Redwood City General Plan Geology, Soils and Seismicity Background Report

The City of Redwood City is in the process of revising their city-wide general plan. This Technical Memorandum describes the Redwood City General Plan Update project's (Project) geologic environment based on published regional geologic reports and maps. Aspects of the geologic setting that are discussed include geomorphology, geologic units, soils, faulting, ground shaking, liquefaction, lateral spreading, slope stability, differential settlement, expansive soils, subsidence and collapse, soil erosion, and tsunami. Information from this Report will be used in California Environmental Quality Act (CEQA)-related environmental review of the General Plan

Setting

The Project area includes the entire City of Redwood, located on the San Francisco peninsula approximately ten miles east of the Pacific Ocean and adjacent to the western shoreside of the San Francisco Bay. The Project is located within California's Coast Ranges Geomorphic Province, a geologically young and seismically active region. Northwest-southeast trending ranges of low mountains and intervening valleys dominate this region.[1]

Topography

The northeastern portion of the Project area is located in existing and former tidal marshes at elevations near sea level. The central portion of the Project area, located southwest of Interstate Highway 101 and including El Camino Real, is a gently sloping plain draining northeast to the tidal marsh, with elevations up to about 20 feet National Geodetic Vertical Datum of 1929

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[1] California Geological Survey (CGS), 2002, *California Geomorphic Provinces, Note 36,* California Dept. of Conservation.

(NGVD). [2] Redwood City's urban center with commercial and mixed uses is located in this central portion of the Project area. The southwestern portion of the Project area forms the eastern foothills of the Santa Cruz Mountains, and has elevations up to about 600 feet NGVD sloping northeast. Most of this portion of the Project area is developed as residences and parks.

Geology

The Project site is located on the San Francisco Peninsula south of the City of San Francisco. The Peninsula is traversed by three large faults of the San Andreas Fault System: the San Andreas, the Pilarcitos, and the San Gregorio Faults. These faults have divided the Peninsula into geologic units. The Project site is located east of the San Andreas Fault in the San Francisco Bay Block or geologic unit. This Block is characterized by Franciscan basement rocks and rocks sheared by fault movement.[3]

Geologic units underlying the Project area vary with distance from the San Andreas Fault. The southwestern portion of the Project area is located adjacent to the San Andreas Fault Zone, and includes serpentinite, greenstone, and sheared rock including greywacke, siltstone, and shale of Jurassic and Cretaceous age. The central portion of the Project area is underlain by coarse-grained older Quaternary alluvial fan and stream terrace deposits, and younger Quaternary finer-grained alluvial fan deposits and basin deposits of silt and clay closer to the San Francisco Bay. The eastern portion of the Project area, beneath and east of Interstate 101, is underlain by Holocene Bay Mud. Bay Mud consists of organic fine clay and silt. Some of the former tidal flats are covered with manmade fill.[4]

Soils

Soil is generally defined as the unconsolidated mixture of mineral grains and organic material that mantles the land surface. Soils can develop on unconsolidated sediments and weathered bedrock. The characteristics of soil reflect the five major influences on their development: topography, climate, biological activity, parent (source) material, and time. The Project area is mantled by soils that reflect the characteristics of the underlying materials on which the soil is developed.

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[2] National Geographic Holdings, Inc., 2001, *Seamless USGS Topographic Maps on CD-ROM*, California.

[3] Sloan, Dorothy, 2006, *Geology of the San Francisco Bay Region*, University of California Press.

[4] United States Geological Survey (USGS), 1983, *Geologic Map of San Mateo County*, California, Map I-1257-A.

Three basic categories of soils are present in Redwood City. Soils in the current and former tidal flat areas are classified as Urban Land Orthents, and include the Novato and Reyes Series soils. These soils are nearly level, poorly drained, clay and silty clay on reclaimed tidal flats with high shrink-swell potential. Soils in the central portion of Redwood City including the downtown area are also classified as Urban Land Orthents on nearly level to gently sloping land. These soils can be poorly drained to well-drained, and are present on alluvial fans, flood plains, and stream terraces. Soils in the upland areas of Redwood City are Urban Land Orthents including the Los Gatos and Fagan Series soils. These soils are present on gently rolling to very steep terrain, and are well-drained and underlain by sandstone.[5]

Seismicity

The Project area is located in the seismically active San Francisco Bay Area. The main feature generating the seismic activity in the region is the tectonic plate boundary between the North American and Pacific plates. Locally, this boundary is referred to as the San Andreas Fault Zone (SAFZ), which includes the San Andreas Fault and numerous other active faults.

The SAFZ includes active faults found by the California Geological Survey under the Alquist-Priolo Earthquake Fault Zoning Act (APEFZA) to be “active” (i.e., to have evidence of fault rupture in the past 11,000 years).[6] Some of the major regional active faults within the SAFZ include the San Andreas, Hayward, Rodgers Creek, Calaveras, San Gregorio-Seal Cove, Maacama, West Napa, Green Valley, Concord, Greenville, and Calaveras faults. The closest active fault to the Project area is the San Andreas Fault, located about 2,000 feet southwest of the western Project area boundary. The inactive Pilarcitos Fault runs almost parallel to the San Andreas Fault about two miles west of the Project area. The San Gregorio-Seal Cove, an active fault, is located about 9.5 miles west of the western Project boundary. Regional active faults are shown on Figure 1.

In a fact sheet published in 2003, the U.S. Geological Survey estimated that there was a 62 percent probability that between 2003 and 2032, a 6.7 or greater magnitude earthquake will occur in the San Francisco Bay Region. The probability of a 6.7 magnitude or greater earthquake occurring along individual faults was estimated to be 21 percent along the San Andreas Fault, ten percent

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[5] USDA, 1991, *Soil Survey of San Mateo County, Eastern Part, and San Francisco County, California*, May.

[6] Alquist-Priolo Earthquake Fault Zoning Act of 1972, California Public Resources Code, Division 2, Chapter 7.5.

along the San Gregorio Fault, 27 percent along the Hayward-Rodgers Creek Fault, and 11 percent along the Calaveras Fault.[7]

Seismic and Geologic Hazards

Surface Rupture

Surface rupture occurs when the ground surface is broken due to fault movement during an earthquake. The location of surface rupture generally can be assumed to be along an active major fault trace. The active San Andreas Fault is oriented roughly parallel to the western Project area boundary, with a local splay, known as the Cañada Fault, just west of the Project area. The eastern edge of the Alquist-Priolo Earthquake Fault Zone for this fault is located approximately 2,000 feet west of the Project area, just west of Cañada College near Interstate 280, as shown on Figure 2.[8] Areas within the Alquist-Priolo Earthquake Fault Zone require special studies to evaluate the potential for surface rupture to ensure that no structures intended for human occupancy are constructed across an active fault.[9]

Multiple potentially-active Quaternary faults cross the Project area. These faults have evidence of activity between 11,000 years and 1.6 million years ago, and are shown on Figure 2. The faults are shown as concealed or buried,[10] and are not classified under the APEFZA to be active faults. The current version of the Alquist-Priolo mapping indicates that a APEFZA zone does not cross the Project area;[11] therefore, potential for fault rupture within the Project area is considered less than significant.

Ground Shaking

Ground shaking is a general term referring to all aspects of motion of the earth's surface resulting from an earthquake, and is normally the major cause of damage in seismic events. The extent of ground shaking is controlled by the magnitude and intensity of the earthquake, distance from the epicenter, and

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[7] USGS, 2003, *Earthquake Probabilities in the San Francisco Bay Region: 2002 to 2032 – A Summary of Findings*, Open File Report 03-214.

[8] California Division of Mines and Geology (CDMG), 1974, *State of California Special Studies Zones, Woodside Quadrangle, Official Map*, July 1.

[9] Alquist-Priolo Earthquake Fault Zoning Act of 1972, op cit.

[10] CGS, 2003, *Digital Database of Faults from the Fault Activity Map of California and Adjacent Areas*, September 29.

[11] CGS, Interim Revision 2007, *Fault-Rupture Hazards Zones in California, Special Publication 42,* California Department of Conservation.

local geologic conditions. Magnitude is a measure of the energy released by an earthquake; it is assessed by seismographs.[12]

Intensity is a subjective measure of the perceptible effects of seismic energy at a given point and varies with distance from the epicenter and local geologic conditions. The Modified Mercalli Intensity Scale (MMI) is the most commonly used scale for measurement of the subjective effects of earthquake intensity (Table 1). Intensity can also be quantitatively measured using accelerometers (strong motion seismographs) that record ground acceleration at a specific location, a measure of force applied to a structure under seismic shaking. Acceleration is measured as a fraction or percentage of the acceleration under gravity (g).

Table 1: Modified Mercalli Scale[a]

	Intensity	**Effects**	**v,[b] cm/s**	**g[c]**
M[d]	I.	Not felt. Marginal and long-period effects of large earthquakes.		
3	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.		0.0035-0.007
4	IV.	Hanging objects swing. Vibration like passing of heavy trucks; or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV wooden walls and frame creak.		0.007-0.015
	V.	Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.	1-3	0.015-0.035
5	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. Small bells ring (church, school). Trees, bushes shaken (visibly, or heard to rustle - CFR).	3-7	0.035-0.07
6	VII.	Difficult to stand. Noticed by drivers of motor cars.	7-20	0.07-0.15

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[12] In the past, the common standard for measurement of magnitude (M_L) by geologists and earthquake seismologists was the Richter Scale. However, due to limitations of the instrumentation used to measure Richter magnitude, moment magnitude (M_W) is now commonly used to characterize seismic events. Moment magnitude is determined from the physical size (area) of the rupture of the fault plane, the amount of horizontal and/or vertical displacement along the fault plane, and the resistance of the rock type along the fault to rupture. The moment magnitude can be calculated following an earthquake or estimated for an expected earthquake if the fault rupture area and displacement and rock properties can be estimated accurately. Therefore, the magnitudes of expected earthquakes in the San Francisco Bay Area are reported as moment magnitudes.

		Hanging objects quiver. Furniture broken. Damage to masonry D, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices (also unbraced parapets and architectural ornaments - CFR). Some cracks in masonry C. Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.		
	VIII.	Steering of motor cars 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.	20-60	0.15-0.35
7	IX.	General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. (General damage to foundations - CFR.) Frame structures, if not bolted, shifted off foundations. Frames racked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluviated areas sand and mud ejected, earthquake foundations, sand craters.	60-200	0.35-0.7
8	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.	200-500	0.7-1.2
	XI.	Rails bent greatly. Underground pipelines completely out of service.		>1.2
	XII.	Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.		

[a] From Richter (1958).

[b] Average peak ground velocity, centimeters per second (cm/s).

[c] Average peak acceleration (away from source).

[d] Richter magnitude correlation.

Note: *Masonry A, B, C, D.* To avoid ambiguity of language, the quality of masonry, brick or otherwise, is specified by the following lettering (which has no connection with the conventional Class A, B, C construction).

- *Masonry A:* Good workmanship, mortar, and design, reinforced, especially laterally, and bound together by using steel, concrete, etc; designed to resist lateral forces.
- *Masonry B:* Good workmanship and mortar, reinforced, but not designed to resist lateral forces.
- *Masonry C:* Ordinary workmanship and mortar; no extreme weaknesses such as non-tied-in corners, but masonry is neither reinforced nor designed against horizontal forces.
- *Masonry D:* Weak materials, such as adobe; poor mortar; low standards of workmanship; weak horizontally.

The San Andreas Fault is considered capable of generating a magnitude 7.9 (M_W) earthquake, similar to the 1906 San Francisco earthquake. A 7.2 (M_W) magnitude event on the Peninsula portion of the San Andreas Fault or a 7.9 (M_W) event on the entire San Andreas Fault could be capable of generating violent (MMI IX) to very strong (MMI VIII) seismic shaking in the Project area. To the east, the Hayward fault could produce a 6.5 (M_W) event that could result in moderate to strong (MMI VI-VIII) seismic shaking in the Project area.[13]

Estimates of the peak ground acceleration have been made for the Project area based on probabilistic models that account for multiple seismic sources. Under these models, consideration of the probability of expected seismic events is incorporated into the calculated prediction of the level of ground shaking at a particular location. The expected peak horizontal acceleration (with a ten percent chance of being exceeded in the next 50 years) generated by any of the seismic sources potentially affecting the Project area is estimated by the California Geological Survey at 60% to 80% of the acceleration of gravity (g), with greater acceleration closer to the San Andreas fault.[14] This level of ground shaking in the Project area is a potentially significant hazard.

Liquefaction and Lateral Spreading

Liquefaction is the temporary transformation of loose, saturated granular sediments from a solid state to a liquefied state as a result of seismic ground shaking. In the process, the soil undergoes temporary loss of strength, which commonly causes ground displacement or ground failure to occur. Since saturated soils are a necessary condition for liquefaction, soil layers in areas where the groundwater table is near the surface have higher liquefaction potential than those in which the water table is located at greater depths.

The San Mateo County Hazards Mitigations maps indicate that the lowland areas of Redwood City have a high potential for liquefaction.[15] The kinds of soils typical of Redwood City include alluvial fan deposits, which are fine-grained soils with a clayey consistency. In combination with the high groundwater table in the Redwood City area, such soils are highly susceptible to liquefaction, particularly during periods of prolonged rainfall. Regional liquefaction hazard mapping indicates that a 7.2 (M_W) magnitude event on the Peninsula portion of

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[13] Association of Bay Area Governments (ABAG), 2007, *Liquefaction Hazard Map, interactive mapping tool* accessed 7-30-08 at: http://www.abag.ca.gov/bayarea/eqmaps/liquefac/liquefac.html.

[14] CGS, 2003, *Probabilistic Seismic Hazards in California,* based on USGS/CGS Probabilistic Seismic Hazards Assessment (PHSA) Model, *accessed 4/30/08 at: http://redirect.conservation.ca.gov/cgs/rghm/pshamap/psha12237.html*.

[15] San Mateo County Hazards Mitigation Maps, 2005, *Earthquake Liquefaction: San Andreas Fault – Peninsula* accessed 4-30-08 at http://www.co.sanmateo.ca.us/smc/department/home/0,,555771_5558929_436489912,00.html.

the nearby active San Andreas Fault or a 7.9 (M_W) event on the entire San Andreas Fault could result in moderate to high liquefaction hazard in the lowland portions of Redwood City.[16]
High to very high liquefaction susceptibility was mapped in 2007 in the tidal flat areas of Redwood City, where a sand boil, formed by liquefaction during the 1989 Loma Prieta earthquake, was reported in Corkscrew Slough.[17] Recent mapping shows moderate to very high liquefaction susceptibility in the tidal flat area based on soil type.[18]

The Seismic Hazards Mapping Act (SHMA) requires site-specific geotechnical investigations within the Zones of Required Investigation to identify the seismic hazard and formulate mitigation measures prior to permitting developments designed for human occupancy.[19] Seismic Hazard Zone Maps have not been developed for most of Redwood City, and are in progress for the Redwood Point and San Mateo quadrangles of maps prepared by the U.S. Geological Survey. Mapping of a portion of the Woodside quadrangle is planned.[20] A Seismic Hazard Zone map has been completed for the portion of eastern central Redwood City.[21] This map shows a liquefaction investigation zone at the intersection of Woodside Road and El Camino Real. The Zone extends southwest along stream beds and north into the tidal flat and salt evaporator areas.

Lateral spreading is a form of horizontal displacement of soil toward an open channel or other “free” face, such as an excavation boundary. Lateral spreading can result from either the slump of low cohesion and unconsolidated material or more commonly by liquefaction of either the soil layer or a subsurface layer underlying soil material on a slope, resulting in gravitationally-driven movement.[22] Earthquake shaking leading to liquefaction of saturated soil

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[16] ABAG, 2007, *Liquefaction Hazard Map*, interactive mapping tool accessed 7-30-08 at http://www.abag.ca.gov/bayarea/eqmaps/liquefac/liquefac.html.

[17] USGS, 2000, *Preliminary Maps of Quaternary Deposits and Liquefaction Susceptibility, Nine-County San Francisco Bay Region, California*, accessed 4/29/08 at http://pubs.usgs.gov/of/2000/of00-444/, and USGS, 1998, *The Loma Prieta, California, Earthquake of October 17, 1989 –Liquefaction,* USGS Professional Paper 1551-B.

[18] USGS, 2006, *Maps of Quaternary Deposits and Liquefaction Susceptibility in the Central San Francisco Bay Region, California*, Open-File Report 06-1037, accessed 4/30/08 at http://earthquake.usgs.gov/regional/nca/qmap/.

[19] Seismic Hazards Mapping Act (SHMA) of 1990, California Public Resources Code, Chapter 7.8, Section 2690-2699.6.

[20] CGS Seismic Hazard Mapping Act information reviewed online at http://gmw.consrv.ca.gov/shmp/html/pdf_maps_no.html on 27 May 2008.

[21] CGS, 2006, *Seismic Hazard Zones, Palo Alto Quadrangle Official Map*, October 18 as accessed on 28 May 2008 at http://gmw.consrv.ca.gov/shmp/download/pdf/ozn_paloa.pdf

[22] Rauch, Alan F., 1997, *EPOLLS: An Empirical Method for Predicting Surface Displacements due to Liquefaction-Induced Lateral Spreading in Earthquakes*, Ph. D. Dissertation, Virginia Tech, Blacksburg, VA.

can result in lateral spreading where the soil undergoes a temporary loss of strength. The Project area topography is flat to hilly and is traversed by creeks. Portions of the Project area are highly susceptible to liquefaction hazards, indicating that lateral movement to an open face is possible; therefore, the risk of lateral spreading is considered to be potentially significant.

Expansive Soils

Expansion and contraction of volume can occur when expansive soils undergo alternating cycles of wetting (swelling) and drying (shrinking). During these cycles, the volume of the soil changes markedly. As a consequence of such volume changes, structural damage to building and infrastructure may occur if the potentially expansive soils were not considered in project design and during construction.

The Novato and Reyes Series soils in the lowland portions of Redwood City are predominately clays and silty clays with high shrink-swell potential. The Fagan Series soils in the upland areas also have a high percentage of clay and moderate to high shrink-swell potential. Clay and associated materials can result in weak, compressible, or expansive soils. These soils are classified as expansive soils.[23]

Slope Stability

Slope failure can occur as either rapid movement of large masses of soil ("landslide") or slow, continuous movement ("creep"). The primary factors influencing the stability of a slope are: 1) the nature of the underlying soil or bedrock; 2) the geometry of the slope (height and steepness); 3) rainfall; and 4) the presence of previous landslide deposits. Most of the hills in the southwest portion of Redwood City are mapped as "few or very few landslides". However, two small areas within the southwest hills of Redwood City near Stulsaft Park are identified as "mostly landslide," indicating the potential for slides and earthflows in the area. The lower elevations in the eastern and northeastern portion of Redwood City are mapped as "flatland" with no landslides. [24]

The Seismic Hazard Zone map completed for a portion of east central Redwood City shows a few Zones of Required Investigation due to landslides near Woodside Road and Junipero Serra Boulevard.[25]

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[23] USDA, 1991, op cit.

[24] San Mateo County Hazards Mitigations Maps, 1997, *Existing Landslides*, accessed online 30 July 2008 at http://www.co.sanmateo.ca.us/vgn/images/portal/cit_609/11/15/436349078Landslide.pdf

[25] CGS, 2006, op cit.

Settlement and Differential Settlement

Differential settlement or subsidence could occur if buildings or other improvements were built on low-strength foundation materials (including imported fill) or if improvements straddle the boundary between different types of subsurface materials (e.g., a boundary between native material and fill). Although differential settlement generally occurs slowly enough that its effects are not dangerous to inhabitants, it can cause significant building damage over time. Portions of the Project area that contain loose or uncontrolled (non-engineered) fill may be susceptible to differential settlement. Portions of Redwood City located in former tidal flats are expected be susceptible to settlement due to low-strength native soils and potential unconsolidated fill, and differential settlement in areas where fill abuts native soil.

Subsidence and Collapse

Subsidence can occur in areas where the subsurface materials such as limestone rock or salt deposits are dissolved by fluid flow, creating subsurface voids that can collapse. Subsidence can occur where groundwater or natural gas is extracted, and soil grains compact. Surface rupture of faults with vertical offset will result in relative subsidence on one side of the fault.

Decomposition of highly organic soils and seasonal drying of expansive clay soils can result in subsidence which could damage buildings. Organic and expansive soils in the Project area are subject to subsidence.

Soil Erosion

Soil erosion is a natural process that can be caused by wind or water. Eroded soils can be entrained in storm water runoff and be discharged to surface waters, thereby affecting the water quality of receiving waters. Storm water runoff quality both during and after construction is regulated by the National Pollutant Discharge Elimination System (NPDES) program (established through the Federal Clean Water Act); the NPDES program objective is to control and reduce pollutants discharges to surface water bodies. In California, the NPDES program is administered by the State Water Resources Control Board (State Board), with local oversight provided by the Regional Water Quality Control Boards (Water Boards). Redwood City is a co-permittee under the San Mateo Countywide Water Pollution Prevention Program.

Tsunami

Large earthquakes can generate seismic sea waves, or tsunamis, which can cause damage along the coastline. Redwood City is located about 10 miles east of the Pacific Ocean shoreline, and is not within the County of San Mateo Tsunami Evacuation Planning area.[26]

In addition to tsunamis, earthquakes also have the potential to generate a seiche. A secihe is the free or standing oscillation of the surface of water. Seiches occur most frequently in enclosed or semi-enclosed basins such as lakes, bays or seas and can be triggered by strong winds, earthquakes, tsunami or tides. As the northeastern boundary of Redwood City borders the San Francisco Bay, Redwood City could experience seiche or seiche-related effects during seismic activity.

Summary

Development or redevelopment of properties in lowland areas have a moderate to high potential for liquefaction, and a potential for settlement due to expansive soils. Areas in the former tidal flats have a very high potential for liquefaction, and a potential for settlement due to unconsolidated fill and low strength native soils. In order to minimize these risks, the City may wish to incorporate requirements for geotechnical studies for any future development in these areas.

Development of properties in the southwest hills of Redwood City may have a risk of slope failure. The City may wish to form Geologic Hazard Abatement Districts (GHADs) in these areas. Development in areas subject to slope instability often use GHADs as a tool to minimize future risks of instability. A GHAD is a tool to effectively abate geologic hazards that cross property boundaries. It allows property owners to cooperate in solving a common problem. It provides for a cost-effective solution, allowing that a single geotechnical engineering firm and one plan solve the problems of several landowners. The formation of a GHAD is appropriate for the repairs of an existing landslides or prevention of an impending one.[27]

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[26] San Mateo County Hazards Mitigations Maps, 2005, *Tsunami Evacuation Planning*, accessed online 27 May 2008 at http://www.co.sanmateo.ca.us/vgn/images/portal/cit_609/30/38/436489908tsunami.pdf

[27] The formation of a GHAD is enabled by the Beverly Act of 1979 (SB 1195) which allows for a financial mechanisms for funding the reduction of hill-slope hazards. Funding for a GHAD may be via owner assessment or by developer funded endowment.[27] The enabling statute, (Division 17 of the California Public Resources Code, Sections 26500 - 26654) provides for the formation of local assessment districts for the purpose of prevention, mitigation, abatement, or control of geologic hazards. The Act broadly defines "geologic hazard" as "an actual or threatened landslide, land subsidence, soil erosion, earthquake, or any other natural or unnatural movement of land or earth".[27] A GHAD may be proposed by one of two means: (1) a petition signed by owners of at least 10 percent of the real property in the district, or (2) by resolution of a local legislative body.

Seismic Hazard Zone maps have not been completed for most of Redwood City. The one completed map for the Palo Alto quadrangle indicates Zones of Required Investigation due to liquefaction and landslides. Site-specific geotechnical studies are required within these zones. Seismic Hazard Zone maps are in progress for the Redwood Point and San Mateo quadrangles, and are planned for the Woodside quadrangle. The City may wish to incorporate requirements for compliance with these maps into the planning process, as soon as the maps are available.

Other geologic, seismic, and soils issues associated with development projects, including soil erosion, ground shaking, and surface rupture appear to be adequately addressed by current State, County, and City programs.