Quality Assurance Plan
Coastal Flood Insurance Studies
Northwest Florida Water Management District

The Northwest Florida Water Management District (NWFWMD) is planning to update and revise Digital Flood Insurance Rate Maps (DFIRMs) and Flood Insurance Studies (FISs). This effort supports the Federal Emergency Management Agency (FEMA) Map Modernization program for the NWFWMD, a Cooperating Technical Partner (CTP) with FEMA. These updates involve storm surge modeling, wave modeling, and storm frequency analysis. Results of which will include coastal hazard analysis, flood zone delineation, DFIRM production, post-processing, and appeal period.

The projects will use the numerical models ADCIRC (for storm surge) and SWAN (for wave setup). These models will be coupled to produce updated stillwater elevations. The results of the numerical modeling will be succeeded by a statistical analysis, using the Joint Probability Method (JPM) approach that will determine return periods for the 10%, 2%, 1% and 0.2% annual chance stillwater elevations. Subcontractors will be used to provide wave modeling, storm selection, and wind-pressure field modeling.

This Quality Assurance Plan for Coastal FIRM and FIS Updates outlines the approach to provide NWFWMD Quality Assurance (QA) and Quality Control (QC) of the coastal study. DFIRM mapping and production are covered by the Quality Assurance Plan for FIRM and FIS Update Projects for NWFWMD, Version 2, dated September, 3, 2004.

Standards

As applicable, QA/QC activities to be performed will be guided by FEMA's Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update Final Draft dated February 2007 (FEMA G&S), Program Memorandums, and related guidance provided by FEMA.

Overview of QA/QC Activities

Internal QA/QC procedures will be performed before project work is submitted to FEMA following the guidelines. For each Submittal as provided below in more detail, an independent qualified QA/QC sub-contractor(s) review of data, submittals, and information will be made. The data to be reviewed, and documentation to be produced after the review, are listed in Appendix A. NWFWMD will review the data submitted and provide review comments to the study contractors. When NWFWMD contractors perform the modeling or mapping work the NWFWMD and its contractor not performing the work will perform the internal QA/QC. The contractor(s) will acknowledge data receipt; respond to the comments provided by NWFWMD/QA/QC subcontractors according with the time frames specified in the project schedule. The contractor(s) will submit revised data and responses to NWFWMD/QA/QC subcontractors. The NWFWMD will then verify comments and data, and provide recommendations for addressing remaining issues. Revised data and review documentation will be archived

to be part of the Technical Study Documentation Notebook (TSDN), which will be developed by NWFWMD and their contractor(s).

The primary QA/QC process will be to establish independent QA/QC teams within the project team and to have the work reviewed according to current accepted engineering practice. There will be a total of 5 submittals to FEMA following the guidelines as follows:

Intermediate Submission No. 1 – Scoping and Data Review:

- Terrain and Bathymetric Data Processing
- Develop/Refine ADCIRC Mesh
- 2-Dimensional Wave Modeling

Intermediate Submission No. 2 – Storm surge Model Calibration and Storm Selection:

- Tidal calibration
- Storm Selection
- Storms Hindcasts and Validation
- Wind and Pressure Field Determination

Intermediate Submission No. 3 – Storm surge Runs and Flood frequency Analysis :

- Production Runs
- Statistical Analysis

Intermediate Submission No. 4 – Nearshore Hydraulics (WHAFIS, Erosion, Runup):

- Erosion and PFD Determination
- Overland Wave Height Analysis
- Wave Runup 2%

Intermediate Submission No. 5 – Draft Flood Hazard Mapping:

- Floodplain Mapping

In accordance with the G&S, NWFWMD and its contractors shall make the above mentioned data as well as any internal QA/QC documentation available to FEMA by uploading the digital data to the MIP. In some cases modeling data files may be significantly large making uploading to the MIP cumbersome. In such cases digital data will be sent via mail on hard drives or disks.

FEMA will provide review comments within approximately four weeks of each submittal. Project work will continue during the FEMA reviews baring any major concerns that might impact the study process.

Technical Support Data Notebook (TSDN)

The documentation produced from this flood hazard mapping project will be appropriately organized into the TSDN. The project team will maintain this TSDN throughout the life of the project and compile a comprehensive set of deliverables for

each of the tasks performed. The storm surge analysis included in the TSDN will be developed in an electronic coastal documentation notebook for the entire storm surge study. This will include the digital data of terrain and bathymetry data, final refined meshes, selected storms and storm parameters selections, wind and pressure fields, tidal calibration results, ADCIRC model and 2-D wave model results, frequency analysis final stillwater elevations, and associated digital products. Appendix A lists the data to be compiled for the TSDN and submitted to FEMA for the storm surge study. For the overland wave modeling and mapping the digital data will include the WHAFIS and RUNUP input and output files, a CHAMP database with modeling input parameters and erosion calculations, and digital GIS linework of the hazard mapping with workmaps. The TSDN will also include all documentation of the QA/QC process.

Appendix A

Submittals and Data Archival

- **Selection of Hindcast Storms (Intermediate Submittal 1)**

1. Historical evidence describing the most significant flooding mechanisms;
2. List of criteria utilized to choose hindcast tropical events;
3. Table listing astronomical tide events; and
4. List of tropical storms selected for the hindcast and calibration along with a list of the available data from these events (e.g., extent and accuracy of high-water mark data, gage data, buoy data, etc.) to facilitate hindcasting and calibration.

- **Review of Hindcast Storms Selection (Intermediate Submittal 1)**

1. A report that describes the findings of the QA/QC review including how any identified issues were resolved.

- **Compile and Finalize Topographic and Bathymetric Data (Intermediate Submittal 1)**

1. Data sets and description of all datasets collected with associated metadata;
2. Documentation describing reasons, methods, dates, and processes applied in order to adjust/modify original dataset. Provide new metadata if changes to datum are applied;
3. Final Seamless Digital Elevation Model (DEM) for the entire area covered by the storm surge modeling and associated metadata;
4. Documentation describing the DEM generation;
5. List of all datasets utilized for each new DEM version; and
6. Software tools (and versions) used to create DEMs.

- **Review of Topographic and Bathymetric Data (Intermediate Submittal 1)**

1. A report that describes the findings of the QA/QC review including how any identified issues were resolved.

- **Compile and Finalize ADCIRC Grid (Intermediate Submittal 1)**

1. Map files, mesh files and DEM and scatter data set files for each completed region and for the final combined ADCIRC mesh;
2. Documentation describing refining processes applied to the existent grid provided by the NOAA/NOS;
3. Documentation on how the scatter data set was created and anything that was done to correct or add to it and what was used as the zero contour (i.e., shoreline file, topography, bathymetry) for both models; and
4. List software tools used to create the mesh, such as SMS (and version).

- **Review of Complete and Final ADCIRC Grid (Intermediate Submittal 1)**

1. A report that describes the findings of the QA/QC review including how any identified issues were resolved.

- **Prepare SWAN Wave Modeling Grids and Procedures (Intermediate Submittal 1)**

1. List of procedures that shall account for generation of offshore boundary conditions, wave model runs, validation of results and coupling with the surge model;
2. Workflow for the 2D wave modeling scheme including generation of offshore boundary condition input data, wave model runs, validation of results and coupling with the surge model;
3. Documentation describing development processes and setting applied to create the SWAN outer and inner grids;
4. SWAN outer and inner grid(s) input files;
5. Documentation on how the grids are interpolated to the DEM; and
6. List software tool(s) use to create the grid(s).

- **Review of Complete and Final SWAN Grids (Intermediate Submittal 1)**

1. A report that describes the findings of the QA/QC review including how any identified issues were resolved.

- **Tidal Calibration (Intermediate Submittal 2)**

1. ADCIRC Input files used for the tide calibration;
    - fort.14 ADCIRC grid file
    - fort.15 input parameter file
    - fort.13 nodal attribute file
2. Final results for the tidal calibration simulation;
    - Harmonic analysis output files
        - fort.51 local/station tidal harmonic analysis at tide stations
        - fort.53 global tidal harmonic analysis
    - fort.63 global output water level time-series file
    - fort.64 global output velocity time-series file
3. Tidal data (from gages);
4. Summary of tidal run and calibration results from above;
5. Any adjustments made to the mesh or input parameters based on tidal runs; and
6. Documentation, tables and graphs showing the re-synthesized tide signal and comparison of hydrograph for 30-day predicted tide vs. simulated tide, and tide constituent comparisons for predicted vs. simulated based on tidal harmonic analysis.

- **Review of Tidal Calibration (Intermediate Submittal 2)**

1. A report that describes the findings of the QA/QC review including how any identified issues were resolved.

- **SWAN Wave Model Hindcast Runs for Calibration/Validation (Intermediate Submittal 2)**

1. Static model input files (WAM, SWAN, parameters, etc);
2. Wind and pressure fields for each storm;
3. WAM global output solution;
4. Final results for each storm;
    - SWAN:
        - ADCIRC water-level and modified wind field (if applicable) interpolated to SWAN domains for both outer and inner grids
        - INPUT control file for both outer and inner grids
        - Significant wave height fields (HSIGN) and peak wave period (RTP) for both outer and inner grids
        - FORCE output files (used as input to ADCIRC for ADCIRC+SWAN simulations) for both outer and inner grids
        - Station output used for validation analysis for both outer and inner grids; and
5. Documentation and graphics of the comparison between observed and simulated wave fields, at available stations, for the selected hindcast storms.

- **Review of SWAN Wave Model Calibration/Validation (Intermediate Submittal 2)**

1. A report that describes the findings of the QA/QC review including how any identified issues were resolved.

- **ADCIRC Surge Model Hindcast Runs for Calibration/Validation ((Intermediate Submittal 2)**

1. Static model input files (ADCIRC run-independent grids, parameters, etc.);
2. Graphic of storm historical tracks for each selected historical storm used for model validation/calibration. Provide plot of the track and landfall location on the ADCIRC grid;
3. Wind model track files and wind/pressure fields for each storm;
4. All ADCIRC “fort” input files used for each individual hindcast run:
    - fort.15 input parameter file
    - fort.13 nodal attribute file
    - atmospheric forcing files: fort.22 (control), fort.221 (atmospheric pressure), fort.222 (10-meter, 10-minute wind velocity)
5. Final results for each storm;

- ADCIRC-only simulations:
    - fort.63 global water level time-series file
    - fort.73 global atmospheric pressure time-series file
    - fort.74 global wind stress time-series file
    - Maximum elevation file for each storm simulation. The modeled water level at a specific location is sampled from these files for comparison to observed high water marks

6. Output water level files from the hindcast validation/calibration runs for all selected storms; and
7. Documentation and graphics of the comparison between measured and simulated surface elevations and measured hydrographs (if available at tide gages) for the selected hindcast storms.

- **Review of ADCIRC Surge Model Calibration/Validation (Intermediate Submittal 2)**

1. A report that describes the findings of the QA/QC review including how any identified issues were resolved.

- **Final ADCIRC-SWAN Model Runs for Hindcast Storms (Intermediate Submittal 2)**

1. Static model input files (WAM, SWAN, ADCIRC run-independent grids, parameters, etc.);
2. Graphic of storm historical tracks for each selected historical storm used for model validation/calibration. Provide plot of the track and landfall location on the ADCIRC grid;
3. Wind model track files and wind/pressure fields for each storm;
4. WAM global output solution;
5. All ADCIRC "fort" input files used for each individual hindcast run:
    - fort.15 input parameter file
    - fort.13 nodal attribute file
    - atmospheric forcing files: fort.22 (control), fort.221 (atmospheric pressure), fort.222 (10-meter, 10-minute wind velocity)
    - wave radiation stress forcing files: fort.23 (control), wave model (SWAN) FORCE files (read natively by ADCIRC);
6. Final results for each storm;

- ADCIRC+SWAN simulations:
    - fort.63 global water level time-series file
    - fort.73 global atmospheric pressure time-series file
    - fort.74 global wind stress time-series file
    - Maximum elevation file for each storm simulation. The modeled water level at a specific location is sampled from these files for comparison to observed high water marks

7. Output water level files from the hindcast validation/calibration runs for all selected storms; and
8. Documentation and graphics of the comparison between measured and simulated surface elevations and measured hydrographs (if available at tide gages) for the selected hindcast storms for both ADCIRC and SWAN results.

- **Review of Final ADCIRC-SWAN Model Hindcast Runs (Intermediate Submittal 2)**

1. A report that describes the findings of the QA/QC review including how any identified issues were resolved.

- **Wind and Pressure Fields Selection (Intermediate Submittal 3)**

1. Original data for each of the selected storms;
2. Report on any adjustments to the original data; and
3. Provide digital data and supporting documentation for the directional wind stress reduction coefficients based on land use analysis.

- **Review of Wind and Pressure Fields (Intermediate Submittal 3)**

1. A report that describes the findings of the QA/QC review including how any identified issues were resolved.

- **Production Simulations (Intermediate Submittal 3)**

1. Graphic of each storm track. Plot the track and landfall location on the ADCIRC grid with numbering to allow matching of storm path with peak elevation output;
2. Wind model track files and wind/pressure fields for each storm;
3. All ADCIRC "fort" input files used for each individual hindcast run:
    - fort.15 input parameter file
    - fort.13 nodal attribute file (specifies canopy, wind-direction dependent wind speed reduction factors, etc.)
    - atmospheric forcing files: fort.22 (control), fort.221 (atmospheric pressure), fort.222 (10-meter, 10-minute wind velocity)
    - wave radiation stress forcing files: fort.23 (control), wave model (SWAN) FORCE files
4. Final result files for each storm:
    - ADCIRC-only and ADICRC+SWAN simulations:
        - fort.63 global water level time-series file
        - fort.73 global atmospheric pressure time-series file
        - fort.74 global wind velocity time-series file
        - Maximum elevation files for each storm simulation. The modeled water level at a specific location is sampled from these files for direct input into subsequent statistical methods.
    - SWAN
        - ADCIRC water-level and modified wind field interpolated to SWAN domains - for both outer and inner grids
        - INPUT control file for both outer and inner grids
        - Significant wave height fields (HSIGN) for both outer and inner grids
        - FORCE output files (used as input to ADCIRC for ADCIRC+SWAN simulations) for both outer and inner grids.

- **JPM analysis (Intermediate Submittal 3)**

1. Complete documentation of
    - Flood Frequency methods;
    - Input file requirements; and
    - Output files and summary tables (*.txt) for all flood frequencies analyzed for both sets of results (SWEL only and SWEL+wave setup).

- **Overland Wave Modeling (Intermediate Submittal 4)**

    - Transect locations;
    - Stillwater elevation surfaces (digital format) for each return period,
    - Digital Base data (Aerial imageries, topographic contour data and shoreline);
    - Narrative of assumptions – related to terrain data sources and development, where it applies;
    - All modeling data – in digital format – such as CHAMP Database and WHAFIS input & output files; and
    - Narrative of modeling assumptions.

- **Hazard Mapping (Intermediate Submittal 5)**

    - Work map with All mapping files – in digital format - such as onshore and offshore transects, zone boundaries, and elevations;
    - Narrative of mapping assumptions; and
    - TSDN.

Submittals and data archival list are compiled accordingly with FEMA G&S, specifically the Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update (February, 2007).

Submittal dates are defined by the submitted project schedule.