Town of Portola Valley General Plan

Safety Element

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Safety Element

Introduction

Purpose

4100 The safety element provides a policy framework for measures the town should take to protect persons, property and the economic and social well-being of the community from earthquakes, fires and floods as well as other natural hazards.

Scope

4101 The element deals with the potential geologic, fire and flooding hazards to persons and property in the planning area. Accordingly, geologic, fire and flooding hazards are addressed while hazards such as wind storm, lightning, falling trees, unsafe structures, motor vehicle accidents and crime are not included. These other hazards are dealt with to some degree in other elements of the general plan. In addition, town regulations and state laws provide public policy and regulate conduct in relation to a wide range of hazards.

Definitions

4102 The following definitions of technical terms are used in this element of the general plan:

1. **Hazard:** a source of danger, peril or jeopardy.
2. **Risk:** the chance of injury, damage or loss.
3. **High Risk:** high probability of property loss and/or personal injury.
4. **Seismic:** pertaining to or caused by an earthquake.

5. **Fault:** a plane or surface in earth materials along which shear failure has occurred and materials on opposite sides have moved relative to one another in response to the accumulation of stress in the rocks.

6. **Active Fault:** a fault that has moved in recent geologic time (last 10,000 years) and is likely to move again in the relatively near future.

7. **Inactive Fault:** a fault that shows no evidence of movement in recent geologic time and is inferred to have little potential for movement in the relatively near future.

8. **Fault Zone:** a zone of related faults that commonly are braided and sub-parallel, but which may be branching and divergent. Its width ranges from a few feet to several miles.

9. **Fault Trace:** the intersection between a fault plane and the ground surface. It is graphically portrayed as a line plotted on geologic maps, or in the case of an en echelon surface rupture as a series of short lines at an angle to the general alignment of the trace.

10. **"Maximum Probable" Earthquake:** the greatest magnitude earthquake that can reasonably be expected to occur in a particular area.

11. **Ground Failures:** includes landslide, soil liquefaction, lurch cracking,* surface faulting, ground settlement, lateral spreading,* soil creep and soil expansion.

12. **Soil Liquefaction:** change of water-saturated cohesionless soil to fluid-like state usually from intense ground shaking that causes soil to lose strength and flow as a liquid.

13. **Landslide:** the downslope movement of masses of earth material along a slip surface.

14. **Active Landslide:** a landslide that is moving or shows signs of recent movement.

15. **Landslide Deposit:** earth materials that have been deposited through the process of landsliding.

16. **Richter Scale** (Est. 1935) – A logarithmic scale intended to express the total amount of energy released by an earthquake. The value is calculated from

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* Not considered to be a significant hazard in Portola Valley, but if new information reveals problems of public concern, the element should be expanded to address the hazard.

the amplitude of peaks recorded on a specific type of seismograph plus a distance conversion factor.

17. **Moment Magnitude Scale** – A more recent logarithmic earthquake magnitude scale intended to more accurately reflect the energy released by fault displacement. The calculated value considers the surface area of fault displacement, slip distance and rock rigidity. Determination of this value requires a greater period of time to calculate than the Richter Scale value which is based on a seismogram.

4103 Not used.

Goals

4104 The basic goals of the Town of Portola Valley in adopting this element of the general plan are to prevent loss of life, to reduce injuries and property damage and to minimize economic and social dislocation that may result from earthquakes, other geologic hazards, fires and flooding.

Objectives

4105 The objectives of the Town of Portola Valley in adopting this element of the general plan are:

1. To define the relative degree of risk in various parts of the planning area so that this information can be used as a guide for minimizing or avoiding risk for new construction and for risk abatement for existing development.

2. To minimize the risk to human life from structures located in hazardous areas.

3. To provide a basis for designating land uses that are appropriate to the geologic, fire and flooding risks in the planning area.

4. To ensure that facilities whose continued functioning is essential to society, and facilities needed in the event of emergency, are so located and designed that they will continue to function in the event of fire or natural disaster.

5. To facilitate post-disaster relief and recovery operations.

6. To increase public awareness of geologic, fire and flooding hazards, and of available ways to avoid or mitigate the effects of these hazards.

Principles

4106 The following principles are intended to guide the town and private parties in future actions.

1. Land uses should be controlled to avoid exposure to risk in excess of the level generally acceptable to the community (defined in this element as "Acceptable Risk").

2. Locate development, to the maximum extent feasible, so that it will avoid areas which present high risk exposure.

3. Development in hazardous areas should be limited to structures and improvements that would not threaten human life or cause substantial financial loss if damaged, or the development or site should be engineered to mitigate the hazard if possible without unduly disturbing the natural environment.

4. Where utility lines and roads are located in or cross high hazard areas, all reasonable measures should be taken to insure continuity or quick restoration of service and prevention of secondary hazards such as fire or flood.

5. High hazard areas should not be subdivided unless and until adequate mitigating measures are assured.

6. Critical facilities, such as major transportation links, communications and utility lines and emergency shelter facilities, should be located, designed and operated in a manner that maximizes their ability to remain functional after a disaster.

7. New structures should be designed and constructed to withstand, within levels of acceptable risk, the hazards known to exist at their locations.

8. Additions to or modifications of existing structures should increase rather than decrease the ability of the original structure to withstand any earthquake or other geologic hazards.

9. The public should be made aware of hazards and measures that can be taken to protect their lives and property.

10. Reports of geologic and/or soil investigations should be required in all instances when a permit is sought and available information indicates a potential substantial threat to life or property from a geological hazard.

11. The location and extent of areas covered by soil and geologic investigations received by the town should be recorded by the town geologist on the town's Geologic Map and Ground Movement Potential Map, and the reports thereon should be considered to be public records. Where appropriate, the results of such detailed investigations will be utilized to supplement and supersede more general information.

Acceptable Risk *(In Relation to Structures and Occupancies)*

4107 This section: (a) defines the term "acceptable risk", and (b) assigns various structures, occupancies and land uses to risk classes.

Acceptable Risk

4108 The term "acceptable risk" is used to describe the level of risk that the majority of citizens accept without expecting governmental action to provide protection. To illustrate this point, consider a site that is subject to occasional flooding. If the chances are one in a thousand that the site will be flooded in any given year, local citizens will probably accept that risk without asking for special protection. If the chances of flooding are one in ten, however, either governmental regulations would be enacted to keep people from building on the site (in order to protect life and property), or property owners would ask the government to build protection devices to control the flood waters.

Classification of Structures and Occupancies

4109 Five major classes of structures and occupancies are established in Table 1 for the purpose of risk rating. The first two classes include critical facilities and occupancies – those structures and occupancies that are especially important for the preservation of life, the protection of property or for the continuing functioning of society. Less critical structures and occupancies are included in Classes 3, 4 and 5. The table includes structures and occupancies not presently or likely to ever be in the Portola Valley planning area. They are included, however, to provide a context for the particular structures and occupancies relevant to the planning area. The fourth column of Table 1 describes the maximum amount of damage deemed acceptable in the event of hazardous events such as a great earthquake similar to the one in 1906, a major fire or a significant flood. The last column classifies acceptable damage in terms of acceptable risk.

Potential Hazards in the Planning Area

4110 Each of the following potential hazards is briefly described in the following pages as it relates to the Portola Valley planning area:

1. Faulting
2. Ground Shaking
3. Landsliding
4. Ground Settlement
5. Soil Liquefaction
6. Flooding
7. Erosion and Sedimentation
8. Expansive Soils and Soil Creep
9. Fire Hazards

4111 Documents upon which these descriptions are largely based and that provide additional pertinent information are listed in Safety Element Appendix 1. Also, the most pertinent references for each type of hazard are listed by numbers in parentheses within and following each hazard summary.

4112 The descriptions of the hazards contained herein and in the sources cited in Appendix 1 provide the general basis for applying the policies set forth in the element. As new information becomes available that supplements or modifies these descriptions of hazards, such new information, when officially accepted by the town, may be used in applying or interpreting town policy.

Faulting

4113 Portola Valley is bisected by the San Andreas Fault Zone which is made up of a number of individual fault traces along which movement has occurred at some time in the past. Some of the traces of the San Andreas Fault Zone are considered to be active; some are of undefined activity; some are deemed to be inactive; and others are poorly defined or are as yet unrecognized and the possibility of their activity is questionable. Experience in California and in other parts of the world where active faulting is taking place indicates that future fault movements are most likely to occur along the traces of recent displacements. Ground rupturing, with horizontal displacements of 8 to 10 feet, took place along several fault traces through Portola Valley in the 1906 earthquake. Measurable earth strain and other geologic considerations suggest that similar or greater amounts of displacement may be anticipated in the Portola Valley area in the years ahead. Recurrence intervals for major movements along the Portola Valley segment of the San Andreas Fault are calculated to be approximately 240 years (47).

4114 Although future fault movement is generally anticipated along only those faults judged to be active, there is always the possibility that movement may occur along

Table 1: Risk Classification of Structures, Occupancies and Land Uses				
Class	**General Category**	**General Examples**	**Acceptable Damage to Facility**	**Level of Acceptable Risk**
1-A	Facilities whose failure might be catastrophic	Nuclear reactors, large dams	None which would result in exposing affected population to death or injury	Near zero
1-B	Facilities whose continuing function is critical	Power plants, power intertie systems	None which would impair safety of facility or disrupt function	Extremely low
2-A	Facilities critically needed for services after disaster	Hospitals, fire stations, telephone exchanges	None which would impair safety of facility or disrupt function	Extremely low
2-B	Critical transportation links	Regional highways, bridges, rail lines, overpasses, tunnels	Minor non-structural; facility should remain operational and safe, or be susceptible to quick restoration of service	Low
2-C	Major local utility lines and facilities	Power substations, gas and water mains	Minor non-structural; facility should remain operational and safe, or be susceptible to quick restoration of service	Low
2-D	Small dams	Small dams	None which would expose “downstream” population to injury	Extremely low
3-A	High occupancy structures	High-rise apartmenets and offices, schools	No structural damage; minor non-structural damage, but structures should remain safe and usable	Low
3-B	Facilities highly desirable for shelter after disaster	Schools, churches, civic buildings	No structural damage; minor non-structural damage, but structures should remain safe and usable	Low
3-C	Local roads, utilities and communication facilities	Local roads, local utility lines	Damage should be susceptible to reasonable rapid repair (or utility shut-off)	Moderate
4-A	Medium occupancy structures	Most commercial and industrial buildings, apartments	Structural integrity must be retained; non-structural damage should not unduly endanger safety of occupants	Low
4-B	Low occupancy structures	Singe family homes	Structural integrity must be retained; non-structural damage should not unduly endanger safety of occupants	Low
5-A	Open space, with developed sites	Recreation areas, orchards, vineyards	Structural integrity must be retained; non-structural damage should not unduly endanger safety of occupants	Moderate
5-B	Open space, with undeveloped sites	Grazing lands, forests	Not applicable	Moderate

traces that are of undefined activity, deemed inactive, poorly defined, or as yet unrecognized, or newly formed. The most detailed information regarding the description and location of the most readily recognizable active fault traces in the Portola Valley area are contained in the following reports: W.R. Dickinson, “Commentary and Reconnaissance Photogeologic Map of San Andreas Rift Belt, Portola Valley, California” (1)*(2) (26) and accompanying map; William Letts & Associates, Inc., ”Seismic Hazard Evaluation, Proposed Portola Valley Town Center” (36) and “Supplemental Surface-Fault Rupture Hazard Evaluation, Proposed Potola Valley Town Cetner” (37).

4115 The traces of the San Andreas Fault Zone judged to be active and with significant potential for future displacement are shown with distinctive heavy lines on the Geologic Map of the Town of Portola Valley (Scale 1" = 500') (34). Fault traces from this source are also shown on the Special Studies Zones Maps of the Mindego Hill and Palo Alto Quadrangles (Scale 1" = 2000') (2) (43), issued by the California Geological Survey in compliance with requirements of the Earthquake Fault Zoning Act.

4116 The hazard associated with active fault traces is clear. Any structure built across such a trace and subsequently offset by faulting would be in danger of collapse and constitute a threat to life. Studies of the San Andreas Fault in California and other similar faults elsewhere in the world show that dislocations associated with faulting tend to be concentrated along relatively narrow traces. In Portola Valley, however, a pattern of en echelon ground breakage has occurred along some of the San Andreas trace. In these locations ground breakage consists of short ruptures on the order of 40 feet oriented obliquely to the general fault trend. Also, a belt of disturbed ground several hundred feet wide or more, characterized by secondary fractures and cracks, ground lurching and warping may develop along traces of dislocation. Although deformation of this zone may result in serious structural damage to buildings within it, the risk of structural collapse due solely to permanent ground deformation is considerably less than for sites across or immediately adjacent to the principal trace of movement. For further information, see also references (4a) (4b) (4c) (4d) (5) (6) (7) (8) (9) (10) and (11) (36) (37) (41) (42) (43).

Ground Shaking

4117 Although sparsely populated, the Portola Valley area experienced considerable damage from ground shaking in the 1906 earthquake, which is estimated to have been of a Richter magnitude* 8.3, (or Moment Magnitude of 7.9) with local intensities ranging from VIII to X, on the Modified Mercalli scale** (1956 edition).

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* All references referred to by number are listed in complete citation form in Appendix 1.
* Richter Magnitude is an instrumentally determined measurement of the energy released by an earthquake at its source. The magnitude scale is logarithmic, hence an increase in one unit of magnitude (e.g. 6 to 7) represents a ten-fold increase in seismic wave amplitude but an approximately 32 times increase in energy released at the source.

** See Safety Element Appendix 2 for explanation of the Modified Mercalli Intensity Scale.

Moment Magnitude, a new term describing earthquakes, takes into consideration more than the ground shaking at a location and includes such considerations as the surface area of a rupture. See Section 4102 for the definitions of Richter Magnitude and Moment Magnitude.

Recently published intensity maps by the Association of Bay Area Governments for a 7.9 Richter Magnitude earthquake (based on a model of the 1906 San Francisco Earthquake with a calculated Richter Magnitude of 7.9) on the San Andreas Fault shows Modified Mercalli Intensities ranging from X (Very Violent) on the floor of Portola Valley with bands on either side calculated as IX (Violent) and VIII (Very Strong). ABAG cautions that these intensities may be incorrect by one unit higher or lower. Nonetheless, it is clear that the town could be subject to very intense shaking forces. (28)

For comparison purposes, one can consider the shaking intensity felt in Portola Valley from the 1989 Loma Prieta Earthquake that had a Richter Magnitude of 6.9 but was at a great distance from Portola Valley. For this earthquake, ABAG's maps show the most violent shaking in the floor of the valley is estimated to be VII (Strong) with much of the rest of the town classified as VI (Moderate). (29) This earthquake did not result in significant damage in Portola Valley. It was, however, a much smaller earthquake than what might occur in the not-too-distant future.

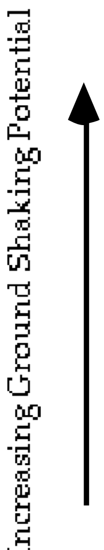
Considerable study has been given to the probability of future earthquakes. ABAG, in collaboration with the U.S. Geological Survey, has published maps showing earthquake probabilities. The most recently published work gives a 62% probability of at least one earthquake of 6.7 or greater magnitude before 2032 somewhere in the San Francisco Bay Area. For the San Andreas Fault, the probability drops to 21%. (33)

Another way of looking at earthquake forces has been to estimate the size of the maximum credible earthquake. This does not, however, provide the probability of occurrence of such an event. More recently, the practice has been to stipulate the probability of exceedence of stated accelerations in terms of gravity. For the floor of Portola Valley there is an estimated 10% probability that ground motion will exceed 0.7 pga (peak ground acceleraton) in the next 50 years (32). Of course, for lesser earthquakes the probability increases.

4118 Not Used

4119 Not Used

4120 The ground effects from seismic shaking in Portola Valley would vary with different underlying rock formations, soil conditions, and the amount of underground water present. Those areas underlain by relatively thick, unconsolidated, water-soaked surficial sediments (such as some recent alluvial deposits) have a greater potential for damaging effects due to ground shaking than do areas of firm bedrock. Table 2, below, defines three "geologic categories" in the Portola Valley planning area in which the geologic materials are grouped on the basis of their anticipated response to seismic shaking. *Surficial Materials* are considered likely to respond more actively to an earthquake than *Near-Bedrock Materials*, which in turn, would respond more actively than *Bedrock Materials*.



Surficial Materials – generally young, often saturated, unconsolidated alluvial deposits of gravel, sand, silt and clay commonly confined to valley floors; slope wash; landslide debris and artificial fill.

Near-Bedrock Materials – semi-consolidated to consolidated older alluvial deposits of gravel, sand, silt and clay (Santa Clara Formation).

Bedrock Materials – hard, stratified to massive, deposits of sandstone, shale, conglomerate, chert, mafic, igneous rocks and serpentine (generally shown as Stable Bedrock-Sbr-on Movement Potential Map of Portola Valley).

Table 2. Relative Ground Shaking Potential in the Portola Valley Planning Area*

For further information, see references (3)(5)(6)(7) (8) (9)(10)(11) (12) (13) (14) (15) (16) (17) (32) (33) (34) (35) (36) (37)(41) (42)(43)

It is clear that portions of Portola Valley are subject to surface fault rupture and that the entire community is subject to violent to less violent shaking. The amount of ground shaking at any location is based on the seismic energy released through the ground. It is prudent to analyze new developments and provide a reasonable level of protection to these two hazards. To that end, the town should adopt and apply the best available information on potential ground shaking. Land uses should be located where the level of risk from seismic forces is deemed acceptable to the community.

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* See Geologic and Movement Potential Maps of Town of Portola Valley for the location of areas underlain by materials described above, references (105) and (106).

At any location, new structures have to comply with the California Building Code (38). Portola Valley and much of California are within the highest seismic risk category in the building code. The code provides differing levels of safety based on building occupancies. In addition, provisions in the code provide detailed requirements for calculating earthquake forces and requiring that buildings be appropriately designed. In Portola Valley, the Building Official is tasked with administering the provisions of the code.

Landsliding

4121 Landsliding is the mass-movement of soil and rock downslope along one or more recognizable slip surfaces; the movement may be rapid (as in rock-falls) or very slow (as in earth flows). In the California coast ranges, landsliding is a natural and widespread phenomenon occurring on many slopes underlain by relatively unstable rocks and soils. Initiation of movement of a new landslide or reactivation of an existing one may be caused by either natural processes or human activities. Strength of hillslope materials may be reduced by weathering and decay of rocks and soils, saturation and strong vibrations. The balance of forces acting on hillslopes, ordinarily in equilibrium, may be upset by addition of weight, removal of lateral support and seismic accelerations. Excavation, construction, irrigation and disposal of waste water in septic drainfields contribute to these processes. Strong ground motion during earthquakes may initiate new landslides and reactivate existing ones. Studies following larger earthquakes in California demonstrate that landsliding is commonly the most widespread type of earthquake related ground failure.

4122 The Geologic Map of Portola Valley shows the location of numerous landslides. Most notably, it indicates that more than half of the hillsides in the western portion of the Portola Valley planning area have been subject to landslide activity. Some of these landslides are ancient and naturally stabilized; some of them are recent and potentially hazardous; and some are actively moving. The hazard to public and private property as well as to public safety from landslides is clear. Roads and utility lines crossing an active landslide may be blocked or severed. Structures may be damaged or destroyed if encroached on or carried downslope by an actively moving landslide. The Ground Movement Potential Map (35) of the town classifies landslides with respect to the potential for future movement and town regulations require that these maps be consulted when new development is proposed. In addition, the California Geological Survey issued Seismic Hazard Zone maps (30) (31) show areas of potential landsliding and require that prior to development in these areas the possibility of landsliding be investigated. For further information, see references (3) (7) (15) (18) (19) (34).

Ground Settlement

4123 Ground settlement is the sinking of the surface of the land and is most commonly due to the compaction of unconsolidated granular sediments and soils. Compaction and settlement of such materials is a natural process that ordinarily takes place slowly and imperceptibly. However, the process can be accelerated by loading imperfectly compacted soils with embankments or buildings, by excessive withdrawal of ground water, or by ground shaking resulting from earthquakes. Seismically induced ground settlement or "shakedown" may occur very rapidly. Settlement, particularly when aggravated by human or seismic processes, may be unequally distributed over a small area (differential settlement) with damaging effects to foundations of structures resting directly on the settled ground. Ground settlement during earthquakes has been a major source of property damage in many earthquake-prone regions of the world.

4124 Areas within Portola Valley with the highest potential for ground settlement are those shown on the Geologic Map of the town as alluvium, slope wash, and landslide deposits. However, some areas underlain by other geologic units may also be subject to ground settlement. Detailed site investigations are required to determine local settlement potential. For further information, see references (3) (5) (15) (39) (40).

Soil Liquefaction

4125 Soil liquefaction is the phenomenon in which certain water-saturated soils temporarily lose their strength when subjected to intense shaking and flow as a fluid. Soils most susceptible to liquefaction are saturated, well-sorted, poorly-compacted, fine sands and silts. Substantial damage in California and other areas of the world has been caused by soil liquefaction brought about by earthquakes.

4126 Although sufficiently detailed geologic and engineering information to predict accurately sites of soil liquefaction in Portola Valley is not currently available, the possibility of liquefaction in localized areas along the valley floor, underlain by unconsolidated alluvium and a seasonally high water table, is considered to be relatively high. In addition, the California Geological Survey issued Seismic Hazard Zone maps show areas of potential liquefaction and require that prior to development in these areas the possibility of liquefaction be investigated (30) (31).

Flooding

4127 In the past, Portola Valley has experienced minor flooding in areas adjacent to streams. These areas include portions of the natural floodplains of Corte Madera, Sausal and Los Trancos creeks, and locations where inadequate or obstructed drainage facilities have been unable to contain peak flows. Hydrologic principles suggest that similar minor flooding will recur sporadically and that somewhat more extensive flooding may take place during widely spaced intervals. The *Flood Insurance Study for Portola Valley* (45) prepared by the Federal Emergency Management Agency in 2008 focuses attention on Corte Madera, Sausal and Los Trancos Creeks. The maps show floodways that include stream channels and any adjoining floodplains where there is a 1% chance of flooding in any year. These floodways are to be kept clear of encroachments so that the 1% annual chance flood can be carried without any substantial increases in flood heights. Inundation by the 100 year flood is indicated for significant portions of Corte Madera Creek. The *Master Storm Drainage Report for Portola Valley* (1970) (21) cites a number of drainage facilities that were judged to be inadequate to pass 10 to 25 year flood flows or which were subject to obstruction by debris and which could contribute to local flooding conditions in their vicinity during periods of high runoff. The results of this study are to be reevaluated by the town.

4128 In addition to the periodic recurrence of minor flooding due to intense rainfall, portions of Portola Valley are exposed to the hazard of flooding that may result from seismically induced failure of small dams. Boronda Lake in Palo Alto Foothills Park in the Los Trancos Creek drainage and the small reservoir behind The Sequoias and the Morshead Lake in the Sausal Creek drainage are retained by earthen embankments. Should either of these dams fail during an earthquake, some downstream flooding may be expected, although no data are available to assess accurately either the seismic stability of the dams or the potential flood hazard. For further information, see references (7) (22).

Erosion and Sedimentation

4129 Erosion and sedimentation are on-going natural processes in Portola Valley as they are elsewhere in the world. Factors influencing the rate of erosion at any particular location include climate, weather, rock and soil characteristics, slope and vegetation. Erosion occurs chiefly on steeper slopes in the upper reaches of drainage basins where runoff velocities are high. Sedimentation, on the other hand, takes place mainly in the lower reaches of drainages where stream gradients and velocities are reduced. No stream gauging or sediment load data are available for the streams in Portola Valley, but it is apparent that the highest erosion potential is found on the steep slopes descending from Skyline Boulevard to the valley floor. Moderately high erosion potential also exists along some short, steep drainages in the eastern part of the town.

4130 Soil maps prepared by Natural Resources Conservation Service dated 1991 and 2008 (39 and 40) provide a generalized view of the distribution of principal soil associations in the Portola Valley area and the relative erodibility of the soil groups. These maps assign a high erosion hazard to the soils on the steep slopes west of the valley floor and a moderate hazard to the foothill areas to the east.

4131 Although no detailed studies of erodibility of the various geologic units (and their associated soils) shown on the Geologic Map of the town have been made, some generalizations are possible. Other factors being equal, surficial deposits of alluvium and slope wash as well as landslide deposits can be expected to be most susceptible to erosion; the beds of the Santa Clara Formation of intermediate erodibility; and the older bedrock units of least, but variable erodablility.

4132 Throughout much of Portola Valley and the surrounding area, the combination of natural slopes, soil structure and native vegetation contribute to a relatively slow natural erosion rate. On the other hand, where natural conditions are disturbed by grading and site development or poorly controlled animal keeping, erosion can be greatly accelerated and cause damage both to the site where it occurs and downstream where sedimentation of the eroded material takes place.

4133 With the exception of the flood plain of Corte Madera Creek along the Portola Valley-Woodside boundary, few persistent areas of natural sedimentation exist in Portola Valley. Most of the sediment produced by erosion is exported by stream flow beyond the boundaries of the town. Local sedimentation does occur along the main creeks and tributary drainages chiefly where human activities have altered stream flow characteristics. Here, sediment accumulations have partially obstructed a number of culverts and drainage ditches, increasing the hazard of local flooding at these points.

For further information, see references (7) and (24).

Expansive Soils and Soil Creep

4134 Some soils and bedrock materials in the Portola Valley area swell when they become wet and shrink when they dry as a result of water absorption by certain contained expansible clay minerals. Building foundations bearing on such materials may suffer destructive distortions if not properly engineered.

4135 Expansive soils may be encountered anywhere within the Portola Valley area, but they occur most frequently in areas shown on the town's Ground Movement Potential Map as expansive soils and bedrock. Individual site investigations and laboratory testing are required to identify expansive soil conditions.

4136 Repeated expansion and contraction of soils on slopes results in slow creep of the soil layer in a downslope direction. The expansion and contraction may be caused merely by bulk absorption and loss of water or freezing and thawing, but soils containing truly expansible clays are subject to pronounced soil creep. Soil creep may exert large enough lateral forces on building foundations to produce significant distortions of the structure or damage to the foundation if unanticipated in the foundation design. For further information, see references (3), (7), and (23).

Fire Hazards

4137 The Portola Valley planning area is served by the Woodside Fire Protection District, the California State Division of Forestry, and Stanford University. Northern and eastern portions of the planning area are also served by the Menlo Park Fire Protection District and the Palo Alto Fire Department. All of these fire protection services fight both structural and non-structural fires, although the equipment operated by the California State Division of Forestry is designed to be most effective against grass, brush and forest fires, rather than structural fires.

4138 A Fire Hazards Map (44), which designates areas subject to significant fire hazards, has been prepared for the town by Moritz Arboricultural Consulting.The map shows eleven vegetation associations and assigns a rating of potential fire behavior to each association. The ratings and general descriptions of associations are as follows:

"highest" (h+) includes a shrub type (chaparral) and three forest types (fire-prone oak woodland, mixed evergreen forest, and fire-prone urban forest)

"high" (h) includes two forest types (fire-prone urban forest and redwood forest) and one scrub type (coastal scrub)

"moderate" (m) includes urban savanna and grassland

"low" (l) includes mowed grass and vineyard

The Moritz map and accompaning report provide guidance for reducing the fire threat from vegetation throughout the town. These informative references should be consulted by property owners and public agencies. Several large areas are discussed below that are of major concern, but the report and map should be consulted since they provide a comprehensive inventory and map of vegetation types as well as prescriptions for reducing fire hazard from vegetation.

Most of the developed parts of the town, that is the area east of the valley floor, is classified as an urban forest and therefore classified as "high" risk. In this area mitigation actions include careful thinning of vegetation, removal of dead materials, and raising of tree limbs. Many actions can be taken by property owners to greatly reduce the risks in these areas.

Several steep wooded canyons and steep slopes in this area are classified as fire-prone oak woodland and therefore classified as the "highest" risk. These canyons are generally the steep back portions of lots where homes, often with wood roofs, are located higher on the properties. Fires in these somewhat remote areas pose a major threat and warrant coordinated actions by property owners bordering the canyons.

Large undeveloped portions of the western hillsides are classified as "highest" risk and "high" risk. It is impractical to undertake extensive removal and trimming of vegetation in these extensive areas. The boundaries of these areas are of greatest concern where they adjoin developed parts of the town.

Also, some developed portions of the western hillsides are classified as fire-prone urban forest and therefore classified as "highest" risk. In these areas, the town and fire district should encourage homeowners to reduce the threat posed by vegetationthrough coordinated efforts.

4139 The Moritz map and report address the fire hazard presented by different vegetation types. The comprehensive fire hazard, however, is further complicated by other factors:

1. Water Supply. The current basic criterion for judging the adequacy of water supply for fire fighting purposes is the 2007 California Fire Code which requires 1,000 gallons per minute for a period of 2 hours, with a residual pressure of 20-lbs/sq. in. for structures under 3,600 sq. ft.

2. Accessibility. The factor of "accessibility" is measured in terms of travel time from a fire station to a potential fire location. It is a measure of the time and degree of roadway access including driveways, in which the responding fire apparatus can navigate to arrive at the incident and and start extinguishment or other operations.

3. Land Slope. Land slope influences fire safety in two ways. First, fire spreads up steep slopes far faster than it does on level land. Secondly, the slope of the land determines how easy it is to move firefighters and equipment to the scene of the fire or other emergencies.

4. Flammability of Structures. The ignition of fires in buildings is conditioned by the building materials that have been used. Concern is not only with respect to a particular building but also to the strong likelihood that fire brands can travel between buildings and thereby contribute to the spread of a fire.

4140 The following portions of the planning area are not shown on the Moritz Fire Hazards Map: the open lands of Stanford University in the northerly part of the planning area including Jasper Ridge Biological Preserve, SLAC, Webb Ranch and the Academic Reserve; the unincorporated area southeast of the town; and the sparsely developed portions of Santa Clara County including the Palo Alto Foothill Park that occupy the easterly fringe of the planning area. An analysis employing the basic fire hazard factors previously described likely would reveal portions of these areas subject to significant fire hazards. When data is available from the responsible fire protection agencies, such data should be referenced herein.

4140a Cal Fire has issued state-wide maps showing Fire Hazard Severity Zones. The maps rate areas in State Responsibility Areas (SRA's) and Local Responsibility Areas (LRA's). The vast area west of Skyline Blvd. that borders Portola Valley is designated as SRA. Within LRA areas, cities are required to adopt Chapter 7A of the Uniform Building Code for areas the state has mapped as very high fire severity. While Portola Valley has not adopted the state maps, it has exceeded the state requirement by adopting Chapter 7A to apply to all new construction throughout town limits. Chapter 7A dictates the use of fire resistant exterior materials and adherence to various design details.

4141 Conclusions drawn from the analysis of fire hazards in Portola Valley are:

1. While the eastern portion of Portola Valley has been developed with adequate roads and has good water supply systems, there are significant fire hazards in canyon areas as well as in heavily vegetated areas. More aggressive programs are needed to addresss these concerns. Fortunately, these areas can be reached quickly by fire fighting equipment, and firefighters are normally able to subdue fires in these areas quite rapidly.

2. The western hillsides of Portola Valley, which are steep, have few roads, lack an adequate water supply and have dense vegetation are relatively hazardous when judged from a fire safety point of view. These areas cannot be reached quickly by fire fighters, and when reached, fire fighters may have substantial difficulty in fighting the fire because of an inadequate road system, dependence on hand carried equipment, and lack of water. These lands are clearly the most hazardous in the planning area. For further information, see reference (25) (44).

3. The large number of homes built in the town with wood siding and wood shingle roofs pose a fire threat because of their relatively easy ignition. Residents should consider replacing these materials with fire resistant construction.

Policies

4142 The following policies are intended to guide the town and private parties in future actions.

Policies Concerning Fault Displacement Hazards

4143 1. Consider all faults shown on the map "Fault Lines Mapped by W.R. Dickenson, November 1971" (2), "Special Studies Zones Maps" (4), the town's Geologic Map and maps prepared by Lettis and Associates (36, 37) as each may be amended, as active faults, unless and until evidence to the contrary is developed through field investigations.

2. Show active and potentially active faults on the town Geologic Map and Ground Movement Potential Map. On the Ground Movement Potential Map show required setbacks for buildings for human occupancy and add corresponding provisions to the zoning ordinance.

3. Subdivisions, structures or other developments within the special studies zones shown on the maps Earthquake Fault Zoning maps (41) should at a minimum comply with pertinent state regulations.

4. Design and construct new roads, bridges and utility lines (either public or private) that cross active fault traces in a manner which recognizes the hazard of fault movement. Such designs should consider that there is a possibility of up to a 20-foot right-lateral displacement on the Woodside and Trancos traces of the San Andreas Fault. Equip water, gas, and electric lines that cross active fault traces with shut-off devices which utilize the best available technology for quick shut-off consistent with providing reliable service.

5. Examine all existing utility lines that cross active fault traces to determine their ability to survive fault movement (in the amount described in paragraph d. above). Utility companies should institute orderly programs of installing shut-off devices on these lines, starting with the lines that cross the Woodside and Trancos traces and those which serve the most people. Consider above-ground crossing of fault traces where continued service and safety cannot be assured for subsurface lines. Establish and maintain adequate emergency water supplies in areas served by water lines that cross active fault traces.

6. Consider fault traces identified as “Fault other than the San Andreas” in the review of applications for the construction of buildings for human occupancy, site development, land divisions and subdivisions. Appropriate geological investigations should be made and reviewed to determine the fault location and characteristics prior to the approval of any such applications.

Policies Concerning Ground Shaking Hazards

4144 1. Design and construct essential services buildings to withstand the “Maximum Considered Earthquake” that has a 2% probability of exceedance in 50 years and remain in service (2007 California Building Code and California Geological Survey). (See Section 4154a for the definition of essential services buildings.)

2. Review the structural integrity of all essential services buildings in the town, and strengthen, remove or replace those that are found to be unable to meet policy a. above.

3. Design and construct residences to retain their structural integrity when subjected to the maximum earthquake that has a 10% probability of exceedance in 50 years (2007 California Building Code and California Geological Survey). Place emphasis on seismic design and seismic bracing systems. Where deemed appropriate by the town, designs should be reviewed by a structural engineer.

4. The Town of Portola Valley endorses the continuing review and updating of the California Building Code (109), which the town has adopted by reference, with the objective of adding to it revisions that reflect information gained from recent earthquakes.

Policies Concerning Landslide Hazards

4145 1. Review all proposed developments with respect to the “Geologic Map” and ”Ground Movement Potential Map” of the town. Require geologic and soil reports, when deemed necessary by the town geologist, for developments in all areas shown with landslides. Reports should be responsive to the information indicated on these maps.

2. Locate structures for human habitation and most public utilities so as minimize disturbances from potential landslides. Give due consideration to mitigating measures, based on geologic and other reports acceptable to the town, that can be taken to reduce the risk from seismic and non-seismic hazards to an acceptable level (as defined in Table 1 and related text).

3. Where roads or utility lines are proposed to cross landslide areas for reasons of convenience or necessity, they should be permitted only if special design and construction techniques can be employed to assure that acceptable risk levels will be met.

4. Adopt implementing policies and regulations that correlate the various land uses permitted by the zoning ordinance with the several categories of landslides shown on the Ground Movement Potential Map which will help assure that any failures of ground due to landslides will not endanger public or private property beyond levels of acceptable risk defined in this element.

5. When considering development in areas that contain unstable ground, it is preferable to develop on those areas of natural stable terrain and thereby

avoid the potential negative environmental impacts from engineered solutions.

Policy Concerning Ground Settlement

4146 1. Consider those areas shown on the "Geologic Map" as alluvium, slope wash or landslide deposits to be areas of potential ground settlement and require detailed site investigation of this potential. Address potential for settlement in other locations in routine site investigations.

Policies Concerning Soil Liquefaction

4147 1. Consider the possibility of soil liquefaction in site investigations in connection with applications for development, especially in areas along the valley floor underlain by unconsolidated alluvium and a seasonally high water table.

2. Review new development proposals against the California Geologic Survey Seismic Hazard Zone Maps as a guide to investigations.

Policies Concerning Flood Hazards

4148 1. Review all applications for subdivisions, building permits and other similar applications in the vicinity of major drainage channels with respect to potential flooding.

2. Do not erect structures in areas determined to be subject to "100 year floods" unless appropriate measures will mitigate potential adverse effects on the structures and nearby properties and will not adversely affect natural riparian zones. Minor structures where there is no threat to life and little threat to property may be allowed.

3. Rely upon Federally issued Flood Insurance Rate maps to define the "100 year flood" area along the relevant portions of Corte Madera Creek, Sausal Creek and Los Trancos Creek unless professionally prepared hydrological reports indicate that the subject site is not within an area that is subjected to "100 year floods."

4. Adopt flood plain regulations in the zoning ordinance to require new construction to minimize potential damage from mapped flood hazards.

5. Replace or improve existing drainage structures such as culverts and pipes deemed to be inadequate to meet acceptable standards. Where possible restore natural systems to convey water.

6. Do not erect structures which will impede the flow of flood waters in a flood channel.

7. Encourage owners of buildings that are in flood-prone areas to take appropriate measures to reduce the likelihood of flood damage to their property. Control any such measures so as to not increase the flood or erosion hazards to other properties or have adverse impacts on the natural riparian zone.

8. Maintain appropriate vegetation on the terrain in the Portola Valley planning area to minimize runoff of rainfall consistent with other safety practices.

9. The town intends to continue to participate in the National Flood Insurance Program and encourages the Federal Insurance Administration to continually update maps as appropriate that indicate the areas in Portola Valley subject to "100 year floods."

10. When the state required flood inundation map for Searsville Dam is available, it should be used in reviewing land uses proposed in the general plan for affected downstream areas.

11. The town should administer creek setback requirements to keep development set back from natural creek channels in order to not impede the flow of water and to limit the extent of development that could be affected by creekbank failure.

Policies Concerning Erosion and Sedimentation

4149 1. Maintain natural slopes and preserve existing vegetation, especially in hillside areas. When change in natural grade or removal of existing vegetation is required, employ remedial measures to provide appropriate vegetative cover to control storm water runoff. Give special attention to minimizing erosion problems resulting from the keeping of animals. In specific applications, these policies will be tempered by the need for fire safety.

2. The town currently administers the provisions of the subdivision ordinance concerning landscaping and erosion control and the provisions of the site development ordinance concerning grading, giving special attention to the protective measures that are appropriate prior to the advent of seasonal rains.

Policy Concerning Expansive Soils and Soil Creep

4150 1. In areas where information available to town officials indicates the probability of expansive soils or soil creep, soils reports should be submitted in connection with all applications for development. In those instances where expansive or creep soils are reported, measures as are necessary to mitigate the probable effects of this hazard should be required.

Policies Concerning Fire Hazards

4151 1. Do not construct buildings for human occupancy, critical facilities and high value structures in areas classified as having the highest fire risk unless it is demonstrated that mitigation measures will be taken to reduce the fire risk to an acceptable level.

2. Prior to the approval of any subdivision of lands in an area of high fire risk, the planning commission should review the results of a study that includes at least the following topics:

    a. A description of the risk and the factors contributing to the risk.

    b. Actions that should be taken to reduce the risk to an acceptable level.

    c. The costs and means of providing fire protection to the subdivision.

    d. An indication of who pays for the costs involved, and who receives the benefits.

3. Homeowners should provide adequate clearance around structures to prevent spread of fire by direct exposure and to assure adequate access in times of emergency and for the suppression of fire.

4. Adopt a town program to reduce fire hazards along the town's public roads.

5. Establish a public information program regarding fire hazards and how property owners can reduce such hazards. Utilize the Moritz report in this effort.

6. In locations identified as presenting high fire hazard, require special protective measures to control spread of fire and provide safety to occupants, including but not limited to types of construction and use of appropriate materials.

7. When reasonable and needed, make privately owned sources of water, such as swimming pools, in or adjacent to high fire risk areas, accessible to fire trucks for use for on-site fire protection.

8. Establish street naming and numbering systems to avoid potential confusion for emergency response vehicles.

9. Design and maintain all private roads to permit unrestricted access for all Woodside Fire Protection District equipment.

10. Apply Chapter 7A of the California Building Code to the entire town to increase the resistance of buildings to fire ignition, and when reviewing developments under Chapter 7A, attempt to choose those materials and colors that are consistent with the visual aspects of the town.

11. When undertaking actions to reduce fire risk by removing or thinning vegetation, homeowners should try to remove the most hazardous material while leaving some native vegetaton to reduce risks of erosion, habitat loss and introduction of potentially dangerous invasive weeds.

Emergency Preparedness

4152 While the nature of hazardous events can be predicted, each event will be different and require different responses. For instance, while the general nature of forest fires is known at this time, the time of day or night and location will not be known until the fire occurs. Nonetheless, it is possible to anticipate the range of possible forest fires and have in place a generic set of actions from which specific actions needed for the particular forest fire can be selected and implemented. An emergency response plan should provide this type of information for the full range of anticipated hazardous events.

The preferable approach, of course, is for the town to take actions that will prevent or minimize the impacts of potential hazardous events. For instance, the town has adopted detailed geologic maps that are administered to prevent new homes from being built across active earthquake fault traces or in landslide prone areas. All impacts of earthquakes, however, are not so easily focused on a few discrete locations since ground shaking will be town-wide. To minimize the impacts of ground shaking, the building code is designed to minimize potential structural damage. For fire hazards, new building code provisions require the use of fire retardant building materials. Also, employment of defensive zones around houses where vegetation is managed to minimize the threat of fire spreading is another example of actions that can be taken before a hazard might occur. In sum the adage “an ounce of prevention is worth a pound of cure” holds true for preventing or minimizing hazardous events. Given that, however, an effective preparedness program is essential for the protection of the town.

4152a Effective response to emergencies requires that, in advance of need, emergency services be organized and necessary physical facilities be provided. Areas of concern include:

1. Fire fighting and rescue

2. Law enforcement

3. Medical services

   a. trained personnel: first aid, nurses, doctors

   b. ambulance service

   c. availability of hospitals

   d. stockpiling of medical supplies

4. Availability of emergency shelter

5. Provision of emergency food supplies

6. Communications networks

   a. emergency services

   b. citizen information

7. Public utilities

8. Transportation facilities

9. Evacuation routes to undamaged areas

10. Command and responsibility structure incorporating town officials, town emergency workers, and other emergency resources.

4153 The town program for emergency preparedness and disaster response should continue to give specific consideration to both the general nature of hazard exposure in the planning area and specific steps that can be taken in advance of natural disaster to facilitate emergency response.

4154 Emergency response measures for the Town of Portola Valley are set forth in the town's Emergency Plan.

4154a Essential services buildings shall be capable of providing essential services to the public after a disaster, be designed and constructed to minimize fire hazards and to resist, insofar as practical, the forces generated by earthquakes, and winds. Essential services buildings include all public buildings supporting emergency operations and those services interruption of which would pose a safety hazard or impede emergency response including but not limited to: fire stations, police stations, emergency operations and communication dispatch centers. (Reference Health and Safety Code Chapter 2, 16000 et seq)

4155 Emergency preparedness planning for the Portola Valley area is based on the premise that local emergencies will be dealt with quickly and effectively by local forces, such as local fire protection services, the County Sheriff, and local health services. The assumption is also made that any major disaster or emergency will require outside assistance, from nearby cities, the county, the state, or from federal sources.

4156 Portola Valley is aware that if an emergency situation affects a wide geographical area (as an earthquake might), that the densely populated areas will probably receive aid first, and that rural areas such as Portola Valley will receive lower priority attention. For this reason, residents of the Portola Valley area need to keep an adequate supply of food, water and medical supplies available, sufficient to sustain them for considerable time after a disaster. Residents also require information and training in self-sufficiency; nieghborhoods require locally-placed resources and an organizational structure supporting local response; and the town needs to organize capabilities for basic rsponses such as shelter and medical care.

Policies Concerning Emergency Preparedness

4157 1. Emergency Preparedness Committee

a. The Emergency Preparedness Committee of the town should prepare and maintain the Town of Portola Valley Emergency Plan.

b. The Emergency Plan should provide for the protection of persons and property in the town in the event of an emergency and provide for the coordination of emergency services of the town and with other public agencies, private persons, cooperation and organizations.

c. The Emergency Plan should address: household preparedness and response, neighborhood preparedness and response, the emergency operations center (EOC), and town resources.

2. Coordination

a. The establishment and maintenance of an emergency operations center is a high priority of the town.

b. The town should cooperate in the activities of the Citizens Emergency Response and Preparedness Program (CERPP) as the town's primary resource for household and neighborhood preparedness and for neighborhood communication and response in an emergency.

c. The town should continue to support measures to increase the ability of local fire, police and health forces to deal with emergencies as they arise, within affordable economic cost.

d. The town should continue its cooperation with county, state and federal agencies in emergency preparedness measures and in mutual assistance programs.

3. Roads

a. Interstate 280 and the arterial roads identified in the circulation element of this general plan are designated as "evacuation routes" that will be utilized in the event of an emergency.

b. The town recognizes the need to have roads of adequate capacity for use in times of emergency. The town has adopted specific standards for road design, including standards for road width, grade and alignment that it finds to be appropriate for the movement of emergency equipment.

c. The town recognizes the necessity of having emergency evacuation routes unimpeded by structures near the traveled way, by narrow bridges, by low overhead signs or by trees that would block the passage of vehicles in time of emergencies. It is therefore town policy to maintain emergency “evacuation routes” in usable condition. The town has adopted zoning regulations that set forth minimum setbacks for buildings from roads.

d. The town recognizes that in spite of precautions some primary emergency evacuation routes may become unusable in an emergency. Therefore, the town catalogs available secondary routes, such as fire and maintenance roads, and verifies operability of any gates and locks protectinng these routes.

4. Exercises

a. Routine emergency exercises should be conducted periodically to continually test the Emergency Plan and make improvements in the system.

b. Major town-wide emergency exercises should be conducted based on carefully prepared scenarios of the major events likely to face the town, most notably wildland fires and earthquakes. The results of these tests should be used to improve emergency response capabilities and also provide information for mitigation measures the town can take to reduce risk prior to a disaster.

5. Other Risk Reduction Measures

a. The town supports a program to identify existing hazards and reduce the risks they pose. Risk reduction includes measures to improve water supplies, provide emergency “escape routes” in areas of high risk, provide legible road signs and other appropriate measures.

b. The town recommends that residents of the Portola Valley planning area keep on hand supplies of food, water, and medical supplies that will be sufficient for their needs for several days in the event of a disaster.

c. Subdivisions and other developments in the Portola Valley planning area should be constructed in such a manner that levels of “acceptable risk” are not exceeded and that built-in “mitigating measures” are taken. This includes the provision of adequate water supplies, roads that are suitable for the safe passage of emergency vehicles and adequate street-name signs.

d. The town recognizes the necessity of having an adequate water supply for fire fighting purposes. It is town policy that lands within the Portola Valley planning area be provided with an adequate water supply as they are developed. More specific standards for water flow, water pressure and water availability for fire fighting are set forth in town regulations.

e. The town endorses, and will continue to participate in, public information programs that will assist local residents in coping with local emergencies that arise from time to time (such as the need for fire protection, or emergency health services), as well as being prepared for possible major disasters.

f. The town has in place and will administer a system to put placards on buildings after a disaster to indicate whether it is safe to occupy a building.

General Policies for Implementation

4158 The preceding pages contain recommendations for avoiding or mitigating hazards that have been identified. Many of the measures that might be taken to mitigate hazards cited in this element could produce results in conflict with other elements of the general plan. Just because natural hazards can be mitigated does not mean that in all cases they should be, especially if such mitigation would produce results that are in conflict with the conservation element, the land use element, the open space element, or other sections of the general plan.

4159 For example, take a tract of land in the hillside areas of Portola Valley that is afflicted with several small landslides and is in an area with very poor fire protection. Merely because the hazards of landslide and fire can be reduced to an acceptably low level of risk does not mean that the town should approve the building of a subdivision there. Before any decision is made on the matter, the town should consider environmental impacts of the mitigation as well as the costs and the benefits of such hillside development, both immediate and long range, and then judge whether or not the public interest would be best served by the approval of the proposed land development.

4160 In translating the policies of this element into specific regulations, particular care should be taken to:

1. Define the scope of "mitigating measures" that should be taken for each hazard and each land use.

2. Provide for a means by which the data from which the policies in this element were derived can be updated or superseded as more accurate or more precise data become available.

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(49) Martin, G.R. and M. Lew, "Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Liquefaction Hazards in California, March 1999, Southern California Earthquake Center.

Safety Element Appendix 2:
Modified Mercalli Intensity Scale

(1956 Version, by Richter, as Reported in U.S. Geological Survey Circular 690)

I. Not felt.

II. Felt by persons at rest, on upper floors or favorably placed.

III. Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.

IV. Hanging objects swing. Vibration like passing of heavy trucks, or sensation of a jolt like a heavy ball striking the walls. Standing automobiles rock. Windows, dishes, doors rattle. Wooden walls and frame may creak.

V. Felt outdoors; direction estimated. Sleepers awakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing. Shutters, pictures move. Pendulum clocks stop, start, change rate.

VI. Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knickknacks, books, etc., off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D[*] cracked.

VII. Difficult to stand. Noticed by drivers of automobiles. Hanging objects quiver. Furniture broken. Weak chimneys broken at roof line. Damage to masonry D[*], including cracks, fall of plaster, loose bricks, stones, tiles and unbraced parapets. Small slides and caving in along sand or gravel banks. Large bells ring.

VIII. Steering of automobile affected. Damage to masonry C[*]; partial collapse. Some damage to masonry B[*]; none to masonry A[*]. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.

IX. General panic. Masonry D[*] destroyed; masonry C[*] heavily damaged, sometimes with complete collapse; masonry B[*] seriously damaged. General damage to foundations.

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[*] Masonry A: Good workmanship and mortar, reinforced and designed to resist lateral forces.
Masonry B: Good workmanship and mortar, reinforced.
Masonry C: Good workmanship and mortar, unreinforced.
Masonry D: Poor workmanship and mortar, weak materials like adobe.

Frame structures, if not bolted, shifted off foundations. Frames racked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground and liquefaction.

X. Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.

XI. Rails bent greatly. Underground pipelines completely out of service.

XII. Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown in the air.

Safety Element Appendix 3:
Implementation of the Safety Element, Actions to Date

1. Special building setbacks have been established along the San Andreas Fault traces in the town.

2. Geology has been mapped at a scale of 1”=500' and a map titled “Ground Movement Potential Map” has been prepared at the same scale.

3. Zoning regulations have been amended to reduce the amount of development possible on unstable lands to 10% of what might otherwise be permitted. Development must also be located on stable ground.

4. A resolution has been adopted that guides the application and revisions of the geology and ground movement potential maps.

5. Zoning, subdivision and site development regulations all require geologic reports in areas where unstable land has been identified.

6. The town engages a town geologist to advise the town on a regular basis with respect to all development where geologic conditions are of a concern.

7. The town has adopted a floodplain combining district in the zoning regulations to regulate development in areas of potential flooding. The town has also adopted the federal flood insurance rate maps.

8. The town has had a fire hazard map prepared based on type of vegetation.