

## Section 5: Vulnerability Analysis

This section contains a countywide vulnerability analysis for the hazards that could affect Monterey County. It consists of the following four subsections:

- 5.1 Overview of Vulnerability Analysis
- 5.2 Asset Inventory, Methodology, and Data Limitations
- 5.3 Exposure Estimates
- 5.4 Future Development

The information presented in this section reflects county level (i.e., countywide) results, numbers, and values. Information specific to each participating jurisdiction is listed in Appendices H through T.

### 5.1 Overview of Vulnerability Analysis

A vulnerability analysis predicts the extent of exposure that may result from a hazard event of a given intensity in a given area. The analysis provides quantitative data that may be used to identify and prioritize potential mitigation actions by allowing participating jurisdictions to focus attention on areas with the greatest risk of damage. A vulnerability analysis is divided into five general steps: asset inventory, methodology, data limitations, exposure estimates for current assets, and areas of future development.

The requirements for a vulnerability analysis as stipulated in federal mitigation planning requirements are described below:

- **A summary of the community's vulnerability to each hazard that addresses the impact of each hazard on the community.**
- An identification of the types and numbers of existing vulnerable buildings, infrastructure, and critical facilities and, if possible, the types and numbers of vulnerable future development.
- Estimate of potential dollar losses to vulnerable structures and the methodology used to prepare the estimate.

### 5.2 Asset Inventory, Methodology, and Data Limitations

#### 5.2.1 Asset Inventory

An asset inventory is the first step in conducting a vulnerability analysis. Assets within each community that may be affected by hazard events include population, residential and nonresidential buildings, and critical facilities and infrastructure. The assets and insured values present within Monterey County, including all incorporated municipalities, are identified and discussed in detail in the subsections that follow. Jurisdiction-specific asset inventory lists are located in Tables H-1 through T-1 in Appendices H through T, respectively.

### 5.2.1.1 Population and Building Stock

Population data for Monterey County, including each participating municipal jurisdiction, was obtained from the 2000 U.S. Census, which was collected at the census block level. Monterey County's total population for 2000 was 401,762 (Table 5-1). Population density throughout Monterey County is shown on Figure E-14 (Appendix E).

Estimated numbers of residential and nonresidential buildings and estimated values for those structures, as shown in Table 5-1, were obtained from local parcel data and tax assessor information. A total of 77,479 residential buildings were considered in this analysis, including single-family dwellings, mobile homes, multi-family dwellings, temporary lodgings, and institutional dormitory facilities. A total of 20,371 nonresidential buildings were also analyzed, including industry, retail trade, wholesale trade, personal and repair services, professional and technical services, banks, medical offices, religious centers, entertainment and recreational facilities, theaters, and parking facilities.

**Table 5-1  
Countywide Population and Building Inventory Estimates**

Population	Residential Buildings		Nonresidential Buildings	
2000 Census Population Count*	Total Building Count	Total Value of Buildings ** (x\$1000)	Total Building Count	Total Value of Buildings *** (x\$1000)
401,762	77,479	15,054,270	20,371	6,949,692

Source: U.S. Census; Monterey County parcel data and tax assessor information.

\* Population count using U.S. census blocks within the countywide limits.

\*\* Total assessed structural value of all residential buildings (including single-family dwellings, mobile homes, etc.) based on Monterey County parcel data and tax assessor information.

\*\*\* Total assessed structural value of all nonresidential buildings (including industry, trade, professional and technical services, etc.) based on Monterey County parcel data and tax assessor information.

### 5.2.1.2 Critical Facilities and Infrastructure

A critical facility is defined as a facility in either the public or private sector that provides essential products and services to the general public, such as preserving the quality of life in Monterey County and fulfilling important public safety, emergency response, and disaster recovery functions. The total number of critical facilities within Monterey County is listed in Table 5-2 and shown on Figure E-15 (Appendix E). Jurisdiction-specific critical facilities are listed in Tables H-2 through T-2 in Appendices H through T, respectively.

Similar to critical facilities, critical infrastructure includes infrastructure elements that are essential to preserving the quality of life and safety in Monterey County. Critical infrastructure identified within Monterey County is shown in Table 5-2 and Figure E-15 (Appendix E).

**Table 5-2  
Countywide Critical Facilities and Infrastructure Estimates**

Category	Total Structures/Total Miles	Total Costs (x\$1000)	
Government	2	0	
Emergency Response	69	33,699	
Lifeline Utilities	19	842,364	
	42	92,282	
Care	117	323,895	
Educational	194	591,633	
Marine, Environmental, and Community	27	92,129	
Special Districts	43	206,255	
Infrastructure	Bridges	200	495,057
	Federal and State highways	388.8 (miles)	3,136,297
	Railroad Tracks	137.8 (miles)	160,017
	Airports	26	19,293

*Source: Monterey County GIS, FEMA HAZUS-MH (estimated values)*

### 5.2.2 Methodology

A conservative, "exposure-level" analysis was conducted to assess the risks of the identified hazards. This analysis is a simplified assessment of the potential effects of the hazards on assets at risk without consideration of probability or level of damage.

Using GIS, the building footprints of critical facilities were compared to locations where hazards are likely to occur. If any portion of the critical facility fell within a hazard area, it was counted as exposed to that given hazard. Residential and nonresidential structures located where hazards are likely to occur were also identified. Using census block level information, a spatial proportion was used to determine the percentage of the population at risk to a hazard. Census blocks that are completely within the boundary of a hazard area were determined to be vulnerable and were totaled. If half of a census block was within a hazard area, half of the population was counted as at risk. A spatial proportion was also used to determine the amount of linear assets, such as highways and pipelines, were within a hazard area. The exposure analysis for linear assets was measured in miles.

Assessed building values were used for all physical assets. These values were obtained from Monterey County tax assessor records. For facilities that did not have specific values per building in a multi-building scenario (e.g., schools), the buildings were grouped together and assigned one value. For each physical asset located within a hazard area, exposure was calculated by assuming the worst-case scenario (that is, the asset would be completely destroyed and would have to be replaced). Finally, the aggregate exposure, in terms of replacement value or insurance coverage, for each category of structure or facility was calculated. A similar analysis was used to evaluate the proportion of the population at risk. However, the analysis simply represents the number of people at risk; no estimate of the number of potential injuries or deaths was prepared.

### 5.2.3 Data Limitations

The vulnerability estimates provided herein use the best data currently available, and the methodologies applied result in an approximation of risk. These estimates may be used to understand relative risk from hazards and potential losses. However, uncertainties are inherent in any loss estimation methodology, arising in part from incomplete scientific knowledge concerning hazards and their effects on the built environment as well as the use of approximations and simplifications that are necessary for a comprehensive analysis.

It is also important to note that the quantitative vulnerability assessment results are limited to the exposure of people, buildings, critical facilities, and infrastructure to the identified hazards. It was beyond the scope of this MJHMP to develop a more detailed or comprehensive assessment of risk (including annualized losses, people injured or killed, shelter requirements, loss of facility/system function, and economic losses). Such impacts may be addressed with future updates of the MJHMP.

### 5.3 Exposure Estimates

The results of the exposure analysis for loss estimations in Monterey County are summarized in **Tables 5-3, 5-4, and 5-5** and in the following discussion. The results of the exposure analysis for the participating communities (including the Special Districts) are located in Tables H-3, H-4, and H-5 through Tables T 3, T-4, and T-5 in Appendices H through T, respectively.

**Table 5-3  
Countywide Potential Hazard Vulnerability Analysis: Population and Buildings**

		Population	SoVI	Buildings			
Hazard Type	Methodology			Number	Residential		Nonresidential
				Number	Value (\$)¹	Number	Value (\$)¹
Agricultural Emergency	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Coastal Erosion	100-year erosion zone	752	N/A	445	112,766	100	144,715
Dam Failure	Inundation area	72,926	N/A	15,304	3,411,892	1,114	2,169,999
Earthquake	Extreme	12,251	N/A	3,357	590,989	129	260,579
	High	295,032	N/A	73,116	15,519,401	2,826	5,330,438
	Moderate	93,431	N/A	29,736	6,472,890	1,255	2,335,072
Flood	100-year flood zone	18,819	N/A	4,886	948,519	607	875,611
Hazardous Materials Event	1-mile buffer mobile	263,681	0.17	46,826	8,078,419	12,523	4,977,242
	1-mile buffer fixed	54,659	0.87	7,566	1,002,522	2,445	994,990
Landslide	High	5,083	-0.31	1,059	308,606	297	59,382
	Moderate	19,389	0.12	5,748	1,614,545	948	231,340
Sea Level Rise	Inundation Area	3,918	-0.02	305	47,496	116	69,179
Tsunami	Inundation Area	1,965	-0.08	312	91,504	194	263,987
Wildland Fire	Very high	3,423	1.43	770	575,131	213	57,124
	High	16,750	0.25	3,532	144,215	1,150	300,476
	Moderate	348,375	0.40	68,006	12,571,027	16,316	5,831,432
Windstorm	Prevailing wind zone	112,466	N/A	19,949	3,691,210	643	1,299,328

¹ Value = Estimated tax assessor structural value (x1000)

**Table 5-4  
Countywide Potential Hazard Vulnerability Analysis – Critical Facilities**

Hazard	Methodology	Government		Emergency Response		Lifeline Utilities		Care		Educational		Marine / Environmental		Total	
		No.	Value (\$) <sup>1</sup>	No.	Value (\$) <sup>1</sup>	No.	Value (\$) <sup>1</sup>	No.	Value (\$) <sup>1</sup>	No.	Value (\$) <sup>1</sup>	No.	Value (\$) <sup>1</sup>	No.	Value (\$) <sup>1</sup>
Agricultural Emergency		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Coastal Erosion	100-year erosion zone	1	1,180	0	0	0	0	0	0	0	0	1	181,022	2	182,202
Dam Failure	Inundation area	10	22,758	11	467	6	845	26	3,887	32	19,747	5	237,167	90	284,871
	Extreme	0	0	3	0	0	0	0	0	2	2,360	2	2,360	7	2,360
Earthquake	High	21	56,474	65	33,519	9	6,086	110	298,775	191	154,989	6	315,436	402	865,279
	Moderate	7	35,655	0	0	0	0	0	0	0	0	6	273,837	13	309,492
Flood	100-year flood zone	0	0	1	0	3	0	3	0	5	2,266	6	418,189	18	420,455
Hazardous Materials Event	1-mile buffer mobile	17	63,892	52	19,583	6	6,086	80	268,509	136	132,425	8	317,796	299	808,291
	1-mile buffer fixed	0	0	7	66	3	6,086	12	3,975	22	885	0	0	44	11,012
Landslide	High	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Moderate	0	0	2	17,902	0	0	2	104	2	0	0	0	6	18,006
Sea Level Rise	Inundation Area	0	0	0	0	0	0	1	0	2	0	0	0	3	0
Tsunami	Inundation Area	0	0	0	0	0	0	1	0	2	1,952	0	0	3	1,952
	Very high	0	0	1	0	0	0	4	104	2	0	0	0	7	104
	High	0	0	4	671	0	0	4	0	7	0	0	0	15	671
Wildland Fire	Moderate	25	89,769	62	33,016	3	845	135	498,230	138	1,955,501	14	591,633	377	3,168,994
Windstorm	Prevailing wind zone	5	27,816	9	11,092	14	463,702	9	15,334	24	14,160	0	0	64	534,976

<sup>1</sup>Value = Assessed structural value (x1000)

**Table 5-5  
Countywide Potential Hazard Vulnerability Analysis – Critical Infrastructure**

Hazard	Methodology	Highways		Railroads		Bridges		Airport	
		Miles	Value (\$) <sup>1</sup>	Miles	Value (\$) <sup>1</sup>	No.	Value (\$) <sup>1</sup>	No.	Value (\$) <sup>1</sup>
Agricultural Emergency	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Coastal Erosion	100-year erosion zone	10.0	51,750	0.0	0	0	0	0	0
Dam Failure	Inundation area	82.0	552,745	67.0	92,510	108	265,383	0	0
Earthquake	Extreme	16.1	96,008	9.3	12,833	22	10,503	0	0
	High	174.3	1,129,465	54.7	75,524	167	272,059	2	12,862
	Moderate	292.9	1,797,304	51.9	71,660	129	197,353	1	6,431
Flood	100-year flood zone	43.6	270,332	15.6	21,552	92	223,124	0	0
Hazardous Materials Event	1-mile buffer mobile	382.0	2,262,957	137.8	160,017	198	408,347	10	6,431
	1-mile buffer fixed	25.9	0	15.8	0	14	0	2	0
Landslide	High	40.6	287,390	2.5	2,748	18	30,269	0	0
	Moderate	22.4	235,944	3.1	2,889	5	8,616	0	0
Sea Level Rise	Inundation Area	6.2	0	8.4	0	6	0	0	0
Tsunami	Inundation Area	5.6	68,852	4.4	10,546	8	68,531	0	0
Wildland Fire	Very high	9.3	56,038	0.0	0	4	7,993	1	0
	High	82.6	758,489	13.9	16,034	33	75,712	16	0
	Moderate	151.5	1,249,652	57.6	53,164	119	299,285	20	12,862
Windstorm	Prevailing wind zone	141.7	1,053,539	77.3	106,724	55	152,534	1	6,431

<sup>1</sup> Value = Assessed structural value (x1000)

### **5.3.1 Agricultural Emergency**

There are 92,791.6 acres (145.0 square miles) of cropland in Monterey County that intersect with the 100-year floodplain.

### **5.3.2 Coastal Erosion**

Coastal erosion is present along the entire coast of Monterey County. On average, the northern County coastline erodes 2.6 feet annually while the steep cliffs along the southern coastline erode 7 inches annually. Therefore, using a 100-year projection to determine areas at risk to coastal erosion, approximately 752 people (less than 1 percent of the total population), 445 residential buildings (worth \$112.7 million), 100 nonresidential buildings (worth \$144.7 million), and 2 critical facilities (worth \$182 million) reside in the coastal erosion hazard area. Approximately 10.0 miles of highway are also located in this hazard area.

### **5.3.3 Dam Failure**

Exposed within the inundation zones of the Nacimiento, San Antonio, San Clemente, Los Padres, Black Rock Creek, Forest Lake, Pacific Grove, and Salinas dams are 72,926 people (18 percent of the total population), 15,304 residential buildings (worth \$3.4 billion), 1,114 nonresidential buildings (worth \$2.2 billion), and 76 critical facilities (worth \$794.7 million). 82.0 miles of highway and 67.0 miles of railroad tracks are also located in this hazard area.

### **5.3.4 Earthquake**

The strongest earthquake shaking is in the northern and southeastern portions of Monterey County. As such, exposed within the extreme shaking area are 12,251 people (3 percent of the total population), 3,357 residential buildings (worth \$590.9 million), 129 nonresidential buildings (worth \$260.6 million), and 7 critical facilities (worth \$7.1 million). 16.1 miles of highway and 9.3 miles of railroad tracks are also located in this hazard area. Exposed within the high shaking hazard area is nearly 75 percent of the total population. This includes 295,032 people, 73,116 residential buildings (worth \$15.5 billion), 2,826 nonresidential buildings (worth \$5.3 billion), and 186 critical facilities (worth \$1.2 billion). Additionally, 174.3 miles of highway, 54.7 miles of railroad tracks, and 2 airports are located in this hazard area. Moderate shaking can be found in the central and western portion of the county. Exposed within the moderate shaking area is the remaining 23 percent of the total population. This includes 93,431 people, 29,736 residential buildings (worth \$6.5 billion), 1,255 nonresidential buildings (worth \$2.3 billion), and 19 critical facilities (worth \$896 million). 292.9 miles of highway, 51.9 miles of railroad tracks, and 1 airport are also located in this hazard area.

### **5.3.5 Flood**

The major Special Flood Hazard Areas (SFHAs) within the county include areas adjacent to the Salinas, Carmel, Pajaro, and Arroyo Seco rivers, the Moro Cojo and Elkhorn sloughs, and low-lying coastal areas that are inundated by wave attack. Exposed within this hazard area are 18,819 people (5 percent of the total population), 4,886 residential buildings (worth \$949 million), 607 nonresidential buildings (worth \$876 million), and 19 critical facilities (worth \$896 million). Approximately 43.6 miles of highway and 15.6 miles of railroad tracks are located in the 100-year floodplain.

### 5.3.6 Hazardous Materials Event

Over half of the countywide total population resides in the 1-mile buffer of transportation corridors. This includes 263,681 people (approximately 66 percent of the population), 46,826 residential buildings (worth \$8.1 billion), 607 nonresidential buildings (worth \$875.6 million), and 299 critical facilities (worth \$808.3 million). These figures are for the entirety of the transportation corridors and, therefore, overstate the exposure since a single hazardous material event at a specific point along one of these corridors is unlikely to affect all of the buffered areas throughout the county.

Approximately 14 percent of the countywide total population resides within a 1-mile buffer around fixed hazardous materials site locations (based on EHS data provided by the U.S. Environmental Protection Agency). This includes 54,659 people, 7,566 residential buildings (worth \$1.0 billion), 2,445 nonresidential buildings (worth \$995 million), and 44 critical facilities (worth \$11.0 million). These figures are for the entirety of the transportation corridors and, therefore, overstate the exposure since a hazardous material event along the corridors is unlikely to affect all of the buffer area.

### 5.3.7 Landslide

The areas of highest susceptibility to earthquake-induced large landslides include Carmel Valley, the southern Big Sur coast, the Arroyo Seco district, and the foothills of southern Salinas Valley. Within the high landslide hazard area are 5,165 people (1 percent of the total population), 2,495 residential buildings (worth \$522.4 billion), 31 nonresidential buildings (worth \$72.2 million), and 3 critical facilities (worth \$1.9 million). Approximately 55.0 miles of highway and 2.0 miles of railroad tracks are located in this high hazard area. Within the moderate landslide hazard area (lower foothills, Monterey coastal bluffs) are 19,473 people (5 percent of the total population), 7,973 residential buildings (worth \$1.6 billion) and 132 nonresidential building (worth \$296.6 million), and 6 critical facilities (worth \$5.1 million). Approximately 43.1 miles of highway and 2.1 miles of railroad tracks are located in this moderate hazard area.

### 5.3.8 Sea Level Rise

The potential for sea level rise is present along the entire coast of Monterey County. However, **less than 4 percent of the county's population resides in this hazard zone. This includes approximately 3,918 people, 305 residential buildings (worth \$47.5 million), 116 nonresidential buildings (worth \$69 million), and 3 critical facilities.** Additionally, 6.2 miles of highway, 8.4 miles of railroad, 6 bridges, and 0 airports are located in this hazard area.

### 5.3.9 Tsunami

While the entire coastal area of Monterey County is susceptible to a tsunami, the coastal low-lying areas and riverine valleys are the most susceptible. Using the New Tsunami Inundation Map data (Cal EMA, CGS, USC), it is estimated that 1,965 people, 312 residential buildings (worth \$91.5 million), and 194 nonresidential buildings (worth \$264 million), and 3 critical facilities (worth \$2 million) are located in this hazard area. Approximately 5.6 miles of highway and 4.4 miles of railroad tracks are located in this hazard area.

### 5.3.10 Wildland Fire

Using the California FRAP model, very high wildland fire hazard areas are located in and around Los Padres National Forest, Hunter Liggett Military Reservation, and Fresno and Kings counties borders. Within this hazard area are 3,423 people (less than 1 percent of the total population), 770 residential buildings (worth \$575.1 million), 213 nonresidential buildings (worth \$57.1 million), and 7 critical facilities (worth \$104,000).

The high wildland fire risk areas, which mainly consist of the areas to the west and east of the Salinas Valley, include 16,750 people (less than 4 percent of the total population), 3,532 residential buildings (worth \$144.2 million), 1,150 nonresidential buildings (worth \$300.5 million), and 15 critical facilities (worth \$671,000).

Moderate wildland fire hazard areas are located from the southernmost area of the Salinas Valley all the way north to Moss Landing and Pajaro. This area includes approximately 86 percent of the countywide total population, including 348,375 people, 68,006 residential buildings (worth \$12.6 billion), 16,316 nonresidential buildings (worth \$5.8 billion), and 377 critical facilities (worth \$3.2 billion).

### 5.3.11 Windstorm

Windstorms created by prevailing northwest sustained surface winds are common throughout the central and southern Salinas Valley from March to October. As such, 112,466 people (28 percent of the total population), 19,949 residential buildings (worth \$3.7 billion), 643 nonresidential buildings (worth \$1.3 billion), and 64 critical facilities (worth \$535.0 million) are located in the windstorm hazard area. It is important to note, however, that the region's average speeds generally reach only 10 to 15 mph with accompanying wind gusts up to 45 mph.

## 5.4 Future Development

The majority of the county's new development (mainly residential and commercial units) is expected to occur in the north-central and inland areas of the county. The northern region includes the communities of Aromas, Castroville, Elkhorn, Las Lomas, Moss Landing, Pajaro, and Prunedale. The inland area generally consists of the Toro region and the Greater Salinas planning area (including the City of Salinas). In addition, rapid development has occurred and is expected to continue to occur along the Highway 101 corridor to the City of Soledad.

Any new development in the north-central and inland area is susceptible to earthquake hazards. In addition, within the northern portion of the county, new development is susceptible to flooding adjacent to the Salinas and Pajaro Rivers. New development in the inland region will not only be susceptible to flooding along the canyon floors and flat floodplains of the Salinas River, but it will be also susceptible to landsliding along the steep ravines, hillsides, and ridgelines. Development down the Highway 101 corridor will be most susceptible to windstorms and hazardous materials events.

Although the Monterey Peninsula and Big Sur Coastal areas are expected to experience only minor changes in land use and development, any new development or redevelopment in this area (mainly visitor serving commercial inn units and employee housing) is susceptible to natural hazards. Along the Big Sur coast, new development is susceptible to landslides and erosion. Further inland, new development is susceptible to landsliding and wildland fires. Along the Monterey Peninsula, the biggest hazard concerns include flooding in the Carmel Valley and coastal erosion along the peninsula and dunes.