



## Coastal Flood Hazard Study Result Summary Ottawa County, Ohio

### Offshore Wave Conditions

The Great Lakes Coastal Flood Study (GLCFS) is a collaboration of the Federal Emergency Management Agency (FEMA), the U.S. Army Corps of Engineers Engineer Research and Development Center (USACE - ERDC), State partners, and the Association of State Floodplain Managers to establish technically sound processes for updating data on Great Lakes coastal flood hazards. As part of the GLCFS, FEMA and its partners performed storm surge analyses for Lake Erie, which incorporated 50 years of historical records including meteorological, water level, wave conditions, and ice field data. Water levels, wave heights, and storm data were analyzed to determine the most important storm, wave height, and water level combinations that could potentially impact the coastline. Two dimensional (2-D) Storm surge and wave models were used to simulate each of the selected historic storms with the highest water level and wave height impacts. The storm surge and wave models were validated against severe historical storms by comparing simulated water levels with measured water levels from the National Oceanic and Atmospheric Administration National Ocean Service long-term measurement stations. The simulated nearshore storm surge and wave conditions were then used in site-specific analyses as described below to establish Base (1-percent-annual-chance) Flood Elevations (BFEs) along the coastline.

### Nearshore Wave Impacts

In sheltered areas when waves are not present, water levels from selected major storms were used to calculate the BFE. In areas where waves are present, the characteristics of the shoreline were analyzed to determine the type of impact. FEMA uses one dimensional (1-D) models to evaluate flood hazards in coastal areas. These 1-D models require that the shoreline be divided into reaches of similar physical characteristics and that the reaches be represented by cross-sectional lines located perpendicular to the shoreline, commonly referred to as transects. A total of 73 transects were used for the coastal flood hazard analysis for Ottawa County's 70-mile long Lake Erie coastline.

Wave runup occurs when waves strike a coastal feature (shore protection structure, dune, bluff, or other topographic feature); overland wave propagation applies when storm surge and waves can flow inland unimpeded. For cases of overland wave propagation, the waves and water levels are statistically analyzed to establish the BFE,

### Glossary of Terms

**1-Percent-Annual-Chance Flood:** A flood that has a 1-percent chance of being equaled or exceeded in any given year. It is also referred to as the base flood or 100-year flood.

**Base Flood Elevation (BFE):** The computed elevation to which floodwater is anticipated to rise during the base flood with wave effects included in coastal areas. The BFE, flood hazard zone, and a structure's elevation are factors in determining the flood insurance premium.

**Coastal High Hazard Area (CHHA) or VE Zone:** An SFHA extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high-velocity wave action from storms or tsunamis.

**Flood Insurance Rate Map (FIRM):** The official map of a community showing the BFEs, Special Flood Hazard Areas and the flood insurance premium zones.

**Special Flood Hazard Area (SFHA):** The area shown as inundated by the floodwaters of the base flood on FIRMs where floodplain management regulations must be enforced and mandatory flood insurance purchase requirements apply.

which is a combination of stillwater elevation and wave height that have a 1-percent-annual-chance of occurrence.

Where waves hit a bluff, dune or other coastal feature, the BFE is determined using a response based approach and statistical analysis of the computed wave runup for that reach of shoreline. Wave runup is influenced by the local bathymetry (specifically by beach steepness) and structure geometry. Therefore, runup can vary considerably along the shoreline. When the potential wave runup elevation exceeds the height of a coastal feature, overtopping occurs, and the BFE is limited by the elevation of the coastal feature.



Figure 1: Coastal BFE includes storm surge, wave setup, overland wave heights or runup elevations.

### Coastal Flood Hazard Mapping

The coastal BFE represents the wave envelope or elevation, which is the elevation of the 1-percent-annual-chance storm surge, plus wave setup, plus overland wave heights (wave crest elevation) or runup elevations (whichever is greater). The BFE calculated at a particular transect is mapped along the reach represented by that transect. The extent of the Special Flood Hazard Area (SFHA) is then determined by the elevation of the land in relation to the BFE. For areas dominated by wave runup, the coastal BFE can vary largely from reach to reach. Understanding and visualizing overland wave propagation is easier than wave runup as waves decay with interactions with obstructions (rising elevation, structures, dense vegetation) or grow (over open water, manicured lawns). Visualizing wave runup as a mapped coastal risk is more difficult. The mapped BFE does not indicate the elevation to which the water will sit, but rather an elevation that is at risk due to the motion of the waves running up and down that coastal feature. The coastal flood risk for Ottawa County is dominated by wave runup.

### Glossary of Terms (Cont'd)

**Limit of Moderate Wave Action (LiMWA):** The line on a FIRM that identifies the 1.5-foot wave height and the landward limit of the “Coastal A Zone” (CAZ).

**Overland Wave Propagation:** The process of simulating a wave as it travels inland during a storm event.

**Storm Surge:** The rise of water generated by a storm, over and above the predicted astronomical tides.

**Wave Runup:** The rush of water up a barrier, such as a dune, seawall or other steep shoreline feature that occurs when waves come ashore. If the wave runup exceeds the elevation of the barrier, overtopping will occur.

**Wave Setup:** The increase in the mean water level above stillwater surface near the shoreline, due to momentum transfer to the water column by waves that are breaking or otherwise dissipating their energy. Wave setup is affected by the wave height, the speed at which waves approach shore, and the nearshore slope.

For additional information please refer to FEMA’s Great Lakes Coastal Guidelines at [https://www.fema.gov/media-library-data/1429644544360-ecb03d79af615495232b3e94c6f318f5/Great\\_Lakes\\_Coastal\\_Guide\\_lines\\_Update\\_Jan2014.pdf](https://www.fema.gov/media-library-data/1429644544360-ecb03d79af615495232b3e94c6f318f5/Great_Lakes_Coastal_Guide_lines_Update_Jan2014.pdf)



## Coastal Engineering Results

The coastal flood hazard analysis result table summarizes the transect number, x-percent-annual-chance total stillwater elevations, elevation associated with the coastal feature used in the wave runoff and overtopping analysis, the 1-percent-annual-chance Base Flood Elevations (BFE) in feet NAVD88, and the mapped hazard.

**Table: Coastal Flood Hazard Analysis Result Table**

Transect	Stillwater Elevations (ft NAVD88) <sup>1</sup>				Top of Coastal Feature (ft NAVD88)	Draft Regulatory BFE at shoreline (ft NAVD 88)	Mapped Hazard
	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance			
1	575.6	576.1	576.2	576.4	N/A	577	WHAFIS
2	575.5	576.0	576.1	576.2	579.2	577	Wave Runup
3	575.4	575.8	576.0	576.1	N/A	577	WHAFIS
4	575.3	575.8	575.9	576.1	577.1	577	Wave Runup
5	575.3	575.8	575.9	576.1	578.3	577	Wave Runup
6	575.3	575.8	575.9	576.0	580.6	577	Wave Runup
7	575.2	575.7	575.8	575.9	N/A	577	WHAFIS
8	575.2	575.6	575.7	575.9	581.9	579	Wave Runup
9	575.9	576.4	576.5	576.6	N/A	578	WHAFIS
10	575.8	576.3	576.4	576.5	N/A	578	WHAFIS
11	575.8	576.3	576.4	576.6	577.1	578	WHAFIS
12	575.8	576.3	576.4	576.6	578.3	578	Wave Runup
13	575.8	576.3	576.4	576.5	N/A	578	Wave Runup
14	575.7	576.2	576.3	576.5	576.7	577	WHAFIS
15	575.7	576.3	576.4	576.6	580.4	577	Wave Runup
16	575.7	576.3	576.5	576.7	579.05	578	Wave Runup

<sup>1</sup> Stillwater Elevation is inclusive of storm surge plus lake level

Transect	Stillwater Elevations (ft NAVD88) <sup>1</sup>				Top of Coastal Feature (ft NAVD88)	Draft Regulatory BFE at shoreline (ft NAVD 88)	Mapped Hazard
	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance			
17	575.7	576.2	576.3	576.5	580.4	578	Wave Runup
18	575.6	576.1	576.2	576.4	N/A	577	Wave Runup
19	575.7	576.3	576.4	576.6	576.6	579	Wave Runup
20	575.7	576.2	576.3	576.5	584.9	581	Wave Runup
21	575.7	576.2	576.3	576.5	578.8	579	Wave Runup
22	575.6	576.2	576.3	576.5	576.5	579	Wave Runup
23	575.7	576.2	576.4	576.5	587.9	579	Wave Runup
24	575.6	576.2	576.4	576.5	584.5	579	Wave Runup
25	575.7	576.3	576.4	576.6	581	581	Wave Runup
26	575.7	576.3	576.5	576.7	576.6	579	Wave Runup
27	575.8	576.3	576.5	576.7	576.5	579	Wave Runup
28	575.8	576.3	576.5	576.7	N/A	579	Wave Runup
29	575.8	576.3	576.5	576.6	N/A	579	Wave Runup
30	575.8	576.3	576.4	576.6	N/A	580	Wave Runup
31	575.8	576.3	576.4	576.5	577.1	580	Wave Runup
32	575.8	576.3	576.4	576.5	584.9	579	Wave Runup
33	575.8	576.3	576.4	576.5	582.1	579	Wave Runup
34	575.8	576.3	576.4	576.6	576.8	579	Wave Runup
35	575.8	576.3	576.5	576.6	585.5	585	Wave Runup
36	575.9	576.4	576.5	576.7	581	579	Wave Runup
37	575.9	576.4	576.5	576.7	581	580	Wave Runup

<sup>1</sup> Stillwater Elevation is inclusive of storm surge plus lake level



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	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance			
38	575.9	576.5	576.6	576.8	585.2	579	Wave Runup
39	575.9	576.5	576.6	576.8	578.5	578	Wave Runup
40	576.0	576.5	576.7	576.9	581.1	579	Wave Runup
41	576.0	576.6	576.7	576.9	579	579	Wave Runup
42	576.1	576.6	576.8	576.9	N/A	579	WHAFIS
43	576.1	576.6	576.8	576.9	577	579	Wave Runup
44	576.1	576.7	576.8	577.0	577.4	579	Wave Runup
45	576.1	576.7	576.8	577.0	580.5	579	Wave Runup
46	576.1	576.7	576.8	577.0	578.6	580	Wave Runup
47	576.1	576.7	576.8	577.0	580.5	579	Wave Runup
48	576.1	576.7	576.8	576.9	578.5	581	Wave Runup
49	576.1	576.7	576.8	576.9	579.7	579	Wave Runup
50	576.1	576.6	576.7	576.9	577.7	579	Wave Runup
51	576.1	576.6	576.7	576.9	577.9	579	WHAFIS
52	576.1	576.6	576.8	576.9	576.9	580	Wave Runup
53	576.2	576.7	576.8	577.0	578.5	579	Wave Runup
54	576.2	576.7	576.8	576.9	578	579	Wave Runup
55	576.2	576.7	576.8	576.9	579	579	Wave Runup
56	575.6	576.2	576.3	576.5	582.4	579	Wave Runup
57	575.6	576.1	576.2	576.4	577.3	579	WHAFIS
58	575.6	576.1	576.2	576.3	N/A	578	WHAFIS

<sup>1</sup> Stillwater Elevation is inclusive of storm surge plus lake level



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	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance			
59	575.74	576.23	576.34	576.47	596.6	586	Wave Runup
60	575.70	576.22	576.33	576.49	578.2	579	Wave Runup
61	575.63	576.13	576.25	576.40	575.2	578	WHAFIS
62	575.58	576.08	576.20	576.35	578.5	578	Wave Runup
63	575.54	576.03	576.14	576.28	576.9	578	WHAFIS
64	575.61	576.10	576.21	576.36	577.3	578	WHAFIS
65	575.68	576.17	576.29	576.43	N/A	578	WHAFIS
66	575.67	576.18	576.30	576.46	N/A	578	WHAFIS
67	575.71	576.23	576.35	576.51	575.7	576	WHAFIS
68	575.61	576.14	576.26	576.43	577.7	578	WHAFIS
69	575.58	576.08	576.20	576.35	580.1	584	Wave Runup
70	575.61	576.12	576.24	576.40	580.3	581	Wave Runup
71	575.65	576.16	576.29	576.45	578.3	579	WHAFIS
72	575.75	576.25	576.36	576.51	588.5	578	Wave Runup
73	575.76	576.24	576.34	576.47	592.4	582	Wave Runup

<sup>1</sup> Stillwater Elevation is inclusive of storm surge plus lake level