



To Pete Kocsik  
From Tom Dixon  
Date March 18, 2014  
Project #  
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CC  
Subject MCUA Edison Pump Station – Basis of Design Memorandum

**GENERAL**

When Hurricane Sandy hit, FEMA was in the process of updating their flood mapping. However, in order to provide elevation standards for rebuilding in a timely manner, FEMA published Advisory Base Flood Elevation (ABFE) maps. These maps provided advisory elevations for the 1% annual chance (100-year) and 0.2% annual chance (500-year) storms, and delineated V Zones (where wave velocity will have impacts), areas of moderate wave action, and A Zones. The information was based on the best available data at the time and was intended to be used as a guide for rebuilding and recovery efforts until the Flood Insurance Rate Maps (FIRMs) were finalized.

FEMA subsequently published Preliminary Work Maps which superseded the ABFE maps, and reflected further coastal flood hazard study. These maps were released as an interim product created in the development of preliminary FIRMs. They were intended to give a better understanding of current flood risks and anticipate future flood insurance requirements. The release of the work maps provided local officials the opportunity to comment on areas they believe were mapped incorrectly, which in turn, would help FEMA avoid delays in publishing the preliminary FIRMs and the need for subsequent revisions. The work maps released indicated V and A Zones, areas of moderate wave action, and 1% annual chance (100-year) base flood elevations, but no 0.2% annual chance (500-year) flood elevations.

On 1/31/14, FEMA issued preliminary FIRMs for Middlesex County, which covered the project area. Meetings will be held to allow community officials to formally review the preliminary FIRMs and other flood risk tools. Later, open house meetings will be held to allow the general public to ask questions related to the mapping, mitigation, and the National Flood Insurance Program (NFIP). Once the preliminary FIRMs and public notice have been issued, there will be a statutory 90-day appeal period to allow submission of scientific and technical information through community officials that better defines local conditions. At the end of the 90-day period, and following the resolution of any appeals, FEMA will finalize the maps and initiate a 6-month compliance period before formal map adoption. After this 6-month period, the updated FIRMs will be considered effective and become the basis for flood insurance requirements and premiums, and for local building regulations. The process usually takes 18 to 24 months from release of the preliminary FIRM to the final effective date. Similar to the Preliminary Work Maps, 500-year flood elevations were not indicated on the preliminary FIRMs reviewed.

MCUA requested and received from FEMA, 500-year stillwater elevations (SWELs) for the project area, but not 500-year design flood elevations that include wave action (see page 7 and 8). Elevations which include wave action are necessary to properly design critical facilities (e.g. hospitals, schools, and public safety buildings). Critical facilities and freeboard are discussed

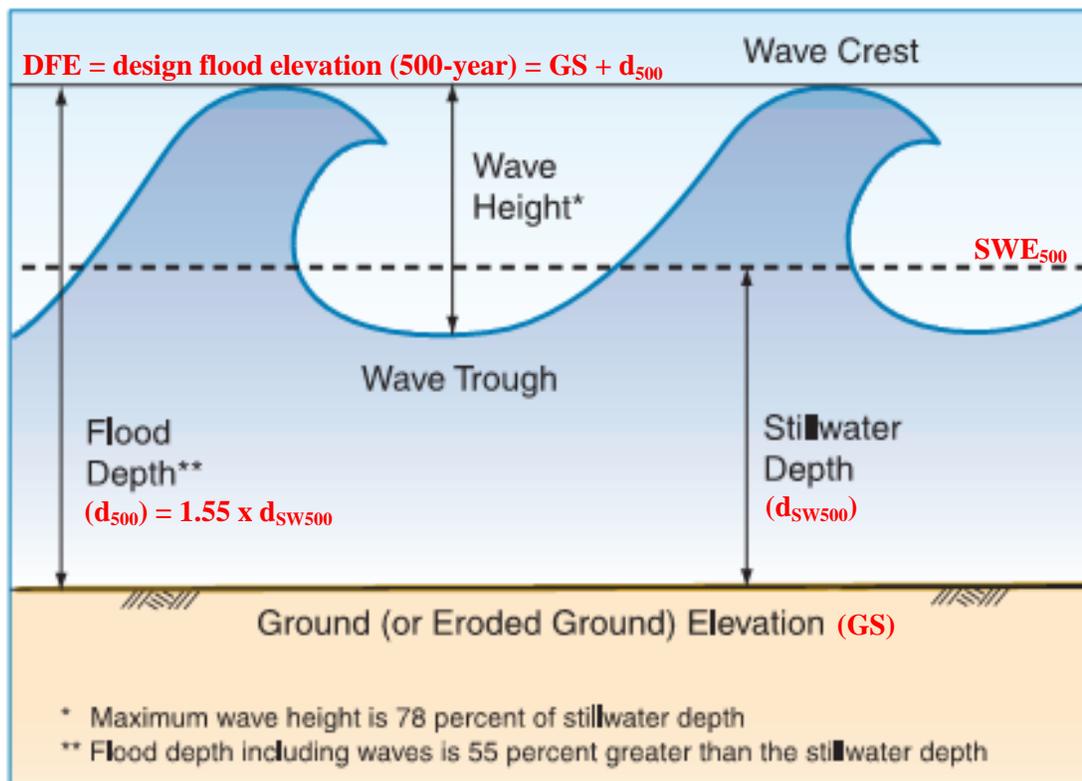


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later in this memo. Therefore, in order to progress design of these critical facilities, reasonable 500-year flood elevations (including wave action) must be derived. This was done using a figure published in FEMA’s January 2007 *Design Guide for Improving Critical Facility Safety from Flooding and High Winds* (FEMA 543), which illustrates the relation between flood depth and stillwater depth. **It should be made clear that the elevations derived by HMM are estimates only, but serve as our “basis of design”.** A determination should be obtained from FEMA on the applicability of this methodology and the implications of a different 500-year elevation being made effective at the site after design has begun.

**DETERMINATION OF 500-YEAR FLOOD ELEVATION**

Figure 2-6 of FEMA’s *Design Guide for Improving Critical Facility Safety from Flooding and High Winds* (FEMA 543) indicates that a flood depth (d) is equal to 1.55 times the stillwater depth (d<sub>sw</sub>). The flood elevation then becomes the ground surface elevation plus the flood depth. The figure is generic relative to return period. Therefore, it is assumed that use for the 500-year event is appropriate (as marked in red below).



**Figure 2-6. Definition sketch – wave height and stillwater depth.  
(annotations in red by HMM)**



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### CALCULATION

MCUA's Edison Pump Station (EPS) lies along the Raritan River, just east of the intersection of Olympic Drive and Cattail Way. The following is a summary of pertinent flood information published by FEMA, in chronological order:

#### Advisory Base Flood Elevation (ABFE) Map ID South Amboy NW, December 7, 2012:

The site is entirely within ABFE: V, 1% (100-year) EL 17, 0.2% (500-year) EL 23.

#### Preliminary Work Map Panel 152, undated:

The site includes Zones VE16, AE15, and AE14, and is partially within the limits of moderate wave action (LiMWA). No 500-year flood elevations are published.

#### Preliminary Flood Insurance Rate Map Panel 152, January 31, 2014:

The site includes Zones VE16, AE15, and AE14, and is partially within the LiMWA line. No 500-year flood elevations are published. Flood zones appear unchanged from the preliminary work map, but the area of moderate wave action was changed. In fact, it appears that the LiMWA line incorrectly extends into the V Zone.

The 500-year stillwater elevation ( $SWE_{500}$ ) at the site, as provided by FEMA (see page 7 and 8 for email), is 17 feet. Based on Figure 2-6 above, and assuming a ground surface elevation (GS) of 8 feet, the 500-year design flood elevation including wave height (DFE) is:

$$DFE = GS + 1.55 (d_{SW500})$$

$$DFE = 8' + 1.55(17' - 8')$$

$$DFE = 22 \text{ feet}$$

### ELEVATION AND FREEBOARD

*ASCE 24-05 Flood Resistant Design and Construction* provides guidance on elevation and freeboard based on type of facility and flood zone. Table 1-1 of this publication categorizes different structures based on their occupation and use. Based this table, the EPS falls under Category III. Elevation requirements for Category III facilities are given below in FEMA 543, Table 2-1 (which references ASCE 24-05).



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**TABLE 1-1. Classification of Structures for Flood-Resistant Design and Construction  
(Classification same as ASCE 7, Ref. [1])**

Nature of Occupancy	Category
<p>Buildings and other structures that represent a low hazard to human life in the event of failure including, but not limited to:</p> <ul style="list-style-type: none"> <li>• Agricultural facilities<sup>a</sup></li> <li>• Certain temporary facilities</li> <li>• Minor storage facilities<sup>b</sup></li> </ul>	I
<p>All buildings and other structures except those listed in Categories I, III, and IV</p>	II
<p>Buildings and other structures that represent a substantial hazard to human life in the event of failure including, but not limited to:</p> <ul style="list-style-type: none"> <li>• Buildings and other structures where more than 300 people congregate in one area</li> <li>• Buildings and other structures with day-care facilities with capacity greater than 150</li> <li>• Buildings and other structures with elementary school or secondary school facilities with capacity greater than 250</li> <li>• Buildings and other structures with a capacity greater than 500 for colleges or adult education facilities</li> <li>• Health care facilities with a capacity of 50 or more resident patients but not having surgery or emergency treatment facilities</li> <li>• Jails and detention facilities</li> <li>• Power generating stations and other public utility facilities not included in Category IV</li> </ul>	III
<p>Buildings and other structures not included in Category IV (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing sufficient quantities of hazardous materials considered to be dangerous to the public if released.</p> <p>Buildings and other structures containing hazardous materials shall be eligible for classification as Category II structures if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in Section 1.5.2<sup>c</sup> that a release of the hazardous material does not pose a threat to the public.</p>	
<p>Buildings and other structures designated as essential facilities including, but not limited to:</p> <ul style="list-style-type: none"> <li>• Hospitals and other health care facilities having surgery or emergency treatment facilities</li> <li>• Fire, rescue, ambulance, and police stations and emergency vehicle garages</li> <li>• Designated earthquake, hurricane, or other emergency shelters</li> <li>• Designated emergency preparedness, communication, and operation centers and other facilities required for emergency response</li> <li>• Power generating stations and other public utility facilities required in an emergency</li> <li>• Ancillary structures (including, but not limited to, communication towers, fuel storage tanks, cooling towers, electrical substation structures, fire water storage tanks or other structures housing or supporting water, or other fire-suppression material or equipment) required for operation of Category IV structures during an emergency</li> <li>• Aviation control towers, air traffic control centers, and emergency aircraft hangars</li> <li>• Water storage facilities and pump structures required to maintain water pressure for fire suppression</li> <li>• Buildings and other structures having critical national defense functions</li> </ul> <p>Buildings and other structures (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing extremely hazardous materials where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction.</p> <p>Buildings and other structures containing extremely hazardous materials shall be eligible for classification as Category II structures if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in Section 1.5.2<sup>c</sup> that a release of the extremely hazardous material does not pose a threat to the public. This reduced classification shall not be permitted if the buildings or other structures also function as essential facilities.</p>	IV



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Table 2-1: ASCE/SEI 24-05 provisions related to the elevation of critical facilities

		Category III	Category IV
Elevation of Lowest Floor or Bottom of Lowest Horizontal Structural	A Zone: elevation of lowest floor	BFE +1 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher
	V Zone and Coastal A Zone: where the lowest horizontal structural member is parallel to direction of wave approach	BFE +1 ft or DFE, whichever is higher	BFE +1 ft or DFE, whichever is higher
	V Zone and Coastal A Zone: where the lowest horizontal structural member is perpendicular to direction of wave approach	BFE +2 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher
Elevation Below which Flood-Damage-Resistant Materials Shall	A Zone	BFE +1 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher
	V Zone and Coastal A Zone: where the lowest horizontal structural member is parallel to direction of wave approach	BFE +2 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher
	V Zone and Coastal A Zone: where the lowest horizontal structural member is perpendicular to direction of wave approach	BFE +3 ft or DFE, whichever is higher	BFE +3 ft or DFE, whichever is higher
Minimum Elevation of Utilities and Equipment	A Zone	BFE +1 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher
	V Zone and Coastal A Zone: where the lowest horizontal structural member is parallel to direction of wave approach	BFE +2 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher
	V Zone and Coastal A Zone: where the lowest horizontal structural member is perpendicular to direction of wave approach	BFE +3 ft or DFE, whichever is higher	BFE +3 ft or DFE, whichever is higher
Dry Floodproofing	A Zone: elevation to which dry floodproofing extends	BFE +1 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher
	V Zone and Coastal A Zone: dry floodproofing not allowed	Not applicable	Not applicable



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### APPLICATION

The EPS is considered a Category III facility. Design elevations are based on the higher of the base flood elevation (BFE) plus a prescribed freeboard depth, and the design flood elevation (DFE). The BFE results from the 100-year event and the DFE from the 500-year event.

Based on Table 2-1 above, floodproofing is not allowed in a V Zone or a Coastal A Zone. Floodproofing the EPS structures in an A Zone (AE15) would need to extend 22 feet (which is the higher of 15 feet plus 1 foot, and 22 feet).

For new structures in a V Zone (V16), the lowest horizontal structural member (where the wave approaches perpendicularly) needs to be 22 feet (which is the higher of 16 feet plus 2 feet, and 22 feet). Utilities and other equipment in the same area would also need to be 22 feet (which is the higher of 16 feet plus 3 feet, and 22 feet).

### CRITICAL FACILITIES

FEMA has identified certain facilities as critical, including water and wastewater facilities and strongly recommends these facilities be designed to the 0.2% (500-year) flood. Other critical facilities include schools, emergency response facilities, healthcare facilities, emergency facilities and utilities. See “Design Guide for Improving Critical Facility Safety from Flooding and High Winds” FEMA 543 for additional facilities that may be considered critical. Municipalities may also consider other facilities as critical and wish to provide a higher level of protection to these facilities; this should be discussed with the municipality.

### CLOSING

FEMA is in the process of updating their FIRMs. Until they become effective, formal design elevations are unknown. **It is suggested MCUA have an understanding that the elevations derived by HMM are estimates only, but will serve as our “basis of design”.** A determination should be obtained from FEMA on the applicability of our 500-year DFE estimate and the implications of a different 500-year elevation being made effective at the site after design has begun.



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**From:** Horwedel, Leroy [mailto:Leroy.Horwedel@fema.dhs.gov]  
**Sent:** Wednesday, January 29, 2014 1:20 PM  
**To:** Bufaino, Angelo  
**Cc:** Richard Fitamant (RFitamant@MCUA.com); 'Dan Tanzi'; Kocsik, Peter E  
**Subject:** FW: 0.2% Stillwater Elevation: Middlesex County Utilities Authority (MCUA) - Woodbridge \ Edison Pump Station [40.49700, -74.32709]

Angelo,

As discussed earlier during our meeting, please see below...

Thank You,  
Leroy

**LEROY HORWEDEL**

HM HPA 406 Task Force Lead & QA/QC Review  
FEMA-DR-4086-NJ  
Joint Field Office (JFO) – Lincroft, NJ  
FEMA BB 202-674-0639  
Emergency Cell 732-684-6075  
[Leroy.Horwedel@fema.dhs.gov](mailto:Leroy.Horwedel@fema.dhs.gov)

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**From:** Nemeth jr, Alexander  
**Sent:** Thursday, January 23, 2014 7:03 PM  
**To:** Horwedel, Leroy  
**Cc:** Mcpartlan, Patrick  
**Subject:** 0.2% Stillwater Elevation: Middlesex County Utilities Authority (MCUA) - Woodbridge \ Edison Pump Station [40.49700, -74.32709]

Hello Leroy:

Starting off, it should be noted that the Preliminary Coastal Work Maps for Middlesex County do not display the 0.2% annual chance flood elevation (unlike the former ABFE maps which provided that data), because they are usually not included on the preliminary FIRM map deliverable. Also, there is actually not a wave component calculated for the 0.2% recurrence interval, thus the elevations are being derived directly from the StillWater Elevation (SWEL) grid. For FEMA projects we have been extracting the 0.2% SWEL based on the project area and using the maximum elevation to be conservative, then rounding up to the nearest foot. Also for reference purposes, the FEMA Modeling Task Force (MOTF) performed a Hurricane Sandy Impact Analysis, modeling estimated water surface elevations in the area of interest at **12.97 feet** for that event. A nearby High Water Mark was taken at **13.36 feet** about 1.5 miles away.

For the area depicted below, the **ABFE** map data recorded a **Flood Zone V with a 1% Annual chance elevation of 17 feet and a 0.2% elevation of 23 feet.**



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The Middlesex County Preliminary Coastal **Work Map** recorded the site hitting a **Coastal LiMWA (1.5'-3' wave action) Flood Zone AE-14 / AE-15 and VE-16 for the 1% Annual chance elevation as depicted below.**

*The highest 0.2% area from the Prelim Work Map for the MUA Woodbridge | Edison Pump Station is at **17 feet (16.82 SWEL)** inside the box displayed below.*



Aerial Imagery