

Appendix 6

Limited Re-evaluation Report (LRR) for the Folly Beach Shore
Protection Project, April 2017

LIMITED RE-EVALUATION REPORT

GEOTECHNICAL APPENDIX
FOLLY BEACH SHORE PROTECTION PROJECT
FOLLY BEACH, SC

FINAL – APRIL 2017



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1.0 GENERAL

1.1 PROJECT LOCATION

Folly Island is 6.1-miles in length and is located about 12 miles south of Charleston, SC (Figure 1). Folly Island is situated between Morris Island and Lighthouse Creek to the northeast and Kiawah Island and Stono Inlet to the southwest. The Island is situated between the Atlantic Ocean to the southeast and Folly River to the northwest.

1.2 PROJECT DESCRIPTION AND AUTHORIZATION

The Folly Beach Shore Protection Project was originally authorized by Section 501 of the Water Resources Development Act of 1986, and later modified by the Energy and Water Development Appropriations Act of 1992. The original authorized project provided for restoration of approximately 3.19-miles of beach on Folly Island. The modification provided for restoration of 5.34-miles of beach on Folly Island, as recommended in the General Design Memorandum (GDM) of 1991 (GDM, 1991).

1.3 PROJECT BEACH PLACEMENT HISTORY

Initial construction of the Folly Beach Shore Protection Project was completed in May 1993 with the placement of approximately 2,800,000 Cubic Yards (CY) of beach-quality material. Initial construction material was dredged from the Folly River navigation channel (GDM, 1991) (Figure 2). The first periodic nourishment placement was completed in May 2005 with the placement of 2,338,000 CY of beach-quality material from Borrow Area A (PIR, 2013). In June 2007, 486,000 CY of material was placed on Folly Beach under the Public Law (PL) 84-99 assistance program (Rehabilitation for Non-Federal Flood Control Projects). This material was dredged from Borrow Area B (PIR, 2013). The second periodic nourishment placement was completed in September 2014 with the placement of 1,419,385 CY of beach-quality material from a combination of Borrow Areas A, B, C, and D (PIR, 2013). After the 2014 placement, Borrow Areas A, B, C, and D had been sufficiently depleted. Based upon initial construction, periodic re-nourishment and PL 84-99 volumes, the total volume of sand placed on Folly Beach is approximately 7,044,000 CY, with an

Figure 1. Folly Beach Location Map

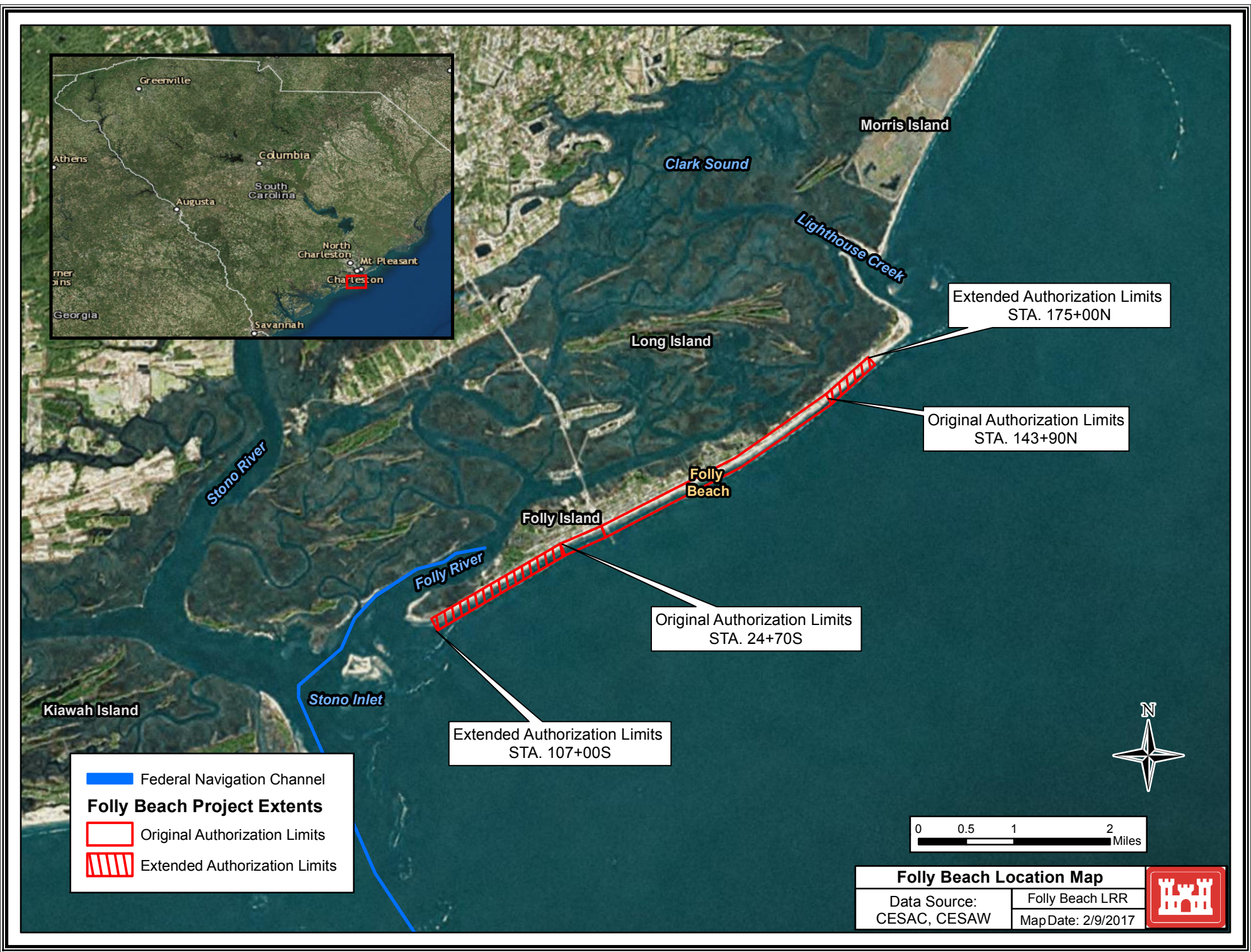
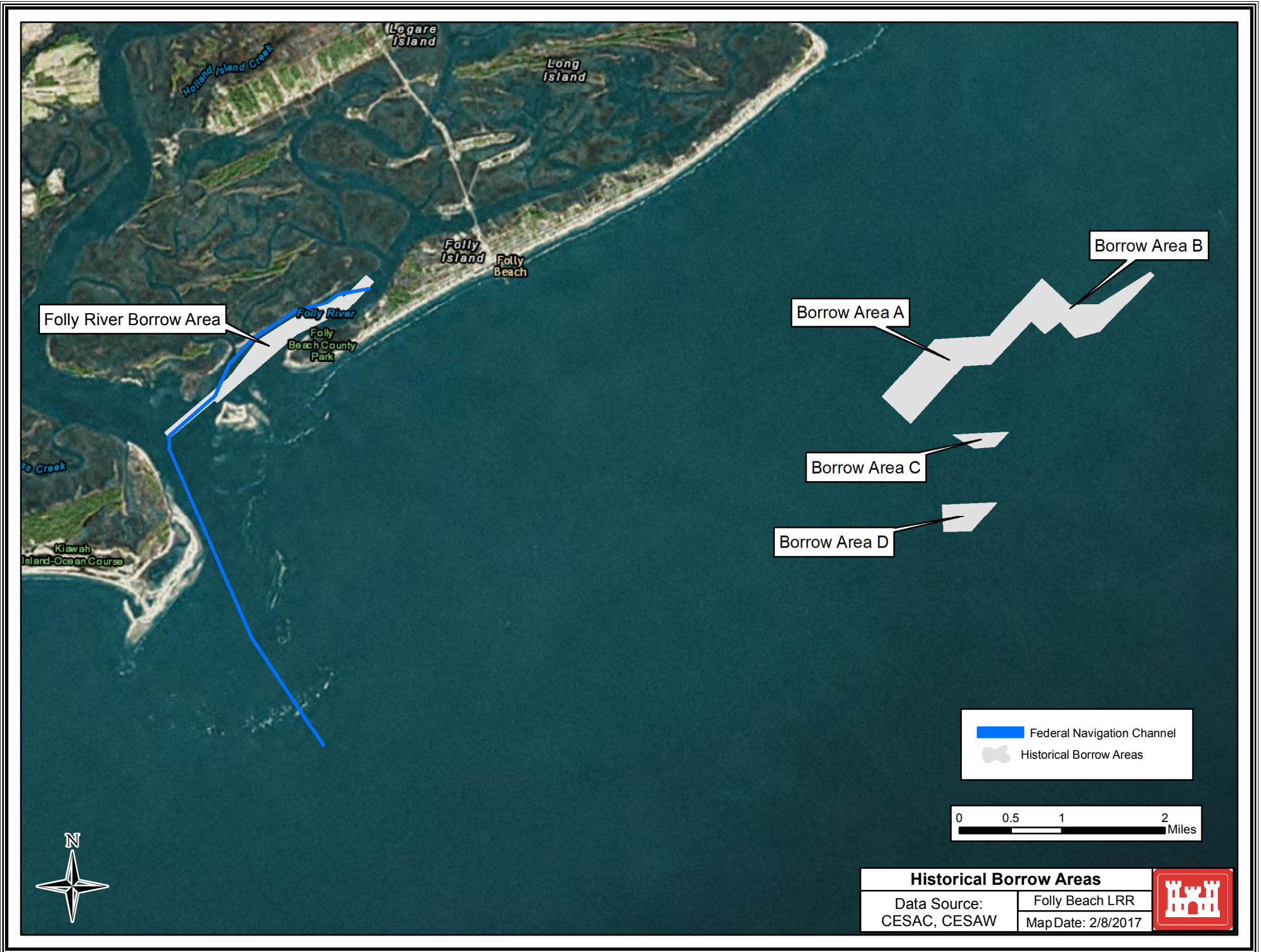


Figure 2. Historical Borrow Areas



average sand loss per year of approximately 336,000 CY (Table 1). Using the average sand loss per year since initial construction, and incorporating losses during construction and natural erosion processes, it is estimated that 11,760,000 CY of material is needed over the remaining 26 years of the authorized project life through 2042.

Table 1. Historical Volumes and Future Needs.

Beach Nourishment Effort	Year	Volume (CY)
Initial Construction	1993	2,800,000
First Periodic Placement	2005	2,338,000
PL 84-99 Assistance	2007	486,000
Second Periodic Placement	2014	1,420,000
	<i>Total placement through 2014</i>	7,044,000
	<i>Total placement per year through 2014</i>	336,000
	<i>Total remaining sand resources needed through 2042</i>	9,408,000
	<i>Total remaining sand resources needed through 2042 with incorporated losses (~25%)</i>	11,760,000

1.4 STUDY PURPOSE

The purpose of this study is to investigate potential borrow areas for beach-quality material for the remainder of the authorized project life. The current authorized project life ends in year 2042.

2.0 EVALUATION OF EXISTING DATA

2.1 GEOLOGIC SETTING

The coastal zone of South Carolina is situated within the South Atlantic Bight (or Georgia Bight), which extends from Cape Hatteras, North Carolina to West Palm Beach, Florida. This

region is characterized by a wide, shallow continental shelf on the trailing edge of the tectonically stable North American Plate. The embayed nature of South Carolina is strongly influenced by the underlying warped and/or faulted basement rock. Overlying this warped basement are Cretaceous to Tertiary strata that form a shelf-ward thickening sedimentary wedge, internally comprised of unconformably bound, on-lapping and off-lapping strata (Horton and Zullo, 1991). Superimposed upon these strata, are numerous erosive channeling and scour features caused by numerous sea-level fluctuations. Figure 3 consists of a map and cross section showing regional geological configuration and physiography of the South Carolina coastal margin.

2.2 NATIVE BEACH

Evaluation of the native beach sand is a vital part of potential borrow source evaluation and proposed borrow area development. The grain size characteristics of the native beach sand, which are used in the compatibility analysis discussed in Section 3.2, are a major factor when assessing the usefulness of a borrow area.

Forty-one (41) beach sediment samples were collected and analyzed, and the grain size characteristics were presented in the 1991 GDM (GDM, 1991). The mean grain diameter of the native beach was determined to be 0.17-mm, or fine-grained sand per the Unified Soil Classification System (USCS). These samples were acquired from the upper beach profile (above mean low water). Sediment samples were also acquired below the mean low water line, however incorporation of these samples results in a finer native mean grain diameter of 0.149-mm. The sand within Folly River, Stono Inlet, and offshore of Folly Beach is typically classified as fine grained sand per the USCS, and will be used for re-nourishment along Folly Beach. Erosion rates typically increase with decreasing grain size. Due to the increased erosion rates associated with using a fine grained sand, the higher native grain size diameter of 0.17-mm was used for the compatibility and overfill calculations. Using the higher native grain size criteria eliminates some of the fine grained sands found within the investigation areas, and ultimately leads to better quality beach-fill material with less susceptibility to erosion.

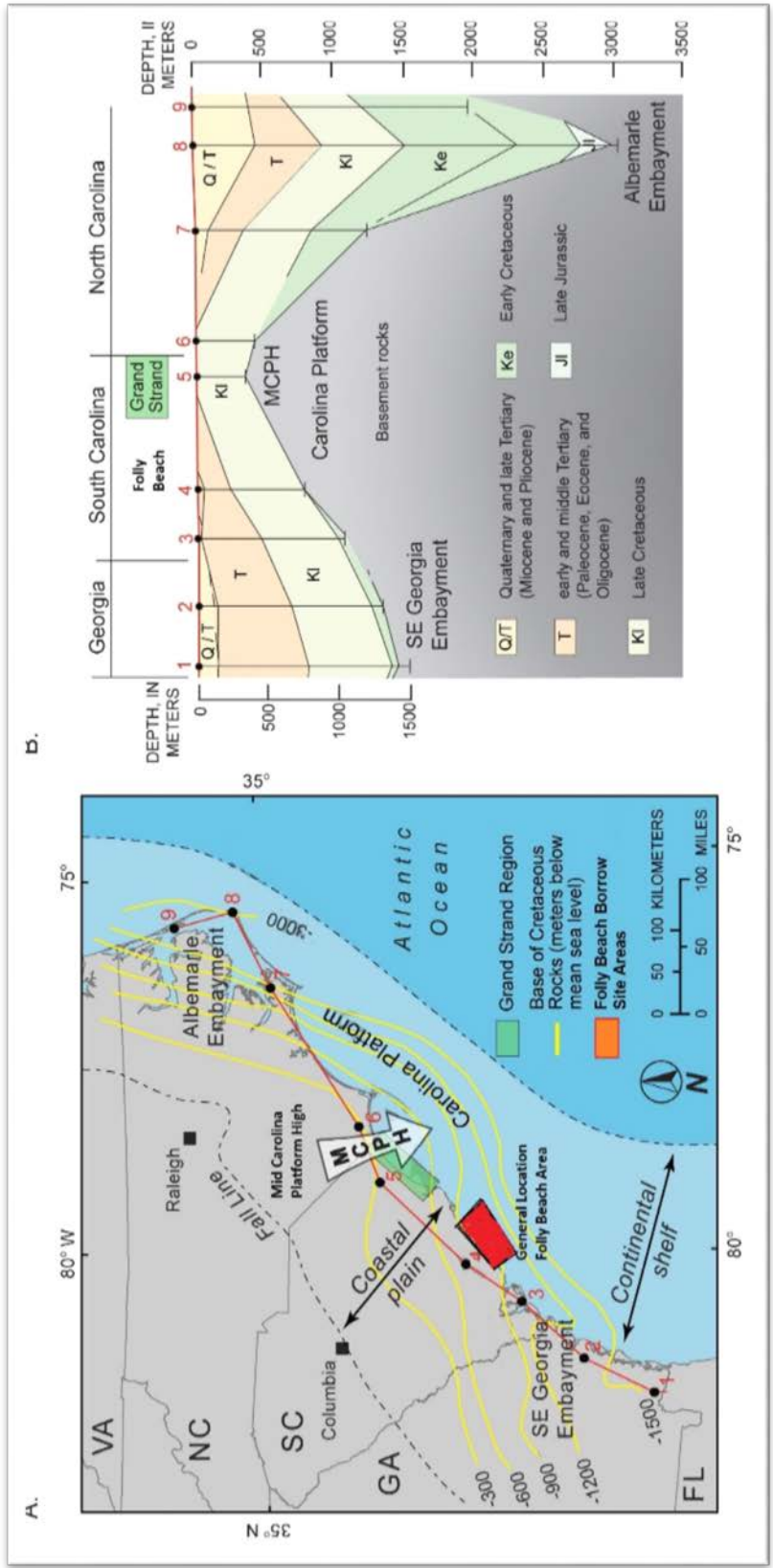


Figure 3. Regional Geologic Setting. Map and cross section showing regional geological configuration and physiography of the South Carolina coastal margin, adapted from Schwab et al., 2009. Yellow lines show structural contours of basement and inherited influence to stratigraphy.

MCPH - Mid-Carolina Platform High

2.3 STRATIGRAPHIC FRAMEWORK OFFSHORE OF FOLLY BEACH

Topographic/bathymetric expression of the landforms indicates that there has been significant shoreline change that is related to fluctuating sea level. Stair stepped marine and estuarine terraces are oriented sub-parallel to the modern shoreline, and they decrease in elevation seaward from +15 meters (49 feet m.s.l.) to -8 meters (-26 feet m.s.l.) where the coastal plain merges with the inner continental shelf (Harris et al., 2005).

The major early-Tertiary units are bounded by unconformable surfaces, which were generated by non-deposition or erosion during periods of lowered sea levels, and channel formation and scour associated with seaward migration of the ancient shoreline, or from erosional scour along the Tertiary shelf edge. Internally, these Tertiary formations contain mappable, gently to steeply dipping seismic reflectors and stratigraphically mappable carbonate and phosphate-rich, cemented lag deposits that form ledges offshore, in inlets and river bottoms, and in subaerial exposures on the Coastal Plain (Harris et al., 2005).

In contrast, Miocene and Pliocene strata are preserved primarily as broad infill sequences within the low stand-incised valleys and as isolated local basins on the earlier portions of the system. Outliers of these Miocene and Pliocene age units are scattered throughout the study area as erosional remnants and also contain variably resistant, scattered strata (Harris et al., 2005).

The Quaternary deposits of the Lower Coastal Plain comprise a series of barrier-island depositional systems created during cyclic sea-level highstands. During lowstands of sea level, valleys were shallowly incised into the exposed continental shelf and backfilled with various sediment types depending upon local geologic conditions and subsequent sea level rise and fall rates. Quaternary paleovalleys tend to be filled with muds, sandy muds, and muddy sands; tidally scoured paleochannels generally contain clean shelly sands (Harris et al., 2005).

2.4 TARGETING OF POTENTIAL OFFSHORE BORROW SOURCES

In 2002, the United States Geological Survey (USGS) and Charleston District (SAC), initiated a cooperative effort to complete a comprehensive geophysical mapping survey of a segment of the inner continental shelf offshore of Folly Beach, SC, (Schwab et al., 2002). This survey was designed to provide a regional reconnaissance of the character of surficial deposits in the vicinity of Folly Beach, and to aid USACE in identifying potential sand sources needed for planned storm damage reduction programs. Approximately 700 kilometers of geophysical data to include side-scan sonar, sub-bottom profiling, backscatter, and precision single-beam bathymetry were collected. Large areas of the inner shelf offshore of Folly Beach were found to exhibit high backscatter (highly reflective) response, which was interpreted to represent a rocky substrate unlikely to yield sufficient volumes of sand (Figure 4). High backscatter areas are shown in light gray in Figure 4. Previous work by Coastal Carolina University (CCU) found that these areas contain deposits of coarse shell hash (Gayes et al., 1995). Areas targeted as potential sand sources were the low backscatter areas, which are shown in dark gray in Figure 4. Areas of low backscatter response are generally indicative of sand or relatively finer grained surficial sediment. Because these areas cannot be further delineated into sand and fine-grained sediment bodies with backscatter alone, subsurface sediment sampling and grain size analysis are needed. Figure 4 shows the locations of Schwab et al's (2002) prioritized potential sand target areas, denoted as Priority Areas (PA) 1, 2, and 3.

PA-1 was defined as an elongate shore-parallel low-backscatter sedimentary deposit lying roughly 4 kilometers offshore of Folly Island. The sediment within this area was interpreted to contain ancient shore-face sand deposits from when sea-level was lower. These ancient deposits were considered the primary potential offshore source for suitable beach fill material. Southwest of PA-1 is an eastward trending shoal located 4 to 5 kilometers offshore of Stono Inlet, designated as PA-2, which was interpreted to be the seaward extension of the Stono ebb tidal delta and was predicted to contain suitable beach fill material. PA-3 is located adjacent to and northeast of PA-1, and was predicted to contain fine to coarse grained suitable beach fill material. PA-1, PA-2, and PA-3 were used as the primary target

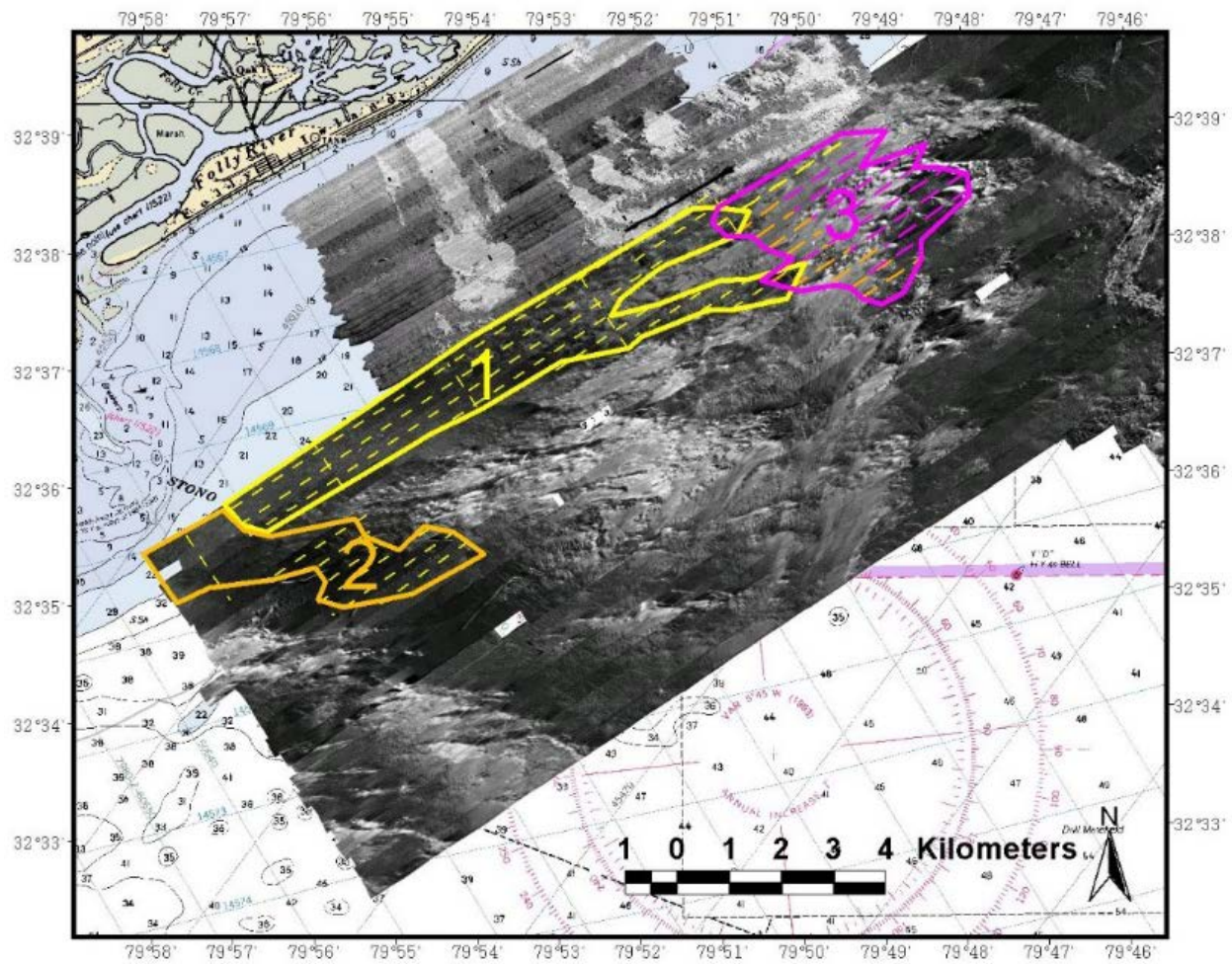


Figure 4. Initial Priority Areas for Offshore Investigations. PA-1, PA-2, and PA-3.

Areas in light gray represent "high backscatter" and are indicative of rocky substrate which is generally unacceptable for use as beach fill. Areas in dark gray represent "low backscatter" and may be indicative of beach quality material.

Schwab et al., (2002)

areas for the USACE Phase I Offshore Investigation conducted in 2015. This investigation is discussed in Section 3.1.

In addition to the USGS and SAC cooperative effort in 2002, multiple other historical geotechnical investigations were used in the targeting of potential offshore borrow areas. These investigations consisted of borings conducted in 1994 by two USGS vessels (NURC and FERREL); borings conducted in 2002 by Coastal Science and Engineering, LLC; borings conducted in 2003, 2004, and 2005 by Athena Technologies, INC; and borings conducted in 2006 by the Snell (Wilmington District). A full inventory of this data has been provided to the Charleston District, and is also stored on the network at the Wilmington District.

3.0 INVESTIGATIONS OF POTENTIAL BORROW SOURCES

3.1 GEOTECHNICAL INVESTIGATIONS

Using historical information described in section 2.4 in addition to offshore bathymetry, a vibracore boring investigation and a seismic reflection survey were conducted to delineate proposed offshore borrow areas for future beach-fill placement throughout the remainder of the project life.

A total of 170 vibracore borings were conducted in 2015 as part of the USACE Phase I Offshore investigation to evaluate the priority areas described in Section 2.4, as well as other areas of interest based upon offshore bathymetry and engineering judgement. Proposed offshore borrow areas were delineated based upon the findings from this investigation, the results of which are discussed in Section 4. After initial delineation of the potential offshore borrow sources USACE and Folly Beach sought additional alternative sites that would help mitigate high dredging costs associated with offshore dredging due to significant hauling or pumping distances. The alternative sites are located in portions of Stono Inlet and Folly River within the Coastal Barrier Resources Act (COBRA) zone. The COBRA of 1982, and later amendments, removed the Federal Government from financial involvement associated with building and development in underdeveloped portions of designated coastal barriers. These areas were mapped and designated as Coastal Barrier

Resources System units or “otherwise” protected areas. They are colloquially called COBRA zones. Due to restrictions on Federal funding being utilized for scientific investigations in COBRA zones, the City of Folly Beach (COFB) conducted two vibracore boring investigations within this zone utilizing non-federal funds. COFB Investigation Phases I and II, consisting of 40 and 25 vibracore borings, respectively, were conducted in portions of Folly River (in and near the Folly River Navigation Channel) and in Stono Inlet in 2015 and 2016 (Table 2). The areas within Stono Inlet and Folly River that were believed to contain beach quality sand were initially scoped using 2015 bathymetric surveys and historical vibracore borings collected in 2012 by the COFB. The vibracore boring layout for USACE Offshore Phase I and COFB Phases I and II, as well as the 2015 geophysical survey, is presented in Figure 5. Boring logs, core photographs, and laboratory results for the USACE Phase I Offshore investigation, and the COFB Phase I and Phase II investigations are attached in Enclosures 1 through 3, respectively. A summary of vibracore boring and geophysical investigations conducted in 2015 and 2016 is presented in Table 2.

Table 2. Summary of LRR Vibracore and Geophysical Investigations.

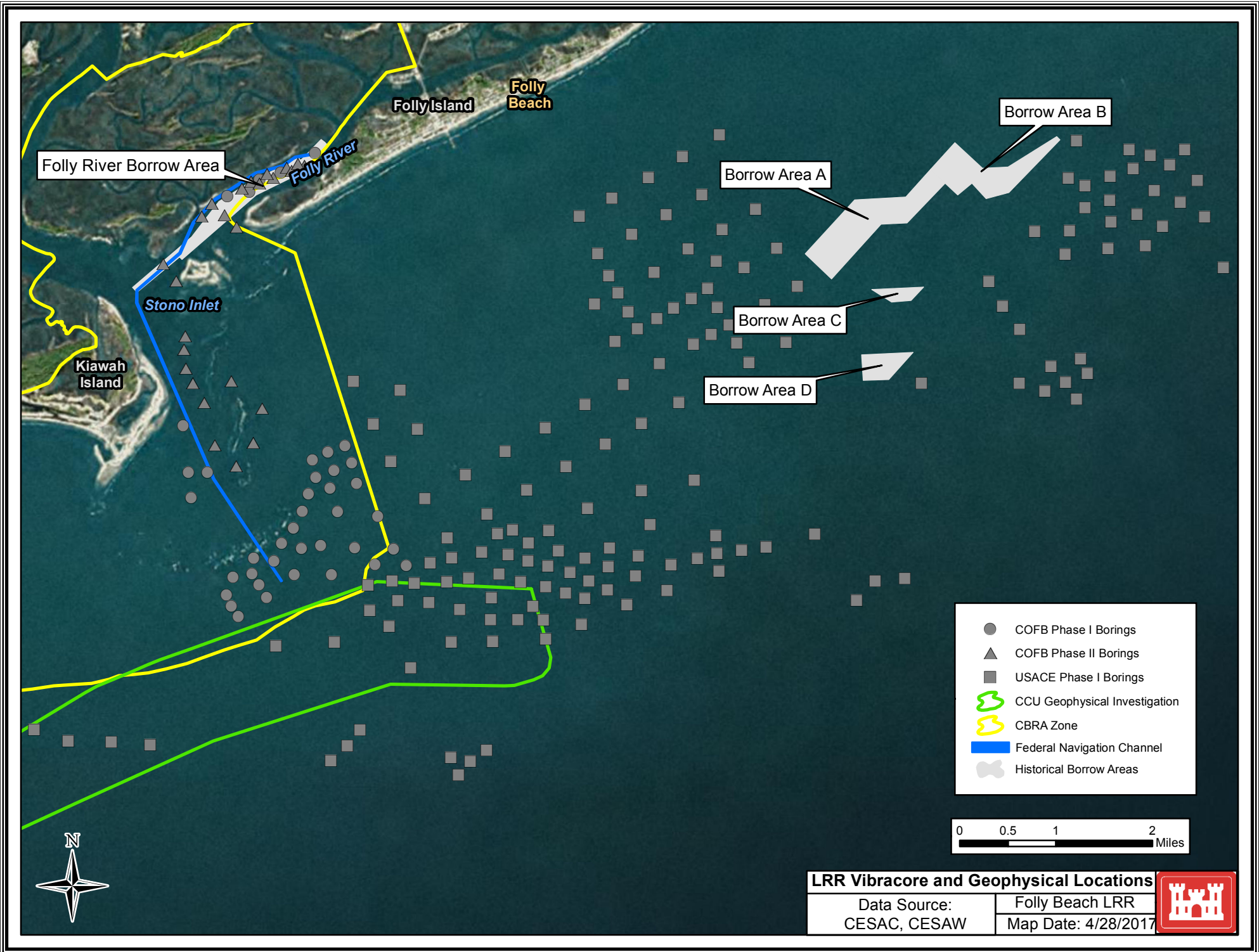
Year	Agency	Location	Investigation	# Borings
2015	CCU	Offshore	Geophysical	N/A
2015	USACE Phase I	Offshore	Vibracores	170
2015	COFB Phase I	Folly River/Stono Inlet	Vibracores	40
2015/2016	COFB Phase II	Folly River/Stono Inlet	Vibracores	25

3.2 COMPATIBILITY ANALYSIS

The first step in delineating potential borrow areas is determining the mean composite grain size for each boring, which consists of a weighted average of the grain size characteristics within the “suitable” portion of the boring. A portion of material considered to be “suitable” for beach-fill may consist of Poorly Graded Sand (SP), Poorly Graded Sand with Silt (SP-SM), or Silty Sand (SM) per the Unified Soil Classification System (USCS), as long as the portion of material meets the following criteria:

- Less than 10 percent, by weight, material passes #200 sieve over weighted average

Figure 5. Folly Beach LRR Vibracore and Geophysical Investigations



- Less than 10 percent, by weight, material retained on the #4 sieve over weighted average
- Material retained on the 3/4 inch sieve does not exceed, by percentage or size, that found on the native beach
- Contains no construction debris, toxic material, or other foreign matter
- Contains no cemented sands

Unsuitable materials encountered in this study consist of SP-SM or SM not meeting the criteria listed above, as well as Poorly Graded Sand with Clay (SP-SC), Clayey Sand (SC), Low Plasticity Silt (ML), High Plasticity Silt (MH), Low Plasticity Clay (CL), and High Plasticity Clay (CH) per the USCS. If there is an unsuitable material that lies on top of the suitable portion, the entire boring must be excluded due to inaccessibility of the suitable material. After composite grain size analysis, the suitable portion of material within the boring is then termed the “usable sand thickness”.

Each vibracore boring conducted during USACE Phase I Offshore, and COFB Phases I and II investigations were assigned either a green square, a red triangle, or a yellow circle based upon the “usable sand thickness”. A boring with less than 3-feet of usable sand is considered to have limited usefulness, and was assigned a red triangle. A boring containing between 3 and 5-feet of usable sand is considered to have good potential, but is still not ideal, therefore assigned a yellow circle. A boring containing greater than 5-feet of usable sand is considered to be ideal, and was assigned a green square. These designations are considered to be very conservative, and should be expanded upon during design level borrow area development. Some borings received lab testing and some did not. Field classified borings were differentiated from lab classified borings by a black dot in the center of the symbol.

After the “suitable sand thickness” is determined, the overfill ratio of this portion of material is then calculated. The overfill ratio is the volume of borrow material required to produce a stable unit of suitable fill material with the same grain size characteristics as the native beach sand. That is, the overfill ratio attempts to account for the natural loss of some fraction of the borrow sediment that is finer than the native beach sediment. For example,

an overfill ratio of 1.2 indicates that 1.2 units of borrow material will be required to place 1 unit of beach fill. There are multiple ways of calculating the overfill ratio, including the Dean Method and the James-Krumbein (J-K) method, (Bodge, K.R., 2006). Of the two methods, the J-K method typically yields smaller overfill ratios, or less conservative results. Because of this, the Dean method was used for this evaluation.

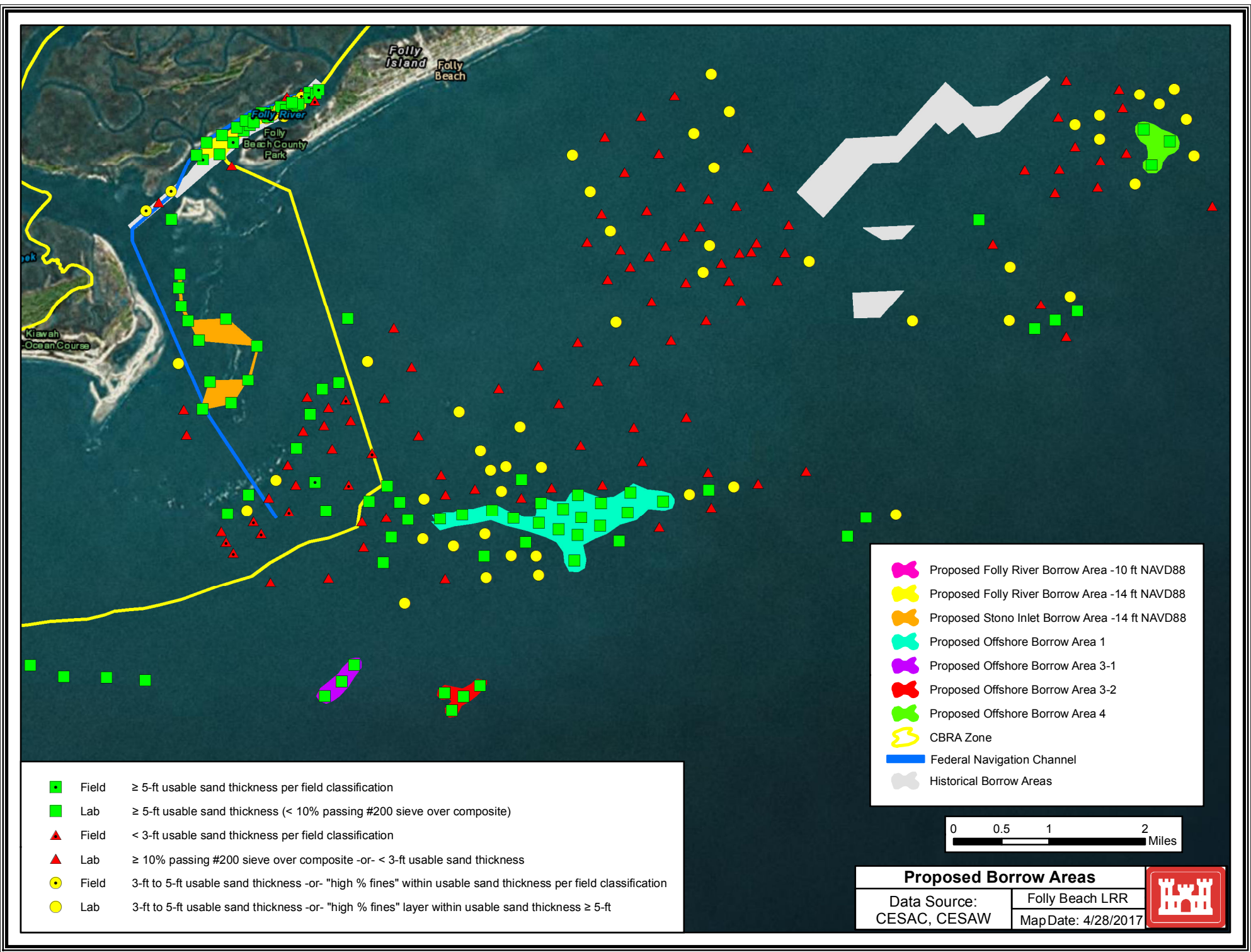
Once the “usable sand thickness” and overfill ratios are determined within each boring, proposed borrow areas are delineated and associated volumes are calculated. Red, yellow, and green designated borings and proposed borrow areas can be seen in Figure 6. The legend in Figure 6 is a summary of the boring designations described above. All proposed borrow areas are discussed in detail in Section 4.

4.0 PROPOSED BORROW AREAS

4.1 PROPOSED OFFSHORE BORROW AREAS

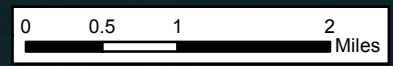
An overview map of the proposed offshore borrow areas can be seen in Figure 6, and individual maps can be seen in Figures 7 through 9. For the individual maps, each boring is labeled with three numbers; the boring number on top, the “usable sand thickness” in the middle, and the overfill ratio at the bottom. These numbers, in conjunction with engineering judgement, were used to delineate the proposed borrow areas. The “usable sand thickness” and overfill ratios are defined in Section 3.2. Bentley InRoads was used to generate preliminary quantities of beach compatible sand based upon a selected uniform “usable sand thickness” and the most recent bathymetric surveys within the proposed borrow areas, which were conducted December 2015. The selected “usable sand thickness” for each proposed area is indicated in the sections below, and was based upon the most conservative dredge cut depth. For example, if a proposed borrow area contained twenty (20) borings with a “usable sand thickness” range from 7 to 10-feet, the more conservative value of 7-feet was selected. This represents the most conservative volume estimation, and should be re-assessed during design level borrow area development. Boring logs, core photographs, and laboratory results for all Offshore Phase I borings can be seen in Enclosure 1.

Figure 6. Proposed Borrow Areas



- Field ≥ 5-ft usable sand thickness per field classification
- Lab ≥ 5-ft usable sand thickness (< 10% passing #200 sieve over composite)
- ▲ Field < 3-ft usable sand thickness per field classification
- ▲ Lab ≥ 10% passing #200 sieve over composite -or- < 3-ft usable sand thickness
- Field 3-ft to 5-ft usable sand thickness -or- "high % fines" within usable sand thickness per field classification
- Lab 3-ft to 5-ft usable sand thickness -or- "high % fines" layer within usable sand thickness ≥ 5-ft

- ✂ Proposed Folly River Borrow Area -10 ft NAVD88
- ✂ Proposed Folly River Borrow Area -14 ft NAVD88
- ✂ Proposed Stono Inlet Borrow Area -14 ft NAVD88
- ✂ Proposed Offshore Borrow Area 1
- ✂ Proposed Offshore Borrow Area 3-1
- ✂ Proposed Offshore Borrow Area 3-2
- ✂ Proposed Offshore Borrow Area 4
- ✂ CBRA Zone
- Federal Navigation Channel
- Historical Borrow Areas



Proposed Borrow Areas	
Data Source:	Folly Beach LRR
CESAC, CESAW	MapDate: 4/28/2017



4.1.1 PROPOSED OFFSHORE BORROW AREA 1

Proposed offshore Borrow Area 1 is located southeast and directly adjacent to Stono Inlet, as can be seen in Figure 7. This area offers the largest volume of beach compatible sand out of all the offshore areas based upon preliminary estimation, totaling 4,889,000 CY. For the purpose of conservative volume calculations, a uniform “usable sand thickness” of 6-feet was selected. Relative data for Area 1 are available in Table 3. Due to the moderate to large spacing of borings within this proposed borrow area, it is recommended that a more precise investigation be conducted before the borrow area is developed for design. With a mean grain size diameter of 0.19-mm, this material is considered to be a fine grained sand per the USCS. If offshore Borrow Area 1 is developed for design, the area may be expanded due to a change in the COBRA zone limits. This would increase the estimated volume.

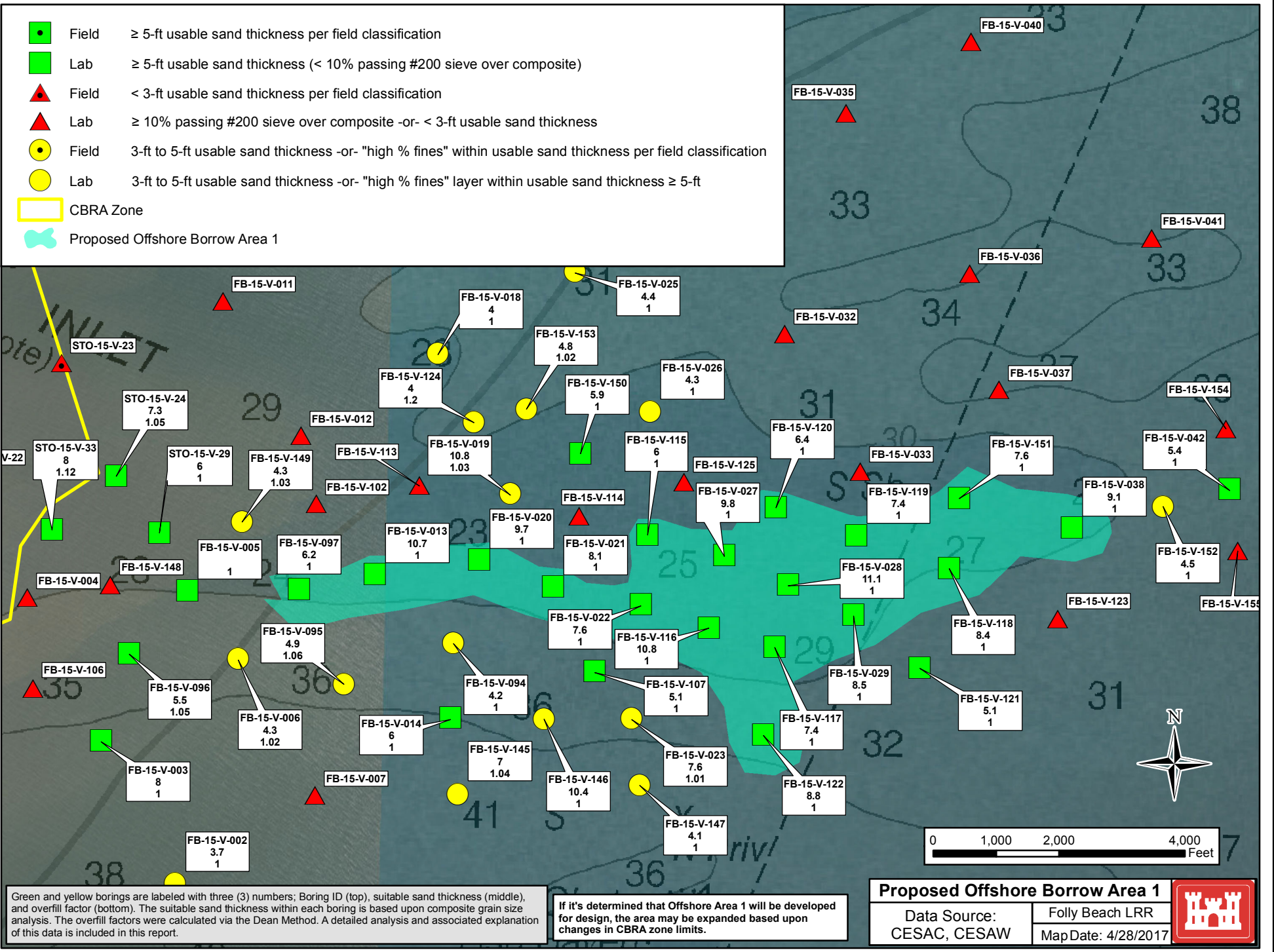
4.1.2 PROPOSED OFFSHORE BORROW AREA 3-1

Proposed Offshore Borrow Area 3-1 is located southeast of Stono Inlet and southwest of proposed Offshore Borrow Area 1, and can be seen in Figure 8. This area offers 836,000 CY of beach compatible sand based upon preliminary estimation. A uniform “usable sand thickness” of 8-feet was selected for volume calculations. Relative data for proposed offshore Borrow Area 3-1 are available in Table 3. With a mean grain size diameter of .37-mm, this material is considered a medium grained sand per the USCS. The limits of Area 3-1 have potential to be expanded greatly with additional geotechnical investigations.

4.1.3 PROPOSED OFFSHORE BORROW AREA 3-2

Proposed offshore Borrow Area 3-2 is located approximately one mile west of Borrow Area 3-1 and southeast of Stono Inlet, and can be seen in Figure 8. This area offers approximately 620,000 CY of beach compatible sand based upon preliminary estimation. A conservative uniform “usable sand thickness” of 6-feet was selected for volume calculations. Relative data for proposed offshore Borrow Area 3-2 are available in Table 3. With a mean grain size diameter of .30-mm, this material is considered to be a medium grained sand per the USCS. The limits of Area 3-2 have potential to be expanded greatly with additional geotechnical investigations.

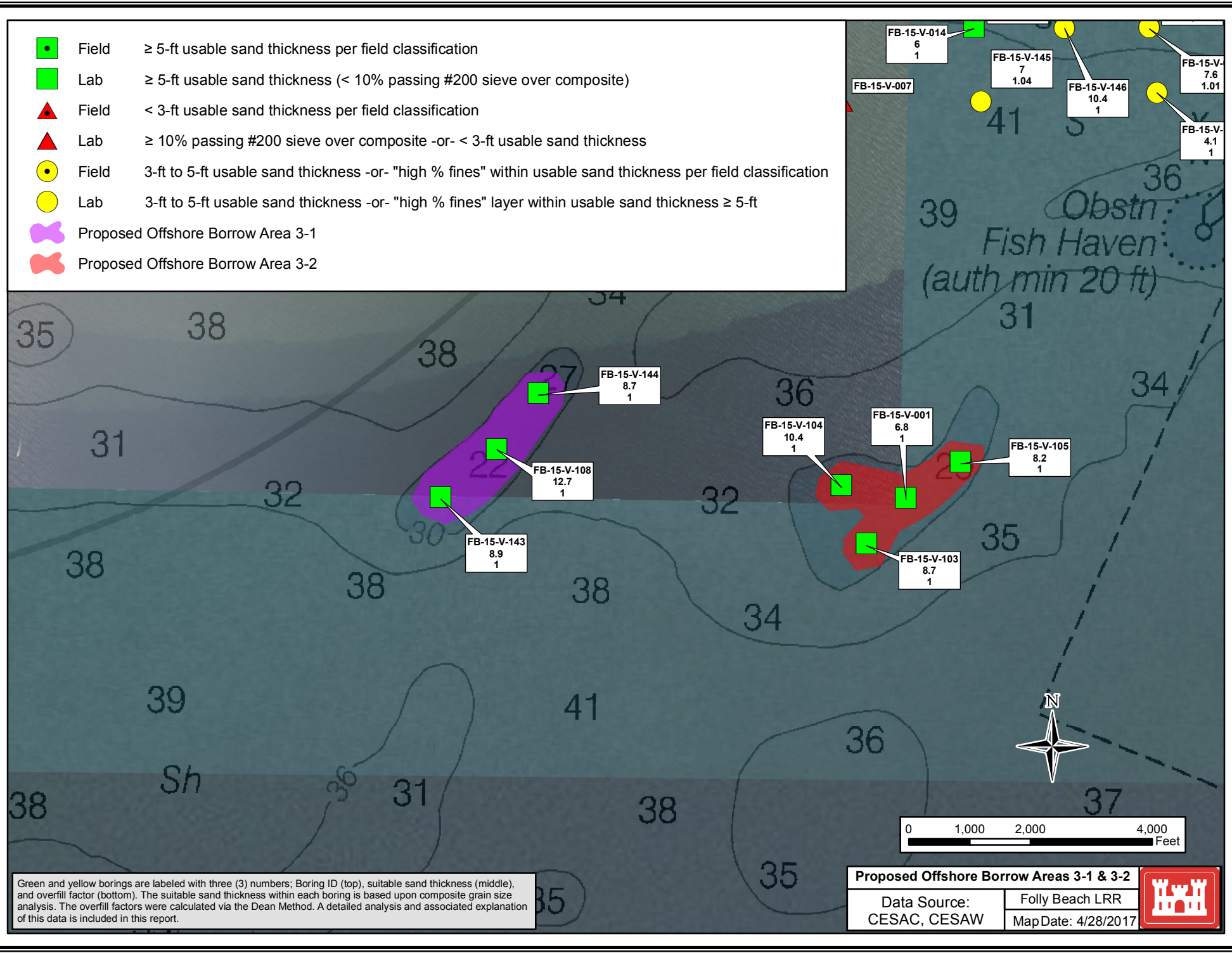
Figure 7. Proposed Offshore Borrow Area 1



Green and yellow borings are labeled with three (3) numbers; Boring ID (top), suitable sand thickness (middle), and overfill factor (bottom). The suitable sand thickness within each boring is based upon composite grain size analysis. The overfill factors were calculated via the Dean Method. A detailed analysis and associated explanation of this data is included in this report.



Figure 8. Proposed Offshore Borrow Areas 3-1 and 3-2



- Field ≥ 5-ft usable sand thickness per field classification
- Lab ≥ 5-ft usable sand thickness (< 10% passing #200 sieve over composite)
- ▲ Field < 3-ft usable sand thickness per field classification
- ▲ Lab ≥ 10% passing #200 sieve over composite -or- < 3-ft usable sand thickness
- Field 3-ft to 5-ft usable sand thickness -or- "high % fines" within usable sand thickness per field classification
- Lab 3-ft to 5-ft usable sand thickness -or- "high % fines" layer within usable sand thickness ≥ 5-ft
- ✶ Proposed Offshore Borrow Area 3-1
- ✶ Proposed Offshore Borrow Area 3-2

Green and yellow borings are labeled with three (3) numbers; Boring ID (top), suitable sand thickness (middle), and overfill factor (bottom). The suitable sand thickness within each boring is based upon composite grain size analysis. The overfill factors were calculated via the Dean Method. A detailed analysis and associated explanation of this data is included in this report.

4.1.4 PROPOSED OFFSHORE BORROW AREA 4

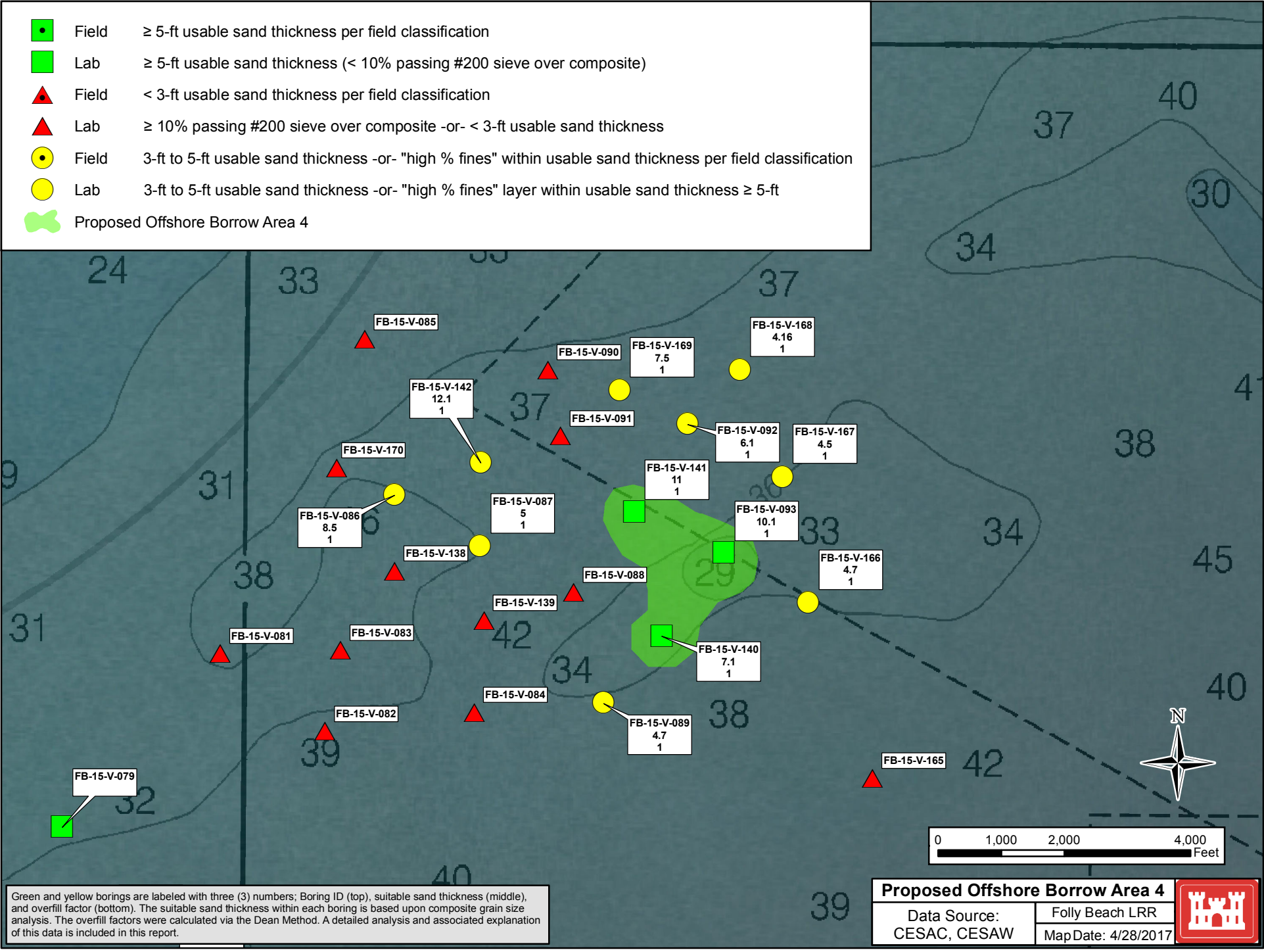
Proposed offshore Borrow Area 4 is located northeast of Stono Inlet, approximately 4.5 miles off Folly Beach, and can be seen in Figure 9. This area offers 985,000 CY of beach compatible sand based upon preliminary estimation. A conservative uniform “usable sand thickness” of 6.5-feet was used for volume calculations. Relative data for proposed offshore Borrow Area 4 are available in Table 3. This area has a mean grain size diameter of .35-mm, indicating a medium grained sand per the USCS. With a boring spacing of almost half a mile, these results should be considered preliminary, and a more detailed investigation should take place for design. The limits of Area 4 have potential to be expanded greatly with additional geotechnical investigations and analysis.

4.2 PROPOSED STONO INLET BORROW AREA

Stono Inlet is an ebb-dominated tidal inlet separating Folly Beach to the north and Kiawah Island to the south. A Federal navigation channel is maintained through Stono Inlet, and is located on the Kiawah Island side of a large ebb shoal. The proposed Stono Inlet borrow area(s) are located within the ebb shoal, approximately 1.5 to 3-miles from the southern end of Folly Island, and are contained within the COBRA zone.

An alternative to explore Stono Inlet was initially included within the alternatives decision matrix and discussed amongst PDT members during multiple meetings at the beginning of the project in early 2015, however a decision was made to forego pursuing the alternative due to Federal limitations imposed within the COBRA zone. After the offshore investigations were complete, proposed borrow areas were developed, and a certified cost estimate was conducted, the PDT chose to re-examine the Stono Inlet alternative due to the excessive cost of using the offshore areas. Review of historical investigations within the ebb shoal, which begins upstream of Bird Key Island and extends all the way through the throat of the inlet, revealed that this area may contain a vast amount of beach compatible sand. In order to better quantify this potential, three (3) different proposed borrow areas were delineated; high confidence, moderate confidence, and low confidence. These confidence areas were delineated based on engineering judgement which incorporated bathymetric


Figure 9. Proposed Offshore Borrow Area 4



Green and yellow borings are labeled with three (3) numbers; Boring ID (top), suitable sand thickness (middle), and overfill factor (bottom). The suitable sand thickness within each boring is based upon composite grain size analysis. The overfill factors were calculated via the Dean Method. A detailed analysis and associated explanation of this data is included in this report.

Proposed Offshore Borrow Area 4

Data Source:	Folly Beach LRR
CESAC, CESAW	Map Date: 4/28/2017

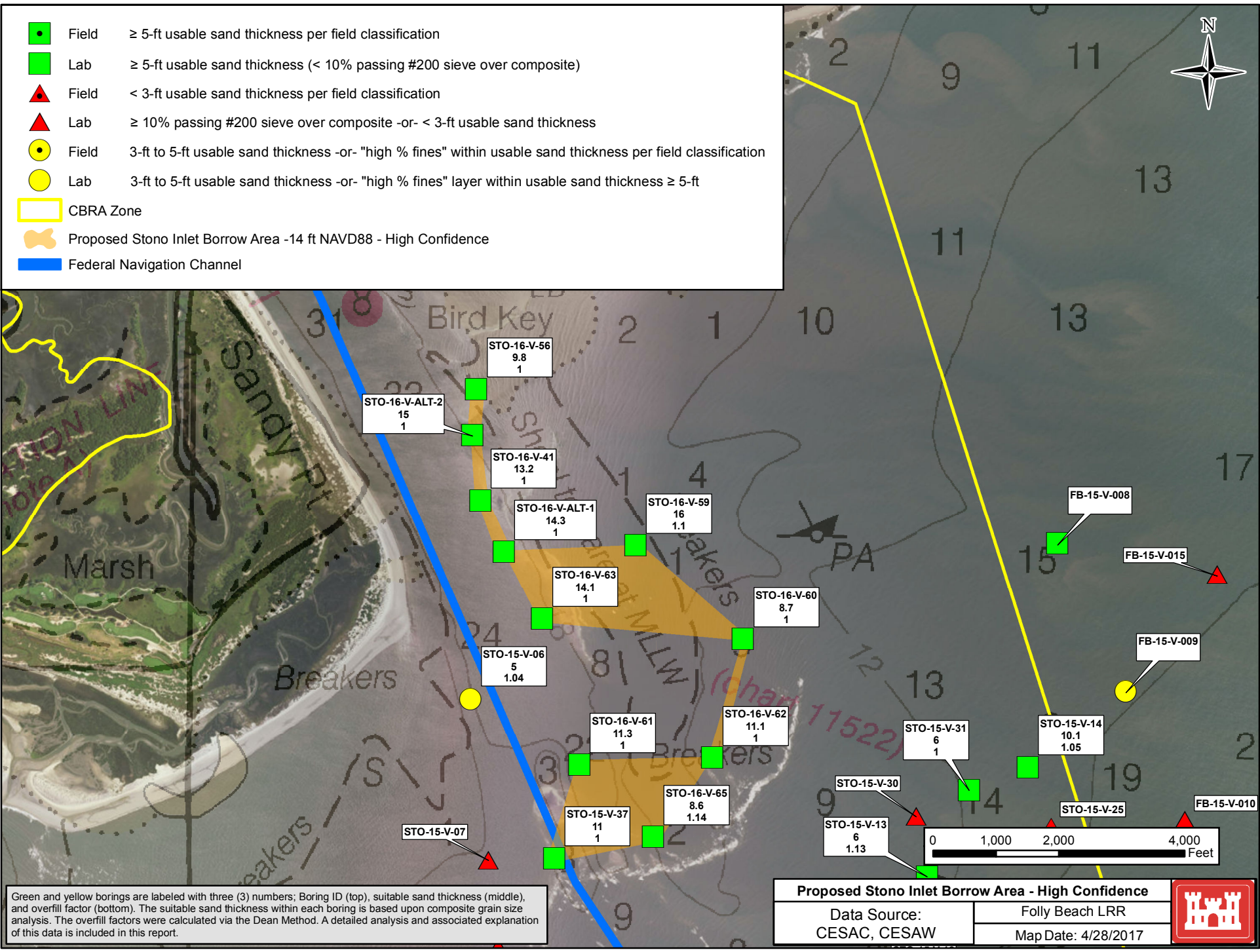


surveys, and current and historical geotechnical investigations. For the high confidence areas, a lateral distance of less than 100-feet was held from each outer boring within the area. For the medium and low confidence areas, larger extrapolations from the outer borings were used based upon the aforementioned surveys and investigations.

For the purpose of general vicinity, an overview map of the proposed Folly River Borrow Area (High Confidence) can be seen in Figure 6. Individual maps for the confidence areas can be seen in Figures 10 through 12. These figures show three numbers directly adjacent to each boring; the boring number on top, the “usable sand thickness” in the middle, and the overfill ratio at the bottom. The “usable sand thickness” and the overfill factor are discussed in detail in Section 3.2. Bentley InRoads was used to generate preliminary quantities of beach compatible sand based upon a maximum dredge cut depth selected by the PDT and the most recent bathymetric survey within the delineated areas, which was conducted in August 2015 by SAC. Material encountered within the borrow areas included primarily Poorly Graded Sand (SP), Poorly Graded Sand with Silt (SP-SM), Poorly Graded Sand with Clay (SP-SC), Silty Sand (SM), and Clayey Sand (SC). Low Plasticity Silt (ML), High Plasticity Silt (MH), Low Plasticity Clay (CL), and High Plasticity Clay (CH) were some of the other materials that were encountered within the borrow areas.

The high, moderate, and low confidence volumes, as well as relative data for the Stono Inlet proposed borrow areas can be seen in Table 3. These areas have a mean grain size diameter of 0.166-mm, which indicates a fine grained sand per the USCS. Per PDT request, the dredge cut depth within these areas was restricted to -14 feet NAVD88. This cut depth represents a very conservative value of the true volume of material within these areas. The ebb shoal within Stono Inlet is believed to contain a large volume of beach compatible sand, possibly larger than any other area discussed in this report, however with a boring spacing of almost half a mile, these results should be considered preliminary, and a more detailed investigation should take place for design. In addition, by modifying the dredge cut depth to incorporate more of the sand column, the volume should increase significantly. These estimated volumes represent one-time borrow volumes, and do not account for recharge. Recharge volumes should be calculated for a more thorough understanding of the true

Figure 10. Proposed Stono Inlet Borrow Area - High Confidence



Green and yellow borings are labeled with three (3) numbers; Boring ID (top), suitable sand thickness (middle), and overfill factor (bottom). The suitable sand thickness within each boring is based upon composite grain size analysis. The overfill factors were calculated via the Dean Method. A detailed analysis and associated explanation of this data is included in this report.

Figure 11. Proposed Stono Inlet Borrow Area - Moderate Confidence

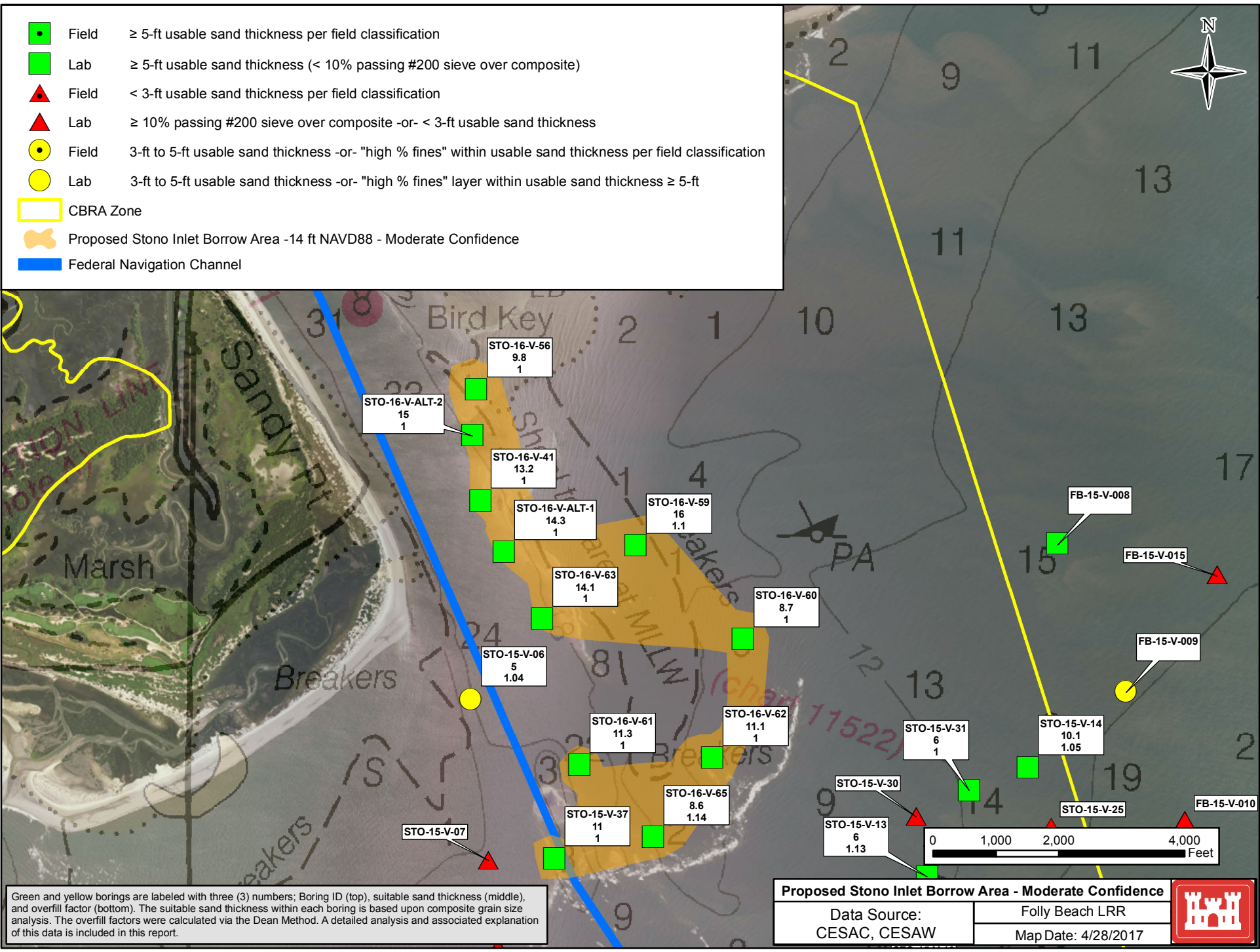
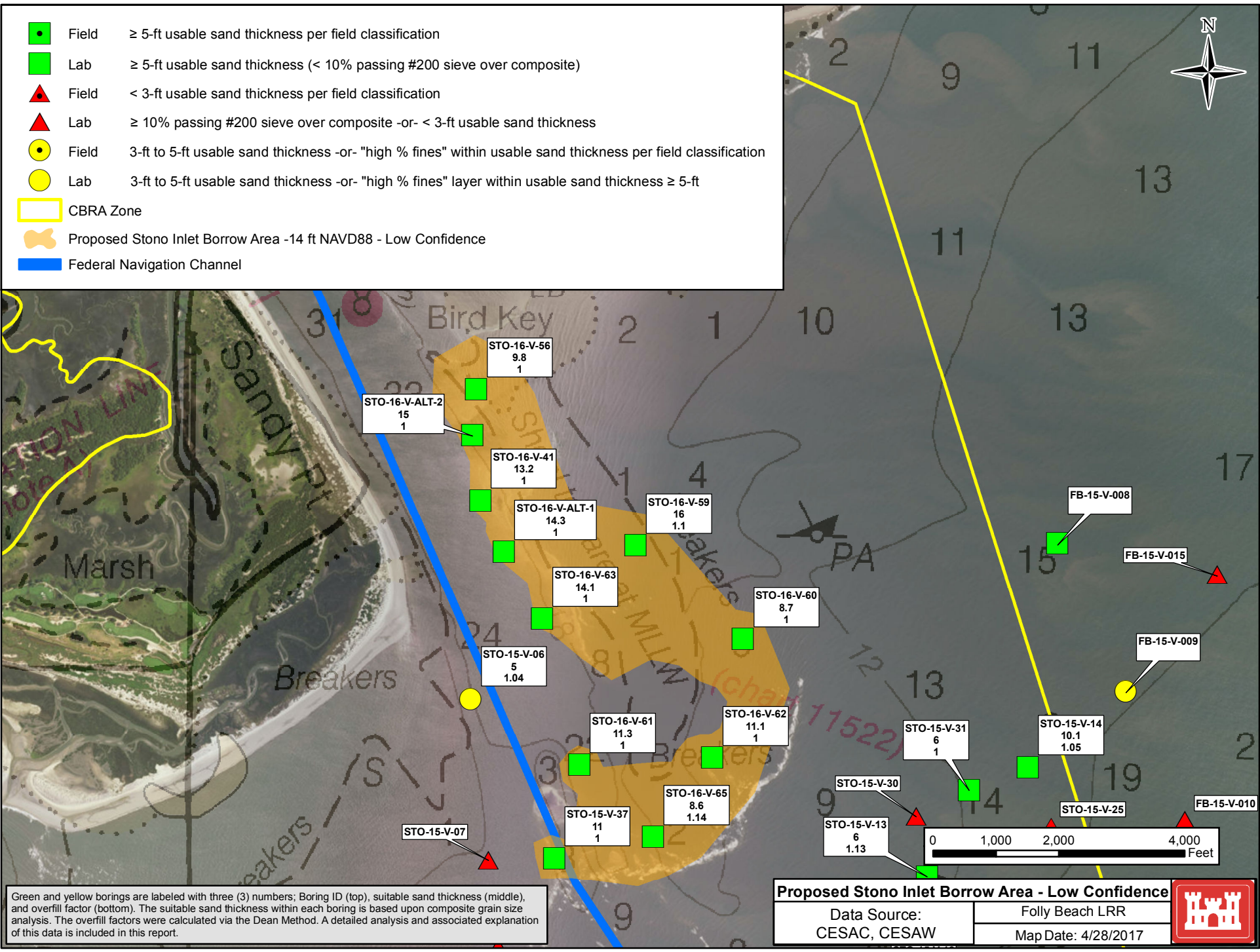


Figure 12 - Proposed Stono Inlet Borrow Area - Low Confidence



Green and yellow borings are labeled with three (3) numbers; Boring ID (top), suitable sand thickness (middle), and overfill factor (bottom). The suitable sand thickness within each boring is based upon composite grain size analysis. The overfill factors were calculated via the Dean Method. A detailed analysis and associated explanation of this data is included in this report.

potential within the proposed Stono Inlet Borrow Area. Boring logs, core photographs, and laboratory results for all Stono Inlet borings can be seen in Enclosures 2 and 3.

Boring locations for this potential borrow area were selected along the edges of the ebb shoal for ease of extraction. The boring locations are not indicative of proposed cuts. For example, removal of a large section of the ebb delta is not endorsed here. Rather, the boring locations provide information for potential cut(s) "inside" the channel from STO-16-V-56 offshore to -V-37, and for other potential cut(s) on the outside edge of the shoal where borings -V-59 offshore to -V-65 characterize the type of material. As mentioned above, a more detailed investigation will be required to refine the borrow area design.

4.3 PROPOSED FOLLY RIVER BORROW AREA

Folly River has been used as a source for two Folly Beach re-nourishment projects in the past, including initial project construction as well as the County Park project at the southern end of the island. Folly River is believed to contain a large amount of beach compatible sand, and has been considered a self-replenishing source by some technical documents.

The Folly River alternative was initially included in the alternatives decision matrix and discussed with the PDT during multiple meetings at the beginning of the project in early 2015, however a decision was made to forego pursuing the alternative due to Federal limitations within the COBRA zone as well as the belief that the needed volume of beach compatible sand was not available within the river. After the offshore investigations were complete, proposed borrow areas were developed, and a certified cost estimate was conducted, the PDT chose to re-examine the Folly River alternative due to the excessive cost of using the offshore areas.

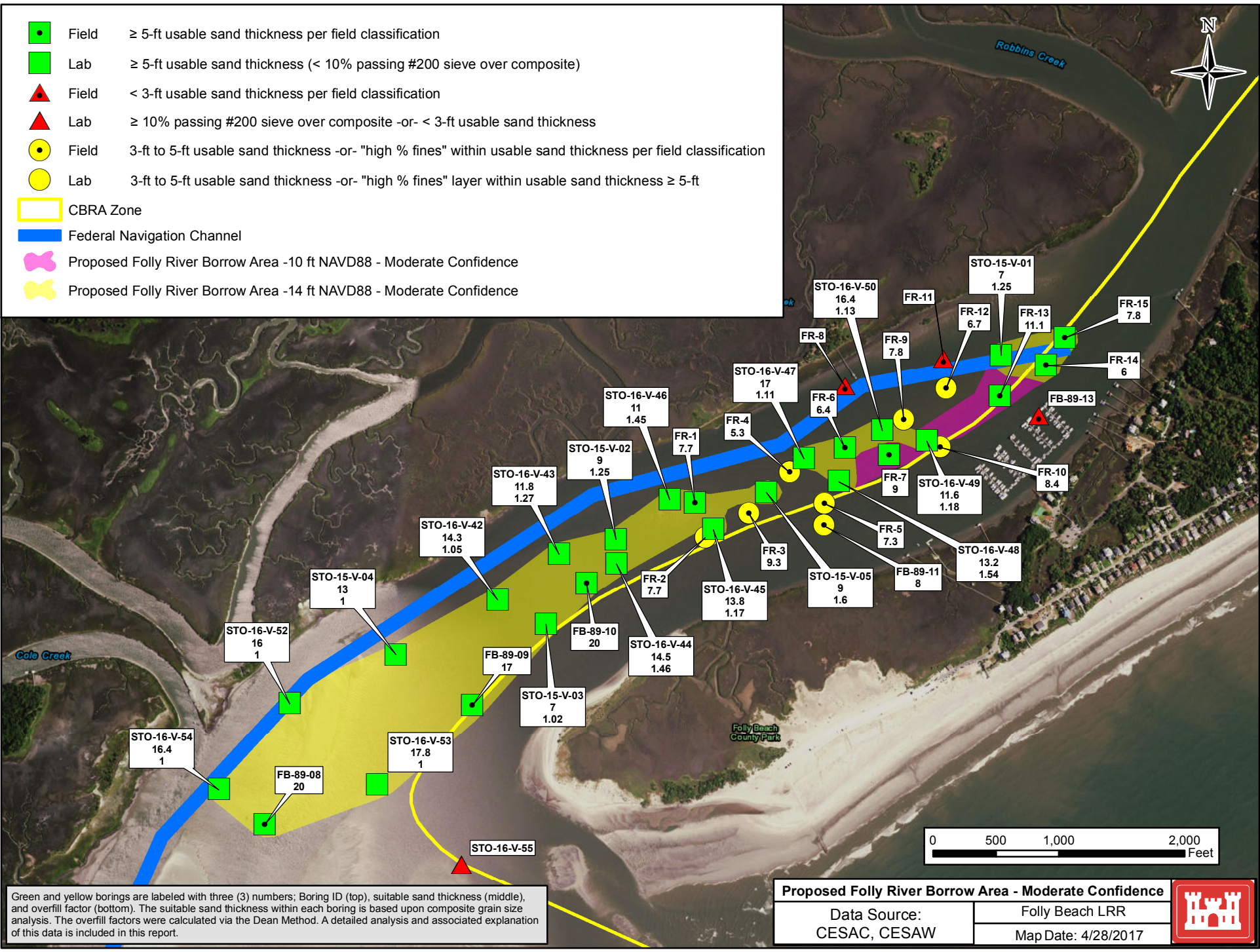
In order to better quantify the potential within Folly River, two (2) different areas were delineated; high confidence and moderate confidence. A low confidence area was not considered due to the amount of unknowns within Folly River. These confidence areas were delineated based on engineering judgement which incorporated bathymetric surveys, and current and historical geotechnical investigations. For the high confidence area, a

lateral distance of less than 100-feet was held from each outer boring within the area. For the medium confidence area, a larger extrapolation from the outer borings was used based upon the aforementioned surveys and investigations.

For the purpose of general vicinity, an overview map of the proposed Folly River Borrow Area (High Confidence) can be seen in Figure 6. Individual maps for the confidence areas can be seen in Figures 13 and 14. These figures show three numbers directly adjacent to each boring; the boring number on top, the “usable sand thickness” in the middle, and the overfill ratio at the bottom. The “usable sand thickness” and the overfill factor are discussed in detail in Section 3.2. Bentley InRoads was used to generate preliminary quantities of beach compatible sand based upon a maximum dredge cut depth selected by the PDT and the most recent bathymetric survey within the delineated areas, which was conducted in August 2015. Material encountered within Folly River included primarily Poorly Graded Sand (SP), Poorly Graded Sand with Silt (SP-SM), Poorly Graded Sand with Clay (SP-SC), Silty Sand (SM), and Clayey Sand (SC). Low Plasticity Silt (ML), High Plasticity Silt (MH), Low Plasticity Clay (CL), and High Plasticity Clay (CH) were also encountered within Folly River. Boring logs, core photographs, and laboratory results for all Folly River borings can be seen in Enclosures 2 and 3.

The high and moderate confidence volumes, as well as the relative data for the Folly River proposed borrow areas can be seen in Table 3. These areas have a mean grain size of 0.16-mm, which indicates a fine grained sand per the USCS. Per PDT request, the dredge cut depth within these areas was restricted to -14 feet NAVD88. This cut depth was used in applicable locations within the proposed borrow areas. A small location exists at the upriver portion of the proposed borrow areas where a dredge cut depth of -14 feet is too deep for the usable sand column. A cut depth of -10 feet NAVD88 was used within this area. This cut depth limitation of -14 feet NAVD88 is considered conservative within the lower portion of the borrow area, with the usable sand thickness extending down to approximately -22 feet NAVD88 within this area. Due to boring spacing of approximately 1000-feet within the lower portion of the borrow area, these results should be considered preliminary, and a more detailed investigation should take place for design. In addition, by


Figure 14 - Proposed Folly River Borrow Area - Moderate Confidence



Green and yellow borings are labeled with three (3) numbers; Boring ID (top), suitable sand thickness (middle), and overfill factor (bottom). The suitable sand thickness within each boring is based upon composite grain size analysis. The overfill factors were calculated via the Dean Method. A detailed analysis and associated explanation of this data is included in this report.

Proposed Folly River Borrow Area - Moderate Confidence

Data Source: CESAC, CESAW	Folly Beach LRR Map Date: 4/28/2017
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modifying the dredge cut depth to incorporate more of the sand column within the lower portion of the proposed borrow area, the volume should increase significantly. These estimated volumes represent one-time borrow volumes, and do not account for recharge. Recharge volumes should be calculated for a more thorough understanding of the true potential within the proposed Folly River Borrow Area.

4.4 SUMMARY OF PROPOSED BORROW AREAS

The proposed borrow areas indicated in Table 3 were based on vibracore boring investigations in which the borings were spaced to maximize the use of the available budget, and cover as much ground within the potential borrow areas as possible. The proposed borrow areas were delineated from these vibracore boring investigations, and as such all volume estimates should be considered preliminary. Detailed investigation(s) should be conducted in which boring spacing provides for design level borrow area development.

Table 3. Summary of Relative Data for Proposed Borrow Areas

PROPOSED BORROW AREAS	MEAN GRAIN		MEAN OVERFILL RATIO	DREDGE CUT		HIGH CONFIDENCE VOLUME (CY)	MODERATE CONFIDENCE VOLUME (CY)	LOW CONFIDENCE VOLUME (CY)
	SIZE (mm)	% PASSING #200 SIEVE		DEPTH (FT)	ELEVATION (FT NAVD88)			
Folly River	0.16	2.6	1.14		-14	1,261,000 ¹	1,370,000 ¹	
Stono Inlet	0.17	1.68	1.11		-14	1,005,000 ¹	1,740,000 ¹	2,454,000 ¹
Offshore Area 1	0.19	3.01	1	6		4,889,000 ²		
Offshore Area 3-1	0.37	3.83	1	8		836,000 ²		
Offshore Area 3-2	0.3	1.07	1	6		620,000 ²		
Offshore Area 4	0.35	4.55	1	6.5		985,000 ²		
<i>Total:</i>						9,596,000	10,440,000	11,154,000

1. Estimated volume represents a one-time borrow volume, and does not account for recharge.
2. It is assumed that no recharge takes place, therefore no additional material will be available once depleted.

Based upon these preliminary volume estimates, the majority of the material needed (11,760,000) over the remaining 26-years of the authorized project life, as calculated in Section 1.3, is available within a combination of the proposed borrow areas.

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