FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

VOLUME 1 OF 3

BERRIEN COUNTY, MICHIGAN

(ALL JURISDICTIONS)

COMMUNITY NAME	NUMBER	COMMUNITY NAME	NUMBER
BAINBRIDGE, TOWNSHIP OF *	261103	LINCOLN, CHARTER TOWNSHIP OF	260037
BARODA, TOWNSHIP OF*	261106	MICHIANA, VILLAGE OF	260275
BARODA, VILLAGE OF *	261105	NEW BUFFALO, CITY OF	260038
BENTON, CHARTER TOWNSHIP OF	260031	NEW BUFFALO, TOWNSHIP OF	260039
BENTON HARBOR, CITY OF	260032	NILES, CHARTER TOWNSHIP OF	260041
BERRIEN, TOWNSHIP OF	260733	NILES, CITY OF	260040
BERRIEN SPRINGS, VILLAGE OF	260330	ORONOKO, CHARTER TOWNSHIP OF	260042
BERTRAND, TOWNSHIP OF	261109	PIPESTONE, TOWNSHIP OF	261104
BRIDGMAN, CITY OF	260033	ROYALTON, TOWNSHIP OF	260043
BUCHANAN, CITY OF	260554	SHOREHAM, VILLAGE OF	260280
BUCHANAN, TOWNSHIP OF	260555	SODUS, TOWNSHIP OF	260046
CHIKAMING, TOWNSHIP OF	260258	ST. JOSEPH, CITY OF	260044
COLOMA, CHARTER TOWNSHIP OF	260034	ST. JOSEPH, CHARTER TOWNSHIP OF	260045
COLOMA, CITY OF	260556	STEVENSVILLE, VILLAGE OF	260557
EAU CLAIRE, VILLAGE OF *	260999	THREE OAKS, TOWNSHIP OF	261111
GALIEN, TOWNSHIP OF	261108	THREE OAKS, VILLAGE OF *	261110
GALIEN, VILLAGE OF *	261107	WATERVLIET, CHARTER TOWNSHIP OF	260048
GRAND BEACH, VILLAGE OF	260268	WATERVLIET, CITY OF	260047
HAGAR, TOWNSHIP OF	260035	WEESAW, TOWNSHIP OF	260049
LAKE, CHARTER TOWNSHIP OF	260036		

*No Special Flood Hazard Areas Identified

REVISED PRELIMINARY

September 2, 2022

REVISED:

TBD

FLOOD INSURANCE STUDY NUMBER
26021CV001B
Version Number 2.4.3.0

FEMA

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FLOOD INSURANCE STUDY REPORT
BERRIEN COUNTY, MICHIGAN

SECTION 1.0 – INTRODUCTION

1.1 The National Flood Insurance Program

The National Flood Insurance Program (NFIP) is a voluntary Federal program that enables property owners in participating communities to purchase insurance protection against losses from flooding. This insurance is designed to provide an alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods.

For decades, the national response to flood disasters was generally limited to constructing flood-control works such as dams, levees, sea-walls, and the like, and providing disaster relief to flood victims. This approach did not reduce losses nor did it discourage unwise development. In some instances, it may have actually encouraged additional development. To compound the problem, the public generally could not buy flood coverage from insurance companies, and building techniques to reduce flood damage were often overlooked.

In the face of mounting flood losses and escalating costs of disaster relief to the general taxpayers, the U.S. Congress created the NFIP. The intent was to reduce future flood damage through community floodplain management ordinances, and provide protection for property owners against potential losses through an insurance mechanism that requires a premium to be paid for the protection.

The U.S. Congress established the NFIP on August 1, 1968, with the passage of the National Flood Insurance Act of 1968. The NFIP was broadened and modified with the passage of the Flood Disaster Protection Act of 1973 and other legislative measures. It was further modified by the National Flood Insurance Reform Act of 1994 and the Flood Insurance Reform Act of 2004. The NFIP is administered by the Federal Emergency Management Agency (FEMA), which is a component of the Department of Homeland Security (DHS).

Participation in the NFIP is based on an agreement between local communities and the Federal Government. If a community adopts and enforces floodplain management regulations to reduce future flood risks to new construction and substantially improved structures in Special Flood Hazard Areas (SFHAs), the Federal Government will make flood insurance available within the community as a financial protection against flood losses. The community's floodplain management regulations must meet or exceed criteria established in accordance with Title 44 Code of Federal Regulations (CFR) Part 60, *Criteria for Land Management and Use*.

SFHAs are delineated on the community's Flood Insurance Rate Maps (FIRMs). Under the NFIP, buildings that were built before the flood hazard was identified on the community's FIRMs are generally referred to as "Pre-FIRM" buildings. When the NFIP was created, the U.S. Congress recognized that insurance for Pre-FIRM buildings would be prohibitively expensive if the premiums were not subsidized by the Federal Government. Congress also recognized that most of these floodprone buildings were built

by individuals who did not have sufficient knowledge of the flood hazard to make informed decisions. The NFIP requires that full actuarial rates reflecting the complete flood risk be charged on all buildings constructed or substantially improved on or after the effective date of the initial FIRM for the community or after December 31, 1974, whichever is later. These buildings are generally referred to as “Post-FIRM” buildings.

1.2 Purpose of this Flood Insurance Study Report

This Flood Insurance Study (FIS) Report revises and updates information on the existence and severity of flood hazards for the study area. The studies described in this report developed flood hazard data that will be used to establish actuarial flood insurance rates and to assist communities in efforts to implement sound floodplain management.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive than the minimum Federal requirements. Contact your State NFIP Coordinator to ensure that any higher State standards are included in the community’s regulations.

1.3 Jurisdictions Included in the Flood Insurance Study Project

This FIS Report covers the entire geographic area of Berrien County, Michigan.

The jurisdictions that are included in this project area, along with the Community Identification Number (CID) for each community and the United States Geological Survey (USGS) 8-digit Hydrologic Unit Code (HUC-8) sub-basins affecting each, are shown in Table 1. The FIRM panel numbers that affect each community are listed. If the flood hazard data for the community is not included in this FIS Report, the location of that data is identified.

Jurisdictions that have no identified SFHAs as of the effective date of this study are indicated in the table. Changed conditions in these communities (such as urbanization or annexation) or the availability of new scientific or technical data about flood hazards could make it necessary to determine SFHAs in these jurisdictions in the future.

Table 1: Listing of NFIP Jurisdictions

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Bainbridge, Township of [1]	261103	04050001	26021C0037C[2] 26021C0040C 26021C0041C[2] 26021C0042C 26021C0045C[2] 26021C0061C 26021C0065C[2] 26021C0130C 26021C0135C 26021C0155C	
Baroda, Township of[1]	261106	04040001, 04050001	26021C0210D 26021C0220C 26021C0228C[2] 26021C0230C[2] 26021C0240C	
Baroda, Village of [1]	261105	04050001	26021C0228C[2]	
Benton, Charter Township of	260031	04050001, 04050002, 04060200	26021C0013D 26021C0014D 26021C0015D 26021C0016D 26021C0017C 26021C0018D 26021C0019C 26021C0037C[2] 26021C0040C 26021C0102D 26021C0104C 26021C0106C 26021C0107C 26021C0108C 26021C0109C 26021C0112C 26021C0120C 26021C0130C	
Benton Harbor, City of	260032	04050001, 04050002, 04060200	26021C0013D 26021C0014D 26021C0018D 26021C0101D 26021C0102D 26021C0104C 26021C0106C	

[1] No Special Flood Hazard Areas Identified
[2] Panel Not Printed

Table 1: Listing of NFIP Jurisdictions (*continued)*

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Berrien, Township of	260733	04050001	26021C0252C 26021C0254C 26021C0256C[2] 26021C0260C[2] 26021C0265C 26021C0270C[2] 26021C0280C[2] 26021C0290C	
Berrien Springs, Village of	260330	04050001	26021C0253C 26021C0254C	
Bertrand, Township of	261109	04040001, 04050001, 07120001	26021C0380C 26021C0384C 26021C0385C 26021C0390C 26021C0395C[2] 26021C0403C 26021C0405C 26021C0408C 26021C0409C 26021C0415C[2] 26021C0417C 26021C0420C	
Bridgman, City of	260033	04040001, 04060200	26021C0204D 26021C0208C 26021C0212D 26021C0216C	
Buchanan, City of	260554	04050001	26021C0384C 26021C0403C 26021C0405C	
Buchanan, Township of	260555	04040001, 04050001	26021C0240C 26021C0245C 26021C0265C 26021C0380C 26021C0384C 26021C0385C 26021C0395C[2] 26021C0403C 26021C0405C	

[1] No Special Flood Hazard Areas Identified
[2] Panel Not Printed

Table 1: Listing of NFIP Jurisdictions (*continued)*

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Chikaming, Township of	260258	04040001, 04060200	26021C0194D 26021C0213D 26021C0214C 26021C0330D 26021C0332D 26021C0335D 26021C0351C 26021C0352C 26021C0355C	
Coloma, Charter Township of	260034	04050001, 04050002	26021C0027C[2] 26021C0029C 26021C0031C 26021C0032C 26021C0033C 26021C0034C 26021C0037C[2] 26021C0041C[2] 26021C0042C	
Coloma, City of	260556	04050001	26021C0029C 26021C0033C 26021C0037C[2] 26021C0041C[2]	
Eau Claire, Village of[1]	260999	04050001	26021C0252C 26021C0256C[2]	
Galien, Township of	261108	04040001, 07120001	26021C0355C 26021C0360C 26021C0365C[2] 26021C0367C[2] 26021C0370C[2] 26021C0380C 26021C0386C 26021C0390C	
Galien, Village of[1]	261107	04040001	26021C0367C[2] 26021C0386C	
Grand Beach, Village of	260268	04040001, 04060200	26021C0316D 26021C0317D 26021C0318D 26021C0319C	

[1] No Special Flood Hazard Areas Identified
[2] Panel Not Printed

Table 1: Listing of NFIP Jurisdictions (*continued)*

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Hagar, Township of	260035	04050001, 04050002, 04060200	26021C0007D 26021C0008D 26021C0009D 26021C0015D 26021C0016D 26021C0017C 26021C0026D 26021C0027C[2] 26021C0028C 26021C0029C 26021C0037C[2] 26021C0040C	
Lake, Charter Township of	260036	04040001, 04050001, 04060200	26021C0204D 26021C0205D 26021C0208C 26021C0210D 26021C0211D 26021C0212D 26021C0213D 26021C0214C 26021C0216C 26021C0220C	
Lincoln, Charter Township of	260037	04040001, 04050001, 04060200	26021C0091D 26021C0092D 26021C0093D 26021C0094D 26021C0112C 26021C0115D 26021C0205D 26021C0210D 26021C0230C[2]	
Michiana, Village of	260275	04040001, 04060200	26021C0314D 26021C0318D	
New Buffalo, City of	260038	04040001, 04060200	26021C0317D 26021C0319C 26021C0336D 26021C0338C	

[1] No Special Flood Hazard Areas Identified
[2] Panel Not Printed

Table 1: Listing of NFIP Jurisdictions (*continued)*

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
New Buffalo, Township of	260039	04040001, 04060200	26021C0317D 26021C0318D 26021C0319C 26021C0330D 26021C0335D 26021C0336D 26021C0338C 26021C0340D 26021C0345C	
Niles, Charter Township of	260041	04050001	26021C0265C 26021C0270C[2] 26021C0290C 26021C0405C 26021C0406C 26021C0407C 26021C0408C 26021C0409C 26021C0417C 26021C0420C 26021C0426C 26021C0428C[2] 26021C0436C 26021C0440C[2]	
Niles, City of	260040	04050001	26021C0407C 26021C0408C 26021C0409C 26021C0417C 26021C0426C 26021C0428C[2] 26021C0436C	
Oronoko, Charter Township of	260042	04040001, 04050001	26021C0230C[2] 26021C0235C 26021C0240C 26021C0245C 26021C0251C 26021C0252C 26021C0253C 26021C0254C 26021C0265C	

[1] No Special Flood Hazard Areas Identified
[2] Panel Not Printed

Table 1: Listing of NFIP Jurisdictions (*continued)*

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Pipestone, Township of	261104	04050001	26021C0130C 26021C0135C 26021C0140C 26021C0145C 26021C0155C 26021C0165C 26021C0252C 26021C0256C[2] 26021C0260C[2] 26021C0280C[2]	
Royalton, Township of	260043	04050001	26021C0104C 26021C0108C 26021C0112C 26021C0115D 26021C0120C 26021C0230C[2] 26021C0235C	
Shoreham, Village of	260280	04040001, 04050001, 04060200	26021C0084D 26021C0092D 26021C0103D	
Sodus, Township of	260046	04050001	26021C0108C 26021C0109C 26021C0120C 26021C0130C 26021C0140C 26021C0235C 26021C0251C 26021C0252C 26021C0253C	
St. Joseph, Charter Township of	260045	04050001	26021C0084D 26021C0092D 26021C0101D 26021C0102D 26021C0103D 26021C0104C 26021C0112C 26021C0115D	
St. Joseph, City of	260044	04040001, 04050001, 04050002, 04060200	26021C0084D 26021C0101D 26021C0102D 26021C0103D	
Stevensville, Village of	260557	04040001, 04050001	26021C0093D 26021C0094D	

[1] No Special Flood Hazard Areas Identified
[2] Panel Not Printed

Table 1: Listing of NFIP Jurisdictions (*continued)*

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Three Oaks, Township of	261111	04040001	26021C0335D 26021C0345C 26021C0355C 26021C0361C[2] 26021C0365C[2]	
Three Oaks, Village of [1]	261110	04040001	26021C0361C[2]	
Watervliet, Charter Township of	260048	04050001	26021C0032C 26021C0033C 26021C0034C 26021C0041C[2] 26021C0042C 26021C0051C 26021C0053C 26021C0061C	
Watervliet, City of	260047	04050001	26021C0034C 26021C0042C 26021C0053C 26021C0061C	
Weesaw, Township of	260049	04040001, 04050001	26021C0214C 26021C0220C 26021C0240C 26021C0352C 26021C0355C 26021C0360C 26021C0380C	

[1] No Special Flood Hazard Areas Identified
[2] Panel Not Printed

1.4 Considerations for using this Flood Insurance Study Report

The NFIP encourages State and local governments to implement sound floodplain management programs. To assist in this endeavor, each FIS Report provides floodplain data, which may include a combination of the following: 10-, 4-, 2-, 1-, and 0.2-percent annual chance flood elevations (the 1-percent-annual-chance flood elevation is also referred to as the Base Flood Elevation (BFE)); delineations of the 1-percent-annual-chance and 0.2-percent-annual-chance floodplains; and 1-percent-annual-chance floodway. This information is presented on the FIRM and/or in many components of the FIS Report, including Flood Profiles, Floodway Data tables, Summary of Non-Coastal Stillwater Elevations tables, and Coastal Transect Parameters tables (not all components may be provided for a specific FIS).

This section presents important considerations for using the information contained in this FIS Report and the FIRM, including changes in format and content. Figures 1, 2, and 3 present information that applies to using the FIRM with the FIS Report.

- Part or all of this FIS Report may be revised and republished at any time. In addition, part of this FIS Report may be revised by a Letter of Map Revision

(LOMR), which does not involve republication or redistribution of the FIS Report. Refer to Section 6.5 of this FIS Report for information about the process to revise the FIS Report and/or FIRM.

It is, therefore, the responsibility of the user to consult with community officials by contacting the community repository to obtain the most current FIS Report components. Communities participating in the NFIP have established repositories of flood hazard data for floodplain management and flood insurance purposes. Community map repository addresses are provided in Table 30, "Map Repositories," within this FIS Report.

- New FIS Reports are frequently developed for multiple communities, such as entire counties. A countywide FIS Report incorporates previous FIS Reports for individual communities and the unincorporated area of the county (if not jurisdictional) into a single document and supersedes those documents for the purposes of the NFIP.

  The initial Countywide FIS Report for Berrien County became effective on April 17, 2006. Refer to Table 27 for information about subsequent revisions to the FIRMs.

- Selected FIRM panels for the community may contain information (such as floodways and cross sections) that was previously shown separately on the corresponding Flood Boundary and Floodway Map (FBFM) panels. In addition, former flood hazard zone designations have been changed as follows:

Old Zone	New Zone
A1 through A30	AE
V1 through V30	VE
B	X (shaded)
C	X (unshaded)

- FEMA does not impose floodplain management requirements or special insurance ratings based on Limit of Moderate Wave Action (LiMWA) delineations at this time. The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave. If the LiMWA is shown on the FIRM, it is being provided by FEMA as information only. For communities that do adopt Zone VE building standards in the area defined by the LiMWA, additional Community Rating System (CRS) credits are available. Refer to Section 2.5.4 for additional information about the LiMWA.

  The CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. Visit the FEMA Web site at www.fema.gov/national-flood-insurance-program-community-rating-system or contact your appropriate FEMA Regional Office for more information about this program.

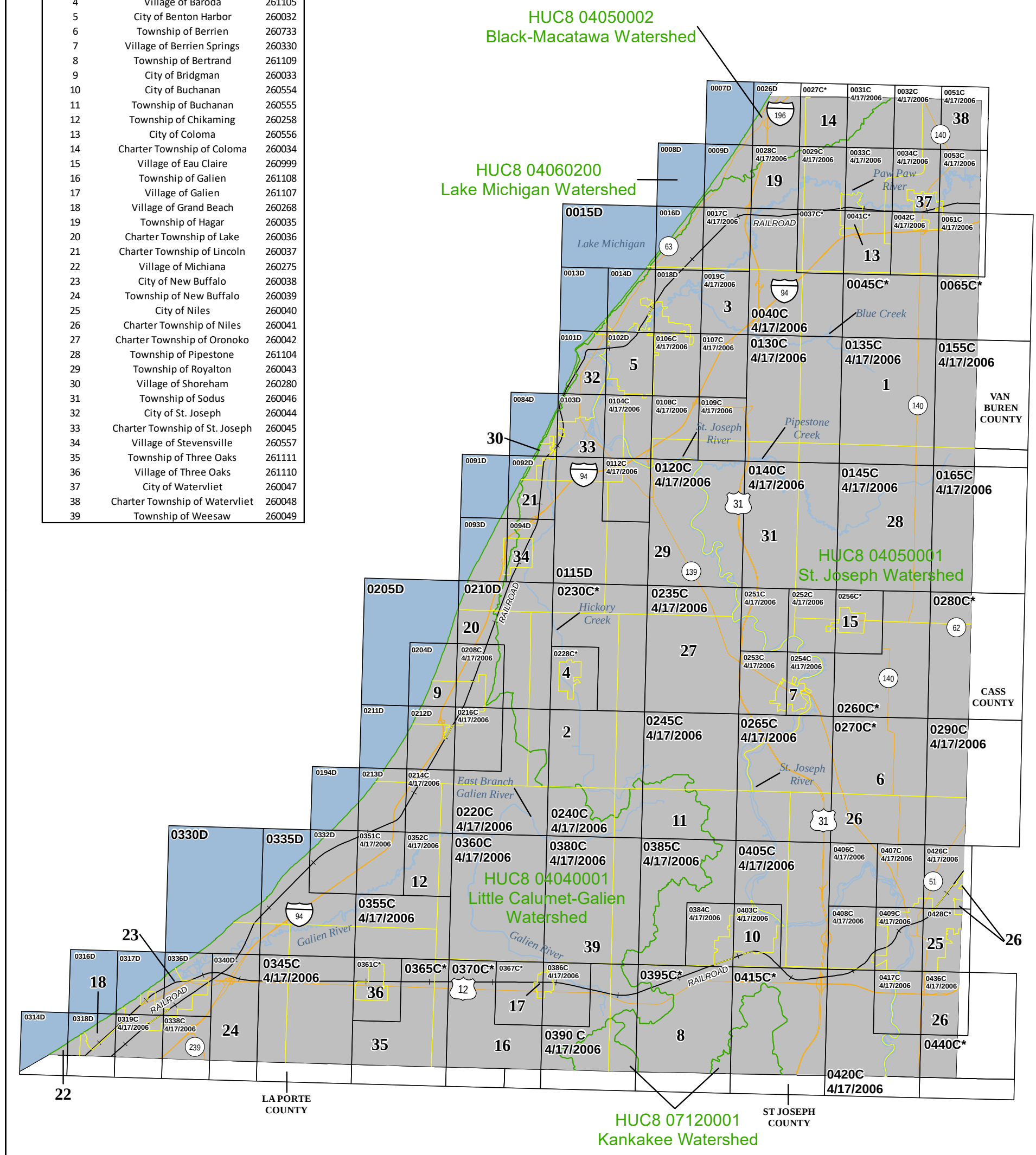
- FEMA does not design, build, inspect, operate, maintain, or certify levees. FEMA is responsible for accurately identifying flood hazards and communicating those hazards and risks to affected stakeholders. FEMA has identified one or more levee systems in this jurisdiction summarized in Table 8 of this FIS Report. For FEMA to accredit the identified levee systems, the levee systems must meet the criteria of the Code of Federal Regulations, Title 44, Section 65.10 (44 CFR 65.10), titled "Mapping of Areas Protected by Levee Systems."

Information on the levee systems in this jurisdiction can be obtained from the USACE National Levee Database (https://levees.sec.usace.army.mil/). For additional information, the user should contact the appropriate jurisdiction floodplain administrator and the levee owner or sponsor.

- FEMA has developed a *Guide to Flood Maps* (FEMA 258) and online tutorials to assist users in accessing the information contained on the FIRM. These include how to read panels and step-by-step instructions to obtain specific information. To obtain this guide and other assistance in using the FIRM, visit the FEMA Web site at www.fema.gov/online-tutorials.

The FIRM Index in Figure 1 shows the overall FIRM panel layout within Berrien County, and also displays the panel number and effective date for each FIRM panel in the county. Other information shown on the FIRM Index includes community boundaries, flooding sources, watershed boundaries, and USGS HUC-8 codes.

Key Number	Political Name	CID
1	Township of Bainbridge	261103
2	Township of Baroda	261106
3	Charter Township of Benton	260031
4	Village of Baroda	261105
5	City of Benton Harbor	260032
6	Township of Berrien	260733
7	Village of Berrien Springs	260330
8	Township of Bertrand	261109
9	City of Bridgman	260033
10	City of Buchanan	260554
11	Township of Buchanan	260555
12	Township of Chikaming	260258
13	City of Coloma	260556
14	Charter Township of Coloma	260034
15	Village of Eau Claire	260999
16	Township of Galien	261108
17	Village of Galien	261107
18	Village of Grand Beach	260268
19	Township of Hagar	260035
20	Charter Township of Lake	260036
21	Charter Township of Lincoln	260037
22	Village of Michiana	260275
23	City of New Buffalo	260038
24	Township of New Buffalo	260039
25	City of Niles	260040
26	Charter Township of Niles	260041
27	Charter Township of Oronoko	260042
28	Township of Pipestone	261104
29	Township of Royalton	260043
30	Village of Shoreham	260280
31	Township of Sodus	260046
32	City of St. Joseph	260044
33	Charter Township of St. Joseph	260045
34	Village of Stevensville	260557
35	Township of Three Oaks	261111
36	Village of Three Oaks	261110
37	City of Watervliet	260047
38	Charter Township of Watervliet	260048
39	Township of Weesaw	260049



ATTENTION: The corporate limits shown on this FIRM Index are based on the best information available at the time of publication. As such, they may be more current than those shown on FIRM panels issued before TBD.

1 inch = 18,750 feet 1:225,000

feet
0 10,000 20,000 30,000

Map Projection:
Michigan State Plane Zone 2113; North American Datum 1983; North American Vertical Datum of 1988

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

HTTPS://MSC.FEMA.GOV

SEE FLOOD INSURANCE STUDY FOR ADDITIONAL INFORMATION

*PANEL NOT PRINTED -- NO SPECIAL FLOOD HAZARD AREAS

COUNTY LOCATOR

NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP INDEX

BERRIEN COUNTY, MICHIGAN (ALL JURISDICTIONS)

PANELS PRINTED:
0007, 0008, 0009, 0013, 0014, 0015, 0016, 0017, 0018, 0019, 0026, 0028, 0029, 0031, 0032, 0033, 0034, 0040, 0042, 0051, 0053, 0061, 0084, 0091, 0092, 0093, 0094, 0101, 0102, 0103, 0104, 0106, 0107, 0108, 0109, 0112, 0115, 0120, 0130, 0135, 0140, 0145, 0155, 0165, 0194, 0204, 0205, 0208, 0210, 0211, 0212, 0213, 0214, 0216, 0220, 0235, 0240, 0245, 0251, 0252, 0253, 0254, 0265, 0290, 0314, 0316, 0317, 0318, 0319, 0330, 0332, 0335, 0336, 0338, 0340, 0345, 0351, 0352, 0355, 0360, 0380, 0384, 0385, 0386, 0390, 0403, 0405, 0406, 0407, 0408, 0409, 0417, 0420, 0426, 0436

MAP NUMBER
26021CIND0B

MAP REVISED

REVISED PRELIMINARY
SEPTEMBER 2, 2022

Each FIRM panel may contain specific notes to the user that provide additional information regarding the flood hazard data shown on that map. However, the FIRM panel does not contain enough space to show all the notes that may be relevant in helping to better understand the information on the panel. Figure 2 contains the full list of these notes.

Figure 2: FIRM Notes to Users

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM including historic versions of this FIRM, how to order products, or the National Flood Insurance Program in general, please call the FEMA Mapping and Insurance eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at 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. Users may determine the current map date for each FIRM panel by visiting the FEMA Flood Map Service Center website or by calling the FEMA Mapping and Insurance eXchange.

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 Table 27 in this FIS Report.

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

PRELIMINARY FIS REPORT: FEMA maintains information about map features, such as street locations and names, in or near designated flood hazard areas. Requests to revise information in or near designated flood hazard areas may be provided to FEMA during the community review period, at the final Consultation Coordination Officer's meeting, or during the statutory 90-day appeal period. Approved requests for changes will be shown on the final printed FIRM.

The map is for use in administering the NFIP. It may not identify all areas subject to flooding, particularly from local drainage sources of small size. Consult the community map repository to find updated or additional flood hazard information.

BASE FLOOD ELEVATIONS: For more detailed information in areas where Base Flood Elevations (BFEs) and/or floodways have been determined, consult the Flood Profiles and Floodway Data and/or Summary of Non-Coastal Stillwater Elevations tables within this FIS Report. Use the flood elevation data within the FIS Report in conjunction with the FIRM for construction and/or floodplain management.

Coastal Base Flood Elevations shown on the map apply only landward of the zero elevation referenced to Low Water Datum of Lake Michigan, administratively established by the National Oceanic and Atmospheric Administration at 176.0 meters (577.5 feet) above zero point International Great Lakes Datum of 1985. This lake-wide elevation is approximately equal to an elevation of 577.6 feet North American Vertical Datum of 1988 (NAVD88). Coastal flood elevations are also provided in the Coastal Transect Parameters table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Coastal Transect Parameters table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on the FIRM.

Figure 2. FIRM Notes to Users *(continued)*

FLOODWAY INFORMATION: Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the FIS Report for this jurisdiction.

FLOOD CONTROL STRUCTURE INFORMATION: Certain areas not in Special Flood Hazard Areas may be protected by flood control structures. Refer to Section 4.3 "Non-Levee Flood Protection Measures" of this FIS Report for information on flood control structures for this jurisdiction.

PROJECTION INFORMATION: The projection used in the preparation of the map was State Plane Michigan South Zone 2113. The horizontal datum was the North American Datum of 1983 NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

ELEVATION DATUM: Flood elevations on FIRM panels 26021C0007D, 008D, 009D, 013D, 014D, 015D, 016D, 018D, 026D, 084D, 091D, 092D, 093D, 094D, 101D, 102D, 103D, 115D, 194D, 204D, 205D, 210D, 211D, 212D, 213D, 314D, 316D, 317D, 318D, 330D, 332D, 335D, 336D, and 340D are referenced to the North American Vertical Datum of 1988. Flood elevations on the remainder of the FIRMs are referenced to the National Geodetic Vertical Datum of 1929. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at www.ngs.noaa.gov.

Local vertical monuments may have been used to create the map. To obtain current monument information, please contact the appropriate local community listed in Table 30 of this FIS Report.

BASE MAP INFORMATION: Base map information shown on this FIRM was provided in digital format by the United States Department of Agriculture - Natural Agriculture Imagery Program (NAIP). This information was derived from digital orthophotography at a 1-meter resolution from photography dated 2012. For information about base maps, refer to Section 6.2 “Base Map” in this FIS Report.

The map reflects more detailed and up-to-date stream channel configurations than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables may reflect stream channel distances that differ from what is shown on the map.

Corporate limits shown on the map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after the map was published, map users should contact appropriate community officials to verify current corporate limit locations.

NOTES FOR FIRM INDEX

REVISIONS TO INDEX: As new studies are performed and FIRM panels are updated within Berrien County, Michigan corresponding revisions to the FIRM Index will be incorporated within the FIS Report to reflect the effective dates of those panels. Please refer to Table 27 of this FIS Report to determine the most recent FIRM revision date for each community. The most recent FIRM panel effective date will correspond to the most recent index date.

ATTENTION: The corporate limits shown on this FIRM Index are based on the best information available at the time of publication. As such, they may be more current than those shown on FIRM panels issued before **TBD**.

SPECIAL NOTES FOR SPECIFIC FIRM PANELS

This Notes to Users section was created specifically for Berrien County, Michigan, effective **TBD**.

LIMIT OF MODERATE WAVE ACTION: Zone AE has been divided by a Limit of Moderate Wave Action (LiMWA). The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave. The effects of wave hazards between Zone VE and the LiMWA (or between the shoreline and the LiMWA for areas where Zone VE is not identified) will be similar to, but less severe than, those in Zone VE.

NON-ACCREDITED LEVEE SYSTEM: Panel 26021C0034C contains a levee system that has not been accredited and is therefore not recognized as reducing the 1-percent-annual-chance flood hazard.

FLOOD RISK REPORT: A Flood Risk Report (FRR) may be available for many of the flooding sources and communities referenced in this FIS Report. The FRR is provided to increase public awareness of flood risk by helping communities identify the areas within their jurisdictions that have the greatest risks. Although non-regulatory, the information provided within the FRR can assist communities in assessing and evaluating mitigation opportunities to reduce these risks. It can also be used by communities developing or updating flood risk mitigation plans. These plans allow communities to identify and evaluate opportunities to reduce potential loss of life and property. However, the FRR is not intended to be the final authoritative source of all flood risk data for a project area; rather, it should be used with other data sources to paint a comprehensive picture of flood risk.

Each FIRM panel contains an abbreviated legend for the features shown on the maps. However, the FIRM panel does not contain enough space to show the legend for all map features. Figure 3 shows the full legend of all map features. Note that not all of these features may appear on the FIRM panels in Berrien County.

Figure 3: Map Legend for FIRM

SPECIAL FLOOD HAZARD AREAS: The 1% annual chance flood, also known as the base flood or 100-year flood, has a 1% chance of happening or being exceeded each year. Special Flood Hazard Areas are subject to flooding by the 1% annual chance flood. The Base Flood Elevation is the water surface elevation of the 1% annual chance flood. The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights. See note for specific types. If the floodway is too narrow to be shown, a note is shown.

	Special Flood Hazard Areas subject to inundation by the 1% annual chance flood (Zones A, AE, AH, AO, AR, A99, V and VE)
Zone A	The flood insurance rate zone that corresponds to the 1% annual chance floodplains. No base (1% annual chance) flood elevations (BFEs) or depths are shown within this zone.
Zone AE	The flood insurance rate zone that corresponds to the 1% annual chance floodplains. Base flood elevations derived from the hydraulic analyses are shown within this zone.
Zone AH	The flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot BFEs derived from the hydraulic analyses are shown at selected intervals within this zone.
Zone AO	The flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the hydraulic analyses are shown within this zone.
Zone AR	The flood insurance rate zone that corresponds to areas that were formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
Zone A99	The flood insurance rate zone that corresponds to areas of the 1% annual chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No base flood elevations or flood depths are shown within this zone.
Zone V	The flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Base flood elevations are not shown within this zone.
Zone VE	Zone VE is the flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Base flood elevations derived from the coastal analyses are shown within this zone as static whole-foot elevations that apply throughout the zone.
	Regulatory Floodway determined in Zone AE.

Figure 3: Map Legend for FIRM *(continued)*

OTHER AREAS OF FLOOD HAZARD

Shaded Zone X: Areas of 0.2% annual chance flood hazards and areas of 1% annual chance flood hazards with average depths of less than 1 foot or with drainage areas less than 1 square mile.

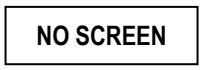
Future Conditions 1% Annual Chance Flood Hazard – Zone X: The flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined based on future-conditions hydrology. No base flood elevations or flood depths are shown within this zone.

Area with Reduced Flood Risk due to Levee: Areas where an accredited levee, dike, or other flood control structure has reduced the flood risk from the 1% annual chance flood.

Area with Flood Risk due to Levee: Areas where a non-accredited levee, dike, or other flood control structure is shown as providing protection to less than the 1% annual chance flood.

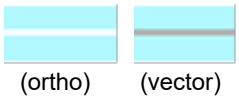
OTHER AREAS

Zone D (Areas of Undetermined Flood Hazard): The flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.



Unshaded Zone X: Areas of minimal flood hazard.

FLOOD HAZARD AND OTHER BOUNDARY LINES



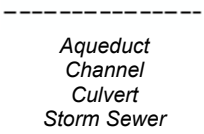
Flood Zone Boundary (white line on ortho-photography-based mapping; gray line on vector-based mapping)

Limit of Study

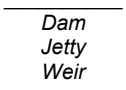
Jurisdiction Boundary

Limit of Moderate Wave Action (LiMWA): Indicates the inland limit of the area affected by waves greater than 1.5 feet

GENERAL STRUCTURES

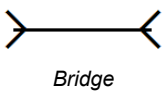


Channel, Culvert, Aqueduct, or Storm Sewer



Dam, Jetty, Weir

Levee, Dike, or Floodwall



Bridge

Figure 3: Map Legend for FIRM *(continued)*

REFERENCE MARKERS	
22.0	River mile Markers
CROSS SECTION & TRANSECT INFORMATION	
B 20.2	Lettered Cross Section with Regulatory Water Surface Elevation (BFE)
5280 21.1	Numbered Cross Section with Regulatory Water Surface Elevation (BFE)
17.5	Unlettered Cross Section with Regulatory Water Surface Elevation (BFE)
8	Coastal Transect
	Profile Baseline: Indicates the modeled flow path of a stream and is shown on FIRM panels for all valid studies with profiles or otherwise established base flood elevation.
	Coastal Transect Baseline: Used in the coastal flood hazard model to represent the 0.0-foot elevation contour and the starting point for the transect and the measuring point for the coastal mapping.
513	Base Flood Elevation Line
ZONE AE (EL 16)	Static Base Flood Elevation value (shown under zone label)
ZONE AO (DEPTH 2)	Zone designation with Depth
ZONE AO (DEPTH 2) (VEL 15 FPS)	Zone designation with Depth and Velocity
BASE MAP FEATURES	
Missouri Creek	River, Stream or Other Hydrographic Feature
234	Interstate Highway
234	U.S. Highway
234	State Highway
234	County Highway
MAPLE LANE	Street, Road, Avenue Name, or Private Drive if shown on Flood Profile
RAILROAD	Railroad

Figure 3: Map Legend for FIRM *(continued)*

_____	Horizontal Reference Grid Line
___	Horizontal Reference Grid Ticks
+	Secondary Grid Crosshairs
Land Grant	Name of Land Grant
7	Section Number
R. 43 W. T. 22 N.	Range, Township Number
^{42}**76**^{000m}**E**	Horizontal Reference Grid Coordinates (UTM)
365000 FT	Horizontal Reference Grid Coordinates (State Plane)
80° 16’ 52.5”	Corner Coordinates (Latitude, Longitude)

SECTION 2.0 – FLOODPLAIN MANAGEMENT APPLICATIONS

2.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance (500-year) flood is employed to indicate additional areas of flood hazard in the community.

Each flooding source included in the project scope has been studied and mapped using professional engineering and mapping methodologies that were agreed upon by FEMA and Berrien County as appropriate to the risk level. Flood risk is evaluated based on factors such as known flood hazards and projected impact on the built environment. Engineering analyses were performed for each studied flooding source to calculate its 1-percent-annual-chance flood elevations; elevations corresponding to other floods (e.g. 10-, 4-, 2-, 0.2-percent annual chance, etc.) may have also been computed for certain flooding sources. Engineering models and methods are described in detail in Section 5.0 of this FIS Report. The modeled elevations at cross sections were used to delineate the floodplain boundaries on the FIRM; between cross sections, the boundaries were interpolated using elevation data from various sources. More information on specific mapping methods is provided in Section 6.0 of this FIS Report.

Depending on the accuracy of available topographic data (Table 22), study methodologies employed (Section 5.0), and flood risk, certain flooding sources may be mapped to show both the 1-percent and 0.2-percent-annual-chance floodplain boundaries, regulatory water surface elevations (BFEs), and/or a regulatory floodway. Similarly, other flooding sources may be mapped to show only the 1-percent-annual-chance floodplain boundary on the FIRM, without published water surface elevations. In cases where the 1-percent and 0.2-percent-annual-chance floodplain boundaries are close together, only the 1-percent-annual-chance floodplain boundary is shown on the FIRM. Figure 3, “Map Legend for FIRM”, describes the flood zones that are used on the FIRMs to account for the varying levels of flood risk that exist along flooding sources within the project area. Table 2 and Table 3 indicate the flood zone designations for each flooding source and each community within Berrien County, respectively.

Table 2, “Flooding Sources Included in this FIS Report,” lists each flooding source, including its study limits, affected communities, mapped zone on the FIRM, and the completion date of its engineering analysis from which the flood elevations on the FIRM and in the FIS Report were derived. Descriptions and dates for the latest hydrologic and hydraulic analyses of the flooding sources are shown in Table 12. Floodplain boundaries for these flooding sources are shown on the FIRM (published separately) using the symbology described in Figure 3. On the map, the 1-percent-annual-chance floodplain corresponds to the SFHAs. The 0.2-percent-annual-chance floodplain shows areas that, although out of the regulatory floodplain, are still subject to flood hazards.

Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data. The procedures to remove these areas from the SFHA are described in Section 6.5 of this FIS Report.

Table 2: Flooding Sources Included in this FIS Report

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
All Base (Zone A) Studies	Benton, Charter Township of; Bertrand, Township of; Buchanan, Township of; Chikaming, Township of; Coloma, Charter Township of; Galien, Township of; Hagar, Township of; Lake, Charter Township of; New Buffalo, City of; New Buffalo, Township of; Niles, Charter Township of; Oronoko, Charter Township of; Royalton, Township of; Sodus, Township of; St. Joseph, City of; St. Joseph, Charter Township of; Three Oaks, Township of; Watervliet, Charter Township of	Varies	Varies	Varies	232.4		N	A	2004
Bedortha Drain	Bridgman, City of; Lake, Charter Township of	Mouth at Tanner Creek	Approximately 1,100 feet north of Rambo Road	04040001	1.3		Y	AE	2004
Bridgman City Drain	Bridgman, City of; Lake, Charter Township of	Confluence with Bedortha Drain	Approximately 700 feet west of Church Street	04040001	0.6		Y	AE	2004
Dowagiac River	Niles, City of; Niles, Charter Township of	City of Niles western corporate limits	City of Niles northern corporate limits	04050001	0.7		N	AE	1985

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Galien River	New Buffalo, City of; New Buffalo, Township of	Mouth at Lake Michigan	Approximately 6,000 feet upstream of the Red Arrow Highway Bridge	04040001	3.6		Y	AE	1978
Glenlord Road Drain (North Branch)	Lincoln, Charter Township of	Mouth at Glenlord Road Drain (South Branch)	Approximately 800 feet north of West Glenorchard Road	04050001	1.2		Y	AE	1976
Glenlord Road Drain (South Branch)	Lincoln, Charter Township of	Mouth at Parker/Richardson Drain	Approximately 560 feet upstream of Washington Avenue	04050001	0.8		Y	AE	1976
Goodrow Drain	Lincoln, Charter Township of	Approximately 750 upstream of confluence with Hickory Creek	Approximately 1,250 feet upstream of Ponderosa Drive	04050001	1.0		Y	AE	1976
Granger Drain	Hager, Township of	Mouth of Paw Paw River	Approximately 1,300 feet west of Pier Road	04050001	2.3		Y	AE	1976
Granger Drain Tributary	Hager, Township of	Mouth at Granger Drain	Approximately 1,300 feet south of Coloma Road	04050001	0.6		Y	AE	1976
Hickory Creek	Shoreham, Village of; St. Joseph, City of; St. Joseph, Charter Township of	Mouth at St. Joseph River	Approximately 3,800 feet upstream of Roosevelt Road	04050001	3.0		Y	AE	1978
Hickory Creek	Lincoln, Charter Township of	Charter Township of St. Joseph/Charter Township of Lincoln corporate boundary	Village of Stevensville eastern corporate limits	04050001	2.4		Y	AE	1976

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Hickory Creek	Lincoln, Charter Township of	Approximately 1,100 feet downstream of Stevensville Baroda Road	Approximately 1,250 feet upstream of Stevensville Baroda Road	04050001	0.4		Y	AE	1976
Lake Michigan	Benton, Charter Township of; Benton Harbor, City of; Bridgman, City of; Chikaming, Township of; Grand Beach, Village of; Hagar, Township of; Lake, Charter Township of; Lincoln, Charter Township of; Michiana, Village of; New Buffalo, City of; New Buffalo, Township of; Shoreham, Village of; St. Joseph, City of	Van Buren County / Berrien County, MI county boundary	Berrien County, MI / Lake County, IN county boundary	04060200	42.3		Y	AE, VE	2017
McCoy Creek	Buchanan, City of	Mouth at St. Joseph River	Northeast intersection of Chamberlain Road and Bakertown Road	04050001	0.7		N	AE	1986
Ox Creek	Benton, Charter Township of	City of Benton Harbor / Charter Township of Benton corporate limits	Approximately 2,200 feet south of East Napier Avenue	04050001	1.6		Y	AE	1977
Ox Creek	Benton Harbor, City of	Mouth at Paw Paw River	Approximately 450 feet upstream of Empire Avenue	04050001	2.4		Y	AE	1977

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Parker/Richardson Drain	Lincoln, Charter Township of	Mouth at Hickory Creek	Approximately 2,850 feet upstream of W John Beers Road	04050001	2.6		Y	AE	1976
Paw Paw Lake	Coloma, Charter Township of; Watervliet, Charter Township of	N/A	N/A	04050001		1.7	N	AE	1983
Paw Paw River	Benton, Charter Township of	City of Benton Harbor / Charter Township of Benton corporate limits	Charter Township of Benton / Township of Hagar corporate limits	04050001	3.1		Y	AE	1976
Paw Paw River	Benton Harbor, City of	Mouth at St. Joseph River	Approximately 1,320 feet upstream of confluence with Blue Creek	04050001	3.1		Y	AE	1976
Paw Paw River	Coloma, City of; Coloma, Charter Township of	Bundy Road at Charter Township of Coloma and Township of Hagar boundary	Charter Township of Coloma / Charter Township of Watervliet corporate limits	04050001	3.3		N	AE	1976
Paw Paw River	Hagar, Township of;	Charter Township of Benton / Township of Hagar corporate limits	Bundy Road at Charter Township of Coloma and Township of Hagar boundary	04050001	4.3		Y	AE	1976
Paw Paw River	St. Joseph, City of	Mouth at St. Joseph River	City of St. Joseph / City of Benton Harbor corporate limits	04050001	0.6		Y	AE	1976

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Paw Paw River	Watervliet, City of; Watervliet, Charter Township of	Charter Township of Coloma / Charter Township of Watervliet corporate limits	North County Line Road at Berrien County / Van Buren County boundary	04050001	4.2		N	AE	1976
St. Joseph River	Benton, Charter Township of	Charter Township of St. Joseph / Charter Township of Benton corporate limits	Charter Township of Benton / Township of Sodus corporate limits	04050001	3.3		Y	AE	1977
St. Joseph River	Benton Harbor, City of	City of St. Joseph / City of Benton Harbor corporate limits	City of Benton Harbor / Charter Township of St. Joseph corporate limits	04050001	0.9		Y	AE	1977
St. Joseph River	Niles, City of	Approximately 600 feet east of Nature Way	Approximately 1,200 feet west of Bond Street	04050001	2.5		Y	AE	1985
St. Joseph River	Oronoko, Charter Township of; Sodus, Township of	Charter Township of Benton / Township of Sodus corporate limits	Approximately 1,100 feet south of Hipps Hollow Road	04050001	10.4		Y	AE	1976
St. Joseph River	Royalton, Township of	City of St. Joseph / Township of Royalton corporate limits	Township of Royalton / Township of Sodus corporate limits	04050001	9.1		Y	AE	1976
St. Joseph River	St. Joseph, City of; St. Joseph, Charter Township of	Mouth at Lake Michigan	Approximately 1,980 feet upstream of confluence with Hickory Creek	04050001	4.9		Y	AE	1976
St. Joseph River (Left Overbank)	Royalton, Township of	Convergence with St. Joseph River	Divergence from St. Joseph River	04050001	1.5		Y	AE	1976

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Tanner Creek	Bridgman, City of	Mouth at Lake Michigan	Approximately 300 feet upstream of Interstate 94	04040001	1.1		Y	AE	2004
Tributary A	Chikaming, Township of	Mouth at Lake Michigan	Approximately 400 feet north of Sawyer Road	04040001	1.5		Y	AE	1977
Tributary B	Chikaming, Township of	Mouth at Lake Michigan	Red Arrow Highway	04040001	1.2		Y	AE	1977
Tributary C	Chikaming, Township of	Mouth at Tributary B	Approximately 650 feet south of Blackwell Drive	04040001	0.5		Y	AE	1977
West Tributary St. Joseph River	Niles, City of	Mouth at St. Joseph River	Approximately 2,650 feet east of South Phillip Road	04050001	0.8		Y	AE	1985
White Creek – East Branch	Grand Beach, Village of; New Buffalo, Township of	Ravine Road	Downstream of Grand Beach Road	04040001	0.4		Y	AE	1977
White Creek – West Branch	Michiana, Village of	Approximately 1,200 feet south of Ridgeview Drive	Michiana Drive	04040001	0.5		Y	AE	1976
William & Esseg Drain	Bridgman, City of	Mouth at Lake Michigan	Approximately 1,300 feet upstream of Interstate 94	04040001	0.2		Y	AE	2004
Yellow Creek	Royalton, Township of	Mouth at St. Joseph River	Approximately 1,400 feet upstream of East John Beers Road	04050001	3.9		Y	AE	1976

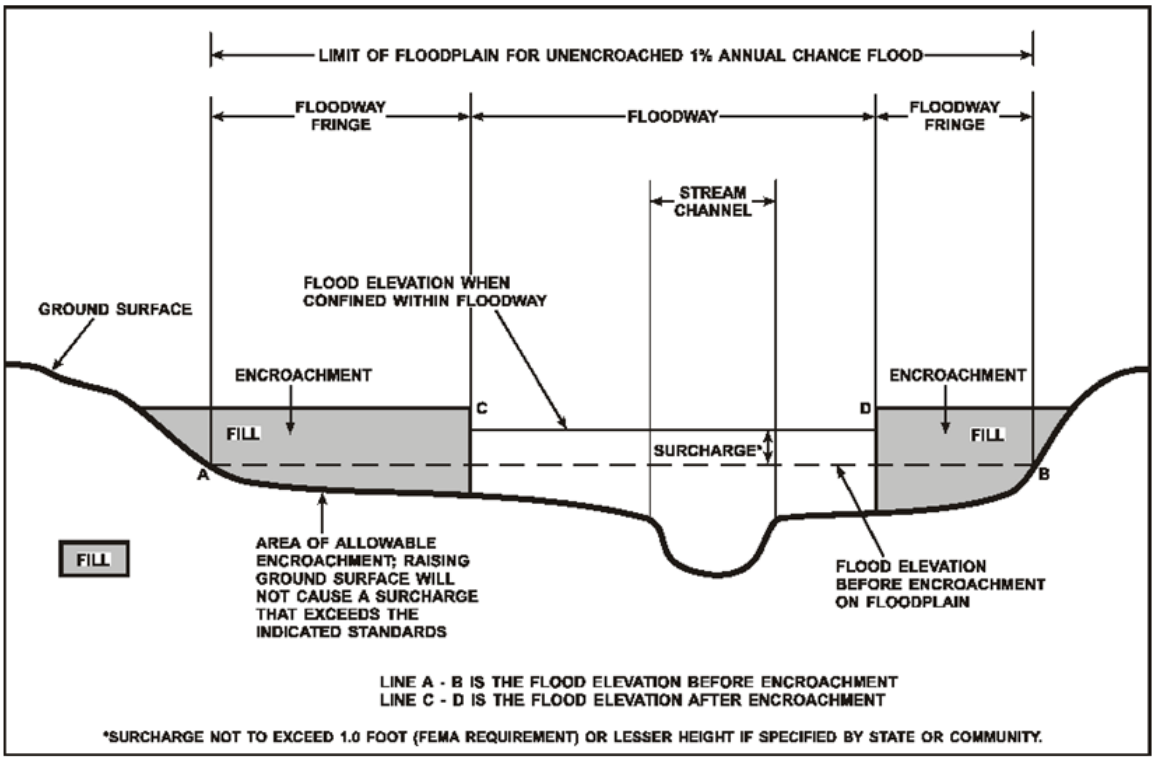
2.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard.

For purposes of the NFIP, a floodway is used as a tool to assist local communities in balancing floodplain development against increasing flood hazard. With this approach, the area of the 1-percent-annual-chance floodplain on a river is divided into a floodway and a floodway fringe based on hydraulic modeling. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment in order to carry the 1-percent-annual-chance flood. The floodway fringe is the area between the floodway and the 1-percent-annual-chance floodplain boundaries where encroachment is permitted. The floodway must be wide enough so that the floodway fringe could be completely obstructed without increasing the water surface elevation of the 1-percent-annual-chance flood more than 1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Table 4.

To participate in the NFIP, Federal regulations require communities to limit increases caused by encroachment to 1.0 foot, provided that hazardous velocities are not produced. Regulations for Michigan under Act 245, Public Acts of 1929, as amended by Act 167, Public Acts of 1968, encroachment in the floodplain is limited to that which will cause only insignificant increases in flood heights. Thus, at the recommendation of the Michigan Department of Natural Resources, Land and Water Management Division, floodways having no more than a 0.1-foot surcharge have been delineated for this study. The floodways in this project are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway projects.

Figure 4: Floodway Schematic



Floodway widths presented in this FIS Report and on the FIRM were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. For certain stream segments, floodways were adjusted so that the amount of floodwaters conveyed on each side of the floodplain would be reduced equally. The results of the floodway computations have been tabulated for selected cross sections and are shown in Table 23, “Floodway Data.”

All floodways that were developed for this Flood Risk Project are shown on the FIRM using the symbology described in Figure 3. In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary has been shown on the FIRM. For information about the delineation of floodways on the FIRM, refer to Section 6.3.

2.3 Base Flood Elevations

The hydraulic characteristics of flooding sources were analyzed to provide estimates of the elevations of floods of the selected recurrence intervals. The BFE is the elevation of the 1-percent-annual-chance flood. These BFEs are most commonly rounded to the whole foot, as shown on the FIRM, but in certain circumstances or locations they may be rounded to 0.1 foot. Cross section lines shown on the FIRM may also be labeled with the BFE rounded to 0.1 foot. Whole-foot BFEs derived from engineering analyses that apply to coastal areas, areas of ponding, or other static areas with little elevation change may also be shown at selected intervals on the FIRM.

BFEs are primarily intended for flood insurance rating purposes. Cross sections with BFEs shown on the FIRM correspond to the cross sections shown in the Floodway Data table and Flood Profiles in this FIS Report. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS Report in conjunction with the data shown on the FIRM. For example, the user may use the FIRM to determine the stream station of a location of interest and then use the profile to determine the 1-percent annual chance elevation at that location. Because only selected cross sections may be shown on the FIRM for riverine areas, the profile should be used to obtain the flood elevation between mapped cross sections. Additionally, for riverine areas, whole-foot elevations shown on the FIRM may not exactly reflect the elevations derived from the hydraulic analyses; therefore, elevations obtained from the profile may more accurately reflect the results of the hydraulic analysis.

2.4 Non-Encroachment Zones

This section is not applicable to this Flood Risk Project.

2.5 Coastal Flood Hazard Areas

For most areas along rivers, streams, and small lakes, BFEs and floodplain boundaries are based on the amount of water expected to enter the area during a 1-percent-annual-chance flood and the geometry of the floodplain. Floods in these areas are typically caused by runoff from storm events. However, for areas on, or near, the Great Lakes, ocean coasts, large rivers, or other large bodies of water, the BFE and floodplain boundaries may be based on additional components that include storm surge and wave dynamics.

Coastal flooding sources that are included in this Flood Risk Project are shown in Table 2.

2.5.1 Water Elevations and the Effects of Waves

Specific terminology is used in coastal analyses to indicate which components have been included in evaluating flood hazards.

The stillwater elevation (SWEL or still water level) is the surface of the water resulting from astronomical tides, storm surge, and freshwater inputs, but excluding wave setup contribution or the effects of waves.

- *Astronomical tides* are periodic rises and falls in large bodies of water caused by the rotation of the earth and by the gravitational forces exerted by the earth, moon and sun. Tidal-induced fluctuations in the Great Lakes are small and their presence is masked by the normal fluctuations due to atmospheric forcing. The Great Lakes can be treated as if no tidal signal exists, and this contribution to water levels is neglected.
- *Storm surge, inclusive of wind setup and seiche-induced fluctuation,* is the additional water depth that occurs during large storm events. These events can bring air pressure changes and strong winds that force water up against the shore. The most common cause of a large seiche in the Great Lakes is the oscillating water level after a storm that moves over the lake, with the downwind portion of

the lake subject to wind setup as water piles up against the coast and the upwind portion subject to a decrease in water levels.

- *Freshwater inputs* include rainfall that falls directly on the body of water, runoff from surfaces and overland flow, and inputs from rivers.

The 1-percent-annual-chance stillwater elevation is the stillwater elevation that has been calculated for a storm surge from a 1-percent-annual-chance storm. The 1-percent-annual-chance storm surge can be determined from analyses of water level station records, statistical study of regional historical storms, or other modeling approaches. Stillwater elevations for storms of other frequencies can be developed using similar approaches.

The total stillwater elevation (also referred to as the mean water level) is the stillwater elevation plus wave setup contribution but excluding the other effects of waves, such as wave runup and overland wave propagation.

- *Wave setup* is the increase in stillwater elevation at the shoreline caused by the breaking of waves in shallow water. It occurs as breaking wave momentum is transferred to the water column.

Like the stillwater elevation, the total stillwater elevation is based on a storm of a particular frequency, such as the 1-percent-annual-chance storm. Wave setup is typically estimated using standard engineering practices or calculated using models, since water level stations are often located in areas sheltered from wave action and do not capture wave height or wave setup information.

Coastal analyses may examine the effects of overland waves by analyzing storm-induced erosion, overland wave propagation, wave runup, and/or wave overtopping.

- *Storm-induced erosion* is the modification of existing topography by erosion caused by a specific storm event, as opposed to long-term erosion that occurs over time.
- *Overland wave propagation* describes the combined effects of variation in ground elevation, vegetation, and physical features on wave characteristics as waves move onshore.
- *Wave runup* is the uprush of water from wave action on a shore barrier. It is a function of the roughness and geometry of the shoreline at the point where the stillwater elevation intersects the land, as shown in Figure 5a.
- *Wave overtopping* refers to the flooding that occurs when wave runup passes over the crest of a barrier, as shown in Figure 5b.

Figure 5a: Wave Runup Transect Schematic

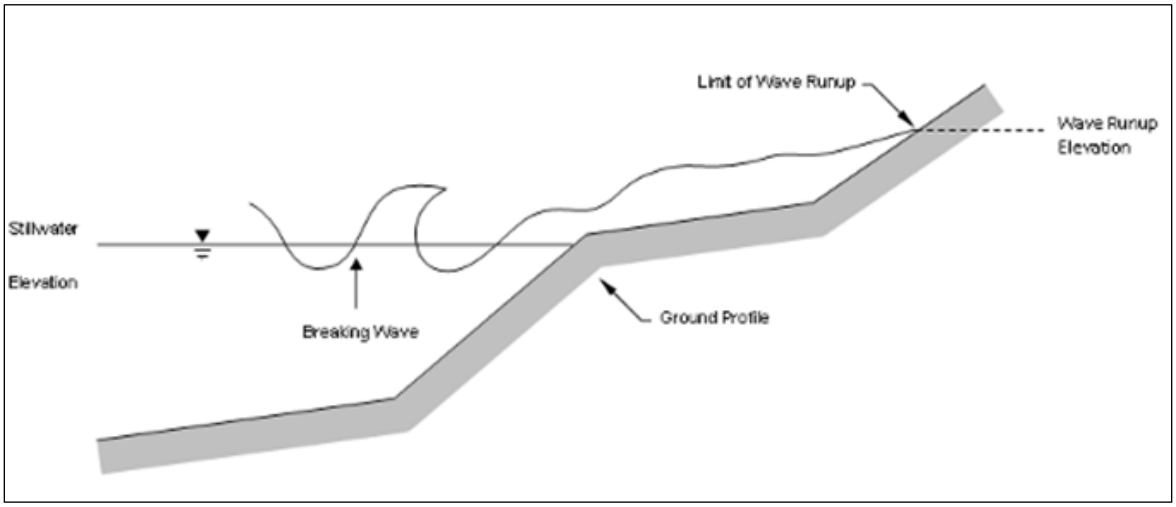


Figure 5b: Wave Overtopping Schematic

2.5.2 Floodplain Boundaries and BFEs for Coastal Areas

For coastal communities along the Atlantic and Pacific Oceans, the Gulf of Mexico, the Great Lakes, and the Caribbean Sea, flood hazards must take into account how storm surges, waves, and in some cases extreme tides or lake level variations interact with factors such as topography, structures, and vegetation. Storm surge and waves must also

be considered in assessing flood risk for certain communities on rivers or large inland bodies of water.

Beyond areas that are affected by storm surge and waves, coastal communities can also have riverine floodplains with designated floodways, as described in previous sections.

Floodplain Boundaries

In many coastal areas, storm surge is the principle component of flooding. The extent of the 1-percent-annual-chance floodplain in these areas is derived from the stillwater elevation for the 1-percent-annual-chance storm. The methods used for calculation of stillwater elevations for coastal areas are described in Section 5.3 of this FIS Report.

In areas dominated by overland wave propagation, the coastal BFEs represent the wave dissipation and generation as the wave propagates landward from the shoreline. The landward extent of the 1-percent-annual-chance floodplain is determined by the stillwater elevation with the addition of wave setup, where applicable. The methods used for calculation of wave setup and overland wave propagation are described in Section 5.3 of this FIS Report.

In some areas, the 1-percent-annual-chance floodplain is determined based on the limit of wave runup or wave overtopping for the 1-percent-annual-chance storm surge. The Special Flood Hazard Area (SFHA) extent is determined based on the elevation of the land in relation to the wave runup elevation or the amount of wave overtopping. For areas dominated by wave runup, the coastal BFE can vary from reach to reach. Where wave runup exceeds the crest of a coastal feature, the SFHA extent is determined by the limit of the overtopping zone. The methods that were used for calculation of wave runup and overtopping hazards are described in Section 5.3 of this FIS Report.

Table 25 presents the types of coastal analyses that were used in mapping the 1-percent-annual-chance floodplain in coastal areas.

Coastal BFEs

Coastal BFEs are calculated as the stillwater elevation for the 1-percent-annual-chance storm plus the additional flood hazard from wave effects (storm-induced erosion, wave setup, overland wave propagation, wave runup, and wave overtopping).

Where they apply, coastal BFEs are calculated along transects extending from offshore to the limit of coastal flooding onshore. Results of these analyses are accurate until local topography, vegetation, or development type and density within the community undergoes major changes.

Parameters that were included in calculating coastal BFEs for each transect included in this FIS Report are presented in Table 16, “Coastal Transect Parameters.” The locations of transects are shown in Figure 9, “Transect Location Map.” More detailed information about the methods used in coastal analyses and the results of intermediate steps in the coastal analyses are presented in Section 5.3 of this FIS Report. Additional information on specific mapping methods is provided in Section 6.4 of this FIS Report.

2.5.3 Coastal High Hazard Areas

Certain areas along the open coast and other areas may have higher risk of experiencing structural damage caused by wave action and/or high-velocity water during the 1-percent-annual-chance flood. These areas will be identified on the FIRM as Coastal High Hazard Areas.

- *Coastal High Hazard Area (CHHA)* is a SFHA extending from offshore to the inland limit of the primary frontal dune (PFD) or any other area subject to damages caused by wave action and/or high-velocity water during the 1-percent-annual-chance flood.
- *Primary Frontal Dune (PFD)* is a continuous or nearly continuous mound or ridge of sand with relatively steep slopes immediately landward and adjacent to the beach. The PFD is subject to erosion and overtopping from high tides and waves during major coastal storms.

The landward limit of the PFD occurs at a point where there is a distinct change from a relatively steep slope to a relatively mild slope; this point represents the landward extension of Zone VE.

CHHAs are designated as “VE” zones (for “velocity wave zones”) and are subject to more stringent regulatory requirements and a different flood insurance rate structure. BFEs are assigned to Zones VE on the FIRM. More detailed information about the identification and designation of Zone VE is presented in Section 6.4 of this FIS Report.

Areas that are not within the CHHA but are SFHAs may still be impacted by coastal flooding and damaging waves; these areas are shown as “AE” zones on the FIRM.

Figure 6a, “Coastal Transect Schematic (Wave Runup and Overtopping),” illustrates the relationship between the base flood elevation, the 1-percent-annual-chance stillwater elevation, and the ground profile as well as the location of the Zone VE and Zone AE/AO in areas subject to wave runup and overtopping.

Figure 6a: Coastal Transect Schematic (Wave Runup and Overtopping)

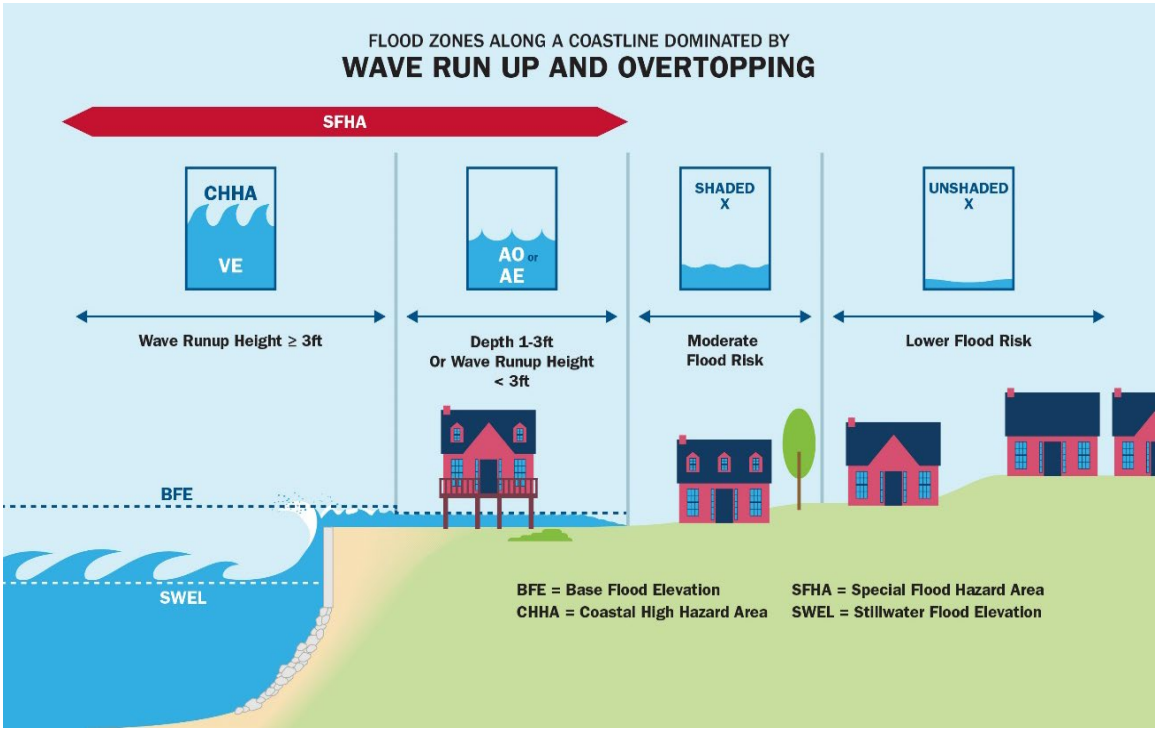
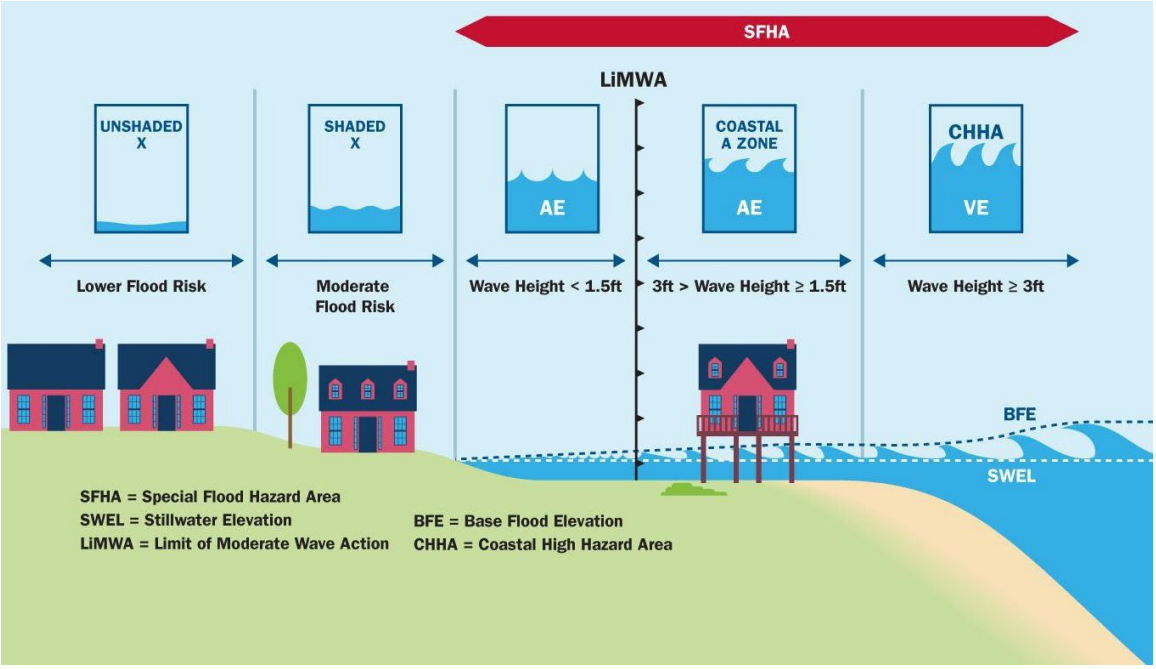


Figure 6b, “Coastal Transect Schematic (Overland Wave Propagation),” illustrates the relationship between the base flood elevation, the 1-percent-annual-chance stillwater elevation, and the ground profile as well as the location of the Zone VE and Zone AE in areas subject to overland wave propagation. This figure also illustrates energy dissipation and regeneration of a wave as it moves inland.

Figure 6b: Coastal Transect Schematic (Overland Wave Propagation)



Methods used in coastal analyses in this Flood Risk Project are presented in Section 5.3 and mapping methods are provided in Section 6.4 of this FIS Report.

Coastal floodplains are shown on the FIRM using the symbology described in Figure 3, "Map Legend for FIRM." The BFE mapped on the FIRM at the shoreline is determined by the 1-percent-annual-chance total water elevation, which includes the stillwater elevation plus wave effects. The 1-percent-annual-chance total water elevations are included in Table 16, along with the statistical stillwater elevations. If the BFE on the FIRM is higher than the stillwater elevations shown in Table 16 due to the presence of wave effects, the higher elevation should be used for construction and/or floodplain management purposes.

2.5.4 Limit of Moderate Wave Action

Laboratory tests and field investigations have shown that wave heights as little as 1.5 feet can cause damage to and failure of typical Zone AE building construction. Wood-frame, light gage steel, and masonry walls on shallow footings or slabs are subject to damage when exposed to waves less than 3 feet in height. Other flood hazards associated with coastal waves (floating debris, high velocity flow, erosion, and scour) can also damage Zone AE construction.

Therefore, a LiMWA boundary may be shown on the FIRM as an informational layer to assist coastal communities in safe rebuilding practices. The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave. The location of the LiMWA relative to Zone VE and Zone AE is shown in Figure 6b.

The effects of wave hazards in Zone AE between Zone VE (or the shoreline where Zone VE is not identified) and the LiMWA boundary are similar to, but less severe than, those in Zone VE where 3-foot or greater breaking waves are projected to occur during the 1-percent-annual-chance flooding event. Communities are therefore encouraged to adopt

and enforce more stringent floodplain management requirements than the minimum NFIP requirements in areas lakeward of the LiMWA. The NFIP Community Rating System provides credits for these actions.

In areas where wave runup elevations dominate over wave crest elevations (Figure 6a), the LiMWA should not be shown on the FIRM. Examples of runup dominated areas include shorelines with steeply sloped beaches, bluffs, or flood protection structures that lie parallel to the shore. Similarly, in areas where the Zone VE designation is based on the presence of a PFD or wave overtopping, the LiMWA is not shown on the FIRM.

The LiMWA was not applicable for any transects within this county.

SECTION 3.0 – INSURANCE APPLICATIONS

3.1 National Flood Insurance Program Insurance Zones

For flood insurance applications, the FIRM designates flood insurance rate zones as described in Figure 3, “Map Legend for FIRM.” Flood insurance zone designations are assigned to flooding sources based on the results of the hydraulic or coastal analyses. Insurance agents use the zones shown on the FIRM and depths and base flood elevations in this FIS Report in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

The 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (e.g. Zones A, AE, V, VE, etc.), and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of additional flood hazards.

Table 3 lists the flood insurance zones in Berrien County.

Table 3: Flood Zone Designations by Community

Community	Flood Zone(s)
Bainbridge, Township of	X
Baroda, Township of	A, X
Baroda, Village of	X
Benton, Charter Township of	A, AE, VE, X
Benton Harbor, City of	A, AE, VE, X
Berrien, Township of	A, AE, X
Berrien Springs, Village of	A, X
Bertrand, Township of	A, AE, X
Bridgman, City of	AE, AH, VE, X
Buchanan, City of	A, AE, X
Buchanan, Township of	A, AE, X
Chikaming, Township of	A, AE, VE, X
Coloma, Charter Township of	A, AE, X
Coloma, City of	AE, X
Eau Claire, Village of	X

Table 3: Flood Zone Designations by Community *(continued)*

Community	Flood Zone(s)
Galien, Township of	A, X
Galien, Village of	X
Grand Beach, Village of	A, AE, VE, X
Hagar, Township of	A, AE, AH, VE, X
Lake, Charter Township of	A, AE, AO, VE, X
Lincoln, Charter Township of	A, AE, VE, X
Michiana, Village of	AE, VE, X
New Buffalo, City of	A, AE, AO, VE, X
New Buffalo, Township of	A, AE, VE, X
Niles, Charter Township of	A, AE, X
Niles, City of	A, AE, X
Oronoko, Charter Township of	A, AE, X
Pipestone, Township of	A, X
Royalton, Township of	A, AE, X
Shoreham, Village of	AE, VE, X
Sodus, Township of	A, AE, X
St. Joseph, Charter Township of	A, AE, X
St. Joseph, City of	A, AE, VE, X
Stevensville, Village of	A, X
Three Oaks, Township of	A, X
Three Oaks, Village of	X
Watervliet, Charter Township of	A, AE, X
Watervliet, City of	A, AE, X
Weesaw, Township of	A, X

SECTION 4.0 – AREA STUDIED

4.1 Basin Description

Table 4 contains a description of the characteristics of the HUC-8 sub-basins within which each community falls. The table includes the main flooding sources within each basin, a brief description of the basin, and its drainage area.

Table 4: Basin Characteristics

HUC-8 Sub-Basin Name	HUC-8 Sub-Basin Number	Primary Flooding Source	Description of Affected Area	Drainage Area (square miles)
Black-Macatawa	04050002	Black River	Stretches along the coastline for northern portions of Berrien County	608
Kankakee	07120001	Little Kankakee River	Effects a small portion of the southern inland boundary of Berrien County	3,031
Lake Michigan	04060200	Lake Michigan	Contains the western areas of the county along the coastline	22,488
Little Calumet-Galien	04040001	Galena River	Stretches along the coastline for southern portions of Berrien County	689
St. Joseph	04050001	North Branch Black River	Just inland of Lake Michigan, this basin covers a majority of the County	4,715

4.2 Principal Flood Problems

Table 5 contains a description of the principal flood problems that have been noted for Berrien County by flooding source.

Table 5: Principal Flood Problems

Flooding Source	Description of Flood Problems
Bedortha Drain	In the 1980's in the City of Bridgman, high water was observed on Bedortha Drain upstream of Red Arrow Highway.
Lake Michigan	Lake Michigan shoreline erosion is a problem in the Charter Townships of Benton, Lake, and Lincoln, in the Cities of New Buffalo and St. Joseph, in the Townships of Chikaming and New Buffalo, and in the Villages of Grand Beach and Michiana. This problem is accentuated during periods of high lake levels.
Ox Creek	Major floods occurred on Ox Creek in 1937 and 1943. Major flooding occurred again in April 1947, inundating several streets in the downtown area of Benton Harbor. In 1949 and 1950, Ox Creek was widened and deepened from its confluence with the Paw Paw River upstream to North Shore Drive. However, in 1950, major flooding occurred again, inundating streets and flooding several buildings in downtown Benton Harbor. In the period from 1950 to 1952, numerous improvements were made in the Ox Creek channel and most of the culverts were enlarged. Since that time, there has been no serious flooding on Ox Creek.

Table 5: Principal Flood Problems *(continued)*

Flooding Source	Description of Flood Problems
Paw Paw River	A major flood occurred on the Paw Paw River in April 1947 when about 5.1 inches of rainfall was recorded in both Benton Harbor and Paw Paw River basins. The USGS determined the peak discharge to be approximately 4,800 cubic feet per second. Major property damage occurred around Paw Paw Lake and in Benton Harbor. Ice jams have occurred on Paw Paw River, with possibly the worst case occurring in January 1969, which caused high water in the City of Benton Harbor. It also caused flooding in the northwestern areas of the Charter Township of Benton along the river. This storm raised the level of Paw Paw Lake to 627.10 NGVD, which is 6.13 feet above the lowest level of record occurring on April 15, 1941. Lake levels of 627.10 feet NGVD elevation caused flooding of the foundations of 84 cottages, interfered with septic tank operation, and subjected wells to the possibility of pollution. Other major floods which caused property damage in the general area occurred in 1943 and 1950. Large storm events occurred in the watershed in 1895, 1914, 1918, 1941, 1975, 1986, and 1997.
St. Joseph River	Flooding has occurred several times on the St. Joseph River. A USACE's report states that major floods occurred in 1876, 1887, 1892, 1903, and 1904. In addition to these floods the USACE Survey Report on Flood Control states that major floods also occurred in 1908, 1937, 1943, 1947, and 1950. The maximum flow of the April 4, 1950 flood was approximately 20,560 cubic feet per second. Ice jams on the St. Joseph River have caused flooding two or three times in the past century. A destructive jam occurred in the 1930's at the Michigan Central Railroad Bridge. The structure was removed in 1975. In the Township of Sodus, the 1950 flood caused a washout on River Road that swept approximately 20 feet of pavement over the sheer river bluff. Rushing water from nearby fields cut a gully ranging from 25 to 30 feet in depth through the roadway at this location. Other factors contributing to the flooding of the St. Joseph River are rainfall and rainfall in combination with spring snowmelt. Also, approximately 3.3 miles of the St. Joseph River are under the influence of Lake Michigan flood elevations. In the Township of Royalton, flooding from the St. Joseph River and Yellow Creek in 1950 washed out Highway 139 at a point 0.5 mile south of Somerlayton Bridge over St. Joseph River. In March 1976, properties were flooding along Linden and Derfla Drives in the northern portion of the township. A relatively recent historical high-water mark for the St. Joseph river was recorded in March 1982 in the City of Niles. The flood was estimated to have a recurrence interval of less than 50 years. Damages caused by the flood event included inundation of over 25 residences, several businesses, the hospital, and the wastewater treatment plant in Niles.

Table 5: Principal Flood Problems *(continued)*

Flooding Source	Description of Flood Problems
Tanner Creek	In the 1980's in the City of Bridgman, Lake Street experienced flooding problems from Tanner Creek. At the time of the flooding, there was a restrictive culvert, which has since been replaced.
White Creek - West Branch	A U.S. Army Corps of Engineers' (USACE) report states that major floods occurred in 1876, 1887, 1892, 1903 and 1904. In addition to these floods, the USACE Survey Report on Flood Control states that major floods also occurred in 1908, 1937, 1943, 1947 and 1950. Ice jams on the St. Joseph River have caused flooding two or three times in the past century. A destructive jam occurred in the 1930s at the Michigan Central Railroad Bridge.

Table 6 contains information about historic flood elevations in the communities within Berrien County.

Table 6: Historic Flooding Elevations

Flooding Source	Location	Historic Peak (Feet NAVD88)	Event Date	Approximate Recurrence Interval (years)	Source of Data
Lake Michigan	Calumet Harbor, IN Gage (master gage for southern Lake Michigan)	581.7	07/19/1970	*	NOAA Gage
Lake Michigan	Calumet Harbor, IN Gage (master gage for southern Lake Michigan)	584.2	07/23/1971	*	NOAA Gage
Lake Michigan	Calumet Harbor, IN Gage (master gage for southern Lake Michigan)	583.0	11/14/1972	*	NOAA Gage
Lake Michigan	Calumet Harbor, IN Gage (master gage for southern Lake Michigan)	582.9	04/25/1973	*	NOAA Gage
Lake Michigan	Calumet Harbor, IN Gage (master gage for southern Lake Michigan)	582.8	06/17/1973	*	NOAA Gage
Lake Michigan	Calumet Harbor, IN Gage (master gage for southern Lake Michigan)	582.8	05/16/1973	*	NOAA Gage
Lake Michigan	Calumet Harbor, IN Gage (master gage for southern Lake Michigan)	583.1	02/22/1974	*	NOAA Gage

***** Data not provided

Table 6: Historic Flooding Elevations *(continued)*

Flooding Source	Location	Historic Peak (Feet NAVD88)	Event Date	Approximate Recurrence Interval (years)	Source of Data
Lake Michigan	Calumet Harbor, IN Gage (master gage for southern Lake Michigan)	582.7	06/22/1974	*	NOAA Gage
Ox Creek	Main Street	586.0	03/31/1949	*	*
Ox Creek	North Shore Drive	580.7	03/31/1949	*	*
Ox Creek	Main Street	584.0	12/22/1949	*	*
Ox Creek	North Shore Drive	579.2	12/22/1949	*	*
Ox Creek	Main Street	583.3	04/04/1950	*	*
Ox Creek	North Shore Drive	580.3	04/04/1950	*	*
Ox Creek	Main Street	588.4	04/24/1950	*	*
Ox Creek	North Shore Drive	583.6	04/24/1950	*	*
Ox Creek	Main Street	585.3	04/25/1950	*	*
Ox Creek	North Shore Drive	581.4	04/25/1950	*	*
Paw Paw Lake	City of Benton Harbor	626.7	01/01/1969	*	*
Paw Paw River	In the vicinity of the Riverside, MI, gaging station, near the Coloma Road Bridge	597.1	01/23/1952	*	USGS Gage
Paw Paw River	In the vicinity of the Riverside, MI, gaging station, near the Coloma Road Bridge	597.7	02/06/1968	*	USGS Gage
Paw Paw River	In the vicinity of the Riverside, MI, gaging station, near the Coloma Road Bridge	597.9	01/04/1973	*	USGS Gage
St. Joseph River	Main Street	579.7	04/04/1950	*	USACE Report
St. Joseph River	Interstate 94 Bridge	591.3	04/05/1950	*	USACE Report
St. Joseph River	U.S. Highway 31 Bridge	592.0	04/05/1950	*	USACE Report
St. Joseph River	Main Street	582.8	06/17/1973	*	USACE Report
St. Joseph River	Main Street	582.7	06/22/1974	*	USACE Report
St. Joseph River	Interstate 94 Bridge	586.7	03/06/1976	*	USACE Report
St. Joseph River	U.S. Highway 31 Bridge	587.8	03/06/1976	*	USACE Report

***** Data not provided

4.3 Dams and Other Flood Hazard Reduction Measures

Table 7 contains information about non-levee flood hazard reduction measures within Berrien County such as dams or jetties. Levee systems are addressed in Section 4.4 of this FIS Report.

Table 7: Dams and Other Flood Hazard Reduction Measures

Flooding Source	Structure Name	Type of Measure	Location	Description of Measure
Lake Michigan	Thandlewane Path	Seawall	Approximately 590 feet west of the intersection of Lakeshore Drive and Orleans Circle	Reduces coastal erosion and flood hazards from Lake Michigan
Lake Michigan	Lakeshore Drive	Seawall	Approximately 290 feet northwest of the intersection of Ravine Drive and Highland Drive	Reduces coastal erosion and flood hazards from Lake Michigan
Paw Paw River	Paw Paw Lake Level Control Structure	Dam	Charter Township of Watervliet	Lake level control structure for Paw Paw Lake on the Paw Paw River in the Charter Township of Watervliet
Paw Paw River	Operation Foresight Temporary Flood Protection Measure	Dam	North side of Graham Street, west of the Paw Paw River	Temporary flood protection measure is part of Operation Foresight in the City of Benton Harbor; the program is sponsored by the USACE.
Paw Paw River	Operation Foresight Temporary Flood Protection Measure	Dam	West of Riverview Drive on the drainage canal north of Main Street	Temporary flood protection measure is part of Operation Foresight in the City of Benton Harbor; the program is sponsored by the USACE.
St. Joseph River	French Paper Company Dam	Dam	In the City of Niles approximately 1,600 feet downstream of the confluence of West Tributary / St. Joseph River	Built in 1914, the dam consists of a 320-foot long concrete spillway with timber flashboards and connecting earth embankments. Crest elevation with the boards up is 653.3 feet (NAVD) and with the boards down is 651.0 feet (NAVD). Although the primary purpose of the dam appears to be power generation, the structure also serves to attenuate flood peaks through storage in the upstream channel.

Table 7: Dams and Other Flood Hazard Reduction Measures *(continued)*

Flooding Source	Structure Name	Type of Measure	Location	Description of Measure
St. Joseph River	Operation Foresight Temporary Flood Protection Measure	Dam	Around the marina complex on the St. Joseph River shore of Radio Island	Temporary flood protection measure is part of Operation Foresight in the City of St. Joseph; the program is sponsored by the USACE.
St. Joseph River	Operation Foresight Temporary Flood Protection Measure	Dam	Around the office building and transmitter of Radio Station WSJM on Radio Island	Temporary flood protection measure is part of Operation Foresight in the City of St. Joseph; the program is sponsored by the USACE.
St. Joseph River	Operation Foresight Temporary Flood Protection Measure	Dam	Around the Shell Oil Corporation yard office on Radio Island	Temporary flood protection measure is part of Operation Foresight in the City of St. Joseph; the program is sponsored by the USACE.
St. Joseph River	Operation Foresight Temporary Flood Protection Measure	Dam	Northern shore of the ship turning basin on the St. Joseph River between US Highway 33 and the Chesapeake and Ohio Railroad bridge	Temporary flood protection measure is part of Operation Foresight in the City of St. Joseph; the program is sponsored by the USACE.
White Creek – West Branch	Chickagami Trail	Culvert	3923 Feet Above Confluence with Lake Michigan	Culvert

4.4 Levee Systems

For purposes of the NFIP, FEMA only recognizes levee systems that meet, and continue to meet, minimum design, operation, and maintenance standards that are consistent with comprehensive floodplain management criteria. The Code of Federal Regulations, Title 44, Section 65.10 (44 CFR 65.10) describes the information needed for FEMA to determine if a levee system reduces the flood hazard from the 1-percent-annual-chance flood. This information must be supplied to FEMA by the community or other party when a flood risk study or restudy is conducted, when FIRMs are revised, or upon FEMA request. FEMA reviews the information for the purpose of establishing the appropriate flood hazard zone.

Levee systems that are determined to reduce the hazard from the 1-percent-annual-chance flood are accredited by FEMA. FEMA can also grant provisional accreditation to a levee system that was previously accredited on an effective FIRM and for which FEMA is awaiting data and/or documentation to demonstrate compliance with 44 CFR 65.10. These

levee systems are referred to as Provisionally Accredited Levees, or PALs. Provisional accreditation provides communities and levee owners with a specified timeframe to obtain the necessary data to confirm the levee system's accreditation status. Accredited levee systems and PALs are shown on the FIRM using the symbology shown in Figure 3. If the required information for a PAL is not submitted within the required timeframe, or if information indicates that a levee system no longer meets 44 CFR 65.10, FEMA will consider the levee system as non-accredited and issue an effective FIRM showing the levee-impacted area as a SFHA or Zone D.

FEMA coordinated with the USACE, the local communities, and other organizations to compile a list of levee systems that exist within Flood County. Table 8**.**, "Levee Systems," lists all accredited levee systems, PALs, and non-accredited levee systems shown on the FIRM for this FIS Report. Other categories of levees may also be included in the table. The Levee ID shown in this table may not match numbers based on other identification systems that were listed in previous FIS Reports. Levee systems identified in the table are displayed on the FIRM with notes to users to indicate their flood hazard mapping status.

Please note that the information presented in Table 8**.** is subject to change at any time. For that reason, the latest information regarding the levee systems presented in the table may be obtained by accessing the National Levee Database. For additional information, contact the levee owner/sponsor or the local community shown in Table 30.

Please note that FEMA has identified levee systems in this jurisdiction that have not been demonstrated by the community or levee owner to meet the requirements of 44 CFR 65.10 of the NFIP regulations as it relates to the levee system's capacity to provide 1-percent-annual-chance flood hazard reduction. As such, the existing flood hazard analysis in the affected areas has been carried forward from the previously-printed effective FIRM panel(s) and the area has been clearly identified on the FIRM panel with notes and bounding lines. This has been done to inform users that a temporary mapping action has been put in place until such time as FEMA is able to initiate a new flood risk project to apply new flood hazard mapping procedures for leveed areas. These levees occur on FIRM panel(s) 26021C0034C, on the Paw Paw River, and are identified on the FIRM panel(s) as potential areas of flood hazard data changes based on further review. Levees and their accreditation status are listed in Table 8. of this FIS Report.

Table 8: Levee Systems

Community	Flooding Source(s)	NLD Levee System ID	NLD Levee System Name	Levee System Status on Effective FIRM	FIRM Panel(s)	Levee Owner(s) / Sponsor(s)
Watervliet, City of	Paw Paw River	2705000006	Paw Paw River	Non-Accredited	26021C0034C	Berrien County

SECTION 5.0 – ENGINEERING METHODS

For the flooding sources in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded at least once on the average during any 10-, 25-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 25-, 50-, 100-, and 500-year floods, have a 10-, 4-, 2-, 1-, and 0.2-percent-annual-chance, respectively, of being equaled or exceeded during any year.

Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 100-year flood (1-percent chance of annual exceedance) during the term of a 30-year mortgage is approximately 26 percent (about 3 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

5.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak elevation-frequency relationships for floods of the selected recurrence intervals for each flooding source studied. Hydrologic analyses are typically performed at the watershed level. Depending on factors such as watershed size and shape, land use and urbanization, and natural or man-made storage, various models or methodologies may be applied. A summary of the hydrologic methods applied to develop the discharges used in the hydraulic analyses for each stream is provided in Table 12. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation.

A summary of the discharges is provided in Table 9. Frequency Discharge-Drainage Area Curves used to develop the hydrologic models may also be shown in Figure 7 for selected flooding sources. A summary of stillwater elevations developed for non-coastal flooding sources is provided in Table 10. (Coastal stillwater elevations are discussed in Section 5.3 and shown in Table 16.) Stream gage information is provided in Table 11.

Table 9: Summary of Discharges

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Bedortha Drain	At confluence with William & Esseg Drain	1.7	110	*	140	160	240
Bedortha Drain	Upstream of Red Arrow Highway	1.6	130	*	210	250	350
Bedortha Drain	Upstream of Bridgman City Drain	0.6	80	*	120	140	190
Bedortha Drain	Downstream of Railroad	0.3	60	*	90	100	140
Bedortha Drain	Upstream of Railroad	0.2	90	*	170	220	320
Bridgman City Drain	At confluence with Bedortha Drain	0.7	60	*	100	120	170
Bridgman City Drain	Railroad crossing outflow	0.5	30	*	47	50	53
Bridgman City Drain	Upstream railroad crossing	0.5	50	*	120	160	250
Dowagiac River	At confluence with St. Joseph River	288	1,270	*	1,490	1,580	1,800
Galien River	Confluence with Lake Michigan	170	3,714	*	5,364	5,836	6,551
Galien River	Red Arrow Highway Bridge	168	3,879	*	5,554	6,034	6,767
Glenlord Road Drain (North Branch)	At confluence with Glenlord Road Drain (South Branch)	0.7	42	*	90	105	145
Glenlord Road Drain (North Branch)	Glenlord Road	0.3	25	*	50	58	71
Glenlord Road Drain (North Branch)	Washington Avenue	0.1	13	*	23	27	36
Glenlord Road Drain (South Branch)	At confluence with Parker / Richardson Drain	1.5	105	*	180	205	265
Glenlord Road Drain (South Branch)	Upstream of confluence with Glenlord Road Drain (North Branch)	0.7	80	*	130	155	200
Glenlord Road Drain (South Branch)	Washington Avenue	0.6	74	*	125	145	190
Goodrow Drain	At confluence with Hickory Creek	0.8	53	*	90	105	130
Goodrow Drain	485 feet upstream of Echo Ridge Road	0.5	41	*	74	87	115
Goodrow Drain	1,400 feet upstream of Ponderosa	0.2	18	*	33	40	53

Table 9: Summary of Discharges *(continued)*

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Granger Drain	Upstream of confluence with Paw Paw River	2.7	98	*	135	140	155
Granger Drain	Downstream of confluence with Granger Drain Tributary	2.2	100	*	130	135	150
Granger Drain	Upstream of confluence with Granger Drain Tributary	1.3	67	*	85	89	98
Granger Drain	C&O Railroad (inflow)	1.1	68	*	125	150	195
Granger Drain	C&O Railroad (outflow)	1.1	62	*	76	79	85
Granger Drain	1,350 feet upstream of Pier Road	0.9	64	*	115	135	175
Granger Drain	Coloma Road	0.4	39	*	66	75	95
Granger Drain Tributary	Upstream of confluence with Granger Drain	0.9	38	*	46	48	52
Granger Drain Tributary	C&O Railroad (inflow)	0.8	68	*	105	115	140
Granger Drain Tributary	C&O Railroad (outflow)	0.8	35	*	41	43	46
Granger Drain Tributary	Coloma Road	0.5	46	*	61	63	66
Hickory Creek	Just upstream of confluence with St. Joseph River	52	1,438	*	2,334	2,678	3,416
Hickory Creek	Charter Township of St. Joseph southern corporate limit	47	1,420	*	2,265	2,588	3,280
Hickory Creek	Maiden Lane	46	1,430	*	2,265	2,585	3,275
Hickory Creek	I-94	45	1,440	*	2,270	2,585	3,265
Hickory Creek	Marquette Woods Road	37	1,190	*	1,870	2,130	2,680
Hickory Creek	John Beers Road	35	1,200	*	1,865	2,120	2,665
Hickory Creek	Rocky Weed Road	34	1,200	*	1,875	2,130	2,675
McCoy Creek	At the confluence with St. Joseph River	18	505	*	825	950	1,290
McCoy Creek	Upstream of the Schirmer Parkway	13	410	*	670	780	1,065

Table 9: Summary of Discharges *(continued)*

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
McCoy Creek	At McCoy-Mill Race Junction	12	350	*	570	665	915
McCoy Creek	At Bakertown Road	11	325	*	535	620	855
Ox Creek	Confluence with Paw Paw River	14	460	*	800	920	1,220
Ox Creek	Britain Avenue	12	400	*	730	855	1,145
Ox Creek	400 feet downstream of Napier Avenue	6.5	230	*	415	490	655
Parker/Richardson Drain	At confluence with Hickory Creek	7.3	380	*	630	725	890
Parker/Richardson Drain	Upstream of confluence with Glenlord Road Drain (South Branch)	5.4	275	*	420	475	585
Parker/Richardson Drain	1,300 feet upstream of Marquette Woods Road	4.4	240	*	370	415	515
Parker/Richardson Drain	1,300 feet downstream of Cleveland Avenue	0.6	56	*	97	110	125
Parker/Richardson Drain	Cleveland Avenue	0.4	44	*	78	92	120
Paw Paw River	Mouth at St. Joseph River	437	2,560	*	4,200	4,880	7,930
St. Joseph River	Benton Harbor	4,230	17,630	*	21,620	23,280	27,240
St. Joseph River	Charter Township of Benton	4,182	17,490	*	21,510	23,190	27,160
St. Joseph River	At Charter Township of St. Joseph eastern corporate limit	4,150	17,490	*	21,510	23,190	27,160
St. Joseph River	Upstream of confluence with Dowagiac River	3,666	15,700	*	20,200	22,000	26,400
Tanner Creek	Mouth at Lake Michigan	2.9	180	*	300	360	510
Tanner Creek	Downstream of Bedortha Drain	2.7	170	*	290	340	460
Tributary A	At mouth	1.7	110	*	190	220	295
Tributary A	400 feet downstream of Ravenswood Avenue	1.3	100	*	170	195	255
Tributary A	200 feet downstream of Sawyer Road	1.0	89	*	125	140	175

Table 9: Summary of Discharges *(continued)*

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Tributary B	At mouth	2.5	87	*	150	170	215
Tributary B	Confluence with Tributary C	1.8	65	*	105	120	140
Tributary B	Prairie Road	1.6	62	*	100	110	130
Tributary B	Chessie System	1.3	57	*	90	98	110
Tributary C	Confluence with Tributary B	0.6	23	*	47	56	79
West Tributary	At confluence with St. Joseph River	2.6	210	*	340	400	500
White Creek – East Branch	At Township of New Buffalo corporate limits	1.6	20	*	45	55	85
White Creek – East Branch	Red Arrow Highway	1.0	20	*	40	50	70
White Creek – West Branch	Frequency-Discharge Curve (Village of Michiana 1977 FIS)	9.0	280	*	510	600	800
William & Esseg Drain	Upstream of Bedortha Drain	1.0	70	*	140	180	270
William & Esseg Drain	State Police Post Driveway	0.6	30	*	70	90	140
Yellow Creek	Frequency-Discharge Curve (Township of Royalton 1977 FIS)	15	625	*	1,100	1,300	1,750
Yellow Creek	Frequency-Discharge Curve (Township of Royalton 1977 FIS)	8.3	220	*	390	450	625

*Not calculated for this Flood Risk Project

Figure 7: Frequency Discharge-Drainage Area Curves

[Not Applicable to this Flood Risk Project]

Table 10: Summary of Non-Coastal Stillwater Elevations

Flooding Source	Location	Elevations (feet NGVD29)				
		10-Percent Annual Chance	4-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance	0.2-Percent Annual Chance
Paw Paw Lake	Coloma, Charter Township of; Watervliet, Charter Township of	626.9	*	628.6	623.6	631.0

*Not calculated for this Flood Risk Project

Table 11: Stream Gage Information used to Determine Discharges

[Not Applicable to this Flood Risk Project]

5.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Base flood elevations on the FIRM represent the elevations shown on the Flood Profiles and in the Floodway Data tables in the FIS Report. Rounded whole-foot elevations may be shown on the FIRM in coastal areas, areas of ponding, and other areas with static base flood elevations. These whole-foot elevations may not exactly reflect the elevations derived from the hydraulic analyses. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS Report in conjunction with the data shown on the FIRM. The hydraulic analyses for this FIS were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

For streams for which hydraulic analyses were based on cross sections, locations of selected cross sections are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 6.3), selected cross sections are also listed in Table 23, “Floodway Data.”

A summary of the methods used in hydraulic analyses performed for this project is provided in Table 12. Roughness coefficients are provided in Table 13. Roughness coefficients are values representing the frictional resistance water experiences when passing overland or through a channel. They are used in the calculations to determine water surface elevations. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation.

Table 12: Summary of Hydrologic and Hydraulic Analyses

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
All Base (Zone A) Studies	Varies	Varies	Unknown	HEC-RAS Version Unknown (USACE ND1)	09/2004	A	The HEC-RAS version was not provided
Bedortha Drain	Mouth at Tanner Creek	Approximately 1,100 feet north of Rambo Road	HEC-HMS (USACE 1998)	HEC-RAS Version Unknown (USACE ND1)	08/2004	AE with Floodway	The HEC-RAS version was not provided
Bridgman City Drain	Confluence with Bedortha Drain	Approximately 700 feet west of Church Street	HEC-HMS (USACE 1998)	HEC-RAS Version Unknown (USACE ND1)	08/2004	AE with Floodway	The HEC-RAS version was not provided
Dowagiac River	City of Niles western corporate limits	City of Niles northern corporate limits	Drainage Area Weighted Gage Analysis	HEC-2 and WSP-2 (USACE 1984; USDA ND1)	08/1985	AE	Flood discharge was estimated based on the transportation of discharge-frequency data from the USGS Sumnerville, MI Gage (04101800) in Cass County, located upstream of the study area. A proportional ratio of the respective drainage areas was used. The statistical analysis of the recorded flows at the Sumnerville gage was performed by the MDNR in WIR 84-4207.
Galien River	Mouth at Lake Michigan	Approximately 6,000 feet upstream of the Red Arrow Highway Bridge	SCS TR-20 (USDA 1965)	HEC-2 and WSP-2 (USACE 1973; USDA ND1)	05/1978	AE with Floodway	Redelineated between cross sections P and T due to 2017 Lake Michigan coastal study.
Glenlord Road Drain (North Branch)	Mouth at Glenlord Road Drain (South Branch)	Approximately 800 feet north of West Glenorchard Road	Unknown	HEC-2 and WSP-2 (USACE 1973; USDA ND1)	12/1976	AE with Floodway	
Glenlord Road Drain (South Branch)	Mouth at Parker/Richards on Drain	Approximately 560 feet upstream of Washington Avenue	Unknown	HEC-2 and WSP-2 (USACE 1973; USDA ND1)	12/1976	AE with Floodway	

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Goodrow Drain	Approximately 750 upstream of confluence with Hickory Creek	Approximately 1,250 feet upstream of Ponderosa Drive	Unknown	HEC-2 and WSP-2 (USACE 1973; USDA ND1)	12/1976	AE with Floodway	
Granger Drain	Mouth of Paw Paw River	Approximately 1,300 feet west of Pier Road	SCS TR-20 (USDA 1965)	HEC-2 and WSP-2 (USACE 1973; USDA ND1)	10/1976	AE with Floodway	
Granger Drain Tributary	Mouth at Granger Drain	Approximately 1,300 feet south of Coloma Road	SCS TR-20 (USDA 1965)	HEC-2 and WSP-2 (USACE 1973; USDA ND1)	10/1976	AE with Floodway	
Hickory Creek	Mouth at St. Joseph River	Approximately 3,800 feet upstream of Roosevelt Road	SCS TR-20 (USDA 1965)	HEC-2 (USACE 1973)	08/1978	AE with Floodway	
Hickory Creek	Village of Stevensville southern corporate limits	Approximately 2,100 feet south of Johnson Road	SCS TR-20 (USDA1965)	HEC-2 (USACE 1973)	12/1976	AE with Floodway	
Hickory Creek	Approximately 1,100 feet downstream of Stevensville Baroda Road	Approximately 1,250 feet upstream of Stevensville Baroda Road	SCS TR-20 (USDA 1965)	HEC-2 (USACE 1973)	12/1976	AE with Floodway	
Lake Michigan	Van Buren County/Berrien County, MI county boundary	Berrien County, MI/Lake County, IN county boundary	N/A	N/A	08/2017	VE	See details in Section 5.3.
McCoy Creek	Mouth at St. Joseph River	Northeast intersection of Chamberlain Road and Bakertown Road	SCS TR-20 (USDA 1965)	HEC-2 and WSP-2	01/1986	AE	
Ox Creek	City of Benton Harbor / Charter Township of Benton corporate limits	Approximately 2,200 feet south of East Napier Avenue	SCS TR-20 (USDA 1965)	HEC-2 (USACE 1973)	02/1977	AE with Floodway	

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Ox Creek	Mouth at Paw Paw River	Approximately 450 feet upstream of Empire Avenue	SCS TR-20 (USDA 1965)	HEC-2 (USACE 1973)	02/1977	AE with Floodway	Redelineated between cross sections B and D due to 2017 Lake Michigan coastal study.
Parker/Richardson Drain	Mouth at Hickory Creek	Approximately 2,850 feet upstream of W John Beers Road	SCS TR-20 (USDA 1965)	HEC-2 and WSP-2 (USACE 1973; USDA ND1)	12/1976	AE with Floodway	
Paw Paw Lake	N/A	N/A	N/A	N/A	11/1983	AE	Lake elevations were computed with the use of flood routing and rating curves. The 1-percent-annual-chance flood elevation for Paw Paw Lake was taken from a November 1983 USACE report entitled "*Paw Paw Lake Final Detailed Project Report and Final Environmental Impact Statement.*"
Paw Paw River	City of Benton Harbor / Charter Township of Benton corporate limits	Charter Township of Benton / Township of Hagar corporate limits	SCS TR-20 (USDA 1965)	WSP-2 (USDA ND1)	07/1976	AE with Floodway	WSELs were taken from a Flood Hazard Analysis Report by the SCS (SCS, "Flood Hazard Analyses, Paw Paw River, Berrien Co, MI, East Lansing, MI)
Paw Paw River	Mouth at St. Joseph River	Approximately 1,320 feet upstream of confluence with Blue Creek	SCS TR-20 (USDA 1965)	WSP-2 (USDA ND1)	07/1976	AE with Floodway	WSELs were taken from a Flood Hazard Analysis Report by the SCS (SCS, "Flood Hazard Analyses, Paw Paw River, Berrien Co, MI, East Lansing, MI). Redelineated between cross sections D and H due to 2017 Lake Michigan coastal study.
Paw Paw River	Bundy Road at Charter Township of Coloma and Township of Hagar boundary	Charter Township of Coloma / Charter Township of Watervliet corporate limits	SCS TR-20 (USDA 1965)	WSP-2 (USDA ND1)	07/1976	AE	WSELs were taken from a Flood Hazard Analysis Report by the SCS (SCS, "Flood Hazard Analyses, Paw Paw River, Berrien Co, MI, East Lansing, MI)
Paw Paw River	Charter Township of Benton / Township of Hagar corporate limits	Bundy Road at Charter Township of Coloma and Township of Hagar boundary	SCS TR-20 (USDA 1965)	WSP-2 (USDA ND1)	07/1976	AE	WSELs were taken from a Flood Hazard Analysis Report by the SCS (SCS, "Flood Hazard Analyses, Paw Paw River, Berrien Co, MI, East Lansing, MI)

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Paw Paw River	Mouth at St. Joseph River	City of St. Joseph / City of Benton Harbor corporate limits	SCS TR-20 (USDA 1965)	WSP-2 (USDA ND1)	07/1976	AE with Floodway	WSELs were taken from a Flood Hazard Analysis Report by the SCS (SCS, "Flood Hazard Analyses, Paw Paw River, Berrien Co, MI, East Lansing, MI). Redelineated between cross sections D and H due to 2017 Lake Michigan coastal study.
Paw Paw River	Charter Township of Coloma / Charter Township of Watervliet corporate limits	North County Line Road at Berrien County / Van Buren County boundary	SCS TR-20 (USDA 1965)	WSP-2 (USDA ND1)	07/1976	AE	WSELs were taken from a Flood Hazard Analysis Report by the SCS (SCS, "Flood Hazard Analyses, Paw Paw River, Berrien Co, MI, East Lansing, MI)
St. Joseph River	Charter Township of St. Joseph / Charter Township of Benton corporate limits	Charter Township of Benton / Township of Sodus corporate limits	Statistical Analysis (Standard log-Pearson Type III Method) as outlined in Bulletin 15 (USWRC 1967)	HEC-2 (USACE 1973)	02/1977	AE with Floodway	Floodflow-frequency data were based on the statistical analysis of stage-discharge records from two USGS gages: Niles, MI (04101500) and Berrien Springs (04102000).
St. Joseph River	City of St. Joseph / City of Benton Harbor corporate limits	City of Benton Harbor / Charter Township of St. Joseph corporate limits	Statistical Analysis (Standard log-Pearson Type III Method) as outlined in Bulletin 15 (USWRC 1967)	HEC-2 (USACE 1973)	02/1977	AE with Floodway	Floodflow-frequency data were based on the statistical analysis of stage-discharge records from two USGS gages: Niles, MI (04101500) and Berrien Springs (04102000).

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
St. Joseph River	Approximately 600 feet east of Nature Way	Approximately 1,200 feet west of Bond Street	Statistical Analysis (Standard log-Pearson Type III Method) as outlined in Bulletin 15 (USWRC 1967)	HEC-2 (USACE 1973)	08/1985	AE with Floodway	Floodflow-frequency data were based on the statistical analysis of stage-discharge records from two USGS gages: Niles, MI (04101500) and Berrien Springs (04102000).
St. Joseph River	Charter Township of Benton / Township of Sodus corporate limits	Approximately 1,100 feet south of Hipps Hollow Road	Statistical Analysis (Standard log-Pearson Type III Method) as outlined in Bulletin 15 (USWRC 1967)	HEC-2 (USACE 1973)	12/1976	AE with Floodway	Floodflow-frequency data were based on the statistical analysis of stage-discharge records from two USGS gages: Niles, MI (04101500) and Berrien Springs (04102000).
St. Joseph River	City of St. Joseph / Township of Royalton corporate limits	Township of Royalton / Township of Sodus corporate limits	Statistical Analysis (Standard log-Pearson Type III Method) as outlined in Bulletin 15 (USWRC 1967)	HEC-2 (USACE 1973)	12/1976	AE with Floodway	Floodflow-frequency data were based on the statistical analysis of stage-discharge records from two USGS gages: Niles, MI (04101500) and Berrien Springs (04102000).
St. Joseph River	Mouth at Lake Michigan	Approximately 1,980 feet upstream of confluence with Hickory Creek	Statistical Analysis (Standard log-Pearson Type III Method) as outlined in Bulletin 15 (USWRC 1967)	HEC-2 (USACE 1973)	07/1976	AE with Floodway	Floodflow-frequency data were based on the statistical analysis of stage-discharge records from two USGS gages: Niles, MI (04101500) and Berrien Springs (04102000). Redelineated between cross sections R and T for 2017 Lake Michigan coastal study.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
St. Joseph River (Left Overbank)	Convergence with St. Joseph River	Divergence from St. Joseph River	Unknown	HEC-2 (USACE 1973)	12/1976	AE with Floodway	
Tanner Creek	Mouth at Lake Michigan	Approximately 300 feet upstream of Interstate 94	HEC-HMS (USACE 1998)	HEC-RAS Version Unknown (USACE ND1)	08/2004	AE with Floodway	Tanner Creek changes to William & Esseg Drain upstream of the Interstate Highway 94 bridge. The HEC-RAS version was not provided.
Tributary A	Mouth at Lake Michigan	Approximately 400 feet north of Sawyer Road	SCS TR-20 (USDA 1965)	HEC-2 and WSP-2 (USACE 1973; USDA ND1)	03/1977	AE with Floodway	
Tributary B	Mouth at Lake Michigan	Red Arrow Highway	SCS TR-20 (USDA 1965)	HEC-2 and WSP-2 (USACE 1973; USDA ND1)	03/1977	AE with Floodway	Redelineated between cross sections A and B due to 2017 Lake Michigan coastal study.
Tributary C	Mouth at Tributary B	Approximately 650 feet south of Blackwell Drive	SCS TR-20 (USDA 1965)	HEC-2 and WSP-2 (USACE 1973; USDA ND1)	03/1977	AE with Floodway	
West Tributary St. Joseph River	Mouth at St. Joseph River	Approximately 2,650 feet east of South Phillip Road	SCS TR-55 (USDA 1975)	HEC-2 and WSP-2 (USACE 1984; USDA ND1)	08/1985	AE with Floodway	This stream was named “West Tributary” within the City of Niles prior to the 2006 countywide FIS.
White Creek – East Branch	Ravine Road	Downstream of Grand Beach Road	SCS TR-20 (USDA 1965)	HEC-2 and WSP-2 (USACE 1973; USDA ND1)	04/1977	AE with Floodway	This stream was named “White Creek” within the Village of Grand Beach prior to the 2006 countywide FIS.
White Creek – West Branch	Approximately 1,200 feet south of Ridgeview Drive	Michiana Drive	SCS TR-20 (USDA 1965)	HEC-2 and WSP-2 (USACE 1973; USDA ND1)	12/1976	AE with Floodway	This stream was named “White Creek” within the Village of Michiana prior to the 2006 countywide FIS.
William & Esseg Drain	Approximately 300 feet upstream of Interstate 94	Approximately 1,300 feet upstream of Interstate 94	HEC-HMS (USACE 1998)	HEC-RAS Version Unknown (USACE ND1)	08/2004	AE with Floodway	Tanner Creek changes to William & Esseg Drain upstream of the Interstate Highway 94 bridge. The HEC-RAS version was not provided.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Yellow Creek	Mouth at St. Joseph River	Approximately 1,400 feet upstream of East John Beers Road	SCS TR-20 (USDA 1965)	HEC-2 and WSP-2 (USACE 1973; USDA ND1)	12/1976	AE with Floodway	

Table 13: Roughness Coefficients

Flooding Source	Channel “n”	Overbank “n”
Bedortha Drain - City of Bridgman	0.040	0.070
Bridgman City Drain - City of Bridgman	0.055	0.070 - 0.080
Dowagiac River - City of Niles	0.033 - 0.040	0.050 - 0.100
Galien River - City of New Buffalo	0.030 - 0.035	0.050 - 0.100
Galien River - Township of New Buffalo	0.035	0.050 - 0.100
Glenlord Road Drain - Charter Township of Lincoln	0.032 - 0.065	0.035 - 0.080
Goodrow Drain – Charter Township of Lincoln	0.045 - 0.055	0.035 - 0.070
Granger Drain - Township of Hager	0.040 - 0.060	0.070 - 0.150
Granger Drain Tributary - Township of Hager	0.040 - 0.060	0.070 - 0.150
Hickory Creek - Charter Township of Lincoln	0.045	0.070 - 0.090
Hickory Creek - Charter Township of St. Joseph	0.045	0.070 - 0.100
McCoy Creek - City of Buchanan	*	*
Ox Creek - City of Benton Harbor	0.040 - 0.045	0.035 - 0.100
Ox Creek - Charter Township of Benton	0.040 - 0.100	0.035 - 0.100
Parker / Richardson Drain - Charter Township of Lincoln	0.035 - 0.055	0.040 - 0.080
Paw Paw River - City of Benton Harbor	0.050	0.060 - 0.150
Paw Paw River - City of St. Joseph	*	*
Paw Paw River - City of Watervliet	*	*
Paw Paw River - Charter Township of Benton	0.050	0.060 - 0.150
Paw Paw River - Charter Township of Coloma	*	*
Paw Paw River - Township of Hager	0.050	0.150
Paw Paw River - Charter Township of Watervliet	*	*
St. Joseph River - City of Benton Harbor	0.030 - 0.032	0.032 - 0.060
St. Joseph River - City of Niles	0.025 - 0.034	0.080 - 0.100
St. Joseph River - City of St. Joseph	0.030 - 0.035	*
St. Joseph River - Charter Township of Benton	0.032 - 0.037	0.050 - 0.125
St. Joseph River - Township of Royalton	0.032 - 0.039	0.040 - 0.120
St. Joseph River - Township of Sodus	0.040 - 0.120	0.032 - 0.039
St. Joseph River - Charter Township of St. Joseph	0.032 - 0.035	0.060 - 0.120
Tanner Creek - City of Bridgman	0.035 - 0.055	0.040 - 0.090

* Data not provided

Table 13: Roughness Coefficients (*continued)*

Flooding Source	Channel "n"	Overbank "n"
Tributary A - Township of Chikaming	0.025 - 0.055	0.030 - 0.100
Tributary B - Township of Chikaming	0.025 - 0.055	0.030 - 0.100
Tributary C - Township of Chikaming	0.025 - 0.055	0.030 - 0.100
West Tributary - City of Niles	0.030 - 0.060	0.035 - 0.100
White Creek - Village of Grand Beach	0.040 - 0.060	0.070 - 0.080
White Creek - Village of Michiana	0.030 - 0.050	0.030 - 0.160
William & Esseg Drain - City of Bridgman	0.035 - 0.055	0.040 - 0.090
Yellow River - Township of Royalton	0.050 - 0.065	0.030 - 0.160

* Data not provided

5.3 Coastal Analyses

For the areas of Berrien County that are impacted by coastal flooding processes, coastal flood hazard analyses were performed to provide estimates of coastal BFEs. Coastal BFEs reflect the increase in water levels during a flood event due to storm surge as well as overland wave effects.

The following subsections provide summaries of how each coastal process was considered for this FIS Report. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation (STARR, 2017). Table 14 summarizes the methods and/or models used for the coastal analyses. Refer to Section 2.5.1 for descriptions of the terms used in this section.

Table 14: Summary of Coastal Analyses

Flooding Source	Study Limits From	Study Limits To	Hazard Evaluated	Model or Method Used	Date Analysis was Completed
Lake Michigan	Entire coastline of Berrien County, MI	Entire coastline of Berrien County, MI	Lake-wide Storm Surge	Advanced Circulation Model (ADCIRC)	10/31/2016
Lake Michigan	Entire coastline of Berrien County, MI	Entire coastline of Berrien County, MI	Lake-wide Wave Generation	Simulating Waves Nearshore Model (SWAN)	10/31/2016
Lake Michigan	Entire coastline of Berrien County, MI	Entire coastline of Berrien County, MI	Event-Based Erosion	Cross-Shore Numerical Model (CSHORE)	08/01/2017

Table 14: Summary of Coastal Analyses *(continued)*

Flooding Source	Study Limits From	Study Limits To	Hazard Evaluated	Model or Method Used	Date Analysis was Completed
Lake Michigan	Entire coastline of Berrien County, MI	Entire coastline of Berrien County, MI	Structure Failure Analysis	FEMA Guidance for Flood Risk Analysis and Mapping – Coastal Structures	08/01/2017
Lake Michigan	Entire coastline of Berrien County, MI	Entire coastline of Berrien County, MI	Statistical Analyses	GPD with Q-Q Optimization	08/01/2017
Lake Michigan	Entire coastline of Berrien County, MI	Entire coastline of Berrien County, MI	Wave Setup	Direct Integration Method (DIM)	08/01/2017
Lake Michigan	Entire coastline of Berrien County, MI	Entire coastline of Berrien County, MI	Wave Runup	Stockdon, Van Gent, and Shore Protection Manual (SPM)[1]	08/01/2017
Lake Michigan	Entire coastline of Berrien County, MI	Entire coastline of Berrien County, MI	Wave Overtopping	EurOtop Manual; Plateau Method	08/01/2017

[1] U.S. Army Corps of Engineers (USACE) Shore Protection Manual (SPM) (USACE 1984)

5.3.1 Total Stillwater Elevations

The stillwater elevations for the 1-percent-annual-chance flood were determined for areas subject to coastal flooding. The models and methods that were used to determine storm surge and wave setup are listed in Table 14. The stillwater elevation that was used for each transect in the coastal analyses is shown in Table 16, “Coastal Transect Parameters.” Figure 8 shows an example of the stillwater elevations for the 1-percent-annual-chance flood that was determined for this coastal analysis; wave setup is computed at each transect location and added to the stillwater elevation to determine a total stillwater elevation.

Stillwater elevations and starting wave conditions for Berrien County were determined from the lake-wide wave and storm surge study conducted for Lake Michigan by FEMA and Strategic Alliance for Risk Reduction (STARR, 2016). The study was performed using the coupled SWAN + ADCIRC hydrodynamic and wave model on a mesh of 1,045,141 nodes and validated using water levels and waves for six historical storms. The model was then used to simulate 150 selected historic storms based on historic peak water levels and peak wave heights. When available, ice coverage was accounted for in validation and production events. The modeled data were used to create a history of water elevation and wave height records from which the 10-, 2-, 1-, and 0.2-percent-annual-chance of exceedance elevations were calculated.

Figure 8: 1% Annual Chance Stillwater Elevations for Coastal Areas

Storm Surge Statistics

Storm surge is modeled based on characteristics of actual storms responsible for significant coastal flooding. The characteristics of these storms are typically determined by statistical study of the regional historical record of storms or by statistical study of water level stations.

When historic records are used to calculate storm surge, characteristics such as the strength, size, track, etc., of storms are identified by site. Storm data was used in conjunction with numerical hydrodynamic models to determine the corresponding storm surge levels. An extreme value analysis was performed on the storm surge modeling results to determine a stillwater elevation for the 1-percent-annual-chance event.

In an oceanic environment, water level stations can be used instead of historic records of storms when the available station record for the area represents both the astronomical tide component and the storm surge component. Great Lakes studies rely on water level stations to identify the highest water level storm events from the historic record. The selected storms are then used to simulate storm surge and wave heights across the study area. Table 15 provides the water level station name, managing agency, station type, station identifier, start date, end date, and statistical methodology applied to each station to determine the stillwater elevations.

Table 15: Water Level Station Analysis Specifics

Gage Name	Managing Agency of Tide Gage Record	Station Type	Start Date	End Date [1]	Statistical Methodology
Mackinaw City, MI (9075080)	National Oceanic and Atmospheric Administration (NOAA)	Water Level	1960	2009	N/A
Ludington, MI (9087023)	NOAA	Water Level	1960	2009	N/A
Holland, MI (9087031)	NOAA	Water Level	1960	2009	N/A
Calumet Harbor, IL (9087044)	NOAA	Water Level	1960	2009	N/A
Milwaukee, WI (9087057)	NOAA	Water Level	1960	2009	N/A
Kewaunee, WI (9087068)	NOAA	Water Level	1973	2009	N/A
Sturgeon Bay, WI (9087072)	NOAA	Water Level	1960	2009	N/A
Green Bay, WI (9087079)	NOAA	Water Level	1960	2009	N/A
Port Inland, MI (9087096)	NOAA	Water Level	1964	2009	N/A

[1]Available data within study period of record (1960-2009).

For each return period, the stillwater elevation at each node was used to create a raster surface using ArcInfo geoprocessing tools. The storm surge modeling was performed with elevation data referenced to the long term low water datum. At the time of this study, the low water datum for Lake Michigan was 577.6 feet NAVD88 or 577.5 feet IGLD85. The node or point data was converted to the vertical datum of NAVD88 (from IGLD85).

5.3.2 Waves

Starting wave heights and wave periods for Berrien County were determined from the lake-wide wave and storm surge study conducted for Lake Michigan by FEMA and STARR as described in Section 5.3.1. The modeled data were used to create a history of wave height and wave period records which was used to determine starting wave conditions for the transect analysis.

Wave Setup Analysis

Wave setup was computed based on the wave and water level modeling results through the methods and models listed in Table 14. To adequately capture the complex hydrodynamics of wave-breaking across the surf zone, wave setup was calculated at each transect using the Direct Integration Method (DIM).

5.3.3 Coastal Erosion

A single storm episode can cause extensive erosion in coastal areas. Storm-induced erosion was evaluated using the methods listed in Table 14 to determine the modification to existing topography that is expected to be associated with coastal flooding events. The post-event eroded profile was used for the subsequent transect-based onshore wave hazard analyses.

5.3.4 Wave Hazard Analyses

Overland wave hazards were evaluated to determine the combined effects of ground elevation, vegetation, and physical features on overland wave propagation and wave runup. These analyses were performed at representative transects where waves are expected to be present during the floods of the selected recurrence intervals. The results of these analyses were used to determine elevations for the 1-percent-annual-chance flood. The transect analysis was performed with elevations in the vertical datum of IGLD85 and ultimately converted to NAVD88 for mapping.

Transect locations were chosen with consideration given to the physical land characteristics as well as development type and density so that they would closely represent conditions in their locality. Additional consideration was given to changes in the total stillwater elevation. Transects were spaced close together in areas of complex topography and dense development or where total stillwater elevations varied. In areas having more uniform characteristics, transects were spaced at larger intervals. Transects shown in Figure 9, “Transect Location Map,” are also depicted on the FIRM. Table 16 provides the location, stillwater elevations, and total water elevations for all coastal analysis transects. Starting wave conditions are also provided for each transect evaluated for overland wave hazards. In this table, “starting” indicates the parameter value at the beginning of the transect.

Wave Height Analysis

Wave height analyses were performed to determine wave heights and corresponding wave crest elevations for the areas inundated by coastal flooding and subject to overland wave propagation hazards. Refer to Figure 6b for a schematic of a coastal transect evaluated for overland wave propagation hazards.

The methodology for analyzing the effects of wave heights associated with coastal storm surge flooding is described in a report prepared by the National Academy of Sciences (NAS). This method is based on three major concepts. First, depth-limited waves in shallow water reach maximum breaking height that is equal to 0.78 times the stillwater depth. The wave crest is 70 percent of the total wave height above the stillwater level. The second major concept is that wave height may be diminished by dissipation of energy due to the presence of obstructions, such as sand dunes, dikes and seawalls, buildings and vegetation. The amount of energy dissipation is a function of the physical characteristics of the obstruction and is determined by procedures prescribed in the NAS Report. The third major concept is that wave height can be regenerated in open fetch areas due to the transfer of wind energy to the water. This added energy is related to fetch length and depth.

Along each transect, wave heights and wave crest elevations were computed considering the combined effects of changes in ground elevation, vegetation, and physical features. The joint probability method (JPM) is used to compute five theoretical combinations of wave and water level conditions that have a joint 1-percent-annual-chance probability of occurrence. These theoretical combinations were simulated to determine the water levels, which include wave setup, and wave conditions at the shoreline. Wave heights and wave crest elevations were modeled using the methods and models listed in Table 14.

There were no overland wave propagation transects within this county.

Wave Runup and Overtopping Analysis

Wave runup is the uprush of water caused by wave action on a shore barrier exceeding the total stillwater level. As part of the coastal study, an evaluation of wave runup is conducted to determine the total water elevation due to storm surge, wave setup, and wave runup, and whether that total water elevation is the dominant coastal flood hazard for an area. Wave runup is evaluated for areas having dune barrier systems, coastal bluffs, as well as sloped and vertical structures. Structures that are not certified to withstand the 1-percent-annual-chance coastal flood event were analyzed in both the intact and failed conditions. Failed structure geometries were calculated using the methods and models listed in Table 14.

Wave runup elevations were calculated for each coastal transect using the methods and models listed in Table 14, which follow the FEMA Guidelines and Specifications. For gently sloping shorelines (slopes less than 1:10), the Stockdon equations were applied (Stockdon et al., 2006). For steeper (but non-vertical) sloping shorelines, the van Gent method was performed (van Gent, 2001). For vertical structures, runup elevations were determined using the guidance in Figure D-14 of the FEMA Guidelines and Specifications obtained from the SPM (USACE, 1984). The SPM results in a mean wave runup value, which was multiplied by 2.2 to obtain the 2-percent runup height.

Wave overtopping occurs when the potential wave runup elevation is greater than the topographic feature crest elevation. The overtopping rate will depend on the incident water level and wave conditions, the barrier geometry and roughness characteristics, and the upland slope. Overtopping rates were calculated using the methods and models listed in Table 14, which follow the FEMA Guidelines and Specifications.

Wave overtopping behavior is determined based on the slope landward of the barrier crest. Where the shoreline geometry is characterized by a low-crested bluff or structure backed by a positively-sloping, nearly level upland, the Plateau Method was applied to calculate an adjusted runup elevation and the inland extent of runup. Where the shoreline geometry is characterized by a negative slope landward of the barrier crest, the overtopping water will result in sheet flow on the negative slope and may propagate until it reaches another flooding source or ponding area.

Table 16: Coastal Transect Parameters

Flood Source	Coastal Transect	Starting Wave Conditions for the 1-Percent Annual Chance [1,2]		Starting Stillwater Elevations (feet NAVD88)					1% Annual Chance Total Water Elevation[4] (ft NAVD88)
		Significant Wave Height H_s (feet)	Peak Wave Period T_p (seconds)	10-Percent Annual Chance	4-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance[3]	0.2-Percent Annual Chance	
Lake Michigan	1	N/A	N/A	582.9	583.3	583.6	583.8	584.1	588.2
Lake Michigan	2	N/A	N/A	582.9	583.4	583.6	583.9	584.2	587.7
Lake Michigan	3	N/A	N/A	583.0	583.4	583.7	583.9	584.3	592.2
Lake Michigan	4	N/A	N/A	583.0	583.4	583.7	583.9	584.2	597.7
Lake Michigan	5	N/A	N/A	583.0	583.4	583.7	583.9	584.2	593.3
Lake Michigan	6	N/A	N/A	582.9	583.4	583.7	583.9	584.3	587.7
Lake Michigan	7	N/A	N/A	582.9	583.3	583.6	583.8	584.1	588.0
Lake Michigan	8	N/A	N/A	582.9	583.3	583.6	583.8	584.1	591.8
Lake Michigan	9	N/A	N/A	582.9	583.3	583.6	583.8	584.2	596.2
Lake Michigan	10	N/A	N/A	582.9	583.4	583.6	583.8	584.2	592.7

[1]Wave data are provided for WHAFIS-based transects only. The 1% starting wave parameters are not applicable for runup transects since a response-based approach is utilized.
[2]Wave data correspond to the 1-percent-annual-chance floodplain but may not be directly associated with the 1-percent-annual-chance SWEL.
[3]Statistical 1-percent-annual-chance starting Stillwater elevation may be different than that used in WHAFIS wave analysis as a result of the Joint Probability approach.
[4]Includes wave action representative of 1% Total Water Level (for wave runup and overtopping) or 1% Wave Crest Elevation (for overland wave propagation).

Table 16: Coastal Transect Parameters (continued)

Flood Source	Coastal Transect	Starting Wave Conditions for the 1-Percent Annual Chance [1,2]		Starting Stillwater Elevations (feet NAVD88)					1% Annual Chance Total Water Elevation[4] (ft NAVD88)
		Significant Wave Height H_s (feet)	Peak Wave Period T_p (seconds)	10-Percent Annual Chance	4-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance[3]	0.2-Percent Annual Chance	
Lake Michigan	11	N/A	N/A	582.9	583.3	583.6	583.8	584.2	589.6
Lake Michigan	12	N/A	N/A	582.9	583.3	583.6	583.8	584.2	589.6
Lake Michigan	13	N/A	N/A	582.9	583.3	583.6	583.8	584.2	590.3
Lake Michigan	14	N/A	N/A	582.9	583.4	583.6	583.9	584.2	589.0
Lake Michigan	15	N/A	N/A	582.9	583.3	583.6	583.8	584.2	592.3
Lake Michigan	16	N/A	N/A	582.9	583.3	583.6	583.8	584.2	592.7
Lake Michigan	17	N/A	N/A	582.9	583.3	583.6	583.8	584.2	591.7
Lake Michigan	18	N/A	N/A	582.9	583.3	583.6	583.8	584.2	591.6
Lake Michigan	19	N/A	N/A	582.9	583.3	583.6	583.8	584.1	591.2
Lake Michigan	20	N/A	N/A	582.8	583.3	583.5	583.8	584.1	590.1

[1]Wave data are provided for WHAFIS-based transects only. The 1% starting wave parameters are not applicable for runup transects since a response-based approach is utilized.
[2]Wave data correspond to the 1-percent-annual-chance floodplain but may not be directly associated with the 1-percent-annual-chance SWEL.
[3]Statistical 1-percent-annual-chance starting Stillwater elevation may be different than that used in WHAFIS wave analysis as a result of the Joint Probability approach.
[4]Includes wave action representative of 1% Total Water Level (for wave runup and overtopping) or 1% Wave Crest Elevation (for overland wave propagation).

Table 16: Coastal Transect Parameters (continued)

Flood Source	Coastal Transect	Starting Wave Conditions for the 1-Percent Annual Chance [1,2]		Starting Stillwater Elevations (feet NAVD88)					1% Annual Chance Total Water Elevation[4] (ft NAVD88)
		Significant Wave Height H_s (feet)	Peak Wave Period T_p (seconds)	10-Percent Annual Chance	4-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance[3]	0.2-Percent Annual Chance	
Lake Michigan	21	N/A	N/A	582.8	583.3	583.5	583.7	584.1	588.8
Lake Michigan	22	N/A	N/A	582.8	583.3	583.5	583.7	584.1	588.6
Lake Michigan	23	N/A	N/A	582.9	583.3	583.6	583.8	584.1	589.2
Lake Michigan	24	N/A	N/A	582.9	583.4	583.6	583.8	584.2	587.7
Lake Michigan	25	N/A	N/A	582.9	583.3	583.6	583.8	584.2	588.3
Lake Michigan	26	N/A	N/A	582.8	583.2	583.5	583.7	584.1	587.3
Lake Michigan	27	N/A	N/A	582.8	583.3	583.6	583.8	584.2	587.4
Lake Michigan	28	N/A	N/A	582.9	583.3	583.6	583.8	584.1	587.4
Lake Michigan	29	N/A	N/A	582.9	583.4	583.6	583.9	584.2	596.0
Lake Michigan	30	N/A	N/A	582.9	583.3	583.6	583.8	584.1	587.1

[1]Wave data are provided for WHAFIS-based transects only. The 1% starting wave parameters are not applicable for runup transects since a response-based approach is utilized.
[2]Wave data correspond to the 1-percent-annual-chance floodplain but may not be directly associated with the 1-percent-annual-chance SWEL.
[3]Statistical 1-percent-annual-chance starting Stillwater elevation may be different than that used in WHAFIS wave analysis as a result of the Joint Probability approach.
[4]Includes wave action representative of 1% Total Water Level (for wave runup and overtopping) or 1% Wave Crest Elevation (for overland wave propagation).

Table 16: Coastal Transect Parameters (continued)

Flood Source	Coastal Transect	Starting Wave Conditions for the 1-Percent Annual Chance [1,2]		Starting Stillwater Elevations (feet NAVD88)					1% Annual Chance Total Water Elevation[4] (ft NAVD88)
		Significant Wave Height H_s (feet)	Peak Wave Period T_p (seconds)	10-Percent Annual Chance	4-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance[3]	0.2-Percent Annual Chance	
Lake Michigan	31	N/A	N/A	582.8	583.3	583.5	583.7	584.1	588.0
Lake Michigan	32	N/A	N/A	582.8	583.3	583.5	583.7	584.1	586.7
Lake Michigan	33	N/A	N/A	582.8	583.3	583.6	583.8	584.2	587.1
Lake Michigan	34	N/A	N/A	582.9	583.3	583.6	583.8	584.1	593.3
Lake Michigan	35	N/A	N/A	582.8	583.3	583.6	583.8	584.1	587.8
Lake Michigan	36	N/A	N/A	582.8	583.3	583.5	583.8	584.2	589.5
Lake Michigan	37	N/A	N/A	582.8	583.3	583.6	583.8	584.1	589.8
Lake Michigan	38	N/A	N/A	582.8	583.3	583.6	583.8	584.1	587.5
Lake Michigan	39	N/A	N/A	582.9	583.3	583.6	583.8	584.1	587.5
Lake Michigan	40	N/A	N/A	582.9	583.3	583.6	583.8	584.1	587.8

[1]Wave data are provided for WHAFIS-based transects only. The 1% starting wave parameters are not applicable for runup transects since a response-based approach is utilized.
[2]Wave data correspond to the 1-percent-annual-chance floodplain but may not be directly associated with the 1-percent-annual-chance SWEL.
[3]Statistical 1-percent-annual-chance starting Stillwater elevation may be different than that used in WHAFIS wave analysis as a result of the Joint Probability approach.
[4]Includes wave action representative of 1% Total Water Level (for wave runup and overtopping) or 1% Wave Crest Elevation (for overland wave propagation).

Table 16: Coastal Transect Parameters (continued)

Flood Source	Coastal Transect	Starting Wave Conditions for the 1-Percent Annual Chance [1,2]		Starting Stillwater Elevations (feet NAVD88)					1% Annual Chance Total Water Elevation[4] (ft NAVD88)
		Significant Wave Height H_s (feet)	Peak Wave Period T_p (seconds)	10-Percent Annual Chance	4-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance[3]	0.2-Percent Annual Chance	
Lake Michigan	41	N/A	N/A	582.8	583.3	583.5	583.7	584.0	588.2
Lake Michigan	42	N/A	N/A	582.8	583.2	583.5	583.7	584.0	587.4
Lake Michigan	43	N/A	N/A	582.8	583.3	583.6	583.8	584.1	587.7
Lake Michigan	44	N/A	N/A	582.8	583.3	583.5	583.8	584.1	587.8
Lake Michigan	45	N/A	N/A	582.7	583.2	583.4	583.7	584.1	587.7
Lake Michigan	46	N/A	N/A	582.7	583.1	583.4	583.6	583.9	587.5
Lake Michigan	47	N/A	N/A	582.7	583.2	583.4	583.7	584.1	588.0
Lake Michigan	48	N/A	N/A	582.7	583.2	583.4	583.6	583.9	595.0
Lake Michigan	49	N/A	N/A	582.7	583.2	583.4	583.7	584.0	592.6
Lake Michigan	50	N/A	N/A	582.7	583.1	583.4	583.6	584.1	588.2

[1]Wave data are provided for WHAFIS-based transects only. The 1% starting wave parameters are not applicable for runup transects since a response-based approach is utilized.
[2]Wave data correspond to the 1-percent-annual-chance floodplain but may not be directly associated with the 1-percent-annual-chance SWEL.
[3]Statistical 1-percent-annual-chance starting Stillwater elevation may be different than that used in WHAFIS wave analysis as a result of the Joint Probability approach.
[4]Includes wave action representative of 1% Total Water Level (for wave runup and overtopping) or 1% Wave Crest Elevation (for overland wave propagation).

Table 16: Coastal Transect Parameters (continued)

Flood Source	Coastal Transect	Starting Wave Conditions for the 1-Percent Annual Chance [1,2]		Starting Stillwater Elevations (feet NAVD88)					1% Annual Chance Total Water Elevation[4] (ft NAVD88)
		Significant Wave Height H_s (feet)	Peak Wave Period T_p (seconds)	10-Percent Annual Chance	4-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance[3]	0.2-Percent Annual Chance	
Lake Michigan	51	N/A	N/A	582.8	583.2	583.5	583.7	584.0	594.4
Lake Michigan	52	N/A	N/A	582.8	583.2	583.5	583.7	584.1	591.0
Lake Michigan	53	N/A	N/A	582.7	583.2	583.5	583.7	584.2	591.8
Lake Michigan	54	N/A	N/A	582.8	583.2	583.5	583.6	583.9	590.7
Lake Michigan	55	N/A	N/A	582.8	583.2	583.5	583.7	584.0	587.7
Lake Michigan	56	N/A	N/A	582.7	583.2	583.4	583.7	584.0	588.0
Lake Michigan	57	N/A	N/A	582.7	583.2	583.4	583.7	584.1	588.0
Lake Michigan	58	N/A	N/A	582.7	583.2	583.5	583.7	584.1	588.0
Lake Michigan	59	N/A	N/A	582.8	583.2	583.4	583.6	583.9	587.5
Lake Michigan	60	N/A	N/A	582.7	583.1	583.4	583.6	584.0	587.2

[1]Wave data are provided for WHAFIS-based transects only. The 1% starting wave parameters are not applicable for runup transects since a response-based approach is utilized.
[2]Wave data correspond to the 1-percent-annual-chance floodplain but may not be directly associated with the 1-percent-annual-chance SWEL.
[3]Statistical 1-percent-annual-chance starting Stillwater elevation may be different than that used in WHAFIS wave analysis as a result of the Joint Probability approach.
[4]Includes wave action representative of 1% Total Water Level (for wave runup and overtopping) or 1% Wave Crest Elevation (for overland wave propagation).

Table 16: Coastal Transect Parameters (continued)

Flood Source	Coastal Transect	Starting Wave Conditions for the 1-Percent Annual Chance [1,2]		Starting Stillwater Elevations (feet NAVD88)					1% Annual Chance Total Water Elevation[4] (ft NAVD88)
		Significant Wave Height H_s (feet)	Peak Wave Period T_p (seconds)	10-Percent Annual Chance	4-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance[3]	0.2-Percent Annual Chance	
Lake Michigan	61	N/A	N/A	582.6	583.1	583.4	583.6	584.0	587.2
Lake Michigan	62	N/A	N/A	582.7	583.2	583.5	583.7	584.1	587.1
Lake Michigan	63	N/A	N/A	582.6	583.1	583.3	583.5	583.9	587.4
Lake Michigan	64	N/A	N/A	582.7	583.2	583.5	583.7	584.1	588.4
Lake Michigan	65	N/A	N/A	582.7	583.1	583.4	583.6	583.9	591.4
Lake Michigan	66	N/A	N/A	582.7	583.1	583.4	583.6	584.0	591.6
Lake Michigan	67	N/A	N/A	582.6	583.1	583.3	583.6	583.9	592.9
Lake Michigan	68	N/A	N/A	582.8	583.2	583.4	583.6	584.0	589.8
Lake Michigan	69	N/A	N/A	582.6	583.1	583.4	583.6	584.0	591.6
Lake Michigan	70	N/A	N/A	582.7	583.2	583.5	583.7	584.2	593.4

[1]Wave data are provided for WHAFIS-based transects only. The 1% starting wave parameters are not applicable for runup transects since a response-based approach is utilized.
[2]Wave data correspond to the 1-percent-annual-chance floodplain but may not be directly associated with the 1-percent-annual-chance SWEL.
[3]Statistical 1-percent-annual-chance starting Stillwater elevation may be different than that used in WHAFIS wave analysis as a result of the Joint Probability approach.
[4]Includes wave action representative of 1% Total Water Level (for wave runup and overtopping) or 1% Wave Crest Elevation (for overland wave propagation).

Table 16: Coastal Transect Parameters (continued)

Flood Source	Coastal Transect	Starting Wave Conditions for the 1-Percent Annual Chance [1,2]		Starting Stillwater Elevations (feet NAVD88)					1% Annual Chance Total Water Elevation[4] (ft NAVD88)
		Significant Wave Height H_s (feet)	Peak Wave Period T_p (seconds)	10-Percent Annual Chance	4-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance[3]	0.2-Percent Annual Chance	
Lake Michigan	71	N/A	N/A	582.6	583.1	583.4	583.6	584.1	594.1
Lake Michigan	72	N/A	N/A	582.8	583.2	583.4	583.6	584.0	588.0
Lake Michigan	73	N/A	N/A	582.7	583.2	583.5	583.7	584.1	589.8
Lake Michigan	74	N/A	N/A	582.7	583.1	583.4	583.7	584.1	590.1
Lake Michigan	75	N/A	N/A	582.8	583.2	583.5	583.7	584.0	594.1
Lake Michigan	76	N/A	N/A	582.8	583.2	583.4	583.6	584.0	592.7
Lake Michigan	77	N/A	N/A	582.8	583.2	583.5	583.7	584.0	592.7
Lake Michigan	78	N/A	N/A	582.7	583.2	583.4	583.7	584.1	591.2
Lake Michigan	79	N/A	N/A	582.7	583.2	583.4	583.7	584.0	590.4
Lake Michigan	80	N/A	N/A	582.8	583.2	583.5	583.7	584.0	587.3

[1]Wave data are provided for WHAFIS-based transects only. The 1% starting wave parameters are not applicable for runup transects since a response-based approach is utilized.
[2]Wave data correspond to the 1-percent-annual-chance floodplain but may not be directly associated with the 1-percent-annual-chance SWEL.
[3]Statistical 1-percent-annual-chance starting Stillwater elevation may be different than that used in WHAFIS wave analysis as a result of the Joint Probability approach.
[4]Includes wave action representative of 1% Total Water Level (for wave runup and overtopping) or 1% Wave Crest Elevation (for overland wave propagation).

Table 16: Coastal Transect Parameters (continued)

Flood Source	Coastal Transect	Starting Wave Conditions for the 1-Percent Annual Chance [1,2]		Starting Stillwater Elevations (feet NAVD88)					1% Annual Chance Total Water Elevation[4] (ft NAVD88)
		Significant Wave Height H_s (feet)	Peak Wave Period T_p (seconds)	10-Percent Annual Chance	4-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance[3]	0.2-Percent Annual Chance	
Lake Michigan	81	N/A	N/A	582.7	583.1	583.4	583.6	584.0	591.1
Lake Michigan	82	N/A	N/A	582.7	583.1	583.4	583.6	584.0	592.4
Lake Michigan	83	N/A	N/A	582.6	583.0	583.3	583.5	584.0	586.1
Lake Michigan	84	N/A	N/A	582.6	583.1	583.4	583.6	584.0	589.3
Lake Michigan	85	N/A	N/A	582.7	583.1	583.5	583.7	584.3	591.3
Lake Michigan	86	N/A	N/A	582.6	583.1	583.3	583.6	584.1	589.5
Lake Michigan	87	N/A	N/A	582.7	583.2	583.4	583.6	583.9	591.9
Lake Michigan	88	N/A	N/A	582.7	583.2	583.4	583.6	584.0	587.2
Lake Michigan	89	N/A	N/A	582.6	583.1	583.4	583.7	584.1	589.1
Lake Michigan	90	N/A	N/A	582.6	583.1	583.4	583.7	584.2	587.0

[1]Wave data are provided for WHAFIS-based transects only. The 1% starting wave parameters are not applicable for runup transects since a response-based approach is utilized.
[2]Wave data correspond to the 1-percent-annual-chance floodplain but may not be directly associated with the 1-percent-annual-chance SWEL.
[3]Statistical 1-percent-annual-chance starting Stillwater elevation may be different than that used in WHAFIS wave analysis as a result of the Joint Probability approach.
[4]Includes wave action representative of 1% Total Water Level (for wave runup and overtopping) or 1% Wave Crest Elevation (for overland wave propagation).

Table 16: Coastal Transect Parameters (continued)

Flood Source	Coastal Transect	Starting Wave Conditions for the 1-Percent Annual Chance [1,2]		Starting Stillwater Elevations (feet NAVD88)					1% Annual Chance Total Water Elevation[4] (ft NAVD88)
		Significant Wave Height H_s (feet)	Peak Wave Period T_p (seconds)	10-Percent Annual Chance	4-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance[3]	0.2-Percent Annual Chance	
Lake Michigan	91	N/A	N/A	582.6	583.1	583.5	583.8	584.4	587.6
Lake Michigan	92	N/A	N/A	582.6	583.0	583.3	583.5	583.9	588.0
Lake Michigan	93	N/A	N/A	582.6	583.1	583.4	583.6	584.1	588.3
Lake Michigan	94	N/A	N/A	582.6	583.0	583.3	583.6	584.0	587.6
Lake Michigan	95	N/A	N/A	582.6	583.1	583.3	583.6	584.1	587.4
Lake Michigan	96	N/A	N/A	582.6	583.1	583.3	583.6	584.0	587.4
Lake Michigan	97	N/A	N/A	582.7	583.2	583.4	583.6	584.0	587.4
Lake Michigan	98	N/A	N/A	582.7	583.2	583.4	583.6	583.9	587.0
Lake Michigan	99	N/A	N/A	582.6	583.1	583.4	583.7	584.1	587.4
Lake Michigan	100	N/A	N/A	582.7	583.2	583.4	583.7	584.0	590.6

[1]Wave data are provided for WHAFIS-based transects only. The 1% starting wave parameters are not applicable for runup transects since a response-based approach is utilized.
[2]Wave data correspond to the 1-percent-annual-chance floodplain but may not be directly associated with the 1-percent-annual-chance SWEL.
[3]Statistical 1-percent-annual-chance starting Stillwater elevation may be different than that used in WHAFIS wave analysis as a result of the Joint Probability approach.
[4]Includes wave action representative of 1% Total Water Level (for wave runup and overtopping) or 1% Wave Crest Elevation (for overland wave propagation).

Table 16: Coastal Transect Parameters (continued)

Flood Source	Coastal Transect	Starting Wave Conditions for the 1-Percent Annual Chance [1,2]		Starting Stillwater Elevations (feet NAVD88)					1% Annual Chance Total Water Elevation[4] (ft NAVD88)
		Significant Wave Height H_s (feet)	Peak Wave Period T_p (seconds)	10-Percent Annual Chance	4-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance[3]	0.2-Percent Annual Chance	
Lake Michigan	101	N/A	N/A	582.6	583.1	583.4	583.6	584.1	591.4
Lake Michigan	102	N/A	N/A	582.7	583.2	583.4	583.7	584.0	589.6
Lake Michigan	103	N/A	N/A	582.7	583.1	583.4	583.6	583.9	587.6
Lake Michigan	104	N/A	N/A	582.6	583.0	583.3	583.6	584.0	589.9
Lake Michigan	105	N/A	N/A	582.6	583.0	583.3	583.6	584.1	587.6
Lake Michigan	106	N/A	N/A	582.6	583.0	583.3	583.5	584.0	591.8
Lake Michigan	107	N/A	N/A	582.6	583.0	583.3	583.6	584.0	590.1
Lake Michigan	108	N/A	N/A	582.6	583.0	583.3	583.6	584.0	588.3
Lake Michigan	109	N/A	N/A	582.6	583.0	583.3	583.6	584.0	587.6
Lake Michigan	110	N/A	N/A	582.6	583.0	583.3	583.6	584.0	587.5

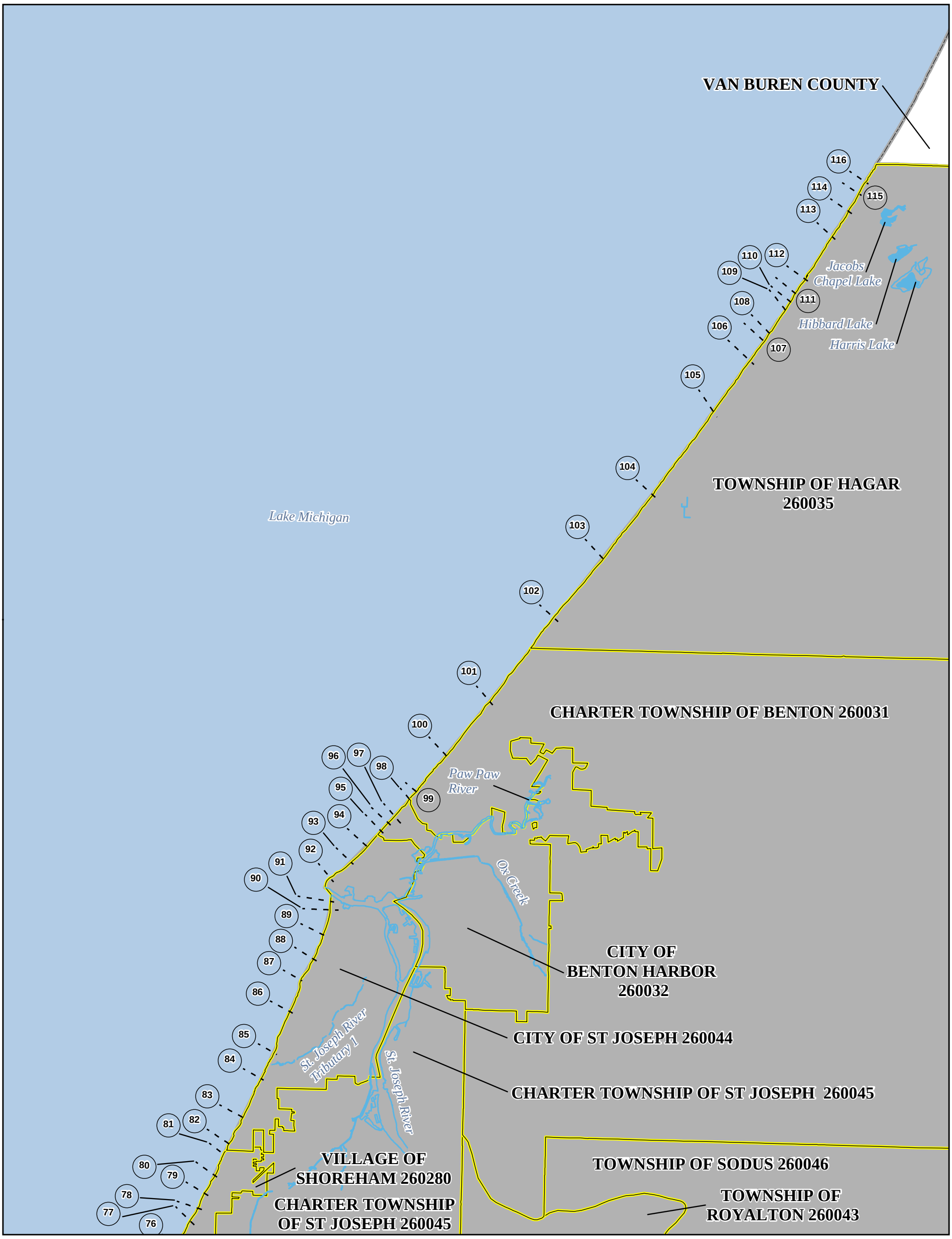
[1]Wave data are provided for WHAFIS-based transects only. The 1% starting wave parameters are not applicable for runup transects since a response-based approach is utilized.
[2]Wave data correspond to the 1-percent-annual-chance floodplain but may not be directly associated with the 1-percent-annual-chance SWEL.
[3]Statistical 1-percent-annual-chance starting Stillwater elevation may be different than that used in WHAFIS wave analysis as a result of the Joint Probability approach.
[4]Includes wave action representative of 1% Total Water Level (for wave runup and overtopping) or 1% Wave Crest Elevation (for overland wave propagation).

Table 16: Coastal Transect Parameters (continued)

Flood Source	Coastal Transect	Starting Wave Conditions for the 1-Percent Annual Chance [1,2]		Starting Stillwater Elevations (feet NAVD88)					1% Annual Chance Total Water Elevation[4] (ft NAVD88)
		Significant Wave Height H_s (feet)	Peak Wave Period T_p (seconds)	10-Percent Annual Chance	4-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance[3]	0.2-Percent Annual Chance	
Lake Michigan	111	N/A	N/A	582.6	583.0	583.3	583.6	584.0	587.5
Lake Michigan	112	N/A	N/A	582.6	583.1	583.4	583.6	584.1	587.2
Lake Michigan	113	N/A	N/A	582.6	583.0	583.4	583.6	584.1	586.9
Lake Michigan	114	N/A	N/A	582.7	583.2	583.4	583.6	584.0	591.0
Lake Michigan	115	N/A	N/A	582.6	583.1	583.4	583.7	584.2	590.4
Lake Michigan	116	N/A	N/A	582.6	583.1	583.4	583.7	584.3	590.0

[1]Wave data are provided for WHAFIS-based transects only. The 1% starting wave parameters are not applicable for runup transects since a response-based approach is utilized.
[2]Wave data correspond to the 1-percent-annual-chance floodplain but may not be directly associated with the 1-percent-annual-chance SWEL.
[3]Statistical 1-percent-annual-chance starting Stillwater elevation may be different than that used in WHAFIS wave analysis as a result of the Joint Probability approach.
[4]Includes wave action representative of 1% Total Water Level (for wave runup and overtopping) or 1% Wave Crest Elevation (for overland wave propagation).

Figure 9 - Transect Location Map



COUNTY LOCATOR

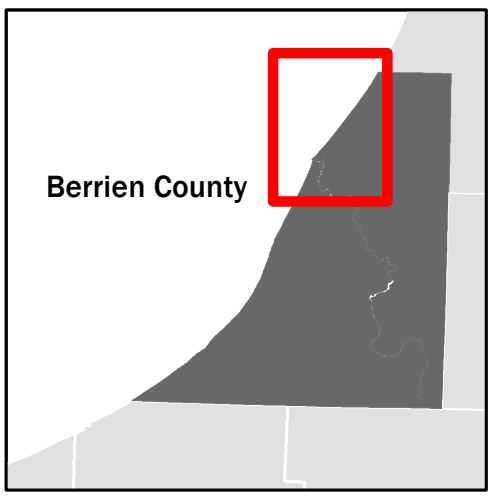
1 inch = 6,000 feet

Feet

0 3,000 6,000 12,000

N

Map Projection:
NAD 1983 State Plane
Michigan South FIPS 2113 Feet



NATIONAL FLOOD INSURANCE PROGRAM

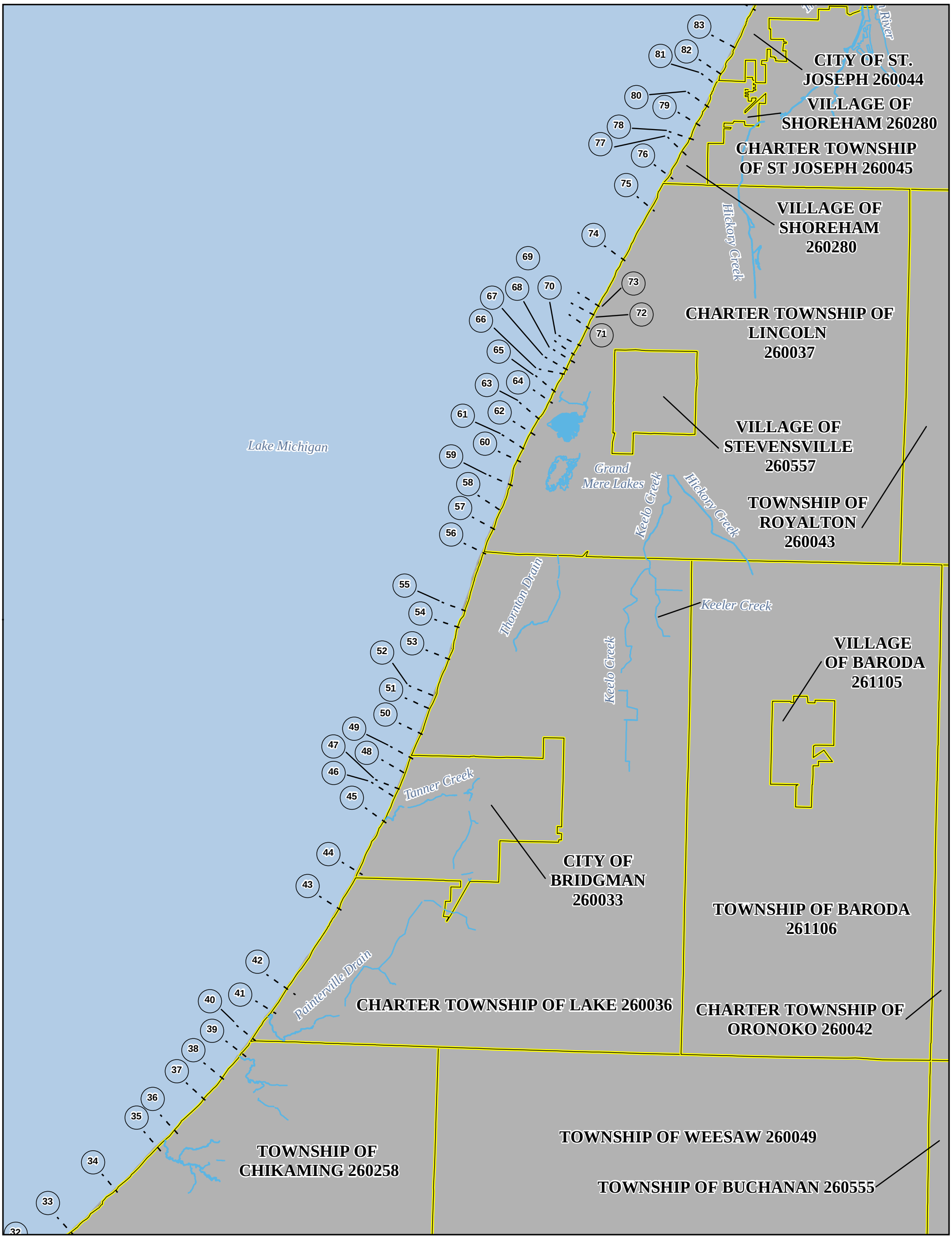
Transect Locator Map

PANELS WITH TRANSECTS:

0007, 0009, 0013, 0014, 0015, 0016, 0026, 0084, 0091, 0092, 0093, 0101, 0103, 0194, 0204, 0205, 0210, 0211, 0212, 0213, 0314, 0316, 0317, 0318, 0330, 0332, 0335, 0336

FEMA

Figure 9 - Transect Location Map

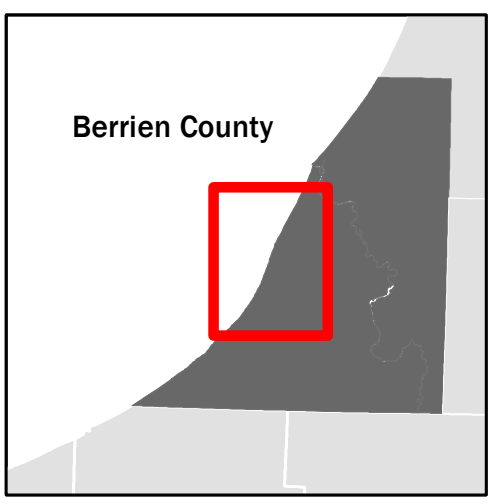


COUNTY LOCATOR

1 inch = 6,000 feet

Feet
0 3,000 6,000 12,000

Map Projection:
NAD 1983 State Plane
Michigan South FIPS 2113 Feet



NATIONAL FLOOD INSURANCE PROGRAM

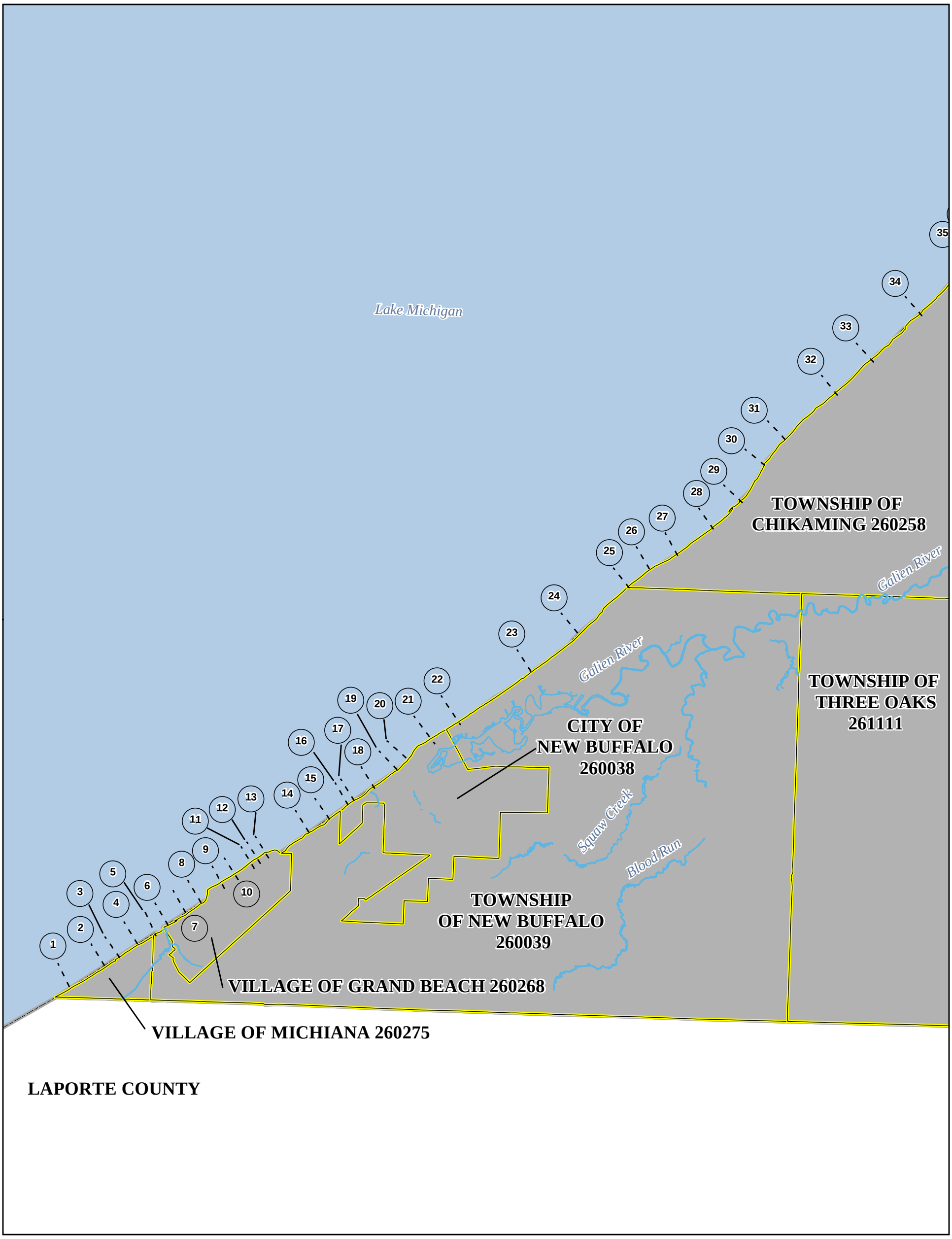
Transect Locator Map

PANELS WITH TRANSECTS:

0007, 0009, 0013, 0014, 0015, 0016, 0026, 0084, 0091, 0092, 0093, 0101, 0103, 0194, 0204, 0205, 0210, 0211, 0212, 0213, 0314, 0316, 0317, 0318, 0330, 0332, 0335, 0336

FEMA

Figure 9 - Transect Location Map



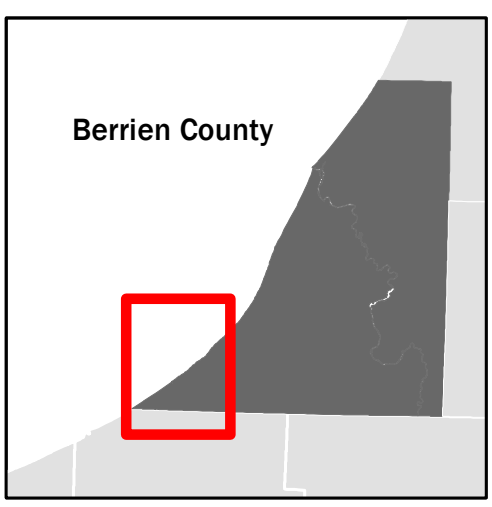
1 inch = 5,500 feet

Feet

0 2,750 5,500 11,000

Map Projection:
NAD 1983 State Plane
Michigan South FIPS 2113 Feet

COUNTY LOCATOR



NATIONAL FLOOD INSURANCE PROGRAM

Transect Locator Map

PANELS WITH TRANSECTS:

0007, 0009, 0013, 0014, 0015, 0016, 0026, 0084, 0091, 0092, 0093, 0101, 0103, 0194, 0204, 0205, 0210, 0211, 0212, 0213, 0314, 0316, 0317, 0318, 0330, 0332, 0335, 0336

FEMA

5.4 Alluvial Fan Analyses

This section is not applicable to this Flood Risk Project.

Table 17: Summary of Alluvial Fan Analyses

[Not Applicable to this Flood Risk Project]

Table 18: Results of Alluvial Fan Analyses

[Not Applicable to this Flood Risk Project]

SECTION 6.0 – MAPPING METHODS

6.1 Vertical and Horizontal Control

All FIS Reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum used for newly created or revised FIS Reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD29). With the completion of the North American Vertical Datum of 1988 (NAVD88), many FIS Reports and FIRMs are now prepared using NAVD88 as the referenced vertical datum.

Flood elevations on FIRM panels 26021C0007D, 008D, 009D, 013D, 014D, 015D, 016D, 018D, 026D, 084D, 091D, 092D, 093D, 094D, 101D, 102D, 103D, 115D, 194D, 204D, 205D, 210D, 211D, 212D, 213D, 314D, 316D, 317D, 318D, 330D, 332D, 335D, 336D, and 340D are referenced to the North American Vertical Datum of 1988. Flood elevations on the remainder of the FIRMs are referenced to the National Geodetic Vertical Datum of 1929. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between NGVD29 and NAVD88 or other datum conversion, visit the National Geodetic Survey website at www.ngs.noaa.gov.

Temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the archived project documentation associated with the FIS Report and the FIRMs for this community. Interested individuals may contact FEMA to access these data.

To obtain current elevation, description, and/or location information for benchmarks in the area, please visit the NGS website at www.ngs.noaa.gov.

The datum conversion locations and values that were calculated for Berrien County are provided in Table 19.

Table 19: Countywide Vertical Datum Conversion

Quadrangle Name	Quadrangle Corner	Latitude	Longitude	Conversion from NGVD29 to NAVD88 (feet)
Baroda	NE	42.000	-86.375	-0.448
Benton Harbor	NE	42.125	-86.375	-0.489
Benton Heights	NE	42.250	-86.375	-0.473
Berrien Springs	NE	42.000	-86.250	-0.444
Bridgman	NE	42.000	-86.500	-0.446
Coloma	NE	42.250	-86.250	-0.483
Galien	NE	41.875	-86.375	-0.417
Lydick	NE	41.750	-86.375	-0.375
Michigan City East	NE	41.750	-86.750	-0.373
New Buffalo East	NE	41.875	-86.625	-0.406
New Carlisle	NE	41.750	-86.500	-0.360
Niles West	NE	41.875	-86.250	-0.455
Sodus	NE	42.125	-86.250	-0.477
South Bend West	NE	41.750	-86.250	-0.423
Springville	NE	41.750	-86.625	-0.369
Stevensville	NE	42.125	-86.500	-0.484
Three Oaks	NE	41.875	-86.500	-0.417
Average Conversion from NGVD29 to NAVD88 = -0.432 feet				

Table 20: Stream-Based Vertical Datum Conversion

[Not Applicable to this Flood Risk Project]

6.2 Base Map

The FIRMs and FIS Report for this project have been produced in a digital format. The flood hazard information was converted to a Geographic Information System (GIS) format that meets FEMA's FIRM Database specifications and geographic information standards. This information is provided in a digital format so that it can be incorporated into a local GIS and be accessed more easily by the community. The FIRM Database includes most of the tabular information contained in the FIS Report in such a way that the data can be associated with pertinent spatial features. For example, the information contained in the Floodway Data table and Flood Profiles can be linked to the cross sections that are shown on the FIRMs. Additional information about the FIRM Database and its contents can be found in FEMA's *Guidelines and Standards for Flood Risk Analysis and Mapping*, www.fema.gov/flood-maps/guidance-partners/guidelines-standards.

Base map information shown on the FIRM was derived from the sources described in Table 21.

Table 21: Base Map Sources

Data Type	Data Provider	Data Date	Data Scale	Data Description
Aerial Photography photogrammetrically compiled at a scale of 1:24000 feet	Berrien County Planning and GIS Mapping	1996	1:24000	Orthoimagery for FIRMs dated 04/17/2006 (Berrien 1996)
Datum Conversion Points	National Oceanic and Atmospheric Administration	2017	N/A	Spatial points for datum conversion for FIRMs dated **TBD** (NOAA 2017)
Flood Insurance Rate Map, Berrien County, MI, All Jurisdictions	Federal Emergency Management Agency	2006	N/A	Spatial and attribute information for FIRM Panel layout (FEMA 2006b)
Michigan Geographic Framework: Berrien County	Center for Shared Solutions and Technology Partnerships	2012	1:6,000	Spatial and attribute information for transportation features, political boundaries, and Public Land Survey System (PLSS) boundaries for FIRMs dated **TBD** (Berrien 2012)
National Agriculture Imagery Program Digital Orthophotography	United States Department of Agriculture	2012	1:6,000	Orthoimagery for Berrien County, MI for FIRMs dated **TBD** (NAIP 2012)
National Hydrography Dataset - High Resolution	United States Geological Survey	2013	1:6,000	Spatial and attribute information for stream centerlines and watershed boundaries for FIRMs dated **TBD** (NHD 2013)
Public Land Survey System (PLSS) and Water areas for Berrien County, Michigan	Unknown	2006	N/A	PLSS grid and Water areas for FIRMS dated 4/17/2006 (UNK2 2006)
Submittal Info, Berrien County	STARR II	2017	N/A	Spatial and attribute information for coastal submission for FIRMs dated **TBD** (STARR 2017c)
Transportation and Water lines for Berrien County	Unknown	2006	N/A	Transportation and Water Lines for FIRMS dated 4/17/2006 (UNK1 2006)

6.3 Floodplain and Floodway Delineation

The FIRM shows tints, screens, and symbols to indicate floodplains and floodways as well as the locations of selected cross sections used in the hydraulic analyses and floodway computations.

For riverine flooding sources, the mapped floodplain boundaries shown on the FIRM have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were interpolated using the topographic elevation data described in Table 22. For each coastal flooding source studied as part of this FIS Report, the mapped floodplain boundaries on the FIRM have been delineated using the flood and wave elevations determined at each transect; between transects, boundaries were delineated using land use and land cover data, the topographic elevation data described in Table 22, and knowledge of coastal flood processes. In ponding areas, flood elevations were determined at each junction of the model; between junctions, boundaries were interpolated using the topographic elevation data described in Table 22.

In cases where the 1-percent and 0.2-percent-annual-chance floodplain boundaries are close together, only the 1-percent-annual-chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

The floodway widths presented in this FIS Report and on the FIRM were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. Table 2 indicates the flooding sources for which floodways have been determined. The results of the floodway computations for those flooding sources have been tabulated for selected cross sections and are shown in Table 23, “Floodway Data.”

Table 22: Summary of Topographic Elevation Data used in Mapping

Community	Flooding Source	Source for Topographic Elevation Data			
		Description	Vertical Accuracy	Horizontal Accuracy	Citation
Benton Harbor, City of; Benton, Charter Township of; Bridgman, City of; Chikaming, Township of; Grand Beach, Village of; Hagar, Township of; Lake, Charter Township of; Lincoln, Charter Township of; Michiana, Village of; New Buffalo, City of; New Buffalo, Township of; Shoreham, Village of; St. Joseph, Charter Township of; St. Joseph, City of	Lake Michigan	1 Meter Resolution DEM Data	15cm RMSE V.	1 Meter	JALBTCX 2013
Benton Harbor, City of; Benton, Charter Township of; Bridgman, City of; Chikaming, Township of; Grand Beach, Village of; Hagar, Township of; Lake, Charter Township of; Lincoln, Charter Township of; Michiana, Village of; New Buffalo, City of; New Buffalo, Township of; Shoreham, Village of; St. Joseph, Charter Township of; St. Joseph, City of	Lake Michigan; Redelineated stretches of Galien River, Ox Creek, Paw Paw River, St. Joseph River, and Tributary B	1/3 Arc-Second DEM Data	1 Meter	10 Meters	USGS 2017
Bertrand, Township of; Bridgman, City of; Chikaming, Township of; Galien, Township of; Lake, Charter Township of; New Buffalo, Township of; Niles, Charter Township of; Oronoko, Charter Township of; Pipestone, Township of; Sodus, Township of; Three Oaks, Township of; Weesaw, Township of	All Base (Zone A) Studies: Bedortha Drain (approximate), Brandywine Creek, Bridgman City Drain (approximate), Galien River (approximate), Lemon Creek, Pipestone Creek, and William & Esseg Drain (approximate); Bedortha Drain (detailed); Bridgman City Drain (detailed); Tanner Creek, William & Esseg Drain (detailed)	Berrien County Planning and GIS Mapping	*	*	*

*Not provided in FIS effective April 17, 2006

Table 22: Summary of Topographic Elevation Data used in Mapping *(continued)*

Community	Flooding Source	Source for Topographic Elevation Data			
		Description	Vertical Accuracy	Horizontal Accuracy	Citation
Baroda, Township of; Benton, Charter Township of; Benton Harbor, City of; Berrien, Township of; Berrien Springs, Village of; Bertrand, Township of; Bridgman, City of; Buchanan, City of; Buchanan, Township of; Chikaming, Township of; Coloma, Charter Township of; Coloma, City of; Galien, Township of; Grand Beach, Village of; Hagar, Township of; Lake, Charter Township of; Lincoln, Charter Township of; Michiana, Village of; New Buffalo, City of; New Buffalo, Township of; Niles, Charter Township of; Niles, City of; Oronoko, Charter Township of; Pipestone, Township of; Royalton, Township of; Shoreham, Village of; Sodus, Township of; St. Joseph, Charter Township of; St. Joseph, City of; Stevensville, Village of; Three Oaks, Township of; Watervliet, Charter Township of; Watervliet, City of; Weesaw, Township of;	Galien River (detailed); Ox Creek; Paw Paw River; St. Joseph River; Tributary B; all other flooding sources	*	*	*	*

*Not provided in FIS effective April 17, 2006

BFEs shown at cross sections on the FIRM represent the 1-percent-annual-chance water surface elevations shown on the Flood Profiles and in the Floodway Data tables in the FIS Report. Rounded whole-foot elevations may be shown on the FIRM in coastal areas, areas of ponding, and other areas with static base flood elevations.