sand will be placed on the oceanfront beaches of Surf City. Despite that, measures and plans are in place for the off chance that unsuitable material is encountered.

The written specifications provided in the bid will require the contractor to closely monitor the material being discharged and disposed of on the beach. In the event that excessive unsuitable, non-beach compatible material (i.e. abundant shell, silt or clay) is encountered, the beach would be scraped and the undesirable material would be removed and stored at the construction staging area near Broadway Avenue. Upon completion of the navigation maintenance, the shells and undesirable sediment will placed at USACE Disposal Area 203, outside of the Federal AIWW right-of-way. This island was used as a borrow site for the winter 2010/2011 Topsail Beach Nourishment Project and has historically been subject to wake-induced erosion due to summer boat traffic which erodes the dike system along Topsail Creek. The material will be placed where needed on the island, working to repair the dike if needed at the time of construction. Otherwise, the unsuitable material will be placed in the upland portion of the island, outside of the USACE Right of Way (**Figure 13**).

Figure 13. Unsuitable material will be placed in DA-203, outside of the USACE Right of Way.