**Lake St Clair Flood Risk Reduction Study**

**For the Jefferson-Chalmers Neighborhood, Detroit, Michigan**

**U.S. Army Corps of Engineers (USACE) - Floodplain Management Services Program (FPMS)**

**July 2022**


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# 1. Detroit FPMS Study

## 1.1 FPMS Purpose and Authority

People who live in a floodplain need to know about flood hazards and the actions that they can take to reduce property damage and to prevent the loss of life caused by flooding. The Flood Plain Management Services (FPMS) Program was developed by the U.S. Army Corps of Engineers (USACE) specifically to address this need.

The program's authority stems from Section 206 of the 1960 Flood Control Act (PL 86-645), as amended. Its objective is to foster public awareness of the options for dealing with flood hazards and to promote prudent use and management of the Nation's floodplains. The program also provides guidance and assistance for meeting standards of the National Flood Insurance Program and for conducting workshops and seminars on non-structural floodplain management measures, such as flood proofing.

The FPMS Program provides the full range of technical services and planning guidance that is needed to support effective floodplain management.

**General Technical Services**: The program develops or interprets site-specific data on obstructions to flood flows, flood formation, and timing; flood depths or stages; floodwater velocities; and the extent, duration, and frequency of flooding. It also provides information on natural and cultural floodplain resources of note, as well as flood loss potentials, before and after use of floodplain management measures.

**General Planning Assistance**: On a larger scale, the program provides assistance and guidance in the form of "Special Studies" on all aspects of floodplain management planning including the possible impacts of land use changes on the physical, socio-economic, and environmental conditions of the floodplain. This can range from helping a community identify present or future floodplain areas and related problems, to a broad assessment of which of the various remedial measures may be effectively used. Some of the most common types of "Special Studies" include:

- Floodplain Delineation/Flood Hazard Evaluation Studies
- Dam Break Analysis Studies
- Flood Warning/preparedness Studies
- Regulatory Floodway Studies
- Comprehensive Floodplain Management Studies
- Flood Damage Reduction Studies
- Urbanization Impact Studies
- Stormwater Management Studies
- Flood Proofing Studies
- Inventory of Flood Prone Structures

## Detroit FPMS Study Background

Water levels in the Great Lakes system have been rising substantially in the last few years. On Lake St. Clair, water levels have risen over five feet over the past seven years. The heavy precipitation in the winter and spring of 2019 has caused Lake St Clair's water level to continue its rapid increase to an elevation higher than some of the coastal, canal front, and riverine shorelines throughout the City of Detroit. This rise has increased the occurrence and magnitude of flooding in the densely-populated neighborhoods along canals connected to Lake St. Clair. In response to the 2019 flooding, the City of Detroit utilized sand bagging techniques to build up shorelines and minimize the impacts of flooding as the situation worsened rapidly. However, these efforts were not successful in mitigating all damages. In preparation for 2020 flooding, the City of Detroit employed additional temporary flood protection defenses, including HESCO barriers and Tiger Dam structures, along with sandbag structures, to provide additional protection to residences, public infrastructure, and public health in general. These measures are intended to mitigate flood damages in the short term, until a more permanent solution is developed and implemented in the Jefferson-Chalmers region.

In August of 2019, the City of Detroit requested USACE FPMS assistance for the identification of effective long-term flood mitigation measures in the Jefferson-Chalmers neighborhood in Detroit (see Figure 1, below). This was initiated by both preliminary FEMA Flood Information Rate Maps (FIRM) (now final) that put more homes in the 1% flood zone, as well as experiencing flooding due to record high Great Lakes levels in 2019. This study is intended to be the first step in evaluating mitigation measures that can be utilized for a long-term solution to reduce flood risk due to coastal influences from Lake St. Clair and the Detroit River. This study *does not* evaluate severe storm events that result in interior drainage flooding.

This FPMS study is designed to help inform the process undertaken by the City of Detroit to pursue the implementation of long-term solutions for flood mitigation efforts in the Jefferson-Chalmers area. This study looks at concept-level alternatives and does not provide a feasibility level solution, nor does it include design efforts.

### 1.2.1 Study Area

The efforts of this study were focused on a portion of the Jefferson-Chalmers neighborhood located on the lower east side of Detroit. The study area is bordered on the north and south by East Jefferson Ave and the Detroit River respectively, and on the east by Alter Rd. and the west by Clairepoint St. (see Figure 2). This region was one of the most impacted flood hazard areas of Detroit along the Detroit River and presents a unique challenge for the use of flood mitigation measures, due to the network of canals creating 2 "islands". The inconsistent edge conditions of this waterfront property result in multiple floodwater inundation (entry) points and, along with the proximity of homes to each other and the water, it leaves little room for the implementation of flood mitigation measures.

The Jefferson-Chalmers study area is home to approximately 8,000 residents. The area consists of more than 160 acres of waterfront parks, boat launches, fishing access points and other outdoor recreation opportunities. As part of the spring 2019 flood fighting efforts, flood barrier structures were created using sandbags and were employed to mitigate flood damages at roughly 94 of these parcels.

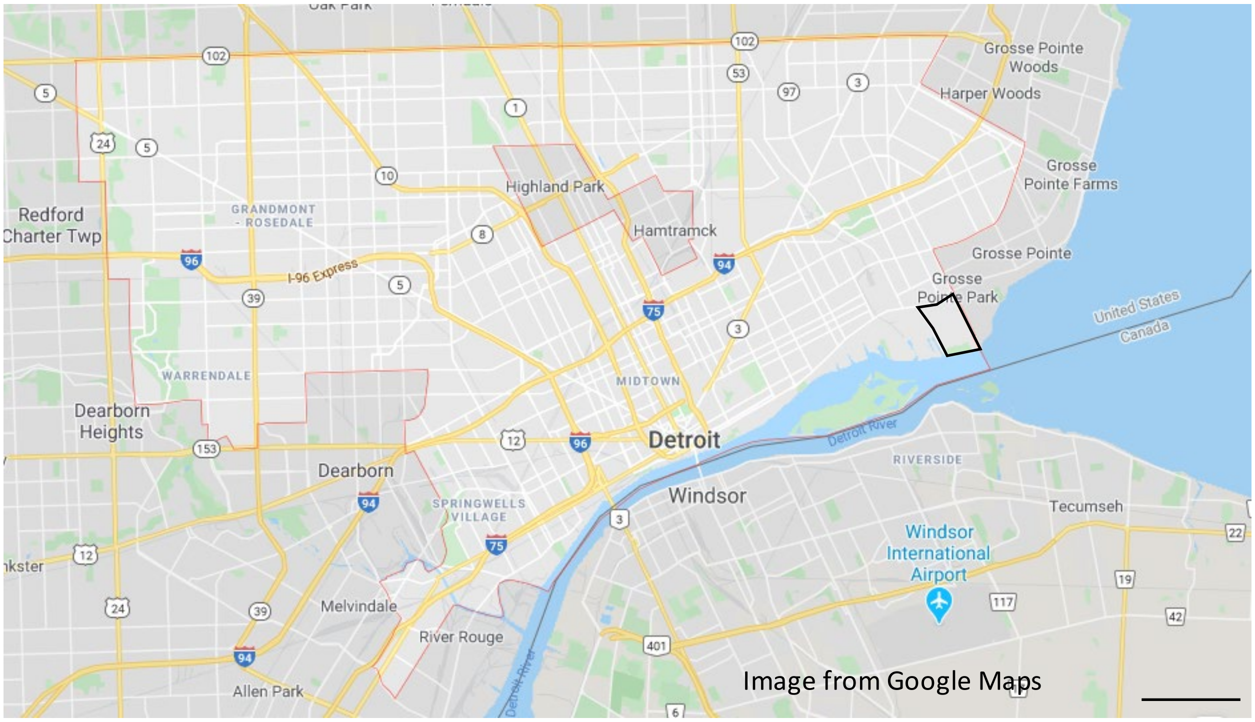


*Figure 1*: Study location in Detroit, MI

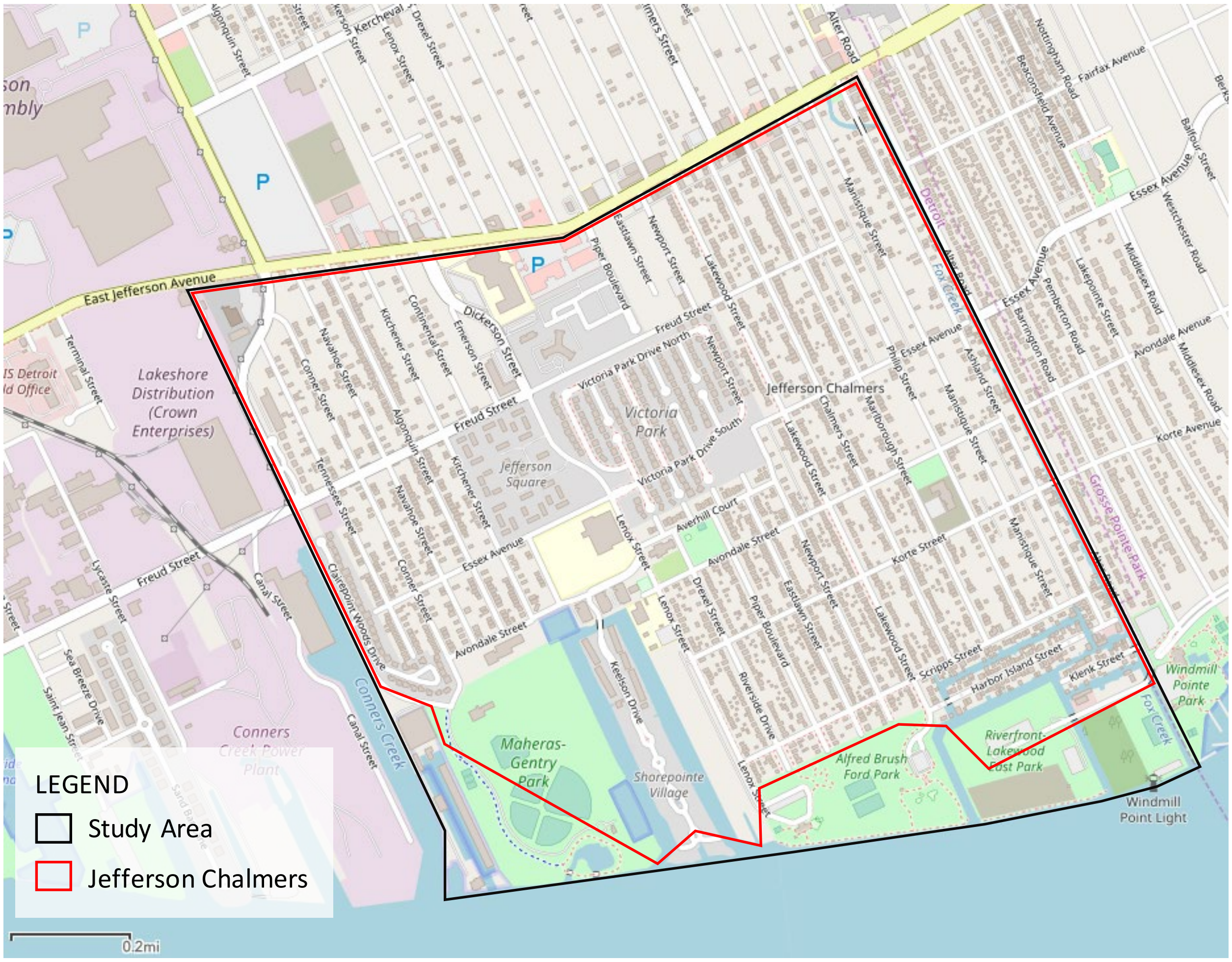


*Figure 2*: Jefferson-Chalmers area study limits.

### 1.2.2 Study Scope

The Detroit FPMS study is a planning document outlining feasible flood risk mitigation measures that can be combined to provide flood risk reduction in the Jefferson-Chalmers region. These include both structural and nonstructural measures. Plan formulation and analysis efforts were performed by USACE, along with collaborative multi-agency team, consisting of representatives from Detroit entities that would need to be involved, or would be impacted by installation of long-term flood risk mitigation measures. Analysis was limited to feasibility of construction, pros and cons of options, and extent to which goals are accomplished. The study does not include the development of complete design plans or specifications, cost calculations, nor the funding of construction activities. Once appropriate mitigation measures are identified, the scope of the Detroit FPMS Study will also include community outreach.

### 1.2.3 Study Participants and Coordination

As part of the scope of the study, a multi-agency team was organized to collaborate in the consideration and analysis of feasible flood risk management measures. Team meetings were held monthly. The following agencies and departments were represented:

- City of Detroit - Mayor's Office
- City of Detroit – Housing and Revitalization Department (HRD)
- City of Detroit - Detroit Water and Sewerage District (DWSD)
- Detroit Land Bank Authority (DLBA)
- City of Detroit – Law Department
- Great Lakes Water Authority (GLWA)
- City of Detroit - Detroit Homeland Security and Emergency Management (DHSEM)
- City of Detroit - Detroit General Services Department (GSD)
- City of Detroit - Buildings, Safety Engineering and Environmental Department (BSEED) – Environmental Affairs
- City of Detroit - Detroit Building Authority (DBA)
- City of Detroit – Department of Neighborhoods (DON)
- Environmental Protection Agency (EPA)

## 1.2 Prior Studies and Reports

Three prior studies were referenced that examined flooding and risk reduction issues within the study area:

### 1.3.1 Southeastern Michigan Water Resources Study, U.S. Army Corps of Engineers, September 1978:

High water elevations on the Great Lakes System, due to above normal amounts of precipitation during the period 1972 through 1976, caused a considerable number of water-related problems for the regions of Wayne County, MI located on the Detroit River and Lake St. Clair. The Southeastern Michigan Water Resources Study was authorized through the River and Harbor Act of 1966 and Flood Control Act of 1965, for the purpose of determining the feasibility of a flood protection project for the shoreline areas of northeast Wayne County. An initial investigation was performed by the U.S. Army Corps of Engineers to determine whether a flood protection project could be justified and be in the Federal interest. The study area extended from the shoreline of the Detroit River inland to the 500-year frequency flood elevation, for a roughly 2.4-mile reach of the river between Alter Rd. and Marquette Dr.

Both structural and non-structural flood risk reduction measures were developed to form alternative solutions that were evaluated based on cost, benefit, and environmental and socioeconomic effects. Comments and preferences were provided by residents of study area and were taken into consideration. The overall benefit-cost ratio was determined to be 4.16 for the measures recommended for implementation. However, the project was not selected for federal funding to initiate design and implementation.

### 1.3.2 Detroit Far East Side Flood Control Study, NTH Consultants, July 2005

In 2005, NTH Consultants, Ltd. was retained by the City of Detroit Planning & Development Department, to develop a flood control study to evaluate the Federal Emergency Management Agency's (FEMA) proposed changes to floodplain elevations, and their effect on the City's Far East Side Area. Alternatives proposed varied from filling all canals, lining the banks of all canals with SSP, and installing levees along the entire Detroit River shoreline in the project area. Other alternatives considered were the occasional closure of canals with levees or closure structures or allowing controlled passage with the installation of floodgates and boat locks. The recommended plan (i.e., 'Stillwater Protection Plan') included installing three stop log structures, each 30 feet wide, with a top elevation of 580 at Fox Creek, Philip Canal and Lakewood Canal.

### 1.3.3 Detroit Floodplain Study, Giffels-Webster, dated July 2019

In 2019, Giffels-Webster was contracted by the City of Detroit to evaluate the preliminary FEMA Flood Insurance Rate Maps (FIRMs) released in December 2018. The study included an assessment of the potential for the City of Detroit to challenge the preliminary FIRM updates, the location of floodwater inundation points, and proposal of flood mitigation techniques to reduce the number of properties located in the regulated floodplain. Two study areas were included in this project: Jefferson-Chalmers and Jefferson Village, which is bounded by East Jefferson Ave. to the north, St. Jean St. to the east, Freud St. to the south and Marquette Dr. to the west.

Giffels-Webster surveyed the two regions and did not find a technical basis for the City of Detroit to challenge the preliminary FIRM panels. Jefferson Village was found to have one inundation point at the Harding Canal. Inundation points in Jefferson-Chalmers were located along the inconsistent edge conditions of Fox Creek and the canal located north of Harbor Island.

In the areas of inundation, possible mitigation measures considered for the floodwater inundation areas in Jefferson-Chalmers included an earthen levee, seawall improvements and floodgates. These measures would be built to an elevation of 580 feet and would reduce flooding impacts but would remain insufficient for mitigation of impacts from a 100-year storm event, shown on FEMA FIRMs.

# 2. Problem and Needs

## 2.1 Flooding Background

Water levels in the Great Lakes depend upon precipitation and the watershed drainage surrounding them. In normal years, the evaporation from the lakes is almost equal to the precipitation and runoff that enters them, resulting in a consistent water level. However, the hydrologic characteristics of the outlets and connecting channels of the Great Lakes are such that they do not provide sufficient capacity to discharge above normal amounts of precipitation, nor do they produce sufficient control to hold back water when below normal precipitation occurs. The result is that lake levels rise or fall depending on whether or not surpluses or deficiencies of rain and snow occur. The flooding experienced in recent years in the Jefferson-Chalmers area is primarily a result of extreme precipitation events in the Great Lakes Basin. Precipitation rankings in Michigan show that the last five years have been the wettest 5-

year timeframe in the entire period of record of precipitation data, spanning 1895 to 2020[1]. This increasing precipitation trend, combined specifically with the weather in winter 2018-19 and heavy precipitation in spring 2019, has caused the water levels in the Great Lakes System to significantly rise. This rise has increased the occurrence and magnitude of flooding in the densely-populated neighborhoods along canals connected to Lake St. Clair. This region is especially prone to flooding impacts due to its location on the western shore of Lake St. Clair. Wind compounds the problem already created by high water levels, as easterly winds cause the water to "run-up" on the western shore of the lakes. The combination of high-water levels and wind generated waves cause a considerable amount of damage.

Figure 3, below, shows 100 years of water level data for each of the Great Lakes, as well as Lake St. Clair, which connects Lake Huron and Lake Erie. Water levels in Lake Superior and Lake Ontario are less variable due to the regulation they experience from the Soo Locks and compensating works, and associated hydroelectric plants and Niagara Falls respectively. In the other three lakes, water level peaks have been experienced in the spring seasons of 1929, 1952, 1973 and 1974, 1986, 1997, and most recently in 2019. The 2019 peak set records for water levels in each of the lakes except Lake Michigan-Huron, which just missed setting a record. Throughout the last 100 years, flooding impacts have been experienced in the low-lying regions on the western shores of Lake Huron, Lake St, Clair, and the Detroit River and this region is experiencing another period of above average water levels, causing more damage.

High water elevations create water and related land resource problems in the study area. The effects of high water range from nuisance conditions to major destruction of property. Temporary flood protection measures have been employed but a solution providing long-term protection is needed during this period of above average water levels, and for the periods to come.

[1] https://www.ncdc.noaa.gov/cag/statewide/rankings/20/pcp/202002

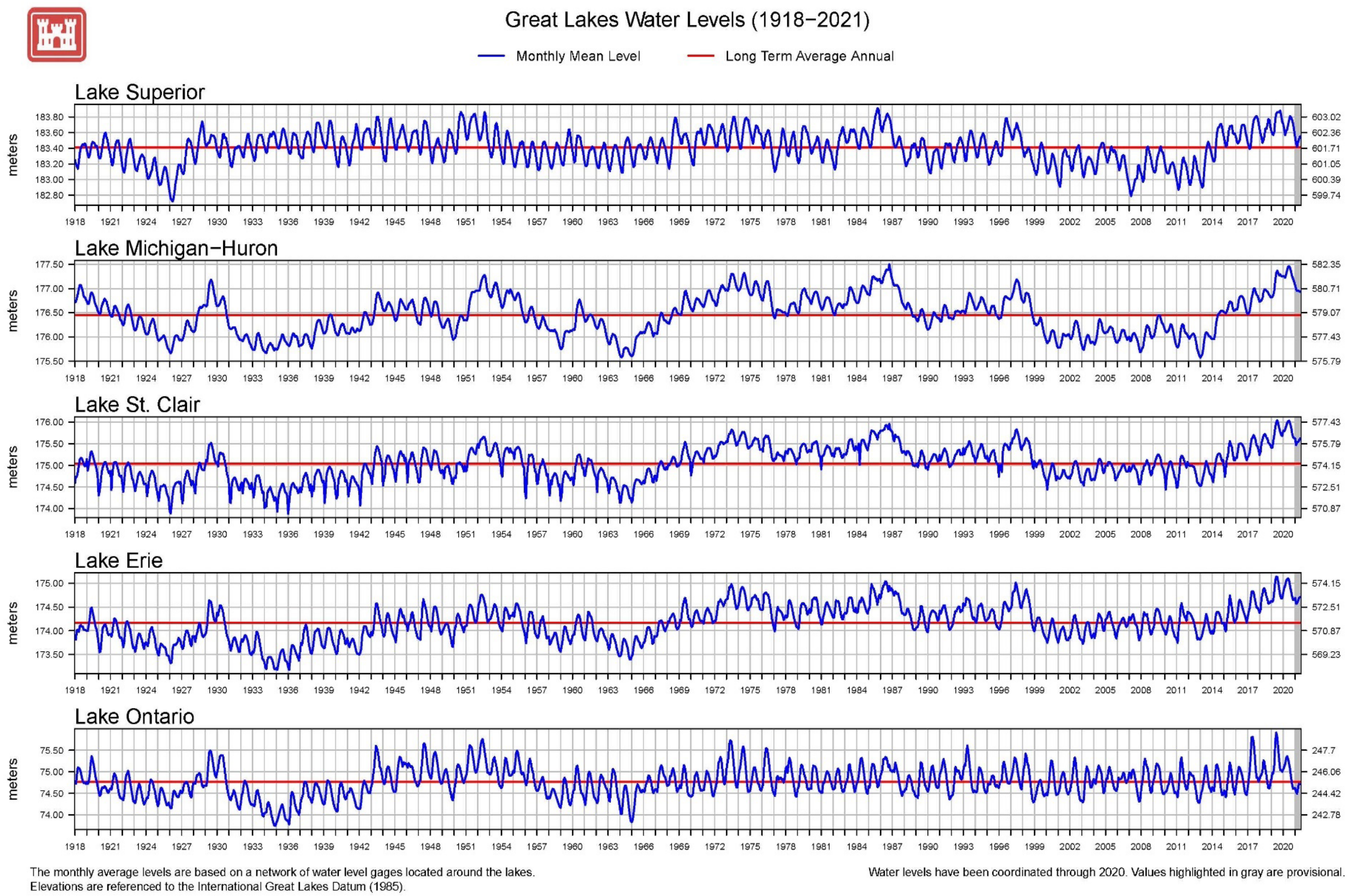


*Figure 3*: Great Lakes Historic Water Levels

## 2.2 Forecasting Conditions

Due to their direct correlation with weather events, water levels are challenging to forecast for long periods in advance. However, USACE maintains a six-month Great Lakes water levels forecast that is updated monthly based on the recently experienced and expected weather conditions. The most recent output is pictured below in Figure 4. The five lakes analyzed all began 2021 having lower water levels than the same time in 2020. This is an indication that spring 2022 water levels can be expected to be similar to, but slightly lower than 2021 levels, but still above average, as depicted in Figure 5 below for Lake St. Clair.

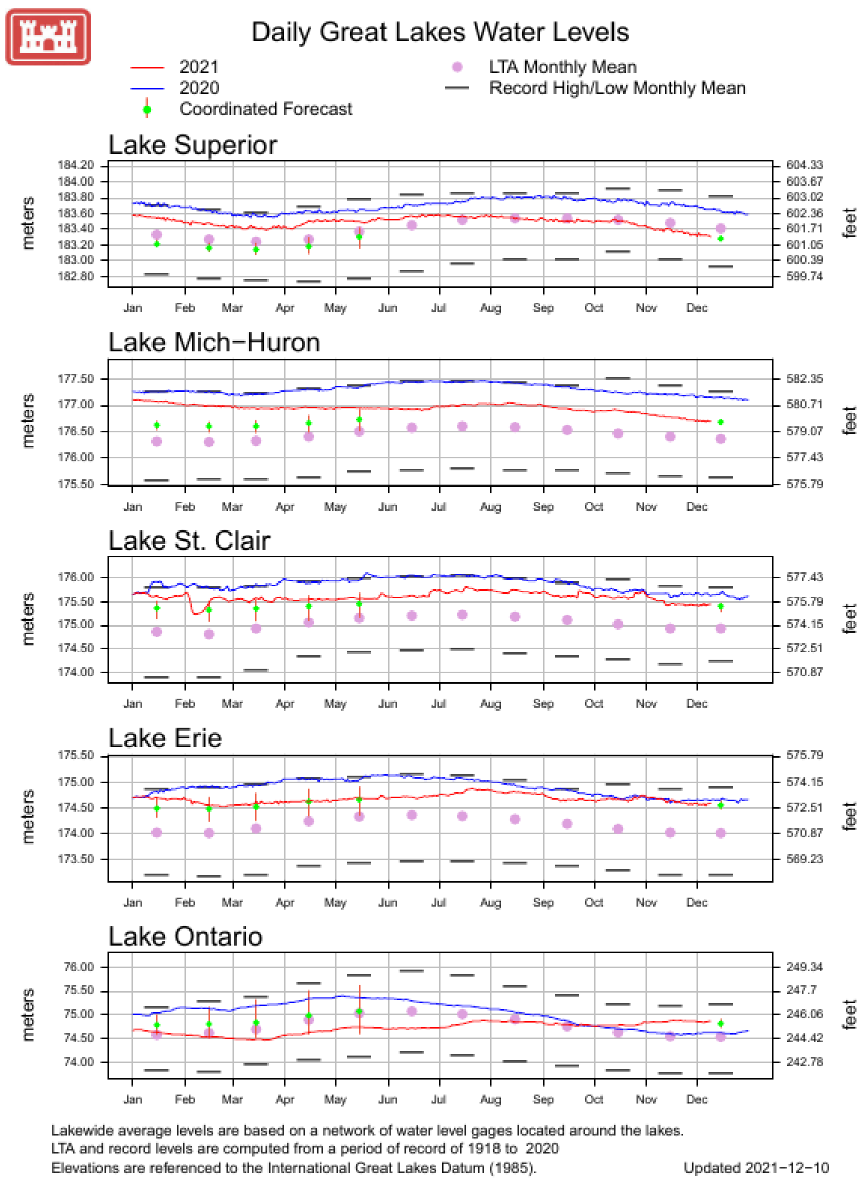


*Figure 4*: Great Lakes Forecasted Water Levels 2020-2021[2]

[2] https://www.lre.usace.army.mil/Missions/Great-Lakes-Information/Great-Lakes-Information-2/Water-Level-Data/

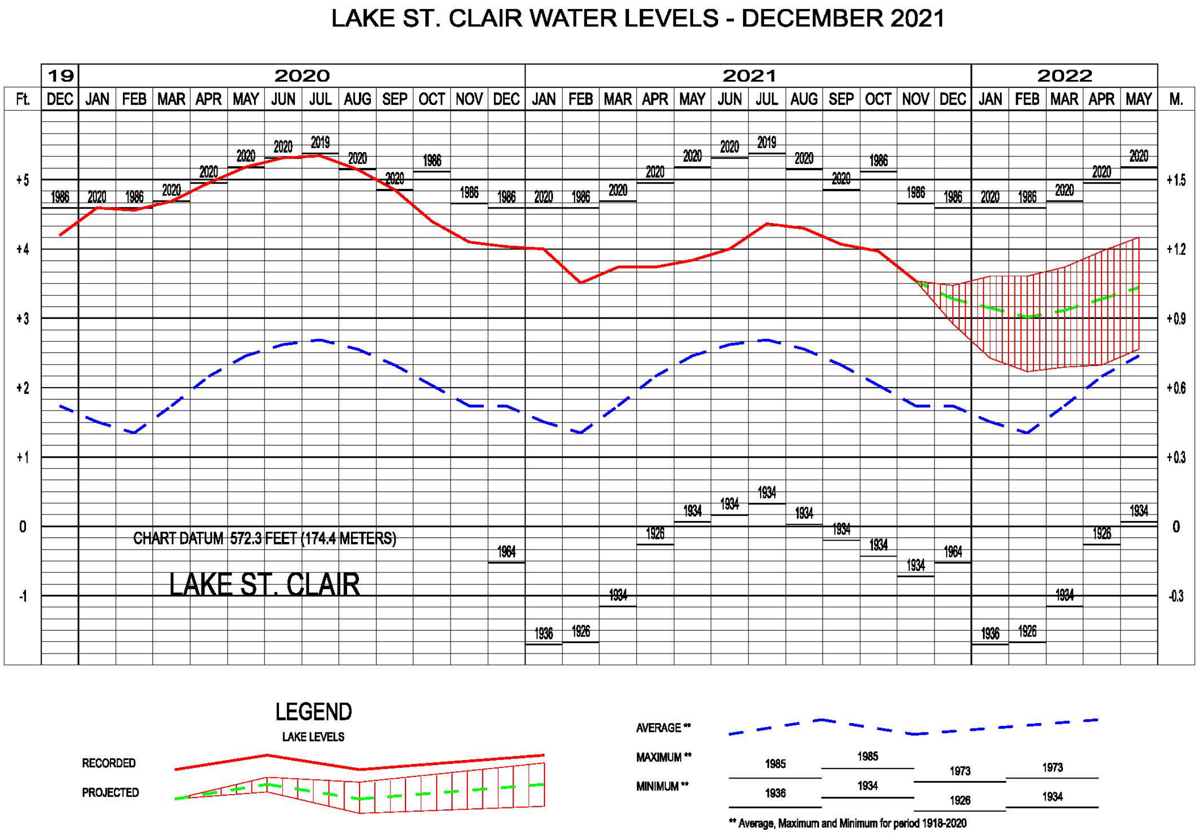


*Figure 5*: Lake St. Clair 6 Month Forecasted Water Levels 2021-2022[3]

## 2.3 Flooding in Jefferson-Chalmers

The project area sits at the southwest border of Lake St. Clair, at the headwaters of the Detroit River. The cause of the flooding in the project area is from a combination of high lake levels and wave action/run-up from Lake St. Clair.

Several flood risk reduction studies have occurred over the last several decades, but no significant long-term solutions have been implemented.

The low, flat terrain along the shoreline of the study area makes this land more susceptible to flooding. Primary inundation points in Jefferson-Chalmers are along residential properties that have varying heights of seawalls.

[3] https://www.lre.usace.army.mil/Missions/Great-Lakes-Information/Great-Lakes-Information-2/Water-Level-Data/

The most recent significant flood events in 2019 were due to record high Great Lakes levels that inundated back yards and roads through low points along the canal systems. The City used sandbags for flood protection during record high great lake levels and is seeking a more permanent solution for flood risk reduction. In Figure 1, parcels shown in blue indicate locations where sandbags were used for flood mitigation in 2019.


*Figure 6:* 2019 Sandbag locations

### 2.3.1 Flooding Impacts

In spring 2019, constant flow from Lake St. Clair and the Detroit River entered low areas and resulted in continuous, uncontrolled flooding, which entered the storm sewer system for weeks at a time. This additional load on Detroit's Combined Sewer Outflow (CSO) system resulted in increased discharges of untreated water into the Detroit River, violating water quality requirements. It also increased the load on the pump stations and the wastewater treatment plant.

Flooding has caused significant economic impact to the Jefferson-Chalmers residents, due primarily to basement flooding. Significant property damage also occurred in 2019 in this area. Residents along the canals are subject to inundation due to the inconsistent heights of seawalls along the canals. Residents along the west shore of Lake St Clair are susceptible to flooding during easterly wind events.

*Table 1*: Study area demographics

| Census Tract | Population | Age >65 | Age <19 | Unemployed | Poverty Status | Persons with a Disability | Median Household Income | Per Capita Income |
|---|---|---|---|---|---|---|---|---|
| 5132 | 1,756 | 11.2% | 29.1% | 13.7% | 40.7% | 21.9% | $33,828 | $16,556 |
| 5133 | 2,433 | 19.3% | 22.4% | 7.3% | 21.6% | 15% | $42,670 | $28,897 |
| 5137 | 3,598 | 16% | 36.1% | 13.1% | 36.1% | 18% | $23,162 | $17,364 |
| Michigan | 9,925,568 | 15.8% | 25.1% | 7.4% | 15.6% | 14.3% | %52,668 | $28,938 |
| USA | 321,004,407 | 14.9% | 24.7% | 6.6% | 14.6% | 12.6% | $57,562 | $31,177 |

Additionally, there are historic properties located in Jefferson-Chalmers that could be impacted by future flooding. The Vanity Ballroom and the Jefferson-Chalmers Historic Business District are both listed on the National Register of Historic Places. Other properties including the Fox Creek Historic District, Lighthouse Subdivision Historic District, Marlborough Chalmers Historic District, Riverside Historic District, and Guyton School are eligible to be listed on the National Register of Historic Places. The historic value of these venues and properties would be greatly impacted by flooding.

### 2.3.2 FEMA Map Revisions

FEMA incorporates flood hazards and risks into flood maps known as Flood Insurance Rate Maps (FIRMs). These maps support the National Flood Insurance Program (NFIP), detailing the requirements for flood insurance and community floodplain management. In December of 2018, FEMA published draft (preliminary revised) FIRM maps for Wayne County that would greatly increase the number of homes located within the 1% annual chance (100-year) event floodplain for the Jefferson-Chalmers neighborhood.

Figure 7 shows the changes to the FEMA FIRM for the study area. The FIRM panels include contour lines representing the base flood elevation, calculated for the 100-year (1% annual chance) and 500-year (0.2% annual chance) flood events. The preliminary map identifies the entire study area, minus some elevated park spaces, as having a *1% Annual Chance Flood Hazard*.

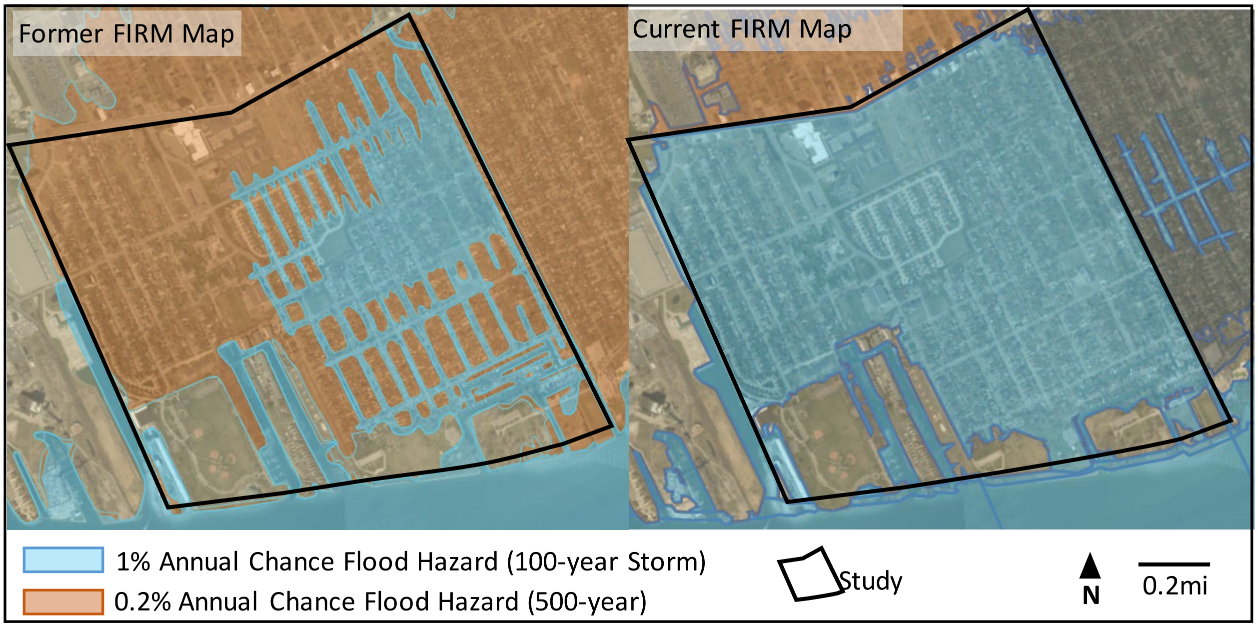


*Figure 7*: FEMA Flood Insurance Rate Map Update in the Study Area

https://hazards-fema.maps.arcgis.com/apps/webappviewer/index.html?id=8b0adb51996444d4879338b5529aa9cd

### 2.3.3 FEMA Freeboard Requirements

The purpose of 'freeboard' is to account for the uncertainties associated with the Hydraulic and Hydrology (H&H) analysis and to minimize damages and threat to life and property. The freeboard requirements vary if the levee system lies within a riverine area or a coastal area. Since the flood source is Lake St. Clair, coastal freeboard requirements apply.

The coastal freeboard requirements are stated in 44 CFR 65.10(b)(1)(iii), which states the following:

"For coastal levees, the freeboard must be established at one foot above the height of the one percent wave or the maximum wave runup (whichever is greater) associated with the 100-year still water surge elevation at the site. To show that a levee system provides base flood hazard reduction in a coastal area, the top of the levee must be equal or greater than the highest value of the following:

1. Two (2) feet above the base flood total stillwater storm surge elevation including wave setup;

2. One (1) foot above the base flood wave crest elevation; or

3. One (1) foot above the maximum base flood wave runup elevation.

The stillwater surge elevation shall be considered the water level in the absence of waves, but with all other processes present. This includes the stillwater elevation of the base flood event plus a wave setup component. The wave setup is defined as the increase in mean water level above the stillwater level due to momentum transfer to the water column by waves that are breaking or otherwise dissipating their energy."

The levee/ floodwall elevations required in the project area are shown in the following table:

*Table 2:* Required levee/ floodwall elevations

| Transect | 1% Annual Chance Stillwater Elevations | Required levee elevation for Stillwater (inland) inundation areas<br><br>(including 2' freeboard) | 1% Max runup elevation | Required levee elevation for runup-influenced areas<br><br>(including 1' freeboard) |
|---|---|---|---|---|
| WAY-12 | 578 | 580 | 579 | 580 |
| WAY-13 | 578 | 580 | 582 | 583 |
| WAY-14 | 578 | 580 | 581 | 582 |
| WAY-16 | 578 | 580 | 580 | 581 |

Elevations taken from Preliminary FEMA FIRM Maps for Wayne County, Michigan as well as the *Coastal Flood Hazard Study Result Summary, Wayne County, Michigan* published by greatlakescoast.org.

# 3. Plan Formulation

Plan formulation is undertaken to develop a comprehensive water management plan which provides the best uses, or combination of uses, of water and related land resources to meet the identified needs of the Detroit Shoreline study area. The formulation process therefore involves identification of project limitations and objectives that inform the creation and evaluation of flood risk mitigation measures.

## 3.1 Project Limitations

Both structural and nonstructural flood risk mitigation measures for use in the Jefferson-Chalmers area are limited by cost, recreational and environmental constraints. These are aspects that limit the feasibility of a flood risk reduction project, and then there are additional constraints that limit the acceptability of a flood risk reduction project by the City and the study area residents.

There have been flood reduction studies conducted for this region since prior to 1978, but limited action has been taken to mitigate damage from flooding in this area. This is primarily due to the high costs associated with the construction of a project having the scale to mitigate flood impacts to hundreds of acres of residential property, combined with the City's limited ability to finance or provide cost-share funding for projects due to, in part, low property values. Additionally, there is not much available space throughout the impacted area for structural improvements along the associated canals. Much of the land along the canals is private property and any construction in these regions would involve the challenge of obtaining private property easements.

Since high water levels and an increase in strong storm events are a current problem, without a foreseeable resolution, the time constraints to get a long-term project in place also create additional challenges for project implementation. Permanent projects to provide flood risk mitigation take a long time to plan and design. When water levels start to decline, as they have in 2021, the desire to pursue flood mitigation solutions also decreases, and both the administration and the public can start to lose interest in the development of a flood risk mitigation project.

Limitations on the acceptability of any given proposed flood risk reduction project largely stem from residents' desires for water views and direct water access to the canals, Lake St. Clair and the Detroit River. Public engagement, while not initially part of this study, will be crucial in the ultimate development of a constructible project that mitigates flood risks within the Jefferson-Chalmers area.

## 3.2 Planning Objectives and Constraints

The primary Planning Objectives identified from an analysis of the problems, needs, limitations, and opportunities within the study area is as follows:

- Reduce the risk of flooding due to high water levels and wave run-up of Lake St. Clair in the Jefferson-Chalmers neighborhood;
- Develop a plan that is considerate of the desires and needs of the residents and is acceptable to the City of Detroit.
- Remove the properties located in the Jefferson-Chalmers study area from the high risk floodplain (1%, 100 year event) in order to alleviate flood insurance costs.

Planning Constraints and considerations used in the plan formulation analysis include:

- Avoid measures that would displace existing homeowners;
- Minimize impacts to private property;
- Preserve the 'viewscape' of residents, wherever possible;
- Avoid measures that block boater access to the canals, the Detroit River and Lake St. Clair.

## 3.3 Additional Considerations

- Enhance the social well-being of the study area's population.

The Detroit River is listed on the Environmental Protection Agency's (EPA) Area of Concern (AOC) list. The EPA Guidance Plan details 14 specifically chosen habitat restoration projects to remove the 14 fish and wildlife related Beneficial Use Impairments (BUIs) in this AOC. One of these projects is the Detroit Upper Riverfront Parks Restoration project. Initial design of the project began in 2017 and, as of July 2018, the project plan involves wetland creation and riparian enhancements on the riverfront and canal shorelines, and plantings including a pollinator garden in Alfred Brush (AB) Ford Park and Riverfront Lakewood East Park. However, after the FEMA FIRM map revisions and City of Detroit's decision to pursue a long-term flood reduction project in these areas, design and construction of the EPA park project was halted. The current design may not be feasible to implement alongside many of the potential flood risk management measures, but the City of Detroit will continue to coordinate with EPA in the attempt to also allow for future habitat restoration in these areas. GSD expects the EPA project to begin construction in 2023 and continues to hope that the detailed design of flood mitigation measures will be in consideration of the habitat project to maintain its original intent where possible.

An additional consideration for the design of a flood risk mitigation project will involve accommodating internal drainage requirements for the Jefferson-Chalmers neighborhood, which would require a separate stormwater risk reduction study.

While 'residential' is the primary land type in the Jefferson-Chalmers neighborhood, it is important to consider the additional entities and specific groups of people that would also be affected by any plans to drastically alter the shoreline or canal-front environments in the formulation of potential flood risk mitigation projects. Potential stakeholders were identified through collaborative efforts and are listed below:

i. Residents - specifically seniors on fixed income
ii. Businesses
    - Jefferson Ave. businesses
    - Fiat Chrysler Automobiles
    - Nearby marina (impacted by canal use changes)
iii. Development Activity
    - Guyton Elementary Redevelopment (former public school – adding mixed use development that provides significant portion of homeowner assistance programs – paid for with HUD money that cannot be applied to development within a floodplain)
iv. Detroit Water and Sewage Department (DWSD)
    - Combined storm/sanitary sewer and treatment system impacts
v. Great Lakes Water Authority (GLWA)
vi. Buildings, Safety Engineering and Environmental Department (BSEED)
vii. Land bank properties (quasi-city agency, technically public property, EDC/DEGC)
    - Detroit Economic Growth Corporation (DEGC)
    - The Economic Development Corporation (EDC)
    - Detroit Land Bank Authority
viii. Planning and Development Department (PDD)
ix. Housing Revitalization Department (HRD)
x. General Services Department (GSD)
    - city parks and improvement projects – river front
xi. Real estate projects that depend on federal funds
xii. Emergency Management/Homeland Security
xiii. Recreational Users
    - Fishing
    - Kayaking
    - Boating
xiv. Marina – associated businesses within the canal closures

## 3.4 Flood Risk Mitigation Measures Considered

Flood risk mitigation measures are the building blocks of flood risk mitigation solutions and are categorized as either ‘structural’ or ‘nonstructural’. Structural measures include constructing physical barriers to reduce flood risk, such as levees and floodwalls. Non-structural measures include flood-warning systems, removing property that can be damaged from a flood-prone area, elevating homes and other actions. Equal consideration must be given to these two categories of measures during the planning process.

### 3.4.1 Nonstructural Flood Risk Measures

As mentioned above, nonstructural measures consist of flood risk reduction actions other than the construction of physical barriers along the river to contain floods. Non-structural measures could also be used in combination with structural measures to reduce the potential for flood damages in the study area. Nonstructural measures considered in the creation of flood risk mitigation plans generally include permanent relocation/removal of buildings and property from the floodplain, floodproofing of houses, and filling basements to reduce flood impacts to structures. None of the nonstructural measures listed below will protect the combined sewerages system. Basic descriptions of these measures are included in the following sections.

- *Permanent Relocation from the Floodplain*

Relocation would require moving residents and removal of all floodplain structures, roadways, and utilities from the design level floodplain. Evacuated land would thus become available for appropriate uses such as parks, sports fields, wetlands, marshlands, etc.

- *Floodproofing*

Floodproofing typically consists of structure modifications to buildings such that floodwaters cannot penetrate and damage the contents. Buildings in the study area would be best floodproofed by the placement of a series of aluminum panels immediately adjacent to the unit.

- *Additional Nonstructural Measures*

    - Elevating homes
    - Filling in home basements

### 3.4.2 Structural Measures

Structural measures that were considered which reduce flooding impacts include levees, floodwalls, seawalls, floodgates, lock systems, and canal fill.

# 4. Canal Environments

Throughout the Jefferson-Chalmers study area, the presence of canals allows water to flow inland from the Detroit River and Lake St. Clair, creating larger numbers of waterfront residences. While these canals are enjoyed by many residents desiring open-water access, during periods of high water they can create major flooding problems for residents and public infrastructure as they provide a path for inundation.

In the study area there are approximately 6 canals that have the potential to allow inundation into the low-lying Jefferson-Chalmers region: Connor Creek, Grayhaven East and West, Lakewood, Phillip St, and Fox Creek Canals. The latter three canals surround two land areas in the study area, creating Harbor and Klenk Islands. The location of these islands and canals are shown in Figure 8 below. Each of these canals are characterized by different features and different flooding impacts. Brief descriptions of each canal are included in the sections below.

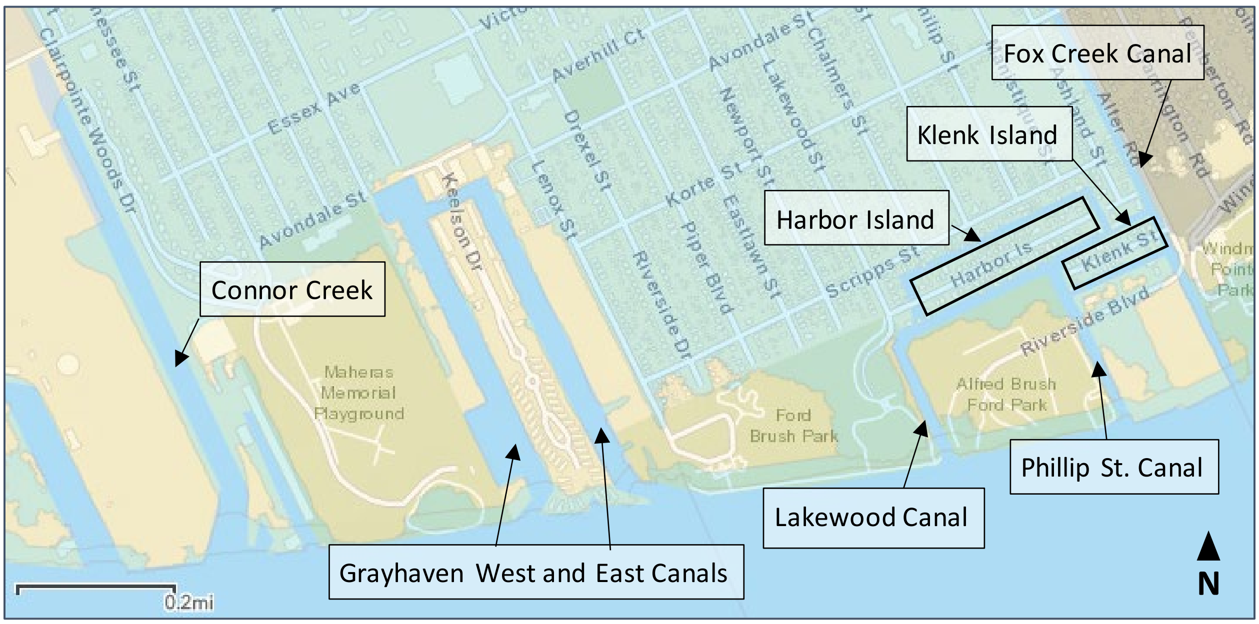


*Figure 8*: Jefferson Chalmers canal configuration

## Lakewood Canal

The Lakewood Canal runs parallel and in line with Lakewood St. and is nearly 900 feet in length. The Lakewood canal connects to the Phillip St. and Fox Creek canals, as well as the waters surrounding Klenk and Harbor Islands. The Lakewood Canal is the widest and deepest canal entering the Detroit River, at 70-80 feet in width. For this reason, most boat owners in the Jefferson-Chalmers neighborhood use a route through the Lakewood Canal to get to the river. Both east and west banks consist of Steel Sheet Pile (SSP) seawall and the elevation of most of the land area surrounding the canal is 580 feet, which is above the FEMA flood hazard area. The property on both sides of the canal is owned by the City of Detroit Parks and Recreation Department and is used as minimally developed parkland.

## Phillip St Canal

The Philip Street Canal runs parallel and in line with Phillip St. and is over 1,100 feet in length. Approximately 700 feet from the Detroit River, Riverside Rd. crosses the canal on a low bridge that only allows the passage of kayaks and small boats. The west bank of the Phillip St. Canal consists of SSP seawall and the elevation of most of the west bank land area is 580 feet, keeping it out of the FEMA flood hazard area. The east bank of the canal is natural, lined with riprap. The land elevation on this side of the canal is more variable but with most portions reaching 580 feet. The property on the west side of the canal is owned by the City of Detroit Parks and Recreation Department and used as minimally developed park land. The 7-acre property to the east of the canal is owned by Riverfront Limited Partnership and consists of vacant land, with a riprap lined shoreline along the Detroit River. This site has a $5.7M brownfield tax credit for blight and may also be considered as a wetland, which would increase permitting requirements for development in this area. Development in this area would require property acquisition or permanent easements.

## Fox Creek Canal

Fox Creek Canal is the longest canal in the Jefferson-Chalmers region; 1.25 miles of it is included in the study area. On average, it is 40 feet wide throughout. The east bank of Fox Creek consists of a continuous SSP seawall built to elevation 580 feet. This seawall runs along Alter Rd. and was built to reduce flooding in the City of Grosse Pointe Park region. The west bank of the canal is characterized by varying structures built to varying elevations. Around 125 parcels have access to the canal on the west bank, approximately 75% of which are private resident-owned and the other 25% are owned by private companies. The Detroit Land Bank also has a small presence here. Around 30 of these parcels have boathouses, which tend to be locations of inundation, and nearly 40 of the parcels on Fox Creek were sandbagged for flood protection during the spring 2019 event.

Recreational uses in Fox Creek include fishing, paddle boarding, and kayaking. The presence of Korte St. Bridge, approximately a half mile into the canal, limits the boat access from north of the bridge into the Detroit River. There is not normally enough clearance for many larger boats to pass under the bridge and when water levels are high, smaller boats are occasionally unable to pass under the bridge as well. Table 3 presents the details described above regarding Fox Creek.

It is also important to note that Fox Creek Canal does not receive stormwater inflow from the Jefferson Chalmers region. Much of the stormwater that would enter this canal is collected by the combined sewer system in Detroit and conveyed to the GLWA regional system or collected by separated stormwater sewers in Grosse Pointe Park and conveyed to Lake St. Clair. If activated, the discharge is a combination of stormwater and combined sewer overflow. If the canal is closed, accommodation for conveyance will be required.

*Table 3*: Fox Creek Canal Background

| | North of Korte St Bridge | South of Korte St Bridge |
|---|---|---|
| Resident owned parcels | ~65 | 26 |
| Company owned parcels | ~25 | 7 |
| Land Bank Parcels | 1 | 1 |
| Approximate # of Boathouses | ~25 | 6 |
| # of Parcels Sandbagged | 27 | 8 |

| | | |
|---|---|---|
| % of total properties sandbagged | 28.4% | 8.4% |
| Uses | Paddleboard, Kayak, Small Boats when water is low, Fishing | Paddleboard, Kayak, Boats, Fishing |
| Notes | When water levels are high, residents cannot take boats to the Detroit River. | |

## Harbor Island

*Table 4*: Harbor Island Background

| | North of Korte St Bridge |
|---|---|
| Resident owned parcels | ~91 |
| Company owned parcels | ~6 |
| Land Bank Parcels | 0 |
| Approximate # of Boathouses | ~36 |
| # of Parcels Sandbagged | 50 |
| % of total properties sandbagged | 51.5% |
| Uses | Paddleboard, Kayak, Boats, Fishing |
| Notes | |

## Klenk Island

*Table 5*: Klenk Island Background

| | North of Korte St Bridge |
|---|---|
| Resident owned parcels | 34 |
| Company owned parcels | 15 |
| Land Bank Parcels | 0 |
| Approximate # of Boathouses | ~7 |
| # of Parcels Sandbagged | 9 |
| % of total properties sandbagged | 18.4% |
| Uses | Paddleboard, Kayak, Boats, Fishing |
| Notes | |

### Conner Creek Canal

This canal receives limited stormwater from adjacent/nearby properties and treated combined sewer wet weather discharges from the GLWA Conner Creek Retention Treatment Basin (GLWA Conner Creek RTB). The Conner Creek RTB was designed to provide treatment for up to 13,200 cubic feet per second in accordance with its National Pollutant Discharge Elimination System (NPDES) permit. Discharge frequency and volume varies with precipitation. In a typical year the Conner Creek RTB will discharge approximately 15 times and the total annual treated discharge typically exceeds 5 billion gallons.

<u>Additional Considerations:</u>

-Canals are not heavily used for recreational purposes, but any canal closure is likely to be unpopular with residents. The Conner Creek Canal and the Fox Creek Canal must provide hydraulic capacity to convey treated combined sewer overflows and stormwater and emergency discharges from the GLWA regional collection system (unless alternative measures are instituted that provide for conveyance/discharge).

-All options should be presented against the "No Action" alternative that results in flood insurance premiums.

-Limitations of bridges are increased when water levels are higher

<u>**Stormwater/Storm sewers**</u>

*Fox Creek outfall*: Much of the stormwater that would enter this canal is collected by the combined sewer system in Detroit and conveyed to the GLWA regional system or collected by separated stormwater sewers in Grosse Pointe Park and conveyed to Lake St. Clair. The GLWA discharge at Jefferson and Ashland at the Backwater Gate Chamber B001 is only activated on an emergency basis in accordance with its NPDES permit. If activated, the discharge is a combination of stormwater and combined sewer overflow.

*Conner Creek*: This canal receives limited stormwater from adjacent/nearby properties and treated combined sewer wet weather discharges from the GLWA Conner Creek Retention Treatment Basin (GLWA Conner Creek RTB). The Conner Creek RTB was designed to provide treatment for up to 13,200 cubic feet per second in accordance with its NPDES permit. Discharge frequency and volume varies with precipitation. In a typical year the Conner Creek RTB will discharge approximately 15 times and the total annual treated discharge typically exceeds 5 billion gallons.

<u>**Canal Dedications**</u>: If canals are dedicated to the public as "water highways", City Law Department review is needed with city code discussions.

## 5. Structural Flood Risk Reduction Measure Alternatives

The scope of this study includes development of conceptual level alternatives to reduce the coastal flood risk but does not include the detailed design or cost estimating of the features included. However, a detailed review of FEMA FIRMs, existing LiDAR data, and current land use was conducted to determine the potential layouts of the structural measures. It is important to note that the scope of this study is focused on alternatives to reduce the coastal flooding risk. While there is a cost assumed for necessary interior drainage upgrades, interior drainage analysis or design is not included in this study.

The threat of flooding from *high lake levels and storm surges/run-up* in the Jefferson-Chalmers region stems from a series of canals allowing water to flow inland and overtop existing canal walls during periods of high lake levels and run-up. The canal walls are largely residential and have inconsistent elevations.

This can be addressed in two ways: 1) placing a structure across the mouth of canal to prevent high water and storm surges/run-up from entering the canals, or 2) raising the height of the shoreline protection across all properties that border Lake St. Clair/ Detroit River, as well as all properties along the canal. Alternative 2 includes the latter option, while Alternatives 1 & 3 include canal closure measures.

The following sections will describe the 'base alternatives', which are defined as the levees, floodwalls, and seawalls, as well as assumed costs for necessary interior drainage upgrades. The base alternatives *do not include* the canal closures for Alternatives 1 and 3. Conceptual cost estimates were developed separately for each of the 'base' alternatives and different canal closure options, so that different configurations could be compared easily. For Alternative 2 (Open Canals with Extensive Shoreline and Canal Steel Sheet Pile Structures), no additional cost for closure systems is needed, since that alternative includes flood risk reduction measures along the entire shoreline/ canal front, in lieu of closure.

For all three alternatives, the conceptual design west of Lenox Street is similar. In this area there are 'high ground" areas (areas that meet the required height including freeboard) surrounding the Grayhaven East & West Canals. On the west side of Clairpointe Street adjacent to the Conner Creek Canal, the Great Lakes Water Authority completed a new concrete wall in April 2022 to replace a former flood berm. The top elevation of the new wall is approximately El 582 (NAVD88). While not currently certified as a floodwall, the wall was designed to meet that certification. Therefore, all alternatives include a floodwall at this location, as well as a cost with the assumption it has not yet been constructed.

All alternatives will significantly reduce the risk of overloading the interior drainage structures during periods of high lake levels and run-up, and remove most, if not all, residents from the FEMA base flood (1% annual exceedance probability) flood event.

Conceptual cost estimates referenced in Section 5 are discussed in more detail in Section 6 (Appendix A).

## 5.1. Alternative 1: Closed Canal, Levees and Floodwalls Outside of Wave Run-up Zone

FEMAs requirements for levee heights in the project area are lower when the levee/floodwall is outside of the wave runup zone. For Alternative 1, the levee/floodwall alignment between Alter Road and Lenox Street would be set back from the waterfront. This has the advantage of a shorter structure elevation, as well as keeping the riverfront view. The closure structures (noted in red in Figure 9) would also be set back. It should be noted that any land lakeward of this alignment would not have any flood reduction benefits with this option.

Alternative 1 includes the following feature (see Figure 9):

- 560 linear feet of upland steel sheet pile floodwall (shown in purple)
- 1700 linear feet of earthen levee (shown in yellow)
- 3 canal closure structures (shown in red)
- Stop log closure or gate at KAM Marine/ Bayview Yacht Club entrance


*Figure 9: Conceptual alignment, Alternative 1: Closed Canal with Levees and Floodwalls Outside of Wave Run-up Zone. NOTE: Circled portion is the same for all alternatives.*

The proposed western portion of the project along Clairpointe Avenue, tying into the high ground areas near the Greyhaven Marina (circled area in Figure 9) is the same for all alternatives. A detailed discussion of these features is only included in Alternative 1 for brevity. The description of proposed features below is from west to east.

Clairpointe Street: Construction is expected to be complete in the near future for a floodwall along approximately 1400 feet of Clairpointe Street, and it is assumed as 'existing' for the alternatives developed. Review of design documentation was not included in the scope of work. Approximately 560 feet of floodwall is needed to extend the floodwall to high ground near Conner Street. To allow access to the KAM Marina/Bayview Yacht Club, a removable stop log structure across the driveway is recommended.

The floodwall type and cross-section would be determined in the design phase, and can vary depending on soil types, land restrictions, aesthetics, and preferences for future O&M costs. They are typically constructed of either steel sheet pile, reinforced concrete, or a combination of the two. In Figure 10 below, typical “I-wall” type floodwalls are shown. I-walls are common for floodwalls less than 6 feet, but the exact wall type would be determined during design phase.

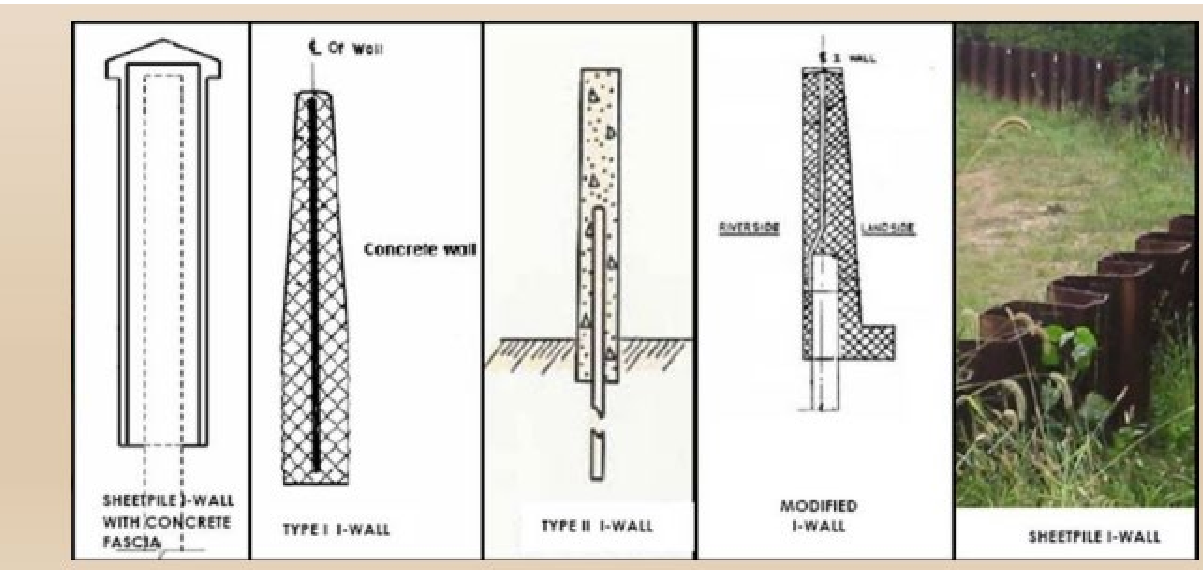


*Figure 10: Typical "I wall" floodwalls (embedded portion not shown)*

KAM Marina/Bayview Yacht Club: In order to maintain access to the KAM Marina/Bayview Yacht Club, a closure structure is needed that would be placed during high water periods to prevent floodwaters from entering the neighborhood. The elevations near the access to the Marina dip and are approximately 6 feet below the required elevation based on LiDAR Data. (See Figure 11). The area would be open during normal water levels, but during high water periods, stop logs would be placed across the road, as shown in Figure 12a and 12b. A storage shed would be needed nearby to store the stoplogs when not needed. Aluminum stop logs were assumed for this report but other types of closures, such as slide gates, could be explored. Slide gates are more expensive but have the advantage of less time and labor needed to close.


*Figure 11: Elevations from LiDAR data near KAM Marina/ Bayview Yacht Club. (Location of proposed upland stop log structure in red)*

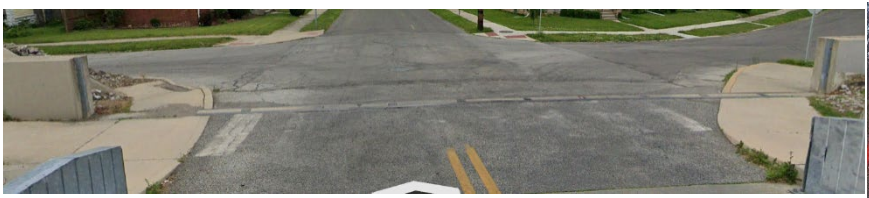

*Figure 12a (left): Stop logs retracted during normal water levels.*
*Figure 12b (right): Aluminum stop log panels being installed.*

Greyhaven Canal: Only the northwestern corner of the Greyhaven Canal is less than the required elevation. A levee is proposed in this area, approximately 3 feet high, based on current LiDAR data. This would result in a levee with a 28-foot wide foundation. We would also recommend a 15-foot setback from the levee toe that is kept clear of any structures, to allow for proper inspection, maintenance, and floodfighting. In addition, no vegetation other than grass is recommended on the levee, or within 15 feet of the levee toe. Trees and brush can create seepage and stability issues, as well inhibit inspection. A typical levee design cross section is illustrated in Figure 13 below.

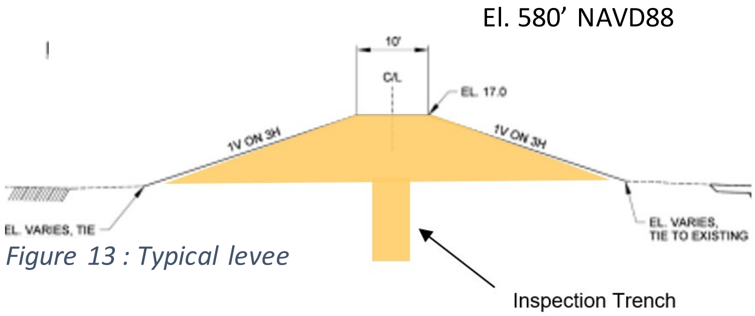


*Figure 13 : Typical levee*

*(Note: from this point on, Alternatives differ)*

Alfred Brush Ford Park: The western portion of the park meets the required stillwater elevation, approximately 150 feet from the water’s edge. No structures are needed in this area, but the wave run up zone may be flooded during the 1% annual exceedance probability event (100 year). The eastern portion is lower, and a 3-foot levee is estimated to be needed for this area. This is set back further from the waterfront (at the City’s request) to allow for aquatic habitat creation along the river. This would tie into a canal closure structure across the Lakewood Street Canal. (See section 5.4 for more discussion on canal closures).

Lakewood East Park: The eastern portion of the park between Lakewood Street Canal and Phillip Street Canal largely meets the elevation requirements. However, there is a portion in the middle of the park that appears lower, based on LiDAR data, and could be inundated. A structure was not assumed for this area since flooding of the park would not have significant consequences. The elevations and land use for this area should be evaluated in future design efforts.

Riverside Boulevard: On the east side of the Phillip Street Canal, a 3-foot levee, approximately 380 feet long, is proposed, tying into high ground at Windmill Point Lighthouse Road. Another canal closure is needed at the Fox Canal, tying into high ground in Grosse Pointe Park.

The cost for Alternative 1 (no closure structure included) is approximately $32.5 Million. For this option, closure structures are needed across the three canals that cross the proposed alignment: Lakewood Street Canal, Phillip Street Canal, and Fox Creek Canal.

The full estimated construction cost with canal closure structures, ranges from $34 Million (3 earthen dam permanent closures) to $161 Million (two stop log structure and a lock system). The range in annual operation and maintenance cost is approximately $315,000 to $1.8 Million, with the high end of the range including a lock system that would allow continual use of Lakewood Canal. Canal closure options are discussed in paragraph 5.4.

## 5.2. Alternative 2: Open Canal with Extensive Floodwalls

If closure structures are not desired, another option for reducing impact to existing water treatment system and reducing flood risk to residents is placing flood risk reduction structures (seawalls) and levees around the creek bordering Klenk Island, along Fox Creek and near KAM Marine/Bayview Yacht Club. The full length of the canal that meets FEMAs required elevation for levee system accreditation (for the 1% AEP stillwater elevation plus the required 2 feet of freeboard, or 580 feet elevation, see Table 2). The canal front is extremely varied in both alignment and elevation, with numerous boathouses. A detailed evaluation of each property would be required for design. The conceptual alignment is provided in Figure 13. Alternative 2 includes the following features:

- 560 linear feet of upland steel sheet pile floodwall (shown in purple)
- 15,800 linear feet of steel sheet pile seawalls along *all properties* along the canals between Fox Creek and Klenk Island, that are within the FEMA base flood hazard area (between Alter Road and Lenox Road). Walls would function as both seawalls and floodwalls and would be constructed to an elevation of 580' NAVD88.
- 1600 linear feet of earthen levee
- *No canal closure structures*
- Stop log closure or gate at KAM Marine/Bayview Yacht Club


*Figure 14*: Conceptual Alignment, Alternative 2: Open Canal with Extensive Floodwalls Along Canal Front.

This alternative is similar to Alternative 1, from Clairepointe Street to Lakewood Street Canal. Since this alternative does not keep canal waters out of the neighborhood, structures are needed along the entire canal front to an elevation of 580' NAVD88, estimated at 15,800 lineal feet, or almost 3 miles of seawall. Floodwalls and levees will also be needed on the south side of Riverside Boulevard to prevent floodwaters from inundating Riverside Boulevard.

This alternative would allow the canals to remain open to the public and would remove the Jefferson-Chalmers neighborhood from the FEMA Flood Hazard Area. However, this would effectively eliminate direct water access for individual homeowners due to the height of the new wall. This would be extremely difficult, due to the numerous properties along the canal that feature a variety of structures, including boat houses and docks. This alternative would require significant modification of the existing canal front and require support of the community to proceed.

The base cost for Alternative 2 (no closure structure included) is approximately $88 Million with an estimated annual O&M cost for the levees and floodwalls of $425,000. The cost estimates prepared for this alternative <u>did not</u> include maintaining water access for residents.

## 5.3. Alternative 3: Closed Canal, Levees & Floodwalls Within Wave Run-up Zone

The alternative is very similar to Alternative 1, with the exception that the flood risk reduction structures are along the waterfront, east of Lenox Street.

This provides flood risk reduction for the entire footprint of the study area, including the parks and open spaces that were excluded in Alternative 1. However, this alignment falls within FEMA's coastal zone designation, and any structures built within this zone will require a higher elevation to prevent waves from overtopping the structure. In addition, these structures would need to be resistant to wave and ice forces that they would be subjected to along the shoreline. Alternative 3 includes the following features (see Figure 15, below):

- 560 linear feet of upland steel sheet pile floodwall (shown in Figure 15)
- 1800 linear feet of riverfront floodwalls
- 2,600 linear feet of earthen levee (shown in yellow)
- 3 canal closure structures (shown in red)
- Upland stop-log closure or gate at KAM Marine/Bayview Yacht Club entrance (shown in orange)


*Figure 15*: Conceptual layout of Alternative 3

The proposed structures west of Lenox Road are the same as Alternative 1, and only need to meet the stillwater elevation requirement of 580 feet NAVD88.

From the high ground west of Lenox Street, approximately 1900 feet of 6-foot high levees, up to the Lakewood Canal, and approximately 1800 feet of 6-foot high seawall between Lakewood Street Canal and Fox Creek Canal near Alter Street is proposed with this alternative. Three closure structures are included in this alternative, similar to Alternative 1, but the required height would be 583 feet, 3 feet higher than Alternative 1, to account for wave run-up. It should be noted that either floodwalls or levees could be used along these areas.

While this alternative provides flood risk reduction to a larger footprint, constructing a floodwall or levee to 583 feet NAVD88 would eliminate, or significantly impact, access to the waterfront. For example, at Alfred Brush Park (east of Lenox Street), the existing ground is approximately 577.4 feet NAVD88.[4] To meet FEMAs flood insurance criteria, the levees and seawalls would need to be constructed to 583 feet NAVD88, or 5 feet, 7 inches above the approximate ground height. If a seawall is constructed in this area, the riverfront view and access for recreational fishing would be significantly impacted. This could be alleviated by including recreational walkways into the design at an extra cost. *Due to the waterfront impact, the City has not expressed interest in this alternative.*

The base cost for Alternative 3 (no closure structures included) is approximately $45 Million, with an estimated annual O&M cost for the levees and floodwalls of $210,000. The full estimated construction cost with closure structures ranges from $47 Million (3 earthen dam permanent closures), to $173 Million (two stop log structures and a lock system). The annual operation and maintenance cost ranges from $500,000 to $2 Million , with the high end of the range including a lock system that would allow continual use of Lakewood Canal. Canal closure options are discussed in paragraph 5.4.

[4] Approximate elevation taken from LIDAR data

## 5.4 Canal Closure Options

Canal closures can be used to reduce the likelihood of high-water levels and storm surges/wave run-up from Lake St. Clair/Detroit River from entering the Jefferson-Chalmers neighborhood. There are several options for the type of structure that can be used. The key factors separating the options are cost and impacts to the use of the canal.

### 5.4.1 Permanent Canal Closure (Earth/ Rock Dam Fill)

Under this option, a portion of the canal would be filled with earthen materials (soil, rock) to create a permanent damming structure that would prevent high lake levels or storm surges/wave run-up from entering the canal. The exact dimensions and requirements would be determined in design. Under this partial fill option, consideration would need to be given to maintaining sufficient flow to prevent the canals from becoming stagnant and maintaining requirements for any discharges for interior drainage and pumping systems. This would be determined during design phase but could include a drainage structure with a flap gate.

Earthen dams were estimated at a cost of $320,000 – $990,000, with Philip Street Canal at the lower cost due to the smaller width of the canal, compared to Fox and Lakewood Canals (40-foot width vs. 80 and 90 feet, respectively). Costs also vary dependent on location along the canal in Alternatives 1 & 3. An average value of $560,000 was used for a canal closure, for ease of comparison between alternative configurations in the cost matrix (Table 6).

*Note: A formal alternative for complete filling of the canals is not included in this report, due to objection to this alternative by the non-federal sponsor. The City desires continued use of the canals by the Jefferson-Chalmers neighborhood and area residents. However, this option was listed to show it was considered for this analysis.*

### 5.4.2 Stop Log Structures

Since permanent closure of the canal is not desirable, a more costly (but flexible) option is to install a structure that can be closed during high water. A stop log structure, such as the one shown in 16, can be used. A stop log closure system would require manual installation of the stop logs into recessed areas during high water periods and would require removal when water levels return to an acceptable range. A lift system would need to be purchased *(not included in the cost estimate provided)*

*Figure 16: Stop log closure across Hero Canal, New Orleans, LA*

Stop log structures were estimated at a cost of $1.9 million – $4.2 million with Philip Street Canal at the lower cost due to the smaller width of the Canal compared to Fox and Lakewood Canals. Costs also vary dependent on location along the canal in Alternatives 1 & 3. An average value of $3.2 million was used for a canal closure for ease of comparison between alternative configurations.

### 5.4.3 Lock Structure

Permanent closure of the canal to resident boaters will likely be extremely unpopular, and not supported by the non-federal sponsor. The closure of the canals during high lake level events that may stretch months at a time will also have impacts to the use of the canal for recreational activities and have impacts to water quality and interior drainage that would have to be managed.

A lock system would have the benefit of maintaining use of the canal system continuously but comes at a much higher cost. Miter gate lock systems are common for smaller locks and can be either manually or remotely operated. Either system will likely require permanent staff to operate and maintain the lock system. During water levels within an acceptable range, the gates could be maintained in an open position. During higher water levels, the double gate system would be utilized to transport recreational watercraft from the canal system to Lake St. Clair/ Detroit River.

Canal lock systems were estimated at a cost of $50 million to $122 million, with Philip Street Canal at the lower cost due to the smaller width of the Canal compared to Fox and Lakewood Canals.

The widest and deepest canal, Lockwood Canal, would likely be the chosen location for the lock system as it is the most heavily used and can transport larger watercraft. The remaining two canals (Fox Creek Canal and Philip Street Canal) would require other closure systems such as stop logs or earthen dams. It is highly unlikely that the City would be interested in constructing and maintaining three lock systems in such proximity. Therefore, construction and O&M costs for of the Lakewood Canal were used in the Cost Matrix (Table 6).

Additional benefits include the ease of obtaining property easements since private land easements or resident relocation would not be required. Land use agreements are needed from both the Riverfront Limited Partnership and the City of Grosse Point Park.

## 5.5 Permit Requirements

Any work performed in water will require state and federal permits:

> *Section 10 of the Rivers and Harbors Act of 1899 provides the Corps with jurisdiction over work waterward of the Ordinary High Water Mark of navigable waters. Section 404 of the Clean Water Act gives the US Army Corps jurisdiction over discharges of fill material in waters of the United States including wetlands.*
>
> *The State and Federal government maintain jurisdiction over many waters. In Michigan the Federal government has transferred jurisdiction of inland waters to the State of Michigan. In most cases, in these areas you will only be required to obtain a permit from the State. Michigan is one of two states in the country to have been transferred this Federal jurisdiction.*

The following permitting criteria is required prior to construction:

- For environmental clearance, proposed scope of work at each specific location for Fish and Wildlife Service (FWS) Threatened and Endangered (T&E) species impacts.
- Quantities (CYD) of excavation (may require sediment testing for contaminant determination and placement) and proposed fill areas (wetlands and floodplains).
- Areas not previously disturbed to project depth that will be impacted by excavation (archeological survey may be required), any tree cutting (number of trees and approximate locations for impacts to T&E bat species).

- Based on the description of the proposed scope of work and locations, a National Environmental Policy Act (NEPA) environmental evaluation is required.
- Michigan Department of Environment, Great Lakes, and Energy (EGLE) State required permits under Part 31, 301 and 404 303.
- In the case where modifications are made to stormwater drainage with discharge through new piping, the piping will need to be added to the City MS4 Stormwater permit with classification as a new outfall.
- Federal Section 10 Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act along with State issued National Pollutant Discharge Elimination System (NPEDS) permit under Section 402(p).

# 6. Conceptual Level Cost Estimate Assumptions

Cost estimates were developed for each of the base alternatives, and for each closure option based on approximations of quantities needed to construct the work. Cost estimates are conceptual and will need to be refined when the design is complete. Please refer to the quantity take off (QTOs) and cost appendix (Appendix A) for further discussion.

Since the project is not in the design phase and there are several unknowns, the following assumptions were made to develop quantity take-off calculations that were used as the basis for the conceptual level cost estimate.

***Levee Assumptions:***

Levees constructed of compacted clay.

Total cubic yards of clay were roughly approximated from LiDAR data values. No detailed CADD models were developed to calculate required quantities.

Crest width: 10 feet

Levee slopes: 1V: 3H. Levee slopes assumed to be 1V:3H (33% grade).

Inspection trench included

Potential utility modification/relocation included (rough approximation)

No seepage cutoff included (this will be determined in design phase)

***Inland Floodwall Assumptions:***

PZ-27 Steel sheet pile floodwall assumed. Material requirements/ preferences would be determined during design phase.

"I-wall" type floodwall assumed. I-walls do not have foundations and are limited to walls less than 6 feet in 'stick up' height. Requirements will be determined in design phase.

***Interior Drainage Assumptions:***

This study did not include an interior drainage study. However, raising floodwalls and levees along the lakefront and canals will cut off existing pathways for stormwater runoff. The existing interior drainage system would need to be upgraded to allow for the increased drainage requirement. In the estimates provided in this report, costs included in 2005 were escalated to 2023 dollars using CWCCIS values.

***Earthen Dam Closure Assumptions****:*

Design & construction requirements need to be determined to create a permanent damming surface across the canal. The following assumptions were made to get an order of magnitude cost estimate:

- Rock and/or earth fill construction, likely in a zoned construction.
- Length of 25 feet, width = approximate width of canal.
- Assumed height of 13 feet for Alternative 1, and 16 feet for Alternative 3.

***Stop Log Closure Assumptions:***

- Design/ use requirements to be determined in design phase. Assumed opening for small watercraft to pass.
- A portage system around the structure when closed may be desired but is not included in this estimate.
- The canal widths were roughly estimated from ArcGIS base map images.

The cost matrix below summarizes the full cost estimates for the alternatives with different closure configurations. The quantity calculations and conceptual level cost estimate are provided in Appendix A.

*Table 6*: Cost Matrix for Alternatives with Closure Options

**Base cost (w/o closures)**

| | |
|---|---|
| Alternative 1 | $ 32,464,375 |
| Alternative 2 | $ 87,924,563 |
| Alternative 3 | $ 44,835,563 |

**Closure Options:**

| | | | Annual O&M costs | | |
|---|---|---|---|---|---|
| Rock/ Earth closure | $ 558,000 | each | $ 55,800 | 10% | |
| Stop log closure | $ 3,285,083 | each | $ 197,105 | 6% | |
| Miter Lock system | $ 121,836,000 | each | $ 1,218,360 | 1% | Assuming lock is at Lakewood Ave. |

*Note: Costs are rough approximate only. Closure costs for different locations were assumed equal for simplicity.*

*****Only enter values into the green cells to build alternatives with different closure options.*****

| | | CONSTRUCTION | | | | OPERATION & MAINTENANCE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Description | Alternative | earth dam | stop log | miter | Total Construction | O&M, levees & floodwalls | O&M, earthen dam | O&M, stop log | O&M miter | Annual O&M | % of const.cost |
| Closed canal outside of wave run up zone; 2 stop logs & 1 lock | Alternative 1 | 0 | 2 | 1 | | | 0 | 2 | 1 | | |
| | $ 32,464,375 | $ - | $ 6,570,167 | $ 121,836,000 | $ 160,870,542 | $ 147,400 | $ - | $ 394,210 | $ 1,218,360 | $ 1,759,970 | 1.1% |
| Closed canal outside of wave run up zone; 3 stop logs | Alternative 1 | 0 | 3 | 0 | | | 0 | 3 | 0 | | |
| | $ 32,464,375 | $ - | $ 9,855,250 | $ - | $ 42,319,625 | $ 147,400 | $ - | $ 591,315 | $ - | $ 738,715 | 1.7% |
| Closed canal outside of wave run up zone; 3 earthen closures | Alternative 1 | 3 | 0 | 0 | | | 3 | 0 | 0 | | |
| | $ 32,464,375 | $ 1,674,000 | $ - | $ - | $ 34,138,375 | $ 147,400 | $ 167,400 | $ - | $ - | $ 314,800 | 0.9% |
| Closed canal outside of wave run up zone; 3 earthen closures | Alternative 1 | 2 | 1 | 0 | | | 2 | 1 | 0 | | |
| | $ 32,464,375 | $ 1,116,000 | $ 3,285,083 | $ - | $ 36,865,458 | $ 147,400 | $ 111,600 | $ 197,105 | $ - | $ 456,105 | 1.2% |
| Open canals, extensive steel sheet pile structures | Alternative 2 | 0 | 0 | 0 | | | 0 | 0 | 0 | | |
| | $ 87,924,563 | $ - | $ - | $ - | $ 87,924,563 | $ 423,540 | $ - | $ - | $ - | $ 423,540 | 0.5% |
| Closed canal outside of wave run up zone; 2 stop logs & 1 lock | Alternative 3 | 0 | 2 | 1 | | | 0 | 2 | 1 | | |
| | $ 44,835,563 | $ - | $ 6,570,167 | $ 121,836,000 | $ 173,241,729 | $ 207,540 | $ - | $ 394,210 | $ 1,218,360 | $ 1,820,110 | 1.1% |
| Closed canal outside of wave run up zone; 3 stop logs | Alternative 3 | 0 | 3 | 0 | | | 0 | 3 | 0 | | |
| | $ 44,835,563 | $ - | $ 9,855,250 | $ - | $ 54,690,813 | $ 207,540 | $ - | $ 591,315 | $ - | $ 798,855 | 1.5% |
| Closed canal outside of wave run up zone; 3 earthen closures | Alternative 3 | 3 | 0 | 0 | | | 3 | 0 | 0 | | |
| | $ 44,835,563 | $ 1,674,000 | $ - | $ - | $ 46,509,563 | $ 207,540 | $ 167,400 | $ - | $ - | $ 374,940 | 0.8% |
| Closed canal outside of wave run up zone; 2 earthen closures & 1 stop log | Alternative 3 | 2 | 1 | 0 | | | 2 | 0 | 0 | | |
| | 44835562.5 | $ 1,116,000 | $ 3,285,083 | $ - | $ 49,236,646 | $ 207,540 | $ 111,600 | $ - | $ - | $ 319,140 | 0.6% |

*Table 7*: Structural Alternative Comparison

| Measure Description | Pros | Cons | Notes/ Requirements |
|---|---|---|---|
| Levee Along Waterfront | • Continuous structure<br>• Kayaking and canoeing could still take place in the canals<br>• Unchanged canal front environment<br>• Overland flooding prevented<br>• Minimal property easements required to obtain<br>• No Operation needs, minimal maintenance | • Access to Detroit River and Lake St. Clair removed for all residents<br>• Higher levee height and width requirements for wave run-up<br>• Significant amount of material would be required to build a levee to meet FEMA's standards<br>• Would conflict with EPA Park Project if it is in area of park<br>• May hinder residents' water views<br>• Loss of property values | • Stagnant canal water - Would require gated pipe for water circulation/ pumping facility<br>• Internal drainage system improvements required<br>• Closing Fox Creek would require an agreement with the City of Grosse Pointe Park<br>• Require accommodation and/or agreement with GLWA regarding operations or alternate discharge accommodations |
| Floodwall along Waterfront | • Continuous structure<br>• Kayaking and canoeing could still take place in the canals<br>• Takes less space<br>• Minimal property easements required to obtain | • Access to Detroit River and Lake St. Clair removed for all residents<br>• High height requirements<br>• Would conflict with EPA Park Project if it is in area of park<br>• May hinder residents' water views<br>• Loss of property values<br>• May hinder residents' water view | |
| Setback Levees/ Floodwalls | • Would accommodate both canal and coastal EPA project wetlands<br>• Public would have an easier time accessing the water<br>• Fishing could take place at the mouths of the canals<br>• Lowest cost<br>• Lower levee height and width requirements<br>• Kayaking and canoeing could still take place in the canals<br>• Minimal property easements required to obtain<br>• A boat launch could be installed near the mouth | • Watercraft access to Detroit River and Lake St. Clair restricted; removed entirely during high water occasions for all residents.<br>• Would need to develop a way to keep canals from being stagnant (flush out)<br>• Loss of property values | |

| | | | |
|---|---|---|---|
| | of the canal for easier access | | |
| Above Options with Canal Fill | • Could use as park area Possible additional yard space for residents or pu<br>• Limited land easements | • No Access to water for residents,<br>• No potential for sewer discharges (without new discharge system)<br>• Environmental Impacts<br>• Likely to be least acceptable to residents<br>• Private property easements required and difficult to obtain.<br>• Loss of property values | Internal drainage system improvements required.<br>A boat launch could be installed near the mouth of the canal |

# 7. Conclusion

This study developed and analyzed three structural flood risk reduction alternatives to assist with mitigating flood impacts to the Jefferson-Chalmers neighborhood, located in Detroit, MI. Upon extensive hydrological analysis, it is determined that the source of the reoccurring flooding is from heightened lake levels, combined with surge and wave-runup. During east and northeast wind events, water is forced into the local canals connected to Lake St. Clair, raising water levels in the canals and resulting in flooding. It is important to note that the scope of this study is focused on alternatives to reduce the coastal flooding risk. While there is a cost assumed for necessary interior drainage upgrades, interior drainage analysis or design is not included in this study. The recommended structural flood risk reduction alternatives to be considered are as follows:

- **Alternative 1 (3 Configuration Options):** Closed canal, levees and floodwalls *outside* of the wave run up zone
- **Alternative 2 (1 Configuration Option):** Open Canal with Extensive Floodwalls
- **Alternative 3 (3 Configuration Options):** Closed Canal, levees & floodwalls *within* the wave run up zone

The recommended alternatives included in this report are conceptual. Significant design efforts and hydraulic modeling are needed prior to construction. Modifications and refinement to the concept level alternatives based on these design efforts shall be expected.

Estimated material quantities and total cost (labor and material) for each alternative are detailed in Sections 5 and 6 of this report. Each alternative recommendation, if implemented, will provide flood protection to the Jefferson-Chalmers neighborhood from heightened lake levels overwhelming the series of associated canals in the area. The three alternatives presented would result in flood risk reduction by preventing storm surge/wave run-up from overtopping the canal walls, which results in inland surface flooding that has historically overwhelmed storm and sanitary sewer drainage systems. Additionally, each alternative would qualify the Jefferson-Chalmers area to be removed from the 100-year (1% annual chance of flooding) floodplain (currently listed as a high-risk flood zone) within the limits of the study area detailed in this report, resulting in less cost and more grant opportunities for flood insurance coverage.

US Army Corps of Engineers

DETROIT DISTRICT

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**JEFFERSON CHALMERS FLOOD PLAIN**

**MANAGEMENT SYSTEMS STUDY**

**DETROIT, MICHIGAN**

# Appendix A: Cost Estimate

JULY 2022

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# Table of Contents

# 1 Introduction

The purpose of this appendix is to summarize the assumptions and basis of the cost estimate for the different proposed plans and features of the project. This includes the costs of the construction, contingency and non-construction costs such as Planning, Engineering, and Design (PED) and Construction Management (CM).

# 2 Alternatives

Three major base alternatives were considered for this study which are defined as a series of levees, floodwalls, seawalls and interior drainage upgrades. In addition to the base alternatives there are 3 different types of optional closure structures that can be incorporated into the alternatives in a mix and match fashion.

## 2.1 Alternative 1: Closed canal, levees and floodwalls outside of wave run up zone

Alternative 1 includes the following features (see figure 1):

- upland steel sheet pile floodwall (shown in purple)
- earthen levee (shown in yellow)
- 3 canal closure structures (shown in red)
- 6' stop log closure or gate at KAM Marine/ Bayview Yacht Club

Figure 1

## 2.2 Alternative 2: Open Canal with Extensive Floodwalls

Alternative 2 includes the following features (see figure 2):

• steel sheet pile seawalls along *all properties* along the canals between Fox that are within the FEMA base flood hazard area (between Alter Road and Lenox Road). Walls would function as both seawalls and floodwalls and would be constructed to an elevation of 580' NAVD88.

• earthen levee

• No canal closure structures

• 6' stop log closure or gate at KAM Marine/ Bayview Yacht Club

Figure 2

## 2.3 Alternative 3: Closed Canal, levees & floodwalls WITHIN wave run up zone

Alternative 3 includes the following features (see Figure 3):

• upland and canal steel sheet pile floodwalls (shown in purple)

• earthen levee (shown in yellow)

• 3 canal closure structures (shown in red)

• 6' stop log closure or gate at KAM Marine/ Bayview Yacht Club

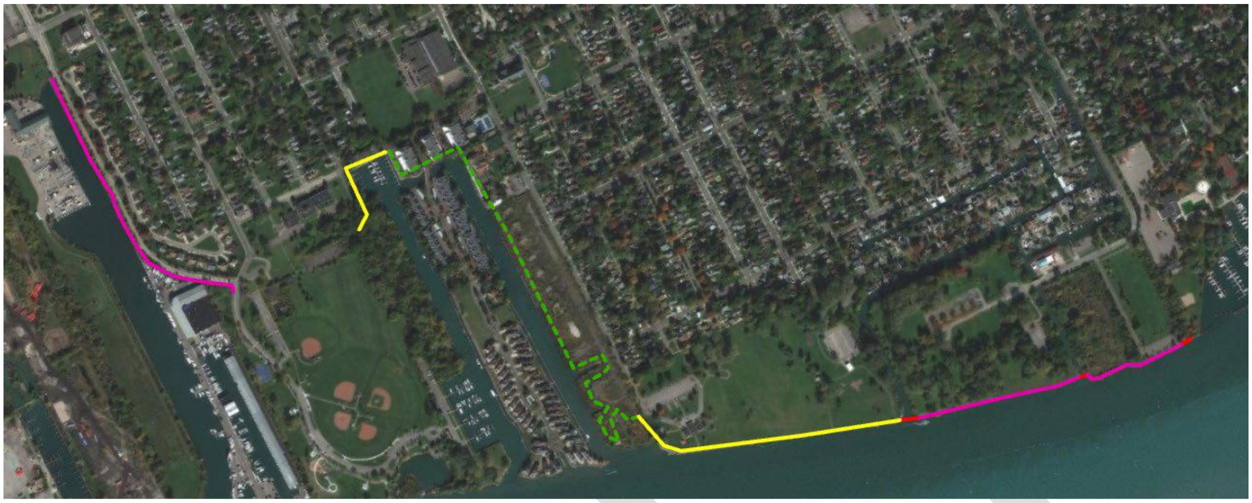

Figure 3

## 2.4 Canal Closure Options

Canal closures can be used to reduce the likelihood of high-water levels and storm surges from Lake St. Clair/ Detroit River from entering the Jefferson Chalmers neighborhood. There are several options for the type of structure that can be used. The key factors separating the options are cost and impact to the use of the canal.

### 2.4.1 Permanent canal closure (earth/rock dam fill)

Under this option, a portion of the canal would be filled with earthen materials (soil, rock) to create a permanent damming structure that would prevent high lake levels or storm surges from entering the canal. The exact dimensions and requirements would be determined in design. Under this partial fill option, consideration would need to be given to maintaining sufficient flow to prevent the canals from becoming stagnant and maintaining requirements for any discharges for interior drainage and pumping systems. This would be determined during design phase but could include a drainage structure with a flap gate.

### 2.4.2 Stop Log Structures

If permanent closure of the canal is not desirable, a more costly option is to install a structure that can be closed during high water. A stop log structure, such as the one shown in Figure 2, can be used. A stop log closure system would require manual installation of the stop logs into recessed areas during high water periods and would require removal of stop logs when water levels return to an acceptable range.

Figure 4. stoplog structure

### 2.4.3 Lock Structures

Permanent closure of the canal to resident boaters will likely be extremely unpopular. The closure of the canals during high lake level events that may stretch months at a time will also have impacts to the use of the canal for recreational activities and have impacts to water quality and interior drainage that would have to be mitigated.

A lock system would have the benefit of maintaining use of the canal system continuously but comes at a much higher price tag. Miter gate lock systems are common for smaller locks and can be either manually or remotely operated. Either system will likely require permanent staff to operate and maintain the lock system. During water levels within an acceptable range, the gates could be maintained in an open position. During higher water levels, the double gate system would be utilized to transport recreational watercraft from the canal system to Lake St. Clair/ Detroit River.

# 3 Cost Summary

Summary of alternative and closure structure costs in present dollars:

| Summary | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|
| Construction Cost | $ 19,983,500 | $ 54,125,250 | $ 27,599,650 |
| Contingency | $ 4,995,875 | $ 13,531,313 | $ 6,899,913 |
| Non-Construction Cost | $ 7,485,000 | $ 20,268,000 | $ 10,336,000 |
| Total Project cost | $ 32,464,375 | $ 87,924,563 | $ 44,835,563 |

The closure structure costs varied due to the canal widths at 3 separate locations so a range of cost is shown:
Earthen dam closures:
Construction cost: $196k - $608k
Total project cost: $320k - $987k

Stop log structure closures:
Construction cost: $1.2M - $2.6M
Total project cost: $1.9M - $4.2M

Lock structure closures:
Construction cost: $30M - $75M
Total project cost: $49M - $122M

Non-construction cost includes Planning, Engineering, and Design (PED) and Construction Management (CM) cost.

Total project cost includes contingency and non-construction costs.

# 4 Basis of Estimate

## 4.1 Basis of Design

### 4.1.1 Levee design assumptions

- Levees constructed of compacted clay.
- Total cubic yards of clay were roughly approximated from xxx LiDAR data values. No detailed CADD models were developed to calculate required quantities.
- Crest width: 10 feet
- Levee slopes: 1V: 3H. levee slopes assumed to be 1V:3H (33% grade).
- Inspection trench included
- Potential utility modification/relocation included (rough approximation)
- No seepage cutoff included (this will be determined in design phase)

### 4.1.2 Inland floodwall design assumptions

- PZ-27 Steel sheet pile floodwall assumed. Material requirements/ preferences would be determined during design phase.
- "I-wall" type floodwall assumed. I-walls do not have foundations and are limited to walls less than 6' in stick up height. Requirements will be determined in design phase.

### 4.1.3 Interior drainage design assumptions

This study did not include an interior drainage study although the existing interior drainage system would need to be upgraded to allow for the increased drainage requirement. The interior drainage cost provided in this report used a previous cost from 2005 and was escalated to 2022 dollars using Civil Works Construction Cost Index System (CWCCIS) values.

### 4.1.4 Earthen dam closure design assumptions

Design & construction requirements need to be determined to create a permanent damming surface across the canal. The following was assumed to get a rough cost for comparison:
• Rock and/or earth fill construction, likely in a zoned construction.
• Length of 25 feet, width = approximate width of canal.
• Assumed height of 13 feet for Alternative 1, and 16' for Alternative 3.

### 4.1.5 Stop log closure assumptions

- Design/ use requirements to be determined in design phase. Assumed opening for small watercraft to pass.

- A portage system around the structure when closed may be desired but is not included in this estimate.
- Assume steel stop log structure with concrete abutment and base.
- The canal widths were roughly estimated from ArcGIS base map images.

## 4.2 Basis of Quantities

Quantities provided by the technical team.

## 4.3 Construction Estimate

Due to the level of design for this study (conceptual) the estimate falls into a Class 5 category, based on ER 1110-2-1302. There is still substantial lack of technical information and scope clarity resulting in major estimate assumptions in technical information and quantities especially for the canal closure stop log structures and lock structures. Broad based assumptions, costs from comparable projects and data, cost book, cost engineering judgment and historical parametric data were heavily relied on. While certain construction elements such as the base alternatives can be estimated in better detail, there is still a great deal of uncertainty relative to major construction components. For the corollary cost data, recent projects in the Great Lakes region with similar scope were used when possible to give the most reasonable similar costs. Typical contingency range for this class of estimate could be 25% to 200%.

Costs in this Appendix cover construction of project items with a markup to cover Planning, Engineering, and Design (PED) as well as Construction Management (CM). These items are covered by percentages uniformly applied to the construction costs. These costs are conservative estimates and a detailed breakdown of the costs for these items will need to be more fully developed during the next phase of design.

The alternative analysis included unit costs of all project features and contrasted the options in order to sc ale relative differences.

All items in this cost estimate are presented in 2022 dollars.

Major Construction Features for the alternatives were estimated as follows:

Compacted Clay Levee: cubic yard cost was developed using MCACES Second Generation (MII) software. Cost was then inflated to capture any miscellaneous associated sight work not captured in the scope of this study.

Inspection Trench: cubic yard excavation cost was developed in MII software. Cost was then inflated to capture an un-estimated amount of various utility closures not captured in the scope of this study.

Interior drainage cost: derived from a report prepared by NTH Consultants in 2005; cost was escalated to present day value using CWCCIS.

River and upland SSP: developed using MII software and then contrasted the different sheet lengths and land vs marine construction techniques in order to estimate appropriate differences relative to one another.

Upland stoplog closure: Developed using MII software from a conceptual design from a previous flood control project. Includes concrete work, H pile and extruded aluminum panels.

Earthen dam closure structures: developed using MII software and inflated for potential costs such as additional unidentified site work, water control, etc. The closures are specific to 3 separate locations of varying widths and the cost reflects the different level of effort for each location.

Stop log closure structures: This cost was developed parametrically based on a recent similar project Au Sable river sea lamprey trap. Only relevant portions of the lamprey trap cost were utilized such as the water control, stop log structure and any SSP placement to narrow the channel towards the stop log structure. The cost was then scaled for the various widths of the 3 separate location to reflect the different level of effort associated with each location.

Lock closure structures: this cost is based on a very broad based assumption along with recent cost data for construction of much larger lock structures than these canal locations. Engineering judgement was used to develop what seemed a reasonable cost for locations of this size and then the cost was further scaled for the widths of the 3 different locations.

Operations and Maintenance cost for the levees and floodwalls: these costs are based on an estimated level of effort to perform annual inspections, mowing, brush removal, monitoring, etc.

Operations and Maintenance for all other features: based on percentages using engineering judgement to determine a value that seemed reasonable.

# 5 References

U.S. Army Corps of Engineers, 1993, *Engineering and Design Cost Engineering Policy and General Requirements, Engineering Regulation 1110-1-1300,* Department of the Army, Washington D.C., 26 March 1993.

U.S. Army Corps of Engineers, 2016, *Civil Works Cost Engineering, Engineering Regulation 1110-2-1302,* Department of the Army, Washington D.C., 30 June 2016.

U.S. Army Corps of Engineers, 2019, *Civil Works Construction Cost Index System (CWCCIS), Engineering Manual 1110-2-1304,* Department of the Army, Washington D.C., 31 March 2020.

| INDEPENDENT GOVERNEMENT ESTIMATE | | | | | SHEET 01 OF 01 |
|---|---|---|---|---|---|
| PROJECT: | **JEFFERSON CHALMERS FLOOD PLAIN MANAGEMENT STUDY** | | | | |
| ITEM NO. | DESCRIPTION | EST. QTY | U OF M | UNIT PRICE | ESTIMATED AMOUNT |
| | | | | | |
| | | | | | |
| | ALTERNATIVE 1 - Closed Canal, levees and floodwalls outside of wave run up zone | | | | |
| | CONSTRUCTION COST | 1 | LS | $ 19,983,500 | $ 19,983,500 |
| | CONTINGENCY | 25% | | $ 4,995,875 | $ 4,995,875 |
| | NON-CONSTRUCTION COST | 1 | LS | $ 7,485,000 | $ 7,485,000 |
| | **TOTAL PROJECT COST ALTERNATIVE 1** | | | | **$ 32,464,375** |
| | | | | | |
| | ALTERNATIVE 2 - Open canal with extensive floodwalls | | | | |
| | CONSTRUCTION COST | 1 | LS | $ 54,125,250 | $ 54,125,250 |
| | CONTINGENCY | 25% | | $ 13,531,313 | $ 13,531,313 |
| | NON-CONSTRUCTION COST | 1 | LS | $ 20,268,000 | $ 20,268,000 |
| | **TOTAL PROJECT COST ALTERNATIVE 2** | | | | **$ 87,924,563** |
| | | | | | |
| | ALTERNATIVE 3 - Closed Canal, levees and floodwalls within wave run up zone | | | | |
| | CONSTRUCTION COST | 1 | LS | $ 27,599,650 | $ 27,599,650 |
| | CONTINGENCY | 25% | | $ 6,899,913 | $ 6,899,913 |
| | NON-CONSTRUCTION COST | 1 | LS | $ 10,336,000 | $ 10,336,000 |
| | **TOTAL PROJECT COST ALTERNATIVE 3** | | | | **$ 44,835,563** |
| | | | | | |
| | **OPTIONAL CLOSURE STRUCTURE COST RANGES:** | | | | |
| | **EARTHEN DAM CLOSURES** | | | | |
| | CONSTRUCTION COST | $196,000 - $608,000 | | | |
| | **TOTAL PROJECT COST** | **$320,000 - $987,000** | | | |
| | | | | | |
| | **STOP LOG STRUCTURE CLOSURES** | | | | |
| | CONSTRUCTION COST | $1,200,000 - $2,600,000 | | | |
| | **TOTAL PROJECT COST** | **$1,900,000 - $4,200,000** | | | |
| | | | | | |
| | **LOCK STRUCTURE CLOSURES** | | | | |
| | CONSTRUCTION COST | $30,000,000 - $75,000,000 | | | |
| | **TOTAL PROJECT COST** | **$49,000,000 - $122,000,000** | | | |
| | | | | | |
| | SUBMITTED BY:<br>UDELL.JULIE.1296161833 Digitally signed by UDELL.JULIE.1296161833 Date: 2022.03.23 11:57:20 -04'00' | APPROVAL RECOMMENDED BY: | | | |
| | **JULIE UDELL**<br>Civil Engineer | **ALEX L. JIMENEZ, P.E.**<br>Chief, Cost & General Engineering Branch | | | |
| | REVIEWED BY:<br>MALHOTRA.SHEETAL.R.1230528280 Digitally signed by MALHOTRA.SHEETAL.R.1230528280 Date: 2022.03.23 16:56:17 -04'00' | | | | |
| | **SHEETAL MALHOTRA**<br>Civil Engineer | | | | |

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| | | | |
|---|---|---|---|
| US Army Corps of Engineers ® Detroit District | PROJECT TITLE:<br>**Lake St Clair Flood Study, Jefferson Chalmers Neighborhood Detroit, Michigan**<br>COMPUTATION TITLE:<br>**Summary of Quantities** | **Prepared by:**<br>Marie Dock<br>**Corrected/Updated by:**<br>Tina Kowitz<br>**CHECKED BY:**<br>Julie Udell | DATE:<br>8/18/2021<br><br>2/28/2022<br><br>3/10/2022 |

**ALTERNATIVE 1 : Closed Canal, outside of wave run up zone**

| | | | | | |
|---|---|---|---|---|---|
| Compacted Clay Levee | 3,632 | CY | or | 6,373 | tons |
| Inspection Trench | 1,147 | CY | or | 1,935 | tons |
| Canal Closures | 3 | Total | | | |
| | | | | | |
| Option 1: Rock/Earth Dam | | EA | (matrix for alternatives developed) | | |
| Option 2: Stop Logs | | EA | | | |
| Option 3: Lock w/ miter gates | | EA | | | |
| | | | | | |
| <u>**UPLAND SSP**</u> | | | | | |
| PZ-22 SSP | 8,402 | SF | or | 92 | tons |
| Wale cap | 560 | ft | | | |
| Upland stop log closure | 120 | ft | 120' long x 6' high | | |
| INTERIOR DRAINAGE/ PUMPS | | LS | LUMP SUM | | |

**ALTERNATIVE 2 : Open Canal Extensive Floodwalls**

| | | | | | |
|---|---|---|---|---|---|
| **Compacted Clay Levee Construction** | 3,487 | CY, or | | 6,119 | tons |
| **Inspection Trench** | 1,101 | CY, or | | 1,858 | tons |
| | | | | | |
| <u>**River Canal SSP (Anchored retaining/ floodwalls)**</u> | | | | | |
| PZ-22 SSP | 126,468 | SF | or | 1,391 | tons |
| Wale cap | 15,808 | ft | | | |
| tie rods | 23,713 | (ft) length Spacing not yet designed. Rough assumptions | | | |
| | | | | | |
| <u>**UPLAND SSP (Cantelevered SSP floodwall)**</u> | | | | | |
| PZ-22 SSP | 14,155 | SF | or | 156 | tons |
| Wale cap | 786 | ft | | | |
| Upland stop log closure | 584 | SF | | | |
| INTERIOR DRAINAGE/ PUMPS | | LS | LUMP SUM | | |

**ALTERNATIVE 3 : Closed Canal, levees & floodwalls WITHIN wave run up zone**

| | | | | | |
|---|---|---|---|---|---|
| Compacted Clay Levee Construction | 13,221 | CY | or | 23,204 | tons |
| Inspection Trench | 1,752 | CY | or | 2,957 | tons |
| Canal Closures | 3 | Total | | | |
| | | | | | |
| Option 1: Rock/Earth Dam | | EA | (Matrix developed for closure alternatives) | | |
| Option 2: Stop Logs | | EA | | | |
| Option 3: Lock w/ miter gates | | EA | | | |
| | | | | | |
| <u>UPLAND SSP I-wall:</u> | | | | | |
| PZ-22 SSP | 3,671 | SF | or | 92 | tons |

| | | | | | |
|---|---|---|---|---|---|
| Wale cap | 560 | ft | | | |
| Upland stop log closure | 200 | SF | | | |
| **Coastal & Canal SSP retaining/floodwall** | | | | | |
| PZ-22 SSP | 58,739 | SF | or | 646 | tons |
| Wale cap | 1,836 | ft | | | |
| tie rods | 2,753 | (ft) | Assumed spacing. | | |
| | | | | | |
| INTERIOR DRAINAGE/ PUMPS | | LS | LUMP SUM | | |

| | PROJECT TITLE: | Prepared by: | | DATE: |
|---|---|---|---|---|
| US Army Corps of Engineers® Detroit District | **Lake St Clair Flood Study, Jefferson=Chalmers Neighborhood Detroit, Michigan** | Marie Dock | | 8/18/2021 |
| | | **Corrected/Updated by:** | | |
| | | Tina Kowitz | | 2/28/2022 |
| | COMPUTATION TITLE: | **CHECKED BY:** | | |
| | **Alternative 1, Quantity Take Off** **Page 1 of 4** | Julie Udell | | 3/10/2022 |

**ALTERNATIVE 1 : Closed Canal, levees & floodwalls outside of wave run up zone**

**Description:**

| | | | | |
|---|---|---|---|---|
| Total levee | 1720 | LF | | |
| Total Upland Floodwall | 560 | LF | | |
| Total Canal Closures | 202 | LF | 3 | Closures |
| Total Upland Stop Log Closures | 117 | LF | 1 | Closures |
| Total Length: | 2600 | LF | 0.4924 | Miles |

**Levee Assumptions:**

| | | | |
|---|---|---|---|
| Unit weight of clay: | 130 | pcf | Approx. value for in place compacted clay |
| Req'd Levee crest height | 580 | | FEMA 1% stillwater elevation +2 feet |
| Levee Slope ratio | 1 | :3 | Typical slope for clay levee |
| Unit weight of inspection trench soil: | 125 | pcf | Approx. value for in place compacted soil. |
| Inspection trench depth | 6 | feet | Inspect for pipes, seal/ relocate/encase, backfill |
| Inspection trench width | 3 | feet | Assume no seepage cutoff needed |

| **Levee** Section Name | Levee Length (ft) | Approx Ground Elevation | Levee Height (ft) | Levee Crest (ft) | Levee Width (ft) | Levee Construction Levee Volume (cft) | CY | **Insp. Trench** Volume (CF) | |
|---|---|---|---|---|---|---|---|---|---|
| 3' Levee | 1720.24 | 577 | 3 | 10 | 28 | 98054 | 3632 | 30964 | |
| TOTAL Levee Volume | | | | | | 98054 | CF | 30,964 | CF |
| **Total Levee Volume** | | | | | | **3631.62** | **CY** | **1,147** | **CY** |
| Total Weight | | | | | | 12746993.6 | lbs | 3,870,545 | lbs |
| | | | | | | **6373.50** | **tons** | **1,935** | **tons** |

| | PROJECT TITLE: | Prepared by: | | DATE: |
|---|---|---|---|---|
| US Army Corps of Engineers® Detroit District | **Lake St Clair Flood Study, Jefferson=Chalmers Neighborhood Detroit, Michigan** | Marie Dock | | 8/18/2021 |
| | | Corrected/Updated by: | | |
| | | Tina Kowitz | | 1/11/2022 |
| | COMPUTATION TITLE: | CHECKED BY: | | |
| | **Alternative 1, Quantity Take Off Page 2 of 4** | Julie Udell | | 3/10/2022 |

**Upland SSP Assumptions**

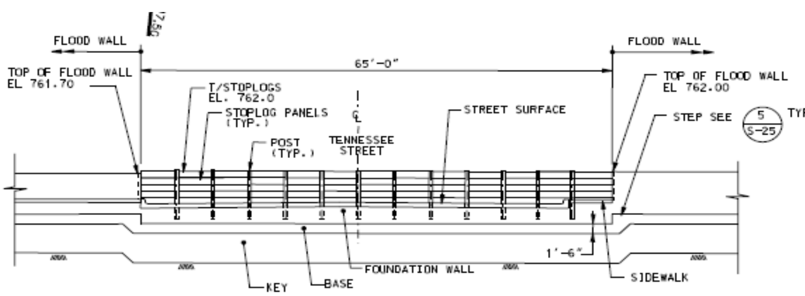
| | | | |
|---|---|---|---|
| Unit weight of steel sheet pile (PZ-22): | 22 | psf | Assumed PZ22 |
| Protected ground elevation | 576 | | *Assumed value from Lidar |
| SSP embedment ratio | 2 | :1 | |
| | | *No concrete cap assumed at this time, but may be needed/desired.* | |
| Required SSP height | 580 | | FEMA 1% stillwater elevation +2 feet |
| Cap length | 560 | | |

| Section Name | Length (ft) | Ground Elev. NAVD88 | Stick up height' (ft) | SSP Total Length (ft) | SSP Area (SF) | Weight (tons) |
|---|---|---|---|---|---|---|
| ~5' Clairpoint St floodwall | 560 | 575 | 5 | 15 | 8402 | 92 |
| | | | | Total: | **8402** | **92** |

**Stop Log Closure at Bayview Yacht Club**

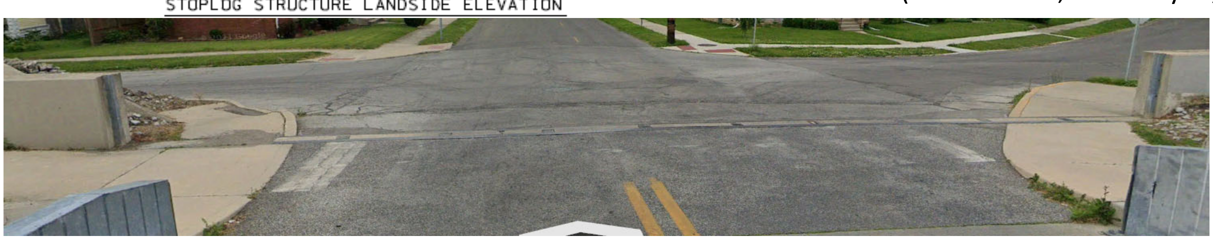
117 feet wide, 5 feet high (measured from road surface)

Stop log structure show below as example (Fort Wayne, Indiana)




STOPLOG STRUCTURE LANDSIDE ELEVATION

Example of stop logs being placed (Lawton Park, Fort Wayne, Indiana)



View of stop log location without panels (Tecumseh Street, Fort Wayne, Indiana)

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|---|---|---|---|
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| | **Alternative 1, Quantity Take Off** | Tina Kowitz | 2/28/2022 |
| | **Page 3 of 4** | CHECKED BY: | |
| | | Julie Udell | 3/10/2022 |

ArcGIS export:

| Name | FeatureType | Length (ft) |
|---|---|---|
| Closure Structure No 1 - Fox Creek | Canal Closure | 79.57 |
| Riverside Blvd Levee | Levee | 382.25 |
| Closure Structure No 2 - Philip St Canal | Canal Closure | 36.73 |
| Mariner Park High Ground | High Ground | 323.56 |
| Closure Structure No 3 - Lakewood Canal | Canal Closure | 86.03 |
| Lakewood East Park High Ground | High Ground | 1212.58 |
| Alfred Brush Park Levee | Levee | 816.17 |
| High Ground | High Ground | 5398.20 |
| Greyhaven West Levee | Levee | 521.82 |
| High ground | High Ground | 1046.27 |
| Clairpointe Ave Existing Floodwall | Existing Floodwall | 1448.18 |
| Clairpoint Ave Conner St. tie in | Upland Floodwall | 276.38 |
| Clairpoint Stoplog Closure | Upland Stop Log C | 116.87 |
| Clairpoint Ave tie in to existing floodwall | Upland Floodwall | 283.77 |

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| **Alternative 1, Quantity Take Off** | Tina Kowitz | 1/11/2022 |
|  | CHECKED BY: | |
| | Julie Udell | 3/10/2022 |

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Closure Structures

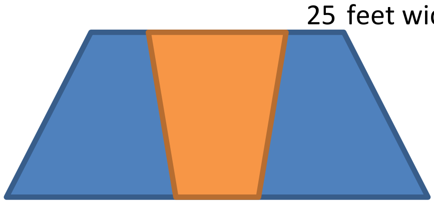
| | ~width (ft) | ~ Height (ft) | Option 1: Rock/Earth dam | | Option 2: Stop logs | Option 3: miter lock gates |
|---|---|---|---|---|---|---|
| CS No 1 - Fox Creek | 80 | 4 | 1964 | CY | 3 | 3 |
| CS No 2 - Philip St Canal | 40 | 13 | 982 | CY | 3 | 3 |
| Closure No 2 | 90 | 13 | 2210 | CY | 3 | 3 |

Description of Options:

Option 1: Quarry run stone/ earthen Dam: Construct permanent damming feature in canal to keep high Lake levels out of canal. Assume 25' at top, 2:1 slopes for 13'.

Assume:

25 feet wide



13 feet high

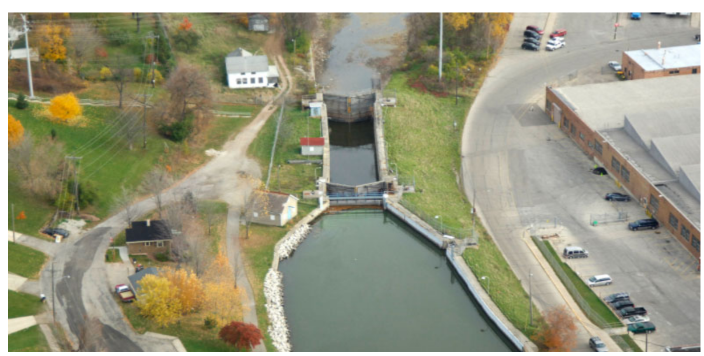
| | | | |
|---|---|---|---|
| Depth of canal | 567 | | ASSUMED |
| | 25 | feet | at crest |
| | 77 | feet | at base |
| | 663 | square feet per ft canal width | |

**Note: Rough assumptions. Needs to be designed

Opt 2: Stop logs. Assume similar to Hero Canal In New Orleans. Large stop logs placed to temporarily close canal during high lake levels.

WBV-09b Stoplog Structure on Hero Canal

Opt 3: Miter gates Assume 2 sets of miter gates needed to access during high lake levels, similar to Fox River Dams.



| | PROJECT TITLE: | Prepared by: | | DATE: |
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| US Army Corps of Engineers ® Detroit District | **Lake St Clair Flood Study, Jefferson Chalmers Neighborhood Detroit, Michigan** | Marie Dock | | 8/18/2021 |
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| | | Tina Kowitz | | 2/28/2022 |
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| | **Alternative 2, Quantity Take Off Page 1 of 4** | Julie Udell 3/10/2022 | | |

**ALTERNATIVE 2 : Open Canal Extensive Floodwalls**

**Description:**

| | | | | |
|---|---|---|---|---|
| Total levee | 1,652 | LF | | |
| Total Upland Floodwall | 786 | LF | | |
| Total Upland Stop Log Closures | 117 | LF | | |
| Total Canal Floodwall | 15,808 | LF | | |
| Total Length: | 18,363 | LF | 3.47792 | miles |

**Canal Closure Structures:** NONE

**Levee Assumptions:**

| | | | |
|---|---|---|---|
| Unit weight of clay: | 130 | pcf | Approx. value for in place compacted clay |
| Reqd stillwater elev. | 580 | | FEMA 1% stillwater elevation +2 feet |
| Levee Slope ratio | 1 | :3 | Typical slope for clay levee (steeper would make mowing difficult) |
| Unit weight of inspect | 125 | pcf | Approx. value for in place compacted soil. |
| Inspection trench dep | 6 | feet | Inspect for pipes, seal/ relocate/encase, backfill |
| Inspection trench wid | 3 | feet | Assume no seepage cutoff needed |

| **Levee** | | | Levee Construction | | | | | **Inspection Trench** | |
|---|---|---|---|---|---|---|---|---|---|
| Section Name | Levee Length (ft) | Avg ground elev. | Levee Height (ft) | Levee Crest (ft) | Levee Width (ft) | Levee Volume (cft) | CY | Volume (CF) | |
| Average Levee | 1652 | 577 | 3 | 10 | 28 | 94144 | 3487 | 29,730 | |
| TOTAL Levee Volume | | | | | | 94,144 | CF | 29,730 | CF |
| **Total Levee Volume** | | | | | | **3,487** | **CY** | **1,101** | **CY** |
| Total Weight | | | | | | 12,238,659 | lbs | 3,716,192 | lbs |
| | | | | | | **6,119** | **tons** | **1,858** | **tons** |

| | PROJECT TITLE: | Prepared by: | | DATE: |
|---|---|---|---|---|
| US Army Corps of Engineers® Detroit District | **Lake St Clair Flood Study, Jefferson Chalmers Neighborhood Detroit, Michigan** | Marie Dock | | 8/18/2021 |
| | | Corrected/Updated by: | | |
| | | Tina Kowitz | | 1/11/2022 |
| | COMPUTATION TITLE: | CHECKED BY: | | |
| | **Alternative 2, Quantity Take Off Page 2 of 4** | Julie Udell | 3/10/2022 | |

**Canal SSP Assumptions**

| | | | |
|---|---|---|---|
| unit wt. of SSP: | 22 | psf | Assumed PZ22 |
| Depth of canal: | 567 | | ASSUMED |
| SSP embed. ratio | 1 | :1 | Assumed anchored wall w tie rods 7 cap. |
| | | | No concrete cap assumed at this time, but could be required |
| Reqd SSP height | 580 | NAVD88 | FEMA 1% stillwater elevation +2 feet |
| Tie rod spacing | 10 | feet | (rough assumption, not designed) |
| Tie rod length | 15 | feet | (rough assumption, not designed) |

| Section Name | Length (ft) | Ground Elev. | Stick up height' | Total SSP length | SSP Area (SF) | Weight (tons) | # Tie rods (each) | Tie rod length (ft) |
|---|---|---|---|---|---|---|---|---|
| Average canal wall | 15808.49 | 574 | 4.0 | 8 | 126,468 | 1,391 | 1,581 | 23,713 |
| | | | | Total: | **126,468** | **1,391** | **1,581** | **23,713** |

**<u>Upland</u> SSP Assumptions**

| | | | |
|---|---|---|---|
| Unit weight of steel sheet pile): | 22 | psf | Assumed PZ22 |
| SSP embedment ratio | 2 | :1 | No concrete cap assumed at this time, but may be desired |
| Reqd height, stillwater | 580 | | FEMA 1% stillwater elevation +2 feet |

| Section Name | Length (ft) | Ground Elev. NAVD88 | Stick up height' (ft) | SSP Total Length (ft) | SSP Area (SF) | Weight (tons) |
|---|---|---|---|---|---|---|
| Weighted average | 786.4 | 575 | 6 | 18 | 14155 | 156 |
| | | | | Total: | **14155** | **156** |

**Stop Log Closure at Bayview Yacht Club**

117 feet wide 5 feet high (measured from road surface)

(See graphics on next page)

| | | | | |
|---|---|---|---|---|
| US Army Corps of Engineers® Detroit District | PROJECT TITLE: | **Prepared by:** | | **DATE:** |
| | **Lake St Clair Flood Study, Jefferson Chalmers Neighborhood Detroit, Michigan** | Marie Dock | | 8/18/2021 |
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| | | Tina Kowitz | | 2/28/2022 |
| | COMPUTATION TITLE: | **CHECKED BY:** | | |
| | **Alternative 2, Quantity Take Off Page 3 of 4** | Julie Udell | 3/10/2022 | |

ArcGIS export:

| Name | Type | Length (ft) | |
|---|---|---|---|
| Riverside Blvd floodwall curb | Upland Floodwall | 113.287449 | |
| RiverSide Blvd curb | Upland Floodwall | 112.967381 | |
| 3' x500' Levee | Levee | 504.068632 | |
| 3' x 650' Levee | Levee | 734.338727 | |
| Existing Clairpoint St floodwall | Existing Floodwall | 1452.770385 | |
| Riverside Blvd Canal Walls | Canal Floodwall | 1055.469358 | |
| Klenk St Floodwalls | Canal Floodwall | 2182.930142 | |
| Harbor Island St Floodwalls | Canal Floodwall | 3304.753088 | |
| S Lakewood Floodwall | Canal Floodwall | 393.215335 | |
| Fox Creek Floodwall | Canal Floodwall | 4222.590949 | |
| Fox Creek Floodwall - NorthWest | Canal Floodwall | 4171.056835 | |
| RIverside Blvd levee | Levee | 413.233535 | |
| High Ground | High Ground | 5394.726365 | |
| High ground | High Ground | 1046.269156 | |
| Lakewood Canal floodwall | Canal Floodwall | 478.476164 | |
| high ground | High Ground | 289.598401 | |
| Clairpoint Ave Conner St. tie in | Upland Floodwall | 276.377296 | x |
| Clairpoint Stoplog Closure | Upland Stop Log Closure | 116.874785 | |
| Clairpoint Ave tie in to existing floodwall | Upland Floodwall | 283.775319 | x |

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|---|---|---|---|
| **Lake St Clair Flood Study, Jefferson Chalmers Neighborhood Detroit, Michigan** | Marie Dock | | 8/18/2021 |
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| **Alternative 2, Quantity Take Off**  | Julie Udell | 3/10/2022 | |

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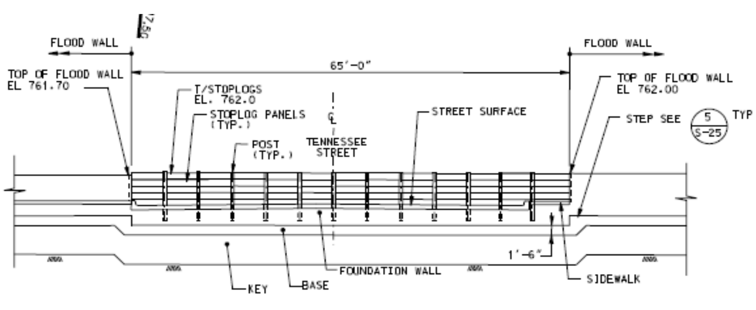
Detroit District

Determination of average height of structures:

| | NAME | Length (ft) | General Elevation | 580'-Elev | | "stick up height", Weighted average (ft) |
|---|---|---|---|---|---|---|
| Upland | Clairpointe | 560.1526 | 574-577 | **6** | 3360.9 | |
| | Riverside Blvd | 112.97 | 574 | **6** | 677.8 | |
| | Riverside Blvd floodwalls cu | 113.29 | 574 | **6** | 679.7 | |
| | | 786 | | | 4718.5 | 6.0 feet |
| | | | | | | 6 for calcs |

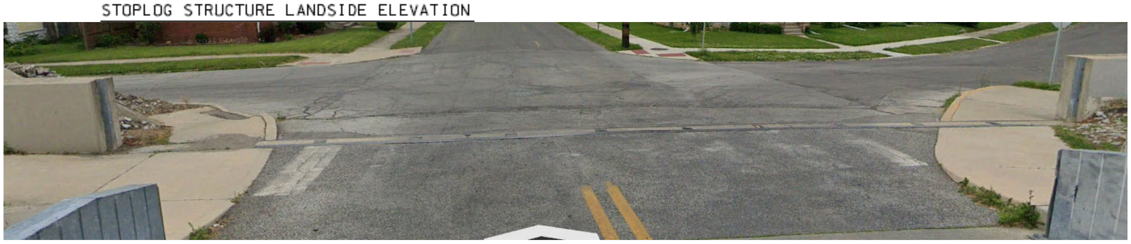
| Canal retaining/floodwalls | | | | | |
|---|---|---|---|---|---|
| S Lakewood Floodwall | 393.2153 | 574 | **6** | 2359.3 | |
| Fox Creek Floodwall | 4222.591 | 574-577 | **6** | 25335.5 | |
| Harbor Island St Floodwalls | 3304.753 | 577 | 3 | 9914.3 | |
| Klenk St Floodwalls | 2182.93 | 577 | 3 | 6548.8 | |
| Riverside Blvd Canal Walls | 1055.469 | 574-577 | **6** | 6332.8 | |
| Fox Creek Floodwall - NorthWest | 3668.19 | 577 | 3 | 11004.6 | |
| | 14,827 | | | 61495.3 | 4.1 feet |
| | | | Use | | 4 for calcs |

Stop log structure show below as example (Fort Wayne, Indiana)



STOPLOG STRUCTURE LANDSIDE ELEVATION


Example of stop logs being placed (Lawton Park, Fort Wayne, Indiana)



View of stop log location without panels (Tecumseh Street, Fort Wayne, Indiana)

| | PROJECT TITLE: | | |
|---|---|---|---|
| US Army Corps of Engineers® Detroit District | **Lake St Clair Flood Study, Jefferson=Chalmers Neighborhood Detroit, Michigan** | **Prepared by:** | **DATE:** |
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| | | **Corrected/Updated by:** | |
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| | **Alternative 3, Quantity Take Off** | **CHECKED BY:** | |
| | **Page 1 of 4** | Julie Udell | 3/10/2022 |

**ALTERNATIVE 3 : Closed Canal, levees & floodwalls WITHIN wave run up zone**

**Description:**

| | | | | |
|---|---|---|---|---|
| Total levee | 2628 | LF | | |
| Total Upland Floodwa | 560 | LF | | |
| Total Canal Closures | 288 | LF | | |
| Total Upland Stop Log | 117 | LF | | |
| Total Canal Floodwall | 1836 | LF | | |
| Total Length: | 5429 | LF | 1.0282 | miles |

**Levee Assumptions:**

| | | | |
|---|---|---|---|
| Unit weight of clay: | 130 | pcf | Approx. value for in place compacted clay |
| Req. stillwater elev. | 580 | | FEMA 1% stillwater elevation +2 feet |
| Req. coastal elev. | 583 | | FEMA coastal elevation +1 foot |
| Levee Slope ratio | 1 | :3 | Typical slope for clay levee (steeper would make mowing difficult) |
| Unit weight of inspect | 125 | pcf | Approx. value for in place compacted soil. |
| Inspection trench dep | 6 | feet | Inspect for pipes, seal/ relocate/encase, backfill |
| Inspection trench wid | 3 | feet | Assume no seepage cutoff needed |

| **Levee** | | | | | Levee Construction | | | Inspection Trench |
|---|---|---|---|---|---|---|---|---|
| Section Name | Levee Length (ft) | Approx Ground Elev. | Levee Height (ft) | Levee Crest (ft) | Levee Width (ft) | Levee Volume (cf) | CY | Volume (CF) |
| Coastal Levee | 1866 | 577 | 6 | 10 | 46 | 313546 | 11613 | 33594 |
| Stillwater levee | 762 | 577 | 3 | 10 | 28 | 43434 | 1609 | 13716 |

| | | |
|---|---|---|
| TOTAL Levee Volume | 356980 CF | 47310 CF |
| **Total Levee Volume** | **13221 CY** | **1752 CY** |
| Total Weight | 46407397 lbs | 5913786 lbs |
| | **23204 tons** | **2957 tons** |

| US Army Corps of Engineers® Detroit District | PROJECT TITLE: | Prepared by: | | DATE: |
|---|---|---|---|---|
| | **Lake St Clair Flood Study, Jefferson=Chalmers Neighborhood Detroit, Michigan** | Marie Dock | | 8/18/2021 |
| | | **Corrected/Updated by:** | | |
| | COMPUTATION TITLE: | Tina Kowitz | | 2/28/2022 |
| | | **CHECKED BY:** | | |
| | **Alternative 3, Quantity Take Off** <br> **Page 2 of 4** | Julie Udell 3/10/2022 | | |

**Upland SSP Assumptions**

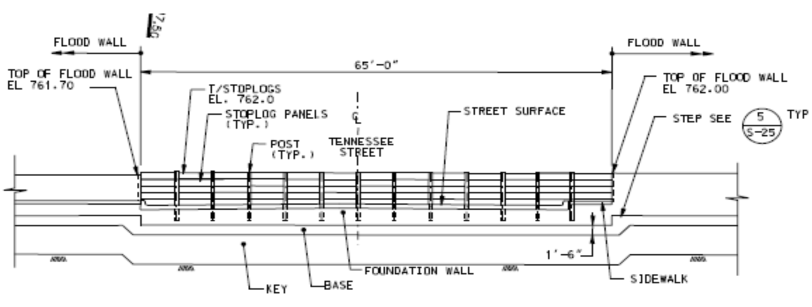
| | | | |
|---|---|---|---|
| Unit weight of steel sheet pile): | 22 | psf | Assumed PZ22 |
| SSP embedment ratio | 2 | :1 | |
| | | No concrete cap assumed at this time, but could be required | |
| Reqd height, stillwater | 580 | | FEMA 1% stillwater elevation +2 feet |

| Section Name | Length (ft) | Ground Elev. NAVD88 | Stick up height' (ft) | SSP Total Length | SSP Area (SF) | Weight (tons) |
|---|---|---|---|---|---|---|
| ~5' Clairpoint St floc | 560 | 575 | 5 | 15 | 8402 | 92 |
| | | | | Total: | **8402** | **92** |

**Stop Log Closure at Bayview Yacht Club**

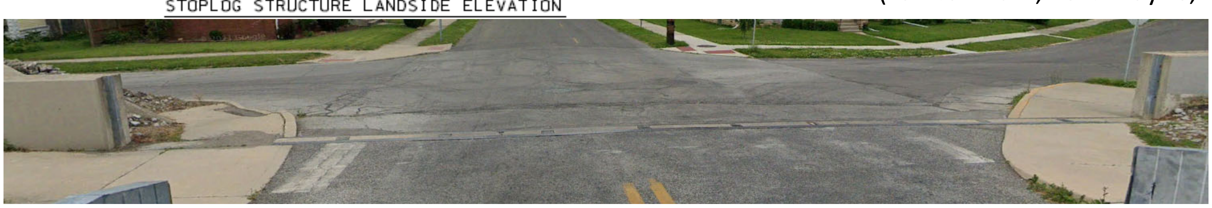
40 feet wide 5 feet high (measured from road surface)

Stop log structure show below as example (Fort Wayne, Indiana)




STOPLOG STRUCTURE LANDSIDE ELEVATION

Example of stop logs being placed (Lawton Park, Fort Wayne, Indiana)



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| | | Corrected/Updated by: | |
| | COMPUTATION TITLE: | Tina Kowitz | 2/28/2022 |
| | | CHECKED BY: | |
| | **Alternative 3, Quantity Take Off Page 3 of 4** | Julie Udell | 3/10/2022 |

ArcGIS export:

| Name | Feature | Length (ft) |
|---|---|---|
| Closure Structure No 1 - Fox Creek | Canal Closure | 79.57 |
| Mariner Park floodwall to El 583 | Canal Floodwall | 710.3 |
| Closure Structure No 2 - Philip St Canal | Canal Closure | 68.53 |
| Closure Structure No 3 - Lakewood Canal | Canal Closure | 139.9 |
| Lakewood East Park floodwall to El 583 | Canal Floodwall | 1125 |
| Alfred Brush Park Levee | Levee | 1866 |
| High Ground | High Ground | 3923 |
| Greyhaven West Levee | Levee | 762 |
| High ground | High Ground | 1046 |
| Clairpoint Ave Conner St. tie in | Upland Floodwall | 276.4 |
| Clairpoint Stoplog Closure | Upland Stop Log Closur | 116.9 |
| EXISTING Clairpoint St floodwall | Existing Floodwall | 1453 |
| Clairpoint Ave tie in to existing floodwall | Upland Floodwall | 283.8 |

| US Army Corps of Engineers® Detroit District | PROJECT TITLE: **Lake St Clair Flood Study, Jefferson=Chalmers Neighborhood Detroit, Michigan** COMPUTATION TITLE: **Alternative 3, Quantity Take Off** **Page 4 of 4** | **Prepared by:** | **DATE:** |
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| | | **Corrected/Updated by:** | |
| | | Tina Kowitz | 2/28/2022 |
| | | **CHECKED BY:** | |
| | | Julie Udell | 3/10/2022 |

Closure Structures

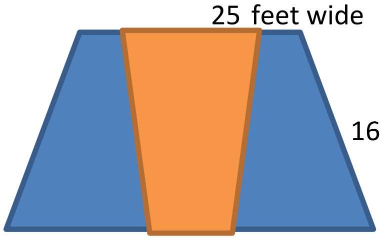
| | ~width (ft) | ~ Height (ft) | Option 1: Rock/Earth dam | | Option 2: Stop logs | Option 3: miter lock gates |
|---|---|---|---|---|---|---|
| CS No 1 - Fox Cre | 80 | 580 | 2702 | CY | 3 | 3 |
| CS No 2 - Philip S | 40 | 580 | 1351 | CY | 3 | 3 |
| Closure No 2 | 90 | 580 | 3040 | CY | 3 | 3 |

Description of Options:

Option 1: Quarry run stone/ earthen Dam: Construct permanent damming feature in canal to keep high Lake levels out of canal. Assume 25' at top, 2:1 slopes for 16'.

Assume:

25 feet wide



16 feet high

| | | |
|---|---|---|
| 25 | feet | at crest |
| 89 | feet | at base |
| 912 | square feet per ft canal width | |

**Note: Rough assumptions. Needs to be designed

Opt 2: Stop logs. Assume similar to Hero Canal In New Orleans.
Large stop logs placed to temporarily close canal during high lake levels.

WBV-09b Stoplog Structure on Hero Canal

Opt 3: Miter gates Assume 2 sets of miter gates needed to access during high lake levels, similar to Fox River Dams.


## FLOOD HAZARD INFORMATION

**SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT**

**THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT**

**HTTPS://MSC.FEMA.GOV**

| | |
|---|---|
| SPECIAL FLOOD HAZARD AREAS | Without Base Flood Elevation (BFE) *Zone A,V, A99* |
| | With BFE or Depth *Zone AE, AO, AH, VE, AR* |
| | Regulatory Floodway |
| OTHER AREAS OF FLOOD HAZARD | 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X* |
| | Future Conditions 1% Annual Chance Flood Hazard *Zone X* |
| | Area with Reduced Flood Risk due to Levee See Notes. *Zone X* |
| | Area with Flood Risk due to Levee *Zone D* |
| OTHER AREAS | NO SCREEN Areas of Minimal Flood Hazard *Zone X* |
| | Area of Undetermined Flood Hazard *Zone D* |
| GENERAL STRUCTURES | Channel, Culvert, or Storm Sewer |
| | Levee, Dike, or Floodwall |
| | E 18.2 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation |
| | 8 Coastal Transect |
| | Coastal Transect Baseline |
| | Profile Baseline |
| | Hydrographic Feature |
| | 513 Base Flood Elevation Line (BFE) |
| OTHER FEATURES | Limit of Study |
| | Jurisdiction Boundary |

## NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Base map information shown on this FIRM was provided in digital format by the United States Department of Agriculture Farm Service Agency (USDA-FSA). This information was derived from digital orthophotography at a 1-meter resolution from photography dated 2012.

ACCREDITED LEVEE: Check with your local community to obtain more information, such as the estimated level of protection provided (which may exceed the 1-percent-annual-chance level) and Emergency Action Plan, on the levee system(s) shown as providing protection for areas on this panel. To mitigate flood risk in residual risk areas, property owners and residents are encouraged to consider flood insurance and floodproofing or other protective measures. For more information on flood insurance, interested parties should visit https://www.fema.gov/national-flood-insurance-program.

## SCALE

N

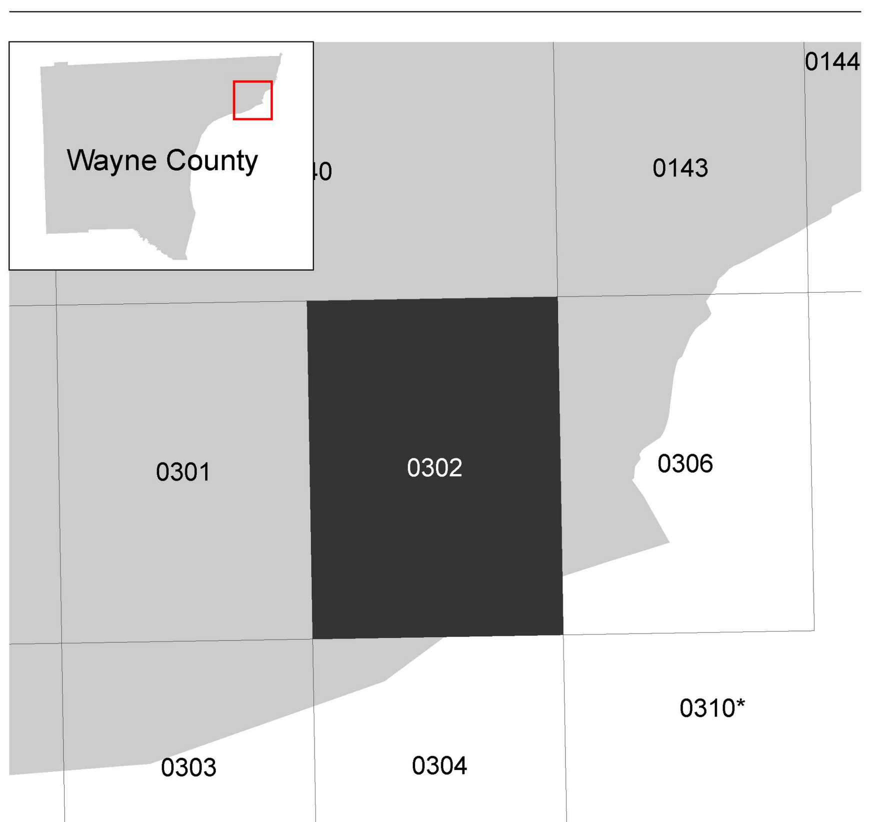
Map Projection:
NAD 1983 StatePlane Michigan South FIPS 2113 Feet; Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 500 feet 1:6,000

0 500 1,000 2,000 Feet

0 125 250 500 Meters

## PANEL LOCATOR




* PANEL NOT PRINTED

FEMA

National Flood Insurance Program

**NATIONAL FLOOD INSURANCE PROGRAM**

**FLOOD INSURANCE RATE MAP**

**WAYNE COUNTY, MICHIGAN**
(All Jurisdictions)

PANEL **302** OF **575**

FEMA

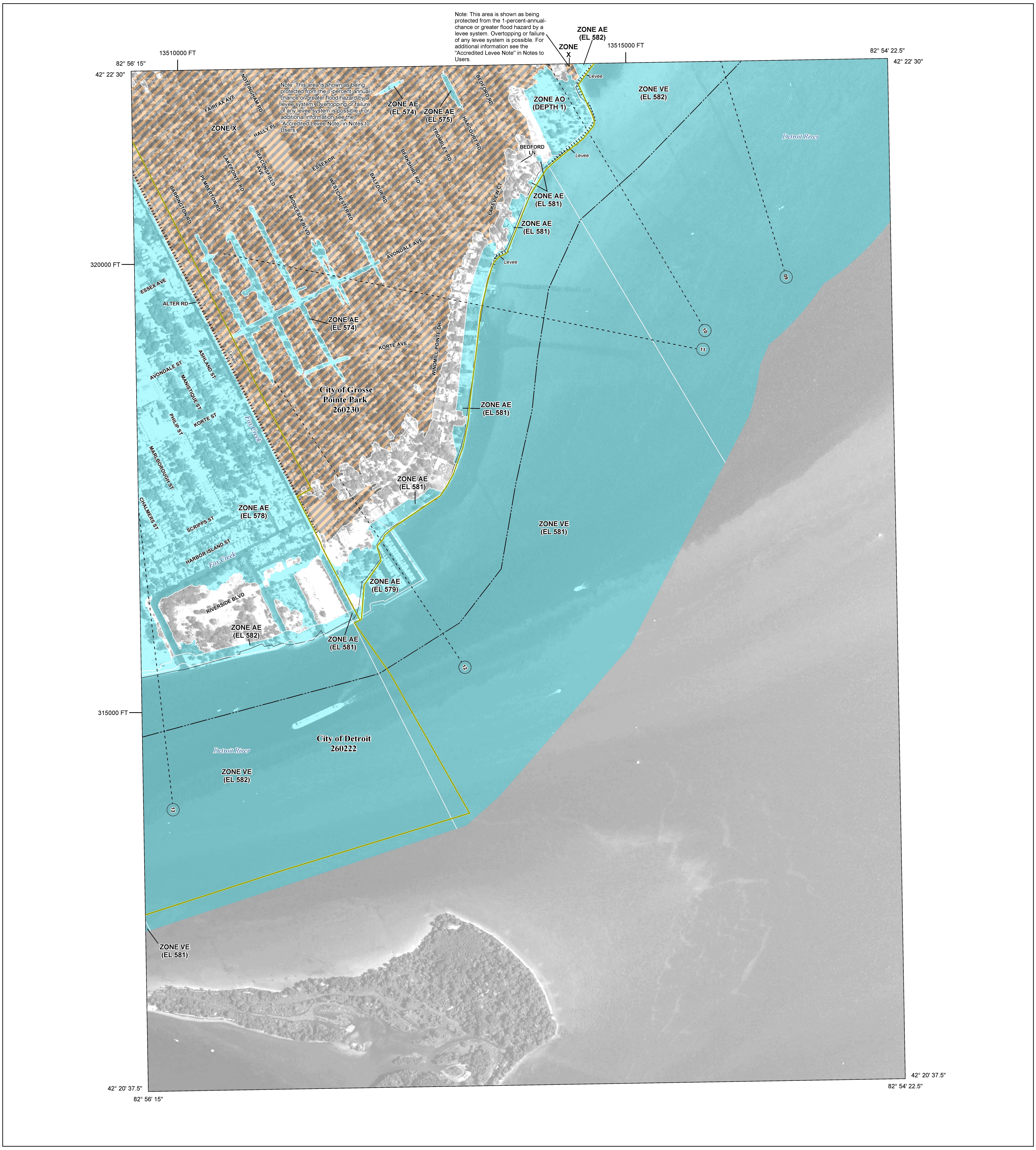
Panel Contains:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| DETROIT, CITY OF | 260222 | 0302 | F |
| GROSSE POINTE PARK, CITY OF | 260230 | 0302 | F |

VERSION NUMBER
**2.4.3.5**

MAP NUMBER
**26163C0302F**

MAP REVISED
**OCTOBER 21, 2021**




## FLOOD HAZARD INFORMATION

**SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT**

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**HTTPS://MSC.FEMA.GOV**

| | |
|---|---|
| SPECIAL FLOOD HAZARD AREAS | Without Base Flood Elevation (BFE) *Zone A,V, A99* |
| | With BFE or Depth *Zone AE, AO, AH, VE, AR* |
| | Regulatory Floodway |
| OTHER AREAS OF FLOOD HAZARD | 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X* |
| | Future Conditions 1% Annual Chance Flood Hazard *Zone X* |
| | Area with Reduced Flood Risk due to Levee See Notes. *Zone X* |
| | Area with Flood Risk due to Levee *Zone D* |
| OTHER AREAS | NO SCREEN Areas of Minimal Flood Hazard *Zone X* |
| | Area of Undetermined Flood Hazard *Zone D* |
| GENERAL STRUCTURES | Channel, Culvert, or Storm Sewer |
| | Levee, Dike, or Floodwall |
| OTHER FEATURES | E 18.2 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation |
| | 8 Coastal Transect |
| | Coastal Transect Baseline |
| | Profile Baseline |
| | Hydrographic Feature |
| | 513 Base Flood Elevation Line (BFE) |
| | Limit of Study |
| | Jurisdiction Boundary |

## NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Base map information shown on this FIRM was provided in digital format by the United States Department of Agriculture Farm Service Agency (USDA-FSA). This information was derived from digital orthophotography at a 1-meter resolution from photography dated 2012.

ACCREDITED LEVEE: Check with your local community to obtain more information, such as the estimated level of protection provided (which may exceed the 1-percent-annual-chance level) and Emergency Action Plan, on the levee system(s) shown as providing protection for areas on this panel. To mitigate flood risk in residual risk areas, property owners and residents are encouraged to consider flood insurance and floodproofing or other protective measures. For more information on flood insurance, interested parties should visit https://www.fema.gov/national-flood-insurance-program.

## SCALE

**Map Projection:**
NAD 1983 StatePlane Michigan South FIPS 2113 Feet; Western Hemisphere; Vertical Datum: NAVD 88

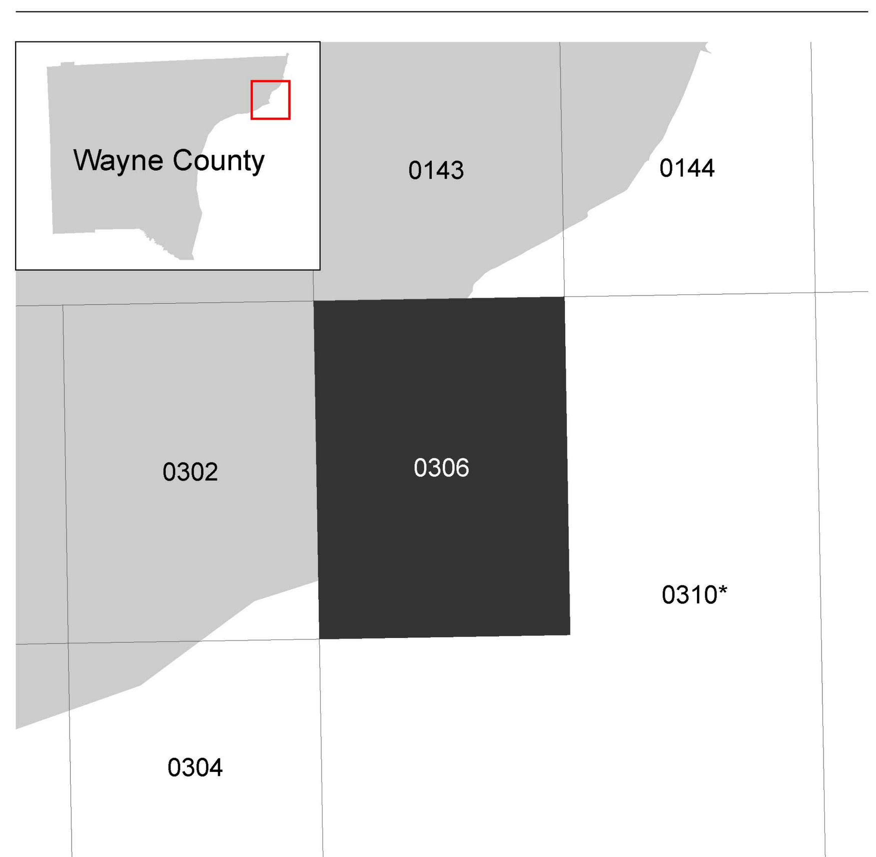
N

1 inch = 500 feet 1:6,000

0 500 1,000 2,000 Feet

0 120 240 480 Meters

## PANEL LOCATOR




* PANEL NOT PRINTED

FEMA

National Flood Insurance Program

**NATIONAL FLOOD INSURANCE PROGRAM**

**FLOOD INSURANCE RATE MAP**

**WAYNE COUNTY, MICHIGAN**
(All Jurisdictions)

PANEL 306 OF 575

Panel Contains:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| DETROIT, CITY OF | 260222 | 0306 | F |
| GROSSE POINTE PARK, CITY OF | 260230 | 0306 | F |

VERSION NUMBER
2.4.3.5

MAP NUMBER
26163C0306F

MAP REVISED
OCTOBER 21, 2021

# Guidance for Flood Risk Analysis and Mapping

## Levees

November 2019

Requirements for the Federal Emergency Management Agency (FEMA) Risk Mapping, Assessment, and Planning (Risk MAP) Program are specified separately by statute, regulation, or FEMA policy (primarily the Standards for Flood Risk Analysis and Mapping). This document provides guidance to support the requirements and recommends approaches for effective and efficient implementation. The guidance, context, and other information in this document is not required unless it is codified separately in the aforementioned statute, regulation, or policy. Alternate approaches that comply with all requirements are acceptable.

For more information, please visit the FEMA Guidelines and Standards for Flood Risk Analysis and Mapping webpage (www.fema.gov/guidelines-and-standards-flood-risk-analysis-and-mapping), which presents the policy, related guidance, technical references, and other information about the guidelines and standards development process.

# Table of Revisions

The following summary of changes details revisions to this document subsequent to its most recent version in February 2019.

| Affected Section or Subsection | Date | Description |
|---|---|---|
| Section 1 and all subsections | November 2019 | Corrected minor typos and alignment of wording. |
| Section 2 | November 2019 | Corrected minor typos and alignment of wording. Removed list of acronyms. |
| Section 3 and all subsections | November 2019 | Corrected minor typos and alignment of wording. |
| Section 4 and all subsections | November 2019 | Corrected minor typos and alignment of wording. |
| Section 5 and all subsections | November 2019 | Corrected minor typos and alignment of wording. |
| Section 6 and all subsections | November 2019 | Corrected minor typos and alignment of wording. |
| Section 7 and all subsections | November 2019 | Corrected minor typos and alignment of wording. |
| Section 8 and all subsections | November 2019 | Corrected minor typos and alignment of wording. |

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## List of Tables

## 1.0 Levees Overview

This consolidated guidance document was prepared for FEMA, as part of the Risk MAP program, to promote sound and consistent implementation of levee-related National Flood Insurance Program (NFIP) regulations and mapping program standards that apply to levees.

This guidance document is intended to provide current information on the mapping of levees and associated flood hazards. This document captures current standards and practices and, therefore, does not address all topics related to the identification of flood hazards and risks associated with levees.

Federal, State, and local officials have often considered levee systems an effective structural approach for reducing average annual flood losses. However, it is an approach that needs to be considered cautiously. Carefully engineered and well-maintained levees should divert floodflows as intended in their design and keep the areas landward of the levees dry if their structural integrity is not compromised, all elements of the system are functional, and the floodwaters do not overtop the structure. However, a primary drawback is that levees could lead to increased development of areas landward of the levees over time and thereby increase the exposure to catastrophic failures during extreme events (A Levee Policy for the National Flood Insurance Program, National Academy Press, 1982).

When it comes to working with communities on levee-related mapping projects or issues, FEMA shares a mission with its State agency partners, the U.S. Army Corps of Engineers (USACE), and other Federal agencies. That mission entails helping levee owners, flood control districts, community officials, floodplain managers, the media, and other stakeholders understand and properly communicate the risks associated with living and working landward of levees. Living with levees is a shared responsibility and local community officials should remain engaged in flood risk management activities. It is important for all stakeholders to know the risk; their role in helping to reduce that risk; and what specific actions they can take, including the purchase of flood insurance to further reduce the financial risk associated with living and working in levee-impacted areas. For more information, visit the Living with Levees: It's a Shared Responsibility portion of the FEMA website (www.fema.gov/living-levees-its-shared-responsibility).

The primary audiences for this guidance document are communities, regional entities, Tribal entities, and State agencies, including those participating in the Cooperating Technical Partners program (CTPs), FEMA Project Teams that are formed to carry out projects in support of the FEMA Regional Offices, and FEMA Regional Office and Headquarters staff. The FEMA Project Teams often include representatives of the FEMA Risk MAP providers. This guidance document is also intended for communities and local stakeholders involved in levee accreditation and the implementation of FEMA non-accredited levee analysis and mapping procedures.

The levee guidance in this document emphasizes the Risk MAP program vision of collaborating with local, regional, State, and Tribal entities throughout a watershed to deliver quality data that increases public awareness and leads to mitigation actions that reduce flood risk to life and property. To achieve this vision, FEMA transformed its historic documents for flood hazard identification and mapping efforts into a more integrated process of identifying, assessing, communicating, planning, and mitigating flood-related risks aligned with the Risk MAP vision[1].

To accomplish this process, the appropriate analyses, mapping, and communication of risk of levee systems is necessary throughout the Risk MAP project lifecycle. FEMA has prepared this consolidated guidance in keeping with that responsibility.

## 1.1 Prior Guidance Documents

The consolidation of work that guided users through decades of levee-related procedures implemented during flood hazard mapping projects were incorporated into this guidance document. This is intended to promote sound and consistent implementation of policies, regulations, and standards for levee risk evaluation. This guidance enhances compliance with the Code of Federal Regulations; incorporates portions of Analysis and Mapping Procedures for Non-Accredited Levee Systems New Approach, (July 2013); and FEMA standards to facilitate implementation during flood hazard mapping projects. This guidance document has been prepared to expand on, and supersede, guidance provided in FEMA Operating Guidance (OG) 12-13; Procedure Memorandum (PM) Nos. 34, 43, 45, 51, 52, 53, and 63; and Appendix H of Guidelines and Specifications for Flood Hazard Mapping Partners. More details for each superseded guidance document are provided in each chapter of this document.

This guidance document does not supersede the following existing FEMA guidance documents:

- Analysis and Mapping Procedures for Non-Accredited Levee Systems New Approach, dated July 2013.
- Guidance Document No. 29, Guidance for Flood Risk Analysis and Mapping: Levee Seclusion, dated November 2014.
- Guidance Document No. 34, Guidance for Flood Risk Analysis and Mapping: Zone A99 and Zone AR Determinations, dated May 2015.
- Guidance Document No. 72, Guidance for Flood Risk Analysis and Mapping: Levee-Specific Non-Regulatory Flood Risk Datasets, dated May 2016.

These and additional mapping guidance and best practices can be accessed through the FEMA Guidelines and Standards for Flood Risk Analysis and Mapping webpage.

## 1.2 Flood Hazard Mapping and Levees

FEMA does not design, build, inspect, operate, maintain, or certify levees. However, as administrator of the NFIP, FEMA is responsible for accurately identifying flood hazards and communicating those hazards and risks to affected stakeholders.

Conditions in a community or watershed change over time; therefore, the need to update flood hazard information reflected on Flood Insurance Rate Maps (FIRMs) is assessed periodically to better reflect the current flood risk to people and property. FEMA updates FIRMs nationwide through the Risk MAP program. FEMA shows levee systems on the FIRM as being accredited,

[1] For more information on the Risk MAP program, see https://www.fema.gov/risk-mapping-assessment-and-planning-risk-map.

provisionally accredited, non-accredited, or in the process of being restored or constructed. FEMA designates the areas landward of the levees as Zone A, Zone AE, Zone AR, Zone A99, Zone D, Zone X (shaded), or Zone X depending on the status of the levee systems and the type of study performed. With new or updated FIRMs, community officials will have information to help them advise where and how to build more safely, and the public will understand their risk, allowing more informed decisions about reducing the risk to families, homes, and businesses.

Levees add complexity to an ongoing flood hazard study. To address the complexities that levees introduce, a FEMA Project Team should consider the presence of levees and appropriate mapping procedures as early in the study process as possible. Early consideration will help ensure that appropriate data collection and coordination occur. Subsections 1.2.1 through 1.2 5 briefly introduce the possible mapping options for levees.

### 1.2.1 Accredited Levee System

An accredited levee system is a system that FEMA has determined meets requirements of the NFIP regulations as cited in the Code of Federal Regulations (CFR) at Title 44, Chapter 1, Section 65.10 (44 CFR 65.10) and that FEMA has recognized on a FIRM as reducing the flood hazards posed by a base (1-percent-annual-chance) flood. This determination is based on a submittal, by or on behalf of a community, which includes 44 CFR 65.10–compliant design data and documentation, certified by a registered Professional Engineer (P.E.), and operations and maintenance documentation under the appropriate jurisdiction. FEMA strongly encourages flood insurance for all insurable structures in floodplains, including those in areas landward of levees.

FEMA accreditation of a levee system does not guarantee that the levee will provide flood hazard reduction to properties from flooding; therefore, FEMA has included a note on related FIRM panels that overtopping, or failure of an accredited levee system is possible. To mitigate flood risk in residual risk areas, property owners and residents are encouraged to consider flood insurance and floodproofing or other protective measures. Chapter 4 of this document provides detailed information on the mapping of accredited levee systems.

### 1.2.2 Provisionally Accredited Levee System

When the area impacted by an accredited levee system shown on an effective FIRM is in the process of being remapped, FEMA may ask the levee owner or community to provide data and documentation demonstrating the levee system still meets the requirements set forth in 44 CFR 65.10. To assist levee owners and communities, FEMA established the Provisionally Accredited Levee (PAL) designation as an option for mapping the area while providing levee owners or communities more time to gather the required data and documentation. The levee owner signs and submits an agreement to FEMA indicating the data and documentation required for compliance with 44 CFR 65.10 will be provided within 24 months of the 91st day following the date of the initial FEMA notification letter. FEMA places a note on the impacted FIRM panel(s) landward of the levee system to indicate FEMA has provisionally accredited the levee system and the designation of any existing Zone X (shaded) areas of flood hazard reduction due to levees is provisional. Chapter 5 of this document provides detailed information on the mapping of PALs.

### 1.2.3 Non-Accredited Levee System

Non-accredited levee systems are levee systems that do not meet the NFIP regulatory requirements of 44 CFR 65.10 and that are not shown on a FIRM as reducing the base flood hazard. FEMA recognizes that non-accredited levee systems do impact flood risk; for that reason, FEMA has developed analysis and mapping procedures for non-accredited levees that provide a suite of approaches for analyzing flood hazards landward of levee systems. Chapter 6 of this document provides detailed information on the mapping of non-accredited levee systems.

### 1.2.4 Levees Undergoing Restoration (Zone AR) and Undergoing Construction (Zone A99)

The NFIP regulations contain two provisions that help ameliorate the flood insurance impact on property owners during the restoration of non-accredited levee systems or construction of new levee systems. These are based on provisions of the National Flood Insurance Act of 1968, as amended, as cited in the United States Code (U.S.C.) at 42 U.S.C. 4014 (e) and 42 U.S.C. 4014(f). These provisions are intended to provide reduced flood insurance premium rates for insurable structures landward of levee system projects designed and intended for eventual accreditation. Under these provisions, a levee system undergoing construction, or restoration, but that cannot currently meet 44 CFR 65.10 requirements, is recognized by FEMA as providing some (less than the base flood) level of hazard reduction.

FEMA issues Flood Protection Restoration determinations, regulated through 44 CFR 65.14, in areas where a project is sufficiently underway to restore a levee system to meet 44 CFR 65.10 accreditation requirements. FEMA maps the areas landward of the levee system that is being restored as Zone AR on the FIRM and may present Base Flood Elevations (BFEs) representing the current hazard as if the levee system was not in place. The Zone AR determination may provide property owners with reduced flood insurance premium rates lower than rates in other mapped Special Flood Hazard Areas (SFHAs).

FEMA issues adequate progress determinations, regulated through 44 CFR 61.12, in areas where FEMA determines that a community has made adequate progress on a levee system construction or reconstruction project designed for flood hazard reduction. FEMA maps the areas landward of the levee system as SFHAs designated Zone A99 on the FIRM. The Zone A99 determination also provides flood insurance premium rates and floodplain management requirements that are generally less than those required in other SFHAs. The Zone A99 designation is used in place of a shaded Zone X protected by levee designation for the landward area of the levee system. The horizontal extent of the Zone A99 would match the boundary extent of the potential area of reduced flood hazard that in the future would be adjusted to a shaded Zone X protected by levee designation.

Detailed information on Flood Protection Restoration and Adequate Progress determinations is provided in FEMA Guidance Document No. 34, <u>Guidance for Flood Risk Analysis and Mapping: Zone A99 and Zone AR Determinations</u>. Guidance Document No. 34 is accessible through the FEMA Guidelines and Standards for Flood Risk Analysis and Mapping webpage.

### 1.2.5 Levee Seclusion Mapping

In March 2011, FEMA committed to updating the way flood hazards for non-accredited levee systems were analyzed and mapped. As a result, some in-progress FIRM updates that included levee systems were delayed or otherwise impacted while FEMA developed the analysis and mapping approach for non-accredited levees. FEMA developed the levee seclusion mapping approach as a project management solution to allow the release of the FIRM updates for those portions of the community outside of the levee-impacted area. Through the levee seclusion mapping approach, FEMA maintains the flood hazard information as depicted on the current effective FIRM (the FIRM in effect before the in-progress update) with map notes explaining that the flood hazard information in these areas will be updated after FEMA applies an updated levee analysis and mapping approach. Levee seclusion was not intended to be a long-term mapping approach and was not anticipated to be implemented on any mapping projects initiated after July 2013. Detailed information on seclusion is provided in FEMA Guidance Document No. 29, Guidance for Flood Risk Analysis and Mapping: Levee Seclusion, which is accessible through the FEMA Guidelines and Standards for Flood Risk Analysis and Mapping webpage.

## 1.3 Summary of Recent Legislation and Recommendations

This section summarizes some recent legislation and recommendations related to managing and assessing levee systems.

### 1.3.1 Water Resources Development Act of 2007

Title IX of the Water Resources Development Act (WRDA) 2007, the National Levee Safety Act of 2007, as amended, includes activities incentivizing the creation of State and Tribal levee safety programs and increased public awareness of levee systems. Activities include, among other provisions, the development and maintenance of the National Levee Database (NLD); inventory and review levees; development of levee guidelines; and development of technical assistance and training materials. Recommendations leading up to this legislation can be found on the USACE website (www.usace.army.mil/National-Levee-Safety/).

### 1.3.2 Flood Protection Structure Accreditation Task Force

The USACE and FEMA formed the Flood Protection Structure Accreditation Task Force (Task Force) in accordance with Section 100226 of Public Law (P.L.) 112-141. The primary charge of the Task Force was to align agency processes, so information collected for either program can be used interchangeably and to align the information and data collected by USACE, so it is sufficient to satisfy NFIP accreditation requirements. The Task Force resulted in a list of recommendations and a formal memorandum of understanding signed by USACE and FEMA committing to establishing a coordinated approach for levee activities that is aligned with policies and goals of both agencies to promote life safety, flood risk reduction, risk communication, and sound national investments. The final Task Force report and memorandum of understanding can be found at https://www.usace.army.mil/Missions/Civil-Works/Levee-Safety-Program/Task-Force/.

### 1.3.3 National Academy of Science Recommendations

The National Research Council (NRC) document titled A Levee Policy for the National Flood Insurance Program, published in 1982, made recommendations to FEMA for a comprehensive levee policy for use in administering floodplain management, insurance, and hazard mapping aspects of the NFIP. The document addressed five areas that NRC deemed critical to a levee policy: (1) Minimum design standards; (2) Inspection and evaluation to be conducted by FEMA to assure conformance with minimum design standards at the time a levee is recognized in the program; (3) Requirements FEMA should place on communities with recognized levees; (4) Estimation of risk in areas landward of levees for use in setting insurance rates; and (5) Floodplain mapping of levee-impacted areas to portray SFHAs, degree of flood risk, and evacuation routes.

The National Academy of Sciences (NAS) document titled Levees and the National Flood Insurance Program, Improving Policies and Practices, published in 2013, examines the way levees are addressed in the NFIP and provides advice as to what actions might be taken to improve program efficiency and effectiveness. The NAS document includes 11 recommendations and 10 conclusions to improve the policies and practices related to levees and the NFIP. Additional information on the NAS document is accessible through the NAS website at https://nas-sites.org/levees/. While FEMA is making progress toward achieving some of the goals and objectives, this guidance document does not address the modern risk-informed analysis recommended in the NAS document.

## 1.4 Levee-Related Communication and Community Engagement

To appropriately analyze and map the flood hazards in levee-impacted areas, FEMA will coordinate with communities during the Discovery Phase of a Flood Risk project, and throughout the project lifecycle as necessary, to understand the location and impacts of levee systems. The current, effective FIRMs may inadvertently represent levee systems as providing flood hazard reduction or other impacts to the conveyance of floodwaters, and as such, may indicate a lesser flood hazard and corresponding risk than what may actually exist in these areas. Because communities and property owners may not be fully aware of the risk associated with levee systems, coordination with local stakeholders is essential to identify, analyze, and map the flood hazards associated with levee systems and to provide relevant information and tools to help them understand their flood risk and mitigation opportunities in these areas.

FEMA developed the Risk Communications and Risk MAP Playbook, also known as the Community Engagement and Risk Communication (CERC) Playbook, to focus on the value of outreach and community engagement in ensuring the successful delivery of the Risk MAP program goals and demonstrating how communication can facilitate an understanding of the value of mitigation and the importance of resilience. The Playbook provides guidance to FEMA, FEMA Risk MAP providers (primarily, the Production and Technical Services [PTS] and CERC providers), and CTPs on developing approaches that will ultimately motivate communities toward mitigation action throughout the Risk MAP lifecycle, including those communities impacted by levees.

Section 5 of the Playbook, “Risk Communication for Communities with Levees”, provides guidance on FEMA’s role regarding levees, how that role intersects with the roles of other agencies; and how to effectively communicate flood risk with respect to levees. The levee section of the Playbook includes information on the following topics:

- Levee Systems: Who Does What?
- What Is Risk Communication in Relation to Levees?

- Why and How Does FEMA Map Flood Hazards for Levee-Impacted Areas?
- Risk Messaging for Levees
- Developing your Community Engagement Plan
- Building Resiliency

Project Team members should refer to the CERC Playbook for additional information about stakeholder engagement and links to examples, tools, and templates. The CERC Playbook can be accessed through the password-protected Risk Management Directorate SharePoint Portal or by contacting the FEMA Project Officer.

This guidance document focuses on mapping guidance and therefore does not cover risk communication in detail, although these are important portions of the flood hazard mapping project lifecycle.

## 1.5 Chapter Overviews

Primary topics covered by this guidance document include the collection and management of levee data; procedures for addressing accreditation, PALs, and non-accredited levees; addressing the topic of evaluating and mapping flood hazards landward of non-levee features; and coordination with USACE and other Federal agencies. Additional summary information for each chapter is provided in Subsections 1.5.1 through 1.5.8

### 1.5.1 Chapter 2, Glossary of Levee Terms

The glossary in Chapter 2 contains levee terminology to be used throughout this guidance document.

### 1.5.2 Chapter 3, Levee Data Inventory

Chapter 3 provides an overview and brief history of FEMA historic levee inventory systems. The chapter introduces FEMA's overall mission with early identification of levees, levee data tracking, inventory, mapping, and coordination/cooperation with USACE in the direction toward a unified national levee database. Chapter 3 provides guidance for populating and maintaining the FEMA accreditation status tracking system, the NLD, and National Flood Hazard Layer (NFHL).

### 1.5.3 Chapter 4, Accredited Levee Systems

Chapter 4 provides focused guidance on levee accreditation, leveraging the requirements in 44 CFR 65.10 and the transformation of PM 45, Revisions to Accredited Levee and Provisionally Accredited Levee Notation, issued on May 12, 2008; and PM 63, Guidance for Reviewing Levee Accreditation Submittals, issued on September 2, 2010. In addition to the transformed guidance, Chapter 4 includes clarifications and best practices that have been collected since the implementation of PMs 45 and 63.

### 1.5.4 Chapter 5, Provisionally Accredited Levees

Chapter 5 provides guidance to Project Team members (FEMA, FEMA Risk MAP providers, CTPs, and CTP subcontractors) on implementing the PAL process. This chapter is a transformation and revision of PM 43, Guidelines for Identifying Provisionally Accredited Levees, issued on September 25, 2006; PM 45, Revisions to Accredited Levee and Provisionally

Accredited Levee Notation, issued on May 12, 2008; and PM 53, Guidelines for Notification and Mapping of Expiring Provisionally Accredited Levee Designations, issued on April 24, 2009.

### 1.5.5 Chapter 6, Non-Accredited Levees

Chapter 6 provides guidance to FEMA Regional Office staff, FEMA Risk MAP providers, CTPs, and CTP subcontractors involved in performing flood hazard mapping projects where non-accredited levee systems have been identified. This chapter follows the levee analysis and mapping procedures described in OG 12-13, Non-Accredited Levee Analysis and Mapping Guidance, dated September 2013.

### 1.5.6 Chapter 7, Non-Levee Features

Chapter 7 recommends actions that would help ensure adequate identification, analysis, and mapping of potential flood hazards around non-levee features. This chapter is a transformation and revision of PM 51, Guidance for Mapping of Non-Levee Embankments Previously Identified as Accredited, issued on February 27, 2009.

### 1.5.7 Chapter 8, FEMA and Other Federal Agency Coordination

Chapter 8 provides guidance to FEMA Regional Office staff, Risk MAP providers, and CTPs performing flood hazard mapping projects where other Federal agencies may have a role. These potential roles could include policy development, actual mapping actions, and accreditation efforts involving levees. In addition, mitigation and outreach activities may involve other Federal agencies.

## 2.0 Glossary

Key levee terms used throughout this guidance document. are defined in Table 1.

**Table 1: Levee Terms**

| Levee Term | Description |
|---|---|
| Accredited Levee System | A levee system shown on a FIRM that is recognized as reducing the flood hazards posed by a base flood. This determination is based on the submittal of data and documentation as required by 44 CFR 65.10. The area landward of an accredited levee system is shown as Zone X (shaded) on the FIRM except for areas of residual flooding, such as ponding areas, which are shown as SFHA. |
| Berms | Horizontal strips or shelves of material built contiguous to the base of either side of levee embankments for the purpose of providing risk reduction from underseepage or erosion or increasing the stability of the slopes of the earthen embankment. |
| Certification | As stated in 44 CFR 65.2(b), certification of analyses is a statement that the analyses have been performed correctly and in accordance with sound engineering practices. Certification of structural works is a statement that works are designed in accordance with sound engineering practices to provide risk reduction from the base flood. Certification of "as built" conditions is a statement that the structure(s) has been built according to the plans being certified is in place and is fully functioning. Certification documentation is the responsibility of the local project sponsor. |
| Closure Devices | Any movable and essentially watertight barriers, used during flood periods to close openings in levee systems, securing but not increasing the levee systems' design level of risk reduction. Must be structural parts of the system during operation and designed according to sound engineering practice. |
| Erosion | The wearing away of land masses through gradual natural processes or catastrophic events. |
| Flood Risk | The risk of flooding in a leveed area that remains at any point in time after accounting for the flood risk reduction contributed by the levee system. Risk is a measure of the probability and severity of undesirable consequences. Flood risk is comprised of three parts: (1) the likelihood of occurrence of an event (e.g., flood, earthquake, etc.), (2) the likelihood associated with the performance of the levee system (e.g., levee breach, closure malfunction, overtopping, etc.), and (3) the magnitude of the consequences resulting from inundation of the levee impacted |

| Levee Term | Description |
|---|---|
| | area during that event (e.g., life loss, economic damages, environmental damages, etc.). |
| Floodwall | A designed structural wall constructed adjacent to shorelines for the purpose of reducing flooding of property on the landward side of the wall. Floodwalls are normally constructed in lieu of or to supplement levees where the land required for levee construction is too expensive or not available. |
| Freeboard | A factor of safety usually expressed in feet above a flood level for purposes of floodplain management. "Freeboard'' tends to compensate for the many unknown factors that could contribute to flood heights greater than the height calculated for a selected size flood and floodway conditions, such as wave action, bridge openings, and the hydrological effect of urbanization of the watershed. At times, overbuild to account for long-term settlement and incrementing the height to ensure maintenance access during flood events is referred to as freeboard as well. For levees and purposes of the NFIP, this is the vertical distance between the top of a levee and the water level that can be expected during the base flood. |
| Freeboard Deficient Procedure | Non-accredited levee analysis and mapping procedure that is applicable if the freeboard requirement is not met, but the top of levee is above the base flood. A Freeboard Deficient levee reach must meet the structural requirements of 44 CFR 65.10 and have documented operation, maintenance, and emergency preparedness plans. Freeboard Deficient Levee reaches differ from an accredited levee system because they are part of a levee system that as a whole cannot meet accreditation requirements and because they cannot meet the regulatory freeboard standard. |
| Gravity outlets | Culverts, conduits, or other similar conveyance openings through embankments or floodwalls that permit discharge of interior floodwaters by gravity when the outlets are above exterior water levels. Gravity outlets are equipped with gates to prevent flows from entering the levee impacted area during time of high exterior stages. |
| Hazard | An event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business, and other types of loss or harm. |
| Hydraulic Analysis | An engineering analysis of a flooding source carried out to determine how flood waters will move within the system in response to differing discharge quantities. |

| Levee Term | Description |
|---|---|
| Hydraulic Independence | Two levees or levee reaches are considered hydraulically independent when their level of flood hazard reduction functions independently from the other; their corresponding levee impacted areas are not identical; and if one breaches or overtops, the structural integrity of the other levee/levee reach is not adversely impacted. |
| Hydraulically Insignificant | For mapping purposes, a structure is considered hydraulically insignificant if, during a 1-percent–annual-chance flood event, the peak water-surface elevations landward of the structure may be the same regardless of whether the structure was in place. |
| Inspection | A visual assessment of physical features of a levee system to determine the general condition and operability of the levee. This may include operation and mechanical features such as pumps or gates. |
| Interior Drainage | Natural or modified removal of runoff within an area landward of a levee. |
| Interior Drainage Systems | Systems associated with levee systems that usually include storage areas, gravity outlets, pumping stations, or a combination thereof to control interior drainage. |
| Levee | Per 44 CFR 59.1, a manmade structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water to reduce flood hazards posed by temporary flooding. |
| Leveed Area | A spatial feature in the National Levee Database defined by the lands from which floodwater is excluded by the levee system. |
| Levee Breach | A rupture, break, or gap in a levee system that causes flooding in the area landward of the levee system and may be due to overtopping or levee feature failure. |
| Levee Feature | A structure that is critical to the functioning of a levee system, including: (A) an embankment section; (B) a floodwall section; (C) a closure structure; (D) a pumping station; (E) an interior drainage work; and (F) a flood damage reduction channel. |
| Levee Impacted Area (*for base flood*) | 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 Term | Description |
|---|---|
| Levee Owner | A federal or state agency, a water management or flood control district, a local community, a levee district, a nonpublic organization, or an individual considered the proprietor of a levee. The levee owner is responsible for administering the operations, maintenance, and emergency preparedness plans for the levee system. Often referred to as levee sponsor. |
| Levee Reach | A levee reach is a portion of a levee system (usually a length of a levee) that may be considered for analysis purposes to have approximately uniform representative properties. A levee reach is a unique component having properties different than other reaches of the levee system and may be used to evaluate the performance of a portion of the levee system. No minimum or maximum length is associated with a reach. Any continuous section of a levee to which a single analysis and mapping procedure may be considered as a reach. |
| Levee Segment | A discrete portion of a levee system that is operated and maintained by a single entity. A levee segment can be comprised of a single levee reach or multiple reaches. A levee segment may comprise one or more levee feature. |
| Levee System | A flood hazard-reduction system that consists of one or more levee segments/reaches 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 levee impacted area, and which are constructed and operated in accordance with sound engineering practices. |
| Line of Flood Hazard Reduction | The centerline of the levee segments/reaches which exclude floodwaters from the base flood event from the levee impacted area. |
| Local Levee Partnership Team (LLPT) | A workgroup that is facilitated by FEMA 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. |

| Levee Term | Description |
|---|---|
| National Levee Database (NLD) | The NLD, developed by the USACE in cooperation with FEMA, is a dynamic, searchable inventory of information for all levee systems in the nation. The database contains information to facilitate and link activities, such as flood risk communication, levee system evaluation for the NFIP, levee system inspections, floodplain management, and risk assessments. The NLD continues to be a dynamic database with ongoing efforts to add levee data from federal agencies, states and tribes. |
| Natural Valley Procedure | Non-accredited levee procedure that can be applied to all non-accredited levee reaches. The Natural Valley Procedure is used in two ways: first landward of the entire levee system to determine the outer limits of any levee impacted Zone D areas, and second as a potential procedure applied to individual levee reaches to determine the SFHA on the landward side of the levee reach. Several factors are considered when determining whether to use the Natural Valley Procedure to determine the SFHA:<br>• The levee reach does not significantly obstruct the flow of water;<br>Data necessary for more complex methods is not and will not be available in the near term; or<br>• The community (or tribal entity, when appropriate) provides feedback that it is the acceptable procedure to use.<br>For riverine levee systems, the Natural Valley Procedure reflects the levee geometry in the hydraulic model but allows water to flow on either side of the levee. For coastal levee systems, the Natural Valley Procedure reflects the levee geometry, and consideration is given as to how the levee system impacts wave propagation. |
| Non-Accredited Levee System | A levee system that does not meet the requirements in the NFIP regulations 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 the base flood hazards. |
| Non-levee Feature | A physical feature that is not designed, constructed, operated, or maintained as a flood control structure, but may inadvertently confine flow during some flood events. |

| Levee Term | Description |
|---|---|
| Non-levee Reach | A form of manmade high ground which a levee system or segment/reach ties into, whose existence and performance is necessary for excluding floodwaters from the levee impacted area. |
| Overtopping | A condition that occurs when water levels, including any wave or run-up factors, exceed the top elevation of a levee system and flow into areas landward of the levee system. Levee system may be damaged and/or compromised. |
| Overtopping Procedure | Non-accredited levee procedure is applicable when the base flood is above the levee crest for a reach, and the community or levee owner has provided appropriate technical justification that the base flood event will not cause a levee breach. In addition to the structural standards established in 44 CFR 65.10, it is expected that more detailed structural analysis will be required to justify that the levee system can sustain the base flood. As with a Sound Reach and Freeboard Deficient levee reach, an operations and maintenance plan and documentation of inspection are required. |
| Piping | The result of water seepage that progressively erodes and washes away soil particles, leaving large voids in the soil. Removal of soil through sand boils by piping or internal erosion damages levees, their foundations, or both, which may result in settlement and has the potential to cause catastrophic failures of levees. |
| Ponding | The result of runoff or flows collecting in a depression that may have no outlet, subterranean outlets, rim outlets, or manmade outlets such as culverts or pumping stations. Impoundments landward of manmade obstructions are included in this type of shallow flooding as long as they are not backwater from a defined channel or do not exceed 3.0 feet in depth. |
| Provisionally Accredited Levee (PAL) | A designation for a levee system that FEMA has previously accredited with reducing the flood hazards associated with a base flood on an effective FIRM, and for which FEMA is awaiting data and/or documentation that will demonstrate the levee system's compliance with the NFIP regulatory criteria of 44 CFR 65.10. |
| Pumping Stations | Pumps located at or near the levee system to discharge interior drainage over or through the levees or floodwalls (or through pressure lines) when free outflow through gravity outlets is prevented by high exterior stages. |

| Levee Term | Description |
|---|---|
| Rehabilitation | The term rehabilitation means the repair, replacement, reconstruction, or reconfiguration of a levee system, including a setback levee. |
| Residual Risk (or Flood risk) | The flood risk (probability of capacity exceedance or failure and the associated consequences) that remains after the flood risk management measure is implemented. |
| Ring Levees | Levees that completely encircle or “ring” an area subject to inundation from all directions. |
| Risk Assessment | A systematic, evidence-based approach for quantifying and describing the nature, likelihood, and magnitude of risk. |
| Setback Levees | Levees that are built landward of existing levees, usually because the existing levees have suffered distress or are in some way being endangered, as by river migration. |
| Shallow Flooding | Flat areas where a lack of channels prevents water from draining away easily. Shallow flood types fall into three categories: sheet flow, ponding, and urban drainage. For the purposes of the NFIP, shallow flooding is distinguishable from riverine or coastal flooding because it generally occurs in an area where there is no channel or identifiable flow path. |
| Sound Reach Procedure | A reach that has been designed, constructed, and maintained to withstand the flood hazards posed by a base flood, in accordance with the standards in 44 CFR 65.10 of the NFIP regulations, but is part of a system that cannot be accredited. |
| Structural-Based Inundation Procedure | Non-accredited levee analysis and mapping procedure applicable to some levee systems having reaches with either structural deficiencies that are known or structural integrity that is unknown (a common occurrence for older levee systems). For these levee reaches, FEMA will rely on modeling of breaches along the levee reach. It is not possible to predict the exact location of a levee breach. This procedure, therefore, does not predict the probability of failure at any breach location, nor does it provide a specific determination or evaluation of the overall levee system performance or require a determination of the likely failure mechanism. The procedure instead results in the development of a levee reach-specific SFHA that might occur as a result of potential breaches along a particular levee reach during the base flood. To determine this SFHA, possible locations of system breaches, geometry, and failure duration will be considered. |

| Levee Term | Description |
|---|---|
| Zone A99 | As defined in 44 CFR 61.12, areas subject to inundation by the base flood event, but which will ultimately be accredited upon completion of an under-construction levee system. These are areas of special flood hazard where enough progress has been made on the construction of a levee system, such as dikes, dams, and levees, to consider it complete for insurance rating purposes. Zone A99 may only be used when the levee system has reached specified statutory progress toward completion. No BFEs or depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply. |
| Zone AR | As defined in 44 CFR 61.12, areas that result from the new non-accredited status of a previously accredited levee system that is determined to be in the process of being restored to provide base flood risk reduction. Mandatory flood insurance purchase requirements and floodplain management standards apply. |
| Zone D | An area of possible, but undetermined flood hazard. When analyzing and mapping areas landward of non-accredited levee systems, a Zone D may represent areas landward of a non-accredited levee, within the natural valley footprint, that are not depicted as SFHA resulting from freeboard deficient, sound reach, overtopping, and/or structural-based inundation procedures. The Zone D designation is used for non-accredited systems instead of the Zone X (shaded) designation because the flood hazard potential is more uncertain and possibly greater. |

# 3.0 Levee Data Inventory

The construction of flood hazard-reduction structures, such as levees and floodwalls, has had a significant effect on flood-prone areas throughout the United States. These structures are of particular importance in identifying flood hazards and risks to lives and property. As such, FEMA and USACE share a common interest in managing and administering levee information and data throughout the Nation. This chapter provides background on previous FEMA levee inventory systems; introduces FEMA's overall mission with regard to identification of levees, levee data tracking, inventory, mapping, and coordination/cooperation with USACE on the development of a unified national levee database; and provides guidance for populating and maintaining the FEMA accreditation status tracking system, NLD, and NFHL database.

## 3.1 Background

With the enactment of WRDA in 2007, the U.S. Congress directed USACE to develop a national database for levee data and information. USACE developed the database model for the NLD to meet that long-term goal. FEMA initially used a simplified subset of the NLD database schema to compile a midterm levee inventory database for internal use. The two agencies synchronized the two databases to track information specific to their respective agencies with the goal to merge the two into one authoritative database. USACE focused on levees as part of their agency Levee

Safety Program while FEMA's interest was to inventory all levees to identify those affecting flood hazard mapping efforts as part of the NFIP.

The FEMA midterm levee inventory database contained data gathered for many levees that were designed to provide flood hazard reduction from the base flood. This standard is the minimum level of flood hazard reduction that is recognized by the NFIP. However, the database also frequently included data for levees that did not meet this minimum NFIP criterion for accreditation, as well as agricultural levees and levees of small and potentially less significant nature.

Beginning in 2012, FEMA and USACE formed a team of levee Subject Matter Experts (SMEs) to collaboratively merge the FEMA inventory into the NLD. The FEMA/USACE team completed the effort to integrate the two databases in May 2016.

## 3.2 National Levee Database

USACE and FEMA envision the NLD to be the main repository for comprehensive information about all levees and floodwalls in the United States. The NLD is a dynamic database, with USACE and FEMA staff continuously updating its content and adding levee data from other Federal agencies, States agencies, and communities. The NLD contains various levels of information for levees within the USACE Levee Safety Program and non-USACE Program levees, with information from FEMA and other organizations.

The NLD includes attributes of levees and floodwalls relevant to design, construction, operations, maintenance, repair, inspections, and performance. The NLD will facilitate linking levee safety activities, such as flood risk communication, levee system evaluations for the NFIP, levee system inspections, floodplain management, and risk assessments. Most of the information in the NLD is publicly available. Only information deemed sensitive from a security standpoint is not publicly available. For information on accessing the non-public NLD, interested parties should consult with FEMA Project Officer, other FEMA Regional Office staff, or the designated mapping partner responsible for supporting the Region with levee inventory and tracking.

## 3.3 Identification and Mapping of Levees in Flood Hazard Studies and Map Revisions

An important step in identifying and mapping areas impacted by levee systems is to first consult with FEMA Regional Office staff that are not part of the FEMA Project Team, as well as the local community Floodplain Administrator (FPA) and the State. When the Project Team identifies a potential flood-control structure, the assigned team member should evaluate the structure to determine whether it can be considered a levee and is subject to the procedures described in this guidance document. FEMA will only consider a structure to be a levee when it can be demonstrated that the structure was designed and has been operated and maintained as a levee. FEMA verifies whether a structure meets this definition of a levee by coordinating with community officials and levee owners, and by reviewing available levee data and documentation.

The FEMA Region and other Project Team members will be able to use the available accreditation status tracking systems to provide details about levee systems, special situations, or any additional analysis or outreach that may be necessary. The local FPA may have knowledge of any newly constructed flood-control projects that may not yet be inventoried by FEMA or USACE. The local FPA also may be able to provide updates to the data FEMA and USACE have already inventoried. Items that the Project Team should consider when determining whether the flood hazard mapping project will impact any levees include, but are not limited to, those listed below (in no particular order of priority).

- Levee features in the S_Levee feature class of the NFHL
- Levee symbology on the effective FIRM
- Levee features USACE NLD database
- Local data for new flood control projects recently completed that may not already be inventoried by FEMA or USACE
- Effective FEMA accreditation status of all existing levees in the project footprint
- Any existing, pending, or missing 44 CFR 65.10 certification data and documentation
- Non-accredited levees that may require new/updated levee analysis and mapping procedures for non-accredited levees
- Topographic data, such as Light Detection and Ranging (LiDAR)-generated data and U.S. Geological Survey (USGS) quadrangles, that may show potential flood-control structures

If discrepancies exist between the NFHL and the NLD, the assigned Project Team member should coordinate with the FEMA regional levee data leads, USACE District, and the local FPA to determine the best available data.

The FEMA-led Project Team or mapping partner should complete the research and identification of levees early on during the project. Early identification of levees allows the Project Team or mapping partner time to reach out to the community, or to another party seeking recognition of levee, to collect information and discuss options, responsibilities, and expectations regarding mapping of the levee system(s) and the levee-impacted area(s) on the FIRM.

The Project Team or mapping partner is to examine the current effective FIRM, as well as the existing effective S_Levee feature class in the NFHL database and compare it to the NLD to resolve any discrepancies. The Project Team or mapping partner can download the current effective NFHL data from the FEMA Flood Map Service Center (MSC) for counties that have been converted to a digital FIRM format. For levees that were not previously mapped on the FIRM, or inventoried in the NLD, the assigned Project Team member or mapping partner must input a new entry in S_Levee, with relevant information collected and recorded, as described in Section 3.6 of this document.

The assigned Project Team member or mapping partner should next examine the levee features in the NLD that are located within the project footprint, making note of any spatial misalignments and additional/missing features between the NFHL and the NLD. The assigned Project Team member or mapping partner is to verify and correct these discrepancies in the production data through the use of best available orthoimagery, topographic data, and online web mapping data (such as Google Earth) and through engagement with local community officials. The assigned team member or partner is to report the updated levee mapping to FEMA as described in Section 3.6 of this document. The Project Team or mapping partner is to verify any changes to the USACE Program Levee alignments with the responsible USACE District first.

When levees are identified, FEMA is to inform the community of the data requirements for FEMA to recognize on the FIRM a levee with reducing the base flood hazard. In accordance with 44 CFR 65.10(a), it is the responsibility of the community or other party seeking recognition of a levee system at the time of a flood hazard study or restudy to provide the data outlined in 44 CFR 65.10. (See Chapter 4 – Levee Accreditation of this document.)

FEMA will update the FIRMs to depict the hazard associated with the levee based on the data and documentation provided (if any) by the community, levee owner, or certifying engineer. In addition, FEMA will notify the community or party seeking recognition of the data collection period to provide information regarding the hazards associated with the levee system.

The specific data requirements and the length of the collection time period depend on the level of intended flood hazard reduction and the mapping path forward. The data and timelines are discussed in Chapter 4 – Accredited Levee Systems, Chapter 5 – Provisionally Accredited Levee Systems, and Chapter 6 – Non-Accredited Levee Systems. At any point, a levee owner may choose to submit a map revision following the MT-2 process regarding the submittal of data and documentation and updates to the flood hazards on the FIRMs.

## 3.4 FEMA Regulatory Levee Data

Once the Project Team or mapping partner has identified and researched all flood-control structures in the project areas, as discussed in Section 3.3, the team or partner uses the S_Levee table in the FIRM database to store the spatial features, and whether they have been demonstrated to meet NFIP requirements in 44 CFR 65.10. The Project Team or mapping partner will symbolize all flood control features inventoried in the S_Levee table on the FIRM panel as outlined in Flood Insurance Rate Map (FIRM) Panel Technical Reference: Format for Flood Insurance Rate Maps and noted as accredited or non-accredited.

The accreditation status of any levee in the NFHL and on the FIRM panel is only as current as the date of the effective study. At this time, FEMA does not define a set time period in which a certification of data for a levee remains valid for accreditation. The certifying engineer may provide a timeframe for which the certification of data for a levee is valid. When a map action is initiated to revise a current effective FIRM panel containing a levee, the assigned Project Team member or mapping partner will need to revisit the certification and subsequent accreditation status of that levee. Further discussion regarding the continued accreditation of levees is provided in Chapter 4 of this document.

Inside the FIRM database, the assigned Project Team member or mapping partner must include the levee System ID from the NLD in the S_Levee table. For more information on populating the NLD System ID in the S_Levee table, the team members or partner should refer to Technical Reference: Flood Insurance Rate Map (FIRM) Database. It is critical that this NLD System ID is correctly attributed in the S_Levee table to maintain the linkage to the detailed levee records maintained in the FEMA accreditation status tracking systems and the NLD. The Project Team or mapping partner should always depict accredited levee systems on the FIRM with a “Zone X – Area with Reduced Flood Risk Due to Levee” flood hazard zone on the landward side of the levee. In addition, the Project Team or mapping partner should show all accredited levees, PALs, and non-accredited levees (all other levees shown on the FIRM with a levee symbol) in Table 9 of the current, effective Flood Insurance Study (FIS) Report(s). The team or partner shall ensure that the information in Table 9 matches the data populated in the S_Levee table. For more information on including levee information in the FIS Report, Project Team members or partners should refer to the current version of Flood Insurance Study (FIS) Report Technical Reference: Preparing FIS Reports.

The Technical References cited above are accessible from the FEMA Technical References webpage (https://www.fema.gov/media-library/assets/documents/34519).

If discrepancies exist between the FIRM database and the NLD, the assigned Project Team member must correct the discrepancies as part of the current map action so that the FIRM database, and subsequent NFHL, represent the most accurate levee alignment and inventory. Reporting requirements for the updated levee mapping are described in Section 3.6 of this document.

## 3.5 Tracking Levee Accreditation Status

Tracking specific levee information is critical to meeting FEMA program goals. As part of the NLD and subsequent tracking systems, FEMA maintains information about all levee systems such as:

- Current accreditation status on the effective FIRM
- Long-term levee project planning and prioritization
- Levee-related FIRM mapping issues
- 44 CFR 65.10 certification records
- Levee-related risk assessments
- Ongoing levee studies
- Local ownership, media, and political information

The NLD can be accessed and edited by designated USACE staff, FEMA staff, and FEMA Regional levee SMEs who help to maintain the database while keeping it synched with NFHL databases.

## 3.6 Reporting Levee System Updates

The FEMA mapping partner or Project Team member producing the updated FIRM is expected to have detailed knowledge of whether the map update includes any updates to levee system reach alignments or changes to levee accreditation status. The process of researching levees for flood studies and map revisions was described in Section 3.3 of this document.

When new levee features are added to the inventory or existing levee data is modified, the mapping partner or Project Member must incorporate the updates into the FIRM database and then into the NFHL database. The mapping partner and Project Team is to ensure that all updates are coordinated with the FEMA Region and designated levee SMEs to incorporate appropriate updates into the NLD, and FEMA tracking systems.

Specific questions related to levee data updates exist in the Key Decision Point (KDP) questionnaires. Accurate and complete answers to these levee questions are very important. The

KDP levee information provided will give the FEMA Region staff and their designated Levee Project Monitors visibility on any updates that need to take place in the national levee data inventory and tracking systems. More detailed information on the KDP process and copies of the questionnaires are provided in FEMA Guidance Document No. 35, Guidance for Flood Risk Analysis and Mapping: Key Decision Point (KDP) Process Guidance Document, which is accessible from the FEMA Guidelines and Standards for Flood Risk Analysis and Mapping webpage.

If levee map revisions are requested through the MT-2 Letter of Map Revision (LOMR) process, the appropriate FEMA Regional Levee Project Monitor must review the submittal so that the appropriate updates to the levee attributes and alignments can be entered in the NLD.

## 3.7 Levee Data Storage Standards

To depict the hazard associated with levee systems on the FIRM, FEMA collects certified data pertaining to the requirements under 44 CFR 65.10 for levee accreditation and certain scenarios pertaining to the analysis and mapping procedures for non-accredited levees. The details of the data requirements and processes are laid out in Chapter 4--Accredited Levee Systems and Chapter 6--Non-Accredited Levee Systems) of this document. Once the FEMA Levee Project Monitor or designee considers the submitted certified data, the data needs to be consistently captured and documented for search ability throughout all FEMA Regions. The methods differ depending on whether the submitted certified data for an area is associated with a FEMA-funded mapping project, an area associated with a LOMR case, or unfunded area.

### 3.7.1 Levee Data Storage and Documentation for the MIP

Levee accreditation data and documentation provided to mapping partners from the Region or its supporting staff, in conjunction with a PAL or analysis and mapping procedures for non-accredited levees process, needs to be captured under a funded mapping project to update the levee-related flood hazard on the FIRM. These projects can be funded solely to update the levee hazard or can be done in conjunction with a larger study effort for the flooding source, county, or watershed.

On the FEMA Mapping Information Platform (MIP), a levee purchase option is available for funded projects to capture pertinent levee information. This purchase includes several tasks available for levees, including Levee Data Capture, Analysis and Mapping Procedure for Non-Accredited Levees Data Capture, and associated QA/QC and Validation Tasks. The main tasks can be defined as follows:

- **Levee Data Capture Task**: Under this task, the assigned Project Team member or partner captures levee data certification submittals, levee analysis and mapping approach packages for non-accredited levees (i.e., Sound Reach Procedure, Freeboard Deficient Procedure Overtopping Procedure, Structural-Based Inundation Procedure, Natural Valley Procedure), new PAL offers, and Natural Valley Concurrence letters (if the full levee deficiency based analysis workflow was not applied). For FEMA-funded mapping projects, this task is intended for non-engineering modeling data only because models are to be stored separately in the Hydraulics Data Capture and/or Hydrology Data Capture Tasks in the MIP.

- **Levee Analysis and Mapping Procedures Data Capture Task**: Under this task, the assigned Project Team member or partner captures data useful to evaluate the appropriate levee analysis and mapping approach discovered during the process of Identification and Plan Preparation concluding with a full analysis and mapping procedure plan for the non-accredited levee or Natural Valley Concurrence. The team member or partner also may document the Natural Valley Concurrence under the Levee Data Capture task if the full levee analysis and mapping procedures were not funded.

All levee-related data pertaining to the mapping of the hazard and risk associated with the levee system on the FIRM should be captured under the Levee Data Capture Task. The Levee Data Capture task can be utilized to capture submitted levee data that includes levee accreditation data or data pertaining to the analysis and mapping procedure scenarios of a non-accredited levee that can be retrievable under the case number.

More detailed information on levee-related data storage is provided in, but may not be limited to, the FEMA guidance documents and technical references listed below.

- MIP User Guidance
- Guidance Document No. 12, Guidance for Flood Risk Analysis and Mapping: National Flood Hazard Layer (NFHL)
- Guidance Document No.46, Guidance for Flood Risk Analysis and Mapping: Data Capture - General
- Guidance Document No. 51, Guidance for Flood Risk Analysis and Mapping: Data Capture – Workflow Details
- Guidance Document No. 56, Guidance for Flood Risk Analysis and Mapping: Mapping Information Platform (MIP)
- Data Capture Technical Reference
- Flood Insurance Rate Map (FIRM) Panel Technical Reference: Format for Flood Insurance Rate Maps
- Flood Insurance Study (FIS) Report Technical Reference: Preparing FIS Reports
- Domain Tables Technical Reference: FEMA Spatial Databases

The MIP User Guidance is accessible from the User Guides and Documentation page on the MSC Web Portal. Guidance Document Nos. 12, 46, 51, and 56 are accessible from the previously referenced FEMA Guidelines and Standards for Flood Risk Analysis and Mapping webpage. The Technical References are available from the previously referenced FEMA Technical References webpage.

## 4.0 Accredited Levee Systems

FEMA analyzes and maps the flood hazards associated with levee systems based on the information provided by other Federal agencies, levee owners, and/or communities. Accredited levee systems are depicted as reducing the base flood hazard on a Flood Insurance Rate Maps (FIRM) if FEMA has been provided with documentation and certified data that meets the requirements of 44 CFR 65.10, including an adopted operation, maintenance and emergency preparedness plan provided by the community or other qualified entity seeking accreditation. This information can be submitted to FEMA at any time including through the Flood Risk Project study process, PAL process, or through the MT-2 process.

Accreditation can only be considered for an entire levee system which meets the full requirements of 44 CFR 65.10. As noted in Chapter 2 of this guidance, a levee system is defined as

> A flood hazard-reduction system that consists of one or more levee segments/reaches 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 levee impacted area, and which are constructed and operated in accordance with sound engineering practices.

Because the levee system must be considered hydraulically independent, failure of any portion of the system will only adversely impact the system itself and not any surrounding areas or levee systems. See Figure 1.

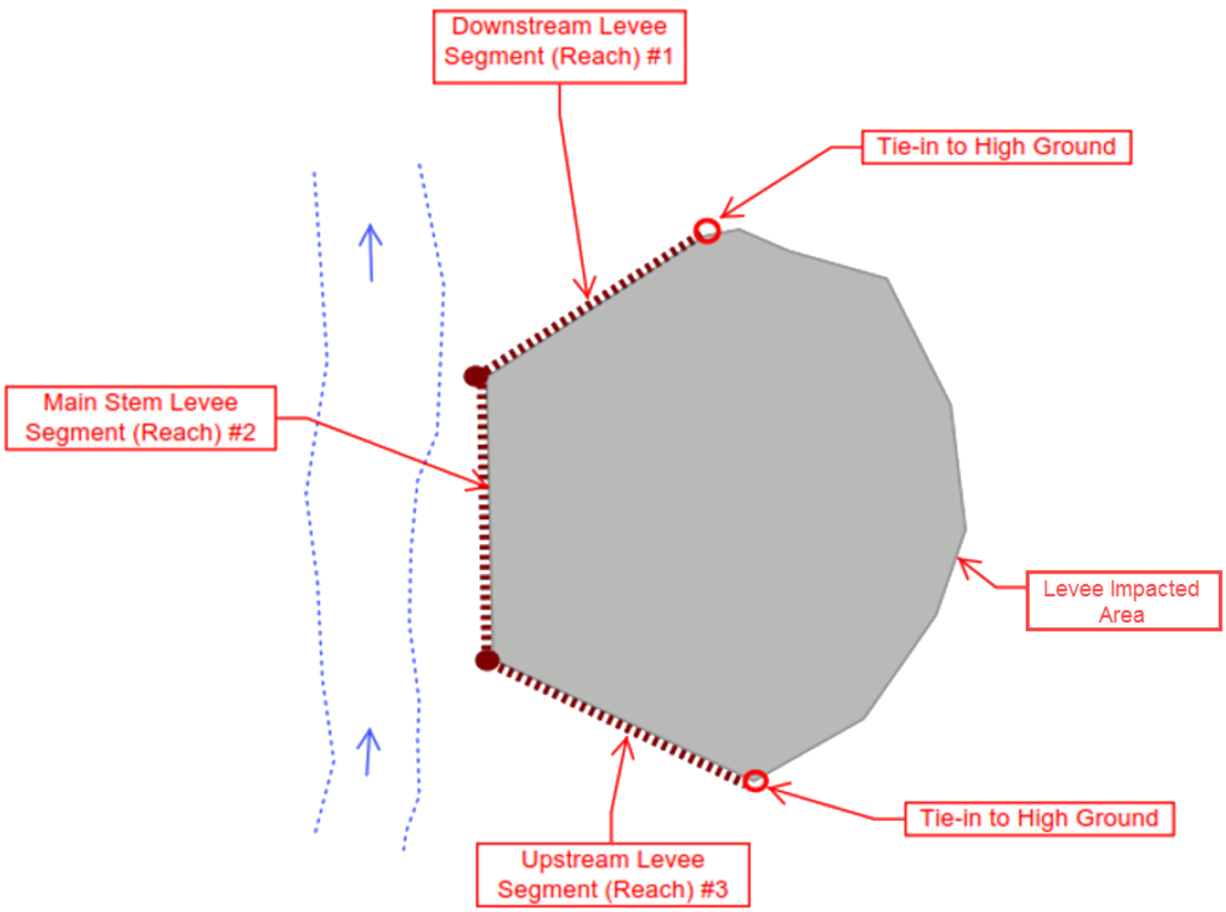



**Figure 1: Example Levee System A**

Levee System A is a typical example of a main stem levee with both upstream and downstream levees extending to high ground. The levee impacted area is shown in gray shading and represents the area which would be inundated during the base flood if the levee system fails to provide flood hazard reduction for the base flood. For an accredited levee system, the levee impacted area would be shown as Zone X (shaded) and labeled with the "Area with Reduced Flood Risk due to Levee" note on the Flood Insurance Rate Map.

For a levee system to be considered eligible for accreditation, the structure must first be identified as a levee system and meet the following minimum criteria:

- Meets the definitions of a levee and levee system, as defined in 44 CFR 59.1
- Has an identifiable owner
- Is operated, maintained, and inspected as a levee
- Is hydraulically independent from other levee systems or flood control structures
- Meets full requirements of 44 CFR 65.10

Unless designed as a ring levee, a levee system's requirements should also include that the levee system tie into natural high ground at either end of the system. High ground will be considered as topography that has not been revised due to manmade influences and should conform to the existing topography including no side slopes or heights outside of the typical terrain in the area. High ground should be sufficient to provide a stable foundation for the levee system to meet the structural requirements of 44 CFR 65.10 at both upstream and downstream tie-ins. For certain situations, it may not be feasible for the downstream end of a levee to tie into high ground. There may also be certain levee conditions, such as levees in urban or coastal areas where they do not tie-in to natural high ground. These situations will need to be coordinated and approved by the FEMA Regional Office and in coordination with FEMA Headquarters. Accreditation may still be considered for certain situations as described in Section 4.2 of this chapter.

## 4.1 44 CFR 65.10 Requirements

Regarding the NFIP, FEMA will only recognize the flood hazard and risk mapping efforts of those levee systems that meet and continue to meet the requirements of 44 CFR 65.10. Technical data submitted to meet 44 CFR 65.10(b) requirements must be certified by a registered PE. Additionally, the accreditation package must be certified by a P.E. in its entirety to ensure that all 44 CFR 65.10 elements, topographic information, as well as the hydrology and hydraulics (H&H), as updated as warranted, are consistent with the information that is basis of accrediting the levee on the FIRM. For accreditation, a levee system must meet all the requirements listed below. It should be noted that FEMA's analysis and mapping procedures for non-accredited levee systems (see Chapter 6--Non-accredited Levee Systems), necessitate that most requirements of 44 CFR 65.10 be met.

### 4.1.1 Freeboard

The purpose of freeboard is to acknowledge and consider the uncertainties associated with the H&H analysis and to minimize damages and threat to life and property. The freeboard requirements vary if the levee system lies within a riverine area or a coastal area. The appropriate requirements will be determined by the modeling method used for analysis. Coastal modeling should only be considered if the available fetch of the waterbody is 0.5 miles or greater.

### 4.1.2 Riverine Freeboard

The riverine freeboard requirements are stated in 44 CFR 65.10(b)(1)(i) and states the following:

> *Riverine levees must provide 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 in 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 freeboard shall be based on the difference between the top of levee elevation to the elevation and the BFE at the riverside of the levee. A current top of levee survey or certified as-built plans should accompany any documentation regarding the freeboard requirement for a levee system. Older data may be accepted if accompanied with a statement from the certifying engineer that the older survey data still reflects current top levee conditions for the levee.

The levee shall tie into high ground at both the upstream and downstream end and maintain the required minimum freeboard at the tie into high ground. There may be cases in which high ground itself may not have the required freeboard at the tie-in location. If the tie into high ground cannot meet the minimum freeboard requirements within the vicinity of the levee, the levee can still be considered for meeting freeboard if the high ground lies above the BFE at the tie-in location of the levee. In some geographic areas, levee systems are designed to end in the absence of high ground at the downstream end. In these cases, the levee system may still be considered for accreditation as described in Subsection 4.2.1 of this guidance.

The levee freeboard should be determined based on the effective hydrologic and hydraulic models. New hydrology or hydraulics may be introduced for evaluation of freeboard as part of a FEMA initiated study, LOMR or Conditional Letter of Map Revision (CLOMR) to be evaluated by FEMA prior to consideration for accreditation. If during collection of data for accreditation it is determined that the effective BFEs are incorrect (too low), it is incumbent on the P.E. to provide updated information to FEMA through the MT-2 process such that the levee can be determined to reduce risk against the current base flood.

The tapering requirement for the additional 0.5-foot freeboard requirement at upstream end of levee system will be determined perpendicular to the flow of the base flood event and to help prevent overtopping at the structure. All aspects of levees, including mainline and tributary levees, are subject to an additional 0.5 feet of freeboard if they are perpendicular to flow at upstream end of levee. See Figure 2.

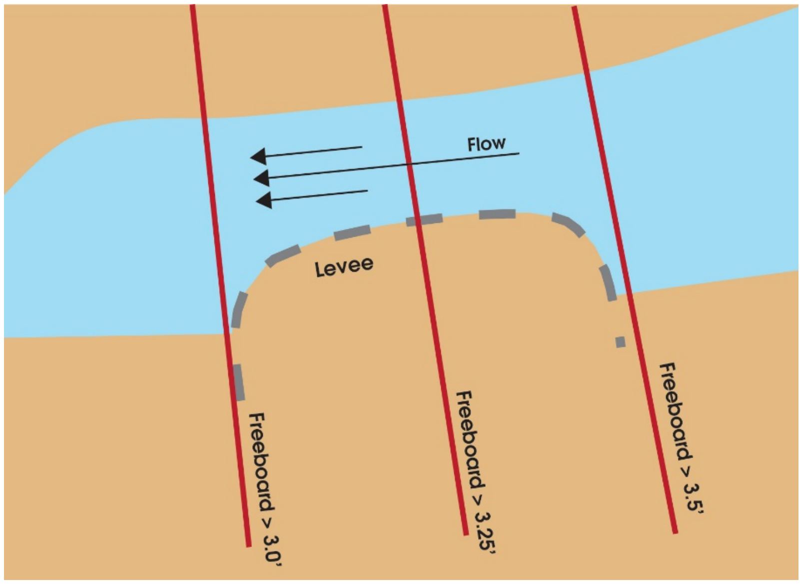



**Figure 2: Freeboard Determination**

There may be some circumstances in which the upstream end and downstream end of the levee are indistinguishable and the freeboard tapering requirement may not apply. This may include levees along stillwater bodies or large rivers where velocities are slow and there is no change in water-surface elevation along the length of the levee system. A waiver may be granted from FEMA for exclusion of the freeboard tapering requirement if the certifying engineer can provide data that justifies the waiver request.

The additional 1.0 foot of freeboard around structures is needed for any areas that constrict the natural flow of the river, such as bridges or culverts perpendicular to the flow. The 100 feet on either side of the structure shall be considered from the furthest upstream and downstream point of the structure that influences the flow, not the center of the structure. See Figure 3.

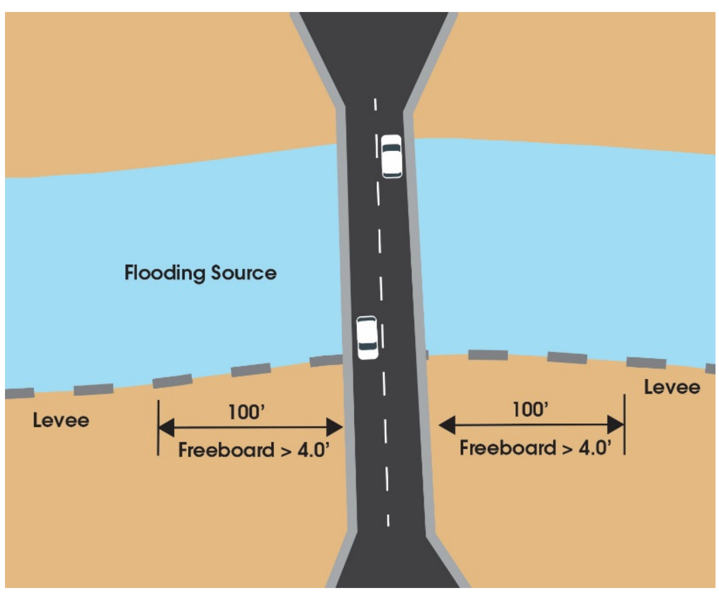



**Figure 3: Freeboard Near Structures**

If a structure is located at the upstream end of a levee system, the required freeboard shall be 4.0 feet (not a cumulative 4.5 feet) as the variability in flow at the upstream end of the levee and around structures has redundant uncertainties. In certain instance, it may be advantageous for the levee to have an additional half foot where debris or ice flow may incur additional flood risk or where overtopping at the structure needs to be avoided.

The additional freeboard requirement around structures may be waived if the certifying engineer can demonstrate that the structure does not influence the flow pattern of the base flood or the overtopping would not result in structure failure at that location. Possible considerations may include demonstrating the low chord of a bridge is above the base flood plus minimum freeboard requirement as well as the related embankments outside the floodplain. Debris and ice accumulation would need to be addressed before the exception is granted. In certain situations, FEMA may request additional analyses.

Freeboard must also take into account the impacts of settlement and subsidence for completeness of this section as described under 44 CFR 65.10(b)(5).

#### 4.1.2.1 Riverine Freeboard Exceptions

Exceptions of the freeboard requirement for levees in a riverine area are stated in 44 CFR 65.10(b)(1)(ii), which states the following:

> *Occasionally, exceptions to the minimum riverine freeboard requirement described in paragraph (b)(1)(i) of this section, may be approved. Appropriate engineering analyses demonstrating adequate protection with a lesser freeboard must be submitted to support a request for such an exception. The material presented must evaluate the uncertainty in the estimate base flood elevation profile and include, but not necessarily be limited to an assessment of the statistical confidence limits of the 100-year discharge; changes in the stage-discharge relationships; and the sources, potential, and magnitude of debris, sediment, and ice accumulation. It must be also shown that the levee will remain structurally stable during the base flood when such loading considerations are imposed. Under no circumstances will freeboard of less than two feet be accepted.*

Based on the requirements laid forth in 44 CFR 65.10(b)(1)(ii), the levee must demonstrate it can meet the following items of the freeboard exception process:

- Assessment of the statistical confidence limits of the 1-percent-annual-chance discharge
- Assessment of the changes in stage discharge relationships
- Assessment of the sources, potential, and magnitude of debris, sediment, and ice accumulation
- Stability analysis indicating levee will remain structurally stable during the base flood when additional loading considerations required by the uncertainty analysis are imposed

**Statistical Confidence Limits of the 1-percent-annual-chance Discharge**

A statistical analysis should be performed demonstrating the conditional non-exceedance probability is 95 percent or greater for the base flood.

FEMA will accept an analysis of the upper 5-percent confidence limits of the base flood discharge or 0.2-percent-annual-chance event, whichever is greater. Additional analyses may be accepted pending FEMA concurrence.

**Changes in Stage Discharge Relationships**

An evaluation should be performed on the uncertainty due to changes to the stage-discharge relationship of the water body. This would include physical conditions that may change the relationship between the stage and discharge rating curve over time. It is suggested the certifying engineer utilize the appropriate USACE guidelines to demonstrate this requirement.

**Sources, Potential, and Magnitude of Debris, Sediment, and Ice Accumulation**

An analysis should be done demonstrating that any debris, sediment, and ice accumulation would have a negligible impact on the required freeboard.

**Stability Analysis at Most Critical Section**

A stability analysis should be done that conforms to the requirements laid out under 44 CFR 65.10(b)(4) demonstrating the levee will remain structurally stable with the reduced freeboard.

### 4.1.3 Coastal Freeboard

The coastal freeboard requirements are stated in 44 CFR 65.10(b)(1)(iii), which states the following:

> *For coastal levees, the freeboard must be established at one foot above the height of the one percent wave or the maximum wave runup (whichever is greater) associated with the 100-year stillwater surge elevation at the site.*

To show that a levee system provides base flood hazard reduction in a coastal area, the top of the levee must be equal or greater than the highest value of the following:

1. Two (2) feet above the base flood total stillwater storm surge elevation including wave setup;
2. One (1) foot above the base flood wave crest elevation; or
3. One (1) foot above the maximum base flood wave runup elevation.

The stillwater surge elevation shall be considered the water level in the absence of waves but with all other processes present. This includes the stillwater elevation of the base flood event plus a wave setup component. The wave setup is defined as the increase in mean water level above the stillwater level due to momentum transfer to the water column by waves that are breaking or otherwise dissipating their energy. Wave setup may be included in the FIS provided stillwater elevations if coupled 2D wave and surge modeling has been performed for the coastal study. If coupled 2D wave and surge modeling has not been performed wave setup may be calculated and added to the stillwater separately. Care should be taken to ensure the proper values are being used to evaluate coastal levee freeboard.

Wave runup is the vertical extent of the wave uprush on a beach or structure due to the breaking waves as shown in Figure 4.

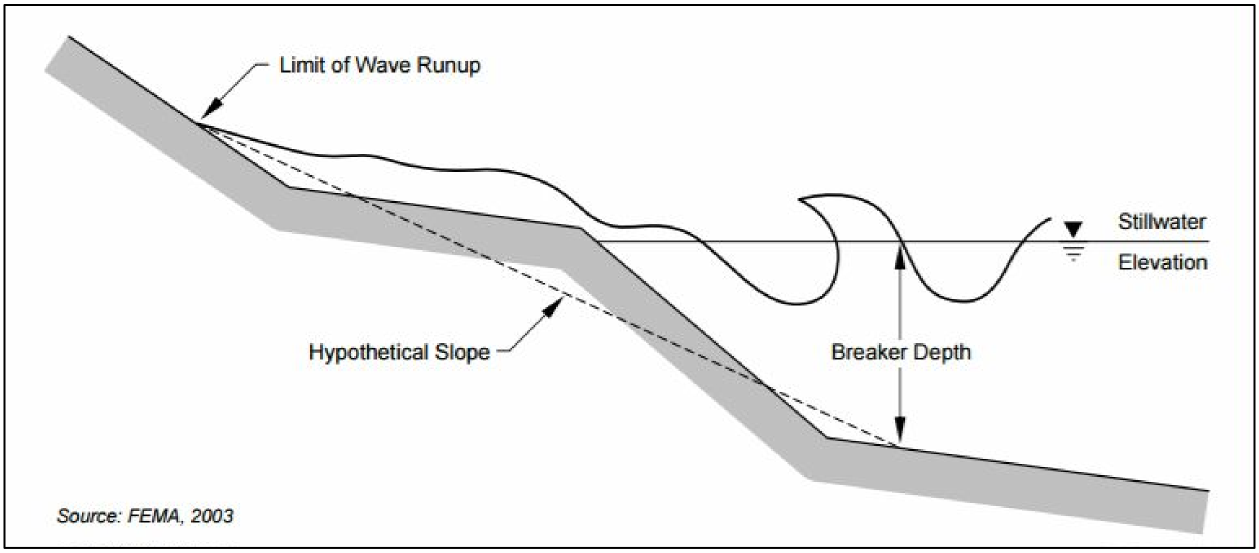



**Figure 4: Wave Runup**

Commonly used methods can include TAW, DIM, ACES, and CSHORE to calculate the wave runup. As stated, 44 CFR §65.10(b)(1)(iii) requires the maximum wave runup elevation. The maximum wave runup is the statistical highest wave runup attained by a group of irregular waves. The most frequently modeled wave runup heights are the mean ($R_{mean}$ and the runup exceeded by 2 percent of the wave runup values attained by a group of irregular waves ($R_{2\%}$ Depending on the output of the method employed, one of the following conversion factors will need to be applied to calculate the maximum wave runup value required for freeboard determination:

1. $R_{max} = R_{mean} * 2.87$
2. $R_{max} = R_{2\%} * 2.87/2.23 = R_{2\%} * 1.29$

The freeboard shall be evaluated using the 1-percent total stillwater, the BFE on the FIRM, or the maximum wave runup elevation and the effective coastal model. As the 1 percent total stillwater and the maximum wave runup elevations may not be directly stated on the FIRM or in the FIS Report, these values must be derived utilizing the effective coastal modeling data. New wave runup analysis may be needed at the levee location if not including in the effective coastal study or the coastal levee is recently constructed. New coastal modeling may be introduced for evaluation of freeboard, but any new or updated models must be submitted as part of a LOMR or CLOMR to be evaluated by FEMA prior to incorporation. If the proposed model output is more conservative (BFE, velocities, duration, etc.) than the effective, the model results may be used without a LOMR or CLOMR review, pending FEMA concurrence.

#### 4.1.3.1 Coastal Freeboard Exceptions

Exceptions to the freeboard requirement for levees in a coastal area are stated in 44 CFR 65.10(b)(1)(iv), which states the following:

> *Occasionally, exceptions to the minimum coastal levee freeboard requirement described in paragraph (b)(1)(iii) of this section, may be approved. Appropriate engineering analyses demonstrating adequate protection with a lesser freeboard must be submitted to support*

*a request for such an exception. The material presented must evaluate the uncertainty in the estimated base flood loading conditions. Particular emphasis must be placed on the effects of wave attack and overtopping on the stability of the levee. Under no circumstances, however, will a freeboard of less than two feet above the 100-year stillwater surge elevation be accepted.*

An analysis must be provided that evaluates the uncertainty in the base flood loading and demonstrates the stability of the levee will not be compromised with the acceptance of a lesser freeboard. Any Freeboard exceptions would need to be concurred upon by both the FEMA Region and headquarters.

### 4.1.4 Closures

The closures requirements are stated in 44 CFR 65.10(b)(2), which states the following: "All openings must be provided with closure devices that are structural parts of the system during operation and design according to sound engineering practice."

A closure shall be considered for any opening within the levee system elevated at or below the minimum freeboard elevation that pertains to a hydraulic connection between the riverside and landside of the levee system. Closures can include road openings and utility penetrations. All considered closures must have a documented and properly designed closure device and procedure in the levee system operation and maintenance manual that meets the requirements laid out for Operation Plans and Criteria under 44 CFR 65.10(c). Closures that require manual intervention, such as road openings, gate structures and manual operation for closures on pipe penetrations, must have a warning system in place that allows adequate time to respond.

Temporary closures which are not a structural part of the levee may be used as a closure device for any areas where the closure invert is above the BFE. Examples of temporary closures include sandbags, manufactured closures, and earthen closures. Temporary closures cannot be used for meeting freeboard requirements if the minimum invert elevation of the closure is below the base flood elevation.

### 4.1.5 Embankment Protection

The embankment protection requirements are stated in 44 CFR 65.10(b)(3), which states the following:

*Engineering analyses must be submitted that demonstrate that no appreciable erosion of the levee embankment can be expected during the base flood, as a result of either currents or waves, and that anticipated erosion will not result in failure of the levee embankment or foundation directly or indirectly through the reduction of the seepage path and subsequent instability. The factors to be addressed in such analyses include but are not limited to: expected flow velocities (especially in constricted areas); expected wind and wave action; ice loading; impact of debris; slope protection techniques; duration of flooding at various stages and velocities; embankment and foundation materials; levee alignment, bends, and transitions; and levee side slopes.*

Existing embankment protection must be identified along the entire levee system. It must be demonstrated that during the conditions associated with the base flood event that the duration of the event and erosion will not compromise the stability of the levee. Flow velocities and duration of flooding used for evaluation, at a minimum, must coincide with effective hydraulic model associated with the BFE listed on the FIRM.

For coastal levees, wave runup should be addressed each time VE zones are mapped in the area or a fetch of 0.5 mile or greater is presented along the waterbody. Appropriate analyses should be presented documenting the wave impacts along the levee. If the fetch is less than 0.5 mile or circumstances are present that minimize the impacts of waves along the levee, the certifying engineer should submit a statement and documentation justifying this position.

Ice loading should be addressed when the certifying engineer believes it pertains. The certifying engineer should include a statement and justification if ice loading does not apply to the levee system.

If a previous analysis regarding the adequacy of the embankment protection is still applicable to current conditions, it may be used in lieu of providing a new analysis. A registered P.E. would need to provide the previous data and documentation and certify that it still applies to current conditions.

#### 4.1.6 Embankment and Foundation Stability

The embankment and foundation stability requirements are stated in 44 CFR 65.10(b)(4), which states the following:

> *Engineering analyses that evaluate levee embankment stability must be submitted. The analyses provided shall evaluate expected seepage during loading conditions associated with the base flood and shall demonstrate that seepage into or through the levee foundation and embankment will not jeopardize embankment and foundation stability. An alternative analysis demonstrating that the levee is designed and constructed for stability against loading conditions for Case IV as defined by US Army Corps of Engineers (COE) manual, "Design and Construction of Levees" (EM 1110-2-1913, Chapter 6, Section II) may be used. The factors that shall be addressed in the analyses include: Depth of flooding, duration of flooding, embankment geometry and length of seepage path at critical locations, embankment and foundation materials, embankment compaction, penetrations, other design factors affecting seepage (such as drainage layers), and other design factors affecting embankment and foundation stability (such as berms).*

To meet the requirements shown above, the certifying engineer should include a seepage and stability analysis. An example method is outlined in USACE EM 1110-2-1913. This should include an examination of component material characteristics of the foundation and levee embankment, compaction design, seepage at critical locations (including at the levee tie-in locations), and penetrations. It is recommended that data including information on soil borings and laboratory results be included in the documentation for this requirement. Additionally, the impact of any structure, including but not limited to bridges and roads crossing the levee must be addressed.

If a previous seepage and stability analysis was done for the levee system, it may be used if the certifying engineer states that the findings and data are still representative of current conditions for the levee system. A recent soil boring may be required to demonstrate the current composition of the levee is representative of the original analysis.

### 4.1.7 Settlement

The settlement requirements are stated in 44 CFR 65.10(b)(5), which states the following:

> *Engineering analyses must be submitted that assess the potential and magnitude of future losses of freeboard as a result of levee settlement and demonstrate that freeboard will be maintained within the minimum standards set forth in paragraph (b)(1) of this section. This analysis must address embankment loads, compressibility of embankment soils, compressibility of foundation soils, age of the levee system, and construction compaction methods. In addition, detailed settlement analysis using procedures such as those described in the COE manual, "Soil Mechanics Design – Settlement Analysis" (EM 1100-2-1904) must be submitted.*

An analysis or calculation utilizing the composition of the levee to determine current and future settlement is required for areas subject to both coastal and riverine flooding to demonstrate the current and future impacts of settlement on the freeboard. This analysis may leverage existing data if still applicable regarding calculations and composition of the levee. The analysis must address any future loss of freeboard associated with settlement over time, including subsidence impacts.

The settlement requirement is to determine the impacts on freeboard over time due to the natural settling of a levee. If a levee is not newly constructed, has not been improved and the certifying engineer can demonstrate that the minimum freeboard will be maintained when all current and future settlement is considered, a statement from the certifying engineer may suffice instead of a settlement analysis. If a levee cannot meet these requirements, a settlement analysis is still required.

### 4.1.8 Interior Drainage

The interior drainage requirements are stated in 44 CFR 65.10(b)(6), which states the following:

> *An analysis must be submitted that identifies the source(s) of such flooding, the extent of the flooded area, and, if the average depth is greater than one foot, the water-surface elevation(s) of the base flood. This analysis must be based on the joint probability of interior and exterior flooding and the capacity of facilities (such as drainage lines and pumps) for evacuating interior floodwaters.*

Interior drainage represents all runoff, seepage inflow, coastal overwash, and collection associated with the flooding sources tributary to the landside or interior drainage area of the levee system. An analysis must identify and demonstrate the modes and potential runoff paths from the interior drainage area. This will involve an analysis of runoff, seepage inflow, streams, coastal overwash, pump stations, detention/retention ponds, storm sewers, and other stormwater management facilities based on the judgement of the certifying engineer. The certifying engineer should evaluate and certify all data associated with the flooding sources within the interior drainage area related to handling the anticipated runoff and seepage landward of the levee and identify any ponding areas or streams. Any areas with an average depth greater than one foot must be identified with the relevant BFE. A work map should be provided indicating the inundation areas of the analysis.

The interior drainage analysis should be done utilizing a FEMA approved hydrologic and hydraulic model. A list of these acceptable models can be found at www.fema.gov/numerical-models-meeting-minimum-requirements-national-flood-insurance-program. Any analyses done with a model that has not been accepted by FEMA will not be considered as valid under this requirement and results cannot be mapped.

The analysis should include a joint probability analysis of events on the interior and exterior of the levee, with the most conservative combination used for final analysis. In lieu of a joint probability analysis, the engineer may evaluate several scenarios rather than identify a probability-based based flood event, the most conservative combination should be used for final analysis. Comparable methodology is also available in appropriate USACE guidelines.

If a flooding source on the landside of the levee is instrumental to the interior drainage analysis but not previously identified on the FIRM, an analysis of the flooding source should be done by the certifying engineer and submitted as part of the interior drainage analysis. The analysis should meet relevant FEMA Guidance and Standards (G&S) but the associated inundation areas on the workmap provided by the certifying engineer do not need to meet FEMA G&S for mapping. However, FEMA must convert inundation areas into flood hazard areas on the FIRM, as appropriate, in accordance with FEMA G&S and in coordination with the impacted community.

If a previous analysis of interior drainage was performed and is still applicable to current hydrologic and hydraulic conditions, it may be used in lieu of providing a new analysis. A registered P.E. must certify the previous data and documentation represent current interior drainage conditions and associated flood hazards.

#### 4.1.9 Other Design Criteria

Other design criteria are stated in 44 CFR 65.10(b)(7), which states the following:

> *In unique situations, such as those where the levee system has relatively high vulnerability, FEMA may require that other design criteria and analyses be submitted to show that the levees provide adequate protection. In such situations, sound engineering practice will be the standard on which FEMA will base its determinations. FEMA will also provide rationale for requiring this additional information.*

FEMA reserves the right to request additional information pertaining to the purpose, design, or construction, of the levee systems under unique situations that are not covered under 44 CFR 65.10(b)(1) through (6). These situations may include levees with a higher landward risk, levee systems that cannot tie into high ground and require additional analyses demonstrating that they meet and continue to meet design requirements and the structural integrity would not be compromised when exposed to the base flood event, or unique characteristics that cannot be adequately evaluated under traditional methods. FEMA will coordinate with the levee owner in writing with notification and justification for additional design requirements prior to final accreditation submission and provide adequate time for preparation of additional material.

### 4.1.10 Plans for Maintenance, Operation, and Emergency Preparedness

A levee submittal must include detailed plans that describe the operation, maintenance, and emergency preparedness activities to be implemented. These plans must be officially adopted and be under the jurisdiction of Federal or State agencies, an agency created by Federal or State law, or an NFIP participating community. An officially adopted plan is a plan that is signed by the Chief Executive Officer (CEO) or highest elected official of the community or the appropriate head of the agency or entity that is accepting the ultimate responsibility for all the tasks and actions listed in those plans. All plans must be prepared for the specific levee system for which accreditation is being evaluated. Generic plans that include addendums covering specific requirements may be accepted, with FEMA concurrence.

#### 4.1.10.1 Operation Plans

The criteria for operation plans are described in 44 CFR 65.10(c), which states the following:

> *All closure devices or mechanical systems for internal drainage, whether manual or automatic, must be operated in accordance with an officially adopted operation manual, a copy of which must be provided to FEMA by the operator when levee or drainage system recognition is being sought or when the manual for a previously recognized system is revised in any manner. All operations must be under the jurisdiction of a Federal or State agency, an agency created by Federal or State law, or an agency of a community participating in the NFIP.*
>
> *(1) Closures. Operation plans for closures must include the following:*
>
> *(i) Documentation of the flood warning system, under the jurisdiction of Federal, State, or community officials, that will be used to trigger emergency operation activities and demonstration that sufficient flood warning time exists for the completed operation of all closure structures, including necessary sealing, before floodwaters reach the base of the closure.*
>
> *(ii) A formal plan of operation including specific actions and assignments of responsibility by individual name or title.*
>
> *(iii) Provisions for periodic operation, at not less than one-year intervals, of the closure structure for testing and training purposes.*
>
> *(2) Interior drainage systems. Interior drainage systems associated with levee systems usually include storage areas, gravity outlets, pumping stations, or a combination thereof. These drainage systems will be recognized by FEMA on NFIP maps for flood protection purposes only if the following minimum criteria are included in the operation plan:*
>
> *(i) Documentation of the flood warning system, under the jurisdiction of Federal, State, or community officials, that will be used to trigger emergency operation activities and demonstration that sufficient flood warning time exists to permit activation of mechanized portions of the drainage system.*

*(ii) A formal plan of operation including specific actions and assignments of responsibility by individual name or title.*

*(iii) Provision for manual backup for the activation of automatic systems.*

*(iv) Provisions for periodic inspection of interior drainage systems and periodic operation of any mechanized portions for testing and training purposes. No more than one year shall elapse between either the inspections or the operations.*

*(3) Other operation plans and criteria. FEMA may require other operating plans and criteria to ensure that adequate protection is provided in specific situations. In such cases, sound emergency management practice will be the standard upon which FEMA determinations will be based.*

All items outlined in the operation plan must reflect current conditions of the levee system and must align with the certified activities covered in 44 CFR 65.10(b)(1) through (7). All discrepancies between existing conditions or operations must be resolved prior to the levee being accepted for accreditation.

If flood fighting activities are listed in an operation plan, it must be ensured that these activities are not necessary in order to meet the requirements of 44 CFR 65.10.

If sandbags or other nonstructural measures are to be used as closure devices, the operation plan must include the details for the storage, hauling, and placement of the required materials and equipment.

Portable pumps may be accepted as modes of alleviating flood risk associated with interior drainage if details of application, flood triggers and implementation are clearly laid out in the operation plan. Portable pumps should also be shown to be readily available and onsite.

#### 4.1.10.2 Emergency Preparedness Plans

FEMA Standard (SID) 444 requires that the submittal for levee accreditation include a current emergency preparedness plan that must, at a minimum, be adopted by the community, include the area impacted by the levee system, and procedures for emergency operations and public evacuation, meeting the requirements of 44 CFR 65.10(c)(3). Although this plan may be included in the adopted operation plan, it may also be submitted as a separate document. The size and required detail of the submitted documentation is scalable and should be appropriate for the levee system. Many communities may already be familiar with similar planning efforts and may have the relevant information available in other forms. Provided the information is appropriate to meet these requirements, the document is not required to have the title "emergency preparedness plan". Refer to the following documents for more information on preparing these plans and sample content and format for the plans:

- U.S. Department of Homeland Security, Emergency Preparedness Guidelines for Levees, A Guide for Owners and Operators, dated July 2012. This document may be obtained at www.fema.gov/media-library/assets/documents/131081 or by requesting a copy from the DHS-FEMA Map Information eXchange (FMIX) toll free at 1-877-FEMA MAP (1-877-336-2627).

- The Silver Jackets, Emergency Action Plan, Guidebook, Version 2.0, dated August 2016, website: www.mvp.usace.army.mil/Portals/57/docs/Operations%20Center/EM/EAP%20Guidebook/EAP_Combined_Ver2.0_including_appendices_Aug16.pdf?ver=2016-09-16-120924-387.
- USACE EC 1110-2-6074, Guidance for Emergency Action Plans, Incident Management and Reporting, and Inundation Maps for Dams and Levee Systems, dated January 31, 2018, website:

  https://www.publications.usace.army.mil/Portals/76/Publications/EngineerCirculars/EC_1110-2-6074.pdf?ver=2018-01-22-100438-250 .
- FEMA, "CPG 101, Developing and Maintaining Emergency Operations Plans, Version 2", dated November 2010, website: https://www.fema.gov/media-library/assets/documents/25975?id=5697.
- FEMA, "Federal Guidelines for Emergency Action Planning for Dams", dated July 2013, website: https://www.fema.gov/media-library/assets/documents/3357.

#### 4.1.10.3 Maintenance Plans

The criteria for operation plans are described in 44 CFR 65.10(d), which states the following:

> *Levee systems must be maintained in accordance with an officially adopted maintenance plan, and a copy of this plan must be provided to FEMA by the owner of the levee system when recognition is being sought or when the plan for a previously recognized system is revised in any manner. All maintenance activities must be under the jurisdiction of a Federal or State agency, an agency created by Federal or State law, or an agency of a community participating in the NFIP that must assume ultimate responsibility for maintenance. This plan must document the formal procedure that ensures that the stability, height, and overall integrity of the levee and its associated structures and systems are maintained. At a minimum, maintenance plans shall specify the maintenance activities to be performed, the frequency of their performance, and the person by name or title responsible for their performance.*

The maintenance activities and the frequency of their performance to maintain the levee's compliance with requirements of 44 CFR 65.10 and well documented. At a minimum, plans must address provisions for inspection of the levee and maintenance of all mechanical systems, such as closure devices, pumps, valves, and relief wells.

### 4.1.11 Certification Requirements

The criteria for certification of data are described in 44 CFR 65.10(e) which states the following:

> *Data submitted to support that a given levee system complies with the structural requirements set forth in paragraphs (b)(1) through (b)(7) of this section must be certified by a registered professional engineer. Also, certified as-built plans of the levee must submitted. Certifications are subject to the definition given at §65.2 of this subchapter. In lieu of these structural requirements, a Federal agency with responsibility for levee design*

*may certify that the levee has been adequately designed and constructed to provide protection against the base flood.*

Certified as-built plans submitted must cover the entire levee system that is being considered for accreditation. The as-built plans should match levee features certified in design requirements under 44 CFR 65.10(b)(1) through (7). A new levee survey may be required if certified as-built plans are missing, or do not cover the entire length of the levee. The new survey must include all the necessary information for the review, including but not limited to topographic information, location and dimensions of all structures, pipes and utilities crossing the levee, and all the facilities that are part of the interior drainage system. If certified as-built plans are not available, the certifying engineer may also submit more recent plans conveying similar information if certified that they represent current conditions of the levee system.

In lieu of the structural requirements cited in 44 CFR 65.10(b)(1) through (7) a Federal agency with responsibility for levee design may certify that the levee has been adequately designed and constructed. Further details on this topic is shown under Subsection 4.2.2 (Other Federal Agency Accreditation Submittals).

#### 4.1.11.1 Permits and Other State and Local Requirements

The submittal must adequately address all applicable Federal, State, and local laws regulations and requirements, including, but not limited to, Federal, State, and local floodplain management laws, environmental laws, and permit requirements. This requirement is the responsibility of the NFIP community. This can be verified through communication with the requester. A record of these communications must be kept in the FEMA project file for future reference.

## 4.2 Additional Levee Accreditation Considerations

Situations may arise during the evaluation of a levee system for accreditation that may warrant further discussion or evaluation of the specific situations. Some of the more common situations that may warrant additional considerations may include the following:

- Levees systems designed to end in the absence of high ground at the downstream end
- Considerations for review of accreditation packages from other Federal agencies
- Guidance for addressing continued accreditation of a levee system after it initially met the requirements of 44 CFR 65.10

### 4.2.1 Levee System Tie-In Considerations

Typically, levee systems are designed and constructed to tie into high ground at the upstream and downstream portions of the levee system, unless they are designed as ring levees. In some geographic areas, levee systems are designed to end in the absence of high ground at the downstream end. If certain criteria are still met, these levees may be eligible for accreditation. Variations of these types of levee systems are described as follows:

- The most common scenario occurs when the downstream end of a levee system meets the 44 CFR 65.10 freeboard requirements, but it does not tie into high ground at this downstream end.

- A variation occurs when the downstream end of a levee system meets the freeboard requirements but ties into a non-accredited levee (see Chapter 6) or a non-levee reach (see Chapter 7), which is part of the entire levee system. In this case, the certifying engineer must provide certified data and documentation that meets requirements of 44 CFR 65.10 to demonstrate base flood hazard reduction in the leveed impacted area.

If a levee system designed to end in the absence of high ground at the downstream end meets the requirements of 44 CFR 65.10, the “levee impacted area” defined by a natural valley analysis would be shown on a FIRM as Zone X (shaded) overlaid with the appropriate SFHAs, as determined by interior drainage analyses and/or backwater flooding that comes around the downstream end of the levee system.

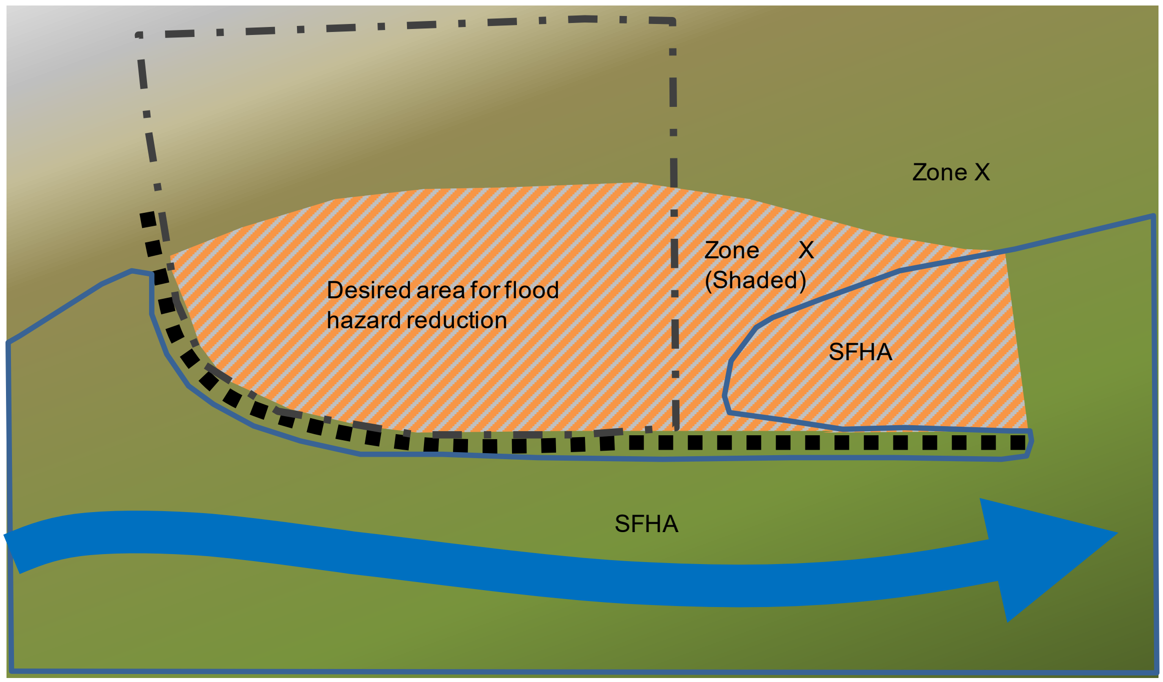



**Figure 5: Levee System Designed to End in the Absence of High Ground**

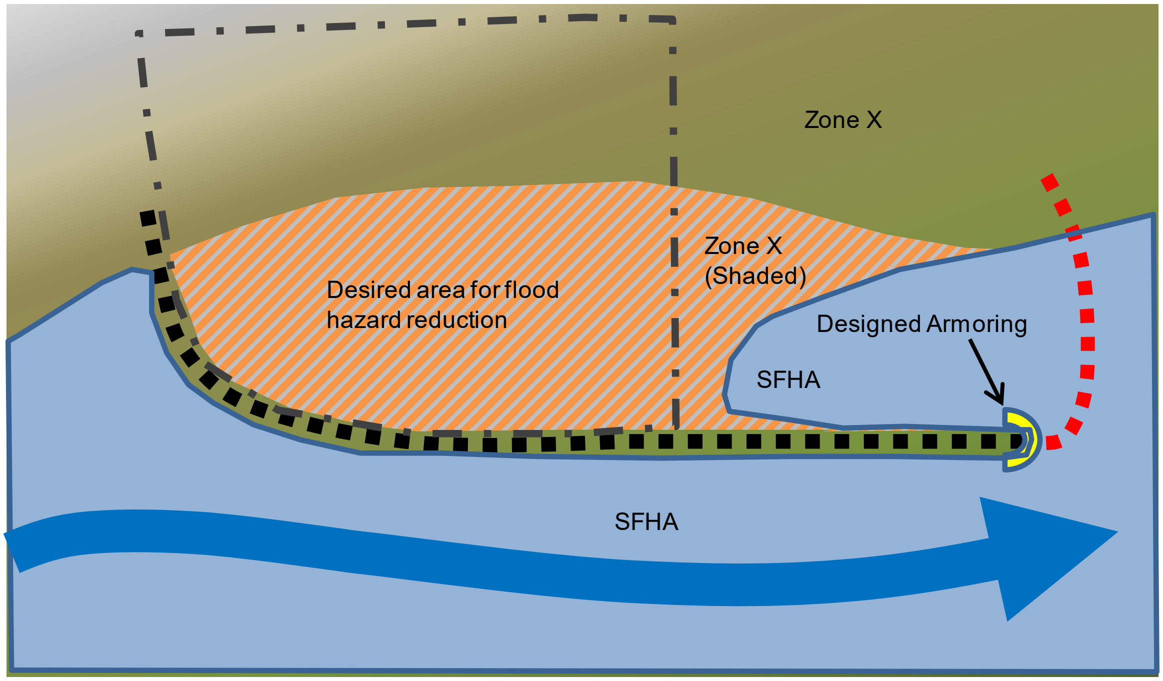



Figure 6: Levee System Tying into Non-Levee Reach

If a levee system designed to end in the absence of high ground at the downstream end does not meet the requirements of 44 CFR 65.10, but can be analyzed and mapped in accordance with the analysis and mapping procedures for non-accredited levees (See Chapter 6), the resulting flood hazard would be mapped as Zone D with the appropriate SFHA overlaid.

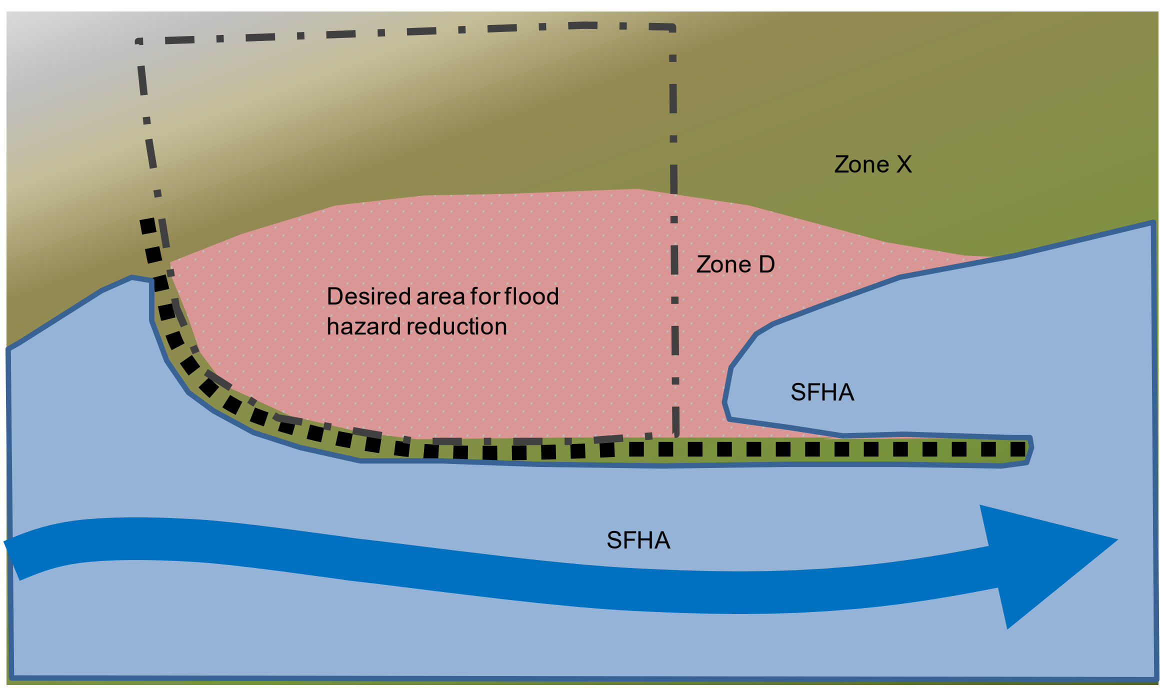



Figure 7: Non-Accredited Levee System

Before a levee system designed to end in the absence of high ground at the downstream end can be considered for accreditation or under the analysis and mapping procedures for non-accredited levees, the following three criteria must be met:

1. The levee system, including the downstream end, meets the full requirements defined in 44 CFR 65.10, except freeboard unless pursuing accreditation. But it will not be required to tie-in to high ground, which is required by 44 CFR 65.10.
2. The levee system be designed and constructed using sound engineering practices, and that the data certification specifically state that the downstream end of the levee system and the landward side exposed to any flooding conditions/loading be able to continue to meet design requirements and not “unravel” or result in the failure of the upstream levee reaches.
3. Any potential flooding that would come around the back, landward side of the downstream end of the levee be analyzed and mapped and shown on the FIRM as a SFHA.

For cases where the levee system ties into another levee or non-levee reach that has not been demonstrated to meet the requirements of 44 CFR 65.10, the certifying engineer must meet all the criteria above, as well as consider the situation where the other structure fails at the tie-in point and is analyzed with breach, overtopping, and/or natural valley analyses. The potential flooding from breaching, overtopping, or natural valley analyses on the non-accredited structure would be shown as SFHA, if this flooding creates backwater that impacts the landward side of the accredited levee system.

### 4.2.2 Other Federal Agency Accreditation Submittals

The federal agency certification requirements are cited at 44 CFR 65.10(e), which states the following:

> *In lieu of these structural requirements, a Federal agency with responsibility for levee design may certify that the levee has been adequately designed and constructed to provide protection against the base flood event.*

The structural requirements are considered those listed in 44 CFR 65.10(b)(1) through (7) which are required to be certified by a registered P.E. However, if the accreditation submittal is provided by a Federal agency with responsibility for levee design (e.g., USACE, U.S. Bureau of Reclamation [USBR]), that agency may provide a recommendation for accreditation of the levee system, and FEMA may require additional supporting data and documentation, as appropriate.

In these cases, FEMA will perform a completeness check of the submitted data and documentation and may require a statement from the submitting Federal agency regarding recommendations for accreditation involving elements that do not directly align to the requirements for 44 CFR 65.10. Formally adopted operation, maintenance and emergency preparedness plans, and the most recent levee inspections are required to be submitted to FEMA for the entire levee system before FEMA will depict the levee system as accredited on a FIRM.

FEMA will review the formally adopted operation, maintenance and emergency preparedness plans to ensure that the requirements of 44 CFR 65.10(c) and (d) are met. In addition, the community or entity seeking accreditation will be required to provide interior drainage analyses and resulting inundation maps to meet the requirements of 44 CFR 65.10(b)(6) if that information was not provided by the Federal agency.

USACE has historically provided data to FEMA in support of levee accreditation through various means including through the flood risk study, MT-2, and PAL processes, in accordance with the requirements of 44 CFR 65.10(e). USACE also provided data to FEMA in accordance with EC 1110-2-6067, USACE Process for National Flood Insurance Program (NFIP) Levee System Evaluation, which expired on August 31, 2012, and which superseded prior USACE technical letters and all other USACE policy memoranda related to evaluating levee systems with respect to FEMA accreditation under the NFIP. These evaluations provided direct findings for most of the requirements of 44 CFR 65.10. It should be noted that USACE is transitioning away from utilizing this deterministic methodology to a risk-informed approach for levee systems with respect to accreditation for the NFIP.

USACE and FEMA have agreed to specific cases when information collected by USACE through their Levee Safety Program will inform some or all requirements for levee system accreditation for the NFIP. When USACE performs levee inspections and screening level risk assessments, USACE will identify when a subset of the requirements of 44 CFR 65.10 has been met or not, using the terminology of positive finding (when met), negative finding (when not met), and inconclusive (when there is not enough information to make a determination). FEMA does not need to request additional information or documentation related to a specific 44 CFR 65.10 criteria in which USACE has provided a positive or negative finding, unless there is additional information that this finding needs verification. In addition, USACE is now providing FEMA with a probabilistic determination based on a risk-informed approach to assess flood risk for select levee systems with respect to accreditation for the NFIP. These USACE risk assessments provide a systematic, evidence-based approach for estimating and describing the likelihood and consequences of existing and future risk associated with levee systems.

When USACE performs risk assessments, it will include a recommendation related accreditation for the NFIP, if a recommendation can be made. These risk assessments include Quantitative Risk Assessments (QRAs) and Semi-Quantitative Risk Assessments (SQRAs), as defined by USACE, and are performed on complete levee systems. If the results of a SQRA or QRA have a sufficient level of assurance, USACE will either recommend or not recommend that the levee system be accredited for NFIP purposes. A levee system recommendation to accredit will only be provided when all segments of the levee system, including any non-project segments (considered by FEMA as non-levee reaches; see Chapter 7 of this document), have been explicitly evaluated in the risk assessment. SQRAs may result in an accreditation recommendation, or, depending on the level of detail and degree of uncertainty, may provide an inconclusive recommendation related to accreditation for the NFIP. QRAs will have sufficient detail to make a levee accreditation recommendation each time.

SQRA and QRA reports will identify additional considerations such as interior drainage studies that are also required for NFIP levee accreditation but are not addressed in the risk assessment.

USACE districts will coordinate with the appropriate FEMA Regions before the start of each SQRA or QRA to determine the appropriate level of engagement with FEMA. As soon as the FEMA Regional Office staff is made aware of a planned or ongoing USACE QRA or SQRA, FEMA

Headquarters must be notified and engaged throughout the process to ensure documentation of lessons learned and consistent implementation of best practices. USACE will coordinate with FEMA throughout the risk assessment process, providing visibility on the data and hydrologic and hydraulic modeling being used for the risk assessment. This engagement allows FEMA to determine if potential changes to the effective base flood are warranted, if and how USACE modeling maybe used to update the FIRM if appropriate, and whether interior drainage is addressed in the risk assessment.

It should be noted that both the SQRA and QRA may be based on hydrologic and hydraulic modeling that is different than the modeling used to develop FEMA's regulatory BFEs and flood hazard mapping on the effective FIRM. As part of the SQRA and QRA, USACE evaluates the levee system performance for several flood elevations ranging from the toe to the top of the levee. Based on this analysis, USACE may determine a 1-percent-annual-chance exceedance flood elevation that is different from FEMA's BFE. When reviewing a levee accreditation recommendation provided by USACE, FEMA will compare the effective BFE to the range of flood elevations evaluated by USACE to ensure that the effective BFE falls within this range. If it does not, FEMA will need to determine if the BFE and supporting modeling in this area should be updated based on consultation with USACE. Note that USACE modeling may require additional analyses and refinements to meet FEMA's regulatory requirements, guidance, and standards for flood hazard mapping for the NFIP.

It is also possible that the freeboard provided above regulatory BFE or 1-percent-annual-chance exceedance flood elevation determined by USACE may be less than the minimum freeboard requirement of 44 CFR 65.10(b)(1), and accreditation of this levee system may still be possible. It is not anticipated that a recommendation for accreditation will be made when a regulatory BFE or 1-percent-annual-chance exceedance flood elevation exceeds the height of the levee system. In any case where the minimum freeboard requirement of 44 CFR 65.10(b)(1) is not met in comparison with the regulatory BFE or 1-percent-annual-chance exceedance flood elevation determined by USACE, the FEMA Regional Office should consult with FEMA Headquarters.

Each time a USACE district conducts a levee inspection, it will identify when a levee segment meets or does not meet a specified subset of requirements in 44 CFR 65.10 as identified in the inspection checklist by providing a positive, negative, or inconclusive finding. Other information obtained from the inspections, such as identification of serious deficiencies, may also inform a NFIP levee accreditation decision. Therefore, it is important to consider the full inspection results and not just the limited identified 44 CFR 65.10 criteria. Inspections are performed on a levee segment basis and caution should be taken to ensure that inspection results are considered collectively, in addition to the results for all the levee segments for the levee system, when using inspection information to inform a levee accreditation decision. It will also be important to consider the most recent risk assessment result for a levee system. At a minimum, USACE district will notify FEMA directly when the inspection results in a negative finding for any of the criteria. FEMA will consider USACE Program levee system inspection results (and corresponding risk assessment results as necessary) and will determine if any additional coordination is needed with the community and the levee sponsor for NFIP mapping purposes.

Communities or parties seeking accreditation, or recognition of a levee system as reducing the base flood hazard on FIRMs, must provide data and documentation to FEMA in accordance with

44 CFR 65.10. In cases when information collected by USACE through their Levee Safety Program will inform some of the requirements for levee accreditation, the communities or parties seeking accreditation will have to provide information to fulfill the remaining requirements. Because some of the USACE Levee Safety Program activities are conducted on a levee segment basis, caution should be taken to ensure information is used, presented, and considered collectively on a levee system basis when using USACE information to inform a levee accreditation decision.

USACE risk assessments and inspections provide direct findings that may meet all or a specified subset of requirements in 44 CFR 65.10, respectively. Even though there may not be a finding associated with a specific 44 CFR 65.10 requirement, the information provided by USACE still may be useful to inform a NFIP levee accreditation decision. FEMA will review the information provided by USACE and will determine if additional coordination is needed with the community and the levee sponsor for NFIP mapping purposes. If a community or other entity seeks accreditation of their levee system, FEMA and USACE will work together to engage the community and levee sponsor to explain what, if any, information provided by USACE meets the requirements of 44 CFR 65.10, and what additional information the community or levee sponsor will need to provide to FEMA to meet the remaining requirements of 44 CFR 65.10.

More information on coordination with other Federal agencies as well as a list of potential agencies involved in levee design and construction can be found in Chapter 8 of this document.

### 4.2.3 Continued Accreditation

Accreditation of a levee system requires the levee owner to demonstrate that the levee system meets, and continues to meet, the requirements of 44 CFR 65.10. Therefore, accreditation is not a one-time activity, and over time, factors may change that require FEMA to reassess accreditation status. These factors can include the expiration of the certification of data by a certifying engineer, endorsement of accreditation by a Federal agency, changes to the hydrologic or hydraulic conditions of the flooding source that necessitates a restudy, and documented deficiencies or lack of maintenance.

### 4.2.4 Expiration of Data Certification or Endorsement

A certifying engineer or federal agency may choose to place an expiration date on the use of the data and documentation for accreditation of a levee system. This expiration date will be tracked by FEMA in the NLD. Once the certification of this data and documentation has expired, FEMA will no longer consider the levee system as meeting the requirements of 44 CFR 65.10 and will initiate engagement with the levee owner and impacted community regarding the submittal of certified data and documentation demonstrating the levee system continues to meet the requirements of 44 CFR 65.10 to remain accredited. If this certified data and documentation cannot be provided in a timely manner, FEMA may initiate the analysis and mapping procedures for non-accredited levees (see Chapter 6) to update the flood hazard information impacted by the levee system. At no time shall a levee system with an expired certification of data be remapped as accredited without updated documentation and a certification of data by a registered P.E. or endorsement from an authorized Federal agency.

### 4.2.5 Updated Modeling along an Accredited Levee

During any update to the FIRM, the flood hazards associated with levee systems should be re-evaluated for all levee systems located along newly studied or restudied flooding sources. If the new or updated study impacts a levee system accredited in accordance with 44 CFR 65.10, the levee owner will be asked to provide data and documentation demonstrating the levee continues to meet the requirements of 44 CFR 65.10 based on the updated hydraulic loadings.

If the hydraulic loading and flood hazard information (BFE, velocities, duration, etc.) from the updated study is less than those used in the previous accreditation documentation for the requirements of 44 CFR 65.10(b), the levee may retain its accreditation status pending submission of the documents meeting the requirements of 44 CFR 65.10(c) and (d), and confirmation from the levee owner that the levee has not been structurally modified since the prior certification of data. In cases where a levee system or levee appurtenance has undergone structural modifications since the previous certification of data, submittal of data and documentation meeting the requirements of 44 CFR 65.10(b) and (e) may also be required.

If the hydraulic loading and flood hazard (BFE, velocities, duration, etc.) from the updated study is greater than those used in the previous accreditation documentation for the design requirements under 44 CFR 65.10(b), the levee owner must submit updated certified data and documentation based on the updated loading and flood hazard information demonstrating the levee system continues to meet the minimum requirements of 44 CFR 65.10. Understanding that the analysis and data collection may require additional time, Regions should take this into consideration when planning project schedules.

In some instances, an updated mapping project may include a levee system that was accredited through the LOMR process. The above requirements for updated certification of data and documentation would also apply to levees accredited through the LOMR process, granted the information provided in support of the LOMR reflects the current conditions of the levee system.

If the new or updated study impacts a levee system that has not been accredited in accordance with 44 CFR 65.10, FEMA will proceed with implementing the analysis and mapping procedures for non-accredited levees, as appropriate.

### 4.2.6 Noted Structural or Maintenance Deficiencies

FEMA reserves the right to re-evaluate the accreditation status of a levee system if structural or maintenance deficiencies are noted that may cause concern over the validity of the current flood hazard noted on the FIRM. This re-evaluation of the levee status on the FIRMs may be triggered based on inspection reports of State or Federal agencies or performance of the levee system in the context of a base flood event or less. If deficiencies are noted that impact requirements of 44 CFR 65.10, FEMA will coordinate with the levee owner as outlined under Chapter 6 of this document for resolution and additional data collection, as needed. If resolution is not accepted in a timely manner, FEMA will proceed with action to update the flood hazard on impacted FIRM(s) appropriately.

## 4.3 Levee Accreditation Reviews

This section outlines the process FEMA will follow when reviewing levee accreditation submittals. This process shall be the same for all types of submittals, including those for new and existing levee systems that have not yet been evaluated and identified during the Discovery phase, PALs, Letters of Map Change (LOMCs), Physical Map Revisions (PMRs), and accredited levee systems impacted by updated hydraulic modeling along the water body. The review process in this section applies to hydraulically independent levee systems defined in Chapter 2 of this document.

FEMA does not require communities or levee owners to accredit their levee systems, however, in accordance with NFIP regulations, communities or other parties seeking recognition of a levee system on NFIP maps may provide data and documentation demonstrating compliance with regulations cited in the 44 CFR 65.10. Once compliance with 44 CFR 65.10 is determined by FEMA, the hydraulically independent levee system will be accredited on NFIP maps, reflecting the appropriate NFIP SFHA and risk premium rate zones for levee-impacted areas. Accreditation by itself is not a guarantee or warranty of performance of levee systems during a flooding event. It is a determination that the levee system meets the minimum design, operation, and maintenance standards set forth in 44 CFR 65.10, to be shown on the NFIP map as providing flood hazard reduction from the base flood event.

The preferred format for the submittal materials is an electronic PDF with each volume clearly labeled with state, county, community, levee names and document chapter. The backup data in its native electronic format is recommended. However, FEMA may request data in PDF format in cases when data are generated using proprietary software that is not commonly used.

### 4.3.1 FEMA Completeness Check

The review of the levee accreditation submittal is a completeness check. It is neither a technical review nor an evaluation of design, it also is not performed to determine how a levee will perform during a flood event. The incoming data supporting 44 CFR 65.10 requirements must be certified by a registered P.E., and licensed by their respective states, or by a federal agency with responsibility for levee design. The completeness check is performed to ensure that all data demonstrating compliance with 44 CFR 65.10 is submitted, so FEMA can delineate the appropriate NFIP SFHA and risk premium rate zones on NFIP maps. However, if FEMA is presented with conflicting data, a more in-depth review can be performed. This additional and more in-depth review would require approval and consultation with FEMA Region and/or HQ, as appropriate. Although FEMA performs a completeness check for 44 CFR 65.10 compliance, submittals must include backup data and supporting information for all calculations demonstrating the certified conclusions for each requirement. Certified summary reports without all backup data are not acceptable.

To make the levee accreditation process efficient, the reviewer may stop the review at any point if basic data requirements are not met. The examples of submittals lacking basic data includes, but not limited to, submittals with no backup data, lack of certification signatures, and submittals with data not organized intelligibly.

If the reviewer decides to stop the review, a data request should be compiled and sent to the requester noting the extent of what has already been reviewed and that additional data requests might be forthcoming once the review is restarted.

FEMA suggests that the data is submitted in the FEMA recommended data organization noted in the document titled FEMA Suggested Tabbed Submission for 44 CFR 65.10 Accreditation Material. This document allows for a cover page for each certification requirement contained in 44 CFR 65.10(b)(1) through (b6). Completeness check of the accreditation materials submitted in a format other than that presented in this document may be significantly delayed or the review may stop moving forward were the basic data appear to be missing due to poor data organization.

#### 4.3.1.1 44 CFR 65.10 Accreditation Requirements Reviews

This portion of the completeness check is performed to verify whether the submittal has complete data to meet the minimum requirements of 44 CFR 65.10.

#### 4.3.1.2 Freeboard Check

The data submitted must contain a profile that shows adequate freeboard exists. The reviewer shall verify the freeboard evaluation profile uses appropriate BFEs from the source consistent with sources recommended in Subsection 4.1.1 compared to the top of levee elevation. The reviewer shall request additional data in cases where the submitted data is not detailed enough to reasonably evaluate the freeboard of the levee under request for accreditation, and the submittal does not provide information about the upstream and downstream tie-ins. The evaluation criteria of upstream and downstream tie-ins shall be consistent with the requirements detailed in Subsection 4.1.2 or Subsection 4.2.1 of this document. The reviewer shall also verify freeboard information shows the levee meets all the requirements of 44 CFR 65.10(b)(1)(i), described in Section 4.1.2 of this document.

In cases where levee does not meet the minimum freeboard requirements, the reviewer shall check whether the submittal provides data supporting the levee meeting the requirements of 44 CFR 65.10(b)(1)(ii). Information on requirements for freeboard exceptions is in Subsection 4.1.2 of this document. In cases where a freeboard exception is requested, the reviewer shall verify that the levee evaluations of the other 44 CFR 65.10 criteria are evaluated using the loading conditions estimated for the freeboard exception requirements.

In case of the levees in coastal areas the reviewer shall check if the data submitted demonstrates the levee meets all the requirements of 44 CFR 65.10(b)(1)(iii), as described in Subsection 4.1.3 of this document. Occasionally, exceptions to the minimum freeboard for the levees in coastal areas are allowed. In these circumstances, the reviewer shall check the data to verify whether the submitted data meets the requirements of 44 CFR 65.10(b)(1)(iv), described in Subsection 4.1.3 of this document and coordinate with the FEMA Regional Office and FEMA Headquarters.

#### 4.3.1.3 Closures Check

The data submitted shall meet all the requirements outlined in Subsection 4.1.4 of this document. Closures include all levee openings and low points noted in Subsection 4.1.4 of this document. The reviewer shall check the data to verify the submittal, includes information on the numbers of closures, closure location, invert elevations, pictures, and type of closure. The reviewer shall verify consistency in the closure data between submitted reports, as-built plans, operation and maintenance plans, and emergency preparedness plans, when applicable.

The reviewer shall also verify that operations and maintenance requirements of the closures are fully met for the completeness of the closure requirements. Also, all closures must be addressed in the submitted inspection reports.

#### 4.3.1.4 Embankment Protection Check

The data submitted shall include technical documentation regarding the existing embankment protection. The reviewer shall check the submittal documentation to verify whether the data include an analysis addressing existing protection of the levee embankment and levee foundation from erosion. The analyses shall consider all but not limited to, the factors mentioned in the Subsection 4.1.5 that might impact the erosive forces acting on the levee embankment and foundation. In cases where some of the factors are not accounted for (such as wave action, ice loading, etc.), the reviewer shall seek a written justification for the omission from the certifying engineer. Analysis must at minimum use loadings associated with the effective base flood event.

The reviewer shall check the submittal to verify the type of current embankment protection for the entire levee system, references to accepted documents to demonstrate current protection is adequate against the erosive forces acting on the levee embankment and foundation during the base flood, and backup data supporting the analysis is provided.

USACE has developed reference materials for embankment protection evaluations that may be used as technical reference. Other Federal agencies, such as USBR, may have technical references that may be leveraged. It is up to the certifying engineer to identify and use the methodology that is most appropriate for the levee being evaluated, other evaluation approaches deemed applicable by the certifying engineer may also be considered if warranted and approved.

#### 4.3.1.5 Embankment and Foundation Stability Check

The data submitted shall include technical documentation addressing the embankment and foundation stability of the levee. The reviewer shall check the submitted documentation to verify whether the submitted data includes a seepage and stability analyses demonstrating the levee and foundation stability during the base flood or less frequent events. In cases where flood control structures are flood walls the reviewer shall also check the analyses demonstrating adequate strength and stability of flood walls are also provided. The analyses shall at the minimum consider the stability conditions mentioned in the Subsection 4.1.6 that might impact the stability of the flood control structures and their foundation.

The reviewer shall check the submittal to verify the submittal identifies the location of evaluated flood control structure section, and that justification is provided for its selection. The reviewer shall also check submittal to verify it includes the backup data supporting the analysis.

The reviewer shall also review the submitted documentation to verify loading conditions used in the analysis are consistent with the base flood used to evaluate other requirements of 44 CFR 65.10.

USACE has developed reference material for levee and foundation stability evaluations that may be used as technical reference. It is up to the certifying engineer to identify and use the methodology that is most appropriate for the levee being evaluated, other methodologies to evaluate levee and foundation stability deemed applicable by the certifying engineer may also be considered if warranted and approved.

#### 4.3.1.6 Settlement Check

The data submitted shall include technical documentation that assesses the potential settlement of the levee and reduced freeboard over time. The reviewer shall check the submitted data to verify it includes settlement analysis, information on the current top of levee elevations, and subsidence evaluation, where applicable. The reviewer shall check that the submitted documentation has information to demonstrate that freeboard will be maintained within the minimum standards for the entire levee system after settlement and applicable subsidence are considered. The minimum freeboard applied for evaluation shall correspond to the requirements established in Subsection 4.1.7.

The reviewer shall check the submittal report to verify the analysis considers all, but not limited to, the factors mentioned in Subsection 4.1.7, that might impact the settlement and future freeboard of the levee. In cases where some of the factors are not considered, the reviewer shall request written justification from certifying engineer for omission. The reviewer shall check the submitted data to verify the backup data supporting the analysis is included.

USACE has developed reference material for settlement evaluations that may be used as technical reference. Other Federal agencies, such as USBR, may have technical references that may be leveraged. It is up to the certifying engineer to identify and use the methodology that is most appropriate for the levee being evaluated. Other approaches to evaluate a levee's settlement and estimating future loss of freeboard deemed applicable by the certifying engineer may also be considered if warranted and approved.

#### 4.3.1.7 Interior Drainage Check

The reviewer shall verify the submittal includes a hydrologic and hydraulic analysis of the flooding sources on the landside of the levee, identifies the source(s) and extent of flooding due to the flooding sources on the landside, includes a topographic work map showing the extent of any flooded area, and in cases where the average depth of flooding is greater than one-foot, the water-surface elevation of the base flood. New BFEs and/or SFHAs resulting from the interior drainage analysis are subject to the appeal process set forth in 44 CFR Part 67.

The reviewer shall verify the analyses submitted are performed based on the joint probability of interior and exterior flooding, and the capacity and operation of the facilities to evacuate interior floodwaters in the analysis is consistent to the operation and maintenance plans submitted for the levee system.

USACE has developed reference material for joint probability analysis that is commonly used as technical reference for interior drainage analysis. However, analyses performed using other relevant agency or local jurisdiction publications on joint probability are also accepted. The reviewer shall verify the methodology used for interior drainage analysis comply with the methods discussed in Subsection 4.1.8.

The reviewer shall perform a thorough H&H review for all flooding sources identified within the impacted drainage area. The review of the interior drainage analysis shall involve evaluation of the submitted data to check the methodology used complies with the requirements of 44 CFR 65.10 detailed in Subsection 4.1.8 of this document, as well as meets current FEMA G&S for H&H analyses. The reviewer shall check the data submitted to verify the digital versions of the models used as well as any background calculations or references are included.

#### 4.3.1.8 Other Design Criteria Check

In unique situations FEMA may require that additional design criteria and analysis be submitted. The reviewer shall coordinate with FEMA to verify such additional design criteria is applicable for the levee under evaluation. When additional design criteria are applicable, the reviewer shall verify the analysis and design addressing the additional design criteria requested by FEMA and the backup data is provided.

#### 4.3.1.9 Operation Plans and Criteria Check

The reviewer shall verify that the submittal includes an officially adopted operation plan that includes information on interior drainage systems, if any, and all closure structures or devices. The reviewer shall check the submitted package includes official adoption documentations the plan meets all the requirements of 44 CFR 65.10(c) as described in Subsection 4.1.10, and it corresponds with the other sections of the submittal and backup data.

#### 4.3.1.10 Emergency Preparedness Plan Check

The levee accreditation submittal shall also include an emergency preparedness plan. The plan must comply with all the emergency preparedness plan requirements discussed in Subsection 4.1.10. Some of the commonly used emergency preparedness plan guideline documents are also provided in this subsection.

The reviewer shall verify the submittal include an officially adopted emergency preparedness plan and it meets the minimum requirements discussed in Subsection 4.1.10. In cases where emergency preparedness plan is a part of the levee's operation plan a separate official adoption document is not necessary.

#### 4.3.1.11 Maintenance Plans Check

The reviewer shall verify the submittal includes an officially adopted maintenance plan, verify the plan documents the formal procedure that addresses all the requirements of 44 CFR 65.10(d) as described in Subsection 4.1.10, and the plan corresponds to other sections of the submittal and backup data.

The reviewer shall also verify that both the operation and maintenance plans are prepared for the specific levee for which accreditation is requested. In cases where generic O&M plans, non-specific to the levee system, i.e., plans that cover an entire county or State is used, they are only used as reference and the submitted operation and maintenance plan also include operational and maintenance procedure specific to the levee requested for accreditation.

#### 4.3.1.12 Certification Requirements Check

The reviewer shall verify the data submitted, associated with the requirements of 44 CFR 65.10(b)(1) through (7), are certified by a registered PE, licensed by the appropriate State. If the data are submitted by a Federal agency with responsibility for levee design, the reviewer shall confirm that documentation consistent with Subsection 4.2.2 is provided.

The reviewer shall also check the submitted data to verify a certified copy of as-built plans are submitted and they correspond with other submitted data.

When as-built plans from levee's original construction drawings are used, the as-builts generally are updated adding notes and updates at the locations where the leveraged data does not correctly represent the current condition. It is the certifying engineer's responsibility to ensure the submitted data are still valid. The reviewer shall verify the submittal package in its entirety is certified by a PE.

Once the completeness check is finished and all required components have been submitted and deemed complete, FEMA will accredit the corresponding levee on the affected NFIP map(s). If any component is found to be missing or erroneous and the requester cannot provide missing data to show compliance with 44 CFR 65.10, FEMA will not accredit the levee and reserves the right to suspend or deny the request.

#### 4.3.1.13 Other Checks

This portion of the checks are performed to verify the submitted data complies with other regulatory and FEMA standards.

#### 4.3.1.14 Regulations

The reviewer shall verify the requester has confirmed that the all the applicable permits related to the levee have been obtained. The permits include but, are not limited to the regulations mentioned in Subsection 4.1.11. The verification is generally through communication with the requester. A record of these communications shall be kept in a file. In cases where the requestor provides the information, the data submitted shall be organized and kept in a file.

#### 4.3.1.15 New Hydrologic and Hydraulic Analyses

If new hydrologic and/or hydraulic analyses are submitted as part of a levee certification package, the submittal must follow the process outlined in Subsection 4.4.1.

#### 4.3.1.16 Inspection Reports

The reviewer shall verify the documentation, including tests and inspection reports that are required by regulation under 44 CFR 65.10(c)(1)(iii) and 65.10(c)(2)(iv), are provided.

All other applicable inspection reports from either USACE or other sources must be considered as part of the review to ensure that any issues related to 44 CFR 65.10 have been addressed. The reviewer shall verify these documents are provided in the submittal.

#### 4.3.1.17 Levee System Cross Reference Check and Certified Reach Documentation

The reviewer shall verify that all components in 44 CFR 65.10 use the same flooding elevations and conditions, and that the entire levee system (if a system consists of different reaches) is considered in the submittal. In cases where the levee system provides flood hazard reduction from multiple flooding sources, the reviewer shall verify the certified analyses use flood elevations from the appropriate flooding source(s).

A certifying engineer may submit certified data and documentation for a levee reach that may not meet all components in 44 CFR 65.10 under the analysis and mapping procedure for non-accredited levee systems (see Chapter 6). In these instances, the submittal may not include data for the entire levee system. In these cases, the submitted package shall clearly identify the reach for which the data is applicable. The package shall also include all the necessary data to demonstrate the section under evaluation meets the definition of a levee reach. The reviewer shall perform the completeness check of the data, document the applicable procedure consistent with the analysis and mapping procedure for non-accredited levees, and clearly identify the levee reach for which the data is submitted. The reviewer shall inform FEMA and the requester that the data does not meet requirements for the full accreditation of the levee system.

### 4.3.2 Data Storage and Delivery

Once the accreditation package has been considered complete by FEMA or its designee, the applicable correspondence, complete accreditation package, and all applicable models will be provided to the mapping partner responsible for updating the FIRM with revised flood hazard information. Data will be captured under the applicable funded project and MIP case number as described in the Guidance Document No. 51, Data Capture – Workflow Details, and the Data Capture Technical Reference.

Complete levee accreditation packages that do not have a funded mapping project or accreditation data submitted through the MT-2 process will be captured and stored as laid out under Section 3.6 of this document.

## 4.4 Accredited Levee Mapping and Notes

### 4.4.1 New Hydrologic and Hydraulic Analysis

If a new hydrologic and/or hydraulic analysis for the exterior flooding source is submitted as part of a levee accreditation package, the package must be reviewed to determine that it meets FEMA criteria before it can be used to revise the effective BFEs. If the new hydrologic and/or hydraulic analysis indicates the base flood hazards are less conservative than the effective flood hazards, this review must occur and the effective BFEs must be updated before the levee can be accredited. However, if the new hydrologic and/or hydraulic analysis indicate the base flood hazards are more conservative than the effective flood hazards, the levee system may be accredited without revising the BFEs; FEMA will determine if a future revision based on the new analysis is warranted.

### 4.4.2 “With Levee” and Natural Valley Analyses

If a new hydrologic and/or hydraulic analysis is performed in an area with a levee, then both “with levee” and “natural valley” analyses must be performed. For accredited levees, the “with levee” analysis contains all of the 1-percent-annual-chance discharge riverward of the levee. The “natural valley” procedure assumes the levee does not impede floodflows. Because the “natural valley” analysis allows for additional conveyance and/or storage of floodwaters on the landward side of the levee, it typically results in lower BFEs than the “with levee” analysis.

If levees have been built on both sides of the flooding source, the “with levee” analysis assumes that the base flood discharge is contained between the two levees. However, a separate “natural valley” analysis is required for each levee. The “natural valley” analysis for the right levee should assume the left levee is in place and the “natural valley” analysis for the left levee should assume that the right levee is in place. This approach should also be used for analyzing the 0.2-percent-annual-chance flood or lesser events if requested.

Both the “with levee” and “natural valley” analyses should include all of the effective FIS flood frequency profiles and those flood frequency profiles required by current FEMA guidance to be analyzed for the project.

### 4.4.3 Flood Profiles

For accredited levees, the results of the “with levee” hydraulic analysis will be used to generate the Flood Profiles for the FIS Report. It is not necessary to generate Flood Profiles for the “natural valley” analysis unless specifically requested by the community and approved by FEMA.

### 4.4.4 BFE and SFHA Mapping

For accredited levees, the results of the “with levee” hydraulic analysis are used to map the BFEs riverward of the levee. The area landward of the levee will be mapped using water-surface elevations from the “natural valley” hydraulic analysis and will be mapped on the best available topography landward of the levee. The BFEs will be mapped landward of the levee as Zone X (shaded) to show the area with a reduced base flood hazard. The 0.2-percent-annual-chance flood will also be mapped landward of the levee as Zone X (shaded). These two areas of Zone X (shaded) will be differentiated by using the appropriate symbology and notes as described in the FIRM Panel Technical Reference. Any areas of residual risk and interior drainage flooding that fall within this area will be mapped as an SFHA, the area subject to inundation from the base flood.

### 4.4.5 Floodway Analysis and Mapping Methods

NFIP regulations and Standards SID 69 and 70 state:

> Floodway surcharge values must be between zero and 1.0 ft. If the state (or other jurisdiction) has established more stringent regulations, these regulations take precedence over the NFIP regulatory standard. Further reduction of maximum allowable surcharge limits can be used if required or requested and approved by the communities impacted… [and] If a stream forms the boundary between two or more states and/or tribes, either the 1.0-foot maximum allowable rise criterion or existing floodway agreements between the parties shall be used.

Coordination with communities may be necessary in establishing the floodway extents implementing the floodway analysis methodology described below. The community coordination process shall be in accordance to Section 2 of FEMA Guidance Document No. 79, Floodway Analysis and Mapping, accessible through the FEMA Flood Risk Analysis and Mapping webpage.

Accredited levee systems are assumed to be hydraulically significant levees, and floodways for areas impacted by accredited levee systems should be computed using the same procedures outlined in Chapter 6 of this document for hydraulically significant levees. Please refer to Section 6.19 of this document for a description of these methods.

### 4.4.6 Multiple Levee Scenarios

When multiple levee systems may reduce flood hazards for the same area, each system must be individually analyzed, and the higher BFEs from the "natural valley" analyses shall be used on the FIRM for the levee-impacted area. If an area is impacted by both an accredited levee and non-accredited levee systems, the area shall be mapped in accordance with the appropriate procedure for both the accredited and non-accredited levee systems. Refer to the Chapter 6 of this document for information about mapping non-accredited levees.

In some cases, where one or more levee systems are located within the levee-impacted area of a larger levee system (exterior levee system), such as interior drainage levees (interior levee system). In these cases, it may be possible that both levee systems are accredited (see Figure 8) and the natural valley floodplain for the interior levee will fall within the natural valley floodplain for the exterior levee. For mapping purposes, gutterlines should be used to separate the Zone X (shaded) areas impacted by the interior levees from the Zone X (shaded) area impacted by only the exterior levee system.

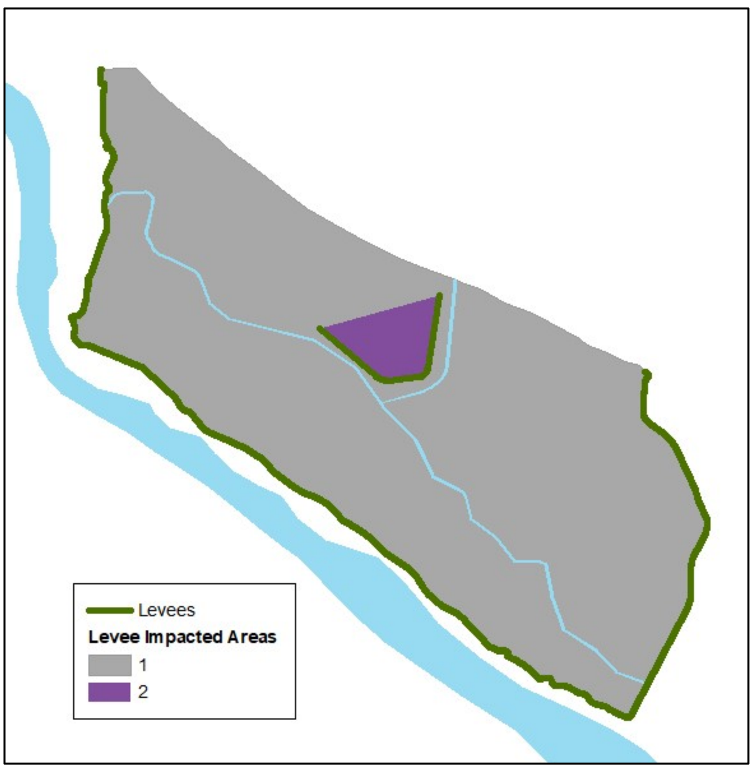



**Figure 8: Multiple-Levee Scenario**

In many cases, the interior levee system is designed to provide flood hazard reductions from an interior flooding source that may have an identified SFHA with a lower flood hazard than the exterior levee system. Three basic scenarios are possible:

1. If the exterior levee system is accredited (levee-impacted area 1 in Figure 8), the accreditation of any interior levee systems (levee-impacted area 2 in Figure 8) shall be based on the characteristics of the interior flooding sources to be shown with a reduced flood hazard.
2. If the exterior levee system is non-accredited (levee-impacted area 1 in Figure 8 ), the accreditation of any interior levee system (levee-impacted area 2 in Figure 8) shall be based on the characteristics of both the interior flooding sources and the exterior flooding sources to be shown with a reduced flood hazard.
3. If the interior levee system does not meet the accreditation requirements in either case, it shall be mapped using the procedures for non-accredited levee systems.

When no SFHA has been identified from any flooding source or interior drainage system associated with an interior levee, then an analysis of flood hazards shall be performed per Section 6.10 of this document to determine if a flood hazard exists.

### 4.4.7 Accredited Levee Notes to Users

When an accredited levee is shown on a FIRM panel, the Notes to Users section of the panel should include an accredited levee note as described in the FIRM Panel Technical Reference. This note should also be included in the Notes to Users section of the FIS Report.

### 4.4.8 Accredited Levees in the FIS Report

All accredited levees should be referenced in the FIS Report as explained in the FIS Report Technical Reference. This consists of including all levees in Table 9 of the FIS Report and referencing them on the Floodway Data Table as appropriate.

# 5.0 Provisionally Accredited Levee Systems

## 5.1 Provisional Levee Accreditation Overview

Levee owners and other levee stakeholders are responsible for providing 44 CFR 65.10-compliant design, operation, and maintenance documentation for FEMA to issue FIRMs recognizing the base flood hazard reduction capability of levee systems, also referred to as accreditation. In 2005, FEMA issued guidelines to clarify roles and responsibilities for levee flood hazard identification during a Flood Risk Project. FEMA further recognized that levee-impacted communities or other levee stakeholders may not have all documentation readily available to meet the requirements of 44 CFR 65.10, which could delay a Flood Risk Project. In 2007, FEMA issued guidelines establishing the PAL designation. The PAL designation provides communities and levee owners a specified timeframe to gather and submit 44 CFR 65.10-compliant data and documentation while allowing FEMA to move forward with preliminary and effective FIRMs while minimizing impact to the map production schedule.

A levee system is not eligible for a PAL designation if it is not shown as providing flood hazard reduction on the effective FIRM or on an attachment to a LOMR. A PAL designation can only be offered once for any given levee system.

This chapter provides guidance on determining if a levee system is eligible for a PAL designation and, if so, the process to offer the PAL, associated communication, and mapping. The determination of PAL eligibility requires coordination with Federal, State, and local levee stakeholders to support the decision-making process. Table 2 highlights the eligibility requirements that a levee system must meet to be considered for a PAL designation and provides the appropriate PAL category for the offer to the levee owner. If the levee system cannot meet any of the eligibility requirements listed in Table 2, then the levee system is not eligible for a PAL designation.

**Table 2: Summary of Minimum PAL Requirements**

| Non-USACE or USACE Program Levee System | PAL Category | Levee System Shown as Providing Base Flood Hazard Reduction on Effective FIRM | PAL Not Previously Offered for Levee System |
|---|---|---|---|
| Non-USACE Program Levee System | A | X | X |
| USACE Program Levee System | B | X | X |

## 5.2 PAL Eligibility Requirements

When levee systems are identified during a Flood Risk Project, a PAL designation may be considered in certain circumstances. Upon completing the levee system identification process, as specified in Section 3.3 of this document, within the project area, a Project Team member will perform an assessment of PAL eligibility. For a PAL eligibility determination, the levee systems identified should first be separated into three categories:

1. Levee systems not identified on the effective FIRM
2. Levee systems identified on the effective FIRM, but not shown as providing base flood hazard reduction
3. Levee systems identified on the effective FIRM and are shown as providing base flood hazard reduction

Only levee systems identified on the effective FIRM and shown as providing base flood hazard reduction can be considered for a PAL designation. If the levee system is shown as providing base flood hazard reduction on the effective FIRM, the Project Team must determine whether a PAL designation has been previously offered for the levee system. FEMA will only offer a PAL designation once to any given levee system. If a PAL designation was previously offered for the levee system, then the levee system is not PAL eligible.

To determine if a levee system is “PAL eligible”, FEMA must first establish, through coordination with USACE, whether the levee system is a USACE Program levee system or a non-USACE Program levee system.

For this document, USACE Program levee systems typically have recent inspection and risk assessment data, and are described in the following categories:

- Levee systems built by USACE that were authorized for construction by the U.S. Congress or by USACE continuing authorities (e.g., Section 205). These levee systems may contain levee projects constructed by non-Federal entities or other Federal agencies and incorporated into the USACE Program levee system by specific congressional action. In either case, these levee systems may be:

  - Owned or partially owned by USACE
  - Operated and maintained by USACE
  - Operated and maintained by a local sponsor (also referred to levee sponsor, public sponsor, or non-federal sponsor)
  - A combination of the above

- Non-Federal projects that are Active in the USACE Rehabilitation Program (pursuant to PL 84-99).

For non-federal projects that are Inactive in the USACE Rehabilitation Program, but were previously Active, USACE may still have data available to share with FEMA. As USACE continues to collect and expand information for all levees in the Nation in the NLD, it is best practice to look for information in the NLD and coordinate with USACE.

For this document, levee systems that do not meet the above criteria for a USACE Program levee system will be considered a non-USACE Program levee system, and this includes non-federal projects made Inactive in the USACE Rehabilitation Program.

Additionally, levee system symbology on the effective FIRM is important when determining PAL eligibility. If levee system symbology is not shown on the effective FIRM, the Project Team will consider the presence of a levee and the purpose of the structure. If levee symbology is not identified on an effective FIRM, but the structure implies base flood hazard reduction and has been verified to meet the definition of a levee system, a PAL designation may be considered.

Consideration of offering a PAL designation for a USACE Program levee system or a non-USACE Program levee system can follow different procedures and require different documentation, and as a result, have different PAL categories. The PAL categories are A: non-USACE Program levee system and B: USACE Program levee system. Table 2 shows that both categories of levee systems must meet the same general PAL eligibility requirements. Figure 9 (on page 61 of this document) provides a workflow process for assessment of PAL eligibility.

## 5.3 Considerations for Offering PAL to PAL Eligible Levee Systems

Even when a levee system is eligible for PAL Category A or B, FEMA may find that offering a PAL designation is not the best course of action. Therefore, additional considerations should be assessed before a PAL designation is offered.

If a levee system is determined to be PAL eligible per Section 5.2, the next step is for the Project Team to consider if:

- The levee system crest is at least 2 feet above the effective BFE.
- Operation and maintenance requirements of 44 CFR 65.10(c) and 44 CFR 65.10(d) have been met.

O&M plans under the jurisdiction of a federal or state agency, an agency created by federal or state law, or agency of a community participating in the NFIP is a regulatory requirement of 44 CFR 65.10(c) and 44 CFR 65.10(d). It is also information all communities are required to provide as part of a qualifying levee system for a PAL designation. FEMA will evaluate, before offering a PAL designation, whether an O&M plan under one of the jurisdictions cited above is available for the levee system. If the levee system does not have an O&M plan per 44 CFR 65.10(c) and 44 CFR 65.10(d), FEMA may not offer a PAL designation for the levee system.

Considerations and coordination with levee system stakeholders vary somewhat between non-USACE Program levee systems and USACE Program levee systems when deciding to offer a PAL designation and are described in detail in Subsections 5.3.1 and 5.3.2 and illustrated in the decision tree in Figure 9 on page 61 of this document.

### 5.3.1 PAL Category A – Considerations for Offering PAL for Non-USACE Program Levee Systems

The Project Team will assess the following considerations for offering a PAL designation when a levee system is determined to be eligible for PAL Category A:

- Where the levee system crest elevation and BFE are available, the Project Team should compare them to determine if the levee system crest elevation is at least 2 feet above the effective BFE. At no point along the levee system should the crest elevation be less than 2 feet above the effective BFE.
- Does information exist that indicates the levee system does not meet the design criteria of 65.10(b)?
- The levee owner must demonstrate that the levee system meets the operation and maintenance requirements of 44 CFR 65.10(c) and 44 CFR 65.10(d). The levee owner must be able to provide records of levee system maintenance and operation, as well as tests of mechanized interior drainage systems, if applicable.

Even for a non-USACE Program levee system, FEMA should first coordinate with USACE to determine if they have any data related to the levee system. The assessment to offer a PAL designation for non-USACE Program levee systems should then be performed in coordination with the local levee owner or the entity responsible for the levee system operation and maintenance.

It may be more difficult to obtain levee system crest elevation data for non-USACE Program levee systems. FEMA will need to work with the levee owner(s) to determine best available levee system crest elevation information and BFE information. FEMA will estimate the BFE(s). New or more up to date modeling may result in BFEs that are different than what is provided in the effective study. New or more recent BFEs may be used only if increases are demonstrated above the effective BFEs information. Water-surface elevation decreases in new or updated locations may not be used in place of the effective information.

FEMA recognizes that non-USACE Program levee systems may not have levee inspections and/or levee risk assessments like a USACE Program levee system may have. At a minimum, the levee owner must be able to provide records of levee system operation and maintenance, as well as tests of mechanized interior drainage systems, if applicable. If no operation and maintenance records exist, FEMA will not offer a PAL designation for the levee system.

### 5.3.2 PAL Category B – Considerations for Offering PAL to USACE Program Levee Systems

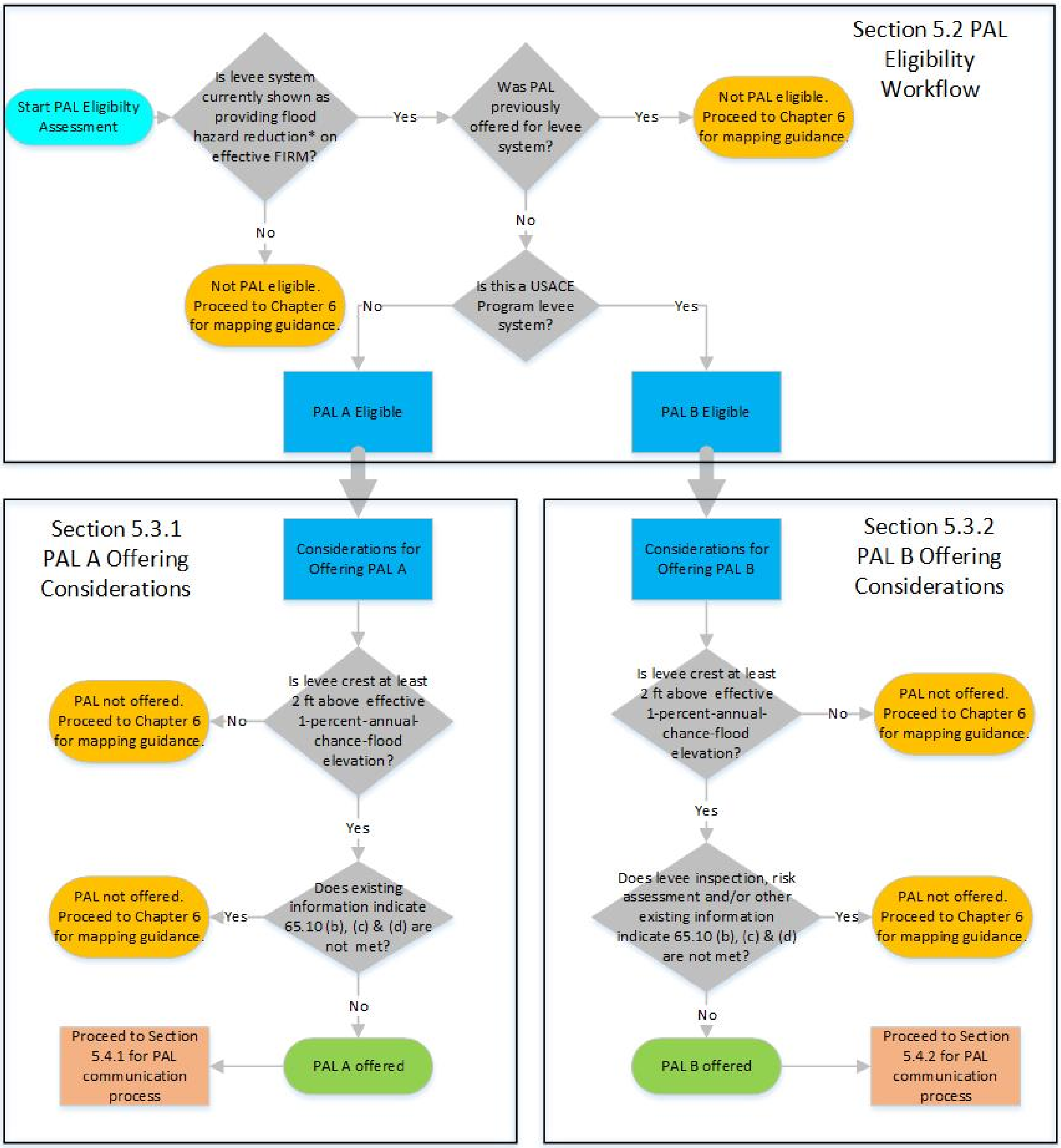
This subsection provides considerations that the Project Team should be assess before FEMA will offer a PAL designation to USACE Program levee systems determined to be eligible for PAL Category B. In addition, this subsection identifies the suggested coordination with USACE when assessing whether a PAL should be offered. FEMA and USACE will initially coordinate PAL assessment and then should jointly engage the local levee system sponsor and impacted communities after it has been agreed that the levee system is PAL eligible. Coordination with USACE will include requesting data and documentation concerning USACE Program levee systems to facilitate the assessment for offering a PAL designation.

The Project Team should assess the following considerations for offering a PAL designation when a levee system is determined to be eligible for PAL Category B:

- No readily available information indicates that the levee system does not have base flood risk reduction capability.
- Where the levee system crest elevation and BFE are available, the Project Team should compare them to determine if the levee system crest elevation is at least 2 feet above BFE. At no point along the levee system, can the crest elevation be less than 2 feet above BFE.
- Does information exist that indicates the levee system does not meet the design criteria of 44 CFR 65.10(b)?
- The levee owner must demonstrate that the levee system meets the operation and maintenance requirements of 44 CFR 65.10(c) and 44 CFR 65.10(d).
- For USACE Program levee systems, levee inspections and risk assessments provide valuable information to help determine if the above-mentioned criteria may be met for the levee system.

In some cases, new or more up to date modeling may result in BFEs that are different than what is provided in the effective study. New or more recent BFEs may be used only if increases are demonstrated above the effective BFEs information. Water-surface elevation decreases in new or updated locations may not be used in place of the effective information.

For non-Federal levee systems that have been placed on Inactive status in the USACE Rehabilitation Program, the FEMA Regional Office will obtain a copy of the USACE notification letter to the levee owner informing the owner that the levee system status has been changed from Active to Inactive. They will also coordinate with the appropriate USACE District office to determine whether the levee owner should be offered a PAL designation for the levee system.




Footnote: * represents the 1-percent-annual-chance flood hazard

**Figure 9: PAL Determination Decisions Tree**

## 5.4 PAL Communication and Coordination Processes

This section discusses the communication and coordination processes followed by FEMA, Project Team members, levee owners, and USACE once a levee system has been identified as being eligible for a PAL designation per the criteria outlined in Sections 5.2 and 5.3 of this document. This section also discusses the required PAL submission and 44 CFR 65.10-required data and documentation submission from the levee owner to FEMA. Levee systems not eligible for a PAL designation should be evaluated through analysis and mapping procedures for non-accredited levee systems and associated engagement. See Chapter 6 of this document for more information regarding non-accredited levee systems.

### 5.4.1 PAL Category A

The Project Team will prepare an initial notification letter for the FEMA Regional Office to send to the appropriate levee owner(s) to identify the levee system(s) that meet the criteria in Subsection 5.3.1 of this document and are, therefore, PAL eligible. The FEMA letter will describe the PAL category and the requirements and supporting documentation to enter a PAL agreement with FEMA.

The following attachments will accompany the initial notification letter sent to the levee owner(s) of non-USACE Program levee systems:

- A description of the requirements to meet 44 CFR 65.10
- An agreement to accept the PAL designation (agreement for Category A), for the levee owner(s) to sign and return to FEMA before the 91st day following the date of the initial notification letter. FEMA will send a similar agreement to levee-impacted community(ies).

Once the FEMA Regional Office sends the initial notification letter for Category A, the levee owner will have 90 days to return the PAL submission. The PAL submission requirements are as follows:

- An agreement signed by the levee owner(s) stating that the mapping of the PAL on a FIRM (PAL designation) is warranted because the levee system can be demonstrated to meet the requirements of 44 CFR 65.10, and that data demonstrating such will be provided to FEMA within 24 months. A similar, signed agreement must be provided by any levee impacted community(ies).
- A copy of the adopted operation and maintenance plan for the levee system.
- Records of levee system maintenance and operation, as well as tests of the mechanized interior drainage systems, if applicable.

Any levee owner that signs a PAL agreement must submit 44 CFR 65.10-compliant data and documentation within 24 months of the 91st day following the date of the initial notification letter. Levee owners may provide 44 CFR 65.10-compliant data to FEMA at any point within this 24-month timeframe and are encouraged to do so as soon as possible. In addition, the levee owner(s) must submit a progress report to FEMA 12 months after signing the PAL agreement to document progress toward obtaining 44 CFR 65.10-compliant data and documentation.

### 5.4.2 PAL Category B

The Project Team will prepare an initial notification letter for the FEMA Regional Office to send to the appropriate levee owner(s) to identify the levee system(s) that meet the criteria in Subsection 5.3.2 of this document and are, therefore, PAL eligible. A copy of this letter will be sent to the appropriate USACE District office for awareness. The FEMA letter will describe the PAL category and the requirements and supporting documentation to enter a PAL agreement with FEMA.

The following attachments will accompany the initial notification letter sent to the levee owner(s) of USACE Program levee systems:

- A description of the requirements to meet 44 CFR 65.10, Mapping of Areas Protected by Levee Systems.
- An agreement to accept the PAL (agreement for Category B), for the levee owner(s) to sign and send back to FEMA before the 91st day following the date of the initial notification letter. FEMA will send a similar agreement to levee impacted community(ies).

When the levee system is fully or partially owned by USACE, FEMA will coordinate with the USACE District office and other levee owner(s), if any, to determine if the levee owner(s) intend to sign a PAL agreement.

Once the FEMA Regional Office sends the initial notification letter for Category B, the levee owner will have 90 days to return the PAL submission. The PAL submission requirements are as follows:

- An agreement signed by the levee owner(s) stating that the PAL designation is warranted because the levee system can be demonstrated to meet the requirements of 44 CFR 65.10, and that data demonstrating such will be provided to FEMA within 24 months. A similar, signed agreement must be provided by any levee impacted community.

Any levee owner that signs a PAL agreement must submit 44 CFR 65.10-compliant data and documentation within 24 months of the 91st day following the date of the initial notification letter. Levee owners may provide 44 CFR 65.10-compliant data to FEMA at any point within this 24-month timeframe and are encouraged to do so as soon as possible. In addition, the levee owner(s) must submit a progress report to FEMA 12 months after signing the PAL agreement to document progress toward obtaining 44 CFR 65.10-compliant data and documentation.

### 5.4.3 Timing of Initial Notification Letter

To minimize the risk of the PAL designation expiring prior to the effective date of the FIRM panel impacted by the PAL note, ideally the initial notification letter from FEMA should be timed such that the signed PAL agreements from levee owners and impacted communities are received before FEMA issues the Preliminary FIRM as indicated in Figure 10.

For example, an initial notification letter could be provided after KDP 2. This would allow the 90-day PAL offer period (beginning the date of the initial notification letter and ending 90 days later) to expire before the conclusion of the Quality Review 3 (QR3) review and the result of the PAL offer could be reflected on the Preliminary FIRM. Coordination with the QR3 reviewer may be necessary to allow the PAL note to be shown on the FIRM before the expiration of the PAL offer period and the QR3 review should not be deemed complete before to the 91st day past the date of the initial notification letter. This timing for the QR3 review to overlap the PAL offer period reduces, but does not eliminate, the risk of the 24-month PAL period expiring before the effective date of the FIRM.

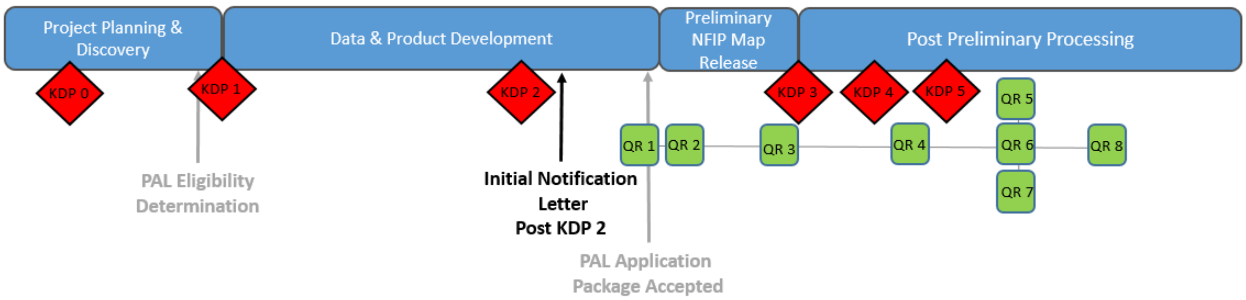



**Figure 10: Initial Notification Letter within Risk MAP Project Timeline**

### 5.4.4 Communication Guidance for PAL Submission Accepted by FEMA

This subsection provides guidance for communication to levee owners when FEMA accepts a PAL submission.

During the 24-month period that the PAL agreement is active (24-month PAL period), the FEMA Project Officer or designee will notify the levee owners and other stakeholders of the ongoing 24-month PAL period during which the levee owner must submit 44 CFR 65.10-compliant data and documentation to FEMA. This notification will be accomplished by sending a series of letters during the 24-month PAL period as follows:

- 30 days after initiation of the PAL agreement
- 10 months after initiation of the PAL agreement
- 16 months after initiation of the PAL agreement
- 90 days before the PAL period expiration date
- 30 days before the PAL period expiration date

Additionally, a progress report reminder letter will be sent to the levee owner to remind the owner that a progress report is due to FEMA 12 months after the start of the 24-month PAL period to document progress toward compliance with the PAL agreement.

The FEMA Project Officer or designee will send the letters to each levee owner signatory of the PAL Agreement, and will send copies of the letters to the following (at a minimum):

- CEOs of all impacted communities
- FPAs of all impacted communities
- State NFIP Coordinator(s)
- State levee safety officials, where appropriate
- District offices of U.S. Senators and U.S. Representatives
- USACE District offices, if the levee system is a USACE Program levee system

It is important that appropriate District offices of U.S. Senators and U.S. Representatives are aware of this communication effort throughout the 24-month PAL period, especially in advance of the PAL period expiration date. Therefore, in addition to sending copies of the letters, FEMA Regional Offices shall notify their Regional Legislative Affairs Division who may coordinate additional outreach efforts, as appropriate.

The FEMA Project Officer may choose standard U.S. mail or certified mail to send the letters to the levee owners and impacted communities. Use of a tracking number and mail service website (such as USPS.com) is recommended for delivery tracking to confirm delivery of the letter. The FEMA Project Officer or designated Project Team member will file return receipts, fax reports, or phone logs documenting the followup telephone calls in the case file for each affected community. The FEMA Project Officer or designated Project Team member will also include copies of the letters with other technical and administrative support data in the Technical Support Data Notebook (TSDN) for the project upon the expiration of the PAL period.

Additionally, the FEMA Project Officer should consider conducting an in-person PAL outreach meeting with the levee owner and other stakeholders to discuss:

- Status of the levee system
- Data collection process in support of submitting 44 CFR 65.10-compliant data and documentation to FEMA for contents only review and approval prior to the expiration date of the PAL period
- Analysis and mapping procedures for non-accredited levee systems, if applicable

The recommended timing of this meeting is near the time that the levee owner is to provide the 12-month progress report to FEMA.

The FEMA Project Officer or designated Project Team member will distribute and track the letters to each levee owner signatory of the PAL agreement and other federal, state, and local stakeholders.

### 5.4.5 Communicaton Guidance for PAL Submission Not Accepted by FEMA

Conditions may arise where FEMA has determined a levee system to be PAL eligible and offered a PAL designation, but then decides not to proceed with PAL designation for the levee system. If any of the following conditions occur, FEMA may decide not to accept the PAL submission:

- The signed PAL agreement is not returned to FEMA before the 91st day following the date of the initial notification letter.
- The PAL submission is determined to be deficient, such as:
    - A copy of the adopted operation and maintenance plan for the levee system is deficient or not provided.
    - For non-USACE Program levee systems, records of levee system maintenance and operation, as well as tests of the mechanized interior drainage systems, if applicable, are deficient or not provided.

### 5.4.6 Rescinding the PAL Designation

If any of the following conditions arise during the 24-month PAL period, FEMA may take immediate action to rescind the PAL designation and revise the FIRM for the area landward of the levee system:

- FEMA determines that the data and documentation required for compliance with 44 CFR 65.10 is deficient within 24 months of the 91st day following the date of the initial notification letter.
- The 12-month progress report is not provided to FEMA, and the FEMA Regional Office believes the PAL agreement should be rescinded.

If the FEMA Project Officer, based on the above criteria, concludes that a PAL designation should be rescinded before the expiration of the 24-month PAL period, the FEMA Project Officer will send a notification letter to the levee owner. The FEMA letter will clearly state the reason for rescinding the PAL designation and identify the levee system as non-accredited. See Chapter 6 of this document for more information regarding non-accredited levee systems.

### 5.4.7 Data and Documentation Submission for PAL Levee Systems in Support of 44 CFR 65.10

If a levee owner can provide 44 CFR 65.10-compliant data and documentation for a levee system to FEMA before the expiration date of the PAL, the levee system will be accredited and mapped accordingly, either within a current mapping project, or through a LOMR or PMR. The timing of the submission will impact FEMA's decision on the appropriate mapping process. Completeness regarding 44 CFR 65.10 requirements is discussed in Chapter 4.3.

FEMA will not grant extensions to the 24-month PAL period. However, accreditation opportunities for levee system are still available after the expiration date of the PAL agreement and before the Letter of Final Determination (LFD) for the update map showing the levee system not having base flood hazard reduction capability, if applicable.

If a levee owner can provide 44 CFR 65.10-compliant data and documentation and the submission is deemed complete by FEMA after the expiration date of the PAL agreement but before the effective date of the updated FIRM, FEMA will revise the FIRM and process it following the accreditation guidance provided in Chapter 4 of this document. This process does not provide an extension to the PAL period and may cause FEMA to spend funds to revise the FIRM to reflect the hazard of the non-accredited levee system, only to receive the submission and change direction to accreditation during the in-progress mapping project. However, this process provides consistency nationwide in initiating map revisions in a timely manner following the expiration of a PAL period.

If a levee owner provides the FEMA Regional Office with the 44 CFR 65.10 data and documentation submission and the data is deemed non-compliant by FEMA, the levee owner may submit additional data and documentation to substantiate compliance with 44 CFR 65.10. However, this data must be deemed compliant prior to the LFD date for the updated FIRM. If additional data and documentation submitted up to the day before the LFD date still do not meet the requirements of 44 CFR 65.10, FEMA may delay the FIRM. If issues with the data and documentation cannot be resolved, the flood hazard associated with the levee system should be addressed through analysis and mapping procedures for non-accredited levee systems. See Chapter 6 of this document for more information regarding analysis and mapping procedures for non-accredited levee systems.

After the date of the LFD for the updated FIRM, a levee owner may provide 44 CFR 65.10-compliant data and documentation submission to FEMA for a completeness check through the LOMR or PMR process.

## 5.5 PAL Mapping and Notes

### 5.5.1 Mapping Project with PAL Designations

#### 5.5.1.1 Cartographic Specifications for PALs

For levee systems with PAL designations, the levee-impacted area can still be mapped as Zone X (shaded) area with reduced flood hazard due to levee. The PAL designation associated with the Zone X (shaded) area with reduced flood hazard due to levee will be indicated on the FIRM panel with a PAL note. See FIRM Panel Technical Reference for more information regarding the depiction of flood hazard features and notes.

#### 5.5.1.2 Notes to Users

For levee systems with PAL designations, the Notes to Users section of the FIRM directs map users to additional information about provisionally accredited levee systems. This note shall be on all FIRM panels that contain PALs. See FIRM Panel Technical Reference for more information regarding the FIRM Levee Notes to Users for PALs.

The Notes to Users example in FIRM Panel Technical Reference includes blanks in the note for the Project Team member to populate with the end date of the PAL period for the levee system associated with the flood zone.

See Subsection 5.4.1.6 and FIRM Database Technical Reference for more information regarding the S_Levee Table.

#### 5.5.1.3 FIRM Panel Index

The Project Team does not need to revise the FIRM Panel Index due to a PAL designation. The Project Team does not need to revise and update the FIS Report to identify and include the levee systems that have a PAL designation. The Levees table in the FIS Report should show all accredited, provisionally accredited, and non-accredited levee systems. See FIS Report Technical Reference for more information regarding the Levees table of the FIS Report.

#### 5.5.1.4 FIRM Database

The FEMA FIRM Database stores the digital GIS data used in the map production process, as well as tabular information inside the FIS Report.

The S_Levee table, part of the FIRM Database, contains information about levee systems shown on the FIRMs, including levee systems with PAL designations. For levee systems with PAL designations, the S_Levee table contains a field to be populated with the end date of the PAL period for the levee systems associated with the flood zone. The end date of the PAL period for the levee system is 24 months from the start date of the PAL period. If the date is not known, the assigned Project Team member can obtain this date through consultation with FEMA Project Officer or other Regional Office staff. For more information regarding the S_Levee table, see FIRM Database Technical Reference.

#### 5.5.1.5 Flood Risk Products

The L_Levee_Scenario table describes scenarios modeled for levee systems in the Flood Risk Database. The table contains a field to be populated by the Project Team member with levee system accreditation status, which includes the option of PALs. See Flood Risk Database Technical Reference for more information regarding the L_Levee_Scenario table. For a list of acceptable values for levee accreditation status, see the D_Levee_Accreditation domain in Domain Tables Technical Reference.

### 5.5.2 Mapping Project with Expired PAL Designation

The L_Levee_Scenario table describes scenarios modeled for levee systems in the Flood Risk Database. The table contains a field to be populated by the Project Team member with levee system accreditation status, which includes the option of PALs. See Flood Risk Database Technical Reference for more information regarding the L_Levee_Scenario table. For a list of acceptable values for levee accreditation status, see the D_Levee_Accreditation domain in Domain Tables Technical Reference.

# 6.0 Non-Accredited Levee Systems

This chapter provides guidance to FEMA Regional Office staff, FEMA Risk MAP providers, CTPs, and CTP providers involved in performing Flood Risk Projects where non-accredited levee systems have been identified. The FEMA, provider, and CTP staff involved in these "non-accredited levee projects" are hereinafter referred to as "Project Teams". An overview of the process described in this chapter is shown in Figure 11 on page 72.

## 6.1 Non-Accredited Levee Systems Defined

Non-accredited levee systems are systems that do not meet the NFIP regulatory requirements of 44 CFR 65.10 as described in Chapter 4 of this document and that are not shown on a FIRM as reducing the base flood hazard. This process for non-accredited levee systems will not be applied to non-levee features (discussed in Chapter 7 of this document), levee systems that are not hydraulically significant, or coastal structures[2] that reduce the flood hazard to areas below sea level. For mapping purposes, a structure is considered hydraulically insignificant if, during a base flood event, the peak water-surface elevations landward of the structure may be the same regardless of whether the structure was in place.

The technical procedures described in this document may be used for non-accredited levee systems that are not hydraulically significant, but the process as a whole does not apply.

[2] For coastal structures, such as seawalls, revetments, and bulkheads, the USACE Coastal Engineering Research Center (CERC) prepared Technical Report CERC-89-15, Criteria for Evaluating Coastal Flood Protection Structures, in December 1989.

## 6.2 Other Considerations

Subsections 6.2.1 through 6.2.5 provide information regarding the submission of data through the LOMR process, coastal considerations, expiring PAL system designations, projects involving multiple levee systems, and projects involving levee systems that are in the process of being restored.

### 6.2.1 Submission of Data through the Letter of Map Revision Process

Mapping of non-accredited levee systems may be completed following the MT-2 process for LOMRs provided that the requester follows the guidance for analysis and mapping procedures for non-accredited levee systems as outlined in this document. Before submitting the LOMR request, the community FPA or designee establish a Local Levee Partnership Team (LLPT) with participation of stakeholders, including FEMA, based on the complexity and scope of the levee system under evaluation. The organizer of the LLPT must document the options discussed by the LLPT members and FEMA decisions regarding the appropriate analysis and mapping procedures to be used. So that all stakeholders are included in the map revision process, the organizer or designee will make copies of these documents available directly or through a publicly accessible website. Upon completion of a Levee Analysis and Mapping Plan, discussed in Section 6.7 of this document, the requester can submit a request for a LOMR.

### 6.2.2 Coastal Considerations

Flood Risk Projects involving non-accredited levee systems in coastal areas may have a longer timeline for completion than a “typical” levee-related Flood RiskProject in a riverine or lacustrine setting.

The Project Team also may need to assess and discuss the transition zones between coastal and riverine levees. Additional information regarding coastal considerations is provided in the discussion of each of the technical procedures in Subsections 6.11 through 6.15 of this document.

### 6.2.3 Expiring Provisionally Accredited Levee Designations

Because extensive coordination may have been performed as part of the PAL process (see Chapter 5), the Project Team may not need to carry out some outreach and data collection for levee systems where PAL designations are expiring. Where outreach and data collection activities are necessary, the Project Team is to perform these tasks in conjunction with the remaining parts of the PAL process. For example, the Stakeholder Coordination and Data Collection Meeting (discussed in Section 6.4) may be combined with the PAL Meeting (discussed in Subsection 5.4.4) to discuss whether the PAL status or designation is expiring, along with potential options to address the levee. The FEMA Project Officer will make this determination through coordination with other Project Team members at the appropriate time to incorporate the FEMA levee analysis and mapping procedures for non-accredited levees into the project timeline.

### 6.2.4 Projects Involving Multiple Levee Systems

If levee systems have been constructed on both sides of a flooding source, or if multiple levee systems overlap, the Project Team will analyze the extents of the natural valley area and reach-specific flood hazards for each system independently, assuming the other system remains in place.

### 6.2.5 Levee Restoration and Adequate Progress

Situations may occur where FEMA determines, through coordination with community officials, levee owners, and/or OFAs), that a restoration (Zone AR, 44 CFR 65.14) or adequate progress (Zone A99, 44 CFR 61.12) project for the levee is underway. In these instances, levee reaches are not used. Rather, the regulatory requirements provided in 44 CFR 61.12 for new construction projects that have made adequate progress toward completion or the regulatory requirements provided in 44 CFR 65.14 for de-accredited levee systems that are being restored to provide base flood event design, or greater, would apply. Section 100230 of the Biggert-Waters Flood Insurance Reform Act of 2012 (Public Law 112-141) provides additional guidance on reconstruction or improvement of flood hazard reduction systems. Additional guidance is provided in Guidance Document No. 34, Guidance for Flood Risk Analysis and Mapping: Zone A99 and Zone AR Determinations, which is accessible from the FEMA Guidelines and Standards for Flood Risk Analysis and Mapping webpage

## 6.3 Levee Analysis and Mapping Procedure

Under the FEMA levee analysis and mapping approach followed before FEMA issued guidance in July 2013, FEMA analyzed and mapped a levee system that did not meet the NFIP requirements of 44 CFR 65.10 as if it had no effect on flooding on the landward side of the levee system during the base flood. This was known as the “without levee” approach.

The FEMA document titled Analysis and Mapping Procedures for Non-Accredited Levee Systems, issued in July 2013, provides additional information on the process used by FEMA to analyze and map areas on the landward side of non-accredited levee systems that are shown on FIRMs. The document, which is accessible from the FEMA website (https://www.fema.gov/media-library/assets/documents/33587), provides:

- A synopsis of FEMA’s historic analysis in the vicinity of levee systems
- An overview of the development process and teams responsible for procedure development
- Response to the public comments received and incorporated
- An understanding of analyses and mapping approaches

The technical aspects of Analysis and Mapping Procedures for Non-Accredited Levee Systems have been incorporated into this document.

Given recent technological advances in data collection and H&H modeling, FEMA can implement a more refined approach to mapping flood hazards in areas landward of levee systems. The current levee analysis and mapping procedures were developed to analyze and map areas on the landward side of non-accredited levee systems that are shown on FIRMs. The current levee analysis and mapping procedures better meet the needs of the public and provide results that are more refined.

The current FEMA levee analysis and mapping procedures for non-accredited levee systems provide for a repeatable and flexible approach that:

- Complies with all existing statutory and regulatory requirements governing the NFIP, most notably the requirements of 44 CFR 65.10
- Leverages local input, knowledge, and data through proactive stakeholder engagement
- Aligns available resources for engineering analysis and mapping commensurate with the level of hazard in the areas landward of levee systems
- Recognizes the uncertainty associated with levee systems
- Allows analysis of levee reaches
- Considers, from an engineering perspective, the unique characteristics of each levee system

Figure 11 illustrates the current FEMA levee analysis and mapping procedures for non-accredited levee systems. Guidance on the identification of the levees is detailed in Section 3.3 of this document. Following confirmation that a structure is a levee; the Project Team conducts an initial accreditation evaluation to determine if the levee system is accredited or can be provisionally accredited. If neither, then the Project Team analyzes the levee system following the levee analysis and mapping procedures illustrated in Figure 11.

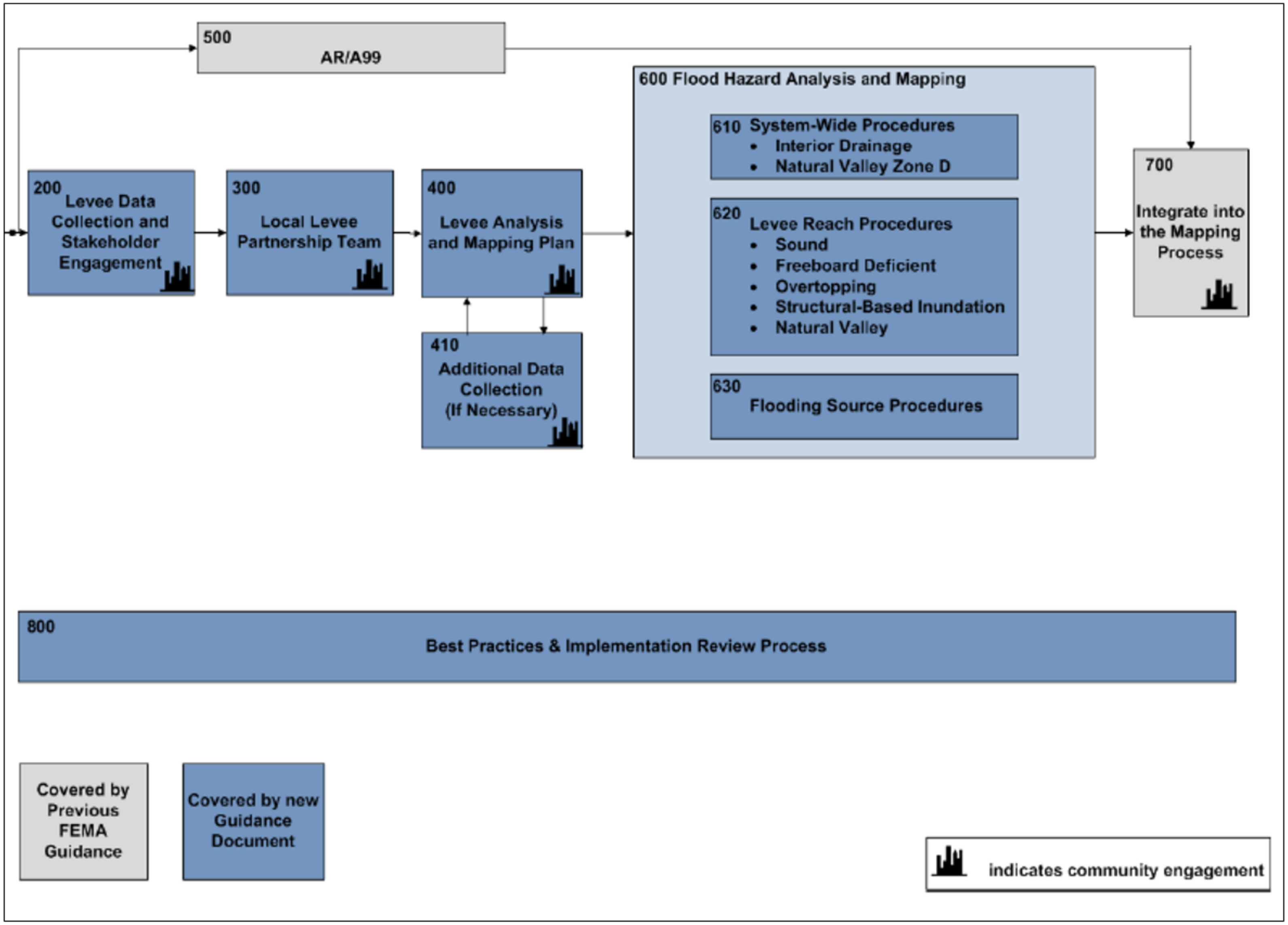



**Figure 11: FEMA Levee Analysis and Mapping Procedure**

## 6.4 Levee Data Collection and Stakeholder Engagement (Figure 11, Element 200)

The FEMA analysis and mapping procedures for non-accredited levees include an interactive coordination process with key stakeholders, including State and community officials, officials of participating Tribes, and levee owner(s). The primary goals of the levee data collection and stakeholder engagement phase are:

1. Improve stakeholder understanding of the levee analysis and mapping process.
2. Help the Project Team obtain a comprehensive understanding of data available and the levee system(s) in project areas so that informed decisions may be made by FEMA regarding the procedures to be used to model and map flood hazards for non-accredited levee systems.

FEMA has developed email and letter templates that the Project Team may use when inviting community stakeholders to meet with the LLPT. Project Team members may obtain copies of Region-specific templates through the FEMA Project Officer.

FEMA Regional Office staff are to plan, and budget for, stakeholder coordination, data collection, and establishment of an LLPT for all Flood Risk Projects involving non-accredited levee systems. Each step is discussed in this document. If little or no data are available, or if the Natural Valley Procedure discussed in Subsection 6.10.1 of this document is preferred by the affected communities and that preference is documented, the scope may be limited. This stakeholder coordination step should typically occur during the Discovery process for the watershed/project area that is the focus of the Flood Risk Project.

The Project Team will perform the initial levee stakeholder coordination and data collection steps for all non-accredited levee systems. In some instances, the results of these data collection efforts may indicate that the data and documentation already collected are adequate and are sufficient to make a decision on potential analysis and mapping procedures. Where applicable, such a decision will be made by the FEMA Project Officer with input from the LLPT. The primary function of the LLPT will be to provide feedback, additional data, and options on levee reach selection for the system. Additional information on the LLPT is provided in Section 6.5 of this document. Thereafter, FEMA, through coordination with community officials, Tribal officials, levee owner(s), and local project sponsor(s), will proceed with modeling the levee system and mapping the flood hazards in areas landward of the levee system. (See Figure 11, Elements 500 and 600.)

The levee data collection and stakeholder engagement process are shown in Figure 12 and discussed in more detail in Subsections 6.4.1 through 6.4.4.

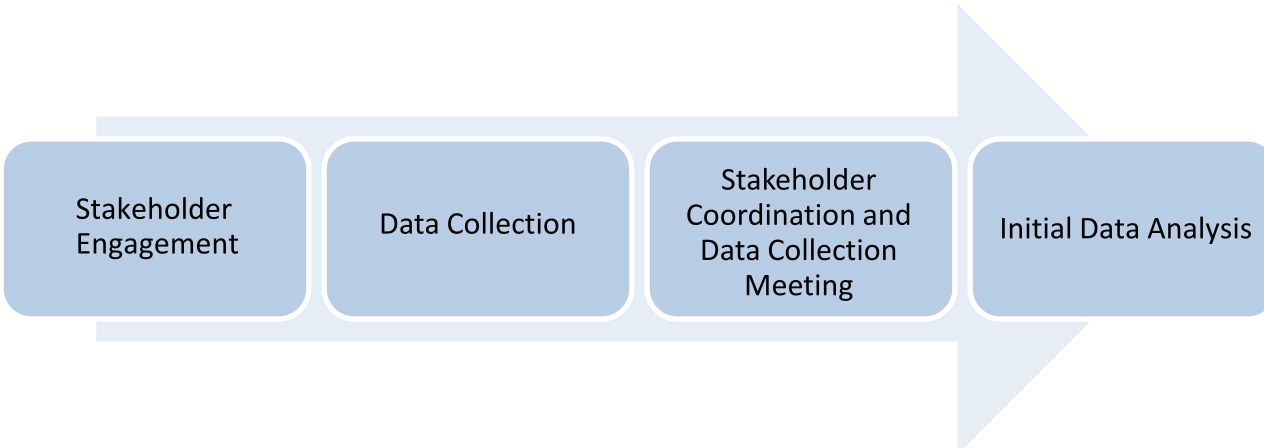



**Figure 12: Levee Data Collection and Stakeholder Engagement Process**

### 6.4.1 Stakeholder Engagement

The FEMA Project Officer or designee will engage levee-impacted communities, levee owners/operators, and levee sponsors during the stakeholder engagement process. The purpose of this initial engagement is twofold:

1. Discuss the levee analysis and mapping process.
2. Collect initial community- and levee system-related information and data to help streamline and facilitate future meetings. This upfront coordination may take the form of conference calls, Web-enabled meetings, or other means that facilitates two-way communication.

For a Flood Risk Project involving a non-accredited levee system, the Project Team will need to engage with a different array of community, county, regional, and State officials and other stakeholders than may be engaged for a Flood Risk Project that does not involve such systems. The stakeholders to be engaged include, but are not limited to, the following:

- Community, County, and State emergency management officials
- Levee owners/operators
- Officials from communities upstream of, downstream of, and across the flooding source from the levee system
- State or regional groups with a vested interest in water resources, such as levee boards, conservation districts, and watershed/river basin commissions
- Dam safety officials
- Members of Tribal communities, as defined through consultation and coordination with Tribal officials
- GIS managers and specialists, community and regional planners, and county land use departments

- Representatives of district offices of OFAs with responsibility for levee systems in the project area, including USACE District offices
- Economic development and commerce representatives
- Members of the local engineering community

This upfront coordination may take the form of conference calls, Web-based meetings, or other means of two-way communication. The types of levee stakeholders engaged in a levee-related project may vary by State or Region but may include local community and Tribal officials and agencies, local economic development organizations or environmental groups, members of the local engineering community, State, and regional representatives, USACE, and OFAs.

### 6.4.2 Data Collection

The Project Team will obtain available supporting data and documentation for the levee system elements from levee system owners; levee system operators; State agencies; local agencies; private individuals or corporations; FEMA data repository and online services; and USACE, including the NLD; and OFAs. The Project Team may perform some of this data collection before an initial meeting with levee stakeholders. This data collection effort before the meeting will help FEMA facilitate and encourage substantive discussion during the meeting. In addition, the Project Team will obtain available supporting documentation regarding historical performance of the levee system, considering both successful performance and unsuccessful performance issues.

Collecting data and information early in the process will help the Project Team facilitate and encourage substantive discussion during meetings with stakeholders. Data collection efforts may vary based on the uniqueness of the levee system. FEMA will not fund any efforts related to certifying data for levee accreditation or making determinations of the levee's structural conditions. Levee owners may choose to perform additional data collection activities but must do so at their own expense. The Project Team will work with various stakeholders as appropriate to obtain supporting data and documentation. The Project Team will make the data and documentation available to those who request it.

Depending on the complexity of the levee system, data and documentation collected may include (if available and applicable), but are not be limited to, the following:

- Design reports/memorandums
- Construction documentation reports/memorandums, specifications, or plans
- Post-construction plans and specifications (e.g., bridges, roads, utility construction that occurred since levee construction)
- Survey data
- Geotechnical reports
- Structural analyses
- Interior drainage analyses
- O&M plans

- Inspection reports
- Historical news articles or data regarding levee breaches and flood fighting efforts and levee distress
- USACE NLD data, Levee Screening, or Risk Assessment Reports
- Flood records and streamflow data
- Current orthophotography and topographic data
- Related data from the FEMA MIP, the FEMA Engineering Library, and other FEMA archives/databases
- Building footprint/parcel data
- Master drainage plans and/or flood modeling
- PAL or accreditation review documentation

Project Team members are to use the NLD as a first resource, if available. The data and information collected will help FEMA and the levee stakeholders develop an approach for modeling and mapping the flood hazard in areas landward of non-accredited levee systems.

Typically, the FEMA Project Officer will make the initial contact with district offices of OFAs to obtain data and information regarding levees. The Project Officer will determine the appropriateness of followup contacts with OFAs by other Project Team members. Data and information collection efforts may also vary based on the potential uniqueness of each area landward of a levee system. The FEMA Project Officer and other Project Team members will work with various stakeholders in these areas to obtain the best available supporting data, information, and documentation. Levee owners may choose to perform additional data and information collection activities but must do so at their own expense.

The Project Team is to develop and maintain a distribution list for disseminating information to all stakeholders involved in the process and maintain this list throughout the lifecycle of the project

If, during the data collection effort, information and documentation is provided substantiating that the levee system may be accredited, FEMA will reconsider the accreditation determination following the guidance discussed in Chapter 4 of this document.

### 6.4.3 Stakeholder Coordination and Data Collection Meeting

An in-person meeting with stakeholders, referred to as the Stakeholder Coordination and Data Collection Meeting, is vital during the data collection phase of a levee mapping project. Information on the objectives, timing, attendees, messages to be delivered, pre- and post-meeting activities, and field reconnaissance efforts related to the meeting is provided in Subsections 6.4.3.1 through 6.4.3.7.

#### 6.4.3.1 Meeting Objectives

The overarching objectives of the Stakeholder Coordination and Data Collection Meeting are:

- To introduce stakeholders to each other

- To discuss areas of flood risk, available data, and the FEMA process for analyzing and mapping flood hazards landward of non-accredited levees

To accomplish these objectives, the Project Team performed the upfront research and data and information collection activities described in Subsection 6.4.2. This first meeting is a working meeting, so it is important that attendees are prepared to contribute and that the meeting facilitator and other Project Team members encourage participation.

A comprehensive list of the meeting objectives is included below. It may not be possible to cover these objectives at every stakeholder meeting. However, this list includes the array of topics that may be discussed depending on the levee system.

- Introduce the Project Team to the community officials, Tribal officials, and other stakeholders with areas of influence within the areas potentially impacted by a new levee analysis and mapping project.
- Emphasize that the goal of the levee analysis and mapping project is to apply the technical procedure that best reflects the flood hazard in the area landward of the levee based on available resources, data, and community needs.
- Review available data on the levee system, confirm whether the data are accurate, and obtain stakeholders' perspectives about their flood hazards. This will help determine the appropriate procedure for modeling the levee system.
- Emphasize the importance of the stakeholders' responsibility in providing necessary data and keeping the public informed of flood hazards and the relevance of those hazards.
- Discuss floodplain management and flood insurance implications of the use of Zone D as the flood hazard designation on the FIRM.
- Discuss potential members of an LLPT, which is discussed in more detail in Section 6.6 of this document.

#### 6.4.3.2 Meeting Timing

The Project Team is to hold the Stakeholder Coordination and Data Collection Meeting after Project Team members have collected available data, documentation, and information and have had initial discussions with identified stakeholders. The Project Team will plan the Stakeholder Coordination and Data Collection Meeting in coordination with the affected community officials, Tribal officials, and levee owner(s)/operator(s).

#### 6.4.3.3 Meeting Attendees

The Project Team is to invite all stakeholders contacted during the levee data collection and stakeholder engagement process to the Stakeholder Coordination and Data Collection Meeting. It may not be possible for all stakeholders to attend all meetings. However, their input is important, and Project Team members should attempt to coordinate with these stakeholders in advance of the meeting if their attendance is not feasible or to arrange for remote participation when necessary. Additionally, Project Team members are to ask stakeholders for suggestions of other stakeholders who should be included in the Stakeholder Coordination and Data Collection

Meeting and any subsequent meetings. Project Team members are to follow up on meeting outcomes and actions with those stakeholders who are not able to attend in person or remotely.

#### 6.4.3.4 Meeting Messages

Messages that are to be emphasized during the Stakeholder Coordination and Data Collection Meeting include, but are not limited to, the following:

- The levee analysis and mapping approach is a process with a variety of options, where the stakeholders are actively engaged in the process.
- The goal of the levee analysis and mapping project is to apply the procedure that best reflects the flood hazard in the area landward of the levee system based on available resources, data, and community needs.
- It is important for community officials to keep the public informed of flood hazards and associated risks and the relevance of those risks and identifying the public as a stakeholder in the process.
- The use of Zone D landward of the levee system has both floodplain management and flood insurance implications.
- Some risk of flooding will always exist landward of a levee system.
- Additional information is available from the Living with Levees - It's a Shared Responsibility webpage on the FEMA website, available at www.fema.gov/living-levees-its-shared-responsibility.

#### 6.4.3.5 Pre-Meeting Activities

Meeting-related actions and materials that the Project Team is to compile before the Stakeholder Coordination and Data Collection Meeting include, but are not limited to, the following:

- Coordinate with stakeholders upfront to obtain data; understand the levee system being assessed and its history; and to learn about a community's or Tribe's resources, assets, future plans, vision, etc.
- Confirm best available data (including the timing of such data) and discuss data-sharing agreements.
- Prepare talking points to discuss the levee system, the levee analysis and mapping approach, and the project lifecycle.
- Prepare NFIP compliance/adoption information as appropriate.
- Arrange for a field reconnaissance visit during the Stakeholder Coordination and Data Collection Meeting if appropriate.
- Prepare and distribute a meeting invitation, meeting agenda appropriate for the levee system, and map for discussion purposes.

The FEMA Project Officer, the FEMA Regional Tribal Liaison, or other FEMA Regional Office staff will identify any additional items that may be needed when Tribal nations are affected through consultation and coordination with Tribal officials.

#### 6.4.3.6 Meeting Activities

Stakeholder Coordination and Data Collection Meeting activities include, but are not limited to, the following:

- An interactive, collaborative discussion. Project Team members are to facilitate discussions between community officials and other stakeholders, offer suggestions, and manage the time.
- Review of available data. Project Team members are to make a map providing a system-wide view of available data gathered to date available in GIS format. The GIS format allows a Project Team member to zoom in and out to specific, targeted areas for discussion purposes during the meeting.
- Identification of gaps in data collected. Project Team members are to work with meeting participants to identify data gaps that need to be filled and formulate a reasonable plan or alternatives, to fill the gaps especially if filling the gap is critical to project completion.
- Discussion of the procedures for analyzing and mapping the levee system(s) that are the focus of the project. Project Team members are to present the information in a logical way that illustrates the levee system(s) and the currently available and potentially available data. This will allow the majority of the meeting time to be focused on gaining a better understanding of the next steps for all participants.

#### 6.4.3.7 Field Reconnaissance

In some instances, the Project Team may participate in a field reconnaissance of the levee system after the Stakeholder Coordination and Data Collection Meeting. The FEMA Project Officer will decide the type and level of field reconnaissance based on project needs and available resources.

Field reconnaissance generally is recommended along reaches where the Overtopping Procedure (discussed in Subsection 6.10.3 of this document) or the Structural-Based Inundation Procedure (discussed in Subsection 6.10.2 of this document) could potentially be used to model and map a levee reach. The field reconnaissance effort may be a drive along the levee system or a walk on top of the levee system to view areas of interest. The Project Team is to document the field reconnaissance using notes, markups, sketches, and/or photographs.

The field reconnaissance is not an inspection or an attempt by the Project Team to make technical conclusions on the quality, substance, or performance of the levee system. The primary purpose of the field reconnaissance is for the Project Team to gain a better understanding of the levee system to reflect the flood hazard information on the FIRM in areas landward of the levee system. FEMA analyses for flood hazard mapping do not predict or guarantee the performance, reliability, or overall safety of a levee system and are used only to identify the flood hazards landward of the levee system.

### 6.4.4 Initial Levee Data Analysis

The Project Team will analyze the collected data, information, and documentation to prepare for the LLPT Meeting(s). By performing this data analysis, the Project Team will be better prepared for specific discussions with the LLPT members about levee system history, characteristics, modeling procedures available, flood hazards, flood hazard communications, and outreach. The

FEMA Project Officer will determine the appropriate level of effort for this activity; the level of effort should be commensurate with the level of risk to the community, the complexity of the levee system, and the available data. Two main efforts may occur during this step.

1. The Project Team will analyze currently available and potentially available data to determine what reach-specific procedures could potentially be applied to the levee system(s) being analyzed. For example, if data to meet the structural requirements is not available and not expected to be available, the LLPT Meeting discussion should be focused on both the Natural Valley and Structural-Based Procedures.

2. The Project Team will conduct an analysis to determine baseline estimates and expected ranges of the SFHA extent and depth. This will usually include a Natural Valley analysis, evaluation of levee crest elevations, or the use of previously developed preliminary flood hazard zone boundaries. A rough analysis using the Structural-Based Inundation Procedure may be included as well. The Project Team will perform the analysis using readily available data, such as topographic data from the USGS National Elevation Dataset https://nationalmap.gov/elevation.html or more detailed data from the community.

As part of this initial Natural Valley analysis, the Project Team will develop 1-percent-annual-chance flood elevations by one of the following methods:

- Use the effective analysis.
- Prepare a Base Level analysis that applies the effective or a proposed flood discharge with a Base Level hydraulic model.
- Extend the effective BFEs landward of the levee.

In most situations, extending BFEs landward of the levee system represents a worst-case scenario for defining the limits of the SFHA. The Project Team will develop water-surface elevations for discussion purposes only, and the Project Team is to clearly inform the LLPT members that the final BFEs and SFHA delineations that will be shown on the FIRM may not match the results of this initial data analysis.

To show the results of this analysis, the Project Team will select depth profile locations to communicate the variability resulting from the various procedures as shown in Figure 13. For example, in Figure 13, the initial data analysis indicates that no single approach results in the shallowest depths landward of the levee. At the upstream end, the red area is the area where a Natural Valley analysis results in the deepest depths. In the central part of the levee (yellow area), however, the Natural Valley analysis results in the lowest depths, and the Structural-Based Inundation analysis results in the deepest depths. This initial analysis will provide the LLPT with an early indication of what the results from various types of analyses might provide.

The Project Team is to present the results through maps and a draft version of the Levee Analysis and Mapping Plan that summarizes the methods used and results. The Project Team will use the draft maps and draft plan to facilitate discussions with the LLPT regarding the available data and the range of potential outcomes. The FEMA Project Officer will provide templates for the draft maps and plan.

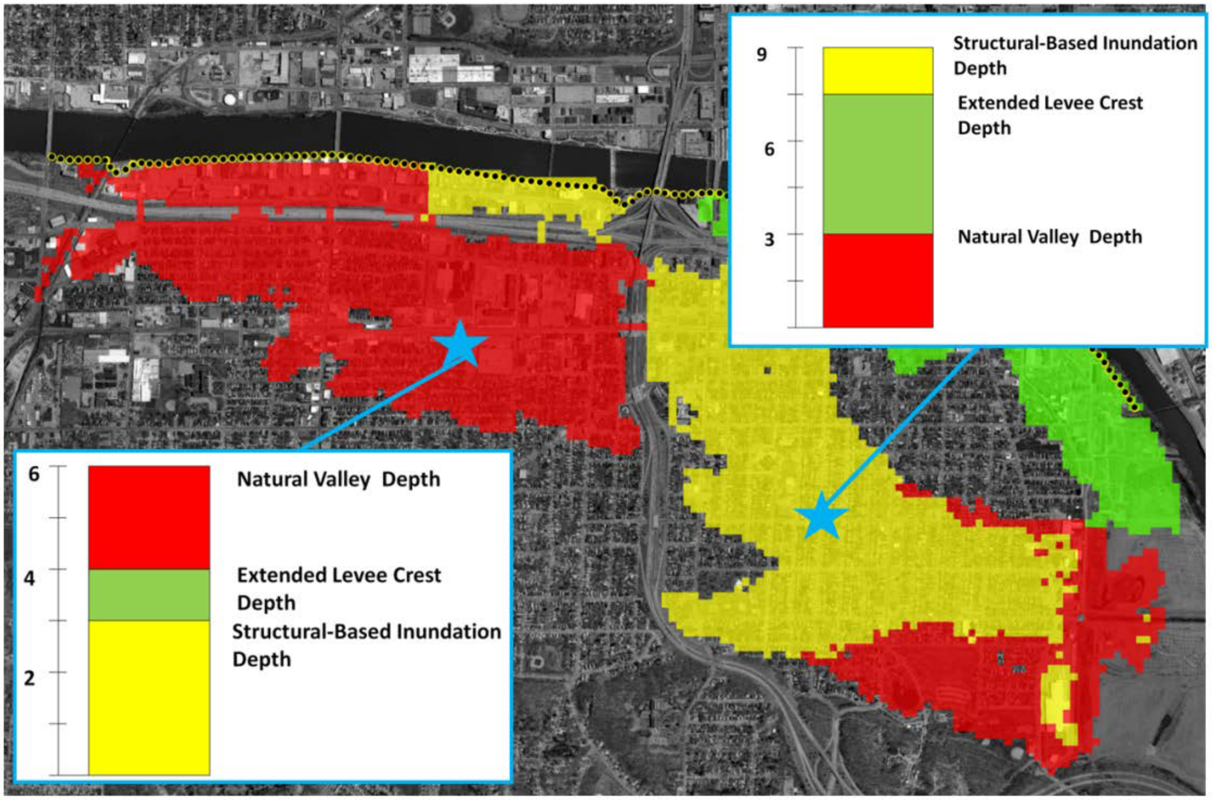



**Figure 13: Sample of Potential Inundation Extents**

## 6.5 Local Levee Partnership Team (Figure 11, Element 300)

### 6.5.1 Introduction and Mission

The levee analysis and mapping procedures provided for an interactive coordination effort with stakeholders, especially the key stakeholders that are invited to participate in the LLPT. A LLPT must be established with participation of diverse stakeholders based on the complexity and scope of the levee system under evaluation. The options discussed by the LLPT members and the decisions by FEMA regarding the appropriate analysis and mapping procedures to be used, must be documented, and made available to stakeholders. Participants in the LLPT will vary, depending on the scope and complexity of the levee system that is being analyzed and mapped.

The primary function of the LLPT will be to provide feedback and, if necessary, additional data, information, or documentation. The role of the FEMA Project Officer or other Regional Office representative as the facilitator of the LLPT will be to present results of the initial levee data analysis and any subsequent analysis, solicit and consider input from other LLPT members, and make the final decision on the technical procedure(s) to be applied to effectively analyze and map the flood hazards in the area landward of the levee system.

In consultation with the other LLPT members, the FEMA Project Officer or other Regional Office representative will determine the number and format for the LLPT meetings and coordination activities.

### 6.5.2 Transparency

The LLPT membership and activities must be transparent. To maintain this transparency, an assigned LLPT member or other designee is to create an attendance sheet documenting invitees and members attending meetings (in person, by telephone, or via the Web). In addition, the LLPT is to prepare meeting minutes that document important discussions, action items, and decisions made by FEMA. The LLPT is to make these documents available to stakeholders by U.S. mail, email, or postings to a publicly accessible website.

### 6.5.3 Membership

During the Stakeholder Coordination and Data Collection Meeting, the FEMA Project Officer or other Regional Office representative will explain the need for the LLPT and the types of individuals who could be members. The Project Officer or other representative from the FEMA Regional Office will always be a member of the LLPT but may not always attend meetings in person.

Once established, FEMA will provide outreach and training materials to enhance the ability of the LLPT members to meet their objectives successfully. For most projects, LLPT members will be a subset of those stakeholders that participated in the Stakeholder Coordination and Data Collection Meeting.

At minimum, all communities and tribes affected by flooding related to how the levee is analyzed and mapped will have the opportunity to have a participating member on the LLPT. If a community or tribe does not own or operate the levee in question, levee owners/operators will also have an opportunity to participate.

The following are the types of groups and individuals that could be invited to participate in the LLPT:

- Community CEO or designee (individual with decision-making authority, if not the CEO)
- CEO or designee of participating tribe (individual with decision-making authority)
- Community FPA
- Tribe FPA
- State NFIP Coordinator
- Levee owner and/or local project sponsor (if levee is not owned by a community)
- Local engineer/technical representative invited by the community
- FEMA Regional Office representative
- Representatives of OFA district offices that could provide additional input
- Other Project Team members (i.e., CTPs, FEMA Risk MAP providers, CTP subcontractors)
- Others as determined jointly by the community and FEMA Regional Office representative

### 6.5.4 Roles and Responsibilities

The FEMA Regional Office representative will coordinate with the LLPT, obtain LLPT member input, and make final decisions on the way to analyze and map the flood hazards in the areas landward of the levee system. The FEMA Regional Office representative will decide how reaches of the levee system are analyzed and mapped.

The Project Team will perform the levee analyses and mapping activities as directed by the FEMA Regional Office representative. This may include preparing the initial data analysis, as well as developing intermediate flood risk products. As previously stated, the non-FEMA LLPT members' primary role is to provide data and input to FEMA, including commenting on the creation of levee reaches and the procedures to be used for analyzing and mapping the reaches based on local levee conditions.

In some circumstances, State agencies other than the State agency represented by the State NFIP Coordinator may be active participants in the LLPT. Their roles will vary based on the specific agency's mission and relationship to the impacted communities and levee owners.

In many situations, a USACE District office will have a history of providing support to impacted communities and levee owners. The FEMA Regional Office representative should coordinate with USACE District office staff before establishing the LLPT to discuss what role the USACE District Office staff will assume on the LLPT. Likewise, the FEMA Regional Office representative will coordinate with OFAs other than USACE in determining their role when it is appropriate for them to participate.

## 6.6 Local Levee Partnership Team Meetings (Figure 11, Element 300)

### 6.6.1 Meeting Objectives

In addition to the general Risk MAP objectives, the LLPT has the following specific objectives:

- Provide all members the opportunity to explain the unique conditions that will influence the analysis and mapping associated with the non-accredited levee system.
- Allow for discussion on the information and data obtained and the results of any analyses presented.
- Allow for comment on methods for levee reaches, analyses, and mapping within the allowable guidelines.
- Develop, if necessary, a reasonable schedule for obtaining input or additional data.

### 6.6.2 Meeting Timing and Format

Depending on the complexity of the levee system under consideration, the FEMA Regional Office representative and LLPT members will determine the number and format for the LLPT Meetings and other coordination activities.

The initial LLPT Meeting will take place after the stakeholder coordination, data collection, and initial data analysis have taken place. As discussed in Section 6.4 of this document, the FEMA

Project Officer and other Project Team members will use the initial data analysis to help explain alternatives to the LLPT members and get their input.

In many instances, an initial field reconnaissance will have occurred before the initial LLPT Meeting. However, as discussed in Subsection 6.3.7 of this document, this reconnaissance activity could follow the initial LLPT Meeting, depending on the local situation.

The LLPT Meetings may be held in-person, via conference call, or via the Internet. Decisions regarding where and when to hold meetings will be based on the local logistical situation, availability of members, and the complexity of the levee system being evaluated.

### 6.6.3 Meeting Attendees

The FEMA Regional Office representative is to assure that all LLPT members are invited to all LLPT Meetings. (See Subsection 6.5.3 of this document for a list of potential LLPT participants).

### 6.6.4 Meeting Messages

The message for the initial LLPT Meeting (and subsequent meetings) continues to be "Living with levees - It's a shared responsibility". The specific message to the LLPT is that FEMA recognizes that unique local levee conditions exist, and the FEMA Regional Office representative will work with the other LLPT members and use local data and input to determine how best to analyze and map hazards in levee-impacted areas. An additional message is that, while FEMA has the final decision-making authority on how the flood hazards landward of the non-accredited levee system will be analyzed and mapped, the process for reaching that decision will emphasize an interactive exchange of information and ideas among the LLPT members.

### 6.6.5 Pre-Meeting Activities

The following activities will occur before the initial LLPT Meeting:

- The FEMA Regional Office representative will send an invitation email to the first LLPT Meeting (and all subsequent meetings) to each LLPT member.
- The FEMA Regional Office representative will provide LLPT members with introductory briefings and training materials on the procedures for analyzing and mapping non-accredited levee systems.
- The Project Team will conduct an initial data analysis, discussed in Subsection 6.4.4 of this document, to provide an overview of alternative approaches for various levee reaches. This could include any draft maps or other results that would be helpful to communicate the impact of different approaches.
- The Project Team will develop a summary of data and information obtained during the data collection and reconnaissance efforts.

### 6.6.6 Meeting Activities

During the LLPT Meeting(s), the FEMA Regional Office representative will:

- Explain the LLPT Meeting objectives and the need for transparency.

- Inform the LLPT members that meeting minutes to document who attended and what happened at the meeting will be produced and made available to all stakeholders.
- Provide a summary of the background of the flood hazard mapping project.
- Provide a summary of the levee analysis and mapping process.
- Answer any questions about the levee analysis and mapping process and the briefing and training information previously provided.
- Summarize the following information:
  - Meeting messages
  - Results from the data collection efforts
  - Results from the initial data analysis, including any draft map and USACE Levee Screening Tool results
  - Possible alternative approaches for analyzing and mapping flood hazards landward of the levee system(s)

## 6.7 Levee Analysis and Mapping Plan (Figure 11, Element 400)

The LLPT will use the data available to select the appropriate procedure to analyze and map the flood hazards landward of the levee system(s) being considered. The initial evaluation will be an estimate of the natural valley floodplains. This information can provide an initial sense of where flooding may occur landward of the levee system. If other information is available, such as an estimate of a levee breach analysis/map, the LLPT will also use that information. Some examples of key considerations in selecting the appropriate levee analysis and mapping procedure are as follows:

- Levee system characteristics
- Data availability
- 44 CFR 65.10 deficiency type
- Length/size of the levee system and/or levee reach
- Levee crest profile versus BFEs
- Levee system performance history
- Accreditation status of levee system on current, effective NFIP map(s)
- Flooding characteristics
- Contributing drainage area
- Terrain data
- Population consequence, risk, and population information
- Community, Tribe, levee owner, and/or local project sponsor willingness to contribute data or analyses

The LLPT may discover that a restoration project for the levee system is underway through coordination with State, community, or Tribal officials; levee owners; and/or OFAs, including USACE. FEMA has not revised the regulatory requirements provided in 44 CFR 61.12 for new construction projects that have made adequate progress toward completion nor the regulatory requirements provided in 44 CFR 65.14 for decertified levee systems that are being restored to base flood hazard-reduction capability. (See Figure 11, Element 500.)

Once the LLPT has completed its deliberations, the Project Team will produce a final version of the Levee Analysis and Mapping Plan. The Plan will include the following:

- Copies of the data developed, including agendas, meeting minutes, attendance sheets, and correspondence
- Summary of the data and information collected, when they were received, type, and source
- Summary of data, documentation, and information FEMA expects to receive from stakeholders, including the recommended timeframe for delivery
- Flood hazard analysis and mapping options based on data that are already available and timeframe for when data to be collected by stakeholders is to be provided to FEMA

In addition to the Levee Analysis and Mapping Plan, FEMA will use the data and information collected to update the NLD if data collected during this phase came from sources other than the NLD. See Chapter 3 of this document for more information on reporting updates to levee data documentation and inventory. FEMA will provide the final version of the Levee Analysis and Mapping Plan and database to the levee stakeholders with whom FEMA coordinated during the data collection and stakeholder engagement process, including all LLPT members.

## 6.8 Additional Data Collection (Figure 11, Element 410)

In some cases, the Levee Analysis and Mapping Plan may include a summary of data FEMA expects to receive from stakeholders that may affect the reach approaches used and the recommended timeframe for delivery of the additional data. The timeframe for the community providing additional data will depend on many factors, including:

- Whether the levee system was previously provisionally accredited
- Type of data being collected
- Planned project schedule, if the levee is part of a larger watershed or countywide flood hazard mapping project
- Contractual timeframes between the FEMA Regional Office and other Project Team members (i.e., CTPs, Risk MAP providers)
- Size and complexity of the levee system.

Table 3 presents suggested ranges of timeframes for supplying additional data. Because the appropriate timeframe for supplying additional data will depend on many factors, the chosen timeframe should fit the actual project conditions, but should generally not exceed the upper limits of the listed ranges.

**Table 3: Suggested Timeline for Additional Data**

| Data Type | Timeframe Range | | Stakeholder Responsible for Data |
|---|---|---|---|
| | Previous PAL Designation | No Previous PAL Designation | |
| Elevation Information for the Levee Crest and Toe | Up to 2 months | Up to 6 months | Levee Owner/Community |
| Operations and Maintenance Plan | Up to 3 months | Up to 3 months | Levee Owner/Community |
| Structural Design Requirements | Up to 6 months | Up to 18 months | Levee Owner/Community |
| Inspection Reports | Up to 2 months | Up to 2 months | Levee Owner/Community |
| Evaluation of Overtopping Erosion Potential | Up to 18 months | Up to 18 months | Levee Owner/Community |

## 6.9 System-Wide Analysis and Mapping Procedures (Figure 11, Element 610)

For non-accredited levee systems, the Project Team will combine four major components to develop the final flood hazard information reflected on the FIRM:

1. A system-wide Zone D area developed using the Natural Valley Procedure
2. A system-wide SFHA based on an interior drainage analysis developed assuming the levee system remains in place
3. Merged SFHAs determined from the appropriate levee reach procedures detailed in Section 6.10 of this document
4. An SFHA developed for the flooding source side of the levee system assuming the levee system remains in place

A registered P.E. must sign and seal all engineering data developed for each procedure, and this will satisfy the certification requirements of 44 CFR 65.2 and 44 CFR 65.10(e). If required, structural, operations, maintenance, and overtopping analysis data submitted by a levee owner or community will be reviewed for completeness.

## 6.10 Interior Drainage Analysis

The Project Team will evaluate the adequacy of the interior drainage systems and map an SFHA for the base flood where applicable. Interior drainage associated with levee systems usually includes storage areas, gravity outlets, pumping stations, and other residual flooding, or a combination thereof. In performing the interior drainage analyses, the Project Team will assume that all sections of the levee and associated structures will remain intact in their current condition.

Judgment will be required to determine if the interior drainage systems need to be analyzed. The FEMA Regional Office representative will decide how to analyze and map interior drainage after consultation with the community officials, levee owner(s), and/or local project sponsor(s), and the Project Team. If the potential for mappable flooding exists on the landward side of the levee system due to interior flooding, the Project Team will perform an interior drainage analysis. If the Project Team used the Natural Valley Procedure (discussed in Section 6.12 of this document or Structural-Based Inundation Procedure (discussed in Section 6.13 of this document) for the entire system, no additional interior drainage analysis may be required if those flooding conditions would result in flooding more extensive than the interior drainage analysis.

USACE Engineer Manual (EM) EM 1110-2-1413, Engineering and Design - Hydrologic Analysis of Interior Drainage Areas (or subsequent updates on this topic), provides guidance and criteria for performing an interior drainage analysis for levee systems, including joint probability analyses.

### 6.10.1 Natural Valley Zone D

FEMA will represent the uncertainty of the hazards associated with the non-accredited levee system(s) through use of the Zone D designation. FEMA uses the Zone D designation on a FIRM to identify areas of undetermined, but possible, flood hazards. In the future, FEMA may define and adopt another zone designation through the regulatory process.

The Project Team will depict any area within the Natural Valley footprint that is not an SFHA as Zone D on the FIRM. The Project Team will use the Zone D designation to identify the area of possible base flood hazard that exists because the levee system is non-accredited. The Project Team will determine this area using the Natural Valley Procedure (discussed in Section 6.12 of this document). This is similar to the process used to determine the Zone X (shaded) areas for accredited levee systems.

The Zone D designation is used for non-accredited systems instead of the Zone X (shaded) designation used for accredited levee systems because the flood hazard potential is greater and more uncertain than with accredited levee systems.

If levee systems exist on both sides of a flooding source, or multiple systems that overlap exist, the Project Team will determine the extents of the Zone D area for each system independently, assuming the other systems remain in place.

## 6.11 Levee Reach Analysis and Mapping Procedures (Figure 11, Element 620)

In addition to the system-wide hazard mapping associated with the Natural Valley Procedure, the levee system may be divided into reaches (see Figure 14) to develop additional SFHA. A levee reach is defined as any continuous length of a levee system to which a single technical procedure may be applied. A levee reach has no minimum or maximum length requirement. Individual reaches can be analyzed using the following procedures:

- Natural Valley Procedure
- Structural-Based Inundation Procedure
- Overtopping Procedure
- Freeboard Deficient Procedure
- Sound Reach Procedure

The Project Team may apply each procedure, except for the Sound Reach Procedure, at both the reach and system levels. The Sound Reach Procedure cannot be used because a levee system of sound reaches would be considered an accredited levee. The Project Team will complete the analysis of a single reach with all other levee reaches intact.

The Project Team will merge the flood hazard information that results from the analyses of the individual levee reaches within the system along with any interior drainage flood hazards. The result will be a composite SFHA delineation landward of the levee system. As mentioned in Subsection 6.9.2 of this document, the Project Team will designate any area within the Natural Valley footprint that is not SFHA as Zone D.

No stakeholder data or documentation is required for applying the Natural Valley Procedure. In situations where FEMA is not provided with the data/documentation required for use in the reach analysis procedures, the Project Team will apply the Natural Valley Procedure at the reach or system level.

The Project Team will apply the reach analysis procedures and corresponding stakeholder data requirements shown in Table 4 when analyzing non-accredited levee systems. It is the responsibility of the community, Tribe, levee owner, and/or local project sponsor to provide the data/documentation to support the standards in Table 4 for the levee reach if that approach is to be applied.

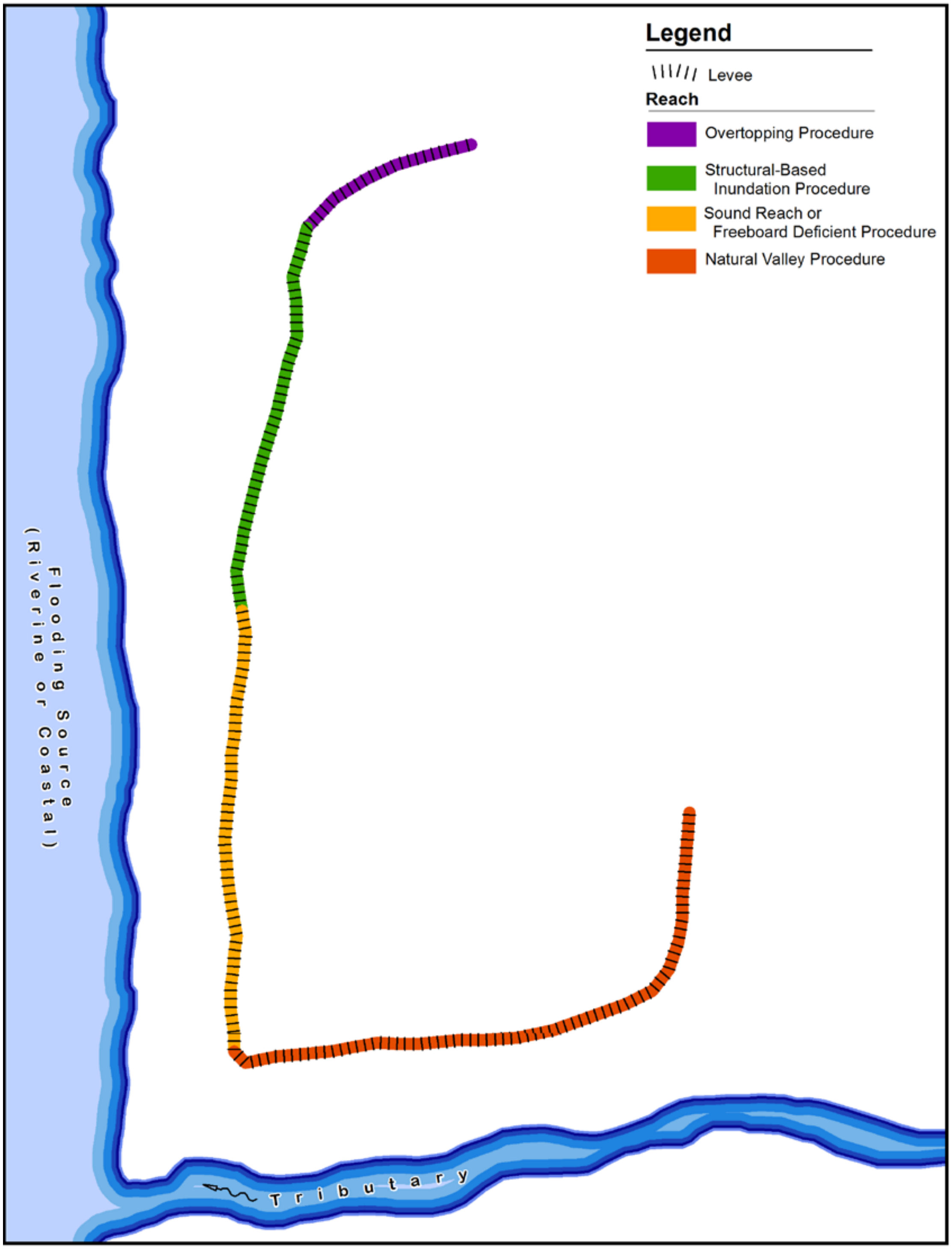



Figure 14: Example Segmentation of a Levee System

**Table 4: Summary of Stakeholder Data Requirements for Reach Analysis Procedures**

| Data Element | Applicable Portion of CFR | Reach Analysis Procedures | | | | |
|---|---|---|---|---|---|---|
| | | Sound | Freeboard Deficient | Overtopping Approach | Structural Based Inundation | Natural Valley |
| Elevation Information for Levee Crest and Toe | N/A | Required | Required | Required | Required | N/A |
| BFE + Freeboard Less than Levee Crest | 44 CFR 65.10(b)(1) | Required | N/A | N/A | N/A | N/A |
| BFE Less than Levee Crest | N/A | Required | Required | N/A | N/A | N/A |
| O&M Plan | 44 CFR 65.10(c) | Required | Required | Required | Recommended | N/A |
| Structural Design Requirements | 44 CFR 65.10(b)(2) – 44 CFR 65.10(b)(7) | Required | Required | Required | N/A | N/A |
| Inspection Reports | 44 CFR 65.10(c)(2)(iv) | Required | Required | Required | Recommended | N/A |
| Evaluation of Overtopping Erosion Potential | N/A | N/A | N/A | Required | N/A | N/A |

Surveyed elevation data for the levee crest and levee toe, if required, must meet FEMA standards. All engineering data submitted for each of the procedures must be signed and sealed by a registered P.E. The registered P.E.'s signature and seal have the same meaning as the certification required by the NFIP regulations as cited at 44 CFR 65.2 and 44 CFR 65.10(e). Review of this data shall be performed as described in Section 4.3 of this document.

FEMA will not fund any efforts solely related to certifying data for levee accreditation or making determinations of the levee's structural conditions.

### 6.12 Natural Valley Procedure (Figure 11, Element 620)

The Natural Valley Procedure can be applied to all non-accredited levee system reaches to determine the SFHA and to determine the Zone D area. Factors that the Project Team will need to consider when determining whether to use the Natural Valley Procedure to determine the SFHA for a reach are provided below.

### 6.12.1 Hydraulic Significance of the Levee Reach

In some cases, a levee reach is so significantly overtopped during the peak of the base flood event that the existence of the levee does not have a noticeable effect on the water-surface elevation (WSEL). Techniques and items to consider for this situation are included in Subsection 6.12.5.

### 6.12.2 Availability of Data

If no data are available to support the other procedures, the Project Team will apply the Natural Valley Procedure. In some locations, the SFHA shown on the effective FIRM for the flooding source side of the non-accredited levee system is based on a Base Level study and, therefore, the SFHA is designated as Zone A or Zone V. In these locations, FEMA will evaluate the need for new modeling of the flooding source for performing the Natural Valley Procedure. If the need does not exist, the SFHA shown for the effective flooding source mapping will continue to be designated Zone A. If the need exists, the SFHA for the flooding source may be designated Zone A or Zone AE, depending on the modeling method(s) used.

### 6.12.3 Needs of the Community

Because of the limited data requirements and resources required to analyze a levee reach using the Natural Valley Procedure, a community may prefer to use this method. Therefore, the community may also request that FEMA use the Natural Valley Procedure.

The Project Team will model and map the natural valley floodplain landward of the non-accredited levee systems as an SFHA, except when additional analysis indicates an alternate treatment. The Project Team will only depict the natural valley floodplain landward of non-accredited levee systems as Zone D when the Freeboard Deficient, Sound Reach, Overtopping, or Structural-Based Inundation Procedure is implemented.

### 6.12.4 Data or Documentation Requirements

No data or documentation are required from community officials, levee owners, and/or local project sponsors to proceed with the Natural Valley Procedure.

### 6.12.5 Technical Procedures

Using the Natural Valley Procedure, the Project Team will model the flooding along the levee reach by allowing the discharge to flow freely on either side of the levee for the entire levee reach. The levee will not impede conveyance in the model. For riverine levee reaches using one-dimensional models, topographic features of the levee will be in-place in the model, but not allowed to obstruct lateral flow (see Figure 15). Figure 16 shows an example of an SFHA delineation when the Natural Valley Procedure is applied to a reach of a non-accredited levee system.

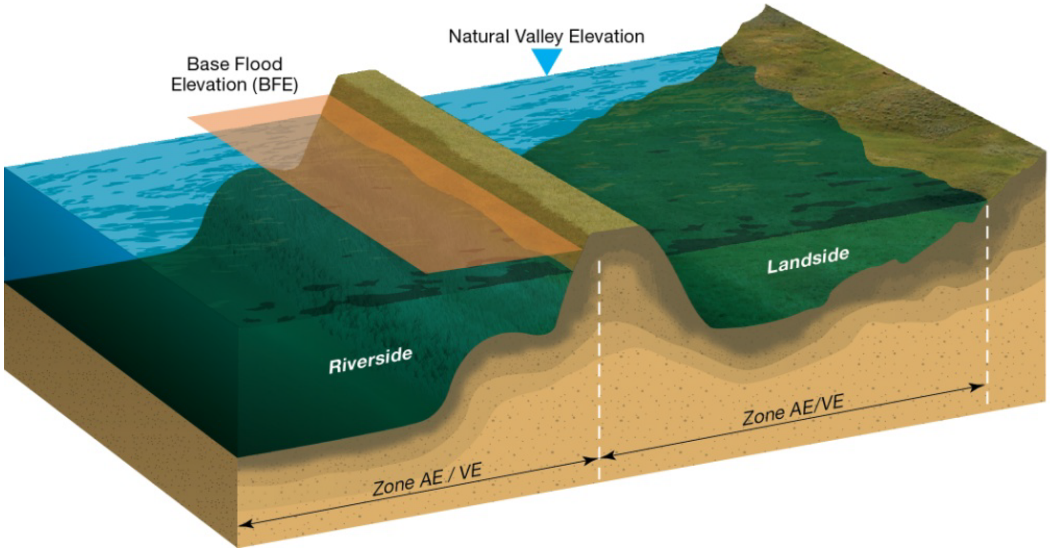



**Figure 15: Natural Valley Cross-Section View**

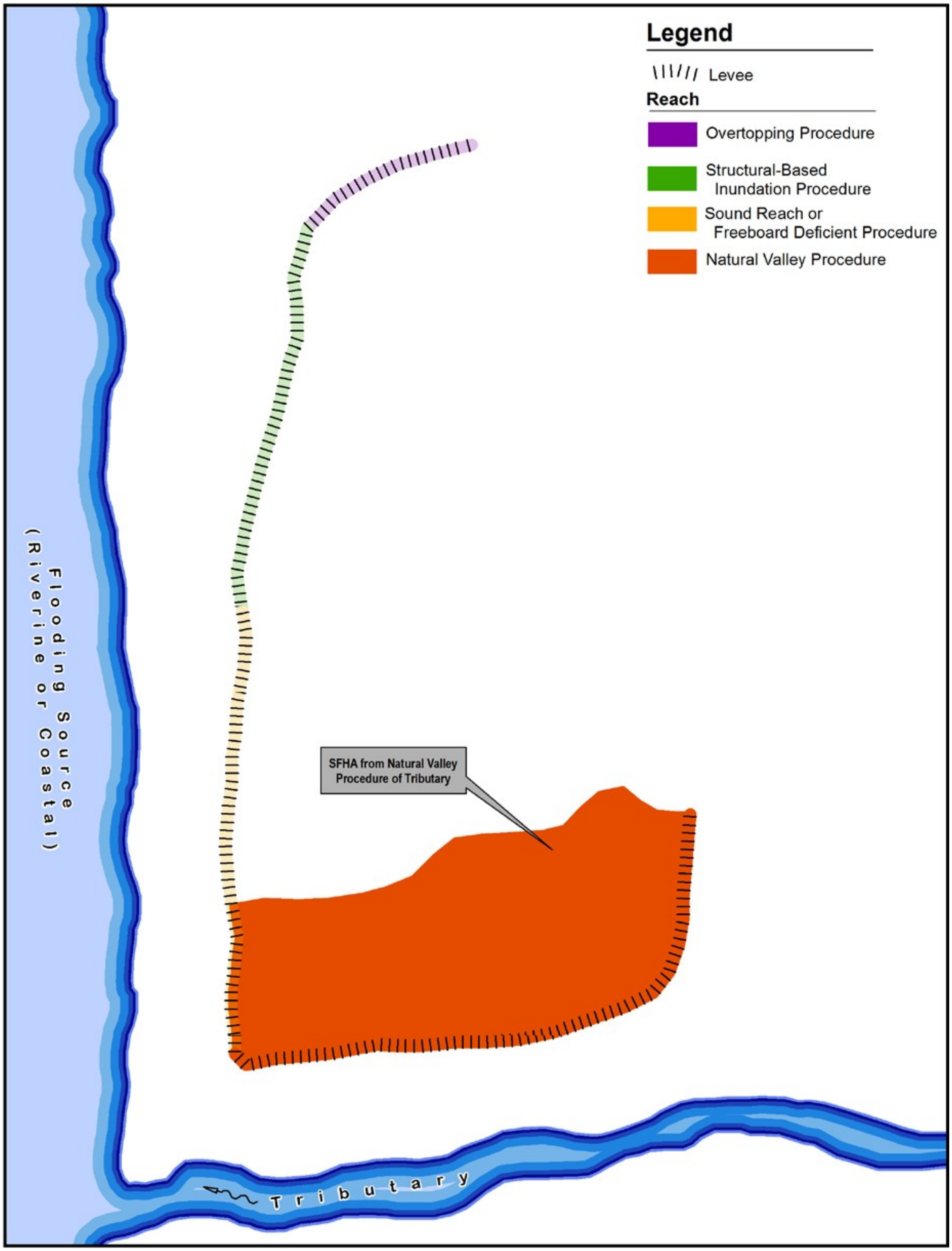



**Figure 16: SFHA Delineation Using Natural Valley Procedure**

#### 6.12.5.1 Testing the Hydraulic Significance of the Levee Reach for Riverine Levees

Characteristics of the levee reach that may indicate the levee is not hydraulically significant include:

- Levee/floodwall is fully submerged, and landward conveyance is in the direction of the riverflow.
- Lateral exchange of flow across a levee that is overtopped is insignificant or does not exist because the water level on the landside of the levee equalizes with the flooding source.
- Height of the levee/floodwall is low compared to the WSEL over the crest of the levee/floodwall for the majority of the length of the levee/floodwall, as outlined in Section 6.13.

#### 6.12.5.2 Modeling the Natural Valley Procedure on Levees Subject to Riverine or Lacustrine Flood Forces

Using the Natural Valley Procedure, the Project Team will model the riverine levee reaches by leaving the topographic features of the levee in the model but allowing the discharge to flow on either side of the levee, as shown in Figure 15. The levee will be modeled as not impeding conveyance.

### 6.12.6 Coastal Levee Situations

Coastal non-accredited levees subject to flood forces will be intact within the storm surge model setup to determine peak storm-surge elevations seaward of the levees. In these situations, the Project Team will consider how the levee system will influence wave propagation. The team will then assume a steady-state condition landward of the levee and will extend the BFE landward of the non-accredited levee until it intersects the ground elevation (or the levee on the opposite side, in the case of a ring levee). The Project Team will evaluate the potential of waves forming again landward of the levee. The Project Team may apply a similar procedure when a detailed storm surge model is not available.

### 6.12.7 Natural Valley Letter of Acceptance

A community's agreement for using the Natural Valley Procedure for the levee system(s) may be documented in a "Natural Valley Letter of Acceptance." The FEMA Project Officer will provide the template for the Natural Valley Letter of Acceptance. In preparing this letter, the Project Team is to follow the appropriate concurrence process, as determined by the FEMA Project Officer, so that the letter is properly reviewed and approved.

## 6.13 Structural-Based Inundation Procedure (Figure 11, Element 620)

In some instances, levee systems have reaches with either known structural deficiencies or a lack of data to support one of the other procedures. For levee reaches that fall into this category, FEMA developed the Structural-Based Inundation Procedure to identify the limits of the base flood that may result from the potential levee failure. This procedure relies on the modeling of levee breaches along the levee reach.

Predicting the exact location of a future breach to a levee or floodwall is not possible. The Structural-Based Inundation Procedure, therefore, does not predict the probability of failure at any breach location nor does it provide a specific determination or evaluation of the overall levee system performance or require a determination of the likely failure mechanism. Implementation of the procedure instead results in the development of an SFHA based on the flood hazard due to potential breaches along a particular levee reach during a base flood event.

### 6.13.1 Data Requirements

The only mandatory data required are accurate top-of-levee and toe-of-levee elevations. However, in certain circumstances, FEMA may require the following information to apply the Structural-Based Inundation Procedure, which should follow the standards of 44 CFR 65.10:

- O&M Plan. Details of the O&M Plan standard are provided in 44 CFR 65.10(c).
- Structural design standards. Structural design should meet minimum design standards including data regarding closures in 44 CFR 65.10(b)(2), embankment protection in 44 CFR 65.10(b)(3), embankment and foundation stability in 44 CFR 65.10(b)(4), settlement in 44 CFR 65.10(b)(5), and any other design standards in 44 CFR 65.10(b)(6).
- Inspection reports. The standard for documentation of inspection is provided in 44 CFR 65.10(c)(1)(iii) and 44 CFR 65.10(c)(2)(iv).

No freeboard or WSEL requirements apply to the Structural-Based Inundation Procedure. Therefore, the Project Team will apply this procedure when the levee crest is lower than the base flood level, but high enough to impede flow.

### 6.13.2 Technical Procedures

Methods to identify possible locations of system breaches, modes of failure, geometry, failure triggers, and failure duration for use in mapping the base flood resulting from the breaches are described in Subsections 6.13.2.1 through 6.13.2.4. Given the number and nature of assumptions inherent in this procedure, FEMA will allow flexibility in the use of the Structural-Based Inundation Procedure to enable the use of engineering judgment. In rural settings, where levee systems reduce the hazard to primarily agricultural lands, yet the levees are hydraulically significant, simplification of the approach may be warranted to limit analysis costs that would not result in significantly different flood hazard mapping.

#### 6.13.2.1 Determination of Modeled Breach Locations

The locations of possible levee breaches could be determined using the method described below.

- Select initial breach locations for each levee reach, one representing a breach location near the downstream end of the levee reach and another near the upstream end of the levee reach.
- Determine the hydrograph through each breach, also known as “the breach hydrograph”, and independently analyze the hazard for the base flood landward of the levee for each breach.
- Combine the resulting flood hazard boundary delineations into a composite SFHA delineation.

- Make an initial judgment, through examination of the terrain landward of the levee and/or preliminary modeling results, on whether the selected breach locations will result in a reasonable identification of the flood hazard. The flood hazard will be considered to have been reasonably identified when all potential storage areas and flow paths that can be reached by breach flows are reflected in the flood hazard mapping (as Zone AE, Zone AH, and/or Zone AO). The final SFHA on the landside of a reach using the Structural-Based Inundation Procedure must reflect the fact that a breach may occur at any location along the reach.
- Add additional breach locations to the initial locations if additional breaches can change the flood elevations or the extent of the composite flood hazard area significantly.

The assigned Project Team member generally will place the breach locations to capture the full flood hazard on the landside of the levee. The assigned team member will base exact locations on breach potential indicators, such as greatest overtopping depth, past breach locations, encroachment or known seepage locations, or changes in levee material or shape. For coastal areas, the assigned team member will also consider levee exposure to waves and potential wave runup.

#### 6.13.2.2 Time of Breach Initiation

The time that a breach is assumed to be triggered will influence the peak flow and volume through the breach. For an overtopping breach, the assigned Project Team member will conduct a sensitivity analysis to estimate the breach initiation time that produces the most reasonable SFHA. The team member will choose the time that produces the most reasonable case using sound engineering judgment. For an internal failure analysis, the breach failure should initiate at the peak flood stage, unless information that suggests a different breach initiation time is appropriate.

Another option for the assigned Project Team member to consider when determining at what point to initiate the breach is the point in time when the water rises to an elevation at which the levee fails to meet all standard engineering criteria. This will be before peak stage in most cases.

#### 6.13.2.3 Breach Shape

A rectangular shape extending vertically from the levee crest to the riverside toe elevation will be adequate to describe the breach shape, unless additional analysis determines breach side slopes are important and necessary for accurate modeling of the breach. The minimum breach width will be 100 feet for clay levees and 500 feet for sand levees. These minimum accepted breach widths are based on a qualitative review of the historic breach width information available. However, levee attributes and sound engineering practice should support the breach width chosen.

Based on an evaluation of historic breach widths, typically breach widths should be larger than these minimum accepted values. The breach width estimation may consider levee embankment height, levee material, crest width, depth and duration of overtopping, longitudinal velocity, area impacted by the levee, distance from the flooding source, and duration of flooding event. The method to estimate breach width will be based on sound engineering judgment, adjusted by comparing to historical documented levee breaches where available.

The assigned Project Team member will provide adequate justification for the choice of breach parameters. Unless other information is available, the team member will assume that the breach will extend vertically to the bottom of the levee.

#### 6.13.2.4 Empirical Methods for Estimating Breach Shape

**Dam Breach Equations**

Several authors have developed empirical equations to estimate breach size, shape, and failure time for dam breaches. The equations are based on examination of historical data for dam breaches. Levee failures generally end with much wider breach bottom widths than dams, relative to the height of the levee/dam. The wide breach width may be caused in part by the erosive sheer force of floodflow parallel to levees and in part by the tendency for the hydraulic head over the breach to remain elevated for a longer period. Dam breach parameter empirical equations may be applicable to levees in some situations, but justification for their use will be needed if they are chosen for the levee breach width computation.

**Historical Levee Breach Information**

If available, historic levee breach information is an important tool in determining breach shape and development time. No nationwide compendium of historic breach information is available, but the assigned Project Team member performing the analysis will search for historical breach information.

**Physically Based Models for Estimating Breach Shape**

Where appropriate information is available to do so, the Project Team may use physically based breaching models. These models can be based on erodibility of the levee and levee foundation, levee, and levee foundation soil type, levee vegetative cover, flood stage, and flood duration.

When floodwalls fail, it is typically a partial breach as one or more sections (i.e., monolith) formed during the floodwall construction are forced apart by escaping water. When conducting a breach analysis on a floodwall, the assigned Project Team member will need to determine the number of sections that might fail as the breach width is based on the particular structure, available documentation, and engineering judgment. The minimum expected breach width for a floodwall is one section (i.e., monolith).

**Development Time**

Typically, the Project Team member can set the time for breach formation (the time from breach initiation to the time full breach width is realized) to zero to simplify the analysis. If is the assigned team member determines that the breach formation time would have a significant impact on the breach hydrograph, the assigned member may need to consider this variable in the analysis.

**Sensitivity Analysis**

A Project Team will conduct sensitivity analysis to evaluate the effects that varying the levee breach width and failure initiation time will have on the resulting flood hazards, within reasonable limits. This sensitivity analysis will include widening and narrowing the levee breach width within reasonable bounds and investigating the impacts of different breach initiation times. As the parameters are varied, the assigned team member will note the impacts to the peak discharge, volume through the breach, and the SFHA. In general, the final parameters chosen by the assigned team member will represent the most reasonable flood hazard that result from the parameters evaluated.

To test the impact of failure initiation time, the assigned Project Team member will conduct a calculation initiating the breach at the point of overtopping of the levee on the ascending or rising limb of the flood hydrograph. Also, the assigned team member will perform a breach calculation at the time to peak flood stage, but not greater than 2 hours after overtopping begins. The team member may extend the duration of overtopping if technical calculations, prepared by a registered P.E., are provided by the community, Tribe, levee owner, and/or local project sponsor to indicate that the levee can withstand additional overtopping without failure. The assigned team member will compare breach flows or hydrographs and will use the one that produces the most reasonable flood hazard landward of the levee.

For coastal levees, the sensitivity analysis will include testing related to the duration of a storm surge hydrograph.

### 6.13.3 Mapping Breach Analysis Results

The SFHA shown on the FIRM will be based on a composite of the base flood hazard developed at each breach location. (See Figure 17.) Figure 18 shows an example of an SFHA delineation when the Structural-Based Inundation Procedure is applied to a reach of a non-accredited levee system. The Project Team will assure that the final SFHA reflects the fact that a breach may occur at any location along the Structural-Based Inundation levee reach. The modeled breach locations should not be apparent in the final SFHA delineation or BFEs.

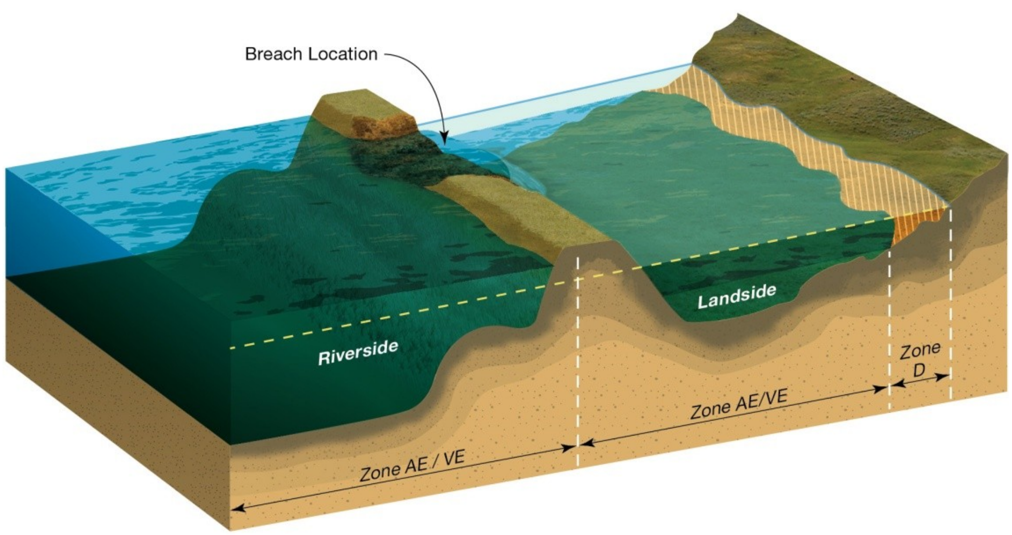



Figure 17: Structural-Based Inundation Cross-Section View

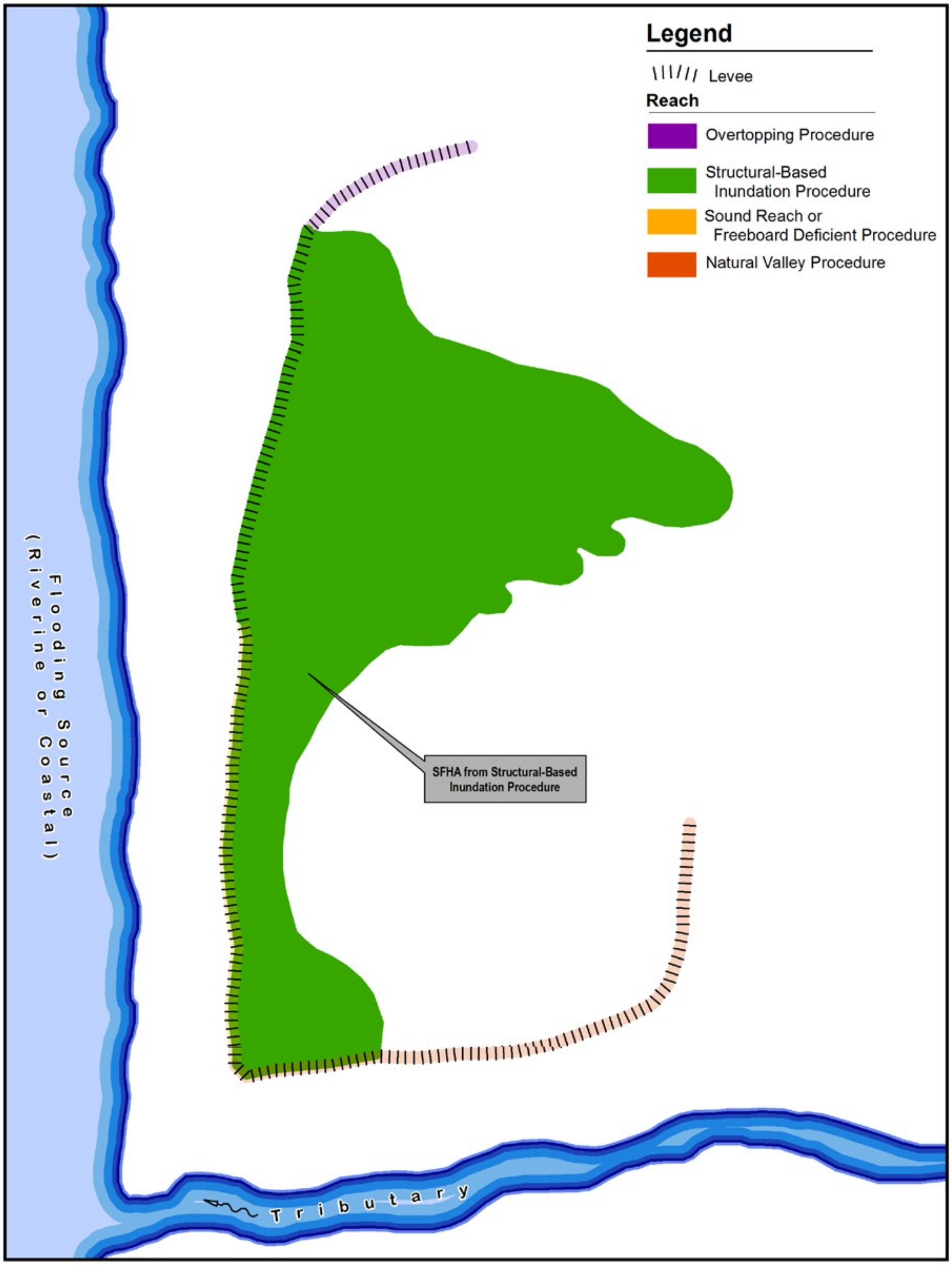



**Figure 18: SFHA Delineation Using Structural-Based Inundation Procedure**

## 6.14 Overtopping Procedure (Figure 11, Element 620)

In some instances, levee systems have locations that have been specifically armored to sustain overtopping flows or the rate of overtopping flow is sufficiently small or of sufficiently short duration that the system would not fail during the base flood. The Overtopping Procedure can be applied when the BFE is above the levee crest for a reach, but it can be demonstrated that the base flood event will not cause structural failure and the levee reach meets all requirements of 44 CFR 65.10 except 44 CFR 65.10(b)(1).

### 6.14.1 Data Requirements

For the Overtopping Procedure to be used for a reach, the community, levee owner, or local levee sponsor must submit an analysis, signed, and sealed by a registered P.E., to FEMA. This analysis must indicate that no appreciable erosion of the levee crest, toe, embankment, or foundation occurs during the overtopping of the base flood event because of either currents or waves. The analysis must also demonstrate that the anticipated erosion will not result in structural failure. Failure is defined as breach of the levee, directly or indirectly, through loss of embankment material due to erosive forces, the reduction of the seepage path, or piping and subsequent instability. In addition, the community, levee owner, or local levee sponsor must submit documentation to meet the following standards from 44 CFR 65.10 to FEMA:

- O&M Plan. Details of the O&M plan standard are provided in 44 CFR 65.10(c).
- Structural design standards. Structural design must meet minimum design standards, including data regarding closures in 44 CFR 65(b)(2), embankment protection in 44 CFR 65.10(b)(3), embankment and foundation stability in 44 CFR 65.10(b)(4), settlement in 44 CFR 65.10(b)(5), interior drainage in 44 CFR 65.10(b)(6), and any other design standards as detailed in 44 CFR 65.10(b)(7).
- The structural design documentation should also include a discussion if the failure of an adjacent levee could affect the structural integrity reach if that adjacent levee reach is not categorized as Sound or Freeboard Deficient.
- Inspection reports. The standard for documentation of inspection is provided in 44 CFR 65.10(c)(1)(iii) and 44 CFR 65.10(c)(2)(iv).
- Elevation information for the levee crest and toe.
- Certified as-built drawings

All items must be signed and sealed by a registered P.E.

In addition to the standards detailed in 44 CFR 65.10, more expansive structural documentation as well as O&M documentation will be required for these reaches to certify the overtopping analysis. These are detailed further in the subsections below.

#### 6.14.1.1 Loading Conditions Used for Evaluation

For the loading conditions used for evaluation, the certifying P.E. will use the base flood event plus a factor of safety, such as an elevation freeboard, that takes into account uncertainty in the data. The factor of safety used will depend on the levee reach and engineering judgment. For example, the factor of safety will vary when unique tie-in conditions exist, or control structures are present. Because of the uncertainty in depth and duration of the overtopping flows, a factor of safety will typically be applied when considering the structural stability of the levee reach.

#### 6.14.1.2 Armored Surfacing

Based on the certified engineering analysis submitted, a community, levee owner, and/or local project sponsor may be able to demonstrate that armoring is not required for a levee reach to fall within this scenario. However, in most cases, armoring will be expected. Some of the reasons for armored surfacing include:

- Some indication that flow along the levee reach may cause some erosion that will initiate levee breaching
- A lack of proper and continuous maintenance that would result in a non-continuous, non-uniform surface, including the lack of irrigation, fertilization, and annual inspections
- Concerns about localized irregularities, which lead to flow anomalies, because available survey data may not be indicative of localized conditions along the levee reach
- Local conditions, on the landside of the levee, include the presence of dips, depressions, or protrusions (including trees, posts, or other surface anomalies)
- Traffic rutting along the levee crest that induces non-uniform crest conditions, in terms of both levee profile and structural condition
- Difficulty in establishing and properly maintaining a dense and continuous grass cover (in semi-arid and arid regions)
- Debris carried by floodflow that could induce damage to the protective surfacing
- A small amount of damage to a dry or cracked embankment, leading to a catastrophic failure during overtopping
- Risk reduction in high-impact areas

The items below may be considered when determining the viability of an armored surface:

- History of Events. Flood levels, overtopping locations, damage assessments, and maintenance records can be considered to evaluate the damage that occurred during past overtopping events, especially if depth and duration can be established and evidence shows minor to no damage occurred. If the levee has experienced piping or sand boils, the stability of the levee should be questioned. These data will not be used to change the accreditation determination made at the beginning of the levee analysis and mapping process.
- Potential freeboard loss due to subsidence or localized settlement. Frequent, accurate surveys are critical so that an adequate safety factor is maintained in an area where long-term settlement and regional subsidence are common.
- Overtopping height and overtopping flow rate (cubic feet per second). Velocity and tractive-force calculations are key considerations to assess erosion potential.
- Overtopping duration. Levee design discharge or stage hydrographs indicating minutes, hours, or days of anticipated overtopping are especially critical for grass-covered levees.

- Uplift potential and maximum induced shear stress along the interface between the armored surfacing and the overtopping flow. Adequacy of the selected armoring scheme must be demonstrated for given site conditions.
- Resiliency of levee material. Granular and sandy soils will require surface armoring for small rates and depths of flow.
- Flow concentration potential. Surface discontinuities and irregularities can lead to irregular hydraulic flow patterns. Armoring is to be provided if gullies, tire tracks, access roads, fences, utility poles, animal burrows, cattle paths, roads, bike trails, or other conditions may exist that will concentrate flow. For grass-lined levees, the downstream slope can be evaluated to determine if it is uniform from crest to toe, with no interruptions or irregularities such as dips, depressions, or protrusions (e.g., trees, posts, or other surface anomalies).
- Effect of debris on flow patterns. Armored reaches can be subject to damage from flood-borne debris.
- Levee toe protection. This is especially required at the location of eddies, groins, and hydraulic jumps. The depth and thickness of toe protection need to be considered.
- Levee armoring alternatives. Alternatives include soil cement, articulated concrete blocks, roller-compacted concrete, gabions, geocells, and rock chutes. Each alternative will have placement thickness recommendations and associated components/feature design considerations (e.g., tieback levees, sub-drainage, anchoring requirement).
- Wind and wave action. The impact of breaking waves over the levee should be evaluated.
- Cavitation potential. How overtopping flows will affect armored surfacing should be evaluated.
- Levee height. Low levees may be more tolerant to overtopping.
- Interior side slopes. Flatter slopes (i.e., > 4H: 1V) are more tolerant. This is especially important for grass-covered levees.
- Inspections. Inspection frequency is especially important for grass-covered levees or after historical events where overtopping occurs, or the levees have been stressed.
- Validity of the O&M Plan. The O&M Plan should provide confidence in emergency planning that minimizes the effects of overtopping, including the impact at overtopping location(s) and interior drainage.
- Filter capability and free-draining bedding. Filter materials should be protected from high rates of flow.

#### 6.14.1.3 Additional Considerations for Levees Subject to Coastal Flood Forces

A levee reach subject to coastal flood forces will need to include adequate embankment protection, foundation, and embankment stability. The levee reach will need to be designed, constructed, operated, and maintained to resist wave effects (potentially including wave overtopping and storm surcharge to resist erosion) and prevent flooding of interior areas landward of the levee crest.

For levee reaches subject to coastal flood forces with minimal freeboard, armored surfacing will need to be considered on both the seaward side and landsides of the coastal levee, including the crest, to ensure that the levee reach can withstand the wave forces to which the levee is subjected. Further discussion about armoring coastal levees is presented in USACE CERC-89-15, Criteria for Evaluating Coastal Flood Protection Structures.

### 6.14.2 Technical Procedures

If the appropriate data are provided as detailed in Subsection 6.14.1, the assigned Project Team member will route the flooding source hydrograph over the levee reach with the levee remaining intact. The assigned team member will then model the flooding landward of the levee system to determine the SFHA. (See Figure 19.) Figure 20 shows an example of an SFHA delineation when the Overtopping Procedure is applied to a reach of a non-accredited levee system.

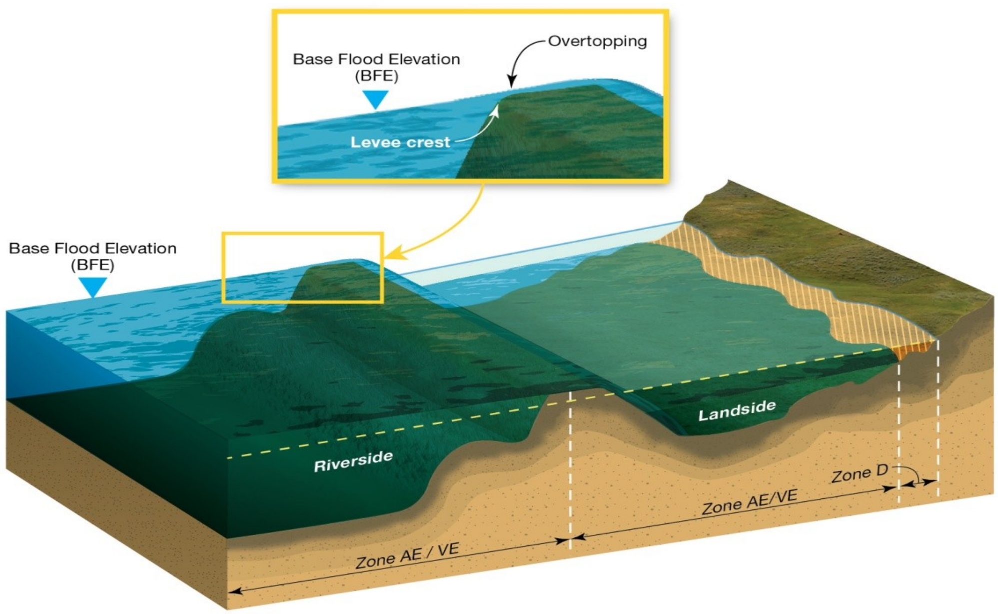



Figure 19: Overtopping Cross-Section View

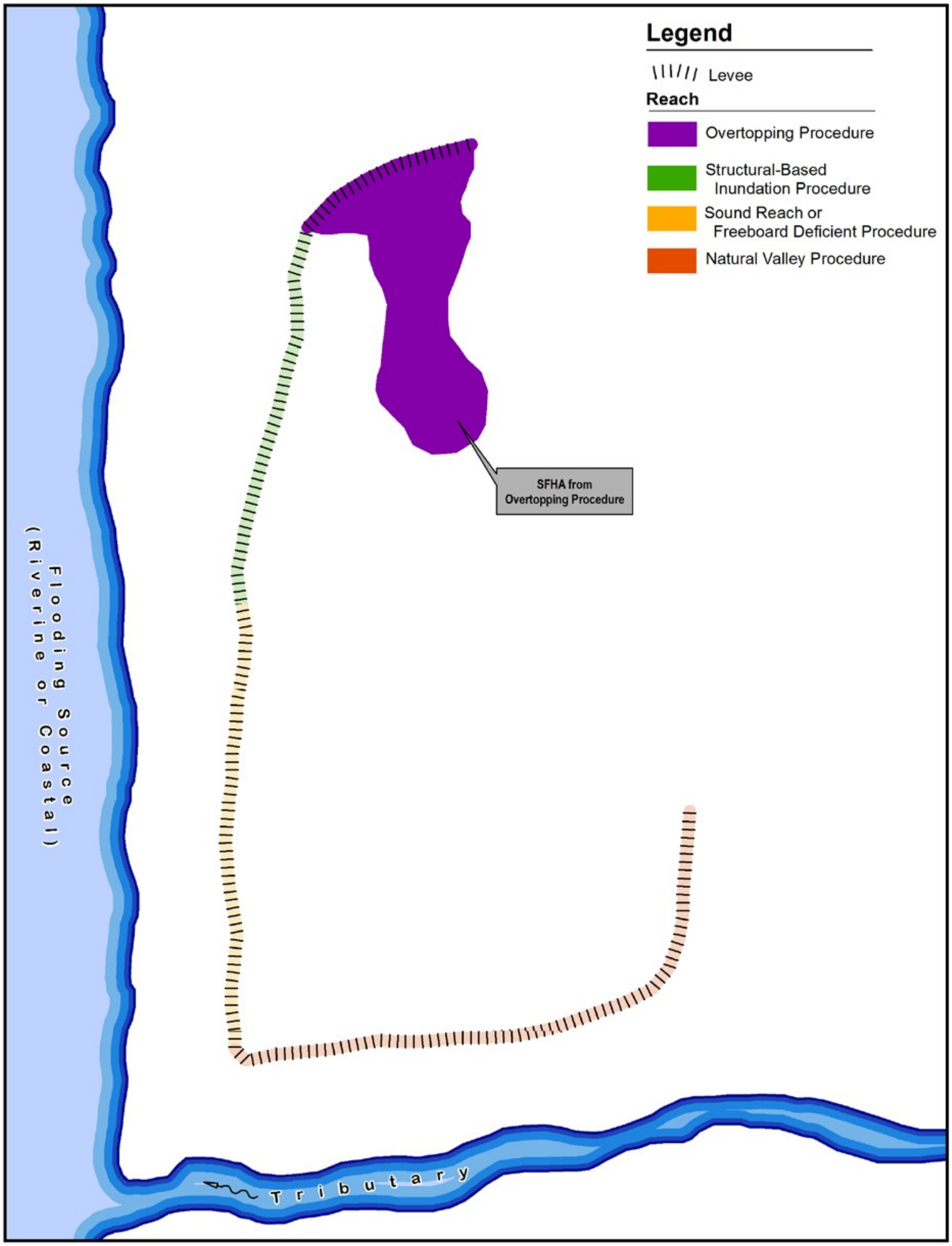



**Figure 20: SFHA Delineation Using Overtopping Procedure**

## 6.15 Freeboard Deficient Procedures (Figure 11, Element 620)

The Freeboard Deficient Procedure can be applied to reaches where the levee system meets the structural requirements of 44 CFR 65.10, lacks adequate freeboard, and has a documented O&M Plan.

### 6.15.1 Data Requirements

To designate a levee reach as a Freeboard Deficient levee reach, the community, levee owner, or local levee sponsor must submit documentation to meet the following standards from 44 CFR 65.10 to FEMA:

- The top of the levee crest and closure structures along the entire reach must be above the BFE.
- O&M Plan. Details of the O&M Plan standard are provided in 44 CFR 65.10(c).
- Structural design standards. Structural design must meet minimum design standards, including data regarding closures in 44 CFR 65(b)(2), embankment protection in 44 CFR 65.10(b)(3), embankment and foundation stability in 44 CFR 65.10(b)(4), settlement in 44 CFR 65.10(b)(5), interior drainage in 44 CFR 65.10(b)(6), and any other design standards as detailed in 44 CFR 65.10(b)(7).
- The structural design documentation should also include a discussion of whether the failure of an adjacent levee could affect the structural integrity reach if that adjacent levee reach is not categorized as a Sound Reach or Freeboard Deficient levee reach.
- Inspection reports. The standard for documentation of inspection is provided in 44 CFR 65.10(c)(1)(iii) and 44 CFR 65.10(c)(2)(iv).
- Elevation information for the levee crest and toe.
- 
- Certified As-built drawings.

All items must be signed and sealed by a registered P.E.

FEMA will review the submittal in accordance with the appropriate sections of Chapter 4 of this document.

### 6.15.2 Technical Procedures

No reach-specific modeling is required for a reach evaluated using the Freeboard Deficient Procedure, but the Project Team will map the system-wide Zone D area landward of the levee system for these reaches. (See Figure 21.) The SFHAs from the system-wide interior drainage analysis and/or adjacent levee reaches where different procedures have been applied may still be present on the landside of the levee with Freeboard Deficient levee reaches. This will depend on the presence of interior ponding areas and other terrain features on the landside of the levee.

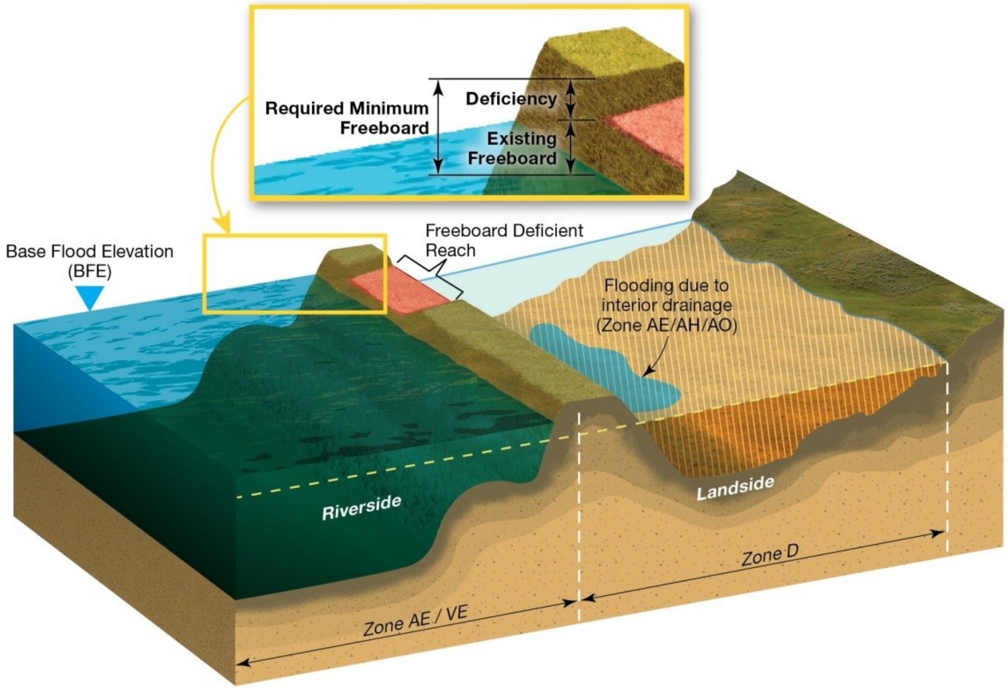



Figure 21: Freeboard Deficient Cross-Section View

## 6.16 Sound Reach Procedure (Figure 11, Element 620)

A Sound Reach is a levee reach that has been designed, constructed, and maintained, in accordance with sound engineering practices, to withstand and reduce the flood hazards posed by a base flood even if the entire system does not.

### 6.16.1 Data Requirements

Sound Reaches are part of a levee system that cannot meet accreditation requirements. Because they are only a component of a levee system, they cannot be accredited as a hydraulically independent system.

To designate a reach as sound, the community, levee owner, or local levee sponsor must submit technical data to FEMA to demonstrate that the levee reach will withstand the forces of the 1-percent- annual-chance flood event, and reasonably account for uncertainty. To accomplish this, documentation to meet the following standards from 44 CFR 65.10 must be submitted to FEMA:

- Freeboard. The levee reach must meet the minimum freeboard standards in 44 CFR 65.10(b)(1).
- O&M Plan. Details of the O&M Plan standard are provided in 44 CFR 65.10(c).
- Structural design standards. Structural design must meet minimum design standards, including data regarding closures in 44 CFR 65(b)(2), embankment protection in 44 CFR 65.10(b)(3), embankment and foundation stability in 44 CFR 65.10(b)(4), settlement in 44 CFR 65.10(b)(5), interior drainage in 44 CFR 65.10(b)(6), and any other design standards as detailed in 44 CFR 65.10(b)(7).

The structural design documentation should also include a discussion if the failure of an adjacent levee could affect the structural integrity reach if that adjacent levee reach is not categorized as Sound or Freeboard Deficient.

- Inspection reports. The standard for documentation of inspection is provided in 44 CFR 65.10(c)(1)(iii) and 44 CFR 65.10(c)(2)(iv).
- Elevation information for the levee.
- 
- Certified as-built drawings.

All items must be certified and sealed by a registered P.E.

FEMA will review the submittal in accordance with Chapter 4 of this document.

### 6.16.2 Technical Procedures

No levee reach-specific modeling is required for a Sound Reach, but the Project Team will map the system-wide Zone D landward of the levee for these reaches. The SFHAs from the system-wide interior drainage analysis and/or adjacent levee reaches may still be present on the landside of Sound Reaches. (See Figure 22.) This will depend on the presence of interior ponding areas and other terrain features on the landward side of the levee. The SFHAs that form these areas will supersede the system-wide Zone D areas, as applicable.

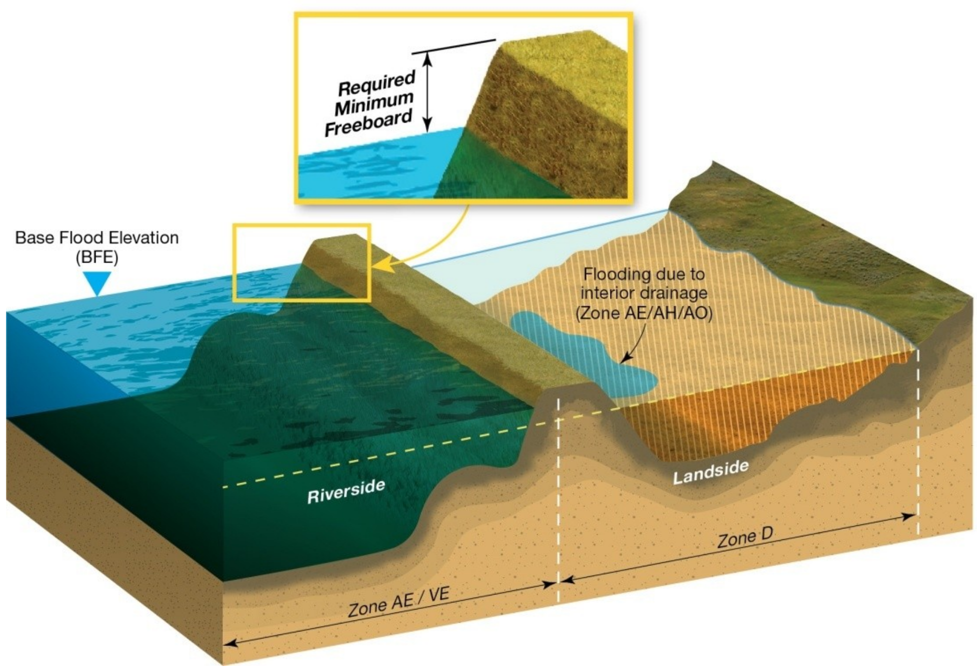



**Figure 22: Sound Reach Cross-Section View**

## 6.17 Flood Hazards Evaluated by Flooding Source (Figure 11, Element 630)

The assigned Project Team member will analyze and map the BFEs on the riverside of the levee assuming that all levee reaches remain intact. If a levee is overtopped and flow would be lost to the landside of the levee, the assigned team member may consider those losses and may reduce flow in the main flooding source in accordance with FEMA Guidance Document No. 80, Guidance for Flood Risk Analysis and Mapping - Hydraulics: One Dimensional Analysis, which is accessible from the FEMA Guidelines and Standards for Flood Risk Analysis and Mapping webpage.

## 6.18 Hydrograph Development

### 6.18.1 Riverine Hydrograph Development

Traditionally, projects conducted for flood insurance purposes have only calculated peak-flow or peak-surge elevation. Both the Structural-Based Inundation and Overtopping Procedures will often require a base flood hydrograph to complete the modeling, making the development of a flood hydrograph necessary. Computing and selecting a representative hydrograph shape with an appropriate volume is an important step. For many systems, the hydrograph shape and volume will be a key parameter influencing the resultant SFHA delineations.

FEMA determines that a cost-effective method is needed to estimate flood hydrographs for projects where only peak discharges/surge elevations are available, where a rainfall-runoff model or storm surge model is not available, or where funding is not sufficient to develop a rainfall-runoff or storm surge model. Procedures discussed below will use the base flood hydrograph for the levee analysis, but other flood return frequencies also could be used if appropriate.

The approach presented in this subsection is based on both the availability of data and the type of flooding. For flooding sources with gaging stations near the study location, two methods for developing desired-percent-chance flood hydrographs may be followed:

1. Scale a major (10-percent-annual-chance peak discharge or larger) observed flood hydrograph by multiplying the ordinates by a factor to create the desired-percent-chance flood hydrograph.
2. Develop a balanced synthetic flood hydrograph using peak discharges and N-day volumes.

The above methods for developing flood hydrographs are not the only acceptable approaches. The application of any method, including those above, should be evaluated for reasonableness.

The balanced synthetic flood hydrograph will be used when no major (10-percent-annual-chance peak discharge or larger) observed flood hydrograph is available for scaling to obtain the desired-percent-chance hydrograph, or the volume under the observed flood hydrograph is not considered representative of the desired-percent-chance hydrograph.

To scale a smaller hydrograph to a larger hydrograph, the assigned Project Team member will plot several observed flood hydrographs to determine a representative hydrograph shape that can be scaled to become a desired-percent-chance flood hydrograph. The observed hydrograph with the largest peak discharge and volume is the most logical choice. Unit discharge data are available from the USGS Instantaneous Data Archive for many gaging stations from the late

1980s through September 2007. Since October 1, 2007, the unit discharge data are available on the National Water Information System (NWIS).

The discharge ordinates of the representative observed hydrographs can be scaled by multiplying them by a ratio of the desired-percent-chance peak discharge to the observed peak discharge (or the reverse ratio if scaling down the observed hydrograph). If the gaging station drainage area is within 50 percent of the drainage area of the study location, the assigned Project Team member can transfer the desired-percent-chance hydrograph upstream or downstream using the ratio of drainage areas and regional flood frequency relations. Scaling the peak discharge also scales the flood volume with the time base of the hydrograph held constant (basin lag time assumed constant for a given watershed).

The above procedure is valid for steady flow. For unsteady flow, the Project Team member must take volume into consideration for hydrograph development.

The balanced synthetic hydrograph can be constructed using desired-percent-chance flood volumes for different durations (e.g., 1-day, 3-day, 7-day). The N-day flood volumes can be obtained from daily discharge data in the NWIS. Some of the available computer programs for estimating the desired-percent-chance N-day flood volumes include the USACE Hydrologic Engineering Center Statistical Software Package (HEC-SSP) and USGS Surface-Water Statistics (SWSTAT) computer program. The balanced synthetic hydrograph is shaped using an observed major flood hydrograph. More information on this method is provided in the USBR Flood Hydrology Manual and in USACE Engineer Manual 1110-2-1415, Hydrologic Frequency Analysis (or subsequent updates on this topic).

If the effective FIS Report was based on a rainfall-runoff model, the assigned Project Team member can use that model to obtain the appropriate flood hydrograph for ungagged watersheds. If a rainfall-runoff model was not developed for the effective FIS Report, a rainfall-runoff model may have been developed for other purposes, such as a master drainage plan. If available, the team member can scale the flood hydrographs from that model to be consistent with the peak discharges developed for the effective FIS Report.

If a continuous simulation rainfall-runoff model is available, then several simulated flood hydrographs are available. The assigned Project Team member can scale the simulated flood hydrograph with largest volume and peak discharge to get the desired-percent-chance flood hydrograph.

If no rainfall-runoff model is available, it may be feasible for the assigned Project Team member to develop a simplified rainfall-runoff model for a single watershed area with no subdivision and no channel/reservoir routing or model calibration. The team member can scale the flood hydrographs from this model to be consistent with peak discharges determined from other methods.

Examples of dimensionless unit hydrographs are provided in Figure 23, where the vertical ordinate is a ratio of discharge (Q) to the peak discharge (Qp) and the horizontal ordinate is a ratio of time (t) to basin lag time ($T_L$) to time to peak ($T_P$).

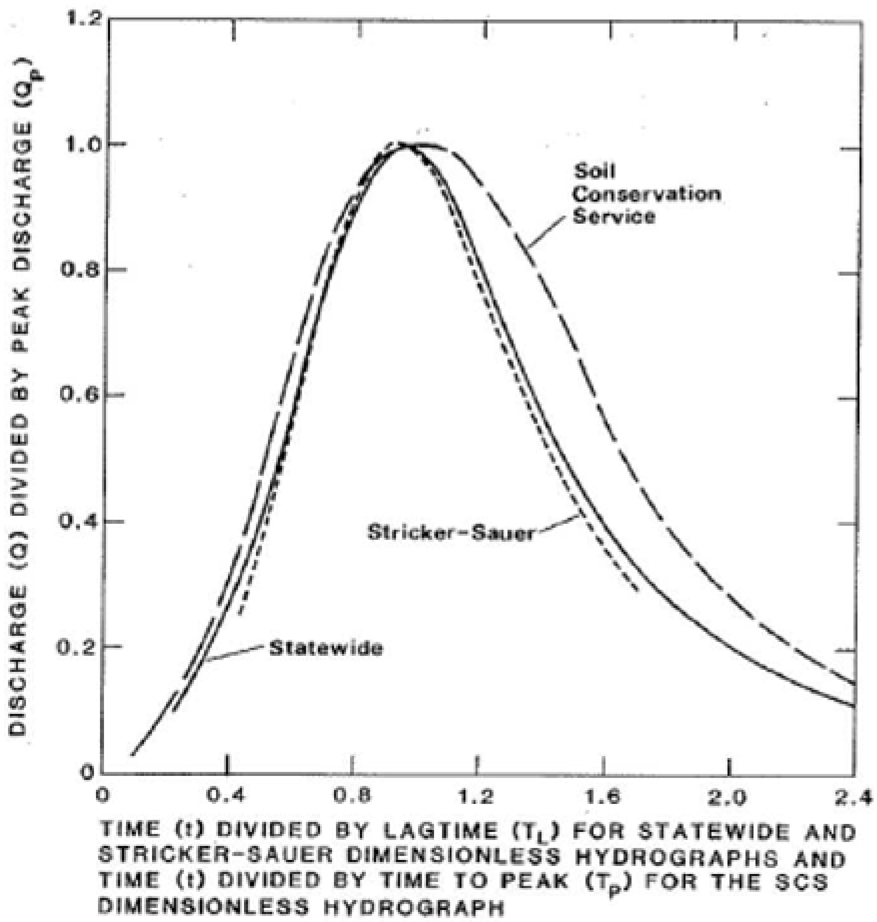



**Figure 23: Sample Dimensionless Unit Hydrograph**

The "Statewide" hydrograph in Figure 23 was developed by E, J. Inman in USGS Water-Supply Paper 2317, Simulation of Flood Hydrographs for Georgia Streams, using data for 80 gaging stations in Georgia. This dimensionless hydrograph is implemented in the USGS National Streamflow Statistics (NSS) Computer Program. The "Stricker-Sauer" hydrograph (USGS Open-File Report 82-365, Techniques for Estimating Flood Hydrographs for Ungaged Urban Watersheds), was theoretically developed from Clark unit hydrograph procedures. The "SCS" dimensionless hydrograph is described in Chapter 16, Part 630, Hydrology, of the Natural Resources Conservation Service (NRCS) National Engineering Handbook. The USGS dimensionless hydrographs shown in Figure 23 (Stricker-Sauer) can be converted to desired-percent-chance flood hydrographs by multiplying the discharge ratio by the desired-percent-chance peak discharge and the time ratio by basin lag time. The resultant flood hydrograph is assumed to be a typical flood hydrograph for a desired-percent-chance peak discharge. There is no implication that the volume under the hydrograph has a desired-percent chance of being exceeded. The desired-percent-chance peak discharge and the basin lag time are watershed-specific characteristics that determine the shape of the hydrograph.

Other flood hydrograph estimation methods developed by State, regional, and local agencies can be used in a similar manner. In the more arid regions of the Western United States, methods developed by State, regional, and local agencies may be particularly relevant because the USGS national dimensionless hydrograph was developed for streams in Georgia and other USGS statewide analyses are generally restricted to the Eastern United States.

In addition to the Georgia dimensionless hydrograph ("statewide") available in the USGS NSS program, the USGS has developed dimensionless hydrographs for several other states:

- Water-Resources Investigations Report 89-4076, Techniques for Simulating Flood Hydrographs and Estimating Flood Volumes for Ungaged Basins in East and West Tennessee.
- Water-Resources Investigations Report 89-4087, Determination of Flood Hydrographs for Streams in South Carolina: Volume 1. Simulation of Flood Hydrographs for Rural Watersheds in South Carolina.
- Water-Resources Investigations Report 97-4279, Techniques for Simulating Peak-Flow Hydrographs in Maryland.

The dimensionless hydrographs developed for other states agree reasonably well with the Georgia dimensionless hydrographs, but the state-specific hydrographs are to be used if available. For ungaged streams that are not regulated by flood-control structures, the dimensionless hydrograph method may be used to estimate the desired-percent-chance hydrograph.

The desired-percent-chance peak discharge for rural and urban ungaged watersheds may be estimated from USGS regression reports or from other regression equations developed for the study area. The basin lag time may be estimated by regression equations given in USGS reports on dimensionless hydrographs, many of which are summarized in Appendix B of USGS Techniques and Methods 4-A6, The National Streamflow Statistics Program: A Computer Program for Estimating Streamflow Statistics for Ungaged Sites, and other regression equations developed for basin lag time. The basin lag time as used in the USGS dimensionless hydrograph approach is the time from the center of mass of rainfall excess to the center of mass of runoff.

Using rainfall-runoff data for 81 watersheds in Maryland, in Estimation of Time of Concentration for Maryland Streams, Thomas and others demonstrated that the basin lag time used to define the USGS dimensionless hydrograph was, on average, only 5 percent less than the watershed time of concentration. Therefore, basin lag time as defined above may be approximated by the time of concentration as estimated by the NRCS travel time method documented in Technical Release 55, Urban Hydrology for Small Watersheds.

The balanced synthetic hydrograph method described above for gaged streams may also be applied to ungaged streams by implementing the method below.

- Estimate N-day volumes (e.g., 1-day, 3-day, 7-day) at gaging stations in the vicinity of the ungaged streams.
- Develop regression equations for estimating the desired-percent-chance N-day volumes for ungaged streams.

- Construct a balanced synthetic hydrograph with the desired-percent-chance N-day volumes.

This method is more time consuming, but it may be used if the dimensionless hydrograph method does not provide reasonable results or in areas where the dimensionless hydrograph method may not be applicable.

### 6.18.2 Coastal Hydrograph Development

For coastal analyses, one way to create a synthetic storm surge hydrograph is using procedures in the Federal Highway Administration (FHWA) Hydrologic Engineering Circular No. 25, Tidal Hydrology, Hydraulics, and Scour at Bridges. If data from a detailed coastal model are not available. The required variables for the method are:

- Peak surge elevation ($S_p$)
- Forward speed of the storm (f)
- Radius of maximum winds (R)

$S_p$ is given directly from the published BFE noted in the FIS Report, while a range of values for both R and f are possible for a given location.

Coastal Flood Risk Projects based on modern methods involving Joint Probability Method (JPM) analysis contain enough information about the range of storm parameters that a representative R and f to associate with the value of $S_p$ can be calculated directly. For flood hazard mapping projects where the Project Team did not employ a JPM approach for determining the BFE, these values may need to be estimated by examining historical storms in the region.

Pilot tests suggest that the ultimate extent of flooding landward of a breached or overtopped coastal levee is not highly sensitive to the shape of the synthetic hydrograph, so the exact choice for f and D may not be a critical factor. The peak surge and width of failure in a breaching condition is of primary importance within this analysis.

## 6.19 Regulatory Floodways

For some communities, regulatory floodways may have already been delineated for levee-impacted areas along a flooding source. FEMA has developed an approach for modeling and delineating the regulatory floodway in levee-impacted areas.

The following guiding principles form a basis to support this effort and are discussed in more detail in the subsections that follow:

1. Baseline Model
   The baseline model is either the effective model (for the base flood event) if an effective floodway exists or the baseline model does not consider any existing encroachments since the area was first shown on an NFIP map.

2. Surcharge Limits (Values)

   NFIP regulations and Standard SID 69 states:

Floodway surcharge values must be between zero and 1.0 ft. If the state (or other jurisdiction) has established more stringent regulations, these regulations take precedence over the NFIP regulatory standard. Further reduction of maximum allowable surcharge limits can be used if required or requested and approved by the communities impacted". Standard SID 70 states "If a stream forms the boundary between two or more states and/or tribes, either the 1.0-foot maximum allowable rise criterion or existing floodway agreements between the parties shall be used.

3. Effective Floodway

   a. Existing Conditions - Presence of an effective floodway provides a starting point for:

      1. Baseline model; and

      2. Floodway encroachment.

      If no effective floodway exists, then the baseline model using equal conveyance reduction becomes the initial floodway analysis.

   b. Proposed or Changed Conditions - If the proposed or changed project results in BFE increases in excess of those permitted under 44 CFR 60.3 (c)(10) or (d)(3), the community must apply for CLOMR per 44 CFR 65.12. CLOMRs are encouraged for all levee projects.

4. Equal Conveyance

   Standard SID 72 states: "An equal conveyance reduction method must be used to establish the minimal regulatory floodway." Floodways need to be based on equal conveyance except where an initial equal conveyance floodway is adjusted in coordination with FEMA and affected communities.

5. Removal or No Floodway

   In some situations, floodways may not make sense if there is already a built-out condition, or other flow conditions not supporting a floodway analysis exists. In these situations, coordination with FEMA and affected communities is needed to come to an agreement on the proper approach.

6. Hydraulically Insignificant Levees (refer to Subsection 6.19.3)

   For levees which are considered hydraulically insignificant, that is, the levee does not significantly affect the natural flow through the valley or is significantly overtopped during the base flood event, the floodway is modeled using the Natural Valley Procedure with initial floodway analyses using the equal conveyance reduction. For mapping purposes, a structure is considered hydraulically insignificant if, during a base flood event, the peak WSELs landward of the structure may be the same regardless of whether the structure was in place.

7. Hydraulically Significant Levees (refer to Subsection 6.19.4)

   For levees which are considered hydraulically significant, which can include accredited levees and/or non-accredited levees, the floodway is computed in one of two ways:

   a. Levee on one bank

   b. Levee on both banks

8. Mapping Floodway Boundaries on the Levee
   Standard SID 452 states, "Floodway boundaries shall be placed on the riverside of a levee unless the community specifically requests otherwise, or where hydraulic calculations demonstrate a floodway is warranted elsewhere". Where the floodway boundary lands on the levee, the boundary is placed at the computed location, unless the State or community request otherwise. Some States, who have jurisdiction over the floodways, regularly show the floodway boundaries on the landside toe. The floodway should not extend past the landside toe for an accredited levee without concurrence from the FEMA Regional Office and FEMA Headquarters.

### 6.19.1 Coordination with Communities

The regulatory floodway is a community floodplain management tool. While a default approach is presented below, FEMA decisions about the final approach to determining the regulatory floodway will be made in coordination with officials of the affected communities, the levee owner(s), and impacted property owners. In addition, when the jurisdictions along either side of a flooding source are different, coordination between the Project Team, the State NFIP Coordinator(s), and local jurisdictions affected will need to take place before the modeling approach is finalized.

Development and designation of floodways in urban situations where significant development has already occurred may not be beneficial to the community as minor public and homeowner projects will need to demonstrate "no-rise" in the BFE. In such situations, designation of a floodway hinders floodplain management rather than aids it. Such situations require additional coordination among FEMA, the State, and the communities.

### 6.19.2 Floodway Analysis and Mapping Methods

The floodway should be modeled as described in FEMA Guidance Document No. 79, Guidance for Flood Risk Analysis and Mapping: Floodway Analysis and Mapping. Per this guidance, the baseline model for the allowable surcharge is the model used to determine the BFEs the first time a floodway was adopted for the reach. Unless it is demonstrated that the model should be revised for reasons other than encroachments into the floodplain, all subsequent revisions to the floodway are limited to the maximum allowable surcharge above the elevations determined in the base model. That way, as hydraulic models are updated to reflect encroachments into the floodway fringe, the cumulative effect of those and future encroachments is limited to the maximum allowable surcharge.

In case of leveed reaches, it is acceptable to compare the floodway WSELs to the "with-levee" BFEs to determine surcharges if acceptable surcharge limit cannot be achieved using the baseline WSEL. In these situations, the methodology outlined in the following subsections limit the floodway encroachments at the levee. Coordination with FEMA and community officials is required in case the encroachment location on the riverside of the levee is warranted. Generally, the floodway analysis in leveed reaches consist of up to three parts:

1. An initial floodway analysis to determine the natural valley equal conveyance reduction locations to set the regulatory floodway location.

2. An intermediate floodway analysis to verify that the allowable surcharges are not exceeded with the levee in place.

3. A final floodway analysis that has surcharges within the allowable limits.

The conditions used for the baseline model and the floodway analyses steps listed above (and described below) could vary on case-by-case basis. Coordination with FEMA and the affected communities will be required in these cases.

### 6.19.3 Hydraulically Insignificant Levees

If a levee is determined to be hydraulically insignificant and the Natural Valley Procedure is used, the regulatory floodway may still extend landward of the levee. The assigned Project Team member will develop the floodway analysis following established equal conveyance standards. In addition, if the levee is overtopped during the base flood event and a defined flow path must be preserved, the assigned team member may find that a floodway analysis of the flow path may be required.

### 6.19.4 Hydraulically Significant Levees

If a levee(s) is determined to be hydraulically significant, the procedures outlined below are applied for floodway modeling. It is likely that a combination of the scenarios discussed below will exist at various cross sections along the levee system. The methods described in Subsections 6.19.5 through 6.19.9 can be applied to specific cross sections. However, the Project Team should evaluate consideration of the model as a whole when adjusting encroachment stations due to the impact to surcharge values and community input.

### 6.19.5 Hydraulically Significant Levees – On One Bank

For streams with no effective floodway, an initial floodway analysis will be developed using the natural valley analysis with equal conveyance standards. For streams with an effective floodway, an initial floodway analysis is performed using the natural valley analysis with the effective floodway encroachment stations to verify that the allowable surcharge limits can still be met. If the initial floodway analysis resulted in floodway encroachment stations on the riverside of the levee and meeting the allowable surcharge limits, the floodway can be delineated at the computed locations. If the floodway limit is located on the riverside of the levee and the impacted State and/or community with jurisdiction over the floodway requests, FEMA will map the floodway limit on the landside toe of the levee for an accredited levee system. In case of a non-accredited levee system, States or communities may decide to delineate the floodway at the computed location within the levee-impacted area. In these cases, the intermediate steps discussed below are not necessary.

If the initial floodway analysis resulted in a floodway encroachment landward of the levee (see Figure 24), an intermediate floodway analysis can be developed. This is done by maintaining the location of the encroachment stations on the non-leveed side and shifting the leveed-side encroachment stations to the levee line. (See Figure 25.) The resulting regulatory floodway elevations are compared to the baseline without floodway elevations to determine if the surcharges are within the allowable limit. If the surcharges are within the allowable limit, the floodway can be delineated at the location computed in this model.

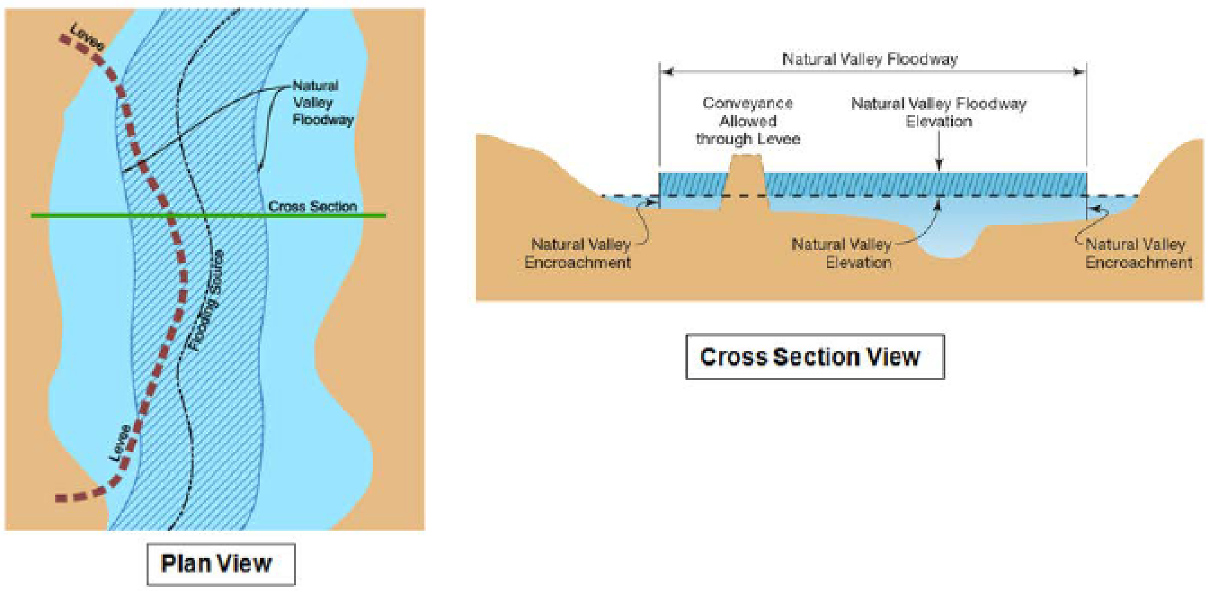



Figure 24: Floodway Analysis Process Initial Analysis

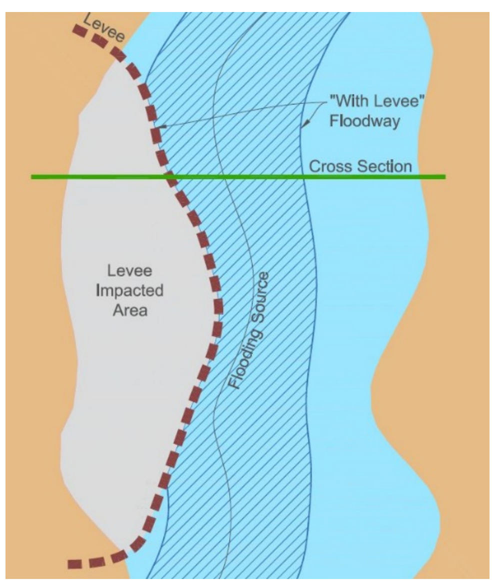



Figure 25: Floodway Analysis Process Initial Analysis

If surcharge in the intermediate floodway model exceeds the maximum allowable limit, the regulatory floodway on the non-levee side is widened to bring the surcharge within the allowable limit, as shown in Figure 26. This condition would require coordination with the State or community officials and affected property owners. If the surcharges cannot be kept within allowable limit by widening the non-levee side, the surcharge can be reevaluated by comparing the results of the intermediate floodway analysis to the with-levee BFE. Situations may arise where it is not possible to bring the floodway surcharge within allowable limit by widening the floodway or evaluating the surcharges against the with-levee BFEs. In these situations, coordination among community officials, affected property owners, and FEMA is required to determine the most appropriate approach.

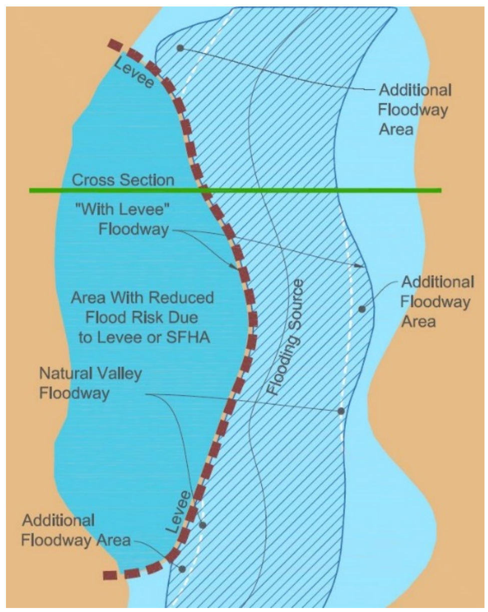



**Figure 26: Final Regulatory Floodway**

### 6.19.6 Hydraulically Significant Levees on Both Banks

When hydraulically significant levees exist on both banks, three scenarios could potentially result from the initial natural valley equal conveyance reduction floodway analysis methodology outlined in Subsection 6.19.2.

- Both encroachment stations computed on the levees or on the riverside of the levees.
- One encroachment station is computed on the landside of the levee and the other is on or riverside of the levee.
- Both encroachment stations are computed on the landside of the levees.

### 6.19.7 Both Encroachment Stations Computed on Levee or on Riverside of Levee

If the initial floodway analysis resulted in a floodway encroachment on the riverside of the levee on both sides (Figure 27), the floodway can be delineated at the computed location. However, if requested by the community, the floodway may be mapped at the landside toe of the levees.

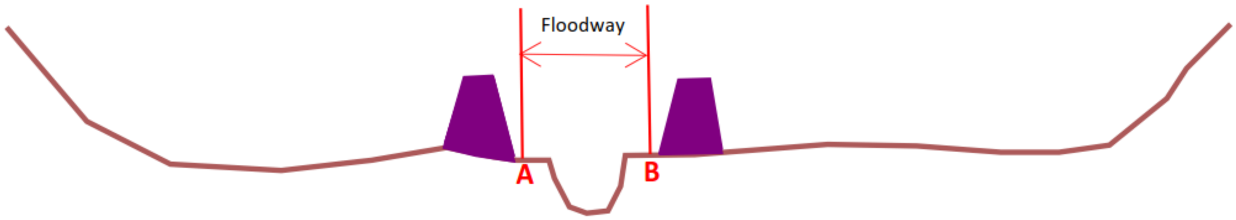



**Figure 27: Both Encroachments (A and B) on Riverside of Levees**

### 6.19.8 One Encroachment Station Is on Landside of the Levee and the Other Is on the Levee or on the Riverside of the Levee

If the initial floodway analysis resulted in a floodway encroachment on the riverside of the levee on one side and on the landside of the levee on the other side, as shown by points A and B, respectively, in Figure 28 below, then an intermediate floodway analysis will be developed.

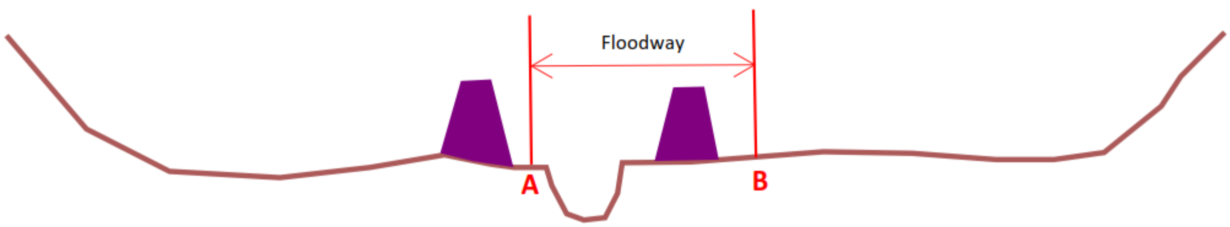



**Figure 28: One Encroachment on Riverside of Levee (A) and the Other on Landside of Levee (B)**

This is done by maintaining the location of the encroachment station A and shifting encroachment station B to the levee location as shown in Figure 29. The resulting regulatory floodway elevations are compared to the baseline model elevations to determine if the surcharges are within the allowable limit. If the surcharges are within the allowable limits, the floodway can be delineated at the location computed in this model. If requested by the community, the floodway on one or both sides may be mapped at the landside toe of the levee.

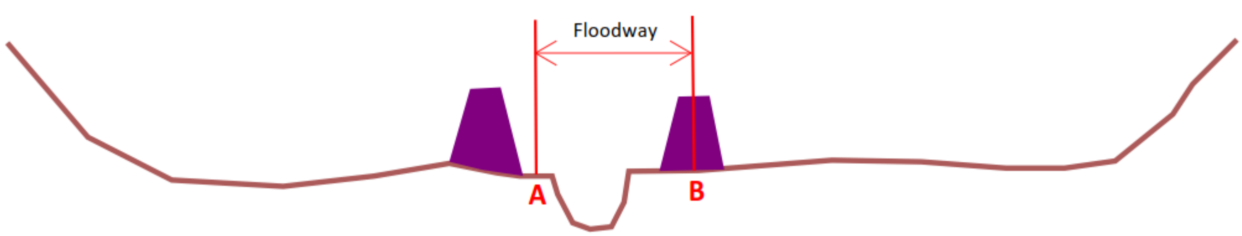



**Figure 29: The Landside Encroachment (B) Moved to the Levee**

If surcharge in the intermediate floodway model exceeded the maximum allowable, the regulatory floodway on side A is widened to bring the surcharge within the allowable limits, as shown in Figure 30. If the surcharge limit cannot be met by moving the encroachments to the levees, the surcharge can be reevaluated by comparing the results of the intermediate floodway analysis to the with-levee BFE. Situations may arise where it is not possible to bring the floodway surcharge within the allowable limit by widening the floodway and using the with-levee BFE for surcharge calculation. Coordination between community officials and FEMA is required to determine the most appropriate approach.

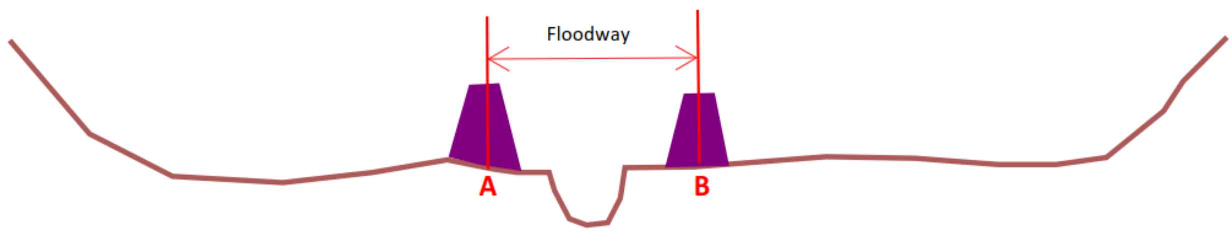



Figure 30: Both Encroachments at Levees

### 6.19.9 Both Encroachment Stations Fall on Landside of the Levees

If the initial floodway analysis resulted in a both floodway encroachments on the landside of the levees on both banks, as shown in Figure 31 below, then an intermediate floodway analysis will be developed. This is done by moving both encroachments to the levee (as shown in Figure 30) and comparing the floodway elevation to the baseline model elevations to determine if the surcharges are within the allowable limits. If they are within the allowable limits, then the floodway is mapped at the levees.

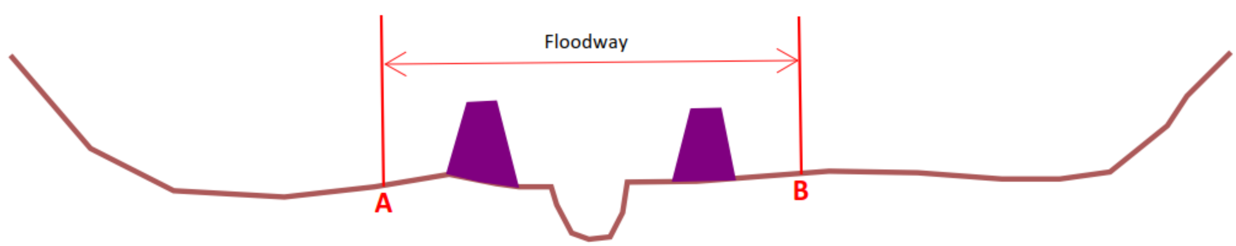



Figure 31: Both Encroachments Landward of the Levees

If surcharge in the intermediate floodway model exceeded the maximum allowable, the surcharge can be reevaluated by comparing the results of the intermediate floodway analysis to the with-levee BFE. If the surcharges are within allowable limit, the floodway can be mapped at the levees. If the surcharges exceed the allowable limit, coordination between community officials and FEMA is required to determine the most appropriate approach.

### 6.19.10 The Methodology for Development of the Regulatory Floodway

This subsection outlines the step-by-step process for determining the final floodway encroachment stations for hydraulically significant levees on both banks. Steps 5 and 6 apply only to non-accredited levees.

As mentioned in previous sections, the regulatory floodway is a community floodplain management tool, and the final approach to determining the regulatory floodway will be made in coordination between FEMA and the affected communities. The method below is a general guideline expected to be applicable for floodway identification in most levee situations. These steps should be applied in consideration of the model as a whole when adjusting encroachment stations.

1. Compute the WSEL with both levees holding to produce the with- levee BFE.
2. Compute the WSEL with the left levee holding (BFE riverside of right levee).
3. Compute the WSEL with the right levee holding (BFE riverside of left levee).
4. Perform the Natural Valley Procedure floodway analysis to determine encroachment stations A and B. (See Figure 32.)

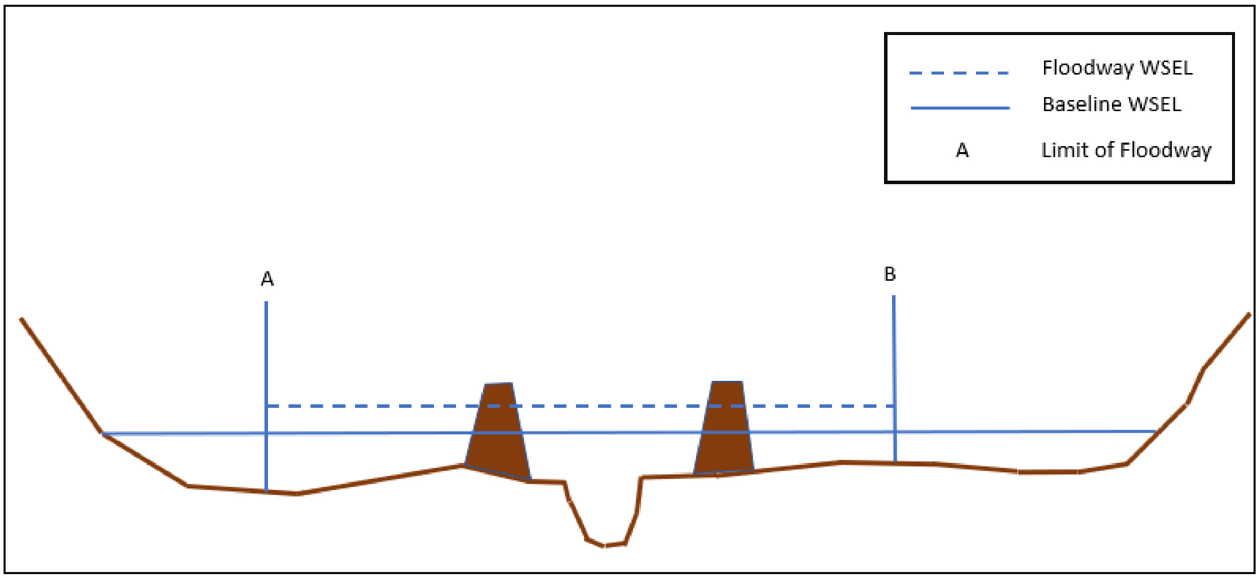



**Figure 32: Use of Natural Valley Procedure to Determine Initial Encroachment Stations A and B**

5. Run floodway analysis with the left levee holding to determine encroachment station C. Left encroachment station is set at the left levee. (See Figure 33.)

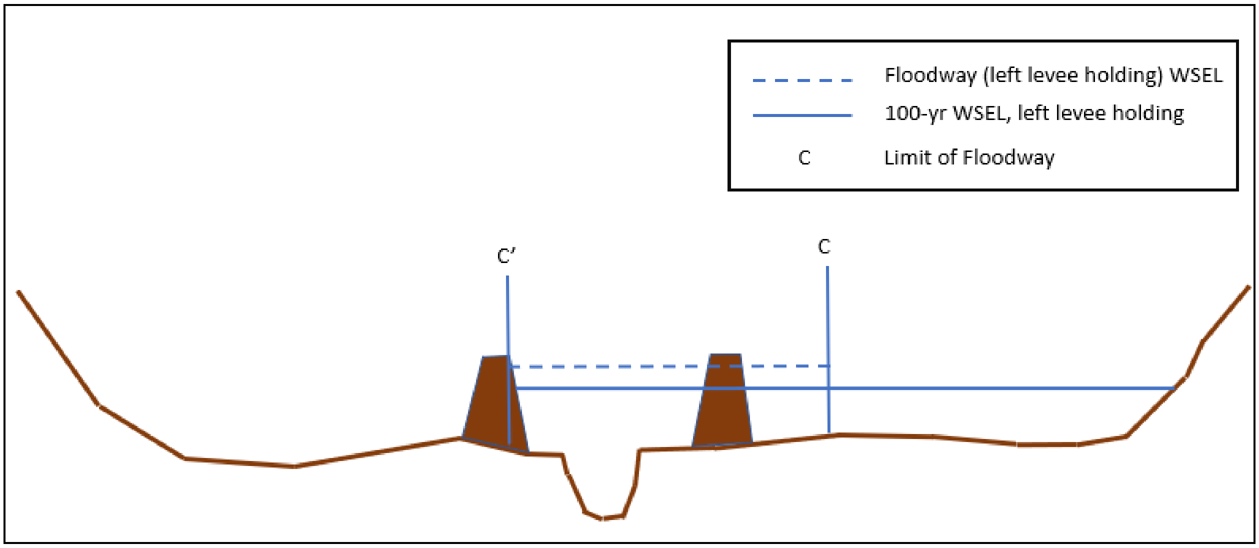



**Figure 33: Using Left levee holding to find encroachment station C**

6. Run floodway analysis with the right levee holding to determine encroachment station D. Right encroachment station is at the right levee. (See Figure 34.)

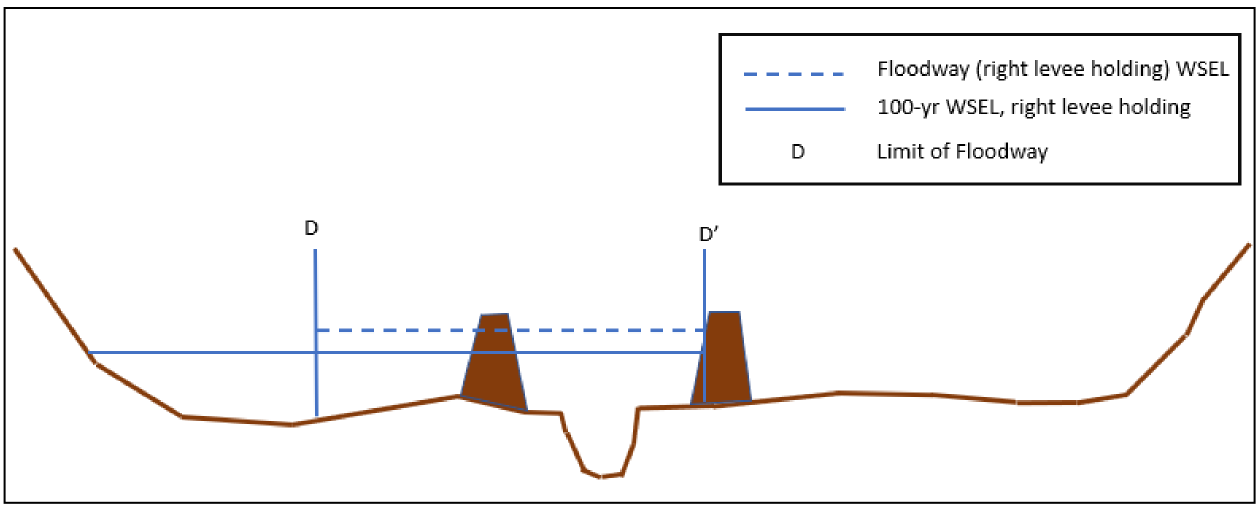



**Figure 34: Right Levee Holding to Find Encroachment Station D**

7. If both levee systems are accredited, start with A and B as initial locations as shown in Figure 32. If both levees are non-accredited, start with C and D as initial locations from encroachments computed in previous steps. (See Figure 35.) if the left levee is non-accredited and right levee is accredited, start with B and D as initial locations from encroachments computed in previous steps. (See Figure 36.) If the right levee is non-accredited and left levee system is accredited, start with A and C as initial locations from encroachments computed in previous steps. (See Figure 37.) Then follow the steps outlined below.

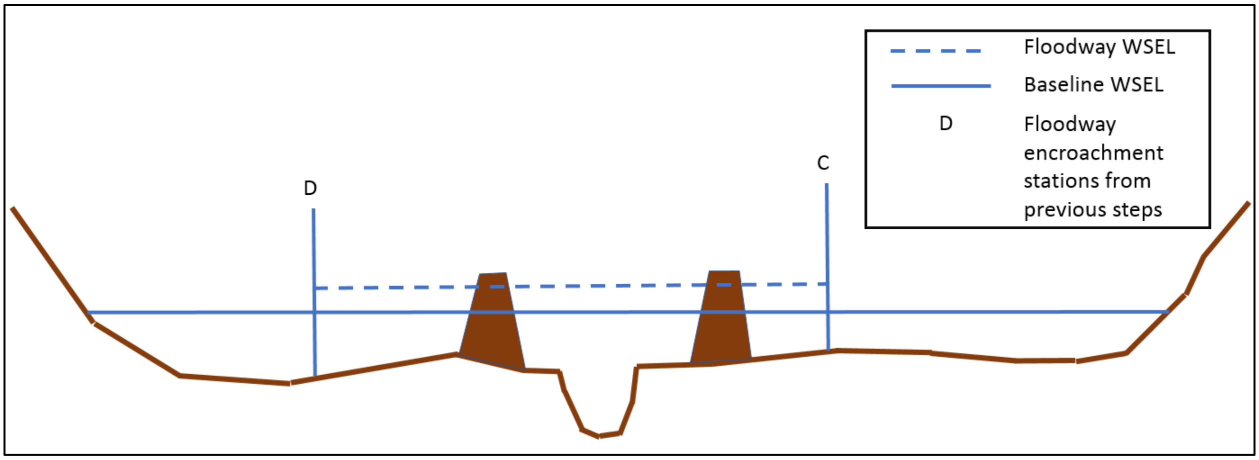



**Figure 35: Both levees Are Non-accredited**

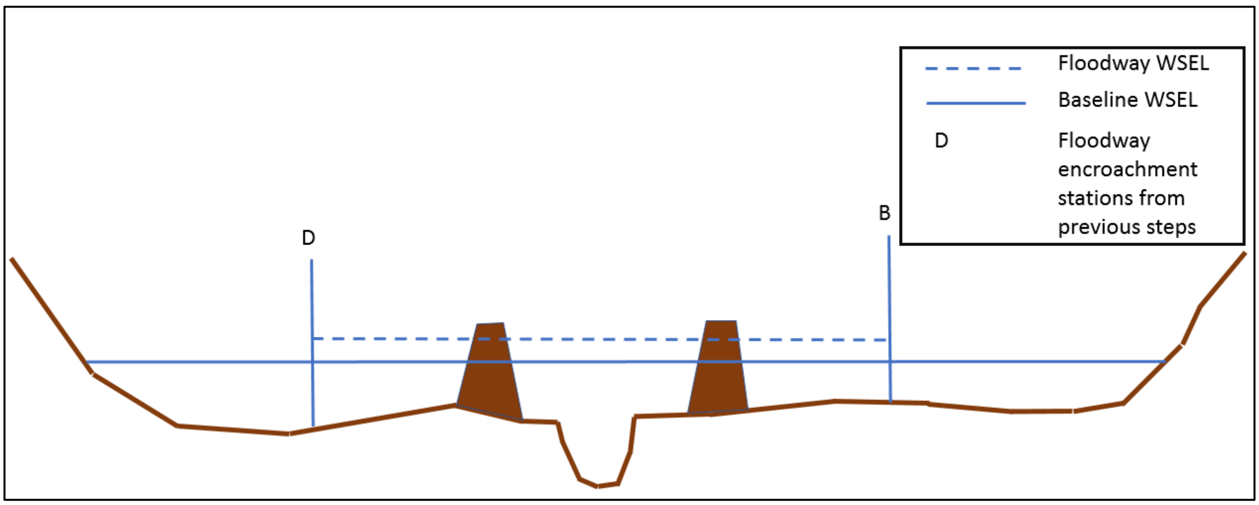



**Figure 36: Left Levee Is Non-accredited, Right Levee Is Accredited**

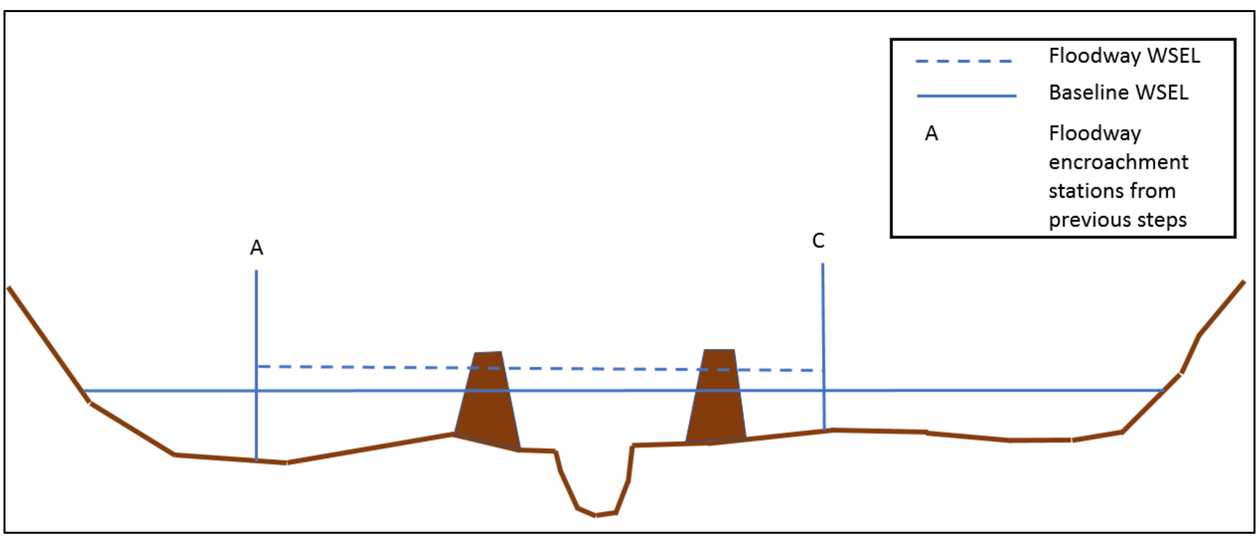



**Figure 37: Right Levee Is Non-accredited, Left levee Is Accredited**

a. Start with initial encroachment stations from Step 7. Compute the surcharge for the floodway using the baseline WSEL. If the surcharges are within the maximum allowable limit, and both the left and the right encroachments are on the riverside of the levee, the floodway analysis is complete. The floodway is mapped on the riverside of the levee at the final computed location.
b. If the surcharges are higher than the maximum allowable limit and the encroachments are on the riverside of the levee, move the encroachments to the levees (C' and D'). If the surcharge is within the allowable limits, the floodway analysis is complete. If the surcharge is still higher than the allowable limits, proceed to Step d.
c. If both or either of the encroachments are on the landside of the levee, then move the landside encroachment(s) to the levee(s) (C' and/or D') and test if surcharge is within allowable limit using the baseline water-surface elevation. If it is within the allowable limit, the floodway analysis is complete. If the surcharge is higher than allowable, move the riverside encroachment to the levee (C' or D') where applicable, and test if the surcharge is within allowable limits. If it is, the floodway analysis is complete. If the surcharge is still higher than the allowable limits, proceed to Step d.
d. If surcharges with encroachments set at the levees are higher than the allowable limit using the baseline WSEL, evaluate whether the allowable surcharge can be met by widening encroachments at the non-leveed cross sections. If the surcharge is still higher than the allowable limits, test the surcharge using the with-levee WSEL. If the surcharge is within allowable limits using the with-levee baseline, then the analysis is complete. If the surcharge is still higher than the allowable limits, proceed to Step e (for non-accredited levees) or Step f (for accredited levee systems).
e. In the case of non-accredited levee systems, if the surcharge with encroachments set at the levees is higher than the limit using the with-levee baseline WSEL, encroachments C and D can be moved to the landside of the levees until the allowable surcharge is achieved. If the allowable surcharge limits cannot be met by moving the encroachment outward or the affected communities do not want a floodway on the landside of the levee, coordination between the community and FEMA is required to identify the appropriate approach.
f. In the case of accredited levee systems, if the surcharge with encroachments set at the levees is higher than the allowable limit using the with-levee baseline WSEL, typically encroachments A and B can be not moved to the landside of the levees. Adjust encroachments at adjacent non-leveed cross sections to achieve an allowable surcharge. If the allowable surcharge limits cannot be met by adjustment of encroachments at non-leveed sections, coordination between the community and FEMA is required to identify the appropriate approach.

## 6.20 Hydraulic Modeling on Landside of the Levee

This subsection presents recommended guidance to be used for the mapping of the landside flood hazard area for levee reaches that are evaluated using the Overtopping or Structural-Based Inundation Procedures. For these procedures, often an unsteady flow will be required. While Appendix C of FEMA's Guidelines and Specifications for Flood Hazard Mapping Partners (discusses both one- and two-dimensional unsteady-flow modeling, this subsection provides additional guidance specific to levees.

The flood hazard area created by levee overtopping or breach is assumed to be subject to the same annual-chance flooding as the exterior flooding source. For example, if a levee is breached by the base flood, the assigned Project Team member will delineate the area on the landside of the levee as an SFHA on the FIRM.

Hydrologic or hydraulic analyses are necessary to compute the flood elevations created by the inflow. Reservoir routing and pump operation will be the features generally applied to determine flood elevations for hydrologic analyses.

One-dimensional (1-D), two-dimensional (2-D) steady flow, and unsteady flow solution methods are the hydraulic analysis methodologies applicable to compute flood elevations. The applicability and data requirements for these methodologies are summarized below.

### 6.20.1 Hydrologic Flow Routing

Hydrologic flow routing is applicable when floodplain storage, not conveyance, is the dominant factor determining the flood elevation. This will generally be applicable if the inflow is for a limited duration and the interior floodplain has the capability to store the volume of flow entering the impacted area. A stage-inflow hydrograph of the exterior flooding source is essential to determine the duration and rate of the inflow, and to conduct a hydrologic flow routing. Depending on the mode of failure, the assigned Project Team member can compute inflow hydrographs by applying appropriate hydraulic computations. Most hydrologic flow routing models also have the capability to reflect flow evacuation features, such as pumping stations.

### 6.20.2 Hydraulic Modeling

A hydraulic approach is applicable when an alternate flow path is created on the landside of the levee for floodwater to flow downstream. Conveyance and floodplain storage along the flow path are the dominant factors controlling the flood elevations. For general floodplain analyses based on the formulation of basic equations of motion, four types of solutions procedures are available. They are categorized as 1-D steady flow, 1-D unsteady flow, 2-D steady flow, and 2-D unsteady flow solutions. Where groundwater is close to ground level, it may be appropriate for the assigned Project Team member to account for groundwater interaction.

The Project Team can select any hydraulic analysis software accepted by FEMA for flood hazard area development for hydraulic modeling. General data requirements and applicability of the different types of hydraulic flow modeling are provided in Subsections 6.20.3 through 6.20.6.

### 6.20.3 One-Dimensional Steady Flow Analysis

One-dimensional steady flow analyses are applicable where flow is limited to defined flow paths. Inflow would be peak flow rates generated from the subject levee failure conditions – overtopping, segment failure, dynamic breach, or final breach condition. Weir and split flows are two commonly used options.

Inflow discharges due to overtopping can be computed by applying lateral weir flow computations. For weir flow assumptions to be applicable, the flow crossing the crest profile of the levee or flood wall must not be submerged on the landside of the levee. The weir flow method is also applicable if the final breach geometry creates weir-flow conditions.

When overtopping flow accumulated on the floodplain creates a fully submerged condition on the landside of the levee, split flow becomes applicable. When a breached levee fails to the natural ground level, inflow may be computed as split-flow conditions in the vicinity of the breach location. The breach or overtopping flow may return to the same river downstream, join another flooding source, or flow into a large water body whose WSEL will not noticeably change despite receiving the inflow from levee failure. In addition, most steady flow analyses can also reflect constant pumping rates.

One-dimensional steady flow models are generally not applicable in coastal situations.

### 6.20.4 One-Dimensional Unsteady Flow Analysis

Unsteady flow analyses are most suitable if the flow is limited to defined flow paths and defined storage areas are present in the overbank. However, unsteady flow models using link-node concepts to represent flow have the capability to model a larger number of flow paths and offline floodplain storage. Unsteady flow analyses have the capability to simulate online floodplain storage and dynamic impacts of pumping activities.

Unsteady flow analyses can be applied to a variety of downstream boundary conditions. Flow may rejoin the same river downstream, at other flooding sources, travel to storage/ponding areas, or reach an ocean impacted by daily tide level variations.

Unsteady 1-D numerical models also may be applied to model the hydraulics for coastal levee overtopping and breach scenarios. In selecting an appropriate model, consideration is to be given to models that include modules for incorporating flow-control structures and supercritical flow.

Models developed with modules accounting for dam-break scenarios may also be applied to levee breach scenarios. Models that are applicable to coastal flooding sources and include wave overtopping also exist and can be used.

### 6.20.5 Two-Dimensional Flow Analysis

Two-dimensional flow routing is most applicable to natural floodplains with flat terrain or urban floodplains where flow directions are dictated by streets, storm drain alignments, and obstructions caused by buildings. When levee breach or overtopping occurs, inflow from the channel may be modeled as 1-D flow near the breach and develop into 2-D flow, either forming flow paths or remaining as sheet flow to spread over the floodplain. A typical 2-D model can model levee, flow paths, street flow, or shallow flow conditions.

Generally, 2-D models have the capability to provide unsteady flow solutions. A hydrograph and can be generated outside of the 2-D model and provided as input. Inflow hydrographs can be computed using methodologies described for 1-D unsteady flow analysis. Some 2-D software accepted for flood study development can also model levee overtopping, piping, and slope stability failure as well as flow routing on the adjoining floodplain.

Two-dimensional analyses provide a convenient method to simulate multiple modes of failure at different locations without significant additional effort. Two-dimensional analysis is also applicable to simulate flood ponding in areas between two levees or areas impacted by ring levees. When a breach occurs in one of the levees, areas between two levees will be inundated until the ponding elevation reaches the equivalent elevation of the flooding source side or overtops the other levee. In the latter situation, the ponding elevation is to be mapped as the elevation of levee being overtopped. Pumping and other flood-mitigating features may be reflected in most 2-D models through rating curves.

The storm surge modeling system most prevalently used in coastal flood hazard studies includes the ADCIRC 2-D circulation model, which is then coupled with a 2-D wave model (STWAVE or UnSWAN). A 2-D model will have varying levels of complexity. A simple 2-D model using terrain data may be easily produced. In comparison, a complex 2-D model that includes detailed hydraulic structures and streets may be time-consuming to prepare.

### 6.20.6 Combination of One-Dimensional and Two-Dimensional Models

Increasingly, 1-D unsteady flow and 2-D software developers have provided the capability to link 1-D and 2-D solutions as needed. Users have the capability to use the appropriate solutions for appropriate locations. Some such models also have options to model the levee breach process. The channel flow is typically modeled as 1-D, using cross sections. Landside flow from a levee breach or overtopping is routed using 2-D grids or finite element mesh.

The selected analysis methodology should be able to reflect flow conditions adequately and develop reliable flood elevations and flood hazard area boundaries for the area landward of a levee that does not meet the 44 CFR 65.10 criteria. Decision factors include the consequences of levee failure, nature of the terrain, complexity of the levee systems, mode of failure mechanisms, data availability, and availability of funds.

## 6.21 Flood Hazard Mapping

### 6.21.1 Mapping Process

In the event that a stakeholder disagrees with the final analysis and mapping procedures used to create the FIRM, the current FEMA appeals and Scientific Resolution Panel procedures may be used. These procedures are documented in FEMA Guidance Document No. 26, Guidance for Flood Risk Analysis and Mapping: Appeal and Comment Processing. The guidance document is accessible from the FEMA Guidelines and Standards for Flood Risk Analysis and Mapping webpage.

The final mapped flood hazard boundaries landward of non-accredited levee systems will be a worst-case combination of three main sources:

1. The composite SFHA resulting from the levee reaches evaluated by the Overtopping, Structural-Based Inundation, or Natural Valley Procedures for each levee reach. Sound and Freeboard Deficient levee reaches will not have an SFHA associated with the individual reach analysis.
2. The SFHA resulting from the interior drainage analysis.

3. The area developed using the Natural Valley Procedure, which will be used to depict the potential base flood hazard that exists landward of a non-accredited levee system in areas where an SFHA has not been identified. This Zone D will be shaded on the FIRM differently than a typical Zone D to clarify the difference in how the two zones are developed.

This concept is illustrated in Figure 38. If BFEs are to be shown on the FIRM, they will be based on the highest elevation of the composite mapping.

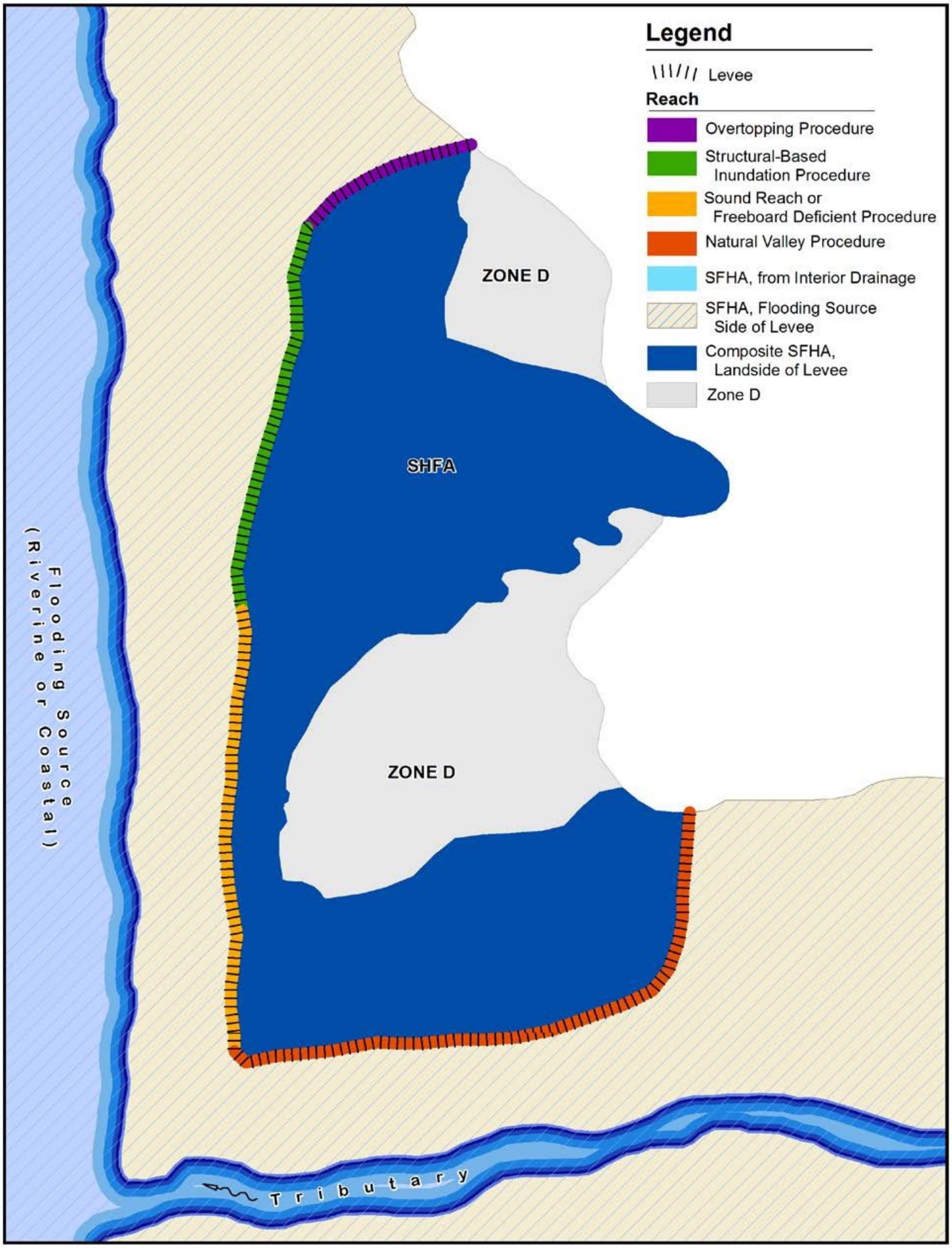



Figure 38: Composite Mapping of Flood Hazards for the Levee System

When the Structural-Based Inundation Procedure is used, the SFHA for that levee reach will be a composite of each independently analyzed breach location. The resulting floodplain from the analysis of a Structural-Based Inundation reach must reflect the fact that a breach could occur at any location along the reach. To achieve this, it may be acceptable for the assigned Project Team member to extrapolate breach analysis results to areas that were not analyzed separately. This will most often occur in situations where breach flows seek a flow path or storage area that is not directly adjacent to the levee. The final mapping will not reflect the analyzed breach locations, however; the final mapping will reflect the composite flood hazards resulting from all breach analyses conducted.

The input data requirements to map BFEs on the FIRM for the Overtopping and Structural-Based Inundation Procedures follow FEMA Guidance Document 31, Guidance for Flood Risk Analysis and Mapping: Mapping Base Flood Elevations on Flood Insurance Maps. The guidance document is accessible from the FEMA Guidelines and Standards for Flood Risk Analysis and Mapping webpage.

### 6.21.2 Flood Insurance Implication of Zone D Mapping

The NFIP defines Zone D as an area of possible, but undetermined, flood hazards. Historically, FEMA has used the Zone D designation in areas where a flood hazard analysis has not been completed.

When analyzing and mapping areas landward of non-accredited levee systems, FEMA will use Zone D to designate the possible 1-percent–annual-chance flood inundation on FIRMs. Zone D will supplement the SFHAs developed through the procedure(s) applied to individual levee reaches. The size and location of the Zone D areas will vary and be based on the results of the composite SFHA analysis that results from the Natural Valley Procedure. The natural valley analysis is hydraulically modeled for riverine levee reaches by retaining the topographic features of the levee in the model but allowing the discharge to flow on either side of the levee, assuming that the levee does not impede conveyance.

Flood insurance is available in Zone D; however, properties located in Zone D areas are not subject to the federally mandated flood insurance purchase requirement. Lenders may, however, require insurance coverage for properties located landward of levee systems regardless of the zone designation, as a condition of a loan, as part of their regular lending practices.

### 6.21.3 Floodplain Management Implications of Zone D Mapping

FEMA views the analysis of the non-accredited levee systems as an intermediate step in the possible process leading to full levee accreditation. Because Zone D is not considered an SFHA, SFHA regulations do not apply. Floodplain management requirements are applied at the discretion of local officials as long as the community complies with the minimum standards of the NFIP regulations cited at 44 CFR 60.3(a).

FEMA will depict the Zone D area landward of the levee system on the FIRM with a different symbology than the traditional Zone D area. The Zone D landward of the levee system will be accompanied by a note in the Notes to Users portion of the FIRM communicating the distinction between the two Zone D types. The differentiation between Zone D types will allow various stakeholders to identify Zone D areas landward of the levee system for use in determining flood insurance requirements, enforcing floodplain management and mitigation, and communicating risk.

If the community chooses to enforce elevation requirements in Zone D areas landward of the levee for new construction, local officials could require development to take place at a set height above grade, taking an approach similar to floodplain management in an SFHA with established BFEs. If requested, tools that FEMA would make available to communities to aid in the enforcement of elevation requirements include flood depth grids and WSELs derived from the Zone D natural valley analysis. These tools would provide flood depths and elevations to which a community could regulate new construction. The data could be provided to the community upon completion of the non-accredited levee analysis.

### 6.21.4 Guidance Regarding FIRM Graphic and Database Stantdards

This subsection presents guidance on how to depict flood hazard information associated with non-accredited flood-control structures. The Zone X flood hazard zone designation, with a zone subtype defined as “Area with Flood Risk Due to Levee” should be used for the flood hazard zone on the landward side of the non-accredited levee. For FIRMs developed using the current standards, the Project Team will apply the detailed specifications summarized in FEMA FIRM Panel Technical Reference.

In addition, FIRMs prepared under these graphical specifications will include the following note inside the map body. The note should be placed in the proximity of the subject levee feature(s).

Note: This panel contains levees that have not been accredited and are therefore not shown as reducing the hazard from the base flood.

The modeling results for the natural valley analysis should also be stored in the regulatory FIRM database. The community can use the natural valley cross-section GIS data to assist in elevation determinations for the purpose of map amendments and revisions. Therefore, the modeling cross sections from the natural valley analysis must be included in the regulatory FIRM database S_XS feature class. As described in the FEMA FIRM Database Technical Reference, all cross sections used in the development of the effective hydraulic models shall be stored in the S_XS table, regardless of flood hazard zone depiction on the effective panel. The Zone D cross sections are provided as backup data, as such they shall be assigned a XS_LN_TYP field value of “NOT LETTERED, NOT MAPPED”. The Zone D cross sections must be assigned an appropriate model identifier in the MODEL_ID field of the S_XS table, as well as an appropriate source citation in the SOURCE_CIT field, to provide a link between the natural valley model and the spatial data. In addition, the S_XS table must link to data in the L_XS_ELEV table. The L_XS_ELEV table is designed to store cross section information for all event types and levee scenarios. For more information about populating the S_XS and L_XS_ELEV tables see the FIRM Database Technical Reference.

The Technical References cited above are accessible from the FEMA Technical References webpage (https://www.fema.gov/media-library/assets/documents/34519).

## 6.22 Guidance Regarding Flood Insurance Study Report Standards

This subsection includes guidance on how to capture flood hazard information associated with a non-accredited flood-control structure in the Flood Insurance Study report.

### 6.22.1 Text

For flood hazard mapping projects performed using the current standards, the assigned Project Team member will need to add information to Table 5: Summary of Hydrologic and Hydraulic Analyses. The flooding source should be identified as <Streamname> (Landside of Levee Reach #) and extents should correspond to the extents of the levee reach. The methodology used to determine the Zone D area should also be included in the table. An example of this table with appropriate information included is provided in Table 5 below.

The Technical References cited above are accessible from the FEMA Technical References webpage (https://www.fema.gov/media-library/assets/documents/34519).

**Table 5: Sample Summary of Hydrologic and Hydraulic Analyses Table Guidance Clarification Routing**

| Flooding Source | Study Limits | | Hydrologic Model or Method Used | Hydraulic Model or Method Used | Date Analyses Completed | Flood Zone on FIRM | Special Considerations |
|---|---|---|---|---|---|---|---|
| | Downstream Limit | Upstream Limit | | | | | |
| Culvert Creek (Landside of Levee Reach 1) | Confluence with South Fork Inundation River | 1.3 miles upstream of confluence of Ripple Creek | Scaled Stream Gage Hydrograph | FLO-2D v. 2009.06 | 3/31//2012 | AE | Modeling using the Structural-Based Inundation Procedure |
| Culvert Creek (Landside of Levee Reach 2) | 1.3 miles upstream of confluence of Ripple Creek | 0.5 miles upstream of confluence of Ripple Creek | Scaled Stream Gage Hydrograph | HEC- RAS 4.0 | 3/31//2012 | AE | Modeling using the Natural Valley Procedure |
| Culvert Creek (Landside of Levee) | Confluence with South Fork Inundation River | 0.5 miles upstream of confluence of Ripple Creek | Log Pearson Type III Frequency Analysis | HEC- RAS 4.0 | 3/31//2012 | D | Modeling using the Natural Valley Procedure |

### 6.22.2 Floodway Data Table

The Floodway Data Table will show the elevations and surcharges based on the With Levee run. However, if applicable, the Floodway Data Table also will include the following footnote to alert future users that may modify the regulatory floodway:

*The floodway limits on the non-leveed side of the flooding source are determined from the Natural Valley analysis.*

## 6.23 Documentation

For levee reaches analyzed and mapped using the Structural-Based Inundation Procedure, the Project Team will document levee breach location, parameters, and description of the methods used to determine this data. The Project Team also will document any historic breach data or other data used to support various procedures and decisions that were available.

The Project Team is to include documentation, such as reports submitted to satisfy the requirements of 44 CFR 65.10, except for survey data for each reach, in the General Folder of the Hydraulics Data Capture Standards submission. See the FEMA Data Capture Technical Reference for more information on levee documentation in the Hydraulics task.

## 6.24 Review Procedures

FEMA Regional Offices may determine that the review for mapping non-accredited levees should be conducted through the regional support staff of FEMA's Risk MAP providers. Decisions made during the process should be coordinated with the entity performing the independent Quality Assurance/Quality Control (QA/QC) review.

Submittals must include backup data and supporting information for all calculations, in case a more detailed review is required. A more detailed review must be coordinated with FEMA Headquarters.

The Project Team independent QA/QC reviewer will verify that all components use the same flooding elevations and conditions, and that the entire levee system (if a system consists of different segments) is considered in the submittal.

### 6.24.1 Reviewing Data Required to Apply Different Procedures

FEMA will review the submittal in accordance with Chapter 4 of this document. Due to the complexity and uniqueness of each coastal levee, the FEMA Project Officer or designee will coordinate and consult with FEMA Headquarters for all levees affected by coastal forces.

To verify that a submittal meets the overtopping analysis standard, the Project Team member assigned to perform an independent QA/QC review will verify that the submission includes documentation supporting two main items.

1. The documentation shows that no appreciable erosion of the levee crest, toe, embankment, or foundation occurs during the overtopping of the base flood event because of currents or waves.
2. The documentation indicates that the anticipated erosion will not result in structural failure (i.e., breach of the levee, directly or indirectly, through loss of embankment material due to erosive forces or the reduction of the seepage path or piping and subsequent instability).

The Project Team member assigned to perform the independent QA/QC review will verify that the submission includes a discussion of the items to consider as discussed in this guidance document and why they may or may not apply.

### 6.24.2 Reviewing Modieling and Mapping for Non-Accredited Levees

All hydraulic analyses, hydrologic analyses, and floodplain mapping submitted performed by the Project Team will be reviewed to verify that they satisfy FEMA standards. All data and documentation submitted to satisfy the requirements of 44 CFR 65.10 will be reviewed per the criteria in Chapter 4.

For reaches modeled using the Structural-based Inundation Procedure, the Project Team member assigned to perform the independent QA/QC review will focus on verifying the following:

- The resulting SFHA does not indicate where individual breaches were located.
- The analysis reflects that the levee reach could breach at any location within the reach.
- How the submitter determined that additional breach locations were not required is documented.
- The breach parameters chosen fall within the historic ranges for the size, location, flooding source type, and soil type of the levee.
- The resulting SFHA reasonably reflects the composite results of all breach analyses.

# 7.0 Non-Levee Reaches and Non-Levee Features

Physical manmade features that were not designed and constructed as levees may exist near or within flood-prone areas, and these features may impact the conveyance of floodwaters. Levee systems may tie into these manmade features, whose existence and performance are necessary for excluding floodwaters from the levee-impacted area. In this case, these features are referred to as “non-levee reaches” in this document. Alternately, these features may exist independent of a levee system, but still may inadvertently impact floodwater conveyance; those features are referred to as “non-levee features” in this guidance document.

In either case, these features may be represented on effective FIRMs as reducing flood hazards and must be reconsidered when a new Flood Risk Project is initiated so that FEMA appropriately analyzes and maps the flood hazards that may be impacted by these features. For non-levee reaches that are part of or tie into a levee system for which the levee owner is seeking accreditation, the owner must provide documentation and certified data to FEMA demonstrating that the entire levee system meets the requirements of 44 CFR 65.10. If this requirement cannot be met, FEMA will analyze the levee system and map the levee-impacted area in accordance with FEMA’s levee analysis and mapping procedures for non-accredited levee systems (refer to Chapter 6 of this document). To demonstrate that a non-levee feature impacts the conveyance of floodwaters, detailed data and engineering analyses must be provided to FEMA and certified by a registered P.E. in accordance with sound engineering practice. If an entity seeks accreditation for a non-levee feature, that entity must demonstrate that the feature meets the requirements of 44 CFR 65.10.

Previous FEMA mapping procedure documents (including Procedure Memorandum No. 51, dated February 27, 2009, which has been superseded by this document) used the term “non-levee embankments” to describe some of these types of features. Although this term is not used in this document, roadway and railroad embankments are examples of physical manmade features that are not typically designed and constructed to function as a levee system or other flood-control structure. However, these features may inadvertently represent flood hazard reduction or other impacts to the conveyance of floodwaters on current effective FIRMs, and as such, may indicate a lesser flood hazard and corresponding risk than what may actually exist in areas near these structures. Thus, it is important to understand the impact each feature may have on the flooding source to appropriately analyze and map the corresponding flood hazard in these areas.

It should also be noted that FHWA issued a memorandum on September 10, 2008, titled Highway Embankments versus Levees, and other Flood Control Structures, to their field offices and State Departments of Transportation (DOTs), emphasizing that most highway embankments are not designed and constructed to perform as a levee system or other flood-control structure. This memorandum also highlighted the distinctions between highway embankments, levee systems, and other flood-control structures; clarified the FHWA role with respect to flood control; and acknowledged that communities may have incorrectly assumed that these structures provide some level of flood hazard reduction.

This chapter provides clarity on the appropriate classification and subsequent data considerations, analysis, and mapping requirements for physical manmade features that are not designed and constructed as levee systems. In addition, guidance is provided that emphasizes the importance of coordination with communities to understand the location and impacts of these features to appropriately analyze and map the flood hazards in these areas.

## 7.1 Non-Levee Reach

Non-levee reaches are considered a form of manmade high ground that a levee system ties into and whose existence and performance is necessary for excluding floodwaters from the levee-impacted area. USACE also refers to these types of structures as “non-project segments.” To demonstrate that non-levee reaches meet the requirements of 44 CFR 65.10, they must be evaluated based on their current condition to determine eligibility for accreditation of the entire levee system of which they are a part. Coordination with communities and the owners of the non-levee reaches is essential to identify these features, appropriately analyze and map the flood hazards associated with these non-levee reaches, and to provide communities with information and tools to help them communicate flood risk and mitigation opportunities in these areas. Figure 39 provides an example of a non-levee reach.

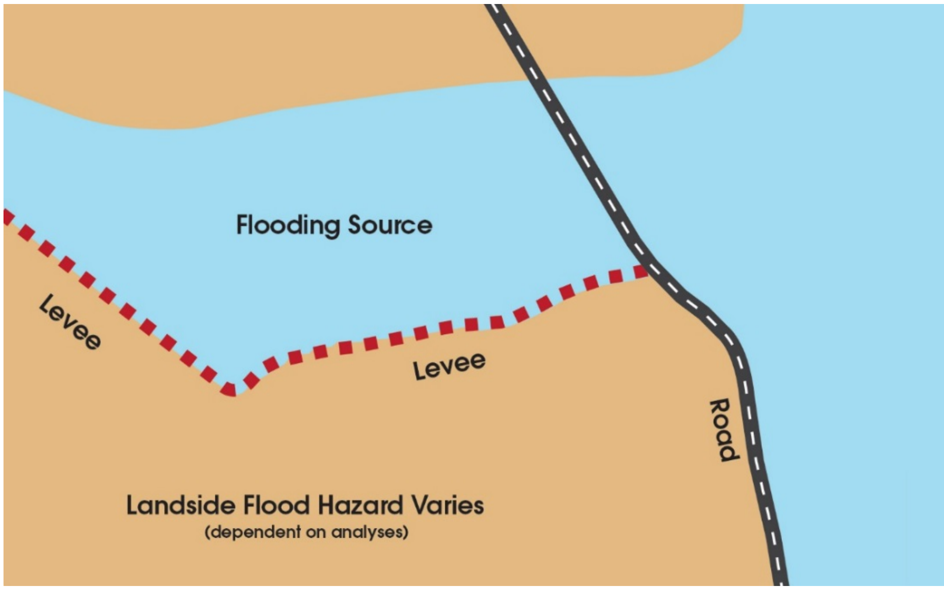



Figure 39: Non-Levee Reach

## 7.2 Non-Levee Features

A non-levee feature is considered a physical feature that is not designed, constructed, operated, or maintained as a flood-control structure, but may inadvertently confine flow during some flood events. These features may encroach on the floodplain but are not connected to any existing levee system and do not meet the definition of a levee system. They may include roadway and railroad embankments, canals, berms, retaining walls, seawalls, and other features, which involve placing fill or other material within flood-prone areas and which may impact the conveyance of floodwaters in these areas.

These features carry an inherent risk and may have inadvertently been represented as providing flood hazard reduction on a FIRM. Therefore, it is important to fully understand the impact of these features to identify the appropriate flood hazards in these areas. Coordination with communities and the owners of these non-levee features, when applicable, is essential to identify, analyze, and map the flood hazards associated with these non-levee features, and to provide communities with information and tools to help them communicate flood risk and mitigation opportunities in these areas. Figure 40 provides an example of a non-levee feature.

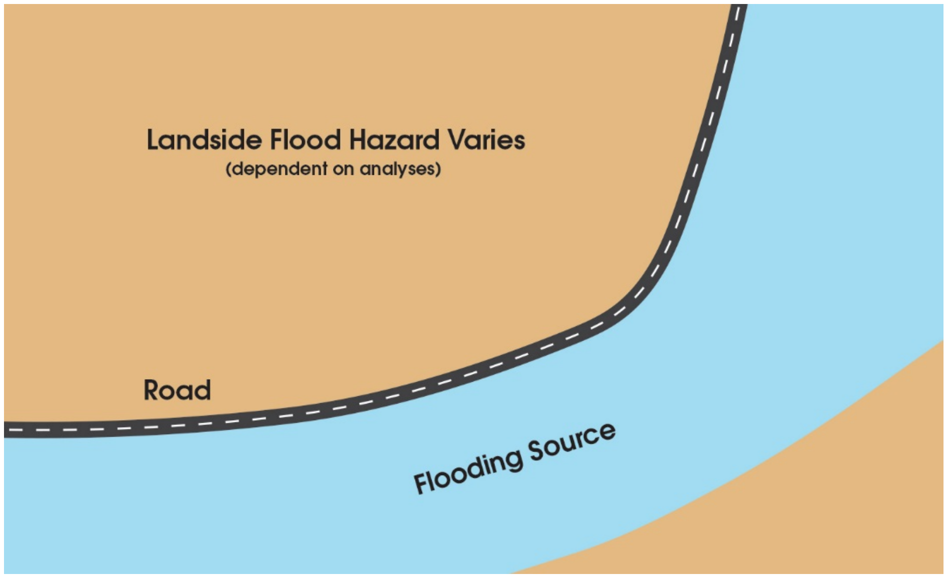



**Figure 40: Non-Levee Feature**

The flood hazard on the landside of most non-levee features will be analyzed and mapped as not providing base flood hazard reduction. If an entity seeks accreditation for a non-levee feature, that entity must demonstrate that the feature meets the requirements of 44 CFR 65.10. To demonstrate that a non-levee feature impacts the conveyance of floodwaters, detailed data and engineering analyses must be provided to FEMA and certified by a registered P.E. in accordance with sound engineering practice.

FEMA has documented several best practices that use various acceptable approaches for modeling and mapping of non-levee features based on standard engineering practice. Individuals should coordinate with the FEMA Regional Office or FEMA Headquarters to discuss flood hazard analysis and mapping requirements that may be appropriate for particular non-levee features.

## 7.3 Communication of Risk

To appropriately analyze and map the flood hazards in impacted areas, FEMA will coordinate with communities during the Discovery Phase of a Flood Risk Project, and throughout the project lifecycle as necessary, to understand the location and impacts of non-levee reaches and non-levee features. Where physical manmade features that were not designed and constructed as levee systems exist near or within flood-prone areas, the impact of these features on the conveyance of floodwaters may change over time. The current effective FIRMs may inadvertently represent these features as providing flood hazard reduction or other impacts to the conveyance of floodwaters, and as such, may indicate a lesser flood hazard and corresponding risk than what may actually exist in areas near these structures.

Communities and property owners may not be fully aware of the risk associated with these non-levee features. Therefore, coordination with local stakeholders is essential to identify, analyze, and map the flood hazards associated with these non-levee features to provide relevant information and tools to help them understand their flood risk and mitigation opportunities in these areas.

# 8.0 FEMA and Other Federal Agency Coordination

OFAs may have a role in working with FEMA to develop levee-related policy, identify flood risk, conduct mitigation, and outreach activities, or provide data to inform the FEMA flood hazard mapping program for areas impacted by levees.

## 8.1 USACE

Though FEMA and USACE have different roles and responsibilities related to levee systems, both agencies have complementary objectives related to reducing risk to life and property and communicating flood hazards and risks. FEMA has information and data to supplement USACE Levee Safety Program activities. Conversely, information from USACE Levee Safety Program activities will supplement FEMA activities. Jointly, FEMA and USACE will align activities, information, and messaging related to levee systems to improve public awareness of flood risk. Main areas of engagement between the USACE Levee Safety Program and FEMA flood hazard identification activities are further described below.

- Leveraging Data: Both USACE and FEMA perform activities using best available information to include, but not limited to, mapping, hydrologic, hydraulic, and coastal modeling, and infrastructure condition. Early coordination of both USACE Levee Safety Program and FEMA activities will result in finding opportunities to share and leverage information that will benefit both agencies. Both agencies will use the NLD as the main database of information for both the NFIP and USACE Levee Safety Program.
- Mapping Levee-Related Flood Hazards for the NFIP: Communities or parties seeking recognition of a levee system as reducing the base flood hazard on FIRMs, also referred to as levee accreditation, must provide data and documentation in accordance with 44 CFR 65.10. USACE and FEMA have agreed to specific cases when information collected by USACE through their Levee Safety Program will inform some or all requirements for levee accreditation, and that is further specified in Chapter 4 of this document. In cases when information collected by USACE informs some of the requirements for levee accreditation, the communities or parties seeking accreditation will have to provide information to fulfill the remaining requirements. Because some of the USACE Levee Safety Program activities are conducted on a levee segment basis, caution should be taken to ensure information is used, presented, and considered collectively on a levee system basis when using USACE information to inform a levee accreditation decision. Examples of USACE information include inspections and risk assessments.
- Risk Communication: Both USACE and FEMA have the objective to increase public awareness as related to flood risk. In areas with levee systems, USACE typically engages directly with levee sponsors and FEMA engages directly with community officials. Coordination of these relationships helps improve public awareness and effective risk communication. USACE and FEMA will coordinate to ensure consistent messages related to risk, levee condition, and mapping/modeling efforts. One example is the importance for FEMA to verify and maintain NFIP-related information in the NLD and ensure that information is accurate and includes the appropriate messaging for levee sponsors and communities.

- Engagement Processes: FEMA will develop engagement processes with the appropriate USACE District and Division offices and will identify processes to ensure information is exchanged in the most efficient, beneficial, and meaningful way possible. Engagement processes should include cross-walking FEMA mapping efforts with USACE Levee Safety Program activities and planning for joint engagement with levee sponsors and communities where most efficient and effective.
- Routine Coordination: Each step in the FEMA KDP process asks if there is a levee system in the project footprint, and if so, is there an ongoing or recently completed USACE project or analysis that may impact how the levee is represented on the FIRM? This question is asked at each KDP to serve as a reminder that levee system conditions and data change over time, so it is important for FEMA to routinely coordinate with USACE to ensure the most current information is taken into consideration throughout the Risk MAP project lifecycle.
- Disaster Recovery: Under the Stafford Act, FEMA may direct USACE (as an operating agent for the U.S. Department of Defense) to use its available resources to provide assistance in case of a major disaster or emergency declaration by the President. In areas with levee systems, USACE levee safety information and expertise contribute to the recovery efforts.
- Coordination of Agency Processes and Policies: USACE and FEMA will coordinate on the development and implementation of levee-related policy, including coordination of acceptable technical standards related to operation and maintenance plans, emergency preparedness plans, and levee design, construction, and rehabilitation activities.

Additional OFAs may have levee system-related data and may interact directly with communities and levee owners. If during the Flood Risk Project lifecycle, a Project Team determines that OFAs have information about a particular levee system, FEMA will contact the agencies to determine what useful input may be available. Some potential items to consider from different agencies are:

- USBR: USBR works in the western states and is involved with levees, canals, and dams. They may have useful data, such as construction drawings and O&M procedures.
- USGS: USGS is a primary source of hydrologic data used to determine flows and potential water-surface profiles related to the levees.
- NOAA: NOAA is a primary source for coastal data used to evaluate impacts on levees in coastal areas.
- NRCS: NRCS has historical involvement with some agricultural levees; drawings and design data may be available.
- United States Section of the International Boundary and Water Commission (IBWC) (Rio Grande River): IBWC has worked on, and been responsible for the design, construction, operation, and maintenance of, some levees along the Rio Grande River. However, they rarely have data related to interior drainage, so coordination with the local communities will still be required.

- U.S. Department of Agriculture (USDA): FEMA has developed some talking points related to agricultural levees, potential impacts on crop insurance, and potential coordination with local USDA staff that might be useful. (See Table 6.)
- Federal Energy Regulatory Commission (FERC): Some dam or levee structures may be owned by hydropower companies and regulated by FERC, whose efforts are usually related to safety and security, so the availability of information may be restricted.
- U.S. Environmental Protection Agency (EPA): As part of levee accreditation process, there may be a need for the levee owner to coordinate with EPA related to local environmental requirements.
- U.S. Department of Housing and Urban Development (HUD): FEMA and HUD sometimes coordinate outreach activities, so coordination with the FEMA Regional Office will be necessary to determine if there is a need for further coordination.
- The U.S. Fish and Wildlife Service (USFWS): Similar to EPA, there may be circumstances where FEMA needs to contact USFWS. For instance, dealing with vegetation on levees to provide shade to control water temperatures related for salmon in the northwest.

Any other Federal or State agency that owns or operates a levee system would likely be a source of useful information.

**Table 6: Crop Insurance, Flood Insurance Rate Maps, and Levees**

**Internal Talking Points for FEMA/Contract Staff Attending Community Levee Meetings**

| | |
|---|---|
| **Background** | Stakeholders in rural areas have asked FEMA staff about what impact Flood Insurance Rate Maps (FIRMs) and levee accreditation status may have on their crop insurance policy rates. |
| **Crop Insurance Rate Determinations** | • The USDA Risk Management Agency (RMA) makes crop insurance determinations.<br>• Crop insurance premiums are determined by county and crop type on a case-by-case basis. RMA focuses on **actual flood events**, not a statistical 1-percent-annual-chance flood event. The determinations by RMA are based on gage data and USACE flood-related data, satellite imagery, aerial photography, and soil maps, to indicate the severity and/or extent of flooding. In addition, the timing of past floods compared to crop type is used to determine premiums. |
| **FEMA/USACE Related Resources** | • **FIRMs:** FIRMs are not used by RMA for making crop insurance premium determinations. The base flood event on a FIRM is a statistical prediction of a flood, not a depiction of an actual event.<br>• **NLD:** RMA does, on occasion, use this data source. It provides information on levee location, condition, and the "Leveed Area.". |
| **Role of Levees** | • **Levee Impact:** Levees may have positive or negative impacts on cropland.<br>o Positive: May reduce risk of flooding.<br>o Negative: Interior drainage can back up on the landside of the levee, causing crop damage – especially if pump stations, flap gates, etc. are not properly operated and maintained. An actual levee breach will |

| | |
|---|---|
| | impact crop insurance premiums. RMA monitors levee repairs with USACE and/or local levee districts. |
| **Summary** | • FEMA does not determine crop insurance premiums.<br>• Flood hazard boundaries shown on FIRMs have no impact on the USDA crop insurance program related to premium rating.<br>• A levee may be considered by RMA on a case-by-case basis. It could provide flood risk reduction, but it could also make interior drainage worse.<br>• Data collected for FEMA's flood hazard mapping studies or accreditation per 44 CFR 65.10 may be provided to RMA to assist in rating information, but FEMA will only do so when requested by stakeholders or RMA staff. |

The need for additional information on engagement with OFAs should be coordinated through the FEMA Regional Office.