

Reconstruction Guidance Using Hurricane Katrina Surge Inundation and Advisory Base Flood Elevations



FEMA

HURRICANE KATRINA RECOVERY ADVISORY

Purpose: To discuss available flood hazard information and to recommend reconstruction practices using Advisory Base Flood Elevations (ABFEs).

Key Issues

- Following Hurricane Katrina, FEMA updated its flood frequency analyses to include more recent storm surge data (including storm surge stillwater levels measured after Katrina). The results of the analysis show that the updated 1 percent annual chance stillwater levels (also known as the 100-year stillwater levels) are 3 to 8 feet above the stillwater levels previously used to produce the pre-Katrina Flood Insurance Rate Maps (FIRMs).
- For post-Katrina recovery purposes, FEMA devised a method to approximate 1 percent annual chance wave crest elevations. The results of this effort are known as Advisory Base Flood Elevations (ABFEs, sometimes referred to as Advisory Flood Elevations [AFEs]), which are shown on a series of 228 maps for Hancock, Harrison, and Jackson Counties, Mississippi. These maps are also known as “Katrina Recovery Maps” (see Figure 1).
- The ABFEs are updated estimates of the 1 percent annual chance flood elevations, and are generally 5 to 12 feet higher than the base flood elevations (BFEs) shown on the pre-Katrina FIRMs. ABFEs also extend farther inland than the Special Flood Hazard Areas (SFHAs) shown on the pre-Katrina FIRMs.
- The Katrina Recovery Maps also show the approximate inland extent of storm surge inundation experienced during Hurricane Katrina. Since Katrina exceeded the BFE in most locations (based on the updated flood frequency analysis), the inland extent of Katrina storm surge penetration generally lies inland of the ABFE limit. However, where the Katrina impact was less extreme (very near the eye where the hurricane winds are small, to the left of the eye where the peak winds blow offshore rather than onshore, and far to the right of the eye where the winds weaken), the Katrina surge penetration properly lies seaward of the ABFE limit.
- FEMA and the State of Mississippi will conduct detailed studies during 2005 and 2006 to produce revised FIRMs. The revised FIRMs will result from more detailed storm surge stillwater analyses and more detailed wave analysis methods than those used to produce the Katrina Recovery (ABFE) Maps. As a result, BFEs on the revised FIRMs may differ from the ABFEs. In the interim, the ABFEs should be treated as the best available 1 percent annual chance elevation information.

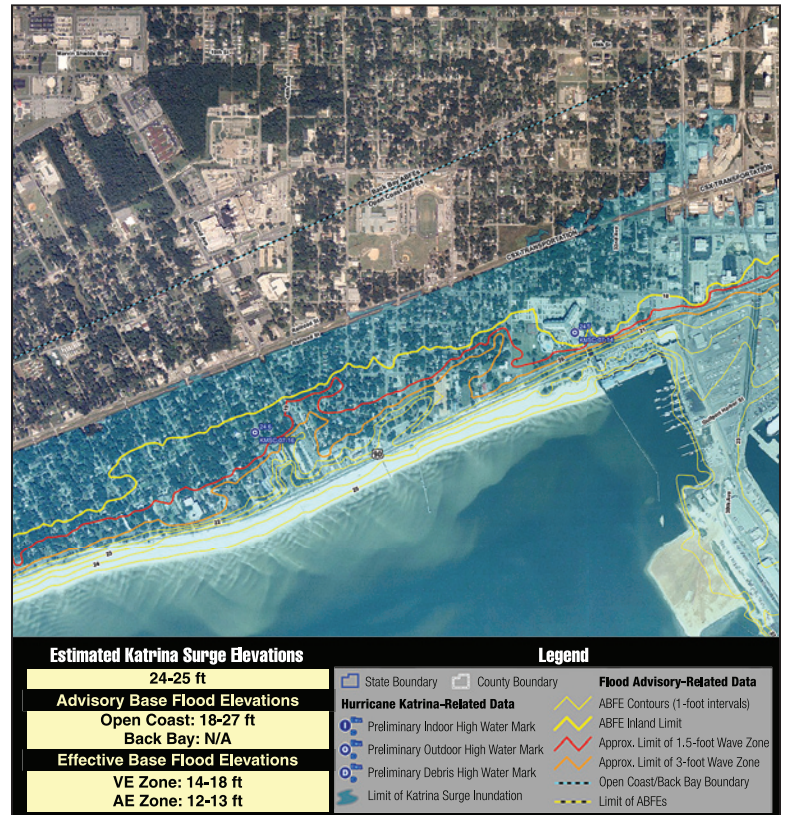


Figure 1. Sample Hurricane Katrina Surge Inundation and Advisory Base Flood Elevations. The shaded region in blue indicates the approximate inland extent of storm surge inundation experienced during Katrina; the ABFE contours are shown in yellow and the predicted inland limit of damaging wave effects during the advisory base flood is shown by the red line. Blue points indicate surveyed Katrina high water mark elevations.

- Although the information contained on the Katrina Recovery Maps is advisory in nature, communities are encouraged to use ABFEs to regulate reconstruction and new construction until the revised FIRMs are produced by FEMA.
- Until such time as the revised FIRMs are published by FEMA and adopted by communities, those communities may use the pre-Katrina FIRMs, or Katrina Recovery Maps, or other flood elevations to regulate reconstruction and new construction (as long as the other flood elevations are not lower than those shown on the pre-Katrina FIRMs).

Advisory Base Flood Elevations (ABFEs)

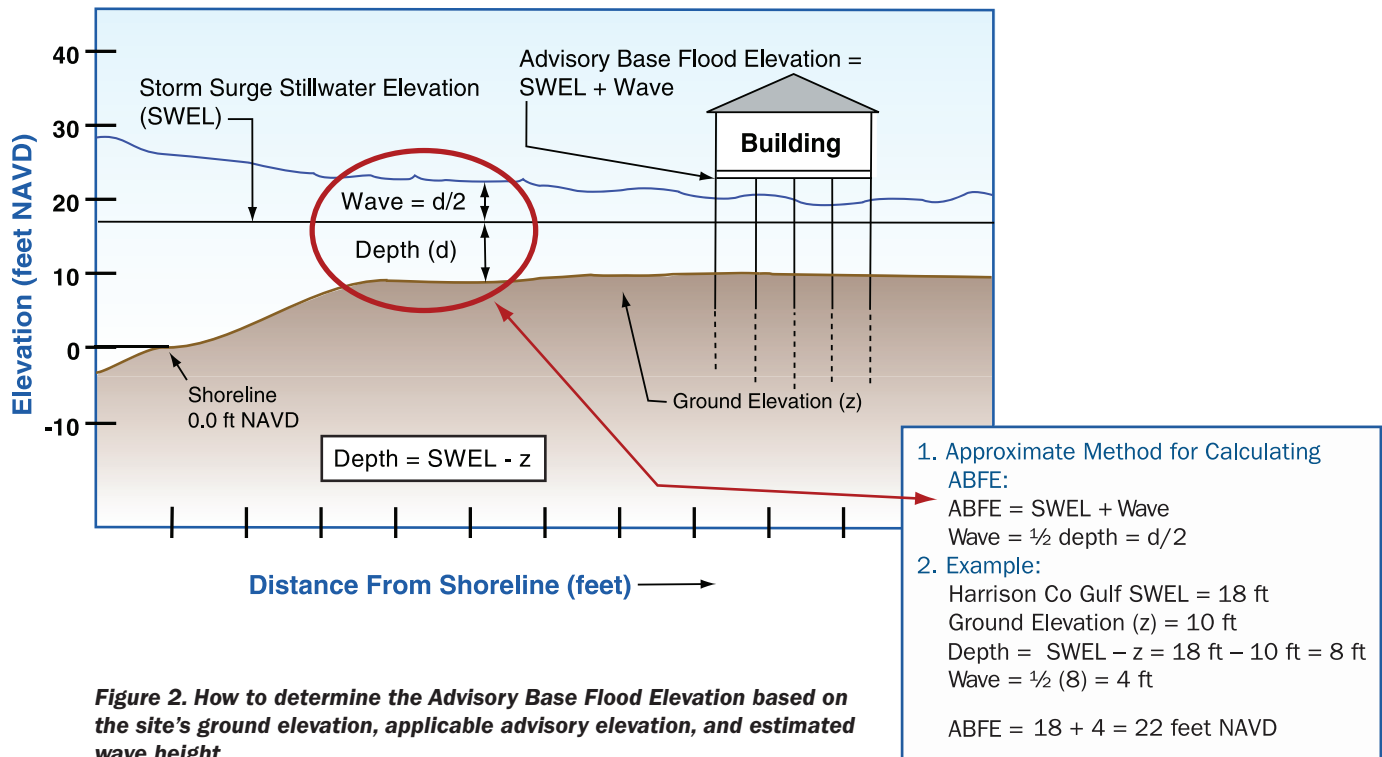
The pre-Katrina FIRMs for communities in Hancock, Harrison, and Jackson Counties were published between the early 1980s and 2002; the current maps underestimate today's risk. Following Hurricane Katrina, FEMA updated the stillwater flood frequency analysis for coastal Mississippi to include tide and storm surge stillwater data for the past 25 plus years. These revised stillwater elevations formed the basis for FEMA's calculation of ABFEs.

The revised 1 percent annual chance storm surge stillwater levels were published by FEMA on October 3, 2005, for Hancock, Harrison, and Jackson Counties in Mississippi (see Table 1). The procedure which makes use of these elevations to compute ABFEs is illustrated in Figure 2 and the example below.

Table 1. Updated 1 Percent Annual Chance (100-Year) Stillwater Elevations for Use in Calculating ABFEs

County (Mississippi)	Updated 1 Percent Annual Chance Stillwater Elevations (SWEL), (ft NAVD*)	
	Gulf of Mexico Shoreline	Back Bay Shorelines
Jackson	14	12
Harrison	18	16
Hancock	20	18

*North American Vertical Datum of 1988
Storm Surge Stillwater Elevation (SWEL)



Communities and designers may note that the ABFE procedure is a simplified version of FEMA's Wave Height Analysis for Flood Insurance Studies (WHAFIS) program used to map base flood conditions on coastal FIRMs. The ABFE procedure does not account for wave attenuation due to dense stands of vegetation, buildings, or other obstructions. Nor does it account for wave growth and regeneration across flooded upland areas. Thus, BFEs on the revised FIRMs (anticipated in 2007) may differ from the ABFEs computed during this interim period. The ABFEs can be considered the best available data at this time.

Figure 3 illustrates the relationships between the stillwater flood elevation, ground elevations, associated 1 percent annual chance stillwater flood depths, ABFEs, and associated flood hazard zones.

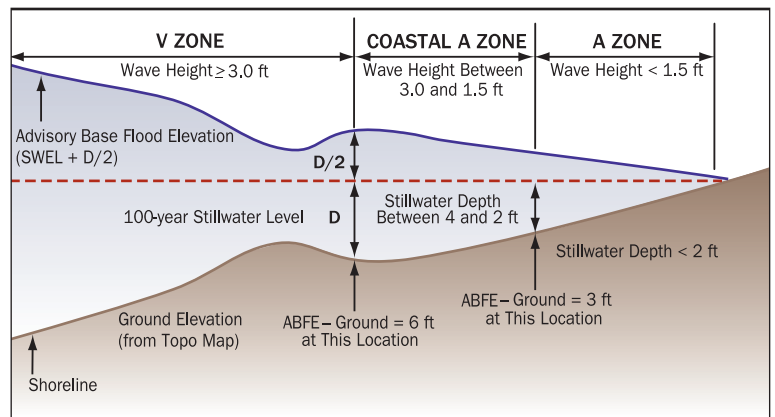


Figure 3. Cross-section showing 1 percent annual chance stillwater elevation, stillwater depth and ABFE, and inland limits of V Zone and Coastal A Zone.

Advisory Base Flood Elevations

The Katrina Recovery Maps (see Figure 1) include the following information:

- Pre-Katrina aerial photographs (as a base map)
- Approximate Katrina surge inundation limit (shaded area)
- ABFE contours (ft NAVD)
- Predicted inland limit of damaging wave effects during the advisory base flood (red line)
- Surveyed Katrina high water mark elevations

More background information on ABFEs and their use can be found in Flood Recovery Guidance-Frequently Asked Questions, dated October 3, 2005, and available at:

www.fema.gov/hazards/floods/recoverydata/katrina_ms_resources.shtm

Communities are encouraged to use the Katrina Recovery Maps. They may continue to enforce their adopted FIRMs and associated design and construction requirements. However, by using the ABFEs any reconstruction or new construction (following Katrina and before issuance of revised FIRMs, expected in 2007) will be at much less risk from future flood damage, and will be eligible for reduced flood insurance premiums (new and reconstructed buildings can be rated using BFEs and flood hazard zones on the effective FIRM, until revised FIRMs are adopted by the community).

Flood Protection Levels for Post-Katrina Reconstruction and New Construction

Until revised FIRMs are published by FEMA and adopted by communities, those communities are free to regulate reconstruction and new construction using several methods:

- Continue to use pre-Katrina FIRMs (understanding that this would knowingly put people and buildings at risk)
- Modify the use of pre-Katrina FIRMs (e.g., add freeboard to the pre-Katrina BFEs)
- Use the Katrina Recovery (Advisory Base Flood Elevation) Maps
- Modify the Katrina Recovery Maps (e.g., conduct a more detailed wave analysis and add to the 1 percent annual chance stillwater elevation, replacing ABFE contours shown on the maps)
- Develop other maps and methods (as long as the resulting BFEs and flood hazard zones are no less restrictive than the pre-Katrina FIRMs)

Each of these methods has advantages and disadvantages, both for implementation and for the long-term protection of buildings constructed after Hurricane Katrina. These are summarized in Table 2.

Table 2. Comparison of Various Methods for Providing Post-Katrina Flood Protection to Reconstructed Buildings and New Construction

Advantages	Disadvantages
Continue Use of Pre-Katrina FIRMs	
<p>No change from pre-Katrina flood hazard maps</p>	<ul style="list-style-type: none"> • Underestimates inland extent of flooding during base flood • Underestimates flood depths • Underestimates inland extent of the V Zone and damaging wave effects • Does not protect buildings outside the pre-Katrina SFHA against damage during the base flood • Limits eligibility for post-Katrina hazard mitigation grants and other reconstruction funds
Add Freeboard to Pre-Katrina FIRMs (where freeboard is less than that indicated by updated 1 percent annual chance flood analysis)	
<ul style="list-style-type: none"> • Provides increased flood protection for buildings within the pre-Katrina V Zone • Provides increased flood protection for buildings near the inland limit of the pre-Katrina A Zone • Buildings elevated to the new (freeboard) elevation will be eligible for flood insurance premium discounts (they can be rated using the pre-Katrina FIRM) 	<ul style="list-style-type: none"> • Underestimates inland extent of flooding during base flood • Does not protect buildings outside the pre-Katrina SFHA against damage during the base flood • Does not expand the V Zone inland, and does not protect buildings in the seaward portion of the pre-Katrina A Zone against wave damage • Does not fully protect any buildings subject to the updated 1 percent annual chance flood • Limits eligibility for post-Katrina hazard mitigation grants and other reconstruction funds
Use Katrina Recovery (ABFE) Maps	
<ul style="list-style-type: none"> • Uses the latest 1 percent annual chance flood elevation and mapping guidance to characterize the extent, depth and severity of updated base flood hazards • ABFEs near the coast may be comparable to revised BFEs expected in 2007 • Provides flood protection consistent with the latest estimate of the updated base flood • Reduces potential floor elevation and foundation differences between buildings reconstructed/constructed to ABFEs and those constructed after adoption of revised BFEs. • Buildings elevated to the ABFE will be eligible for flood insurance premium discounts (they can be rated using the pre-Katrina FIRM) 	<ul style="list-style-type: none"> • Large differences between pre-Katrina building floor elevations and post-Katrina building floor elevations • ABFEs near the inland limit of flooding and in areas sheltered from wave effects may overstate wave hazards and wave crest elevations
Modify the Katrina Recovery (ABFE) Maps (via improved wave height analysis)	
<ul style="list-style-type: none"> • Same as ABFE entries above • Reduce wave height overestimates introduced by the ABFE approach 	<p>Large differences between pre-Katrina building floor elevations and post-Katrina building floor elevations</p>
Other Methods	
<p>Vary with method selected</p>	<p>Vary with method selected</p>

Using the Advisory Base Flood Elevations

Communities can make use of the Advisory Base Flood Elevations by those methods summarized in Table 2. In addition, communities can take several steps that will help to protect reconstruction and new construction:

- Define the revised inland extent of the SFHA using ground contours equal to the stillwater elevations contained in Table 1.
- Define the revised inland extent of the coastal high hazard area (V Zone) based on a 4-foot stillwater depth (the depth required to support a 3-foot wave), using whatever new 1 percent stillwater elevation the community adopts. If the community adopts the stillwater elevations in Table 1, ground elevations corresponding to the new inland V Zone limit are shown in Table 3. In most cases, the first encounter with that ground elevation (starting at the shoreline and moving inland) will be the inland V Zone limit.
- Define the inland extent of a Coastal A Zone (see Hurricane Katrina Recovery Advisory, Design and Construction in Coastal A Zones) based on a 2-foot stillwater depth (the depth required to support a 1.5-foot wave), using whatever new 1 percent stillwater elevation the community adopts. If the community adopts the stillwater elevations in Table 1, ground elevations corresponding to the inland limit of the Coastal A Zone are shown in Table 3. In most cases, the first encounter with that ground elevation (starting at the shoreline and moving inland) will be the inland limit of the Coastal A Zone.
- Implement a local ABFE revision process, to allow for special circumstances where property owners can supply better topographic data or information which will result in a more accurate delineation of flood hazards. Note: such a revision process should not allow reduction of the stillwater elevations in Table 1.
- If a community has adopted the International Building Code or the International Residential Code, define the “Design Flood Elevation” as the ABFE. Define the “Flood Hazard Area” as the inland extent of flooding using the ABFE procedure.

Table 3. Ground Elevations Corresponding to Inland Limits of V Zones and Coastal A Zones (based on 1 percent annual chance stillwater elevations published by FEMA, October 3, 2005)

County, Flood Source	1 Percent Annual Chance Stillwater Elevation (ft NAVD)	Ground Elevation Corresponding to Inland Limit of V Zone (ft NAVD)	Ground Elevation Corresponding to Inland Limit of Coastal A Zone (ft NAVD*)
Jackson, Gulf of Mexico	14	10	12
Jackson, Back Bay	12	8	10
Harrison, Gulf of Mexico	18	14	16
Harrison, Back Bay	16	12	4
Hancock, Gulf of Mexico	20	16	18
Hancock, Back Bay	18	14	16

* North American Vertical Datum of 1988

Design and Construction Practices Using ABFEs

FEMA recommends that all reconstruction and new construction within the revised flood hazard area employ a “best practices” approach, incorporating those methods known to eliminate or reduce flood damage. This will mean:

- Elevating buildings higher than before Katrina, on stronger foundations, with continuous load paths and stronger connections, and with wind- and water-resistant walls, windows, doors, and roofs.
- Elevating buildings with the bottom of the lowest horizontal structural member supporting the lowest floor above the ABFE (or whatever regulatory flood elevation a community adopts). *In A Zones, do not elevate the building only such that the lowest floor walking surface is at the ABFE (or whatever regulatory flood elevation a community adopts).*
- Using flood-damage resistant building materials above the lowest floor elevation of the building (remember, floods more severe than the base flood can, and do, occur).
- Designing and constructing buildings using methods and materials described in:
 - The latest model building codes and standards
 - FEMA 55, *Coastal Construction Manual* (revised 2000)
 - FEMA 499, *Home Builder’s Guide to Coastal Construction*, Technical Fact Sheet Series (2005) (<http://www.fema.gov/fima/mat/fema499.shtm>)