Chapter 11 Landslide

11.1 Risk Assessment

11.1.1 Description of Hazards

Requirement §201.6(c)(2)(i): The risk assessment shall include a description of the type location and extent of all natural hazards that can affect the jurisdiction.

Landsliding is a general term that describes a wide variety of mass downslope movements of soil and rock in response to gravity. Landsliding occurs as falls, topples, slides, spreads, flows, and a combination of these categories, and may change from one form of failure to another during their movement.

Factors causing landsliding include the rock strength and orientation of elements on the slope, erosion, weathering, high rainfall, steepness of slopes, recent fire activity, and human activities such as the removal of vegetation and inappropriate grading.

Landslides occur throughout the world, but Santa Cruz County's unique geologic conditions make large portions of the County particularly susceptible to many forms of landsliding. Factors that contribute to landsliding in Santa Cruz County include:

- storms
- earthquakes
- fires
- freezing and thawing
- erosion
- wildfire burn scars along steep terrain
- vegetation removal, grading and other human activities.

Landslide problems can also be caused by land or stormwater drainage mismanagement, particularly in mountain, canyon, and coastal regions. In areas burned by forest and brush fires, a lower threshold of precipitation will initiate landslides or debris flows. The deterioration of old timber harvest roads may also result in concentration of drainage that induces landsliding. The County of Santa Cruz's General Plan, along with Chapter 16.10 of the County Code set standards to reduce damage from landslides through avoidance of hazardous areas and/or mitigation. These County standards, along with the California Building Code and good engineering practices minimize many landslide problems, but do not eliminate them.

Landsliding occurs throughout Santa Cruz County, but is centered primarily along the steeper slopes in the hills and mountains, along stream corridors, and along coastal bluffs and inlets. Large areas of the County are subject to several forms of landsliding as indicated in Figure 23, but isolated sliding occurs throughout the County. The types of landsliding that occur in Santa Cruz can be summarized as follows:

- Coastal Bluffs: Shallow landslides, debris flows and topples
- Rivers and streams: Shallow landslides, rotational landslides, and lateral spreading
- Hillslopes: Large deep composite landslides, and debris flows.

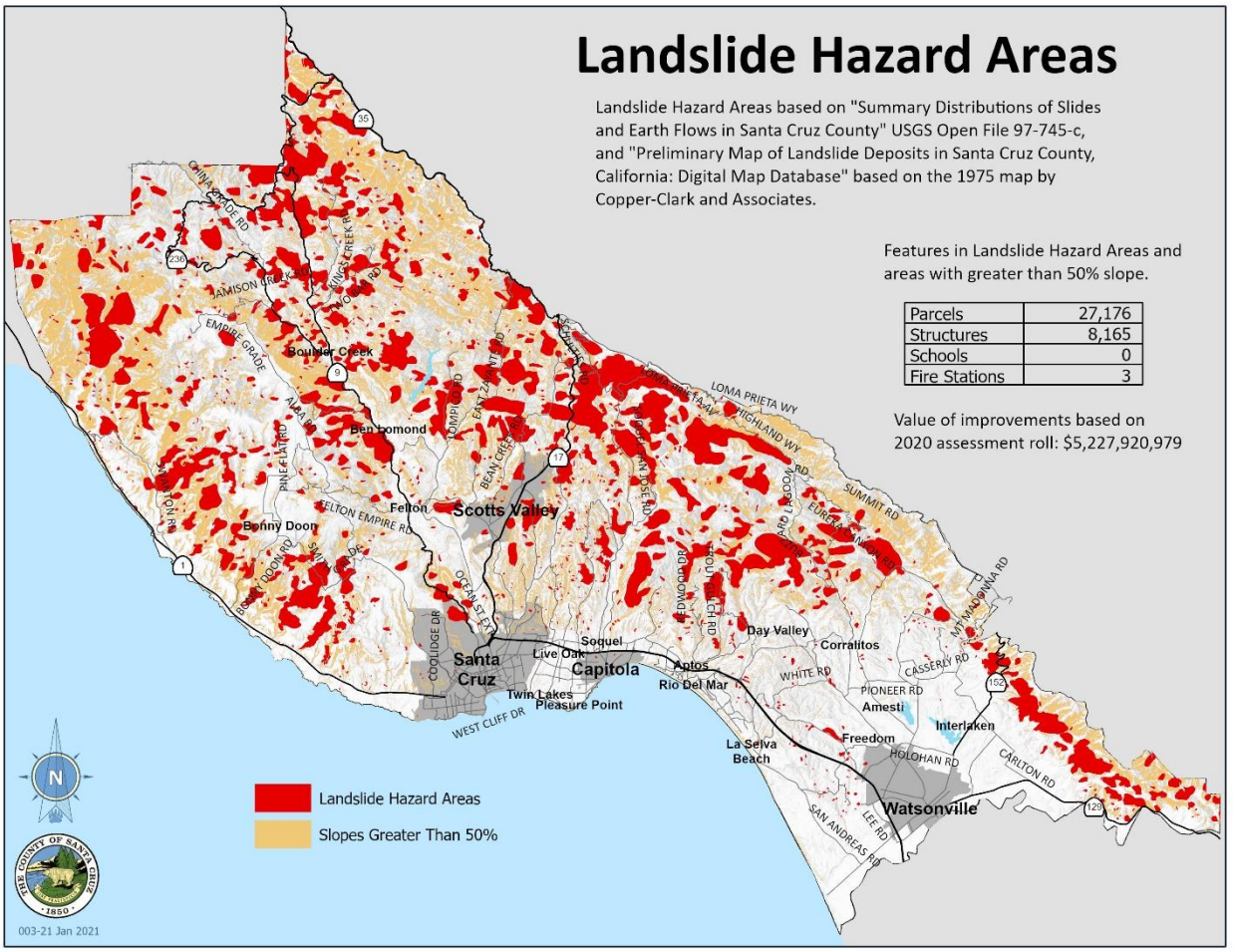

Figure 23 Landslide hazard areas

Landslides are a common occurrence in the Santa Cruz Mountains. Our intense winter storms, high rainfall amounts, especially during El Nino weather patterns, and steep terrain are conducive to landsliding. Earthquake activity contributes to this landsliding, as illustrated by the 1906 earthquake, which set off dozens of large landslides in the Santa Cruz Mountains, some of which claimed human lives. The 1989 Loma Prieta earthquake produced a similar pattern of landsliding. The potential for loss of life and property is much greater today due to the increase in population residing in areas of possible instability.

Most recent landslides in the Santa Cruz Mountains have been caused by a combination of human activity and natural factors. Human activities that act to further destabilize slopes, are old timber harvest roads and skid trails, conversion of land from forest to residential and agricultural uses, road building, grading and other housing construction and any activity that alters normal drainage patterns or concentrates runoff. The likelihood that any of these factors will contribute to landsliding is dependent upon the existing conditions and also on the care with which activities are conducted in these locations.

County Code Section 16.10 in combination with the California Building Code require careful consideration of landslide factors by both engineering geologists, soils engineers, and civil engineers.

However, even with proper care, there remains a higher-than-normal potential for damage from landsliding in many areas of the County.

11.1.2 Previous Occurrences

Requirement §201.6(c)(2)(i): The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

Several periods of landsliding have occurred in Santa Cruz County in recent history. Some of the better-documented landslides are:

Mount Hermon Landslide: The Mountain Hermon landslide moved in the late 1950s after the El Nino year of 1957–1958. This landsliding occurred in an area of suspected older landsliding and the new movement extended from the Kaiser Quarry to the bottom of Bean Creek blocking Conference Drive and is one of the reasons for construction of the Mount Hermon bypass. At the time of the landsliding there was some concern that the quarry (and a small earthquake) may have contributed to the re-initiation of the landslide.

Rainstorms of January 1982: Severe storms caused multiple landslides throughout the Bay Area and especially in the Santa Cruz Mountains. One very large composite landslide along Love Creek, west of Loch Lomond Reservoir, killed ten people. This landslide was and continues to be an indicator of the potential severity of landslide activity and the need for observation and/or mitigation. Other landslides, including debris flows, destroyed 135 homes, damaged 300 homes, and killed 5 other people. In addition to damage to homes, widespread landslide damage occurred to roadways, driveways, and stream channels.

Loma Prieta Earthquake October 17, 1989: Landslides occurred throughout Santa Cruz County during and after the Loma Prieta earthquake. Most of these larger landslides moved only during the actual shaking, but others continue to the present. Smaller landslides occurred along coastal bluffs and along ridge tops.

El Nino Winter Storms of 1986, 1998, and 2005: These storms caused multiple landslides, particularly debris flows, throughout the Santa Cruz Mountains. During the 1998 winter, many homes were affected by landsliding and several roadways were damaged including Highway 9, Branciforte Road, and Amesti Road. Winter rains also induced landsliding within the quarries throughout the County.

Landsliding will continue to affect the County, especially during El Nino weather patterns. Most of the critical structures within Santa Cruz County are located away from landslides, but many homes and roadways are located in and around landslides. El Nino weather patterns will continue approximately every seven years, and the San Andreas Fault, as well as other faults, will generate earthquakes, which will contribute to the formation of landslides.

11.1.3 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.

Past experience has shown that many areas of the County are susceptible to the effects of landslides. Most of the damage caused by landslides will be to privately owned structures although a fair number of County maintained roads are also at risk.

Santa Cruz County terrain, weather, and seismicity increase the likelihood of landsliding. Homes built before 1989 are particularly vulnerable to landslides as some of these were constructed without the benefit of engineering or engineering geologic investigations. Most of the roadways were constructed many years ago with little consideration to slope stability and will likely be affected by landsliding in the future. Because utilities follow these roads, damage to roads will often disrupt sewers, water systems, gas and electricity, and cable and telephone utilities.

Areas that have experienced landsliding include:

- The steep hillslopes throughout the Santa Cruz County, especially near the Zayante and San Andreas fault zones, and within the San Lorenzo Valley and Eureka Canyon.
- The river channels along major streams, and across the broader alluvial plain of the Pajaro River and Corralitos Creek.
- Along coastal bluffs, especially above Beach and Las Olas drives, and above Sunset Beach in the Seacliff Beach area.

The 2020 CZU Lightning Complex Fire, created an increased potential for debris flows in the burned watersheds. While storm driven shallow landslides and debris flows are common within the Santa Cruz Mountains, the loss of soil cover, vegetation, and canopy, as well as soil heating caused by the CZU Fire increased the landslide hazard. The increased hazard is expected to persist for the next several winter seasons because of the wildfire. The debris flow hazard exists on the steep slopes within the drainage areas burned by the wildfire and extends out onto the alluvial fans at the mouth of the drainages, which are typically occupied by residential development.[5]

11.1.4 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 areas.

Parcels and structures potentially subject to landslide hazards were identified by location in a mapped landslide hazard area or on greater than 50% slopes. A wide range of land uses are located in a landslide hazard area as listed in Table 24, but 90% of the structures are residential. The WERT report on the CZU

[5] Watershed Emergency Response Team (WERT) Evaluation, CZU Lightning Complex, CA-CZU-005205. October 1, 2020.

Fire identified over 100 “Values-at-Risk” (VARs) related to human life safety and property, including residences and infrastructure, from increased debris hazards. The report identified significant risk to water supply infrastructure for the San Lorenzo Valley Water District and the City of Santa Cruz.

11.1.5 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)(ii)(A) of this section and a description of the methodology used to prepare the estimate.

Figure 23 includes information on the number and type of structures located within mapped landslide hazard areas and on slopes greater than 50 percent and the total value of the structures. Table 24 is a summary of the number, type, and value of all structures located in landslide hazard areas and on slopes greater than 50 percent. The methodology used to prepare the estimate used the County’s GIS application. The landslide hazard areas and areas with slopes greater than 50 percent is overlayed on the parcel layer to identify the parcels that fall within the landslide hazard layer and their assessed value. This estimate would include many, if not all of the VARs identified in the WERT report. Over 27,000 parcels have been identified as under threat from landslide. However, many of these parcels are undeveloped or unbuildable. Over 8,000 structures have been identified on these parcels, which represent a value of over $5 billion.

Land Use	Parcels	Structures	Total Assessed Value 2020
Agricultural	973	341	$161,623,207
Commercial	249	91	$138,413,982
Government	892	59	$0
Industrial	64	36	$53,961,882
Institutional	276	170	$225,750,431
Miscellaneous	738	146	$82,767,371
Residential	23,763	7,309	$4,563,981,817
Utilities	221	13	$1,422,289
Total	**27,176**	**8,165**	**$5,227,920,979**
Population	18,806		
Population based on 2010 census. Blocks that had centers in the Landslide hazard area or slopes greater than 50% were included.			

Table 24 Landslide potential loss inventory

11.1.6 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.

Santa Cruz County has a number of compact urban communities as well as extensive areas of agricultural land and forested hillsides. A number of rural villages and towns are located throughout the County. As dictated by the 1978 Growth Management Ordinance, most new development has occurred within or adjacent to the urban services line (i.e., the boundary point for such infrastructure as water and sewage service). As with most communities, increased housing costs have resulted in the need to provide higher density housing. In Santa Cruz County, all development of this type occurs where urban services are available. Other development is mostly infill or reuse development, and development of existing rural residential properties.

Growth management policies prevent development from occurring where hazards are present and, in most cases, require substantial setbacks from these hazards.

No changes in these development regulation or patterns occurred that would affect the County's overall vulnerability since the previous plan was adopted in 2016. While the County does not track the number of residential and commercial structures that have been built in landslide hazard zones since the last LHMP was adopted in 2016, it is a subset of the overall number of new structures built in the unincorporated portion of the County. According to annual Growth Management Reports, there have been 909 new residential structures built in the County since 2010 (Table 12). As noted above, however, most new development of residential structures and virtually all new development of commercial structures occurs within the urban services line and outside of landslide hazards zones.

As stated above, growth management policies prevent new development from occurring where hazards are present. Development on existing lots of record is required to avoid hazards and incorporate appropriate setbacks and other requirements to mitigate potential impacts from landslide hazards. The Environmental Planning Section of the Planning Department, staffed by Resource Planners, specialize in reviewing each application for new residential and commercial structures to ensure that new development does not occur in hazard zones and that development on existing lots of record avoid, minimize, and mitigate potential impacts from identified potential landslide hazards.

11.2 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.

An assessment of this mitigation strategy as part of this 5-year plan update indicates the strategy is effective for reducing potential losses identified in the risk assessment. The Planning Department continues to review development applications for emergency use and critical structures, and all other

structures, for compliance with the California building code and the Geologic Hazards Ordinance regarding landslide hazards.

As a result of the CZU Fire, the landslide risk has increased since the previous plan was adopted. Based on the increased hazard, the County implemented the recommendations of the WERT report during the winter of 2020 and 2021, which was a historically dry winter overall and only minor debris flow activity occurred during individual storm events. The County's preparations, however, included utilizing early warning systems (CodeRED), monitoring of rainfall events, public education, and increased maintenance and monitoring of storm drainage systems. These heightened preparations will be implemented in future winters as long as the increased debris flow hazard persists in the burn area.

11.2.1 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 County's over-all strategy to mitigate landslide hazards is to:

Landslide 1 - Require the involvement of qualified experts in identifying specific landslide hazards.

Landslide 2 - Maintain records of the types and locations of these hazards.

Landslide 3 - Require that new development avoid landslide areas whenever possible.

Landslide 4 - Ensure that building plans incorporate all reasonable mitigation measures for structures that must be sited in or near hazard areas.

An assessment of this mitigation strategy as part of this 5-year plan update indicates the strategy is effective for reducing potential losses identified in the risk assessment. The Planning Department continues to review development applications for emergency use and critical structures, and all other structures, for compliance with the California building code and the Geologic Hazards Ordinance regarding landslide hazards. The landslide risk has changed since the previous plan was adopted as a result of the CZU Lightning Complex Fire. Adjustments were implemented to address a change in circumstances to address the elevated debris flow hazard after the fire disaster. There have been no landslide related disasters during the five-year update period.

11.2.2 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.

Landslide hazard mitigation strategies include the following actions. The alpha-numeric identifiers after each action are further described in Chapter 15 Mitigation Strategy.

- Continue to require that the County Geologist review development in areas of suspected landsliding and require engineering geology reports when landsliding is identified or suspected. (A-15)
- Continue to require that an engineering geologist and/or geotechnical engineer investigate the site of any proposed construction near landsliding and require mitigation of landslide hazards before issuing any building or grading permits. (A-16)
- Continue to require that an engineering geologist and/or a geotechnical engineer investigate any landslide damage to homes or roadways before repair of the landslide and reuse of the homes or roadways. (A-17)
- Enhance our early warning, and rainfall monitoring capacity in the high debris flow risk areas of the County following the CZU fires of 2020. (A-22 New)
- Identify, monitor, and mitigate where feasible the hazards and risks associated with post fire debris flows. (A-23 New)

2021 Progress Report

The integration of the plan into existing planning mechanisms and the implementation of mitigation actions demonstrate progress in risk reduction. An explanation of how the mitigation plan for landslide hazards has been implemented over the last five years is included in Appendix L and described below for each Mitigation Action related to landslide hazard reduction.

- Staff continues to review all development for slope instability including landsliding. (A-15)
- Sites near landsliding are investigated by engineering geologist and/or geotechnical engineers, and mitigations are required (where necessary) to prevent damage to development. (A-16)
- Engineering geologic and geotechnical engineering investigations and reports are required for all homes and habitable structures damaged by landsliding. (A-17)
- Implementation of rainfall monitoring and early warning systems after the CZU Fire during the winter of 2020 and 2021 along with an extensive public education campaign, positioned the County to respond to an eminent debris flow hazard and protect public safety through evacuation warnings and orders. A relatively dry winter overall resulted in no evacuations; however, these capabilities will be maintained and enhanced in preparation for future winter seasons. (New)
- An extensive effort to identify and map debris flow hazard areas after the fire disaster allowed the Count to identify potential hazard zones and infrastructure at risk. This allowed the County to perform pre-disaster mitigation of infrastructure such as culvert cleanout and pre-positioning of equipment to respond to a debris flow event. These efforts will continue in future winter seasons. (New)

By using these planning mechanisms to avoid, minimize, and mitigate landslide hazards, the County has demonstrated progress in reducing the risk from landslide hazards. Further explanation of how the previous mitigation plan has been implemented over the last five years is included in Appendix L. The worksheets in Appendix L also describe how the current mitigation strategy, including the goals and hazard mitigation actions, will be implemented over the next five years. The projects described in Mitigation Actions A-15, C-16, and C-17 are still relevant and will continue to be implemented over the next five years along with the new mitigation actions described above related to debris flow hazard.