10. GEOLOGY AND SOILS

This chapter describes existing conditions and the potential impacts of the Specific Plan related to soil and geologic conditions, and identifies mitigations for potentially significant effects.

10.1 SETTING

10.1.1 Geology and Topography

The Specific Plan area is located in the Coast Ranges geomorphic province at the southern end of Mt. George-Twin Sisters Ridge. The Coast Range geomorphic province generally consists of northwest-trending hills that have been folded and faulted, separated by narrow valleys. Geologic units in the plan area vicinity include Holocene alluvium, Pleistocene alluvium, Sonoma volcanics, and Vacaville shale. These units are described in more detail in section 8.1.2(a) of this Draft EIR. In much of the plan area, the depth to bedrock is greater than 2 to 3 feet, although lesser depths (1 foot) are found in the eastern and western portions of the area.[1]

10.1.2 Soils

According to the Solano County General Plan EIR, soil associations in the plan area include the following.[2]

(a) Yolo-Brentwood, Yolo-Sycamore, and Rincon-Yolo Associations. These associations are found generally west of Green Valley Road in the central portion of the plan area. They are described as "nearly level to moderately sloping, well-drained to somewhat poorly drained soils on alluvial fans."

(b) Capay-Clear Lake, Sacramento, Egbert-Ryde, Valdez, Joice-Suisun, and Reyes-Tamba Associations. These associations are generally found in the vicinity of Green Valley Creek in the central portion of the plan area. They are described as "nearly level to gently sloping, moderately well-drained to very poorly drained soils on basin rims, alluvial fans, and deltas, and in basins, dredge spoil areas, and salt water marshes."

(c) Altamont Diablo, Dibble-Los Osos, Milsholm, Maymen-Los Gatos, and Hambright-Toomes Associations. These associations are found in the eastern and western parts of the plan area. They are described as "gently sloping to very steep, well-drained and somewhat excessively drained soils on dissected terraces and mountainous uplands."

[1]EDAW, Solano County Draft General Plan Draft Environmental Impact Report, April 18, 2008, Exhibit 4.7-8, page 4.7-29.

[2]EDAW, Solano County Draft General Plan Draft Environmental Impact Report, April 18, 2008, Exhibit 4.7-4, page 4.7-21.

10.1.3 Seismicity and Seismic Hazards

(a) Earthquake Faults. The Specific Plan area is located in a region of high seismicity. The San Francisco Bay Area and Coast Range-Central Valley contain a large number of active strike-slip faults, and have been the site of numerous moderate and large magnitude earthquakes.

The active faults in the plan area subregion are the Concord/Green Valley, Cordelia, West Napa, Great Valley, Hunting Creek-Berryessa, Rodgers Creek, and Hayward faults. As shown in Figure 10.1, the Concord/Green Valley fault passes through the central portion of the plan area. In addition, the Cordelia fault is located immediately east of the plan area (between Green Valley Road and Suisun Valley Road). The other active faults are located farther from the plan area.

The Concord/Green Valley fault system, including the Concord and Green Valley faults and some active secondary traces such as the Cordelia fault, consists of a highly complex zone with potential for either major or smaller events to the northwest and southeast of Suisun Bay. The Green Valley fault has been the focus of past studies by the California Division of Mines and Geology (Dooley 1972), and continues to be investigated by the United States Geologic Survey (USGS). This fault trends northwest along the eastern front of the Benicia Hills and appears to have right lateral offset (Dooley 1972), which means that the western side has moved northward relative to the eastern side, or vice versa. The fault shows many features associated with recent activity: offset fences and power lines, location of micro-earthquake epicenters along the fault trace, scarps in Holocene alluvium, disrupted drainage patterns, and a conspicuous alignment of topographic depressions and saddles.

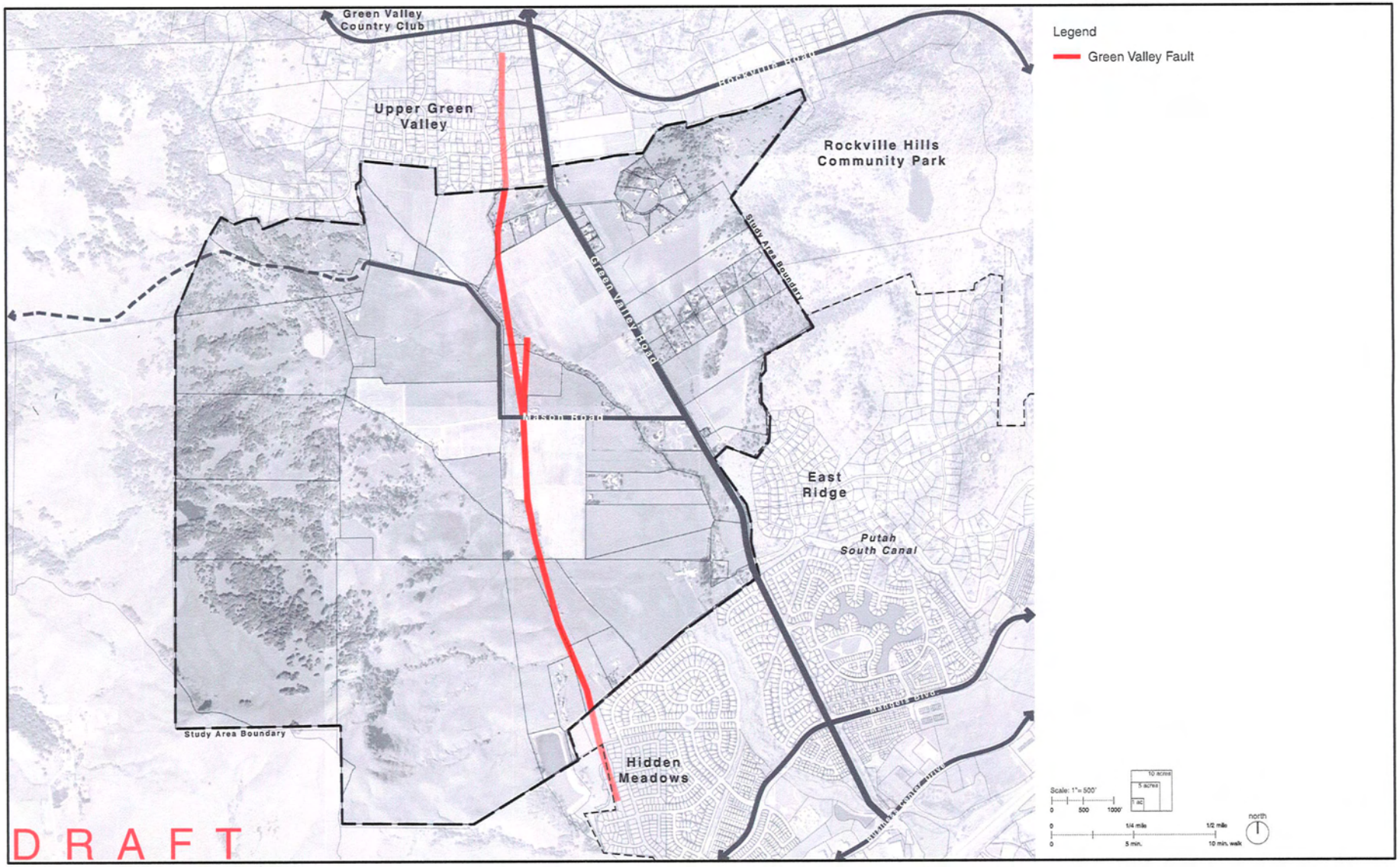
In 2002, the USGS Working Group on California Earthquake Probabilities (WGCEP) determined that there is a 62 percent chance of a magnitude (M_w) 6.7 or greater earthquake striking the San Francisco Bay Area by 2031. The WGCEP also identified more specific probabilities for various faults in the Bay Area. The WGCEP-identified 30-year (2002 to 2031) probability estimate of a M_w 6.7 or greater earthquake on the Hayward-Rodgers Creek fault is 27 percent and on the Concord/Green Valley fault is 4 percent.

The Green Valley fault has also been investigated by a number of consultants in connection with proposed development projects in Green Valley. These investigations have included trenching and geophysical surveys and have provided additional evidence of recent activity. Although the fault can be traced from Suisun Bay northward across the county line, definitive evidence of activity is lacking north of where the fault crosses Green Valley Creek. Vegetative cover in these areas makes both aerial photographic and field studies difficult. [1]

(b) Potential Earthquake Hazards. Three major types of hazards may be associated with earthquakes in the Specific Plan area vicinity: (1) fault rupture, (2) ground shaking, and (3) ground failure.

Fault Rupture. Ground surface rupture, or fault rupture, is associated with earthquakes of magnitude 5.5 and greater. Projects within earthquake fault zones require geologic evaluation to determine if a potential hazard from any fault, whether previously recognized or not, exists.

[1] EDAW, Solano County Draft General Plan Draft Environmental Impact Report, April 18, 2008, Exhibit 4.7-4, page 4.7-11.



SOURCE: J.J. Lienkamper with the USGS

Figure 10.1

GREEN VALLEY FAULT TRACE

Fault rupture is a potential hazard in the plan area due to the Green Valley Fault, which extends through the central part of the area. Both the Concord Fault and the Green Valley Fault have been designated as active faults by the state and have been included in Special Studies Zones under the Alquist-Priolo Geologic Hazards Zones Act (chapter 7.5 of Public Resources Code). Policies and criteria of the State Mining and Geology Board state that no structure may be placed across the trace of an active fault. The area within 50 feet of an active fault is presumed to be underlain by active branches of the fault unless proven otherwise.

The zone of actual rupture on a fault is generally small compared to the area that is subjected to severe ground shaking. Displacement along the Green Valley Fault could be as much as 2½ feet for an earthquake of magnitude 6+. The Solano County General Plan EIR indicated that fault rupture along the Green Valley Fault can be expected to cause damage to Interstate 80, State Routes 12 and 21, and the Southern Pacific Railroad line through Cordelia; and that freeway overcrossings may be displaced or may collapse as a result of fault movement.[1]

It is possible to greatly reduce damage from fault rupture by avoiding construction on active fault traces.

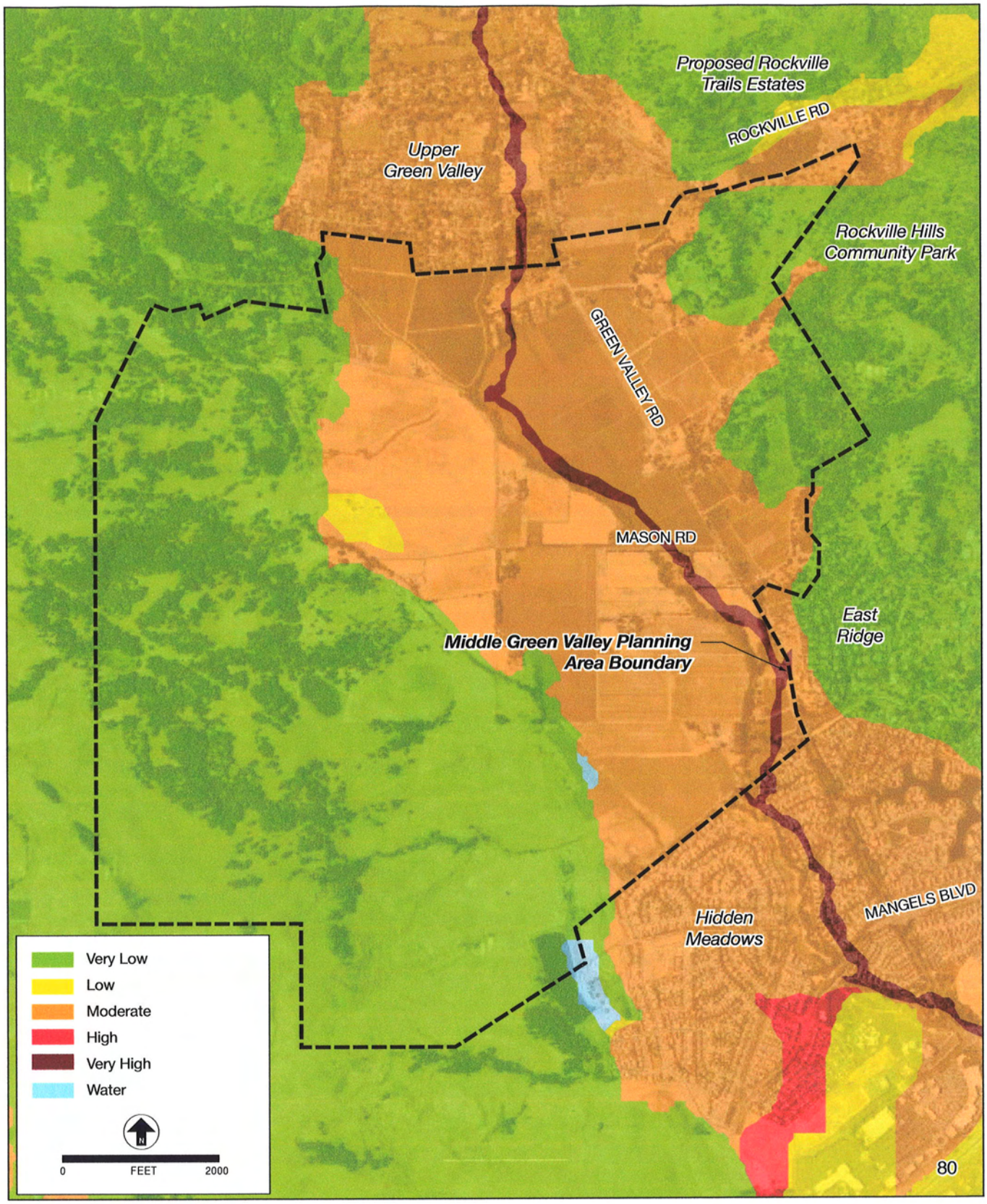
Ground Shaking. Strong ground shaking can be expected in the plan area during moderate to severe earthquakes in the general region. These strong ground motions could damage structures in the area, even if all applicable building regulations are followed. This risk is common to virtually all land development in the greater San Francisco Bay Area.

The extent of hazard from seismic shaking depends on the specifics of the earthquake and the resistance of individual structures. Structures founded on thick soft soil deposits are more likely to experience more destructive shaking, with higher amplitude and lower frequency, than structures founded on bedrock. In addition, thick soft soil deposits far from earthquake epicenters may result in seismic accelerations significantly greater than expected in bedrock. Structures not adequately bolted to their foundations have a greater risk of damage than adequately secured structures.

Ground Failure. Seismic shaking can also result in ground failure through liquefaction, lateral spreading, ground lurching, and differential settlement. Liquefaction occurs when granular sediments lose cohesion due to vibration and are transformed into a temporary liquid state. This phenomenon typically occurs in saturated, unconsolidated deposits. Lateral spreading is the horizontal movement of material adjacent to a steep, unsupported face (i.e., stream bank, cut face, etc.) during liquefaction of underlying deposits. Ground lurching is the downslope movement of material on a steep slope that does not involve a discrete plane of movement (as occurs in a landslide). Ground lurching is analogous to rapid soil creep, and can affect large areas on a hillslope during a strong earthquake.

As shown in Figure 10.2, portions of the plan area immediately adjoining Green Valley Creek have “very high” liquefaction potential, and the rest of the central part of the plan area has “moderate” liquefaction potential. In the eastern and western portions of the plan area, liquefaction potential is “very low” or “low.” More precise determinations of liquefaction,

[1]EDAW, Solano County Draft General Plan Draft Environmental Impact Report, April 18, 2008, Exhibit 4.7-4, page 4.7-11.



SOURCE: 2008 Solano County General Plan

Figure 10.2
LIQUEFACTION POTENTIAL IN PLAN AREA AND VICINITY

differential settlement, and lateral spreading potential in the plan area would require site-specific geotechnical studies.

10.1.4 Slopes

As shown in Figure 10.3, slopes in the central portion of the plan area are generally less than four percent, while the eastern and western portions of the plan area contain slopes of 15 percent or greater.

10.1.5 Landslide and Erosion Hazards

Landsliding is a form of ground failure involving a relatively rapid downslope movement of a dry mass of soil, rock, and rock debris. Landslides can cause damage to upslope or downslope structures, roads, utilities, and drainage systems.

As shown in Figure 10.4, the central portion of the plan area is the least susceptible to landslides, while the eastern and western portions are more susceptible. Correspondingly, according to the Solano County General Plan EIR, erosion hazards in the central portion of the plan area are slight, while the eastern and western portions contain areas of moderate to severe erosion hazard.[1]

10.1.6 Shrink-Swell Potential

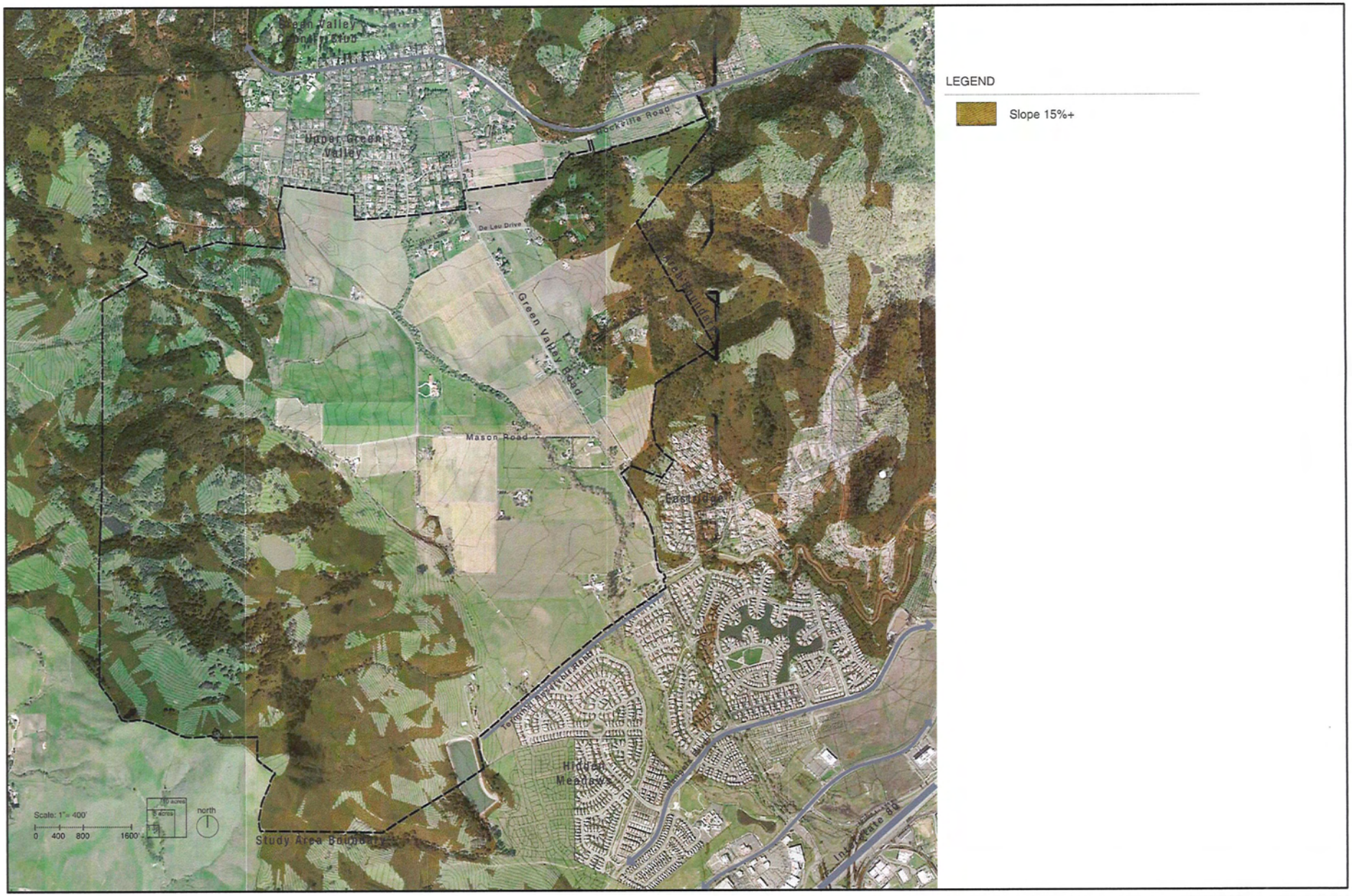
Shrink-swell potential is the relative change in volume to be expected with changes in moisture content, i.e., the extent to which the soil may shrink as it dries out or swells when it gets wet. The extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils can cause damage to building foundations, roads, and other structures. A high shrink/swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.[2] As shown in Figure 10.5, the plan area contains areas of moderate to high shrink-swell potential.

10.2 PERTINENT PLANS AND POLICIES

CEQA requires an EIR to identify the plan and policy setting within which the project is proposed and discuss any inconsistencies between the proposed project and these applicable plans and policies adopted to minimize environmental impacts [CEQA Guidelines sections 15124(b) and 15125(d)]. Adopted state and local policies and regulatory requirements pertinent to consideration of the geology and soils impacts of the proposed Specific Plan are described below.

[1]EDAW, Solano County Draft General Plan Draft Environmental Impact Report, April 18, 2008, Exhibit 4.7-6, page 4.7-25.

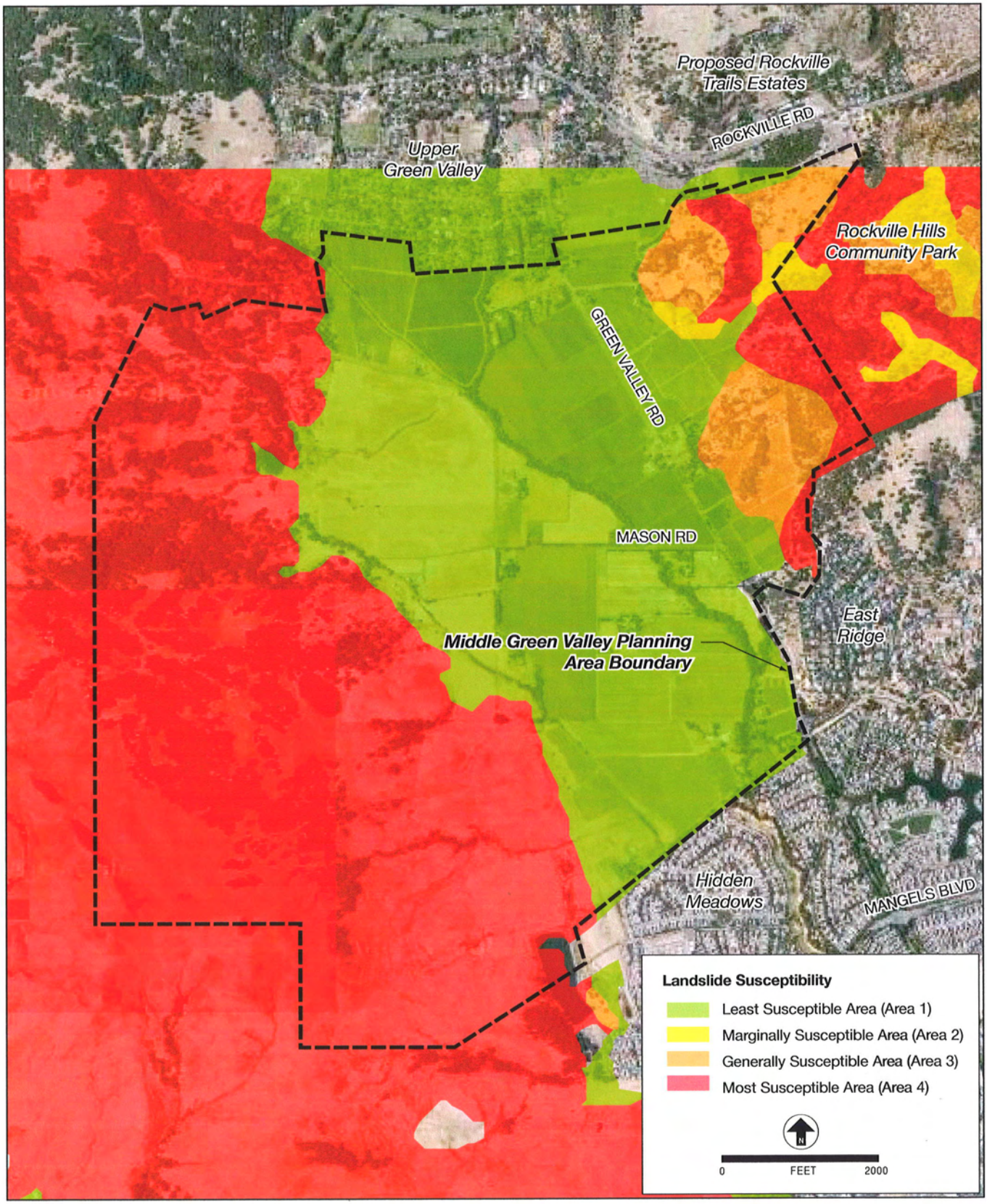
[2]EDAW, Solano County Draft General Plan Draft Environmental Impact Report, April 18, 2008, page 4.7-20.



SOURCE: Hart Howerton, Planners and Architects

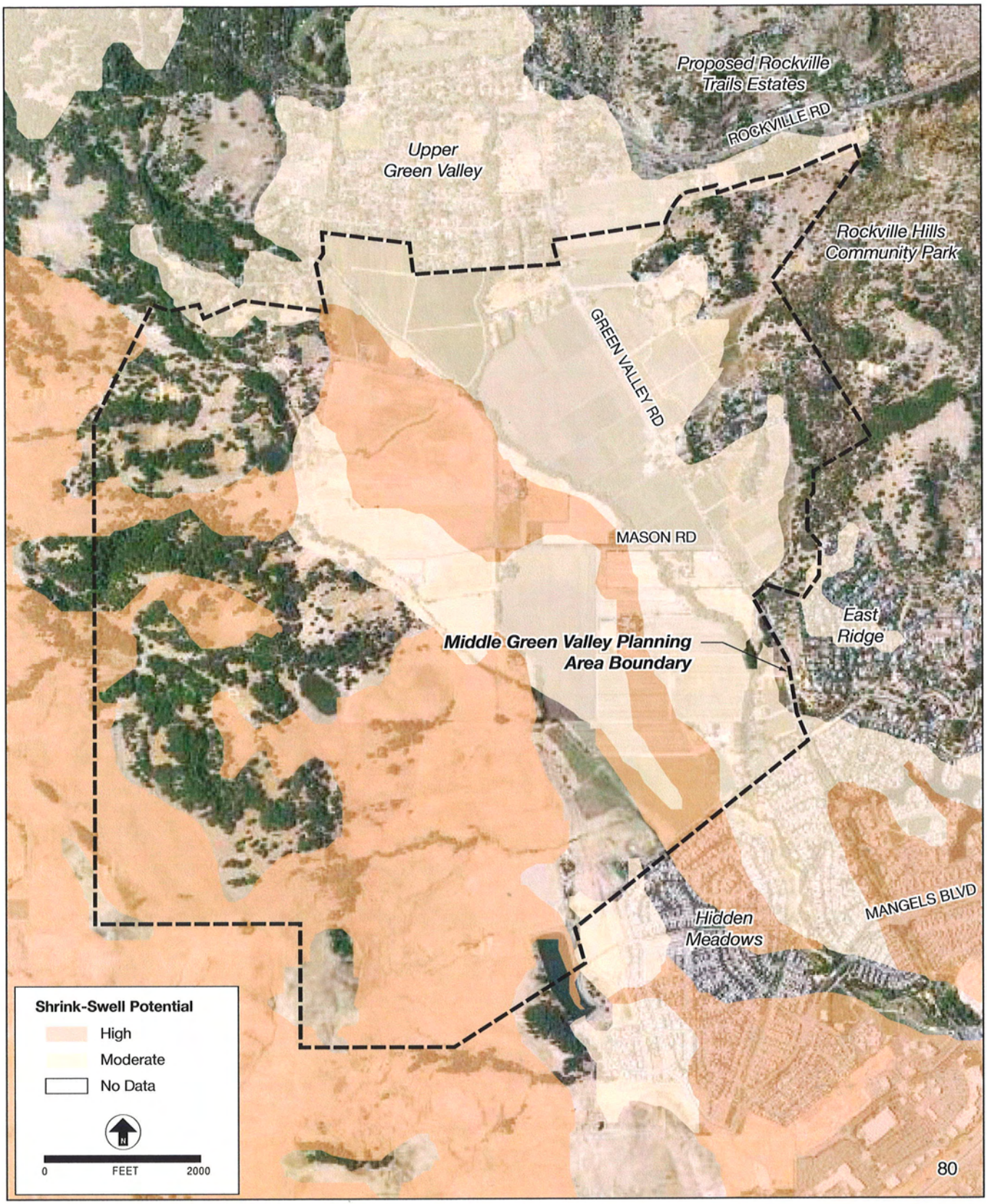
Figure 10.3

SLOPE HAZARDS IN PLAN AREA AND VICINITY



SOURCE: 2008 Solano County General Plan

Figure 10.4
LANDSLIDE SUSCEPTIBILITY IN PLAN AREA AND VICINITY



SOURCE: 2008 Solano County General Plan

Figure 10.5
SHRINK-SWELL POTENTIAL IN PLAN AREA AND VICINITY

10.2.1 State Regulations

(a) Alquist-Priolo Earthquake Fault Zoning Act. The Alquist-Priolo Earthquake Fault Zoning Act is the state law that addresses hazards from active earthquake fault zones. Its purpose is to mitigate the hazard of surface fault rupture by regulating structures designated for human occupancy near active faults. As required by the Act, the California Geological Survey (CGS) has delineated Earthquake Fault Zones along known active faults in California. An Alquist-Priolo Earthquake Fault Zone has been designated along the Concord/Green Valley fault, including the Green Valley fault segment that passes through the center of the plan area. The Alquist-Priolo Act prohibits the construction of new homes within Alquist-Priolo zones unless a comprehensive geologic investigation shows that the fault does not pose a hazard to the proposed structure.

In accordance with the Alquist-Priolo Earthquake Fault Zoning Act, before permitting a proposed project within this fault zone, local agencies must require a geologic investigation that demonstrates that structures for human occupancy will not be constructed across active faults. If an active fault is found during the geologic investigation, all structures designated for human occupancy must be set back from the fault. [1]

(b) California Building Standards Code. The State of California provides minimum standards for building design and construction through the California Building Standards Code (Title 24 of the California Code of Regulations). The California Building Standards Code is based on the Uniform Building Code, which is used widely throughout the United States, but has been modified for California conditions with numerous more detailed and/or more stringent requirements. The Title 24 code specifies standards for geologic and seismic hazards and includes regulations for earthquake-resistant design and construction.[2] The code is periodically updated to reflect latest "state-of-the-art" construction specifications for seismic resistance and other factors.

10.2.2 Solano County General Plan

The Solano County General Plan includes the following policies and implementation programs pertinent to consideration of the geology and soils impacts of the proposed Specific Plan:

- *Require new development proposals in moderate or high seismic hazard areas to consider risks caused by seismic activity and to include project features that minimize these risks.* (Policy HS.P-12)

- *Review and limit the location and intensity of development and placement of infrastructure in identified earthquake fault zones.* (Policy HS.P-13)

- *Identify and minimize potential hazards to life and property caused by fault displacement and its impact on facilities that attract large numbers of people, are open to the general public, or provide essential community services and that are located within identified earthquake fault zones.* (Policy HS.P-14)

[1] EDAW, Solano County Draft General Plan Draft Environmental Impact Report, April 18, 2008, pages 4.7-38 through 4.7-39.

[2] Solano County, Solano County General Plan, December 2008, page HS-22.

- *Reduce risk of failure and reduce potential effects of failure during seismic events through standards for the construction and placement of utilities, pipelines, or other public facilities located on or crossing active fault zones.* (Policy HS.P-15)

- *Require minimum setbacks for construction along creeks between the creek bank and structure, except for farm structures that are not dwellings or places of work, based on the susceptibility of the bank to lurching caused by seismic shaking.* (Policy HS.P-16)

- *Restrict the crossing of ground failure areas by new public and private transmission facilities, including power and water distribution lines, sewer lines, and gas and oil transmission lines.* (Policy HS.P-17)

- *Make information about soils with a high shrink-swell potential readily available. Require proper foundation designs in these areas.* (Policy HS.P-18)

- *Require geotechnical investigation and recommendations for buildings meant for public occupancy within geologic hazard areas. A state-certified Engineering Geologist shall produce a report examining development issues that considers:*

  - *soil, slope, or other geologic hazard conditions found on site;*
  - *potential off-site development impacts, such as increased runoff and/or slope instability; and*
  - *requirements of any regulations concerning the hazard area.* (Implementation Program HS.I-21)

- *Require geotechnical evaluation and recommendations before new development in moderate or higher-hazard areas. Such geotechnical evaluation shall analyze the potential hazards from:*

  - *landslides*
  - *liquefaction*
  - *expansive soils*
  - *steep slopes*
  - *erosion*
  - *subsidence*
  - *Alquist-Priolo Earthquake Fault Zones or other identified fault zones*
  - *tsunamis*
  - *seiches*

  Require new development to incorporate project features that avoid or minimize the identified hazards. Costs related to providing or confirming required geotechnical reports will be borne by the applicant. (Implementation Program HS.I-22)

10.2.3 Solano County Code Chapter 31 (Grading and Erosion Control)

Chapter 31 of the Solano County Code provides regulations related to grading and erosion control. In conjunction with Chapter 70 of the Uniform Building Code, this chapter sets forth the means for controlling soil erosion, sedimentation, increased rates of water runoff, and related environmental damage. It does so by establishing minimum standards and providing

regulations for the construction and maintenance of fills, excavations, cuts and clearing of vegetation, revegetation of cleared areas, drainage control, and protection of exposed soil surfaces to protect downstream waterways and wetlands and promote the safety, public health, convenience, and general welfare of the community.[1]

10.3 IMPACTS AND MITIGATION MEASURES

10.3.1 Significance Criteria

Based on the CEQA Guidelines,[2] the proposed Specific Plan would have a significant adverse impact related to soil or geologic conditions if it would:

(a) expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

(1) 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 (refer to Division of Mines and Geology Special Publication 42);

(2) strong seismic ground shaking;

(3) seismic-related ground failure, including liquefaction; or

(4) landslides;

(b) result in substantial soil erosion or the loss of topsoil;

(c) 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; or

(d) be located on expansive soil as defined in Table 18-1-B of the Uniform Building Code, creating substantial risks to life or property.

10.3.2 Future Study and Subsequent Mitigation

Geotechnical/geologic mitigation requirements identified in this Draft EIR chapter require completion of additional, more detailed studies to address specific concerns as individual, site-specific project applications are submitted. For any mitigation recommendations that require future additional determinations, the CEQA Guidelines and recent court decisions indicate that such mitigation must be capable of ensuring that the project would be implemented in a manner that alters the significant impacts of the project. There is substantial, reasonable, historic

[1]EDAW, Solano County Draft General Plan Draft Environmental Impact Report, April 18, 2008, page 4.7-39.

[2]CEQA Guidelines, Appendix G, Items VI(a) through VI(e), X(a), and X(b).

information to support the conclusion that the specific subsequent geotechnical/geologic investigations, inspections, and specific formulations identified in the following section of this Draft EIR would adequately mitigate related impacts to less-than-significant levels. Solano County routinely requires such geotechnical/geologic investigations and specifications at phases of development review that follow EIR certification.

A significant record exists demonstrating the effectiveness of such post-EIR-certification design and engineering requirements in mitigating the related soil and geologic impacts of concern identified in this EIR. Under the County's subdivision, grading and building permit provisions, requirements, and regulations, a project cannot be given final approval without reasonable indication of project compliance with these geotechnical/geologic requirements. These requirements and related County inspection and verification procedures prior to project occupancy provide reasonable assurances that a project would incorporate the design and engineering refinements necessary to reduce the impact to a less-than-significant level by either avoiding identified soil and geologic impact areas altogether (i.e., basic project design changes), or by rectifying the impact through conventional engineering and construction procedures identified throughout the post-EIR investigation and monitoring process.

10.3.3 Relevant Project Characteristics

The proposed Specific Plan includes the following provisions formulated to minimize geologic and soils impacts:

(a) Steep Slope Avoidance. The Specific Plan proposes that slopes of more than 30 percent be designated as "unsuitable for development," with only minor road crossings and utility improvements allowed in these areas.[1]

(b) Grading and Drainage Plan Requirements. The Specific Plan proposes the following standards that are to be met in all grading and drainage plans:[2]

- *Reduce hydrologic impacts by minimizing impervious surfaces, graded areas, and vegetation clearing…*
- *All topsoil disturbed by grading operations is to be stockpiled within the construction site and reused as part of landscape restoration plans. Excavated topsoils shall be protected from erosion by wind or rain by tarps or other suitable materials.*
- *Site buildings to minimize grading and earthwork to reduce construction costs, such as those associated with retaining systems and drainage redirection, and minimizes [sic] soil erosion and downstream water impacts.*
- *The extent of grading and site disturbance is to be limited to the Building Envelope. Balancing cut and fill quantities on-site is required.*

[1]Solano County, Middle Green Valley Specific Plan, Preliminary Draft, October 28, 2009, page 2-7.

[2]Solano County, Middle Green Valley Specific Plan, Preliminary Draft, October 28, 2009, page 5-65.

- *Cut and fill slopes on the foothills are to be revegetated and blended into the surrounding environment.*

- *Retaining walls may be used when it is necessary to preserve unique site attributes such as existing trees or where they are designed as extensions of the architecture. Retaining walls are to be a maximum of 4 feet in height and utilize materials that complement the architecture such as brick, dry stacked stone or tabby.*

(c) Landscape Standards. Landscape standards on pages 5-7 and 5-68 of the Specific Plan would prevent overwatering and limit irrigated turf area, measures that would serve to reduce slope disturbance.

(d) Other Objectives and Standards. The Specific Plan also proposes the following related standard for "low impact design":[1]

- *Site buildings to minimize grading and earthwork. This reduces construction costs, such as those associated with retaining systems and drainage redirection, and minimizes soil erosion and downstream water impacts.*

See further discussion of related Specific Plan drainage guidelines and standards in section 11.3.3, in chapter 11, Hydrology and Water Quality, of this Draft EIR.

10.3.3 Impacts and Mitigation Measures

Project Fault Rupture Impacts. The Specific Plan designates portions of the Green Valley fault zone, which extends through the central portion of the plan area, for *Agricultural-Residential*, *Rural Farm*, *Community Services,* and *Agricultural Tourism* uses, but also recommends maintenance of a 50-foot building setback along the fault trace. In addition, the state (California Geologic Survey) identification of the Green Valley fault as an Alquist-Priolo Earthquake Zone and associated existing state and county development review, evaluation and setback requirements provide adequate assurance that Specific Plan-related environmental impacts associated with the identified potential for future fault rupture along the Green Valley fault would be ***less-than-significant*** (see criterion [a][2] under section 10.3.1, "Significance Criteria," above).

Explanation: As illustrated on Draft Specific Plan Figure 2.5 (Combined Constraints Map), the Specific Plan-proposed development layout has been largely determined by an identified combination of environmental constraints, including the location of the active Green Valley fault. Specific Plan Figure 2.5 indicates a 50-foot building setback along the fault. In addition, as indicated in section 10.2.1(a) herein, under state law, the Alquist-Priolo Earthquake Fault Zone designation along the Green Valley fault prohibits construction of new homes within the zone unless comprehensive geologic investigation shows that the fault does not pose a hazard to the proposed structure. Furthermore, related Solano County General Plan Health and Safety policies HS.P-12, HS.P-13, HS.P-14, and HS.P-15, and General Plan implementation programs US.I-21 and US.I-22, stipulate that the County shall: (a) review and limit the location and intensity of development and the placement of infrastructure in identified fault zones; (b) restrict the crossing of such potential ground failure areas by new public and private transmission facilities, including electrical power and water distribution lines and sewer lines; and (c) require

[1]Solano County, Middle Green Valley Specific Plan, Preliminary Draft, October 28, 2009, page 5-64.

geotechnical evaluation and recommendations by a State-certified Engineering Geologist before new development is permitted in Alquist-Priolo Earthquake Zones. Also, the Solano County Code requires a residential building setback zone between 50 and 100 feet (50 feet for one-story homes and 100 feet for two-story homes) on either side of the fault trace.

Because all future plan area subdivision map and other discretionary development approvals in the Green Valley fault vicinity would be subject to these existing State and County review, evaluation and minimum setback requirements, the proposed Specific Plan would not be expected to have a substantial adverse effect related to exposure of people or structures to rupture along the Green Valley fault.

Mitigation: No significant environmental impact related to fault rupture has been identified; no additional mitigation is required.

Project Ground Shaking Impacts. All future development in western Solano County, including future development in accordance with the proposed Specific Plan, would continue to place residences, businesses, and infrastructure in a subregion that is expected to experience severe earthquake-induced ground shaking during the useful life of these improvements. The severe earthquake-induced shaking could be caused by a major earthquake (magnitude 6.7 or greater) on one of the active faults among the San Francisco Bay Area and Coast Range-Central Valley fault systems. In the project subregion, these include the Concord/Green Valley, Cordelia, West Napa, Great Valley, Huntington Creek-Berryessa, Rodgers Creek and Hayward faults.

Shaking intensity can vary depending of the overall magnitude, distance to the fault, focus of earthquake energy, and type of geologic material. Strong or sustained shaking could cause differential settlement of poorly consolidated soils and induce ground failure within soils that may be prone to liquefaction.

Most of the areas proposed for development under the Specific Plan have “moderate” liquefaction potential. Areas along Green Valley Creek have “very high” liquefaction potential (see Figure 10.2 and Figure 2.3 in chapter 2, Project Description). The two proposed water storage tank locations in the western part of the plan area have “very low” liquefaction potential (see Figure 10.2 and Figure 2.10 in chapter 2, Project Description).

At County discretion and consistent with Solano County General Plan policies HS.P-12 through HS.P-15 and HS.P-17 and implementation programs HS.I-21 and HS.I-22, future subdivision and discretionary development approvals may be subject to detailed, design-level geotechnical investigation requirements that include analysis of project site seismic stability, liquefaction potential, and soil response characteristics with respect to ground acceleration, in accordance with current State requirements. All future building construction in the plan area would be required by existing building regulations to incorporate the engineering techniques and standards included in uniform codes adopted by the State of California and Solano County, and incorporated into the Solano County Code (section 6.3-03) for geotechnical building safety, including the California Building Standards Code, 2001 Edition, California Code of Regulations, Title 24 (adopted by reference as the Building Code of Solano County), which incorporates the Uniform Building Code (UBC), 1997 Edition. These seismic engineering techniques and standards are widely known and accepted in the professional fields of design and construction. Individual solutions for particular developments to achieve Uniform Building Code compliance are typically and most efficiently specified at the detailed individual development and building

design phase. These code-mandated engineering techniques and standards require that all project structural designs be based on proper estimates by the project geotechnical engineer of peak and maximum repeatable earthquake-induced ground surface accelerations expected to occur on the project site. Required compliance with these existing standard State and County regulations would be sufficient to reduce the potential effects of ground shaking on Specific Plan development to a ***less-than-significant level***.

Mitigation: No significant project ground-shaking impact has been identified; no additional mitigation is required.

Impact 10-1: Landslide and Erosion Hazards. The Specific Plan would allow development in areas that may be subject to landslide and erosion hazards, representing a ***potentially significant impact*** (see criteria [a] through [c] under subsection 10.3.1, "Significance Criteria," above).

Landslide potential would generally be of greatest concern in (a) the two water tank locations in the western portion of the plan area, which are considered "most susceptible" to landslides; and (b) the eastern portion of the plan area, where the Specific Plan would allow *Rural Farm*, *Agriculture-Residential*, and *Agricultural Tourism* uses in areas considered "generally susceptible" or "most susceptible" to landslides (see Figure 10.4 and Figure 2.3 in chapter 2, Project Description).

Mitigation 10-1. At County discretion and consistent with Solano County General Plan policies HS.P-12 through HS.P-15 and HS.P-17 and implementation programs HS.I-21 and HS.I-22, future subdivision and other discretionary development approvals may be subject to *detailed, design-level geotechnical investigations* that include analysis of landslide and erosion hazards and recommend stabilization measures. The County may also require preparation of Preliminary Grading Plans and/or Preliminary Geotechnical Reports, prepared by a licensed Engineering Geologist, before approval of specific developments within the plan area. Under this existing County authority, the investigating Engineering Geologist may be required to determine the extent of any necessary landslide remediation and supervise remediation activities during project construction to ensure that any existing or potential future landslides are fully stabilized. Mitigation measures (e.g., soil replacement, setbacks, retaining walls) shall be required as needed to protect against damage that might be caused by slope failure. Required compliance with these existing Solano County policies, implementation programs and development review procedures to the satisfaction of the County would reduce the potential effects of landsliding and soil erosion to a ***less-than-significant level***.

Impact 10-2: Expansive Soil Hazards. Most of the areas proposed for development under the Specific Plan have "moderate" to "high" shrink-swell potential. The plan area's moderately to highly expansive soils would be expected to undergo repeated cycles of shrinking and swelling in response to changes in soil moisture. Utility lines, road and building foundations, and sidewalks and concrete flatwork constructed on top of naturally occurring expansive soils, or based on fills that contain a high percentage of expansive soils, would be subject to long-term damage, representing a ***potentially significant impact*** (see criterion [d] under subsection 10.3.1, "Significance Criteria," above).

Mitigation 10-2. The *detailed, design-level geotechnical investigations* required at the County's discretion (see *Mitigation 10-1*) shall include analysis of expansive soil hazards and shall recommend warranted stabilization measures. The individual project Engineering Geologist shall inspect and certify that any expansive soils underlying individual building pads and all roadway subgrades have been either removed or amended in accordance with County-approved construction specifications, or shall make site-specific recommendations for grading, drainage installation, foundation design, the addition of soil amendments, and/or the use of imported, non-expansive fill materials, as may be required to fully mitigate the effects of weak or expansive soils and prevent future damage to project improvements. These recommendations shall be reviewed and approved by a County-retained registered geologist and incorporated into a report to be included with each building permit application and with the plans for all public and common area improvements. Implementation of these measures to the satisfaction of the County, combined with conformance with standard Uniform Building Code and other applicable regulations, would reduce the potential effects of expansive soils to a ***less-than-significant level***.

Impact 10-3: Groundwater Impacts. Mass grading, construction of cuts and fills, redirection of existing drainage patterns, and installation of landscaping irrigation as part of future development allowed by the Specific Plan could affect existing patterns of groundwater flow in the plan area, resulting in slope instabilities that would represent a ***potentially significant impact*** (see criterion [c] in subsection 10.3.1, "Significance Criteria," above).

Unidentified seeps and streams that are buried under fills or exposed in cuts during dry-season construction could surcharge fills, weaken slopes, and oversaturate utility trenches when they reappear during the rainy season. Overwatering within landscape areas and the redirection of surface runoff onto otherwise stable slopes could cause similar concentrations of groundwater.

Mitigation 10-3. Onsite drainage systems shall be regularly maintained to ensure that storm water runoff is directed away from all slope areas. Educational materials that discourage overwatering in landscaped areas shall be furnished to all future lot owners and property managers at the time of purchase and periodically thereafter (perhaps by inclusion with water or tax bills), as part of an effort to control groundwater seepage. Implementation of these measures to the satisfaction of the County would reduce this potential effect to a ***less-than-significant level***.

Cumulative Geology and Soils Impacts. In addition to development allowed by the Specific Plan, other development unrelated to the Specific Plan would continue to occur elsewhere in the county and subregion. Geotechnical impacts related to future development in the County would involve hazards associated with site-specific soil conditions, erosion, and ground shaking during earthquakes. The impacts on each site would be specific to that site and its users, and would not be common to or contribute to (or shared with, in an additive sense) the impacts on other sites. In addition, development on each site would be subject to uniform site development and construction standards that are designed to protect public safety. Therefore, cumulative geology and soils impacts would be ***less-than-significant***, and no mitigation measures are required.

Mitigation. No significant cumulative geology or soils impact has been identified; no mitigation is required.