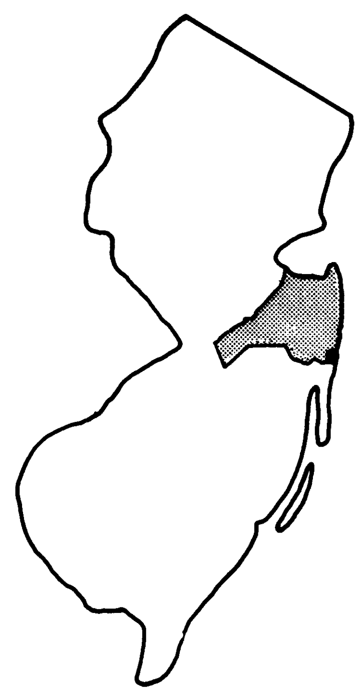
FLOOD INSURANCE STUDY

SUPPLEMENT- WAVE HEIGHT ANALYSIS

BOROUGH OF MANASQUAN, NEW JERSEY
MONMOUTH COUNTY



JUNE 15, 1983

Federal Emergency Management Agency

COMMUNITY NUMBER - 345303

TABLE OF CONTENTS

TABLE OF CONTENTS - continued

Page

FIGURES

TABLES

EXHIBITS

1.0 INTRODUCTION

1.1 Background and Purpose

The Federal Emergency Management Agency (FEMA) recently adopted recommendations by the National Academy of Sciences to include prediction of wave heights in Flood Insurance Studies for coastal communities subject to storm surge flooding, and to report the estimated wave crest elevations as the base flood elevations on Flood Insurance Rate Maps (FIRMs).

Previously, FIRMs were produced showing only the stillwater elevations due to the lack of a suitable and generally applicable methodology for estimating the wave crest elevations associated with storm surges. These stillwater elevations were subsequently stipulated in community flood plain management ordinances as the minimum elevation of the lowest floor including basement of new construction. Communities and individuals had to consider the additional hazards of velocity waters and wave action on an ad hoc basis. Because there has been a pronounced tendency for buildings to be constructed only to meet minimum standards, without consideration of the additional hazard due to wave height, increasing numbers of people could unknowingly be accepting a high degree of flood-related personal and property risk in coastal areas subject to wave action. Therefore, the FEMA has pursued the development of a suitable methodology for estimating the wave crest elevations associated with storm surges. The recent development of such a methodology by the National Academy of Sciences has led to the adoption of wave crest elevations for use as the base flood elevations in coastal communities (Reference 1).

The Borough of Manasquan is subject to flooding from tropical storms, extratropical cyclones, and, to a lesser extent, severe thunderstorm activity. Most serious tidal flooding problems are attributed to hurricanes which occur during the late summer and early autumn. In addition to heavy precipitation, hurricanes, high tides, and strong waves can result in severe damage to coastal areas. Although extratropical cyclones, referred to as northeasters, can develop at almost any time of the year, they are more likely to occur during the winter and spring. Thunderstorms are a common occurrence during the summer months.

In recent years, the storms of September 1944, November 1950, and March 1962 caused damage to the New Jersey coast (References 2 and 3). The hurricane of September 14, 1944, struck the shoreline of New Jersey with wind velocities ranging from 90 miles per hour (mph) at Atlantic City to over 100 mph at New York City. During the passage of the storm, many communities reported extreme high tides. A strong northeaster struck the New Jersey shoreline on November 25, 1950, causing gale-force winds and more than 3 inches of rainfall.

The northeaster of March 6-8, 1962, struck the coastline of New Jersey with gale-force winds, extreme high tides, and heavy precipitation in the form of wet snow. Generating winds of 70 mph, the storm remained in the study area for 60 hours. The unusually long duration coincided with five successive high spring tides. Severe flooding conditions, not only in the study area but along the entire shoreline of New Jersey, resulted from the high stormwaters, waves, and gale-force winds. In Manasquan, the beach and bluffs were eroded, the paved beachwalk was destroyed, and the jetty was damaged. One house was completely destroyed, and 50 houses and one restaurant were damaged (Reference 4).

The purpose of this study is to revise the FIRM for the Borough of Manasquan to include the effects of wave action for the following flooding source: Atlantic Ocean.

The wave height analysis for this study was prepared by Dewberry & Davis for the FEMA, under Contract No. EMW-C-0543. This work was completed in December 1982.

2.0 INVESTIGATIONS

2.1 Previous Studies

Stillwater elevations used in this analysis for the Atlantic Ocean were taken from a set of storm surge profiles for the open coast of New Jersey as developed by Dewberry & Davis (Reference 5). In the vicinity of Manasquan, the elevations for the Atlantic Ocean were determined by analyzing a surge-frequency study of the Sandy Hook, New Jersey, tidal gage as performed by the New York District of the U. S. Army Corps of Engineers (COE), and an analysis using a FEMA coastal storm surge model (References 6 and 7). The COE used a graphical analysis of systematic records from the Sandy Hook gage (1933-1975). The FEMA coastal storm surge model is a hydrodynamic model coupled with the statistical treatment of storm data and annual, astronomic tide predictions. This study supersedes the previous Flood Insurance Study for the Borough of Manasquan (Reference 8).

2.2 Data Collection and Review

All available source data applicable for the wave height analysis were collected and reviewed. Because wave height calculations are based on such parameters as the size and density of vegetation, natural barriers (sand dunes), buildings, and other manmade structures, it was necessary to obtain detailed information on the physical and cultural features of the study area.

During the course of this analysis, the Borough of Manasquan, Keystone Aerial Surveys Incorporated, the New Jersey Department of Environmental Protection, the New Jersey Highway Authority, the New Jersey Department of Geology, the Monmouth County Planning Department, the Monmouth County Engineer, and the COE were contacted for data.

The principal source materials used for the wave height analysis are described below.

1. Aerial photographs and glass aerial plotting plates (stereoscopic coverage) of Manasquan were obtained from Keystone Aerial Surveys of Philadelphia, Pennsylvania (Reference 9). The aerial plotting plates generated the topographic maps used in this analysis. The aerial photographs were used to determine the type, size, and density of vegetation and physical features.

2. Topographic maps for the shoreline areas of Manasquan at a scale of 1:2,400 and a contour interval of 4 feet were developed by Dewberry & Davis (Reference 10). These maps were used to supplement the base maps, for work maps to calculate wave heights, and for plotting elevations and boundaries of the Flood Hazard Zones (Section 3.1).

3. U. S. Geological Survey (USGS) quadrangles of Asbury Park and Point Pleasant were used to supplement the base and work maps, for fetch calculations, and for the placement of transects (Reference 11).

4. Stillwater elevations for the Atlantic Ocean were obtained from a profile developed by Dewberry & Davis (Reference 5).

2.3 Wave Height Analysis

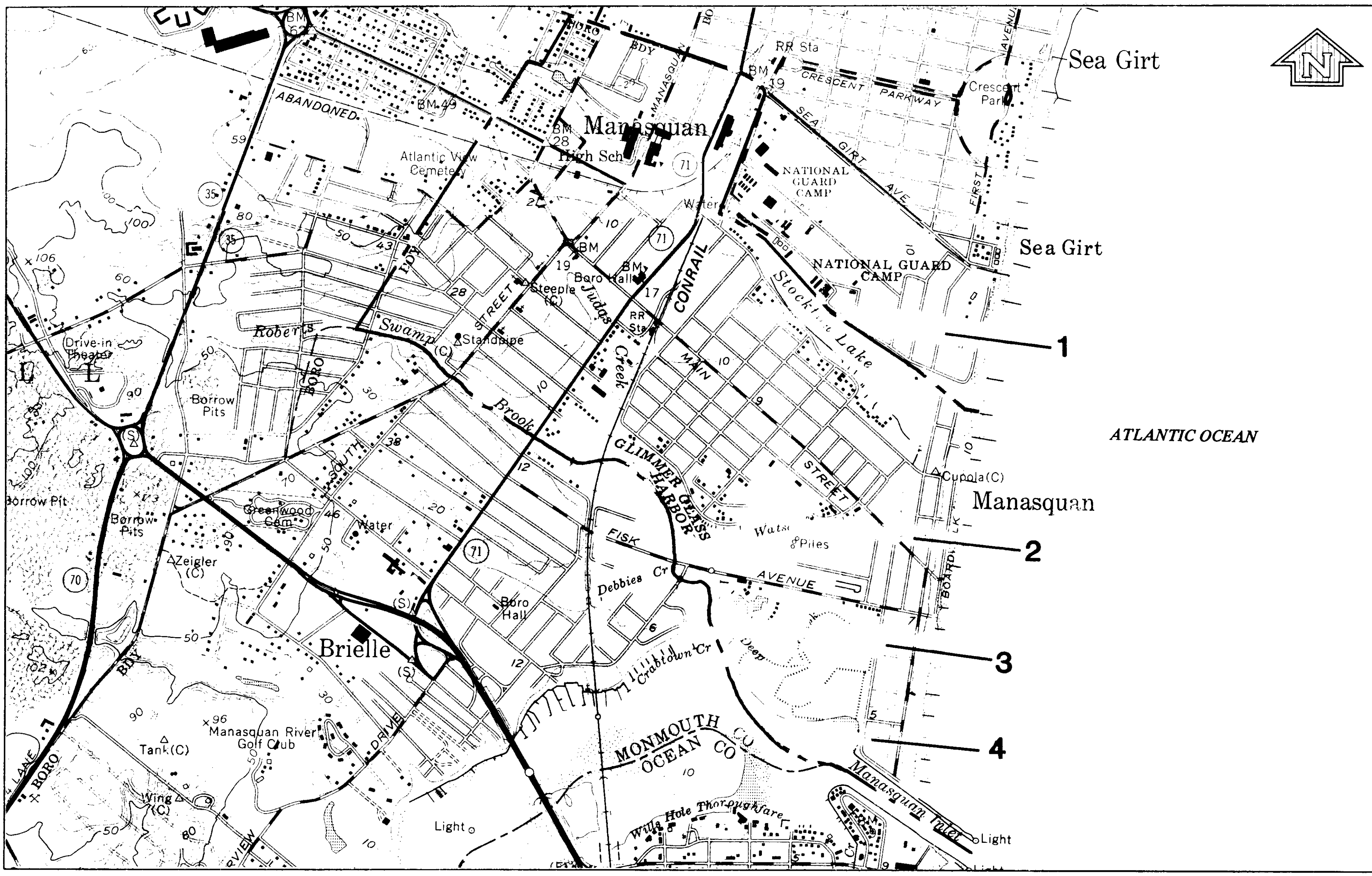
The methodology for analyzing the effects of wave heights associated with coastal storm surge flooding is described in the National Academy of Sciences report (Reference 1). This method is based on three major concepts. First, depth-limited waves in shallow water reach a maximum breaking height that 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 described in Reference 1. 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.

Wave heights were computed along transects (cross section lines) that were located along the coastal areas, as illustrated in Figure 1, in accordance with the Users Manual for Wave Height Analysis (Reference 12). The transects were located with consideration given to the physical and cultural characteristics of the land so that they would closely represent conditions in their locality. Transects were spaced close together in areas of complex topography and dense development. In areas having more uniform characteristics, they were spaced at larger intervals. It was also necessary to locate transects in areas where unique flooding existed and in areas where computed wave heights varied significantly between adjacent transects.

Each transect was taken perpendicular to the shoreline and extended inland to a point where wave action ceased. Along each transect, wave heights and elevations were computed considering the combined effects of changes in ground elevation, vegetation, and physical features. The stillwater elevations for the 100-year flood were used as the starting elevations for these computations. Wave heights were calculated to the nearest 0.1 foot, and wave elevations were determined at whole-foot increments along the transects. The location of the 3-foot breaking wave for determining the terminus of the V Zone (area with velocity wave action) was also computed at each transect. Table 1 provides a listing of the transect location and stillwater starting elevations, as well as maximum wave crest elevations. It was assumed that the beach area would erode during a major storm, thus reducing its effectiveness in decreasing wave heights.

TABLE 1 - TRANSECT DESCRIPTIONS

Transect	Location	Elevation (feet) Stillwater 100-year	Elevation (feet) Maximum Wave Crest 100-year
No. 1	Northern corporate limits to Ocean Avenue, extended	8.5	13
No. 2	Ocean Avenue, extended, to Brielle Road, extended	8.5	13
No. 3	Brielle Road, extended, to Whiting Avenue, extended	8.5	13
No. 4	Whiting Avenue, extended, to southern corporate limits	8.4	13



FEDERAL EMERGENCY MANAGEMENT AGENCY

BOROUGH OF MANASQUAN, NJ

(MONMOUTH CO.)

APPROXIMATE SCALE

2000 0 2000 4000 6000 FEET

TRANSECT LOCATION MAP

FIGURE 1

Figure 2 is a profile for a typical transect illustrating the effects of energy dissipation and regeneration on a wave as it moves inland. This figure shows the wave elevations being decreased by obstructions, such as buildings, vegetation, and rising ground elevations, and being increased by open, unobstructed wind fetches. Actual wave conditions in the Borough of Manasquan may not include all the situations illustrated in Figure 2.

After analyzing wave heights along each transect, wave elevations were interpolated between transects. Various source data were used in the interpolation, including the topographic work maps, aerial photographs, notes and photographs taken during field inspection, and engineering judgment. Controlling features affecting the elevations were identified and considered in relation to their positions at a particular transect and their variation between transects.

2.4 Results

Computed wave heights and elevations associated with the 100-year storm surge are summarized below for various reaches in the study area.

Atlantic Ocean (Transects 1-4)

The maximum wave crest elevation affecting the Manasquan shoreline from the Atlantic Ocean is 13 feet. Waves greater than 3 feet propagate inland approximately 80 feet seaward of First Avenue where they are reduced to less than 3 feet by development. Waves less than 3 feet propagate inland across most of the borough, with the exceptions of the high ground in the northwestern section of Manasquan and the high ground south of Deep Creek. Waves less than 3 feet propagate inland to where flooding from Roberts Swamp Creek, Judas Creek, and Mac's Brook becomes predominate.

On January 21, 1983, the results of the study were reviewed at a final Consultation and Coordination Officer's (CCO) meeting attended by representatives of the FEMA, the Borough of Manasquan, and Dewberry & Davis.

3.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

A prime purpose of the National Flood Insurance Program is to encourage local governments to adopt sound flood plain management programs designed to reduce future flood losses. The FIRM for the Borough of Manasquan has been revised to incorporate the latest available information, including wave height data, to assist these communities in developing the most appropriate and effective flood plain management measures.

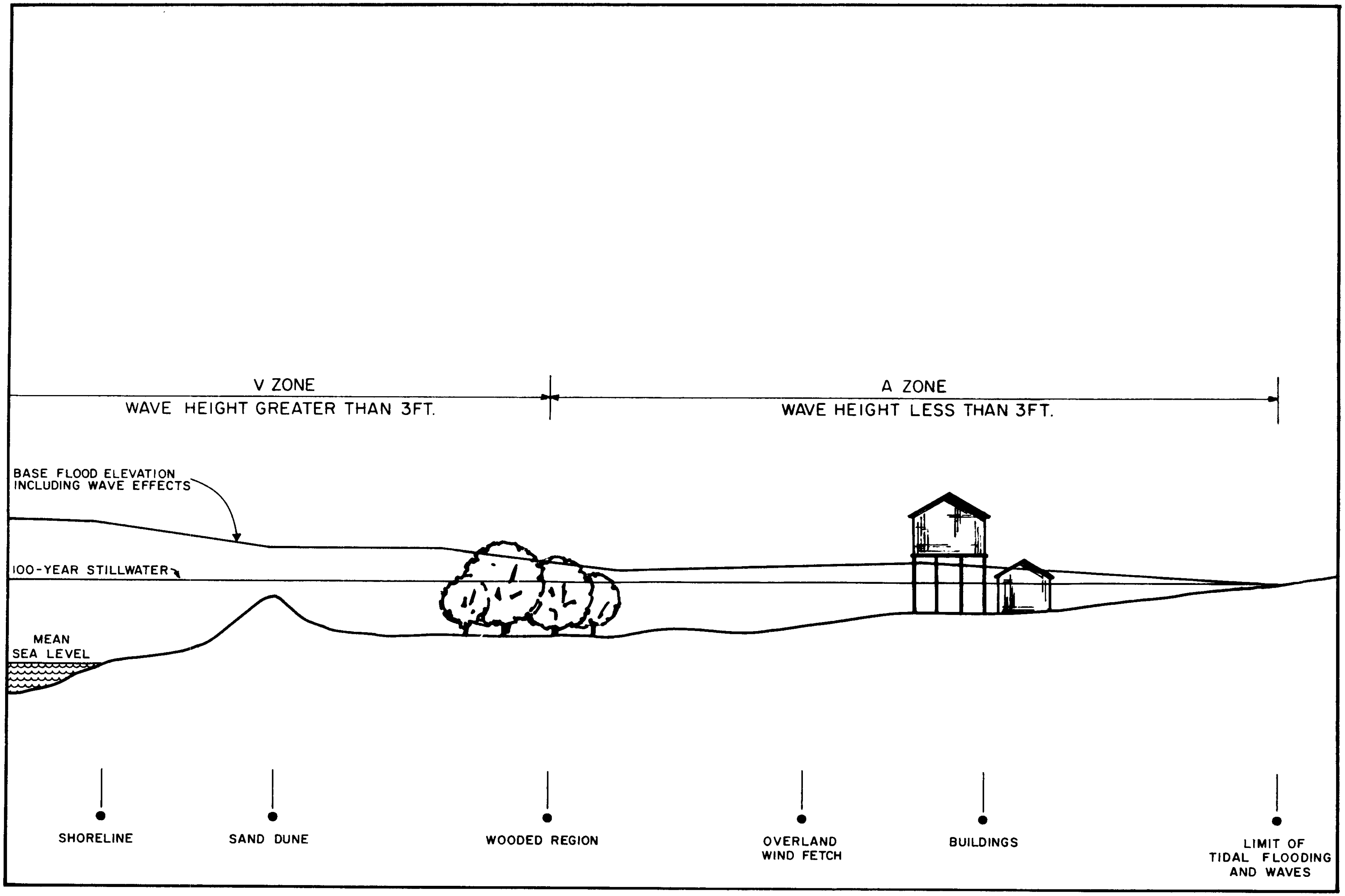


FIGURE 2
TYPICAL TRANSECT SCHEMATIC

3.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the FEMA as the base flood for purposes of flood plain management. This flood has a 1 percent chance of being equalled or exceeded each year and is expected to be exceeded once on the average during any 100-year period. The risk of having a flood of this magnitude or greater increases when periods longer than 1 year are considered. For example, over a 30-year period, there is a 26 percent chance of experiencing a flood equal to or greater than the 100-year flood. The 500-year flood plain is also shown on the FIRM to indicate areas of moderate flood hazards.

Areas inundated by the 100-year flood are shown as A and V Zones on the community's FIRM. It is in these areas that the FEMA requires local communities to exercise flood plain management measures as a condition for participation in the National Flood Insurance Program.

3.2 Base Flood Elevations

Areas within the communities studied by detailed engineering methods have base flood elevations established in A and V Zones. These are the elevations of the base (100-year) flood relative to the National Geodetic Vertical Datum (mean sea level) of 1929. In coastal areas affected by wave action, base flood elevations are generally maximum at the normal open shoreline. These elevations generally decrease in a landward direction at a rate dependent on the presence of obstructions capable of dissipating the wave energy. Where possible, changes in base flood elevations have been shown in 1-foot increments on the FIRMs. However, where the scale did not permit, 2- or 3-foot increments were sometimes used. Base flood elevations shown in the wave action areas represent the average elevation within the zone. Current program regulations generally require that all new construction be elevated such that the first floor, including basement, is above the base flood elevation in A and V Zones.

3.3 Velocity Zones

The U. S. Army Corps of Engineers has established the 3-foot breaking wave as the criterion for identifying coastal high hazard zones (Reference 13). This was based on a study of wave action effects on structures. This criterion has been adopted by the FEMA for the determination of V Zones. Because of the additional hazards associated with high-energy waves, the National Flood Insurance Program regulations require much more stringent flood plain management measures in these areas, such as elevating structures on piles or piers. In addition, insurance rates in V Zones are higher than those in A Zones with similar numerical designations.

The location of the V Zone is determined by the 3-foot breaking wave as discussed previously. The detailed analysis of wave heights performed in this study allowed a much more accurate location of the V Zone to be established. The V Zone generally extends inland to the point where the 100-year flood depth is insufficient to support a 3-foot breaking wave.

4.0 INSURANCE APPLICATION

The assignment of proper actuarial insurance rates requires that frequency and depth of flooding be estimated as accurately as possible. Because waves can add considerably to expected flood depths, it is important that insurance rates consider this additional hazard. The FEMA has developed a process to transform the data from this study into flood insurance criteria. This process includes the determination of Flood Hazard Factors and the designation of flood insurance zones.

4.1 Flood Hazard Factors

The Flood Hazard Factor (FHF) is the device used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHF are used to set actuarial insurance premium rate tables.

The FHF is shown as a three-digit code that expresses the difference between the 10- and 100-year flood elevations to the nearest 0.5 foot. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, the FHF is computed to the nearest foot.

4.2 Flood Insurance Zones

After wave elevations for the 100-year storm surge were determined and mapped, the study area was divided into zones, each having a specific flood potential and FHF. Each zone was assigned one of the following flood insurance zone designations:

Zone V6: Special Flood Hazard Areas along coasts inundated by the 100-year flood as determined by detailed methods, and that have additional hazards due to velocity (wave action); base flood elevations shown, and zones subdivided according to FHFs.

Zones A5 and A6: Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown, and zones subdivided according to FHF.

Zone B: Areas between the Special Flood Hazard Area and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; also, areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.

Zone C: Areas of minimal flooding.

Table 2, "Flood Insurance Zone Data", summarizes the FHFs, flood insurance zones, and base flood elevations for the flooding source in the study area.

TABLE 2 - FLOOD INSURANCE ZONE DATA

Flooding Source	Stillwater Elevation 10-Year	50-Year	100-Year	500-Year	FHF	Zone	Base Flood Elevation (Feet NGVD)*
Atlantic Ocean							
Transects 1-3	6.6	7.8	8.5	10.0	030	V6	11-13
					025	A5	9-11
Transect 4	6.6	7.8	8.4	10.0	030	V6	11-13
					025	A5	8-11
					030	A6	8-10

*Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.

4.3 Flood Insurance Rate Map

After flood insurance zones were established for the study area, the FIRM for the Borough of Manasquan was revised to incorporate the new zone information. This map contains the official delineation of flood insurance zones and base flood elevations. The base map was changed using the more accurate topographic maps developed for this analysis (Reference 10).

5.0 OTHER STUDIES

The Flood Insurance Studies for the adjacent Boroughs of Brielle and Point Pleasant are currently being conducted and will include wave height analyses (References 14 and 15). The results of those studies will be in exact agreement with the results of this study.

Flood Insurance Rate Maps for the adjacent Borough of Sea Girt are being revised to include a wave height analysis (Reference 16). The results of the revised study will be in exact agreement with the results of this study.

No wave height analysis for the adjacent Township of Wall is being conducted at this time (Reference 17). Therefore, the Flood Insurance Rate Maps for that study will not agree with those for the Manasquan study. Also, the stillwater elevations determined in the study for Wall are not in agreement with the elevations determined for the Manasquan study. That study used the COE Sandy Hook gage analysis directly, while the Manasquan study uses the COE Sandy Hook gage analysis combined with a FEMA coastal storm surge analysis (References 6 and 7).

6.0 REFERENCES

1. National Academy of Sciences, Methodology for Calculating Wave Action Effects Associated With Storm Surges, Washington, D. C., 1977.

2. U. S. Army Corps of Engineers, New York District, Raritan Bay and Sandy Hook Bay, New Jersey, Cooperative Beach Erosion Control and Interim Hurricane Study (Survey), New York, November 1960.

3. U. S. Army Corps of Engineers, Philadelphia District, Tidal Flood Plain Information, Toms River Area, Ocean County, New Jersey, Philadelphia, Pennsylvania, June 1972.

4. U. S. Army Corps of Engineers, North Atlantic Division, Report on Operation Five High, March 1962 Storm, August 1963.

5. Dewberry & Davis, prepared for the Federal Emergency Management Agency, Tidal Flood Profiles for the New Jersey Coastline, Fairfax, Virginia, Developed in April 1982 (Unpublished).

6. U. S. Army Corps of Engineers, New York District, Weibull Plotting Positions Analyses for the Battery, Sandy Hook, and East Newark, Albany, New York, 1979.

7. Federal Emergency Management Agency, Coastal Flooding Storm Surge Model, Methodology, Part 1, Washington, D. C., February 1981.

8. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Borough of Manasquan, Monmouth County, New Jersey, Washington, D. C., November 12, 1971.

9. Keystone Aerial Surveys of Philadelphia, Pennsylvania, Aerial Photographs and Aerial Plotting Plates, Scale 1:12,000: Manasquan, New Jersey, March 1979.

10. Dewberry & Davis of Fairfax, Virginia, prepared for the Federal Emergency Management Agency, Topographic Maps, Scale 1:2,400, Contour Interval 4 Feet: Borough of Manasquan, New Jersey, Developed in October 1982 (Unpublished).

11. U. S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 20 Feet: Asbury Park, New Jersey, 1954, Photorevised 1970; Point Pleasant, 1953, Photorevised 1971.

12. Federal Emergency Management Agency, Users Manual for Wave Height Analysis, Washington, D. C., Revised February 1981.

13. U. S. Army Corps of Engineers, Galveston District, Guidelines for Identifying Coastal High Hazard Zones, Galveston, Texas, June 1975.

14. Federal Emergency Management Agency, Flood Insurance Study, Borough of Brielle, Monmouth County, New Jersey (Unpublished).

15. Federal Emergency Management Agency, Flood Insurance Study, Borough of Point Pleasant, Ocean County, New Jersey (Unpublished).

16. Federal Emergency Management Agency, Flood Insurance Study, Wave Height Analysis, Borough of Sea Girt, Monmouth County, New Jersey (Unpublished).

17. U. S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Township of Wall, Monmouth County, New Jersey, Washington, D. C., August 16, 1976.