CHAPTER 6: FLOODS AND ASSOCIATED COASTAL STORMS

6.3.0 FLOOD RISK ASSESSMENT

6.3.1 IDENTIFYING FLOOD HAZARDS

> **3.1 Identifying Hazards – Requirement §201.6(c)(2)(I):**
>
> The risk assessment **shall** include a description of the type … of all natural hazards that can affect the jurisdiction.

Flooding and coastal storms present essentially the same risks and are frequently related types of hazards in the City of Santa Cruz. Coastal storms can cause increases in tidal elevations (called storm surge) wind speed and erosion as well as flooding

A flood is a natural event for rivers and streams. Excess water from snowmelt, rainfall, or storm surge accumulates and overflows onto the banks and adjacent floodplains. Floodplains are lowlands adjacent to rivers, lakes and oceans that are subject to recurring floods. Several factors determine the severity of floods, including rainfall intensity (or other water source) and duration.

A flood occurs when a waterway receives a discharge greater than its capacity. Floods may result from intense rainfall, localized drainage problems, tsunamis or failure of flood control or water supply structures such as levees, dams or reservoirs. Floodwaters can carry large objects downstream with a force strong enough to destroy stationary structures such as bridges and break utility lines. Flood waters also saturate materials and earth resulting in the instability, collapse and destruction of structures as well as the loss of human life. The City of Santa Cruz has lost bridges and other infrastructure during previous storms.

Floods occur in relation to precipitation. Flood severity is determined by the quantity and rate at which water enters the waterway, increasing volume and velocity of water flow. The rate of surface runoff, the major component to flood severity, is influenced by the topography of the region as well as the extent to which ground soil allows for infiltration in addition to the percent of impervious surfaces. It is important to note that a stream can crest long after the precipitation has stopped.

CLIMATE ADAPTATION CONSIDERATIONS

The City of Santa Cruz Climate Adaptation Plan considers flooding and severe coastal storms to be a considerable, potential risk to the city and its residents. Intense, increased rainfall may lead to larger flood flows. Noted in the CAP are the potential for greater storm surges, wind speeds and resultant coastal erosion. These events are predicted to occur more frequently due to climate change impacts, including the impacts from sea level rise.

6.3.2 PROFILING FLOOD HAZARD EVENTS

3.2 Profiling Hazards –
Requirement §201.6(c)(2)(i):

The risk assessment **shall** include a description of the … location and extent of all natural hazards that can affect the jurisdiction.

The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

A LOCATION

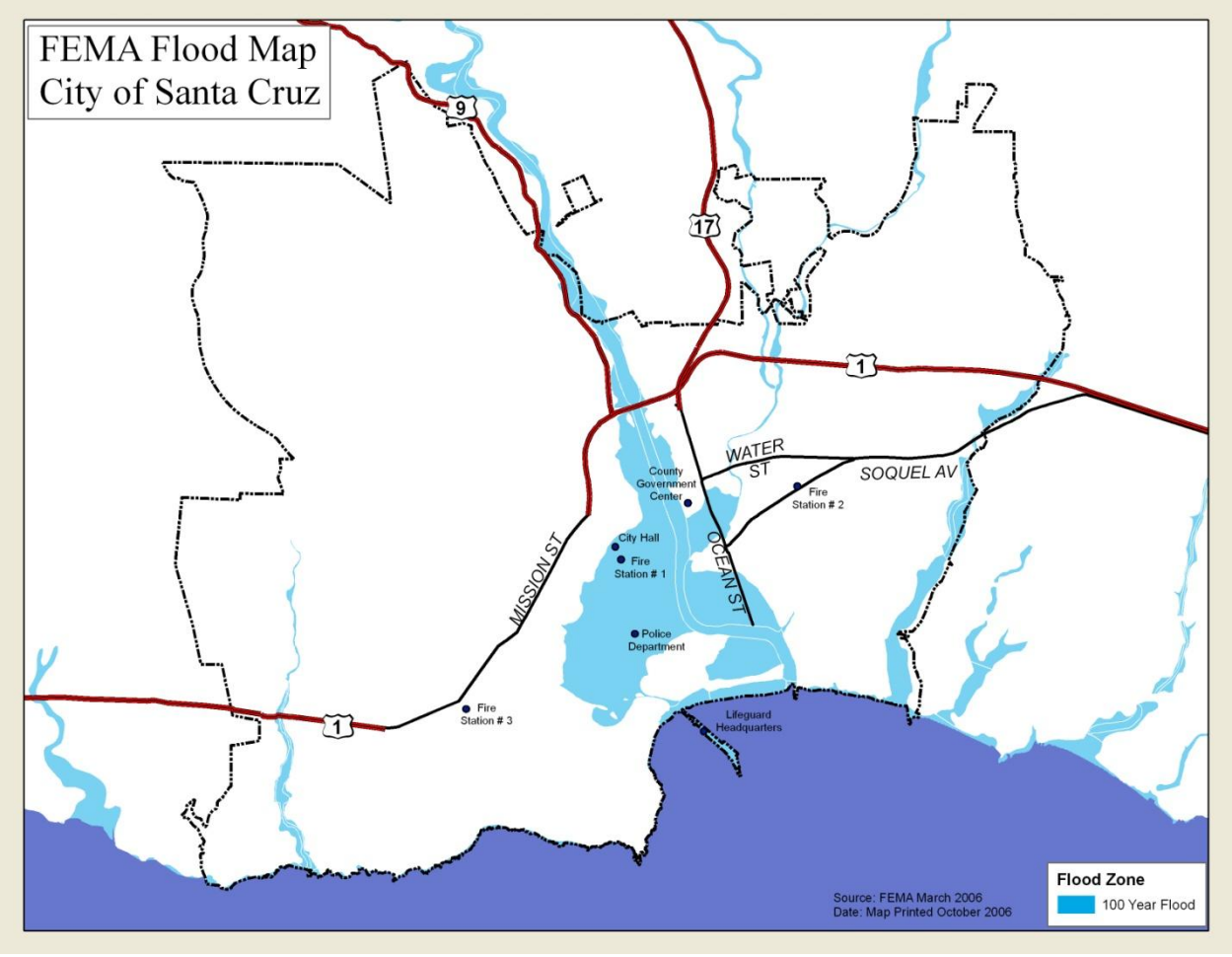

Figure 15 – FEMA Flood Map showing 100-year flood zone

Most of the known floodplains in the United States have been mapped by FEMA, which administers the National Flood Insurance Program (NFIP.) Information on Santa Cruz can be

found in FEMA's most recent Flood Insurance Study (FIS — http://www.bakeraecom.com/wp-content/upLoads/2010/03/06087CV000B2.pdf).

Within the City of Santa Cruz there are several areas subject to flooding. The San Lorenzo River runs through the downtown corridor and the majority of the downtown area is in the San Lorenzo floodplain. The San Lorenzo River also runs along the edge of the Harvey West Commercial–Industrial area including the new Tannery Arts Center and its associated housing.

Flooding along the coast of Santa Cruz may occur with the simultaneous occurrence of large waves and storm swells during the winter. Storm centers from the southwest produce the type of storm pattern most commonly responsible for the majority of serious coastline flooding. The strong winds combined with high tides that create storm surges are also accompanied by heavy rains. When storms occur simultaneously with high tides, flood conditions including flooding at the mouth of the San Lorenzo River are exacerbated.[16]

There are several smaller creeks in the City that are subject to periodic flooding. Flooding is a hazard on the lower reaches of Moore Creek where only shallow stream channels are present, the lower portion of Arana Gulch, north of Santa Cruz Yacht Harbor, and along portions of Branciforte and Carbonera creeks. In these areas there is minimal impact on public structures and facilities and only a few residential structures are within these flood zones.

B EXTENT: MAGNITUDE OR SEVERITY

The San Lorenzo River drains 357 sq. km (138 square miles) of the central California coast range with the annual rainfall in the Redwood forest basin averaging 120 centimeters (47in).[17] The flood season for the San Lorenzo River extends from November to April with most of the historic floods occurring in December or January. The floods that have caused the most damage were generally of short duration and were the result of the small size and steepness of the basin.

The FEMA Community Rating System (CRS) has awarded the City of Santa Cruz a Class Seven rating. The CRS rating is an important factor in determining the magnitude of the potential for flood along the San Lorenzo River. The Community Rating System (CRS) is a voluntary incentive program that is part of the National Flood Insurance Program (NFIP.) The CRS recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from community actions meeting the following three goals of the CRS:

- Reduce flood losses
- Facilitate accurate insurance rating
- Promote awareness of flood insurance

For communities participating in the CRS, flood insurance premium rates are discounted in increments of 5 percent. For example, a Class One community would receive a 45 percent premium discount, and a Class Nine community would receive a five percent discount. A Class Ten community does not participate in the CRS and receives no discount. The CRS classes for local communities are based on 18 creditable activities organized under the following four categories:

- Public Information

- Mapping and Regulations
- Flood Damage Reduction
- Flood Preparedness — Currently, approximately 1,200 communities nationwide, including Santa Cruz, receive flood insurance premium discounts based on implementation of local mitigation, outreach, and educational activities that go well beyond minimum NFIP requirements.

The Flood Insurance Rate Map (FIRM) is an official map of a community for which the Federal Insurance and Mitigation Administration has delineated the Special Flood Hazard Area (SFHA) and the risk premium zones applicable to the community. All known areas of the City subject to natural flooding hazards have been designated and mapped by the Federal Emergency Management Agency (FEMA), such as the 100 year floodplain boundaries which appear on FEMA's Flood Insurance Rate Maps and are a source for the floodplain map included in this chapter.

The City of Santa Cruz has worked to improve the flood capacity of the San Lorenzo River levees over the past twenty years. In 2002, FEMA re-designated much of the downtown and beach area from A-11 to the A-99 Flood Zone designation in recognition of the significant flood improvements resulting from the San Lorenzo River Flood Control and Environmental Restoration Project. Under the A-99 designation, new buildings and improvements are no longer mandated to meet FEMA flood construction requirements and flood insurance premiums are significantly reduced. The FEMA Community Rating System (CRS) class seven rating for the City of Santa Cruz further reduces the National Flood Insurance Program (NFIP) A-99 flood insurance rates by five percent. At present the combination of the CRS class seven rating and the A-99 designation reduces flood insurance by 45%. The City of Santa Cruz is one of the 5.5% of communities in the FEMA National Flood Protection Program who participate in the CRS Program.

Despite recent flood control projects and improved flood rating in much of the downtown and beach area, the risk of flooding is still a concern to the City. While the levee project has resulted in a more flood-resistant downtown, floods may still occur. The levee project did not impact areas along the San Lorenzo River above the Highway 1 bridge (including the new Tannery Arts Center and the associated live-work studios) where flooding is still a significant risk and construction requirements must still address the risk of floods.

C PREVIOUS OCCURRENCES

The City of Santa Cruz is located around the floodplain of the San Lorenzo River and has been subject to floods throughout recorded history from the time the Mission was first built in 1793 to the "Christmas Flood" on December 22, 1955. Eighteen floods, eight of which have been considered severe, have occurred over the last 10 decades here in Santa Cruz. As discussed above, the San Lorenzo River Levee Project has significantly reduced the risk of flooding in the downtown area. However, the downtown and beach areas are still designated as floodplains.

Historical Record of Severe Floods of Santa Cruz 1862-2006

- **January 11, 1862**
  Land consumed and buildings along river banks destroyed. "Bulkhead" at Bulkhead Street was built after this flood to prevent water from reaching Main and Willow Streets (now Front Street and Pacific Avenue).
- **December 23, 1871**
  Bridges built after 1862 flood across San Lorenzo damaged.
- **January 25, 1890**
  River level highest recorded to this date. A debris dam collected against pilings behind the rail bridge at the mouth of the river. With the failure of the rail bridge, flood levels dropped dramatically. The practice of using pilings to span the river was stopped after this flood.
- **January 4, 1895**
  Levels exceeded the Bulkhead and caused basement, yard and lot flooding in the downtown area.
- **March 27, 1907**
  This flood had water levels higher than previous floods. Flood control discussion increased**.**
- **February 27, 1940** Very severe flooding**.**
- **February 9, 1941**
  This was the third flood to hit in four years. Flood control becomes a focus.
- **December 22, 1955**
  Highest historic flood in the area, filling 410 acres of lowlands outside the river channel including the downtown. Ninety percent of the damage in the county occurred within the City of Santa Cruz and cost the City millions of dollars.
- **January 4, 1982**
  The water rose to within two feet of the top of the levees along the San Lorenzo River and flooding occurred both north and south of the freeway along Carbonera and Branciforte Creeks in the Twin Creeks and Brookside Glen developments. This approximately 30-year event also reached the top of the concrete portion of Branciforte Creek at Market Street and overflowed. The older part of the Soquel Avenue bridge, built in 1923 also collapsed.
- **February 1995 Storms**
  Santa Cruz was one of 57 counties declared disaster areas due to flooding.
- **January 1997**
  Santa Cruz was one of 48 counties declared disaster areas due to severe storms and flooding.
- **February 1998 El Niño**
  Santa Cruz was one of a number of counties declared disaster areas due to El Niño.
- **April 2006**
  Severe storms and flooding. Santa Cruz was one of several counties to be declared a disaster area. FEMA Disaster 1646*

- **March 2011**
  Severe storm damage. Santa Cruz County was among 19 counties proclaimed by the Governor as in a state of emergency due to storms between March 15 and 27.

**06/05 California Severe Storms, Flooding, Landslides, and Mudslides*

D PROBABILITY OF FUTURE EVENTS

Significant storms and associated damage from flooding strike the Monterey Bay communities with a frequency of one large storm every three to four years. A 100-year flood has a one percent probability of occurring in any given year and while considered to be a severe flood, it still has a reasonable possibility of regular occurrence. For the purposes of the protection of property, life and safety, floods of other magnitudes and occurrence intervals should also be considered in mitigation efforts.

Floods and flooding are gauged by their size (width and depth of the affected area) and the probability of occurrence. The size and depth of the floodplain area is computed using mathematical models of precipitation, slope, runoff, soil type and cross-section. Flood depths are calculated at intervals along a stream or channel corridor and then mapped and interpolated between sections. This results in the floodplain map.

The probability of occurrence is expressed in a percentage of the chance of a flood of a specific extent occurring in any given year. The most widely adopted design and regulatory standard for floods in the United States is the 1-percent annual chance flood, and this is the standard formally adopted by FEMA. The 1-percent annual flood is also commonly referred to as the "100-year flood," leading to the misconception that it should occur only once every 100 years. In fact, a 100-year flood may occur in any year, regardless of the time that has passed since the last one. It is the probability that smaller floods occur more often than larger floods that compels the percentage.

Table 6-1 – Flood Probability Terms

Flood Occurrence Intervals	Percent Chance of Occurrence Annually
10 years	10.0%
50 years	2.0%
100 years	1.0%
500 years	0.2%

6.3.3 ASSESSING FLOOD VULNERABILITY: OVERVIEW

3.3 Assessing Vulnerability: Overview – Requirement §201.6(c)(2)(ii):

The risk assessment **shall** include a description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section.

This description shall include an overall summary of each hazard and its impact on the community.

A OVERALL SUMMARY OF VULNERABILITY TO FLOODS

The City of Santa Cruz has worked for the past twenty years to improve the flood capacity of the San Lorenzo River levees. Work is now complete on the final phase of the Army Corps of Engineers San Lorenzo River Flood Control Project and FEMA has recognized the increased flood protection that the new higher levees provide by granting the A-99 flood zone designation. The downtown and the area along the river are still in a 100-year floodplain. Coastal storms contribute to the risk of flooding in this area.

The river bank north of the Highway 1 bridge (near the new Tannery Arts site) was not part of the Army Corps of Engineers Project and this area is subject to flooding as are some low lying areas near creeks and streams. While the most vulnerable areas along the river, particularly the downtown corridor, are now less vulnerable, they are still at risk during a 100-year storm, until the fifth phase of the Corps project is completed.

6.3.4 ASSESSING FLOOD VULNERABILITY: IDENTIFYING STRUCTURES

3.4 Assessing Vulnerability: Identifying Structures – Requirement §201.6(c)(2)(ii)(A):

The plan **should** describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.

Types and Numbers of Existing Buildings, Facilities and Infrastructure

Much of the downtown and beach areas are in the 100 year floodplain. The Emergency Operations Center as well as most of the City and County government buildings are in the floodplain. The floodplain includes the following:

- 2,232 Structures (2,270 parcels)
- The Central Fire Station
- The Police Station
- City Hall campus
- Lifeguard and Marine Safety Headquarters
- The County Government Center
- 41 schools and day care centers

6.3.5 ASSESSING VULNERABILITY: ESTIMATING POTENTIAL LOSSES

3.5 Assessing Vulnerability: Estimating Potential Losses – Requirement §201.6(c)(2)(ii)(B):

The plan **should** describe vulnerability in terms of an estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate .

A POTENTIAL DOLLAR LOSSES TO VULNERABLE STRUCTURES

Table 6-2 – Flood Potential Loss Inventory

Inventory Assets								
FLOOD								
	# of Parcels		**# of Structures**		**Critical Structures**		**Loss in Value$***	
Type	**Total**	**Hazard**	**Total**	**Hazard**	**Total**	**Hazard**	**Total**	**Hazard**
Residential	14,808	1,552	17,128	1,692			$6,793,642,000	$777,637,000
Commercial	1,480	574	1,293	415			$1,700,635,000	$538,840,000
Industrial	257	14	321	1			$366,560,000	$27,955,000
Religious	57	8	89	5			$128,734	$25,380,000
Government	216	119	27	69			$63,524,000	$7,974,000
Agricultural	5	2	70	41			$22,438,000	$7,621,898
Education	228	0	57	9			$128,938,000	$1,919,200,000
Total	**17,051**	**2,269**	**18,985**	**2,101**	**38**	**19**	**$9,204,471,000**	**$1,382,485,200**
# of People	**59,946**	**12,073**						
DATE:	April 2012							
Total = total number of structures, residents, values within the entire community and FEMA Flood Hazard Area								
*Loss estimates generated by FEMA's Hazus Flood Model, a nationally applicable standardized methodology that contains models for estimating potential losses from earthquakes, floods, and hurricanes. Hazus uses Geographic Information Systems (GIS) technology to estimate physical, economic, and social impacts of disasters								
*Government Parcels, Public Schools and most Utilities are not assessed.								

B METHODOLOGY USED TO PREPARE ESTIMATE

Parcel Valuation:

Valuation of parcels within a hazard area are based on improvement values only as collected by appraisers with the County of Santa Cruz County Assessor's Office. They don't reflect sale value or replacement value. If a parcel intersected a hazard, the entire improvement value of that parcel was used.

Population:
Census population blocks were reduced to center points. If a hazard intersected a center point, that population was counted.

Flood Analysis:
Since FEMA flood data is mapped on the federal level, the data is extremely coarse in horizontal accuracy. The data was not meant to be measured against parcel level information and therefore is a rough estimate of damage and loss.

Estimating flood losses is an established process. If a "100-year" flood occurred in Santa Cruz, meaning the flood that has a 1% chance of occurring in any given year, it would impact approximately 2,100 structures to various degrees. This was determined by intersecting the city's database of structures with the FEMA developed maps of the 100-year floodplain.

Santa Cruz structures in the floodplain vary in construction, size and materials, ranging from single family homes to multi-family to commercial. The downtown of the City of Santa Cruz lies almost entirely within the 100-year floodplain. Many structures in this area are multi-story.

The primary purpose of the San Lorenzo Levee Project was to reduce flood damage and loss within the City of Santa Cruz 100-year floodplain. According to the Federal Emergency Management Agency, the December 1955 flood caused over $40 million in damage. The U.S. Army Corps of Engineers estimated that a 100-year flood in the downtown area in 2002 would cause $86 million in damage.[18]

6.3.6 ASSESSING VULNERABILITY: ANALYZING DEVELOPMENT TRENDS

> **3.6 Assessing Vulnerability: Analyzing Development Trends – Requirement §201.6(c)(2)(ii)(C):**
>
> The plan **should** describe vulnerability in terms of providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

A DESCRIPTION OF LAND-USES AND DEVELOPMENT TRENDS

As was described previously, the City of Santa Cruz is a compact urban community that is surrounded by natural barriers to outward expansion including the Santa Cruz Mountains, the Pacific Ocean and a designated greenbelt. In Santa Cruz, most development is now infill or reuse development.[19]

The beach and downtown commercial areas are in the 100-year floodplain. Increasing residential density and mixed use development continue in the downtown core. The Tannery Arts project including a residential component is located in a floodplain next to the San Lorenzo River above the levee project area.

The City is required by Association of Monterey Bay Area Governments (AMBAG) to zone for its share of housing. Two of the three available properties with the highest density zoning are located in the floodplain.

6.4.0 MITIGATION STRATEGY

> **4.0 Mitigation Strategy: Requirement §201.6(c)(3):**
>
> The plan **shall** include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

The City of Santa Cruz addresses land use within the flood plain in the General Plan as well as actively enforcing building and zoning codes, and other land use regulations concerning development within the 100-year flood plain. The City of Santa Cruz has worked to improve the flood capacity of the San Lorenzo River levees over the past twenty years. In 2002, FEMA re-designated much of the downtown and beach area from A-11 to the A-99 Flood Zone designation in recognition of the significant flood improvements resulting from the San Lorenzo River Flood Control and Environmental Restoration Project.

The City will continue to work with FEMA and the Army Corps of Engineers to minimize impacts of flooding in Santa Cruz. The City will also work to maintain or improve its CRS rating.

6.4.1 MITIGATION GOALS

> **4.1 Local Hazard Mitigation Goals – Requirement §201.6(c)(3)(i):**
>
> The hazard mitigation strategy **shall** include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

The City of Santa Cruz has developed several flood hazard mitigation goals to create a more flood resistant community.

Flood Goals:

Flood 1 — Avoid or reduce the potential for life loss, property and economic damage from flooding.
Flood 2 — Facilitate accurate insurance ratings through participation in CRS
Flood 3 — Promote public awareness of flood hazards, mitigation measures and flood insurance

6.4.2 IDENTIFICATION AND ANALYSIS OF MITIGATION ACTIONS

> **4.2 Identification and Analysis of Mitigation Actions – Requirement §201.6(c)(3)(ii):**
>
> The mitigation strategy **shall** include a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.

Flood Mitigation Actions:

The City participates in a number of ongoing mitigation actions to avoid or reduce the threats of flood. These measures are listed in this Plan in Part 4, Mitigation Strategy. Actions include:

- Participation with other agencies in an early warning system for evacuation of areas susceptible to flooding, tsunami or dam failure. (B-4)
- Regulations on development and alteration of flood plains, stream channels and protective barriers that accommodate overflow are in place. (B-5)
- Encouragement of property owners, potential buyers and residents living in flood plains and coastal inundation areas to participate in Federal Flood Insurance Program. (B-6)
- The City has adopted the Creeks and Wetlands Management Plan (February 2006) which provides guidelines including measures to reduce creek flooding. (B-7)
- The City is continually working to rehabilitate the City's culverts and storm drainage system to reduce flooding caused by inadequate storm drainage. (B-8)
- Annual flood control maintenance on the San Lorenzo River by the Public Works Department. This work is required by the U.S. Army Corps of Engineers and consists primarily of managing in-stream riparian vegetation to encourage geomorphic form and function. The vegetation management is identified in the San Lorenzo Urban River Plan and requires vegetated buffer zones to be generally maintained at 10 feet at the toe of the levees and 5 feet along the wetted edge of the river. Vegetation management is required in order for winter flows not to exceed the design capacity of the river and to promote scouring of the river. The maintenance generally takes about four to five weeks each year to complete. (C-10)