PETITION TO ESTABLISH
RED HILLS VITICULTURAL AREA

The proposed Red Hills viticultural area is located entirely within the Clear Lake viticultural area in Lake County, California. The petitioned area is a sub-appellation of the Clear Lake Viticultural area. It lies on the south rim of Clear Lake, extending from the Excelsior Valley on the east to Big Valley on the west, and it is bounded on the south by the high volcanic peaks of the Mayacmas Mountains. Differences in topography, soils, and climate distinguish the proposed Red Hills viticultural area from the surrounding region.

The proposed area is approximately 31,250 acres (approximately 49 square miles), of which approximately 2,000 to 3,000 acres are currently planted to grapes, mostly red varietals, as well as some Sauvignon Blanc. An additional 500 acres currently in walnuts, and another 3,000 to 5,000 acres of currently uncultivated land are estimated to be plantable.

The proposed AVA

The proposed viticultural area encompasses a large contiguous tract of rocky, red colored soils of volcanic origin. These soils blanket Mt. Konocti, a volcanic mountain which anchors the northwestern corner of the proposed viticultural area. The red soils also mark the extent of a volcanic field stretching to the south and east of Mt. Konocti. In this volcanic field are several smaller volcanic vents whose flows of lava, ash, and rock contributed to the geologic heritage of the proposed area.

Unlike most of Lake County, which is dominated by mountain ranges and the valleys between them, the proposed Red Hills AVA is a gently rolling upland plain. The proposed appellation's hilly terrain creates a distinctive microclimate, enhanced by the area's proximity to Clear Lake, which also distinguishes this area from the surrounding region.

This petition describes the distinct features of the Red Hills viticultural area in more detail, demonstrating that the proposed area is a geographically unique grape-growing region under the definition set forth in 27 CFR 4.25a (e) (1). In order to enable wineries to designate grapes originating from this unique area, so that consumers may make informed decisions as to the wines they purchase, it is appropriate that the Red Hills be established as an American Viticultural Area in accordance with 27 CFR Part 9.

This petition is submitted by Compliance Service of America on behalf of the Red Hills Appellation Committee, whose members are as follows:

Rick Gunier - Lake County Winegrape Commission
Andy Beckstoffer- Beckstoffer Vineyards
George Buonaccorsi - Beringer Blass Wine Estates
Pete Downs - Kendall-Jackson Vineyards and Winery
Bob Roumiguiere - Roumiguiere Vineyards
George Myers - Snows Lake Vineyard
Ron Bartolucci - Bartolucci Vineyards

Respectfully,

Sara Schorske

Distinguishing physical features

Distinguishing topography

Lake County is a generally mountainous territory, named for Clear Lake, a very large lake near its center and its most prominent physical feature. South of the lake is a field of volcanic hills and mountains, considered to still be active, whose eruptions continued into geologically recent times. Clear Lake is itself believed to have been formed by a lava flow damming pre-existing stream valleys.

Lake County's alpine terrain creates many distinct valleys of varying sizes. Much of the early agriculture in the county, as well as its early settlement, was concentrated in these valleys, because of their fertile alluvial soils and sheltered climates.

In contrast to the more rugged topography found throughout most of Lake County, the proposed Red Hills viticultural area is an area of gently sloping, rolling terrain, contained entirely within the Clear Lake volcanic field referred to above. It is bounded on the south by Coast Range mountains and on the north by Mt. Konocti and Clear Lake. On the east and west, ridges separate the area from the lower, flatter floors of neighboring valleys to either side.

The terrain differences that mark the boundaries of the proposed Red Hills viticultural area are illustrated in Exhibit A. Page 1 of the exhibit is an aerial photograph of the view across Clear Lake. In the foreground is the northern part of the alluvial plain in which the town of Lower Lake, east of the appellation, is located. The rolling hills of the proposed Red Hills appellation begin at the south shore of Clear Lake, visible along the left side of the photograph, and extend off the edge of the picture. Mount Konocti, appearing near the upper left corner of the photograph, marks the northwestern corner of the proposed appellation. Beyond Mount Konocti, the photo shows the alluvial expanse of Big Valley, west of the proposed appellation.

Pages 2 and 3 of the exhibit are photos taken on Snows Lake Ranch, located at the southeastern corner of the proposed appellation, to illustrate terrain differences to the east and south of the proposed boundary.

Southern boundary. On and beyond Red Hills' southern border are several volcanic peaks: Mt. Hannah (3,978 feet), Boggs Mountain (3,720 feet), Seigler Mountain (3,692 feet), and farther south, Cobb Mountain (4720 feet). Although these peaks share a common volcanic heritage with the rolling hills of the proposed area, the steep slopes and high elevations of these mountains makes them unsuitable for commercial viticulture.

The southern boundary line generally coincides with the southern boundary of the Clear Lake viticultural area, which was drawn to exclude the high mountains of the Mayacmas Range. The boundary of the proposed area, however, has been modified to also exclude three areas that lie adjacent to the boundary of Clear Lake AVA: the bottomlands of Salminas Meadow and Seigler Valley, whose flat topography and alluvial soils are very different from the proposed appellation, and the large vernal pool called Boggs Lake in the southwest corner of the proposed appellation, which is a natural wetlands area and is therefore unsuitable for viticulture.

Western boundary. At the appellation's northwest corner is the massive Mt. Konocti, 4,299 feet in elevation. The northernmost portion of the western boundary has been drawn to exclude the steeper terrain at the top and on the flanks of Mt. Konocti, as well as Shaul Valley, another isolated area containing a vernal pool surrounded by bottomland soils at the mountain's base. Farther south, the western boundary follows Bottle Rock Road south from Carlsbad Spring, excluding the steeper terrain of Camelback Ridge to the west. Beyond Mount Konocti and Camelback Ridge, the terrain quickly descends on the northwest toward Big Valley, while it continues to ascend on the southwest into the Mayacmas Mountains separating Lake and Sonoma Counties.

The changes in terrain at the western border of the proposed appellation are illustrated in Exhibit B. Page 3 of this exhibit shows Figure 3, "Slope and Fault Characteristics," a map of slopes and faults in the Cobb Mountain Planning Area, reproduced from Lake County's Cobb Mountain Area Plan. *[**Note:** The proposed viticultural area is overlapped by parts of three Lake County Planning Areas — Cobb Mountain Planning Area, Rivieras Planning Area, and Lower Lake Planning Area. Overlapping the southwestern part of the proposed Red Hills viticultural area, the Cobb Mountain Planning Area covers approximately one third of the appellation.(See pages 1 and 2 of Exhibit B)]*

According to the data displayed on page 3 of Exhibit B, the portion of the Cobb Mountain Planning Area within the Red Hills AVA contains areas with slopes of 0-8%, slopes of 8-15%, slopes of 15-30% and slopes greater than 30%. No one group clearly predominates. However, in the portion of the Planning Area outside the proposed AVA (west of Bottle Rock Road), almost all of the terrain shown has slopes of 15% and above.

Northern boundary. The northern boundary of the proposed area has been drawn to exclude the higher elevations of Mt. Konocti and the waters of Clear Lake. The 2600 foot contour line on Mt. Konocti's southern face forms part of the area's northern boundary line. Also excluded are lake shore areas at the eastern and northern base of Mt. Konocti, which have never been historically associated with the Red Hills area, and which have different soils (discussed in greater detail later). On the eastern side of the proposed appellation, the northern boundary excludes Anderson Flat, a lower lying area which also has different soils.

Eastern boundary. The eastern boundary separates the proposed area from the alluvial plain in which the town of Lower Lake sits. A northwest/southeast oriented ridge extending east from the confluence of Perini Creek and Seigler Canyon Creek has also been excluded. Most of this ridge is steeper than the proposed Red Hills viticultural area. In addition, the bedrock structure of the excluded ridge is significantly older than the bedrock in the proposed area, and the soils are different as well.

The rock formation of this ridge is mapped as Lower Cretaceous Marine Sedimentary on the Geologic Map of California, Santa Rosa Sheet, compiled by James Koenig, 1963. Comprised of shales, sandstones, siltstones, conglomerates, and local detrital serpentine, these rocks date back to the Cretaceous Period of the Mesozoic Era, making them 65 to 136 million years old. In contrast, the bedrock underlying most of the proposed Red Hills viticultural area is mapped as Pleistocene Volcanic Rocks of the Quaternary Period, less than two million years in age, and some as young as 100,000 years. (Absolute geologic time values from Putnam's Geology, Fourth Edition.) Like the rocks beneath them, the soils on this excluded ridge are also non-volcanic in origin.

Distinguishing soils

The proposed Red Hills viticultural area encompasses the largest contiguous body of red volcanic soils in Lake County. Over 90% of the soils in the proposed area are of volcanic origin, and virtually all of these are red in color. The Lake County Soil Survey maps three general soil map units in the area: Glenview-Bottlerock-Arrowhead, Konocti-Benridge, and Collayomi-Aiken Whispering (Exhibit C). All of these soils formed in material derived dominantly from extrusive basic igneous rock.

The **Glenview-Bottlerock-Arrowhead** unit is comprised of deep, well drained gravelly and sandy loams, primarily found on volcanic hills east of Mount Konocti, "in the Red Hills and Camelback Ridge areas" *[Lake County Soil Survey, page 13]*. Approximately 23% of the proposed appellation is covered with soils of this general soil map unit, which include soil complexes of Glenview, Bottlerock, and Arrowhead soils.

The soils in this unit formed in material weathered from obsidian. In some areas, the soils have 35 to 70 percent obsidian cobbles and stones throughout the profile. Elevation ranges from 1,500 to 3,000 feet. The average annual precipitation is 30 to 50 inches, the average annual temperature is 53 to 59 degrees F, and the average frost-free period is 150 to 195 days.

The **Konocti-Benridge** unit is comprised of deep, well drained cobbly loam and loam, primarily found on hills and mountains. This map unit is mainly in the area around Mount Konocti and extending southeast toward Lower Lake. Approximately 41% of the proposed appellation is covered with soils of this unit, which include soil complexes comprised of Konocti, Benridge, Hambright, and Sodabay soils.

The soils in this unit formed in material derived mainly from andesite, basalt, dacite, and pyroclastic[1] material. Elevation ranges from 1,000 to 4,300 feet. The average annual precipitation is 25 to 40 inches, the average annual temperature is 53 to 60 degrees F, and the average frost-free period is 140 to 200 days.

The **Collayomi-Aiken-Whispering** unit is comprised of well drained very gravelly loam and loam, primarily found on mountains. This map unit is found in the more rugged Boggs Mountain and Cobb Mountain area south of the proposed appellation, but also in the Perini Hill/Snows Lake area within the proposed appellation. Approximately 33% of the proposed appellation is covered with soils of this unit, which include soil complexes comprised of Aiken, Collayomi, Sobrante, and Whispering soils.

The soils in this unit formed in material derived mainly from andesite, basalt, dacite, and pyroclastic tuff[2]. Elevation ranges from 1,400 to 4,600 feet. The average annual precipitation is 35 to 65 inches, the average annual temperature is 50 to 55 degrees F, and the average frost-free period is 120 to 185 days.

Over 90% of the soils in the proposed Red Hills viticultural area are distinctly red in color, due to red-colored topsoil or shallow-laying red-colored subsoil. Not only are virtually all the soils red in color, but almost all contain a high content of rock fragments or gravel in their structure, and in much of the area cobbles, rocks, and boulders ranging from 1 foot to 30 feet in diameter are common on the surface. Exhibit D shows photos illustrating the striking red color of the soils and the soils' rock content at various locations in the proposed viticultural area. Pages 1 through 6 are color photos taken by the petitioners. Page 7 is a map showing the locations of the photos. Page 8 is a typical profile of an example of Konocti cobbly loam soil, illustrating the high rock content typical of most of the soils in the proposed area, copied from a page of the Lake County Soil Survey.

The strikingly red color of the hills in the region is the reason that the name "Red Hills" has come to be associated with the proposed area. The red, stony soils were also the primary attraction that motivated the recent dramatic growth of viticulture in the area.

Below are descriptions of the color profiles and rock content of the most common soil components in the area, excerpted from the Lake County Soil Survey:

Aiken loam: Formed in material weathered from basalt. Typically, the upper part of the surface layer is reddish brown loam 5 inches thick and the lower part is reddish brown clay loam 4 inches thick. The upper 11 inches of the subsoil is yellowish red clay loam, and the lower 54 inches is reddish yellow clay and cobbly clay.

Arrowhead extremely gravelly sandy loam: Formed in material weathered from obsidian. Typically, the upper part of the surface layer is brown extremely gravelly sandy loam 1 inch thick and the lower part is brown gravelly sandy loam 3 inches thick. The upper 4 inches of the subsoil is brown gravelly sandy loam, the next 6 inches is light brown gravelly sandy clay loam, and the lower 17 inches is reddish yellow very stony clay. Hard, fractured obsidian is at a depth of 31 inches. In some areas the surface layer is sandy loam.

Arrowhead soils typically contain a high content of rock fragments (15 to 35 percent angular obsidian pebbles). In addition, the surface pavement is 75 to 95 percent covered with angular obsidian fragments.

Benridge loam: Formed in material weathered from volcanic ash, breccia, or tuff. Typically, the surface layer is light brown loam 6 inches thick. The upper 57 inches of the subsoil is yellowish red gravelly clay loam, and the lower 5 inches is yellowish red clay. Weathered volcanic breccia is at a depth of 68 inches.

Benridge soils typically contain 5 to 30 percent rock fragments. Some soils associated with this soil type contain 35 to 55 percent rocks and cobbles throughout.

Bottlerock extremely gravelly loam: Formed in material weathered from obsidian. Commonly has a surface pavement that is 90 percent gravel. Typically, the upper 5 inches of the surface layer is dark grayish brown extremely gravelly loam, the next 4 inches is light gray very gravelly loam, and the lower 10 inches is very pale brown very gravelly loam. The upper 9 inches of the subsoil is very pale brown very gravelly sandy clay loam, the next 11 inches is light brown very gravelly clay loam, and the lower 24 inches is dark red, strong brown, and reddish yellow very gravelly clay.

Bottlerock soils have a high content of rock on and near the surface (35 to 50 percent)—with an erosion pavement of up to 95 percent angular obsidian fragments. Some soils associated with this soil type contain 35 to 70 percent rocks and cobbles.

Collayomi very gravelly loam: Formed in material weathered from andesite, basalt, or dacite. Typically, about 5 percent of the surface is covered with stones and boulders. The surface layer is light brown very gravelly loam 15 inches thick. The upper 35 inches of the subsoil is light brown and reddish yellow very gravelly loam, and the lower 10 inches is light reddish brown extremely gravelly loam.

Collayomi soils typically contain a high content of rock fragments (35 to 60 percent). Typically, about 10 percent of the soil surface is covered with stones and boulders 10 inches to 8 feet in diameter.

Glenview very gravelly loam: Formed in material weathered from obsidian. Typically, the upper part of the surface layer is brown very gravelly loam 1 inch thick and the lower part is brown gravelly loam 5 inches thick. The upper 9 inches of the subsoil is reddish yellow clay loam, the next 25 inches is reddish yellow gravelly clay, and the lower 25 inches is reddish yellow gravelly clay loam. In some areas the surface layer is very gravelly sandy loam.

Pebble content is from 5 to 35 percent.

Guenoc clay loam: Formed in material weathered from basalt. Typically, the surface layer is reddish brown clay loam 3 inches thick. The upper 5 inches of the subsoil is dark red clay, and the lower 20 inches is dark red gravelly clay. Hard, fractured basalt is at a depth of 28 inches. In some areas the surface layer is loam.

Rock fragment content ranges from 5 to 35 percent; fragments consist of pebbles and cobbles.

Hambright very gravelly loam: Formed in material weathered from basalt. Typically, the surface layer is reddish brown very gravelly loam 4 inches thick. The subsoil is reddish brown very gravelly loam 12 inches thick. Fractured basalt is at a depth of 16 inches. In some areas the surface layer is clay loam.

Hambright soil contains 35 to 65 percent rock fragments consisting of varying percentages of pebbles, cobbles, and stones.

Konocti gravelly loam: Formed in material weathered from basalt. Typically, 10 percent of the surface is covered with cobbles and stones. The surface layer is brown gravelly loam 6 inches thick. Below this is strong brown gravelly loam 4 inches thick. The subsoil is yellowish red very stony clay loam 19 inches thick. Hard basalt is a depth of 29 inches.

Konocti gravelly loam has a high content of rocks and stones (20 to 60 percent). Typically, about 10 percent of the soil surface is covered with stones and boulders.

Konocti stony loam: Formed in material weathered from andesite, basalt, or dacite. Typically, the surface layer is brown stony loam 4 inches thick. The upper 5 inches of the subsoil is brown stony loam, and the lower 19 inches is light reddish brown very stony loam. The substratum to a depth of 39 inches is reddish yellow very stony clay loam. Fractured dacite is at a depth of 28 inches. In some areas the surface layer is very stony loam.

Konocti cobbly loam: Formed in material weathered from andesite, basalt, or dacite. Typically, the surface layer is brown cobbly loam 8 inches thick. The upper 8 inches of the subsoil is brown stony loam, and the lower 16 inches is light reddish brown very stony loam. The substratum to a depth of 39 inches is reddish yellow very stony loam. Slightly weathered dacite is at a depth of 39 inches.

This soil has a high content of rocks and stones (20 to 60 percent). Up to 25 percent of the surface can be covered with rocks, stones, and boulders.

Sodabay loam: Formed in material weathered from dacite, tuff, breccia, or volcanic ash. Typically, the surface layer is light reddish brown loam 6 inches thick. The upper 46 inches of the subsoil is light reddish brown clay loam, and the lower 11 inches is light reddish brown gravelly clay loam. Weathered pyroclastic tuff is at a depth of 63 inches.

5 to 20 percent pebbles and some cobbles are found in Sodabay soils. Included rock represents a lower percentage near the surface, and increasing proportions in the lower horizons.

Sobrante loam: Formed in material weathered from basalt. Typically, the surface layer is reddish brown loam 10 inches thick. The upper 11 inches of the subsoil is reddish brown loam, and the lower 17 inches is reddish brown clay loam. Hard fractured basalt is at a depth of 38 inches.

Typically, 10 to 50 percent of the soil surface is covered with stones and boulders as much as 3 feet in diameter.

Whispering loam: Formed in material weathered from andesite, basalt, or dacite. Typically, about 5 percent of the surface is covered with stones and boulders. The surface layer is brown loam 5 inches thick. The upper 10 inches of the subsoil is reddish yellow gravelly loam, and the lower 11 inches is yellowish red very cobbly clay loam. Hard, fractured andesite is at a depth of 26 inches.

Whispering soils typically contain a high content of rock fragments (up to 55 percent). Typically, about 10 percent of the soil surface is covered with stones and boulders.

Southern boundary. East of Seigler Valley, the southern boundary of the proposed viticultural area follows the southernmost edge of the field of volcanic soils which characterize the area. West of Seigler Valley, red volcanic soils (predominantly Collayomi-Aiken-Whispering complex, 5 to 50 percent slopes) extend beyond the proposed AVA boundary; however, the mountainous terrain outside the proposed area precludes commercial viticulture. In addition, the area south of the south boundary line of the proposed viticultural area is also excluded from the Clear Lake viticultural area, of which the proposed area is a sub-appellation.

Two clearly defined bottomland areas just inside the southern boundary of Clear Lake viticultural area — Salminas Meadow and Seigler Valley — have been excluded from the proposed area because of their very different terrain and soils.

Salminas Meadow has Oxalis Variant silt loam. Oxalis Variant soil is very deep, poorly drained soil found on alluvial plains, formed in alluvium from volcanic sources. Slope is 0 to 2 percent. Color varies from light brownish gray at the surface to gray, and finally white, as the depth of the sample increases.

Seigler Valley has Clear Lake Variant clay on the valley floor. Clear Lake Variant soil is very deep, poorly drained soil found in basins, formed in very fine grained sediment and alluvium from mixed sources. Slope is 0 to 2 percent. The color of the top 41 inches is very dark gray.

Western boundary. The ridges southwest of the proposed area which represent a change to steeper terrain also mark the approximate western extent of the prehistoric volcanic flows. Different geological parent materials underlay the soils outside the proposed western boundary. These differences are succinctly described in the Cobb Mountain Area Plan (italicized comments have been added by the petitioners):

> "The Mayacmas Mountains belong to the Franciscan assemblage, which consists of a complex including sandstone, shale, chert, greenstone, and various igneous and metamorphics, including serpentine. Soils in the area located generally west of Bottle Rock Road *[which forms part of the western boundary line of the proposed appellation]* area developed from parent materials of the Franciscan assemblage, which result in poorly drained and often steep soil conditions. Generally, soils formed from the Franciscan formation are characterized by poor soil and mineral quality. Areas to the

east of Bottle Rock Road *[i.e., areas included in the proposed appellation]* are generally influenced by soils of volcanic origin.

Soils in the Cobb and Boggs Mountain area *[this is the mountainous area with volcanic soils south of the proposed area]* result from volcanic parent materials which overlap the Franciscan assemblage. This area consists of well-drained soils with gently sloping to very steep soils. Soils in the northern and eastern portions *[i.e. within the proposed Red Hills viticultural area]* are formed from volcanic parent materials, including ash deposits attributed to Clear Lake volcanics. In general, soils of volcanic origins are of much better quality than Franciscan soils...."
[Cobb Mountain Area Plan, p. 3.2]

"The Clear Lake volcanics region occupies approximately 250 square miles, including most of the area east of the Bottle Rock Road alignment *[i.e. within the proposed Red Hills viticultural area]*. Volcanics apparently began in the early Pleistocene and ended about 10,000 years ago, covering the existing Franciscan formation in the area."
[Cobb Mountain Area Plan, p. 4.3]

"Serpentine soils of the Franciscan formation offer poor soil quality and nutrition. which often leads to unusual characteristics of endemic plant communities. For example, a large area of serpentine soils west of Bottle Rock Road *[i.e., outside the western boundary line of the proposed area]* is the site of an extensive Sargent cypress pygmy forest."
[Cobb Mountain Area Plan, p. 3.7]

".... Western portions of the planning area, located generally west of Bottle Rock Road *[i.e., outside the western boundary line of the proposed area]*, are underlain by bedrock of the Franciscan formation, which has a relatively low infiltration rate. A high percentage of rainfall is converted to surface runoff in this area, and as a result, there is less groundwater and fewer year-round springs.

By contrast, areas generally east of Bottle Rock Road *[i.e. including the proposed Red Hills viticultural area]* are underlain by geologically younger and more porous volcanic rocks and soils. The percentage of surface runoff is considerably less in areas with volcanic bedrock, while infiltration is higher. As a result, more springs and year round surface waters find their source in the eastern part of the planning area. Many springs in this area occur near the contact between the relatively permeable volcanic rocks and the much less permeable Franciscan rocks."
[Cobb Mountain Area Plan, p. 3.4]

On the northwestern boundary of the proposed area stands Mount Konocti, whose slopes are totally mantled in the red volcanic soils which derive from its ancient eruptions. This dormant volcano has never been considered to be part of the Red Hills area. Mount Konocti, which dominates the landscape south of Clear Lake, divides the region south of the lake into several distinct areas: Red Hills to the southeast, the Soda Bay area to the northeast, along the lake shore, and Big Valley to the west (see Exhibit A). Therefore, the northern portion of the proposed appellation's western boundary line cuts across the southwestern flank of Mt. Konocti, excluding all but its lowest foothills.

Also excluded by the western boundary line is Shaul Valley, a small, clearly defined bottomland area with very different soils from the proposed appellation. Shaul Valley contains two soils found nowhere else in the proposed appellation: Talmage very gravelly sandy loam and San Joaquin Variant fine sandy loam. Talmage soil is very deep, somewhat excessively drained soil found on alluvial fans and flood plains, formed in coarse-grained alluvium deposited relatively recently from mixed sources. Slope is 0 to 8 percent. Color varies from grayish brown to light yellowish brown, depending on the depth of the sample. San Joaquin Variant soil is moderately deep, well drained soil found in alluvial plains and stream terraces, formed in alluvium derived from volcanic rock. Slope is 1 to 5 percent. It has light gray topsoil and light brown subsoil.

Also excluded at the northwestern corner of the appellation is a narrow margin of red colored volcanic soils (Sodabay loam) found along the shore of Clear Lake at the base of Mount Konocti. These soils differ from the soils of the proposed appellation because they are lacking in rock content in surface soil layers or rocks on the surface, which is one of the characteristics of the soils of the proposed area. Within the proposed appellation, Sodabay loam is found only in association with Konocti cobbly loam and Konocti stony loam, never alone as it is at the base of Mount Konocti.

Northern boundary. The northern boundary of the proposed viticultural area is defined on its eastern end by two flat areas with very different soils — the marshy Fluvaquentic Haplaquolls soils of Slater Island and the deep, flat alluvial Still loam soils of Anderson Marsh. Neither area is suitable for viticulture; Anderson Marsh is protected as a State Historic Park and as a significant wetland habitat, vital to maintaining Clear Lake's fish and wildlife production. An 871 acre site there was purchased for inclusion in the State Parks system in 1983. Approximately 540 acres of the park are classified as wetlands and managed as a natural preserve. The 253 acre McVicar-Audubon reserve is located adjacent and west of state-managed lands of Anderson Marsh. This reserve is also a wetland-riparian area.

The northern boundary is defined on its western end by steep, high slopes of Mount Konocti. The lower elevation lake shoreline area north and east of Mount Konocti is excluded; it is historically and geographically known as part of the Soda Bay area — listed as a unique place in such historical texts as The Historical and Descriptive Sketchbook of Napa, Sonoma, Lake and Mendocino Counties by C. A. Menefee, published 1873 and History of Napa and Lake Counties published by Slocum, Bowen and Co. in 1881, and others — and has never been associated with the Red Hills area.

In between Slater Island on the east and Mount Konocti on the west, the northern appellation boundary follows the shores of Clear Lake.

Eastern boundary. The eastern boundary of the proposed viticultural area corresponds to the easternmost edge of the field of volcanic soils that characterize the area.

In the vicinity of the town of Lower Lake and the mouth of Cache Creek north of town are small patches of red volcanic soils (Benridge-Sodabay loam and Benridge variant loam) outside of the Red Hills appellation boundary. Like the red volcanic soils of the Soda Bay area (described above), these soils are different from the red volcanic soils found inside the proposed area in that they are lacking in rock content in surface soil layers or rocks on the surface. Benridge-Sodabay loam is not found at all inside the boundaries of the proposed area, and there are only two small patches of Benridge variant loam within the proposed Red Hills AVA.

Distinguishing climate

Rainfall. Precipitation varies greatly over the Mayacmas Mountains due to the rapid changes in topography. Rain-bearing clouds dump their moisture when forced to rise over mountains in their path. Therefore, as expected, the area of highest rainfall in Lake County is centered over the mountainous region south of the proposed appellation, between Lake County and Sonoma County. Rainfall there reaches levels of 80 inches, and more in some years. Rainfall as high as 117 inches has been reported for this mountainous region.

The location of lowest annual rainfall in the county, averaging only 22 inches a year, is centered over Clear Lake. The proposed Red Hills viticultural area, which is located between these two places, ranges from 25 to 40 inches of rainfall a year (see Exhibit E).

Meteorology. As in all parts of California's coast ranges, Lake County's climate is greatly dependent on the interaction of coastal air and local terrain, and microclimates abound. However, because of Lake County's relatively inland location and protecting mountain ranges, the influence of the Pacific Ocean there is less than in parts of the coast mountains closer to the ocean. The cool, moist, ocean air has been slowly warmed by its overland passage by the time it reaches Lake County. Its temperature and humidity have also been altered by the changes in elevation the ocean wind has encountered in its inland travel. Therefore, local meteorological effects play a more important role in creating Lake County's microclimates, and more significantly account for the differences between various areas, than in other coastal regions.

Generation of local winds in the proposed Red Hills viticultural area. Winds develop as the result of temperature differentials. Temperature gradients due to differences in elevation generate mountain-valley winds, and water-land temperature differentials generate lake-land winds in accordance with the principles described below. Both factors — its hilly terrain and its proximity to Clear Lake — contribute to the unique wind patterns in the Red Hills area.

The mountain-valley winds are strongest at night when air in contact with hillside surfaces cools and becomes dense. This heavier air slips downhill, collects in the valleys, and drains down along the water courses. Depending upon local topography, these downslope ("katabatic" or gravity-driven) winds can be quite strong. After sunrise, when hillsides warm, this process stops and eventually reverses. However, the reverse up-valley ("anabatic") afternoon winds are weaker than the nighttime drainage winds.

Land adjacent to large bodies of water, such as Clear Lake, similarly experiences winds driven by temperature contrasts. The phenomenon that water warms more slowly than adjacent land during the day, and also holds its heat longer at night, is the driving force that creates land-water winds. At night, air passing over Clear Lake is warmed, becomes less dense, and rises, while air over the relatively cool land on the shores becomes denser and sinks. This causes nocturnal katabatic winds to develop towards the lake. During the day, the land quickly becomes warmer than the lake, reversing the process and causing the winds to blow inland. Again, the on-shore (anabatic) daytime winds are weaker than the off-shore nocturnal winds.

In many locations, mountain-valley breezes and land-water breezes result in incomplete circulation. Warmer air that is displaced by the cooler breeze rises, disperses broadly and mixes with lower air slowly, so that little of the displaced air is re-circulated in the breeze. In the Clear Lake basin, however, because both processes occur in a relatively small and confined space, these winds are a kind of perpetual motion machine.

Cool, offshore winds draining from the hills to the valleys at night warm when they settle over Clear Lake, and begin to ascend. The lake-heated air fills the basin to its spill-over points. Some of it mixes with the descending drainage winds to recycle once more.

During the day, as the land warms much more quickly than the lake waters, the land-heated, up-valley winds rise to ridge tops. Much of this warmed air is drawn back into the system to replace air cooling over the lake, descending and flowing on-shore again. Only part of it spills over the surrounding mountains and leaves the basin.

This mountain-valley, lake-land system is so dominant in the Clear Lake basin that it operates all day. Studies of data from the Lake County Air Pollution Control District mechanical weather station network indicate that local katabatic drainage winds predominate up to eighteen hours a day, during the night and morning hours. The afternoon regime, which predominates the remaining six hours each day, is the opposite of the ones just described. (Data reported in Environmental Data Compilation: Red Hills Geothermal Prospect Area).

Natural frost protection in Red Hills viticultural area. A unique combination of factors, including location, elevation, and terrain, combine to make artificial frost protection generally unnecessary in the proposed Red Hills viticultural area. In contrast, all other grape growing areas in Lake County require frost protection in early spring.

Long time residents and experienced growers in the area unanimously relate that in the early morning hours of cold spring days, naturally generated winds keep frost from forming on tender grape shoots — even when temperatures dip below freezing — in most locations within the proposed Red Hills AVA. Isolated cold spots throughout the proposed appellation, such as locations at the base of a hill, are also usually free from damage, because in these the cooler locations, bud break is delayed so shoot growth usually remains minimal until warmer weather ends the danger of frost damage. [Personal communications: David Tuttle, Bill Diener, Bob. Roumiguiere, Frank Anderson]

Red Hills' hilly, open terrain and its proximity to Clear Lake enhance the operation of the air flow system described in the section above, and explain the natural "wind machine" effect that eliminates the threat of frost. The undulating, open terrain throughout the area, with no steep sided drainage valleys and no narrow exits to restrict dispersion, prevents cold air from accumulating at the lower elevations. The proximity of Clear Lake and the lack of significant topographic barriers blocking off-shore flow onto the lake allows the power of the land-lake winds to augment the momentum of the mountain-valley winds, thus insuring effective air flow and mixing on frosty mornings.

The enhanced strength of the winds in the Red Hills area adds a potent factor to natural frost protection mechanism: "adiabatic warming." Adiabatic temperature changes are known to meteorologists as the temperature changes air experiences without any transfer of heat, caused simply by pressure changes when the air ascends or descends. When air ascends, the pressure on it decreases, and the air expands. It takes energy for gases to expand, as heat is converted into kinetic energy by faster moving molecules. As a result, the temperature of rising air cools. Conversely, descending air is warmed by compression as it enters regions of greater pressure. The air molecules slow down and release their kinetic energy in the form of heat, which warms the air.

Normally, the adiabatic warming of air in a mountain-valley wind is more than offset by the cooling of the air from contact with the cold slopes. That is, the air cools faster by radiation than it warms by compression. However, when local conditions generate unusually fast winds, such as happens when air is forced through narrow canyons, adiabatic warming may exceed radiation cooling. This phenomenon has been recognized by meteorologists to produce effective frost protection: "In Utah, the effects of this warming and of the turbulent mixing of the air by reasons of rapid motion are sufficient to prevent early frosts in autumn and thus to prolong the growing season on the bench lands at the mouths of canyons." (Weather Elements, A Text in Elementary Meteorology, 5th Edition, p. 130). Growers' experience indicates that this phenomenon is also at work in the proposed appellation. In the Red Hills viticultural area, high wind speeds are attained not by passage through narrow canyons, but by the combined effect of mountain-valley AND land-lake winds operating in a symbiotic system.

Heat summation in the proposed Red Hills viticultural area. Heat summation, calculated as the sum of the mean monthly temperature above 50° during the growing season and expressed as degree days, is universally accepted as the most important climatic factor in predicting the suitability of a site for specific grape varietals. A system of Climatic Regions was developed by University of California viticulture professors Amerine and Winkler, categorizing locations as Region I (less than 2,500 degree days), Region II (2,501 to 3,000 degree days), Region III (3,001 to 3,500 degree days), Region IV (3,501 to 4,000 degree days) and Region V (over 4,501 degree days).

Degree days calculated from a large number of data points within the proposed viticultural area were examined and analyzed. Although the climate support available at any given site in the proposed area varies somewhat depending on the site's elevation and aspect, the data clearly places Red Hills in Region III. The average of 18 sites in the proposed Red Hills viticultural area is 3,244 degree days for the 2000 growing season. This corroborates the experience of growers with vineyards in Red Hills, that vineyard sites in the proposed area are warm enough to admirably ripen the longer season red varietals of Barbera, Cabernet Sauvignon, Cabernet Franc, Merlot, Petite Sirah, Syrah, and Zinfandel.

Red Hills is warmer than Big Valley to the west. Degree day calculations for sites in Big Valley identify it as a high Region II area. Average degree days for the 2000 growing season was 2,985, and for the 1999 growing season was 2,849. In addition, Winkler and Amerine's classic text, *General Viticulture*, places the Big Valley town of Kelseyville, with 2930 degree days, in their listing of grape growing areas with a Region II climate. (See Exhibit F.) This also corroborates the experience of Lake County growers with vineyards in both areas.

For example, Bob Roumiguiere has over a decade of experience with vineyards in both Big Valley and Red Hills. (Mr. Roumiguiere's Big Valley vineyards were planted in 1980; his Red Hills vineyards were planted in 1989.) Mr. Roumiguiere states that the climate in Big Valley is cooler; bud break is consistently later. He reports that his Red Hills Cabernet Sauvignon is often picked in late August, while his Big Valley Cabernet hangs until October.

In addition, of course, Mr. Roumiguiere's vineyards in Big Valley — like all other vineyards throughout the county, but in contrast to Red Hills vineyards — need vigilant frost protection throughout the spring. This is true even at a vineyard located quite close to the shore of Clear Lake. Mr. Roumiguiere starts his sprinkler-based frost protection system at his vineyards in Big Valley nightly at 10 or 11 PM throughout the frost season. In contrast, he has never needed frost protection in his Red Hills vineyards; no sprinklers are even installed there. *[personal communication R. Roumiguere, May 11, 2001]*

Historical and name evidence

Historical background

Settlement of Lake County. Because of Lake County's rugged terrain, agricultural and urban development in the 1800s concentrated in the valleys. Other small settlements grew up around tourist attractions — the lake itself and the many mineral and hot springs found in the region — and at stage coach resting places, while plentiful timber and wildlife resources attracted early pioneers to homesteads in the mountains.

Lake County's mountainous landscape isolated individual settlements from each other and made travel relatively slow and arduous. Because of the high expense and time involved in transporting goods around the county and to the outside world, perishable agricultural crops were grown primarily to meet domestic needs and the local demands of the early settlers, the miners, and the tourists. Stock raising (including dairying) was the major agricultural pursuit.

The Lower Lake area was among the first to be populated in Lake County, because of its relative proximity to the settlements of Sonoma and Napa County, and the earliest vineyards were planted there. Agriculture later spread from there to the many valleys surrounding Lower Lake to the south and east, to the large fertile expanse of Big Valley at the west end of the Lake, and to the many small valleys in the west and north parts of the state, but remained concentrated in valley terrains until the second half of the 1900s.

Historical uses of the proposed area. The first pioneer families and their wagon trains came into Lake County in 1854 through Napa Valley. Some settled in the more level lands in the lower end of the county — in Loconoma Valley, where Middletown is located; in Lower Lake Valley, home of Lower Lake; and several smaller valleys nearby. Others sought to establish homesteads in the Big Valley, at the far end of Clear Lake. The major emigrant routes between these most populous parts of the county crossed the Red Hills area. These roads were also used by travelers seeking refreshment at the many hot springs resorts located around the periphery of the area (Carlsbad Springs, Hoberts Resort, Harbin Springs, Seigler Springs, Glenbrook Resort, Bonanza Springs, and Adams Springs were all clustered in the more mountainous areas surrounding Red Hills).

The S-Bar-S Ranch, located northwest of the intersection of Highway 29 and Soda Bay Road, was originally a stage coach stop-over on the road between Lower Lake and Kelseyville. In the 1880's a school, the Ely Post Office, a hotel, and commercial lumbering formed the nucleus of a small town located there.

The town disappeared when timber in the area eventually ran out and road improvements eliminated the need of a rest stop on the ranch.

Prior to 1870, Boggs Lake was on the route between Middletown and Kelseyville, which followed Wildcat Road and McIntire Creek. In 1870, a more direct route, known as the Boggs Toll Road, was constructed. This route was accepted by the state as Highway 29 in 1924 and was redesignated as Highway 175 in 1963.

The Boggs Lake area has been used for a number of purposes over the years. The early pioneers of Big Valley traveled to the areas around Boggs Lake and Salminas Ranch to hunt for elk, but this attraction lasted only until 1858, when the more accessible elk herds had been killed. A lumber and grist mill was operated on the south shores of Boggs Lake from 1860 to 1866, when the operation was moved to Boggs Mountain. In the winters between 1869 and 1876, ice was manufactured on the lake and stored in sawdust for summer use. In 1878 an attempt was made to raise German Carp in the lake; this operation, however, proved uncompetitive and subsequently failed. Boggs Lake is currently recognized and protected as a vernal pool natural area.

The Perini Hill area, as well as Perini Road and Perini Creek, are named after the Perini family who originally settled that area of the county. Joe Perini, a former chef, came to California from Europe. While working as a cook near Lower Lake, he discovered the ranch one day while hunting. He and his wife bought the place for purposes of cattle raising and moved to it about 1901.

Perini Ranch soon became a popular Lake County destination, and remained so for many years. Inspired by the proximity of several hot springs resorts, the Perinis started serving special Italian dinners to the public at their ranch. The family also built cabins to cater to the summer tourist trade. "Perini's Italian Gardens" proved so popular that the tradition was continued by the family for seven decades.

Other historical uses of the Perini Ranch area are varied. These uses have included timber harvesting and walnut production. The Perini property was the site of a sawmill which utilized logs from the ranch and the surrounding region until the late 1930's. Timber harvesting occurred over most of the Perini Hill area beginning around the 1870's and continuing until the Second World War. In 1945, a major forest fire in the area destroyed most of the remaining pine trees.

Agricultural uses of the proposed area. A hilly region, the proposed AVA did not attract settlement in any large scale. Stock raising and home production of fruits and vegetables were the primary agricultural pursuits. Timbering was also practiced until trees were depleted.

Historically, walnuts were the predominant agricultural crop in the Red Hills viticultural area. The Red Hills area boasted the county's largest commercial plantings of walnuts. These orchards, many of which persisted to modern times, were centered near the heart of the Red Hills appellation, along Highway 175 in the vicinity of Red Hills Road. The rolling terrain and deep red soil have been long recognized for their value in fruit production.

There were also walnut plantings in the Perini Hill/Snows Lake area. Walnuts were first planted there in the 1920's and 1930's. In 1946 and 1947, the Teichert Dried Fruit Company cleared the remaining native vegetation and planted approximately 1,100 acres of walnuts. Unfortunately, the company experienced financial difficulties and as a result abandoned the orchards after a few years. Much of the cleared acreage subsequently reverted to native vegetation.

The Snow Ranch, encompassing the area south of Snows Lake, a vernal lake named after Sam Snow, was also planted in walnuts in the 1930's. Today both the Perini Ranch and the Snow Ranch are owned by Snows Lake Vineyard Co.

The existence of established walnut orchards in the area is an incentive to the growth of viticulture in the Red Hills area. Current county development policies make it much easier for a grower to convert acreage from walnuts to grapes, than to clear uncultivated acreage to establish a new vineyard. Therefore, many existing walnut groves may soon be targeted to be replanted with vines.

Viticultural uses of the proposed area. Historical accounts document the presence of at least two small vineyards in the area prior to Prohibition. It is likely that other local residents also cultivated vineyards for home or local wine production, but no records of these smaller operations persist.

The Diener family, who still farm lands located on Diener Drive near the center of the proposed appellation, had a 15 acre vineyard in the late 1800's, growing a mixture of red, white, and Muscat grapes used for brandy production. The vines were pulled out during or shortly after Prohibition and replaced with walnuts. Wine grapes were replanted on Diener Ranch in 1996.

The Perini family, whose lands were located on Perini Road in the southeastern portion of the proposed appellation, also had a vineyard, of unrecorded acreage, whose grapes were used for processing into wine for catered meals at "Perini's Italian Gardens." Although the family carried on the dinner house tradition from 1905 into the 1970's, the grape vines were removed in the 30's and replaced with walnut orchards.

The Red Hills District is currently the second largest wine grape growing area in Lake County, second only to Big Valley. All of the wine grape acreage currently under cultivation in the Red Hills District was planted in the last 20 years, mostly in the last decade.

Beringer Vineyards was the first company to establish a large vineyard in the Red Hills area, planting 120 acres in 1987. Two other vineyards were planted in 1990, and most of the rest of the current acreage has been planted since 1996. Vineyard development in the area is continuing; with several significant new vineyard blocks currently planned.

Name evidence

The proposed Red Hills AVA takes its name from a road, contained entirely within the proposed viticultural area, which runs through the heart of the area. A well known connector road linking Highway 29 and Highway 175, the two principal arteries in the area, Red Hills Road was itself named for the most striking and unifying features of the area — its prevalent red soils and gently hilly terrain.

Not only the lands fronting on the road, but the entire area, has been thought of by locals as the Red Hills area for many years. Local history binders, assembled by volunteers at the Lake County Museum, contain three direct references to the name "Red Hills."

On May 5, 1977, Henry Mauldin, Lake County's most prominent and prolific modern historian, wrote the following brief description entitled "Red Hills":

> "The eastern end of Soda Bay Road ends at Highway 29 near the S Bar S Ranch between Kelseyville and Lower Lake. At that point and going south is another road, Red Hills Drive [*the previous name for the road*]. It is only a couple of miles long but goes up through rolling red soil and thus received its name. The title Red Hills means an area and not a separate prominent point. It is believed this location contains the greatest joining acreage planted to walnuts of any place in Lake County and under different ownerships.
>
> Land was very cheap, all in brush, and most of it cleared by large tractors. It is thought that the first clearing and planting of walnuts was by Ed Auschwitz, a German, in 1911, at the southeast corner of the junction of Highway 29 and Red Hills Drive."

Mr. Mauldin's account was probably based on an earlier record, written by Ed Auschwitz around March 10, 1949, and excerpted below:

> "Ed dug an 88' well at the Auschwitz home.... The first 7 feet was red soil, the next 10 feet was porous, yellowish ash, the next 33 feet was red soil and clay, and the last 38 feet was solid obsidian....
>
> Red Hills' walnut territory, which lies on both sides of Red Hills Drive, but mostly to the east, now contains about 985 acres. This is either planted or will be this winter. It belongs to various owners. The first clearing in this area was on the northern part near the Auschwitz home in 1911 and was done by Ed."

Oral history binders at the Lake County Museum also contain the following entry:

> "T12N R8W Red Hills is an area of moderately sloped land, with a north exposure, that is systematically being cleared and planted to walnuts today. It lies mostly in sections 3, 4, 9, 10, and 11. Drainage is into Thurston Creek."

The characteristic red hills identified with the proposed area are so well recognized that Lake County repeatedly refers to the area by the name "Red Hills" in its published planning documents (see excerpts below). The Cobb Mountain Area Plan, published by the Lake County Planning Department in March 1989, contains nine separate references to "Red Hills" in the following six passages:

1. "Extensive areas of dryland walnut orchards occur in the area known as the **Red Hill** [sic] district in the extreme northeastern portion of the area."
   [page 3.7]

2. "Most commercial agricultural activities are located in the northeastern portions of the Cobb Mountain Area in the vicinity of Red Hills Road and Seigler Springs Road. English walnuts are the dominant crop in this area. Other area agriculture includes livestock ranching, several Christmas tree farms, and newly planted vineyards....

   Approximately 1,200 acres of walnuts are in production in the area. Most of this acreage is dry farmed on the Class III and IV soils formed from volcanic and ash deposits found in the **Red Hills** district. While net yields are below county averages where irrigation is normally practiced, quality is above average. The principal agricultural constraint in this area is excessive erosion of the light volcanic soils. Although groundwater supplies and springs are available in much of the Red Hills area, irrigation is not usually practiced. Most agricultural preserves in the Cobb area are found in the vicinity of the **Red Hills** walnut district."
   [page 3.11]

3. "**Agriculture and Timber Policy 3.5a:** Development of the viticulture industry in the **Red Hills** agricultural district should be encouraged.

   Agriculture and Timber Policy 3.5b: The U.S. Department of Agriculture should be encouraged to include eligible agricultural land

in its erosion control and observation reserve program. Highly erodible hillside areas such as the **Red Hills** district should be included in the USDA's criteria. "
[page 3.25]

4. "The California Department of Forestry and Fire Protection classifies nearly all of the planning area as a very high wildland fire hazard area, except for the **Red Hills** agricultural district which is considered to be a high wildland fire hazard area."
[page 4.1]

5. "Agriculture ("A") and agricultural preserve ("APZ") zoning is applied to 2,170 acres and 1,570 acres respectively. All agriculturally zoned lands are found in the **Red Hills** district, and involve lands which contain substantial amounts of Class III or IV soils and are devoted to orchard, wine grape, or hay and pasture production. Most lands under agricultural preserve contracts are also located in the **Red Hills** District and are zoned "APZ."
[page 6.8]

6. "The greatest limitations to agriculture in the Cobb Mountain area are its poor mountain soils and excessive slops. However, the **Red Hills** walnut district has potential to accommodate much greater wine grape production over the long term. Adequate water supplies could be developed for much of this area, with drip irrigation of wine grapes.
[page 3.12]

The name "Red Hills" is also used to identify a weather station used in the UC IPM (University of California Integrated Pest Management Project) weather database. The location of this weather station, inside the proposed boundaries of the Red Hills District viticultural area, is shown on Exhibit G, page 1.

In addition, the name "Red Hills" identified a geothermal prospect area investigated by Occidental Geothermal, Inc. and Republic Geothermal, Inc. in the late '70s. The location of this geothermal leasehold, situated near the western boundary of the proposed appellation, is shown on Exhibit G, page 2.

[1] *Andesite, basalt, dacite,* and *pyroclastic* are all designations of igneous rock. Andesite is generally a gray to gray-ish black, fine grained volcanic rock formed from magmas of intermediate temperatures. It has a porphyritic texture, meaning it contains crystals of two markedly different sizes. Basalt is by far the most abundant of all volcanic rocks. It is ordinarily coal black to dark gray, and fine grained in texture. It was formed from extremely hot magmas rich in magnesium, iron, and calcium. Dacite is the igneous equivalent of quartz diorite, containing crystals of various minerals in a groundmass of alkalic feldspar and silica minerals. Pyroclastic material is rock formed from lava hurled into the air, in sizes ranging from large rocks, cinders, tiny fragments, and dust-size ash particles. *[Putnam's Geology, Fourth Edition, pages 132-142; Glossary of Geology and Related Sciences, page 73]*

[2] *Breccia* is an deposit of angular projectile rocks or volcanic "bombs," cinders, lapilli (tiny fragments of chilled lava), and ash, in an unsorted mixture, but possessing crude layering. *Tuff* refers to material in which ash predominates. *[Putnam's Geology, Fourth Edition, page 142]*

Boundaries

The proposed Red Hills Viticultural Area is located entirely within the Clear Lake viticultural area in Lake County, California, south of Clear Lake, between Lower Lake and Kelseyville. It is bounded on the east by the ridges overlooking Excelsior Valley; on the west by foothills of Mt. Konocti which separate the proposed area from Big Valley; on the north by Anderson Marsh, the shores of Clear Lake, the higher slopes of Mt. Konocti, and the distinct community of Soda Bay.

Boundaries are found on five U.S.G.S. 7.5′ series topographic maps, the Kelseyville (1959, photorevised 1975) Quadrangle, Clearlake Highlands (1958, photorevised 1975) Quadrangle, Lower Lake (1993) Quadrangle, and Whispering Pines (1958, photoinspected 1975) Quadrangle.

The beginning point is the intersection of the section line between Sections 3 and 4, T12N, R7W with the shoreline of Clear Lake, on the Clearlake Highlands Quadrangle.

1. From the beginning point, follow the section line between Sections 3 and 4, T12N, R7W south to its intersection with the 1400 foot contour line.

2. Follow the 1400 foot contour line in a generally easterly and southerly direction onto the Lower Lake Quadrangle and then back onto the Clearlake Highlands Quadrangle, to its intersection with Seigler Canyon Creek, in Section 10, T12N, R7W.

3. Follow Seigler Canyon Creek westerly to its confluence with Perini Creek.

4. Follow Perini Creek southerly to its intersection with the 1800 foot contour line in Section 16, T12N, R7W.

5. Follow the 1800 foot contour line southerly, crossing from the Clearlake Highlands Quadrangle to the Whispering Pines Quadrangle, to its point of intersection with Copsey Creek.

6. Follow Copsey Creek westerly to its headwaters in Section 29, T12N, R7W.

7. Proceed westerly in a straight line to the headwaters of Bad Creek, and then due west in a straight line a short distance to Big Canyon Road.

8. Follow Big Canyon Road northerly, to its intersection with Loch Lomond Road in Section 19, T12N, R7W on the Clearlake Highlands Quadrangle.

9. Follow Loch Lomond Road westerly and then southerly to its intersection with the southern boundary line of Clear Lake Viticultural Area (a straight line connecting Childers Peak and Mt. Hannah) in Section 25, T12N, R8W on the Whispering Pines Quadrangle.

10. Follow the Clear Lake AVA boundary line northwesterly to its intersection with Salmina Road in Section 23, T12N, R8W on the Clearlake Highlands Quadrangle.

11. Follow Salmina Road northerly to its intersection with Highway 175.

12. Follow Highway 175 southerly to its intersection with the southern boundary line of Clear Lake Viticultural Area (a straight line connecting Childers Peak and Mt. Hannah) in Section 15, T12N, R8W on the Clearlake Highlands Quadrangle.

13. Follow the Clear Lake AVA boundary line northwesterly to Mt. Hannah and then westerly, along the straight line connecting Mt. Hannah to the southeastern corner of Section 13, T12N, R8W, to its intersection with the 2800 foot contour line which circles Boggs Lake in Section 17, T12N, R8W, on the Kelseyville Quadrangle.

14. Follow the 2800 foot contour line northerly, westerly, and southerly, around Boggs Lake, to its intersection with Harrington Flat Road in Section 18, T12N, R8W.

15. Follow Harrington Flat Road northerly to its intersection with Bottle Rock Road.

16. Follow Bottle Rock Road northerly to its intersection with an unnamed unimproved road, just inside Section 1, T12N, R9W.

17. Follow the unimproved road northerly to Boundary Marker 2080.

18. Proceed northeasterly in a straight line to Mt. Olive, a peak of elevation 2485 in Section 31, T13N, R8W.

19. Proceed northeasterly in a straight line to an unnamed peak of elevation 2295 in Section 30, T13N, R8W.

20. Proceed northeasterly in a straight line to the intersection of the 2600 foot contour line with the section line between Sections 19 and 20, T13N, R8W.

21. Follow the 2600 foot contour line easterly to its intersection with an unnamed stream near the section line between Sections 20 and 21, T13N, R8W.

22. Proceed easterly in a straight line to the intersection of Konocti Bay Road and Soda Bay Road in Section 22, T13N, R8W, on the Clearlake Highlands Quadrangle.

23. Proceed due east to the shore of Clear Lake.

24. Proceed southeasterly along the shoreline of Clear Lake to the point of beginning.

EXHIBITS TO PETITION TO ESTABLISH RED HILLS VITICULTURAL AREA

Exhibit A (Terrain overview)

Page 1: View across Clear Lake, reproduced from the explanatory notes of the Santa Rosa Sheet of the Geologic Map of California, compiled by James B. Koenig, 1963

Pgs. 2-3: Color photos from proposed appellation

Exhibit B (Planning Areas and slopes)

Page 1: Map of Lake County Planning Areas

Page 2: Color coded map of proposed appellation showing planning areas

Page 3: Slope and Fault Characteristics," reproduced from Figure 3 from Lake County's Cobb Mountain Area Plan

Exhibit C (Soil maps)

Page 1: General Soil Map of Lake County, California from Soil Survey of Lake County

Page 2: Color coded appellation map showing general soil map units

Exhibit D (Soil photos)

Pgs. 1-6: Color photos from proposed appellation

Page 7: Map showing location of photos

Page 8: Figure 6 from Soil Survey of Lake County, a photograph of a profile of Konocti Cobbly Loam showing typical rock content

Exhibit E (Precipitation)

Precipitation map of Clear Lake area, reproduced from Figure 5.1-1 of Draft EIR for Robbins-Perini Hill Geothermal Exploratory Project, prepared by Gennis and Associates, Engineers July, 1980

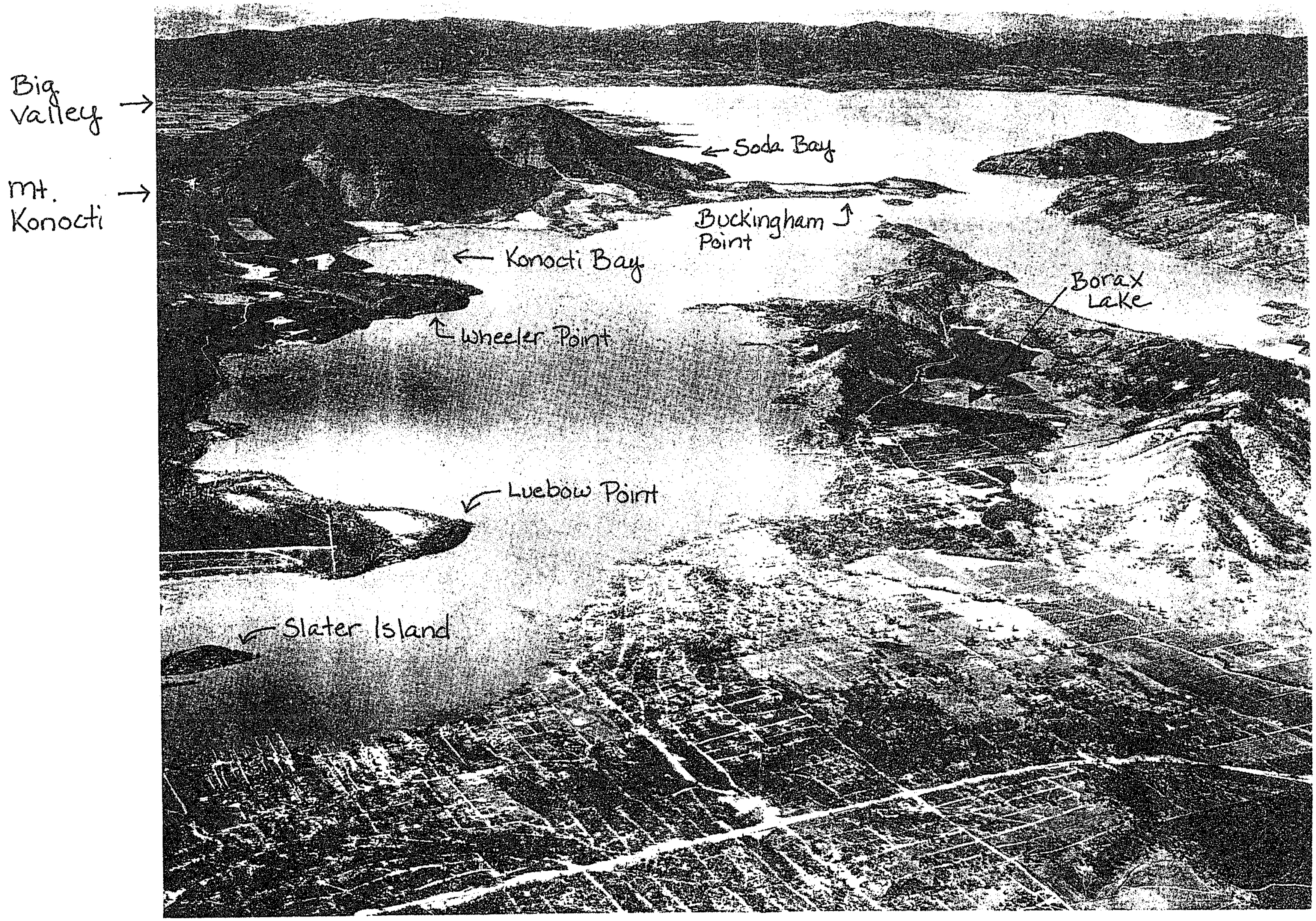
Exhibit F (Degree days)

Portion of Table 3, "Heat Summation as Degree-Days above 50° F. for the Period April 1 to October 31 at Various County Locations in California and a Few Foreign Locations, from General Viticulture by Amerine and Winkler

Exhibit G (Name evidence)

Page 1: Map printed from UC Davis Integrated Pest Control web site, showing location of "Red Hills" weather station

Page 2: Location map showing study area from the Environmental Data Compilation, Red Hills Geothermal Prospect Area, Lake County, California, prepared by Gennis and Associates, Engineers, March 1979



View northwest across Clear Lake (Santa Rosa and Ukiah map sheets). The lake, it is believed, was formed by a lava flow damming pre-existing stream valleys. Mt. Konocti (upper left), composed of Pleistocene dacite and andesite, rises nearly 3000 feet above the lake. Beyond Mt. Konocti is alluvium-filled Big Valley. The hills west of Big Valley and along the north shore of Clear Lake are principally composed of rocks of the Franciscan Formation. Borax Lake (dark patch, right center) was the first commercial source of borax in California. Beyond Borax Lake lies Sulphur Bank Point, famous for mercury and sulphur production. The plain in the foreground is formed by sediments of the Cache Formation, capped by basalt, dacite, and obsidian, and bordered by alluvium. Volcanic activity in this area probably continued into Recent time. *Photo by Aero Photographers, Sausalito, 1959*

LOCATION 1: Snows Lake Vineyard, looking east toward Lower Lake

LOCATION 2: Snows Lake Vineyard, looking east toward Excelsior Valley

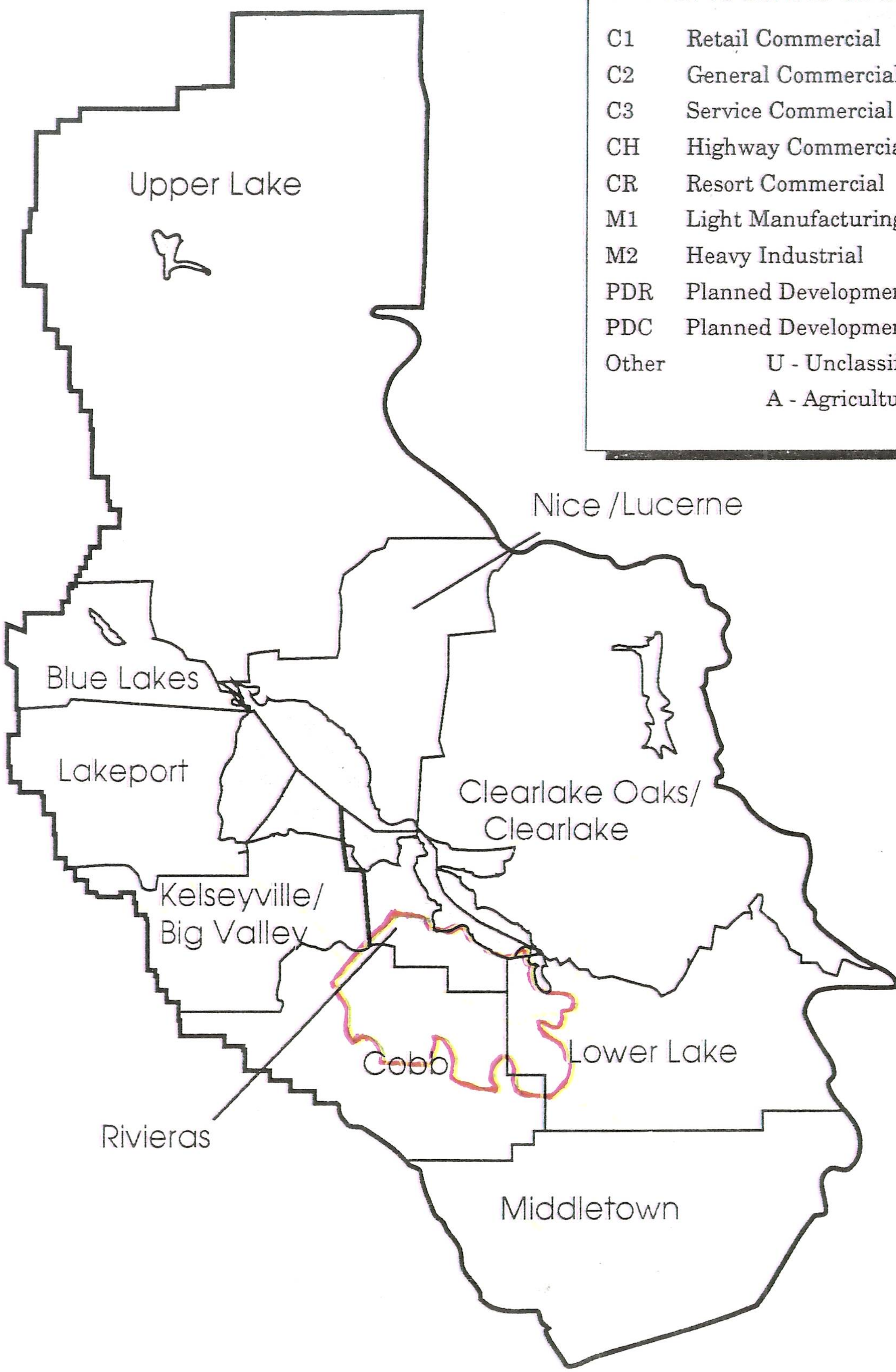
LOCATION 3: Snows Lake Vineyard, looking south toward Copsey Creek

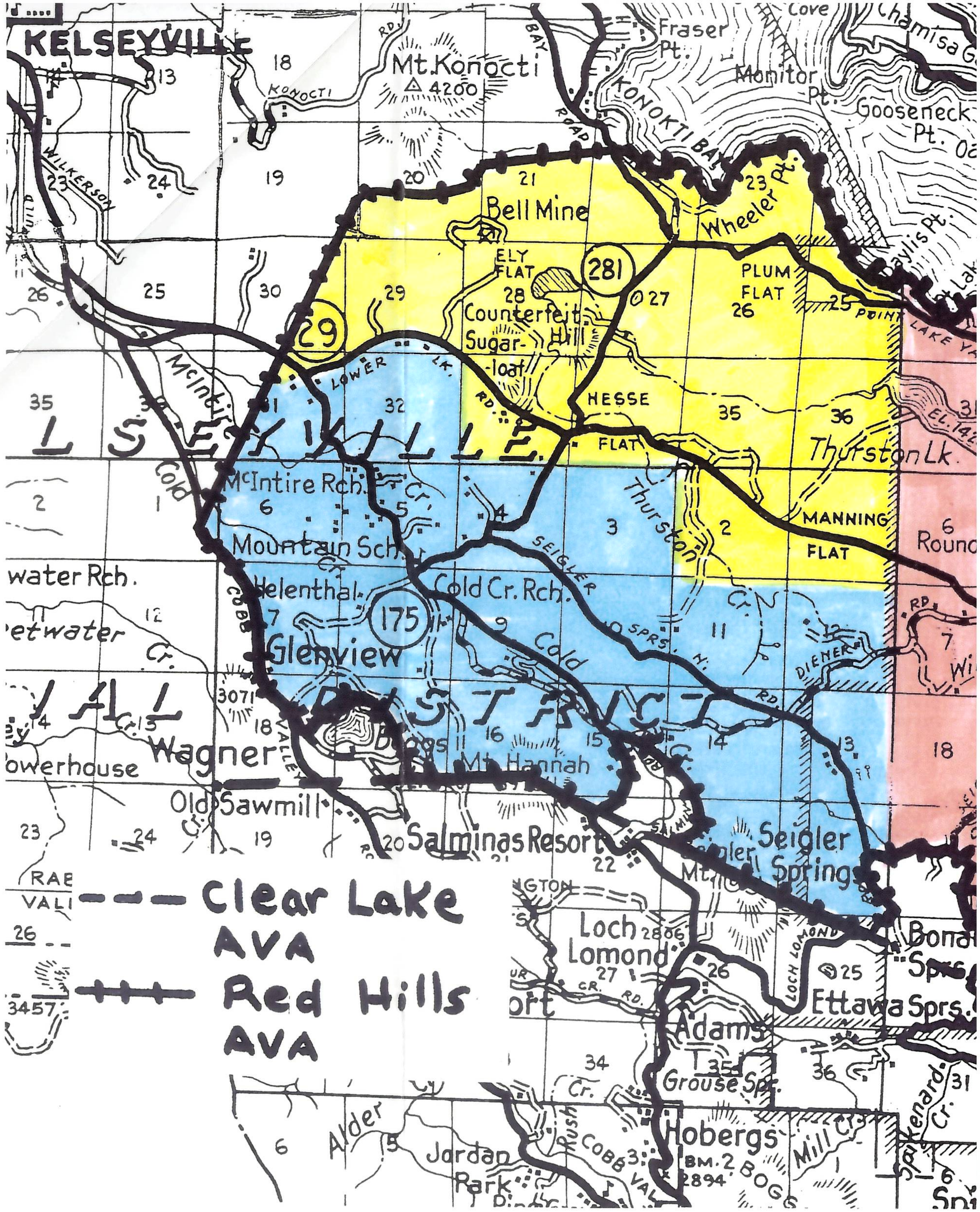
LOCATION 4: Snows Lake Vineyard, looking west toward Seigler Mtn.

COUNTYWIDE COMMUNITY PLANNING AREAS

KEY TO ZONING CLASSIFICATION

C1	Retail Commercial
C2	General Commercial
C3	Service Commercial
CH	Highway Commercial
CR	Resort Commercial
M1	Light Manufacturing
M2	Heavy Industrial
PDR	Planned Development Residential
PDC	Planned Development Commercial
Other	U - Unclassified
	A - Agricultural




KELSEYVILLE
Mt. Konocti
4200
Konokti Bay
Fraser Pt.
Monitor Pt.
Gooseneck Pt.
Wheeler Pt.
Bell Mine
Ely Flat
Counterfeit Hill
Sugar-loaf
Plum Flat
Hesse Flat
Thurston Lk.
Manning Flat
McIntire Rch.
Mountain Sch.
Helenthal
Cold Cr. Rch.
Glenview
Boggs Mt.
Hannah
Seigler Springs
Seigler Mt.
Salminas Resort
Wagner
Old Sawmill
Powerhouse
Loch Lomond
Adams
Grouse Spr.
Hobergs
Ettawa Sprs.
Jordan Park
Alder Cr.
Kelseyville District
281
29
175
--- Clear Lake AVA
+++ Red Hills AVA

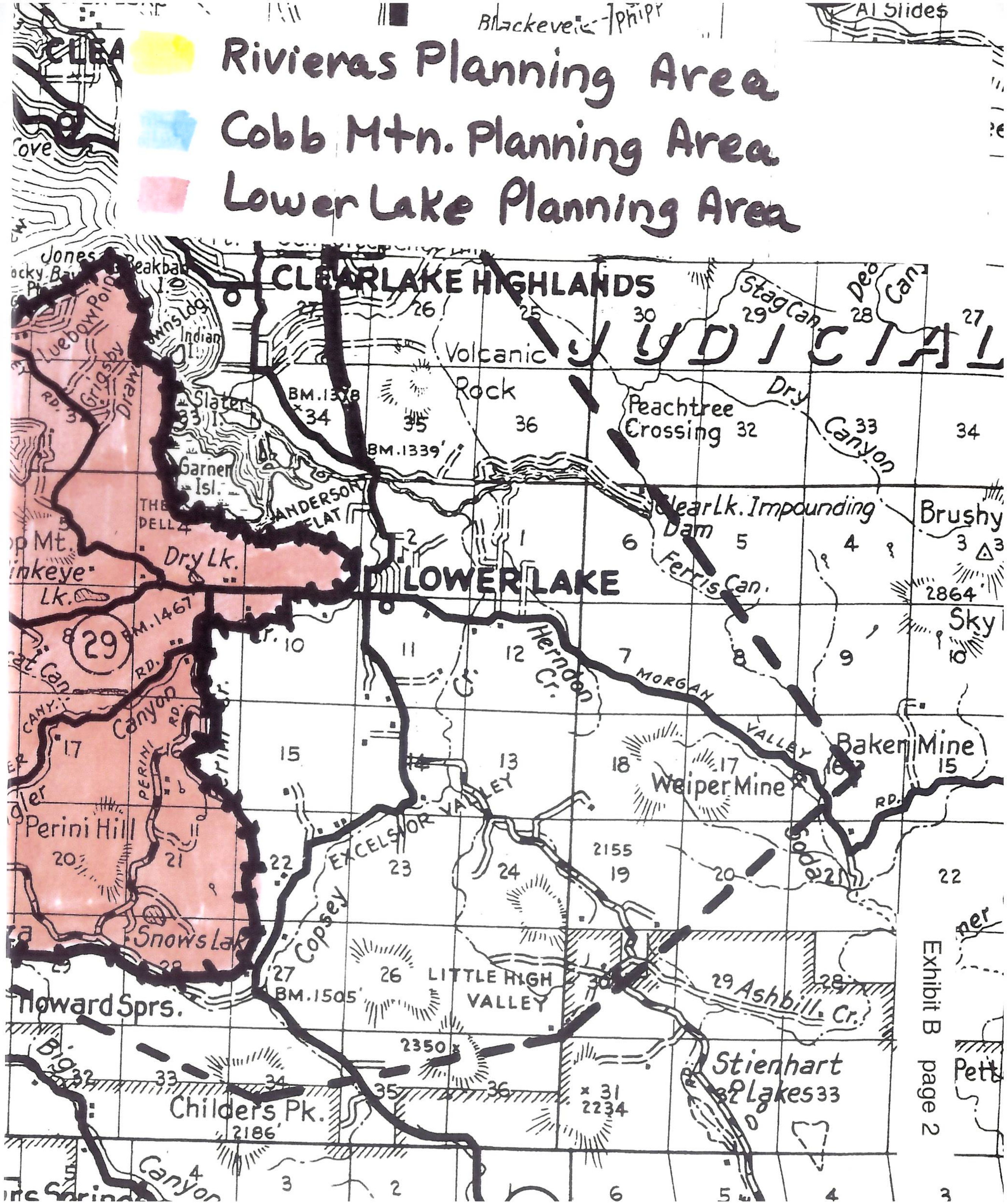
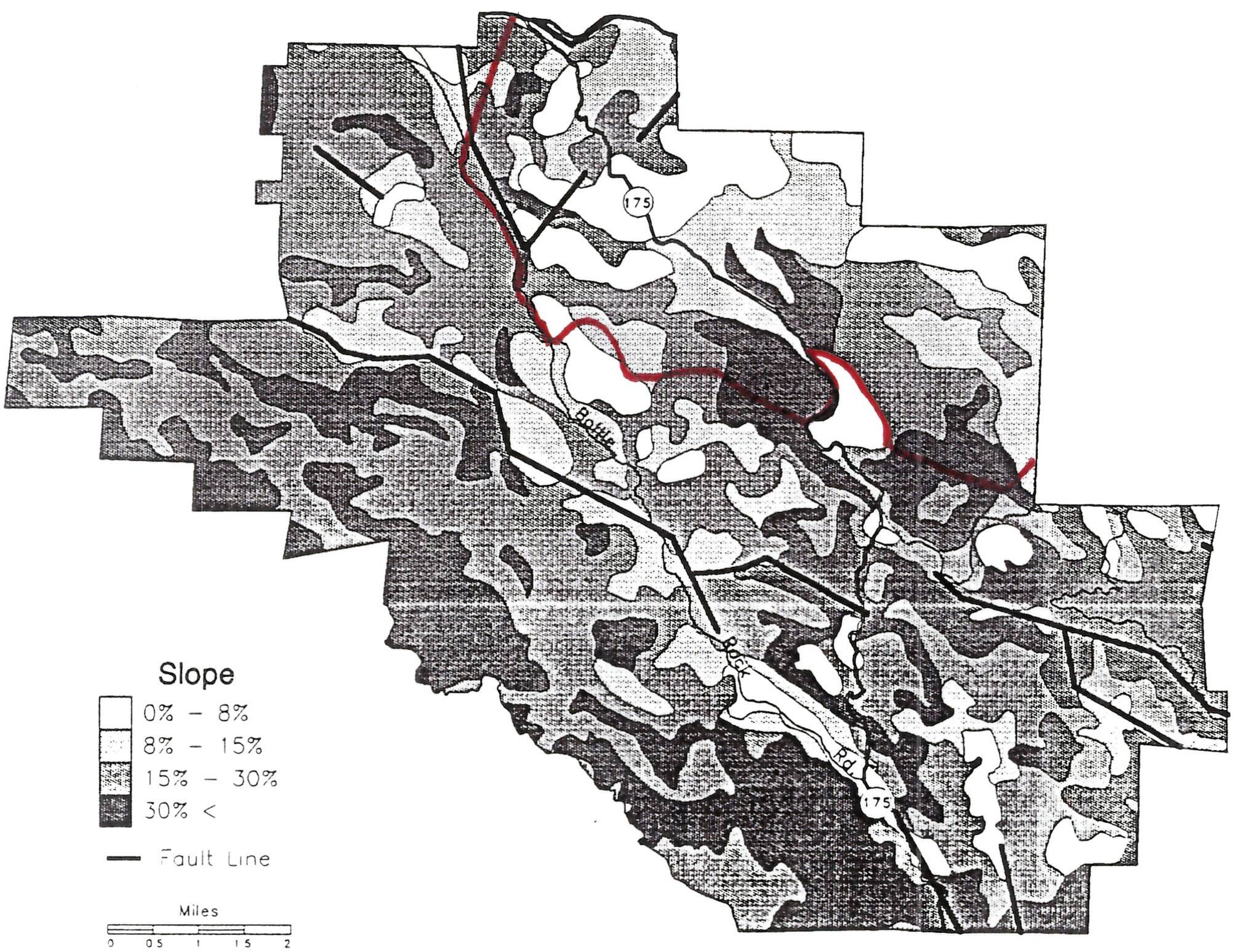


Exhibit B page 2

FIGURE 3

Slope and Fault Characteristics

Cobb Mountain Area Plan



LOCATION 5: Snows Lake Vineyard, red soil at north edge of Snows Lake

LOCATION 5: Snows Lake Vineyard, red soil at west edge of Snows Lake

LOCATION 6: Rolling Knolls Vineyard, looking east toward Lower Lake

LOCATION 6: Rolling Knolls Vineyard, showing red soil, rockpile

LOCATION 7:
Red soil visible
at quarry

LOCATION 8: Red Hills Vineyard

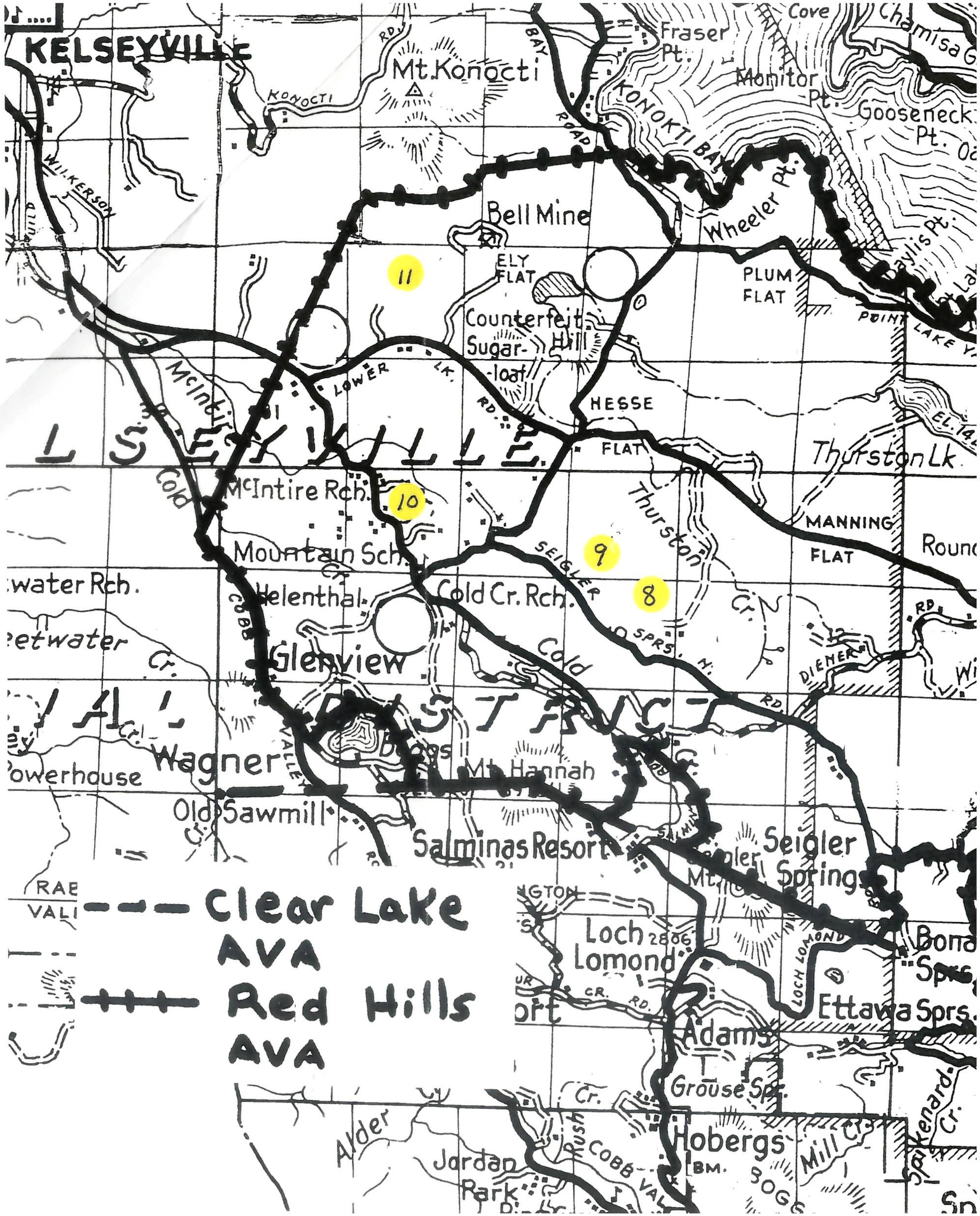
LOCATION 9: Amber Knolls Vineyard, rockpile

LOCATION 9: Amber Knolls Vineyard

LOCATION 9: Amber Knolls Vineyard

LOCATION 10: Beringer Blass Wine Estates

LOCATION 11: Planned vineyard site showing red soil, Mt. Konocti flank



KELSEYVILLE
Mt.Konocti
Fraser Pt.
Monitor Pt.
Gooseneck Pt.
KONOKTI BAY
Wheeler Pt.
Bell Mine
ELY FLAT
PLUM FLAT
Counterfeit Hill
Sugar-loaf
LOWER LK. RD.
HESSE FLAT
Thurston Lk
MANNING FLAT
McIntire Rch.
Mountain Sch.
Helenthal
Cold Cr. Rch.
SEIGLER
Thurston Cr.
Glenview
Cold Cr.
Wagner
Powerhouse
Old Sawmill
Mt. Hannah
Salminas Resort
Seigler Springs
Loch Lomond
Ettawa Sprs.
Adams
Grouse Sp.
Hobergs
Mill Cr.
Jordan Park
Alder
11
10
9
8
Clear Lake AVA
Red Hills AVA

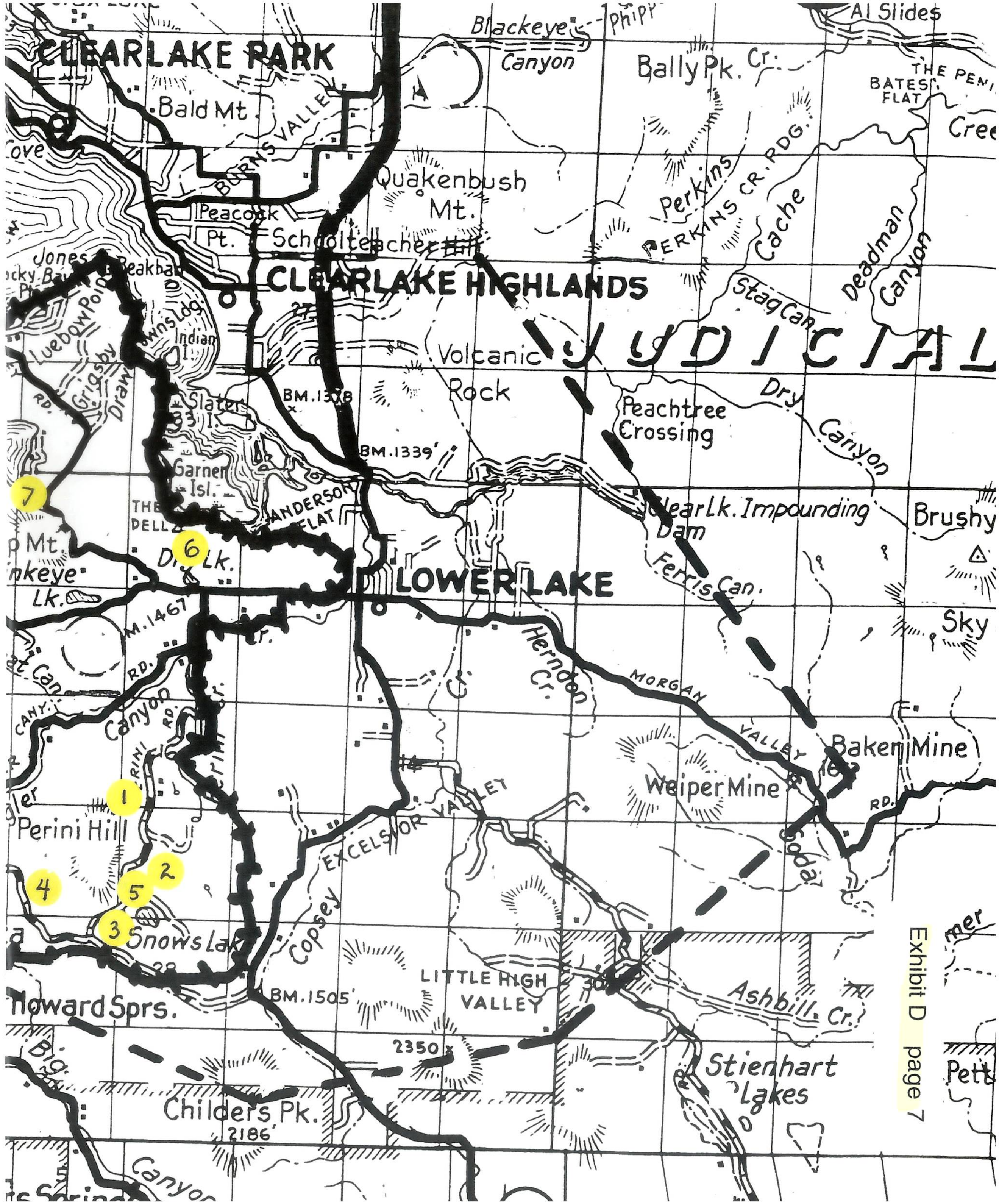


Exhibit D page 7

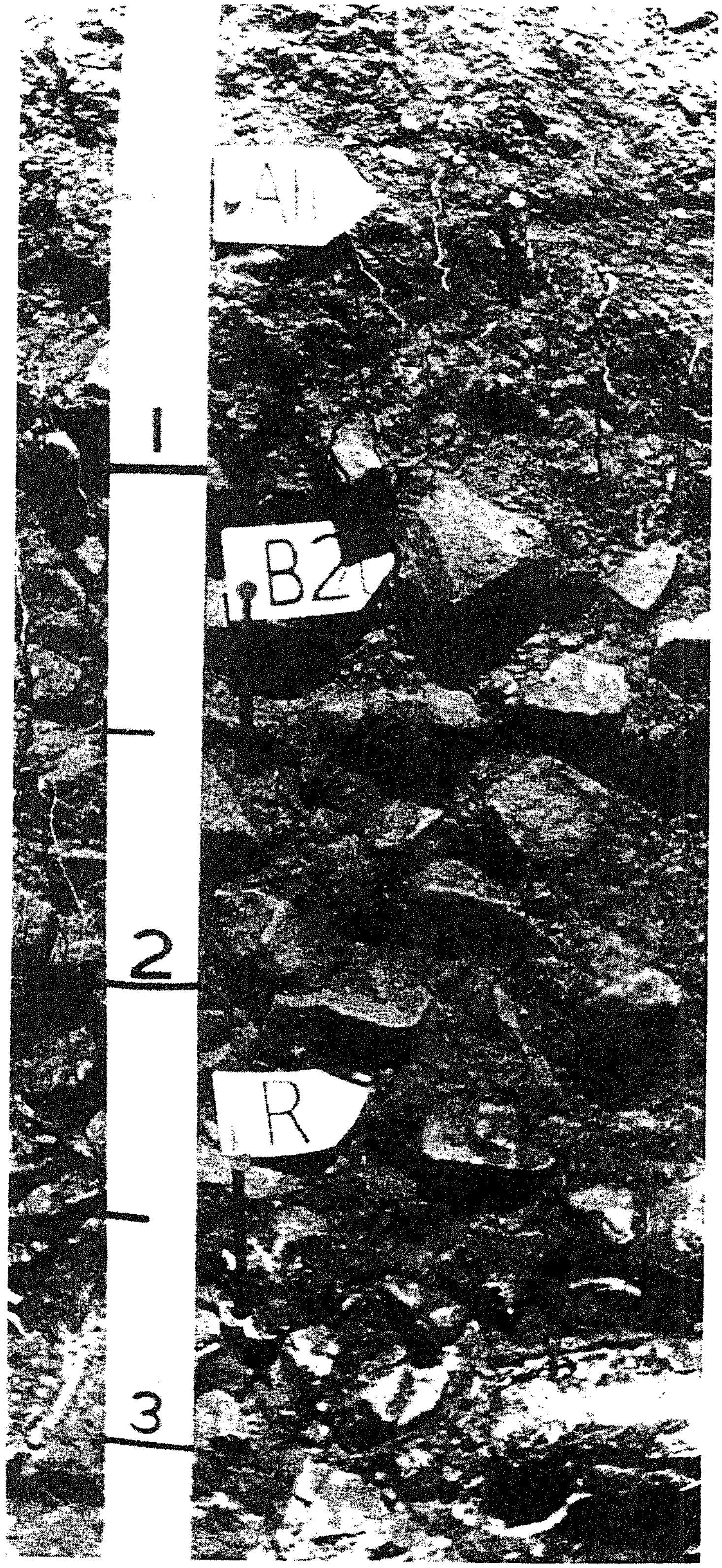
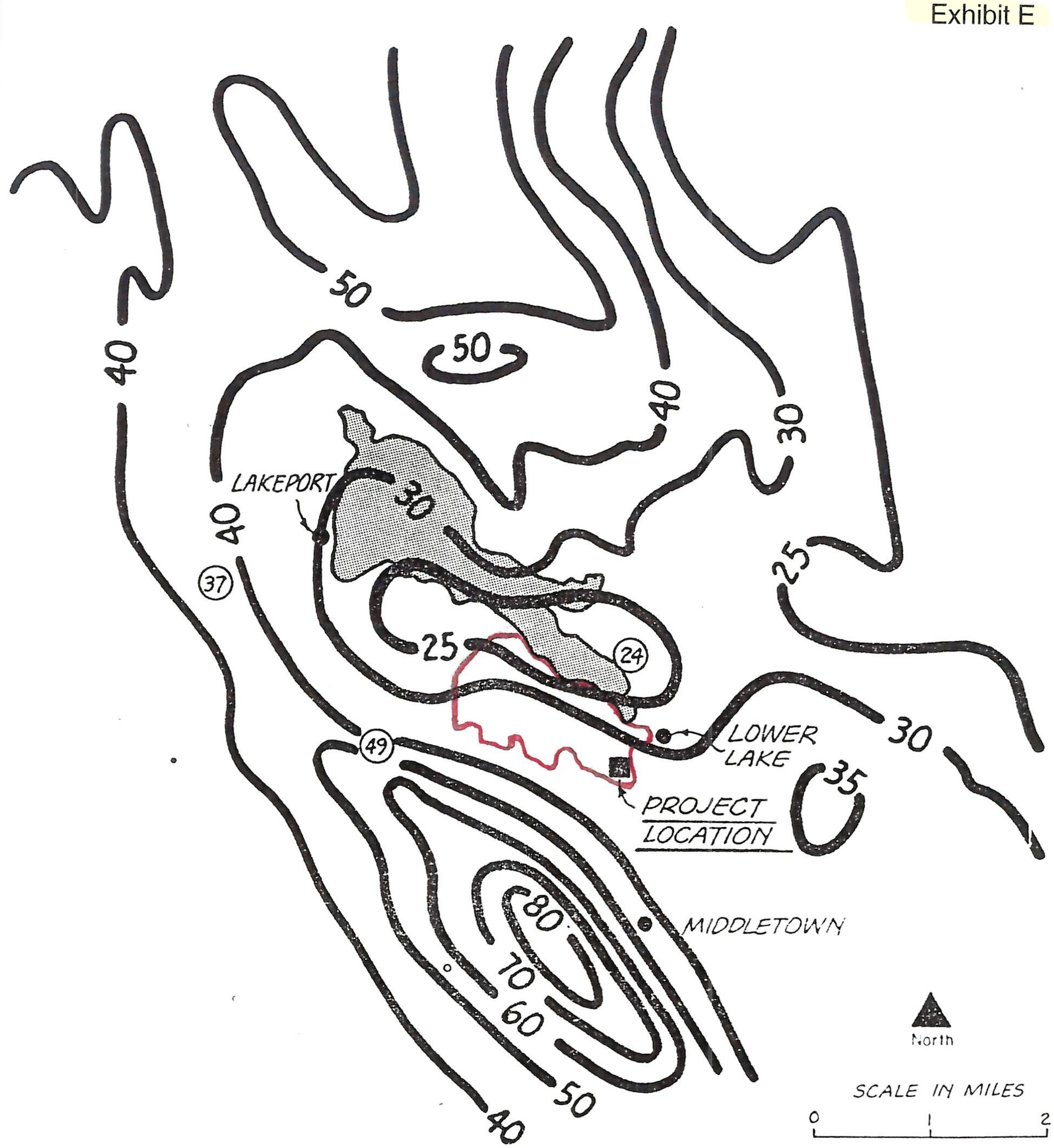


Figure 6.—Profile of a Konocti cobbly loam in an area of Benridge-Konocti association, 30 to 50 percent slopes.

Exhibit E



EXPLANATION

(37) Location of a rain gauge station and measured annual precipitation in inches

MEAN ANNUAL PRECIPITATION IN VICINITY OF PROJECT AREA

ROBBINS-PERINI HILL GEOTHERMAL EXPLORATORY PROJECT AREA

FIGURE 5.1-1

3,501 to 4,000 degree-days; and V, 4,001 or more degree-days. Some acteristics of the climatic regions in California and their adaptation nportant wine-producing localities follow. For further information on location of the different climatic regions in California see figure 12. ical and potential wine producing locations and their heat summation egree-days for California along with a few well-known foreign areas hown in table 3.

TABLE 3
HEAT SUMMATION AS DEGREE-DAYS ABOVE 50° F. FOR THE PERIOD APRIL 1 TO OCTOBER 31 AT VARIOUS COUNTY LOCATIONS IN CALIFORNIA AND A FEW FOREIGN LOCATIONS

Station and ounty or country	*Heat summation*	*Station and county or country*	*Heat summation*
Climatic Region I locations			
, Germany	1700 *	Woodside, San Mateo	2320
enheim, Germany	1790 *	Nevada City, Nevada	2320
scomb, Humboldt	1810	Santa Cruz, Santa Cruz	2320
ıs, France	1820 *	Gonzales, Monterey	2350
poc, Santa Barbara	1970	Hegglalya, Hungary	2360 †
n, Oregon	2030	Hayward, Alameda	2370
tchpec, Trinity	2080	Betteravia, Santa Barbara	2370
sonville, Santa Cruz	2090	Peachland, Sonoma	2380
ıy Doon, Santa Cruz	2140	Ben Lomond, Santa Cruz	2390
pbell, Santa Clara	2160	Bordeaux, France	2390 *
ıawarra, Australia	2170 W	Geneva, New York	2400
s, Santa Cruz	2190	Cuyamaca, San Diego	2410
;hts, Santa Clara	2220	Anderson Valley High School, Mendocino	2400
burg, Oregon	2220	Erie, Pennsylvania	2450
‹sburg, Humboldt	2230	Santa Maria, Santa Barbara	2490
ilde, Riverside	2240	El Gavlin Vd., San Benito	2480
:va, Switzerland	2260 N		
ne, France	2300 *		
Climatic Region II locations			
its, Mendocino	2520	Grass Valley, Nevada	2830
and, New Zealand	2540 N	Crocket, Contra Costa	2840
ı Clara, Santa Clara	2550	Ankara, Turkey	2840 N
verville, Trinity	2550	Atascadero, San Luis Obispo	2870
yside, Washington	2570	Redwood City, San Mateo	2870
:sa, Russia	2580 *	Soledad, Monterey	2880 ‡
pest, Hungary	2570 N	Napa, Napa	2880
Alto, San Mateo	2590		

TABLE 3 (*Continued*)

Station and county or country	*Heat summation*	*Station and county or country*	*Heat summation*
Yakima, Washington	2600	Santa Barbara, Santa Barbara	2820
San Luis Obispo, San Luis Obispo	2620	Los Gatos, Santa Clara	2880
Gilroy, Santa Clara	2630	San Mateo, San Mateo	2880
Sebastapol, Sonoma	2630	Hollister, San Benito	2890
Grants Pass, Oregon	2680	Monte Rosso Vd., Sonoma	2900
Covelo, Mendocino	2710	Asti, Italy	2930 †
Santiago, Chile	2710 N	Kelseyville, Lake	2930
Hulville, Sonoma	2720	Santa Rosa, Sonoma	2950
Petaluma, Sonoma	2740	Sonoma, Sonoma	2950
Dyerville, Humboldt	2750	Bucharest, Romania	2960 N
Melbourne, Australia	2750 N	Placerville, El Dorado	2980
San Jose, Santa Clara	2760	Novorossisk, Russia	2990 *
Climatic Region III locations			
Oakville, Napa	3100 ‡	Milan, Italy	3310 N
Ukiah, Mendocino	3100	Pinnacles, San Benito	3330
Upper Lake, Lake	3100	Cuyama, Santa Barbara	3340
Paso Robles, San Luis Obispo	3100	Santa Ana, Orange	3360
		Tibilis, Russia	3370 *
Calistoga, Napa	3150	Jamestown, Tuolumne	3400
King City, Monterey	3150	Camino, El Dorado	3400
Hopland, Mendocino	3150 ‡	Queretaro, Mexico	3400 ++
Astrakhan, Russia	3160 *	Mokelumne Hill, Calaveras	3400
St. Helena, Napa	3170	Livermore, Alameda	3400
Santa Margarita, San Luis Obispo	3180	Potter Valley, Mendocino	3420
Healdsburg, Sonoma	3190	Cloverdale, Sonoma	3430
Poway, San Diego	3220	Ramona, San Diego	3470
Clear Lake Park, Lake	3260	Mandeville Island, San Joaquin	3480
North Fork, Madera	3260		
Hamadan, Iran	3280 D		
Climatic Region IV locations			
Martinez, Contra Costa	3500	Gallo Vd., Merced	3740
Escondido, San Diego	3510	Nacimento, San Luis Obispo	3740
Upland, San Bernardino	3520	Davis, Yolo	3780
Suisun, Solano	3530	Vacaville, Solano	3780
Florence, Italy	3530 N		

Exhibit F

Exhibit G page 1

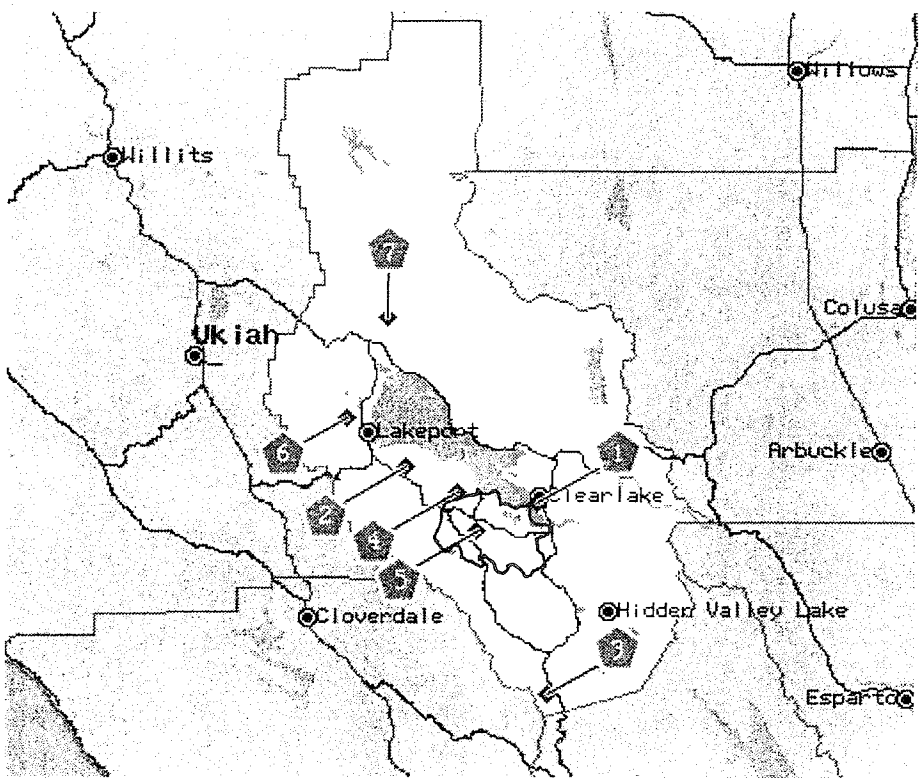
UNIVERSITY OF CALIFORNIA
STATEWIDE INTEGRATED PEST MANAGEMENT PROJECT

California PestCast Stations

Lake County Pear and Grape Network

PestCast Research

1. Clearlake
2. Kelseyville
3. Middletown
4. Mt. Konocti
5. Red Hills
6. Scotts Valley
7. Upper Lake



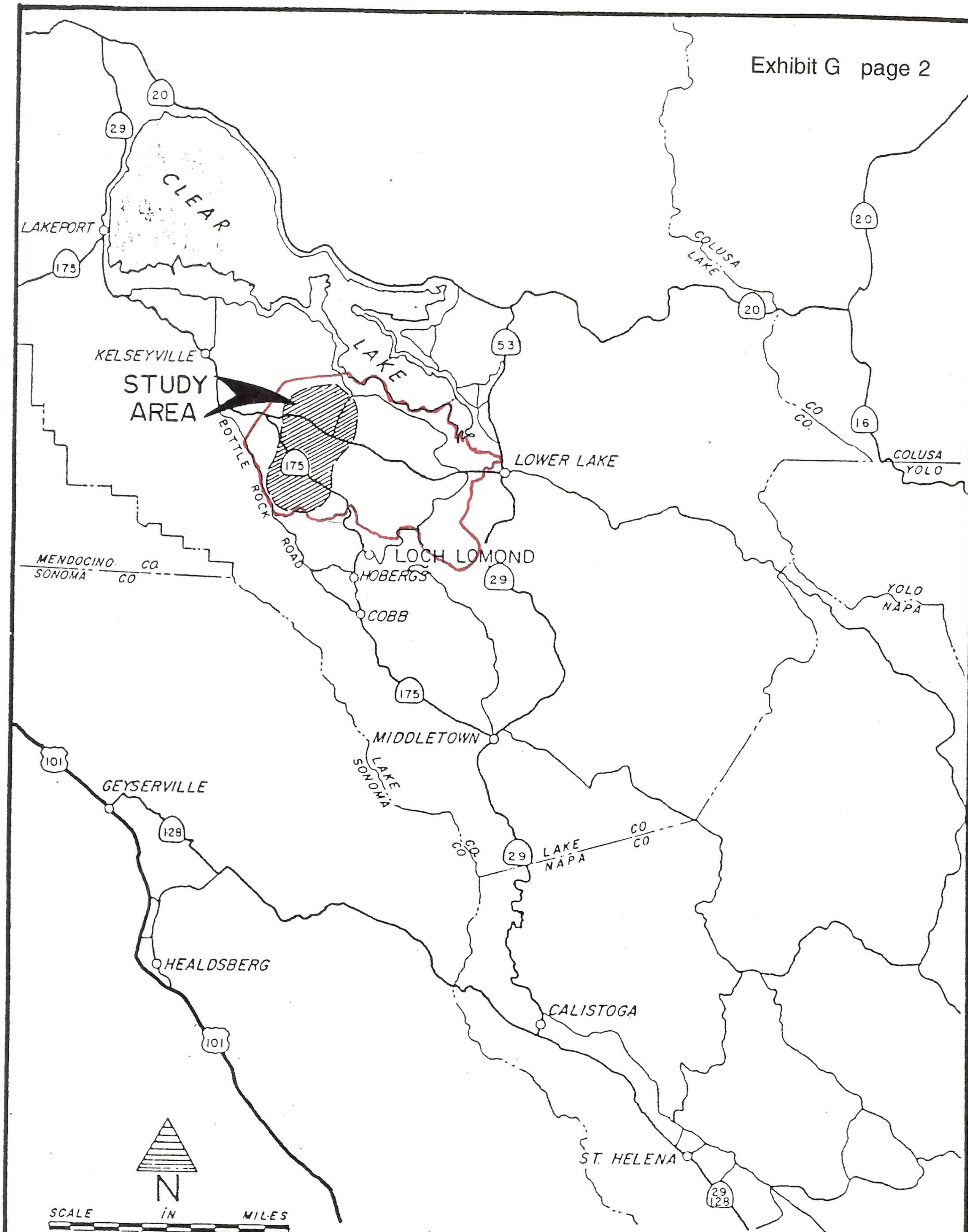
Legend	
Networks and Stations	**Map**
Automatic (daily, current data)	County
TouchTone (daily, current data)	Water
PestCast (daily & hourly, current data)	Expressway
Climate (daily, at least 3-6 months old)	Highway
	Connector

UC IPM HOME | HELP DESK | SEARCH

ABOUT | MANAGE PESTS | PESTICIDES | RESOURCES | FUNDED PROJECTS | WHAT'S NEW?

Acknowledgments
Statewide IPM Project, University of California, Division of Agriculture and Natural Resources.

WEATHER/SITES/pcnetlake.html revised: February 24, 1999
Please e-mail your comments to: ipmig@ucdavis.edu ■ Sorry we're unable to answer personal questions.
Statewide IPM Project, University of California, One Shields Avenue, Davis, CA 95616-8621



RED HILLS GEOTHERMAL PROSPECT
PROJECT LOCATION MAP

FIGURE 2

O K I 6 - I I H L S (2)

TEL: 800-400-1353
FAX: 541-271-1609
www.csa-compliance.com

CSA
COMPLIANCE SERVICE of AMERICA, LLC

POST OFFICE BOX 43
GARDINER, OR 97441
csa@csa-compliance.com

October 8, 2001

Ms. Nancy Sutton
Regulatory Specialist
Bureau of Alcohol, Tobacco and Firearms
221 Main Street, 11th Floor
San Francisco, CA 94105

VIA FEDERAL EXPRESS
(415) 744-5192

Re: Red Hills Viticultural Area Information Request

Dear Nancy:

Enclosed are the following in response to your information request of September 27, 2001:

1. Copy of a page from *DeLorme's Norther California Atlas & Gazetteer* showing a map containing Red Hills Road with the name in plural

2. Copy of a map from the *Lake County Travel Atlas Guide* showing Red Hills Road with the name in plural

3. Copy of the Rand McNalley Napa/Lake County California map showing Red Hills Road with the name in plural

4. Copy of page 140 from the Lake County 2000-2001 Telephone Directory showing a listing for Red Hills Country Day School at 8085 Red Hills Road, Kelseyville

5. Copy of the Scenic Resources section of Lake County's Cobb Mountain Area Plan, showing references to Red Hills Road with the name in plural

6. Replacement pages 28 through 30 of the petition showing a revised boundary description, eliminating references to the Clear Lake AVA boundary, and using only points on the Red Hills boundary. Paragraphs 9 through 13 have been replaced with new paragraphs 9 through 16, and the subsequent paragraphs have been renumbered.

7. Copies of the Clearlake Highlands and Kelseyville USGS maps showing all the boundary lines traversing these maps (very slightly modified in the area between Mt. Hannah and Boggs Lake to match the new description)

I have spoken with Mark Lockhart, Agricultural Commissioner for Lake County, about more accurate acreage figures. His best figure currently is 2,500 acres of winegrapes in the proposed area. He will be calculating a new figure in connection with his crop report due April 1, 2002 and plans to have revised data available in early February. If you need a more accurate figure than 2,500, can you wait until February, or do you need me to hurry him up?

I have my Lake County contacts working on the vineyard map. I will forward it to you when ready.

Cordially,

Sara Schorske

Encl.

Boundaries

The proposed Red Hills Viticultural Area is located entirely within the Clear Lake viticultural area in Lake County, California, south of Clear Lake, between Lower Lake and Kelseyville. It is bounded on the east by the ridges overlooking Excelsior Valley; on the west by foothills of Mt. Konocti which separate the proposed area from Big Valley; on the north by Anderson Marsh, the shores of Clear Lake, the higher slopes of Mt. Konocti, and the distinct community of Soda Bay.

Boundaries are found on five U.S.G.S. 7.5' series topographic maps, the Kelseyville (1959, photorevised 1975) Quadrangle, Clearlake Highlands (1958, photorevised 1975) Quadrangle, Lower Lake (1993) Quadrangle, and Whispering Pines (1958, photoinspected 1975) Quadrangle.

The beginning point is the intersection of the section line between Sections 3 and 4, T12N, R7W with the shoreline of Clear Lake, on the Clearlake Highlands Quadrangle.

1. From the beginning point, follow the section line between Sections 3 and 4, T12N, R7W south to its intersection with the 1400 foot contour line.

2. Follow the 1400 foot contour line in a generally easterly and southerly direction onto the Lower Lake Quadrangle and then back onto the Clearlake Highlands Quadrangle, to its intersection with Seigler Canyon Creek, in Section 10, T12N, R7W.

3. Follow Seigler Canyon Creek westerly to its confluence with Perini Creek.

4. Follow Perini Creek southerly to its intersection with the 1800 foot contour line in Section 16, T12N, R7W.

5. Follow the 1800 foot contour line southerly, crossing from the Clearlake Highlands Quadrangle to the Whispering Pines Quadrangle, to its point of intersection with Copsey Creek.

6. Follow Copsey Creek westerly to its headwaters in Section 29, T12N, R7W.

7. Proceed westerly in a straight line to the headwaters of Bad Creek, and then due west in a straight line a short distance to Big Canyon Road.

8. Follow Big Canyon Road northerly, to its intersection with Loch Lomond Road in Section 19, T12N, R7W on the Clearlake Highlands Quadrangle.

9. Follow Loch Lomond Road westerly and then southerly to its first intersection with the 2640 foot elevation line in Section 25, T12N, R8W on the Whispering Pines Quadrangle.

10. Proceed northwesterly in a straight line to Seigler Mountain, elevation 3692.

11. Continue northwesterly along the same line to its intersection with Salmina Road in Section 23, T12N, R8W on the Clearlake Highlands Quadrangle.

12. Follow Salmina Road northerly to its intersection with Highway 175.

13. Follow Highway 175 southerly to its intersection with the section line between Sections 15 and 22, T12N, R8W, on the Clearlake Highlands Quadrangle.

14. Proceed northwesterly in a straight line to Mt. Hannah, elevation 3978.

15. Proceed southwesterly in a straight line to the point where the 3000 foot elevation line intersects the section line between Sections 16 and 17 T12N, R8W, on the Kelseyville Quadrangle.

16. Continue southwesterly along the same line to its intersection with the 2800 foot contour line which circles Boggs Lake in Section 17, T12N, R8W.

17. Follow the 2800 foot contour line northerly, westerly, and southerly, around Boggs Lake, to its intersection with Harrington Flat Road in Section 18, T12N, R8W.

18. Follow Harrington Flat Road northerly to its intersection with Bottle Rock Road.

19. Follow Bottle Rock Road northerly to its intersection with an unnamed unimproved road, just inside Section 1, T12N, R9W.

20. Follow the unimproved road northerly to Boundary Marker 2080.

21. Proceed northeasterly in a straight line to Mt. Olive, a peak of elevation 2485 in Section 31, T13N, R8W.

22. Proceed northeasterly in a straight line to an unnamed peak of elevation 2295 in Section 30, T13N, R8W.

23. Proceed northeasterly in a straight line to the intersection of the 2600 foot contour line with the section line between Sections 19 and 20, T13N, R8W.

24. Follow the 2600 foot contour line easterly to its intersection with an unnamed stream near the section line between Sections 20 and 21, T13N, R8W.

25. Proceed easterly in a straight line to the intersection of Konocti Bay Road and Soda Bay Road in Section 22, T13N, R8W, on the Clearlake Highlands Quadrangle.

26. Proceed due east to the shore of Clear Lake.

27. Proceed southeasterly along the shoreline of Clear Lake to the point of beginning.

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FAX: 541-271-1609
www.csa-compliance.com

POST OFFICE BOX 43
GARDINER, OR 97441
csa@csa-compliance.com

COMPLIANCE SERVICE of AMERICA, INC.

TO: Nancy Sutton ~ TTB
FAX: 707-773-1415
FROM: Sara Schorske
RE: Reply to information request re rebuttal to comment letter
DATE: May 5, 2003 **# OF PAGES:** 18

The publication date of the Red Hills EIR is March 1979. A copy of the cover page with the pertinent information is attached. The publication date ("adoption date") of the Kelseyville Area Plan is August 15, 1995.

Also attached are several pages from the Lake County Soil Survey. Included are

1. Descriptions of the various Lake County soil "units" from the legend of the General Soil Map of Lake County
2. Detailed descriptions of the following general soil units referenced in the comment and rebuttal letter: Manzanita-Wappo-Forbesville, Phipps-Bally, Glenview-Bottlerock-Arrowhead, Konocti-Benridge, and Collayomi-Aiken-Whispering.
3. Specific descriptions of the following soil "series" containing more information on soil parent materials and colors: Bally-Phipps gravelly loams, Bally-Phipps complex, Benridge-Konocti association, Bottlerock-Glenview-Arrowhead complex, and Collayomi-Aiken-Whispering complex.

It's a little more than you asked for, but I think it's what you really wanted!

Please let me know if you need anything else. We're all excited to be on the home stretch finally!

ENVIRONMENTAL DATA COMPILATION

RED HILLS GEOTHERMAL PROSPECT AREA

LAKE COUNTY, CALIFORNIA

PREPARED FOR: OCCIDENTAL GEOTHERMAL, INC.
5000 Stockdale Highway
Bakersfield, CA 93309

REPUBLIC GEOTHERMAL, INC.
11823 E. Slauson Avenue, Suite 1
Santa Fe Springs, CA 90670

PREPARED BY: GENNIS AND ASSOCIATES, ENGINEERS
1812 14th Street, Sacramento, CA 95814
390 Forbes Street, Lakeport, CA 95453

Work Order No. 7901-20
March, 1979

LEGEND

NEARLY LEVEL TO STRONGLY SLOPING SOILS IN VALLEYS AND BASINS

1 Tulelake-Fluvaquentic Haplaquolls: Very deep, nearly level, very poorly drained and poorly drained silty clay loam; in lake basins and marshes

2 Cole-Clear Lake Variant-Clear Lake: Very deep, nearly level, poorly drained clay loam and clay; in basins

3 Still-Lupoyoma: Very deep, nearly level, moderately well drained and well drained loam and silt loam; on alluvial plains and flood plains

4 Talmage-Xerofluvents-Riverwash: Very deep, nearly level to moderately sloping, somewhat excessively drained very gravelly sandy loam and very gravelly loamy sand, and Riverwash; on alluvial fans and flood plains

5 Maxwell-Yorkville Variant: Very deep, nearly level to strongly sloping, somewhat poorly drained and well drained clay loam; on valley and basin floors and rims

GENTLY SLOPING TO MODERATELY STEEP SOILS ON DISSECTED ALLUVIAL TERRACES

6 Manzanita-Wappo-Forbesville: Very deep, gently sloping to moderately steep, moderately well drained and well drained loam; on dissected alluvial terraces

MODERATELY SLOPING TO VERY STEEP SOILS ON UPLIFTED, DISSECTED HILLS

7 Phipps-Bally: Very deep, gently sloping to very steep, well drained loam and gravelly sandy clay loam; on uplifted, dissected hills

MODERATELY SLOPING TO VERY STEEP SOILS ON HILLS AND MOUNTAINS

8 Millsholm-Skyhigh-Bressa: Shallow and moderately deep, moderately sloping to steep, well drained loam; on hills

9 Henneke-Okiola-Montara: Shallow, moderately sloping to steep, well drained and somewhat excessively drained very gravelly loam and clay loam; on hills and mountains

10 Maymen-Etsel: Shallow, moderately sloping to very steep, somewhat excessively drained loam and gravelly loam; on hills and mountains

11 Sanhedrin-Speaker-Kekawaka: Moderately deep to very deep, moderately sloping to very steep, well drained loam and gravelly loam; on mountains

12 Neuns-Deadwood-Sheetiron: Shallow and moderately deep, moderately steep to very steep, well drained and somewhat excessively drained gravelly loam and very gravelly sandy loam; on mountains

13 Freezeout-Yollabolly: Shallow and moderately deep, steep and very steep, well drained and excessively drained very gravelly sandy loam; on mountaintops

GENTLY SLOPING TO VERY STEEP SOILS ON VOLCANIC HILLS AND MOUNTAINS

Glenview-Bottlerock-Arrowhead: Moderately deep and very deep, gently sloping to steep, well drained very gravelly loam, extremely gravelly loam, and extremely gravelly sandy loam; on obsidian hills

15 Sobrante-Guenoc-Hambright: Shallow and moderately deep, gently sloping to very steep, well drained loam, clay loam, and very gravelly loam; on basalt hills

16 Konocti-Benridge: Moderately deep and very deep, gently sloping to very steep, well drained cobbly loam and loam; on andesite, basalt, and dacite hills and mountains

17 Collayomi-Aiken-Whispering: Moderately deep and very deep, moderately sloping to very steep, well drained very gravelly loam and loam; on andesite, basalt, and dacite mountains

Compiled 1985

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FOREST SERVICE
UNITED STATES DEPARTMENT OF INTERIOR
BUREAU OF LAND MANAGEMENT
UNIVERSITY OF CALIFORNIA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

LAKE COUNTY, CALIFORNIA

Scale 1:316,800

1 0 1 2 3 4 5 Miles

1 0 5 10 Km

Clear Lake soils typically are clay to a depth of 72 inches or more.

Of minor extent in this unit are very deep, moderately well drained Cole Variant soils and Xerofluvents.

This unit is used mainly for irrigated field crops and hay and pasture.

3. Still-Lupoyoma

Very deep, nearly level, moderately well drained and well drained loam and silt loam; on alluvial plains and flood plains

This map unit is in bottom land areas throughout the county. Most areas are cultivated. Vegetation in areas not cultivated is mainly annual grasses and oaks.

This unit makes up about 3 percent of the survey area.

Still soils are well drained. Typically, these soils are loam over somewhat stratified clay loam, loam, and extremely gravelly loamy coarse sand to a depth of 70 inches or more.

Lupoyoma soils are moderately well drained. Typically, these soils are silt loam to a depth of 84 inches or more.

Of minor extent in this unit are very deep, well drained Kelsey and Wolfcreek soils; very deep, moderately well drained Cole Variant and Kilaga Variant soils; very deep, well drained Mocho Variant and Maywood Variant soils; and moderately deep, well drained San Joaquin Variant soils.

This unit is used mainly for irrigated field crops and hay and pasture. It is also used for homesite development. Some of the most productive cropland in the county is in this unit.

4. Talmage-Xerofluvents-Riverwash

Very deep, nearly level to moderately sloping, somewhat excessively drained very gravelly sandy loam and very gravelly loamy sand, and Riverwash; on alluvial fans and flood plains

This map unit is in bottom land areas near streams and creeks throughout the county. Vegetation in areas not cultivated is mainly annual grasses and scattered oaks on the Talmage soils and Xerofluvents. Vegetation on Riverwash is sparse; some grasses and shrubs grow on the sandbars and streambanks.

This unit makes up about 1 percent of the survey area.

Talmage soils typically are very gravelly sandy loam over very gravelly loam to a depth of 69 inches or more.

A reference profile of Xerofluvents is very gravelly loamy sand over very gravelly coarse sand and gravelly coarse sand to a depth of 84 inches or more.

Riverwash consists of erratically stratified layers of water deposited sand, gravel, and cobbles.

Of minor extent in this unit are very deep Still, Kelsey, and Maywood Variant soils.

This unit is used mainly for hay and pasture and as wildlife habitat.

5. Maxwell-Yorkville Variant

Very deep, nearly level to strongly sloping, somewhat poorly drained and well drained clay loam; on valley and basin floors and rims

This map unit is adjacent to serpentinitic uplands, mainly in the southern part of the county. Vegetation is mainly annual grasses and forbs.

This unit makes up about 1 percent of the survey area.

Maxwell soils typically are clay loam over clay to a depth of 84 inches or more.

Yorkville Variant soils typically are clay loam over sandy clay loam and clay to a depth of 71 inches or more.

This unit is used mainly for hay and pasture.

Gently sloping to moderately steep soils on dissected alluvial terraces

The soils in this group are in the lower positions on the landscape. Slopes range from 2 to 25 percent. Elevation ranges from 1,350 to 1,650 feet. The average annual precipitation is 25 to 35 inches, and the average annual temperature is 55 to 59 degrees F. The frost-free season is 160 to 205 days.

These soils are very deep and are well drained and moderately well drained. They formed in old alluvium derived from mixed sources. Vegetation in areas not cultivated is mainly oaks, annual grasses, and shrubs.

This group is used mainly for crop production, homesite development, hay and pasture, and livestock grazing.

One map unit is in this group. It makes up about 1 percent of the survey area.

6. Manzanita-Wappo-Forbesville

Very deep, gently sloping to moderately steep, moderately well drained and well drained loam; on dissected alluvial terraces

This map unit is in parts of Big Valley and Scotts Valley and near Upper Lake. Much of the city of Lakeport is in this map unit. Vegetation in areas not cultivated is mainly oaks, annual grasses, and shrubs.

This unit makes up about 1 percent of the survey area.

Manzanita soils typically are loam over clay loam in the upper part. Below this is clay over gravelly clay to a depth of 76 inches or more.

Wappo soils typically are loam over clay in the upper part. Below this is clay loam to a depth of 63 inches or more.

Forbesville soils typically are loam over clay in the upper part. Below this is very gravelly clay to a depth of 70 inches or more.

Of minor extent in this unit are soils that have more than 35 percent rock fragments in the profile or are cooler, very deep Wappo Variant soils, and moderately deep Asbill soils.

This unit is used mainly for walnuts and wine grapes, homesite development, hay and pasture, and livestock grazing.

Moderately sloping to very steep soils on uplifted, dissected hills

The soils in this group are in intermediate positions on the landscape. Slope ranges from 2 to 75 percent. Elevation ranges from about 1,100 feet to 2,500 feet. The average annual precipitation is 25 to 35 inches, and the average annual temperature is 55 to 59 degrees F. The frost-free season is 160 to 200 days.

These soils are very deep and well drained. They formed in semiconsolidated uplifted sediment of the Cache Formation. Vegetation is dominantly brush, oak, and annual grasses.

These soils are used mainly for livestock grazing, wildlife habitat, and watershed.

One map unit is in this group. It makes up about 4 percent of the survey area.

7. Phipps-Bally

Very deep, gently sloping to very steep, well drained loam and gravelly sandy clay loam; on uplifted, dissected hills

This map unit occupies an area east of Clearlake Oaks and Clearlake Highlands. Vegetation is mainly brush, oaks, and annual grasses.

This unit makes up about 4 percent of the survey area.

Phipps soils typically are loam over gravelly clay loam in the upper part. Below this is gravelly sandy clay loam over very gravelly sandy clay loam. Depth to semiconsolidated sediment is 75 inches or more.

Bally soils typically are gravelly sandy clay loam over very gravelly sandy clay loam in the upper part. The lower part is very gravelly sandy clay. Depth to semiconsolidated sediment is 65 inches or more.

Of minor extent in this unit are soils that have less clay in the profile than do the major soils, very deep Forbesville soils, moderately deep Asbill soils, and Badland.

This map unit is used mainly for livestock grazing, wildlife habitat, and watershed.

Moderately sloping to very steep soils on hills and mountains

The soils in this group are dominantly on the intermediate and upper positions on the landscape. Slope ranges from 5 to 75 percent. Elevation ranges from about 640 feet in the southern part of the county to 7,050 feet on Snow Mountain. The average annual precipitation is 25 to 70 inches, and the average annual temperature is 43 to 60 degrees F. The frost-free season is 90 to 205 days.

The soils are shallow to very deep and are well drained to excessively drained. They formed in residuum derived from sedimentary, metasedimentary, or serpentinitic rock. Vegetation is mainly annual grasses and oak or brush on hills and at the lower elevations of the mountains and is conifer forest at the intermediate and upper elevations of the mountains.

This group is used mainly for livestock grazing, timber production, wildlife habitat, and watershed. It is also used for homesite development and recreation.

Six map units are in this group. They make up about 77 percent of the survey area.

8. Millsholm-Skyhigh-Bressa

Shallow and moderately deep, moderately sloping to steep, well drained loam; on hills

This map unit is mainly in the Clear Lake Basin and in the southern and eastern parts of the county. Small areas occur as glades in the Mendocino National Forest. The soils in this unit formed in material derived mainly from sandstone and shale. Vegetation is mainly annual grasses, forbs, and oak. Elevation ranges from 640 to 4,000 feet. The average annual precipitation is 25 to 60 inches, and the average annual temperature is 54 to 60 degrees F.

This unit makes up about 14 percent of the survey area.

Millsholm soils are shallow. Typically, the profile is loam over clay loam. Fractured sandstone is at a depth of 18 inches.

Skyhigh soils are moderately deep. Typically, the soils are loam in the upper part and clay loam over clay in the lower part. Fractured sandstone is at a depth of 38 inches.

Bressa soils are moderately deep. Typically, the soils are loam over clay loam. Soft, fractured sandstone is at a depth of 26 inches.

Of minor extent in this unit are deep and very deep Sleeper soils; deep Yorkville, Pomo, and Yorktree soils; shallow Maymen soils; and moderately deep Asbill, Squawrock, Hopland, and Shortyork Variant soils. Some of the minor soils in this unit are at elevations of as much as 4,500 feet, in the Mendocino National Forest, where the average annual precipitation is higher and the average annual temperature is lower than those of the major soils of this unit.

This unit is used mainly for livestock grazing, wildlife habitat, and homesite development.

9. Henneke-Okiota-Montara

Shallow, moderately sloping to steep, well drained and somewhat excessively drained very gravelly loam and clay loam; on hills and mountains

This map unit is in scattered areas throughout the survey area, but the largest areas are in the southern and eastern parts. The soils formed in material derived mainly from serpentinite and peridotite. Vegetation is

Of minor extent in this unit are deep Sanhedrin soils; very deep Bamtush soils; moderately deep Speaker, Decy, Tyson, and Marpa soils; shallow Maymen soils; and Rock outcrop.

This map unit is used mainly for timber production, wildlife habitat, and watershed.

13. Freezeout-Yollabolly

Shallow and moderately deep, steep and very steep, well drained and excessively drained very gravelly sandy loam; on mountaintops

This map unit is mainly in the Mendocino National Forest, on Goat, Hull, and Snow Mountains. The soils in this unit formed in material derived mainly from metasedimentary sandstone. Vegetation is adapted to the cold climate and is mainly conifer forest consisting of white fir on the Freezeout soils and brush on the Yollabolly soils. Elevation ranges from 5,000 to 7,050 feet. The average annual precipitation is 50 to 70 inches, most of which occurs as snowfall, and the average annual temperature is 43 to 48 degrees F.

This unit makes up about 2 percent of the survey area.

Freezeout soils are moderately deep and well drained. Typically, the soils are very gravelly sandy loam over extremely gravelly sandy loam. Hard sandstone is at a depth of 25 inches.

Yollabolly soils are shallow and excessively drained. Typically, the soils are very gravelly sandy loam over extremely gravelly loam. Hard sandstone is at a depth of 14 inches.

Of minor extent in this unit are areas of Rock outcrop; areas of debris slopes that are devoid of vegetation; and Deadwood, Neuns, and Bamtush soils at the lower elevations.

This unit is used mainly for recreation, wildlife habitat, and timber production. Among the recreational uses are hiking and bridle paths and hunting.

Gently sloping to very steep soils on volcanic hills and mountains

The soils in this group are in the intermediate and upper positions on the landscape, in the Clear Lake volcanic field. Slope ranges from 2 to 75 percent. Elevation ranges from about 800 feet south of Middletown to 4,600 feet at Cobb Mountain. The average annual precipitation is 25 to 65 inches, and the average annual temperature is 50 to 60 degrees F. The frost-free season is 120 to 205 days.

These soils are shallow to very deep and are well drained. They formed in material derived dominantly from extrusive basic igneous rock. Vegetation is dominantly brush on the hills and at the lower and intermediate positions on the mountains and is conifer forest on the upper positions.

This group is used mainly for timber production, livestock grazing, wildlife habitat, and watershed. It is also used for dryland crop production, firewood production, and homesite development. Geothermal wells are being developed in some areas.

Four map units are in this group. They make up about 11 percent of the survey area.

14. Glenview-Bottlerock-Arrowhead

Moderately deep and very deep, gently sloping to steep, well drained very gravelly loam, extremely gravelly loam, and extremely gravelly sandy loam; on obsidian hills

This map unit occurs east of Mount Konocti, in the Red Hills and Camelback Ridge areas. The soils in this unit formed in material derived mainly from obsidian. Vegetation is dominantly brush with some scattered areas of conifers. Some areas have been cleared and cultivated. Elevation ranges from 1,500 to 3,000 feet. The average annual precipitation is 30 to 50 inches, and the average annual temperature is 53 to 59 degrees F.

This map unit makes up about 1 percent of the survey area.

Glenview soils are very deep. Typically, the soils are very gravelly loam over gravelly loam in the upper part and gravelly clay loam over clay in the lower part. Fractured obsidian is at a depth of more than 65 inches.

Bottlerock soils are very deep. Typically, the soils are extremely gravelly loam over very gravelly loam in the upper part and very gravelly clay loam over very gravelly clay in the lower part. Fractured obsidian is at a depth of more than 63 inches.

Arrowhead soils are moderately deep. Typically, the soils are extremely gravelly sandy loam over gravelly sandy loam in the upper part and gravelly sandy clay loam over extremely stony clay in the lower part. Fractured obsidian is at a depth of 31 inches.

Of minor extent in this unit are soils that are similar to the major soils but that are on south-facing slopes and have a warmer average annual temperature.

This map unit is used mainly as wildlife habitat and watershed. Cleared areas are used for cultivated crops. They can be used for timber production.

15. Sobrante-Guenoc-Hambright

Shallow and moderately deep, gently sloping to very steep, well drained loam, clay loam, and very gravelly loam; on basalt hills

This map unit is mainly in the southern part of the county, near Middletown and the Spruce Grove Road area. The soils in this unit formed in material derived mainly from olivine basalt. Vegetation is mainly annual grasses and forbs, oaks, and brush with some small areas of conifers. Elevation ranges from 800 to 3,500 feet. The average annual precipitation is 25 to 50 inches, and the average annual temperature is 50 to 60 degrees F.

This unit makes up about 3 percent of the survey area.

Sobrante soils are moderately deep. Typically, the soils are loam over clay loam. Fractured olivine basalt is at a depth of 38 inches.

Guenoc soils are moderately deep. Typically, the soils are clay loam in the upper part and clay over gravelly clay in the lower part. Fractured olivine basalt is at a depth of 28 inches.

Hambright soils are shallow. Typically, the soils are very gravelly loam throughout the profile. Fractured olivine basalt is at a depth of 16 inches.

Of minor extent in this unit are very deep Neice soils, moderately deep Benridge Variant and Whispering soils, very deep Aiken and Collayomi soils, and shallow Stonyford soils.

This unit is used mainly for livestock grazing, wildlife habitat, watershed, and homesite development.

RH

16. Konocti-Benridge

Moderately deep and very deep, gently sloping to very steep, well drained cobbly loam and loam; on andesite, basalt, and dacite hills and mountains

This map unit is mainly in the area around Mount Konocti and extending southeast toward Lower Lake. Another small area is northeast of Clearlake Oaks, near Round Mountain. The soils in this unit formed in material derived mainly from andesite, basalt, dacite, and pyroclastic material. Vegetation is mainly brush. Some areas have been cleared and cultivated. Elevation ranges from 1,000 to 4,300 feet. The average annual precipitation is 25 to 40 inches, and the average annual temperature is 53 to 60 degrees F.

This unit makes up about 4 percent of the survey area.

Konocti soils are moderately deep. Typically, the soils are cobbly loam over very stony loam. Fractured dacite is at a depth of 39 inches.

Benridge soils are very deep. Typically, the soils are loam in the upper part and gravelly clay loam over clay in the lower part. Breccia is at a depth of 68 inches.

Of minor extent in this unit are very deep Sodabay soils, shallow Hambright soils, deep Konocti Variant soils, very deep Oxalis Variant soils on alluvial flats, Vitrandepts, Rock outcrop, and Cinderland.

This unit is used mainly as wildlife habitat and watershed. It is also used for cultivated crops and homesite development.

RH

17. Collayomi-Aiken-Whispering

Moderately deep and very deep, moderately sloping to very steep, well drained very gravelly loam and loam; on andesite, basalt, and dacite mountains

This map unit is mainly in the Boggs Mountain and Cobb Mountain areas. The soils in this unit formed in material derived mainly from andesite, basalt, dacite, and pyroclastic tuff. Vegetation is mainly conifer forest. Elevation ranges from 1,400 to 4,600 feet. The average annual precipitation is 35 to 65 inches, and the average annual temperature is 50 to 55 degrees F.

This unit makes up about 3 percent of the survey area.

Collayomi soils are very deep. Typically, the soils are very gravelly loam. Basalt is at a depth of more than 60 inches.

Aiken soils are very deep. Typically, the soils are loam in the upper part and clay loam over clay in the lower part. Basalt is at a depth of more than 75 inches.

Whispering soils are moderately deep. Typically, the soils are loam in the upper part and gravelly loam over very cobbly loam in the lower part. Fractured andesite is at a depth of 26 inches.

Of minor extent in this unit are shallow Kidd soils, very deep Forward Variant soils, and moderately deep Forward soils.

This unit is used mainly for timber production, wildlife habitat, and watershed. It is also used for homesite development and geothermal well development.

Broad Land Use Considerations

The soils in Lake County vary widely in their potential for major land uses. About 5 percent of the county is used for cultivated crops, mainly pears, walnuts, and wine grapes. The cropland is concentrated largely in general soil map units 2, 3, and 6. Some areas of units 1, 4, 5, and 14 are also used as cropland, mainly for dryland walnuts, specialty crops, and pasture. Seasonal flooding is a concern in units 1 and 2. Wetness caused by flooding and ponding of water is the major soil limitation, and it may result in damage to crops. Soil erosion is a serious concern in areas of unit 14 that are cultivated for crops. Measures are needed to minimize soil loss.

Map units 7, 9, 10, and 16 and parts of units 14 and 15 are dominated by brush and are used mainly as wildlife habitat and watershed. These areas make up about 40 percent of the county. Wildfire and associated soil erosion are major concerns in these areas. Small areas of soils in these map units have the potential to be converted from brush to grass. Plant production on the soils in unit 9 is limited because of inherent soil fertility problems.

About 35 percent of the county supports conifer and hardwood forests. Included within this forest land are areas that are favorable for commercial timber production and for hardwood production. Hardwood production in the county is mainly for use as fuelwood. Timber and hardwood production is high in map units 11, 12, and 17. Some areas of units 13 and 14 have moderate potential for timber production. Areas of units 6, 7, 8, and 15 can be used as a source of fuelwood. The use of heavy equipment is limited to the drier seasons on many of the soils. Steepness of slope, the hazard of soil erosion, shallow depth to bedrock, and a high content of rock fragments in the soil profile are this unit is used for septic tank absorption fields, the limitations of moderate depth and slow permeability can be minimized by increasing the size of the absorption field or by using a specially designed sewage disposal system. Buildings and roads should be designed to offset the effects of shrinking and swelling and the limited ability of the soil in this unit to support a load. The effects of shrinking and swelling can be minimized by using proper engineering designs and by backfilling with material that has low shrink-swell potential. If the soil in this unit is used as a base for roads and streets, it can be mixed with sand and gravel to increase its strength and stability.

This map unit is in capability unit IIIe-5 (15), irrigated and nonirrigated.

105—Badland. This map unit is in steep ravines and on barren dissected terrace escarpments. It formed in areas of semiconsolidated uplifted alluvial deposits derived from mixed rock sources. Active geologic erosion is extreme. Slopes are 50 to 100 percent. This unit commonly is barren; however, some areas support very sparse annual grasses or brush. Elevation is 1,100 to 2,000 feet.

Areas of this unit have severely eroded terrace slopes with "V"-shaped gullies or consist of recent slip faces on very steep or nearly vertical stream escarpments. Local relief generally ranges from 50 to 500 feet.

Included in this unit are small areas of Bally and Phipps soils. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Surface runoff is very rapid, and the hazard of erosion is severe. These actively eroding areas generally produce a high sediment yield to nearby streams.

Areas in which stability is a severe problem commonly are produced by stream channels that undercut the terrace slope. Suitable streambank protectors could be used where the cutting occurs to reduce the amount of sediment in the streams.

Revegetating these areas is difficult because of the extreme geologic erosion, steepness of slope, and the low fertility of the geologic material.

This map unit is in capability subclass VIIIe (15), nonirrigated.

106—Bally-Phipps gravelly loams, 2 to 8 percent slopes. This map unit is on uplifted, dissected hills. The vegetation is mainly brush. Elevation is 1,100 to 1,500 feet. The average annual precipitation is 25 to 35 inches, the average annual air temperature is 55 to 59 degrees F, and the average frost-free period is 160 to 200 days.

This unit is about 45 percent Bally gravelly loam and 35 percent Phipps gravelly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Talmage soils. Also included are small areas of soils that are similar to the Bally and Phipps soils but have less than 35 percent clay in the subsoil. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Bally soil is very deep and well drained. It formed in alluvium derived from mixed rock sources. Typically, the surface layer is yellowish brown gravelly loam 16 inches thick. The subsoil is yellowish brown very gravelly clay loam 31 inches thick. The substratum to a depth of 80 inches or more is brown very gravelly clay loam.

Permeability of the Bally soil is slow. Available water capacity is 5 to 7 inches. Effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is slight.

The Phipps soil is very deep and well drained. It formed in alluvium derived from mixed rock sources. Typically, the surface layer is brown gravelly loam 3 inches thick. The upper 20 inches of the subsoil is brown and pale brown gravelly clay loam, and the lower 38 inches is light yellowish brown gravelly clay.

Permeability of the Phipps soil is slow. Available water capacity is 8.0 to 9.5 inches. Effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is slight.

This unit is used mainly as wildlife habitat and watershed. It is also used for homesite development. It can be used for livestock grazing.

If this unit is used for homesite development, the main limitation is slow permeability. If the soils are used for septic tank absorption fields, the limitation of slow permeability can be minimized by increasing the size of the absorption field or by using a specially designed sewage disposal system.

The production of forage is limited by the tendency of this unit to produce woody species. If shrubs are managed to create open areas, this unit can produce a good stand of desirable grasses and forbs. Woody species should be left in drainageways to reduce erosion and provide habitat for wildlife. The characteristic plant community on this unit is mainly chamise and ceanothus. Estimates of rangeland productivity have not been made for this unit.

This map unit is in capability unit IIIs-3 (15), nonirrigated.

107—Bally-Phipps complex, 15 to 30 percent slopes. This map unit is on uplifted, dissected hills. The vegetation is mainly brush. Elevation is 1,400 to 2,500 feet. The average annual precipitation is 25 to 35 inches, the average annual air temperature is 55 to 59 degrees F, and the average frost-free period is 160 to 200 days.

This unit is about 40 percent Bally gravelly sandy clay loam and 35 percent Phipps loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Forbesville soils. Also included are small areas of Bally and Phipps soils that have slopes of more than 30 percent or less than 15 percent, soils that have a very gravelly surface layer, and soils that have a thicker dark colored surface layer and are in areas that are less subject to erosion. Included areas make up about 25 percent of the total acreage. The percentage varies from one area to another.

The Bally soil is very deep and well drained. It formed in alluvium derived from mixed rock sources. Typically, the surface layer is yellowish brown gravelly sandy clay loam 2 inches thick. The upper 8 inches of the subsoil is yellowish brown gravelly sandy clay loam, and the lower 27 inches is variegated brown and reddish yellow very gravelly sandy clay loam and very gravelly sandy clay. The substratum to a depth of 65 inches or more is variegated brown and reddish yellow very gravelly sandy clay loam. In some areas the surface layer is sandy clay loam, loam, or gravelly loam.

Permeability of the Bally soil is slow. Available water capacity is 5 to 7 inches. Effective rooting depth is 60 inches or more, but most roots do not penetrate to a depth of more than about 15 to 25 inches because of the clayey texture of the subsoil. Surface runoff is rapid, and the hazard of erosion is moderate.

The Phipps soil is very deep and well drained. It formed in alluvium derived from mixed rock sources. Typically, the surface layer is dark brown loam 6 inches thick. The subsoil is brown gravelly clay loam about 15 inches thick. The substratum to a depth of 73 inches is brown and yellowish brown gravelly and very gravelly sandy clay loam. In some areas the surface layer is sandy clay loam.

Permeability of the Phipps soil is slow. Available water capacity is 6.0 to 7.5 inches. Effective rooting depth is 60 inches or more. Surface runoff is rapid, and the hazard of erosion is severe.

This unit is used mainly as wildlife habitat and watershed. It can also be used for livestock grazing.

The production of forage is limited by the tendency of this unit to produce shrubs. If the shrubs are managed to create open areas, this unit can produce a good stand of desirable grasses and forbs. Woody species should be left in the drainageways and in the steeper areas to reduce erosion and provide habitat for wildlife. This unit should be managed to protect the soil from erosion. Loss of the surface layer results in a severe decrease in productivity and in the potential of the unit to produce plants suitable for grazing. The characteristic plant community on this unit is mainly chamise and ceanothus. Estimates of rangeland productivity have not been made for this unit.

This unit is dissected by numerous drainageways. To provide for seasonal runoff, properly designed culverts should be installed where roads cross natural drainageways. Water bars help to control erosion on roads.

This map unit is in capability unit IVs-1 (15), nonirrigated.

108—Bally-Phipps-Haploxeralfs association, 30 to 75 percent slopes. This map unit is on uplifted, dissected hills. The vegetation is mainly brush. Active geologic erosion occurs throughout this unit. Elevation is 1,400 to 2,500 feet. The average annual precipitation is 25 to 35 inches, the average annual air temperature is 55 to 59 degrees F, and the average frost-free period is 160 to 200 days.

This unit is about 35 percent Bally gravelly sandy clay loam, 20 percent Phipps loam, and 20 percent Haploxeralfs. The Bally and Phipps soils have slopes of 30 to 50 percent, and the Haploxeralfs have slopes of 50 to 75 percent. Landslips and active geologic erosion occur on the steeper slopes.

Included in this unit are small areas of Forbesville soils. Also included are small areas of Bally and Phipps soils that have slopes of less than 30 percent, soils that have a thicker dark-colored surface layer and are in areas that are less subject to erosion, and soils that are similar to the Bally soil but have been severely eroded. Included areas make up about 25 percent of the total acreage. The percentage varies from one area to another.

The Bally soil is very deep and well drained. It formed in alluvium derived from mixed rock sources. Typically, the surface layer is yellowish brown gravelly sandy clay loam 2 inches thick. The upper 8 inches of the subsoil is yellowish brown gravelly sandy clay loam, and the lower 27 inches is variegated brown and reddish yellow very gravelly sandy clay loam and very gravelly sandy clay. The substratum to a depth of 65 inches or more is variegated brown and reddish yellow very gravelly sandy clay loam. In some areas the surface layer is sandy clay loam, loam, or gravelly loam.

Permeability of the Bally soil is slow. Available water capacity is 5 to 7 inches. Effective rooting depth is 60 inches or more, but most roots do not penetrate to a depth of more than about 15 to 25 inches because of the clayey texture of the subsoil. Surface runoff is very rapid, and the hazard of erosion is severe.

The Phipps soil is very deep and well drained. It formed in alluvium derived from mixed rock sources. Typically, the surface layer is brown loam 6 inches thick. The subsoil is brown gravelly clay loam about 15 inches thick. The substratum to a depth of 60 inches or more is brown gravelly and very gravelly sandy clay loam. In some areas the surface layer is sandy clay loam.

Permeability of the Phipps soil is slow. Available water capacity is 6.0 to 7.5 inches. Effective rooting depth is 60 inches or more. Surface runoff is very rapid, and the hazard of erosion is severe.

temperature is 49 to 55 degrees F, and the average frost-free period is 120 to 180 days.

This unit is about 30 percent Bamtush gravelly loam, 30 percent Speaker gravelly loam, and 15 percent Sanhedrin gravelly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Deadwood, Kekawaka, Marpa, and Neuns soils and Rock outcrop. Also included are small areas of Bamtush, Speaker, and Sanhedrin soils that have slopes of less than 50 percent. Included areas make up about 25 percent of the total acreage. The percentage varies from one area to another.

The Bamtush soil is very deep and well drained. It formed in material weathered from sandstone. Typically, the surface is covered with a mat of partially decomposed needles, leaves, bark, and twigs 1 inch thick. The surface layer is brown gravelly loam 7 inches thick. The upper 10 inches of the subsoil is brown very gravelly loam, and the lower 46 inches is strong brown very gravelly loam.

Permeability of the Bamtush soil is moderate. Available water capacity is 5.0 to 7.5 inches. Effective rooting depth is more than 60 inches. Surface runoff is very rapid, and the hazard of erosion is severe.

The Speaker soil is moderately deep and well drained. It formed in material weathered from sandstone. Typically, the surface is covered with a mat of partially decomposed needles, leaves, and twigs 1 inch thick. The surface layer is brown gravelly loam 2 inches thick. The upper 6 inches of the subsoil is reddish yellow gravelly loam, and the lower 19 inches is reddish yellow clay loam. Soft sandstone is at a depth of 27 inches.

Permeability of the Speaker soil is moderately slow. Available water capacity is 2 to 6 inches. Effective rooting depth is 20 to 40 inches. Surface runoff is very rapid, and the hazard of erosion is severe.

The Sanhedrin soil is deep and well drained. It formed in material weathered from sandstone. Typically, the surface is covered with a mat of partially decomposed needles, leaves, bark, and twigs about 2 inches thick. The upper part of the surface layer is brown gravelly loam 4 inches thick, and the lower part is pale brown gravelly loam 4 inches thick. The upper 33 inches of the subsoil is light yellowish brown and reddish yellow gravelly loam, and the lower 16 inches is reddish yellow gravelly clay loam. Sandstone is at a depth of 57 inches.

Permeability of the Sanhedrin soil is moderately slow. Available water capacity is 4 to 8 inches. Effective rooting depth is 40 to 60 inches. Surface runoff is very rapid, and the hazard of erosion is severe.

This unit is used mainly for timber production, wildlife habitat, and watershed.

Douglas-fir, ponderosa pine, California black oak, and Pacific madrone are the main tree species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 134 on the Bamtush soil, 107 on the Speaker soil, and 121 on the Sanhedrin soil. On the basis of a 100-year site curve, the mean site index for ponderosa pine is 139 on the Bamtush soil, 106 on the Speaker soil, and 116 on the Sanhedrin soil. The potential annual production of ponderosa pine on the Bamtush soil is 830 board feet per acre from a fully stocked stand of trees. The potential annual production of ponderosa pine on the Speaker soil is 425 board feet per acre from a fully stocked stand of trees. The potential annual production of ponderosa pine on the Sanhedrin soil is 530 board feet per acre from a fully stocked stand of trees. Among the trees of limited extent are sugar pine, canyon live oak, Oregon white oak, and white fir.

The main limitations for the harvesting of timber are steepness of slope and the hazard of erosion. Cable yarding systems generally are used on this unit. Unsurfaced roads and skid trails are slippery when wet. They may be impassable during rainy periods. Rock for construction of roads is not readily available on this unit. Establishing plant cover on steep cut and fill slopes reduces erosion. Unless adequate plant cover or water bars are provided, steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff.

Plant competition is a concern in the production and reforestation of timber on this unit. When openings are made in the canopy, invading brushy plants that are not controlled can prevent the establishment of conifer seedlings. Reforestation can be accomplished by planting Douglas-fir, sugar pine, and ponderosa pine seedlings. If seed trees are present, natural reforestation of cutover areas by conifers frequently occurs.

Among the common forest understory plants are bedstraw, perennial fescue, brackenfern, and rose.

This map unit is in capability subclass VIIs (5), nonirrigated.

112—Benridge-Konocti association, 15 to 30 percent slopes. This map unit is on hills and mountains. The vegetation is mainly brush on south- and east-facing slopes and brush with scattered hardwoods and conifers on north- and west-facing slopes. Elevation is 1,300 to 4,300 feet. The average annual precipitation is 25 to 40 inches, the average annual air temperature is 53 to 59 degrees F, and the average frost-free period is 140 to 200 days.

This unit is about 40 percent Benridge loam, 20 percent Konocti cobbly loam, and 20 percent Konocti stony loam. The Konocti soils are on the upper part of side slopes, on ridgetops, and in ravines, and the Benridge soil is in the other areas of the unit.

Included in this unit are small areas of Konocti Variant soils and Rock outcrop and boulders 3 to 20 feet in diameter that are predominantly in areas of the Konocti soils. Also included are small areas of Benridge and Konocti soils that have slopes of more than 30 percent or less than 15 percent; small areas of soils that are similar to the Benridge and Konocti soils but are cooler; soils that are similar to the Benridge soil but have a thinner surface layer because of erosion; and soils that have 35 to 55 percent rocks and stones throughout. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Benridge soil is very deep and well drained. It formed in material weathered from volcanic ash, breccia, or tuff. Typically, the surface layer is light brown loam 6 inches thick. The upper 57 inches of the subsoil is yellowish red gravelly clay loam, and the lower 5 inches is yellowish red clay. Weathered volcanic breccia is at a depth of 68 inches.

Permeability of the Benridge soil is moderately slow. Available water capacity is 6.5 to 10.5 inches. Effective rooting depth is 60 inches or more. Surface runoff is rapid, and the hazard of erosion is severe.

The Konocti cobbly loam is moderately deep and well drained. It formed in material weathered from andesite, basalt, or dacite. Typically, the surface layer is brown cobbly loam 8 inches thick. The upper 8 inches of the subsoil is brown stony loam, and the lower 16 inches is light reddish brown very stony loam. The substratum to a depth of 39 inches is reddish yellow very stony loam. Slightly weathered dacite is at a depth of 39 inches.

Permeability of the Konocti cobbly loam is moderately slow. Available water capacity is 2 to 5 inches. Effective rooting depth is 20 to 40 inches. Surface runoff is rapid, and the hazard of erosion is severe.

The Konocti stony loam is moderately deep and well drained. It formed in material weathered from andesite, basalt, or dacite. Typically, the surface layer is brown stony loam 4 inches thick. The upper 5 inches of the subsoil is brown stony loam, and the lower 19 inches is light reddish brown very stony clay loam. Slightly weathered dacite is at a depth of 28 inches.

Permeability of the Konocti stony loam is moderately slow. Available water capacity is 2 to 5 inches. Effective rooting depth is 20 to 40 inches. Surface runoff is rapid, and the hazard of erosion is severe.

This unit is used mainly as wildlife habitat and watershed. It is also used for homesite development.

Woody shrubs are the most extensive plants on this unit. The characteristic vegetation is mainly manzanita, chamise, and California scrub oak with scattered areas of knobcone pine. Properly planned and applied prescribed burning or chemical or mechanical treatment can be used in small areas to improve habitat for wildlife, increase access, and reduce the risk of fire.

If this unit is used for homesite development, the main limitations are steepness of slope, the hazard of erosion, and the moderately slow permeability. Other limitations are the depth to bedrock in the Konocti soils and large stones in the Konocti stony loam. Extensive cutting and filling generally are required. Cut and fill slopes are susceptible to erosion. The risk of erosion is increased by leaving the soil surface exposed during site development. Preserving the existing vegetation and revegetating disturbed areas around construction sites helps to control erosion. Cuts needed to provide building sites on the Konocti soils can expose bedrock and large stones. Large stones in the Konocti stony loam may interfere with building site preparation. Slope limits installation of septic tank absorption fields. Absorption lines should be installed on the contour. The limitations of moderately slow permeability of the Benridge and Konocti soils and the moderate depth of the Konocti soils can be minimized by increasing the area of the absorption fields or by using a specially designed sewage disposal system.

The Benridge soil is in capability unit IVe-1 (15), nonirrigated. The Konocti soils are in capability unit IVs-1 (15), nonirrigated.

113—Benridge-Konocti association, 30 to 50 percent slopes. This map unit is on hills and mountains. The vegetation is mainly brush on south- and east-facing slopes and brush with scattered hardwoods and conifers on north- and west-facing slopes. Elevation is 1,300 to 4,300 feet. The average annual precipitation is 25 to 40 inches, the average annual air temperature is 53 to 59 degrees F, and the average frost-free period is 140 to 200 days.

This unit is about 40 percent Benridge loam, 30 percent Konocti cobbly loam, and 15 percent Konocti stony loam. The Konocti soils are on the upper side slopes, on ridgetops, and in ravines, and the Benridge soil is in the other areas of the unit.

Included in this unit are small areas of Konocti Variant soils; Rock outcrop and stones 3 to 25 feet in diameter, mainly in areas of the Konocti soils; Benridge and Konocti soils that have slopes of more than 50 percent; and soils that are similar to the Benridge and Konocti soils but have soil temperatures lower than 59 degrees F. Also included are small areas of soils that are similar to the Konocti soils but have fewer rock fragments and small areas of soils that are similar to the Benridge soil but have 35 to 55 percent rock fragments throughout the profile. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Benridge soil is very deep and well drained. It formed in material weathered from volcanic ash, breccia, or tuff. Typically, the surface layer is light brown loam 6 inches thick. The upper 57 inches of the subsoil is yellowish red gravelly clay loam, and the lower 5 inches is yellowish red clay. Weathered volcanic breccia is at a depth of 68 inches.

Permeability of the Benridge soil is moderately slow. Available water capacity is 6.5 to 10.5 inches. Effective rooting depth is 60 inches or more. Surface runoff is very rapid, and the hazard of erosion is severe.

The Konocti cobbly loam is moderately deep and well drained. It formed in material weathered from andesite, basalt, or dacite. Typically, the surface layer is brown cobbly loam 8 inches thick. The upper 8 inches of the subsoil is brown stony loam, and the lower 16 inches is light reddish brown very stony loam. The substratum to a depth of 39 inches is reddish yellow very stony loam. Slightly weathered dacite is at a depth of 39 inches.

Permeability of the Konocti cobbly loam is moderately slow. Available water capacity is 2 to 5 inches. Effective rooting depth is 20 to 40 inches. Surface runoff is rapid, and the hazard of erosion is severe.

The Konocti stony loam is moderately deep and well drained. It formed in material weathered from andesite, basalt, or dacite. Typically, the surface layer is brown stony loam 4 inches thick. The upper 5 inches of the subsoil is brown stony loam, and the lower 19 inches is light reddish brown very stony clay loam. Slightly weathered dacite is at a depth of 28 inches. In some areas the surface layer is very stony loam.

Permeability of the Konocti stony loam is moderately slow. Available water capacity is 2 to 5 inches. Effective rooting depth is 20 to 40 inches. Surface runoff is rapid, and the hazard of erosion is severe.

This unit is used mainly as wildlife habitat and watershed. It is also used for homesite development.

Woody shrubs are the most extensive plants on this unit. The characteristic vegetation is mainly manzanita, chamise, and California scrub oak with scattered areas of knobcone pine. Properly planned and applied prescribed burning or chemical or mechanical treatment can be used in small areas to improve habitat for wildlife, increase access, and reduce the risk of fire.

If this unit is used for homesite development, the main limitations are steepness of slope, the hazard of erosion, and the moderately slow permeability. Other limitations are depth to bedrock in the Konocti soils and large stones in the Konocti stony loam. Preferred building sites are limited to knolls and the less sloping areas. Extensive cutting and filling generally are required to provide building sites. These cuts may expose bedrock and large stones on the Konocti soils. Large stones in the Konocti stony loam may interfere with building site preparation. Cut and fill slopes are susceptible to excessive erosion. The risk of erosion is increased by leaving the soil surface exposed during site development. Preserving the existing vegetation or revegetating disturbed areas around construction sites helps to control erosion. Slope is a major limitation for the installation of septic tank absorption fields. Absorption lines should be installed on the contour. If this unit is used for septic tank absorption fields, the limitations of moderate depth of the Konocti soils and moderately slow permeability of the Konocti and Benridge soils can be minimized by increasing the size of the absorption field or by using a specially designed sewage disposal system.

The Benridge soil is in capability subclass VIe (15), nonirrigated. The Konocti soils are in capability subclass VIs (15), nonirrigated.

114—Benridge-Sodabay loams, 8 to 15 percent slopes. This map unit is on hills. The vegetation is mainly brush with a few scattered oaks and conifers. Elevation is 1,350 to 1,450 feet. The average annual precipitation is 25 to 30 inches, the average annual air temperature is 56 to 59 degrees F, and the average frost-free period is 160 to 200 days.

This unit is about 45 percent Benridge loam and 40 percent Sodabay loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Guenoc, Hambright, and Konocti soils. Also included are small areas of soils that are similar to the Benridge and Sodabay soils but are 40 to 60 inches deep to bedrock and Benridge and Sodabay soils that have slopes of 15 to 30 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Benridge soil is very deep and well drained. It formed in material weathered from dacite, breccia, or tuff. Typically, the surface layer is light brown loam 6 inches thick. The upper 57 inches of the subsoil is yellowish red gravelly clay loam, and the lower 5 inches is yellowish red clay. Weathered breccia is at a depth of 68 inches.

Permeability of the Benridge soil is moderately slow. Available water capacity is 6.5 to 10.5 inches. Effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is moderate.

The Sodabay soil is very deep and well drained. It formed in material weathered from dacite, tuff, breccia, or volcanic ash. Typically, the surface layer is light reddish brown loam 6 inches thick. The upper 46 inches of the subsoil is light reddish brown clay loam, and the lower 11 inches is light reddish brown gravelly clay loam. Weathered pyroclastic tuff is at a depth of 63 inches.

Permeability of the Sodabay soil is moderately slow. Available water capacity is 9.0 to 10.5 inches. Effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is moderate.

This unit is used for homesite development, wildlife habitat, and watershed.

If this unit is used for homesite development, the main limitation is the moderately slow permeability of the soils. If this unit is used for septic tank absorption fields, the limitation of moderately slow permeability can be overcome by increasing the size of the absorption field or by using a specially designed sewage disposal system.

The production of forage is limited by the restricted available water capacity. Where oaks and brush grow, forage production will be increased by managing harvesting of the trees and controlling brush. Vegetation in drainageways should be left for erosion control, wildlife habitat, and esthetic purposes. Volumes of 9 cords of wood per acre have been measured on this unit. This unit responds well to fertilizer, to rangeland seeding, and to proper grazing use. The main limitations for seeding are the presence of some stony areas and the tendency of the unit to produce woody plants. Among the common understory plants are soft chess, filaree, and annual clover.

If this unit is used for homesite development, the main limitations are the depth to bedrock, the very slow permeability, and the high shrink-swell potential of the subsoil. If the unit is used for septic tank absorption fields, the limitation of very slow permeability can be minimized by increasing the size of the absorption field or by using a specially designed sewage disposal system. The high shrink-swell potential of the subsoil should be considered when designing and constructing foundations, concrete structures, and paved areas. The effects of shrinking and swelling can be minimized by backfilling with a material that has low shrink-swell potential.

This map unit is in capability unit IVe-8 (15), nonirrigated.

117—Bottlerock-Glenview-Arrowhead complex, 5 to 30 percent slopes. This map unit is on volcanic hills. The vegetation is mainly brush with scattered conifers. Elevation is 1,500 to 3,000 feet. The average annual precipitation is 30 to 50 inches, the average annual air temperature is 53 to 59 degrees F, and the average frost-free period is 150 to 195 days.

This unit is about 50 percent Bottlerock extremely gravelly loam, 20 percent Glenview very gravelly loam, and 15 percent Arrowhead extremely gravelly sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of soils that are similar to the Arrowhead soil but are 10 to 20 inches deep over obsidian and small areas of soils that are similar to the Glenview soil but have 35 to 70 percent cobbles and stones throughout. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Bottlerock soil is very deep and well drained. It formed in material weathered from obsidian. Typically, the upper 5 inches of the surface layer is dark grayish brown extremely gravelly loam and commonly has a surface pavement that is 90 percent gravel, the next 4 inches is light gray very gravelly loam, and the lower 10 inches is very pale brown very gravelly loam. The upper 9 inches of the subsoil is very pale brown very gravelly sandy clay loam, the next 11 inches is light brown very gravelly clay loam, and the lower 24 inches is dark red, strong brown, and reddish yellow very gravelly clay.

Permeability of the Bottlerock soil is slow. Available water capacity is 2.5 to 6.0 inches. Effective rooting depth is 60 inches or more. Surface runoff is rapid, and the hazard of erosion is moderate.

The Glenview soil is very deep and well drained. It formed in material weathered from obsidian. Typically, the upper part of the surface layer is brown very gravelly loam 1 inch thick and the lower part is brown gravelly loam 5 inches thick. The upper 9 inches of the subsoil is reddish yellow gravelly clay loam, the next 25 inches is reddish yellow gravelly clay, and the lower 25 inches is reddish yellow gravelly clay loam. In some areas the surface layer is very gravelly sandy loam.

Permeability of the Glenview soil is moderately slow. Available water capacity is 6.5 to 9.5 inches. Effective rooting depth is 60 inches or more. Surface runoff is rapid, and the hazard of erosion is moderate.

The Arrowhead soil is moderately deep and well drained. It formed in material weathered from obsidian. Typically, the upper part of the surface layer is brown extremely gravelly sandy loam 1 inch thick and the lower part is brown gravelly sandy loam 3 inches thick. The upper 4 inches of the subsoil is brown gravelly sandy loam, the next 6 inches is light brown gravelly sandy clay loam, and the lower 17 inches is reddish yellow very stony clay. Hard, fractured obsidian is at a depth of 31 inches.

Permeability of the Arrowhead soil is moderately slow. Available water capacity is 1.5 to 3.5 inches. Effective rooting depth is 20 to 40 inches. Surface runoff is rapid, and the hazard of erosion is moderate.

This unit is used mainly as wildlife habitat and watershed. It can be used for production of timber and Christmas trees.

Proper site preparation on the Bottlerock and Glenview soils might make it possible to replace stands of brush and hardwoods with conifers. These soils are suited to the production of ponderosa pine. On the basis of a 100-year site curve, the mean site index for ponderosa pine is 103 on the Bottlerock soil and 110 on the Glenview soil. The potential annual production of ponderosa pine on the Bottlerock soil is 400 board feet per acre from a fully stocked stand of trees. The potential annual production of ponderosa pine on the Glenview soil is 460 board feet per acre from a fully stocked stand of trees. Estimates of the site index and yield for the Arrowhead soil have not been made because the vegetation is mostly brush.

A concern for the harvesting of timber is the potential shredding effect of the obsidian on rubber tires. The soils in this unit also are subject to gullying when the surface layer is removed. Disturbance of this protective layer can be reduced by the careful use of wheeled and tracked equipment. Establishing plant cover on steep cut and fill slopes reduces erosion on the Glenview soil; however, revegetation of cut and fill slopes is difficult on the Bottlerock and Arrowhead soils because of the restricted available water capacity and the high content of rock fragments.

Seedling survival is a concern in the production of timber. Reforestation can be accomplished on the Bottlerock and Glenview soils by planting large ponderosa pine seedlings following proper site preparation. The droughtiness of the surface layer reduces the survival rate of seedlings, especially on south- and southwest-facing slopes. Reforestation should be carefully managed to reduce competition from undesirable plants and to provide partial shade for seedlings. Because of the high risk of fire on the surrounding brush-covered soils, firebreaks are needed to protect plantations on this unit. Planting on the Arrowhead soil is not practical because of the restricted available water capacity. Properly planned and applied prescribed burning or chemical or mechanical treatment can be used in small areas to improve habitat for wildlife, increase access, and reduce the risk of fire.

Among the common forest understory plants are blueblossom ceanothus, interior live oak, and manzanita.

This map unit is in capability unit IVs-1 (5), nonirrigated.

118—Bottlerock-Glenview-Arrowhead complex, 30 to 50 percent slopes. This map unit is on volcanic hills. The vegetation is mainly brush with scattered conifers. Elevation is 1,500 to 3,000 feet. The average annual precipitation is 30 to 50 inches, the average annual air temperature is 53 to 59 degrees F, and the average frost-free period is 150 to 195 days.

This unit is about 40 percent Bottlerock extremely gravelly loam, 20 percent Glenview very gravelly loam, and 15 percent Arrowhead extremely gravelly sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of soils that are similar to the Arrowhead soil but are 10 to 20 inches deep over obsidian and small areas of Arrowhead, Bottlerock, and Glenview soils that have slopes of more than 50 percent. Also included are small areas of soils that are similar to the Glenview soil but have 40 to 75 percent stones and cobbles throughout and small areas of soils that are similar to the Bottlerock, Glenview, and Arrowhead soils but are severely eroded. Included areas make up about 25 percent of the total acreage. The percentage varies from one area to another.

The Bottlerock soil is very deep and well drained and commonly has a surface pavement that is 90 percent gravel. It formed in material weathered from obsidian. Typically, the upper 5 inches of the surface layer is dark grayish brown extremely gravelly loam, the next 4 inches is light gray and very pale brown very gravelly loam, and the lower 10 inches is very pale brown very gravelly loam 10 inches thick. The upper 9 inches of the subsoil is very pale brown very gravelly sandy clay loam, the next 11 inches is light brown very gravelly clay loam, and the lower 24 inches is strong brown and reddish yellow very gravelly clay.

Permeability of the Bottlerock soil is slow. Available water capacity is 2.5 to 6.0 inches. Effective rooting depth is 60 inches or more. Surface runoff is rapid, and the hazard of erosion is moderate.

The Glenview soil is very deep and well drained. It formed in material weathered from obsidian. Typically, the upper part of the surface layer is brown very gravelly loam 1 inch thick and the lower part is brown gravelly loam 5 inches thick. The upper 9 inches of the subsoil is reddish yellow clay loam, the next 25 inches is reddish yellow gravelly clay, and the lower 25 inches is reddish yellow gravelly clay loam. In some areas the surface layer is very gravelly sandy loam.

Permeability of the Glenview soil is moderately slow. Available water capacity is 6.5 to 9.5 inches. Effective rooting depth is 60 inches or more. Surface runoff is rapid, and the hazard of erosion is moderate.

The Arrowhead soil is moderately deep and well drained. It formed in material weathered from obsidian. Typically, the upper part of the surface layer is brown extremely gravelly sandy loam 1 inch thick and the lower part is brown gravelly sandy loam 3 inches thick. The upper 4 inches of the subsoil is brown gravelly sandy loam, the next 6 inches is light brown gravelly sandy clay loam, and the lower 17 inches is reddish yellow very stony clay. Hard, fractured obsidian is at a depth of 31 inches.

Permeability of the Arrowhead soil is moderately slow. Available water capacity is 1.5 to 3.5 inches. Effective rooting depth is 20 to 40 inches. Surface runoff is rapid, and the hazard of erosion is severe.

This unit is used mainly as wildlife habitat and watershed. It can be used for production of timber and Christmas trees.

Proper site preparation on the Bottlerock and Glenview soils might make it possible to replace stands of brush and hardwoods with conifers. These soils are suited to the production of ponderosa pine. On the basis of a 100-year site curve, the mean site index for ponderosa pine is 103 on the Bottlerock soil and 110 on the Glenview soil. The potential annual production of ponderosa pine on the Bottlerock soil is 400 board feet per acre from a fully stocked stand of trees. The potential annual production of ponderosa pine on the Glenview soil is 460 board feet per acre from a fully stocked stand of trees. Estimates of the site index and yield for the Arrowhead soil have not been made because the vegetation is mostly brush.

Some concerns for the harvesting of timber are steepness of slope, the hazard of erosion, and the potential shredding effect of the obsidian on rubber tires.

The soils in this unit have a tendency to gully when the surface layer is removed. Disturbance of this protective layer can be reduced by the careful use of wheeled and tracked equipment. Unless adequate plant cover or water bars are provided, steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying. Rocks and loose soil material may slide down roadcuts on this unit. Establishing plant cover on steep cut and fill slopes reduces erosion on the Glenview soil; however, revegetation of cut and fill slopes is difficult on the Bottlerock and Arrowhead soils because of the restricted available water capacity and the high content of rock fragments.

Seedling survival is a concern in the production of timber. Reforestation can be accomplished on the Bottlerock and Glenview soils by planting large ponderosa pine seedlings following proper site preparation. The droughtiness of the surface layer reduces the survival rate of seedlings, especially on south- and southwest-facing slopes. Reforestation should be carefully managed to reduce competition from undesirable plants and to provide partial shade for seedlings. Because of the high risk of fire on the surrounding brush-covered soils, firebreaks are needed to protect plantations on this unit. Planting on the Arrowhead soil is not practical because of the restricted available water capacity. Properly planned and applied prescribed burning or chemical or mechanical treatment can be used in small areas to improve habitat for wildlife, increase access, and reduce the risk of fire.

Among the common forest understory plants are blueblossom ceanothus, interior live oak, and manzanita.

This map unit is in capability subclass VIs (5), nonirrigated.

119—Bressa-Millsholm loams, 8 to 15 percent slopes. This map unit is on hills. The vegetation is mainly annual grasses and oaks. Elevation is 1,200 to 2,500 feet. The average annual precipitation is 30 to 40 inches, the average annual air temperature is 56 to 59 degrees F, and the average frost-free period is 160 to 200 days.

This unit is about 50 percent Bressa loam and 30 percent Millsholm loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Rock outcrop and small areas with stones on the surface. Also included are small areas of Bressa and Millsholm soils that have slopes of less than 8 percent, soils that are similar to the Bressa and Millsholm soils but receive more than 40 inches of precipitation annually, and soils that are similar to the Millsholm soil but are less than 10 inches deep to bedrock. Included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Bressa soil is moderately deep and well drained. It formed in material weathered from sandstone. Typically, the surface layer is light brownish gray and pale brown loam 12 inches thick. The subsoil is light yellowish brown clay loam 14 inches thick. Fractured sandstone is at a depth of 26 inches.

Permeability of the Bressa soil is moderately slow. Available water capacity is 3.0 to 7.5 inches. Effective rooting depth is 20 to 40 inches. Surface runoff is medium, and the hazard of erosion is moderate.

The Millsholm soil is shallow and well drained. It formed in material weathered from sandstone or shale. Typically, the surface layer is brown loam 3 inches thick. The subsoil is pale brown clay loam 8 inches thick. Fractured sandstone is at a depth of 11 inches.

Permeability of the Millsholm soil is moderate. Available water capacity is 1.5 to 3.5 inches. Effective rooting depth is 10 to 20 inches. Surface runoff is medium, and the hazard of erosion is moderate.

This unit is used mainly for livestock grazing, wildlife habitat, and watershed. It is also used for homesite development and firewood production.

The production of forage is limited by a dense canopy cover in some areas and the restricted available water capacity and shallow depth of the Millsholm soil. Where oaks are present, forage production can be increased by managed harvesting of the trees. Vegetation in drainageways should be left for erosion control, wildlife habitat, and esthetic purposes. Volumes from 13 to 36 cords of wood per acre have been measured on the Bressa soil. The Bressa soil responds well to fertilization, rangeland seeding, and proper grazing use. The main limitation for seeding is the woody canopy cover. Among the common understory plants on this unit are wild oat, soft chess, and filaree.

If this unit is used for homesite development, the main limitation is depth to bedrock. Another limitation is the moderately slow permeability of the Bressa soil. Cuts needed to provide building sites can expose bedrock. Shallow depth to bedrock in the Millsholm soil is a major limitation for septic tank absorption fields. If the Bressa soil is used for septic tank absorption fields, the limitations of depth to bedrock and moderately slow permeability can be minimized by increasing the size of the absorption field or by using a specially designed sewage disposal system.

This map unit is in capability subclass VIe (15), nonirrigated.

120—Bressa-Millsholm loams, 15 to 30 percent slopes. This map unit is on hills. The vegetation is mainly annual grasses and oaks. Elevation is 1,200 to 2,500 feet. The average annual precipitation is 30 to 40 inches, the average annual air temperature is 56 to 59 degrees F, and the average frost-free period is 160 to 200 days.

deep road cuts are made on the steeper parts of this unit.

Seedling establishment is a concern in the production of timber. Reforestation can be accomplished by planting ponderosa pine and Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by ponderosa pine and Douglas-fir frequently occurs. Areas of Rock outcrop limit the even distribution of reforestation.

Among the common forest understory plants are squawcarpet, coffeeberry, poison-oak, brackenfern, manzanita, and perennial grasses.

This map unit is in capability subclass VIIs (5), nonirrigated.

127—Collayomi-Aiken-Whispering complex, 5 to 30 percent slopes. This map unit is on mountains. The vegetation is mainly conifers and oaks. Elevation is 1,400 to 4,000 feet. The average annual precipitation is 35 to 60 inches, the average annual air temperature is 50 to 55 degrees F, and the average frost-free period is 130 to 180 days.

This unit is about 35 percent Collayomi very gravelly loam, 35 percent Aiken loam, and 15 percent Whispering loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Rock outcrop near ridges. Also included are small areas of Aiken, Collayomi, and Whispering soils that have slopes of more than 30 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Collayomi soil is very deep and well drained. It formed in material weathered from andesite, basalt, or dacite. Typically, about 5 percent of the surface is covered with stones and boulders. The surface layer is light brown very gravelly loam 15 inches thick. The upper 35 inches of the subsoil is light brown and reddish yellow very gravelly loam, and the lower 10 inches is light reddish brown extremely gravelly loam.

Permeability of the Collayomi soil is moderate. Available water capacity is 2.5 to 4.5 inches. Effective rooting depth is 60 inches or more. Surface runoff is rapid, and the hazard of erosion is moderate.

The Aiken soil is very deep and well drained. It formed in material weathered from andesite, basalt, or dacite. Typically, the surface is covered with a mat of partially decomposed needles, leaves, twigs, and bark 1 inch thick. The upper 5 inches of the surface layer is reddish brown loam, and the lower 4 inches is reddish brown clay loam. The upper 11 inches of the subsoil is yellowish red clay loam, and the lower 54 inches is reddish yellow clay and cobbly clay.

Permeability of the Aiken soil is moderately slow. Available water capacity is 9.0 to 10.5 inches. Effective rooting depth is 60 inches or more. Surface runoff is rapid, and the hazard of erosion is moderate.

The Whispering soil is moderately deep and well drained. It formed in material weathered from andesite, basalt, or dacite. Typically, about 5 percent of the surface is covered with stones and boulders. The surface is covered with a mat of pine needles and twigs 1 inch thick. The surface layer is brown loam 5 inches thick. The upper 10 inches of the subsoil is reddish yellow gravelly loam, and the lower 11 inches is yellowish red very cobbly clay loam. Hard, fractured andesite is at a depth of 26 inches.

Permeability of the Whispering soil is moderate. Available water capacity is 2 to 5 inches. Effective rooting depth is 20 to 40 inches. Surface runoff is rapid, and the hazard of erosion is severe.

This unit is used mainly for timber production, wildlife habitat, and watershed. It is also used for homesite development and orchards.

Ponderosa pine, California black oak, sugar pine, and Douglas-fir are the main tree species on this unit. On the basis of a 100-year site curve, the mean site index for ponderosa pine is 122 on the Collayomi soil, 137 on the Aiken soil, and 109 on the Whispering soil. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 110 on the Collayomi soil, 134 on the Aiken soil, and 107 on the Whispering soil. The potential annual production of ponderosa pine on the Collayomi soil is 595 board feet per acre from a fully stocked stand of trees. The potential annual production of ponderosa pine on the Aiken soil is 800 board feet per acre from a fully stocked stand of trees. The potential annual production of ponderosa pine on the Whispering soil is 455 board feet per acre from a fully stocked stand of trees. Estimates of the site index and yield for sugar pine and California black oak have not been made.

A concern for the harvesting of timber is seasonal wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and can damage the roots of trees. Disturbance of the protective layer of duff can be reduced by the careful use of wheeled and tracked equipment. Unsurfaced roads and skid trails on the Aiken soil are slippery when wet. They may be impassable during rainy periods. Rock for construction of roads is not readily available on this unit. Establishing plant cover on the steep cut and fill slopes reduces erosion. Revegetation of cut and fill slopes is difficult on the Collayomi and Whispering soils because of the high content of rock fragments and the restricted available water capacity.

Seedling establishment is a concern in the production of timber. Reforestation can be accomplished by planting ponderosa pine and Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by ponderosa pine and Douglas-fir frequently occurs. The high soil temperature and low content of soil moisture during the growing season cause high mortality of

Douglas-fir seedlings, especially on the south- and southwest-facing slopes.

Among the common forest understory plants are squawcarpet, coffeeberry, poison-oak, brackenfern, manzanita, and perennial grasses.

If this unit is used for homesite development, the main limitations are the steepness of slope and hazard of erosion. Other limitations are the moderately slow permeability and low load bearing capacity of the Aiken soil and the depth to bedrock in the Whispering soil. Cutting and filling generally are required to provide level building sites. Cuts can expose bedrock in the Whispering soil. Cut and fill slopes are susceptible to excessive erosion. The risk of erosion is increased if the soil surface is left exposed during site development. Preserving existing vegetation or revegetating disturbed areas around construction sites helps to control erosion. Cut and fill slopes on the Aiken soil are not stable and are subject to slumping. Buildings and roads should be designed to offset the limited ability of the subsoil in the Aiken soil to support a load. If the Aiken soil is used as a base for roads and streets, it can be mixed with sand and gravel to increase its strength and stability. Slope limits installation of septic tank absorption fields. Absorption lines should be installed on the contour. The limitations of moderately slow permeability of the Aiken soil and moderate depth to bedrock in the Whispering soil can be minimized by increasing the size of the absorption field or by using a specially designed sewage disposal system.

The main crop grown on this unit is walnuts. Irrigation commonly is not used because an adequate irrigation water supply has not been developed. Walnut orchards are primarily in areas of the Aiken and Collayomi soils that have slopes of 5 to 15 percent. The main limitations are the hazard of erosion and steepness of slope. Available water capacity and stones and boulders on the surface also limit use of the Collayomi soil. The Whispering soil is poorly suited to orchards. It is also limited by depth to bedrock, available water capacity, and stones and boulders on the surface. Areas of this unit that have slopes of more than 15 percent are poorly suited to orchards. Use of a cover crop between rows of trees helps to control erosion. All tillage should be on the contour or across the slope. Tillage should be kept to a minimum. Adding organic matter to the soil increases the available water capacity and fertility. Stones and boulders on the surface limit the use of most equipment on the Collayomi and Whispering soils. Rock deflectors should be used on all moving equipment.

This map unit is in capability unit IVs-1 (5), nonirrigated.

128—Collayomi-Aiken-Whispering complex, 30 to 50 percent slopes. This map unit is on mountains. The vegetation is mainly conifers and oaks. Elevation is 1,400 to 4,000 feet. The average annual precipitation is 35 to 60 inches, the average annual air temperature is 50 to 55 degrees F, and the average frost-free period is 130 to 180 days.

This unit is about 40 percent Collayomi very gravelly loam, 35 percent Aiken loam, and 15 percent Whispering loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Aiken and Whispering soils that have slopes of less than 30 percent. Also included are small areas of soils that are similar to the Collayomi soil but have more clay in the subsoil. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Collayomi soil is very deep and well drained. It formed in material weathered from andesite, basalt, or dacite. Typically, 5 percent of the surface is covered with stones and boulders. The surface layer is light brown very gravelly loam 15 inches thick. The upper 35 inches of the subsoil is light brown and reddish yellow very gravelly loam, and the lower 10 inches is light reddish brown extremely gravelly loam.

Permeability of the Collayomi soil is moderate. Available water capacity is 2.5 to 4.5 inches. Effective rooting depth is 60 inches or more. Surface runoff is rapid, and the hazard of erosion is moderate.

The Aiken soil is very deep and well drained. It formed in material weathered from andesite, basalt, or dacite. Typically, the surface is covered with a mat of partially decomposed needles, leaves, twigs, and bark 1 inch thick. The upper part of the surface layer is reddish brown loam 5 inches thick, and the lower part is reddish brown clay loam 4 inches thick. The upper 11 inches of the subsoil is yellowish red clay loam, and the lower 54 inches is reddish yellow clay and cobbly clay.

Permeability of the Aiken soil is moderately slow. Available water capacity is 9.0 to 10.5 inches. Effective rooting depth is 60 inches or more. Surface runoff is rapid, and the hazard of erosion is severe.

The Whispering soil is moderately deep and well drained. It formed in material weathered from andesite, basalt, or dacite. Typically, 5 percent of the surface is covered with stones and boulders. The surface is covered with a mat of pine needles and twigs 1 inch thick. The surface layer is brown loam 5 inches thick. The upper 10 inches of the subsoil is reddish yellow gravelly loam, and the lower 11 inches is yellowish red very cobbly clay loam. Hard, fractured andesite is at a depth of 26 inches.

Permeability of the Whispering soil is moderate. Available water capacity is 2 to 5 inches. Effective rooting depth is 20 to 40 inches. Surface runoff is rapid, and the hazard of water erosion is severe.

This unit is used mainly for timber production, wildlife habitat, and watershed. It is also used for homesite development.

Ponderosa pine, California black oak, sugar pine, and Douglas-fir are the main tree species on this unit. On the basis of a 100-year site curve, the mean site index for ponderosa pine is 122 on the Collayomi soil, 137 on the Aiken soil, and 109 on the Whispering soil. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 110 on the Collayomi soil, 134 on the Aiken soil, and 107 on the Whispering soil. The potential annual production of ponderosa pine on the Collayomi soil is 595 board feet per acre from a fully stocked stand of trees. The potential annual production of ponderosa pine on the Aiken soil is 800 board feet per acre from a fully stocked stand of trees. The potential annual production of ponderosa pine on the Whispering soil is 455 board feet per acre from a fully stocked stand of trees. Estimates of the site index and yield for sugar pine and California black oak have not been made.

Some concerns for the harvesting of timber are steepness of slope, the hazard of erosion, and seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and can damage the roots of trees. Unless adequate plant cover or water bars are provided, steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying. Disturbance of the protective layer of duff can be reduced by the careful use of either wheeled and tracked equipment or cable harvesting systems. Unsurfaced roads and skid trails on the Aiken soil are slippery when wet. They may be impassable during rainy periods. Rock for construction of roads is available in some areas of this unit. Establishing plant cover on steep cut and fill slopes reduces erosion on the Aiken soil. Revegetation of cut and fill slopes is difficult on the Collayomi and Whispering soils because of the high content of rock fragments and restricted available water capacity.

Seedling establishment is a concern in the production of timber. Reforestation can be accomplished by planting ponderosa pine and Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by conifers occurs frequently. The high soil temperature and low content of soil moisture during the growing season cause high mortality of Douglas-fir seedlings, especially on the south- and southwest-facing slopes.

Among the common forest understory plants are squawcarpet, coffeeberry, poison-oak, brackenfern, manzanita, and perennial grasses.

If this unit is used for homesite development, the main limitations are the steepness of slope and hazard of erosion. Other limitations are the moderately slow permeability and low load bearing capacity of the Aiken soil and depth to bedrock in the Whispering soil. Preferred building sites are limited to knolls and the less sloping areas. Extensive cutting and filling generally are required. Cuts needed to provide building sites can expose bedrock in the Whispering soil. Cut and fill slopes are susceptible to erosion. The risk of erosion is increased if the soil surface is left exposed during site development. Preserving existing vegetation or revegetating disturbed areas around construction sites helps to control erosion. Cut and fill slopes on the Aiken soil are not stable and are subject to slumping. Buildings and roads should be designed to offset the limited ability of the Aiken soil to support a load. If the Aiken soil is used as a base for roads and streets, it can be mixed with sand and gravel to increase its strength and stability. Steepness of slope is a major limitation for septic tank absorption fields. Absorption lines should be installed on the contour. The limitations of moderately slow permeability of the Aiken soil and moderate depth to bedrock in the Whispering soil can be minimized by increasing the size of the absorption field or by using a specially designed sewage disposal system.

This map unit is in capability subclass VIs (5), nonirrigated.

129—Collayomi-Whispering complex, 30 to 50 percent slopes. This map unit is on mountains. The vegetation is mainly conifers and oaks with an understory of shrubs. Elevation is 3,000 to 4,600 feet. The average annual precipitation is 50 to 65 inches, the average annual air temperature is 50 to 55 degrees F, and the average frost-free period is 120 to 160 days.

This unit is about 60 percent Collayomi very gravelly loam and 30 percent Whispering loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Aiken loam and Collayomi stony loam. Also included are small areas of Collayomi and Whispering soils that have slopes of more than 50 percent or less than 30 percent and soils that are similar to the Whispering soil but are 40 to 60 inches deep. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Collayomi soil is very deep and well drained. It formed in material weathered from andesite, basalt, or dacite. Typically, 5 percent of the surface is covered with stones and boulders. The surface layer is light brown very gravelly loam 15 inches thick. The upper 35 inches of the subsoil is light brown and reddish yellow very gravelly loam, and the lower 10 inches is light reddish brown extremely gravelly loam.

Permeability of the Collayomi soil is moderate. Available water capacity is 2.5 to 4.5 inches. Effective rooting depth is 60 inches or more. Surface runoff is rapid, and the hazard of erosion is moderate.

The Whispering soil is moderately deep and well drained. It formed in material weathered from andesite, basalt, or dacite. Typically, 5 percent of the surface is covered with stones and boulders. The surface is covered with a mat of pine needles, leaves, and twigs 1 inch thick. The surface layer is brown loam 5 inches thick. The upper 10 inches of the subsoil is reddish