4.5 GEOLOGY AND SOILS

The following chapter summarizes information concerning current geologic conditions at the EA Study Area. It also provides an evaluation of the potential environmental consequences of future development that could occur by adopting and implementing the proposed Housing Element Update, General Plan Consistency Update, and associated Zoning Ordinances amendments, together referred to as the "Plan Components," to result in significant direct and indirect environmental impacts related to geology and soils.

A. Regulatory Framework

The State of California and local governmental agencies have established regulations and policies that relate to geological hazards and seismic safety, especially where they pertain to the structural integrity of buildings. The following regulations are relevant to the environmental review process for geology and soils in this EA.

1. State Laws and Regulations

a. Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to reduce the hazards posed by surface fault rupture to structures used for human occupancy.[1] The main purpose of the Act is to prevent the construction of buildings used for human occupancy on top of active faults. Although the Act addresses the hazards associated with surface fault rupture, it does not address other earthquake-related hazards, such as seismically-induced ground shaking or landslides.[2]

The law requires the State Geologist to establish regulatory zones (known as Earthquake Fault Zones or Alquist-Priolo Zones) around the surface traces of active faults, and to issue appropriate maps that depict these zones.[3] The maps are then distributed to all affected cities, counties, and State agencies for their use in planning and controlling new or renewed construction. In general, construction within 50 feet of an active fault zone is prohibited.

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[1] Known as the *Alquist-Priolo Special Studies Zones Act* prior to 1994.

[2] California Geological Survey (CGS), Alquist-Priolo Earthquake Fault Zoning Act. URL: http://www.consrv.ca.gov/cgs/rghm/ap/Pages/main.aspx, accessed on January 9, 2013.

[3] Earthquake Fault Zones are regulatory zones around active faults. The zones average about 0.25 mi. wide. http://www.consrv.ca.gov/cgs/rghm/ap/Pages/main.aspx, accessed on January 9, 2013.

b. Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act of 1990 addresses earthquake hazards other than surface fault rupture. These hazards include strong ground shaking, earthquake-induced landslides, liquefaction, or other ground failures.[4] Much like the Alquist-Priolo Earthquake Fault Zoning Act, these seismic hazard zones are mapped by the State Geologist in order to assist local governments in the land use planning process. The Act states that “it is necessary to identify and map seismic hazard zones in order for cities and counties to adequately prepare the safety element of their general plans and to encourage land use management policies and regulations to reduce and mitigate those hazards to protect public health and safety.” The Act also states that “cities and counties shall require, prior to the approval of a project located in a seismic hazard zone, a geotechnical report defining and delineating any seismic hazard.”[5]

c. California Building Standards Code

The California Building Standards Code, also known as Title 24 of the California Code of Regulations, reflects various building criteria from three different sources.[6] One of these sources is the International Building Code (IBC), a model building code adopted across the United States that has been modified to suit conditions in the State, thereby creating what is known as the California Building Code (CBC), or Part 2 of CCR Title 24.

The CBC is updated every three years, and the current 2010 CBC took effect on January 1, 2011. The 2013 CBC is scheduled to go into effect in January 2014.[7] Through the CBC, the State provides a minimum standard for building design and construction. The CBC contains specific requirements for seismic safety, excavation, foundations, retaining walls, and site demolition. It also regulates grading activities, including excavation, grading, fill, drainage, and erosion control.[8]

[4] California Geological Survey, Special Publication 118, *Recommended Criteria for Delineating Seismic Hazard Zones in California*. May 1992 (revised April 2004).

[5] California Public Resources Code, Division 2, Chapter 7.8, Article 7.8, Section 2697(a).

[6] California Building Standards Commission, http://www.bsc.ca.gov/codes.aspx, accessed on January 9, 2013.

[7] California Building Standards Commission, http://www.bsc.ca.gov/Home.aspx, accessed on January 9, 2013.

[8] California Building Standards Commission, 2011. *2010 California Building Standards Administrative Code California Code of Regulations, Title 24, Part 2.*

2. Local Regulations and Policies

a. Emergency Operation Plan[9]

The City of Menlo Park adopted an Emergency Operation Plan (EOP) in 2011. The City developed the EOP to better prepare for responses to emergency situations that could result from natural disasters and technological incidents. To prepare for these emergencies, the City estimated the potential risks associated with earthquakes, flooding, wildland fire, and other disasters. Based on this evaluation, various preparation strategies were developed. These strategies are addressed in Volume 2 of the EOP as follows: Chapter 1 introduces the City's Emergency Management System and four emergency management phases, as well as required activities and responsible parties for each phase; Chapter 2 describes regulatory frameworks and relevant legal authorities; Chapter 3 provides a threat assessment including estimated potential risks associated with various natural and man-made disasters; and Chapter 4 provides a recovery plan, including damage assessments and disaster assistance programs.

b. Menlo Park Municipal Code

i. Chapter 12.04, Adoption of Codes

In accordance with Title 12, Chapter 12.04 of the City of Menlo Park Municipal Code, the City has adopted all parts of the most recent triennial publication of the California Code of Regulations, Title 24 except Part 9, California Fire Code, and are known as the building code of the City. In addition, Chapters 12.06 through 12.18 of the Municipal Code implement certain amendments to the building-related codes of the City.

ii. Grading and Drainage Control Guidelines[10]

The City of Menlo Park Engineering Division's Grading and Drainage Control Guidelines establish design requirements for new construction, additions to existing buildings, and redevelopment projects. These guidelines describe stormwater control and treatment measures (including Best Management Practices [BMPs] such as underground detention systems, vegetated swales, inlet/filter basins, and the like) that are intended to reduce stormwater runoff and prevent sediment and pollutants from entering into the City's storm drain system and creeks, as well as the San Francisco Bay.

In addition, the guidelines present the requirements for grading and drainage (G&D) plans, which the City of Menlo Park Engineering Division requires for any building project that will affect more than 500 square

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[9] City of Menlo Park, 2011. *Emergency Operation Plan, Basic Plan*, Volume 2.

[10] City of Menlo Park, *Grading and Drainage Control Guidelines*, August 2010, http://www.menlopark.org/departments/pwk/grade_guide.pdf, accessed on January 9, 2013.

feet of a given lot. The guidelines also require the inclusion of site plans and storm drain control plans in a G&D plan, so that proposed storm drain and utility systems, frontage improvements, and irrigation plans are clearly identified. The City also requires G&D plans to address erosion and sedimentation control details and to include an Impervious Area Worksheet that evaluates potential changes to impervious areas.

B. Existing Conditions

1. Regional Seismicity

The Earth's crust includes tectonic plates that locally collide with or slide past one another along plate boundaries. California is particularly susceptible to such plate movements, notably the largely horizontal or "strike-slip" movement of the Pacific Plate, as it impinges on the North American Plate. In general, earthquakes occur when the accumulated stress along a plate boundary or fault is suddenly released, resulting in seismic slippage. This slippage can vary widely in magnitude, ranging in scale from a few millimeters or centimeters, to tens of feet.

The performance of man-made structures during a major seismic event varies considerably due to a number of factors: location with respect to active fault traces or areas prone to liquefaction or seismically-induced landslides; the type of building construction (i.e. wood frame, unreinforced masonry, non-ductile concrete frame); the proximity, magnitude, and intensity of the seismic event itself; and many other factors. In general, evidence from past earthquakes shows that wood frame structures tend to perform well especially when their foundations are properly designed and anchored. Older, unreinforced masonry structures, on the other hand, do not perform as well, especially if they have not undergone appropriate seismic retrofitting. Applicable building code requirements, such as those found in the CBC, include seismic requirements that are designed to ensure the satisfactory performance of building materials under prescribed seismic conditions.

a. Faults

The EA Study Area, like much of the San Francisco Bay area, is vulnerable to seismic activity due to the presence of several active faults in the region. The closest and most prominent active fault near the EA Study Area is the San Andreas Fault System, which is located about 2.5 miles west of Interstate 280 and the western boundary of the EA Study Area.[11] Other active earthquake faults in the region include the Monte

[11] United States Geological Survey (USGS), Montara Mountain (1980), Palo Alto (1973), San Mateo (1980), and Woodside (1973), Quadrangles, California, 7.5 Minute Series (Topographic), scale 1:24,000.

Vista Fault, which lies roughly 3 miles to the south, the Hayward Fault which lies roughly 13 miles to the east, the Calaveras Fault which is approximately 19 miles to the east, and the San Gregorio Faults, whose trace passes as close as 13 miles southwest of the EA Study Area.[12] No mapped earthquake faults run within the EA Study Area. Thus, surface fault rupture is not considered a significant hazard within the EA Study Area.[13]

b. Ground Shaking

The severity of ground shaking depends on several variables such as earthquake magnitude, hypocenter proximity, local geology including the properties of unconsolidated sediments, groundwater conditions, and topographic setting. In general, ground shaking hazards are most pronounced in areas that are underlain by loosely consolidated soil/sediment.[14]

When earthquake faults within the Bay Area's nine-county area were considered, the United States Geological Survey (USGS) estimated that the probability of a magnitude (M) 6.7 or greater earthquake prior to year 2032 is 62 percent, or roughly a two-thirds probability over this timeframe. Individually, the forecasted probability for each individual fault to produce an M 6.7 or greater seismic event by the year 2032 is as follows: 27 percent for the Hayward Fault, 21 percent for the San Andreas Fault, 11 percent for the Calaveras Fault, and ten percent for the San Gregorio Fault.[15] Earthquakes of this magnitude can create ground accelerations severe enough to cause major damage to structures and foundations not designed to resist the forces generated by earthquakes. Underground utility lines are also susceptible where they lack sufficient flexibility to accommodate the seismic ground motion.[16] In the event of an earthquake of this magnitude, the seismic forecasts presented on the Association of Bay Area Governments' website (developed by a cooperative

[12] Hart, E.W., and Bryant, W.A., *Fault-Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones Maps*, California Geological Survey, Special Publication 42, revised 1997, Supplements 1 and 2, 1999, Supplement 3, 2003. 19 International Conference of Building Officials, Uniform Building Code, Volumes 1, 2 & 3; Chapter 16, Structural Forces (earthquake provisions).

[13] Annex to 2010 Association of Bay Area Governments (ABAG), *Local Hazard Mitigation Plan Taming Natural Disasters, City of Menlo Park*, http://www.ci.menlo-park.ca.us/departments/com/LMHPDraft%20.pdf, accessed on January 9, 2013.

[14] Southern California Earthquake Center (SCEC), 2011. *Putting Down Roots in Earthquake Country*, Lucile M. Jones, United States Geological Survey (USGS), and Mark Benthien, SCEC.

[15] United States Geological Survey (USGS), San Francisco Region Earthquake Probability, http://earthquake.usgs.gov/regional/nca/wg02/images/percmap-lrg.html, accessed January 9, 2013.

[16] Association of Bay Area Governments (ABAG), 1995. *The San Francisco Bay Area On Shaky Ground*, Publication Number P95001EQK, 13 maps, scale 1:1,000,000.

working group that included the USGS and the CGS) suggest that most parts of EA Study Area southwest of Highway 101 are expected to experience "strong" shaking, most sites northeast of Highway 101 are expected to experience "very strong" shaking, and sites located within 1 mile of the Dumbarton Bridge are expected to experience "violent" shaking.[17]

The April 1906 earthquake on the San Andreas fault, estimated between M 7.7 and M 8.3, was the largest seismic event in recent history that affected the EA Study Area. More recently, the M 6.9 Loma Prieta earthquake of October 1989 on the San Andreas fault caused significant damage throughout the Bay Area, although no deaths were reported in San Mateo County.

c. Liquefaction

Liquefaction generally occurs in areas where moist, fine-grained, cohesionless sediment or fill materials are subjected to strong, seismically-induced ground shaking. Under certain circumstances, the ground shaking can temporarily transform an otherwise solid material to a fluid state. Liquefaction is a serious hazard because buildings in areas that experience liquefaction may subside and suffer major structural damage. Liquefaction is most often triggered by seismic shaking, but it can also be caused by improper grading, landslides, or other factors. In dry soils, seismic shaking may cause soil to consolidate rather than flow, a process known as densification.

Liquefaction potential in the EA Study Area ranges from very low in the western hill areas to very high in the Baylands. Close to San Francisco Bay, in the northeastern most part of the EA Study Area, the prevailing soil type is known as "Bay Mud," which consists of silty clay, sand, gravel, peat, and shell fragments. These low-lying areas that front the bay are susceptible to liquefaction. The more eastern portions of the EA Study Area, within 2 miles of the Dumbarton Bridge, are also considered to be a "high hazard" area for earthquake-induced liquefaction.[18] In the westernmost parts of the EA Study Area, the prevailing soil type often consists of alluvium that lies atop the sandstone, chert, shale, and limestone of the Late Jurassic to Early Cretaceous Franciscan Formation.[19] This area is judged to have a low susceptibility to liquefaction.

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[17] Association of Bay Area Governments (ABAG), 2012. GIS Viewer, Hazards Maps Earthquake Shaking Scenarios.

[18] California Geological Survey (CGS), 2006. Seismic Hazards Zone, Palo Alto Quadrangle, Official Map, released October 18, 2006. Scale 1:24,000.

[19] City of Menlo Park, 1994. Final Environmental Impact Report for Amendments to the City of Menlo Park General Plan Land Use and Circulation Elements and Zoning Ordinance, pages IV.H-1 to IV.H-5.

2. Landslides, Erosion, and Subsidence

Landslides are gravity-driven movements of earth materials that may include rock, soil, unconsolidated sediment, or combinations of such materials. The rate of landslide movement can vary considerably. Some move rapidly as in a soil or rock avalanche, while other landslides creep or move slowly for extended periods of time. The susceptibility of a given area to landslides depends on many variables, although the general characteristics that influence landslide hazards are well understood. The factors that influence the probability of a landslide and its relative level of risk include the following:

- Slope Material: Loose, unconsolidated soils and soft, weak rocks are more hazardous than are firm, consolidated soils or hard bedrock.
- Slope Steepness: Most landslides occur on moderate to steep slopes.
- Structure and Physical Properties of Materials: This includes the orientation of layering and zones of weakness relative to slope direction.
- Water Content: Increased water content increases landslide hazard by decreasing friction and adding weight to the materials on a slope.
- Vegetation Coverage: Abundant vegetation with deep roots promote slope stability.
- Proximity to Areas of Erosion or Man-made Cuts: Undercutting slopes can greatly increase landslide potential.
- Earthquake Ground Motions: Strong seismic ground motions can trigger landslides in marginally stable slopes or loosen slope materials, and also increase the risk of future landslides.

Landslides have the potential to occur within the EA Study Area, most notably on some of the hilly slopes that lie west of the street Alameda de las Pulgas. In general, landslides are commonly associated with bedrock outcrops of the Franciscan Formation, which frequently form steeper slopes. Shale is the most unstable of the rock types within the Franciscan Formation, whereas sandstone and conglomerate tend to be more stable with a lower landslide risk. Much of the upland areas in the EA Study Area are typified by shallow soil that overlies Franciscan bedrock very close to the surface. Landslides are not an issue in parts of the EA Study Area where the topography is flat. Due to the differences in the physical characteristics of slope materials, which markedly influence landslide potential, some superficially similar areas may differ widely in terms of landslide hazards. For this reason, site-specific geotechnical analyses are essential to the accurate assessment of potential landslide hazards at any given project.

3. Land Subsidence

Subsidence hazards are known to be present in the diked baylands due to the highly compressible nature of the underlying fill as well as historical groundwater overdraft.[20] Areas susceptible to earthquake-induced subsidence include those areas underlain by thick layers of colluvial material or poorly engineered fill. This fill was reported to have settled historically with hydro-compaction being an element of the settlement as well. Land subsidence occurred within the low-lying areas, mainly along the Bay margins.

4. Expansive soil

Expansive soils can change dramatically in volume depending on moisture content. When wet, these soils can expand; conversely, when dry, they can contract or shrink. Sources of moisture that can trigger this shrink-swell phenomenon can include seasonal rainfall, landscape irrigation, utility leakage, and/or perched groundwater. Expansive soil can exhibit wide cracks in the dry season, and changes in soil volume have the potential to damage concrete slabs, foundations, and pavement. Special building/structure design or soil treatment are often needed in areas with expansive soils.

Expansive soils are typically very fine-grained with a high to very high percentage of clay, typically montmorillonite, smectite, or bentonite clay. Two types of soil tests are used to identify expansive soils. The first is referred to as a linear extensibility test, which measures the change in length of an unconfined clod as the moisture content is decreased from a moist to dry state. The volume change is reported as a percent change for the entire sample. In the linear extensibility test, shrink-swell potential is considered low if the soil has a linear extensibility of less than 3 percent; moderate if 3 to 6 percent; high if 6 to 9 percent; and very high if more than 9 percent.[21] A linear extensibility of 3 percent or greater indicates that shrinking and swelling has the potential to cause damage to buildings, roads, and other structures.

A 1991 U.S. Department of Agriculture (USDA) soil survey of San Mateo County provides an overview of the soil types present in the EA Study Area soils as well as their physical and engineering properties.[22] The study, whose extent embraced the southernmost part of the County including the City of Menlo Park, broadly identified three major soil associations in the EA Study Area: 1) the Accelerator-Fagan association

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[20] Todd Engineers, 2005. *Feasibility of Supplemental Groundwater Resources Development Menlo Park and East Palo Alto, California*.

[21] Army Corps of Engineers Field Manual TM 5-818-7, 1985. Accessed November 2012 from: http://armypubs.army.mil/eng/DR_pubs/DR_a/pdf/tm5_818_7.pdf.

[22] U.S. Department of Agriculture (USDA), 1991. Soil Conservation Service, Soil Survey of San Mateo County, Eastern Part, and San Francisco County, California. Issued May 1991.

soils, typically comprised of deep, well-drained loams or clay loams that are most prevalent in the western foothills; 2) the Botella complex soils that are generally composed of deep or very deep, well drained clay loams, and predominantly found in the central part of the EA Study Area; and 3) and Urban land-Orthents, very deep, poorly drained, texturally heterogeneous soils that have been used for fill in a (proportionally) smaller area along the Baylands edge.

The USDA county-wide soil survey notwithstanding, the shrink-swell potential at a given project within the EA Study Area may often be highly site-specific, requiring careful geotechnical investigation prior to project design and construction. For example, soils on the northeastern Baylands edge, as in the vicinity of the Facebook East and West Campus Project, are known to be clay-rich and poorly drained, and are likely to possess high shrink-swell potential.[23] Elsewhere in the EA Study Area, soil test data in the USDA's Web Soil Survey (a nationwide data repository) shows soil plasticity index values of 10 to 12 percent, suggesting low to moderate shrink-swell potential at those locations.[24]

5. Mineral Resources

As noted in the Initial Study prepared for the Plan Components, which has been included as Appendix A of this EA, no areas within the EA Study Area have been identified by the California Geological Survey as a viable source of aggregate or other construction-related mineral resources.[25]

C. *Standards of Significance*

The Plan Components would have a significant impact with regard to geology, soils, and seismicity if they would:

1. Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

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[23] City of Menlo Park, 2011. Facebook Campus Project Draft EIR, dated December 2011, prepared by Atkins, Inc.

[24] U.S. Department of Agriculture (USDA), Natural Resources Conservation Center, Web Soil Survey, 2013. http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm last accessed February 15, 2013.

[25] California Geological Survey (CGS), OFR 96-03, 1996. *Update of Mineral Land Classification: Aggregate Materials in the South San Francisco Bay Production-Consumption Region*. Kohler-Antablin, Susan.

- Surface rupture along an active fault, including those faults identified on recent Alquist-Priolo Earthquake Fault Zoning Maps issued by the State Geologist, or active faults identified through other means (i.e. site-specific geotechnical studies, etc.).
- Strong seismic ground shaking.
- Seismic-related ground failure, including liquefaction.
- Landslides, mudslides, or other similar hazards.

2. Result in substantial soil erosion or the loss of topsoil.

3. Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on-or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse.

4. Be located on expansive soil, as defined in Section 1803.5.3 of the California Building Code (2010), creating substantial risks to life or property.

D. *Impact Discussion*

1. Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving surface rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault; strong seismic ground shaking; seismic-related ground failure, including liquefaction, and landslides; mudslides; or other similar hazards.

There are no Alquist-Priolo Earthquake Fault Zones that have been mapped within the EA Study Area and the potential for ground rupture is therefore considered low for any potential future housing in the EA Study Area. However, in the event of a large, M 6.7 or greater seismic event, much of the EA Study Area is projected to experience “strong” to “very strong” ground shaking, with the most intense shaking forecast for the northeastern part of the EA Study Area.[26] Similarly, certain northeastern parts of the EA Study Area, particularly those areas underlain by Bay Muds, are judged to have a very high potential for seismically-induced liquefaction. Based on a USGS geologic map of the area, none of the five housing appear to lie atop

[26] California Seismic Safety Commission (CSSC), California Geological Survey (CGS), California Emergency Management Agency (CalEMA), and United States Geological Survey (USGS), *Earthquake Shaking Potential for the San Francisco Bay Region*, 2003, http://quake.abag.ca.gov/shaking/, accessed on January 11, 2013.

Bay Muds. Potential housing Site 5 (Haven Avenue) is located on artificial fill that lies adjacent to Bay Muds; considering this setting, this site may be at greater risk for liquefaction.[27]

However, all future residential development would be subject to existing federal, State, and local regulations and the following amended General Plan policies and programs:

a. Amended General Plan Seismic Safety and Safety Element

- Policy S-1.3: Hazard Data and Standards. Integrate hazard data (geotechnical, flood, fire, etc.) and risk evaluations into the development review process and maintain, develop and adopt up-to-date standards to reduce the level of risk from natural and human-caused hazards for all land use.
- Program S-1.E: Modify the Zoning and Subdivision Ordinances as Needed to Address Hazard Mitigation. Modify the Zoning Ordinance as needed when new information on natural hazards becomes available and to provide for hazard reduction measures as a part of the design criteria for development review. Review the Subdivision Ordinance and modify as needed to include hazard reduction in the process of dividing land for development.
- Policy S-1.7: California Building Standards Code. Encourage the reduction of seismically vulnerable buildings and buildings susceptible to other hazards through enforcement of the California Building Standards Code and other programs.
- Program S-1.H: Enforce Seismic Risk Analysis and Adequate Construction Standards. Enforce seismic risk analysis and adequate construction standards through the building permit and inspection process.
- Policy S-1.13: Geotechnical Studies. Require site-specific geologic and geotechnical studies for land development or construction in areas of potential land instability as shown on the State and/or local geologic hazard maps or identified through other means.
- Policy S-1.14: Potential Land Instability. Prohibit development in areas of potential land instability identified on State and/or local geologic hazard maps, or identified through other means, unless a geologic investigation demonstrates hazards can be mitigated to an acceptable level as defined by the State of California.
- Policy S-1.5: New Habitable Structures. Require that all new habitable structures to incorporate adequate hazard mitigation measures to reduce identified risks from natural and human-caused hazards.

[27] United States Geological Survey (USGS), 2000. *Geologic Map and Map Database of the Palo Alto 30' X 60' Quadrangle, California*, E.E. Brabb, R.W. Graymer, and D.L. Jones.

- Program S-1.C: Review Building Code Updates. Continue to review State Building Code updates and incorporate local amendments as appropriate to require that new construction be designed under the most current safety standards. The review of updates should also consider requirements for facilities housing sensitive populations, such as seniors and persons living with disabilities.
- Program S-1.D: Require Early Investigation of Potential Hazard Conditions. Require that potential geologic, seismic, soils, and/or hydrologic problems confronting public or private development be thoroughly investigated at the earliest stages of the design process, and that these topics be comprehensively evaluated in the environmental review process by persons of competent technical expertise.
- Goal S-1: Assure a Safe Community. Minimize risk to life and damage to the environment and property from natural and human-caused hazards, and assure community emergency preparedness and a high level of public safety services and facilities.
- Program S-1.B: Maintain Up-to-Date Hazard Maps and Databases. Maintain up-to-date databases and maps of geologic and other hazards to identify areas prone to hazards for planning purposes on an ongoing basis concurrently with the Housing Element Updates.
- Program S-1.A: Link the City's Housing and Safety Elements. Continue to review and revise the Safety Element, as necessary, concurrently with updates to the General Plan Housing Element whenever substantial new data or evidence related to prevention of natural and human hazards become available.

Compliance with existing federal, State, and local regulations and the goals, policies and programs listed above would ensure that the impacts associated with seismic hazards are minimized to the maximum extent practicable. Consequently, overall, associated seismic hazards impacts would be *less than significant*.

2. Result in substantial soil erosion or the loss of topsoil.

Substantial soil erosion or loss of topsoil during construction could undermine structures and minor slopes, and this could be a concern of nearly all future housing under the Plan Components. However, compliance with existing regulatory requirements, such as implementation of erosion control measures as specified in the City of Menlo Park Engineering Division's Grading and Drainage Control Guidelines, would reduce impacts from erosion and the loss of topsoil. Examples of these control measures include hydroseeding or short-term biodegradable erosion control blankets; vegetated swales, silt fences, or other inlet protection at storm drain inlets; post-construction inspection of drainage structures for accumulated sediment; and post-construction clearing of debris and sediment from these structures. Furthermore, the future housing permitted by the Plan Components would be concentrated on sites either developed and/or underutilized, and/or in close proximity to existing residential and residential-serving development, where development would result in limited soil erosion or loss of topsoil. Therefore, adherence to existing regulatory requirements would ensure that impacts associated with substantial erosion and loss of topsoil during the future development of the housing sites would be *less than significant*.

3. **Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse.**

Unstable geologic units are known to be present within the EA Study Area. The impacts of such unstable materials include, but may not be limited to subsidence in the diked baylands, where the underlying fill has been described as highly compressible. Such subsidence has been exacerbated by historical groundwater overdraft. Areas underlain by thick colluvium or poorly engineered fill as well as low-lying areas along the Bay margins may also be prone to subsidence. Of the five potential housing locations, Site 5 (Haven Avenue), which lies in the northeastern part of the EA Study Area atop mapped artificial fill, could be at greater risk for subsidence. As previously noted, Site 5 (Haven Avenue) and second units in the northeastern part of the EA Study Area may also be at greater risk for seismically-induced liquefaction. However, compliance with amended General Plan Policy S1.13, which requires site-specific geologic and geotechnical studies for land development or construction in areas of potential land instability as shown on the State and/or local geologic hazard maps or identified through other means, would reduce the potential impacts to future development from an unstable geologic unit or soil to a *less-than-significant* level.

4. **Be located on expansive soil, as defined in Section 1803.5.3 of the California Building Code (2010), creating substantial risks to life or property.**

As previously discussed, the pattern of expansive soils within the EA Study Area is such that expansive soils (denoted by soils with high linear extensibility and plasticity index) are most prevalent in the northeastern part of the EA Study Area, in the neighborhoods that lie closest to San Francisco Bay. Potential future housing Sites 2 and 3 (MidPen's Gateway Apartments), Site 4 (Hamilton Avenue), and Site 5 (Haven Avenue) and second units therefore may be at greatest risk to expansive soils. However, development of housing in this part of the EA Study Area would be subject to the CBC regulations and provisions, as adopted in Chapter 12.04 of the City's Municipal Code and enforced by the City during plan review prior to building permit issuance. The CBC contains specific requirements for seismic safety, excavation, foundations, retaining walls, and site demolition, and also regulates grading activities, including drainage and erosion control. Furthermore, requirements for geologic/geotechnical reports at development locations identified as "potential problem areas" are bolstered by various goals, programs, and policies within the Seismic Safety and Safety Element of the General Plan as listed under Section D.1 above. Thus, compliance with existing regulations and policies would ensure impacts to the future development permitted under the Plan Components would be reduced to a *less-than-significant* level.

5. Cumulative Impacts

This section analyzes potential cumulative geological impacts that could arise from a combination of the development of the Plan Components together with the regional growth in the immediate vicinity of the EA Study Area.

Given the fact that active earthquake faults have not been mapped/identified with the EA Study Area, the risk of primary fault rupture on occupied buildings within the EA Study Area is judged low. In addition, new development in the EA Study Area would be subject to CBC requirements. Compliance with these building code requirements would, to the maximum extent practicable, reduce cumulative, development-related impacts that relate to seismically-induced ground-shaking, liquefaction, and expansive soils. Similarly, compliance with the amended General Plan goals, policies, and programs, and the City's Grading and Drainage Control Guidelines,[28] including implementation of various control measures, would minimize the cumulative impacts associated with soil erosion and loss of topsoil to the maximum extent practicable.

The cumulative impacts associated with development of the Plan Components, together with growth in the immediate vicinity of the EA Study Area, would result in a *less-than-significant* cumulative impact with respect to geology and soils.

E. Impacts and Mitigation Measures

The Plan Components, as currently envisioned, would not result in any significant impacts with respect to geology and soils. Therefore, no mitigation measures are necessary.

[28] City of Menlo Park, *Grading and Drainage Control Guidelines*, August 2010, http://www.menlopark.org/departments/pwk/grade_guide.pdf, accessed on January 9, 2013.