

GEOLOGY, SOILS, AND SEISMICITY

4.5 GEOLOGY, SOILS, AND SEISMICITY

This chapter evaluates the potential environmental impacts related to geology, soils, and seismicity that could occur as a result of the implementation of Scenarios 5 and 6. This analysis is based on the Regulatory Framework and Existing Conditions information provided in the February 2016 Draft EIR.

4.5.1 ENVIRONMENTAL SETTING

No revisions are necessary to the Regulatory Framework and Existing Conditions information provided in the February 2016 Draft EIR except for updates to the descriptions of some regulations (deletions are shown in ~~strikethrough~~ and additions are underlined).

State Regulations

~~Title 24 California Building Code~~

The California Building Code (CBC) is ~~part~~ Part 2 of Title 24 of the California Code of Regulations, known as the California Building Standards Code. The CBC incorporates the International Building Code, a model building code adopted across the United States. Current State law requires every local agency enforcing building regulations, such as cities and counties, to adopt the provisions of the CBC within 180 days of its publication. The publication date of the CBC is established by the California Building Standards Commission. ~~The most recent building code adopted by the legislature and used throughout the State is the 2013 version of the CBC that took effect on January 1, 2014. However, as part of the 2015 Triennial Code Adoption Cycle, the California Building Standards Commission is expected to publish the 2016 CBC on or before July 1, 2016 and it will go~~ went into effect on January 1, 2017.¹ The CBC, as adopted by local cities or counties, is often modified with more restrictive amendments that are based on local geographic, topographic, or climatic conditions. These codes provide minimum standards to protect property and public safety by regulating the design and construction of excavations, foundations, building frames, retaining walls, and other building elements to mitigate the effects of seismic shaking and adverse soil conditions.² They also regulate grading activities, including drainage and erosion control.

The California Residential Code is Part 2.5 of Title 24. The 2016 California Residential Code went into effect on January 1, 2017 and is based on the 2015 International Residential Code. The California Residential Code applies to one- and two-family dwellings and townhouses.

¹ California Building Standards Commission, 2015 Triennial Code Adoption Cycle. Available online at: <http://www.bsc.ca.gov/Codes.aspx>, accessed on ~~October 14, 2015~~ January 11, 2017.

² California Building Standards Commission. Available online at: <http://www.bsc.ca.gov/codes.aspx>, accessed on February 3, 2015.

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Local Regulations

City of Palo Alto Municipal Code

The City of Palo Alto has adopted the current CBC as the basis for the City's Building Regulations, a part of the City's Municipal Code.³ The provisions of the City's Building Regulations are set forth in Chapter 16.04 of the Palo Alto Municipal Code. Several additional building-related requirements were put in place as the CBC was adopted by the City, some of which are relevant to geology, soils, and seismicity. For example, Chapter 16.04.330 of the Municipal Code includes additional provisions for the seismic evaluation of earthquake-damaged structures and related design procedures for their repair.

Chapter 16.06 of the Municipal Code adopts the 2016 California Residential Code and includes local amendments to several sections.

The Palo Alto Municipal Code contains other requirements that pertain to geologic or seismic hazards. Chapter 16.42 lays out the building-related requirements of the City's Seismic Hazards Identification Program. The program seeks to enhance public safety through the identification of buildings that may possess structural deficiencies from a seismic safety perspective. Such buildings are investigated to determine the severity and extent of those deficiencies and the potential to result in loss of life or injury during an earthquake.

Depending on the project scope or location, certain proposed construction projects that are subject to the City's Municipal Code must perform a detailed soils investigation beforehand to identify potentially unsuitable soil conditions, such as expansive, corrosive, or compressible soils. In these instances, the soil investigation report must include recommendations for foundation type/design, and the recommendations are to be incorporated in the construction design. Examples of projects where a soils report is required under current Palo Alto Building Regulations include, but are not limited to 1) single family residential construction that includes a basement, retaining walls, or pier grade beam foundation, or single-family residential construction "west of I-280," or 2) new commercial building construction, including building additions or modifications, that include "substantial foundation design" of commercial buildings that "include a basement."⁴

Chapter 16.28 of the City's Municipal Code includes detailed requirements for construction-related grading and erosion and sediment control. The main goal of these requirements is to "provide for safe grading operations, to safeguard life, limb and property, and to preserve and enhance the natural environment,

³ City of Palo Alto Municipal Code, Title 16, Chapter 16.04. Available online at: [http://www.amlegal.com/nxt/gateway.dll/California/paloalto_ca/title16buildingregulations*/chapter1604californiabuildingcode*?f=templates\\$fn=default.htm\\$3.0\\$vid=amlegal:paloalto_ca\\$anc=JD_16.04.330](http://www.amlegal.com/nxt/gateway.dll/California/paloalto_ca/title16buildingregulations*/chapter1604californiabuildingcode*?f=templates$fn=default.htm$3.0$vid=amlegal:paloalto_ca$anc=JD_16.04.330), accessed on June 29, 2015.

⁴ City of Palo Alto, Development Services Department, Building Division. Available online at: <http://www.cityofpaloalto.org/gov/depts/ds/building/>, accessed on December 8, 2015.

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including, but not limited to, water quality, by regulating clearing and grading on private property.”⁵ Through their excavation and grading permit program, the City’s Public Works Department, Engineering Services Division, requires the submittal of a detailed Erosion and Sediment Control Plan as an important part of the permit application.⁶ Chapter 16.28.150 requires detailed engineering geology reports in areas of suspected geological hazards.⁷

The City’s Municipal Code also provides incentives for the seismic retrofit/upgrade of older buildings in the Downtown Business District (CD). Chapter 18.18.060 provides bonuses in the Floor Area Ratio (FAR) requirements for buildings that have undergone such seismic upgrades.

Chapter 16.10 of the Municipal Code governs Private Sewage Disposal Systems, or septic systems. The City’s objective is to connect all buildings in Palo Alto to the public sewer system. This section regulates the installation of septic systems in limited cases where, “in the opinion of the city, installation of public sanitary sewerage facilities is clearly not feasible.”

4.5.2 STANDARDS OF SIGNIFICANCE

Implementation of the proposed Plan would result in a significant impact with respect to geology, soils, and seismicity if it would:

- Expose people or structures to substantial adverse effects including the risk of loss, injury or death involving rupture of a known earthquake fault, strong seismic ground shaking, seismic related ground failure (including liquefaction), landslides, or expansive soil.
- Expose people or property to major geologic hazards that cannot be mitigated through the use of standard engineering design and seismic safety techniques.
- Be located on a geologic unit or on 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.
- Cause substantial erosion or siltation.

4.5.3 IMPACT DISCUSSION

The remaining discussion in this chapter analyzes the potential project impacts as they pertain to geology, soils, and seismicity. Cumulative impacts are also considered, as they might arise from growth that is

⁵ City of Palo Alto Municipal Code, Title 16, Chapter 16.28. Available online at: [http://www.amlegal.com/nxt/gateway.dll/California/paloalto_ca/paloaltomunicipalcode?f=templates\\$fn=default.htm\\$3.0\\$vid=amlegal:paloalto_ca](http://www.amlegal.com/nxt/gateway.dll/California/paloalto_ca/paloaltomunicipalcode?f=templates$fn=default.htm$3.0$vid=amlegal:paloalto_ca), accessed on February 3, 2015.

⁶ City of Palo Alto Public Works Department, Engineering Division, 2015, Excavation and Grading Permit Instructions, Section E, page 3, revised July 2, 2009.

⁷ City of Palo Alto Municipal Code, Title 16, Chapter 16.28. Available online at: [http://www.amlegal.com/nxt/gateway.dll/California/paloalto_ca/paloaltomunicipalcode?f=templates\\$fn=default.htm\\$3.0\\$vid=amlegal:paloalto_ca](http://www.amlegal.com/nxt/gateway.dll/California/paloalto_ca/paloaltomunicipalcode?f=templates$fn=default.htm$3.0$vid=amlegal:paloalto_ca), accessed on February 3, 2015.

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expected to occur during the life of the proposed Plan, or as they might occur due to the combined impacts of nearby projects outside the city of Palo Alto.

The following impact evaluation relies on the same analytical approach that was used in the February 2016 Draft EIR. The relevant characteristics of Scenarios 5 and 6 are described in detail in Section 3.4 of Chapter 3, Project Description, of this Supplement to the Draft EIR.

GEO-1	Implementation of the proposed Plan would not expose people or structures to substantial adverse effects including the risk of loss, injury or death involving rupture of a known earthquake fault, strong seismic ground shaking, seismic-related ground failure (including liquefaction), landslides, or expansive soil. (Less than Significant – Scenarios 5 and 6)
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February 2016 Draft EIR Findings: Less than significant for Scenarios 1 through 4.

Summary of Supplemental Analysis: The impact would be less than significant under Scenarios 5 and 6.

As described in the February 2016 Draft EIR, the proposed Plan Scenarios 5 and 6 would have a significant impact if allowable new development would expose people or structures to hazards associated with rupture of a known earthquake fault, strong seismic ground shaking, seismic-related ground failure (including liquefaction), landslides, or expansive soil.

At the outset, the “footprints” of the development anticipated under Scenario 5 (Sustainability Tested II) and Scenario 6 (Housing Tested II) are, from the geologic setting perspective, very similar. In other words, the development would take place in geographically similar parts of the city where the known geologic hazards are also very similar.

As previously discussed in the February 2016 Draft EIR, the only State-designated fault hazard zone in the EIR Study Area is the San Andreas Fault Zone in the southwest part of the EIR Study Area, where very little development is forecast under these two scenarios. In any case, the protections afforded by the Alquist-Priolo Earthquake Fault Zoning Act of 1972, as well as relevant City of Palo Alto Municipal Code ordinances (i.e., Chapter 16.28.150) requiring detailed engineering geology reports in areas of suspected geological hazards, are sufficiently robust that the potential for ground rupture would be adequately mitigated for future development under Scenario 5 or Scenario 6.

Given the similar geographic extent and geologic settings for Scenario 5 and Scenario 6, as well as the broadly similar types of new construction forecast under these scenarios, the anticipated intensity of ground shaking during a major earthquake would be similar for both scenarios. Published seismic forecasts have projected that much of the EIR Study Area would experience “strong” or “very strong” ground shaking, with the most intense shaking predicted for the northeast part of the EIR Study Area. Protections against strong seismic ground shaking are afforded by the requirements of the California Building Code (CBC) as well as

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the City of Palo Alto Municipal Code. For existing buildings, the City's Seismic Hazards Identification Program (Municipal Code Title 16 Chapter 16.42) helps identify structurally deficient buildings and evaluate the severity and extent of those deficiencies.

The potential for seismically-induced landslides is greatest in the southwest part of the EIR Study Area, notably in the hilly slopes west of Interstate 280. It should be noted that very little development is forecast in these areas under Scenario 5 or Scenario 6. Local laws and regulations, such as the City of Palo Alto Municipal Code, require detailed soils and/or engineering geology reports in such areas of suspected geological hazards. These regulatory protections would help ensure that the potential for seismically-induced landsliding would be mitigated for future development in that part of the EIR Study Area.

The potential for seismically-induced liquefaction appears low in the west and central parts of the EIR Study Area, where nearly all of the anticipated development under Scenario 5 and Scenario 6 is projected to occur. By contrast, large parts of the northeast part of the EIR Study Area have been designated a liquefaction hazard zone by the State. Without adequate assessment and incorporation of appropriate foundation design measures, buildings constructed in these zones could be damaged by soil liquefaction during a large earthquake.

Protections from these hazards are afforded by State and local regulations such as the requirements of the CBC as well as the City of Palo Alto Municipal Code. For existing buildings, the City's Seismic Hazards Identification Program is intended to identify buildings with structural deficiencies that may be more prone to liquefaction damage. Similarly, zoning regulations under the City's Municipal Code Chapter 18.40.120 imposes requirements in areas that have been identified as having moderate or high risk due to seismic activity hazard, including liquefaction. Such a setting can trigger requirements for detailed geologic, soils, and engineering studies prior to development. Such reports typically include recommendations for project design and construction, such as site grading/soil preparation, and foundation design, as well as quantitative evaluations of liquefaction susceptibility. The final grading, drainage, and foundation plans are reviewed before construction to confirm incorporation of the report recommendations.

In light of the protections afforded by the regulations and laws described above, the potential impact associated with risk of loss, injury, or death involving rupture of a known earthquake fault, strong seismic ground shaking, seismic-related ground failure (including liquefaction), landslides, or expansive soil is considered *less than significant* under Scenario 5 and Scenario 6.

Applicable Regulations:

- California Building Code, California Code of Regulations, Title 24
- California Residential Code, California Code of Regulations, Title 24
- City of Palo Alto Municipal Code, Title 16, Chapter 16.04
- City of Palo Alto Municipal Code, Title 16, Chapter 16.06
- City of Palo Alto Municipal Code, Title 16, Chapter 16.28
- City of Palo Alto Municipal Code, Title 16, Chapter 16.42

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- City of Palo Alto Municipal Code, Title 18, Chapter 18.120
- City of Palo Alto Municipal Code, Title 18, Chapter 18.40

Significance before Mitigation: Compliance with existing regulations would ensure that impacts associated with the risk of loss, injury or death involving rupture of a known earthquake fault, strong seismic ground shaking, seismic-related ground failure (including liquefaction), landslides, or expansive soil due to implementation of Scenarios 5 and 6 would be less than significant.

GEO-2 Implementation of the proposed Plan would not expose people or property to major geologic hazards that cannot be mitigated through the use of standard engineering design and seismic safety techniques. (Less than Significant – Scenarios 5 and 6)

February 2016 Draft EIR Findings: Less than significant for Scenarios 1 through 4.

Summary of Supplemental Analysis: The impact would be less than significant under Scenarios 5 and 6.

Implementation of the proposed Plan under Scenario 5 and Scenario 6 would have a significant impact if new development allowed by the Plan would expose people or buildings/structures to major geologic hazards that are not readily mitigated by customary engineering design and/or seismic safety measures. In this analysis, the term “major geologic hazards” is construed as those hazards that are significant enough to warrant identification, evaluation, and/or notification by local, State, or federal government agencies, or considered under CEQA. The hazards that are most amenable to mitigation through standard engineering design or seismic safety techniques are: 1) strong seismic ground shaking; 2) liquefaction; and 3) seismically-induced slope failure, including landsliding.

The types of structures that would be built under Scenarios 5 and 6 are essential to this evaluation. Although the scenarios envision different land use mixes, the same basic building types would be allowed under both scenarios. The building types would include: 1) new residential construction; 2) reconfigured and/or new commercial construction, including parking garages; and 3) transportation infrastructure such as bicycle and pedestrian improvements. Under both scenarios, minor departures from the City’s 50-foot height limit would be allowed for mixed-use projects with ground floor retail space and residences above.

Development and redevelopment allowed under Scenario 5 and Scenario 6 would have to comply with the engineering and seismic design requirements in the CBC, as well as the building design requirements in the Palo Alto Municipal Code and the City’s Seismic Hazards Identification Program. Construction-related grading must also adhere to the City’s Building Code requirements. Compliance with these existing requirements would ensure that impacts would be *less than significant* under Scenarios 5 and 6.

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Applicable Regulations:

- California Building Code, California Code of Regulations, Title 24
- California Residential Code, California Code of Regulations, Title 24
- City of Palo Alto Municipal Code, Title 16, Chapter 16.04
- City of Palo Alto Municipal Code, Title 16, Chapter 16.06
- City of Palo Alto Municipal Code, Title 16, Chapter 16.28
- City of Palo Alto Municipal Code, Title 16, Chapter 16.42
- City of Palo Alto Municipal Code, Title 18, Chapter 18.120
- City of Palo Alto Municipal Code, Title 18, Chapter 18.40

Significance before Mitigation: Compliance with the previously discussed existing regulations would ensure that impacts associated with the exposure of people or property to major geologic hazards would be less than significant.

GEO-3 **Future development allowed by the proposed Plan would not be located on a geologic unit or on 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. (Less than Significant – Scenarios 5 and 6)**

February 2016 Draft EIR Findings: Less than significant for Scenarios 1 through 4.

Summary of Supplemental Analysis: The impact would be less than significant under Scenarios 5 and 6.

Development under Scenarios 5 and 6 of the proposed Plan would result in potentially significant adverse impacts if it allowed development on a geologic unit or on 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.

In general, unstable geologic units prone to lateral spreading, subsidence, or collapse are not known to be present in the EIR Study Area. Furthermore, areas prone to seismically-induced landslide hazard zones in the EIR Study Area are confined to steeper hillsides in the extreme southwest part of the study area near Interstate 280. Neither Scenario 5 nor Scenario 6 would add development or increase allowed densities in this area. Seismically-induced landsliding is not an issue in parts of the EIR Study Area where the topography is flat, which embraces the preponderance of development under Scenarios 5 and 6.

As discussed under Impact GEO-1, much of the northeast portion of the EIR Study Area lies within a State-designated liquefaction hazard zone. Protections from these hazards are afforded by the requirements of the CBC as well as the regulations of the City of Palo Alto Municipal Code that include, but are not limited to, the City's Seismic Hazards Identification Program (Chapter 16.42) and the Hazardous Conditions chapter of

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the City's Zoning Code (Section 18.40.120). Among other things, these regulations and laws can require detailed soils and/or geotechnical studies in areas of suspected geological hazards such as unstable geologic units that may be subject to collapse, subsidence, landsliding, liquefaction, or lateral spreading. Compliance with these existing requirements would ensure that impacts would be *less than significant* under Scenarios 5 and 6.

Applicable Regulations:

- California Building Code, California Code of Regulations, Title 24
- California Residential Code, California Code of Regulations, Title 24
- City of Palo Alto Municipal Code, Title 16, Chapter 16.04
- City of Palo Alto Municipal Code, Title 16, Chapter 16.06
- City of Palo Alto Municipal Code, Title 16, Chapter 16.28
- City of Palo Alto Municipal Code, Title 16, Chapter 16.42
- City of Palo Alto Municipal Code, Title 18, Chapter 18.120
- City of Palo Alto Municipal Code, Title 18, Chapter 18.40

Significance before Mitigation: The aforementioned regulatory protections would ensure that impacts associated with development under Scenarios 5 and 6 on a geologic unit or on soil that is unstable, or otherwise prone to on- or off-site landslides, lateral spreading, subsidence, liquefaction, or collapse would be less than significant.

GEO-4	Implementation of the proposed Plan would not cause substantial erosion or siltation. (Less than Significant – Scenarios 5 and 6)
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February 2016 Draft EIR Findings: Less than significant for Scenarios 1 through 4.

Summary of Supplemental Analysis: The impact would be less than significant under Scenarios 5 and 6.

Scenario 5 and Scenario 6 would have a significant impact if the allowable new development would cause substantial erosion or siltation at development sites. Substantial soil erosion or siltation (i.e., fine sediment deposition) during construction could undermine structures and minor slopes and/or impede proper drainage, and this could be a concern during development under either scenario.

However, compliance with existing regulatory requirements, such as the implementation of grading erosion control measures specified in the CBC and the City's Municipal Code, would reduce impacts from erosion and siltation. Examples of these control measures are Best Management Practices (BMPs) such as hydroseeding or short-term biodegradable erosion control blankets; vegetated swales, silt fences, or other forms of 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.

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In addition to the safeguards discussed above, Chapter 16.28 of the Palo Alto Municipal Code contains a number of rules and regulations that govern site clearing, backfilling, excavation, and other activities that have the potential to result in erosion or siltation. The chapter sets forth regulations, permit requirements, review standards, and enforcement protocols that seek to effectively control these activities. Compliance with these existing requirements would ensure that impacts would be *less than significant* under Scenarios 5 and 6.

Applicable Regulations:

- California Building Code, California Code of Regulations, Title 24
- California Residential Code, California Code of Regulations, Title 24
- City of Palo Alto Municipal Code, Title 16, Chapter 16.04
- City of Palo Alto Municipal Code, Title 16, Chapter 16.06
- City of Palo Alto Municipal Code, Title 16, Chapter 16.28
- City of Palo Alto Municipal Code, Title 16, Chapter 16.42
- City of Palo Alto Municipal Code, Title 18, Chapter 18.120
- City of Palo Alto Municipal Code, Title 18, Chapter 18.40

Significance before Mitigation: The aforementioned regulatory protections would ensure that impacts associated with development under Scenarios 5 and 6 as they would relate to substantial erosion or siltation would be less than significant.

4.5.4 CUMULATIVE IMPACTS

GEO-5 Implementation of the proposed Plan, in combination with past, present, and reasonably foreseeable projects, would result in less-than-significant cumulative impacts with respect to geology, soils, and seismicity. (Less than Significant – Scenarios 5 and 6)

February 2016 Draft EIR Findings: Less-than-significant cumulative impact for Scenarios 1 through 4.

Summary of Supplemental Analysis: The cumulative impact would be less-than-significant under Scenarios 5 and 6.

The following analysis takes into account the projected growth due to proposed Plan Scenarios 1 through 4, as well as Scenarios 5 and 6, together with future development in the immediate vicinity of the adjoining jurisdictions, as forecasted by the Association of Bay Area of Governments (ABAG). Potential cumulative geological impacts could arise from a combination of proposed Plan implementation, together with future development in the immediate vicinity.

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The Alquist-Priolo Earthquake Fault Zone associated with the San Andreas Fault intersects the southwestern-most edge of the EIR Study Area, near the crest of the Santa Cruz Mountains. This part of the EIR Study Area is sparsely populated and is dominated by parklands and open space, and further development under any of the scenarios is not planned. Accordingly, the risk of primary fault rupture to occupied buildings in the EIR Study Area and immediate areas in adjoining jurisdictions is considered to be low. Within the EIR Study Area, new development allowed by the proposed Plan would be subject to CBC and Municipal Code requirements. Within adjoining jurisdictions, development projects would be subject to CBC requirements as well as certain municipal laws, regulations, and programs. One such example is the neighboring City of Menlo Park Engineering Division's Grading and Drainage Control Guidelines that establish design requirements for new construction, additions to existing buildings, and redevelopment projects. These guidelines also require the preparation and implementation of erosion and sedimentation controls as part of that City's grading permit process. Although the City of Palo Alto does not monitor compliance with these requirements, their implementation should, to the maximum extent practicable, reduce cumulative, development-related impacts that relate to seismic shaking, seismically induced landslides and liquefaction, and expansive soils. Similarly, compliance with relevant local regulations as described above for Impacts GEO-1 through GEO-4, as well as the requirements of the CBC, would minimize the cumulative impacts associated with substantial erosion or siltation. Therefore, the cumulative impacts associated with Plan implementation, including Scenarios 5 and 6, together with anticipated growth in the immediate vicinity of the EIR Study Area, would result in a *less-than-significant* cumulative impact with respect to geology, soils, and seismicity.

Applicable Regulations:

- California Building Code, California Code of Regulations, Title 24
- California Residential Code, California Code of Regulations, Title 24
- City of Palo Alto Municipal Code, Title 16, Chapter 16.04
- City of Palo Alto Municipal Code, Title 16, Chapter 16.06
- City of Palo Alto Municipal Code, Title 16, Chapter 16.28
- City of Palo Alto Municipal Code, Title 16, Chapter 16.42
- City of Palo Alto Municipal Code, Title 18, Chapter 18.120
- City of Palo Alto Municipal Code, Title 18, Chapter 18.40

Significance before Mitigation: Compliance with existing regulations would ensure that cumulative geology, soils, and seismicity impacts would be less than significant.