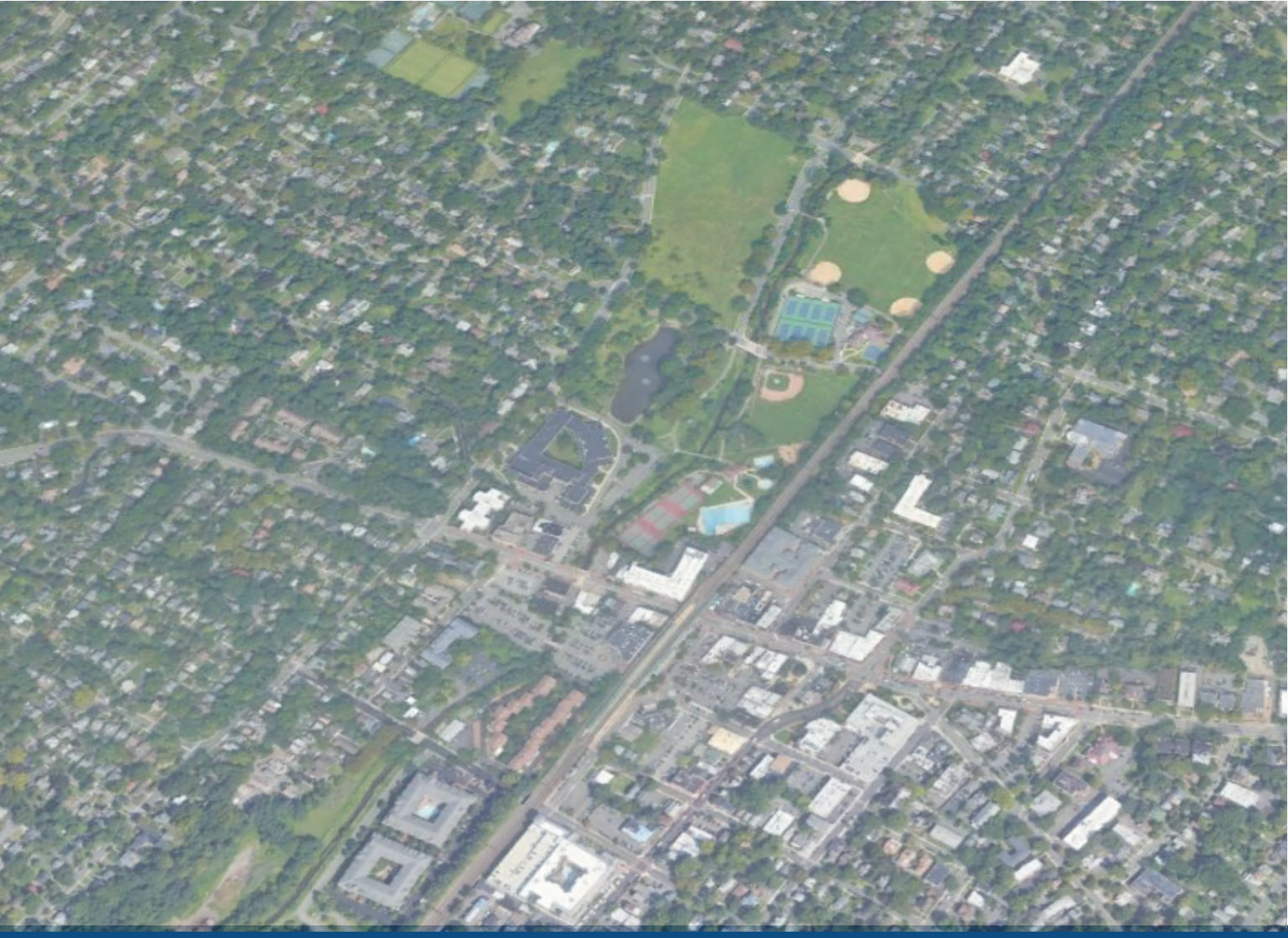

Levee Plan
South Orange Flood Risk Management Project

Township of South Orange Village,
Essex County, New Jersey

May 2021

FEMA

RiskMAP
Increasing Resilience Together

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Acronyms

BFE	Base Flood Elevation
BLE	Base Level Engineering
BRIC	Building Resilient Infrastructure Communities
CERC	Community Engagement and Risk Communication
CFR	Code of Federal Regulations
DPW	Department of Public Works
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FRMP	Flood Risk Management Project
H&H	Hydrologic and Hydraulic (Analyses)
HMP	Hazard Mitigation Plan
LiDAR	Light Detection and Ranging (System)
LLPT	Local Levee Partnership Team
LOMR	Letter of Map Revision
NFIP	National Flood Insurance Program
NJDEP	New Jersey Department of Environmental Protection
NLD	National Levee Database
NRCS	Natural Resources Conservation Service
O&M	Operations and Maintenance
PTS	Production and Technical Services
SFHA	Special Flood Hazard Area
STARR II	Strategic Alliance for Risk Reduction
USACE	U.S. Army Corps of Engineers

Definitions

The terms below have been used in this document. Additional terms are provided in FEMA's *Guidance for Flood Risk Analysis and Mapping, Levees* (November 2019) in the Glossary. The current edition of the guidance document is available from the FEMA Library at https://www.fema.gov/media-collection/guidance-femas-risk-mapping-assessment-and-planning# or can be requested by contacting FEMA Region 2 Risk Analysis Branch.

Base Flood Elevation (BFE) – The elevation of a flood having a 1-percent chance of being equaled or exceeded in any given year.

Levee Analysis and Mapping Procedures – Levee mapping procedures for non-accredited levees, which include Sound Reach, Freeboard Deficient, Overtopping Analysis, Structural-Based Inundation, and Natural Valley. Details on these approaches can be found in FEMA's *Guidance for Flood Risk Analysis and Mapping, Levees*.

Leveed Area – A spatial feature in the National Levee Database defined by the lands from which flood water is excluded by the Levee System. This area is delineated based on the levee crest elevations.

Levee Impacted Area* – The area landward of a levee system that would be inundated by the corresponding base flood if the flood hazard reduction effect of the levee system is not considered. Often, this area will be identified by applying the Natural Valley Procedure for the levee system.

Levee Reach* – Any continuous section of a levee system to which a single analysis and mapping procedure may be applied.

Levee System* – A flood hazard-reduction system that consists of one or more levee segments and other features, such as floodwalls and pump stations, which are interconnected and necessary to ensure exclusion of the design flood from the associated hydraulically independent leveed area, and which are constructed and operated in accordance with sound engineering practices.

Local Levee Partnership Team (LLPT)* – A work group that FEMA can facilitate when a levee system will be analyzed by levee analysis and mapping procedures for non-accredited levees. The primary function of this group is to share information/data and identify options based on stakeholder roles and knowledge.

National Levee Database (NLD)* – A database developed by the U.S. Army Corps of Engineers (USACE) in cooperation with FEMA, which is a dynamic, searchable inventory of information for all levee systems in the Nation. The NLD contains information to facilitate and link activities, such as flood risk communication, levee system evaluation for the NFIP, levee system inspections, flood plain management, and risk assessments.

Non-Accredited Levee System* – A levee system that does not meet the requirements at Title 44, Chapter 1, Section 65.10 of the Code of Federal Regulations (44 CFR 65.10), *Mapping of Areas Protected by Levee Systems*, and is not shown on a FIRM as reducing base flood hazards.

Zone A – An area inundated by 1-percent-annual-chance flooding, for which no BFEs have been determined.

Zone D – Area of possible but undetermined flood hazard.

*Term description from FEMA's *Guidance for Flood Risk Analysis and Mapping, Levees*

Executive Summary

In November 2020, FEMA Region 2 partnered with local, state, and Federal levee stakeholders to form a Local Levee Partnership Team (LLPT) with the Township of South Orange Village. The LLPT coordinated to collect and evaluate available data, complete an initial data analysis, and discuss mapping needs.

This levee plan summarizes that information and informs the path forward. The plan outlines potential options to evaluate the flood hazard on the landside of the levee systems on future Flood Insurance Rate Maps (FIRMs). It also identifies additional data collection needs.

The South Orange Flood Risk Management Project (South Orange FRMP) was designed and constructed by United States Army Corps of Engineers (USACE) to reduce flood risk to the Township of South Orange Village. The project consists of two levee systems along the East Branch Rahway River (the Left Bank North Levee and the Right Bank South Levee) and one flood control channel system.

The Federal Emergency Management Agency (FEMA) identifies flood risk and maps flood hazard. The flood risk for the 1-percent-annual-chance flood (base flood) is discussed in the Flood Insurance Study (FIS) report. The flood hazard is mapped on the FIRM. The two levee systems of the South Orange FRMP are shown as reducing the base flood hazard on the effective FIRM panels for the Township of South Orange Village. The effective FIRM panels for the Township of South Orange Village are dated June 4, 2007. These FIRMs are the regulatory flood insurance maps.

FEMA Region 2 is planning to initiate a Base Level Engineering (BLE) project for this area in 2021, including the East Branch Rahway River. A BLE project is a comprehensive watershed flood risk assessment performed at a large scale with several automated components. The results of a BLE project provide a preliminary depiction of flood risk based on better data and inform future flood hazard mapping updates within the watershed. The BLE project results will not replace the flood hazard information shown on the effective FIRM panels, but may be leveraged when a new, more detailed regulatory flood risk study is conducted to update the FIS and FIRM panels. As part of this overall process, FEMA Region 2 is proactively engaging the Township of South Orange Village to understand how the levee systems affect the local flood hazard identification.

FEMA guidance on evaluating levees was updated in 2013. The updated guidance included the *Analysis and Mapping Procedures for Non-Accredited Levee Systems*. These procedures feature more interactive stakeholder engagement. These procedures also provide more options to analyze and map flood hazards for non-accredited levee systems.

Based on the limited data available, the Natural Valley Procedure was used to estimate the levee impacted area. A refined leveed area was also prepared based on as-built levee crest information. The Township of South Orange Village retains the option to move forward with accreditation or other applicable levee analysis procedures at any time, should sufficient information be provided to meet the applicable data requirements.

1 Introduction

The levee plan summarizes stakeholder coordination, data collection, initial data analysis, and potential options for depicting the flood hazard for the levee systems on a future FIRM. This levee plan is the result of collaboration between FEMA, the Township of South Orange Village, the New Jersey Department of Environmental Protection (NJDEP), USACE, and other stakeholders.

FEMA uses current modeling techniques to refine flood hazard reduction provided by non-accredited levee systems. This process, known as the "Analysis and Mapping Procedures for Non-Accredited Levee Systems", enhances interactive stakeholder engagement. This process recognizes the uncertainty associated with hazard identification of levee-impacted areas providing multiple options to show flood hazard.

This approach is being applied to the levee systems along the East Branch Rahway River, within the Township of South Orange Village. Analysis and Mapping Procedures for Non-Accredited Levee Systems activities were initiated by FEMA Region 2; its Production and Technical Services (PTS) provider, Strategic Alliance for Risk Reduction II (STARR II); and its Community Engagement and Risk Communication (CERC) provider (*Resilience Action Partners*).

Flood hazards change over time. Conditions within a watershed may also change. FEMA Region 2 is planning a BLE project for the Sandy Hook-Staten Island Watershed to help inform flood risk mapping projects in the future. This BLE project is planned to include the East Branch Rahway River in the Township of South Orange Village. The results of the BLE project will not replace the effective study, FIS, and FIRM panels in the Township of South Orange Village (see Section 2.3 for more information).

When a stream with a levee system is restudied, levee system protective status is reevaluated. In this case, if the East Branch Rahway River is restudied, the levee systems in the Township of South Orange Village will be reevaluated. Currently, the levee systems are mapped on the effective FIRM panels as reducing the hazard of the base flood (also known as accredited); however, there is no data or documentation available to support that the levee systems meet the (National Flood Insurance Program (NFIP) requirements for accreditation (44 CFR §65.10). For the levee systems to be shown as accredited on future FIRM panels, the levee systems would need to meet the NFIP requirements of 44 CFR §65.10. The data and documentation in support of 44 CFR §65.10 would need to be submitted to FEMA for a compliance check prior to being shown as accredited on future FIRM panels.

2 Levee System Descriptions

2.1 South Orange Flood Risk Management Project (FRMP)

The East Branch Rahway River flows through the Township of South Orange Village from northeast to southwest for approximately 1.5 miles. The Township of South Orange Village is located along the East Branch Rahway River a few miles upstream (northeast) of its confluence with the mainstem of the Rahway River.

USACE designed the South Orange FRMP to reduce flood risk to the Township of South Orange Village. The project was authorized in 1965 and includes two levee systems along the East Branch

Rahway River (referenced as the Left Bank North Levee and the Right Bank South Levee) and one flood control channel system. The Left Bank North Levee system is an earthen levee system located along the east (left) side of the East Branch Rahway River on the north side of the township. The Right Bank South Levee system is an earthen levee located along the west (right) side of the East Branch Rahway River on the south side of the township. References to right and left banks are from the perspective of looking downstream. The channel system consists of channel improvements and concrete channelization of much of the length of the East Branch Rahway River within the township and connects the two levee systems. Construction of the South Orange FRMP was completed in 1976.

The local sponsor of the two levee systems of the South Orange FRMP is the Township of South Orange Village. The sponsor is responsible for the Operation and Maintenance (O&M) of the levee systems per cooperation agreements with USACE. Emergency management activities related to the South Orange FRMP are also addressed at the local and county levels.

More information about the levee systems is provided in Table 1 and the levee system alignments are shown in Figure 1.

Table 1. Levee Systems Summary

Levee System Name	Levee System ID	County	Community	Approximate Total Length of Levee System (ft)	Approximate # of Structures Affected
Left Bank North Levee System[2]	4505000025	Essex	Township of South Orange Village	500[1]	1[1]
Right Bank South Levee System[3]	4505000026	Essex	Township of South Orange Village	690[1]	2[1]

[1] Data from USACE National Levee Database (NLD)
[2] NLD System Name "S_Orange, Rahway River, East Branch, LB North"
[3] NLD System Name "S_Orange, Rahway River, East Branch, RB South"

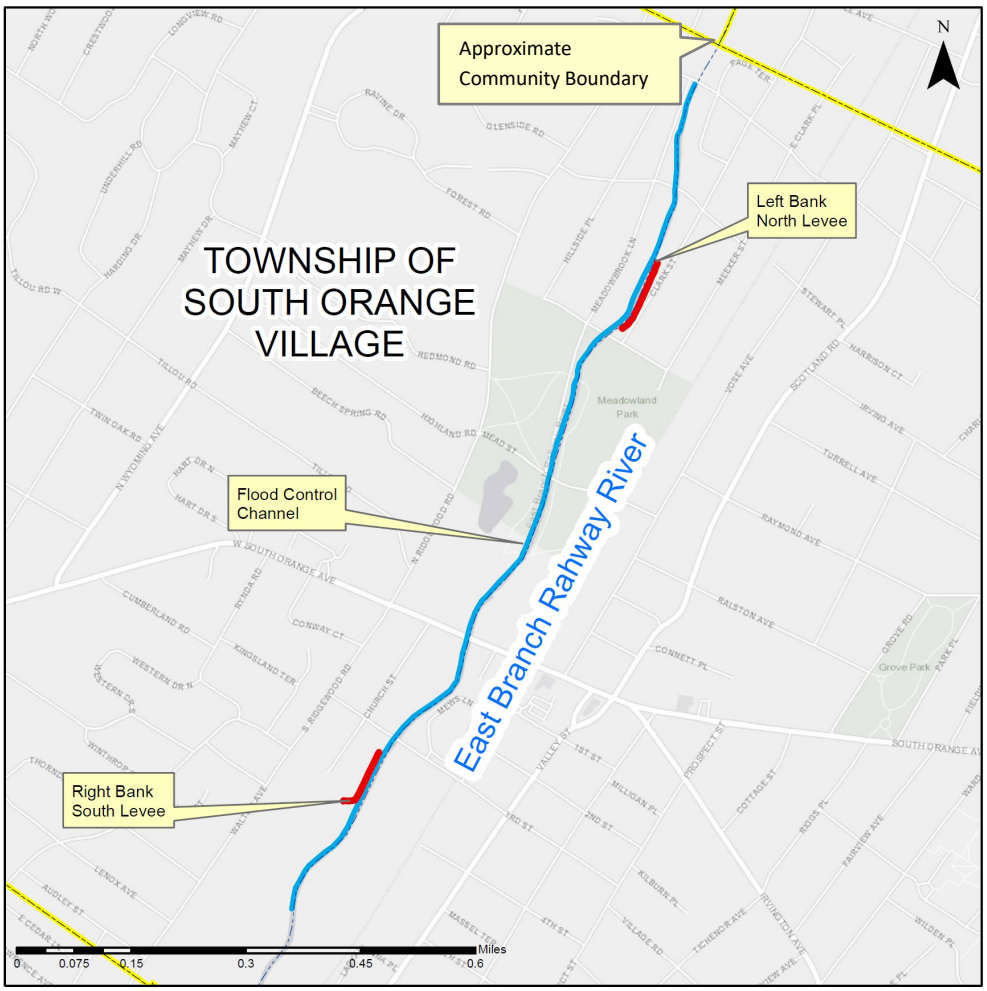


Figure 1: Location Map

2.2 Community NFIP and FIS History

Table 2 summarizes the NFIP participation and FIS report history of the Township of South Orange Village.

Table 2. Community Map History

Community Name	Participating in the NFIP?	Initial Flood Hazard Boundary Map Identification Date	Initial FIRM Identification Date	FIRM Effective Date
Township of South Orange Village	Yes	November 30, 1973	July 18, 1977	June 4, 2007

The effective FIRM panels for the Township of South Orange Village are dated June 4, 2007. The historic 1977 FIRMs show the 1-percent-annual-chance flood of the East Branch Rahway River contained in the channel and no levee systems are shown. The effective 2007 FIRMs show that the 1-percent-annual-chance flood is no longer contained in the channel. While the two levee system

alignments are not shown on the effective FIRMs, the hazard of the base flood is mapped as though the levee systems are reducing the flood hazards.

2.3 Sandy Hook-Staten Island Watershed BLE

FEMA is planning a large-scale BLE project for the Sandy Hook-Staten Island Watershed that includes the East Branch Rahway River in the Township of South Orange Village. This watershed-scale BLE project expected to begin in 2021 and is intended to inform future mapping updates.

BLE is an automated riverine hydrologic and hydraulic (H&H) modeling approach that provides communities with a baseline understanding of their flood risk. It is produced to support the assessment and maintenance of the national flood hazard inventory. A BLE project provides updated information for a large area, with a limited level of detail. The resulting flood risk dataset can be used to initiate flood risk awareness discussions. The results of this BLE project will not replace the detailed study because a replacement study must produce outputs with at least the same level of detail as shown on the current FIRMs. The township will be engaged during developments related to the Sandy Hook-Staten Island Watershed BLE project.

2.4 Future Detailed Study

In the future, FEMA may fund a new detailed study of the East Branch Rahway River in the Township of South Orange Village.

A detailed study is an enhanced level of H&H analysis. A detailed hydraulic analysis may include a field survey data and additional information about stream crossings such as bridges and leveraged information from the upcoming BLE study. A new detailed study would supersede the current effective FIS report and FIRMs when adopted by the community.

3 Stakeholder Engagement and Data Collection

3.1 Local Levee Partnership Team

The LLPT is a group of levee stakeholders who provide FEMA with data and information on local levee conditions. They also share feedback on the procedures for analyzing and mapping the levees in consideration. The stakeholders who participated in the LLPT for this project are listed in Table 3.

Table 3. LLPT Participants

LLPT Member	Contact Information
Salvatore Renda	Engineer/Floodplain Administrator, Township of South Orange Village 973-378-7715; srenda@southorange.org
Michael Candarella	Director of Public Works, Township of South Orange Village 973-378-7741; mcandarella@southorange.org
Walter Clarke	Township Trustee, Township of South Orange Village wclarke@southorange.org
Clyde L. Otis	Township Counsel, Township of South Orange Village COtis@postpolak.com
Adam Loehner	Village Administrator, Township of South Orange Village aloehner@southorange.org
Kunal Patel	NJ Department of Environmental Protection Kunal.Patel@dep.nj.gov
Joseph Ruggeri	NJ Department of Environmental Protection Joseph.Ruggeri@dep.nj.gov
Tom Slowinski	NJ Department of Environmental Protection Tom.Slowinski@dep.nj.gov
Jeffrey W. Gross	U.S. Army Corps of Engineers Jeffrey.W.Gross@usace.army.mil
Brittney R. Soltes	U.S. Army Corps of Engineers Brittney.R.Soltes@usace.army.mil
Shudipto Rahman	Project Monitor, FEMA Region 2 202-702-4273; Shudipto.Rahman@fema.dhs.gov
Thomas Song	Resiliency Specialist, FEMA Region 2 917-374-5475; Thomas.Song@fema.dhs.gov
Stephanie Nurre	Study Manager, STARR II 312-262-2284; stephanie.nurre@stantec.com
Trevor Cone	Deputy Study Manager, STARR II 212-330-6157; trevor.cone@stantec.com
Julia Rinaldi	Regional Service Center (RSC) julia.rinaldi@stantec.com
Dana Kochnower	Resilience Action Partners, Outreach Provider dana.kochnower@ogilvy.com
Koury Wilson	Resilience Action Partners, Outreach Provider 804-837-2514; koury.wilson@ogilvy.com

3.2 Data Collection

Through the stakeholder coordination and data collection process, FEMA asked the LLPT for all available data, information, and documentation associated with the levee systems.

Table 4 provides a summary of the data and documentation collected during the stakeholder coordination and data collection process. The data is included in Appendix D.

Table 4. Data Collection Summary

Data Type	Associated Levee System(s)	Data Description	Source	Date Developed or Obtained
Historic FIS and FIRM Panels	Left Bank North Levee System, Right Bank South Levee System	Township of South Orange Village, New Jersey	FEMA Map Service Center	July 1977
Effective FIRM Panels	Left Bank North Levee System, Right Bank South Levee System	Essex County, Township of South Orange Village, New Jersey	FEMA Map Service Center	June 2007
Effective FIS	Left Bank North Levee System, Right Bank South Levee System	Essex County, Township of South Orange Village, New Jersey	FEMA Map Service Center	April 2020
Topographic Data	Left Bank North Levee System, Right Bank South Levee System	LiDAR	USGS	2014
Levee System Information	Left Bank North Levee System, Right Bank South Levee System	Levee alignments and other levee data	USACE NLD	2020 (Obtained)
USACE Inspection Reports	Left Bank North Levee System, Right Bank South Levee System	USACE periodic (detailed) inspection reports for the two levee systems and channel system including as-builts	USACE/NJDEP	2016
USACE General Design Memorandum and O&M Manual	Left Bank North Levee System, Right Bank South Levee System	Original project designs and Operations and Maintenance Manual	USACE	1969

3.3 LLPT Meeting 1 and Touchpoint Call

A FEMA project team held a virtual LLPT meeting with levee stakeholders on November 18, 2020. The overall intent of the meeting was to gain local insight on the status of the levee systems and confirm the stakeholders who would like to participate in the LLPT. The meeting also discussed the data available for the levee systems and introduced the Analysis and Mapping Procedures for Non-Accredited Levee Systems. More details about the LLPT meeting are in Appendix A.

A touchpoint call was held on December 14, 2020 as a follow up to the first LLPT meeting and serving as the LLPT Meeting 2. The purpose of this call was to address questions from the LLPT meeting and to obtain additional feedback from the LLPT.

The community noted in these discussions that they have experienced significant flooding at their Department of Public Works (DPW) building which lies downstream of the existing levee systems. This concern has also been highlighted as a priority for the township in the 2020 Essex County Hazard Mitigation Plan (HMP). While the Levee Discovery process focuses on the flood risk associated with the levee systems, the community's concerns regarding the flooding of the DPW facilities during frequent storm events can be shared with future study teams for their awareness.

FEMA is often able to support hazard mitigation actions, such as relocation or elevation of existing structures or other measures, through several hazard mitigation assistance grants. One new grant program that may be of interest to the community is the Building Resilient Infrastructure Communities (BRIC) program. More information can be found about this, and other mitigation grant programs, at www.fema.gov/grants/mitigation.

A follow-up email was sent to the LLPT on February 9, 2021 on behalf of FEMA. The email noted that the next step in the Levee Discovery process would be to develop a draft Levee Plan for the LLPT to review prior to reconvening for a final LLPT meeting to discuss the draft Levee Plan.

3.4 LLPT Meeting 3

The FEMA project team led an LLPT Meeting 3 via webinar with levee stakeholders on April 8, 2021. This final meeting built upon discussions held at the previous LLPT meetings. The FEMA project team discussed a draft of this Levee Plan and provided an opportunity for feedback from the LLPT. The FEMA project team also reviewed the mapping update process. Meeting notes and slides are included in Appendix A.

4 Initial Data Analysis

4.1 Understanding Existing Conditions

The effective hydraulic study for the East Branch Rahway River was developed using the HEC-RAS hydraulic modeling program. Because this stream has been identified in a FEMA study needs tracking database as in need of restudy, a new detailed hydraulic model will be developed in the future. For this reason, the initial data analysis was limited to developing estimates of the levee impacted area, refined leveed area, and freeboard analysis as described below.

As noted in Section 2.2 of this document, the levee system alignments are not shown on the effective FIRM panels; however, the flood hazards appear to be reduced along the levee systems. The effective FIRM panels also do not show the levee impacted area. The levee impacted area is the area landward of a levee system that would be inundated by the base flood if the flood hazard reduction effect of the levee system is not considered.

4.2 Computation of Freeboard

The base flood profile of the East Branch Rahway River in the effective FIS profile was used to estimate minimum freeboard, per the requirements of 44 CFR §65.10 (b)(1), which include:

- "... a minimum freeboard of three feet above the water-surface level of the base flood."
- "An additional one foot above the minimum is required within 100 feet on either side of structures (such as bridges) riverward of the levee or wherever the flow is constricted."
- "An additional one-half foot above the minimum at the upstream end of the levee, tapering to not less than the minimum at the downstream end of the levee, is also required."

The effective base flood profile of the East Branch Rahway River was plotted against the as-built levee crest elevations to estimate if the levee crest met minimum freeboard requirements. The approximate freeboard comparison exhibits in Appendix B show that the Left Bank North Levee may be Freeboard Deficient and not meet the minimum freeboard requirements of 44 CFR §65.10 (b)(1). The exhibits in Appendix B also show that the Right Bank South Levee may meet minimum freeboard requirements.

Information from a new detailed study of the East Branch Rahway River may change the Base Flood Elevation (BFE), which would require an update to the freeboard analysis. Additionally, the levee crest elevations for the freeboard comparison are based on as-builts from 1976. A future field survey of the levee crest may produce elevations different from the as-built information and require an update to the freeboard analysis.

4.3 Potential Levee Reach Analysis Procedures

One component of the Analysis and Mapping Procedures for non-accredited levees is to define and identify potential mapping approaches for each reach based on available data and conditions. Potential reach analysis procedures are described in FEMA's *Guidance for Flood Risk Analysis and Mapping, Levees*. The potential reach analysis procedures include Sound Reach, Freeboard Deficient, Overtopping, Structural-Based Inundation, and Natural Valley Procedures. These procedures may be applied to defined levee reaches of an entire system. Each procedure requires the use of different components of data from 44 CFR §65.10. A summary of the levee data required for various levee reach analysis procedures and the available levee data for the Left Bank North and Right Bank South levee systems is shown in Table 5. A full checklist of the levee certification data required under 44 CFR §65.10 for accreditation is provided in Appendix C.

Table 5. Levee Data Summary

Data Type	Data Required for Levee Reach Analysis Procedures					Levee System Data Collected
	Sound Reach	**Freeboard Deficient**	**Overtopping**	**Structural-Based Inundation**	**Natural Valley**	**Left Bank North & Right Bank South Levees**
Levee Crest Information (65.10 sections b & e)	Required[1], BFE + Freeboard Less than Levee Crest	Required[1], BFE Less than Levee Crest	Required[1]	Required[1]	None	USACE as-built levee crest elevations
O&M Plan, Emergency Action Plan (65.10 sections c & d)	Required[1]	Required[1]	Required[1]	Recommended	None	Original 1969 O&M Plan only
Certified As-Built Plans (65.10 section e)	Required[1]	Required[1]	Required[1]	None	None	Yes
Structural Design Requirements[2] (65.10 section b)	Required[1]	Required[1]	Required[1]	None	None	No
Inspection Plan/ Inspection Reports (65.10 section c)	Required[1]	Required[1]	Required[1]	Recommended	None	Yes
Evaluation of overtopping Erosion Potential (65.10 section b)	None	None	Required[1]	None	None	No

[1] Data required from levee stakeholder.

[2] Structural design requirements include: freeboard, closures, embankment protection, embankment and foundation stability analyses, settlement analyses, and interior drainage. These requirements are listed in 44 CFR §65.10(b). A checklist of the levee certification data required under 44 CFR §65.10 is provided in Appendix C.

5 Potential Mapping and Analysis Procedures

For future mapping to show the Left Bank North and Right Bank South levee systems as providing flood hazard reduction during the base flood, the Township of South Orange Village will need to provide FEMA certified levee data that complies with 44 CFR §65.10. A certified levee data package may be incorporated into future mapping if FEMA receives and confirms it is complete prior to the end of the 90-day appeals period after a Preliminary FIRM is released. It is important to note that this data may also be submitted at any time utilizing the Letter of Map Revision (LOMR) process.

If the levee systems cannot meet minimum requirements of 44 CFR §65.10, the flood hazard behind the levee systems may be mapped using a Levee Reach Analysis Procedure of the Analysis and Mapping Procedures for non-accredited levees. Certified levee data that complies with 44 CFR §65.10 and the Levee Reach Analysis Procedure being requested would be required for the Sound Reach, Freeboard Deficient, and Overtopping Procedures.

The flood hazard mapping zones landward of the levee are dependent on the analysis procedures. Accreditation of a levee system may result in a Zone X flood hazard area plus any interior drainage Special Flood Hazard Area (SFHA). The Sound Reach and Freeboard Deficient Procedures may result in mapping flood risk as a Zone D. Overtopping and Structural-Based Inundation procedures may result in a combination of a landward SFHA and Zone D. The Natural Valley Procedure results in a landward SFHA. Interior drainage may also be mapped as SFHA if it is shown to be the dominant source of flooding for an area.

A brief description of the various procedures available to study the South Orange FRMP levee systems based on the FEMA guidance, are presented below. A brief evaluation of the appropriateness of each procedure is presented and focuses primarily on data available.
Based on the initial data review, the levee systems are not being separated into reaches and are each being considered as a hydraulically independent levee system.

5.1 Sound Reach

A Sound Reach is a continuous section of a levee system that has been designed, constructed, and maintained to withstand the flood hazards associated with the base flood (see Figure 2). Sound Reaches differ from an accredited levee system because they are a part of a levee system that cannot meet accreditation requirements.

Without separate reaches to evaluate in this case, the requirements of a Sound Reach analysis are the same as those for accreditation.

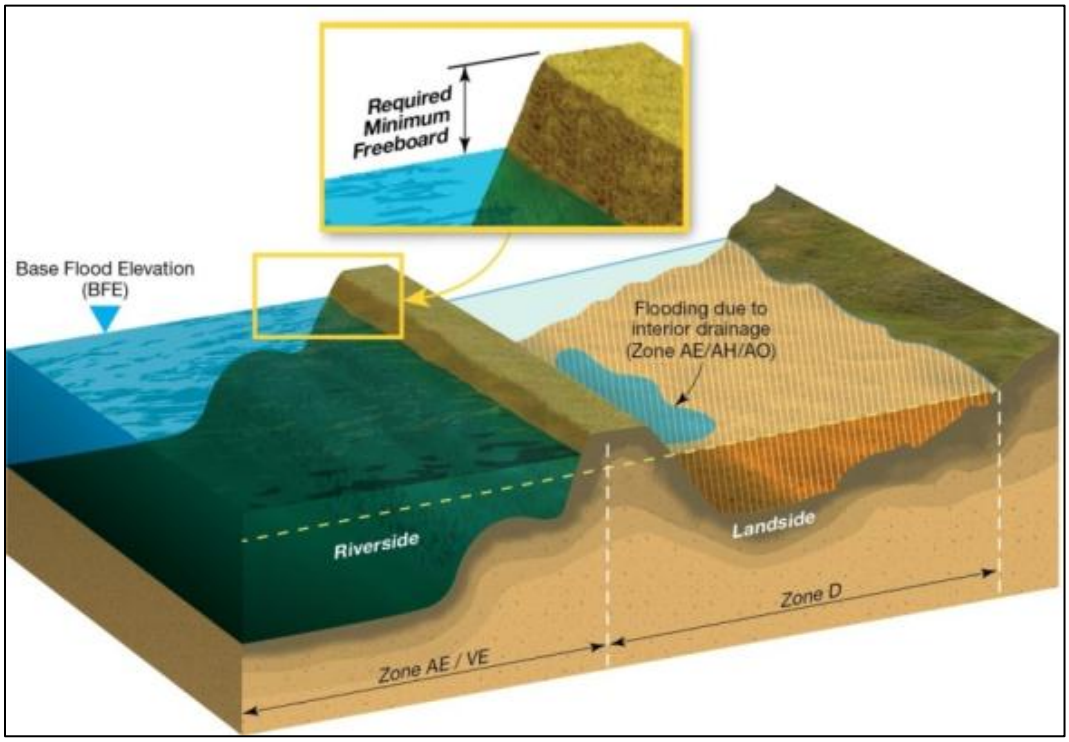


Figure 2: Representation of a Sound Levee Reach and associated flood zones.

5.2 Freeboard Deficient

The Freeboard Deficient Procedure can be applied if the levee crest is above the BFE, but the levee crest does not meet minimum freeboard requirements. A Freeboard Deficient Reach must meet structural requirements, O&M, and inspection standards.

As with the Sound Reach Procedure, no reach-specific modeling is required for a Freeboard Deficient Reach. However, SFHAs from the system-wide interior drainage analysis, and/or adjacent levee reaches, may still be delineated landward of Freeboard Deficient Reaches (see Figure 3).

Based on the initial data review, the levee crest elevation for the Right Bank South Levee system is above the BFE. The levee crest may also meet minimum freeboard requirements; therefore, the levee may not be freeboard deficient and Freeboard Deficient Procedure may not apply.

The levee crest elevations for the Left Bank North Levee system are above the BFEs but do not meet minimum freeboard requirements; therefore, the Freeboard Deficient Procedure may apply.

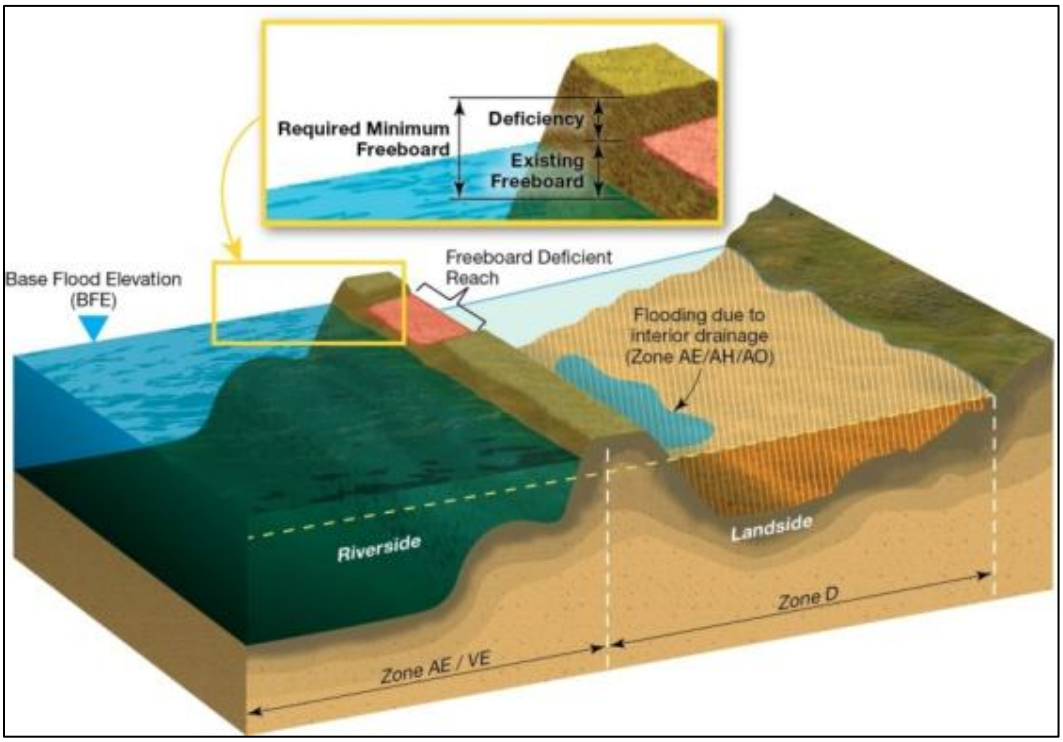


Figure 3: Representation of a Freeboard Deficient Levee Reach and associated flood zones.

5.3 Overtopping

The Overtopping Procedure can be considered when the BFE is above the levee crest for a reach (see Figure 4). In addition to the structural standards established in 44 CFR §65.10, the levee sponsor must provide technical justification that the base flood event overtopping the levee will not cause structural failure to the levee system. As with the Sound Reach and Freeboard Deficient Reach procedures, an O&M Plan and documentation of inspection are required.

Based on initial data review, the Left Bank North Levee and Right Bank South Levee systems may not be overtopped by the BFE of the East Branch Rahway River. When BLE analysis and updated detailed analysis are available, the freeboard estimate of the levee systems should be updated. If the levee systems are overtopped and the levee sponsor provides the missing data listed in Table 5, the Overtopping Analysis may apply. As these levee systems may not have been designed to be overtopped, the overtopping analysis may not be applicable without redesign and construction.

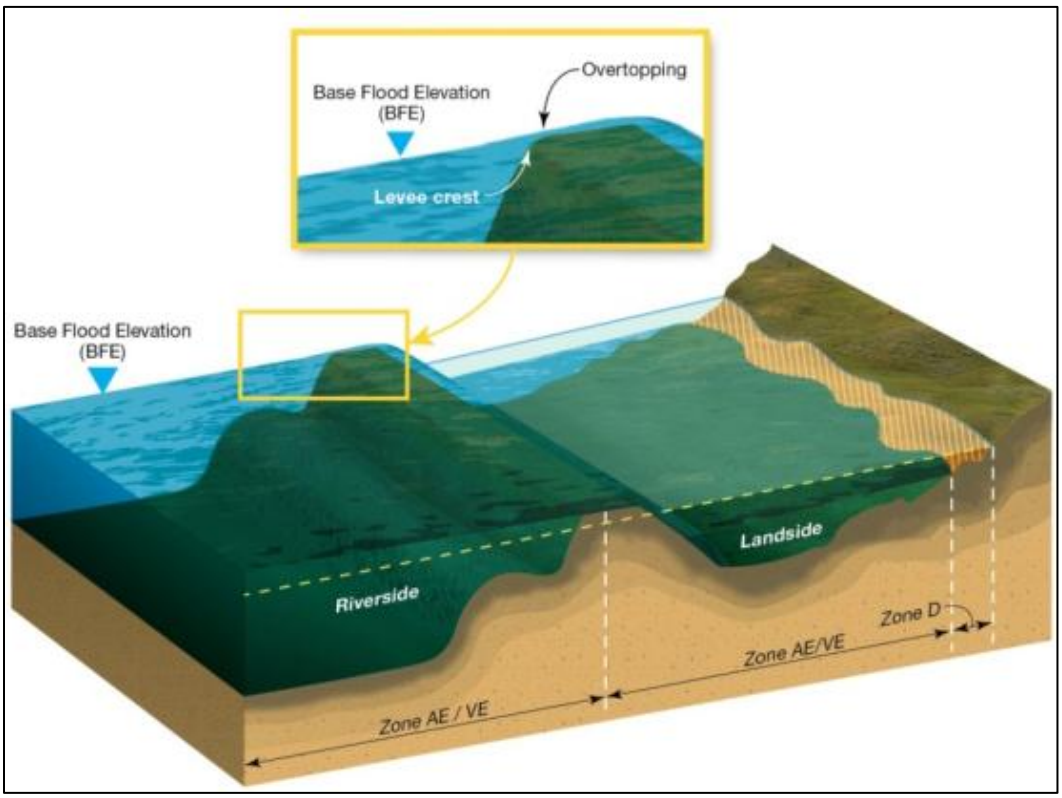


Figure 4: Representation of an Overtopping Levee Reach and associated flood zones.

5.4 Structural-Based Inundation

In some instances, levee systems have reaches with either known structural deficiencies or unknown structural integrity (a common occurrence for older levee systems). Levee systems with structural integrity issues may provide some flood risk reduction by impeding conveyance to some degree. For these levee reaches, FEMA will rely on modeling breaches along the levee reach (see Figure 5).

The South Orange FRMP levees are approximately 500 and 690 feet in length and the estimated levee impact areas are correspondingly small. These factors suggest that a Structural-Based Inundation analysis would not likely yield meaningfully different results than a Natural Valley analysis.

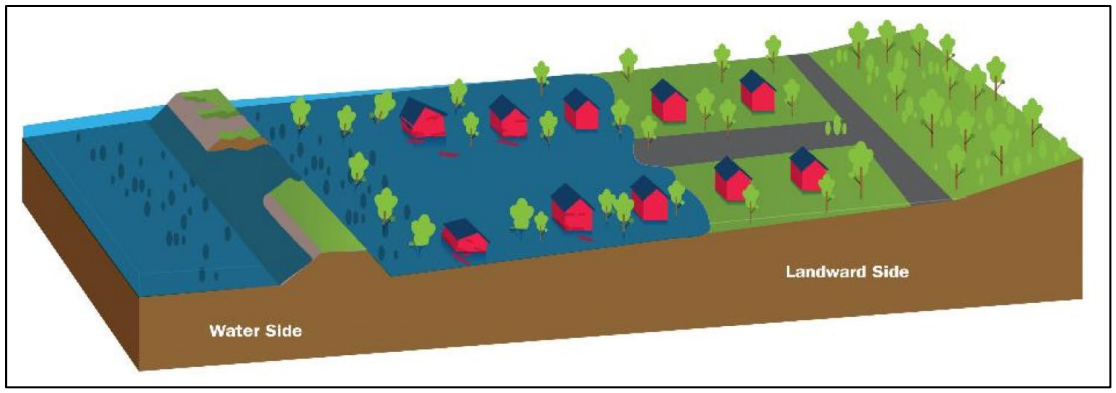


Figure 5: Representation of a Structural-Based Inundation Levee Reach.

5.5 Natural Valley Procedure

FEMA evaluates the Natural Valley Procedure for all levee systems due to data availability and to estimate the potential levee impacted area if the levee system does not reduce flood risk (see Figure 6).

The levee impacted area associated with the Natural Valley Procedure was estimated for the Left Bank North Levee and the Right Bank South Levee using the effective BFEs of the East Branch Rahway River and 2014 USGS LiDAR topography data. Using this information, the area inundated by the BFEs landward of the levee systems was identified and is shown red in in Figures 2 and 3. This may produce a more conservative (larger) inundation area than the traditional Natural Valley Procedure; however, it provides a reasonable level of detail with the data available. These areas would be mapped as SFHAs in a future map update if BFEs remain the same and 44 CFR §65.10 data requirements cannot be met or are incomplete.

For reference, refined leveed areas were estimated based on the available levee crest data for the levee systems. The leveed area is typically shown in the NLD. The levee crest elevations for the refined leveed area were taken from as-built elevations, included in the USACE periodic inspection reports.

The results of the Natural Valley Procedure (the estimated levee impacted areas), as well as the refined leveed areas, are shown in Figure 7 for the Left Bank North Levee system and Figure 8 for the Right Bank South Levee system along the East Branch Rahway River. These results estimate the potential flood risk when the levee systems do not reduce the flood hazard.

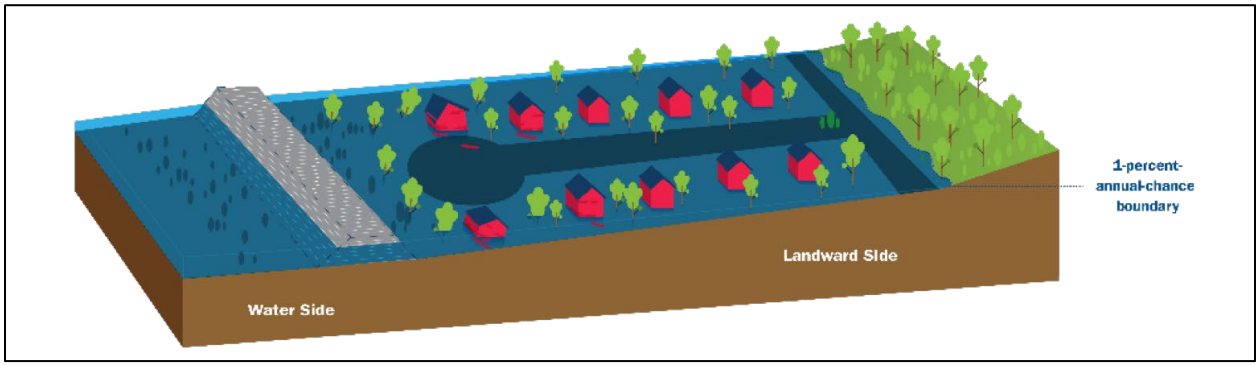


Figure 6: Representation of a natural valley levee reach.

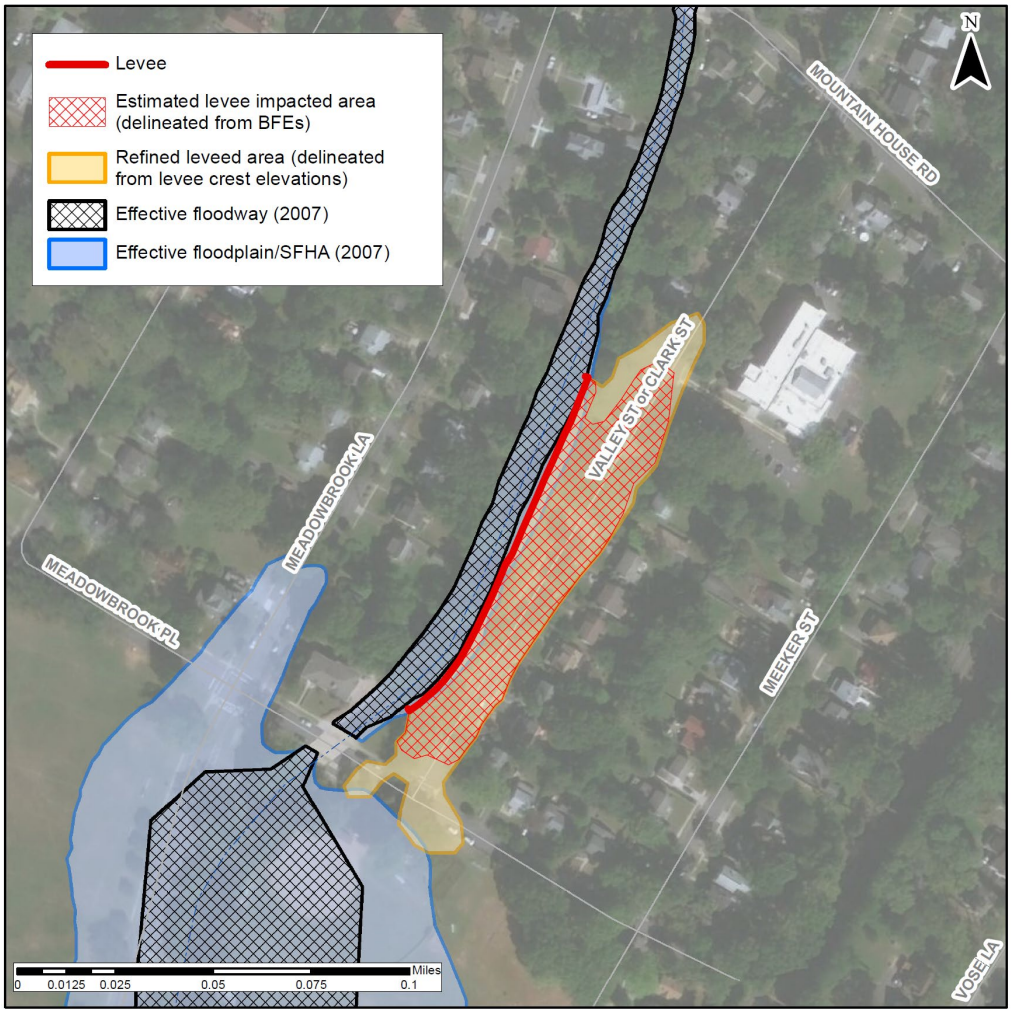


Figure 7: Natural Valley Procedure, Left Bank North Levee System

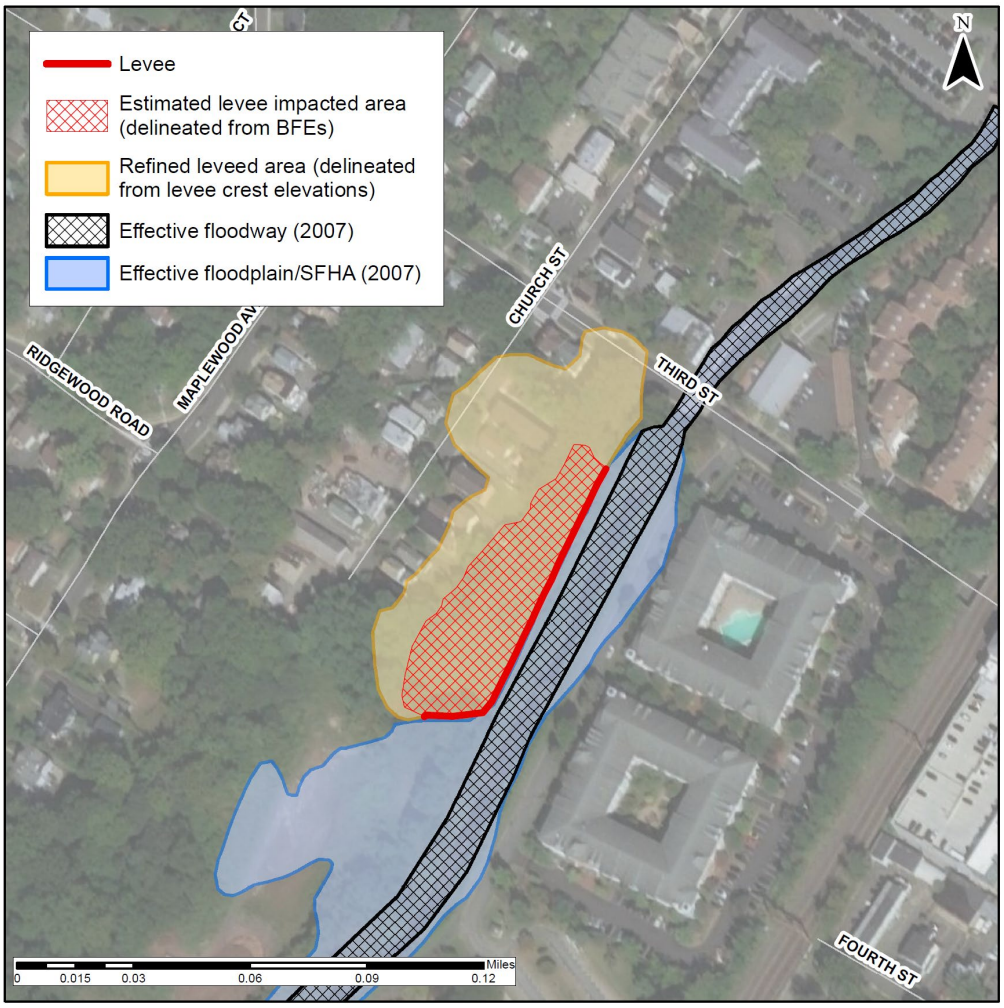


Figure 8: Natural Valley Procedure, Right Bank South Levee System

For a more detailed description of the potential analysis methodologies, please refer to the FEMA's *Guidance for Flood Risk Analysis and Mapping, Levees*.

6 Path Forward and Next Steps

The information within this levee plan provides the community with a tool that can be used for planning and to increase flood risk awareness. This levee plan will also facilitate scoping of a flood mapping project by FEMA in the future. A mapping project will require additional data collection, information gathering, levee owner coordination, detailed hydraulic analysis, and due process. The timetable for a potential project has not been determined as of the completion of this study; however, a BLE project is planned to begin later in 2021. The BLE project will result in updated H&H information that can also be used for planning and to increase flood risk awareness but will not revise the effective mapping.

For the levee systems to be mapped as accredited on future FIRMs, certified levee data that complies with 44 CFR §65.10 will be required for the levee systems within the South Orange FRMP. If the levee systems cannot meet minimum requirements of 44 CFR §65.10, the flood

hazard behind the levee systems may be mapped using one of the *Analysis and Mapping Procedures for Non-Accredited Levee Systems* described in this plan.

Members of the LLPT will be included in future outreach to determine what, if any, changes have taken place with respect to existing conditions or future plans that may have an impact on how these levee systems should be evaluated.

7 References

FEMA: *Flood Insurance Study*, Village of South Orange, New Jersey, Essex County, January 1977

FEMA: *Flood Insurance Study*, Essex County, New Jersey, June 5, 2007

FEMA: *Flood Insurance Study*, Essex County, New Jersey, April 3, 2020

FEMA: *Analysis and Mapping Procedures for Non-Accredited Levee Systems*, July 2013

FEMA: *Guidance for Flood Risk Analysis and Mapping, Levees*, November 2019

USACE, National Levee Database (https://levees.sec.usace.army.mil/#/), 2020

New Jersey Office of Geographic Information Systems (OGIS), Northeast NJ Post-Sandy LiDAR 2014, Available at: https://njogis-newjersey.opendata.arcgis.com/

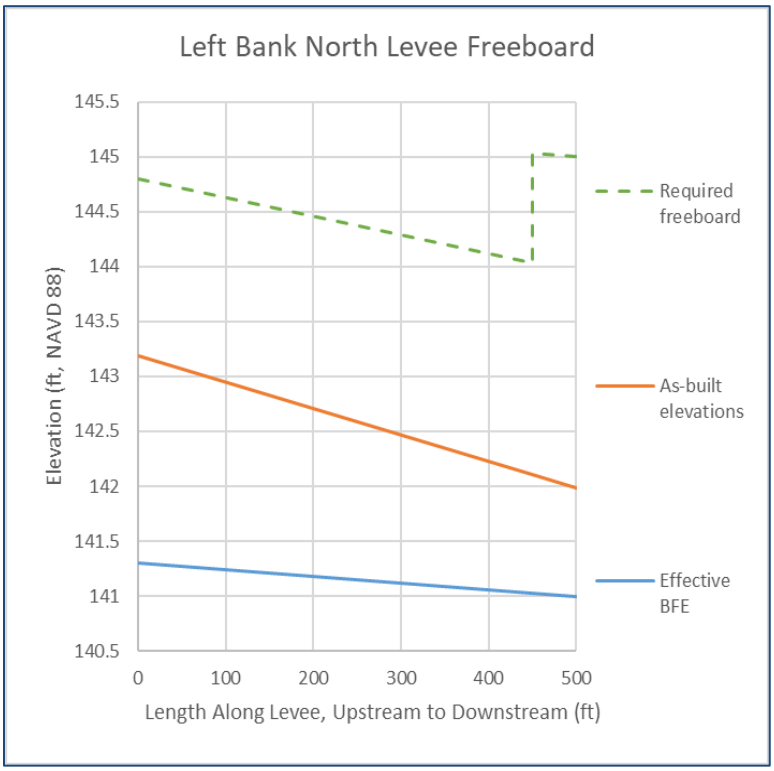
Appendix A

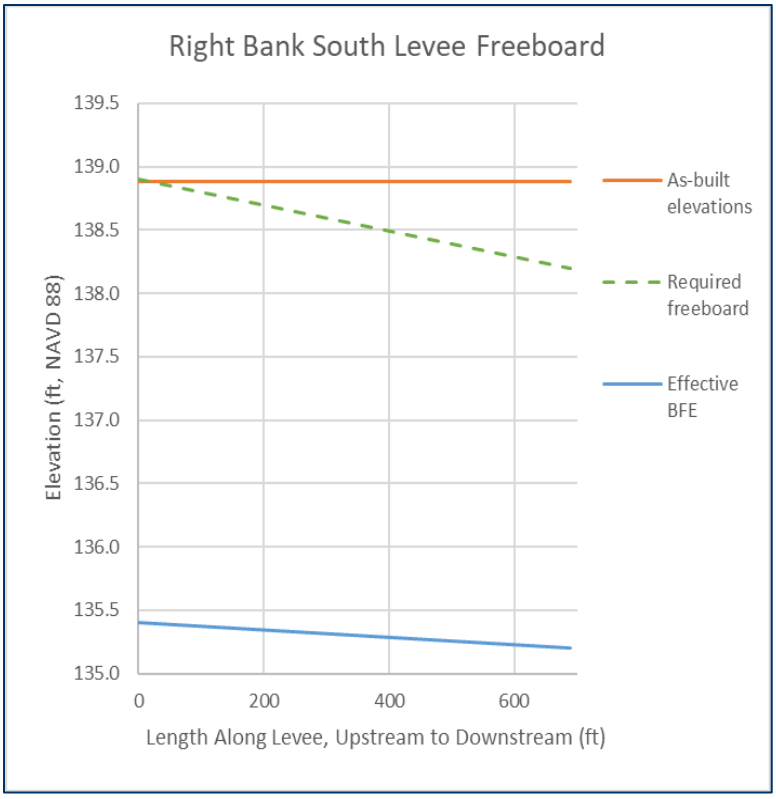
Stakeholder Engagement - LLPT Meeting Information

(full appendix provided separately)

Appendix B

Freeboard Profile Comparison


Left Bank North Levee Freeboard
145.5
145
144.5
144
143.5
143
142.5
142
141.5
141
140.5
Elevation (ft, NAVD 88)
0
100
200
300
400
500
Length Along Levee, Upstream to Downstream (ft)
Required freeboard
As-built elevations
Effective BFE


Right Bank South Levee Freeboard
139.5
139.0
138.5
138.0
137.5
137.0
136.5
136.0
135.5
135.0
Elevation (ft, NAVD 88)
0
200
400
600
Length Along Levee, Upstream to Downstream (ft)
As-built elevations
Required freeboard
Effective BFE

Appendix C

Levee Accreditation Checklist

(full appendix provided separately)

Appendix D

Collected Data

(full appendix provided separately)