



Review & Evaluation of FEMA's Coastal Flood Risk Study

Final Work Plan (Deliverable 1.3)

Task Order #1778-01

March 6, 2020 | 13134.201.R1.Rev0

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13134.201.R1.Rev0

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1. Project Overview

The objectives of this work effort are to review and evaluate the data and methods used by the Federal Emergency Management Agency (FEMA) and its mapping partner (BakerAECOM) for the preparation of coastal flood hazard maps within the County, identify technical issues or concerns with flood modeling and mapping methodologies, and provide recommendations regarding future coordination with FEMA.

The specific objectives of this study are:

- Review and evaluate Coastal Study data and documents
- Summarize key information and methods used to prepare coastal flood hazard maps
- Determine potential impacts of FEMA not using the 2016 County topographic data
- Evaluate the application of FEMA's methodologies and identify potential technical issues/concerns
- Provide recommendations regarding future coordination with FEMA
- Provide recommendations on submitting comments to FEMA on preliminary Flood Insurance Rate Maps (FIRMs) and Flood Insurance Study (FIS) Reports
- Provide recommendations to the County on a potential appeal process (if any)

2. Points of Contact

FEMA ↔ BakerAECOM ↔ Palm Beach County ↔ Baird ↔ Moffatt & Nichol

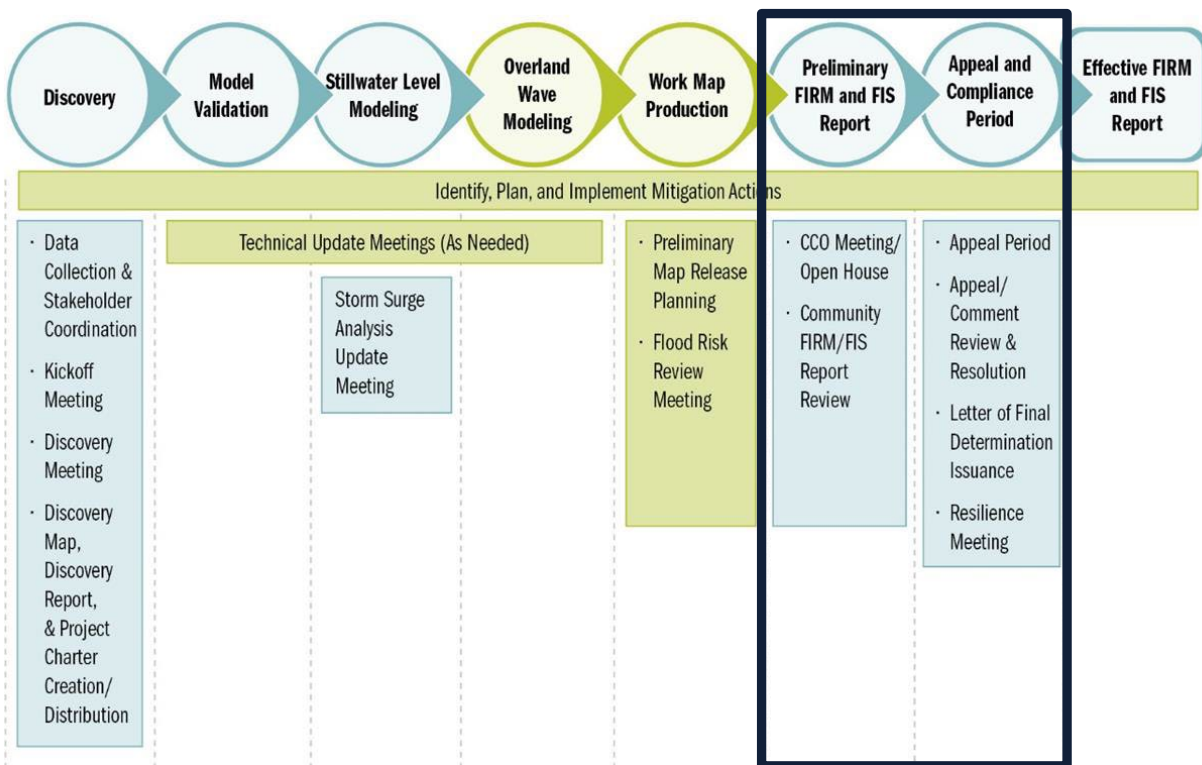
Table 2.1: Points of Contact

| Entity | Name | Phone | Email |
|---------------------------------|---|--|--|
| FEMA | Mark Vieira | (770) 220-5450 | mark.vieira@fema.dhs.gov |
| BakerAECOM (Mapping Partner) | Chris Mack Adam Clinch Zachariah Cohoon | (843) 302-8712 (941) 284-4783 (404) 946-9481 | chris.mack@aecom.com adam.clinch@aecom.com zachariah.cohoon@aecom.com |
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3. Coordination and Reporting

- The County shall be included in critical correspondence between Baird and BakerAECOM, and any correspondence between Baird and FEMA.
- Baird shall keep the County informed regarding the progression of the work and overall schedule. Updates shall entail phone calls, emails, or combinations thereof.
- Where feasible and if the project schedule allows, Baird will strive to provide draft deliverables for the County to review. The County’s comments shall then be incorporated into the final deliverables.
- Baird’s monthly invoices shall generally be for tasks that are complete. If draft deliverables or measurable progress can be documented for a particular task, then the County may consider partial payment during execution of the work.

4. FEMA Process



Consultation Coordination Officer (CCO) Meeting

→ February 4, 2020

Open House (OH) Meetings

→ February 4 and 5, 2020

Publication and Notification of FIRM changes

→ To be Announced

Appeal & Comment Period (90 days)

→ After publication/notification

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5. Approach

Baird's approach in reviewing FEMA's Coastal Flood Risk Study is divided into 5 tasks (Tasks 2 through 6 below). The proposed strategies and key issues to be considered during the technical review are outlined below for each task and are subject to change as the work progresses.

5.1 Task 2 - Topographic Elevation Data Evaluation

One of the initial steps of the coastal study was to develop a surface for which coastal flooding would be modeled. This entails creating a digital elevation model (DEM) from available bathymetric and topographic survey data within the modeling domain. Numerous bathymetric data sets were used to develop the "wet" portions of the domain. The Florida 2007 DEM was used to represent the "dry" portions west of the Intracoastal Waterway (ICWW), while the USACE 2015 LiDAR survey was used for the barrier island. The study DEM will be reviewed for the following.

- Vertical datums and horizontal coordinate systems of the data sets will be confirmed, and conversions verified.
- Merging of the dataset will be reviewed for potential discontinuities (e.g. spikes or large vertical steps) and the appropriateness of the methods utilized.
- Transects used in coastal hazard analysis (e.g. WHAFIS modeling) will be overlain on DEM to confirm that the transects are representative of adjacent areas.
- The DEM will be compared to:
 - Select FDEP beach profile surveys to confirm consistency of the dune features (e.g. crest elevations) and "true" ground in vegetated areas.
 - Select survey data provided by the County documenting the location and elevation of infrastructure and survey benchmarks.
 - A 2016 LiDAR survey performed by the County represents more recent conditions. The DEM will be compared to the County's LiDAR survey to note differences, improvements, or physical features that may have changed and thereby affect the study results. Publicly available parcel information from the County's property appraiser will be overlain on the differences to quantify the number of parcels affected within unincorporated and the County as a whole.

5.2 Task 3 - FEMA and Stakeholder Coordination

The intent is to proactively coordinate with FEMA and stakeholders throughout execution of the work. It will be an ongoing effort that is subject to change as more information becomes available. Coordination will involve a three-pronged approach; FEMA, County staff, and local governments.

Coordination with FEMA will initially focus on obtaining study related information from its website, requesting supporting data, and attending public meetings. This will evolve into seeking clarification to facilitate Baird's technical review.

- Website: FEMA's website is the main conduit utilized to release information to the public. This includes Flood Insurance Study (FIS) reports, discovery reports, Flood Insurance Rate Maps (FIRM), FEMA standards and technical references, and prior FIS reports.
- Data Requests: While information from the website provides the general understanding of the study approach and results, it does not contain the details required to perform a technical review. Data to be requested includes digital elevation models (DEM), joint probability statistics of storm events, location of coastal structures, delineation of the primary frontal dunes (PFD), storm surge and wave setup estimates,

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wave runup calculations, GIS shapefiles, model setups, model input and outputs, and intermediate data submittals (IDS) reports. The files sizes and datasets generated in conjunction with the study update are large. Hard drives have been mailed to FEMA's mapping partner (BakerAECOM) to facilitate the transfer of data and information.

- **Public Meetings:** FEMA holds public meetings throughout the geographic region included within the study area. Baird attended the Consultation Coordination Officer (CCO) Meeting and Open House Meeting on February 4, 2020 in West Palm Beach, Florida. These meetings provided the opportunity for FEMA to inform the public and local governments of the study objectives, analysis, methodologies, findings, and schedule.
- **Clarification:** As the reports, information, and data provided by FEMA are reviewed, there will be a need to seek clarification. Items of clarification may include assumptions made, basis for chosen methodologies, potentially missing data files, and mapping standards.

County staff will be leveraged during execution of the work to help incorporate feedback/input from the public and consider County specific information that may not have been incorporated into FEMA's study. For example, this may include the presence, location, capability and improvements to flood mitigation measures, coastal projects, shoreline stabilization, roads and other public infrastructure, and residential and commercial development. Input from County staff regarding these physical features will occur at two specific points as the work progresses:

- Task 2 while comparing the County's 2016 LiDAR survey to FEMA's digital elevation model (DEM).
- Task 5 while reviewing of the still water elevation (SWEL) inundation maps, overland wave propagation modeling (WHAFIS), and wave runup analyses.

Local governments will be engaged to keep them informed of the work performed and its findings for which the County is funding on their behalf for constituents. This will allow local governments to better understand the County's efforts and how those efforts can be leveraged for their communities in developing compatible and complementary strategies. This will be accomplished by holding a meeting once Task 2, 4, and 5 are substantially complete to present preliminary findings. Another meeting may be considered before/after the preliminary findings meeting to facilitate coordination with County staff or additional engagement with local governments. The dates and locations will be determined in consultation with County staff.

5.3 Task 4 - Review and Summarize Coastal Study Documents and Data

Numerous documents were generated by FEMA and its mapping partner as part of the study, which include:

- Discovery reports
- Intermediate Data Submittal (IDS) reports
- Flood Insurance Study (FIS) report
- Flood Insurance Rate Maps (FIRM)
- Changes Since Last FIRM (CSLF) maps

These study related documents will be reviewed in conjunction with FEMA's published standards, guidance, and technical references. Specifically, the following will be considered during the review.

- Numerous guidelines, standards, and technical references have been published by FEMA. Guidelines utilized during the study will be reviewed to verify their application to the study.
- Discretion by the mapping partners is required in applying FEMA guidelines and methodologies. For example, mapping of the primary frontal dune, erosion and overtopping of dunes, calculating wave runup, and incorporating of coastal structures. The reasonableness of the mapping partner's discretion and assumptions will be reviewed.

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- Published estimates will be compared to FEMA modeling results, which may include wave heights, storm surge, and wave setup.
- Overall consistency between reports, models, calculations, and maps will be noted.

The content of each of the study related documents reviewed will be summarized to provide a general understanding of the information produced in conjunction with the FEMA study. Findings with respect to the above considerations will be documented and cross referenced to the relevant FEMA documents.

5.4 Task 5 - Storm Surge, Wave Model and Flood Map Evaluation

The FEMA study utilized several models in combination with coastal analyses to generate the preliminary FIRM's. Baird will perform a technical review of the coastal modeling and analyses that was performed by FEMA's mapping partner as part of the updated FEMA study. The technical review will be guided by various questions, which may include the following.

Storm Surge and Still Water Elevations:

- The storm climatology analysis was completed in June 2015, which produced a historical storm database of hurricanes impacting the study area. In instances, the database was defined by storms occurring between 1950 and 2012 that passed within 90 nautical miles of the south Florida peninsula. Other instances, the database was defined by storms in the time period between 1950 and 2014 and within 200 nautical miles of Miami. What were the criteria for screening the database as this may have potential effects on the coastal modeling?
- Validation storms included Hurricane Betsy (1965), Hurricane Andrew (1992), Hurricane Georges (1998), and Hurricane Wilma (2005). How were these storms selected? Were other storms such as Hurricanes Frances or Jeanne (2004) considered for validation?
- Measured water levels were used to validate modeling (e.g. South Florida Water Management District (SFWMD) and National Oceanic and Atmospheric Administration (NOAA) gages). NOAA's gage at Lake Worth pier located in Palm Beach County was used. SFWMD gages inland of where tide and storm surge effects do not alter the water level were not considered in validating ADCIRC modeling. Have there been instances, specifically during the validation storms, where the SWEL overtopped the SFWMD water control structures?
- The mesh resolved canals within the mesh resolution limits from the coast to the first (most seaward) SFWMD water control structure. The minimum nodal spacing was 30 feet. Channels along the AIWW narrower than 30 feet were not included. SWEL estimated upstream of SFWMD structures appear to indicate a hydraulic connection (e.g. Boynton Beach Canal). How were SWEL estimated upstream of SFWMD structures and in narrow channels? Did any discontinuities or model instabilities appear in the modeled water surface elevation within inlets, interior water bodies, or canals?
- Field reconnaissance:
 - Site visits were performed to verify and change as need the model mesh. Fewer sites were visited in Palm Beach County as compared to Broward, Miami-Dade, and Monroe Counties. Would additional site visits beneficial to improve the modeling mesh and DEM?
 - Field reconnaissance resulted in a change in the mesh along the shoreline west of South Lake Worth Inlet (site #5) due to a series of seawalls. Are there other areas within Palm Beach County that the mesh may not have been represented properly?
 - Field reconnaissance resulted in a change in the mesh along the open coastline at Boca Raton Inlet (site #11) due to the weir feature in the north jetty. Are there other coastal structures that should have been included in the mesh?

- Field reconnaissance suggested that dune features were well represented by LiDAR survey. Was the DEM compared to FDEP's beach profile surveys?
- Modeling did not include riverine flow in the coastal hydrodynamic modeling due to limited flow rates in project area rivers and channels. The combined effects of riverine flows and storm surge at the interface of these two processes were accounted for within statistical probabilities of occurrence. Where was the interface and was the method consistent with FEMA guidelines?
- Elevated roadways and bridge approaches were not assumed to provide flood protection as they were not designed and certified per 44 CFR Section 65.10, but the map of 1% SWEL indicates that the Overseas Highway in Miami-Dade County affected propagation of inland flooding. How did this assumption affect flooding pathways in Palm Beach County?
- Stillwater frequency analysis:
 - Joint Probability Method-Optimal Sampling (JPM-OS) method was used to statistically model the spatial and temporal occurrence and characteristics of hurricanes impacting the study area.
 - The SURGE_STAT program to define statistical SWEL's at ADCIR+SWAN model nodes. Maximum borrowing distance and breaklines are used to assign SWEL's at notes that were infrequently wetted. Was the user-defined information reasonable?
 - Epsilon term (modeling skill term) within the SURGE_STAT program accounts for uncertainty. The approach in defining the term was reported as being different from prior studies. Was the approach appropriate in developing representative SWEL?
 - Datum conversions between mean sea level (MSL) was required between ADCIR+SWAN modeling and the SURGE_STAT program. Were the conversions applied correctly?
 - SWEL's at the boundary between the East Central Coast Florida (ECCFL) study and South Florida (SFL) study (i.e. Palm Beach and Martin county lines) differed 1.7 feet along the open coast, 2.0 feet in the ICWW, and 2 - 4.2 feet in the Loxahatchee River for the 1% event. The SFL study SWEL's were higher than the ECCFL study. The difference was attributed to JPM-OS method, inclusion of "existing" storms (i.e. originating from the west), and MSL conversion. A 10-mile transition area was identified to smooth the discontinuity. Does the discontinuity suggest a limitation or inaccuracy of the modeling?

Coastal Hazard Analysis:

- Erosion analysis evaluated impacts to the coastal dune during storm events. Volume of dune reservoir above SWEL was quantified and then compared to given thresholds in order to classify dune response during storms as retreat (erosion of the dune face) or removal (erosion and lowering the dune crest). Presence of coastal structures (i.e. seawalls) was factored into the analysis. Was the analysis and modeled site conditions representative at transects where "removal" was identified?
- Overland Wave Propagation:
 - The WHAFIS 4.0 model was used to assess overland wave propagation.
 - Deepwater wave conditions from SWAN and stillwater levels from ADCIRC were assumed coincident and used as the inputs to WHAFIS modeling for open coast transects. Inputs required on offshore boundary include average wave conditions (e.g. significant wave height, wave period) and water surface (WSE) elevations. Uncertainty included in SURGE_STAT program resulted in SWEL greater than the maximum water surface elevation (WSE) of the modeled storms. The approach to generating the inputs for WHAFIS modeling had to be modified. Was the modified approach valid? Why was the WSE of the storms less than the SWEL?
 - Coincidence of peak wave conditions and water levels was not necessarily assumed for inland transects. For instances where wave heights were not coincident with water levels the methods of estimating starting wave conditions were developed in accordance with Guidance for Coastal Flood

Hazard Analysis and Mapping in Sheltered Waters (FEMA, 2008d). Was the judgement applied representative? Was the method of estimating starting wave conditions applied correctly?

- Wave Runup was assessed using RUNUP 2.0 for sandy beach profiles. RUNUP 2.0, USACE Shore Protection Manual (SPM), or Technical Advisory Committee for Water Retaining Structures (TAW) methods were used when a coastal structure existed. Were the various methods applied correctly?
- Flood Hazard Mapping: The SWEL's overlain on the DEM was used to map the landward most boundary of the Special Flood Hazard Area (SFHA). The overland wave propagation, wave runup, overtopping analysis were the basis for defining coastal hazard zones within the SFHA. Was the mapping consistent with FEMA's mapping standards?

It should be noted that the work performed within Task 5 will not necessarily address all of the questions outlined above, nor have all questions be identified at this time. Rather, the work will seek to identify and to provide additional understanding to questions that are likely to have a greater influence on the FEMA study.

5.5 Task 6 - Final Summary

The work performed in Tasks 2 - 5 is intended to provide the basis for the County to decide whether to make an appeal but may not necessarily provide the supporting information/documentation to substantiate an appeal. Baird will inform the County of work required to support an appeal and recommendations regarding future coordination with FEMA. This may include commenting on preliminary FIRMs and FIS report documents and proceeding with an appeal, if appropriate and desired by the County.

FEMA initiates a formal appeal period when there is an updated FIS study or a Letter of Map Revision (LOMR). The coastal study is considered an updated FIS study. The process for the appeal period is briefly summarized below:

- 90-day appeal period starts after the CCO meeting, publishing SFHA changes in the federal registrar, and public notification of changes in local newspaper. Appeals are submitted during this period.
- An additional 30 days may be granted to submit supporting documentation and information for an appeal.
- FEMA reviews and issues an appeal resolution letter
- 30-day comment period starts to contest FEMA's resolution letter
- FEMA issues Letters of Final Determination

Areas eligible for appeal include:

- Areas showing new or revised Special Flood Hazard Area (SFHA) boundaries
- Areas showing new or revised Base Flood Elevations (BFE)
- Areas where there is a change in SFHA zone designations
- Areas showing new or revised regulatory floodway boundaries

Appeals to SFHA boundaries are based on topographic data; the work performed for Task 2 will help assess. An appeal must reflect more recent conditions, identify flooding source being appealed, and provide updated SFHA boundaries.

Appeals to BFEs and SFHA zone designations must be based on data that shows that there is a scientific or technical error; the work performed for Tasks 4 and 5 will help assess. Scientific and technical errors are defined below.

- Scientific (incorrect methodology applied)
- Technical

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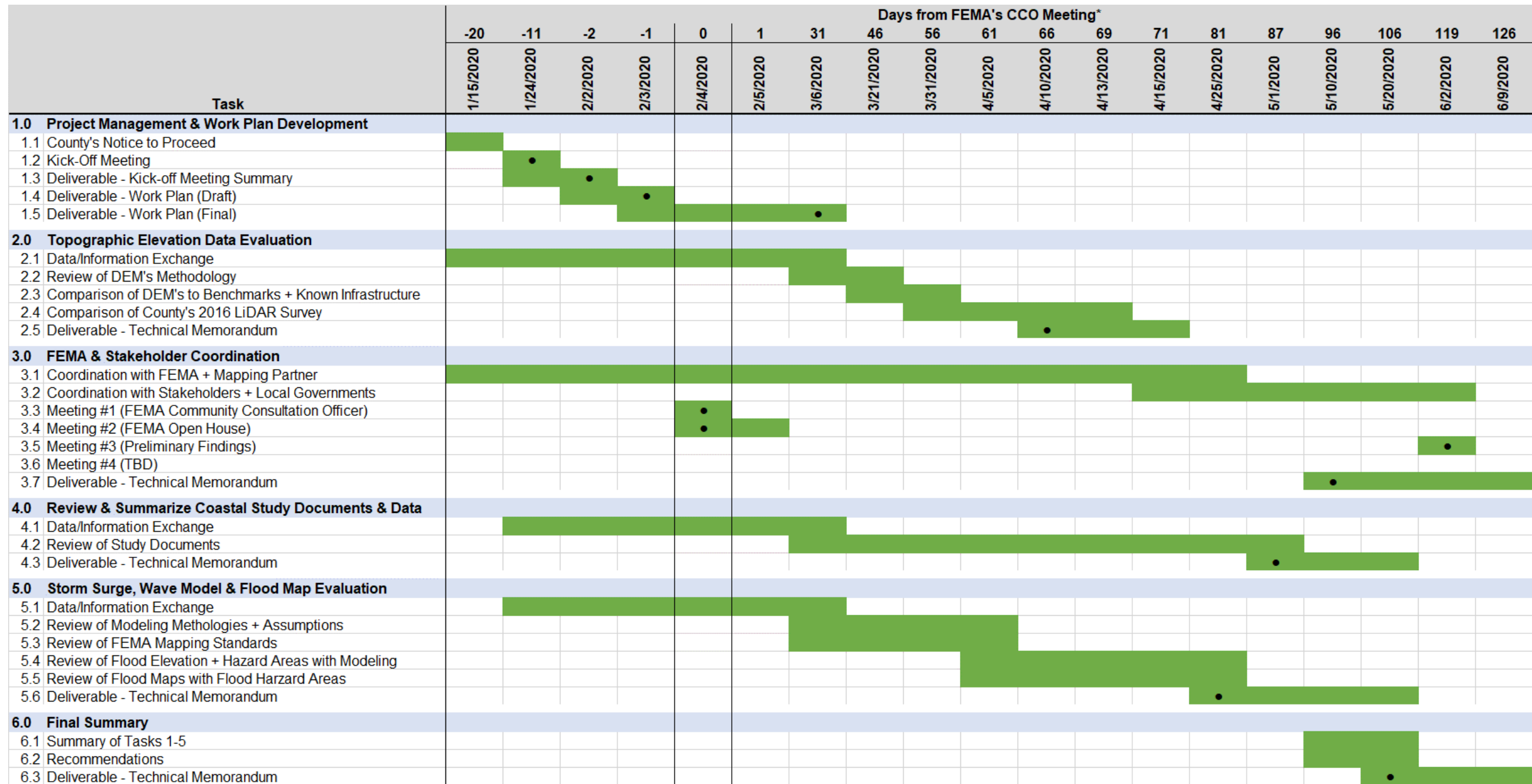


- Methodology was not applied correctly or was based on insufficient or poor-quality data
- Methodology has indisputable mathematical or measurement errors
- Methodology did not account for the effects of natural physical changes in the floodplain

6. Schedule

Baird's initial proposal schedule planned for completion of the work by the end of April 2020 to facilitate FEMA's 90-day appeal period. The appeal period was assumed to start immediately following the CCO Meeting on February 4, 2020 and that exchange of data/information from FEMA's mapping partner would be completed within a week of the meeting. However, Baird's initial request to FEMA/BakerAECOM for data and information was not completed until March 2, 2020. In addition, FEMA indicated at the February 4, 2020 CCO meeting that the appeal period would likely not start until 3 - 6 months after the meeting (i.e. the appeal period may start between May and August 2020).

As such, the schedule was revised to reflect a completion date of June 2020 as shown in Figure 6.1, which accommodates the FEMA appeal period as it is understood at this time. Baird's schedule may be adjusted depending on receipt of future data/information requests from FEMA/BakerAECOM, stakeholder coordination, Baird's preliminary findings, and FEMA's delivery schedule.



Notes:
 *The schedule shown assumes FEMA's appeal period begins the date of the Community Consultation Officer (CCO) Meeting. The schedule may be adjusted depending on the actual dates of FEMA's appeal period, receipt of requested data, and stakeholder coordination.
 ● = Targeted opportunities to solicit County input

Figure 6.1: Schedule