

400 MAPPING AND REGULATIONS

The Community Rating System (CRS) provides credit to communities that enact and enforce regulations that exceed the National Flood Insurance Program's (NFIP's) minimum standards, so that more flood protection is provided for new and existing development.

The activities in this series affect only certain portions of the community and, in some cases, only portions of the delineated Special Flood Hazard Area (SFHA). Therefore, the credit points are adjusted to reflect the area affected. These activities are also adjusted to reflect the community's growth rate as explained in Section 710.

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401 Special Flood-related Hazard Areas

The Federal Emergency Management Agency (FEMA) and many communities in the United States have long recognized that the mapping and regulatory standards of the NFIP do not adequately address all of the flood problems in the country. There are many special localized situations in which flooding or flood-related problems do not fit the national norm for riverine and coastal floodplain management. Therefore, there are situations in which the minimum NFIP requirements do not adequately protect property from flood damage.

To encourage communities to address these hazards, the CRS provides credit throughout the *CRS Coordinator's Manual* for preserving open space and regulating new development in areas subject to seven special flood-related hazards:

1. Uncertain flow paths: alluvial fans, moveable bed streams, channel migration, and other floodplains where the channel shifts during a flood.
2. Closed basin lakes: lakes that have a small or no outlet that may stay above flood stage for weeks, months, or years.
3. Ice jams: flooding caused when warm weather and rain break up a frozen river. The broken ice floats down river until it is blocked by an obstruction, such as a bridge or shallow area, creating a dam.
4. Land subsidence: lowering of the land surface caused by withdrawal of subsurface water or minerals or by compaction of organic soils.
5. Mudflow hazards: a river, flow, or inundation of liquid mud down a hillside, usually as a result of a dual condition of loss of brush cover and the subsequent accumulation of water on the ground, preceded by a period of unusually heavy or sustained rain.
6. Coastal erosion: areas subject to the wearing away of land masses caused primarily by waves on the oceans, Gulf of Mexico, and the Great Lakes.
7. Tsunamis: large ocean waves typically caused by an earthquake, landslide, or underwater volcano.

The credit points for preserving open space and regulating new development in areas affected by these special flood-related hazards are found under Activity 420 and Activity 430. Credit points for mapping coastal erosion and/or tsunami hazards are found under Activity 410.

402 Impact Adjustment for Areas

Many CRS activities are not implemented the same way throughout the floodplain. Therefore, their credit points need to be adjusted to reflect how much of the floodplain they do cover. In CRS credit calculations, this is called the “impact adjustment” (see Section 222).

Some activities are adjusted based on the number of buildings that are affected and some are adjusted based on the size of the area affected. This section reviews how the activity and element credits are adjusted to reflect their impact on the area affected. Section 301 covers impact adjustments based on the number of buildings affected.

Most elements in the activities listed in Table 403-1 (see below) do not affect all of the buildings that could benefit from them. For example, freeboard is often enforced only in areas for which base flood elevations have been determined. A community’s credit for freeboard and other elements is adjusted based on how much of the SFHA is affected. In order to measure the impact of these activities, the community must determine the area affected by each element and the area of the SFHA.

Some activities and elements do not have the impact adjustment step as part of calculating the total credit points. These activities and elements are assumed to be effective throughout the community. In some cases, credit is provided **ONLY** if they are implemented everywhere within the community. For example, in Activity 450 (Stormwater Management) there is no credit for ESC (erosion and sediment control regulations), or WQ (water quality) unless those measures are enforced throughout the entire community.

402.a. Impact Adjustment Ratio

Impact adjustments are calculated by multiplying the points for an element by a ratio that represents how much of the flood problem within the community is being addressed by the element. Impact adjustment ratios are variables with a lower case “r” preceding the acronym for the element.

The value of an impact adjustment ratio is determined by dividing the number of buildings or the total area affected by an element (the numerator) by the appropriate denominator. The number of buildings is designated by a lower case “b,” and the area affected is designated by a lower case “a.”

The denominator for the elements in each activity is specified in the Impact Adjustment section for the element. In most cases, it is the area of the community’s Special Flood Hazard Area or “aSFHA.”

NOTE: *The community’s aSFHA should be reviewed and updated each year for the Program Data Table that is included in the annual recertification (see Section 213.a).*

Example 402.a-1.

In Activity 420 (Open Space Preservation), the credit for preserving open space is adjusted based on its impact, i.e., how much of the SFHA is preserved as open space. This is calculated by multiplying the credit by the impact adjustment. The acronym for open space preservation is “OSP.” The impact adjustment ratio for OSP is rOSP.

rOSP is the total area of the parcels that qualify for OSP credit (aOSP) divided by the area of the community’s SFHA (aSFHA). The formula is

$$rOSP = \frac{aOSP}{aSFHA}$$

For example, in a community with several parks and other properties that qualify as preserved open space:

The total area of the qualifying parcels is 154 acres. aOSP = 154

The total area of the SFHA is 598 acres. aSFHA = 598

$$rOSP = \frac{154}{598} = 0.26$$

The community receives 26% of the maximum possible credit for OSP because 26% of its SFHA is preserved as open space.

In some elements in Activities 410, 420, and 430, it is possible to receive an impact adjustment ratio of up to 1.5. An example would be a community that enforces a higher regulatory standard throughout its “regulatory floodplain” (see Section 120 (Glossary)) that includes the SFHA and flood-prone areas outside the SFHA. Another example is the case in which a community enforces the freeboard requirement throughout the SFHA and on parcels that are partially within the SFHA. These communities may have numerators that are larger than the area of the SFHA, so their impact adjustment ratios would be greater than 1.0.

Although the impact adjustment for Activity 420 can be as much as 1.5 and the impact adjustment for Activity 430 can go up to 1.5, the sum of the impact adjustments for Activities 420 and 430 cannot exceed 1.5.

402.b. Optional Minimum Value

Some elements and activities have an optional minimum value that can be used in place of a calculated impact adjustment ratio. In most cases the value is 0.1 or 10% of the maximum possible. Using this minimum value is optional. It is normally used if

- The community does not want to develop the data needed to determine the numerator or denominator in the impact adjustment ratio, or
- The calculated impact adjustment ratio is less than 0.1. In this case, the community will receive more credit by using the optional minimum.

The activities that use areas for their impact adjustments and the optional minimum value that can be used are listed in Table 403-1, below.

402.c. Regulating Areas Preserved as Open Space

If a community applies for credit for Activity 420 (Open Space Preservation), it means that certain areas are preserved from development. Higher regulatory standards have no impact in those open space areas. Therefore, the impact adjustment ratios for the elements in Activity 430 (Higher Regulatory Standards) cannot be 1.0 if the community regulates only the SFHA and receives credit for open space preservation in Activity 420.

In other words, a community that applies for credit in both Activities 420 and 430 cannot have the maximum impact adjustment ratio for either activity. The numerator in the impact adjustment ratio formula for Activity 430 elements must account for this by excluding the area of preserved open space (aOSP).

Example 402.c-1.

The community in Example 402.a-1 has a freeboard requirement (FRB) for development throughout its SFHA. It can only receive FRB credit for the areas where development may occur, i.e., areas that are not counted toward preserved open space (OSP).

$$rFRB = \frac{aFRB}{aSFHA} = \frac{aSFHA - aOSP}{aSFHA} = \frac{598 - 154}{598} = \frac{444}{598} = 0.74$$

The community receives 74% of the maximum possible credit for freeboard because there will be no new buildings in the areas preserved as open space. The freeboard regulation has no impact in the 26% of the SFHA that is preserved as open space, which is reflected in the impact adjustment.

403 Impact Adjustment Map

An “impact adjustment map” is needed to document and calculate the numerators and denominators in the community’s impact adjustment ratios for certain CRS activities. All appropriate areas for numerators and denominators for impact adjustment ratios must be included with the impact adjustment map. The denominator is usually aSFHA (Table 403-1), and the numerator is the area where each element is effective. For the 600 series of warning and response activities, impact adjustment maps delineate the areas affected by the elements, but the impact adjustments are based on the number of buildings in those areas.

Table 403-1. Impact adjustment maps.			
Activity	Affected Elements	Denominator	Optional Minimum
410 (Flood Hazard Mapping)	NS, SR, HSS, FWS	aSFT	0.10
420 (Open Space Preservation)	OSP, DR, NFOS, LZ	aSFHA	none
	OSI	aSFHA	0.10
	NSP	total length of shoreline	0.10
430 (Higher Regulatory Standards)	DL, FRB, FDN, CSI, LSI, ENL, OHS	aSFHA	0.10
	PCF	a500	none
	CAZ	aSFHA	0.5 / 0.1
440 (Flood Data Maintenance)	AMD	aSFHA	0.10
450 (Stormwater Management)	SMR, WMP	area of the watershed	0.15
540 (Drainage System Maintenance)	CDR, PSM, CIP	number of drainage components	0.10
	SBM	number of storage basins	0.10
610 (Flood Warning and Response)	FTR, EWD, FRO	number of buildings in the SFHA (bSF)	none
620 (Levees)	LM, LFR, LFW, LFO	number of buildings affected by a levee failure (bLF)	none
630 (Dams)	DFR, DFW, DFO	number of buildings affected by a dam failure (bDF)	none
<i>aSFT is the area of the SFHA for the community at the time of adoption of a study.</i> <i>Elements not listed do not have an impact adjustment calculation.</i> <i>There is no optional minimum value for an impact adjustment for preserved open spaces or for impact adjustments based on building counts.</i>			

An impact adjustment map may be prepared on any convenient base map or in a geographic information system (GIS), as long as the scale is suitable for the determination of the areas. If the Flood Insurance Rate Map (FIRM) or other floodplain map is not used as the base map, the boundaries of the SFHA and the areas covered by each element must be drawn on the map with sufficient accuracy that the area calculations can be verified.

No new studies are required to produce an impact adjustment map. The areas are identified and marked on the map based upon the areas under the jurisdiction of the community's regulatory programs. Many communities have produced maps that do this for their own management purposes.

Some communities have found the impact adjustment map they developed for CRS credit helpful as a visual presentation of their floodplain management programs. It identifies where the problems are and where the community is dealing with those problems. If the community completed the CRS Community Self Assessment (see Section 240), the impact adjustment map should be compared to the map(s) developed during the Self Assessment.

403.a. Selecting a Base Map

Selection of an appropriate base map for an impact adjustment map depends on the size of the community and the elements for which it is requesting credit.

- If a community has a GIS that includes its flood data, it is encouraged to produce maps and calculate areas using that system. Many communities now use their GIS to store the data, perform the calculations, and prepare the maps necessary for credit calculation.
- If a community is relatively small, a copy of the FIRM may be the best base map.
- If a community is large in geographic area and its FIRM includes many panels, it may use a base map that fits on one sheet. The SFHAs may already be drawn on the base map (e.g., a zoning map with the regulated areas shown), or they may have to be shown on the base map.
- If the community is requesting credit for mapping or regulating areas outside the SFHA shown on its FIRM, these areas must be shown on the impact adjustment map.
- If a community is large and has different standards for urban and rural areas, maps of differing scales may be needed.
- A community applying for credit under a number of different elements may choose to use overlays or GIS layers to display the elements separately.

If a GIS is not used, choosing base maps depends upon the detail required and the overall bulk of the maps. If maps other than the FIRM are used as bases, all appropriate NFIP zones should be transferred from the FIRM to the base maps.

All base maps must include the scale of the map and a legend for all information provided on the map.

403.b. Mapping aSFHA

The impact adjustment map must show the SFHA. If the FIRM or other floodplain map is not used as the base map, the boundaries of the SFHA must be drawn on the map with sufficient accuracy that the area calculations can be verified.

In general, it is to the community's advantage to have a smaller denominator, or aSFHA, for the impact adjustment calculation (the impact adjustment ratio will be bigger if the denominator is smaller). Although the area of a community's SFHA is a specific area (i.e., acres or square miles), some areas are not included in aSFHA.

Three types of areas within the SFHA—open waters, federally owned lands, and areas beyond the community's regulatory jurisdiction—need to be reviewed and adjustments made to calculate aSFHA.

1. Open water areas larger than 10 acres, such as lakes, bays, and large rivers, must be subtracted from the area of the SFHA. To determine the extent of large water bodies, the shoreline shown on the FIRM may be used. For large rivers, reaches where the average bank-to-bank width shown on the FIRM exceeds 500 feet must be excluded.
2. Areas larger than 10 acres that are either owned by the federal government (e.g., military installations or national parks), are Tribal lands, or are sites on which development is prohibited by the federal government, must be subtracted from the area of the SFHA. Federal land leased to private property owners with the stipulation that the lessees obtain all required local permits are not excluded.
3. At the community's option, areas beyond the regulatory jurisdiction may be subtracted. The community may include or exclude non-federal areas it does not have the authority to regulate, including land owned by the state or another community. These lands must be treated consistently. If they are included in the SFHA for open space credit, they must be included in the SFHA for all activities. If they are open space, the community usually will receive more credit if they are included.

The impact adjustment map must show the areas of the SFHA that the community has excluded from its impact adjustment calculations. These areas should be identified with a distinctive shading or color.

Excluding water bodies and land over which the community has no regulatory control usually will increase the community's CRS credit because the denominator will be reduced. However, if a community can document that non-federal land over which it has no regulatory jurisdiction is eligible for CRS credit, it may include such areas. An example of this would be a state park eligible for credit under Activity 420 (Open Space Preservation).

Large areas of federal lands and some Tribal lands are usually shown on a FIRM as "Areas Not Included." If these areas are shown with mapped SFHAs, and if they are larger than 10 acres, they may be excluded from the impact adjustment map. Smaller parcels need not be excluded—it is the community's option, but the extra work probably will not significantly affect the measurements or the credits.

Example 403.b-1.

West Bay is a fictitious community used for CRS examples. It is a coastal town on the west side of Biloxi Bay. It is 100% flood-prone. The County GIS office provides each community with a digital map that shows streets and FIRM zones (see Figure 400-1).

West Bay's corporate limits go to the middle of Biloxi Bay. Because that area is larger than 10 acres, the Bay shoreline is used as the eastern limit of the SFHA for impact adjustment purposes. A note to that effect is put on the impact adjustment map.

There is also a small state park with a beach in the town. The CRS Coordinator concluded that there would be more credit if the state park were counted as preserved open space than if it were excluded from the area calculated as SFHA. Therefore, it is considered in the SFHA for impact adjustment purposes.

403.c. Marking an Impact Adjustment Map

An impact adjustment map must show the areas affected by each element for which CRS credit is requested. These are areas to be included in the numerator of the impact adjustment calculations. Each area should be outlined or shaded, and labeled (e.g., with the acronym for that element). However, in some cases, a note on the map or in the legend may be simpler and clearer than shading. For example, if a community regulates all of its SFHA for freeboard (FRB), it could use the note "aFRB = aSFHA."

For many communities, the SFHA is the regulatory floodplain. Communities that regulate other flood-prone areas outside the SFHA, in addition to the SFHA, should delineate the area of the regulatory floodplain on the impact adjustment map.

Example 403.c-1.

See Figure 400-1 for an example of an impact adjustment map that is marked to show areas of preserved open space (credited under Activity 420 (Open Space Preservation)) and areas subject to coastal A-Zone regulations (credited under Activity 430 (Higher Regulatory Standards)). It also has a note that the Biloxi Bay portion of the SFHA shown on the FIRM is not counted as part of the town's SFHA for impact adjustment purposes.

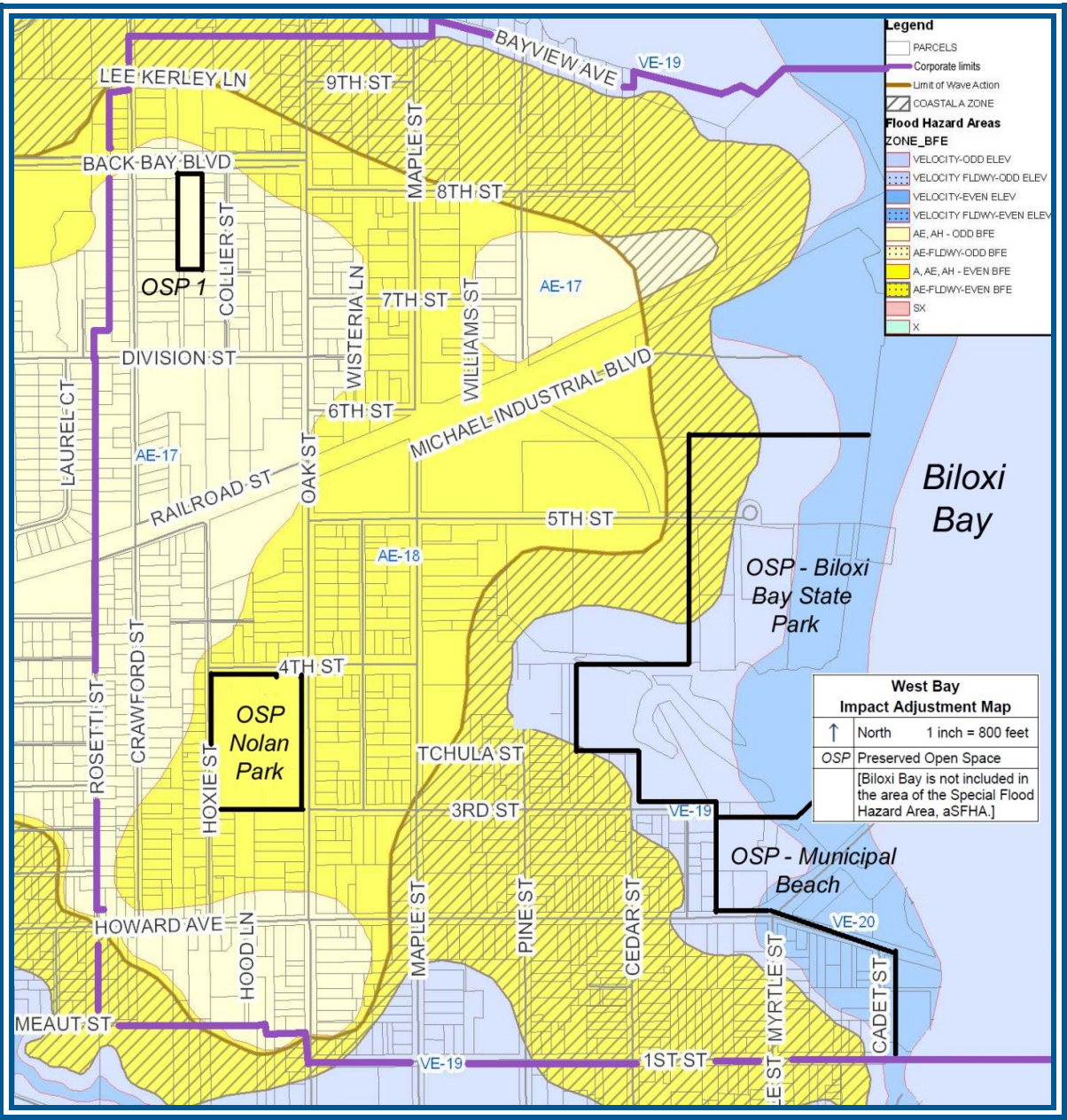


Figure 400-1. West Bay’s impact adjustment map.

403.d. Watershed Impact Adjustment Map

For credit for stormwater management regulations (SMR) and watershed master plan (WMP), under Activity 450 (Stormwater Management), a watershed impact adjustment map must be prepared. This map shows the area affected by the stormwater management program and the watersheds that affect the community. This map and the information needed to develop it are discussed in Section 452.a.

403.e. Calculating Areas

The size of areas delineated on the impact adjustment map(s) may be determined by any method that yields reasonably accurate measurements. The community must document the method or methods it used to determine the areas.

The areas will be recalculated at each cycle verification visit because the numbers can change when there is a new map or if the community annexes land mapped as SFHA. This is done in conjunction with updating the floodplain data table (see Section 214.a).

Calculation Approaches: The community should not spend an inordinate amount of time measuring areas solely for determination of CRS impact adjustment ratios. The following approaches are acceptable:

- Geographic information systems;
- Mechanical or computerized planimetry;
- Areas computed by HEC-2 or other standardized step-backwater methods;
- Known property dimensions, such as those for a city park; or
- Use of a grid overlay. This is technique whereby a transparent grid is placed on the map, the grid squares within an area are counted, and the map scale is used to determine the actual area. Instructions on this approach can be found at www.CRSresources.org/400.

Units of Measure: All area calculations must use the same units, either acres or square miles.

Smaller communities will probably find it easier to measure in acres, while a larger community, such as a county, may prefer to use square miles. The following formulae may be helpful:

- To convert acres to square miles, divide the number of acres by 640.
- To convert square miles to acres, multiply the number of square miles by 640.
- To convert square feet to acres, divide the number of square feet by 43,560.
- To convert square feet to square miles, divide the number of square feet by 27,878,400 (that is, $5,280^2$).

Example 403.e-1.

$$32 \text{ acres} = \frac{32}{640} = 0.05 \text{ square miles}$$

$$2.20 \text{ square miles} = 2.20 \times 640 = 1,408 \text{ acres}$$

$$2,500 \text{ feet} \times 3,600 \text{ feet} = 9,000,000 \text{ square feet}$$

$$\frac{9,000,000}{43,560} = 206.61 \text{ acres}$$

$$1,000 \text{ feet} \times 2,142.50 \text{ feet} = 2,142,500 \text{ square feet} =$$

$$\frac{2,142,500}{27,878,400} = 0.077 \text{ or } 0.08 \text{ square miles}$$

403.f. Example Impact Adjustment Map

The following example discusses how the fictitious community of West Bay developed its impact adjustment map for Activity 420 (Open Space Preservation). It shows how the community selected a base map and used various methods to determine the areas affected by the activity.

Example 403.f-1.

West Bay is a fictitious community used for CRS examples. It is a coastal town on the west side of Biloxi Bay. The county GIS office provides each community with a digital map that shows streets and FIRM zones (see Figure 400-1).

The CRS Coordinator makes sure that the base map shows the corporate limits and the SFHA. Because the town is applying for credit for open space preservation and coastal A-Zone regulations, the impact adjustment map shows the areas that qualify for preserved open space and the coastal A Zone.

The CRS Coordinator used a grid overlay to calculate the area of SFHA within the city (aSFHA, excluding Biloxi Bay) and the area of the coastal A Zone, delineated by the slanted lines on the map in Figure 400-1.

$$\text{aSFHA} = 395.30 \quad \text{and} \quad \text{area of the coastal A Zone} = 116.60$$

The CRS Coordinator obtained the acreage of the four open space areas from the town parks department and the state park. Because they are all entirely in the SFHA, their areas all qualify for OSP. These figures are recorded in the table below.

Area	Acreage
OSP#1: open area preserved by the developer	1.2
Nolan Park	6.9
Biloxi Bay State Park	33.1
Municipal Beach	11.4
Total area of OSP (aOSP)	52.6

When the impact adjustment for open space preservation is calculated for Activity 420 (Open Space Preservation), the area of preserved open space (aOSP) is divided by the area of the SFHA (aSFHA). For West Bay, the formula would be

$$rOSP = \frac{aOSP}{aSFHA} = \frac{52.60}{395.30} = 0.13$$

The resulting ratio (represented by the lower case “r”) means that 13% of West Bay’s SFHA is preserved as open space. This impact adjustment ratio is used in the final step of calculating the credit.

Coastal A Zone regulations (CAZ) have no impact in areas preserved as open space where no new buildings are allowed (see Section 402.c). Therefore, the area where CAZ regulations have an impact is the area of the coastal A Zone minus the area of open space (OSP) in the coastal A Zone. A portion of Bay State Park (4.7 acres) is in the coastal A Zone, so for credit purposes, $aCAZ = 116.60 - 4.70 = 111.90$ acres.

When the impact adjustment for coastal A Zone regulations (CAZ) is calculated for credit under Activity 430 (Higher Regulatory Standards), the regulated area (aCAZ) is divided by the area of the SFHA (aSFHA). For West Bay, the formula would be

$$rCAZ = \frac{aCAZ}{aSFHA} = \frac{111.90}{395.30} = 0.28$$

404 Sea Level Rise Projections and the CRS

The CRS incorporates the consideration of sea level rise into a number of elements, including HSS, Higher study standards under Activity 410 (Flood Hazard Mapping); CAZ, Coastal A Zone (CAZ) credit under Activity 430 (Higher Regulatory Standards); and WMP, Watershed master plan under Activity 450 (Stormwater Management). Including sea level rise in WMP is required for coastal communities to meet the Class 4 prerequisite, and HSS credit for future-conditions hydrology is a Class 1 prerequisite. CRS prerequisites are described in Section 211.

Recognizing that there is uncertainty inherent in estimating future sea levels, the CRS has adopted a base minimum projection for sea level rise for the purposes of CRS credit and meeting CRS prerequisites. The “intermediate-high” projection for 2100, as included in the report *Global Sea Level Rise Scenarios for the United States National Climate Assessment*

(National Oceanic and Atmospheric Administration, 2012, https://scenarios.globalchange.gov/sites/default/files/NOAA_SLR_r3_0.pdf), is the minimum projection that must be used for CRS purposes. Communities may use other projections provided that they are equal to or greater to NOAA’s “intermediate-high” projection for 2100.

Because sea levels are changing at different rates in different parts of the country, global projections must be adjusted to take local conditions into consideration. For this, the CRS uses and recommends the U.S. Army Corps of Engineers “Sea-Level Change Curve Calculator,” an online-tool available at <http://www.corpsclimate.us/ccaceslcurves.cfm>. The CRS anticipates that updates to the National Climate Assessment report will be incorporated into the Sea-Level Change Curve Calculator. If not, then the CRS will provide further guidance to communities, as needed.

See www.CRSresources.org/200 for further details.