U. S. Department of Homeland Security
Region IV
3005 Chamblee Tucker Road
Atlanta, GA 30341

FEMA

IN REPLY REFER TO: APPEAL RES

January 3, 2023

Verdenia C. Baker
County Administrator, Palm Beach County
301 North Olive Avenue, Suite 1101
West Palm Beach, Florida 33401

Community: Palm Beach County, Florida,
Community No.: 120192

Dear County Administrator Verdenia C. Baker:

This letter acknowledges receipt of a submittal dated July 9, 2021, sent from Palm Beach County regarding the preliminary Flood Insurance Rate Maps (FIRMs) and Flood Insurance Study (FIS) for Palm Beach County, FL issued December 20, 2019. The appeal submittal, referenced in this document as the Palm Beach County (PBC) submittal, requested revisions to the preliminary storm surge modeling and subsequent transect-based modeling and mapping of Special Flood Hazard Areas (SFHAs). The submittal identified the following subjects to be addressed:

1. Topographic Data – More recent topographic information was identified, and a change analysis was provided for areas of Palm Beach County Unincorporated.
2. South Florida Storm Surge Study (SFLSSS) Inputs and Methods – Information was provided concerning the wind and pressure field grid resolution, the stability of results with respect to model setup, the model uncertainty, treatment of tidal data, and application of validation storms.

The following subsections provide a response to each of the subjects identified in the PBC appeal submittal:

Topographic Data:

The PBC submittal provided information pertaining to a new topographic dataset, 2016/2017 PBC Light Detection and Ranging (LiDAR), which has full spatial coverage of the county. This 2016/2017 PBC topographic data was collected more recently than the Digital Elevation Model (DEM) used for the preliminary FIS. The preliminary study DEM was based on 2016 USACE LiDAR (generally located on the barrier islands) and 2007 FDEM LiDAR (generally located inland of the barrier islands). The submittal identified some elevation differences between the 2016/2017 PBC LiDAR and the preliminary study DEM in areas west of the barrier islands, covering a portion of 9 preliminary FIRM panels.

When conducting a countywide FIS, FEMA intends to use appropriate topographic data to reflect current conditions, which often involves the most recently-collected LiDAR data. At the start of the transect-based analysis for this study, the topographic data used in the preliminary study DEM was analyzed and deemed appropriate to use in the Palm Beach County FIS by the study team and FEMA. The 2016/2017 PBC LiDAR was not released until 2018, after the transect-based analysis was in progress.

Based on review of the data and analysis provided in the PBC submittal, FEMA determined that sufficient information was provided to make reasonable preliminary mapping adjustments. Zone adjustments were made to accommodate the updated SFHA extents based on the data provided, but no overland modeling adjustments were made based on this data. The updated mapping resulted in an expansion of the Shaded X area to reduce the amount of properties in the SFHA, and adjustments made to the flood zone boundaries to accommodate the new SFHA limit. The revised mapping update has been incorporated into the revised preliminary FIRM panels (12099C0393G, 12099C0581G, 12099C0583G, 12099C0591G, 12099C0593G, 12099C0781, 12099C0783G, 12099C0791G, and 12099C0793G) enclosed with this letter.

Storm Surge Study Inputs and Methods:

The submittal review concluded that the preliminary FIRM panels should not be revised based on the SFLSSS evaluation provided in the PBC appeal submittal. According to both the 44 CFR 67.6 and the FEMA *Guidance for Flood Risk Analysis and Mapping: Appeal and Comment Processing* (Feb 2019), the sole basis of an appeal is the possession of knowledge or information indicating that the flood hazard determinations proposed by FEMA are scientifically or technically incorrect. The appellants are required to demonstrate that the alternative methods or applications result in more correct estimates of flood hazard determinations.

The materials submitted by Palm Beach County have identified some potential areas for an alternative approach or method (such as refined model grids, different model settings, or different validation approaches) but the PBC submittal did not demonstrate that these suggested changes result in more correct estimates of flood hazard elevations and mapping. Further, the PBC submittal did not demonstrate how the alternative analyses would impact preliminary modeling or mapping. The PBC submittal modeled 3 storms, but 392 total storms were modeled to create the statistical Stillwater Elevation (SWEL) that contributes to preliminary modeling and mapping. Three modeled storms cannot be directly integrated or used, and cannot fundamentally demonstrate the impact to the SWEL and the impact on the resultant BFEs.

The review team, consisting of Compass and FEMA, attempted to review all PBC submittal comments regarding the SFLSSS. Based on this review, FEMA has reservations concerning the storm surge results, comparisons, and conclusions, as presented in the report. Enclosure A provides additional discussion of some subsections of the PBC submittal pertaining to modeling-related aspects of the SFLSSS.

A particular concern was found on page 36 of 62, noting that the PBC submittal was unable to replicate modeling results from the SFLSSS using the same model setup and version. Computing environments may lead to minor differences in results, however, independent model runs (with the same SWAN+ADCIRC code version and model control files) across different computing platforms should produce water levels that are very similar. This specific SFLSSS preliminary study model setup was tested on two separate High-performance Computing (HPC) methods for multiple storms, and differences in the maximum water levels produced range from 0 to 2 inches (across over 100 stations). This indicates there is a fundamental difference between the model setup in the submittal analyses and SFLSSS study, and makes any final impact of the analyses proposed in the PBC submittal difficult to evaluate. The evaluation presented in Enclosure A attempts to directly compare the output files submitted by PBC and does not try to recreate these results.

PBC submittal comments regarding the SFLSSS were reviewed by Compass and FEMA and did not result in documented changes to preliminary modeling and mapping. To supplement the above response, Enclosure A provides some additional discussion of some subsections of the PBC submittal pertaining to modeling-related aspects of the SFLSSS.

As a result of the comments received from this PBC submittal, Compass conducted a thorough review of the FIRMs and incorporated changes to additional panels listed below. The total set of revised preliminary Palm Beach County FIRMs are enclosed for your review and comment.

- **12099C0178G**
- **12099C0186G**
- **12099C0393G**
- **12099C0581G**
- **12099C0583G**
- **12099C0591G**
- **12099C0593G**
- **12099C0778G**
- **12099C0779G**
- **12099C0781G**
- **12099C0783G**
- **12099C0787G**
- **12099C0791G**
- **12099C0793G**
- **12099C0976G**
- **12099C0977G**
- **12099C0986G**
- **12099C0987G**
- **12099C0989G**
- **12099C1177G**
- **12099C1178G**

Please review the enclosed preliminary FIRM panels and preliminary FIS report to verify that the updated flood hazard data for this resolution has been satisfactorily incorporated. Please submit any comments regarding the resolution within 30 days of the date of this letter to the following address:

Kristen M. Martinenza, P.E., CFM, Chief
Risk Analysis Branch
FEMA Region IV
3005 Chamblee-Tucker Road
Atlanta, Georgia 30309
770-220-3174

If you feel that the technical issues originally raised have not been adequately addressed by this resolution letter and that an acceptable resolution will not be feasible through the submittal of additional comments as outlined above, please note that FEMA makes Scientific Resolution Panels (SRPs) available to support the appeal resolution process. SRPs are independent panels of experts in hydrology, hydraulics, and other pertinent sciences established to review conflicting scientific and technical data and provide recommendations for resolution. An SRP is an option after FEMA and a local community have been engaged in a collaborative consultation process without a mutually acceptable resolution.

Your community may contact Mitigation Division at 770-220-5406 for additional information on the specific eligibility requirements for the SRP or refer to the enclosed SRP Fact Sheet. To request that an SRP review your scientific or technical data, your community must complete the enclosed SRP Request Form and submit it to the address above within 30 days of the date of this letter.

If we do not receive any comments or the completed SRP Request Form from your community during the 30-day review period associated with this resolution, we will finalize the FIRM and FIS report by issuing a Letter of Final Determination (LFD). The LFD will explain the adoption/compliance process and will state the date when the FIRM and FIS report will become effective.

FEMA appreciates your community's comments and commitment to having the most accurate flood hazard information available reflected on the FIRMs and in the FIS Report. If you have any questions regarding this matter, please contact Kristen Martinenza of FEMA Region IV either by telephone at 770-220-3174 or by e-mail at Kristen.Martinenza@fema.dhs.gov or Michael Taylor of AECOM by telephone at 404-946-9488 or by email at Michael.Taylor@aecom.com.

Sincerely,

Kristen M. Martinenza, P.E., CFM, Chief
Risk Analysis Branch
FEMA Region IV

Enclosures:
Enclosure A
Preliminary FIRM Panels
Preliminary Flood Insurance Study

cc: Robert Weinroth, Mayor, Chairman, Board of County Commissioners, Palm Beach County
Doug Wise, Building Director, Palm Beach County
Conn Cole, CFM, State NFIP Coordinator

Enclosure A: PBC Submittal SFLSSS Comment Review Response

The subsections below provide a more detailed response to the technical items of the SFLSSS that were identified in the PBC submittal:

1. **Wind and Pressure Field Grid:** The PBC submittal identified that a more detailed wind and pressure input grid exists for the southern portion of Palm Beach County compared to a more coarse grid resolution for the central and northern portion of Palm Beach County. Input wind and pressure grid resolution could have an impact on storm surge and wave modeling results; however, evidence has not been provided to show that grid refinement would cause a notable impact to preliminary Base Flood Elevations (BFEs) determined from a statistical analysis of 392 storm simulations.

   Based on the information that was provided in this PBC submittal, an internal evaluation was conducted to examine the effect of the wind and pressure grid setup on results. Similar to the plots shown in Figures 9 to 14 of the submittal, an evaluation was conducted to compare the maximum Water Surface Elevation (WSE) differences between results for Storms 18, 20, and 21 between the SFLSSS results and the results provided in the PBC submittal. For each of the three storms, the PBC Submittal compares the storm result WSE's to the resulting WSE from the more coarse regional grid. Compass tried to replicate these differences shown in Figures 9 to 14 based on the storm surge study data, comparing the storm result WSE's to the WSE's from the more coarse regional grid. Analysis of the differences between these two model grid results indicated WSE differences that are a much lower magnitude than those depicted in the PBC submittal's Figures 9 to 14 (despite attempts to apply the same data). The Compass model comparison results showed smaller magnitude differences, but also different spatial extents of changes compared to the PBC submittal figures, which showed a sporadic and spatially-limited coverage of results. The findings of the Compass comparison are summarized for each storm accounting for the inland and open coast water bodies between South Palm Beach and Delray Beach:

   - Storm 18: maximum WSE differences range from -0.5 ft to 0.2 ft
   - Storm 20: maximum WSE differences range from -0.1 ft to 0.1 ft
   - Storm 21: maximum WSE differences range from -0.1 ft to 0.3 ft

   These differences are noted because the PBC submittal's figures (9 through 14) show differences that can reach approximately 3 to 6 feet. FEMA's reviewers were unable to determine the cause of discrepancies between the differences noted in the PBC submittal and the smaller differences noted in the internal model review for the 3 noted storm simulations.

   Additionally, the above comparisons are between the SFLSSS wind and pressure grid setup (comprised of partially refined and coarse grid resolution) and a fully coarse wind and pressure grid setup across the study site. An analysis of a refined wind grid applied to the entire study area was not conducted in the PBC submittal.

2. **Model Setup:** The PBC submittal outlines some concerns regarding model stability and performance with discussions regarding restricting localized water level gradients and canal filled mesh. The PBC submittal also notes QA/QC concerns, consistent model setups, local numerical instabilities at inlets, and the assignment of nodal attributes.

   The SFLSSS methods and results underwent quality control checks by the internal technical team, the Coastal Advisory Panel, and an independent team developed by FEMA including FEMA staff and independent consultants. These reviews examined technical aspects such as mesh resolution, model configurations applied to develop stability, and nodal attribute assignments. The reviews did not raise concerns about the methods or results applied by the SFLSSS.

   In addition to the above checks, Compass also provided the following responses based on each technical comment regarding the model setup:

   - **Restricting Localized Water Gradient:** The PBC submittal criticizes the use of the Elemental Slope Limiter (ESL) parameter in the SFLSSS, however this parameter is a reasonable way to dampen localized instabilities near canal banks during productions runs. The ESL parameter has been applied to several previous studies, including the North Carolina SSS (2012) and the ongoing New York and New Jersey (NYNJ) SSS (2022).
   - **Canal Filled Mesh:** The PBC submittal notes that there are some canals that were "filled in" or excluded from the mesh. The removal of small hydraulically connected canals for the purposes of improving model stability is a reasonable approach applied to all previous storm surge studies. Small-scale canals are not required to be incorporated into SSS modeling for the purposes of developing a countywide FIS.
   - **Disabled Wind Stress Forcing in Broward County:** The PBC submittal notes that the SFLSSS disabled wind stress forcing in select overland locations to allow the wetting front to propagate solely through local hydrodynamics. The PBC submittal also notes that they did not review the impacts of this application on the model results in the county. SFLSSS results were reviewed during the QA/QC process and issues involving this modeling technique were not identified. A sensitivity analysis of the approach including disabled wind stress forcing is documented in Appendix B of the IDS 3, Section 1 report of the SFLSSS (2018).
   - **Deepening of the Caribbean bathymetry:** The PBC submittal notes that the SFLSSS eliminated instabilities in shallow areas of the Caribbean by artificially deepening nodes near the shorelines of Cuba and the Bahamas. The PBC submittal also notes that they did not review the impacts of this application on model results in the County. SFLSSS results were reviewed during the QA/QC process and issues involving this modeling technique were not identified. Deepening of Caribbean bathymetry areas was also conducted in the Georgia/Northeast Florida (GANEFL) SSS (2015).
   - **Identifying instabilities:** The PBC submittal notes an alternative approach to identifying instabilities. The SFLSSS verified results to ensure that numerical instabilities were identified correctly and ensure that anomalous, yet reasonable, water levels were not incorrectly identified as an instability. The PBC submittal suggested other ADCIRC tools that could have been used to identify instabilities, such as NFOVER, however, this tool can

flag ephemeral spatial gradients at early timesteps which may not necessitate termination of the model run. Numerical instabilities in the SFLSSS were identified using contour plots of maximum WSE at zoomed in scales to identify problematic gradients. The contour maximum and minimum WSE were auto-generated for each plot such that extreme values would be apparent to the reviewer. This methodology for evaluation of numerical instabilities was consistent with other SSS, such as the South Carolina (SC) SSS (2013), the GANEFL SSS (2015), the East Coast Central Florida (ECCFL) SSS (2016), and the NYNJ SSS (2022).

- **Quality Assurance/Quality Control (QA/QC) at Local Level:** The PBC submittal notes that a sensitivity analysis of mesh or nodal attribute changes was examined on a regional scale and not locally. Local changes in results would be expected based on revised mesh; the regional stability of the model is of higher importance based on the scope of this study. Nevertheless, localized model stability is evaluated in the QA/QC process for the SFLSSS. Section 4 of the IDS3: Section 1 SFLSSS report explains the QA/QC process of production runs for the SFLSSS, including a "Detailed Check" of output data. This review includes contour plots of data results at a higher resolution in order to identify any gradients or anomalous values at a higher level of detail.

  As this section of the PBC submittal notes, numerical instabilities often present themselves on a single node. Small-scale localized instabilities generally occur in all large-scale modeling efforts, including FEMA regional storm surge studies. Prior to transect-based modeling, additional checks were done to eliminate any anomalous output points to prevent those outputs from influencing the Stillwater Elevation (SWEL) surface used for transect based modeling and mapping.

- **Consistent Model Setups:** The PBC submittal criticizes the use of unique model mesh and nodal attributes for some storm production runs. The use of unique model mesh and node attributes is common practice in storm surge studies and consistent with most previous SSS, including SC (2013), GANEFL (2015), ECCFL (2016), and NYNJ (2022). As some production runs resulted in instabilities, some were reasonably addressed with updates to the mesh or node attributes, but these updates were relatively minor and did not require updates to production run storms that produced reasonable results on the base mesh.

- **Local Numerical Instabilities at Palm Beach Inlets**: The PBC submittal identified a drop in WSE within Boynton Inlet for a storm production run. FEMA reviewed the information provided and found that the preliminary mesh grid resolution at this site is reasonable based on the scope and large modeling scale of this project. The PBC submittal identifies a drawdown in WSE in the inlet that is improved but not eliminated with a higher mesh resolution. These results are also located in the inlet and not over a developed area of interest for purposes of flood mapping. QA/QC of the maximum water levels produced in the vicinity of Boynton Inlet did not identify spatial gradients. Based on the information provided in the PBC submittal, it is not tested if this modeling result for Boynton Inlet is relevant for any of the other 391 storms modeled in the SFLSSS, and therefore the impact to the SWEL and resulting BFE surface based on this change is not demonstrated. The PBC submittal did not verify whether this proposed mesh change would have an actionable impact on the floodplain mapping.

- **Assignment of Nodal Attributes:** The PBC submittal notes that there are some areas where the C-CAP land cover database and corresponding SFLSSS model node attributes

could be improved for some topographic and bathymetric features. The PBC submittal identified some areas where the C-CAP or model node attributes could be updated but did not verify whether these changes would have an actionable impact on the floodplain mapping. Based on Compass review, the accuracy of the node attributes for the SFLSSS is reasonable based on the scale of this regional model, which contains over 2 million nodes.

- **Re-simulated storm results:** The PBC submittal provided a review of maximum WSE differences between their 3 modified storm production runs and the SFLSSS production runs. The figures provided in the PBC submittal (Figures 27 to 35) show large changes, however, Compass review of the PBC submittal maximum WSE compared to the PBC submittal figure results (27 to 35) showed much smaller magnitude changes than what was shown in the figures. In review of this submittal, Compass compared the SFLSSS max WSE outputs to the max WSE outputs provided in the PBC submittal to evaluate differences. Notable differences in the WSE's were observed as a result of the modeling updates in the PBC submittal, however, these differences did not match the report figures. For example, Storm 18 shows maximum WSE differences of approximately 5 feet in areas, according to Figure 29 of the PBC submittal. Review of the SFLSSS maximum WSE compared to the PBC submittal maximum WSE for Storm 18 showed that these WSE results generally differed by less than 0.5 feet across Palm Beach County inland and open coast areas. These WSE differences also appear to vary spatially compared to the results reviewed by Compass. It is unclear why review of the PBC submittal result files show smaller differences than reported. We continue to have concerns regarding the statement on page 36 of 62, noting that the PBC submittal was unable to replicate modeling results from the SFLSSS using the same model setup and version.
- **Model run for tide effects:** The PBC submittal disagrees with the use of the hot-start to combine tidal runs, stating that this could be susceptible to error. Tidal validation runs were reviewed as part of the QA/QC process and errors were not identified based on the methodology applied. This process was also applied for GANEFL (2015) and ECCFL (2016) SSS.

3. **Model Uncertainty:** The PBC submittal provides information related to the SFLSSS uncertainty analyses and alternative ways to calculate the model performance (uncertainty, skill, bias) based on different decisions or regions. The SFLSSS methods to develop and apply uncertainty estimates followed similar procedures to other recent east coast Florida FEMA storm surge studies where a regional, study-wide, estimate of uncertainty was developed and applied. This is consistent with application in other studies as cited, as well as a correct application per FEMA *Guidance for Flood Risk Analysis and Mapping: Statistical Simulation Methods* (2016). The uncertainty approach and results underwent quality control checks by the internal technical team, the Coastal Advisory Panel, and an independent team developed by FEMA including FEMA staff and independent consultants. In addition, throughout Section 4.3, the PBC submittal does not provide a detailed examination of how these aspects related to model skill or uncertainty would significantly affect the SFLSSS water level versus frequency curves or the base flood elevations developed, nor is there a proposed "more correct" solution.

4. **Additional Items:** The PBC submittal questions the 3-month tide data and the selection of validation storms. Regarding the tide data, FEMA review of the data found the 3-month tide

period to reasonably capture the tidal variation in the project area and to align with the tide periods applied in other recent FEMA regional storm surge studies.

Regarding the validation storms, the PBC submittal identified Hurricane Frances and Hurricane Jeanne as more suitable validation storms, however these storms made landfall north of Palm Beach County. These storms were used to validate ECCFL because of their landfall location. The damage due to storm surge and waves was found to be higher in areas north of Palm Beach County. According to the Florida Department of Environmental Protection (FDEP) Post-storm Beach Conditions and Coastal Impact Report for Hurricane Frances and Hurricane Jeanne (October 2004), "The coastal areas sustaining the greatest impact from each storm were generally the counties north of the point of landfall. Specifically, extending northward from the landfall point were northern Martin, St. Lucie, Indian River, Brevard, and Volusia Counties." The beach and dune conditions in Palm Beach showed minor to moderate erosion conditions, whereas the majority of east coast Florida counties north of Palm Beach identified some beach conditions with major erosion conditions. The PBC submittal did not demonstrate that changes to tidal or storm validation would affect SWEL or resulting BFEs in Palm Beach County.

5. **Additional Appendix D Note for Transect-based Erosion Analysis:** The PBC submittal notes in Section 4 of Appendix D that two preliminary modeling transects (Transects 137 and 138) contained dune reservoir areas that were close to the area threshold (540 square feet) that determines the dune erosion geometry (dune retreat versus dune removal) as described in the FEMA *Guidance for Flood Risk Analysis and Mapping: Coastal Erosion* (2018). The PBC submittal questions the selection of dune crest elevations that can influence the dune reservoir measurement and suggests that a dune retreat erosion geometry could be more suitable than the dune erosion geometry used in the preliminary modeling. Compass review of Transects 137 and 138 found that the dune reservoirs are very close to the 540 square-foot threshold that determines the type of erosion method that is applied. This is a relatively unique portion of the open coast as it is undeveloped and generally less than 500 feet wide from the open coast shoreline to the inland lagoon. Internal reviews of this area were conducted during the preliminary study to evaluate a regionally-consistent approach for this undeveloped area. Additional cross-sections between these transects were also reviewed in order to understand the regionally-representative condition. The review of the topographic data found that profiles located at Transects 137 and 138 appear to have more dune area than surrounding portions of the MacArthur Beach State Park, as shown in the figure below. The decision to apply dune removal to these transects appears justified by the overall regional condition of the dune that these transects intend to represent. Although the dune geometry is likely contributing to the inland VE zone in the lagoon, this mapped area does not appear to impact any habitable structures. The PBC submittal is correct that there may be other reasonable choices for the selection of the dune reservoir that would trigger a different erosion geometry, however additional modeling, mapping, and justification would need to have been provided with the appeal period submittal to support a mapping change.

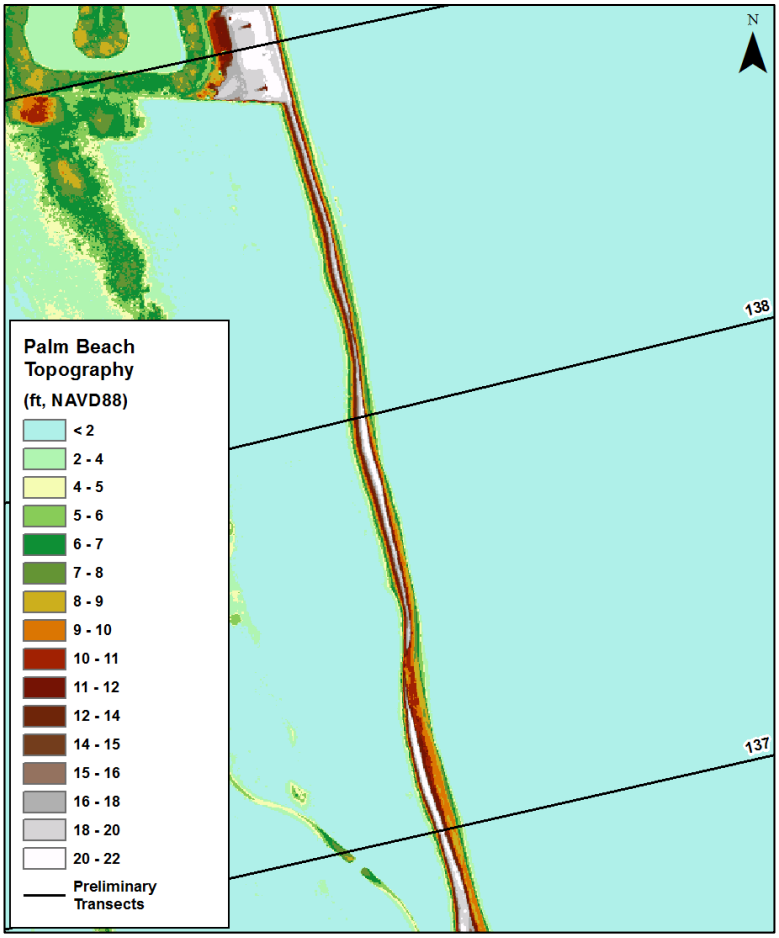

Figure 1. Dune topography of MacArthur Beach State Park.