Levee Analysis and Mapping Plan

Union County LAMP Project
Elizabeth, New Jersey

March 2016

FEMA

RiskMAP
Increasing Resilience Together

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Acronyms

ERFCP	Elizabeth River Flood Control Project
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
LAMP	Levee Analysis and Mapping Procedures
LLPT	Local Levee Partnership Team
MIP	Mapping Information Platform
MLI	Mid-term Levee Inventory
NAVD88	North American Vertical Datum of 1988
NLD	National Levee Database
NYC	New York City
RAMPP	Risk Assessment, Mapping, and Planning Partners
USACE	United States Army Corps of Engineers

1. Background

This is the Non-Accredited Levee Analysis and Mapping Plan for the Elizabeth Levee system in Union County, New Jersey. The Elizabeth Levee Analysis and Mapping Procedures (LAMP) project of Union County is based on the Operating Guidance 12-13: *Non-Accredited Levee Analysis and Mapping Guidance* (FEMA 2013). The LAMP process is an improved mapping approach that replaced the "without levee" approach for flood mapping of areas behind a non-accredited levee. Part of this process includes the creation of a Local Levee Partnership Team (LLPT) made up of representatives from FEMA, the mapping contractor, and local stakeholders. The LLPT provides input to be used during the flood mapping process.

Union County, located in central New Jersey, has a land area of 105 square miles, of which approximately 2.55 square miles is covered with water. Union County is bordered by New York City to the east, Essex County to the northeast, Middlesex County to the south, and Morris and Somerset Counties to the west, as illustrated in Figure 1.

Figure 1. Union County location map

The effective Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRMs) for Union County covers the entire county. The effective FIRMs do not show the Elizabeth River Flood Control Project (ERFCP) as being accredited or providing flood protection, as evidenced by the 1-percent-annual-chance floodplain being shown on the landward side of the levee system. The preliminary FIS and FIRM were prepared under the Risk MAP program and issued on February 3, 2015. The preliminary FIRMs applied seclusion to the levee impact area, which kept the old levee mapping information until a new LAMP study could be done. Therefore it showed identical mapping from the effective FIRMs in the levee seclusion impact area.

The Federal Emergency Management Agency (FEMA) requires that all non-accredited levees be evaluated as part of the LAMP process for flood insurance and floodplain management purposes. For this LAMP project, all non-accredited levees in the City of Elizabeth, New Jersey

listed in the Mid-term Levee Inventory (MLI) and National Levee Database (NLD) will be evaluated . This study focuses on the following flood protection systems, which consist of both earthen levees and floodwalls. For the purposes of this study, all references are considered as viewing the river from to upstream to downstream:

- Elizabeth River Left Bank South
- Elizabeth River Right Bank South

The lineal extent of the levee system differed between the MLI and NLD databases; the study team determined the final extent for Phase 1 through coordination with the United States Army Corps of Engineers (USACE) and site visits to the levees with community stakeholders.

2. Levee Description

The Elizabeth Levee lies in the City of Elizabeth along both banks of the Elizabeth River. The flood protection system along the left bank is approximately 2.5 miles long and consists of both levee and floodwall components. The right bank is approximately 1.3 miles long; the majority of the right bank is an earthen levee with two small sections of floodwall. The flood protection system also includes pumping stations for the levee areas on both banks. A map illustrating the location of the Elizabeth Levee is provided in **Error! Reference source not found.**.

The levee system borders industrial, commercial, and residential properties along the Elizabeth River. Both the effective FIRMs and preliminary FIRMs show the “without levee” scenario because the levee had been reported as non-accredited and not meeting FEMA’s standards described in Title 44 of the Code of Regulations (CFR) § 65.10. The levee protects against both riverine and coastal flood hazards.

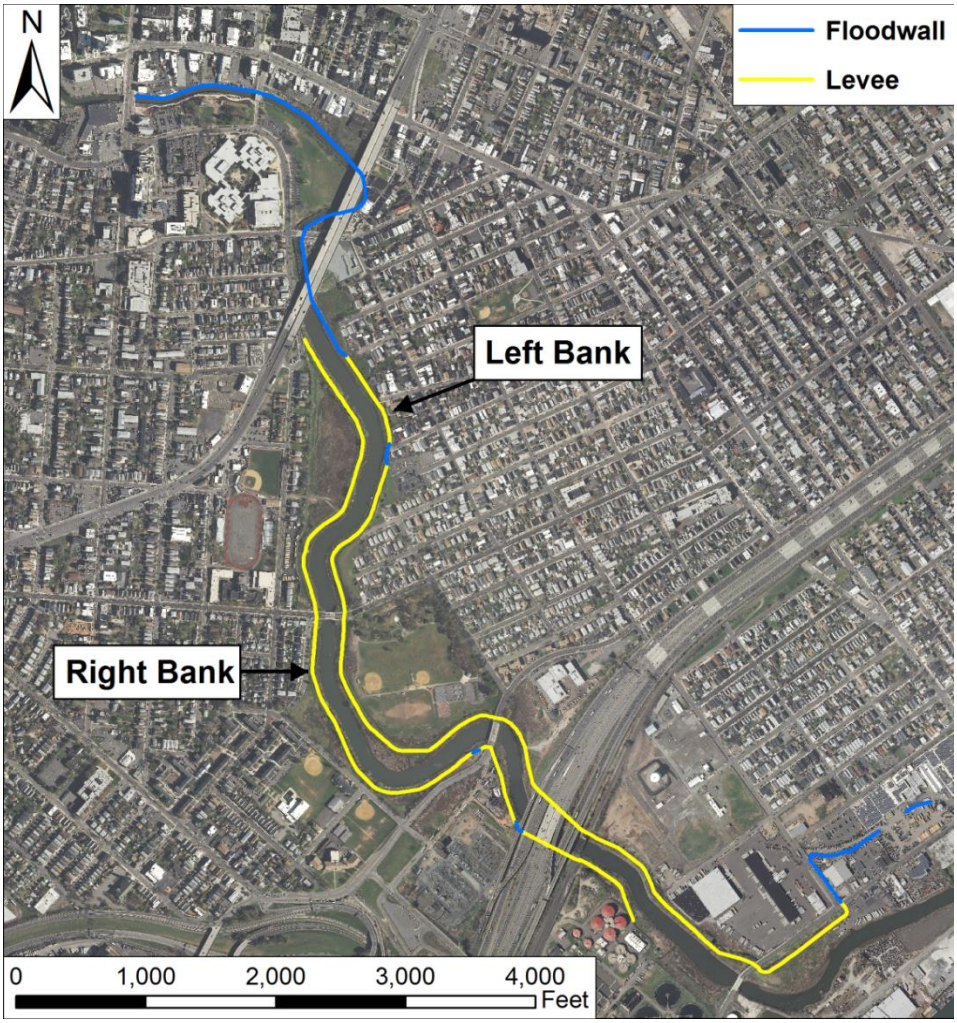

Figure 2: Elizabeth, New Jersey Levee system

According to the latest available survey from the USACE, the levee crest height varies significantly because it ties in with several highways crossing the Elizabeth River; however, most of the levee has a crest elevation between 10 and 13.5 feet using the North American Vertical Datum of 1988 (NAVD88). Based on this survey, most of the levees have 1 to 2 feet of freeboard above the current 1-percent-annual-chance water level; however, there are two sections below the stillwater coastal elevation in a section where the new preliminary coastal flood elevations determine the FEMA flood height.

Figure 3 shows a typical view of the earthen levee just downstream of the New Jersey Turnpike railroad bridge. Figure 4 shows a typical view of the floodwall at the downstream end of the flood protection system. Additional photographs are provided in the Field Reconnaissance Report in Appendix D.

Figure 3: Left and right banks of the Elizabeth Levee looking upstream toward the railroad bridge

Figure 4: Section of floodwall on the left bank of the Elizabeth Levee system

3. Mapping History

The date of the effective FIRM is September 20, 2006. Table 1 indicates the FIRM history of City of Elizabeth affected by the Elizabeth Levee system. Seclusion mapping was applied to the Elizabeth levee impacted area; therefore, the Special Flood Hazard Area (SFHA) (i.e., area with a 1-percent-annual-chance of flooding in any one year) on the preliminary FIRM incorporated the effective FIRM in the seclusion area. Downstream of the seclusion area, the preliminary study indicates higher coastal flood elevations than the effective study did; consequently, the preliminary FIRM outside the seclusion area typically shows a more expansive floodplain than the effective FIRM. Upstream of the seclusion area, the effective riverine flooding is higher than the preliminary coastal flood elevation; consequently, the preliminary FIRM shows a floodplain consistent with the effective FIRM.

Table 1: Summary of Communities

County	Community	Product	Effective FIRM Dates
Union County	City of Elizabeth	FIRM	September 20, 2006
Union County	City of Elizabeth	FIRM	November 1, 1985
Union County	City of Elizabeth	FIRM	December 1, 1978
Union County	City of Elizabeth	FIRM	August 27, 1976
Union County	City of Elizabeth	FIRM	December 26, 1975
Union County	City of Elizabeth	FIRM	May 8, 1971

4. Levee Project Overview

As part of the LAMP process, FEMA and its contractor, Risk Assessment, Mapping, and Planning Partners (RAMPP), work with a Local Levee Partnership Team (LLPT) to understand the operation of levee systems and gather information to assist in the selection of the appropriate LAMP approach to determine the flood risk in the levee impact area. This process is divided into three distinct tasks as shown in Table 2.

Table 2. LAMP Project Tasks

Task	Details	Start Date - End Date
Field Reconnaissance	Representatives from the community and from RAMPP attended on June 21, 2015. Additional field visits were also conducted prior to the LLPT2 meeting.	6/22/2015 - 2/15/2016
Hydrologic and Hydraulic Data Development	LLPT provided input for the hydrologic and hydraulic analysis based on Field Reconnaissance findings.	10/9/2014 - 3/30/2016
Flood Risk Outreach	LLPT is assessing results of the Field Reconnaissance, and Hydrologic and Hydraulic Data Development. LLPT will work at the local level to disseminate findings that could affect local stakeholders.	10/9/2014 - 3/30/2016

5. Stakeholder Engagement and Data Collection

The FEMA-led project team engaged affected communities and levee owners/operators during the Handshake / Stakeholder Coordination meeting and Data Collection process. Contact information for the project team is provided in Appendix A. The purpose of this initial engagement was twofold: (i) to discuss the levee analysis and mapping process; and (ii) to collect initial community/levee-related data and documentation to help streamline and facilitate future coordination meetings. Table 3 lists the stakeholders contacted during this process and their roles.

Table 3. Stakeholder Contacts

Stakeholder Contacted	Role
Dan Loomis Rahway	LLPT
Ray Sarran Rahway	LLPT
Steve Rinaldi Rahway	Stakeholder
John Papetti Rahway	Stakeholder
Peter Ripkey Hatch Mott MacDonald	Stakeholder
Robert Curti Hatch Mott MacDonald	Stakeholder
Encer Shaffer USACE	Stakeholder
Joseph Ruggeri New Jersey Department of Environmental Protection	Stakeholder

The project team initiated a series of meetings, emails, and telephone calls with stakeholders to gain a better understanding of the levee system. This allowed FEMA to tailor a modeling and mapping approach for the levee system that meets the needs of the community and recognizes the available data and documentation, as well as the history of the levee system. Details on meetings and telephone calls conducted during the Stakeholder Coordination and Data Collection process are provided in Appendix C.

5.1 Handshake / Stakeholder Coordination and Data Collection Meeting

FEMA held a Handshake / Stakeholder Coordination and Data Collection Meeting on October 9, 2014 at City Hall located at 50 Winfield Scott Plaza, Elizabeth, New Jersey.

The overarching objectives of the meeting were to introduce stakeholders to each other and discuss areas of flood risk, available data, and the FEMA process for analyzing and mapping flood hazards landward of non-accredited levee systems. Detailed lists of meeting information, attendees sign-in sheet, and meeting minutes are included in Appendix C.

5.2 Data Collection

During the Stakeholder Coordination and Data Collection process, FEMA requested all available data and documentation associated with the levee system.

Table 4 summarizes the data and documentation collected during the Stakeholder Coordination and Data Collection process. The data are included in Appendix D.

Table 4. Data Sources for the Levee System

Data Type	Data Description	Source	Date Obtained
Elizabeth Industrial Center Improvement Plans	Profiles and report on improvements made to sections of the levee	Community	January 2015
Drainage Plans for Elizabeth City and Surrounding Areas	Plans for the sewer system around the City of Elizabeth	Community	January 2015
ERFCP Maintenance Contracts	The plans for the maintenance for the Elizabeth Levee	Community	January 2015
Emergency Maintenance Plans	Plans for emergency operations of the Elizabeth Levee	Community	January 2015
ERFCP Geotechnical Report	Geotechnical report and boring locations	Community	January 2015
New Jersey Department of Environmental Protection Planned Levee Improvements	Overview of improvements and construction for levee	Community	January 2015
Atlantic Street Bridge Dewatering Area	Plans for new dewatering area at Atlantic Street	Community	January 2015
Erie Street Restoration Plans	Plans for levee improvements/restoration at Erie Street	Community	January 2015
Crest Points	Surveyed crest points in GIS format	Community	January 2015
Elizabeth Industrial Center Improvement Plans	Profiles and report on improvements made to sections of the levee	Community	January 2015
Topography	2014 LiDAR collected by U.S. Geological Survey	RAMPP/FEMA	November 2015

Table 5 outlines the unique identifiers associated with this project across the various project tracking systems.

Table 5. Project Tracking and Identification Information

Project Tracking Method	Project Identifier
Project and Purchase ID	Not assigned
MIP Case Number	14-02-2529S
LAMP Study Project Tracker (LAMP_ID)	R2NJ4
Levee Database Segment ID(s)	MLI: 1204000131, 1204000132 NLD: 4505000007, 4505000008, 4505000009, 4505000010

Project Tracking Method	Project Identifier
FIRM Panels and Effective Date	34039C0035G – September 20, 2006 34039C0024G – September 20, 2006

5.3 Local Levee Partnership Team

Based on the discussion during the Coordination and Data Collection Meeting, two stakeholders were identified as members of an LLPT, as shown in Table 6. The primary function of the LLPT is to provide feedback and, if necessary, additional information or documentation.

Table 6. Potential Local Levee Partnership Team Participants

Participant	Title	Contact Information	Meetings Attended	Agreed to Participate in the LLPT?
Daniel Loomis	City Engineer Elizabeth	50 Winfield Scott Plaza Elizabeth, NJ 07201 dloomis@elizabethnj.org (908) 820-4269	October 9, 2014: Kick-off LAMP Meeting (in person) October 27, 2014: Kick-off Follow-up (webinar) March 5, 2015: LLPT1 (in person) February 8, 2016: Preparation for LLPT2 (webinar) February 17, 2014: LLPT2 (in person)	Y
Ray Sarran	Construction Official Elizabeth	50 Winfield Scott Plaza Elizabeth, NJ 07201 rsarran@elizabethnj.org (908) 820-4093	October 9, 2014: Kick-off LAMP Meeting (in person) October 27, 2014: Kick-off Follow-up (webinar) March 5, 2015: LLPT1 (in person) February 8, 2016: Preparation for LLPT2 (webinar) February 17, 2014: LLPT2 (in person)	Y

5.4 Local Levee Partnership Team Meetings

In addition to the Handshake / Stakeholder Coordination and Data Collection Meeting, two additional meetings were held during the Phase 1 portion of the LAMP Study, LLPT Meetings 1 and 2.

The first LLPT meeting was held on March 5th, 2015 at Elizabeth City Hall. The meeting objectives were to review the LAMP study process and discuss the analyses planned for the Phase 1 study. A summary of topics discussed during the first LLPT meeting held on October 9, 2014 is provided below; full meeting minutes are provided in Appendix C.

- Overview and objectives of the LAMP process.
- Identification of potential LLPT members.

- The city's planned repairs to the levee and interior drainage system and how the timing of those will fit in with LAMP analysis.
- The insurance and construction implications for Zone D.

A second LLPT meeting convened on February 17th, 2016 at Elizabeth City Hall to review the results of Phase 1 and to develop a plan for the Phase 2 study. More details on the Phase 1 study results and plan for Phase 2 are provided in Sections 6 and 7, respectively.

A summary of topics discussed during the second LLPT meeting held on February 17, 2016 is provided below; full meeting minutes are provided in Appendix C.

- The city's plans to repair the levee, including clearing of vegetation and raising the levee up to 6 inches to restore it to its design elevation.
- The requirements for certification and accreditation of a levee based on elevation, geotechnical characteristics, closure structures, operation and maintenance, etc.
- The requirements of the LAMP program as an alternative to accreditation, including the mapping of Zone D and the insurance implications.
- The status of the New York City (NYC) appeal and how potential changes to coastal surge might affect the Elizabeth Levee accreditation and/or the LAMP process.
- Two potential paths forward for the Phase 2 analysis (both are based on the assumption that the community will provide needed 44 CFR 65.10 data): a LAMP freeboard deficient analysis if the surge resulting from the NYC appeal is less than two (2) feet of the levee crest (total stillwater), or an accreditation analysis if the stillwater resulting from the NYC appeal is equal to or more than 2 feet below the levee crest and the levee is certified. It was also explained that since there are both coastal and riverine flood conditions, that the certifying engineer will need to check both those requirements in 65.10.

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6. Initial Data Analysis

The initial analysis, also called first pass analysis, used the information provided by stakeholders and the LLPT to produce approximate flooding scenarios associated with possible weak points in the protection system. The information gained from the first pass modeling, along with other data, provides FEMA and the LLPT a better perspective on the appropriate path forward in the LAMP process. The first pass analysis focused on three scenarios: 1) a Natural Valley analysis, which represents the floodplain in the absence of any flood protection structures, 2) an Overtopping analysis, which assumes the levee maintains its current condition during a 1-percent-annual-chance event, and 3) a Freeboard Deficient approach, which assumes the levee crest elevation stays less than 3 feet above than the 1-percent-annual-chance riverine event (less than 2 feet above 1 percent annual stillwater and which would then show the Natural Valley floodplain as Zone D.

For the first pass analysis, the riverine flood elevations from the unsteady detailed HEC-RAS model, were compared to the coastal flood elevations to determine the dominant flood hazard. Comparison demonstrated that the coastal flood elevations were significantly higher downstream of Interstate 95, and the riverine flood elevations only start to dominate upstream of

I-95. Therefore, the flooding scenarios discussed in Sections 6.1 through 6.3 are based on combined riverine and coastal flooding.

6.1 Natural Valley

The Natural Valley represents the floodplain in the absence of any flood protection structures, and is the minimum potential spatial extent of Zone D derived from the LAMP process. The Natural Valley flooding was developed by combining riverine runoff from the upstream limit of the study area with the coastal surge at the downstream limit. The two flood sources were combined using an unsteady state HEC-RAS model with all flood protection structures removed. The resulting Natural Valley floodplain contained approximately 856 structures and covered 364 acres. The flood depth across the study domain resulting from the Natural Valley is shown in Figure 5. This analysis is useful for analyzing the impact of the existing flood control structure.

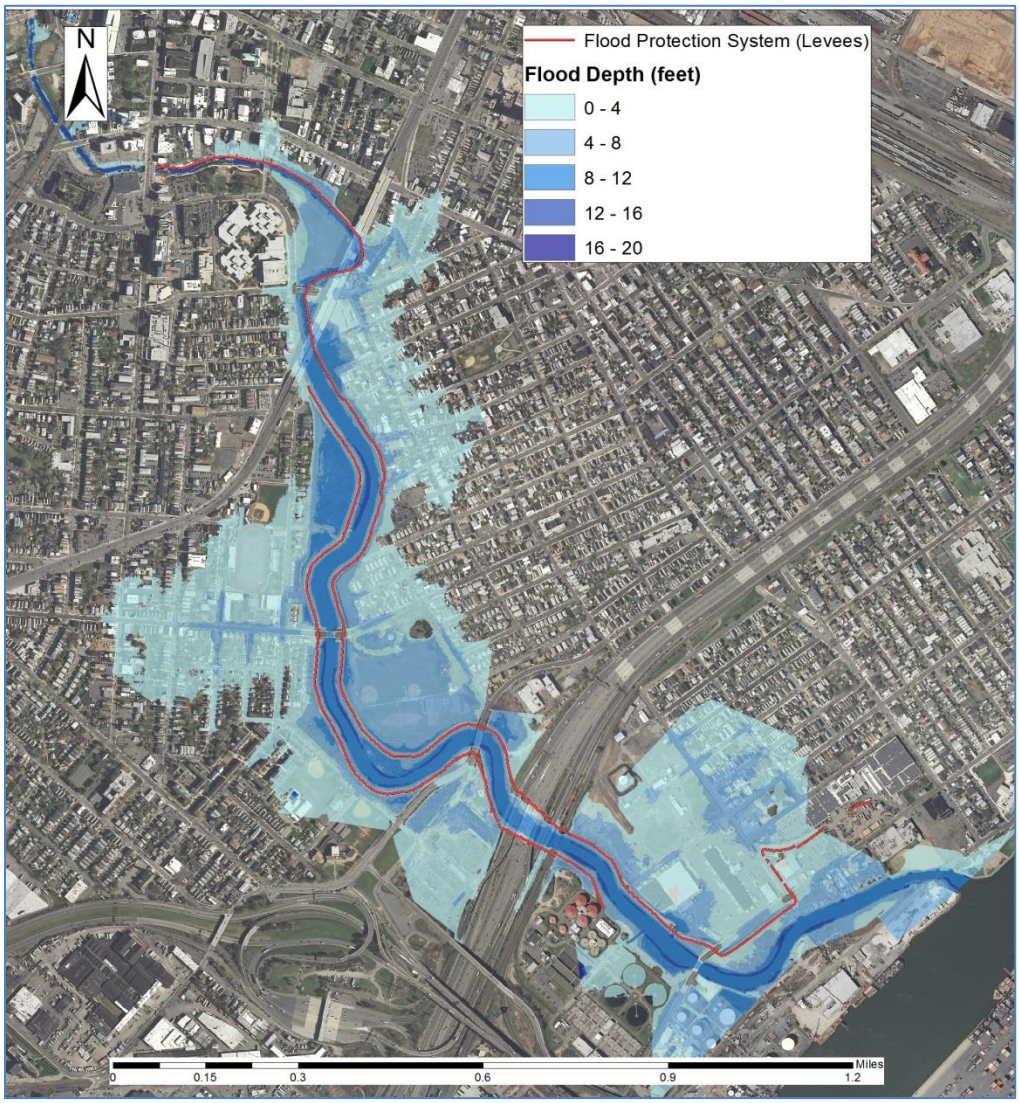

Figure 5. Natural Valley scenario flood depth

6.2 Overtopping

The sections of levee vulnerable to inundation were identified by comparing the USACE survey data to the water surface elevations from the intact levee scenario. A depiction of this comparison is provided in Figure 6. A total of 43 survey points represented in the USACE survey were inundated by the 1-percent-annual-chance water surface elevations. As illustrated in Figure 6, these potential inundated points were typically clustered together with the exception of a few isolated survey points, and were therefore simplified into two reaches for the Overtopping analysis. It is important to note that the levee was not designed for overtopping and therefore this scenario does not represent breaches that could develop at the overtopped locations. The Overtopping scenario described in this section was developed to understand the flooding dynamics of the system and should not be used beyond Phase I of the LAMP study.

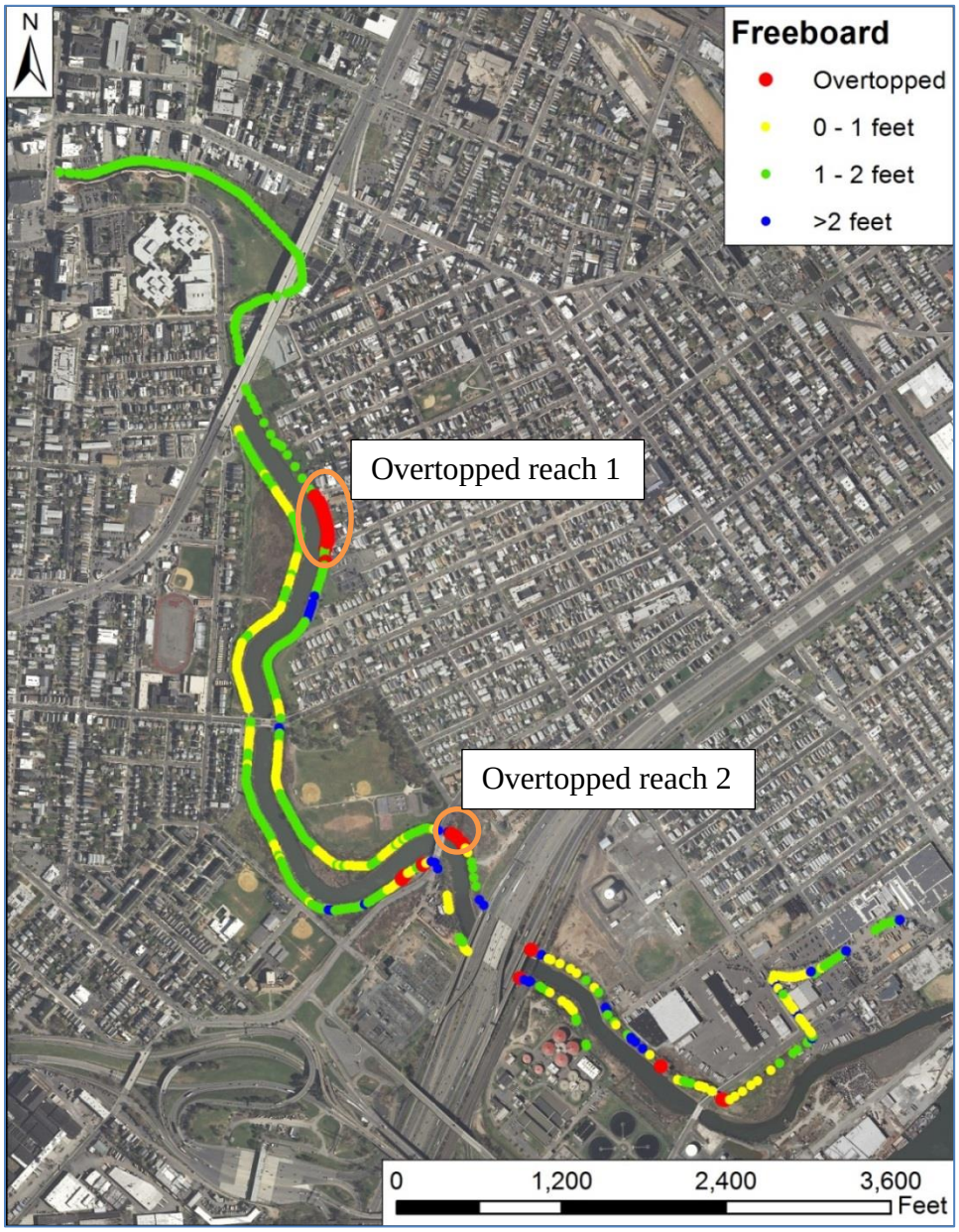

Figure 6. Comparison of surveyed levee crest elevation to the local water surface elevation

The two-dimensional flood routing software, HEC-RAS 5.0, was used to determine the maximum extent and depth of flooding caused by inundation of these levee reaches. The HEC-RAS 5.0 model was developed with a regular grid with a cell size of 100 feet x 100 feet. The levee crest was developed based on the USACE survey information. The model has the ability to incorporate land use data by assigning spatially varying roughness factors, but for the Phase I analysis, a Manning's n value of 0.06 was used for the entire overland 2D area.

Results from the production runs were processed in a Geographic Information System (GIS) to generate high-resolution floodplain boundaries and maximum flood depth grids. These spatial data sets and maps do not provide any regulatory information and are not intended to represent an expectation of how future regulatory data will appear; rather, they are intended to provide information on the impacts from failure or compromise of the selected potential flood sources. The output from the first pass modeling will be used to help select future LAMP approaches, and can also be used for mitigation and emergency management activities. Modeling files and data can be found in Appendix E, Initial Data Analysis / Overtopping. These models can also provide some information related to depth of flooding, velocities and direction of flow.

The flooding produced by the Overtopping scenario is depicted in Figure 7. The resulting water surface elevations varied between 9 and 23 feet NAVD88. The floodplain produced was approximately 189 acres and affected 254 structures. The floodplain produced by the Overtopping scenario was narrower than that for the Natural Valley scenario.

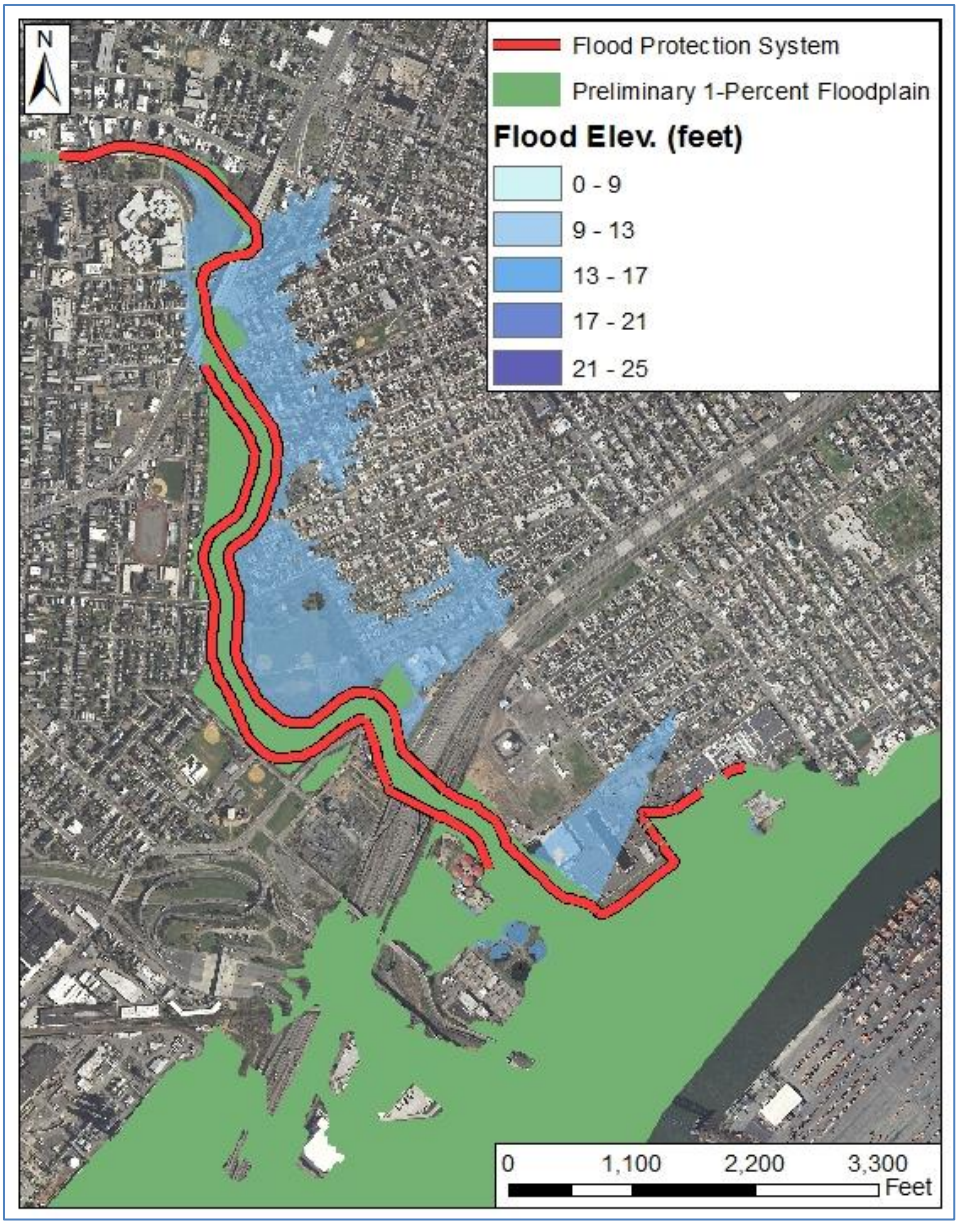

Figure 7. Overtopping scenario flood depth compared to the preliminary 1-Percent-Annual-Chance floodplain

6.3 Freeboard Deficient

Discussion with the community at the second LLPT meeting indicated the levee crest is being elevated, potentially to an elevation higher than the 1-percent-annual-chance flood elevation. However, a certified as-built survey of the new elevations was not available at the time of the Phase 1 study. If the community is able to provide that as-built survey and meet the other needed requirements of 44CFR65.10, the levee could be treated as Freeboard Deficient, which means the Natural Valley scenario described in Section 6.1 would be represented as a Zone D, as depicted in Figure 8. More details on the path to a Freeboard Deficient analysis are discussed in Section 7.

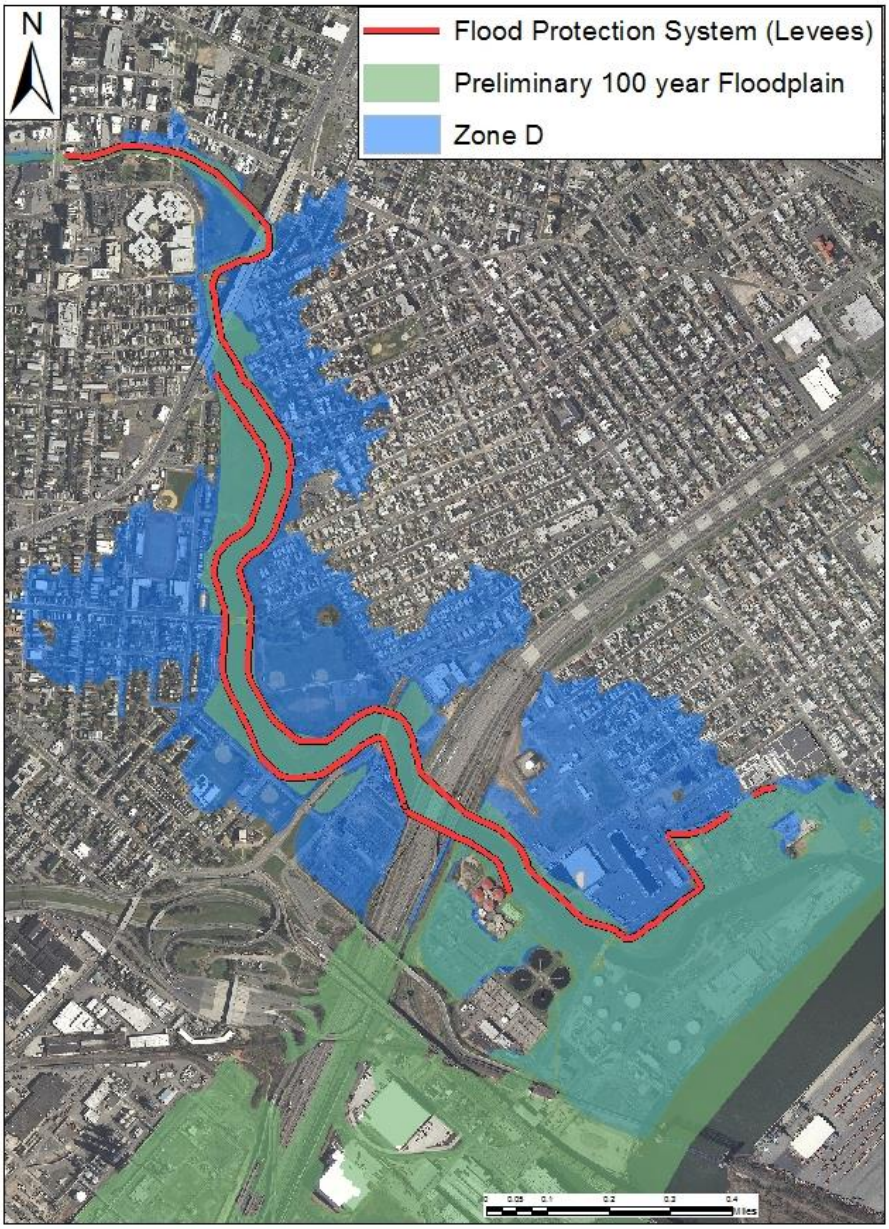

Figure 8. Freeboard Deficient mapping compared to the preliminary 1-Percent-Annual-Chance floodplain

7. Path Forward

The next steps in the LAMP process include continued coordination with the LLPT and stakeholders while refining the technical approach based on feedback and the intended course of action by the communities. Depending on the community's ability to generate or obtain all of the engineering documentation (44 CFR 65.10 data) required for certain LAMP technical approaches, the path forward may change. The following sections describe the path forward that was discussed at the final Phase 1 LLPT meeting based on currently available data.

7.1 Potential Reach Approaches

At the time of this study, NYC had submitted an appeal of the surge modeling used in the Region II preliminary FIS. This appeal may have implications for the City of Elizabeth and its levee. The appeal has the potential to lower the coastal surge elevations throughout coastal New York and New Jersey. Consequently, the outcome of the appeal will govern the study approach recommended for a future LAMP Phase 2 study.

The preliminary FIS shows the coastal surge around 11.2 feet NAVD88. Comparing the coastal surge to the latest USACE survey indicates sections of the levee will be overtopped, as discussed in Section 6.2. However, at the final Phase 1 LLPT meeting, community members explained that they were working to raise low sections of levee by as much as 6 inches.[1] Because the levee elevation and surge elevation could both change, it is uncertain what the best study approach will be for Phase 2. If the levee still fails to meet the freeboard requirements after reconstruction of the levee and resolution of the NYC appeal, then Phase 2 should proceed with a freeboard deficient analysis. If the levee does meet the freeboard requirements, then accreditation could be pursued.[2] A graphical representation of these potential analyses is provided in Figure 9. It was also explained that since there are both coastal and riverine flood conditions, that the certifying engineer will need to check both those requirements in 65.10.

The primary difference between the two approaches is whether the land side of the levee will include a Zone D, similar to the floodplain depicted in Figure 5, or a Shaded Zone X. Both approaches should include a joint probability distribution analysis to show the SFHA for the interior precipitation/drainage associated with the 1-percent-annual-chance coastal storm surge. The corresponding interior drainage analysis should consider including the worst case scenario with the inoperative pump station(s) while the flood gate is closed during a 1-percent-annual-chance storm surge event.

However, if the community is unable to meet any of the non-elevation certification requirements the flood hazards behind the levee will need to be mapped using the LAMP Natural Valley Procedure

[1] The community will need to provide an as-built survey of the levee demonstrating its new elevation in order for it to be considered in the Phase 2 analysis.

[2] The freeboard deficiency or accreditation analyses are contingent on the community meeting all other requirements documented in 44 CFR 65.10.

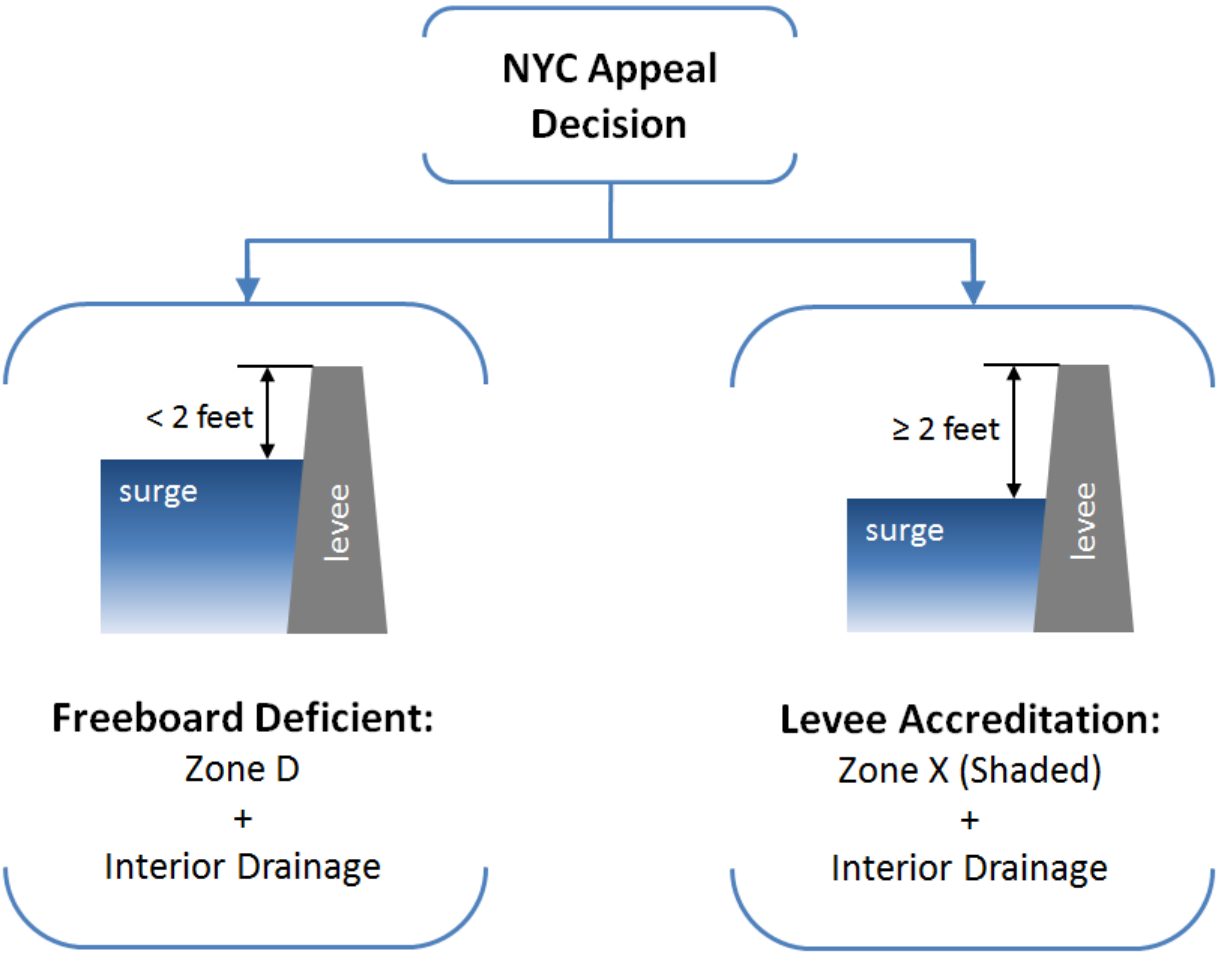

Figure 9. Diagram illustrating potential paths of Phase 2 LAMP coastal reach analysis, depending on the outcome of the NYC appeal

7.2 Model Refinements

The model refinements needed for the Phase 2 analysis are dependent on which study path is chosen. If the levee is found to be freeboard deficient following the resolution of the NYC appeal, the Zone D should be re-evaluated using the best available topography and the revised surge elevations. The study team will also need to develop an interior drainage analysis for Phase 2 based on the capacity of the pumping stations and the 1-percent-annual-chance interior precipitation. If the levee is found to meet freeboard requirements (looking at both coastal and riverine situations) and all other accreditation requirements, only the interior drainage analysis will be necessary.

At the second LLPT meeting, the community expressed interest in treating separate reaches of levee differently in the Phase 2 analysis. For example, the left bank levee might meet accreditation requirements and the right bank might be freeboard deficient. They also expressed interest in treating the levee reaches on either side of I-95 separately. If the community can establish hydraulic independence between the various reaches of levees and their respective protected areas, then it should be reflected in the Phase 2 analysis. Separating the levee on either side of I-95 will also require establishing the highway as a non-levee embankment, as the Federal Highway Administration does not consider highways to be flood control structures.

During the second LLPT meeting, the community highlighted an overpass along I-95 within or close to the natural valley floodplain. In the Phase 2 analysis, the study team should determine the flood impacts of flow through this overpass during a 1-percent-annual-chance event.

If the community is unable to meet any of the non-elevation certification requirements, the Phase 2 study team should analyze and map the 1-percent-annual-chance flood hazards resulting from the flood protection system's deficiency. For example, if an encroachment on the levee embankment is identified, the Phase 2 study team should evaluate the potential impacts, including breaching of the encroachment area to analyze the amount of water expected to infiltrate during a 1-percent-annual-chance event.

7.3 Schedule

Discussion with the community during the second LLPT meeting indicated the community and FEMA would prefer to wait for the resolution of the NYC appeal before moving forward with the Phase 2 analysis. A timeline for resolution of the NYC appeal is currently unknown. Once the appeal is resolved, FEMA will need to plan for and allot funding for the Phase 2 analysis.

8. References

Federal Emergency Management Agency (FEMA), 2015. Preliminary Flood Insurance Study, Union County, New Jersey.

FEMA, 2013. Operating Guidance 12-13: *Non-Accredited Levee Analysis and Mapping Guidance*. http://www.fema.gov/media-library-data/1382477406782-6e78917df29206c388557ca0baf22d3b/Operating%20Guidance%2012-13%20Non-Accredited%20Levee%20Analysis%20and%20Mapping%20Guidance%20(Sept.%202013).pdf

9. Appendix – Associated Files

The appendices are stored digitally under their respective folders on the digital storage device that accompanies this report.

Appendix A – Project Team Contact Information

Appendix B – Stakeholder Engagement Interviews

Appendix C – Stakeholder Engagement Meeting Data

Appendix D – Collected Data

Appendix E – Initial Data Analysis

Appendix F – Exhibits for Elizabeth and Elizabeth Levees