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JAMES J. HILL III, Applicant	**WATER RIGHTS APPLICATION 30166** **WRITTEN TESTIMONY OF L. NIEL ALLEN, PH.D., P.E., SENIOR ENGINEER WITH NATURAL RESOURCES CONSULTING ENGINEERS, INC.**

NRCE

WRITTEN TESTIMONY OF L. NIEL ALLEN
Concerning
Water Right Application #30166

Prepared by:
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1. INTRODUCTION

1.1 Introduction to L. Niel Allen

My name is Dr. L. Niel Allen. I am a Senior Engineer with Natural Resources Consulting Engineers, Inc., ("NCRE"), located in Fort Collins, Colorado. My experience in the field of agricultural irrigation spans over 30 years. I have extensive experience in the analysis of irrigation water requirements, analysis and preparation of water right claims, climate and meteorological data analyses, the development of precipitation runoff and other hydrologic models, preparation of soil erosion management plans, preparation of water use efficiency and conservation and management plans, consumptive water analysis, and irrigation system assessment. I have also planned, designed, and/or evaluated hundreds of gravity, sprinkler and drip irrigation systems, and have designed irrigation scheduling and beneficial use guidelines.

Among my specific assignments in California I have worked with water conjunctive use and an in-lieu groundwater recharge system for Shafter-Wasco Irrigation District and Semitropic Water Storage District in Kern County. I also conducted water use and water conservation studies for Imperial Irrigation District in Imperial County, assisted in preparation of an integrated water resource plan for Arvin-Edison Water Storage District in Kern County, and assisted in an irrigation water reuse study for Sacramento Regional County Sanitation District. I also provided an in-depth analysis of a long-term water transfer of conserved water for the Imperial Irrigation District. A State Water Resources Control Board hearing was held in that matter in May 2002. The transfer to the San Diego County Water Authority from the Imperial Irrigation District also involved an analysis and report for preparation of the 2003 for *US Bureau of Reclamation Part 417 – Procedural Methods for Implementing Colorado River Water Conservation Measures with Lower Basin Contractors and Others* in water transfer agreements that are part of the California Colorado River Quantification Settlement Agreement.

I participated in the Quechan Tribe's adjudication of water rights in the United States Supreme Court by providing expert technical consultation leading to quantification of the Quechan Tribe's water rights. My work included analysis of soils, climate data, and the sources, quantity, and quality of irrigation water available to determine the land within the Reservation that was suitable for agriculture and led to a water right settlement embodied in the Consolidated Colorado River Decree dated March 27, 2006.

My academic training includes Bachelor and Master of Science Degrees in Agricultural & Irrigation Engineering from Utah State University, and a Ph.D. in Civil Engineering from the University of Idaho. Early in my career, I designed and installed agricultural irrigation systems (1980-1985), was a faculty member at Utah State University (1985-1992) as an irrigation specialist and was an associate professor at University of Nevada, serving its Cooperative Extension (1992-1993) as an irrigation and water resources specialist. In addition, I worked for for Bookman-Edmonston Engineering, Inc. (1993-1997) as a senior engineer where I provided analytical support concerning irrigation consumptive use, water rights, environmental considerations, water conservation, and allocation of water resources. I have been a Senior Engineer for Natural Resources Consulting Engineers, Inc., since 1997, specializing in the estimation of crop water and irrigation diversion requirements, the identification and mapping of presently and historically irrigated lands, the evaluation of historical irrigation water use and the estimation of future irrigation water requirements. My published research papers and articles include topics such as the use of weather stations to determine crop water needs, and crop irrigation requirement models. A copy of my resume is attached hereto as Appendix A.

1.2 Introduction to Testimony

I was asked to determine the irrigation requirements for the irrigated pasture at the El Sur Ranch (Ranch) and to address related issues of concern. My testimony includes a brief description of the Ranch, the irrigation system and historical practices, soil characteristics, and climate conditions. It also describes the analysis and methodology I used to determine the crop water requirement, then compares that requirement to historical operations and pumping at the El Sur Ranch, and finds that the irrigation efficiencies are reasonable. In June 2003, as the basis of my analyses, I visited the ranch and inspected the pasture and surrounding areas and the irrigation system, including the wells. In addition, I examined records of irrigation from 1975 – 2009, obtained comprehensive climate data from weather stations installed on the Ranch pasture and at the well sites, as well as Regional weather stations located near the Ranch; I also interviewed the applicant and his ranch manager regarding their ranching and irrigation practices. I studied land use regulations applicable to the Ranch, and also reviewed and analyzed aerial photographs of the pasture dated from 1929 through 2009.

Based on my investigation and analysis, it is my opinion that:

- The irrigated pasture crop is cultivated. I base this opinion on the fact that the pasture is graded, prepared and irrigated, seeds planted and a forage crop grown and either consumed by cattle or cut and baled for future cattle feed.
- The irrigation system being used is the most suitable system for the El Sur Ranch based on the soils, crops, topography, energy costs, climatic conditions including winds, legal restrictions on land use and aesthetics of the coast line.
- The current irrigation and pasture management and practices as described in the application will prevent unreasonable use of irrigation water and protect the irrigated pasture area from soil erosion by wind and water.

2. RANCH DESCRIPTION AND LAND USE|

2.1 Description of the El Sur Ranch

The 292-acre pasture area on El Sur Ranch is located on bench land to the north of the Big Sur River and is comprised of a net 246 acres of irrigated fields on the bench lands, see

Figure 1. Irrigation of the fields is accomplished by pumping water from two wells near the Big Sur River. The irrigation system includes independent pipelines from each well so they can be operated simultaneously to irrigate different pastures. The Old Well has a centrifugal pump with a 60 horsepower motor and was established in the 1950s.

The New Well was drilled in 1975 and put into operation in 1984. The New Well has a 50 horsepower turbine pump. The New Well was drilled because the expanded irrigation system taxed the Old Well capacity and because water pumped from the Old Well was sometimes too saline for irrigation use. Pump differences necessitates that the Old Well be used primarily to supply water to the upper portion of the irrigated pasture and that the New Well primarily be used to supply water to the lower portions of the irrigated pasture.

used to supply water to the lower portions of the irrigated pasture.

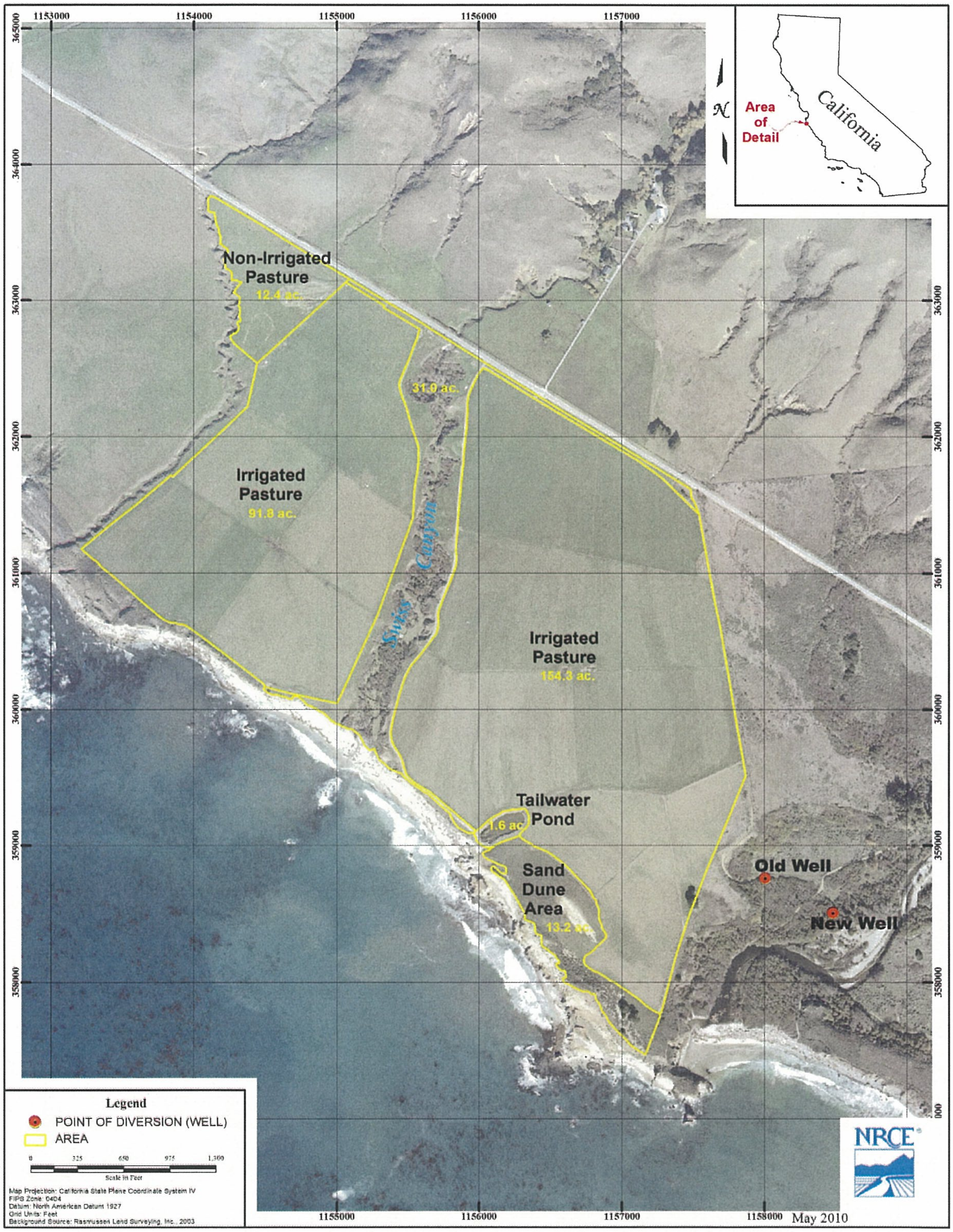

Figure 1: 2003 Aerial Photo Map of the El Sur Ranch Irrigated Pasture.

2.2 Agricultural Land Use

The use of El Sur Ranch land as a cattle ranch is consistent with and protected by both the California Coastal Act and the Monterey County Local Coastal Program. Importantly, the Big Sur Coast Land Use Plan adopts land use goals that not only seek to preserve traditional ranching uses, but also to specifically preserve grazing as a traditional use, as it "contributes much to the character of Big Sur."[1] (See Figure 2).

Figure 2: El Sur Ranch Irrigated Pasture.

2.3 Grazing Management

Irrigation of the pasture allows for the cultivation of high quality forage for the El Sur Ranch needed by the cattle. The fields are well maintained and managed. The pasture is divided into eleven fields; the cattle are rotated through the fields to provide the fields time to re-establish a healthy crop height for optimal forage production. The variety of grasses and legumes in the pasture, including orchard grass, harding grass, fescue, clover, and birdsfoot trefoil, are an indication of good management of the cultivated pasture over a long period of

1 Big Sur Coast Land Use Plan, Section 3.

time. After land leveling and grading, installation of the pipeline system, preparation of the soil, and building the border dikes, the pastures were seeded with an appropriate mix of forage crop species. The pasture is not over-grazed and the healthy stand of forage protects the soil from erosion. Pasture cultivation and production using the current irrigation and management practices has occurred for over 50 years.

2.4 Irrigated Acreage

As previously mentioned, the El Sur Ranch's irrigated fields consist of 246 acres irrigated directly via the two wells near the Big Sur River. In addition, Swiss Canyon receives incidental benefit from the irrigation, through percolated irrigation water. The Canyon supports grasses which are grazed by the cattle and also provides them protection and refuge from the prevailing winds.

3. SOIL CHARACTERISTICS AND EROSION

3.1 Summary

El Sur Ranch Soils are made up primarily of two soil types: the fine sandy loam soil – Santa Ynez, making up 86% of the soils and Lockwood shaly loam, making up 8% of the soil. The Santa Ynez soil is moderately well-drained with a water-holding capacity range of 3-5 inches; the Lockwood soil is well-drained with a water-holding capacity ranging from 6-9 inches. Permeability in the Santa Ynez soil is slow due to a clay-subsoil below the top surface layer resulting in a permeability ranging from 0.6 to 2.0 inches per hour through the top layer of about 16 – 36 inches. The Lockwood soil has a moderately slow permeability ranging from 0.6 to 2.0 inches per hour in the top layer of about 40 inches.

Soil Erosion is not a problem at the Ranch because the irrigated pasture is very well managed. The Universal Soil Loss Equation dictates an estimated soil loss of 0.075 tons per acre per year under conditions on the pasture; less than the 0.1 to 0.2 tons per acre for pasture lands in California reported by the NRCS National Resources Inventory (1982-1997). Further historic aerial photos taken of the bluff-top area west of the irrigated pasture show that there is no evidence of increased erosion activity. Coastal bluff retreat has been accredited to wave action. In fact, during the irrigation season, there is a natural dry buffer between the pasture and the ocean bluff that allows very minimal, if any, lateral flow of water to the bluff face.

3.2 Soil Characteristics

To assess the irrigation management, methods, efficiencies, and requirements the soil characteristics must be analyzed. The soil properties I observed on the El Sur Ranch pasture were consistent with the soil classifications identified by the U.S. Department of Agriculture Natural Resources Conservation Service (formerly called Soil Conservation Service) Soil Survey for Monterey County, California (USDA-SCS, 1978). There are four soil types that make up the irrigated pasture at the Ranch. Santa Ynez fine sandy loam (Mapping Unit: ShC) is the most predominant, as it is found in 86% of the pasture soil. 8% of the soil consists of Lockwood shaly loam (Mapping Unit: LeC), and the remainder 6% of the soil is Pfieffer fine sandy loam (pdC) and badland soils (Mapping Unit: Ba). The Lockwood shaly loam is located mostly in the western portion of the irrigated pasture. The Pfeiffer fine sandy loam and badland soils are located primarily in the southwest corner of the irrigated pasture (on the pump house field).

The Santa Ynez series are moderately well-drained, with water table depths greater than 6 feet. They are formed primarily on terraces in alluvium derived from sandstone and granitic rock. The available water holding capacity ranges from 3 to 5 inches in 5 feet of rooting depth. The permeability is slow because of the clay subsoil below the top surface layer. In a representative profile, the top layer averages about 18 inches in depth (ranges from 16 to 36 inches), while the clayey subsoil is about 25 inches thick. The top layer typically has permeability ranging from 0.6 to 2.0 inches per hour, while the clayey sub-layer has a permeability rate of less than 0.06 inches per hour. The permeability below the clay subsoil ranges from 0.06 to 0.2 inches per hour. Roots can generally penetrate to a depth of about 5 feet. However, some roots may be restricted by the clay sub-layer to a depth of 15 to 36 inches. Runoff is slow to medium with an average slope of about 3 percent in the study area.

The Lockwood series are well drained alluvial soils derived from siliceous shale on alluvial fans and coastal terraces. The available water holding capacity typically ranges from 6 to 9 inches with a rooting depth of 5 feet. The permeability of the Lockwood series is moderately slow, ranging from 0.6 to 2.0 inches per hour in the top 40 inches and 0.2 to 0.6

inches per hour in rooting depths between 40 and 82 inches. Roots penetrate to a depth of more than 5 feet. Runoff is slow to medium and the water table is generally greater than 6 feet. A soil map of the El Sur Ranch is shown in Figure 3.

The Pfeiffer soils in the pasture are well drained, fine sandy loam. The available water holding capacity typically ranges from 5 to 7.5 inches in the rooting depth. The permeability is moderately rapid, ranging from 2 to 6 inches per hour. The runoff is slow to medium and the erosion hazard is slight.

The small portion of the irrigated pasture classified as Badland soils has been reclaimed by filling in eroded areas and land leveling and is now suitable for irrigated pasture. The water table on the irrigated bench land is below the root zone of the pasture. A summary of the soil properties is shown in Table 1: Typical Soil Properties: Santa Ynez Fine Sandy Loam, Lockwood Shaly Loam, and Pfeiffer Fine Sandy Loam.

Table 1: Typical Soil Properties: Santa Ynez Fine Sandy Loam, Lockwood Shaly Loam, and Pfeiffer Fine Sandy Loam.

Santa Ynez (ShC) (86%)		
Root Depth (in)	Permeability (in/hr)	Available Water Holding Capacity (in/in)
0 – 18	0.6 – 2.0	0.09 – 0.16
18 – 43	<0.06	0.01 – 0.03
43 – 61	0.06 – 02	0.01 – 0.03
Lockwood (LeC)(8%)		
Root Depth (in)	Permeability (in/hr)	Available Water Holding Capacity (in/in)
0 – 40	0.6 – 2.0	0.11 – 0.16
40 – 82	0.2 – 0.6	0.07 – 0.14
Pfeiffer (PdC) (6%)		
Root Depth (in)	Permeability (in/hr)	Available Water Holding Capacity (in/in)
0 – 6	2.0 – 6.0	0.12 – 0.16
6 – 60	2.0 – 6.0	0.06 – 0.11

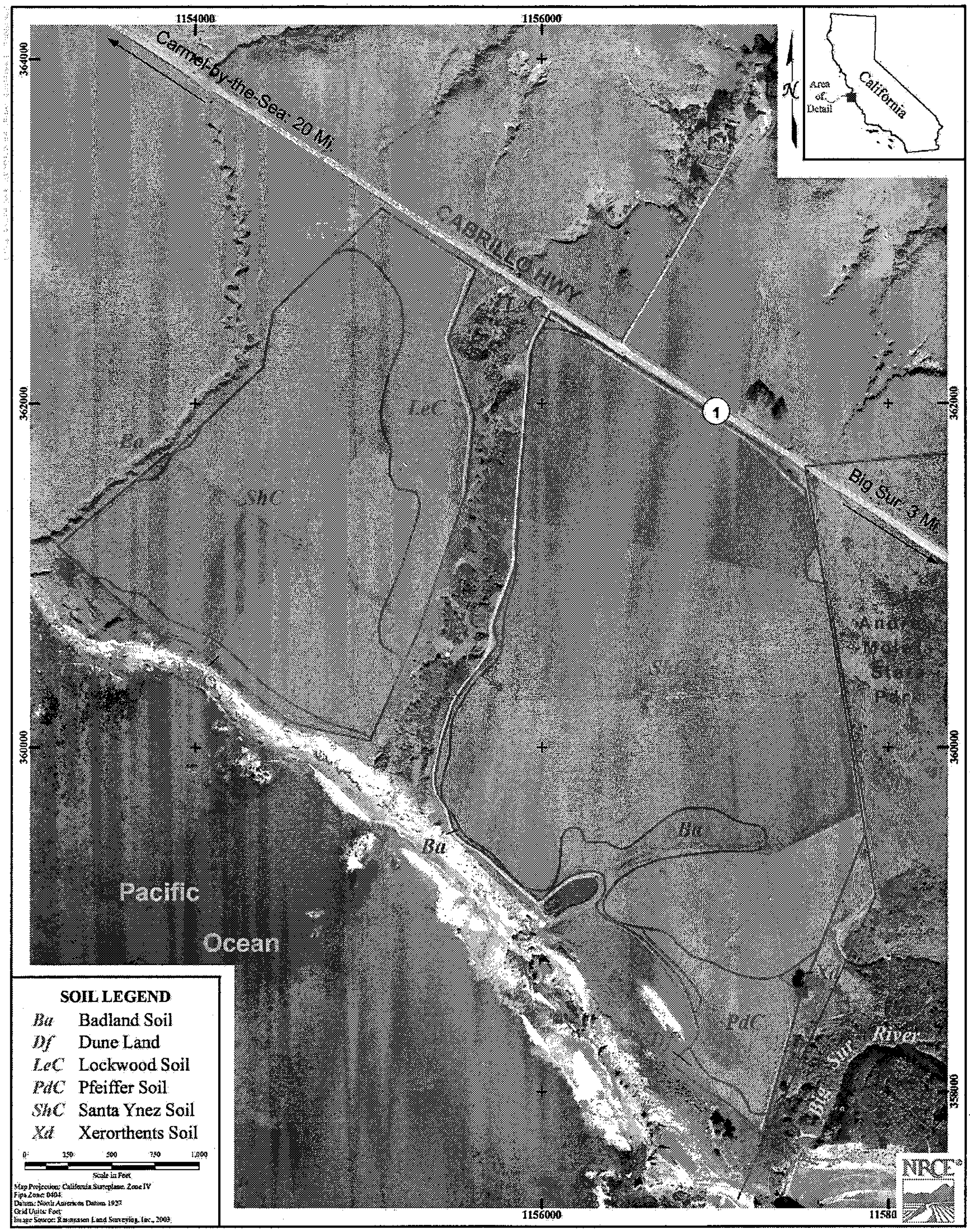

Figure 3: Soils Map of the El Sur Ranch Irrigated Pasture.

3.3 Soil Erosion

In response to concern about potential erosion at the El Sur Ranch, I performed an in-depth analysis of not only the pasture soil characteristics, but also the use of the fields for cattle grazing. I visited the ranch, reviewed studies concerning soil erosion based on the specific soil types at the Ranch and evaluated the potential for soil erosion using the Universal Soil Loss Equation (USLE) published by the U.S. Department of Agriculture in 1965 and other related models (See Exhibit 2, Technical Memorandum dated April 30, 2010 on El Sur Ranch Soil Erosion Study). I also reviewed historical and recent aerial photos of the pasture, Swiss Canyon and the bluff tops west of the irrigated fields.

While not a problem at El Sur Ranch for reasons that I explain below, as a general proposition, grazing has the potential to increase the possibility of erosion. Compaction of the soil surface by cattle can reduce the infiltration of water into the soil profile and may increase the overland sheet flow of water. Loss of plant cover from grazing can also cause increased overland flow rates. Understanding that these concerns exist, the importance of land and water management in grazing operations is seen as the overriding determinant of the potential for erosion from grazing lands. Published studies are in agreement that well-managed grazing lands significantly reduce the potential for erosion, whereas poorly-managed lands can increase the potential for erosion.[2]

The El Sur Ranch pasture is very well managed. Cattle are rotated through the 11 fields, allowing for needed forage growth and protection of soil. Additionally, irrigation of the fields is scheduled to provide needed forage production and to eliminate excessive water application. When possible, irrigation is avoided in fields where the cattle are grazing, thereby limiting soil compaction and the potential for erosion. Application of the USLE with the Water Erosion Prediction Project (WEPP) software for conditions on the pasture provides an estimated soil loss rate of 0.075 tons per acre per year. This is less than 1/1000th of an inch per year soil loss, and less than the erosion rates of 0.1 to 0.2 tons per acre per year for pasture lands in California as reported by the NRCS National Resources Inventory (1982-1997).

2 Huss, 1996; Smiens, 1975; CCWD, 2005; Patric and Helvey, 1986.

There is no evidence of increased erosion activity along the bluff-top west of the irrigated pasture due to irrigation. In fact, an investigation of potential erosion showed that based on: aerial photos taken of the area since 1929; field mapping; and an analysis of prior reports, irrigation of the pasture has had no discernable effect on rates of coastal bluff retreat (Johnson, 2007). According to the Johnson report, coastal bluff retreat is primarily due to wave action. Furthermore, during the irrigation season there is a dry buffer between the westernmost end of the field and the ocean bluff, resulting in very minimal, if any, lateral flow of water to the bluff face, further reducing the potential for erosion. For a more in depth explanation of my analysis and findings, please see a copy of my Soil Erosion Report attached as Appendix B and incorporated into this testimony.

4. ANALYSIS OF CROP WATER REQUIREMENTS

4.1 Introduction

To ascertain the crop water requirement at the El Sur Ranch, several variables must be determined and analyzed. First, an analysis of the amount of water needed for optimal crop growth and productivity must take into consideration the amount of water that evaporates and the amount the plant transpires. Evaporation is the natural process by which water is transformed from a liquid to a vapor. Transpiration is the physiological process by which water, in the form of vapor, is released to the atmosphere through plant leaves. Evapotranspiration (ET) is used to describe the sum of evaporation and plant transpiration. To determine the ET of the forage crops at the El Sur Ranch irrigated fields, a reference ET (ETo) must be modified by consideration of crop type, seasonal growth patterns and site-specific climatic conditions. At the Ranch, the average monthly ETo was calculated using the widely accepted FAO-PM method and ranges from 2.10 inches December to 4.95 inches in June. After the crop's monthly ET rate is determined an analysis of the historical climatic conditions at the Ranch allows an estimation of the long-term historical crop water requirements at ESR. The average annual historical crop water requirement for the Ranch for the period from 1975 - 2006 was calculated to be 43.31 inches or a total of 884 afy – based on 246 irrigated acres.

To determine the amount of the crop water requirement that must be met by irrigation, as opposed to precipitation, an estimate of monthly effective precipitation[3] that the crop can use is subtracted from the average monthly ET. Again using the historical period 1975 – 2006 and based on the calculations for estimating effective rainfall, the long-term effective precipitation at the Ranch averages about 12.3 inches per year out of an estimated average annual precipitation of 27.76 inches. With this information, the net irrigation requirement, or the amount of water that needs to be replaced by irrigation after the soil moisture in the root zone has been depleted by the crop for consumptive use can be calculated. At the El Sur Ranch the average annual net irrigation requirement 31.01 inches or a total of 635 afy – based on 246 irrigated acres.

The net irrigation requirement is not the end of the determination of water need, however. Because at times the irrigation water at the El Sur Ranch is somewhat saline due to the close proximity of the irrigation wells to the ocean, a leaching requirement must be added to the irrigation requirement. The leaching requirement at the Ranch is estimated to be 10%.

Finally, based on specific factors found at the El Sur Ranch such as soil type and uniformity, the crop type, slope of field and available irrigation flow rate, net irrigation requirement must be divided by an irrigation efficiency to calculate the overall amount of water that must be diverted to meet the crop's water requirement for optimal growth and production. The targeted irrigation efficiency at the Ranch is 65 – 70%. Thus, the calculated average annual diversion requirement for the period 1975 – 2006 was 1087 acre feet per year for 246 irrigated acres. An illustration of the factors influencing crop ET are shown in Figure 4.

[3] Not all precipitation is useable by the crop. When the precipitation rate is too great, or the ground is already saturated, much of it runs off the field and some precipitation can infiltrate below the crops roots being unavailable to the crop. The amount of precipitation that infiltrates and is useable to the crop is termed "effective precipitation."

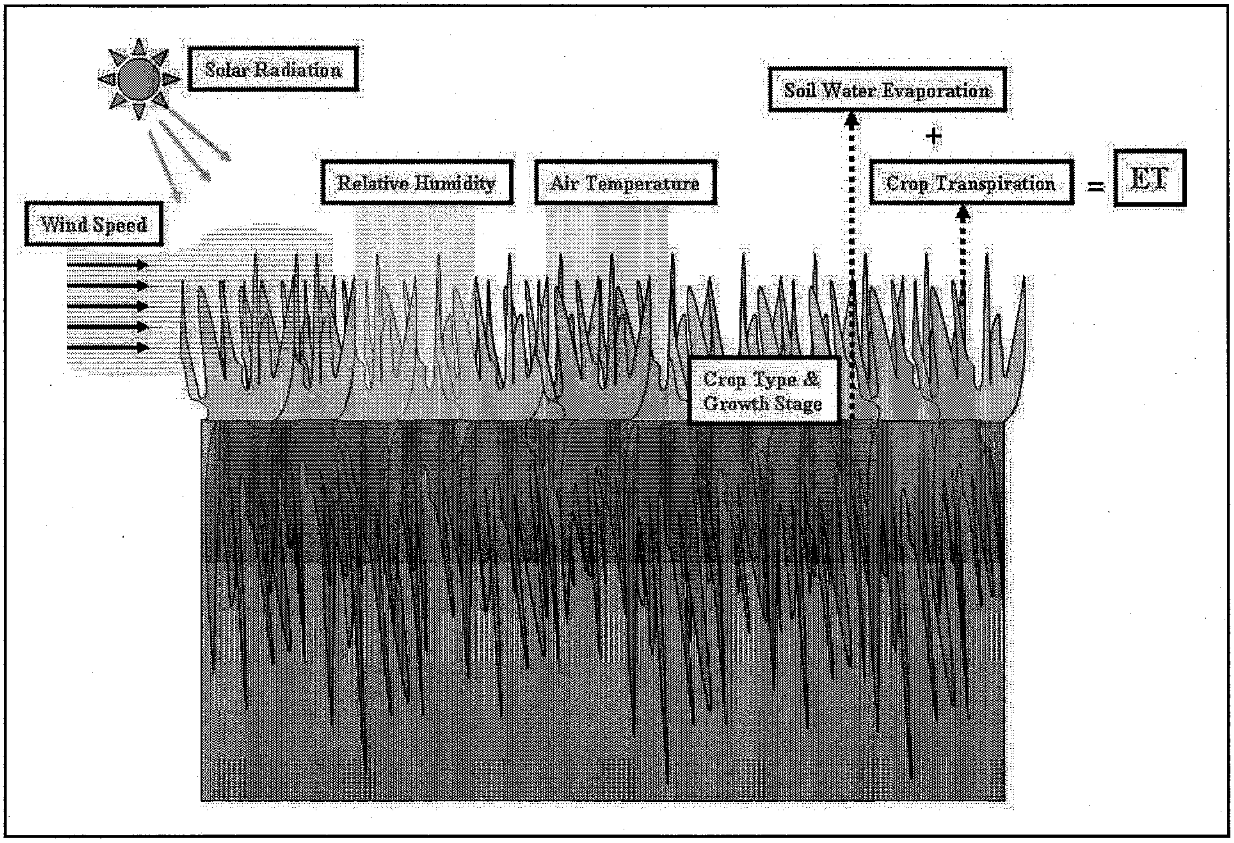

Figure 4: Factors Influencing Crop Evapotranspiration (ET).

An in-depth explanation of the calculations and scientific methods used to analyze the crop water needs at the Ranch is set forth below.

4.2 Reference Evapotranspiration

Reference evapotranspiration (ET_o) is defined as the potential ET rate of a reference crop under optimal conditions, e.g., clipped grass with a fixed five-inch height, well watered, actively growing and shading the soil. Researchers developed ET_o to provide a reference allowing the ET of a specific crop to be estimated without defining a separate ET level for each crop and stage of growth. Grass and alfalfa are widely used around the world as reference crops. For this study, the ET_o was determined using grass as the reference crop. ET_o is initially calculated using only climate data and is therefore only a representation of the evaporating energy of the atmosphere at a specific location and time of year, irrespective of crop and soil characteristics.

4.2.1 Estimation Method

The FAO P-M method to estimate ET has been proven to have global validity as a standardized reference for grass evapotranspiration (Smith et. al., 1991). The P-M is also viewed as producing the most accurate monthly reference crop evapotranspiration (ET_o) estimates when ranked among twenty other evaluated methods (Jensen et al., 1990). In order to determine reference crop evapotranspiration, the FAO P-M method uses climate data such as solar radiation, temperature, humidity, and wind speed. These parameters were measured at the El Sur Ranch weather station from August 2004 to January 2007.[4] The FAO P-M equation and supporting equations, constants, and calculations to determine reference crop evapotranspiration values included in Appendix A. The basic FAO P-M equation for determining ET_o is shown as:

$$ET_o = \frac{0.408\Delta(Rn - G) + \gamma \frac{900}{T+273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34 u_2)}$$

where:

ET_o	=	reference crop evapotranspiration (mm/day)
Rn	=	net radiation at the crop surface ($MJ/m^2/day$)
G	=	soil heat flux density ($MJ/m^2/day$)
T	=	mean daily air temperature at 2 m height (°C)
u_2	=	wind speed at 2 m height (m/s)
e_s	=	saturation vapor pressure (kPa)
e_a	=	actual vapor pressure (kPa)
e_s-e_a	=	saturation vapor pressure deficit (kPa)
Δ	=	slope vapor pressure curve (kPa/°C)
γ	=	psychrometric constant (kPa/°C)

Utilizing this equation and imputing climate data from the Ranch weather stations, the average monthly ET_o at the Ranch was determined to range from 2.10 inches in December to 4.95 inches in June as shown in Table 2.[5]

4 The software program Ref-ET was used to compute the FAO P-M reference crop ET based on the procedures prescribed in the FAO Irrigation and Drainage Paper No. #56 (Allen et. al., 1998).

5 El Sur Ranch Weather Station data was downloaded from the weather station satellite and is attached hereto as Appendix C.

Table 2: Estimated Annual Net Irrigation Requirements for the three Years with the Highest Net Irrigation Requirements.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug*	Sep	Oct	Nov	Dec	Annual
2004	--	--	--	--	--	--	--	3.11	4.4	3.18	2.45	1.91	
2005	1.89	2.14	3.13	3.95	4.45	5.21	5	4.15	3.71	3.68	3.1	2.3	42.71
2006	2.38	2.82	2.86	2.94	3.92	4.69	4.39	3.77	2.56	2.64	2.03	2.09	37.09
2007	2.52	--	--	--	--	--	--	--	--	--	--	--	
Avg.	**2.26**	**2.48**	**3.00**	**3.45**	**4.19**	**4.95**	**4.70**	**3.96**	**3.56**	**3.17**	**2.53**	**2.10**	**40.32**

*August 2004 excluded from the average because the data covered only part of the month

The average annual ET_o for the El Sur Ranch using the FAO P-M method is 40.32 inches. For comparison, the average annual ET_o in Seely, Imperial County, California is 75.4 inches and the average annual ET_o in Castroville, Monterey County, California is 36.2 inches as reported by California Irrigation Management Information System (CIMIS). These locations represent the maximum and minimum of the 133 sites reported by CIMIS.

As previously mentioned, the ET_o calculation assumes standard or reference growth conditions of grass; however, crop height and wind conditions at the El Sur Ranch differ from the standard. To account for these differences, a crop coefficient value is used to determine specific potential crop evapotranspiration. The CIMIS-reported ET_o values are calculated using data from electronic weather stations and a version of the Penman-Monteith equation that is very similar to the FAO P-M used to calculate the ET_o for the El Sur Ranch.

4.3 Crop Coefficient Values at the El Sur Ranch

In general, crop coefficient values are determined by analyzing the following specific data: crop type, crop growth stages, weather conditions, and soil evaporation. The types and varieties of crops affect the calculation of crop coefficient values. Plants that have closer spacing and taller canopy heights and roughness have high crop coefficient values; plants with large leaf resistances, such as citrus trees have small crop coefficient values. The different stages of crop growth are also a factor in determining crop coefficient.[6]

According to FAO#56 (Allen, et. al., 1998), there are two standard sets of crop

[6] (Equations for determining single crop coefficients (as used herein) are contained in my March 2007 Reasonable Beneficial Use – Land Use Study ("March 2007 Study"), section 7.4, and incorporated here as if fully set forth.)

coefficient values used to determine ET_c for pasture grazing. One is for rotated grazing such as utilized on the fields at the El Sur Ranch, and the other is for extensive grazing. The rotated grazing crop coefficients are higher because the taller pastures have the potential transpire more water and produce more forage.

Weather conditions also impact crop coefficient values. The effects of wind speed and relative humidity can increase crop water requirements when the crop is taller than the fixed-height grass reference. When local weather conditions deviate from the standard conditions used to calculate crop coefficient values, those values are adjusted accordingly. As a result, crop coefficient standard values were modified for the weather conditions at the El Sur Ranch. There are two approaches to determining crop coefficient values. The single crop coefficient approach uses single-valued crop coefficients to represent the combined effects of soil evaporation and crop transpiration rate. The value of a single crop coefficient – stated as K_c – is developed by averaging the soil and evaporation over time. A dual crop coefficient approach is divided into two separate individual coefficients to account for the effects of crop transpiration and soil evaporation. The dual crop coefficient requires daily specific information about soil wetting from irrigations and/or precipitation and is generally used for site specific irrigation schedule. For the El Sur Ranch crop water requirement calculation, a single crop coefficient value is more appropriate because of the availability and use of relevant data.

The single crop coefficient value is expressed in the equation:

$$ET_c = K_c * ET_o \qquad (2)$$

where:

ET_c = crop evapotranspiration (mm/day)
K_c = crop coefficient (dimensionless)
ET_o = reference crop evapotranspiration (mm/day

The reference crop evapotranspiration rate does not account for crop types or take crop growth stages into consideration. To account for the different growth stages in calculating the specific crop evapotranspiration rate, crop growth stages, (initial or $K_{c\ ini}$; mid-season or $K_{c\ mid}$; and late season or $K_{c\ end}$) are considered for crops that go through different development stages and/or are dormant in the winter.

Pasture crops at El Sur Ranch are a mix of both grasses (orchard grass, harding, fescue) and legumes (clover, and birdsfoot trefoil).The crop coefficient value for El Sur Ranch, based on rotated grazing and full effective grass cover is estimated to be approximately 1.05 (mid-season stage). The 1.05 K_c value is also suggested by University of California for grasses and clover (UC, 1989). The ET_o value for clipped grass is lower than ET of rotated grazed pasture primarily due to the higher crop height of the pasture. The taller pasture grasses and legumes have more leaf surface area for transpiration and is exposed to more air movement to convey vapor into the atmosphere.

The FAO#56 standard K_c value of 1.05 is based on standard conditions of a sub-humid climate with a minimum relative humidity of 45 percent and an average wind speed of 2.0 m/s (4.47 mph). When local weather conditions deviate from the standard conditions, the K_c values must be modified accordingly. Guidelines are described in the FAO#56 (Allen, et. al., 1998) for adjusting the standard K_c values as a function of weather factors such as wind speed, relative humidity, and crop height. The published standard K_c values were modified for non-standard conditions at El Sur Ranch area. The value of 1.05 was adjusted to 1.06, based on the weather and specific crop conditions, including wind speed, relative humidity and plant height at the El Sur Ranch based on the following equations:

$$Kc_{mid} = Kc_{mid}\,(std.\ conditions) + [\,0.04\,(u_2 - 2) - 0.004\,(RH_{min} - 45)]\left(\frac{h}{3}\right)^{0.3} \quad (4)$$

$$Kc_{end} = Kc_{end}\,(std.\ conditions\,) + [\,0.04\,(u_2 - 2) - 0.004\,(RH_{min} - 45)]\left(\frac{h}{3}\right)^{0.3} \quad (5)$$

where:

$K_{c\ mid,\ end}$ (std. conditions) = $K_{c\ mid,\ end}$ values published in FAO#56 for standard conditions

u_2 = mean value for daily wind speed at 2 m height over grass during the mid-season or end-season growth stage (m/s), for 1 m/s $\leq u_2 \leq$ 6 m/s (estimated at 4.25 m/s based on data collected at the Ranch)

RH_{min} = mean value for daily minimum relative humidity during the mid-season or end-season growth stage (%), for 20% ≤ RH_{min} ≤ 80% (estimated at 62 % based on data collected at the Ranch)

h = mean plant height during the mid-season or end-season stage (m) for 0.1 m < h <10 m (estimated at 0.22 m for rotation grazing on El Sur Ranch)

Equation 5 is applicable only when the published $K_{c\ end}$ (standard conditions) is greater than 0.45 as it is for irrigated pasture. Otherwise when $K_{c\ end}$ (standard conditions) is less than 0.45, $K_{c\ end}$ is equal to $K_{c\ end}$ (standard conditions). Since the grass in this area grows year round without going through dormancy, the K_c at full effective cover ($K_{c\ mid}$) was assumed throughout the year. Therefore, a constant locally adjusted K_c value of 1.06 according to Equation 4 was used to compute the annual crop water requirement of pasture as indicated in Equation 2.

4.4 Historical Climate Conditions

Site specific weather data is necessary to estimate crop water requirement but also needed to assess irrigation efficiency and the beneficial use of irrigation water, effective precipitation, and irrigation requirements. The FAO P-M method to calculate crop evapotranspiration also requires weather data including temperature, solar radiation, relative humidity, and wind speed data in order to estimate the amount of water needed by a particular crop. Long term weather data from the El Sur Ranch irrigated pasture area is unavailable. In this area, significant differences in climate conditions can occur within a short distance, due to the influence of the Santa Lucia Range. Therefore, obtaining site specific climate data was crucial to the analyses set forth in this testimony. To obtain such site specific data, two weather stations were established at the Ranch in August 2004: one located on the irrigated pasture and one near the Old Well. The pasture climate station was situated near the center of the pasture to provide an unambiguous representation of the pasture's climate.

4.4.1 Analysis of El Sur Ranch and Regional Weather Station Data

The weather stations at the El Sur Ranch were leased from FTS, Inc. and included a tipping bucket rain gauge, wind speed and direction sensor, a temperature and humidity sensor, and solar radiation sensor. The two weather stations provided a duplicate set of data in the event a sensor or instrument failed. The El Sur Ranch weather stations recorded maximum, minimum, and average temperature, relative humidity, solar radiation, wind direction and speed, and precipitation, every 15 minutes. Site-specific data was collected from August 2004 to December 2007, and was used to calibrate existing long term climatic data from other regional weather stations.

There are two National Climatic Data Center/National Weather Service Cooperative Network weather stations (NCDC-NWS) located in the region. Station #040790 at Big Sur State Park ("State Park Station") is located approximately 4 miles to southeast of the Ranch and 2.5 miles inland from the coast. Over the last 30 years, the State Park Station recorded an average temperature of about 58° Fahrenheit, and an average annual precipitation of 43.3 inches. This precipitation is influenced by the orographic effects of the high Santa Lucia mountain ranges (over 4,000 feet in elevation) just to the east of the station. Therefore, the precipitation it records is not typical of the lower areas on the coast.

The NWS Station #045795 at Monterey has an elevation of 340 feet, but its precipitation is not influenced by a high mountain range. Over the same 30 year period, the average precipitation at the Monterey station was 20.5 inches, and the average annual mean temperature was about 57° Fahrenheit. Even though the El Sur Ranch weather stations are much closer to the State Park Station there are significant differences in climate data mainly due to the State Park Station's location relative to mountain ranges and the coastline.

While the monthly precipitation patterns for El Sur Ranch, Monterey, and Big Sur State Park for the common period of record are similar, the Monterey data is closer to that of El Sur Ranch. The correlation of weather data from Monterey and the El Sur Ranch and the calibration of crop coefficients (discussed in next section) make it possible to determine the long term crop water use at El Sur Ranch. Figure 6 and Figure 7 show monthly average data for precipitation, temperature, and wind recorded at two regional weather stations and compares those averages with the specific weather data from the El Sur Ranch stations gathered from August 2004 through December 2007.[7] Figure 6 shows the maximum daily average wind speed; this is

[7] Data from the Castroville CIMIS is included for purposes of showing data for calculating ET and also to support why implementation of a sprinkler irrigation system at El Sur Ranch is impractical as explained later in this testimony.

important in the consideration of a sprinkler system as an alternative to surface irrigation as discussed later in my testimony. The wind at El Sur Ranch is also an important consideration in the calculation of crop ET.

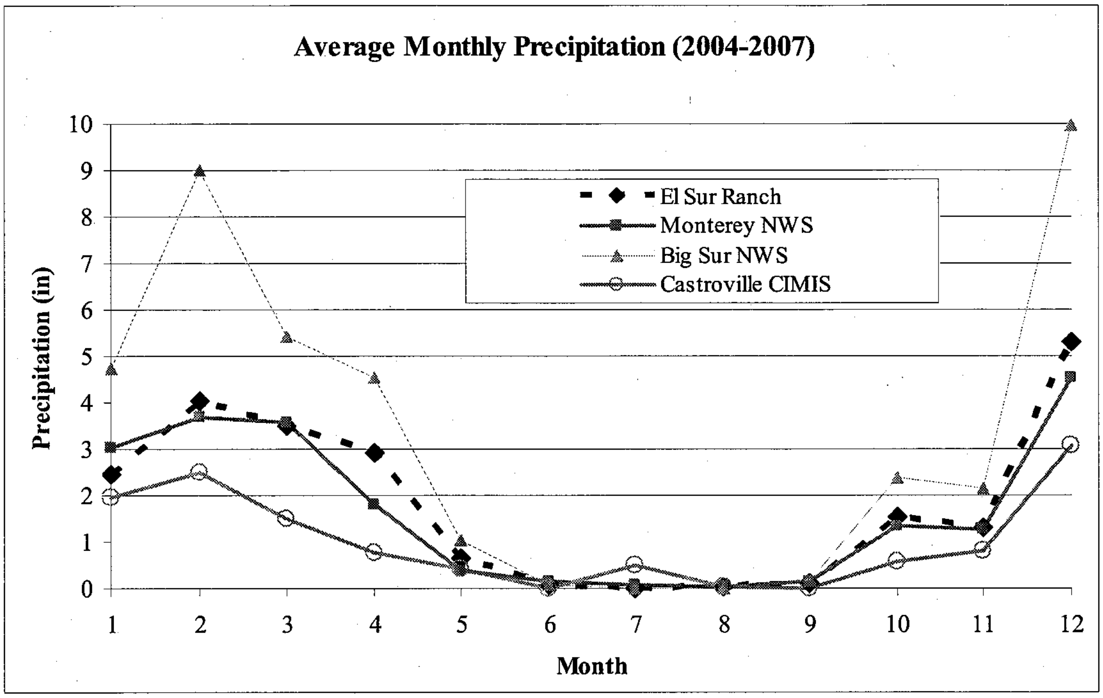

Figure 5: Average Monthly Precipitation from Weather Stations near and at the El Sur Ranch.

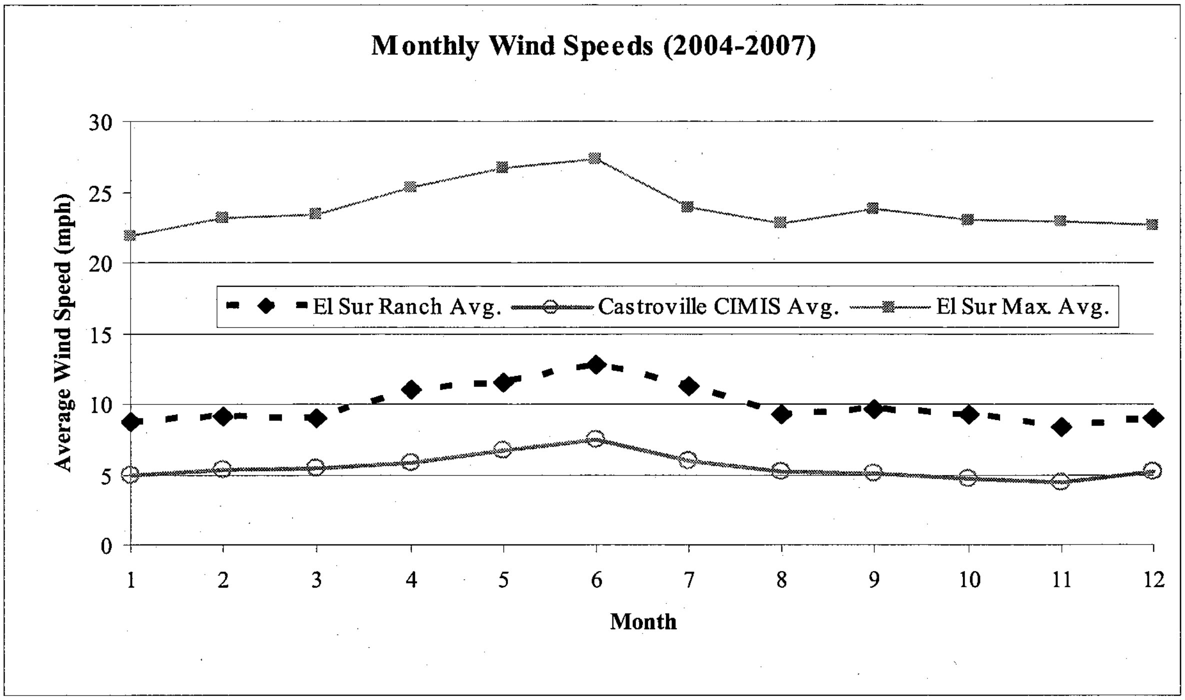

Figure 6: Average Monthly Temperatures from Weather Stations near and at the El Sur Ranch.

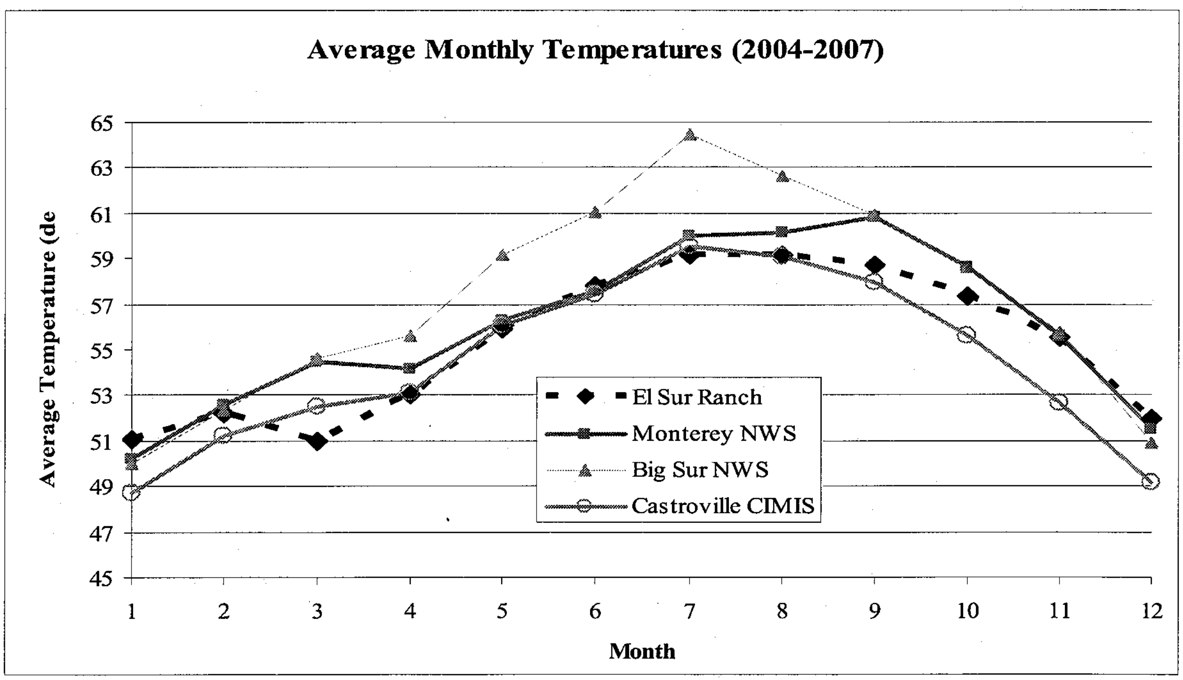

Figure 7: Monthly Wind Speeds from Castroville, CA and at the El Sur Ranch.

4.5 Estimating Long Term Historical Crop Water Requirements

4.5.1 The FAO P-M Method

The FAO P-M method, used to estimate the amount of water a crop needs for growth, or ET, incorporates more physiologically and aerodynamically based parameters than most other methods. The specific crop evapotranspiration can also be calculated by using the following equation:

$$ET_c = K_c * ET_o \tag{6}$$

where:

ET_c = crop evapotranspiration (mm/day)
K_c = crop coefficient (dimensionless)
ET_o = reference crop evapotranspiration (mm/day)

Utilizing the site specific data and the single crop coefficient value, the average monthly ET_c rates (in inches) calculated using the FAO P-M method are set forth in Table 3.

Table 3: Average Monthly ETc (inches) for Pasture at El Sur Ranch (2004-2006).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug*	Sep	Oct	Nov	Dec	Annual
2004	--	--	--	--	--	--	--	3.11	4.66	3.37	2.60	2.02	
2005	1.94	2.27	3.32	4.19	4.72	5.52	5.30	4.40	3.93	3.90	3.29	2.44	45.21
2006	2.52	2.99	3.03	3.12	4.16	4.97	4.65	4.00	2.71	2.80	2.15	2.22	39.32
2007	2.67	--	--	--	--	--	--	--	--	--	--	--	
Avg.	**2.38**	**2.63**	**3.17**	**3.65**	**4.44**	**5.25**	**4.98**	**4.20**	**3.77**	**3.36**	**2.68**	**2.23**	**42.72**

*August 2004 excluded from the average as the data covered only part of the month

But because the average monthly ET_c rates shown above provide rates only for the period the Ranch weather stations were in operation, it was necessary to calibrate the SCS Blaney-Criddle (SCS B-C) method with the FAO P-M method to calculate historical crop evapotranspiration rates for El Sur Ranch and allow the comparison of historical crop water requirements to historical pumping rates.

4.5.2 The SCS B-C Method

The SCS B-C method was first formulated with numerous measurements of evapotranspiration starting in the early 1920s. At that time, evapotranspiration was measured by taking soil samples at two different dates, oven-drying them and measuring the differences in soil moisture. Today the SCS B-C method analyzes the relationship between evapotranspiration, temperature, and percentage of daytime hours. SCS B-C is an appropriate method to determine crop water requirement as the information required for the calculation is readily available, including temperature data from the NWS #5795 Monterey weather station. The SCS B-C method was used here to extend the results reached with the critical FAO P-M three-year "snapshot" calculation. The SCS B-C (USDA-SCS, 1970) equation is expressed as follows:

$$u = \frac{k_c k_t t p}{100} \tag{7}$$

where:

u	=	monthly crop evapotranspiration (inches)
t	=	monthly mean temperature (F)
p	=	percentage of yearly daylight hours occurring during a particular month
k_c	=	monthly SCS crop growth coefficient
k_t	=	climatic coefficient calculated as:
k_t	=	$0.0173\ t - 0.314$, $k_t >= 0.30$

The SCS B-C method does not directly account for wind and humidity which can significantly impact crop water requirements, and therefore it is necessary to calculate a crop coefficient to determine crop water requirements at the Ranch. The crop growth stage coefficients (k_c) from the <u>SCS Technical Release 21 (Irrigation Water Requirements)</u> vary from 0.49 in January to 0.92 in June and July (USDA-SCS, 1970). Crop water use calculated with this method is significantly less than crop water use calculated using the site-specific data-driven recommended FAO P-M method, and therefore the two methods must be calibrated to each other to determine long term-term requirements.

4.5.3 Calibrating the FAO P-M and SCS Blaney-Criddle Methods

In order to calculate a long term historical crop water requirement, we developed a new set of calibrated SCS monthly crop growth coefficients (K_c) to correlate and reflect the ET_c

values determined by the FAO P-M method.[8] After the monthly crop growth coefficients were calibrated for each month and year, an average monthly crop growth coefficient for each respective month was computed using calibrated crop growth coefficients. These site-specific average monthly crop growth coefficients for the pasture crop were then instead of the standard growth crop coefficients to compute the long-term crop water requirement.

The empirical SCS B-C equation was used to develop a new set of calibrated SCS monthly crop growth coefficients ($k_{c\text{-}cal}$) for the SCS B-C equation instead of using the standard monthly growth coefficient curves presented in the USDA-SCS (1970). These new SCS B-C crop growth coefficients were calibrated to reflect the ET_c values set forth above. As these new growth coefficients are correlated to the El Sur Ranch weather station data, they provide a more accurate reflection of the growing conditions at El Sur Ranch. This was accomplished by setting the FAO P-M and SCS B-C equations (i.e., Equations 1 and 7) equal to each other on a monthly basis for the period August 2004 to January 2007, using their respective climate data sources, and then solving for the monthly crop growth coefficients ($k_{c\text{-}cal}$) as the calibrated parameter. A mathematical expression of this calibration approach is shown as the following:

$$k_{c\text{-}cal} = \frac{ET_C}{k_t \, t \, p/100} \qquad (8)$$

where:

$k_{c\text{-}cal}$ = calibrated monthly SCS crop growth coefficient
ET_c = monthly evapotranspiration calculated from the theoretical FAO P-M equation (inches)
k_t = climatic coefficient
t = monthly mean temperature (°F)
p = percentage of yearly daylight hours occurring during a particular month

The SCS-BC equation was computed based on the Monterey (NWS#5795) average monthly air temperature. The variables (i.e., maximum and minimum temperature, relative humidity, solar radiation, and wind speed) measured at the El Sur Ranch weather stations were

[8] A detailed explanation of the methodology employed to determine the long term historical crop water requirement at the El Sur Ranch is set forth in my March 2007 Study, section 7.4.4, previously submitted to this Board and incorporated here as if fully set forth.

applied to the FAO P-M equation in the calibration procedure of the crop growth coefficients.[9] After the monthly crop growth coefficients were calibrated for each month and year, an average monthly crop growth coefficient for each respective month was computed from the calibrated crop growth coefficients. Table 4: Calibrated SCS Monthly Crop Growth Coefficients for the SCS B-C Method (no units).Table 4: Calibrated SCS Monthly Crop Growth Coefficients for the SCS B-C Method (no units). lists the average calibrated monthly SCS crop growth coefficients for the period from September 2004 to January 2007.

Table 4: Calibrated SCS Monthly Crop Growth Coefficients for the SCS B-C Method (no units).

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pasture	1.13	1.19	1.15	1.18	1.20	1.29	1.14	.98	0.94	0.96	1.04	1.06

The average monthly crop growth coefficients for the pasture crop thus developed were then used instead of the standard SCS B-C crop growth coefficients indicated in the SCS-BC equation (Equation 7) to compute the long-term crop water requirement specific to the El Sur Ranch. Figure 8 illustrates the method for calculating the calibrated crop growth coefficients and the long-term crop ET. These estimates were based on historical temperature data from the Monterey (NWS#5795) station from 1949 to 2006. The monthly ET_c estimates from 1949 to 2006 based on the calibrated SCS B-C equation are presented in Appendix C of my 2007 Report and are incorporated here as if set forth fully.

[9] The monthly ET_c values derived from the FAO-PM equation were based on the monthly sum of daily computations.

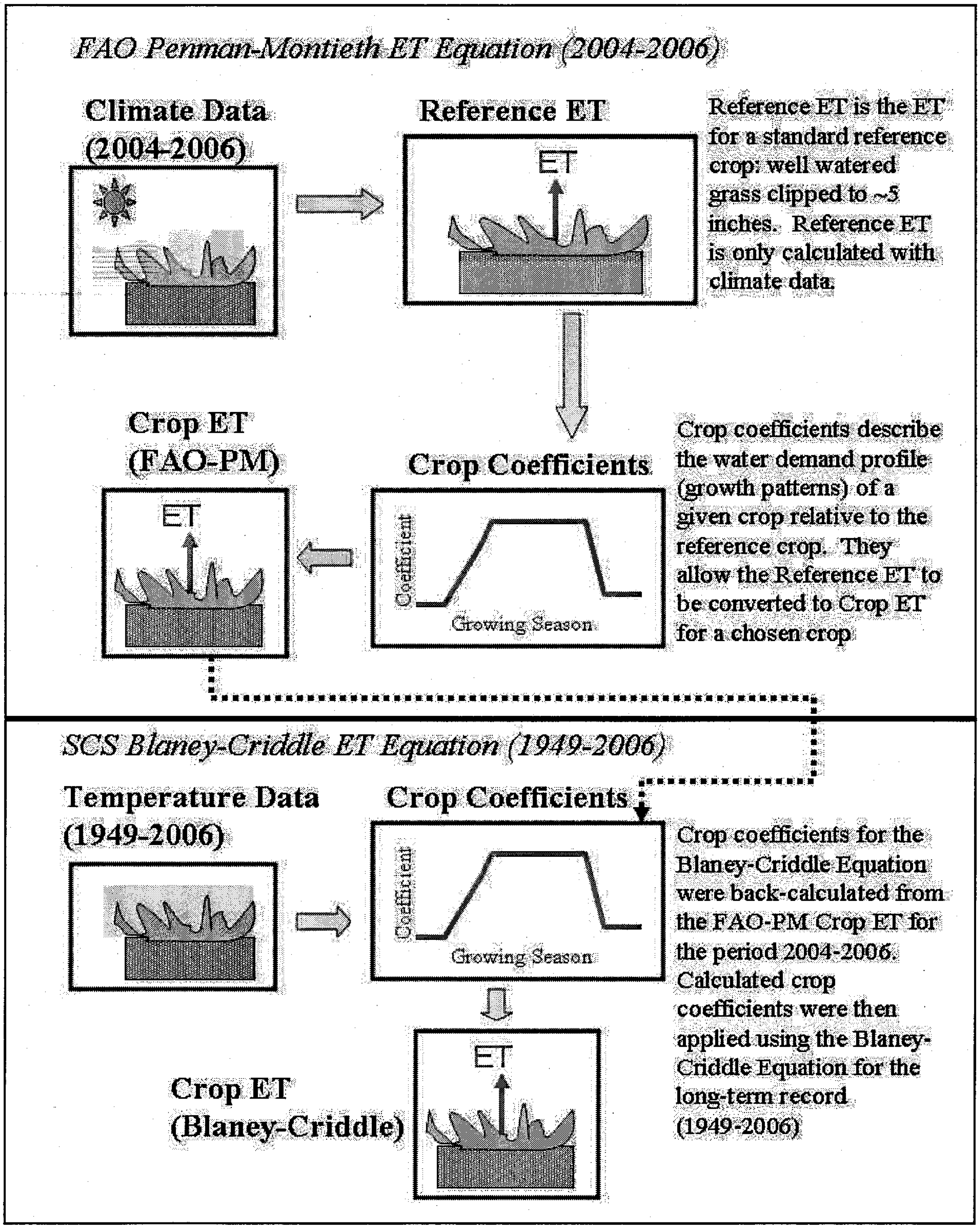

Figure 8: Calculation of Long-Term Crop ET using Calibrated Crop Coefficients for the SCS Blaney-Criddle Equation

The resulting estimated monthly crop water requirements for 1975 – 2006 are listed in Table 5.[10] The calculated average annual crop water requirement for the El Sur Ranch for that period is 43.31 inches.

Table 5: Monthly Crop Water Requirements, 1975 - 2006 (inches).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1975	2.40	2.48	2.92	3.02	4.33	4.87	4.95	4.16	3.42	2.99	2.40	2.07	40.02
1976	2.64	2.48	2.92	3.33	4.53	5.75	5.15	4.50	3.85	3.52	3.11	2.51	44.28
1977	2.40	2.85	2.78	3.49	4.14	5.08	5.15	4.50	3.85	3.25	2.86	2.51	42.87
1978	2.64	2.72	3.83	3.66	4.93	5.30	4.95	4.33	4.15	3.39	2.40	1.87	44.16
1979	2.17	2.36	3.21	3.66	4.72	5.30	5.15	4.33	4.30	3.52	2.62	2.51	43.86
1980	2.64	2.98	3.21	4.00	4.14	5.08	5.36	4.00	3.71	3.52	2.86	2.74	44.24
1981	2.77	2.85	3.21	3.66	4.33	5.75	4.75	4.00	3.42	3.12	2.86	2.40	43.11
1982	2.06	2.72	2.92	3.83	4.14	4.87	4.75	4.16	3.71	3.39	2.51	2.18	41.23
1983	2.64	2.72	3.36	3.66	4.53	5.30	5.36	4.85	4.46	3.80	2.62	2.40	45.70
1984	2.40	2.60	3.51	3.33	4.72	4.87	5.57	4.33	4.62	3.12	2.51	1.97	43.56
1985	2.17	2.60	2.78	3.83	4.14	5.75	5.36	4.16	3.71	3.25	2.18	2.29	42.21
1986	2.89	2.98	3.67	3.66	4.53	5.52	4.95	4.00	3.42	3.25	2.86	2.29	44.02
1987	2.29	2.72	3.36	4.17	4.93	5.30	4.95	4.50	3.71	3.66	2.62	1.97	44.17
1988	2.40	2.85	3.51	4.00	4.33	5.30	5.15	4.50	3.56	3.12	2.51	2.07	43.31
1989	2.17	2.13	3.36	4.35	4.33	5.52	4.75	4.16	3.42	3.39	2.86	2.40	42.84
1990	2.40	2.24	3.06	4.00	4.53	5.52	5.36	4.67	3.85	3.39	2.74	1.77	43.53
1991	2.29	2.85	2.78	3.49	3.96	4.87	4.95	4.33	3.56	3.39	2.62	2.18	41.26
1992	2.52	3.11	3.51	4.72	5.13	5.75	5.78	4.33	3.85	3.80	2.98	2.18	47.67
1993	2.40	2.60	3.67	4.00	5.13	5.98	5.36	4.67	3.56	3.80	2.86	2.29	46.32
1994	2.64	2.48	3.67	3.83	4.33	5.08	4.56	4.16	3.85	3.39	2.18	2.07	42.23
1995	2.77	2.98	3.51	3.83	4.33	5.30	5.78	4.50	3.85	3.66	3.11	2.40	46.01
1996	2.77	2.98	3.51	4.35	4.93	5.08	5.36	4.16	3.56	3.39	2.62	2.40	45.11
1997	2.52	2.72	3.51	4.00	5.77	5.30	5.15	4.85	4.30	3.52	2.98	2.18	46.82
1998	2.64	2.60	3.36	3.66	4.53	5.30	4.95	4.33	3.71	3.12	2.40	1.77	42.36
1999	2.40	2.36	2.64	3.33	3.78	4.66	4.75	4.16	3.56	3.52	2.62	2.29	40.07
2000	2.40	2.72	3.06	4.00	4.72	5.52	4.56	4.00	4.00	3.12	2.18	2.40	42.68
2001	2.29	2.36	3.21	3.02	4.93	5.52	4.75	4.00	3.42	3.25	2.62	2.07	41.44
2002	2.06	2.72	2.92	3.49	3.96	4.66	4.75	4.00	3.71	2.99	2.86	2.18	40.30
2003	2.89	2.48	3.21	3.33	4.14	5.30	4.95	4.33	4.00	3.39	2.29	2.18	42.48
2004	2.13	2.40	3.82	3.95	4.54	4.97	4.99	4.22	4.66	3.37	2.60	2.02	43.68
2005	1.94	2.27	3.32	4.19	4.72	5.52	5.30	4.40	3.93	3.90	3.29	2.44	45.21
2006	2.52	2.99	3.03	3.12	4.16	4.97	4.65	4.00	2.71	2.80	2.15	2.22	39.32
Avg.	**2.45**	**2.65**	**3.26**	**3.75**	**4.51**	**5.28**	**5.07**	**4.30**	**3.79**	**3.38**	**2.65**	**2.23**	**43.31**

[10] These estimates are based on the SCS B-C equation calibrated to crop water requirements estimated by the FAO P-M method using the El Sur Ranch pasture weather data.

4.6 Comparison of El Sur Ranch Monthly Water Requirements with CIMIS

With the calculated crop water requirement for the El Sur Ranch pasture completed, I compared the site specific values to those values obtained for ET zones prepared by the State Department of Water Resources (DWR). DWR's Office of Water Use Efficiency utilizes the California Irrigation Management Information Service (CIMIS) program to manage a network of automated weather stations. (DWR, 2005). CIMIS was developed in 1982 by the DWR and the University of California at Davis to assist California's irrigators in managing their water resources efficiently. For purposes of determining calculated ET rates, researchers divided California into 18 reference ET zones based largely on ET_o calculations from the CIMIS weather station network. The El Sur Ranch is physically located in Zone 1 but adjacent to Zone 6 (See Figure 9). The calculated ET_c at the Ranch is similar to Zone 1 in the summer months because the ocean influence keeps the temperatures lower in the summer than in Zone 6 which is further inland. In the winter months ET at the Ranch is similar to Zone 6, in part due to El Sur Ranch temperatures being similar those in Zone 6 during the winter. The comparison of the monthly ET_c values is shown in Figure 10. The CIMIS data was used as a check on of the calculated water use. Because there are no CIMIS weather stations close to El Sur, weather stations were installed on the El Sur Ranch to provide site specific weather data.

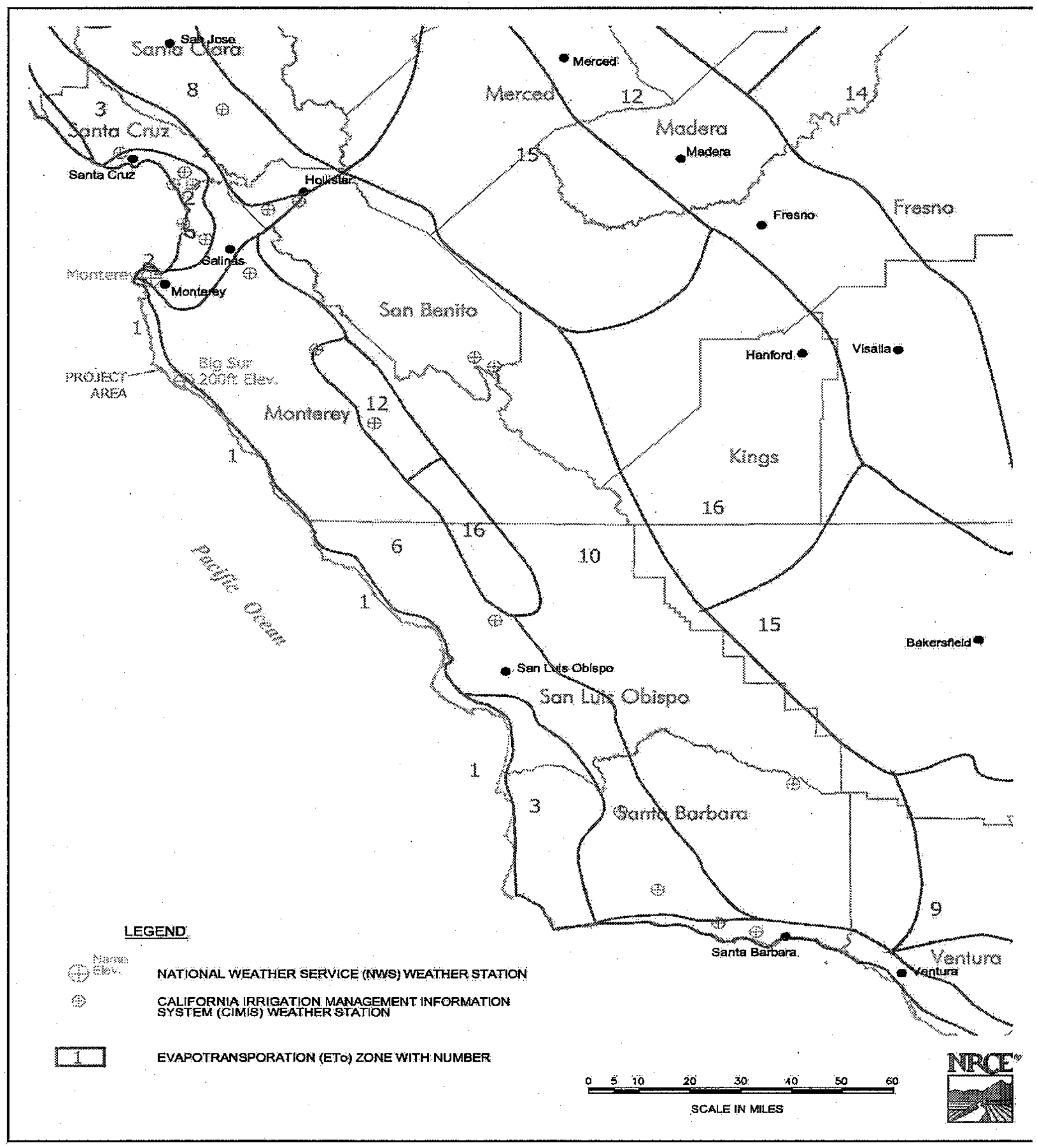

Figure 9: Locations of CIMIS weather stations around El Sur Ranch, California

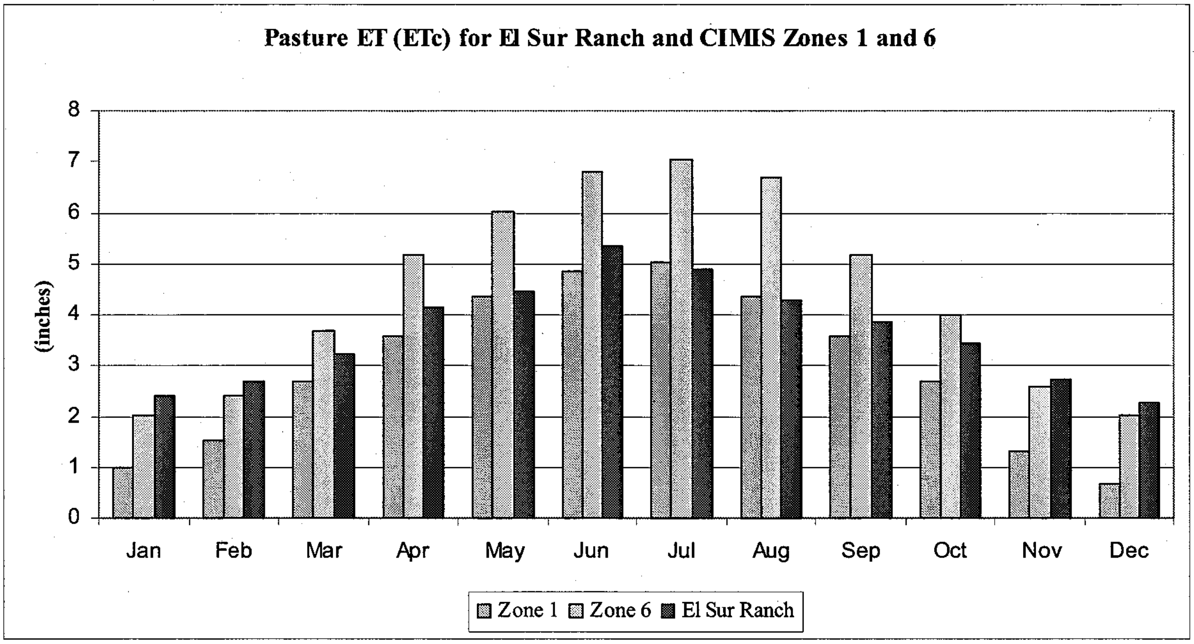

Figure 10: Monthly Pasture ET for El Sur Ranch and CIMIS Climate Zone 1 and Zone 6

4.7 Effective Precipitation|

In determining how much irrigation water a crop needs, it is also necessary to estimate the amount of monthly precipitation that the crop can directly use during the growing season. Effective precipitation is that portion of the total precipitation that satisfies or reduces crop evapotranspiration (ET_c) requirements. The rainfall that can be effectively used by crops is dependent upon the amount, timing, and intensities of rainfall; soil permeability; soil water-holding capacity; runoff characteristics; and the rate of ET_c. Effective rainfall for a given growing season may be estimated using the USDA-SCS (1970) technique reflected as:

$$EP_g = f(D)(0.70917\, P_T^{0.82416} - 0.11556)(10^{0.02426\, ET}) \quad (9)$$

subject to $EP_g \le P_T$ or $EP_g \le ET$

where,

EP_g	=	monthly effective precipitation (inches)
P_T	=	monthly total precipitation (inches)
ET	=	monthly crop ET (inches)
D	=	normal depth of depletion prior to irrigation (set at 2.5 inches in this study)
f(D)	=	$0.531747 + 0.295164D - 0.057697D^2 + 0.003804D^3$

The USDA-SCS calculation takes monthly total precipitation (inches), monthly crop ET (inches), and normal depth of depletion prior to irrigation into consideration in determining the monthly effective precipitation. The long-term rainfall for the El Sur Ranch irrigated pasture was estimated based on a correlation between rainfall at the NWS #5795 Monterey weather station and the specific rainfall data gathered from the weather stations at the El Sur Ranch. The average total annual estimated precipitation for the period 1975 – 2006 was about 27.26 inches with about 82 percent of the total rainfall (or 22.41 inches) occurring from November through March. Based on the calculations for estimating effective rainfall, the long-term (1975-2006) effective precipitation averages about 12.3 inches per year. Thus, the average estimated amount of precipitation that reduces ET_o requirements at the El Sur Ranch 12.3 inches out of an estimated average precipitation of 27.26 inches.

Most of the effective precipitation occurs from October through April. The effective precipitation ranged from a high of 19.32 inches in 1983 (after a total of 51.27 inches of precipitation) to a low of 8.61 inches in 1977 (after a total of 17.52 inches of precipitation).

4.8 Net Irrigation Requirement

The net irrigation requirement is the water that needs to be replaced by irrigation after the soil moisture in the root zone has been depleted due to consumptive use by the crop replenished by precipitation. In other words, the amount of irrigation water that is required for optimal crop growth. The equation to measure the net irrigation requirement is the average monthly crop evapotranspiration (ET_c) less the amount of water contributed by effective precipitation during the growing season. The net irrigation requirement is estimated on a monthly basis from the monthly ET of the pasture minus the effective precipitation, and is expressed as:

$$NIR = ET_c - EP_g \qquad (10)$$

where:

NIR = average monthly net irrigation requirement (inches)
ET_c = average monthly crop evapotranspiration (inches)
EP_g = average monthly effective precipitation (inches)

The month by month net irrigation requirements for the El Sur Ranch based on the above calculation are listed in Table 6.

Table 6: Net Irrigation Requirements for El Sur Ranch Irrigated Pasture (does not include leaching requirement).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
	(inches)												
1975	1.24	0.00	0.00	1.49	4.33	4.75	4.83	3.75	3.42	1.51	1.93	1.76	29.00
1976	2.52	0.11	1.58	1.79	4.53	5.62	5.15	3.53	3.45	2.95	2.44	0.78	34.45
1977	0.93	2.09	1.27	3.49	2.98	5.08	5.15	4.50	3.22	3.18	2.37	0.00	34.26
1978	0.00	0.00	0.00	0.00	4.93	5.30	4.95	4.33	3.89	3.39	0.64	0.56	27.97
1979	0.00	0.00	0.00	3.10	4.45	5.30	4.80	4.32	4.30	1.91	0.33	0.00	28.52
1980	0.00	0.00	1.16	2.37	3.58	5.08	4.59	3.99	3.69	3.52	2.81	1.26	32.05
1981	0.00	1.05	0.04	2.75	4.19	5.75	4.75	3.89	3.42	1.31	0.00	0.98	28.13
1982	0.00	0.75	0.00	1.15	4.14	4.33	4.72	4.16	2.36	1.39	0.00	0.00	23.02
1983	0.00	0.00	0.00	0.10	4.29	5.16	5.36	4.85	3.26	3.35	0.00	0.00	26.37
1984	2.37	0.63	2.36	2.63	4.51	4.73	5.57	4.33	4.62	1.33	0.00	0.33	33.40
1985	1.21	1.40	0.00	3.10	3.85	5.49	5.33	4.16	3.60	1.82	0.00	1.02	30.97
1986	1.09	0.00	0.00	3.26	4.09	5.52	4.95	4.00	2.54	3.19	2.64	0.87	32.16
1987	0.00	0.29	0.98	3.65	4.84	5.30	4.95	4.50	3.71	2.61	1.06	0.00	31.89
1988	0.60	2.18	3.45	2.23	3.70	5.03	5.15	4.50	3.56	3.01	0.30	0.00	33.72
1989	0.86	0.34	0.92	3.38	4.02	5.52	4.75	4.16	2.52	1.88	1.64	2.30	32.30
1990	0.00	0.00	1.66	3.14	2.80	5.52	5.36	4.67	3.85	3.31	2.27	0.41	33.00
1991	1.66	0.95	0.00	3.04	3.76	4.87	4.95	4.10	3.56	2.21	2.55	0.00	31.65
1992	0.70	0.00	0.28	4.72	5.13	5.59	5.78	4.30	3.85	3.17	2.86	0.00	36.39
1993	0.00	0.00	1.05	3.10	4.27	5.06	5.36	4.67	3.56	3.71	1.34	0.49	32.62
1994	0.22	0.00	3.23	2.54	3.50	5.08	4.56	4.16	3.85	3.09	0.00	0.13	30.37
1995	0.00	2.31	0.00	1.83	3.76	3.88	5.78	4.50	3.85	3.66	2.94	0.49	33.00
1996	0.00	0.00	1.05	3.44	3.60	5.08	5.36	4.16	3.56	2.40	0.48	0.00	29.14
1997	0.00	2.57	3.39	3.62	5.72	5.30	5.15	4.65	4.30	2.97	0.00	0.00	37.66
1998	0.00	0.00	0.01	0.83	2.11	4.96	4.72	4.33	3.52	2.56	0.04	0.38	23.46
1999	0.00	0.00	0.00	1.55	3.78	4.36	4.75	4.16	3.41	3.38	1.21	2.19	28.80
2000	0.00	0.00	1.17	3.09	3.91	5.52	4.56	4.00	3.61	0.00	1.70	2.15	29.71
2001	0.00	0.00	1.13	1.15	4.93	5.52	4.75	3.97	3.36	3.11	0.26	0.00	28.17
2002	0.82	1.35	1.65	3.10	2.90	4.63	4.75	4.00	3.71	2.99	0.89	0.00	30.79
2003	1.54	0.57	2.16	1.02	3.21	5.30	4.95	4.33	4.00	3.15	0.84	0.00	31.07
2004	0.55	0.00	3.19	3.93	4.54	4.94	4.87	4.22	4.60	0.47	1.63	0.00	32.94
2005	0.00	0.00	3.22	3.53	4.24	5.41	5.30	4.40	3.93	3.90	2.23	0.00	36.16
2006	2.52	2.64	0.55	0.00	3.38	4.97	4.65	4.00	2.71	2.80	1.06	0.00	29.29
Avg.	**0.59**	**0.60**	**1.11**	**2.44**	**4.00**	**5.12**	**5.02**	**4.24**	**3.59**	**2.60**	**1.20**	**0.50**	**31.01**
Max.	**2.52**	**2.64**	**3.45**	**4.72**	**5.72**	**5.75**	**5.78**	**4.85**	**4.62**	**3.90**	**2.94**	**2.30**	
Maximum Annual (1997)													**37.66**

5. LEACHING REQUIREMENT

5.1 Introduction

The accumulation of excess soluble salts in the root zone of soils can affect a crop's productivity. The predominant mechanism causing the accumulation of salt in irrigated agricultural soils is evapotranspiration, which leaves behind the minerals from the water, which then accumulate and concentrate. Too much salt in the soil can lead to loss of stand, reduced crop growth, reduced yields and ultimately crop failure. To prevent the accumulation of excessive salts, more water than required to meet the net irrigation requirement must be applied to pass through the root zone, carrying with it and leaching the excessive salts. The additional irrigation water is called the leaching requirement. The leaching requirement for the Ranch is estimated to be 10%.

5.2 Assessing the Leaching Requirement at El Sur Ranch

The amount of salinity in irrigation water and the ability of the characteristics of the irrigated soil are taken into consideration when adding a leaching requirement to the calculated net irrigation requirement. This allows an ultimate assessment of the amount of water necessary for optimal crop growth and production. The accumulation of salt in the root zone can affect plant growth and yields by reducing the ability of plant roots to absorb water. Salinity, pertaining to irrigation water, is defined as the total amount of dissolved solids in the water. The response of a crop to soil salinity varies with conditions of growth, such as climatic and soil conditions, agronomic and irrigation management, crop variety, and stage of growth.

Leaching is applying more water than is used by the crop for ET so that the soil salinity is lowered. Leaching is required to prevent the salt concentration in the soils from significantly reducing crop production (more than 10 percent) when irrigating with saline water. The leaching requirement is the fraction of the total amount of applied water that must pass through the root zone to prevent a significant reduction in crop yield.

High salinity in the irrigation water at the Ranch occurs only when the Old Well is in operation. Under current operation, the Old Well is shut down when salinity levels are greater than 1,000 μS/cm (microsiemens per centimeter). A review of daily water reports indicates that for some years the average salinity of pumped water from the Old Well is about 520 μS/cm the average salinity of water pumped from the new well is about 370 μS/cm. Using the traditional equation for leaching requirement defined by Rhoades (1974)[11], the leaching requirement is estimated to be about 7 percent under ideal conditions where the applied water is evenly applied to a uniform soil profile. Such conditions do not exist at El Sur Ranch because in part, the Ranch soil has non-uniform infiltration rates due to soil textures and cracking soils. Moreover, the soil conditions at the Ranch are not ideal for leaching (clay soils require more water to leach than sandy soils). Considering the irrigation and soil conditions at the El Sur Ranch, a leaching requirement of 10% is added to the crop water requirement analysis. The estimate is based on the calculated leaching requirement and judgment due to the characteristics of the soils.

The concept of leaching efficiency was developed to take into account the differences in soil and field conditions such as those mentioned in the preceding paragraph. In general, the leaching efficiency may be defined as the quantity of soluble salts leached per unit volume of water applied. For example in heavy cracking soils, the infiltrated water will flow rapidly through larger pores or cracks with less contact time other portions with the soils. This causes the drainage water to be less saline, thus removing less salt from the soil. The approach to leaching efficiency is to consider the deep percolation water draining from the root zone as a mixture of soil water and irrigation water that has passed unaltered in the root zone. Thus, an allowance must be made for the leaching efficiency in determining the leaching requirement for maintaining the soil salinity level in the root zone.[12]

Heavy, fine-textured soils with larger macropores will tend to have a lower leaching efficien+cy than light coarse-textured soils due to preferential flow of irrigation water through the larger pores and cracks in the heavy soils. Leaching efficiency rates, which vary from 20 to 60 percent for heavy and light soils, respectively, result in an increase of 1.75 times irrigation water for heavy soils to leach out excess salt as compared to light soils – assuming all things equal except for the differences in leaching efficiency.

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[11] A more complete explanation of the traditional equation used to determine the leaching requirement is found in my 2007 Report at section 8, pages 8-1 through 8-8-4.

[12] See Boumand and van der Molen (1964) and Bouwer (1969).

Because most of the soil on the Ranch has a very heavy clay layer at about 18 inches depth, the leaching efficiency is quite low. Therefore, considering a salinity of 500 μS/cm, a leaching fraction of 10 percent is considered appropriate for the irrigation efficiency analysis. This increases the irrigation requirement by about 11 percent (1.0 divided by 0.9).

Wintertime precipitation provides some leaching benefit, but the total leaching requirement is based on providing a favorable environment for the pasture during the entire year. During years of adequate winter leaching benefit from precipitation, less irrigation water would be applied for leaching.

6. EL SUR IRRIGATION EFFICIENCY

6.1 Introduction

When determining how much water needs to be diverted for irrigation, the analysis must include a technical understanding of reasonable and beneficial use. This analysis takes many factors into consideration, such as: the type of crop, climate, including effective precipitation, quality of water supply, and the irrigation system. El Sur Ranch beneficially uses irrigation water for crop production.

In addition to an analysis of reasonable and beneficial use, ascertaining the amount of water that needs to be diverted for irrigation comprises three things: the net irrigation requirement; the leaching requirement, and irrigation system efficiency. Irrigation and leaching requirements have been analyzed and discussed previously in this testimony. In assessing an irrigation system's efficiency, several factors are considered including, but not limited to: soil type and water intake rate, soil uniformity, slope of field; and system type, capacity, and layout. For irrigation conditions at the El Sur Ranch, high irrigation efficiencies (over about 75 percent) is concluded to result in under irrigation and result in loss of production. Based on the site specific factors mentioned in this section, the irrigation efficiency target at El Sur Ranch is between 55% - 75%. A reasonable achievable efficiency at the Ranch is approximately 65%. The reasonable irrigation efficiency was based in part on analysis of irrigation adequacy from aerial photographs and the associated irrigation efficiency (i.e. the 1997 and 2003 aerial photographs show under-irrigation with efficiencies of about 80 percent).

To determine irrigation efficiencies, records of historical pumping for both wells were calculated using a formula of electrical use and pumping rate to determine diversion amounts. With this information, historical irrigation efficiencies for the Ranch were calculated.

6.2 Reasonable and Beneficial Use[13]

From an irrigation standpoint, the reasonable and beneficial use of water is the amount of irrigation required to cultivate the grasses and legumes on the ESR pasture for the continued profitable operation of the Ranch.[14] The reasonable amount of water for irrigation includes not only ET, but also the leaching requirement, and other special irrigation applications such as seedbed/land preparations, germination, and cooling. In order to determine that the use of water for irrigation at the El Sur Ranch is reasonable and beneficial, the following specific circumstances and conditions of the pasture must be analyzed: crop type, irrigation method, soil type, uniformity of water application, water supply, weather conditions, and economic factors. Given these site specific factors, acceptable irrigation efficiencies will vary based on those conditions.

6.3 Ranch Irrigation Efficiency

The results of the crop water requirement analysis and the diversion records may be used to determine the irrigation system performance/efficiency on El Sur Ranch. As stated, acceptable irrigation efficiencies are based on irrigation method and site-specific factors that affect irrigation water application, such as soil's water intake rate, soil uniformity, crop, slope of field, irrigation scheduling, and available irrigation flow rate.

[13] Here, the term "*beneficially used*" is a technical term and does not reflect a legal definition. Determination of beneficial use of irrigation water includes factors such as leaching, crop water requirements, and other special irrigation applications (seedbed/land preparations, germination and cooling).

[14] . Cultivation refers to the preparation of soil, planting of seeds, and growing of crops. The broad idea is that cultivating a crop is the act of promoting and improving its growth through labor and other inputs.

The following equation is used to calculate irrigation efficiency based on water beneficially used and irrigation water supplied.

$$Irrigation\ System\ Efficiency = \frac{Irrigation\ Water\ Beneficially\ Used}{Irrigation\ Water\ Supply} \times 100 \qquad (11)$$

At the El Sur Ranch, the beneficial uses of irrigation water for crop cultivation are: crop water needed to support the soil in preparation of and for growth of forage, and leaching water needed to flush root zones for salinity control.

6.4 Historical Pumping Data

Irrigation water supply (pumping) and irrigation water beneficially used are needed to determine the irrigation system efficiency of the Ranch. Toward that end, historical pumping rates for the two wells were determined using the Ranch records of electricity from 1975 through 2009. The amount of water pumped is calculated based on electrical energy usage by the irrigation pumps at the Old and New Wells.[15] Monthly pump energy usage data were provided by the Ranch for 1989 through 2003, and daily data since 2004 to assist with the calculation of the water pumped.

Periodic pump tests have been performed on the Old Well and New Well from the time they were put into operation in 1950 and 1984 respectively. The tests were completed in 1950, 1960, 1967, 1992 and 2004, and provided information on the relationship between electricity use and pumped flow rate for each irrigated field. The tests allowed establishment of a relationship between energy usage kilo-Watt (kW) and flow (usually gallons per minute (gpm) for each field, which was converted into a relationship between electrical use (kW-hrs) and pumping rate cubic-feet per second (cfs) or volume in acre-feet (AF). The energy to acre-feet conversion factors are based on area (fields) weighted and/or pump usage (Old and New well) data. The area weighted calculation accounts for the pumps providing different flow rates to each pasture based on

[15] Energy usage was determined through energy records provided by Pacific Gas and Electric for years 1975 through 2003, and daily records of pump operations provided by the Ranch since 2004 through 2006. The conversion factors (kW-Hr to acre-feet) are based on several pump efficiency tests taken in 1967, 1992, and 2004.

elevation.

For the period of time prior to 1984, the factor of 169.5 kW-hr/AF was used to estimate monthly pumping based on the 1969 pumping test. From 1984 through 1997, the factor of 160.5 kW-hr/AF was used to estimate monthly pumping based on the 1992 pump tests and available information about days of operation for each pump. From 1997 through 2003 the factor of 193 kW-hr/AF was used based on the 2004 pump tests, which pump was used to irrigate specific fields, and days of operation for each pump. The kW-hr per month was divided by the appropriate kW-hr/AF factor to determine acre-feet pumped during a month. The change in kW-hr/AF rate in 1984 is due to the operation of the New Well. The reason the pumping factor changes after 1997 is due to the decreased production (capacity) of the Old Well. The February 2004 pump tests provided specific pump data including flow rate and kW demand for each field. At the time of installation the Old Well and pump had a maximum pumping capacity of 2,000 gpm (4.46 cfs), but overtime the condition of the Old Well decreased the production capacity to about 1,145 gpm (2.55 cfs). Based on pump tests, the Old Well could provide 2,000 gpm for the pump from 1950 to some time after 1967. Currently, pumping from the Old Well must be throttled from a maximum pump capacity of about 2,000 gpm to about 1,145 gpm so that the pump does not suck air. The throttling decreases the pumping efficiency and results in an increased energy requirement per acre-foot pumped by the Old Well pump. The discharge of the New Well follows the pump curve with the flow being higher when irrigating the lower elevation pastures, with a maximum pumping rate of 1,567 gpm (3.49 cfs).

With these relationships in mind, the average annual pumping rates were calculated. The average annual estimated pumping for 1975 through 2009 was 889 acre-feet per year, with a maximum pumping of 1,737 acre-feet in 1984. The pumping in 1984 is not representative of typical irrigation pumping on the El Sur Ranch; it is thought to be high because it was the first year that both pumps were in operation and January through May of that year were dry. The higher pumping in 1976 and 1977 are likely due to the drought that resulted in more irrigation demand and higher demand for forage due to dry range conditions. Figure 11 depicts estimated annual pumping based on electricity records.

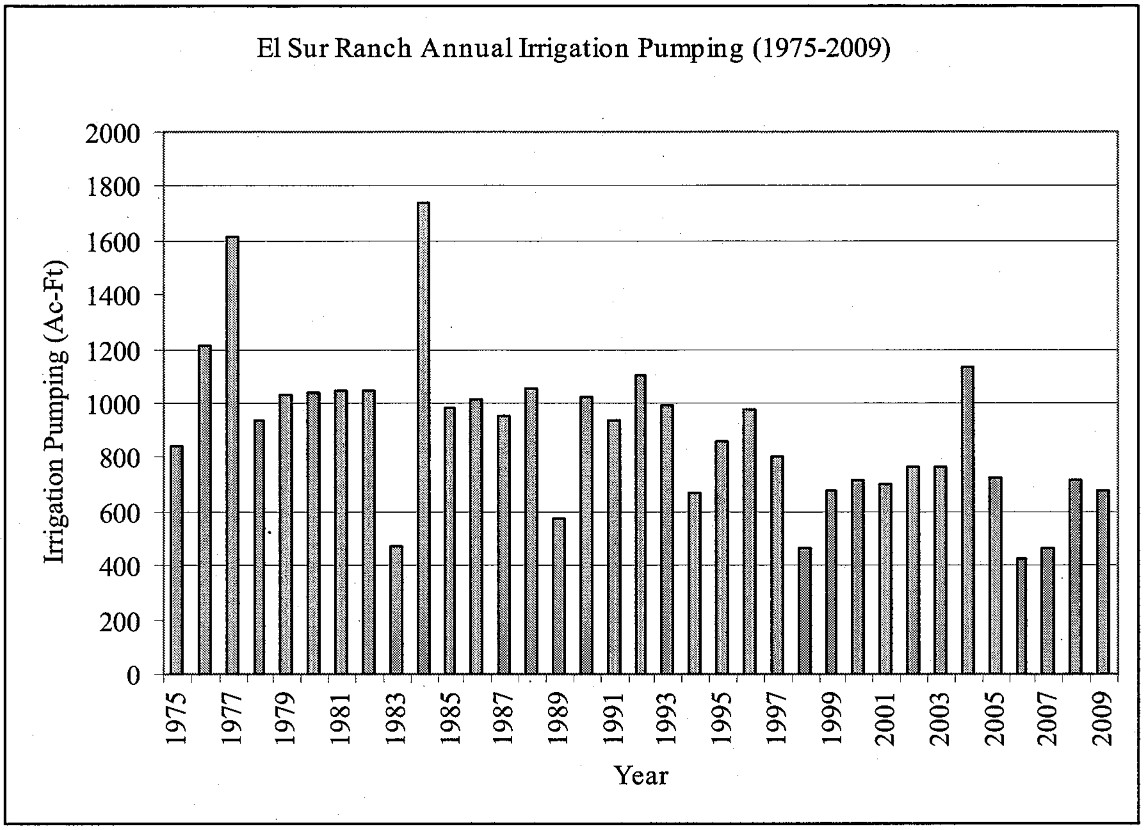

Figure 11: El Sur Ranch Calculated Annual Irrigation Pumping.

Table 7 lists the average monthly El Sur Ranch irrigation pumping for the period 1975 through 2009. The average monthly maximum pumping rate is 2.98 cfs for the month of June. The average pumping rate for April through October is about 2.03 cfs.

Table 7: Average Monthly Irrigation Pumping for the El Sur Ranch Irrigated Pastures.

Month	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
Pumping (cfs)	0.50	1.67	2.98	2.66	2.43	2.51	1.43

6.5 Analysis of Irrigation Efficiencies

Due to the nature of surface irrigation, and the varying site-specific factors previously mentioned, a range of irrigation efficiencies can occur. For example, high surface irrigation efficiencies (above 75 or 80 percent) are usually the result of under-irrigation and loss in production. An example of high irrigation efficiencies with under irrigation results can be seen in a review of the data for 2007. As listed in Table 8: 2007 Monthly Irrigation Requirements and Irrigation Applications., in 2007 there were irrigation requirements in March and April, but irrigation did not begin until late May, the irrigation requirements for March, April, and May were not met. This can occur in the spring or fall when irrigations are postponed in anticipation of precipitation during the time of year when precipitation generally occurs.

Table 8: 2007 Monthly Irrigation Requirements and Irrigation Applications.

Month	Net Irrigation Requirements (inches)	Irrigation (Inches)	Calculated Effective Irrigation for Crop ET (inches)
Jan	0.88	0.00	0.00
Feb	0.00	0.00	0.00
Mar	2.53	0.00	0.00
Apr	2.21	0.00	0.00
May	3.79	0.23	0.23
Jun	4.71	6.22	6.22
Jul	4.78	6.38	6.38
Aug	4.11	3.70	3.70
Sep	3.22	4.74	4.74
Oct	2.13	1.49	1.49
Nov	2.03	0.00	0.00
Dec	0.51	0.00	0.00
Total	**30.91**	**22.76**	**22.76**

Summarizing the significant points shown in Table 8:

- the annual net irrigation requirement was 30.91 inches (34.31 inches with leaching);
- the total annual irrigation was 22.76 inches with 22.76 inches being calculated as used to meet irrigation requirements;
- this results in under irrigation of a portion of the fields;
- however, 8.15 inches (30.91 minus 22.76) of potential crop ET was not provided along with leaching.

While the data reflects all irrigation being used for crop ET in 2007, it is significant to note that there was under-irrigating on a significant of the fields for some year. The under-irrigation that occurred in 2007 can be seen in aerial photo taken on July 30, 2007 (see Figure 12, below).

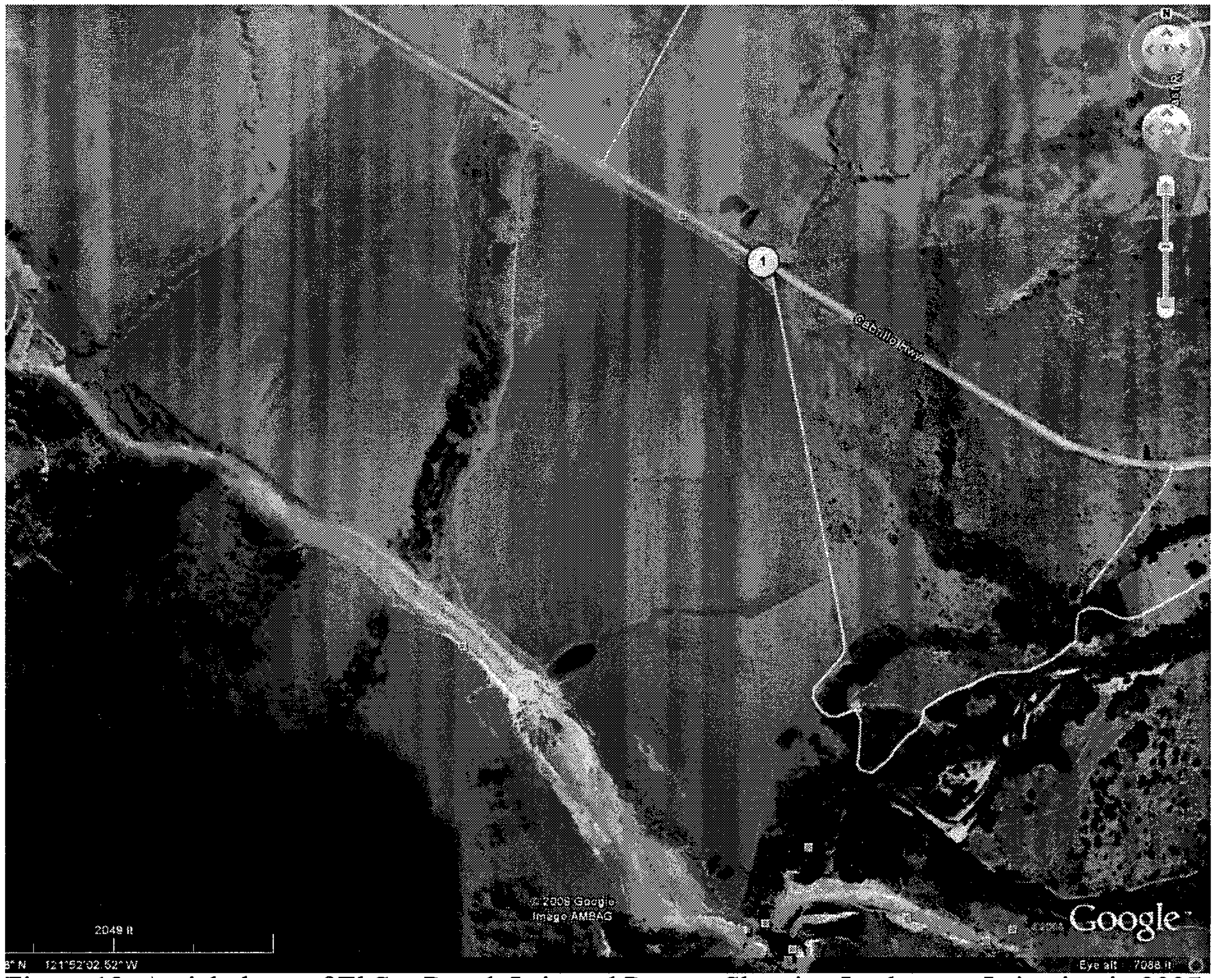

Figure 12: Aerial photo of El Sur Ranch Irrigated Pasture Showing Inadequate Irrigation in 2007 (USDA Farm Service Agency Photo, July 30, 2007).

Importantly, the analysis of historical pumping indicates that irrigation efficiencies on the El Sur Ranch averaged 66% for the period 1975-2006, and 77% for 1994-2006 (note that irrigation efficiencies could not be calculated for 1983, 1997, 1998, and 2006 due to irrigation being less than crop irrigation requirement) (Discussed in Section 9, below). However, the 77% average is not the recommended target irrigation efficiency for the Ranch because, as previously mentioned, because under conditions at El Sur Ranch higher efficiency rates are usually achieved at the expense of under irrigation resulting in less than obtainable forage yield. The concept of optimal forage production is based on needed forage production with best use of irrigation and other production inputs. Optimal production is generally not maximum production.

Figure 13: Estimated Historical Irrigation Efficiencies on El Sur Ranch.

shows the irrigation system efficiencies from 1975 to 2006. Annual irrigation efficiencies for several years could not be calculated because the applied water was less than the irrigation demand. As can be seen from Figure 13, the period includes several years with high efficiency that are likely a result of under-irrigation. Under-irrigation can result from system shutdown due to pipe breaks, pump and/or motor breakdowns, periods for maintenance and repair, labor scheduling, and production needs. In 2007 El Sur Ranch irrigation was only 460 acre-feet per year -- less than the calculated crop ET. The Ranch pumped 75 acre-feet in August, 130.8 acre-feet in July and 127.5 acre-feet in June) resulting in under-irrigation as can be seen in the photo, above. 2007 was a critically dry year with extremely low Big Sur River flows.

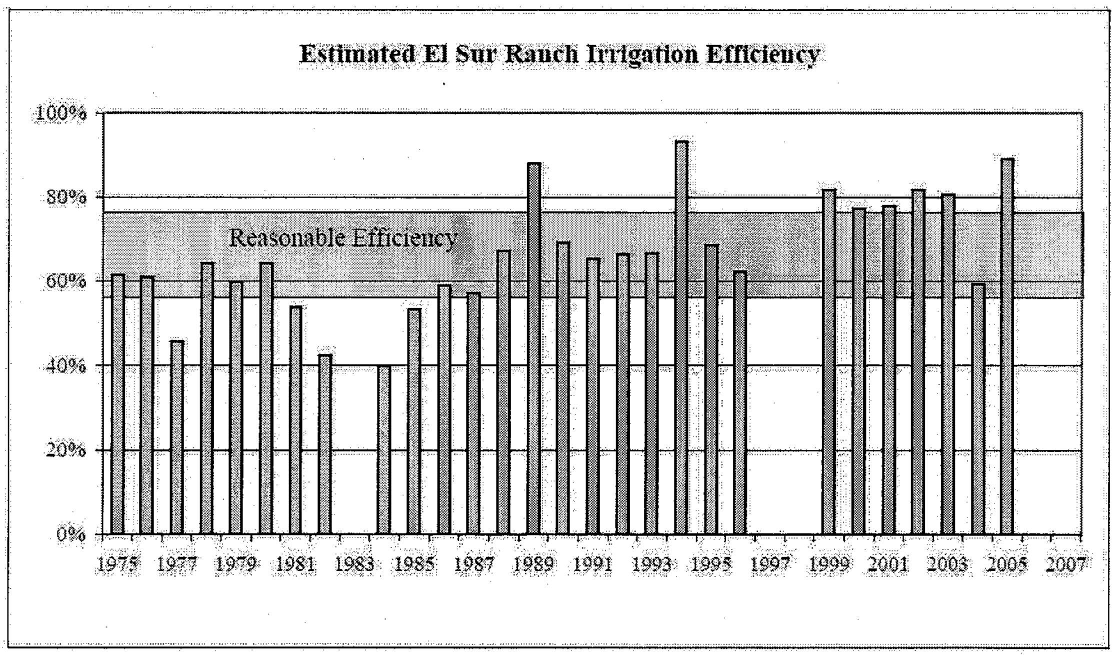

Figure 13: Estimated Historical Irrigation Efficiencies on El Sur Ranch.

6.6 El Sur Ranch Irrigation Diversion Requirements

The irrigation diversion requirements for the El Sur Ranch were calculated from a culmination of the analyses and calculations described in this declaration thus far. **Error! Reference source not found.** summarizes the steps to estimate diversion requirements. Figure 15 and Figure 16 provide a summary of how irrigation diversion requiremetns are calculated based on the factors previously described.

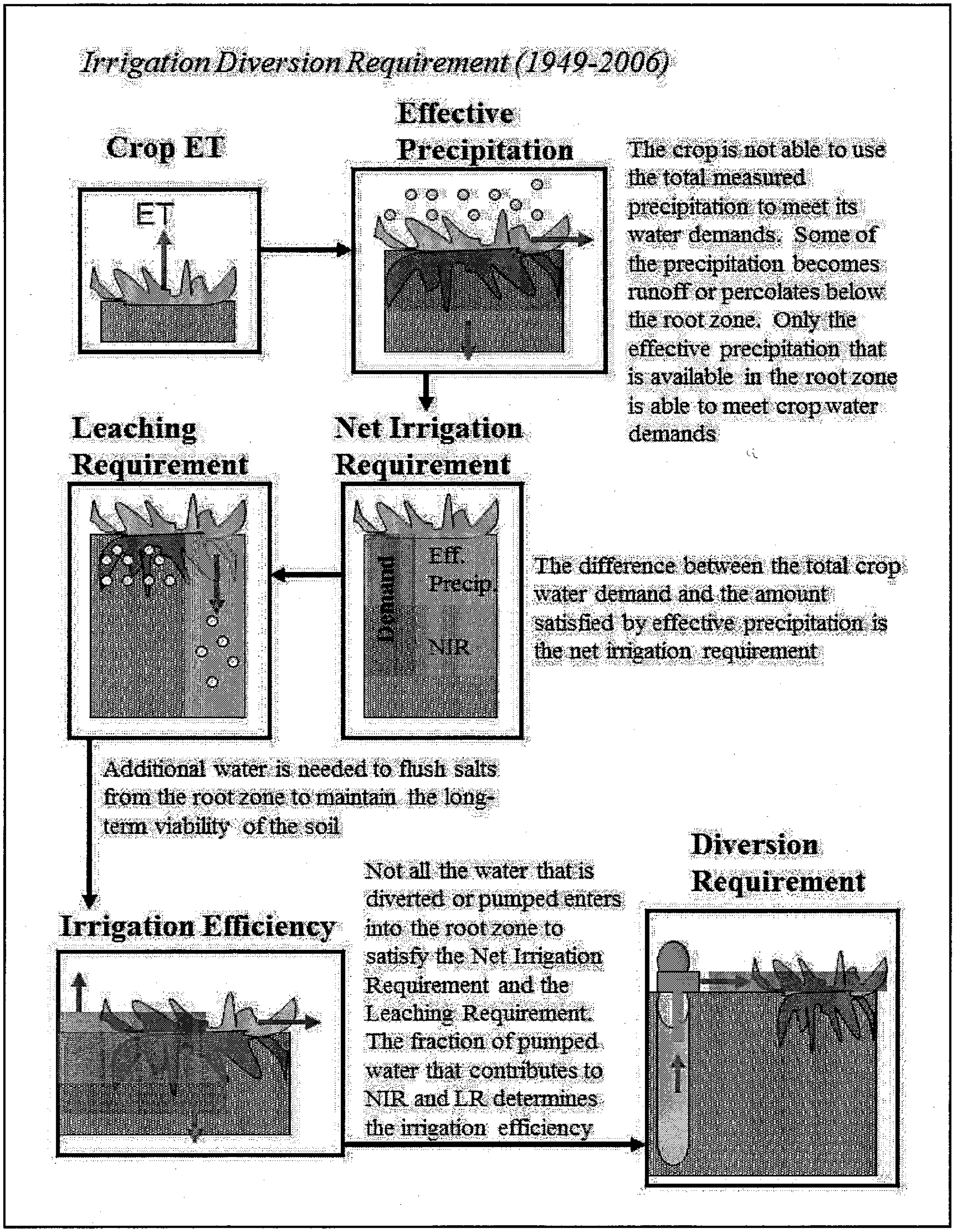

Figure 14: Estimation of Diversion Requirements.

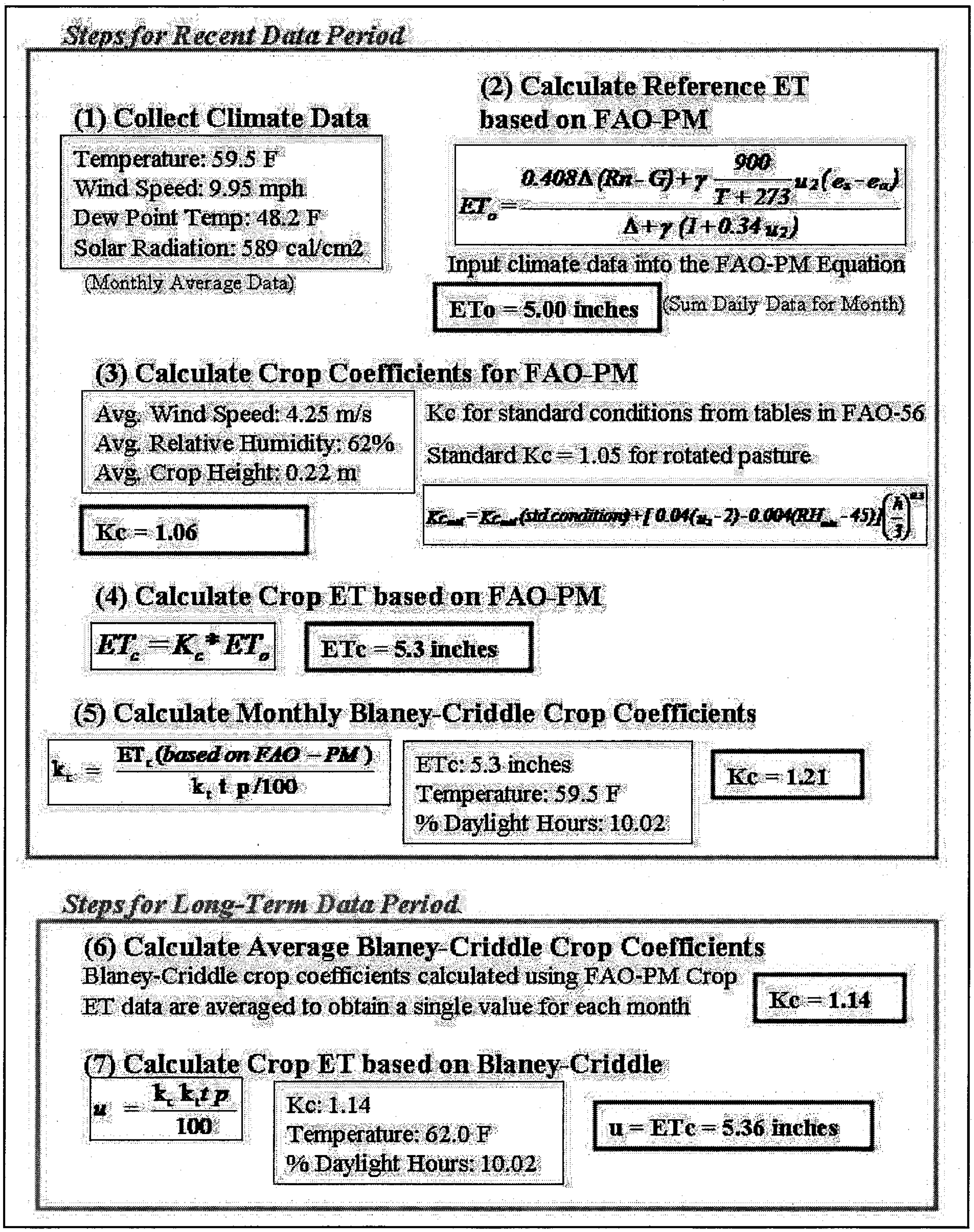

Figure 15: Example Irrigation Diversion Requirement Calculations (1 of 2).

Steps for Long-Term Data Period

(8) Calculate Crop ET based on Blaney-Criddle

Follow Crop ET calculations steps (1) through (7) — **ETc = 5.36 inches**

(9) Calculate Effective Precipitation

$$EP_g = f(D)(0.70917\,P_T^{0.8246} - 0.11556)(10^{0.02426ET})$$

ETc: 5.36 inches
Normal Soil Water Depletion: 2.5 inches
Monthly Precipitation: 0.99 inches

EPg = 0.77 inches

(10) Calculate Net Irrigation Requirement

$$NIR = ET_c - EP_g$$

NIR = 4.59 inches

(11) Calculate Leaching Requirement

$$LR = \frac{EC_w}{(5EC_e - EC_w)}$$

Water Salinity: 500 uS/cm
Salinity Threshold: 1,500 uS/cm

LR = 10%

LR = 7% based on salinity, adjusted based on soil conditions to 10%

(12) Calculate Overall Irrigation Requirement

$$OIR = \frac{NIR}{1 - LR}$$

OIR = 5.10 inches

(13) Determine Irrigation Efficiency

Irrigation Efficiency based on El Sur Ranch's irrigated pasture conditions

Eff = 65%

(14) Calculate Irrigation Diversion Requirement

$$DivReq = \frac{OIR}{Eff}$$

Div Req = 7.85 inches

Figure 16: Example Irrigation Diversion Requirement Calculations (2 of 2).

The irrigation diversion requirement for the El Sur Ranch was calculated based on irrigation of 246 acres, the calculated net irrigation requirement, a leaching requirement of 10 percent, and an irrigation efficiency of 65 percent. Figure 17 shows the annual calculated diversion requirement for years 1975 – 2006 at the El Sur Ranch. The average irrigation requirement from 1975 through 2006 was 1,087 acre-feet per year, the minimum was 807 acre-feet per year in 1982, and the maximum net irrigation requirement for that same period was 1,320 acre-feet per year in 1997.

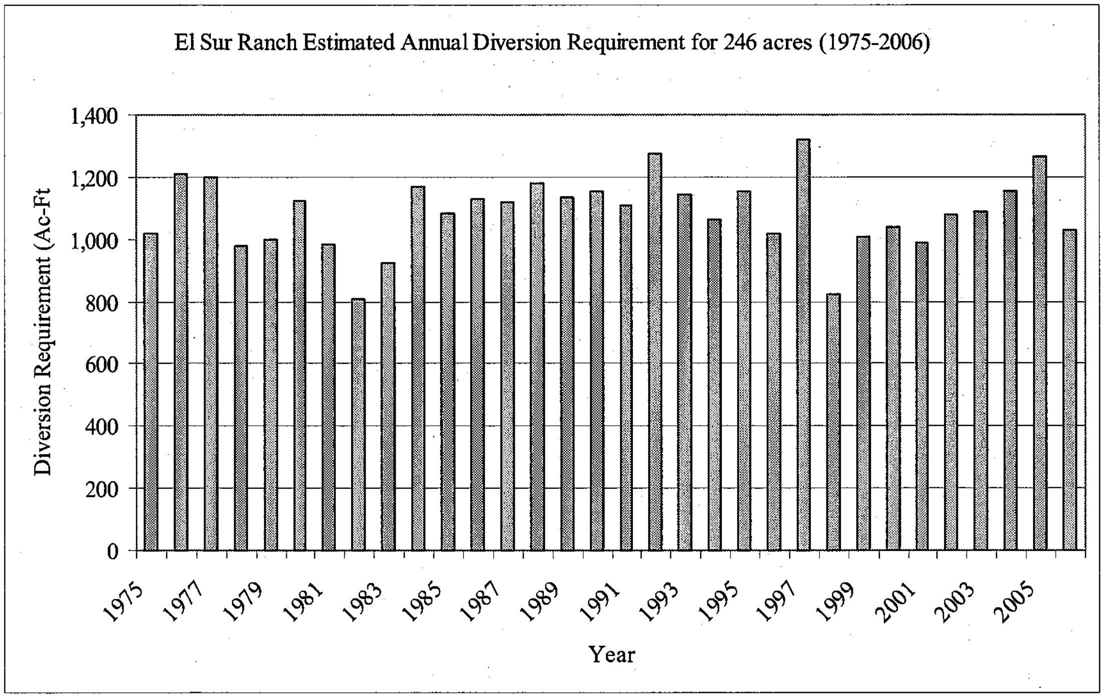

Figure 17: El Sur Ranch Irrigated Pasture Calculated Annual Diversion Requirements.

7. RANCH IRRIGATION OPERATIONS

7.1 Introduction

The El Sur Ranch irrigation system originates with two well sites located in the Andrew Molera State Park, near the Big Sur River. Water is pumped from the wells through pipelines, and reaches valves located at about 28 foot intervals across the fields. The Ranch manager opens the appropriate number of valves to advance water down the fields at rates that depend on soil type, weather and time of day. The irrigation water is divided between borders to help maintain a uniform advance down the borders. A tailwater pond is located south of Pasture 6 to facilitate the reuse of accumulated tailwater where possible. The tailwater pond is also used for stock watering and in emergencies, for fire suppression. The irrigation season at the Ranch is generally from April through October, but irrigation can be needed earlier and later in the year.

7.2 Irrigation System

Water is diverted via pumps at the two well sites near the Big Sur River. While both wells can each be used to irrigate the entire pasture, differences in the pumps dictate that the Old Well be used primarily to supply water to the upper portion of the irrigated pasture and the New Well used primarily to supply water to the lower portion of the irrigated pasture.[16] There are two pipelines between the park lands and the pasture, one for each well. Water from the wells is conveyed via 14-inch concrete pipes (which are replaced with plastic pipes as necessary) to valves located at the head of the field borders and placed at 28-foot intervals across the fields. Four lateral pipes service the eleven fields. Irrigation water reaches the fields by manually opening and adjusting valves; each valve serves two borders. The number of valves that are opened depends on the field that is irrigated and the pump used for irrigation, length of the border, dryness of the soil, soil properties, length and condition of the grass, and irrigation set time. For example, more valves are opened for the longer night-time irrigation because this produces a slower advance of water down the field. Fewer valves are opened to provide a faster water advance rate to achieve more uniform irrigation in fields with high intake rate.

The irrigator determines the number of valves to open based on his experience. Once that determination is made, the flow is divided between the valves. A few hours into the irrigation, the irrigator checks the advance of the water in the borders and makes adjustments to the valves to maintain a uniform advance to the next down-slope border. The borders are designed so that the tailwater from one set of borders flows to the next down-gradient set of borders. The tailwater from the bottom set of borders is discharged to a tailwater pond or to a water control structure to discharge to the ocean. The tailwater pond is designed to facilitate the reuse of accumulated tailwater where possible, or to discharge to the ocean through a water control structure. Figure 18 is a topographic map showing the layout of the El Sur Ranch pasture irrigation system.

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16 Salinity will cause a deviation from this general practice. Salinity readings at the Old Well pump are taken during the irrigation season. If the salinity level of the water at the Old Well exceeds 1,000 μS/cm, it is shut-down and either the irrigation ceases or alternatively, water is pumped from the New Well instead. Historically, salt water intrusion has not occurred at the New Well.

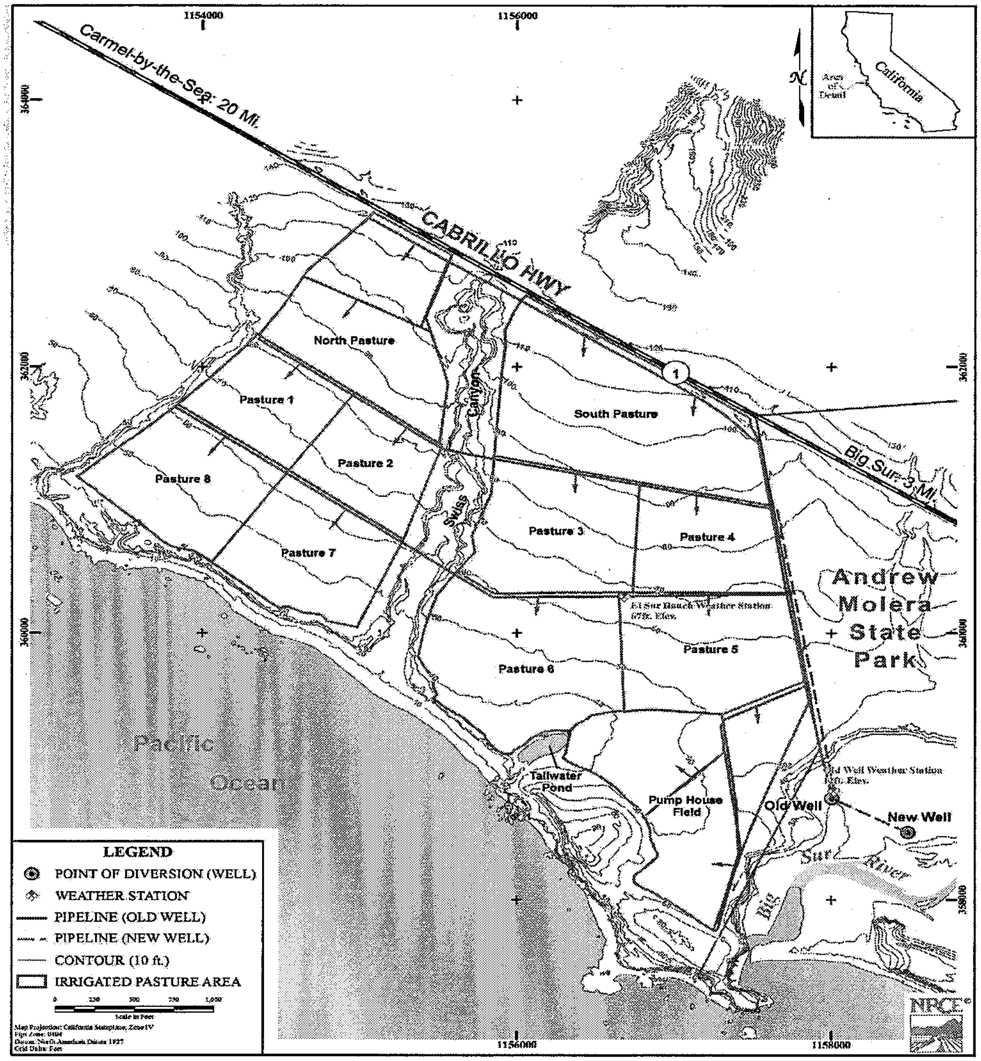

Figure 18: Topographic Map of the El Sur Ranch Irrigated Pasture and its Infrastructures.

7.3 Irrigation Season

In general, the irrigation rotation varies, but during the summer it takes three to four weeks to complete the irrigation of every field, making it suitable given the soil characteristics and the water needs of the fields. Generally, the irrigation season starts in April or May and ends in September or October. During that time, one or both pumps operate continuously. However, if adequate rainfall occurs, irrigation ceases. In dry years, irrigation has occurred in the winter months. The growing season for the pasture grasses and legumes is the entire year.

7.4 Irrigation System Alternatives

The current system provides for good control of irrigation water and does not detract from the appearance of the coastline. In order to address the concern that surface irrigation may not be the most efficient means to accomplish irrigation on the Ranch, other irrigation alternatives were analyzed.

Sprinkler irrigation would be an impractical alternative method to irrigate the El Sur Ranch pasture. A sprinkler system must be pressurized, which would dramatically increase electricity usage about 74% or $26,000 per year at current electrical utility rates (from an estimated irrigation pumping cost of about $35,000 per year to pump 1,087 acre-feet per year[17] for surface irrigation to about $61,000 per year to pump 1,009 acre-feet per year for sprinkler irrigation). This energy cost comparison is based on irrigation of 246 acres with a surface irrigation efficiency of 65 percent and a sprinkler irrigation efficiency of 70 percent. Moreover, high winds would result in poor irrigation application uniformities because daily maximum wind speeds average over 24 mph for the five months (May through September) of the primary irrigation season. These high winds also present a risk that the wheel lines could blow out of the pasture and into the highway, Andrew Molera State Park, or down-slope into the Ocean.

The use of a sprinkler system would require that the entire current irrigation system be replaced, costing approximately $500,000 for installation of new pumps, pipelines and wheel lines. The existing pipeline is inadequate for a pressurized sprinkler system. From an operational and layout perspective, a sprinkler system would be ill-suited because fields are not rectangular and the numerous fence lines delineating separate fields cannot be crossed by wheel lines, causing increased labor costs to move the sprinklers. Additionally, cattle cause damage to sprinkler irrigation equipment. The maintenance cost of a sprinkler system is much more than the current irrigation system because sprinklers have moving parts that wear out and replacing equipment damaged by cattle. Thus, for many reasons, installing a sprinkler irrigation system at

[17] The recent El Sur Ranch pumping has been less than 1,087 acre-feet per year.

the Ranch would be impractical.

Other irrigation methods/systems, such as permanent buried sprinkler and drip irrigation were considered and also found to be impractical or unworkable. The major concerns with a permanent buried sprinkler and drip systems are installation and capital costs, energy costs, and maintenance problems. Sprinkler and drip systems would require a new pipeline and pumping systems that are more expensive to install than wheel line sprinkler systems, and also use pressurized lines requiring more energy than surface irrigation. The wind would result in poor irrigation application uniformity for permanent sprinkler irrigation system. Both drip and sprinkler systems are subject to breakage by grazing cattle. With a buried system, breaks (and thus water loss due to leaks) could be difficult to detect, resulting in water loss, and expensive to repair.

In summary, surface irrigation was determined to be the most practical method of irrigation due, mostly to site-specific weather and topography issues at the Ranch. Wind speed is one of several obstacles that limits the suitability using a sprinkler system. Maximum daily wind speeds average over 24 miles per hour for the months May through September, presenting a risk that the wheel lines could blow out of the pasture and onto Highway 1, into the State Park, or even down-slope into the ocean. Additionally, the costs of replacing the surface irrigation system and operating a sprinkler system is prohibitive – approximately $500,000 in capital costs plus increasing the energy cost by about 75 percent.

8. WATER RIGHT APPLICATION|

The El Sur Ranch water right application seeks to divert only that amount of water which can be reasonably and beneficially used. For purposes of this analysis, the determination of reasonable and beneficial use includes consideration of crop, climate, economics, water supply (quantity and quality), irrigation system, and precipitation.

The reasonable and beneficial use analysis must also include sufficient water to meet irrigation demands during a severe drought. To approximate drought conditions, net irrigation requirements were estimated from 1949 to 2006. The three years with the highest net irrigation requirements are 1959, 1992, and 1997 with annual net irrigation requirements of 37.01, 36.39

and 37.66 inches. The estimated diversion requirements for these years are listed in Table 9. As with the monthly diversion requirements, the annual irrigation requirement could be higher if, at the beginning of the year the soil moisture needed to be replenished. For 1997, the estimated irrigation diversion requirement is 1320 acre-feet.

Table 9: Estimated Annual Net Irrigation Requirements for the three Years with the Highest Net Irrigation Requirements.

Year	Net Irrigation Requirement (inches)	Irrigation Diversion Requirement (acre-feet)[1]
1959	37.01	1,297
1992	36.39	1,275
1997	37.66	1,320

1. The diversion requirement is based on an irrigation efficiency of 65 percent, a leaching fraction of 10 percent, and irrigating 246 acres.

Because it is reasonable to assume that in the future there may be years with similar or higher irrigation diversion requirements than has occurred in the last 58 years, an annual not to exceed pumping volume of 1,320 acre-feet (original application amount was 1,615 acre-feet) is appropriate.

9. CONCLUSIONS

The requested diversion amounts and terms and conditions Water Right Application Number 30166 reflect reasonable and beneficial use of water for the irrigation of pastures on the El Sur Ranch. The irrigated pasture on the El Sur Ranch is an integral part of the cattle operation of the El Sur Ranch. It provides high quality feed during the dry summer months, a suitable environment and location for calving, controls runoff and soil erosion, and provides increased management options and utilization of the non-irrigated range. The pastures are well maintained as indicated by the species and condition of the forage plants. There are erosion control structures and measures in place to minimize soil and water erosion in the pastures.

Surface irrigation is the most suitable irrigation method for the El Sur Ranch irrigated pastures. Surface irrigation of the El Sur Ranch irrigated pastures is better than other irrigation methods because it 1) works well for the irregular shape and dimensions of the pastures, 2) is the most economical method of irrigation for the pastures based on construction and energy costs, 3) is suitable for the topography, soil, and climate conditions at the El Sur Ranch, 4) is compatible with the grazing of the pastures, 5) the irrigation labor needs can be incorporated with other duties of ranch operators, and 6) very importantly it maintains aesthetics of the scenic coast line.

The irrigation of the El Sur Ranch pastures is well managed with appropriate irrigation efficiencies for the irrigation method, crops, soils, topography, and management constraints. This conclusion is based on estimates of historical irrigation pumping, crop ET, and expected irrigation efficiencies. The historical irrigation diversions from pumping were based on electrical energy usage of the pumps and pump efficiency tests that related energy usage to water pumped. The crop ET is based on the FAO Penman-Monteith method using climate data taken within the El Sur Ranch irrigated pastures. The long-term estimation of crop ET is developed by calibrating crop coefficients for the SCS Blaney-Criddle method of ET estimation which only require monthly average temperatures. Long-term precipitation and temperatures for the El Sur Ranch irrigated pastures were based on correlation of the climate data obtained at the El Sur Ranch with National Weather Service climate data from Monterey, CA. The net irrigation requirement is the crop ET minus the effective precipitation. The effective precipitation was estimated using the SCS method.

The average annual calculated crop water requirement for the El Sur Ranch irrigated pastures is 43.3 inches (3.6 feet) for the 1975 through 2006 period. The average annual calculated net irrigation requirement is 31.01 inches (2.58 feet) for the 1975 through 2006 period. The maximum net irrigation requirement is 37.66 inches (3.14 feet).

Due to the salinity of the irrigation water, leaching is required to maintain the soil salinity to prevent unacceptable reduction of yields. The irrigation supply is subject to salinity intrusion from the Pacific Ocean. This can result in a leaching requirement of up to 10 percent of the irrigation application. This leaching requirement is in addition to the irrigation application based on the net irrigation requirement. The El Sur Ranch monitors salinity of the wells on a daily basis when irrigating and discontinues pumping from a well when the electrical conductivity (an indicator of salinity) reaches 1,000 μS/cm. This condition has only occurred in the Old Well; while it occurs in most months it severely decreases pumping during July and August. During years when precipitation is adequate to provide a leaching benefit, leaching from irrigation can be reduced.

It is my opinion that the suitable irrigation efficiency for the El Sur Ranch is 65 percent. This opinion is based on the irrigation method, soils and topography, weather conditions land use constraints, pasture conditions, water supply limitations, soil variability, labor constraints, and economic constraints. Higher irrigation efficiencies associated with tail water recovery and pump-back systems and additional land leveling are not practical due to high costs in relationship to potential water savings. The average annual irrigation diversion requirement, assuming all irrigation need is met and leaching is required is 53 inches (4.42 acre-feet per acre).

For the irrigation of 246 acres, this results in an average irrigation requirement of up to 1,087 acre-feet per year and a maximum irrigation requirement of 1,320 acre-feet per year.

Using the methodology described above the historical irrigation efficiencies of the El Sur Ranch are within the range that is expected for well managed surface irrigation systems. There are several years with very high irrigation efficiencies that result from under-irrigation of the pasture. The under-irrigation results from irrigation management, system break-down, decreased need for pasture production, and/or salinity levels in the Old Well that limits pumping and irrigation. The analysis indicates that in most years the irrigation on the pastures was less than that needed for optimal production and that irrigation has been reasonable and beneficial. This is supported by aerial photography taken during the summer months that indicates irrigation shortages. The calculated irrigation efficiencies of the El Sur Ranch are generally higher than would be expected for optimal crop production based on the irrigation method and conditions.

It is my opinion that the terms, operational limitations, and considerations of Water Right Application #30166 (as amended) and submitted by Mr. James J. Hill III will provide for the reasonable and beneficial use of irrigation water on the El Sur Ranch. Historical irrigation on the El Sur Ranch has shown that water use is efficient and that management and care for the irrigated pastures protect the plants and soils.

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10. REFERENCES

Allen, R.G., Pereira, L.S., Raes, D., and Smith, M. (1998). *Crop Evapotranspiration Guidelines for Computing Crop Water Requirements.* FAO Irrigation and Drainage Paper No. 56, FAO, Rome, Italy.

Allen, R.G. and the University of Idaho. (2000). *Ref-ET: Reference Evapotranspiration Calculation Software for FAO & ASCE Standardized Equations*, Version 2.0 (2000). University of Idaho Research & Extension Center, Kimberly, ID.

Allen, R. G. et al. (2005). *The ASCE Standardized Reference Evapotranspiration Equation.* Published by the American Society of Civil Engineers, 2005.

California Department of Water Resources (CDWR). (1975). Bulletin 113-3. *Vegetative Water Use in California, 1974, State of California*, The Resources Agency, Department of Water Resources, April 1975.

California Department of Water Resources (CDWR). (1986). Bulletin 113-4. *Crop Water Use in California, State of California.* The Resources Agency, Department of Water Resources, April 1986.

California Department of Water Resources (CDWR). (1996). *Memorandum of Understanding Regarding Efficient Water Management Practices by Agricultural Water Suppliers in California (MOU).* California Division of Water Resources, November 1996.

California Department of Water Resources (CDWR). (2010). Annual Land & Water Use Estimates. http://www.water.ca.gov/landwateruse/anlwuest.cfm

California State University, (1998), Technical Editors, David A Goldhamer and Richard L. Snyder. *Irrigation Scheduling – A Guide for Efficient On-Farm Water Management.* University of California, Division of Agriculture and Natural Resources, Publication 21454.

California Irrigation Management Information System (CIMIS). (2006). Online. Available at http://wwwcimis.water.ca.gov/cimis.

California Watersheds (CALWATER 2.2). (1999). *California Department of Forestry and Fire Protection.* Edition 2.2. Online. Available http://gis.ca.gov/meta.epl?oid=5298.

Custis, Kit (2009). Memorandum – Comments on October 2009 Draft EIR for the El Sur Ranch Water Right Application No. 30166. California Department of Fish and Game, December 10, 2009.

Fangmeier, D. D., and Biggs, E. N. (1986). Rep. 8555. *Alternative Irrigation Systems.* Cooperative Extension Service, University of Arizona, Tucson, Arizona.

Jensen, et al. (1990) Evapotranspiration and Irrigation Water Requirements – ASCE Manuals and Reports on Engineering Practice No. 70. American Society of Civil Engineers, Rustin, Virginia

Martin, D. L., Stegman, E. C., and Fereres, E. (1990). *Irrigation Scheduling Principles.* Chapter 7 in *Management of Farm Irrigation Systems* (Monograph), Hoffman, G. J., Howell, T. A., and Solomon, K. H. (eds.). American Society of Agricultural Engineers, St. Joseph, Michigan, 1040p.

Natural Resources Consulting Engineers. (2007) *Reasonable Beneficial Use – Land Use Study for El Sur Ranch Irrigated Pastures, Water Rights Application #3016 (Update of May 18, 2005 Report.* March 2007.

Natural Resources Consulting Engineers. (2010) *Technical Memorandum - Soil and Erosion Information for El Sur Ranch Irrigated Pastures Water Rights Application Number 30166,* April 30, 2010.

Rhoades, J. D. (1974). *Drainage for Salinity Control.* Edited by J. Van Schilfgaarde. *Journal of Drainage for Agriculture,* American Society of Agronomy, No. 17, 433-462.

Smith, M.R., Allen, R.G., Monteith, J.L., Pereira, L.S., and Segeren, A. (1991). *Report on the Expert Consultation on Procedures for Revision of FAO Guidelines for Predicting Crop Water Requirements.* Food and Agricultural Organization of the United Nations, Land and Water Developmental Division, Rome, Italy.

Tanji, K. K. (Ed). (1990). *Agricultural Salinity Assessment and Management.* American Society Civil Engineers Manuals and Reports on Engineering Practices No. 71, New York, New York.

United States Bureau of Reclamation (USBR) and Bureau of Indian Affairs (BIA). (1978). *Water Conservation Opportunities Study.* Washington, D.C. (referenced on pg 37 of *Principles of Farm Irrigation System Design* by James, L.G., 1988).

United States Department of Agriculture, Soil Conservation Service (USDA-SCS). (1978). *Soil Survey of Monterey County, California.*

United States Department of Agriculture, Soil Conservation Service (USDA-SCS). (1970). *Irrigation Water Requirements.* Technical release no. 21 (TR#21).

University of California (1989). *Irrigation Scheduling – A Guide for Efficient On-Farm Water Management*, University of California, Division of Agriculture and Natural Resources, Publication 21545.

Western Region Climate Center (WRCC, 2006). Online. Available at http://www.wrcc.dri.edu/

APPENDIX A

L. Niel Allen, Ph.D., P.E. — *Senior Engineer*

Special Skills and Expertise

Estimation of irrigation water requirements, practicably irrigable acreage (PIA) analysis, preparation of water right claims, preparation of water conservation and management plans, hydrographic surveys, irrigation system assessment, water resources planning, technical litigation support, and water rights negotiation support.

Education

Ph.D., Civil Engineering
University of Idaho, Moscow, Idaho. 1991

M.S., Agricultural & Irrigation Engineering
Utah State University, Logan, Utah. 1980

B.S., Agricultural & Irrigation Engineering
Utah State University, Logan, Utah. 1979

Professional Registrations

Professional Civil Engineer, California, No. C51308, 1994
Professional Civil Engineer, Nevada, No. 011476, 1995
Professional Civil Engineer, Utah, No. 87-172734-5555, 1987
Professional Civil Engineer, New Mexico, No.15602, 2002
State Water-Right Surveyor, Nevada, No. 1114, 2002

Experience

Senior Engineer — **January 1997-Present**
Natural Resources Consulting Engineers, Inc. — **Fort Collins, Colorado**

- Technical Group Leader and Project Manager of NRCE's Agricultural Engineering Group.
- Estimates crop water and irrigation diversion requirements.
- Designs on-farm irrigation, water conveyance, and water distribution systems.
- Provides cost estimates for PIA projects.
- Identifies and maps presently and historically irrigated lands.
- Evaluates historical irrigation water use and estimates future irrigation water requirements.
- Assesses irrigation systems and provides information on water conservation and system rehabilitation.
- Provides expert witness reports and testimony concerning PIA projects and water rights.

Some of his specific projects include:

- Preparing irrigation water claims for the Pueblo of San Juan, Santa Clara, and San Ildefonso Indian Reservations in New Mexico (State of New Mexico v. Abbott and State of New Mexico v. Aragon).
- Preparing irrigation claim and water right negotiations for the Crow Indian Reservation in Montana.
- Evaluated on-farm and district water use and water conservation measures for the Imperial Irrigation District (approximately 460,000 acres of irrigated land) in southern California. Provided technical support for the beneficial use determination and the California Quantification Settlement Agreement (4.4 Plan). Prepared system improvement plan for the irrigation conveyance and distribution system.
- Identified and mapped historically irrigated land on the Shivwits and Acoma Indian Reservations.
- Supervised the mapping and preparation of water right claims for the Duck Valley Indian Reservation in southern Idaho and northern Nevada. Prepared the water right claims that were submitted to the states of Idaho and Nevada.
- Prepared technical information and conducted field investigations concerning irrigation upstream of the Duck Valley Indian Reservation.
- Developed a deficit irrigation model to estimate historical depletion by the Hopi and Navajo Indian Reservations from the northern washes of the Little Colorado River in Arizona and New Mexico.
- Prepared a water conservation and management plan, as well as developed a water measurement program for the Wapato Irrigation Project in central Washington. The Wapato Irrigation Project is a 140,000-acre irrigation project on the Yakama Reservation.
- Directed the preparation of an agricultural economic database for the Platte River in Wyoming, Colorado, and Nebraska. The database was used in the preparation of a Platte River EIS concerning endangered and threatened species that live in and along the Platte River.
- Evaluated and assessed the impacts of the 1999 U.S. Bureau of Reclamation interim operating criteria of the Weber Reservoir in Nevada on the Walker River Indian Reservation irrigated lands. The reservoir was operated at a low level due to safety concerns.
- Evaluated the water right impacts of a proposed Ahtanum Creek off-stream reservoir in Central Washington.
- Assessed irrigation suitability and irrigation delivery system for approximately 20,000 acres of idle lands in the Wapato Irrigation Project in central Washington.
- Reviewed the State of New Mexico's San Jose River Hydrographic Survey for the Acoma Pueblo (State of New Mexico v. Kerr-McGee Crop.). Expert for the Acoma Pueblo in the adjudication of the Rio San Jose basin.
- Provided expert testimony concerning water rights in the Ahtanum Creek basin of Washington (Washington State Department of Ecology v. Acquavella, et al.).
- Project Manager for the Zuni River Basin Hydrographic Survey in New Mexico (*United States and State of New Mexico v. State of New Mexico Commissioner of Public Lands and A & R Production, et al.).* The hydrographic survey is for the adjudication of the Zuni River Basin.
- Project Manager for the design and construction of the Moapa Band of Paiute Indians Valley of Fire Water System.

- Provided expert technical support in the Quechan Tribe's water rights settlement negotiation for the Fort Yuma Indian Reservation (No. 8, Original State of Arizona, Plaintiff v. State of California et al. in the Supreme Court of the United States).
- Provide expert opinion information on retirement of irrigated lands concerning the application for water rights of Tri-State Generation and Transmission Association, Inc. in Prowers County, Colorado (District Court, Water Division 2, Colorado Case No. 2007CW74).

Senior Engineer — **March 1993-January 1997**
Bookman-Edmonston Engineering, Inc. — **Sacramento, California**

- Provided analytical support concerning irrigation consumptive use, water rights, environmental considerations, and allocation of water resources for purposes.
- Assisted in the preparation of environmental reports concerning water reclamation and development projects.

On specific projects Dr. Allen:

- Provided technical information for negotiations concerning the Fort Belknap Indian Reservation (Montana) reserved water rights.
- Provided technical negotiation support for the Truckee-Carson Irrigation District and the Lahontan Valley Environmental Alliance in Fallon, Nevada concerning issues related to water allocation on the Truckee and Carson Rivers.
- Formulated and evaluated agricultural irrigation management and conservation opportunities in the Snake River basin of Idaho and Oregon, increasing Snake River flows by one million acre-feet per year during salmon migration periods.
- Conducted on-farm irrigation and distribution system evaluations, supplied recommendations for irrigation system modifications and management improvements to increase irrigation efficiencies within five large Mexican irrigation districts.
- Prepared the description, economic analysis, and loan documentation for the construction of a groundwater/surface water conjunctive use and an in-lieu groundwater recharge system for Shafter-Wasco Irrigation District and Semitropic Water Storage District in Kern County, California.
- Determined potential agricultural irrigation demands and prepared cost estimates for facilities needing to recycle up to 290,000 acre-feet per year of water in the Sacramento and San Joaquin Counties of California, which was part of a study for the Sacramento Regional County Sanitation District.
- Evaluated institutional and physical transfer and exchange mechanisms required to recycle approximately 450,000 acre-feet per year of wastewater from the San Francisco Bay area.
- Evaluated the impact of fallowing irrigated agricultural lands in the Sacramento Valley on the water supply in the Sacramento River and the Sacramento-San Joaquin Delta.
- Helped prepared an Integrated Resource Plan for Arvin-Edison Water Storage District located in the Central Valley of California.
- Assisted in the preparation of the Definite Plan Report and DEIS for the Spanish Fork Canyon-Nephi System, which is a 510 cfs, 42-mile water conveyance pipeline and a component of the U.S. Department of the Interior Central Utah Project Bonneville Unit.

Extension Water Specialist for Southern Nevada **March 1992-March 1993**
Cooperative Extension Service, University of Nevada **Reno, Nevada**

- Participated in research to determine the suitability of using saline water from shallow perched aquifers in the Las Vegas Valley as an additional source of irrigation water for turf.
- Helped prepare a document to encourage public policy dialogue in forums on managing and allocating water in Nevada, and moderated a public forum in Las Vegas using this document.
- Organized and conducted a technical conference entitled Salinity Effects on Plant-Soil-Water Relationships, which was held in Las Vegas, Nevada in 1993, and concerned the Colorado River Salinity Control Program.
- Taught Irrigation Principles, Irrigation Scheduling, and Irrigation Audit Courses to irrigation and landscape managers in Las Vegas.

Extension Irrigation Engineer and Research Engineer **1985-1992**
Utah State University **Logan, Utah**

- Performed urban and agricultural irrigation audits that included evaluation of irrigation pumping plants, hydraulics of mainlines, and adequacy of irrigation systems for over 100 irrigation systems in Utah.
- Provided guidelines for the operation and management of gravity-pressurized sprinkler irrigation systems.
- Assisted in establishing an electronic weather station network in Utah, and helped develop software that allowed the data to be used for crop water requirements and irrigation scheduling.
- Aided in interdisciplinary research on crop growth and yield as affected by environmental conditions and water management and verified evapotranspiration equations using climatic data and soil moisture measurements from neutron probe readings.
- Other areas of research include consumptive use estimation, nitrate movement determination, and evaluation of the Colorado River Salinity Control Program.
- Helped teach a five-month irrigation management training course, and presented irrigation system management information to water users.

Irrigation Engineer **1981-1985**
Snyder Irrigation and Agri-Services, Inc. **Salt Lake City, Utah**

- Designed and managed the construction of numerous irrigation systems that considered economics, soils, topography, climate, crops, labor, energy, and water resources in Utah, Wyoming, and Idaho for individual farmers and irrigation companies. The work included the design of pumping plants, pipelines, canals, water control structures, and sprinkler systems.

Irrigation Engineer **1980**
Pitcher Irrigation Company **Preston, Idaho**

- Supervised the design, development, and construction of irrigation systems in Idaho and Utah.

Research and Teaching Assistant **1979-1980**
Utah State University **Logan, Utah**

- Conducted some of the first research concerning "surge irrigation", with an emphasis on the advance rate of water down furrows.

- Assisted in teaching a Water Law and Institution course.

Independent Consulting Experience

From 1989 to 1993, Dr. Allen provided irrigation management information to irrigators concerning the reclamation of salt-affected soils and irrigation with poor quality saline or sodic water. In addition, he assisted in the design, management, and construction of a 4,500-acre irrigation rehabilitation project, including 12 wells and 35 pivots. The annual energy usage dropped from over 9 million kilowatt-hours before rehabilitation to less than 5 million kilowatt-hours after work was completed.

Relevant Computer Skills

- *Hydrologic and Crop Water Requirement Models:* Operated several models
- *Hydraulic Models:* Operated a hydraulic pipeline network program
- *Software and Model Development*: Irrigation Scheduling Models, Crop Water Use Models, Irrigation Depletion Models
- *Programming Languages:* BASIC, FORTRAN

Professional Memberships

- American Society of Civil Engineers

Publications

Allen, L. N. (1992). *Economical and Statistical Based On-Farm Irrigation Scheduling,* ASCE Proceedings of the Irrigation and Drainage Session at Water Forum '92 - Saving a Threatened Resource - In Search of Solutions, Baltimore, Maryland.

---. (1992). *Directory of Available Assistance for Nevada's Rural Water Users.*

---. (1991). *Economic and Statistical Based On-Farm Irrigation Scheduling,* Ph.D. Dissertation, Department of Civil Engineering, University of Idaho.

---. (1980). *Advance Rates in Furrow Irrigation of Cycled Flow*, M.S. Thesis, Department of Agricultural and Irrigation Engineering, Utah State University, Logan, Utah.

Allen, L. N., and Hill, R. W. (1988). *Crop Irrigation Requirement Model for Utah,* ASCE Irrigation and Drainage Division Specialty Conference, Lincoln, Nebraska.

---. (1988). *Electronic Weather Stations Help Determine Crop Water Needs*, Utah Farmer-Stockman, Special Insert, August.

---. (1987). *Field Evaluations of Sprinkler Uniformities in Utah,* Pacific Northwest Irrigation Research Workshop, Kennwick, Washington; November.

Allen, L. N., and Morris, R. L. (1992). *Horticulture Handbook, Chapter 4 - Irrigation,* Southern Area, Nevada Cooperative Extension.

---. (1992). *Irrigation Water Quality for Urban Irrigation in the Las Vegas Valley*, Nevada Cooperative Extension, Fact Sheet Number 92-69.

Allen, L. N., and Sorensen, R. (1991). *Fall - Good Time to Maintain Pumping Stations,* Utah Farmer-Stockman.

Bishop, A. A., Allen, L. N., Poole, G., and Walker, W. R. (1981). *Furrow Advance Rates Under Surge Flow Systems,* Transactions of ASCE Irrigation and Drainage Division 107.

Cobourn, J., Johnson, W., Ford, J., Reid, M., and Allen, L. N. (1992). *Nevada's Water Future: Making Tough Choices, A Guide for Public Policy Dialogue,* University of Nevada, Reno.

Cox, D. M., and Allen, L. N. (1992). *Colorado River Basin Salinity Control Project Moapa Valley, Nevada,* Nevada Cooperative Extension, Fact Sheet Number 92-69.

---. (1992). *Irrigation Management and Agricultural Salinity,* Nevada Cooperative Extension, Fact Sheet Number 92-69.

Hill, R. W., and Allen, L. N. (1991). *New Statewide Weather network Helps Answer Irrigation Questions,* Published as a Special Insert to the Utah Farmer-Stockman.

---. (1991). *Water-Table Lysimeter Data Interpretation*, ASCE Proceeding of the International Symposium of Lysimetery - Lysimeters for Evapotranspiration and Environmental Measurements, Honolulu, Hawaii.

---. (1990). *Irrigation Scheduling Using Neutron Moisture Meters*, ASCE Irrigation and Drainage Division Specialty Conference, Durango, Colorado.

Hill, R. W., Allen, L. N., Brockway, C. E., Robinson, C. W., Allen, R. G., and Burman, R. D. (1989). *Duty of Water Under the Bear River Compact: Field Verification of Empirical Methods for Estimating Depletion*, Utah Agricultural Experiment Station, Project No. 801, Research Report 125; Logan, Utah.

Hill, R. W., Allen, L. N., Burman, R. D., and Brockway, C. E. (1986). *Meadow ET in the Bear River Basin of Utah, Wyoming, and Idaho*, ASCE Irrigation and Drainage Division Specialty Conference, Long Beach, California.

Nielson, C., and Allen, N. (1988). *Computer Scheduling Aids Irrigation Companies*, Utah Farmer-Stockman, Special Insert.

Ranjha, A. Y., Peralta, R. C., Deer, H. M., Allen, L. N., and Hill, R. W. (1991). *Sprinkler Irrigation - Pesticide Best Management Systems,* Cooperative Extension Service, Utah State University.

Sorensen, R. B., Allen, L. N., and Hill, R. W. (1990). *Extending Electric Motor Life*, Information Bulletin #14 prepared for The Colorado River Salinity Program.

APPENDIX B

ESR--12

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Phone: (970) 224-1851, Fax: (970) 224-1885

TECHNICAL MEMORANDUM

Date: April 30, 2010

To: Janet Goldsmith, Esq. and Mark Blum, Esq.

From: L. Niel Allen, Ph.D., P.E. and Brett Bovee, M.Eng., P.E.

RE: Soil and Erosion Information for El Sur Ranch Irrigated Pastures Water Rights Application Number 30166

This memorandum describes the soil properties and the potential for erosion due to irrigation of the El Sur Ranch pasture. It provides information to complete the Final Environmental Impact Review (EIR) being prepared by PBS&J for the El Sur Ranch water right application. The memorandum sections include (1), Soil Descriptions, (2) Soil Properties, (3) Water Movement in Soils, and (4) Erosion Potential. In summary, the erosion potential on the El Sur Ranch irrigated pasture has been reduced from conditions prior to irrigation development by the soil conservation practices implemented by El Sur Ranch. Furthermore, during the irrigation season when there is dry buffer between the end of the field and the ocean bluff, the lateral flow of water to the bluff face is minimal, if any.

Soil Descriptions

The soils on the El Sur Ranch irrigated pastures are described in the 1978 Soil Survey of Monterey County prepared by the USDA Soil Conservation Service (USDA-SCS, 1978). A description of the soils was also provided in Chapter 4 of the March 2007 NRCE report (NRCE, 2007). Copies of relevant pages from the 1978 Soil Survey are included in Appendix A. Figure 1 is a copy of Figure 4-1 from the 2007 NRCE report, showing the aerial extent of different soil series on the El Sur Ranch property.

Most (86%) of the irrigated pasture soils are Santa Ynez Fine Sandy Loam, with the next most prevalent soils being Lockwood Shaly Loam (8%) and Pfeiffer Fine Sandy Loam (6%). The soil survey includes a description of the top five feet of the soil profile. Figures 2 to 4 diagram the soil profiles for these three soil types. In addition to the three soil types the irrigated pastures have some Badland soils along the coastline and Swiss Canyon. The badland soils in the irrigated portion of the pasture have been reclaimed.

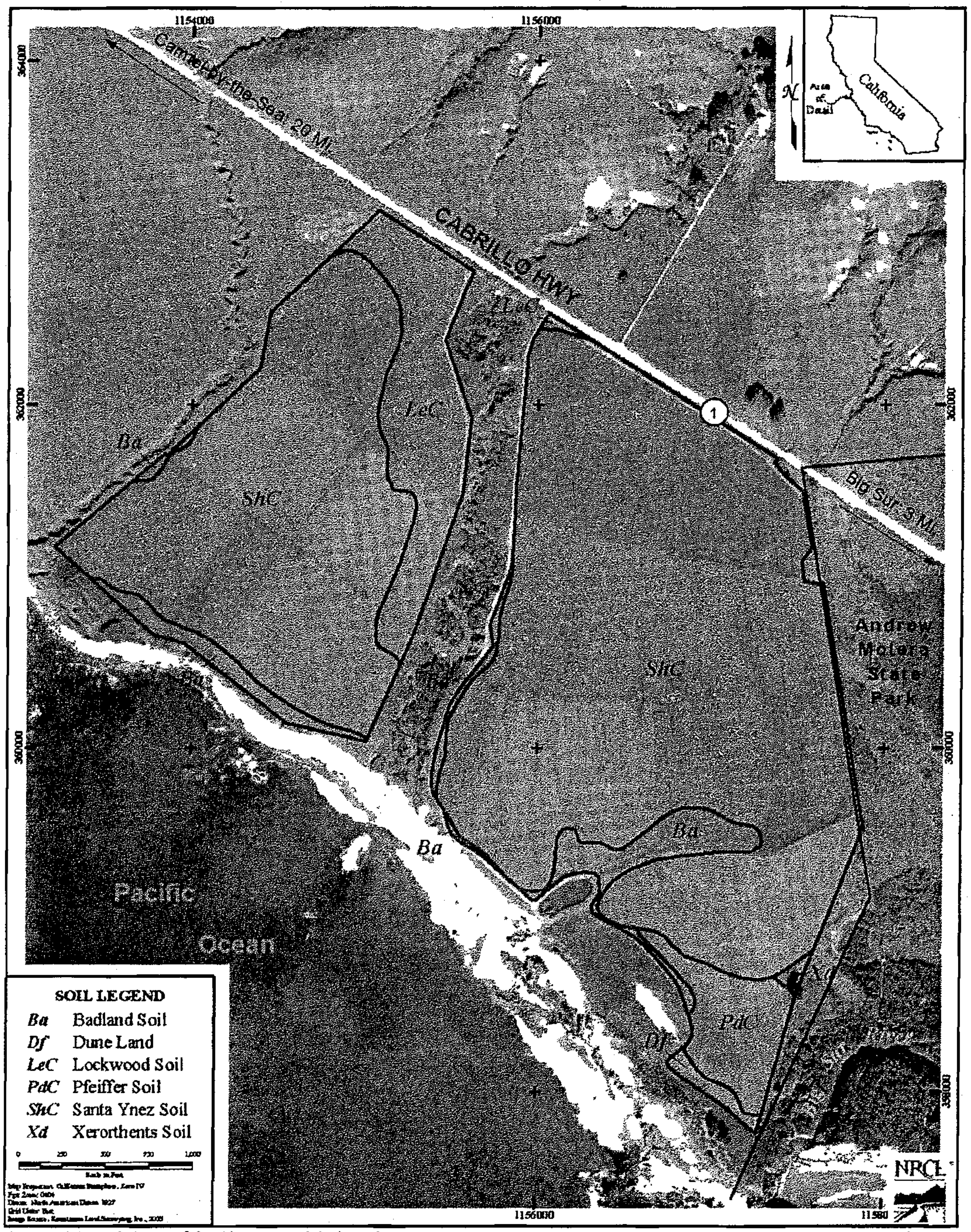

Figure 4-1: Soils Map of the El Sur Ranch Irrigated Pasture

March 2007

ATTORNEY-CLIENT COMMUNICATION
CONFIDENTIAL, PRIVILEGED INFORMATION

PRELIMINARY DRAFT
for attorney-client review

Figure 1: Soil Map of El Sur Ranch

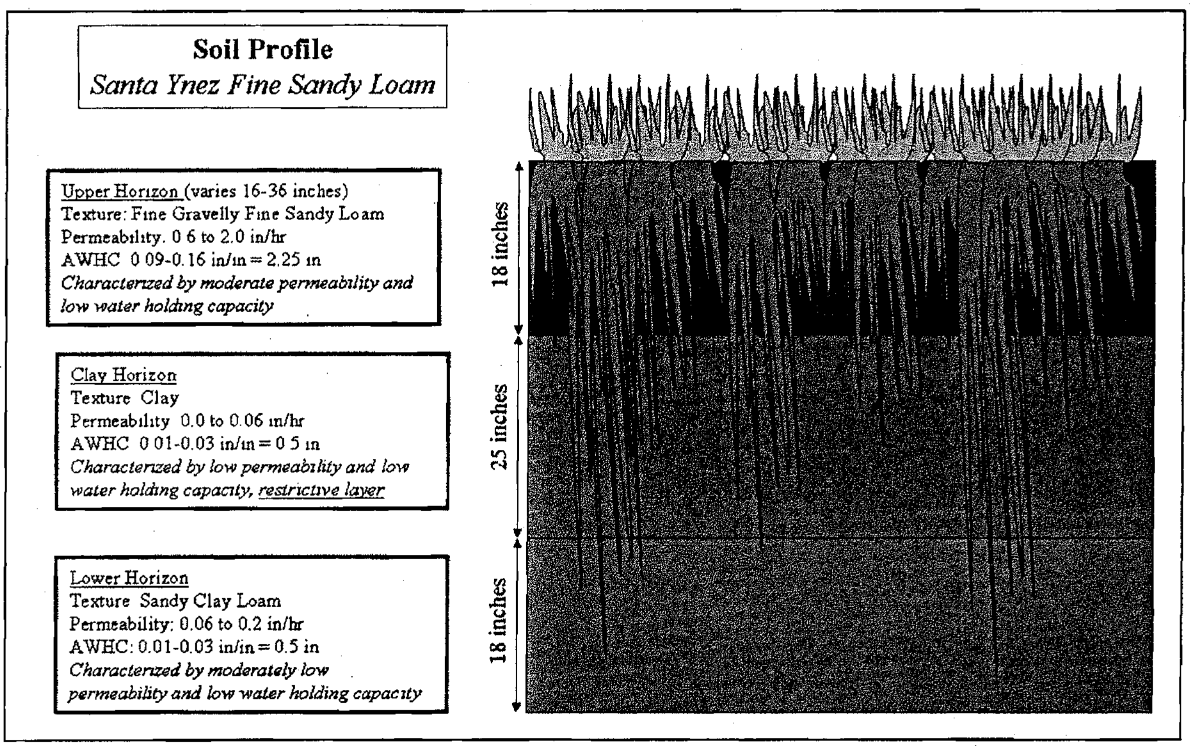

Figure 2: Soil Profile of Santa Ynez Fine Sandy Loam

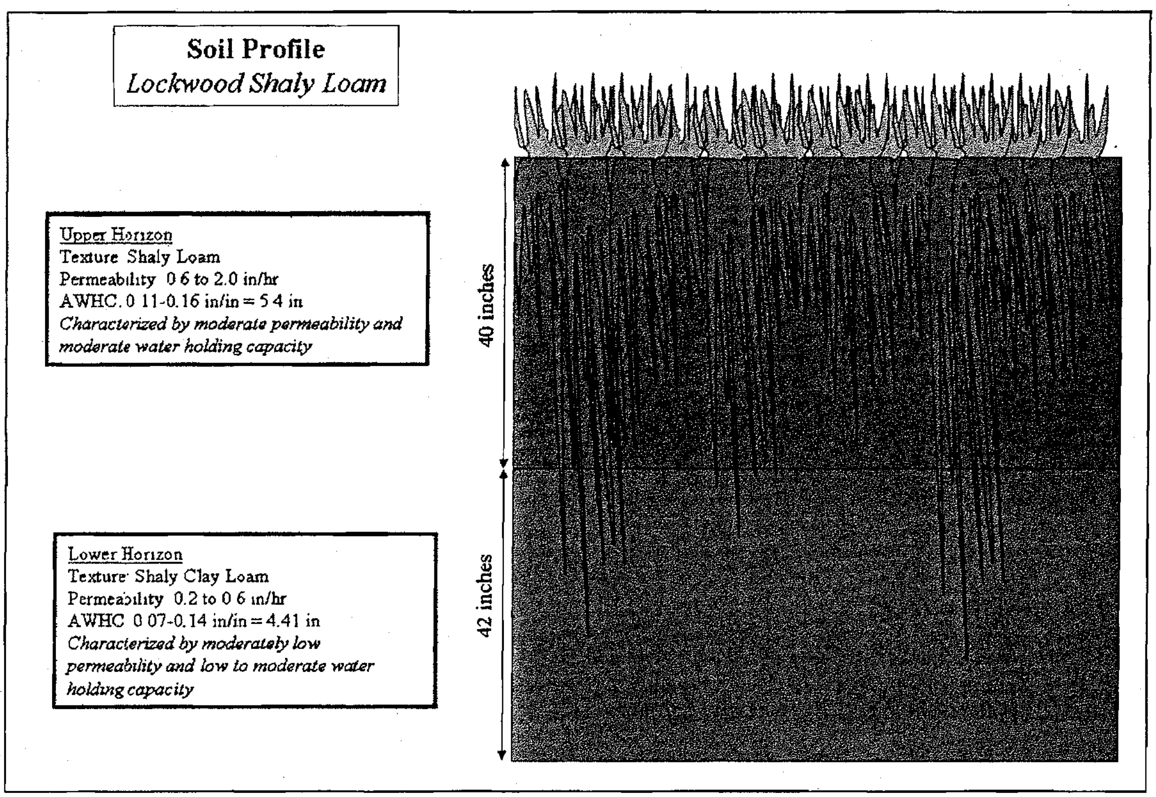

Figure 3: Soil Profile of Lockwood Shaly Loam

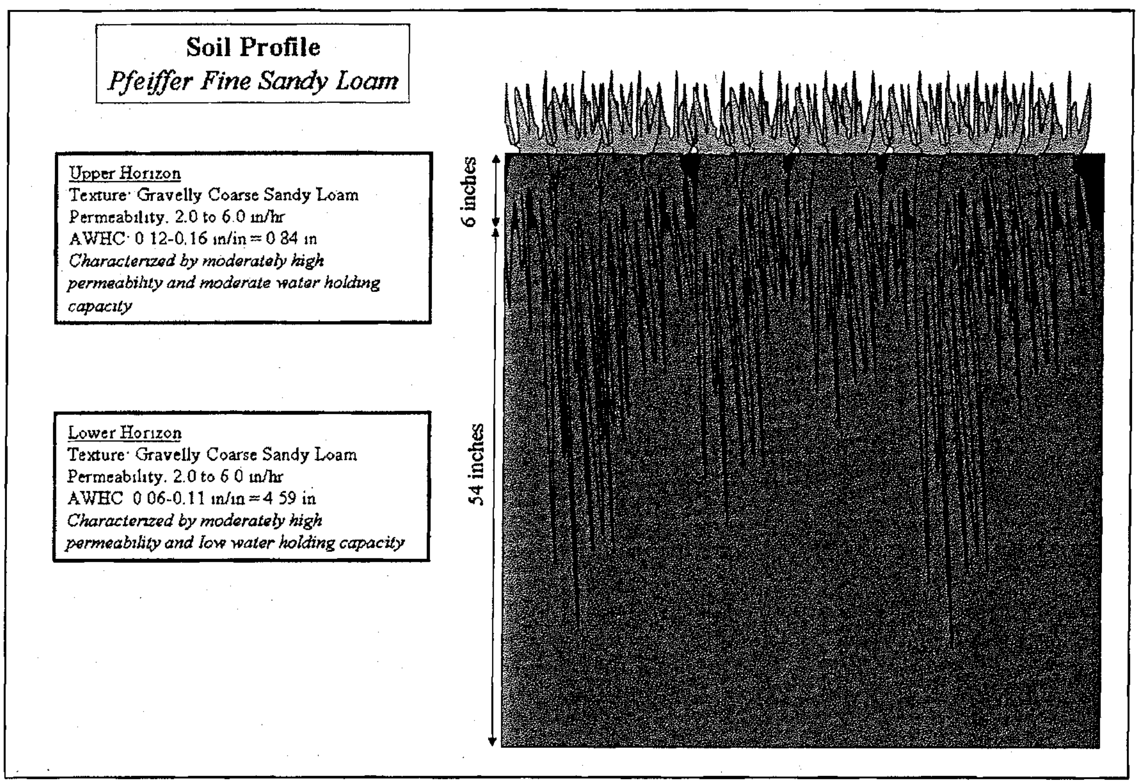

Figure 4: Soil Profile of Pfeiffer Fine Sandy Loam

The 1978 Soil Survey describes soil types and properties in the upper five feet. Two wells that were drilled in the Pump House pasture field on Santa Ynez soils, near the southern edge of the El Sur Ranch property boundary provide soil information at deeper depths. These wells are identified as ESR-11 and ESR-12 in the May 20, 2005 water right application by The Source Group, Inc. (TSG, 2005). The drill log for ESR-11 indicates medium to coarse sandy clay from a depth of about 5 to 20 feet. The groundwater table was reached at a depth of 42 feet and bedrock appears to have been reached at a depth of 90 feet. There were no perched water tables noted in the well drill logs.

Soil Properties

This section defines some of the soil properties that enter into the discussion of water movement through soils. Definitions were largely taken from Maidment (1993).

Saturated Hydraulic Conductivity (K_{sat})

Hydraulic conductivity (K) is a measure of the ability of the soil to transmit water and depends upon both the properties of the soil and the fluid. Hydraulic conductivity is reported in units of length per time (for example, inches per hour of water movement through the soil). Porosity, pore-size distribution, and pore connectivity are important soil characteristics affecting hydraulic conductivity. The saturated hydraulic conductivity (K_{sat}) is measured when the soil is at saturation.

Permeability

Permeability is also a measure of the ability of the soil to transmit water, but depends only upon the properties of the soil. Permeability is reported in units of length squared (for example, square inches). Permeability can be related to hydraulic conductivity by properties of the fluid. The 1978 Soil Survey defines permeability as "the quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil." This definition indicates that permeability reported in the 1978 Soil Survey is actually describing the saturated hydraulic conductivity of the soil.

Porosity

Porosity is the volume of void space per unit volume of porous medium; it is a measure of how much empty space exists in a given amount of soil. Porosity is reported as a fraction or percentage. For example, a soil with 40% porosity means that 40% of the soil consists of voids and 60% consists of solid soil particles. The porosity or void space in a given soil provides a measure of the volume of water than can enter into the soil profile. Various terms are used to describe the degree to which the total porosity (void space) is filled with water, such as saturation, field capacity, and wilting point.

Saturation

Saturation is the condition when the soil voids are filled with water.

Field Capacity

Field capacity refers to the condition wherein soils at saturation have been allowed to drain (typically for 24 to 48 hours). A portion of water remaining in the soil is available for plant use. The water remaining in the soil is held in the soil voids by negative capillary pressure.

Capillary Pressure

The force by which water is drawn around soil particles because there is a stronger attraction between the soil particles and the water molecules themselves. The movement of water within the soil due to the forces of adhesion, cohesion, and surface tension acting in a liquid that is in contact with soil particles. The capillary pressures move water from wet soils to adjacent drier soils. The movement of water in soils due to capillary pressure is generally only a couple of feet. The capillary pressures also hold water in soils against the force of gravity.

Wilting Point

Wilting point refers to the condition where water remains in soil voids and cannot be utilized by plants because the negative pressures holding water in the soil pores are greater than the pressure created by the plant to extract water from the soil voids. Figure 5 shows the differences between these conditions.

Available Water Holding Capacity

The available water holding capacity represents the amount of water that can be held in the soil and is available for uptake by plants. The available water holding capacity is measured as the difference between Field Capacity and Wilting Point, and is reported as depth of water per depth of soil (for example, 2 inches of water available per 12 inches of soil depth).

Drainable Water

Drainable water represents the amount of water that drains out of the soil voids under the influence of gravity. It is calculated as the difference between the volume of water under saturated conditions and the volume of water at field capacity.

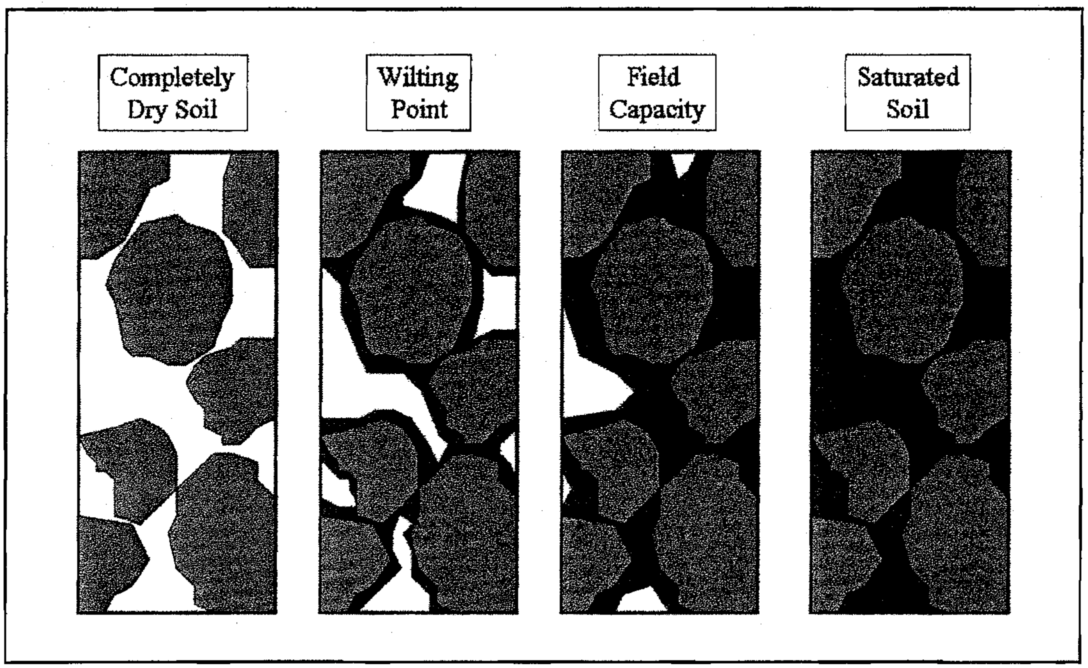

Figure 5: Diagram of Saturation, Field Capacity, and Wilting Point

Infiltration

Infiltration is the process of water entry into a soil from rainfall, snowmelt, or irrigation. Infiltration is influenced by movement of water within the soil as infiltrated water moves vertically downward by gravity and is distributed through the soil profile. Infiltration is dependant upon many factors; including soil type, land cover condition, rainfall or irrigation rate, and degree of saturation of the soil profile. For most soils, as the soil becomes wetter over the course of a rainfall or irrigation event, the infiltration rate decreases. The soil saturated hydraulic conductivity is almost always less than the initial infiltration rate. Runoff occurs when application rate (precipitation or irrigation) is greater than infiltration or when the soil becomes saturated and water movement through the soil is limited either by a restrictive layer or a water table.

Water Movement

This section describes the various pathways that water moves on El Sur Ranch irrigated pasture. An understanding of the soil types and properties provided in the preceding sections is helpful to understand water movement. Water movement is described for two different situations, a peak rainfall event and an irrigation event, because the dominant processes and magnitude of different water pathways differs for each situation.

Irrigation Event
Irrigation begins with water being applied at the head end of a pasture field. Irrigation water is discharged from the supply pipeline at valve locations and immediately starts to pond near the valve. The applied water that does not infiltrate into the soil moves laterally away and down gradient from the valve. Water moves much more readily on the soil surface than in the soil. For surface irrigation the application rate is greater than the water infiltration rate. Thus a portion of the water advances towards the tail end (lower portion of the field) and a portion infiltrates into the soil under the influence of gravity. The advance of the water is a function of the land slope, the surface cover conditions (density of grass, etc.), and the infiltration rate into the soil. The water generally advances down gradient, but also extends laterally a short distance due to the depth of water flow. The lateral movement of surface water is controlled by dikes between the field borders.

As the water advances, water infiltrates into the soil and fills unsaturated voids in the soil. Once the soil is saturated, water moves downward through the soil profile under the influence of gravity at a rate equal to the hydraulic conductivity (or Soil Survey permeability). For Santa Ynez soils, water moves through the upper soil horizon faster than it can move through the restrictive clay layer. With time the upper soil layer becomes saturated. When the upper soil horizon becomes completely saturated, the water infiltration rate decreases to the infiltration rate of the lower clay soil layer. Water that moves downward through the restrictive clay layer will continue to drain through the more permeable layer below the clay layer and eventually to the water table.

As an example, the following discussions refer to a specific pasture on the El Sur Ranch, and for reference purposes Figure 6 shows the El Sur Ranch pasture layout. The various water movement pathways associated with an irrigation event are shown in Figure 7. This condition produces the peak irrigation runoff and would likely only occur for a few hours near the end of the irrigation. Some irrigation events have minimal runoff. The water application rate for an irrigation event was estimated from the 2004 pumping data, which was approximately 2.92 cubic feet per second (cfs) applied to Pasture 7 (18 acres) on June 18-19, 2004. This irrigation application rate is consistent for Pasture 7, because of the pumps and irrigation system capacities. The water movement rates shown in Figure 7 assume that water movement rates are governed by the permeability provided in the 1978 Soil Survey. As previously stated the initial infiltration rate is generally higher than saturated permeability.

Rainfall Event
Rainfall occurs uniformly across the entire ranch area. As raindrops land on the soil surface, water will begin to pond and infiltrate into the soil. Similar to irrigation, the

infiltrating water begins to fill unsaturated voids in the soil matrix. Water continues to move downward through the soil profile under the influence of gravity at a rate equal to the hydraulic conductivity (or Soil Survey permeability). For Santa Ynez soils, water will drain through the upper soil horizon faster than it can drain through the restrictive clay layer. The result is that soil water will start to pond on the clay layer and begin to fully saturate the upper soil horizon. When the upper soil horizon becomes fully saturated, water which has ponded on the surface will not be able to infiltrate into the soil as fast as the rainfall rate. This generates overland runoff as water continues to pond to the point where it starts to flow down-gradient under the influence of gravity.

The dense stand of pasture grass would help to control the velocity of runoff on the pasture fields. An important difference from irrigation is that rainfall occurs everywhere at once on the ranch property. Thus, overland runoff is not limited to a single pasture field, but instead runoff would be occurring from all fields. As runoff generated from rainfall flows down-gradient, it will tend to accumulate into rills and gullies in the natural land surface. Field borders and road embankments formed as part of the pasture land management, as well as the dense pasture, help to reduce the formation of rills and gullies in the pasture fields. In general, if the El Sur Ranch property were not managed for irrigated pasture, the formation of natural rills and gullies from rainfall runoff would be much more likely. A good example of this is the erosion in Pastures 5, 6, and Pump House Field which can be observed in the 1929 and 1942 aerial photos, prior to development of irrigation.

Irrigations occur when the soils are relatively dry, because of high evapotranspiration (ET) rates during the summer and the lack of rainfall. As a result, the initial infiltration of water during irrigation is stored in unsaturated soil. Contrary to this, winter rainfall events often occur when the soil is partially saturated as a result of consistent rainfall and low ET rates during winter. Initial infiltration during a winter rainfall event may encounter partially or fully saturated soils, resulting in rapid runoff. The various water movement pathways associated with a peak rainfall event are shown in Figure 8.

For example, a peak rainfall event recorded by the El Sur Ranch pasture automated weather station occurred December 7, 2004. On this day the total precipitation was 3.07 inches, with 2.76 inches occurring during a 6-hour period. During this 6-hour period, the peak measured rainfall rate of 0.55 inches per hour occurred for 4 hours. The water movement rates shown in Figure 8 assume that no preferential flow pathways exist in the soil matrix, and water movement rates are governed by the permeability provided in the 1978 Soil Survey.

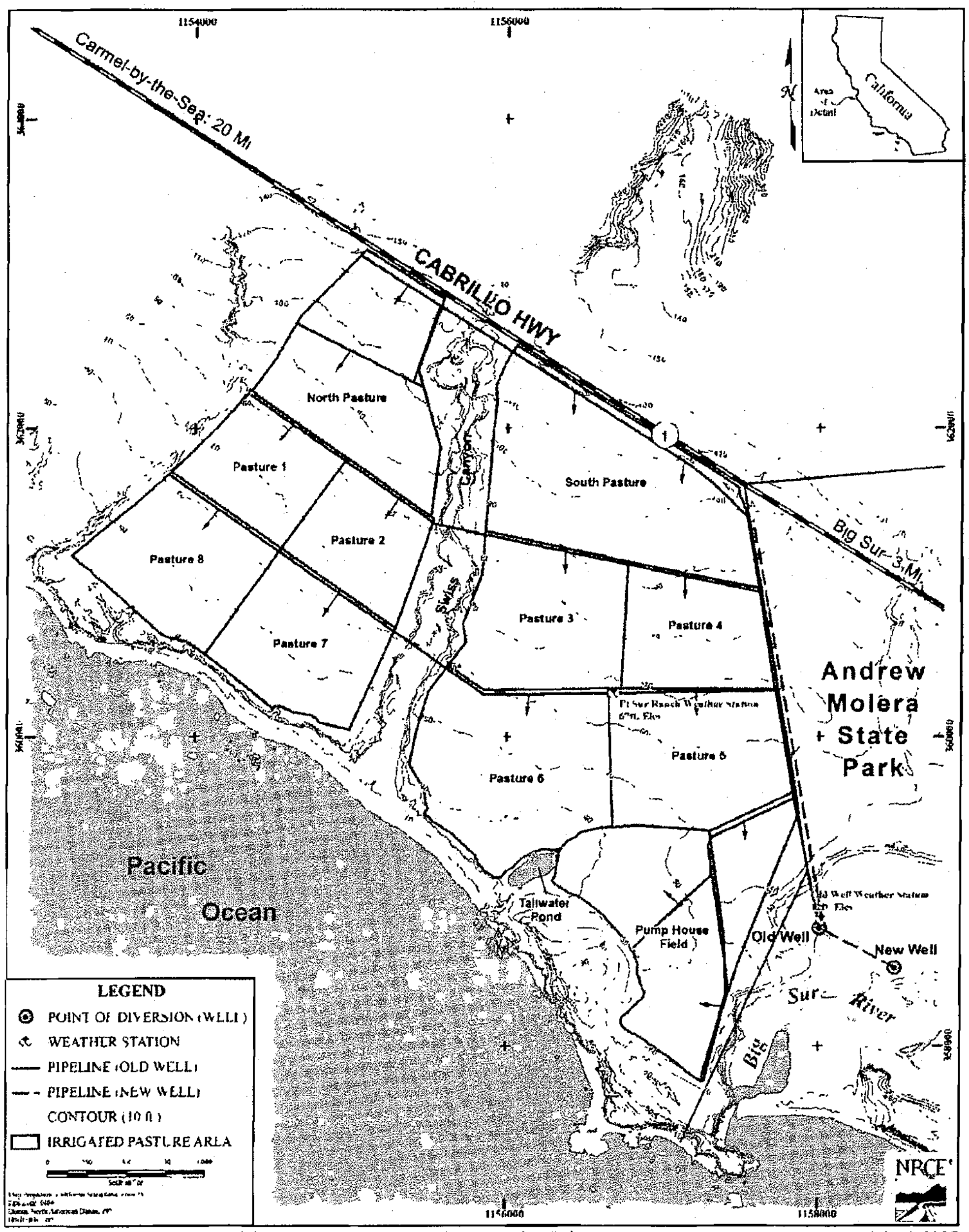

Figure 2-5: Topographic Map of the El Sur Ranch Irrigated Pasture and its Infrastructures March 2007

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Figure 6: El Sur Ranch Irrigated Pasture Layout and Topography.

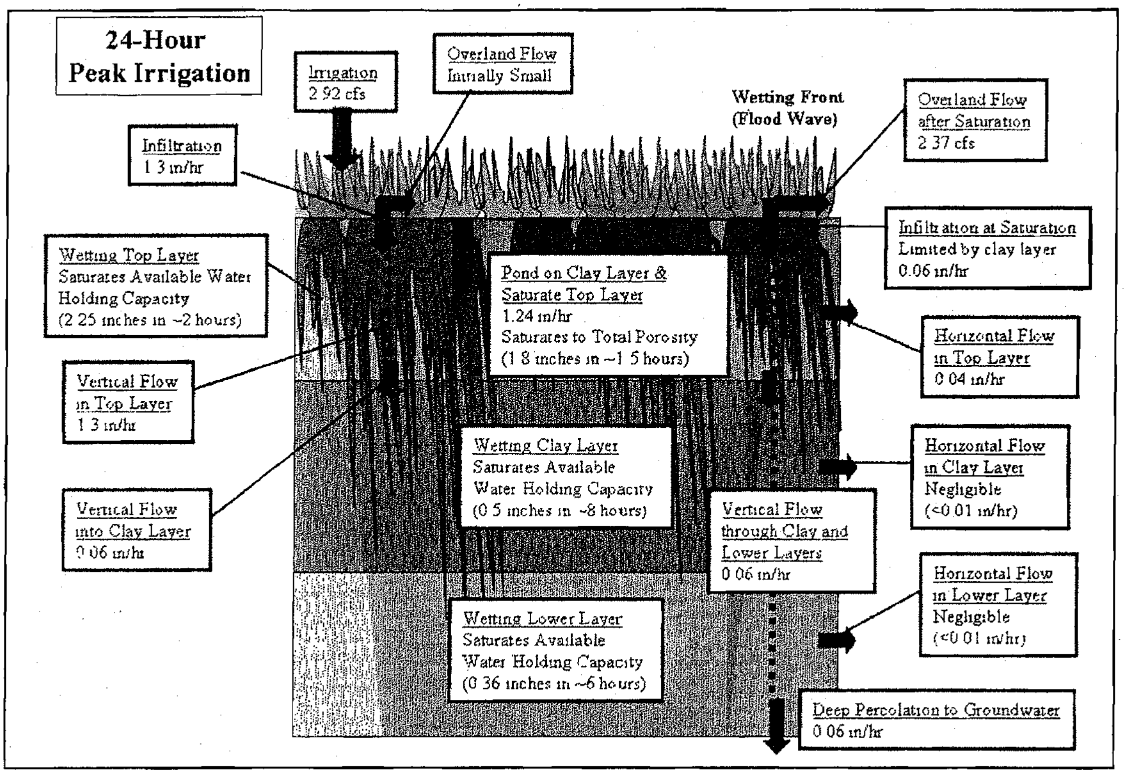


Figure 7: Irrigation Event Water Movement

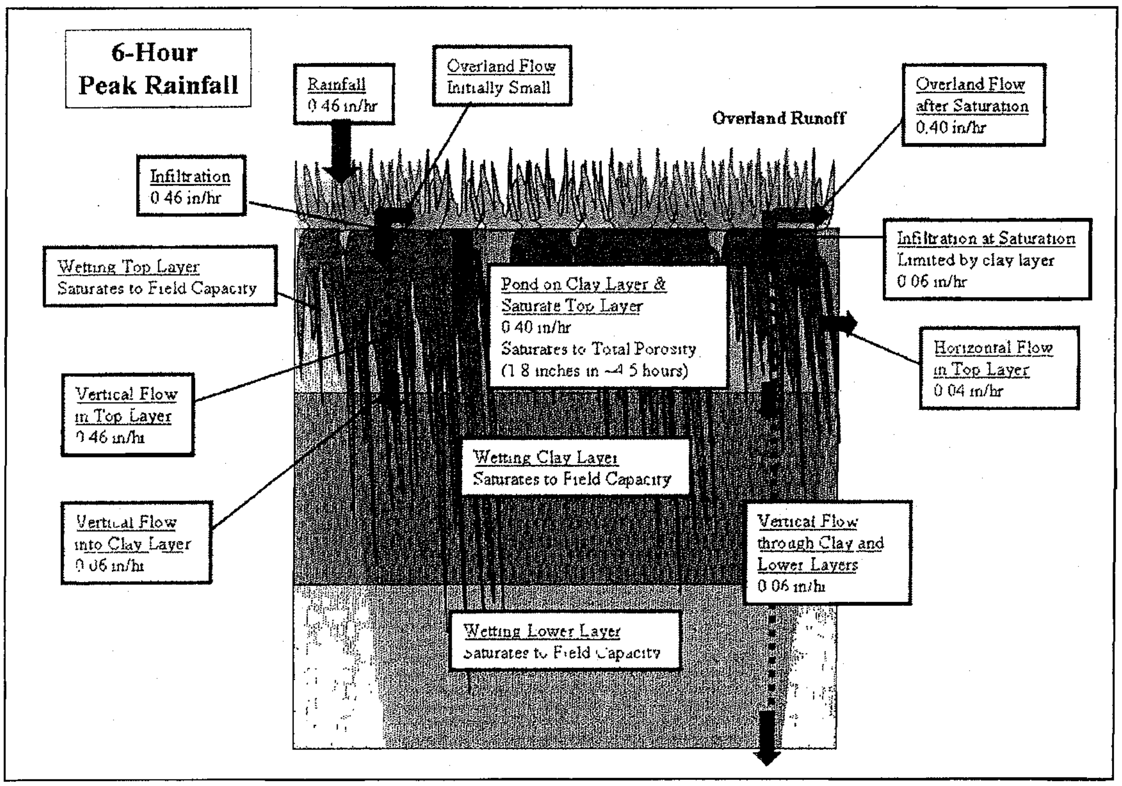


Figure 8: Rainfall Event Water Movement

The calculated runoff rates assume that the upper soil layer is near saturation prior to the storm. It is also assumes that natural rainfall does not cause sealing of the soil surface due to raindrop impact and movement of the surface soil particles. This process acts to reduce the infiltration rate into the soil and increase the magnitude of overland runoff. The presence of the dense stand of pasture grass would reduce the likelihood of surface sealing, because the grass canopy absorbs the energy of the raindrop impact.

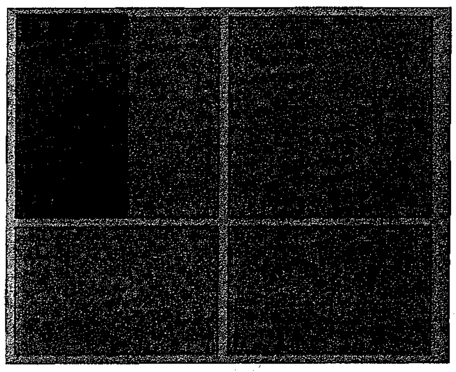
Spatial Analysis of Runoff

Figures 7 and 8 look at water movement in a profile, two-dimensional frame, which is useful in looking at the generation of overland runoff. The movement of water across the land surface and the accumulation of water into channels can be seen as a third dimension of water movement on the ranch. On the El Sur Ranch property, overland runoff is limited in its ability to accumulate into rills and gullies by the field borders and road embankments, and by the dense stand of pasture grass which acts to slow overland flows and keep water uniformly spread across the surface. Also, at the downstream ends of the pasture fields, irrigation tailwater is managed and directed to specific outlet discharge areas. In comparison, a natural landscape that did not contain field borders, dense pasture grasses, and other water management practices would likely contain rills and gullies as overland runoff accumulates in topographic depressions. This erosion occurred in Pastures 5, 6, and the Pump House Field prior to development of irrigation.

Rainfall events would produce more overland runoff over the entire irrigated pasture area, whereas irrigation events are limited to specific fields. The total overland runoff is much greater under rainfall events. For comparison, using the water movement rates provided in Figures 7, irrigation at peak rates might be expected to produce a maximum of 2.37 cfs of overland runoff for a limited time. This runoff is managed by field borders and road embankments. For comparison, during the 6-hour precipitation event on December 7, 2004 the average rainfall rate was 0.46 in/hr with a saturated infiltration rate of 0.06 in/hr for the Santa Ynez soils (Figure 8) for a runoff rate of 0.4 inches per hour. This results in a calculated runoff of 84 cfs (0.4 in/hr runoff times 208 acres (Santa Ynez soils) times 43,560 ft^2/acre divided by 12 in/ft divided by 3,600 sec/hr). The total runoff volume to the ocean from the rainfall event is estimated to be 35 to 55 times greater than the runoff from the irrigation. Under natural conditions this runoff would likely accumulate into rills and gullies. Under the existing irrigated pasture conditions, rills and gullies less likely to occur and discharge from the pasture would occur at the outlet to the tailwater pond and other pasture outlet locations. Figure 9 illustrates the difference between irrigation runoff and rainfall runoff.

Irrigation on Pasture

Peak Application Rate:
0.324 in/hr = 0.324 cfs/acre
2.92 cfs for 9 acre half-field



Runoff Rate:
0.264 in/hr = 0.264 cfs/acre
2.37 cfs for 9 acre half-field

Runoff Conditions:
Runoff distributed across bottom edge of field
Runoff managed by field borders and road embankments

Rainfall on Natural Landscape

Peak Rainfall Rate:
0.46 in/hr = 0.46 cfs/acre
134 cfs for 292 acre ranch

Runoff Rate:
0.40 in/hr = 0.40 cfs/acre
117 cfs for 292 acre ranch

Runoff Conditions:
Runoff accumulates into rills and gullies
Runoff flow is distributed across number of gullies

Figure 9: Plan View of Runoff Water Movement

Lateral water movement towards the ocean also occurs in the irrigated pasture area within the soil profile, but to a much lesser extent than surface water movement. Lateral water movement in the soil is restricted by soil particles and is dependant upon the type of soil. The hydraulic conductivity (Soil Survey permeability) provides the estimated rate of water movement in the vertical direction under the influence of gravity. At a land slope of 3%, the force of gravity pulling soil water in the lateral direction down gradient to the ocean is small.

Lateral Water Movement in Soil

The following calculations show that water within the soil at saturation moves down through the restrictive clay layer more rapidly than towards the coastal bluff. The movement of water in soil is described by Darcy's Law, which states that the flow of water in a porous media (such as soil) is related to the hydraulic conductivity within the media and the pressure gradient acting on the water. One form of Darcy's Law can be described by the following equation:

$$V = K\frac{\Delta H}{L}$$

Where: V = velocity of water flow in soil (ft/s), K = hydraulic conductivity (ft/s), ΔH = head or elevation difference along flow path (ft), L = length of flow path (ft).

For vertical flow within the soil, the term $\Delta H/L$ is equal to one, and so the velocity of water flow is equal to the hydraulic conductivity. For lateral flow within the soil, the term $\Delta H/L$ is equal to the slope of the land surface or less permeable layer, which varies but can be estimated at 3% or 0.03. Applying the above equation and assuming that the hydraulic conductivity of the soil is the same in all directions, the lateral flow velocity is equal to only 3% of the hydraulic conductivity. The velocity of the wetting front of the water in the soil is 2 to 3 times greater than the Darcy's Law velocity because the water is only moving through the pores.

The total amount of water that moves through the soil after an irrigation or rainfall event is equal to the drainable water, which is the difference between water held at saturation and water held at field capacity. Porosity and field capacity for the upper soil layer (sandy clay loam) are estimated to be 0.4 and 0.27, respectively (Risinger and Carver, 1987), resulting in drainable water amount of 0.13 inches per inch of soil depth, or 2.34 inches for the upper soil layer. Water in the upper 18 inches of soil would drain downward at a rate of 0.06 in/hr which is the Soil Survey permeability of the restrictive clay layer, or 1.44 inches per day. Water would travel laterally at a rate of 0.039 in/hr, which is 3% of the average Soil Survey permeability for this upper layer, or 0.94 inches

per day (movement of water in pores would be 2-3 inches per day). These rates indicate that drainable water would move into the restrictive clay layer in about 39 hours, over which time the drainable water would have moved less than a foot in the lateral direction. Thus during the irrigation season when there is dry buffer between the end of the field and the ocean bluff, the lateral flow of water to the bluff face is minimal, if any. However, during the winter when the entire pasture is saturated, there can be lateral water flowing to the bluff face through the saturated upper layer of soil.
As an illustration, consider a sponge saturated with water that is 10 inches long. If one end was elevated by 0.3 inches, there would be little if any water flow out of the lower edge. If additional water was poured on the sponge nearly all the drainage would be out of the bottom of the sponge.

As previously stated negative capillary pressures move water from wetter to drier soil. These pressures can move water laterally, but the capillary pressures are also the pressures that hold water in the soil against gravity.

Erosion Potential

This section describes the erosion potential for the El Sur Ranch irrigated pasture. A general discussion of common types of erosion and factors influencing erosion is followed by a discussion of erosion specifically for El Sur Ranch.

Types of Erosion

Erosion occurs when the forces acting to displace soil particles are greater than the forces holding the soil particles in their original state. More specifically, erosion occurs when the actual shear stress on soil particles (in this case, from water) exceeds the critical shear stress needed to dislodge and suspend the soil particles (Mays, 2005). Erosion of the land surface due to surface runoff can be classified into several types, depending on the severity and type of water flow, such as sheet, rill, and gully. These types of erosion are illustrated in Figure 10 and described below:

- *Sheet Erosion* occurs as overland runoff flows across the soil surface. Sheet erosion can occur as the overland flow picks up soil particles dislodged by rainfall impact, or by the uniform removal of a thin film of soil from the land surface. Sheet erosion is not associated with recognizable water channels.
- *Rill Erosion* begins to occur as overland runoff flow begins to form small concentrated channels. Erosion rates often increase under rill erosion, due to the larger, higher velocity flows in the rills.

- *Gully Erosion* forms as the water flowing in rills accumulates into larger incised channels. Gullies are usually defined as water channels that cannot be remedied by tilling or discing the soil surface. Gully erosion can result in more significant damage to ranch equipment and field borders.

Erosion can also occur along the coastline as a result of ocean waves, tidal or other fluctuations in sea level, surface water runoff over the top of the bluff, and groundwater seepage at the bluff face (Hampton and Griggs, 2004). These processes differ from those shown in Figure 10 and described above.

Factors Influencing Erosion Potential

Factors that would increase the potential for erosion include: increasing flow/application rate and duration (either from rainfall or irrigation), and increasing slope angle. Factors that would decrease the potential for erosion include: density of plant cover (roots to anchor soil), the presence of ground cover, and increasing organic matter in the soil. These factors are incorporated into the Universal Soil Loss Equation (USLE) published by the U.S. Department of Agriculture in 1965. The factors included in the USLE help describe the factors that influence erosion. These factors are provided in Table 1.

Erosion is often a topic of interest on grazing lands because grazing has the potential to increase erosion. Compaction of the soil surface by cattle can reduce the infiltration of water into the soil profile and increases the overland sheet flow of water. This is most problematic when the surface soil is wet, such as when cattle are allowed to graze on a field while it is being irrigated or during the rainy season. Loss of plant cover from grazing can cause increased overland flow rates and reduce beneficial soil anchoring by plant roots. Also, ground cover (duff) can be reduced which exposes the bare soil to rainfall impact and overland sheet flow. Understanding that these erosion concerns exist, the importance of land and water management in grazing operations is seen as the over-riding factor in determining erosion from grazing lands. Several studies provide that well-managed grazing lands will likely reduce the potential for erosion, whereas poorly-managed grazing lands will usually experience an increased potential for erosion (Huss, 1996; Smiens, 1975; CCWD, 2005; Patric and Helvey, 1986).

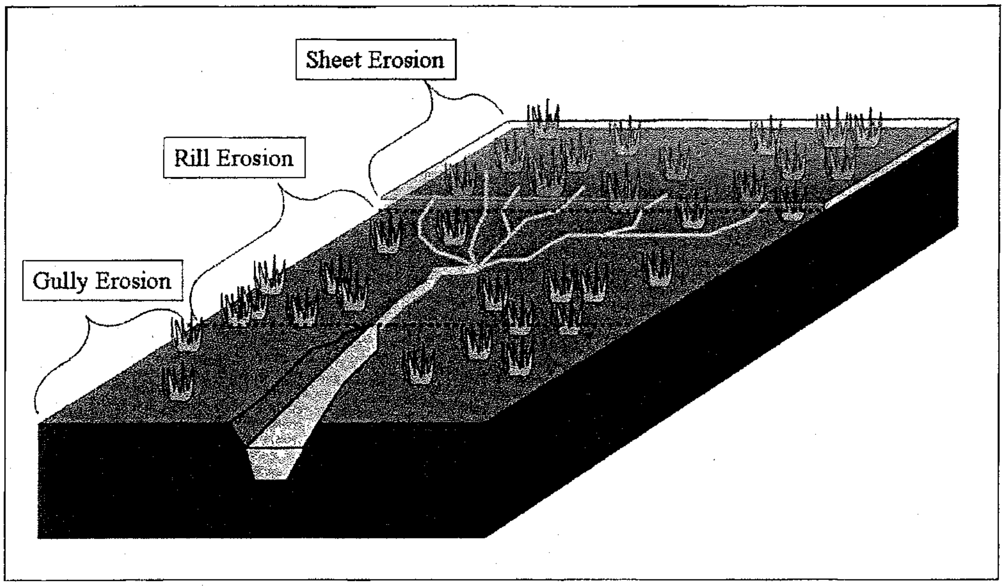


Figure 10: Illustration of Erosion Types

Table 1: Factors Influencing Erosion Potential

Factor	Discussion
Rainfall-Runoff Factor (R)	The intensity (rate) of rainfall is important because it provides the energy to displace surface soil particles and determines the magnitude of overland runoff flow that might cause erosion.
Soil Erodibility Factor (K)	The type of soil is important because soils differ in their infiltration rates, adhesion properties, and overall erodibility. The El Sur Ranch irrigated pasture soils have a slight to moderate Soil Erodibility Factor.
Slope Length (L) and Steepness (S) Factors	Slope length is important because it provides the distance or time over which runoff and erosion may occur. Longer slopes provide a longer opportunity time for erosion to develop. Slope steepness or angle is important because it determines how the force of gravity acts upon the lateral movement of soil and water. Steeper slopes have a greater tendency to erode. El Sur Ranch irrigated pasture slopes are low.
Cover Management Factor (C)	Cover management involves many individual factors. Land use determines what kind of land surface impacts have taken place and what kind of disturbance the topsoil has experienced. The percent of canopy cover determines how much protected the soil surface is from direct raindrop impact. The percent of surface cover determines the degree to which the soil surface is anchored in place by plant roots and to what extent overland runoff is in direct contact with bare soil. The surface roughness determines how fast overland runoff moves across the land surface, which influences the erosive potential of the runoff. Previous soil moisture influences how much water infiltrates into the soil profile instead of becoming overland runoff flow. El Sur Ranch irrigated pastures have good canopy and plant stands
Support Practice Factor (P)	There are several practices that can be implemented to help reduce erosion. Some examples include terracing cultivated fields, installing vegetation buffer strips, and installing subsurface drainage. El Sur Ranch irrigated pastures have good erosion control practices and management.

For the El Sur Ranch, several land and water management practices help to reduce the potential for erosion on the ranch. The erosion control factors in place or in practice on El Sur Ranch include:

(1) Tailwater Pond. A tailwater pond collects irrigation runoff from those fields located south of Swiss Canyon (except the Pump House field, which is about 6.6 acres). The tailwater pond acts as a collection pond so that tailwater from irrigating the fields does not just runoff the coastal bluff, which could be highly erosive. The pond allows the irrigation tailwater to be discharge in a controlled, non-erosive, manner.

(2) Controlled Discharge to Ocean. There are two controlled discharges locations to the Pacific Ocean, one of the northern side of Swiss Canyon and one on the southern side. In the absence of these controlled discharge structures, tailwater runoff from the fields would simply spill over the coastal bluff, likely leading to erosion problems over time. The controlled discharge structures ensure that water is discharged from the El Sur Ranch irrigated pastures in manner that minimizes erosion.

(3) Field Borders and Road Embankments. The pasture fields on El Sur Ranch are irrigated using borders that limit the lateral extent to which flood irrigation water can travel. These field borders ensure that irrigation water does not flow off of the intended pasture and through unintended areas where the potential for erosion is higher. Road embankments and/or tailwater ditches along Swiss Canyon and at the lower edge of the ranch ensure that tailwater runoff and precipitation runoff do not flow off the pasture lands and onto natural landscapes in an uncontrolled fashion. The field borders, road embankments and tailwater ditches basically help El Sur Ranch control the flow of water when irrigating and during rainfall events, which can prevent erosion from occurring.

(4) Irrigation Timing and Management. In addition to controlling the tailwater runoff from irrigation using field borders and road embankments, water is also controlled by properly managing the application of irrigation water to the pasture fields. Irrigation on El Sur Ranch is well-managed and scheduled based on several factors, such as: field or irrigation system maintenance needs, soil moisture conditions, labor constraints, the soils and topography of particular fields, climate conditions, pasture condition and height, and future grazing needs. Irrigation is scheduled to provide pasture production and to limit excessive water applications. Additionally, when possible, irrigation does not occur when cows are grazing on a field, this limits damage to the pasture and the potential for erosion.

(5) Grazing Practices. The grazing practices of El Sur Ranch are intended to maintain a healthy pasture, which reduces the potential for erosion. Pertinent practices include: rotating cows from field to field so that any one field is not over-grazed exposing bare soil; moving cows off of the irrigated pasture lands during the rainy season to ensure that the cows do not compact the soil when it is saturated; and providing water for the cows in troughs as opposed to in creeks or on the pasture itself during flood irrigation.

Erosion Estimation

Equations or methods to estimate erosion are numerous for watershed-scale planning, row crop irrigation practices, and streambed or channel processes. Methods to estimate erosion for flood irrigation of pasture lands are not readily available. After contacting several NRCS field offices in the western U.S., the over-riding response was that field observation of erosion is the best method to estimate erosion potential or likelihood for pasture lands caused by flood irrigation. Based on observation, the erosion potential at El Sur Ranch would be considered low.

Irrigated pasture for grazing has been managed on the El Sur Ranch property for over 50 years. Over this length of time, signs of erosion would be prevalent if in fact erosion was caused by irrigation of the pasture lands. While there have been some instances of overland runoff spilling off of the El Sur Ranch property, and some signs of limited erosion can be found, in general serious erosion concerns are not found within El Sur Ranch. Also, the pasture on El Sur Ranch is healthy as evidenced by the variety of plant species found within the pasture; which indicates the pasture areas have been free excessive from erosion for many years.

The Universal Soil Loss Equation (USLE) is often employed when estimating erosion for large landscapes. The USLE has been extended into several forms, such as the Revised USLE (RUSLE) methods, the Water Erosion Prediction Project (WEPP) software, and the RUSLE2 software program. The USLE and its extensions are rainfall-runoff based methods (specifically the R-Factor), and are not readily applicable to a case where flood irrigation is the driving force behind any erosion.

Application of the USLE with the WEPP software for conditions on the pasture provides an estimated soil loss rate of 0.075 tons per acre per year. This is less than $1/1000^{th}$ of an inch per year soil loss. These estimates are shown in Table 2. The estimate of maximum annual erosion by wind or water that can occur without affecting crop productivity for

Santa Ynez soils over a sustained period is 1 ton per acre per year (NRCE Soil Survey for Monterey County, Erosion Factor "T", Table 7 in Appendix A of this memorandum).

The soil loss estimates provided in Table 2 are very small, indicating the erosion should not be a significant concern on El Sur Ranch. Pasture lands in California have erosion rates of 0.1 to 0.2 tons per acre, per year as reported by the NRCS National Resources Inventory (1982-1997).

Table 2: Application of the USLE to El Sur Ranch Rainfall-Runoff

Method	**Source**	**Factors**	**Estimated Soil Loss (tons/acre/year)**
WEPP	NSERL	Monterey climate station, 700 ft. field length, 900 ft. field width, 3% slope, Santa Ynez soil, Fescue cover with grazing, 30-year simulation	0.0752
USLE	Mays, 2005	R-Factor from map (80), K-Factor for very fine sandy loam (0.41), LS-Factor from graph for 700 foot length at 3% slope (0.5), C-Factor for range cover with no appreciable canopy and 95% cover (0.003)	0.0492

Previous Investigations of Erosion

Three studies have been conducted on the El Sur Ranch to specifically address erosion on the property. The findings of these studies show: (1) that erosion of the coastal bluff is most likely due to ocean surf activity, (2) that erosion in Swiss Canyon has been reduced as a result of pasture establishment and irrigation, and (3) that overland runoff from the Pump House field that has periodically occurred has not caused erosion within or outside of the El Sur Ranch property. No studies or field investigations have been completed regarding erosion of the pasture fields, likely because it has not been a concern. In a review of the water right application and environmental impact review, Custis (2010) has raised several concerns about groundwater seepage causing coastline erosion that are also discussed below.

Rogers E. Johnson & Associates, March 2007

A study by Rogers E. Johnson & Associates, consulting engineering geologists, addressed erosion on the banks of Swiss Canyon and along the coastal bluff on the lower edge of the El Sur Ranch property. The study consisted of reviewing historical aerial photography (taken between 1929 and 2003) and field mapping. Coastal bluff erosion was found to be caused by episodic ocean conditions (high tides and sustained storms) and mostly related to the direction of ocean storm fronts. Erosion along the banks of

Swiss Canyon was found to have been reduced from that which occurred during pre-irrigation years, due to increased riparian vegetation from irrigation and the filling of drainage gullies in establishing the pasture. The study concluded that "irrigation of pasture land has had no discernable effect on rates of coastal bluff retreat within the study area", and that the investigation "did not reveal evidence of increased erosional activity during the past 50 years or so, either along the blufftop or on the banks of Swiss Canyon. In fact, subaerial gullying and slumping has diminished over this time period, primarily due to filling of gullies and control of surface runoff."

The Source Group Inc., 2005

The Source Group, Inc. conducted three separate field visits in March, June, and July of 2005 to investigate claims that overland runoff from El Sur Ranch irrigation was flowing into Andrew Molera State Park. The three field investigations concluded that irrigation of the Pump House field could cause overland runoff onto the State Park lands, but that modifications by El Sur Ranch to the road embankment and irrigation practices could alleviate future occurrence. Although signs of overland runoff were observed, there was no evidence of erosion as a result of runoff onto State Park lands.

Hanson Environmental Inc., 2006

Hanson Environmental Inc. conducted a month-long survey of erosion and seepage conditions along the coastal bluff of El Sur Ranch. Five stations were established along the western (coastal) edge of Fields 7 and 8. Stations were visited and photographed on a twice weekly interval between September 9 and October 16, 2006. This time period included a six-day irrigation of Fields 7 and 8 from October 6 -12. The study did not find any erosion resulting from irrigation or overland runoff along the bluff face during the field surveys. This study is significant because irrigation of Pastures 7 and 8 is the most likely to cause bluff face seepage and erosion.

Custis Memorandum, December 2009

Custis's comments provide a hypothesis on the instability of the coastal bluff and the causes of coastal erosion that differs from previous investigations. Custis notes two processes that might be causing erosion of the coastal bluff; processes that may be accelerated if greater than baseline irrigation applications were to be applied on the pasture field. Both of these processes are described by Hampton and Griggs (2004).

The first process consists of infiltrated groundwater flowing down-gradient (towards the coastal bluff) on top of the restrictive clay layer and accumulating into concentrated groundwater flow paths. According to Custis's hypothesis, upon reaching the bluff, the perched groundwater seeps out of the cliff face and causes gully formation and erosion in the form of scallops or theatre-headed valleys on the bluff face at the location of concentrated groundwater seepage. Custis's comments included photographs of scallops along the El Sur Ranch coastal bluff to support his claim that this process is occurring at El Sur Ranch. The 2005 and 2008 coastline photographs provided by Custis show defined scallop-shaped erosion formations along Pasture 7 near Swiss Canyon. These erosion features could be associated with groundwater flows near the soil surface. However, a few questions are worth asking: (1) Are these features caused by irrigation drainage flows and/or subsurface flows from natural rainfall events? (2) What is the erosion magnitude of these features relative to the total bluff erosion?

The first question was addressed in the investigation by Rogers E. Johnson & Associates, which did not reveal increased erosion activity along the irrigated pasture bluff or banks of Swiss Canyon during the 50 years of irrigation preceding the 2007 report. Based on aerial photos since 1929, field mapping and review of previous reports, Rogers E. Johnson & Associates concluded that "irrigation of pasture land has had no discernable effect on rates of coastal bluff retreat within the study area", and that the investigation "did not reveal evidence of increased erosional activity during the past 50 years or so, either along the blufftop or on the banks of Swiss Canyon. In fact, subaerial gullying and slumping has diminished over this time period, primarily due to filling of gullies and control of surface runoff."

Custis's comments state that. "Seepage at the cliff face and resultant sapping erosion can be expected to increase with an increase in water applied to the adjacent pastures from the baseline of approximately 3 feet to the applicant's 6 to 6.5 feet." However, the comments did not provide evidence that the seepage to the cliff face is a result of irrigation, and did not provide analysis to show that increased irrigation will increase seepage to the cliff face

Based on coastline photography, Custis has commented, "The number and density of these scalloped-shaped gullies appears to have increased significantly between 1989 and 2005." If this is correct, it does not necessarily follow that the cause was the irrigation from 1989 through 2005. The estimated average annual irrigation diversion from 1989 through 2005 was 815 acre-feet per year with a maximum diversion of 1,136 acre-feet in 2004; the estimated average annual irrigation diversion from 1975 through 1988 was 1,070 acre-feet per year with a maximum diversion of 1,737 acre-feet in 1984. In other words, irrigation levels decreased during the period when Custis has suggested that erosional activity increased. This does not support a correlation. Irrigation of the pasture began approximately 60 years ago, and irrigation pumping from 1989 through 2005 is not greater than prior pumping. On the other hand, a review of the monthly precipitation on the El Sur Ranch as correlated from the Monterey precipitation record and the precipitation measure on the El Sur Ranch shows that there were two months during the 1975 through 1988 period with over 10 inches of precipitation and that during the 1889 through 2005 period there were 12 months with over 10 inches of precipitation. While a correlation between irrigation and cliff face erosion is not apparent, there may be a correlation between the greater number of high precipitation periods from 1989 through 2005 than occurred from 1975 through 1988.

Direct evidence of erosion from seepage was not provided in the Custis comments, but photographs were provided showing darkened areas and pampas grass growing along the bluff in specific areas, which Custis has suggested may have resulted from groundwater flows to the cliff face in the upper soil layers. The 2005 and 2008 coastline photographs provided in the Custis comments show vegetative growth, specifically pampas grass, below pasture 7 and 8. The Custis comments suggested that the darkened areas are indicative of seepage and that the presence of pampas grass indicate that groundwater flows are seeping out along the coastline. The comments suggested that the presence of such saturated soils along the coastline would cause instability and slumping of the surface soils. The pictures in the 2006 Hanson report show pampas grass in Pasture 8 (Stations 4 and 5).

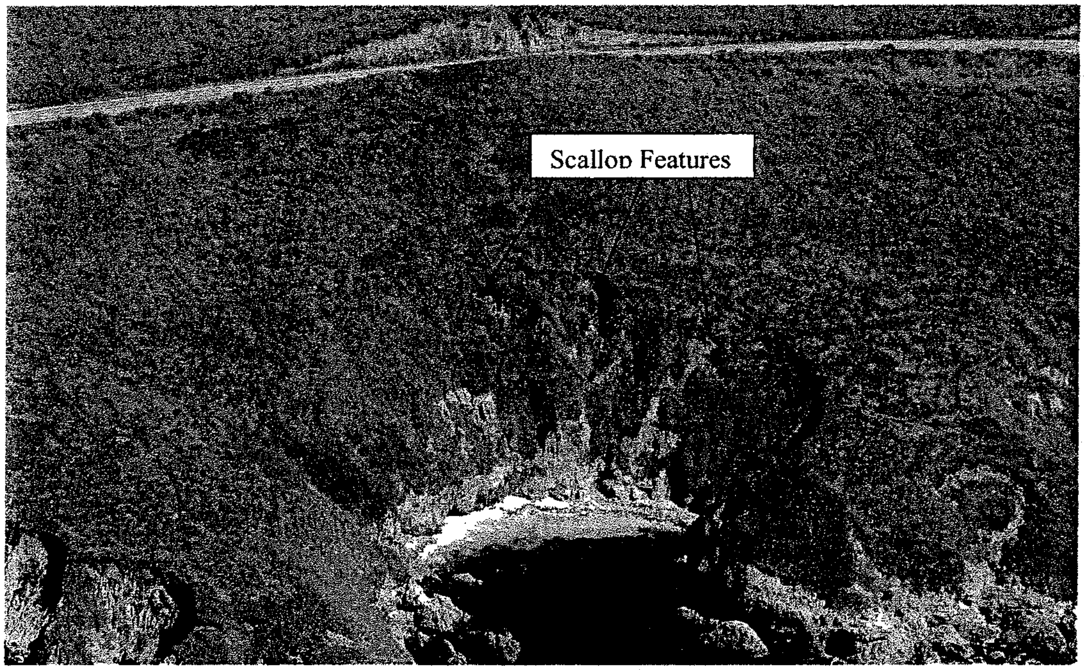
The photographs provided by Custis are not clear support for the conclusions regarding slump erosion processes. The resolution of the coastline photos is too coarse to differentiate between areas darkened by vegetative shading and bare soil faces darkened because of seepage. Supporting a contrary conclusion, the 2006 Hanson field survey of the same Pasture 7 field area found no indications of seepage along the bluff during or after irrigation of the Pasture 7. Little, if any, evidence was provided to support linking the presence of vegetation to the process of erosion by slumping of saturated soils. Further, no mention was made of the role of bluff vegetation in reducing erosion of the bluff because of anchoring by plant roots. If the presence of cliff-face vegetation were, in fact, evidence of erosion by slumping of saturated soils, the saturated soil conditions are much more likely to occur as a result of precipitation than irrigation, as previously discussed.

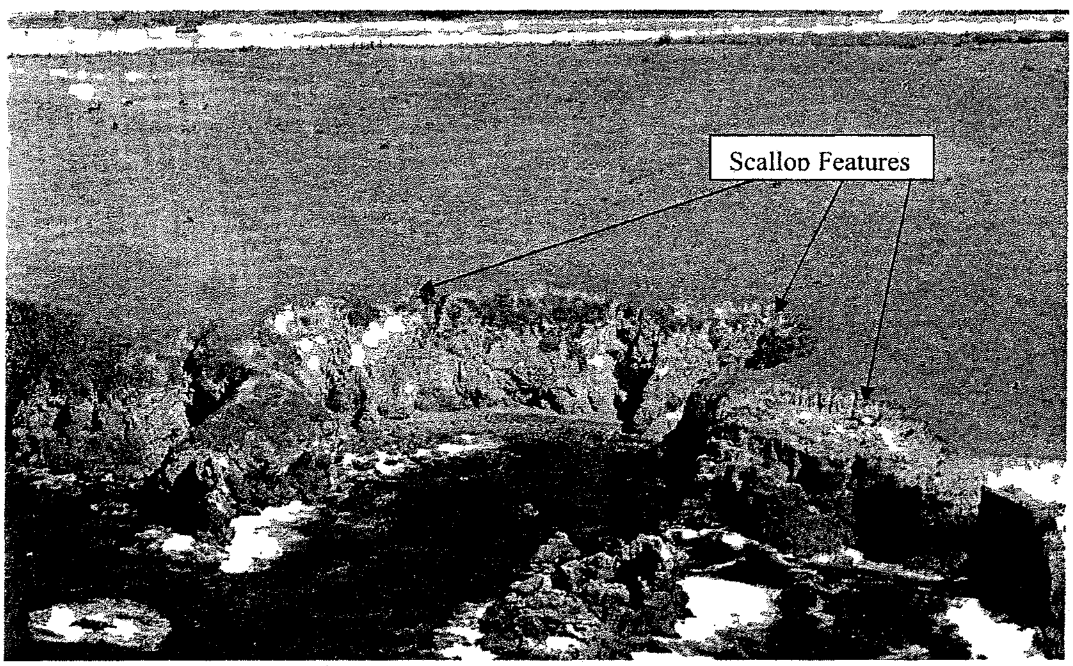
Coastline photographs archived by the California Coastal Records Project were investigated for signs of scallop formation in areas other than El Sur Ranch. Several examples of scallop-shaped erosion formations were found below natural and dry pasture landscapes, where no irrigation occurs (See Figure 11). These areas have some protection from waves and rocky formations to protect the bluffs. If scallop-shaped erosion formations in this section of coastline are due to infiltrated groundwater flowing down gradient, the absence of any irrigation clearly establishes that natural rainfall processes can and do cause such formations to develop. Moreover, natural rainfall processes would be a more likely cause of such formations, because during the irrigation season the lateral flow of irrigation water to the bluff face is minimal, if any because of the dry soil conditions below areas being irrigated. The dry soils could be in lower pastures or areas between the pastures and the bluffs such as roads, ditches, berms, and non-irrigated buffer areas.

The second question related to the importance of scallop erosion features was addressed by Rogers E. Johnson & Associates.
"Surf erosion is the primary agent affecting bluff retreat; if surf erosion ceased, the coastal bluffs would soon reach a stable angle of repose regardless of whether or not the land adjacent to the bluffs is irrigated." If, as suggested in the Custis comments, infiltrated groundwater is flowing down-gradient (whether from natural rainfall or irrigation) on top of the restrictive clay layer, forming scallops or valleys on the bluff face, those processes should yield a stable angle of repose at the bluff face. The fact that the bluff face is nearly vertical -- not the process hypothesized by Custis have not resulted in a stable angle of repose -- supports Johnson's conclusion that by wave action is the primary mechanism of bluff erosion.

The second process of coastal bluff erosion described in the Custis comments consists of infiltrated groundwater flowing down-gradient above the restrictive clay layer and causing saturated soil conditions at the coastal bluff. The saturated soil conditions could result in instability because of pore water pressures and the increased weight of water. If this were to occur, unstable surface soils would then slump off the bluff face. While saturated soil conditions on the bluff face can result in erosion, the saturated soil conditions are much more likely to occur as a result of precipitation than irrigation, as previously discussed.

Figure 11: Coastline Photographs of Scallop Formations





5 References

Bowman, A. and B. Scott. October 2009. *Managing ground cover in the cropping zone of southern NSW.* PrimeFact #957. Government of New South Wales, Australia.

California Coastal Records Project. Aerial photographic survey of the California coastline. Accessed at: http://www.californiacoastline.org/

Contra Costa Water District. 2005. *Using livestock grazing as a resource management tool in California.*

Custis, K. December 2009. *Memorandum: Comments on October 2009 Draft EIR for the El Sur Ranch Water Right Application No. 30166.* California Department of Fish and Game, Fisheries Engineering Program.

Hampton, M.A. and G.B. Griggs. 2004. Editors. *Formation, Evolution, and Stability of Coastal Cliffs – Status and Trends.* USGS Professional Paper 1693.

Hanson Environmental, Inc. 2006. *Erosion Monitoring from Rainfall Runoff and Surface Irrigation Excess Overflow on Coastal Bluffs Bordering El Sur Ranch Pastures 7 and 8 in Late Summer and Early Fall, 2006.* Included in Soil Stability Reports Appendix of Water Right Application #30166 Volume II.

Hubbard, R.K. G.L. Newton, and G.M. Hill. 2004. *Water quality and the grazing animal.* Journal of Animal Science. Volume 82, E255-E263.

Huss, D.L. 1996. *The role of domestic livestock in desertification control.* Food and Agriculture Organization (FAO) of the United Nations.

Maidment, D.R. 1993. Editor in Chief. *Handbook of Hydrology.* McGraw-Hill, Inc.

Mays, L.W. 2005. *Water Resources Engineering.* John Wiley & Sons, Inc.

National Soil Erosion Research Laboratory (NSERL). Water Erosion Prediction Project (WEPP). Accessed at: http://milford.nserl.purdue.edu/

Natural Resources Conservation Service (NRCS). July 2000. *General Resource Reference – Erosion Prediction/Assessment.* NRCS Technical Guide, California Field Office.

Natural Resources Conservation Service (NRCS). No Date. Estimated Rate of Water Induced Sheet and Rill Erosion, State of California. Part of the National Resources Inventory. Accessed at: http://www.ca.nrcs.usda.gov/technical/nri/NRIresults.html

Natural Resources Consulting Engineers (NRCE). March 2007. *Reasonable Beneficial Use – Land Use Study for El Sur Ranch Irrigated Pastures*. Update of May 18, 2005 Report.

Patric, J.H. and J.D. Helvey. 1986. *Some effects of grazing on soil and water in the eastern forest*. U.S. Forest Service, Northeastern Forest Experiment Station. NE-GTR-115.

Risinger, M. and K. Carver. 1987. *Soil Moisture Monitoring: An Overview of Monitoring Methods and Devices*. High Plains Underground Water Conservation District, Water Management Note. Fourth Printing.

Rogers E. Johnson & Associates. March 2007. *Geologic Evaluation of Erosion Issues on Irrigated Pasture Lands, El Sur Ranch, State Highway 1, Big Sur, Monterey County, California*. REJA Job No. C06044-M13.

Smiens, F.E. 1975. *Effects of livestock grazing on runoff and erosion*. Watershed Management Symposium. Irrigation and Drainage Division, American Society of Civil Engineers, Utah Section. August 11-13, Logan, Utah.

Soil Conservation Service (SCS). September 1977, Additions and Revisions until January 1991. *Guides for Erosion and Sediment Control in California*. Davis, California.

Soil Conservation Service (SCS). April 1978. *Soil Survey of Monterrey County, California*. In cooperation with the U.S. Forest Service and the University of California Agricultural Experiment Station.

Sojka, R.E., D.L. Bjorneberg, T.J. Trout, T.S. Strelkoff, and M.A. Nearing. May/June 2007. *The importance and challenge of modeling irrigation-induced erosion*. Journal of Soil and Water Conservation. Volume 62, Number 3.

The Source Group, Inc. 2005. Erosion Inspection Memos of 2005. Appendix D of March 2007 Water Right Application #30166, Volume II – Additional Technical Reports.

United States Department of Agriculture, Soil Conservation Service (USDA-SCS). (1978). *Soil Survey of Monterey County, California*.

U.S. Department of Agriculture (USDA) Agricultural Research Service. January 1997. *Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE)*. Agriculture Handbook 703.

APPENDIX A

Excerpts form

Soils Survey of

Monterey County, California

USDA, Soil Conservation Service

April 1978

SOIL SURVEY OF

Monterey County, California

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with the
U.S. Forest Service and
University of California Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in the period 1965–71. Soil names and descriptions were approved in 1972. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1971. This survey was made by the Soil Conservation Service, in cooperation with the U.S. Department of Agriculture, Forest Service, and the University of California Agricultural Experiment Station and with financial assistance from the U.S. Department of Defense, Department of the Army and Department of the Navy; the U.S. Department of the Interior, Bureau of Land Management; the State of California; Monterey County; and the Gloria, Mission-Soledad, Monterey Coast and Nacitone Resource Conservation Districts.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D. C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, woodlands, and wildlife areas; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Monterey County, California, are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification and storie index of each. It also shows the page where each soil is described and the page for the range site in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the range sites, capability units, and Storie Index ratings.

Foresters and others can refer to the section "Woodland."

Wildlife managers and others can find information about soils and wildlife in the section "Wildlife."

Ranchers and others can find, under "Range," groupings of the soils according to their suitability for range, and also the names of many of the plants that grow on each range site.

Community planners and others can read about soil properties that affect the choice of sites for recreation areas in the section "Recreation."

Engineers and builders can find, under "Engineering," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about the soils in "Formation, Morphology, and Classification of Soils."

Newcomers in the area may be interested in the information about the county given in "Environmental Factors Affecting Soil Use."

Cover: Lion Peak is in the center. Henneke soils are on serpentine rock covered by brush and scattered digger pine. Climara and Montara soils are in most of the grassy areas.

Contents

Issued April 1978

slopes, and areas of a clay soil that is similar to the Ayar soil, but is 20 to 40 inches deep to bedrock.

Runoff is rapid, and the erosion hazard is high.

This Ayar soil is used for dryland hay and grain and for range. Capability unit IVe-5(15); Clayey range site.

AyF—Ayar silty clay, 30 to 50 percent slopes. This is a steep soil on uplands. Slopes are mostly 40 percent.

Included with this soil in mapping were small areas of Nacimiento, Shedd, Alo, Linne, and Diablo soils. Also included were areas of a clay soil that is similar to the Ayar soil, but is 20 to 40 inches deep to bedrock.

The erosion hazard is high, and runoff is rapid.

This soil is used mostly for range. Capability unit VIe-1(15); Clayey range site.

Badland

Ba—Badland. This land type consists of gently sloping to very steep, severely eroded areas that are broken by many deeply entrenched drainage channels. Some Badland is severely eroded bluffs along the Salinas River and other major rivers, small severely eroded gullied areas, or escarpments. The elevation ranges from 200 to 3,000 feet. Much of this land type is barren, but if vegetation is present, it consists of sparse grasses, brush, and a few scattered scrub oaks.

This land type consists mostly of highly erodible, soft sediments that are covered with a thin mantle of relatively unstable soil in places. Reaction of the soil material and soft sediments ranges from medium acid to moderately alkaline and calcareous. Large amounts of silt and debris are deposited.

Included in mapping were small areas of Shedd, Gaviota, Nacimiento, Los Osos, Millsholm, San Andreas, Arnold, and Santa Ynez soils. Some small, narrow areas of Hanford, Gorgonio, Tujunga, and Metz soils and Psamments and Fluvents were included on alluvial plains or bottom lands in canyons. Also included were small areas of soils that have a dense cover of brush, areas that are not severely eroded, or some areas of sandstone and shale outcrop.

Runoff is very rapid, and the erosion hazard is very high. Drainage, subsoil permeability, depth of the root zone, and available water capacity all vary considerably within short distances.

This land type has little or no value for farming. It is used mostly for watershed. Some areas are used for wildlife habitat or recreation. There is a potential hazard of deposition onto adjacent lands. Capability unit VIIIe-1(15); range site not assigned.

Baywood Series

The Baywood series consists of somewhat excessively drained soils that formed in stabilized sand dunes. Slopes are 2 to 15 percent. The vegetation consists of manzanita, chamise, annual grasses, and scattered oaks. The elevation ranges from 50 to 250 feet. The mean annual precipitation is 12 to 18 inches, the mean annual air temperature is about 56° F, and the frost-free season is about 300 days. Summers are warm and foggy, and winters are cool and moist.

In a representative profile the surface layer is dark grayish brown and brown, slightly acid and medium acid sand 21 inches thick. Below this is pale brown, slightly acid sand 6 inches thick. It is underlain by very pale brown, slightly acid sand that extends to a depth of more than 60 inches.

Permeability is rapid, and the available water capacity is 2.5 to 3 inches. Roots penetrate to a depth of more than 60 inches.

Baywood soils are mostly the site for military training maneuvers at Fort Ord. They also have limited use for grazing and browsing wildlife.

Representative profile of Baywood sand, 2 to 15 percent slopes, about 1.75 miles SE from Marina on Fort Ord Military Reservation, 2,300 feet SW from junction of Reservation Road and paved road entering Fort Ord across from entrance to Fritzsbe Airfield; 900 feet west from junction of old country road and paved road across from Fritzsbe Airfield.

A11—0 to 5 inches; dark grayish brown (10YR 4/2) sand, very dark grayish brown (10YR 3/2) when moist; weak medium granular structure and coarse subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine roots; common very fine interstitial pores; slightly acid; clear wavy boundary.

A12—5 to 21 inches; brown (10YR 5/3) sand, dark brown (10YR 3/3) when moist; single grained; loose when dry or moist; many very fine and fine and few medium and coarse roots; few very fine interstitial pores; medium acid; clear wavy boundary.

AC—21 to 27 inches; pale brown (10YR 6/3) sand, dark yellowish brown (10YR 4/4) when moist; single grained; loose when dry or moist; common very fine and fine and few medium and coarse roots; few very fine interstitial pores; slightly acid; clear wavy boundary.

C1—27 to 38 inches; very pale brown (10YR 7/3) sand, brown (10YR 5/3) when moist; single grained; loose when dry or moist; common very fine and fine and few medium and coarse roots; slightly acid; diffuse wavy boundary.

C2—38 to 60 inches; very pale brown (10YR 7/4) sand, pale brown (10YR 6/3) when moist; single grained; loose when dry or moist; few medium and coarse roots; slightly acid.

The A horizon is 20 to 48 inches thick. The A1 horizon ranges from very dark grayish brown to brown, and texture is sand, fine sand, coarse sand, or loamy sand. Reaction ranges from medium acid to neutral.

The C horizon commonly is very pale brown, but ranges from brown to light gray and yellow. Texture is similar to the A1 horizon, but in some places is slightly more coarse. Reaction ranges from strongly acid to mildly alkaline. Thin bands of clay occur in the lower part of this horizon.

BbC—Baywood sand, 2 to 15 percent slopes. This is a gently sloping to rolling soil on stabilized sand dunes.

Included with this soil in mapping were areas of Oceano soils and Dune land. Also included were areas of soils that have a surface layer less than 20 inches thick, areas of moderately alkaline sands, and areas of Baywood soils that have slopes of less than 2 percent or more than 15 percent. Included near the city of Monterey were soils that have sandstone or Monterey shale at a depth of 30 to 60 inches.

Runoff is slow to medium, and the erosion hazard is slight to moderate.

This soil is located mostly on Fort Ord Military Reservation. It is also used for some grazing and browsing. If the vegetation cover is removed, the soil is subject to soil blowing and water erosion. Capability unit VIe-1(15); Sandy range site.

are used for dryland grain. Capability unit IVe–1 (15); Clayey range site.

LcE—Linne-Shedd silty clay loams, 15 to 30 percent slopes. The soils in this complex are hilly. They formed in material that was derived from calcareous shale and sandstone. These soils were so intermingled that it was not feasible to map them separately at the scale used.

Linne soils make up about 40 percent of the complex and Shedd soils 30 percent. The rest is small areas of Diablo, Nacimiento, Ayar, and San Benito soils; areas where slopes are less than 15 percent; and some clay loams that are similar, but that are less than 24 inches or more than 40 inches deep to bedrock.

The Linne soil has an available water capacity of 4 to 8 inches, and roots can penetrate to a depth of 24 to 40 inches. The Shedd soil has an available water capacity of 4 to 7.5 inches, and roots can penetrate to a depth of 24 to 36 inches. Runoff is rapid, and the erosion hazard is moderate to high.

This complex is used mostly for range. Small areas are used for dryland grain. Capability unit IVe–1 (15); Clayey range site.

LcF—Linne-Shedd silty clay loams, 30 to 50 percent slopes. The steep soils in this complex are on uplands. They formed in material that was derived from calcareous sandstone and shale. These soils were so intermingled that it was not feasible to map them separately at the scale used, although exposure is typically to the north on Linne soils and to the south on Shedd soils.

Linne soils make up about 40 percent of the complex and Shedd soils 25 percent. Diablo soils make up 15 percent. The rest of the complex consists of small areas of Nacimiento, San Benito, and Los Osos soils; some soils that are similar, but are less than 24 inches or more than 40 inches deep to bedrock; and areas of landslips.

Linne silty clay loam is 24 to 40 inches deep to bedrock, and the available water capacity is 4 to 8 inches. Shedd silty clay loam is 24 to 36 inches deep to bedrock, and the available water capacity is 4 to 7.5 inches.

Runoff is rapid, and the erosion hazard is high.

This complex is used for range. Capability unit VIe–1 (15); Clayey range site.

LcF2—Linne-Shedd silty clay loams, 15 to 50 percent slopes, eroded. These are hilly and steep soils on uplands. They formed in material that was derived from calcareous sandstone and shale. Small rills and a few gullies are commonly at the heads of the major drainageways. Soil material has been deposited at the mouth of most drainageways. These soils were so intermingled that it was not feasible to map them separately at the scale used, although exposure is typically to the north on Linne soils and to the south on Shedd soils.

Linne and Shedd soils each make up about 35 percent of this complex. The rest consists of small areas of Diablo, Nacimiento, San Benito, and Los Osos soils; some severely eroded areas; areas that have exposed bedrock on ridges; some areas of clay loams that are less than 20 inches deep to bedrock; some small areas of landslips; and some areas that have slopes of more than 50 percent.

Linne silty clay loam has an available water capacity of 3.5 to 8 inches, and roots can penetrate to a depth of 20 to 40 inches. Shedd silty clay loam is 20 to 30 inches deep, and the available water capacity is 3.5 to 6 inches. Runoff is medium to rapid, and the erosion hazard is high. The erosion occurs mostly on Shedd soils, but some sheet erosion occurs on Linne soils.

This complex is used for range, wildlife habitat, and watershed. Capability unit VIe–1 (15); Clayey range site.

LcG2—Linne-Shedd silty clay loams, 50 to 75 percent slopes, eroded. The soils in this complex are very steep and on uplands. They formed in material that was derived from calcareous sandstone and shale. These soils are so intermingled that it was not feasible to map them separately at the scale used, although exposure is typically to the north on Linne soils and to the south on Shedd soils.

Linne soils make up about 40 percent of the complex and Shedd soils 25 percent. Diablo soils make up about 15 percent of the complex and occur throughout the unit. The rest is small areas of Nacimiento, San Benito, and Los Osos soils; some soils that are very similar, but that are less than 20 inches or more than 40 inches deep to bedrock; and some small areas of landslips.

The Linne soil has an available water capacity of 4 to 8 inches and roots can penetrate to a depth of 20 to 40 inches. The Shedd soil has an available water capacity of 4 to 6 inches, and roots can penetrate to a depth of 20 to 30 inches. Runoff is very rapid, and the erosion hazard is very high. Shedd soils are more erodible than Linne soils.

This complex is used for range, watershed, and wildlife habitat. Capability unit VIIe–1 (15); Clayey range site.

Lockwood Series

The Lockwood series consists of well drained soils that formed in alluvium that was derived from siliceous shale. These soils are on alluvial fans and inland and coastal terraces (fig. 5). Slopes are 0 to 15 percent. The vegetation is mainly annual grasses and a few thick stands of buckwheat and chamise and a few scattered oaks. The elevation is 70 to 1,200 feet. The mean annual precipitation is 12 to 35 inches, the mean annual air temperature is 57° to 60° F, and the frost-free season is 150 to 350 days. Summers are hot and dry inland; winters are generally cool and moist, but they are warm and foggy along the coast.

In a representative profile the surface layer is gray, very strongly acid to neutral shaly loam about 26 inches thick. The subsoil is gray, neutral shaly heavy loam and brown, mildly alkaline shaly clay loam that extends to a depth of 82 inches. The substratum is pale brown, mildly alkaline loam to a depth of 86 inches or more.

Permeability is moderately slow. Roots penetrate to a depth of more than 60 inches.

Lockwood soils are used mostly for irrigated field and row crops. Some areas are used for apricots, walnuts, and alfalfa and for dryland grain, irrigated pasture, and annual range as well as for recreation and wildlife habitat.

Representative profile of Lockwood shaly loam, 0 to 2 percent slopes, about 7 miles NW of King City on Central Avenue, 100 feet SW and 50 feet NW from the

Figure 5.—Wave-cut coastal terraces at Pacific Valley. Fluvents, stony, are in the foreground and along the road. The rest of the terrace area is mainly Lockwood shaly loam, 2 to 9 percent slopes.

corner of Teague and Central Avenues; about 30 feet from edge of road.

Ap1—0 to 3 inches; gray (10YR 5/1) shaly loam, very dark grayish brown (10YR 3/2) when moist; moderate fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; many very fine interstitial pores; 15 percent gravel-sized shale fragments; very strongly acid; low surface pH due to fertilizers or pesticides, low pH temporary; abrupt smooth boundary.

Ap2—3 to 16 inches; gray (10YR 5/1) shaly loam, very dark brown (10YR 2/2) when moist; weak very coarse angular blocky structure that parts to moderate medium granular; slightly hard, friable, slightly sticky and slightly plastic; few very fine and common fine roots; common very fine interstitial pores and very few fine tubular pores; 10 percent shale fragments; soil compacted by tillage; slightly acid; gradual smooth boundary.

A13—16 to 26 inches; gray (10YR 5/1) shaly loam, very dark brown (10YR 2/2) when moist; strong medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; many very fine interstitial pores and common fine and medium tubular pores; 10 percent shale fragments; neutral; gradual smooth boundary.

B1—26 to 40 inches; gray (10YR 5/1) shaly heavy loam, very dark grayish brown (10YR 3/2) when moist; moderate medium granular structure; soft, very friable, slightly sticky and slightly plastic; few fine and medium roots; many very fine interstitial pores and common fine tubular pores; 25 percent shale fragments; neutral; clear irregular boundary.

B21t—40 to 57 inches; brown (10YR 5/3) shaly clay loam, dark yellowish brown (10YR 4/4) when moist; massive; slightly hard, very friable, sticky and plastic; many very fine interstitial pores; ½-inch thick dark brown horizontal clay band; continuous thin clay films, few moderately thick clay films bridging mineral grains; 30 percent shale fragments; mildly alkaline; gradual wavy boundary.

B22t—57 to 82 inches; brown (10YR 5/3) shaly clay loam, dark brown (10YR 4/3) when moist; massive; slightly hard, very friable, sticky and plastic; many very fine interstitial pores; continuous thin and few moderately thick clay films bridging grains; 30 percent shale fragments; mildly alkaline; clear smooth boundary.

IIC—82 to 86 inches; pale brown (10YR 6/3) heavy loam, dark brown (10YR 4/3) when moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few thin clay films in pores; mildly alkaline.

The A horizon commonly is gray, very dark grayish brown, dark grayish brown, dark gray, or grayish brown. Texture is loam or clay loam. Shale fragments 2 to 40 millimeters (0.08 to 1.6 inch) in diameter make up 5 to 25 percent of the A horizon. Reaction ranges from very strongly acid to mildly alkaline. The very strongly acid reaction in the Ap horizon is probably due to the presence of such agents as fertilizers.

Depth to the B2t horizon commonly is 36 to 45 inches in the Salinas Valley and 20 to 30 inches in the Lockwood, Hames, and Jolon Valleys. The B2t horizon ranges from brown to very pale brown, and texture ranges from heavy loam to heavy clay loam that is 30 to 35 percent shale fragments in places. Reaction ranges from neutral to moderately alkaline. Common thin to moderately thick clay films bridge mineral grains.

The IIC horizon is quite variable over short distances. Commonly it is pale brown, light yellowish brown, or very pale brown loam. The content of coarse fragments ranges from a few to 60 percent pebbles. Reaction ranges from medium acid to moderately alkaline and commonly becomes more alkaline with increasing depth.

Lime, clay bands, or weakly cemented layers are in the lower B2t horizon or in the IIC horizon in some places. A3, B1, B3t, and B3 horizons commonly occur in the soils.

LdA—Lockwood loam, 0 to 2 percent slopes. This is a nearly level soil on broad alluvial plains. It has a profile similar to the one described as representative of the series, but it has less than 5 to 10 percent siliceous shale fragments. The surface layer commonly is loam, but can be clay loam or light clay loam.

Included with this soil in mapping were small areas of Lockwood shaly loam, 0 to 2 percent slopes.

The available water capacity is 8 to 10 inches. Runoff is slow, and the erosion hazard is slight.

This soil is used mostly for irrigated row and field crops. It is also used for dryland grain and alfalfa hay. Capability units I(14), IIIc–1(15); range site not assigned.

LdC—Lockwood loam, 2 to 9 percent slopes. This is a gently sloping to moderately sloping soil on alluvial fans and terraces. It has a profile similar to the one described as representative of the series, but it has less than 10 percent shale fragments. The surface layer commonly is loam, but can be silt loam or light clay loam. Slopes are mostly 4 percent.

Included with this soil in mapping were areas of Lockwood shaly loam, 0 to 2 percent slopes. Small areas of sheet and rill erosion were also included.

Runoff is medium, and the erosion hazard is moderate. The available water capacity is 8 to 10 inches.

This soil is used mostly for dryland grain, field crops, walnuts, and apricots. Capability units IIe–1(14), IIIe–1(15); range site not assigned.

LeA—Lockwood shaly loam, 0 to 2 percent slopes. This is a nearly level soil on alluvial fans and terraces. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Rincon, Cropley, Arbuckle, Salinas, Pinnacles, and Chamise soils. Also included were areas of a soil that has a subsoil of sandy loam or loam or a subsoil that has more than 35 percent coarse fragments. Some soils that have slopes of 2 to 9 percent were also included.

The available water capacity is 6 to 8 inches. Runoff is slow, and the erosion hazard is slight.

This soil is used mostly for irrigated row and field crops. It is also used for some dryland grain or irrigated alfalfa. Capability units IIs–4(14), IIIs–4(15); range site not assigned.

LeC—Lockwood shaly loam, 2 to 9 percent slopes. This is a gently sloping to moderately sloping soil on alluvial fans and terraces. It has a profile similar to the one described as representative of the series, but the surface layer is shaly clay loam in some places (fig. 6). Slopes are mostly 5 percent.

Included with this soil in mapping were small areas of Lockwood shaly loam, 0 to 2 percent slopes. Also included were areas of Fluvents, stony, and Elder, Gazos, and Pacheco soils; some rock outcrops; and areas where slopes are as steep as 30 percent. The included areas from Big Sur to the Pacific Valley have an intricate pattern. They are black, slightly acid, shaly and very shaly loams that are underlain by brown very gravelly sandy loam. They contain 45 to 50 percent gravel and 10 to 20 percent cobblestones.

The available water capacity is 6 to 8 inches. Runoff is slow or medium, and the erosion hazard is slight or moderate.

This soil is used mostly for field crops, walnuts, apricots, or alfalfa. Along the coast it is used mainly for annual range, dryland and some irrigated pasture, and recreation. Capability units IIe–4(14), IIIe–4(15); range site not assigned.

LeD—Lockwood shaly loam, 9 to 15 percent slopes.

Figure 6.—Profile of Lockwood shaly loam, 2 to 9 percent slopes, at Pacific Valley.

This is a strongly sloping soil on alluvial fans and terraces.

Included with this soil in mapping were small areas of Rincon, Chamise, Santa Lucia, Nacimiento, Arbuckle, and Pinnacles soils and Lockwood shaly loam, 2 to 9 percent slopes. The included areas along the coast have an intricate pattern. They are black, slightly acid shaly and very shaly loams that are underlain by brown, slightly acid very gravelly sandy loam. They contain 45 to 50 percent gravel and 10 to 20 percent cobblestones. Also included along the coast were areas of Gazos and Los Osos soils; a shaly loam that is less than 20 inches deep to bedrock; and a soil that is similar to this Lockwood soil, but that has more than 35 percent coarse fragments in the subsoil. Included near Pfeiffer Point and south of Cape San Martin, was about 200 acres of a grayish brown and dark grayish brown gravelly loam that has a subsoil of dark grayish brown and brown stony or gravelly clay loam that is underlain by hard metamorphosed sandstone and shale.

The available water capacity is 6 to 8 inches. Runoff is medium, and the erosion hazard is moderate.

This soil is used mostly for dryland grain and annual range. Along the coast it is also used for annual range, recreation, wildlife habitat, and building sites. Capability units IIIe–4(14), IIIe–4(15); range site not assigned.

LgA—Lockwood shaly loam, 0 to 2 percent slopes, wet. This soil is in swales on alluvial fans and on bottoms in small valleys. It has a water table at a depth of 28 to 48 inches during winter and spring or when overirrigated. Drainage is restricted by a slowly permeable layer that is typically below a depth of 60 inches. The subsoil is generally grayish brown.

Included with this soil in mapping were small areas of Lockwood shaly loam, 0 to 2 percent slopes, and Cropley and Clear Lake soils. Also included were small areas that have 3 percent slopes, have more than 35 percent gravel, or have a clay subsoil.

Runoff is commonly very slow, and a few areas are ponded during winter. The erosion hazard is slight. Roots generally can penetrate to a depth of more than 60 inches, but can be restricted to a depth of 28 to 48 inches by an intermittently high water table in undrained areas. The available water capacity is 6 to 8 inches.

This soil is used for irrigated pasture, field crops, and native pasture and dryland grain. Capability unit IIw–2(14); range site not assigned.

Lopez Series

The Lopez series consists of somewhat excessively drained soils on hilly uplands. These soils formed in material underlain by hard siliceous shale of the Monterey Formation. Slopes are 15 to 30 percent. The vegetation is mainly annual grasses and a few scattered thickets of scrub oak, chamise, and buckwheat. The elevation is 450 to 3,300 feet. The mean annual precipitation is 12 to 25 inches, the mean annual air temperature is about 60° F, and the frost-free season is about 250 days. Summers are hot and dry, and winters are cool and moist.

In a representative profile the surface layer is gray and grayish brown, medium acid shaly loam and shaly silt loam. It is underlain by strongly acid hard shale at a depth of 11 inches.

Permeability is moderate, and the available water capacity is about 1 inch. Roots penetrate to a depth of 10 to 20 inches.

Lopez soils are used mostly for watershed and wildlife habitat, and some areas are in annual range.

Representative profile of Lopez shaly loam, 15 to 30 percent slopes, about 1,600 feet NNW of Lockwood; on San Ardo Road in the center of NW¼NE¼ sec. 31, T. 22 S., R. 9 E.

A11—0 to 4 inches; gray (10YR 5/1) shaly loam, very dark grayish brown (10YR 3/2) when moist; moderate fine and medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine interstitial pores and few tubular pores; 35 percent angular shale; medium acid; clear wavy boundary.

A12—4 to 11 inches; grayish brown (10YR 5/2) shaly silt loam, dark grayish brown (10YR 3.5/2) when moist; moderate fine and medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine pores; 45 percent angular shale; medium acid; abrupt broken boundary.

R—11 to 15 inches; hard, fractured siliceous shale; strongly acid.

The A1 horizon is dark gray, gray, or grayish brown. The content of coarse fragments ranges from 35 to 50 percent. Reaction is strongly acid or medium acid. Depth to hard shale ranges from 10 to 20 inches.

LhE—Lopez shaly loam, 15 to 30 percent slopes. This is a hilly soil on uplands. Slopes are mostly 20 percent.

Included with this soil in mapping were small areas of Santa Lucia and Reliz soils, rock outcrops, and areas of moderate or severe erosion.

Runoff is medium, and the erosion hazard is high.

This soil is used for annual range, watershed, and wildlife habitat. Capability unit VIIe–1(15); Shallow Loamy range site.

Los Gatos Series

The Los Gatos series consists of well drained soils that formed on uplands in material that was derived from metamorphosed sandstone and shale of the Franciscan Formation. Slopes are 30 to 75 percent. The vegetation is mainly Douglas-fir, Coulter and ponderosa pine, madrone, coast redwood, tanoak, laurel, coast live oak, poison oak, bracken fern, and sedges. The elevation is 600 to 3,200 feet. The mean annual precipitation is 25 to 55 inches, the mean annual air temperature is 56° F, and the frost-free season is about 300 days. Summers are warm and dry, and winters are cool and moist.

In a representative profile the surface layer is brown, slightly acid gravelly loam about 18 inches thick. The subsoil is brown, slightly acid gravelly loam and gravelly sandy clay loam 18 inches thick. The underlying bedrock is fractured, hard, metamorphosed shale.

Permeability is moderately slow, and the available water capacity is 3 to 7 inches. Roots penetrate to a depth of 20 to 40 inches.

Los Gatos soils are used mostly for range, woodland, recreation, wildlife habitat, and watershed.

Representative profile of Los Gatos gravelly loam, 50 to 75 percent slopes, on Willow Creek Road, 1 mile thick. The subsoil is dark brown, neutral clay 10 inches thick. The substratum is pale olive, neutral gravelly loam.

Permeability is slow. Roots penetrate to a depth of 20 to 36 inches.

Parkfield soils are used for range and dryland grain.

Representative profile of Parkfield clay, 2 to 9 percent slopes, about 2 miles SE of Parkfield in the north corner of SW¼NE¼ sec. 31, T. 22 S., R. 15 E.

Ap—0 to 4 inches; brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) when moist; moderate medium subangular blocky and granular structure; hard, friable, very sticky and plastic; common very fine roots; many very fine tubular pores; medium acid; clear smooth boundary.

A12—4 to 14 inches; brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) when moist; moderate coarse angular blocky structure; hard, friable, very sticky and very plastic; common very fine roots; many very fine tubular pores; common thin clay films lining pores; slightly acid; clear wavy boundary.

B2t—14 to 24 inches; dark brown (7.5YR 3/2) clay, dark brown (7.5YR 3/2) when moist; moderate medium angular blocky structure; extremely hard, friable, sticky and very plastic; common very fine roots; common very fine tubular pores; continuous thin clay films lining pores and common thick clay films on faces of peds; neutral; abrupt smooth boundary.

IIC—24 to 62 inches; pale olive (5Y 6/3), semi-consolidated conglomerate gravelly loam; extremely firm; neutral.

The A horizon is brown, dark brown, grayish brown, or dark grayish brown. Texture is clay, clay loam, or silty clay loam that is about 5 percent pebbles. A few areas have 10 to 25 percent pebbles. Structure is moderate and strong subangular blocky. Reaction ranges from medium acid to neutral.

The Bt horizon ranges from brown or dark brown to yellowish brown or dark yellowish brown, but it is dark reddish brown (5YR 3/3) in a few areas. Texture is silty clay or clay, and some areas are gravelly. Structure is subangular blocky, angular blocky, or prismatic. Reaction is neutral to moderately alkaline. When the soil is dry, cracks at least ¼ to ½ inch wide extend to a depth of 20 inches.

Depth to the C horizon ranges from 20 to 36 inches.

PcC—Parkfield clay, 2 to 9 percent slopes. This is an undulating and gently rolling soil on terraces. It has the profile described as representative of the series. Slopes are mostly 5 percent.

Included with this soil in mapping were small areas of Alo, Mocho, Nacimiento, Climara, and Montara soils and Xerorthents, dissected, and Xerorthents, loamy. Also included were areas of a soil that is similar to this Parkfield soil, but has a very gravelly subsoil, which makes up about 15 percent of the mapping unit, and a soil that is less than 24 inches deep to weakly cemented material, which makes up about 10 percent.

Runoff is medium, and the erosion hazard is slight. Roots can penetrate to a depth of 24 to 36 inches. The available water capacity is 3 to 6 inches.

This soil is used for dryland grain and range. Capability unit IIIe-5(15); Clayey range site.

PcE—Parkfield clay, 15 to 30 percent slopes. This is a moderately steep soil on terrace breaks. It has a profile similar to the one described as representative of the series, but several inches of soil material have been removed from the original surface layer by erosion. The soil commonly is 20 to 24 inches deep to the cemented substratum, and 10 to 20 percent rounded pebbles and cobbles are throughout the profile. Slopes are mostly about 20 percent.

Included with this soil in mapping were small areas of Nacimiento, Linne, Alo, and Millsholm soils. Also included were soils that are very similar to this Parkfield soil, but only 10 to 20 inches deep, and small areas of Fluvents and Xerorthents.

Runoff is rapid, and the erosion hazard is high. Roots can penetrate to a depth of 20 to 30 inches. The available water capacity is 2 or 3 inches.

This soil is used mostly for range. A few areas are used for dryland grain. Capability unit VIe-1(15); Clayey range site.

Pfeiffer Series

The Pfeiffer series consists of well drained soils on uplands. These soils formed in material underlain by metamorphic rock, acid igneous rock, and sandstone. Slopes are 2 to 85 percent. The vegetation consists of annual grasses and forbs, a few scattered oaks, and small amounts of brush. The elevation is 50 to 3,000 feet. The mean annual precipitation is 25 to 55 inches, the mean annual air temperature is 57° to 60° F, and the frost-free season ranges from 200 to 280 days. Summers are typically hot and dry, but some areas are occasionally warm and foggy; winters are cool and moist.

In a representative profile the surface layer is dark yellowish brown and brown, neutral and slightly acid gravelly coarse sandy loam about 36 inches thick. The subsoil is strong brown, slightly acid gravelly coarse sandy loam 24 inches thick. Weathered acid igneous bedrock is at a depth of 60 inches.

Permeability is moderately rapid.

Pfeiffer soils have a very limited use for grazing. They are also used for watershed, wildlife habitat, and recreation.

Representative profile of Pfeiffer gravelly coarse sandy loam, in an area of Pfeiffer-Rock outcrop complex, about 350 feet down a ridge and about 100 feet SE on a side slope south from Nacimiento-Fergusson Road; about 1 mile slightly SSW from Nacimiento Guard Station Forest Service, about 750 feet west, and 300 feet south from NE corner of NE¼NE¼ sec. 30, T, 22 S., R. 5 E.

A11—0 to 6 inches; dark yellowish brown (10YR 4/4) gravelly coarse sandy loam, dark brown (10YR 3/3) when moist; moderate fine granular structure; soft and slightly hard, friable, nonsticky and nonplastic; many fine roots; many very fine and fine interstitial pores; 20 percent angular gravel mostly ⅛ to ¾ inch in diameter, but ranging to 2½ inches; neutral; clear wavy boundary.

A12—6 to 16 inches; brown (10YR 4/3) gravelly coarse sandy loam, dark brown (10YR 3/3) when moist; moderate medium and fine granular structure and weak very coarse subangular blocky structure; soft, friable, nonsticky and nonplastic; common fine roots; many very fine interstitial pores and common fine tubular pores; 25 percent angular gravel mostly ⅛ to ¾ inch in diameter, but ranging to 2½ inches; slightly acid; clear wavy boundary.

A13—16 to 24 inches; brown (10YR 4/3) gravelly coarse sandy loam, dark brown (7.5YR 3/3) when moist; moderate fine crumb structure; soft, friable, nonsticky and nonplastic; common very fine roots; many fine interstitial pores and common fine tubular pores; 30 percent angular gravel mostly ⅛ to ¾ inch in diameter, but ranging to 2½ inches; slightly acid; clear wavy boundary.

A14—24 to 36 inches; brown (10YR 4/3) gravelly coarse sandy loam, dark brown (7.5YR 3/3) when moist; massive; soft, friable, nonsticky and nonplastic; common very fine roots; many fine interstitial pores and common fine tubular pores; 30 percent angular gravel mostly ⅛ to ¾ inch in diameter, but ranging to 2½ inches; slightly acid; gradual wavy boundary.

B21—36 to 55 inches; strong brown (7.5YR 5/6) gravelly coarse sandy loam, dark brown (7.5YR 3/3) when moist; massive; soft, friable, nonsticky and nonplastic; common very fine roots; many fine interstitial pores and common fine tubular pores; 45 percent angular gravel mostly ¼ inch to 2 inches in diameter and 5 percent cobblestones; slightly acid; gradual wavy boundary.

B22—55 to 60 inches; strong brown (7.5YR 5/6) very gravelly coarse sandy loam, dark brown (7.5YR 3/3) when moist; massive; soft, friable, nonsticky and nonplastic; common very fine roots; many fine interstitial pores and common fine tubular pores; 50 percent angular gravel mostly ½ inch to 2 inches in diameter and 5 percent cobblestones; slightly acid; gradual wavy boundary.

Cr—60 to 70 inches; weathered granitic bedrock.

The A1 horizon is dark brown, dark gray, dark grayish brown, brown, dark yellowish brown, and grayish brown. Texture is coarse sandy loam, sandy loam, or fine sandy loam that is up to 30 percent gravel. The B2 horizon is brown, grayish brown, light brownish gray, or strong brown. The B22 horizon contains 0 to 50 percent gravel. Bedrock consists of weathered metamorphic and acid igneous rock at a depth of more than 40 inches.

PdC—Pfeiffer fine sandy loam, 2 to 9 percent slopes. This is a gently sloping to moderately sloping soil at the base of hills. It has a profile similar to the one described as representative of the series, but the surface layer is fine sandy loam and the subsoil is sandy loam or fine sandy loam. This soil typically lacks coarse fragments.

Included with this soil in mapping were areas of San Andreas soils making up 20 percent of the acreage, areas of Santa Ynez or Gazos soils making up 15 percent, and small areas of soils that have a surface layer of dark gray or dark grayish brown fine sandy loam more than 20 inches thick. Included on the Hunter Liggett Military Reservation were some soils that have a thin, light brownish gray or pale brown surface layer.

Runoff is slow and medium, and the erosion hazard is slight. Roots can penetrate to a depth of 40 to 60 inches. The available water capacity is 5 to 7.5 inches.

This soil is used for range or pasture. Capability unit IIIe-1 (15); Coarse Loamy range site.

PdD—Pfeiffer fine sandy loam, 9 to 15 percent slopes. This is a strongly sloping soil on hills and uplands. It has a profile similar to the one described as representative of the series, but the surface layer is fine sandy loam and the subsoil is sandy loam or fine sandy loam. This soil typically lacks coarse fragments.

Included with this soil in mapping were areas of San Andreas soils making up about 25 percent of the acreage, areas of Santa Ynez or Gazos soils making up 15 percent, and small areas of soils that have a surface layer of dark grayish brown or dark gray sandy loam more than 20 inches thick.

Runoff is medium, and the erosion hazard is moderate. Roots can penetrate to a depth of 40 to 48 inches. The available water capacity is 5 or 6 inches.

This soil is used mostly for range, pasture, wildlife habitat, and recreation. A few areas are used for dryland grain, and some areas in the northern part of the county are used for building sites. Capability unit IVe-1 (15); Coarse Loamy range site.

Pe—Pfeiffer-Rock outcrop complex. This mapping unit is on mountains. The Pfeiffer soil formed in material that was derived from igneous and metamorphic rocks. It has the profile described as representative of the series. Slopes are 50 to 85 percent. Rock outcrop consists of acid igneous and metamorphic rocks, boulders, and large stones of dolomite and limestone. The soil and rock outcrop were so intermingled that it was not feasible to map them separately at the scale used.

Pfeiffer soils make up about 35 percent of this complex and rock outcrop 25 percent. Areas of Cieneba, Sheridan, Junipero, and Sur soils make up 20 percent. The rest is soils that have more than 35 percent rock fragments larger than one-eighth inch; similar soils that have a surface layer of heavy sandy loam or sandy clay loam that is gravelly in places and a subsoil of reddish brown sandy clay loam; some eroded and gullied areas; and some areas that are less than 10 inches deep to bedrock.

On the Pfeiffer soil, runoff is very rapid, and the erosion hazard is very high. Roots can penetrate to a depth of more than 40 inches. The available water capacity is 4 to 6 inches. On the Rock outcrop, runoff is very rapid, but the erosion hazard is slight.

This complex is used mostly for watershed, wildlife habitat, and recreation. A few small areas are used for grazing. Most areas are inaccessible and can be reached only by foot trail or on horseback. Capability unit VIIIs-1 (15); range site not assigned.

Pico Series

The Pico series consists of well drained soils that formed on flood plains in alluvium derived from sedimentary rocks. Slopes are 0 to 2 percent. The vegetation is mainly annual grasses and a few scattered coast live oaks. The elevation is commonly 50 to 100 feet, but ranges to 1,700 feet in some narrow valleys. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is about 58° F, and the frost-free season is about 235 days. Summers are warm and dry, except in the northern Salinas Valley where they are foggy, and winters are cool and moist.

In a representative profile, the surface layer is grayish brown, mildly alkaline and moderately alkaline fine sandy loam about 18 inches thick. The underlying material is light brownish gray and pale brown, strongly calcareous stratified fine sandy loam, silty clay loam, sandy loam, very fine sandy loam, and sand that extends to a depth of 72 inches or more.

Permeability is moderately rapid, and the available water capacity is 7.5 to 9 inches. Roots penetrate to a depth of more than 60 inches.

Pico soils are used for irrigated crops in the Salinas Valley. Other small areas are used mostly for range.

Representative profile of Pico fine sandy loam, south of Gonzales; 1,200 feet SE on field road along the Southern Pacific Railroad tracks from intersection of Lanini Road, then 450 feet SW into field, about 25 feet from field road.

Ap—0 to 8 inches; grayish brown (2.5YR 5/2) fine sandy loam, very dark grayish brown (2.5Y 3/2) when of the Arroyo Seco, that have a surface layer of pale brown, strongly acid shaly clay loam 3 inches thick and a subsoil of light yellowish brown, very strongly acid shaly clay loam underlain by fractured shale at a depth of about 15 inches. These inclusions are commonly severely eroded.

The Santa Lucia soil has an available water capacity of 2 to 5.5 inches, and roots can penetrate to a depth of 20 to 40 inches. The Reliz soil has the profile described as representative of the Reliz series.

Runoff is rapid or very rapid, and the erosion hazard is very high.

The soils in this association are used for wildlife habitat and watershed. A few areas are used for range. Capability unit VIIe-1(15); Santa Lucia soil in Loamy range site, Reliz soil in Shallow Loamy range site.

Santa Ynez Series

The Santa Ynez series consists of moderately well drained soils that formed on terraces in alluvium derived from sandstone and granitic rock. Slopes are 2 to 30 percent. The vegetation consists of annual grasses, forbs, scattered oaks, and brush. The elevation is 100 to 1,200 feet. The mean annual precipitation is 15 to 25 inches, the mean annual air temperature is 57° to 59° F, and the frost-free season is about 250 days. Summers are mainly warm and dry, but they are often foggy in the northern part of the county, and winters are cool and moist.

In a representative profile the surface layer is grayish brown and gray, medium acid fine sandy loam about 16 inches thick. The subsurface layer is light brownish gray, medium acid fine sandy loam 2 inches thick. The subsoil is gray and grayish brown, medium acid to mildly alkaline clay and clay loam 25 inches thick. The substratum is light gray, moderately alkaline sandy clay loam.

Permeability is very slow.

Santa Ynez soils are used mostly for range and pasture.

Representative profile of Santa Ynez fine sandy loam, 15 to 30 percent slopes, near Corral de Tierra Valley, about 0.5 mile on Underwood Road from Corral de Tierra Road, then 170 feet into field in NW corner of SW¼ sec. 20, T. 16 S., R. 3 E.

A11—0 to 3 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate coarse subangular blocky structure and moderate fine and medium granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine interstitial pores and common very fine and few fine tubular pores; medium acid; clear wavy boundary.

A12—3 to 16 inches; gray (10YR 5/1) or grayish brown (10YR 5/2 rubbed) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and medium and few fine roots; common very fine and fine and few medium tubular pores; medium acid; clear wavy boundary.

A2—16 to 18 inches; light brownish gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; massive; slightly hard, friable, nonsticky and nonplastic; common very fine and fine and many medium roots, mostly horizontal; medium acid; abrupt wavy boundary.

B21t—18 to 26 inches; gray (10YR 5/1 inped) or grayish brown (10YR 5/2 exped) clay, very dark grayish brown (10YR 3/2) when moist; strong coarse columnar structure that parts to strong medium prismatic; very hard, firm, very sticky and very plastic; common very fine and medium and few fine exped roots; few very fine tubular pores; continuous moderately thick clay films on faces of peds and lining pores; medium acid; clear wavy boundary.

B22t—26 to 36 inches; gray (10YR 5/1) heavy clay loam, very dark grayish brown (10YR 3/2) when moist; moderate coarse prismatic structure that parts to strong coarse angular blocky; very hard, firm, sticky and plastic; common very fine and few fine and medium exped roots; few fine tubular pores; continuous thick clay films lining pores; many thin and moderately thick clay films on faces of peds; slightly acid in upper part, neutral in lower part; clear wavy boundary.

B3t—36 to 43 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist; many coarse distinct pale brown (10YR 6/3) mottles; weak coarse subangular blocky structure; very hard, firm, sticky and plastic; few very fine exped roots; few very fine tubular pores; many thin clay films lining pores, common thin clay films bridging mineral grains; mildly alkaline; clear wavy boundary.

C—43 to 61 inches; light gray (2.5Y 7/2) sandy clay loam, grayish brown and light yellowish brown (2.5Y 5/2 and 6/4) when moist; few fine prominent black (10YR 2/1) mottles that appear to be charcoal; massive; slightly hard, friable, slightly sticky and slightly plastic; moderately alkaline.

The profile is up to 15 percent small pebbles 2 to 10 millimeters in diameter.

The A1 horizon is dark gray, gray, dark grayish brown, or grayish brown. Texture commonly is fine sandy loam, but ranges to sandy loam, very fine sandy loam, or loam. The horizon is massive in places. Reaction ranges from medium acid to neutral. The A2 horizon commonly ranges from thin cappings on the B2t horizon to 2 inches thick, but is up to 8 inches thick in some places. It is pale brown, light brownish gray, light gray, or white fine sandy loam or loam.

The B2t horizon is gray, grayish brown, brown, yellowish brown, light olive brown, or light brownish gray. Texture is clay, sandy clay, or heavy clay loam. The B21t horizon typically has columnar or prismatic structure, and the B22t horizon is columnar, prismatic, or angular blocky. Reaction ranges from medium acid to mildly alkaline. Depth to the B2t horizon ranges from 15 to 36 inches.

The C horizon is light brownish gray, pale brown, light gray, very pale brown, or white. Texture is loamy sand, fine sandy loam, or sandy clay loam. Reaction ranges from medium acid to moderately alkaline.

ShC—Santa Ynez fine sandy loam, 2 to 9 percent slopes. This is a gently sloping to moderately sloping soil on terraces. It has a profile similar to the one described as representative of the series, but the surface layer typically is thicker. The surface layer is about 20 to 30 inches thick, but ranges from 16 to 36 inches thick. This soil is neutral to moderately alkaline where cultivated. Slopes are mostly about 5 percent, but north and west of Salinas slopes are typically 2 to 4 percent.

Included with this soil in mapping, and making up about 40 percent of the acreage, was a soil that is very similar to Santa Ynez soil but is underlain by a cemented layer at a depth of 30 to 60 inches. This soil is in the northern part of the Salinas Valley. Also included were some areas where the underlying alluvium is indurated; small areas of Alviso soils near sloughs; Cropley soils in swales and on toe slopes; Elkhorn, San Andreas, Antioch, and Diablo soils on the stronger side slopes; and, in other parts of the county, small areas of Antioch, Lockwood, Garey, San Andreas, and Los Osos soils. Included in areas throughout the county were some soils that are very similar to Santa Ynez soils, but have neutral to moderately alkaline subsoils.

Runoff is slow or medium, and the erosion hazard is slight or moderate. Roots can generally penetrate to a depth of 60 inches or more, but some roots are restricted to a depth of 15 to 36 inches by the clay subsoil. The available water capacity is 3 to 5 inches, and some water is slowly available from the subsoil.

North of Salinas this soil is used for irrigated row crops, strawberries, and pasture. It is also used for dryland grain and range throughout the area. Capability units IVe-3 (14), IVe-3 (15); Claypan range site.

ShD—Santa Ynez fine sandy loam, 9 to 15 percent slopes. This is a strongly sloping soil on terraces and low hills. It has a profile similar to the one described as representative of the series, but the surface layer commonly is 16 to 32 inches thick.

Included with this soil in mapping were small areas of Diablo, Elkhorn, Antioch, and Snelling soils. Included in the northern part of the county, and making up about 60 percent of the acreage, were areas of this Santa Ynez soil that are underlain by a cemented layer at a depth of 30 to 60 inches. Also included were some areas of Santa Ynez soils that have 2 to 9 percent slopes, some areas that have 5 to 15 percent slopes and are eroded, and a few small areas that have 15 to 30 percent slopes.

Runoff is medium, and the erosion hazard is moderate. Roots can generally penetrate to a depth of 60 inches or more, but some roots are restricted to a depth of 16 to 32 inches by the clay subsoil. The available water capacity is 2.5 to 4 inches.

This soil is used mostly for range or pasture. Some areas are used for dryland grain. Capability units IVe-3 (14), IVe-3 (15); Claypan range site.

ShD2—Santa Ynez fine sandy loam, 5 to 15 percent slopes, eroded. This is a gently rolling to rolling soil on low hills and terraces. It has a profile similar to the one described as representative of the series, but is eroded. This soil has many small rills and gullies after winter rains, especially where cultivated. Rill and sheet erosion have removed some of the original surface layer, exposing the subsoil on some hill crests or ridges, and there are some gullies in swales. Depth to the subsoil ranges from 16 to 24 inches.

Included with this soil in mapping were small areas of Antioch, Snelling, Garey, Dibble, and Placentia soils. Also included were small areas of Santa Ynez soils that have 2 to 9 percent slopes, some that have 9 to 15 percent slopes and no erosion, and some that have 15 to 30 percent slopes. Some soils that are underlain by an indurated layer at a depth of 30 to 60 inches and others that have a very strongly acid subsoil were also included.

Runoff is medium, and the erosion hazard is moderate. Roots can generally penetrate to a depth of 60 inches or more, but some roots are restricted to a depth of 16 to 24 inches by the clay subsoil. The available water capacity is 2.5 to 3.5 inches.

This soil is used for dryland grain and range. Capability unit IVe-3 (15); Claypan range site.

ShE—Santa Ynez fine sandy loam, 15 to 30 percent slopes. This is a hilly soil on dissected terraces. It has the profile described as representative of the series. Slopes are mostly about 25 percent.

Included with this soil in mapping were areas of San Andreas soils making up about 15 percent of the acreage; areas of a soil that is very similar to Santa Ynez soil, but is underlain by a cemented layer at a depth of 30 to 60 inches, making up about 35 percent; and small areas of Antioch, Snelling, Elkhorn, Arnold, and Haire soils. Also included were some soils that are very similar to Santa Ynez soils, but have a brown, light gray, or light brownish gray surface layer. Some areas of severe gully erosion were also included.

Runoff is rapid, and the erosion hazard is high. Roots can generally penetrate to a depth of 60 inches or more, but some roots are restricted to a depth of 15 to 30 inches by the clay subsoil. The available water capacity is 2.5 to 4 inches.

This soil is used mostly for range. Capability unit VIe-1 (15); Claypan range site.

Shedd Series

The Shedd series consists of well drained soils on uplands. These soils formed in material underlain by calcareous shale and sandstone. Slopes are 9 to 75 percent. The vegetation consists of annual grasses, forbs, and brush. The elevation is 300 to 2,000 feet. The mean annual precipitation is 10 to 16 inches, the mean annual air temperature is 58° to 60° F, and the frost-free season is about 250 days. Summers are hot and dry, and winters are cool and moist.

In a representative profile the surface layer is gray, moderately alkaline, calcareous silty clay loam about 23 inches thick. It is underlain by light gray, moderately alkaline, calcareous silty clay loam. Soft calcareous shale is at a depth of 30 inches.

Permeability is moderately slow.

Shedd soils are used for range and dryland grain.

Representative profile of Shedd silty clay loam, 15 to 30 percent slopes, about 9 miles east of King City up Wildhorse Canyon, about 30 feet down from the ridgetop, in the center of SE¼NW¼ sec. 11, T. 20 S., R. 9 E.

A11—0 to 5 inches; gray (5Y 6/1) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; moderate medium angular blocky structure; hard, very friable, sticky and plastic; common very fine roots; common very fine interstitial and tubular pores; strongly effervescent with disseminated lime; moderately alkaline; clear smooth boundary.

A12—5 to 12 inches; gray (5Y 6/1) silty clay loam, very dark grayish brown (2.5Y 3/2) when moist; strong medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; many very fine interstitial pores and common very fine, fine, and medium tubular pores; strongly effervescent with disseminated lime; moderately alkaline; gradual smooth boundary.

A13—12 to 23 inches; gray (5Y 6/1) silty clay loam, very dark grayish brown (2.5Y 3/2) when moist; strong medium subangular blocky structure; slightly hard, very friable, sticky and plastic; few very fine roots; many very fine interstitial pores and common very fine, fine, and medium tubular pores; violently effervescent with disseminated lime; moderately alkaline; abrupt wavy boundary.

C1ca—23 to 30 inches; light gray (2.5Y 7/2) silty clay loam, very dark grayish brown (2.5Y 3/2) when moist; moderate medium subangular blocky structure;

TABLE 6.—*Estimated engineering properties and classifications*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil which may have different properties and limitations. For this reason it is necessary to follow carefully the instructions for referring to other series that appear in the first column]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments >3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				*Pct*					*Pct*	
*Alo: AaC, AaD, AaE, AaF, Ab. For Millsholm part of Ab, see Millsholm series.	0–36	Silty clay	CH, CL	A-7	0	100	100	95–100	85–100	40–60	20–40
	36	Weathered bedrock.									
Alviso: Ac, Ad	0–14	Silty clay loam	CL, CH	A-6, A-7	0	100	100	90–100	75–100	35–60	15–30
	14–45	Silty clay	CH	A-7	0	80–100	80–100	75–100	75–100	50–70	30–50
	45–60	Very fine sand	SM	A-4	0	100	100	85–90	35–50		[1]NP
Antioch: AeA, AeC, AeD	0–21	Very fine sandy loam	ML	A-4, A-6	0	95–100	90–100	80–100	50–75	25–40	NP–15
	21–40	Clay	CL, CH	A-7	0	95–100	90–100	90–100	70–90	40–60	20–30
	40–67	Clay loam, sandy clay loam	CL	A-6, A-7	0	95–100	90–100	70–100	70–80	25–45	10–25
	67–72	Sandy loam	SM, ML	A-4	0	90–100	90–100	70–100	35–60	25–35	NP–10
Aquic Xerofluvents: Af	0–60	Variable									
Arbuckle: AgC, AgD	0–17	Gravelly loam	GM	A-4	0–5	50–70	50–70	45–65	35–50	15–25	NP–55
	17–46	Gravelly clay loam	GC	A-6, A-7	0–5	50–70	50–65	45–65	35–50	35–45	15–25
	46–60	Very gravelly loam	GC, GM-GC	A-2	0–10	25–40	20–35	15–30	10–25	15–35	5–15
*Arnold: AkD, AkF, Am, Ar. For San Andreas part of Am, and Santa Ynez part of Ar, see those series.	0–48	Loamy fine sand	SM	A-2	0	90–100	85–100	60–80	20–30		NP
	48	Weathered bedrock.									
Arroyo Seco: AsA, AsB, AsC	0–42	Gravelly sandy loam	SM	A-2, A-4, A-1	0–10	60–80	50–75	40–65	20–40	10–25	NP–5
	42–60	Very gravelly coarse sandy loam.	GM	A-1	5–30	35–60	30–50	15–30	10–20	10–25	NP–5
AvA, AvB	0–42	Gravelly loam	SM	A-2, A-4	0–10	60–80	50–75	40–65	30–40	10–25	NP–5
	42–60	Very gravelly coarse sandy loam.	GM	A-1	5–30	35–60	30–50	15–30	10–20	10–25	NP–5
Ayar: AyD, AyE, AyF	0–45	Silty clay	MH	A-7	0	100	95–100	90–100	85–100	50–70	20–30
	45	Weathered bedrock.									
Badland: Ba. No estimates.											
Baywood: BbC	0–60	Sand	SP-SM, SM	A-3, A-2	0	100	100	50–80	5–30		NP
Chamise: CaD, CaE, CaF	0–19	Shaly loam	SM	A-2, A-4	0	70–95	60–90	30–65	25–45	25–35	NP–10
	19–40	Very shaly clay	GC, SC	A-2, A-7	0	50–80	30–60	25–50	25–45	40–55	15–30
	40–60	Shaly sandy loam	GC, SC, GM-GC, SM-SC	A-2, A-7, A-6	0	50–80	35–75	25–60	15–45	25–50	5–25

Greenfield: GmB, GmC, GmD.	0–22	Fine sandy loam	SM, SM-SC, SC	A–2, A–4	0	95–100	80–100	60–75	25–45	10–25	NP–10
	22–52	Sandy loam	SM-SC, SC	A–2, A–4	0	80–100	70–100	60–80	25–45	20–30	5–15
	52–64	Fine sand	SM	A–2	0	70–100	60–100	50–70	15–35	----------	NP
Haire: HaE	0–11 11–25 25–41	Loam Clay Gravelly sandy clay loam	CL CL, CH GC, SC	A–6, A–7 A–7 A–2, A–6 A–7	0 0 0–30	85–100 100 55–80	80–100 90–100 40–65	70–90 85–100 40–60	50–70 70–95 30–45	30–50 40–60 30–50	10–30 20–30 10–30
	41	Weathered bedrock.									
Hanford: HbB	0–70	Gravelly sandy loam, gravelly loamy coarse sand.	SM, SP-SM	A–1, A–2	0	70–85	50–75	30–50	10–35	15–25	NP–5
Henneke: HcF	0–15 15	Clay loam Unweathered bedrock.	SC, GC	A–2	30–70	50–70	40–60	25–35	15–25	40–60	15–35
*Junipero: JaF	0–5 5–30	Loamy sand Weathered bedrock.	SM SM	A–2, A–4 A–1, A–2, A–4	0–15 0–30	85–100 60–100	80–95 50–95	70–95 40–75	30–50 15–35	---------- 20–30	NP NP–5
	30	Weathered bedrock.									
JbG, Jc For Sur part of Jc, see Sur series.	0–5 5–30 30	Sandy loam Gravelly sandy loam Weathered bedrock.	SM SM	A–2, A–4 A–1, A–2	0–15 0–30	85–100 60–100	80–95 50–95	70–95 40–75	30–50 15–35	---------- 20–30	NP NP–5
*Linne: LaD, LaE, LaF, LbD, LbE, LcE, LcF. For Diablo part of LbD, LbE, LcF, see DbD in Diablo series. For Shedd part of LcE and LcF, see SmE in Shedd series.	0–36 36	Silty clay loam Weathered bedrock.	CL	A–6, A–7	0	90–100	80–100	80–95	70–85	30–50	20–30
LcF2, LcG2 For Shedd part, see Shedd series. For Diablo part of LcG2, see Diablo series.	0–30 30	Silty clay loam Weathered bedrock.	CL	A–6, A–7	0	90–100	80–100	80–95	70–85	30–50	20–30
Lockwood: LdA, LdC	0–40 40–82	Loam Shaly clay loam	CL GC, CL	A–6 A–6, A–7	0 0	85–100 45–80	75–95 40–75	75–90 40–75	70–80 35–60	25–40 35–50	10–25 20–30
LeA, LeC, LeD	0–40 40–82	Shaly loam Shaly clay loam	GC, CL GC, CL	A–6 A–6, A–7	0 0	55–80 45–80	50–75 40–75	45–70 40–75	40–60 35–60	25–40 35–50	10–25 20–30
LgA	0–40 40–82	Shaly loam Shaly clay loam	GC, CL GC, CL	A–6 A–6, A–7, A–2	0 0	60–80 45–80	50–75 35–75	45–70 30–75	35–55 25–60	20–40 30–50	10–20 10–30
Lopez: LhE	0–4 4–11 11	Shaly loam Shaly silt loam Unweathered bedrock.	GM GM	A–1, A–2 A–2	0–15 0–15	35–65 25–50	35–50 20–50	30–40 20–45	20–35 15–35	30–50 30–50	5–15 5–15
Los Gatos: LkF, LkG	0–25 25–36 36	Gravelly loam Gravelly sandy clay loam Unweathered bedrock.	SC, GC CL, SC	A–6 A–6	0 0	55–80 70–100	50–75 60–85	45–70 60–80	35–50 35–65	25–40 30–40	10–25 15–25

See footnote at end of table.

*Nacimiento: NaD, NaE, NaF, NaG, NbF, NbG. For Los Osos part of NbF and NbG, see Los Osos series. For San Benito part, see San Benito series.	0–31	Silty clay loam	CL	A-6, A-7	0	80–100	75–100	70–95	65–85	30–45	10–30
	31	Weathered bedrock.									
Narlon: NcC, NcE	0–13	Loamy fine sand	SM	A-2, A-4	0	85–100	75–95	50–90	15–40		NP
	13–53	Clay	CH	A-7	0	100	95–100	80–100	70–85	50–70	25–40
	53	Weathered bedrock.									
Oceano: OaD	0–80	Loamy sand	SP-SM, SM	A-2, A-3	0	100	100	50–65	5–15		NP
Pacheco:											
Pa	0–65	Clay loam	CL	A-6, A-7	0	100	90–100	80–100	75–85	30–50	15–25
Pb	0–22	Silty clay loam	CL	A-6, A-7	0	100	100	90–100	75–85	30–50	15–25
	22–47	Loam	CL-ML, CL	A-4, A-6	0	100	100	75–95	60–75	10–30	5–15
	47–65	Silty clay loam	CL	A-6, A-7	0	100	100	90–100	75–85	30–50	15–25
Parkfield: PcC, PcE	0–14	Clay	CL	A-6, A-7	0	90–100	80–100	70–90	60–80	30–45	15–30
	14–24	Clay	CL	A-6, A-7	0	70–100	70–95	60–90	50–80	30–45	15–30
	24	Unweathered bedrock.									
Pfeiffer: PdC, PdD, Pe. Rock outcrop part of Pe not estimated.	0–6	Fine sandy loam	SM	A-4	0	90–100	80–90	60–80	35–50	15–30	NP–5
	6–60	Gravelly coarse sandy loam, gravelly sandy loam.	SP-SM, SM, GP-GM, GM	A-1, A-2	0–5	40–90	35–75	20–60	10–30	15–30	NP–5
	60	Weathered bedrock.									
Pico: Pf	0–55	Fine sandy loam	SM	A-4	0	90–100	75–100	70–85	35–50	15–25	NP–5
	55–72	Stratified sand to silty clay loam.	SM	A-1, A-2	0	90–100	75–100	30–50	10–35		NP
Pinnacles:											
PgE	0–17	Coarse sandy loam, gravelly sandy loam.	SM, GM	A-2	0–15	55–75	50–70	30–50	15–35	15–25	NP–5
	17–30	Gravelly clay	GC, CH	A-2, A-7	0–25	55–90	50–85	30–70	25–60	40–50	20–30
	30	Weathered bedrock.									
PhG2	0–12	Stony sandy loam	SM, GM	A-1, A-2, A-4	10–40	55–90	50–80	30–60	15–50	15–25	NP–5
	12–25	Stony sandy clay	GC, CH	A-2, A-7	10–40	55–90	50–85	30–70	25–60	40–60	20–30
	25	Weathered bedrock.									
Pinnacles variant: PkE, PkF	0–24	Coarse sandy loam	SM	A-4	0–5	75–95	65–95	55–80	35–50		NP
	24–32	Gravelly clay	GC	A-2	0–10	35–55	30–50	20–40	15–35	40–50	20–30
	32–60	Very gravelly sandy clay loam.	GC, GM-GC, SC, SM-SC	A-2, A-1	0–10	30–60	20–40	10–30	5–15	20–40	5–15
Pits and dumps: Pm. No estimates.											
*Placentia: PnA, PnC, PnD, PnE, PoE. For Arbuckle part of PoE, see Arbuckle series.	0–13	Sandy loam	SM, ML	A-4	0–5	90–100	85–100	60–95	35–65	15–25	NP–5
	13–36	Clay	CL, CH	A-6, A-7	0	90–100	60–100	60–95	50–80	35–60	20–40
	36–58	Sandy clay loam	SC	A-6, A-2	0	90–100	60–100	60–95	25–50	20–40	10–25
	58–68	Gravelly sandy loam	SM, SM-SC	A-4	0	70–90	60–90	55–80	25–45	15–20	NP–5

See footnote at end of table.

Santa Ynez: ShC, ShD, ShD2, ShE.	0–18	Fine sandy loam	SM	A-2, A-4	0	80–100	75–100	60–70	25–45	20–30	NP–5
	18–43	Clay, clay loam	CL	A-6, A-7	0	80–100	75–100	65–95	60–80	30–50	15–30
	43–61	Sandy clay loam	SC	A-6	0	80–100	75–100	65–85	35–50	20–40	10–20
Shedd:											
SmG3	0–30	Silt loam	ML	A-4, A-6	0	100	100	95–100	85–100	30–40	5–15
	30	Weathered bedrock.									
SnD, SnE, SnF2	0–30	Silty clay loam	CL	A-6, A-7	0	100	100	95–100	85–100	30–50	10–25
	30	Weathered bedrock.									
Sheridan: SoD, SoE, SoG	0–39	Coarse sandy loam	SM	A-2, A-1	0–10	90–100	75–90	25–60	15–35	----	NP
	39	Weathered bedrock.									
*Snelling: SpD, SpE2. For Greenfield part, see Greenfield series.	0–13	Sandy loam	SM, ML	A-4	0	90–100	75–100	65–80	35–60	10–30	NP–5
	13–46	Sandy clay loam	SC, CL	A-6	0	90–100	85–100	70–90	40–60	20–40	10–20
	46–58	Sandy loam	SM	A-2, A-4	0	90–100	75–100	65–80	30–40	10–30	NP–5
Sorrento: SrA, SrC	0–25	Clay loam	CL	A-6, A-7	0	100	95–100	90–100	75–85	30–50	10–25
	25–60	Loam	ML, CL-ML	A-4	0	100	95–100	75–95	60–80	20–40	5–10
*Sur: Ss, St. For Junipero part of Ss, see JbG and Jc in Junipero series. For Plaskett part of St, see Plaskett series.	0–24	Stony sandy loam	GP-GM, GM	A-1	5–40	50–60	45–55	30–50	10–20	----	NP
	24	Unweathered bedrock.									
Tangair: TaC	0–62	Fine sand	SM, SP-SM	A-1, A-2, A-3	0	80–100	75–100	40–80	5–30	----	NP
Tujunga: TbB	0–60	Fine sand	SP-SM, SM	A-1, A-2, A-3	0	90–100	75–100	40–70	5–20	----	NP
Vista: VaD, VaE, VaG, Vb. No estimates for Rock outcrop part of Vb.	0–23	Coarse sandy loam	SM	A-2	0	90–100	80–95	45–65	20–35	----	NP
	23	Weathered bedrock.									
*Xererts-Xerolls complex: Xa.											
Xererts part	0–48	Clay	CL, CH	A-7	0	100	100	95–100	90–100	40–60	20–30
Xerolls part	0–48	Clay loam, silty clay loam	CL	A-6, A-7	0–20	80–100	80–100	75–100	50–95	30–50	10–25
Xerorthents, sandy: Xb	0–60	Sand, loamy sand	SM	A-2, A-4	0–5	90–100	75–85	40–55	25–45	----	NP
Xerorthents, loamy: Xc	0–60	Loam, clay loam	CL	A-6	0–5	90–100	85–100	85–95	75–85	30–40	10–20
Xerorthents, dissected: Xd.	0–60	Variable.									
Xerorthents, shallow	0–8	Variable.									
	8	Unweathered and weathered bedrock.									

[1] NP means nonplastic.

TABLE 7.—*Estimated physical and chemical properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil which may have different properties and limitations. For this reason it is necessary to follow carefully the instructions for referring to other series that appear in the first column. The symbol < means less than; > means more than. The erosion tolerance factor (T) is for the entire profile]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Erosion factors: K	Erosion factors: T
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*					
*Alo: AaC, AaD, AaE, AaF, Ab. For Millsholm part of Ab, see Millsholm series.	0–36	0.06–0.2	0.14–0.17	6.1–8.4	<2	High	High	Low	0.24	2
	36									
Alviso: Ac, Ad	0–14	0.06–0.6	0.07–0.15	6.6–8.4	>2	Moderate	High	High	---	---
	14–45	0.06–0.2	0.07–0.15	6.6–8.4	>2	High	High	High	---	
	45–60	2.0–20.0	0.03–0.07	6.1–8.4	>2	Low	High	High	---	
Antioch: AeA, AeC, AeD	0–21	0.6–2.0	0.11–0.18	5.1–6.0	<2	Low	Moderate	Low	0.43	2
	21–40	<0.06	0.01–0.02	6.6–8.4	<2	High	High	Low	0.28	
	40–67	0.06–0.2	0.01–0.02	7.4–8.4	<2	High	High	Low	0.43	
	67–72	0.2–0.6	0.01–0.02	7.9–8.4	<2	Low	High	Low	0.37	
Aquic Xerofluvents: Af	0–60				<2					
Arbuckle: AgC, AgD	0–17	0.6–2.0	0.08–0.13	5.6–7.3	<2	Low	Low	Moderate	0.28	5
	17–46	0.2–0.6	0.14–0.17	5.6–7.8	<2	Moderate	Moderate	Moderate	0.24	
	46–60	0.2–0.6	0.04–0.08	5.6–7.8	<2	Low	Low	Moderate	0.10	
*Arnold: AkD, AkF, Am, Ar. For San Andreas part of Am, see San Andreas series. For Santa Ynez part of Ar, see Santa Ynez series.	0–48	6.0–20.0	0.05–0.09	5.1–7.3	<2	Low	Moderate	Moderate	0.15	4
	48									
Arroyo Seco: AsA, AsB, AsC, AvA, AvB.	0–42	2.0–6.0	0.06–0.10	6.1–8.4	<2	Low	Moderate	Low	0.17	5
	42–60	2.0–6.0	0.03–0.07	6.6–8.4	<2	Low	Moderate	Low	0.10	
Ayar: AyD, AyE, AyF	0–45	0.06–0.2	0.14–0.17	7.4–8.4	<2	High	High	Low	0.28	3
	45									
Badland: Ba. No estimates.										
Baywood: BbC	0–60	6.0–20.0	0.05–0.11	5.1–7.8	<2	Low	High	Moderate	0.15	5
Chamise: CaD, CaE, CaF	0–19	0.6–2.0	0.11–0.21	5.1–7.3	<2	Low	Moderate	High	0.24	2
	19–40	0.2–0.6	0.10–0.15	4.5–6.0	<2	Moderate	High	High	0.17	
	40–60	0.2–0.6	0.12–0.16	4.5–6.5	<2	Moderate	High	High	0.17	
Chualar: CbA, CbB, CbC	0–21	0.6–2.0	0.15–0.18	6.1–7.8	<2	Low	Low	Low	0.28	3
	21–44	0.2–0.6	0.13–0.16	6.1–8.4	<2	Moderate	Moderate	Low	0.32	
	44–59	0.2–0.6	0.07–0.13	6.1–8.4	<2	Low	High	Low	0.24	
	59–80	2.0–6.0	0.03–0.07	6.6–8.4	<2	Low	High	Low	0.10	
*Cieneba: CcG, Cd, Ce. No estimates for Rock outcrop part of Cd and Ce.	0–11	2.0–6.0	0.07–0.13	5.6–7.8	<2	Low	Low	Low	0.17	1
	11									

Lockwood:										
LdA, LdC	0–40	0.2–0.6	0.16–0.20	5.1–7.8	<2	Moderate	High	Low	0.37	5
	40–82	0.2–0.6	0.07–0.14	5.6–8.4	<2	High	High	Low	0.55	
LeA, LeC, LeD	0–40	0.6–2.0	0.11–0.16	5.1–7.8	<2	Moderate	High	Low	0.49	5
	40–82	0.2–0.6	0.07–0.14	5.6–8.4	<2	High	High	Low	0.55	
LgA	0–40	0.6–2.0	0.11–0.15	5.1–7.8	<2	Moderate	High	Low	0.37	5
	40–82	0.2–0.6	0.07–0.14	5.6–8.4	<2	Moderate	High	Low	0.43	
Lopez: LhE	0–4	0.6–2.0	0.10–0.14	5.1–6.0	<2	Low	Moderate	Moderate	0.15	1
	4–11	0.6–2.0	0.08–0.12	5.1–6.0	<2	Low	Moderate	Moderate	0.10	
	11									
Los Gatos: LkF, LkG	0–25	0.6–2.0	0.12–0.17	5.6–6.5	<2	Moderate	Moderate	Moderate	0.24	2
	25–36	0.2–0.6	0.14–0.20	5.6–6.5	<2	Moderate	Moderate	Moderate	0.37	
	36									
*Los Osos: LmD, LmE, LmF, LmG, Ln. For Millsholm part of Ln, see Millsholm series.	0–11	0.2–0.6	0.17–0.21	6.1–7.3	<2	High	High	Moderate	0.32	2
	11–31	0.06–0.2	0.15–0.18	5.6–7.3	<2	High	High	Moderate	0.28	
	31									
*McCoy: MaE, MaF, MaG, MbE, MbG. For Gilroy part of MbE and MbG, see Gilroy series.	0–18	0.2–0.6	0.16–0.21	6.1–7.8	<2	Moderate	Moderate	Low	0.37	2
	18–27	0.2–0.6	0.15–0.20	6.1–8.4	<2	High	High	Low	0.43	
	27									
McCoy variant: McG	0–17	0.6–2.0	0.12–0.14	6.1–7.3	<2	Low	Moderate	Low	0.20	2
	17–53	0.2–0.6	0.10–0.16	6.1–7.3	<2	Low	Moderate	Low	0.10	
	53									
*McMullin: Md. For Plaskett part, see Plaskett series.	0–7	0.6–2.0	0.10–0.15	5.6–6.5	<2	Low	Low	Moderate	0.17	1
	7–15	0.6–2.0	0.14–0.17	5.6–6.0	<2	Low	Moderate	Moderate	0.20	
	15									
Metz:										
Me	0–12	6.0–20.0	0.07–0.11	6.6–8.4	<2	Low	High	Low	0.17	5
	12–99	0.6–2.0	0.07–0.10	6.6–8.4	<2	Low	High	Low	0.15	
Mf	0–12	2.0–6.0	0.13–0.17	6.6–8.4	<2	Low	High	Low	0.28	5
	12–99	0.6–2.0	0.07–0.10	6.6–8.4	<2	Low	High	Low	0.15	
Mg:										
Loamy sand surface layer	0–12	6.0–20.0	0.07–0.11	6.6–8.4	<2	Low	High	Low	0.17	5
	12–99	0.6–2.0	0.07–0.10	6.6–8.4	<2	Low	High	Low	0.15	
Fine sandy loam surface layer	0–12	2.0–6.0	0.13–0.17	6.6–8.4	<2	Low	High	Low	0.28	5
	12–99	0.6–2.0	0.07–0.10	6.6–8.4	<2	Low	High	Low	0.15	
*Millsholm: MhG, Mk, Mm. For Alo part of Mk, see Alo series. For Gazos part of Mm, see Gazos series.	0–17	0.6–2.0	0.17–0.21	5.6–7.3	<2	Moderate	Moderate	Low	0.43	1
	17									
Mocho:										
MnA	0–68	0.6–2.0	0.16–0.20	7.4–8.4	<2	Moderate	High	Low	0.43	5
MoA, MoC	0–68	0.2–0.6	0.18–0.21	7.4–8.4	<2	Moderate	High	Low	0.37	5
Montara: Mp. No estimate for Rock outcrop part.	0–10	0.2–0.6	0.17–0.20	6.6–8.4	<2	Moderate	High	Low	0.32	1
	10									

TABLE 7.—*Estimated physical and chemical properties*—Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Erosion factors: K	Erosion factors: T
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*					
*Nacimiento: NaD, NaE, NaF, NaG, NbF, NbG. For Los Osos and San Benito parts of NbF and NbG, see Los Osos and San Benito series.	0–31 31	0.2–0.6	0.17–0.19	7.9–8.4	<2	Moderate	High	Low	0.32	2
Narlon: NcC, NcE	0–13 13–53 53	2.0–6.0 <0.06	0.08–0.12 0.01–0.02	5.1–6.5 4.5–5.5	<2 <2	Low High	High High	High High	0.17 0.32	2
Oceano: OaD	0–80	6.0–20.0	0.05–0.08	5.6–7.3	<2	Low	Moderate	Moderate	0.10	5
Pacheco:										
Pa	0–65	0.2–0.6	0.18–0.21	6.1–8.4	<15	Moderate	High	Low	0.43	5
Pb	0–22 22–47 47–65	0.2–0.6 0.2–0.6 0.2–0.6	0.17–0.21 0.15–0.18 0.17–0.21	6.1–8.4 7.4–8.4 7.4–8.4	<8 <8 <4	Moderate Moderate Moderate	High High High	Low Low Low	0.43 0.49 0.43	5
Parkfield: PcC, PcE	0–14 14–24 24	0.06–0.2 0.06–0.2	0.15–0.18 0.13–0.18	5.6–7.3 6.6–8.4	<2 <2	High High	High High	Low Low	0.28 0.28	2
Pfeiffer: PdC, PdD, Pe. No estimates for Rock outcrop part of Pe.	0–6 6–60 60	2.0–6.0 2.0–6.0	0.12–0.16 0.06–0.11	6.1–7.3 6.1–7.3	<2 <2	Low Low	Low Low	Low Low	0.20 0.17	3
Pico: Pf	0–55 55–72	2.0–6.0 0.6–2.0	0.13–0.15 0.03–0.05	7.4–8.4 7.9–8.4	<2 <2	Low Low	High High	Low Low	0.20 0.10	5
Pinnacles:										
PgE	0–17 17–30 30	2.0–6.0 0.06–0.2	0.13–0.18 0.04–0.08	5.6–7.3 4.5–6.0	<2 <2	Low High	Moderate High	Moderate High	0.32 0.24	2
PhG2	0–12 12–25 25	2.0–6.0 0.06–0.2	0.09–0.15 0.04–0.08	5.6–7.3 4.5–6.0	<2 <2	Low High	Moderate High	Moderate High	0.24 0.20	2
Pinnacles variant: PkE, PkF	0–24 24–32 32–60	2.0–6.0 <0.06 0.06–0.2	0.07–0.10 0.02–0.03 0.01–0.02	5.1–6.5 4.5–5.5 4.5–5.5	<2 <2 <2	Low Moderate Low	Moderate High High	High High High	0.28 0.15 0.10	1
Pits and dumps: Pm. No estimates.										
Placentia: PnA, PnC, PnD, PnE, PoE. For Arbuckle part of PoE, see Arbuckle series.	0–13 13–36 36–58 58–68	0.6–2.0 <0.06 <0.06 0.06–0.2	0.17–0.19 0.01–0.02 0.01–0.02 0.01–0.02	5.6–7.8 6.6–8.4 7.9–8.4 7.9–8.4	<2 <8 <8 <8	Low High High Low	Moderate High High High	Low Low Low Low	0.32 0.24 0.32 0.37	1

Plaskett: Pp For Reliz part, see Reliz series.	0–10 10	2.0–6.0	0.06–0.10	5.6–7.3	<2	Low	Moderate	Moderate	0.15	1
Psamments and Fluvents, flooded: Pr, Ps.										
Psamments part	0–60	>20	0.03–0.05	6.6–7.3	<2	Low	Low	Low		
Fluvents part	0–60	>6.0	0.03–0.05	6.6–7.3	<2	Low	Low	Low		
Reliz series	0–12 12	0.6–2.0	0.08–0.11	5.1–7.3	<2	Low	Moderate	Moderate	0.20	1
Rincon: RaA, RaC, RaD, RaE	0–14 14–49 49–60	0.2–0.6 0.06–0.2 0.2–0.6	0.17–0.21 0.15–0.18 0.13–0.17	6.1–7.3 6.6–8.4 7.4–8.4	<2 <2 <2	Moderate High Moderate	Moderate High High	Moderate Low Low	0.37 0.43 0.37	4
Rindge: Rb	0–60	6.0–20.0	0.26–0.30	4.5–6.5	<2	Very low	High	High		
*Rock outcrop: Rc. No estimates for Rock outcrop. For Xerorthents part, see Xerorthents, shallow.										
Salinas:										
SaA	0–5 5–75	0.6–2.0 0.2–0.6	0.16–0.20 0.16–0.20	6.6–7.3 6.6–8.4	<2 <2	Low Low	High High	Low Low	0.43 0.43	5
SbA, SbC	0–5 5–75	0.2–0.6 0.2–0.6	0.18–0.21 0.16–0.20	6.6–7.3 6.6–8.4	<2 <2	Moderate Low	High High	Low Low	0.37 0.43	5
San Andreas: ScE, ScG	0–22 22	2.0–6.0	0.11–0.17	6.1–7.3	<2	Low	Moderate	Moderate	0.15	2
San Benito: SdF, SdG	0–55 55	0.2–0.6	0.17–0.21	6.6–8.4	<2	Moderate	High	Low	0.37	3
San Timoteo: SeG	0–24 24	2.0–6.0	0.09–0.15	7.9–8.4	<2	Low	High	Low	0.28	2
*Santa Lucia: SfD, SfE, SfF, Sg For Reliz and Lopez parts of Sg, see those series.	0–24 24	0.6–2.0	0.10–0.14	5.1–6.5	<2	Low	High	High	0.15	2
Santa Ynez: ShC, ShD, ShD2, ShE	0–18 18–43 43–61	0.6–2.0 <0.06 0.06–0.2	0.09–0.16 0.01–0.03 0.01–0.03	5.6–7.3 5.6–7.8 5.6–8.4	<2 <2 <2	Low High Moderate	Moderate High High	Low Low Low	0.43 0.37 0.32	1
Shedd:										
SmG3	0–30 30	0.6–2.0	0.16–0.19	7.9–8.4	<2	Moderate	High	Low	0.37	2
SnD, SnE, SnF2	0–30 30	0.2–0.6	0.18–0.21	7.9–8.4	<2	Moderate	High	Low	0.32	2
Shedd part of LcF2, LcG2	0–25 25	0.2–0.6	0.18–0.21	7.9–8.4	<2	Moderate	High	Low	0.32	2
Sheridan: SoD, SoE, SoG	0–39 39	2.0–6.0	0.10–0.14	5.6–7.3	<2	Low	Moderate	Moderate	0.24	2
*Snelling: SpD, SpE2 For Greenfield part, see Greenfield series.	0–13 13–46 46–58	0.6–2.0 0.2–0.6 0.6–2.0	0.10–0.13 0.15–0.17 0.08–0.12	6.1–7.3 6.1–7.8 6.1–8.4	<2 <2 <2	Low Moderate Low	Low Moderate High	Low Low Low	0.32 0.20 0.24	5
Sorrento: SrA, SrC	0–25 25–60	0.2–0.6 0.2–0.6	0.18–0.21 0.16–0.21	6.6–8.4 7.9–8.4	<2 <2	Moderate Low	High High	Low Low	0.32 0.43	5

GUIDE TO MAPPING UNITS

Map symbol	Soil name	Described on page	Capability unit	Page	Range site	Page	Storie index
AaC	Alo silty clay, 2 to 9 percent slopes	5	IIIe-5(15)	88	Clayey	109	44
AaD	Alo silty clay, 9 to 15 percent slopes	5	IIIe-5(15)	88	Clayey	109	42
AaE	Alo silty clay, 15 to 30 percent slopes	6	IVe-5(15)	90	Clayey	109	32
AaF	Alo silty clay, 30 to 50 percent slopes	6	VIe-1(15)	91	Clayey	109	20
Ab	Alo-Millsholm complex	6	VIe-1(15)	91	----------	---	1/23
	Alo part	--	----------	--	Clayey	109	-----
	Millsholm part	--	----------	--	Shallow Loamy	113	-----
Ac	Alviso silty clay loam	6	VIIIw-1(15)	92	----------	---	7
Ad	Alviso silty clay loam, drained	7	VIw-1(14)	91	----------	---	24
AeA	Antioch very fine sandy loam, 0 to 2 percent slopes	8	IIIs-3(14)	89	Claypan	110	45
AeC	Antioch very fine sandy loam, 2 to 9 percent slopes	8	IIIe-3(14)	87	Claypan	110	40
AeD	Antioch very fine sandy loam, 9 to 15 percent slopes	8	IVe-3(14)	90	Claypan	110	34
Af	Aquic Xerofluvents	8	IVw-4(15)	90	----------	---	41
AgC	Arbuckle gravelly loam, 2 to 9 percent slopes	9	IIe-4(14), IIIe-4(15)	85, 88	----------	---	65
AgD	Arbuckle gravelly loam, 9 to 15 percent slopes	9	IIIe-4(15)	88	----------	---	61
AkD	Arnold loamy sand, 9 to 15 percent slopes	10	IVe-4(15)	90	Sandy	112	68
AkF	Arnold loamy sand, 15 to 50 percent slopes	10	VIIe-1(15)	91	Sandy	112	27
Am	Arnold-San Andreas complex	10	VIIe-1(15)	91	----------	---	1/9
	Arnold part	--	----------	--	Sandy	112	-----
	San Andreas part	--	----------	--	Coarse Loamy	112	-----
Ar	Arnold-Santa Ynez complex	10	VIe-1(15)	91	----------	---	1/42
	Arnold part	--	----------	--	Sandy	112	-----
	Santa Ynez part	--	----------	--	Claypan	110	-----
AsA	Arroyo Seco gravelly sandy loam, 0 to 2 percent slopes	11	IIIs-4(14)	89	----------	---	63
AsB	Arroyo Seco gravelly sandy loam, 2 to 5 percent slopes	11	IIIe-4(14)	87	----------	---	60
AsC	Arroyo Seco gravelly sandy loam, 5 to 9 percent slopes	11	IIIe-4(15)	88	----------	---	50
AvA	Arroyo Seco gravelly loam, 0 to 2 percent slopes	12	IIs-4(14)	86	----------	---	72
AvB	Arroyo Seco gravelly loam, 2 to 5 percent slopes	12	IIe-4(14)	85	----------	---	72
AyD	Ayar silty clay, 5 to 15 percent slopes	12	IIIe-5(15)	88	Clayey	109	48
AyE	Ayar silty clay, 15 to 30 percent slopes	12	IVe-5(15)	90	Clayey	109	36
AyF	Ayar silty clay, 30 to 50 percent slopes	13	VIe-1(15)	91	Clayey	109	20
Ba	Badland	13	VIIIe-1(15)	92	----------	---	2/<10
BbC	Baywood sand, 2 to 15 percent slopes	13	VIe-1(15)	91	Sandy	112	51
CaD	Chamise shaly loam, 9 to 15 percent slopes	14	IVe-1(15)	89	Terrace	112	28
CaE	Chamise shaly loam, 15 to 30 percent slopes	14	IVe-1(15)	89	Terrace	112	23
CaF	Chamise shaly loam, 30 to 50 percent slopes	14	VIe-1(15)	91	Terrace	112	11
CbA	Chualar loam, 0 to 2 percent slopes	15	I(14), IIIc-1(15)	85, 89	----------	---	85
CbB	Chualar loam, 2 to 5 percent slopes	15	IIe-1(14)	85	----------	---	81
CbC	Chualar loam, 5 to 9 percent slopes	16	IIe-1(14)	85	----------	---	72
CcG	Cieneba fine gravelly sandy loam, 30 to 75 percent slopes	16	VIIe-1(15)	91	Shallow Loamy	113	5
Cd	Cieneba-Rock outcrop complex	16	VIIs-1(15)	92	Shallow Loamy	113	3

Map symbol	Soil name	Described on page	Capability unit	Page	Range site	Page	Storie index
LcE	Linne-Shedd silty clay loams, 15 to 30 percent slopes	40	IVe-1(15)	89	Clayey	109	1/35
LcF	Linne-Shedd silty clay loams, 30 to 50 percent slopes	40	VIe-1(15)	91	Clayey	109	1/19
LcF2	Linne-Shedd silty clay loams, 15 to 50 percent slopes, eroded	40	VIe-1(15)	91	Clayey	109	1/20
LcG2	Linne-Shedd silty clay loams, 50 to 75 percent slopes, eroded	40	VIIe-1(15)	91	Clayey	109	1/7
LdA	Lockwood loam, 0 to 2 percent slopes	42	I(14), IIIc-1(15)	85, 89	----------	---	85
LdC	Lockwood loam, 2 to 9 percent slopes	42	IIe-1(14), IIIe-1(15)	85, 87	----------	---	76
LeA	Lockwood shaly loam, 0 to 2 percent slopes	42	IIs-4(14), IIIs-4(15)	86, 89	----------	---	68
LeC	Lockwood shaly loam, 2 to 9 percent slopes	42	IIe-4(14), IIIe-4(15)	85, 88	----------	---	65
LeD	Lockwood shaly loam, 9 to 15 percent slopes	42	IIIe-4(14), IIIe-4(15)	87, 88	----------	---	59
LgA	Lockwood shaly loam, 0 to 2 percent slopes, wet	43	IIw-2(14)	86	----------	---	41
LhE	Lopez shaly loam, 15 to 30 percent slopes	43	VIIe-1(15)	91	Shallow Loamy	113	11
LkF	Los Gatos gravelly loam, 30 to 50 percent slopes	44	VIe-1(15)	91	Loamy	110	12
LkG	Los Gatos gravelly loam, 50 to 75 percent slopes	44	VIIe-1(15)	91	Loamy	110	8
LmD	Los Osos clay loam, 9 to 15 percent slopes	45	IIIe-3(15)	87	Fine Loamy	109	41
LmE	Los Osos clay loam, 15 to 30 percent slopes	45	IVe-3(15)	90	Fine Loamy	109	34
LmF	Los Osos clay loam, 30 to 50 percent slopes	45	VIe-1(15)	91	Fine Loamy	109	34
LmG	Los Osos clay loam, 50 to 75 percent slopes	45	VIIe-1(15)	91	Fine Loamy	109	9
Ln	Los Osos-Millsholm complex	45	VIIe-1(15)	91	----------	---	1/13
	Los Osos part	--	----------	--	Fine Loamy	109	-----
	Millsholm part	--	----------	--	Shallow Loamy	113	-----
MaE	McCoy clay loam, 15 to 30 percent slopes	46	IVe-1(15)	89	Granitic Clay	109	37
MaF	McCoy clay loam, 30 to 50 percent slopes	46	VIe-1(15)	91	Granitic Clay	109	17
MaG	McCoy clay loam, 50 to 75 percent slopes	46	VIIe-1(15)	91	Granitic Clay	109	12
MbE	McCoy-Gilroy complex, 15 to 30 percent slopes	46	IVe-1(15)	89	----------	---	1/33
	McCoy part	--	----------	--	Granitic Clay	109	-----
	Gilroy part	--	----------	--	Granitic	111	1/33
MbG	McCoy-Gilroy complex, 30 to 75 percent slopes	46	VIIe-1(15)	91	----------	---	1/13
	McCoy part	--	----------	--	Granitic Clay	109	-----
	Gilroy part	--	----------	--	Granitic	111	-----
McG	McCoy gravelly loam, very stony subsoil variant, 30 to 75 percent slopes	47	VIIe-1(15)	91	Loamy	110	8
Md	McMullin-Plaskett complex	48	VIIe-1(15)	91	----------	---	1/4
Me	Metz loamy sand	49	IIIs-4(14)	89	----------	---	72
Mf	Metz fine sandy loam	49	IIs-4(14)	86	----------	---	90
Mg	Metz complex	49	IVe-4(14)	90	----------	---	73
MhG	Millsholm loam, 30 to 75 percent slopes	50	VIIe-1(15)	91	Shallow Loamy	113	8

Map symbol	Soil name	Described on page	Capability unit	Page	Range site	Page	Storie index
Mk	Millsholm-Alo association	50	VIIe-1(15)	91	----------	---	1/7
	Millsholm part	--	----------	--	Shallow Loamy	113	-----
	Alo part	--	----------	--	Clayey	109	-----
Mm	Millsholm-Gazos complex	50	VIIe-1(15)	91	----------	---	1/11
	Millsholm part	--	----------	--	Shallow Loamy	113	-----
	Gazos part	--	----------	--	Fine Loamy	109	-----
MnA	Mocho silt loam, 0 to 2 percent slopes	51	I(14), IIIc-1(15)	85, 89	----------	---	100
MoA	Mocho silty clay loam, 0 to 2 percent slopes	51	I(14), IIIc-1(15)	85, 89	----------	---	90
MoC	Mocho silty clay loam, 2 to 9 percent slopes	51	IIe-1(14)	85	----------	---	81
Mp	Montara-Rock outcrop complex	51	VIIs-1(15)	92	Serpentine	113	5
NaD	Nacimiento silty clay loam, 9 to 15 percent slopes	52	IIIe-1(15)	87	Clayey	109	54
NaE	Nacimiento silty clay loam, 15 to 30 percent slopes	52	IVe-1(15)	89	Clayey	109	38
NaF	Nacimiento silty clay loam, 30 to 50 percent slopes	52	VIe-1(15)	91	Clayey	109	22
NaG	Nacimiento silty clay loam, 50 to 75 percent slopes	53	VIIe-1(15)	91	Clayey	109	9
NbF	Nacimiento-Los Osos complex, 30 to 50 percent slopes	53	VIe-1(15)	91	----------	---	1/20
	Nacimiento part	--	----------	--	Clayey	109	-----
	Los Osos part	--	----------	--	Fine Loamy	109	-----
NbG	Nacimiento-Los Osos complex, 50 to 75 percent slopes	53	VIIe-1(15)	91	----------	---	1/10
	Nacimiento part	--	----------	--	Clayey	109	-----
	Los Osos part	--	----------	--	Fine Loamy	109	-----
NcC	Narlon loamy fine sand, 2 to 9 percent slopes	54	IVe-3(14)	90	Claypan	110	22
NcE	Narlon loamy fine sand, 15 to 30 percent slopes	54	VIIe-1(15)	91	Claypan	110	16
OaD	Oceano loamy sand, 2 to 15 percent slopes	55	IVe-4(14), VIe-1(15)	90, 91	Sandy	112	61
Pa	Pacheco clay loam	56	IIw-2(14)	86	---------	---	68
Pb	Pacheco silty clay loam, occasionally flooded	56	IIIw-2(15)	88	---------	---	54
PcC	Parkfield clay, 2 to 9 percent slopes	57	IIIe-5(15)	88	Clayey	109	31
PcE	Parkfield clay, 15 to 30 percent slopes	57	VIe-1(15)	91	Clayey	109	17
PdC	Pfeiffer fine sandy loam, 2 to 9 percent slopes	58	IIIe-1(15)	87	Coarse Loamy	112	68
PdD	Pfeiffer fine sandy loam, 9 to 15 percent slopes	58	IVe-1(15)	89	Coarse Loamy	112	60
Pe	Pfeiffer-Rock outcrop complex	58	VIIIs-1(15)	92	---------	---	8
Pf	Pico fine sandy loam	59	I(14), IIIc-1(15)	85, 89	---------	---	100
PgE	Pinnacles coarse sandy loam, 5 to 30 percent slopes	60	VIe-1(15)	91	Claypan	110	27
PhG2	Pinnacles stony sandy loam, 30 to 75 percent slopes, eroded	60	VIIe-1(15)	91	Coarse Loamy	112	4
PkE	Pinnacles coarse sandy loam, very gravelly subsoil variant, 5 to 30 percent slopes	61	VIe-1(15)	91	Claypan	110	31
PkF	Pinnacles coarse sandy loam, very gravelly subsoil variant, 30 to 50 percent slopes	61	VIIe-1(15)	91	Claypan	110	11

GUIDE TO MAPPING UNITS--Continued

Map symbol	Soil name	Described on page	Capability unit	Page	Range site	Page	Storie index
Pm	Pits and dumps----------------------------------	61	VIIIe-1(15)	92	----------	---	2/<10
PnA	Placentia sandy loam, 0 to 2 percent slopes--	62	IIIs-3(14)	89	Claypan	110	45
PnC	Placentia sandy loam, 2 to 9 percent slopes--	62	IVe-3(14), IVe-3(15)	90	Claypan	110	37
PnD	Placentia sandy loam, 9 to 15 percent slopes-	62	IVe-3(14), IVe-3(15)	90	Claypan	110	34
PnE	Placentia sandy loam, 15 to 30 percent slopes------------------------------------	63	VIe-1(15)	91	Claypan	110	26
PoE	Placentia-Arbuckle complex, 15 to 30 percent slopes------------------------------------	63	VIe-1(15)	91	----------	---	1/36
	Placentia part----------------------------	--	----------	--	Claypan	110	-----
	Arbuckle part-----------------------------	--	----------	--	Loamy	110	-----
Pp	Plaskett-Reliz complex-----------------------	63	VIIe-1(15)	91	----------	---	6
	Plaskett part-----------------------------	--	----------	--	----------	---	-----
	Reliz part--------------------------------	--	----------	--	Shallow Loamy	113	-----
Pr	Psamments and Fluvents, occasionally flooded------------------------------------	64	VIw-1(15)	91	Sandy	112	28
Ps	Psamments and Fluvents, frequently flooded---	64	VIIIw-1(15)	92	Sandy	112	2/<10
RaA	Rincon clay loam, 0 to 2 percent slopes------	65	IIs-3(14)	86	----------	---	68
RaC	Rincon clay loam, 2 to 9 percent slopes------	65	IIe-3(14)	85	----------	---	61
RaD	Rincon clay loam, 9 to 15 percent slopes-----	65	IIIe-3(14)	87	----------	---	58
RaE	Rincon clay loam, 15 to 30 percent slopes----	65	IVe-3(14)	90	----------	---	39
Rb	Rindge muck----------------------------------	66	VIw-1(15)	91	----------	---	25
Rc	Rock outcrop-Xerorthents association---------	66	VIIIs-1(15)	92	----------	---	2/<10
SaA	Salinas loam, 0 to 2 percent slopes----------	67	I(14)	85	----------	---	100
SbA	Salinas clay loam, 0 to 2 percent slopes-----	68	I(14)	85	----------	---	85
SbC	Salinas clay loam, 2 to 9 percent slopes-----	68	IIe-1(14), IIIe-1(15)	85, 87	----------	---	76
ScE	San Andreas fine sandy loam, 15 to 30 percent slopes----------------------------	68	VIe-1(15)	91	Coarse Loamy	112	43
ScG	San Andreas fine sandy loam, 30 to 75 percent slopes----------------------------	69	VIIe-1(15)	91	Coarse Loamy	112	14
SdF	San Benito clay loam, 30 to 50 percent slopes------------------------------------	69	VIe-1(15)	91	Fine Loamy	109	20
SdG	San Benito clay loam, 50 to 75 percent slopes------------------------------------	69	VIIe-1(15)	91	Fine Loamy	109	14
SeG	San Timoteo gravelly loam, 30 to 75 percent slopes------------------------------------	70	VIIe-1(15)	91	Loamy	110	12
SfD	Santa Lucia shaly clay loam, 2 to 15 percent slopes----------------------------	70	IVe-4(15)	90	Loamy	110	29
SfE	Santa Lucia shaly clay loam, 15 to 30 percent slopes----------------------------	71	IVe-4(15)	90	Loamy	110	22
SfF	Santa Lucia shaly clay loam, 30 to 50 percent slopes----------------------------	71	VIe-1(15)	91	Loamy	110	12
Sg	Santa Lucia-Reliz association----------------	71	VIIe-1(15)	91	----------	---	1/7
	Santa Lucia part--------------------------	--	----------	--	Loamy	110	-----
	Reliz part--------------------------------	--	----------	--	Shallow Loamy	113	-----
ShC	Santa Ynez fine sandy loam, 2 to 9 percent slopes------------------------------------	72	IVe-3(14), IVe-3(15)	90	Claypan	110	54
ShD	Santa Ynez fine sandy loam, 9 to 15 percent slopes------------------------------------	73	IVe-3(14), IVe-3(15)	90	Claypan	110	44
ShD2	Santa Ynez fine sandy loam, 5 to 15 percent slopes, eroded----------------------------	73	IVe-3(15)	90	Claypan	110	32

APPENDIX C

El Sur Ranch Weather Station Data

	Min. Temp	Max. Temp	Ave. Temp	Max. Wind Speed	Ave. Wind Speed	Max. Rel. Humidity	Min. Rel. Humidity	Ave. Rel. Humidity	Tot. Solar Radiance	Tot. Rainfall
	(F)	(F)	(F)	(mph)	(mph)	(%)	(%)	(%)	(W/m2/day)	(in)
	1.0						1	1.0	0	
Average/ Total	**1.0**						**1**	**1**	**0**	
8/5/2004	60.1	67.8	64.3	35.0	20.6	78	50	65.6	3.000	0.00
8/6/2004	55.6	70.7	64.5	35.3	14.8	74	51	65.3	3.750	0.00
8/7/2004	51.3	65.7	59.9	29.2	12.3	92	72	84.3	3.669	0.00
8/8/2004	51.8	64.6	58.2	26.0	10.1	100	83	93.2	3.622	0.00
8/9/2004	50.9	66.9	59.8	33.9	14.7	100	72	87.0	3.800	0.00
8/10/2004	49.5	66.2	59.0	30.7	12.5	99	79	88.9	3.724	0.00
8/11/2004	54.0	63.0	57.8	13.5	5.1	100	86	95.4	2.901	0.00
8/12/2004	55.0	64.4	58.8	12.8	4.3	100	83	94.2	2.220	0.00
8/13/2004	57.4	66.2	60.6	9.6	3.9	100	75	87.9	3.016	0.00
8/14/2004	57.2	65.3	60.1	27.8	9.5	99	75	86.7	2.965	0.00
8/15/2004	52.2	70.2	63.6	37.8	18.0	88	60	74.1	3.737	0.00
8/16/2004	60.8	70.9	65.2	40.0	18.6	86	67	77.1	3.620	0.00
8/17/2004	57.9	69.4	63.5	34.6	16.1	95	67	82.5	3.645	0.00
8/18/2004	48.4	64.9	58.0	32.8	11.5	100	81	91.8	7.401	0.00
8/19/2004	48.0	63.9	56.5	13.2	5.1	100	84	95.5	5.756	0.00
8/20/2004	57.0	66.0	60.4	18.2	6.9	99	83	90.9	6.009	0.00
8/21/2004	58.1	67.1	61.6	16.0	7.1	93	75	86.1	5.815	0.00
8/22/2004	55.4	67.3	61.6	13.9	5.0	92	73	83.6	4.301	0.00
8/23/2004	52.2	64.9	59.7	27.5	8.1	99	83	91.4	5.438	0.00
8/24/2004	57.2	70.7	62.9	30.3	12.4	94	77	88.2	7.139	0.00
8/25/2004	51.6	72.0	63.0	38.9	13.8	100	64	86.5	7.248	0.00
8/26/2004	62.2	70.9	65.7	40.3	19.9	97	54	72.9	7.411	0.00
8/27/2004	53.6	73.4	62.8	18.5	5.5	90	53	76.5	7.278	0.00
8/28/2004	50.4	64.8	58.1	24.6	7.0	100	83	95.7	6.909	0.00
8/29/2004	56.8	63.1	58.9	15.3	5.4	100	95	99.2	3.434	0.00
8/30/2004	52.3	62.8	58.1	18.2	6.0	100	87	97.0	4.056	0.00
8/31/2004	52.0	70.5	62.5	28.2	12.1	100	69	86.9	6.950	0.00
Average/ Total	**54.4**	**67.2**	**60.9**	**26.0**	**10.6**	**95**	**73**	**86**	**4,771**	**0.00**

El Sur Ranch Weather Station Data

September, 2004

September, 2004	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
9/1/2004	52.9	69.6	63.2	35.0	15.8	93	70	80.0	6,966	0.00
9/2/2004	57.4	68.7	62.2	36.4	19.5	91	63	76.5	7,284	0.00
9/3/2004	48.4	76.5	63.2	33.5	11.3	97	31	64.3	7,133	0.00
9/4/2004	50.0	73.2	61.0	14.2	4.3	95	50	73.0	6,967	0.00
9/5/2004	53.1	85.6	68.7	14.9	5.0	89	28	52.3	7,023	0.00
9/6/2004	54.0	79.5	68.5	21.7	7.5	81	25	47.5	6,988	0.00
9/7/2004	53.1	77.2	64.1	20.3	5.7	90	40	67.0	6,898	0.00
9/8/2004	52.3	79.2	63.7	23.5	6.1	90	38	70.3	6,861	0.00
9/9/2004	48.7	68.4	59.0	26.0	9.0	96	69	83.0	6,809	0.00
9/10/2004	45.0	68.0	57.8	26.0	10.6	100	62	85.3	6,950	0.00
9/11/2004	45.7	65.7	58.2	30.0	13.9	95	71	85.2	6,829	0.00
9/12/2004	54.5	68.9	63.6	41.8	19.7	98	63	75.7	6,627	0.00
9/13/2004	59.2	68.4	62.7	37.8	22.9	87	64	76.6	6,540	0.00
9/14/2004	45.5	77.9	61.1	33.5	9.4	95	39	70.6	6,582	0.00
9/15/2004	48.2	69.3	59.1	18.2	4.8	95	57	79.8	6,464	0.00
9/16/2004	48.9	66.2	56.6	22.8	7.2	100	75	90.8	5,128	0.00
9/17/2004	49.1	67.8	58.8	28.9	9.8	100	62	86.5	5,809	0.00
9/18/2004	55.9	64.8	60.2	30.7	17.1	90	48	65.2	3,450	0.00
9/19/2004	50.7	63.9	56.6	21.0	8.8	95	63	76.5	5,658	0.16
9/20/2004	52.3	64.4	58.7	34.6	15.8	80	60	71.1	6,501	0.00
9/21/2004	49.8	74.1	62.1	31.0	8.6	70	30	49.3	6,456	0.00
9/22/2004	49.8	70.3	60.1	13.9	5.0	74	35	57.0	6,360	0.00
9/23/2004	43.0	68.9	56.0	15.3	4.3	100	47	83.8	5,407	0.00
9/24/2004	43.3	65.1	53.4	16.0	5.4	100	81	95.6	5,867	0.00
9/25/2004	43.5	63.7	54.1	31.4	10.9	100	71	89.5	6,190	0.01
9/26/2004	40.3	67.1	56.3	26.4	9.5	100	65	84.8	6,221	0.00
9/27/2004	51.4	65.7	59.2	35.3	15.7	90	67	77.8	6,112	0.00
9/28/2004	51.4	64.9	58.5	18.2	7.0	88	68	79.6	6,004	0.00
9/29/2004	50.0	65.1	57.0	17.1	8.0	99	73	85.2	4,954	0.00
9/30/2004	55.4	62.1	57.6	17.1	8.0	98	65	82.9	2,447	0.00
Average/ Total	**50.1**	**69.7**	**60.0**	**25.8**	**10.2**	**93**	**56**	**75**	**6,183**	**0.17**

El Sur Ranch Weather Station Data

October, 2004

October, 2004	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
10/1/2004	50.7	62.6	57.7	20.0	6.5	88	68	78.0	5.027	0.00
10/2/2004	48.4	61.3	54.6	22.8	7.9	99	78	89.4	5,533	0.00
10/3/2004	48.7	60.8	55.5	21.0	8.7	100	82	95.0	2,975	0.00
10/4/2004	49.8	63.7	58.0	35.3	13.7	97	74	85.2	5,593	0.00
10/5/2004	47.1	67.5	57.5	33.2	12.1	99	52	83.5	5,705	0.00
10/6/2004	47.5	72.5	59.4	36.8	15.8	94	55	79.3	5,612	0.00
10/7/2004	53.4	74.7	60.4	30.7	17.4	98	44	79.7	5,638	0.00
10/8/2004	52.7	72.3	62.2	33.2	12.9	92	53	76.4	5,375	0.00
10/9/2004	55.2	66.6	59.8	37.1	19.4	96	61	76.8	5,494	0.00
10/10/2004	45.1	70.2	58.6	28.5	10.3	89	35	65.5	5,452	0.00
10/11/2004	48.7	70.2	59.7	12.1	4.5	82	37	57.7	5,374	0.00
10/12/2004	51.8	82.8	67.6	22.1	7.1	67	21	41.7	5,268	0.00
10/13/2004	51.6	81.7	64.9	15.7	4.9	100	24	53.3	5,103	0.00
10/14/2004	47.3	56.8	52.9	12.1	4.0	100	98	99.9	2,852	0.00
10/15/2004	49.8	59.2	53.9	17.8	7.5	100	89	96.9	3,529	0.01
10/16/2004	55.4	67.5	59.7	26.4	11.7	96	67	85.2	3,009	0.17
10/17/2004	58.5	64.0	60.8	30.0	10.1	100	93	98.3	1,216	1.46
10/18/2004	49.3	63.5	56.7	13.9	6.0	100	66	86.8	4,939	0.01
10/19/2004	53.6	61.3	58.2	39.6	13.9	100	69	92.9	639	1.96
10/20/2004	50.5	61.9	56.3	17.4	7.3	98	73	87.7	4,861	0.25
10/21/2004	48.4	61.9	55.2	27.8	11.3	94	63	81.3	4,940	0.00
10/22/2004	47.7	63.1	56.0	20.7	9.3	92	65	77.9	4,776	0.00
10/23/2004	48.4	61.5	56.0	10.3	4.4	100	69	88.5	2,838	0.00
10/24/2004	52.5	62.6	57.6	30.3	12.6	100	81	89.8	4,581	0.04
10/25/2004	50.4	60.3	55.0	25.7	11.1	89	65	77.9	4,483	0.00
10/26/2004	45.9	59.0	53.2	28.9	8.4	99	74	88.9	2,946	0.93
10/27/2004	43.5	60.8	51.5	14.9	7.9	94	59	78.3	4,661	0.00
10/28/2004	44.6	60.8	52.1	15.7	6.6	94	59	79.3	3,469	0.00
10/29/2004	46.4	62.1	53.8	13.2	7.3	91	64	80.3	4,446	0.00
10/30/2004	49.6	62.6	56.0	35.0	14.6	88	58	80.3	4,498	0.00
10/31/2004	48.4	67.1	58.1	29.6	15.1	99	38	78.5	4,540	0.00
Average/ Total	49.7	**65.3**	**57.4**	**24.4**	**10.0**	95	62	**81**	**4,367**	**4.83**

El Sur Ranch Weather Station Data

November, 2004

November, 2004	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
11/1/2004	48.7	65.3	56.7	18.5	6.3	77	25	49.3	4.466	0.00
11/2/2004	48.2	68.0	56.4	16.0	7.1	74	36	54.1	4.386	0.00
11/3/2004	46.8	58.8	53.8	32.5	12.4	96	57	77.5	2.140	0.29
11/4/2004	46.0	57.7	51.1	16.4	7.1	98	63	84.9	3.933	0.40
11/5/2004	48.2	64.9	54.0	13.9	5.9	99	47	81.6	2.845	0.08
11/6/2004	47.1	65.5	53.4	18.2	7.0	99	58	82.7	3.201	0.00
11/7/2004	46.8	60.4	54.4	17.4	7.5	100	74	88.0	2.950	0.07
11/8/2004	49.8	59.0	54.3	12.4	4.5	100	74	92.5	1.085	0.00
11/9/2004	52.3	61.5	55.4	16.0	5.5	98	59	83.4	1.999	0.00
11/10/2004	52.0	63.0	56.3	18.5	7.3	95	69	83.0	2.113	0.04
11/11/2004	53.1	62.1	57.3	13.9	6.4	100	90	96.0	1.216	0.11
11/12/2004	46.9	64.0	55.4	29.2	9.8	99	65	85.1	3.784	0.00
11/13/2004	50.2	68.0	58.2	29.2	12.1	90	49	78.8	3.851	0.00
11/14/2004	50.9	65.5	56.2	15.7	6.6	92	55	74.1	3.522	0.00
11/15/2004	50.2	66.4	56.7	15.3	5.9	96	51	75.8	2.568	0.00
11/16/2004	46.6	61.0	52.7	12.1	4.7	100	66	91.4	3.486	0.00
11/17/2004	45.1	61.5	52.0	11.0	4.7	98	75	90.5	3.742	0.00
11/18/2004	43.0	65.1	54.4	26.7	10.1	96	65	82.7	3.769	0.01
11/19/2004	46.2	63.5	55.0	32.1	11.7	92	62	79.4	3.722	0.00
11/20/2004	45.1	65.3	55.6	49.6	8.4	88	14	59.0	3.769	0.00
11/21/2004	46.2	64.9	56.2	31.8	10.2	46	14	26.6	3.919	0.00
11/22/2004	42.8	59.9	50.3	16.7	8.2	90	41	62.0	3.682	0.00
11/23/2004	42.8	59.5	49.8	20.7	9.1	95	56	78.7	3.600	0.00
11/24/2004	45.3	61.2	51.6	15.3	7.6	92	53	76.1	3.582	0.00
11/25/2004	43.5	58.8	52.7	35.0	12.8	86	52	77.5	3.608	0.00
11/26/2004	48.6	62.1	54.8	15.3	6.7	98	79	89.9	3.169	0.00
11/27/2004	47.5	55.8	53.0	32.5	11.9	100	48	85.4	1.329	0.48
11/28/2004	43.2	57.4	51.2	29.6	12.7	53	26	40.0	3.740	0.00
11/29/2004	39.9	57.4	47.4	16.7	7.7	83	19	52.6	3.527	0.00
11/30/2004	38.1	54.5	45.4	23.5	9.5	83	46	66.8	3.465	0.00
Average/ Total	**46.7**	**61.9**	**53.7**	**21.7**	**8.3**	**90**	**53**	**75**	**3,206**	**1.48**

El Sur Ranch Weather Station Data December, 2004

December, 2004	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
12/1/2004	39.9	57.6	47.4	30.0	11.3	83	43	62.3	3,407	0.00
12/2/2004	40.8	57.6	48.1	13.9	6.7	81	43	62.0	3,444	0.00
12/3/2004	43.2	62.6	50.5	17.1	7.3	69	27	47.2	3,542	0.00
12/4/2004	42.1	58.3	49.0	18.5	8.5	87	35	59.7	3,002	0.00
12/5/2004	47.8	61.0	53.4	24.2	10.6	77	44	60.6	2,776	0.00
12/6/2004	44.4	56.8	51.3	31.0	9.9	92	57	74.7	2,956	0.09
12/7/2004	51.3	58.8	54.3	42.1	10.8	100	79	94.0	2,595	3.07
12/8/2004	53.4	57.7	55.7	22.8	9.7	100	93	97.7	316	0.61
12/9/2004	51.8	61.9	56.1	15.3	4.4	100	91	99.0	2,243	0.07
12/10/2004	47.7	63.3	53.1	12.8	4.3	100	75	94.4	3,198	0.01
12/11/2004	46.8	66.9	55.3	14.2	5.2	100	48	79.1	3,228	0.00
12/12/2004	47.1	57.2	53.3	28.5	11.1	100	79	94.1	841	0.01
12/13/2004	48.0	60.8	54.4	17.4	6.6	100	81	89.6	3,134	0.00
12/14/2004	45.5	63.0	53.3	11.4	4.5	100	69	83.9	3,136	0.00
12/15/2004	43.9	61.3	51.3	12.4	4.4	99	64	82.9	3,109	0.00
12/16/2004	41.5	67.5	53.6	14.9	6.2	86	41	63.9	2,958	0.00
12/17/2004	45.7	71.1	56.7	16.7	6.3	61	23	46.6	3,349	0.00
12/18/2004	45.1	66.7	55.2	16.0	7.0	78	32	49.5	3,321	0.00
12/19/2004	45.3	67.3	54.4	19.2	6.7	89	41	63.4	3,268	0.00
12/20/2004	41.4	57.9	51.1	31.0	10.6	89	55	77.3	3,184	0.00
12/21/2004	42.1	60.4	49.3	17.8	5.5	98	60	87.0	3,210	0.00
12/22/2004	43.7	59.9	50.6	18.5	6.5	89	66	78.8	2,918	0.00
12/23/2004	43.3	61.7	50.3	15.7	7.7	84	46	63.0	3,313	0.00
12/24/2004	44.1	59.9	50.1	16.0	8.2	84	45	58.0	3,280	0.00
12/25/2004	43.3	58.1	50.1	15.3	8.5	89	57	75.2	2,975	0.00
12/26/2004	49.6	55.0	52.7	33.5	13.8	97	70	85.2	710	0.31
12/27/2004	46.0	57.4	51.5	50.3	17.4	99	76	92.8	207	2.28
12/28/2004	47.3	54.0	49.9	26.0	7.3	100	81	94.0	693	1.19
12/29/2004	45.7	56.8	50.8	32.1	9.9	98	64	86.6	2,307	0.43
12/30/2004	51.6	56.1	54.5	34.3	15.6	99	90	96.0	388	1.59
12/31/2004	47.7	56.7	52.1	26.0	6.8	100	67	86.3	2,363	0.57
Average/ Total	**45.7**	**60.4**	**52.2**	**22.4**	**8.4**	**91**	**59**	**77**	**2,560**	**10.23**

El Sur Ranch Weather Station Data January, 2005

January, 2005	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
1/1/2005	45.1	56.8	50.2	14.2	6.4	98	66	86.4	2,952	0.19
1/2/2005	44.1	52.2	47.8	23.9	9.3	97	84	92.8	571	0.95
1/3/2005	42.1	55.0	47.2	12.4	5.6	100	65	88.6	2,933	0.12
1/4/2005	39.2	54.0	46.4	16.0	7.8	95	71	85.6	2,796	0.18
1/5/2005	43.9	55.9	47.9	14.2	7.3	97	71	91.8	1,265	0.43
1/6/2005	42.1	55.4	47.6	26.7	9.3	97	62	83.8	2,088	0.00
1/7/2005	49.3	55.8	52.4	51.8	17.5	100	67	94.6	403	1.31
1/8/2005	49.8	55.6	52.4	0.0	8.1	99	86	95.6	717	0.76
1/9/2005	49.3	56.3	52.6	0.0	8.1	100	90	98.3	733	0.42
1/10/2005	49.6	57.6	52.7	0.0	8.1	100	91	97.4	1,217	0.60
1/11/2005	45.5	56.5	50.7	22.8	8.1	94	74	82.5	2,434	0.17
1/12/2005	39.2	62.2	48.1	7.4	8.1	96	66	83.5	4,368	0.00
1/13/2005	40.5	56.5	45.9	11.4	5.7	96	75	87.0	667	0.00
1/14/2005	41.5	60.3	49.6	14.6	7.4	90	47	69.7	3,656	0.00
1/15/2005	45.9	63.3	53.0	15.7	6.2	98	33	67.1	3,195	0.00
1/16/2005	46.8	69.3	56.3	19.2	6.3	86	41	59.7	3,563	0.00
1/17/2005	47.1	62.2	54.8	12.8	4.7	94	64	79.5	2,651	0.00
1/18/2005	47.5	73.4	57.8	14.2	5.8	82	39	62.4	3,755	0.00
1/19/2005	55.4	72.3	62.0	16.7	8.2	73	36	49.3	3,833	0.00
1/20/2005	46.6	66.0	57.6	16.7	7.6	98	45	66.8	3,822	0.00
1/21/2005	42.3	57.0	50.0	15.7	5.0	100	85	95.3	3,180	0.00
1/22/2005	43.7	57.7	51.0	14.6	5.2	99	88	95.4	3,106	0.00
1/23/2005	49.6	64.8	55.0	18.9	4.7	96	68	91.3	3,350	0.00
1/24/2005	47.5	63.1	56.3	23.5	9.7	98	67	85.0	3,369	0.00
1/25/2005	56.7	62.6	59.5	25.7	14.3	92	65	78.2	1,675	0.01
1/26/2005	47.3	60.4	56.0	25.7	9.7	99	80	92.4	2,530	0.42
1/27/2005	44.6	58.8	51.4	36.0	13.0	97	77	88.5	2,260	0.21
1/28/2005	45.3	59.0	54.0	30.7	9.7	98	64	85.8	3,162	0.56
1/29/2005	44.4	56.8	50.4	27.8	11.2	92	57	76.1	4,166	0.02
1/30/2005	40.8	60.1	48.9	26.0	7.6	92	57	77.6	4,219	0.01
1/31/2005	41.9	60.6	50.1	14.2	6.0	93	56	77.8	4,166	0.01
Average/ Total	**45.6**	**59.9**	**52.1**	**18.4**	**8.1**	**95**	**66**	**83**	**2,671**	**6.37**

El Sur Ranch Weather Station Data February, 2005

February, 2005	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
2/1/2005	45.0	68.2	54.4	19.2	6.4	85	18	66.9	4.311	0.01
2/2/2005	44.2	68.0	56.5	21.4	6.7	75	20	53.9	4.405	0.00
2/3/2005	45.0	63.0	52.8	16.7	6.9	89	45	59.9	4.342	0.00
2/4/2005	43.2	63.9	52.7	20.0	7.1	90	45	73.4	4.232	0.00
2/5/2005	47.1	57.2	53.1	31.0	12.7	88	68	80.8	3.746	0.00
2/6/2005	50.4	56.7	52.9	27.1	13.1	89	70	79.3	3.839	0.02
2/7/2005	47.1	55.2	50.9	17.4	7.1	97	73	88.3	1.887	0.17
2/8/2005	43.2	57.6	49.5	11.7	5.7	94	55	79.9	3.780	0.00
2/9/2005	42.1	59.5	49.5	13.2	6.9	91	62	80.7	3.739	0.00
2/10/2005	45.0	67.3	56.3	14.2	6.1	82	40	63.5	4.273	0.00
2/11/2005	52.2	61.7	56.5	11.0	4.0	99	50	75.5	1.255	0.36
2/12/2005	49.5	62.6	54.7	17.1	5.0	100	78	94.8	3.237	0.17
2/13/2005	48.4	54.9	53.0	16.0	6.9	100	81	94.1	689	0.03
2/14/2005	51.6	60.6	54.7	21.7	8.2	88	66	80.7	2.597	0.01
2/15/2005	51.3	58.5	55.2	33.5	13.6	96	77	90.0	615	1.61
2/16/2005	51.3	60.4	56.2	23.5	10.3	96	80	89.3	3.165	0.23
2/17/2005	49.5	60.3	54.7	23.5	7.3	95	73	88.3	915	0.02
2/18/2005	50.7	62.2	56.7	28.2	12.6	94	74	86.4	3.396	0.70
2/19/2005	52.5	58.5	55.1	38.5	11.5	94	76	88.5	1.488	0.07
2/20/2005	52.0	58.1	55.5	35.0	14.1	93	68	81.3	1.386	0.04
2/21/2005	50.2	59.5	54.4	44.6	18.4	93	73	86.2	2.049	0.21
2/22/2005	45.5	62.4	53.3	22.1	6.6	94	62	84.8	4.569	1.36
2/23/2005	47.5	58.6	52.4	27.8	11.6	89	69	83.4	4.554	0.01
2/24/2005	43.7	58.6	51.7	25.0	8.9	92	73	83.5	5.130	0.00
2/25/2005	43.2	60.6	51.7	23.2	7.4	94	68	85.0	5.019	0.00
2/26/2005	45.3	59.9	52.4	11.0	5.4	93	72	84.5	4.487	0.00
2/27/2005	48.0	58.1	52.1	29.2	10.4	90	71	80.1	1.966	0.02
2/28/2005	27.7	59.2	46.2	16.7	6.4	92	11	71.0	5.289	0.95
Average/ Total	**46.9**	**60.4**	**53.4**	**22.8**	**8.8**	**92**	**61**	**80**	**3.227**	**5.99**

# El Sur Ranch Weather Station Data		March, 2005

March, 2005	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
3/1/2005	-999.0	48.9	-607.5	18.2	8.2	74	0	7.2	4.234	0.07
3/2/2005	-999.0	-999.0	-999.0	25.0	8.9	45	0	6.9	5.017	0.01
3/3/2005	-999.0	-999.0	-999.0	23.2	8.9	87	0	31.0	3.079	0.01
3/4/2005	-999.0	-999.0	-999.0	26.4	9.5	86	0	24.3	1.271	0.01
3/5/2005	-999.0	-999.0	-999.0	23.2	8.2	83	0	31.2	5.292	0.01
3/6/2005	-999.0	-999.0	-999.0	20.7	6.8	67	0	8.3	5.442	0.00
3/7/2005	-999.0	-999.0	-999.0	23.9	7.6	45	0	14.7	5.486	0.01
3/8/2005	-999.0	-999.0	-999.0	16.0	4.8	66	0	24.4	4.756	0.00
3/9/2005	-999.0	-999.0	-999.0	23.2	6.2	49	0	25.8	5.674	0.01
3/10/2005	-999.0	-999.0	-999.0	25.7	6.7	80	30	56.8	5.829	0.00
3/11/2005	-999.0	-999.0	-999.0	17.1	7.6	86	53	71.0	4.323	0.00
3/12/2005	-999.0	-999.0	-999.0	11.4	4.8	65	25	40.0	1.215	0.00
3/13/2005	-999.0	-999.0	-999.0	14.6	4.6	53	25	45.2	.935	0.00
3/14/2005	-999.0	-999.0	-999.0	20.3	6.7	83	49	67.0	5.913	0.00
3/15/2005	-999.0	-999.0	-999.0	16.4	6.4	81	45	64.0	6.033	0.00
3/16/2005	-999.0	-999.0	-999.0	16.4	7.0	84	44	65.6	5.787	0.01
3/17/2005	-999.0	-999.0	-999.0	14.2	5.4	84	48	67.2	2.277	0.00
3/18/2005	-999.0	-999.0	-999.0	29.6	10.2	84	60	76.0	1.839	0.00
3/19/2005	-999.0	-999.0	-999.0	28.2	9.8	79	54	70.8	3.153	0.00
3/20/2005	-999.0	-999.0	-999.0	18.5	6.2	79	61	72.4	4.259	0.00
3/21/2005	-999.0	-999.0	-999.0	28.2	9.7	79	58	73.5	2.510	0.01
3/22/2005	-999.0	-999.0	-999.0	36.4	12.1	78	52	67.1	1.336	0.01
3/23/2005	-999.0	-999.0	-999.0	24.6	7.9	88	61	73.9	3.088	0.01
3/24/2005	-999.0	-999.0	-999.0	27.5	9.7	87	52	73.8	6.469	0.00
3/25/2005	-999.0	-999.0	-999.0	31.0	12.3	83	59	71.1	6.434	0.02
3/26/2005	-999.0	-999.0	-999.0	17.4	5.1	85	54	72.8	5.148	0.00
3/27/2005	-999.0	-999.0	-999.0	25.0	8.7	87	72	80.0	3.912	0.01
3/28/2005	-999.0	-999.0	-999.0	28.9	11.0	81	61	71.0	6.102	0.00
3/29/2005	-999.0	-999.0	-999.0	24.6	9.4	87	65	75.8	3.940	0.01
3/30/2005	-999.0	-999.0	-999.0	33.2	13.0	84	48	68.9	6.827	0.00
3/31/2005	-999.0	-999.0	-999.0	14.6	6.0	76	34	57.8	6.803	0.01
Average/ Total	**-999.0**	**-965.2**	**-986.4**	**22.7**	**8.0**	**77**	**36**	**53**	**4.335**	**0.22**

El Sur Ranch Weather Station Data April, 2005

April. 2005	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
4/1/2005	-999.0	-999.0	-999.0	21.7	9.0	81	43	65.8	6.845	0.00
4/2/2005	-999.0	-999.0	-999.0	31.8	12.8	84	54	75.2	5.214	0.00
4/3/2005	-999.0	-999.0	-999.0	24.6	7.3	89	59	75.4	4.385	0.01
4/4/2005	-999.0	-999.0	-999.0	29.2	11.5	86	58	71.6	6.806	0.00
4/5/2005	-999.0	-999.0	-999.0	13.2	6.5	84	50	67.9	6.833	0.00
4/6/2005	-999.0	-999.0	-999.0	12.8	6.0	83	61	76.0	6.012	0.00
4/7/2005	-999.0	-999.0	-999.0	23.9	8.9	83	61	71.3	5.122	0.00
4/8/2005	-999.0	-999.0	-999.0	31.8	8.6	84	63	75.6	1.846	0.01
4/9/2005	-999.0	-999.0	-999.0	34.3	16.2	81	67	74.7	6.718	0.00
4/10/2005	-999.0	59.2	-692.1	34.3	14.2	80	64	75.0	6.882	0.00
4/11/2005	48.9	59.4	53.7	33.5	16.7	78	63	71.8	6.907	0.00
4/12/2005	45.0	57.4	50.7	33.5	16.0	76	62	68.8	6.927	0.00
4/13/2005	44.4	55.2	48.9	33.9	15.5	73	50	63.3	7.216	0.00
4/14/2005	37.9	54.1	47.4	37.8	15.4	73	44	64.6	7.201	0.00
4/15/2005	42.1	59.4	51.6	35.7	12.3	77	53	68.2	7.132	0.00
4/16/2005	-999.0	50.2	-738.3	34.6	16.8	83	62	74.5	7.115	0.01
4/17/2005	-999.0	57.2	-516.3	40.7	20.8	80	59	70.8	7.071	0.00
4/18/2005	-999.0	56.3	-255.6	32.5	18.8	82	63	73.1	7.365	0.00
4/19/2005	-999.0	59.9	-561.3	25.7	11.4	86	43	72.0	7.478	0.00
4/20/2005	-999.0	56.1	-911.4	20.7	9.7	83	65	74.2	7.276	0.00
4/21/2005	-999.0	-999.0	-999.0	23.5	8.1	86	62	76.1	6.987	0.00
4/22/2005	-999.0	-999.0	-999.0	28.5	11.9	83	60	70.9	4.931	0.01
4/23/2005	-999.0	-999.0	-999.0	27.5	8.1	82	62	75.7	3.522	0.23
4/24/2005	-999.0	-999.0	-999.0	13.5	6.2	82	66	74.3	5.723	0.04
4/25/2005	-999.0	-999.0	-999.0	21.7	8.7	82	62	75.5	7.429	0.02
4/26/2005	-999.0	-999.0	-999.0	16.7	6.6	84	55	76.9	6.482	0.01
4/27/2005	-999.0	59.9	-427.4	27.1	10.1	95	59	81.2	3.305	0.02
4/28/2005	48.7	62.6	55.7	22.1	6.5	99	70	89.3	6.808	0.54
4/29/2005	45.3	62.4	54.6	22.5	9.6	97	68	84.4	7.350	0.00
4/30/2005	46.0	62.4	55.4	21.7	7.2	97	64	81.1	5.771	0.00
Average/ Total	**-720.7**	**-470.4**	**-622.3**	**27.0**	**11.2**	**84**	**59**	**74**	**6.222**	**0.90**

El Sur Ranch Weather Station Data May, 2005

May, 2005	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
5/1/2005	45.9	63.3	55.0	13.9	5.7	96	63	83.4	7.173	0.00
5/2/2005	46.8	65.1	56.2	28.9	11.1	95	67	80.4	7,332	0.00
5/3/2005	45.3	64.2	57.8	30.7	11.8	94	68	81.1	7.292	0.00
5/4/2005	48.7	63.1	57.2	19.2	5.2	99	75	88.3	3.122	0.06
5/5/2005	54.1	65.7	58.7	16.7	5.9	99	69	89.5	5,778	0.26
5/6/2005	50.5	65.3	57.7	14.9	5.9	99	68	84.8	7.497	0.03
5/7/2005	46.2	65.1	56.2	18.5	7.3	93	57	77.2	7.343	0.00
5/8/2005	50.9	63.1	56.7	26.7	9.9	98	74	87.7	3,626	0.21
5/9/2005	49.6	64.9	57.2	15.7	5.4	99	64	81.8	7.051	0.08
5/10/2005	46.8	61.2	54.9	27.1	11.8	87	66	75.3	7,608	0.00
5/11/2005	44.1	62.2	56.0	30.3	12.9	93	70	81.0	7.570	0.00
5/12/2005	50.2	63.7	57.5	27.8	11.3	92	57	82.2	7,239	0.00
5/13/2005	50.0	66.0	58.5	28.9	12.5	95	50	82.4	7.104	0.00
5/14/2005	56.1	68.2	61.9	30.0	14.3	92	60	79.8	7,275	0.00
5/15/2005	56.5	74.5	63.7	29.6	11.8	97	62	86.0	6.975	0.00
5/16/2005	53.8	64.9	59.9	26.0	12.2	100	67	83.1	7.130	0.00
5/17/2005	51.4	64.0	57.2	22.5	8.9	90	52	73.8	6,298	0.00
5/18/2005	51.1	67.3	58.5	19.2	8.1	94	63	81.7	4,222	0.00
5/19/2005	57.0	69.6	63.0	21.7	7.2	95	77	86.0	6,996	0.00
5/20/2005	56.8	66.2	61.4	35.3	16.0	86	42	63.1	7,827	0.00
5/21/2005	53.6	69.3	61.7	36.0	14.8	78	45	62.7	7,887	0.00
5/22/2005	55.0	69.1	61.8	37.1	18.2	74	45	63.5	7,796	0.00
5/23/2005	52.5	65.8	57.8	32.5	17.6	82	62	73.2	7.967	0.00
5/24/2005	49.3	62.6	56.3	28.2	13.1	98	76	83.7	7,839	0.00
5/25/2005	44.8	61.0	53.8	14.2	4.7	100	0	84.9	5.650	0.00
5/26/2005	52.7	61.9	55.8	23.5	8.6	100	98	100.0	6,189	0.00
5/27/2005	47.3	61.7	55.5	30.3	10.6	100	93	98.7	7.577	0.00
5/28/2005	47.1	64.2	55.8	30.3	12.0	100	71	91.2	6,300	0.00
5/29/2005	54.1	64.6	58.7	30.0	16.1	100	56	84.3	7.856	0.00
5/30/2005	48.9	63.3	58.0	28.5	12.2	100	82	92.9	7.703	0.00
5/31/2005	51.4	62.8	58.0	31.0	15.0	92	83	88.7	7.683	0.00
Average/ Total	**50.6**	**65.0**	**58.0**	**26.0**	**10.9**	**94**	**64**	**82**	**6,868**	**0.64**

El Sur Ranch Weather Station Data June, 2005

June, 2005	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
6/1/2005	52.9	65.5	58.7	35.0	17.5	90	61	80.2	7.863	0.00
6/2/2005	44.2	60.4	54.1	36.0	13.6	86	73	80.3	7.861	0.00
6/3/2005	45.0	60.4	54.0	40.3	14.4	85	73	80.4	7.018	0.00
6/4/2005	50.2	60.8	55.0	34.3	18.9	84	70	78.6	7.845	0.00
6/5/2005	52.5	61.7	56.2	41.4	20.9	77	54	67.3	7.976	0.00
6/6/2005	50.7	62.4	56.0	33.2	18.5	78	58	68.0	7.869	0.00
6/7/2005	50.0	62.6	56.5	35.0	16.9	75	54	66.1	7.844	0.00
6/8/2005	55.0	66.6	61.1	23.9	12.1	85	51	72.7	7.040	0.00
6/9/2005	55.6	67.5	60.1	31.0	12.3	100	11	89.6	6.729	0.17
6/10/2005	53.4	65.5	58.1	38.2	18.8	100	54	94.8	7.786	0.00
6/11/2005	53.6	62.2	57.0	43.2	21.3	100	87	98.4	7.878	0.00
6/12/2005	50.4	68.5	57.3	32.5	14.1	100	51	86.6	7.928	0.00
6/13/2005	46.2	77.5	59.1	30.3	10.6	100	43	83.9	7.974	0.00
6/14/2005	51.8	65.1	57.6	36.4	17.6	100	60	87.1	7.988	0.00
6/15/2005	44.8	61.7	54.9	30.3	10.3	100	70	96.3	7.953	0.00
6/16/2005	43.3	62.1	53.2	16.4	7.0	100	92	98.9	5.296	0.04
6/17/2005	50.0	62.4	56.2	14.2	4.8	95	70	80.3	7.635	0.01
6/18/2005	48.9	65.1	56.9	14.6	7.6	81	56	70.8	7.956	0.00
6/19/2005	47.7	66.2	58.0	21.0	9.4	77	52	66.1	7.852	0.00
6/20/2005	47.8	67.3	59.2	25.7	10.4	71	52	62.6	7.860	0.00
6/21/2005	49.1	69.1	61.2	33.2	15.5	69	44	60.6	8.003	0.00
6/22/2005	56.1	64.9	60.4	34.6	18.5	69	43	54.1	7.801	0.00
6/23/2005	55.2	66.6	59.9	27.5	9.9	66	40	55.5	7.428	0.00
6/24/2005	54.3	64.8	59.2	14.9	5.6	62	38	53.1	6.710	0.00
6/25/2005	53.4	65.3	59.0	13.5	5.6	61	39	49.5	6.390	0.00
6/26/2005	49.3	64.9	57.4	27.5	10.6	69	42	51.8	7.992	0.00
6/27/2005	48.7	64.2	58.3	25.0	11.9	70	43	55.3	7.235	0.00
6/28/2005	52.2	66.9	59.7	24.2	10.7	88	47	67.4	7.342	0.00
6/29/2005	52.5	65.1	58.2	22.8	8.1	92	64	79.9	7.323	0.00
6/30/2005	52.7	65.8	57.7	20.0	5.9	85	54	71.6	6.489	0.00
Average/ Total	**50.6**	**65.0**	**57.7**	**28.5**	**12.6**	**84**	**55**	**74**	**7.495**	**0.22**

El Sur Ranch Weather Station Data

July, 2005

July, 2005	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
7/1/2005	53.8	66.4	57.8	20.0	7.7	84	44	68.3	6.552	0.00
7/2/2005	54.0	64.2	57.2	17.4	5.9	84	51	69.0	5,791	0.00
7/3/2005	48.2	63.1	56.4	28.5	10.9	88	54	74.5	8.048	0.00
7/4/2005	47.5	63.3	56.2	26.0	11.9	90	61	75.1	7.398	0.00
7/5/2005	53.4	61.9	57.4	34.6	17.6	86	66	76.1	7.961	0.00
7/6/2005	55.2	67.8	59.9	39.6	18.8	89	62	76.1	7.642	0.00
7/7/2005	54.9	64.9	59.4	37.8	19.2	86	60	70.6	7,569	0.00
7/8/2005	56.5	68.5	61.5	37.5	21.3	87	55	73.7	7,593	0.00
7/9/2005	57.6	66.6	61.5	33.2	17.2	82	65	74.3	7,548	0.00
7/10/2005	51.3	70.9	63.8	35.3	15.8	86	49	69.1	7.419	0.00
7/11/2005	57.2	70.5	63.1	37.1	16.8	88	52	71.0	7,582	0.00
7/12/2005	55.8	65.1	60.3	28.2	12.4	84	69	75.9	7.421	0.00
7/13/2005	50.7	64.6	57.2	19.2	7.1	90	61	77.9	7.386	0.00
7/14/2005	52.3	62.4	56.3	13.2	5.3	91	51	74.7	6,560	0.00
7/15/2005	52.3	63.1	56.8	16.7	5.8	100	45	76.2	6.827	0.00
7/16/2005	53.2	62.1	55.9	12.4	4.3	91	47	69.9	5.926	0.00
7/17/2005	52.2	61.2	56.1	9.6	4.1	81	46	63.1	6.629	0.00
7/18/2005	54.9	64.8	59.1	30.7	12.6	72	42	59.5	7.144	0.00
7/19/2005	52.3	65.1	59.8	28.2	12.4	80	57	67.7	7.446	0.00
7/20/2005	55.6	64.0	58.5	15.7	6.6	80	54	69.7	5.731	0.00
7/21/2005	55.2	67.3	60.0	23.9	9.9	78	48	63.8	3.631	0.01
7/22/2005	54.5	68.4	62.5	32.8	13.9	87	63	70.8	7.620	0.00
7/23/2005	48.9	68.0	57.4	15.7	4.6	89	57	76.9	7.471	0.00
7/24/2005	47.5	63.7	55.4	14.6	4.2	88	58	74.0	6.895	0.00
7/25/2005	48.7	63.0	56.0	26.7	9.7	84	50	70.8	7.676	0.01
7/26/2005	50.0	59.9	54.3	11.0	4.7	84	59	72.6	5.605	0.00
7/27/2005	50.7	62.1	55.9	11.4	4.8	80	57	69.8	6.138	0.00
7/28/2005	54.0	64.9	57.8	10.7	4.2	79	54	69.3	5,498	0.00
7/29/2005	53.8	64.8	58.6	16.7	4.8	81	50	69.3	6.185	0.00
7/30/2005	50.4	63.3	57.4	18.5	6.5	83	59	73.4	7.162	0.00
7/31/2005	52.2	64.9	57.9	21.4	7.5	82	55	72.5	6.437	0.00
Average/ Total	**52.7**	**64.9**	**58.3**	**23.4**	**9.9**	**85**	**55**	**71**	**6.855**	**0.02**

El Sur Ranch Weather Station Data August, 2005

August, 2005	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
8/1/2005	54.3	64.0	57.6	23.9	7.3	79	52	68.8	6.389	0.00
8/2/2005	52.2	66.6	58.2	30.3	11.2	81	37	69.1	7.269	0.00
8/3/2005	53.4	62.8	56.7	14.6	5.0	83	55	70.9	4.312	0.00
8/4/2005	53.4	63.1	57.3	19.6	7.0	77	53	67.6	6.885	0.00
8/5/2005	51.4	63.9	57.1	27.5	7.5	79	45	67.0	7.355	0.00
8/6/2005	53.1	63.5	56.8	24.2	5.7	100	61	88.6	6.022	0.00
8/7/2005	52.3	66.4	56.7	23.9	5.6	93	50	70.2	6.294	0.01
8/8/2005	53.4	63.9	57.3	20.3	6.5	75	53	65.6	6.049	0.00
8/9/2005	54.5	64.6	57.4	13.9	5.2	72	46	65.3	5.660	0.00
8/10/2005	52.5	62.8	57.2	17.4	4.9	73	50	63.7	5.255	0.00
8/11/2005	50.4	64.4	56.8	24.2	6.8	79	44	65.8	7.075	0.00
8/12/2005	49.5	63.7	57.3	16.7	5.5	79	52	68.9	6.129	0.00
8/13/2005	54.9	61.2	58.1	12.4	4.7	81	70	74.6	2.601	0.00
8/14/2005	56.3	61.5	58.2	7.8	3.7	78	67	73.0	2.708	0.00
8/15/2005	56.1	62.8	59.0	13.5	5.6	81	69	75.3	2.198	0.00
8/16/2005	54.7	64.6	58.7	16.7	6.5	83	61	73.3	4.004	0.00
8/17/2005	55.4	63.9	58.0	11.4	5.1	80	60	72.5	4.090	0.00
8/18/2005	55.2	63.1	58.3	13.2	4.9	100	73	89.7	3.385	0.01
8/19/2005	53.4	64.9	58.9	22.5	9.1	100	69	87.8	6.759	0.00
8/20/2005	49.3	64.6	58.0	30.3	12.8	96	68	84.5	6.843	0.00
8/21/2005	50.9	64.4	58.3	34.6	15.4	93	68	80.3	6.979	0.00
8/22/2005	50.4	63.5	57.5	31.0	14.2	92	73	83.0	7.144	0.00
8/23/2005	51.3	59.4	55.1	13.5	4.3	100	78	91.8	5.060	0.00
8/24/2005	53.1	63.0	56.7	13.5	5.6	100	70	88.0	4.999	0.00
8/25/2005	49.5	64.8	57.5	17.4	6.4	90	69	78.9	7.053	0.00
8/26/2005	44.4	65.8	56.6	21.7	8.4	90	68	79.0	6.825	0.00
8/27/2005	49.8	65.1	58.2	24.2	8.5	89	69	80.5	6.734	0.00
8/28/2005	50.7	64.6	57.4	26.0	9.0	88	66	80.1	6.666	0.00
8/29/2005	48.0	68.0	59.9	38.9	16.7	88	57	70.8	6.958	0.00
8/30/2005	47.5	80.2	60.8	28.2	10.0	89	33	68.1	6.988	0.00
8/31/2005	46.2	61.7	54.9	20.7	5.9	93	74	85.6	5.986	0.00
Average/ Total	**51.9**	**64.4**	**57.6**	**21.1**	**7.6**	**86**	**60**	**76**	**5.764**	**0.02**

El Sur Ranch Weather Station Data

September, 2005

September, 2005	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
9/1/2005	51 8	61.9	56 0	14 2	5 6	89	69	81 4	4.977	0 00
9/2/2005	50 2	63.3	57 1	24 2	7 6	88	70	78.8	6.007	0 00
9/3/2005	51 4	62 6	56 1	25 7	10 8	86	70	80.3	6.428	0 00
9/4/2005	45 9	66.6	57.8	32.8	13 7	86	60	74 0	6.735	0 00
9/5/2005	56 8	66.0	61.3	28 9	15.4	84	61	71 6	6.703	0 00
9/6/2005	44 2	65.1	55 7	32.8	14.1	88	66	80 8	6.631	0 00
9/7/2005	46 2	62.2	55 0	31 0	12.8	90	72	81 7	6.599	0.00
9/8/2005	55 2	64 2	58.8	16 4	6.1	85	67	79 5	2.993	0 00
9/9/2005	56 5	63.9	59 5	14 6	5.5	86	71	79.9	2.743	0 00
9/10/2005	52 7	63 3	59.0	30.3	12.7	82	63	73.6	6.628	0 00
9/11/2005	49 1	66.0	60.2	28 2	14 7	81	56	72.5	6.498	0 00
9/12/2005	48 0	61.9	56.4	27.8	12.2	85	66	76.3	6.419	0 00
9/13/2005	47 5	62.2	54 7	21.7	9.1	89	67	79.3	5.204	0 00
9/14/2005	46 2	62.8	55 8	29.2	12.3	90	69	79 1	6.425	0 00
9/15/2005	49 1	61 9	56.4	27.1	11.5	89	70	79.3	6.171	0 00
9/16/2005	49 8	63 9	58.5	34.3	12.3	88	68	76.7	5.682	0 00
9/17/2005	55 2	65.7	59.7	35.7	18.9	87	64	78 0	6.307	0 00
9/18/2005	43 9	69.6	57.5	28.5	10.7	87	60	75.1	5.680	0.00
9/19/2005	44 6	70.9	54 3	10 7	4.2	91	54	83.1	5.840	0 00
9/20/2005	48 4	59 9	54.0	11.4	5.1	89	71	82.3	3.278	0 00
9/21/2005	47 3	68.0	57 3	27.8	8.8	86	46	75.9	5.906	0.00
9/22/2005	46 4	63.5	55.2	24.6	7.9	90	70	82.9	5.427	0.00
9/23/2005	45 7	63.0	56.8	38.9	17.7	87	66	75.0	5.951	0 00
9/24/2005	43 9	65.7	56 0	22.8	9.2	88	41	71.5	5.669	0.00
9/25/2005	44 2	60.4	52 4	14.2	5.6	92	76	85.3	5.537	0 00
9/26/2005	49 1	63.7	56.4	10 7	4.8	88	69	80.5	5.717	0 00
9/27/2005	48 4	68.7	57 9	31 8	9.7	87	61	76.1	5.668	0 00
9/28/2005	48.2	72.5	58 7	25.0	9.7	89	54	77.9	5.768	0.00
9/29/2005	50 9	74.5	60.6	17.4	6.8	88	44	75.4	5.868	0.00
9/30/2005	46 6	66.0	55 8	17.8	5.9	90	65	80.0	5.677	0 00
Average/ Total	**48.8**	**65.0**	**57.0**	**24.6**	**10.0**	**88**	**64**	**78**	**5.705**	**0.00**

El Sur Ranch Weather Station Data October, 2005

October, 2005	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
10/1/2005	46.4	69.8	62.2	38.9	15.5	90	64	76.7	5,542	0.00
10/2/2005	54.7	64.2	59.5	36.8	19.6	82	56	69.9	5,650	0.00
10/3/2005	54.3	62.1	58.7	38.5	17.2	81	54	66.0	5,721	0.00
10/4/2005	51.8	63.9	58.3	36.8	15.9	82	51	63.4	5,639	0.00
10/5/2005	52.2	73.6	62.9	28.9	11.0	69	23	47.0	5,484	0.00
10/6/2005	50.2	69.4	58.0	31.4	10.4	88	34	67.5	5,417	0.00
10/7/2005	44.1	65.5	55.0	35.0	13.7	90	61	78.3	5,340	0.00
10/8/2005	54.9	63.3	58.4	35.0	18.2	79	63	71.1	5,326	0.00
10/9/2005	46.2	67.8	57.6	31.4	12.6	87	42	70.6	5,308	0.00
10/10/2005	43.9	74.3	55.3	15.3	4.2	89	34	73.0	5,186	0.00
10/11/2005	41.0	61.2	52.2	30.3	10.8	91	67	82.9	4,997	0.00
10/12/2005	43.0	59.2	50.5	22.8	7.2	91	70	84.6	4,399	0.00
10/13/2005	44.4	72.9	57.0	20.3	5.5	90	44	75.0	5,044	0.00
10/14/2005	48.4	62.8	56.1	23.5	7.6	90	51	77.7	4,959	0.00
10/15/2005	49.1	64.8	57.8	36.0	16.4	86	57	75.3	4,870	0.01
10/16/2005	47.7	72.7	59.5	27.8	9.4	85	34	66.6	4,921	0.00
10/17/2005	52.3	82.9	65.9	29.2	9.6	83	24	52.8	4,053	0.00
10/18/2005	51.4	63.0	58.7	20.0	9.7	87	71	78.8	4,499	0.00
10/19/2005	51.6	65.3	58.3	17.1	6.3	89	68	82.0	3,690	0.00
10/20/2005	46.0	61.9	53.9	27.1	8.4	88	69	82.0	4,536	0.00
10/21/2005	46.4	60.4	52.7	23.5	7.7	90	70	84.1	4,744	0.01
10/22/2005	43.3	58.1	50.9	26.0	7.5	90	66	82.7	3,920	0.00
10/23/2005	43.9	64.2	53.4	25.7	6.8	87	57	80.5	3,426	0.00
10/24/2005	53.6	57.9	55.2	12.4	4.2	87	71	80.6	1,888	0.00
10/25/2005	48.4	62.8	55.8	18.5	6.2	84	62	76.1	3,676	0.01
10/26/2005	48.2	66.9	56.1	18.9	6.9	89	47	74.5	2,090	0.01
10/27/2005	50.5	64.9	56.3	20.0	8.6	86	45	65.1	3,145	0.00
10/28/2005	49.6	62.2	55.2	17.8	7.3	80	58	70.0	4,270	0.00
10/29/2005	50.2	61.9	56.9	28.9	9.5	89	54	72.8	4,033	0.05
10/30/2005	44.8	66.7	55.8	25.7	7.6	90	55	73.0	4,401	0.00
10/31/2005	46.2	75.7	60.4	15.7	7.1	77	29	49.0	4,451	0.00
Average/ Total	**48.3**	**65.9**	**56.9**	**26.3**	**9.9**	**86**	**53**	**73**	**4,536**	**0.09**

El Sur Ranch Weather Station Data

November, 2005

November, 2005	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
11/1/2005	48.9	66.9	58.4	24.6	8.3	89	34	65.0	4.204	0.00
11/2/2005	48.9	62.4	54.9	30.3	9.3	86	50	70.7	2.742	0.00
11/3/2005	45.3	61.7	54.5	26.0	10.6	74	50	64.2	4.353	0.00
11/4/2005	50.5	66.6	58.4	25.0	10.1	86	56	71.5	4.203	0.00
11/5/2005	46.2	67.5	56.3	32.5	10.9	76	41	61.4	4.096	0.00
11/6/2005	47.5	65.3	56.9	28.9	7.7	85	45	66.2	1.832	0.00
11/7/2005	51.3	63.7	56.2	20.3	7.7	88	65	80.0	2.327	0.00
11/8/2005	53.8	63.9	58.2	23.5	10.0	85	67	79.3	2.993	0.05
11/9/2005	49.3	59.2	55.4	23.2	6.4	86	69	80.0	1.308	0.28
11/10/2005	49.8	65.8	55.9	18.5	5.9	84	53	73.8	2.699	0.00
11/11/2005	49.3	61.2	56.4	25.7	10.7	86	58	72.3	4.049	0.00
11/12/2005	47.8	64.8	55.5	21.7	6.3	87	57	74.7	4.180	0.00
11/13/2005	45.9	65.8	56.6	35.7	11.6	87	40	68.0	3.893	0.00
11/14/2005	55.8	64.4	58.7	36.4	15.8	85	52	75.3	4.036	0.00
11/15/2005	51.3	73.9	61.4	21.0	4.3	86	31	60.0	4.096	0.00
11/16/2005	52.2	72.9	62.2	13.2	5.6	76	36	50.5	4.031	0.00
11/17/2005	50.0	71.2	60.6	13.2	5.1	69	36	51.7	4.016	0.00
11/18/2005	56.8	76.3	66.4	16.0	7.3	45	25	31.8	4.160	0.00
11/19/2005	55.0	75.2	63.7	17.4	7.9	61	22	32.8	4.106	0.00
11/20/2005	53.8	72.3	63.0	16.7	8.5	49	20	28.0	4.000	0.00
11/21/2005	52.7	69.3	60.5	17.1	6.9	71	20	35.1	3.626	0.00
11/22/2005	46.0	61.9	54.7	12.1	5.5	89	32	62.4	3.681	0.00
11/23/2005	42.3	63.9	52.9	23.2	6.1	87	61	76.0	3.686	0.00
11/24/2005	45.0	61.9	53.7	25.3	8.6	87	63	77.4	2.596	0.00
11/25/2005	52.0	61.2	56.4	30.3	8.6	88	51	73.4	1.453	0.39
11/26/2005	47.7	55.4	51.5	32.8	16.0	72	55	65.1	3.870	0.00
11/27/2005	44.1	62.4	51.8	24.2	9.5	65	23	41.3	3.617	0.00
11/28/2005	44.4	58.1	51.2	19.6	8.2	90	29	54.4	3.373	0.19
11/29/2005	49.8	59.5	55.1	16.0	6.1	90	76	84.6	1.661	0.64
11/30/2005	46.6	57.2	53.2	19.2	5.8	87	73	82.4	2.963	0.01
Average/ Total	**49.3**	**65.1**	**57.0**	**23.0**	**8.4**	**80**	**46**	**64**	**3.395**	**1.56**

El Sur Ranch Weather Station Data

December, 2005

December, 2005	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
12/1/2005	54.9	60.4	57.4	27.1	12.0	85	64	77.9	759	1.02
12/2/2005	48.0	59.2	52.6	28.5	14.6	83	33	65.0	3,191	0.37
12/3/2005	43.0	55.8	50.4	33.2	13.2	73	48	61.0	3,740	0.00
12/4/2005	40.3	57.7	47.6	16.7	6.7	77	41	58.9	3,513	0.00
12/5/2005	43.2	60.4	49.7	14.6	7.6	71	33	53.1	3,427	0.00
12/6/2005	43.3	59.4	50.0	26.0	8.5	69	38	53.1	3,713	0.00
12/7/2005	41.2	59.5	49.9	12.8	4.5	88	38	60.0	2,493	0.02
12/8/2005	48.9	55.2	51.9	14.2	4.0	90	72	85.2	1,055	0.14
12/9/2005	46.0	66.2	53.2	18.2	7.9	85	31	60.9	2,113	0.00
12/10/2005	50.7	66.6	57.5	16.7	8.1	68	36	51.8	3,019	0.00
12/11/2005	50.2	64.6	55.4	15.7	6.7	85	44	64.8	1,405	0.00
12/12/2005	44.8	59.4	50.9	20.0	6.1	87	59	77.2	1,581	0.00
12/13/2005	44.8	57.6	51.1	18.5	6.1	86	54	74.0	2,182	0.00
12/14/2005	43.2	58.3	48.4	14.6	7.5	88	62	80.7	2,713	0.00
12/15/2005	42.8	56.5	48.6	13.5	5.9	88	64	80.1	3,311	0.00
12/16/2005	39.6	56.1	47.2	21.0	7.0	85	60	74.9	3,273	0.00
12/17/2005	45.7	56.7	51.8	38.9	13.1	85	65	76.4	1,645	0.22
12/18/2005	53.6	57.0	55.5	43.6	22.0	84	76	79.7	221	2.56
12/19/2005	53.6	61.0	57.7	31.4	13.4	79	60	71.1	1,458	0.35
12/20/2005	51.6	65.7	57.9	23.2	7.6	81	50	67.3	2,027	0.07
12/21/2005	54.0	63.3	58.8	17.1	7.3	85	60	75.1	520	0.03
12/22/2005	57.4	62.2	59.1	17.1	6.3	81	69	73.2	612	0.01
12/23/2005	53.4	63.0	56.5	11.4	3.4	74	53	65.4	1,423	0.01
12/24/2005	50.0	67.6	57.1	18.5	5.2	88	51	74.1	3,181	0.01
12/25/2005	51.6	60.4	55.7	19.2	7.7	84	69	77.6	669	0.00
12/26/2005	49.3	61.0	55.7	22.8	6.2	85	57	74.5	2,351	0.01
12/27/2005	50.4	62.4	55.2	20.0	7.2	84	55	74.5	1,904	0.00
12/28/2005	47.7	61.0	56.5	28.2	9.0	88	66	79.5	1,558	0.01
12/29/2005	43.0	58.8	52.4	25.7	8.4	88	54	70.2	2,501	0.01
12/30/2005	47.7	58.6	53.7	22.5	8.5	93	54	78.6	772	0.00
12/31/2005	47.5	61.9	56.7	31.0	12.8	85	65	78.7	2,514	0.01
Average/ Total	**47.8**	**60.4**	**53.6**	**22.0**	**8.5**	**83**	**54**	**71**	**2,092**	**4.85**

El Sur Ranch Weather Station Data

January, 2006

January, 2006	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
1/1/2006	46.8	57.9	54.6	51.1	18.2	86	63	80.1	183	0.00
1/2/2006	51.3	57.7	54.8	47.8	13.4	88	73	80.9	913	0.01
1/3/2006	46.9	57.7	52.3	16.0	8.7	88	61	78.9	1.499	0.00
1/4/2006	49.3	65.3	56.0	19.6	6.2	87	60	78.3	3.257	0.00
1/5/2006	53.4	66.0	59.0	17.8	7.6	82	53	65.1	2.769	0.01
1/6/2006	46.8	65.8	57.0	17.4	7.2	93	49	70.9	3.671	0.00
1/7/2006	48.2	60.1	54.5	29.6	10.5	89	69	80.9	3.547	0.00
1/8/2006	44.6	62.6	53.7	28.5	10.1	86	45	69.3	3.689	0.01
1/9/2006	45.1	61.7	51.7	15.3	6.9	85	54	71.4	3.711	0.00
1/10/2006	43.2	58.1	51.0	27.1	8.1	84	48	71.3	3.533	0.00
1/11/2006	49.8	61.5	54.9	27.8	9.6	90	62	78.7	1.926	0.01
1/12/2006	46.4	60.6	52.9	16.7	6.8	87	56	69.4	3.605	0.00
1/13/2006	47.3	61.0	55.3	31.8	12.5	90	54	74.9	3.082	0.00
1/14/2006	46.4	55.9	51.2	32.5	8.8	92	74	84.0	1.059	0.01
1/15/2006	44.6	53.6	49.5	28.9	12.8	80	56	68.5	4.020	0.00
1/16/2006	38.8	58.1	46.7	19.6	6.7	85	47	67.6	3.257	0.00
1/17/2006	44.8	56.7	50.0	13.5	6.6	89	58	77.8	2.675	0.00
1/18/2006	48.4	57.7	53.3	21.4	7.6	93	66	80.7	1.897	0.01
1/19/2006	42.8	55.4	49.4	26.4	11.0	87.	64	75.2	3.332	0.00
1/20/2006	40.1	57.0	47.7	27.8	9.6	82	51	71.0	4.108	0.00
1/21/2006	41.7	59.4	51.8	25.7	9.8	89	60	75.8	3.901	0.01
1/22/2006	41.9	60.8	50.6	26.4	5.8	84	40	67.5	4.158	0.00
1/23/2006	43.0	59.5	50.2	16.4	7.5	87	48	66.2	4.230	0.00
1/24/2006	46.0	73.6	57.3	17.1	7.2	69	19	46.1	4.276	0.00
1/25/2006	44.4	57.2	51.3	16.7	7.6	87	45	70.0	2.559	0.00
1/26/2006	48.4	55.9	51.7	28.9	10.5	89	61	73.9	3.969	0.00
1/27/2006	41.5	57.2	49.2	20.0	7.8	88	70	78.0	3.111	0.01
1/28/2006	44.2	58.3	50.5	14.2	5.3	91	57	77.6	2.711	0.00
1/29/2006	47.3	57.4	53.1	16.4	5.7	90	67	81.4	3.086	0.00
1/30/2006	44.1	57.4	50.9	25.3	6.2	88	65	80.6	2.162	0.01
1/31/2006	44.2	59.0	51.3	30.3	11.2	86	58	76.3	3.602	0.00
Average/ Total	**45.5**	**59.6**	**52.4**	**24.3**	**8.8**	**87**	**57**	**74**	**3.016**	**0.09**

El Sur Ranch Weather Station Data

February, 2006

February, 2006	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
2/1/2006	44.6	60.3	53.1	22.1	8.4	90	46	75.0	3,909	0.00
2/2/2006	50.9	60.4	56.7	23.5	9.8	85	65	76.0	3,495	0.00
2/3/2006	43.0	59.7	51.0	21.0	5.9	80	56	74.0	4,084	0.01
2/4/2006	43.3	60.8	54.7	31.0	11.1	79	58	71.0	3,021	0.00
2/5/2006	44.6	62.8	52.6	12.8	5.4	80	52	65.8	4,605	0.00
2/6/2006	49.6	68.4	57.2	18.2	6.4	88	38	60.6	3,869	0.00
2/7/2006	46.4	69.6	57.6	16.7	6.6	90	33	56.1	4,712	0.00
2/8/2006	52.5	70.3	60.3	17.4	7.3	66	27	39.5	4,966	0.00
2/9/2006	52.2	74.8	62.2	16.7	7.3	68	29	40.5	5,031	0.00
2/10/2006	42.6	59.0	50.1	13.9	4.9	91	39	77.9	2,558	0.00
2/11/2006	43.5	61.0	52.4	26.4	7.8	83	60	75.8	4,718	0.00
2/12/2006	45.0	68.2	56.2	13.2	3.9	82	48	65.6	4,930	0.00
2/13/2006	47.3	71.8	58.7	21.4	8.0	89	32	51.8	4,940	0.00
2/14/2006	39.6	62.4	51.7	33.9	12.2	90	60	75.3	5,002	0.00
2/15/2006	42.1	52.9	48.4	35.7	13.8	84	61	67.8	5,055	0.00
2/16/2006	33.8	52.5	43.2	15.3	7.6	86	46	68.8	4,835	0.00
2/17/2006	39.2	52.2	43.7	16.7	7.0	91	64	81.2	2,401	0.14
2/18/2006	36.9	51.4	42.8	24.2	9.4	92	61	80.7	3,424	0.07
2/19/2006	37.0	52.2	44.1	13.9	6.8	91	59	78.3	5,133	0.06
2/20/2006	37.0	55.4	45.1	25.7	9.6	87	48	72.4	5,255	0.04
2/21/2006	36.7	54.0	45.4	26.7	9.9	89	65	78.1	5,402	0.03
2/22/2006	39.6	57.0	47.5	14.9	6.6	89	46	69.0	5,405	0.02
2/23/2006	44.1	61.3	51.0	13.5	7.0	84	47	65.3	5,506	0.03
2/24/2006	40.5	56.1	48.6	12.1	5.0	94	51	79.0	5,211	0.02
2/25/2006	36.7	53.8	46.5	23.2	8.5	79	66	74.7	5,061	0.02
2/26/2006	49.1	58.3	53.2	45.3	17.7	87	28	68.3	1,068	0.02
2/27/2006	52.7	59.5	56.5	52.8	27.2	94	64	75.9	571	0.04
2/28/2006	46.2	58.8	52.9	30.3	8.6	85	46	71.7	5,075	0.03
Average/ Total	**43.5**	**60.2**	**51.6**	**22.8**	**8.9**	**85**	**50**	**69**	**4,259**	**0.53**

El Sur Ranch Weather Station Data

March, 2006

March, 2006	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
3/1/2006	43.9	57.0	50.0	14.2	7.9	84	55	72.1	5.649	0.02
3/2/2006	47.8	56.5	51.8	25.7	7.4	92	48	71.0	4.585	0.02
3/3/2006	41.9	54.1	46.7	35.3	8.2	89	49	77.3	4.279	0.02
3/4/2006	37.6	54.5	46.4	17.4	8.8	87	47	71.4	4.612	0.01
3/5/2006	47.5	55.9	53.0	36.8	18.2	88	55	70.0	2.727	0.02
3/6/2006	46.8	57.7	52.4	35.0	7.3	89	55	76.7	4.904	0.02
3/7/2006	45.5	57.6	50.0	26.7	9.8	86	53	73.7	3.816	0.02
3/8/2006	43.2	55.0	49.7	31.4	13.5	91	67	76.2	5.222	0.02
3/9/2006	43.2	53.1	49.9	37.8	13.6	100	49	73.8	4.255	0.01
3/10/2006	39.6	50.5	44.3	37.1	7.2	100	53	82.8	3.249	0.01
3/11/2006	36.7	49.8	43.4	25.3	9.7	97	53	78.8	6.208	0.02
3/12/2006	39.2	51.6	45.0	19.6	6.4	100	53	84.0	4.560	0.02
3/13/2006	37.2	54.5	46.3	14.2	8.3	97	56	76.2	5.985	0.01
3/14/2006	45.5	56.7	50.7	25.3	9.1	99	53	83.8	4.488	0.02
3/15/2006	43.2	56.5	48.7	16.7	7.5	96	54	77.8	5.706	0.02
3/16/2006	42.6	57.2	50.1	14.6	7.0	94	60	77.9	3.950	0.01
3/17/2006	47.8	54.5	50.6	24.2	10.1	97	62	78.9	4.933	0.39
3/18/2006	43.5	55.2	50.3	30.0	13.0	96	67	76.5	6.133	0.01
3/19/2006	42.6	55.4	49.9	26.0	12.1	97	64	80.2	6.420	0.00
3/20/2006	41.7	53.2	47.0	23.5	8.1	100	65	89.3	2.235	0.68
3/21/2006	39.9	53.4	46.2	13.2	6.1	100	70	90.3	3.773	0.19
3/22/2006	41.2	57.2	48.4	16.7	6.8	98	57	84.8	5.859	0.00
3/23/2006	42.1	57.2	49.9	11.7	4.6	98	56	83.7	6.351	0.00
3/24/2006	44.4	62.6	53.3	13.9	5.4	95	52	75.4	4.098	0.00
3/25/2006	49.1	59.0	55.1	22.1	9.4	89	55	76.0	4.841	0.83
3/26/2006	41.4	57.2	50.3	20.3	7.0	97	49	73.3	5.872	0.00
3/27/2006	43.2	54.3	49.0	34.3	13.2	96	73	87.5	2.207	0.34
3/28/2006	43.7	58.6	50.7	35.0	12.5	93	49	83.5	2.526	0.54
3/29/2006	43.0	57.0	50.0	19.6	8.0	93	62	81.7	4.056	0.08
3/30/2006	45.7	57.2	50.5	18.2	7.3	91	64	82.6	3.085	0.06
3/31/2006	45.7	57.6	50.4	28.2	8.8	91	59	83.3	3.500	0.74
Average/ Total	**43.1**	**55.7**	**49.3**	**24.2**	**9.1**	**94**	**57**	**79**	**4.519**	**4.13**

El Sur Ranch Weather Station Data April, 2006

April, 2006	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
4/1/2006	43.0	57.6	49.5	13.9	6.9	95	43	75.5	6.467	0.01
4/2/2006	43.5	59.2	51.1	36.8	14.1	95	48	74.5	3.949	0.48
4/3/2006	54.1	56.5	55.2	42.5	16.7	88	82	85.7	1.029	0.92
4/4/2006	45.5	55.8	52.5	38.2	12.7	97	67	82.5	765	1.78
4/5/2006	45.7	57.7	50.5	28.2	9.0	97	63	81.1	4.816	0.28
4/6/2006	41.9	58.6	49.4	14.9	7.1	100	59	84.5	6.493	0.00
4/7/2006	44.4	58.8	51.1	34.6	12.1	100	63	87.8	4.254	0.25
4/8/2006	45.3	59.5	52.0	12.8	6.7	97	64	82.9	6.927	0.00
4/9/2006	45.0	58.5	51.7	11.4	4.9	96	58	83.5	3.489	0.04
4/10/2006	50.5	59.2	53.9	15.7	5.0	96	68	83.9	5.336	0.40
4/11/2006	51.1	56.1	54.2	40.7	19.3	90	68	82.8	1.728	0.66
4/12/2006	53.2	57.7	56.1	35.3	15.1	97	68	82.7	834	0.97
4/13/2006	53.8	66.9	59.3	20.0	6.6	95	53	79.2	7.084	0.00
4/14/2006	50.9	59.7	54.7	20.0	6.8	94	71	88.5	1.316	0.02
4/15/2006	50.2	59.7	53.8	13.2	5.9	95	56	83.7	3.739	0.24
4/16/2006	48.7	57.2	53.2	22.8	7.3	93	64	84.0	2.552	0.47
4/17/2006	44.4	56.5	50.9	31.8	11.8	87	51	71.3	7.296	0.01
4/18/2006	43.5	63.5	53.8	25.0	8.8	81	45	61.7	5.807	0.00
4/19/2006	45.5	67.1	55.5	24.2	9.2	84	49	70.4	7.422	0.00
4/20/2006	45.1	61.0	53.2	28.5	9.5	100	73	87.1	6.461	0.00
4/21/2006	49.6	58.3	53.3	26.0	8.3	94	72	86.2	3.245	0.00
4/22/2006	49.3	57.6	52.7	14.9	6.4	95	69	83.3	4.331	0.00
4/23/2006	44.4	58.1	52.4	16.0	6.4	98	72	86.7	5.000	0.00
4/24/2006	46.4	60.3	53.7	19.2	7.2	97	63	85.9	5.797	0.00
4/25/2006	51.1	54.1	52.6	18.2	7.8	97	72	84.8	1.210	0.01
4/26/2006	47.3	57.0	53.2	22.1	9.3	98	76	86.4	2.708	0.00
4/27/2006	51.6	58.8	54.1	20.0	5.9	94	77	89.0	3.904	0.00
4/28/2006	52.2	57.9	54.6	11.4	4.8	96	80	91.4	2.712	0.00
4/29/2006	51.6	57.4	54.1	23.2	8.5	93	75	87.7	3.840	0.01
4/30/2006	48.7	69.3	55.3	25.3	8.2	95	48	84.6	5.945	0.00
Average/ Total	**47.9**	**59.2**	**53.3**	**23.6**	**9.0**	**94**	**64**	**83**	**4.215**	**6.55**

El Sur Ranch Weather Station Data

May, 2006

May, 2006	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
5/1/2006	45.3	60.6	54.9	28.9	10.9	100	66	85.1	7.521	0.00
5/2/2006	46.4	55.6	52.5	23.9	6.0	99	75	91.5	3.881	0.00
5/3/2006	50.5	56.5	52.8	9.2	2.9	99	69	90.8	2.185	0.00
5/4/2006	48.4	59.2	54.0	11.0	4.8	100	79	91.1	4.275	0.00
5/5/2006	46.8	57.6	52.8	25.0	8.6	100	79	92.8	3.490	0.00
5/6/2006	44.1	57.4	52.6	32.1	14.7	100	74	86.9	7.463	0.00
5/7/2006	43.5	60.3	53.6	27.1	13.3	100	74	90.4	7.460	0.00
5/8/2006	50.4	59.9	54.9	35.3	17.3	97	72	85.8	7.657	0.00
5/9/2006	48.7	60.6	54.1	31.0	14.0	97	75	87.3	7.563	0.00
5/10/2006	43.9	65.7	53.9	26.7	6.8	100	70	90.8	7.128	0.00
5/11/2006	46.2	61.5	53.7	27.8	9.8	100	68	88.5	7.134	0.00
5/12/2006	45.3	61.5	53.8	28.9	12.2	100	71	85.8	7.191	0.00
5/13/2006	43.2	63.9	53.7	36.4	12.5	100	57	86.5	7.716	0.00
5/14/2006	45.1	70.5	59.1	23.9	4.8	100	53	78.3	6.385	0.00
5/15/2006	53.6	61.7	57.1	25.7	9.0	100	84	97.6	6.756	0.00
5/16/2006	51.8	70.7	59.5	33.9	11.6	100	45	82.8	7.581	0.00
5/17/2006	51.6	60.3	55.8	33.9	15.3	100	80	94.7	7.600	0.00
5/18/2006	49.8	61.7	53.2	20.3	7.0	100	79	97.3	5.763	0.00
5/19/2006	50.5	61.2	54.5	20.3	6.2	100	69	94.4	4.641	0.03
5/20/2006	49.3	62.6	56.0	21.4	8.0	99	64	85.0	6.583	0.00
5/21/2006	54.5	61.0	57.6	28.9	9.6	100	75	94.3	781	1.03
5/22/2006	49.5	61.3	56.6	20.3	7.6	100	67	83.8	7.622	0.01
5/23/2006	52.5	64.9	59.2	17.4	7.7	100	69	86.2	7.625	0.00
5/24/2006	50.5	69.8	60.6	30.3	12.2	100	53	77.4	7.624	0.00
5/25/2006	53.6	61.2	57.7	37.8	18.4	92	62	75.5	7.873	0.00
5/26/2006	53.1	61.0	56.4	32.8	17.6	81	63	73.8	7.444	0.00
5/27/2006	51.3	60.3	55.4	30.3	13.9	79	61	70.8	7.911	0.00
5/28/2006	52.0	59.7	55.4	35.3	15.6	87	62	74.9	7.849	0.00
5/29/2006	49.6	61.0	55.3	35.0	14.5	81	65	75.1	8.000	0.00
5/30/2006	50.9	61.7	56.1	30.7	12.9	96	65	77.2	7.908	0.00
5/31/2006	48.2	70.0	57.4	31.8	13.1	100	62	90.0	7.819	0.00
Average/ Total	**49.0**	**62.0**	**55.5**	**27.5**	**10.9**	**97**	**68**	**86**	**6.594**	**1.07**

El Sur Ranch Weather Station Data June, 2006

June, 2006	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
6/1/2006	51.6	79.9	64.4	36.0	12.2	100	49	74.0	6.673	0.00
6/2/2006	57.0	74.5	66.5	31.4	13.9	100	56	71.4	7.414	0.00
6/3/2006	54.9	72.5	65.1	37.1	14.4	100	53	71.5	7.802	0.00
6/4/2006	57.4	70.2	64.5	34.6	17.2	85	61	74.3	7.708	0.00
6/5/2006	54.0	62.8	57.9	32.8	15.5	100	74	85.0	7.887	0.00
6/6/2006	53.6	63.0	58.0	35.0	16.7	97	70	81.0	7.856	0.00
6/7/2006	53.4	63.7	58.0	35.3	19.6	94	64	76.6	7.693	0.00
6/8/2006	53.2	62.2	56.5	38.5	19.9	91	66	77.5	7.917	0.00
6/9/2006	52.2	62.4	56.2	30.0	14.8	90	65	78.1	7.776	0.00
6/10/2006	53.2	63.1	57.0	25.0	12.4	85	64	75.7	7.164	0.00
6/11/2006	52.9	59.7	55.8	13.2	5.2	90	67	79.3	4.017	0.00
6/12/2006	53.1	63.1	57.9	15.7	5.3	95	63	79.3	4.418	0.00
6/13/2006	50.4	68.2	59.0	19.2	7.9	87	50	67.4	7.636	0.00
6/14/2006	47.1	65.7	58.0	30.7	12.9	91	58	71.0	7.591	0.00
6/15/2006	55.8	65.8	60.3	35.0	18.4	82	52	65.5	7.666	0.00
6/16/2006	53.8	80.8	64.9	26.0	11.0	84	41	64.1	7.709	0.00
6/17/2006	52.7	67.1	59.4	28.2	14.2	88	51	69.6	7.977	0.00
6/18/2006	53.2	63.1	57.7	35.0	16.7	84	56	68.5	7.840	0.00
6/19/2006	52.0	61.3	55.7	34.3	17.7	86	61	72.9	7.940	0.00
6/20/2006	43.0	62.8	53.1	21.0	6.2	100	61	84.2	7.005	0.00
6/21/2006	44.1	64.0	54.9	11.0	3.8	100	66	86.0	7.722	0.00
6/22/2006	43.2	61.5	53.3	21.0	5.9	100	74	93.1	7.216	0.00
6/23/2006	52.0	59.9	54.9	20.3	6.2	96	65	81.4	6.614	0.00
6/24/2006	50.9	61.9	56.2	12.1	4.1	86	65	78.4	5.751	0.00
6/25/2006	55.4	63.1	57.8	14.9	5.3	85	63	77.1	5.541	0.00
6/26/2006	54.5	63.0	57.6	14.9	4.7	85	64	78.2	5.170	0.00
6/27/2006	55.4	63.7	58.6	18.2	5.3	88	72	82.5	4.461	0.00
6/28/2006	54.1	66.2	59.5	21.0	6.8	85	63	78.4	6.763	0.00
6/29/2006	49.1	67.3	59.6	26.7	10.1	92	68	79.6	7.758	0.00
6/30/2006	53.4	65.7	60.5	31.4	14.3	96	77	85.6	7.861	0.00
Average/ Total	**52.2**	**65.6**	**58.6**	**26.2**	**11.3**	91	62	77	**7.018**	**0.00**

El Sur Ranch Weather Station Data July, 2006

July, 2006	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
7/1/2006	53.8	63.0	58.1	33.5	17.4	100	82	88.8	7.870	0.00
7/2/2006	54.1	63.9	58.2	33.9	18.7	96	79	87.6	7.718	0.00
7/3/2006	52.9	63.1	57.1	30.7	16.7	100	81	90.4	7.739	0.00
7/4/2006	53.4	64.0	57.9	32.5	14.4	92	78	85.4	7.438	0.00
7/5/2006	53.6	63.5	57.8	37.1	19.1	94	79	86.0	7.726	0.00
7/6/2006	53.4	64.6	58.2	37.8	19.6	94	74	83.8	7.827	0.00
7/7/2006	46.8	65.7	57.7	24.2	12.5	92	74	83.6	7.826	0.00
7/8/2006	46.8	64.4	55.9	20.7	7.9	100	81	92.0	7.672	0.00
7/9/2006	45.0	62.8	54.7	30.7	10.8	100	74	91.1	7.568	0.00
7/10/2006	49.3	64.9	57.4	28.9	11.1	100	71	86.8	7.627	0.00
7/11/2006	53.2	66.2	59.0	32.8	14.6	94	66	80.8	7.731	0.00
7/12/2006	55.4	71.6	63.4	33.5	13.3	88	65	75.7	7.762	0.00
7/13/2006	47.8	69.3	59.1	24.2	8.4	100	69	85.8	7.697	0.00
7/14/2006	46.6	65.7	57.3	30.0	11.9	100	72	87.2	7.847	0.00
7/15/2006	48.2	69.3	57.8	29.2	11.7	99	58	82.7	7.703	0.00
7/16/2006	46.9	66.2	56.6	21.4	7.6	100	68	88.2	7.538	0.00
7/17/2006	46.4	62.8	55.1	21.7	3.7	100	72	90.6	7.042	0.00
7/18/2006	49.8	65.3	58.6	18.2	4.8	100	68	86.6	6.566	0.00
7/19/2006	55.9	66.7	61.0	18.9	5.1	98	71	84.2	6.977	0.00
7/20/2006	53.1	64.0	58.2	9.2	3.1	100	71	88.5	6.700	0.00
7/21/2006	53.4	71.1	61.2	18.2	5.0	97	55	79.3	7.048	0.00
7/22/2006	56.1	73.6	63.6	18.9	5.7	100	54	82.3	7.188	0.00
7/23/2006	56.5	72.3	63.5	16.7	4.9	100	66	88.3	7.068	0.00
7/24/2006	54.7	71.6	61.6	18.9	5.7	100	65	89.1	7.274	0.00
7/25/2006	54.0	70.9	60.4	18.9	5.6	100	57	87.2	7.277	0.00
7/26/2006	53.6	63.1	58.7	15.7	4.9	100	63	86.8	5.149	0.00
7/27/2006	54.0	63.1	58.7	11.0	4.3	92	60	77.8	5.702	0.00
7/28/2006	57.0	66.4	60.6	17.8	4.9	88	56	75.8	5.715	0.00
7/29/2006	58.5	65.7	60.9	13.9	4.2	86	59	72.5	3.751	0.03
7/30/2006	55.2	67.1	61.9	20.7	5.7	95	52	66.0	5.575	0.00
7/31/2006	49.8	67.3	59.3	35.7	13.4	98	69	85.0	7.450	0.00
Average/ Total	**52.1**	**66.4**	**59.0**	**24.4**	**9.6**	**97**	**68**	**84**	**7.089**	**0.03**

El Sur Ranch Weather Station Data August, 2006

August. 2006	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
8/1/2006	48.9	64.8	58.8	25.3	12.1	100	84	92.9	7.451	0.00
8/2/2006	49.6	62.2	56.5	17.8	6.0	100	81	93.0	5.121	0.00
8/3/2006	47.3	62.4	56.0	15.3	5.6	100	65	87.4	4.975	0.00
8/4/2006	55.8	67.5	60.0	16.4	6.6	100	72	89.8	5.549	0.00
8/5/2006	54.3	70.5	62.1	12.4	4.6	100	62	82.1	6.474	0.00
8/6/2006	53.2	67.3	60.5	13.5	6.5	99	73	88.3	7.205	0.00
8/7/2006	51.4	70.5	61.7	20.7	9.4	100	61	83.6	7.262	0.00
8/8/2006	49.5	67.6	60.1	27.1	10.4	100	75	90.8	7.313	0.00
8/9/2006	48.4	77.2	62.3	23.5	7.7	100	58	86.0	7.475	0.00
8/10/2006	51.1	68.9	59.7	26.7	8.4	100	73	93.0	7.237	0.00
8/11/2006	51.1	64.2	58.1	29.2	11.4	100	75	89.9	7.384	0.00
8/12/2006	52.3	62.4	57.7	15.7	4.0	95	74	82.8	4.342	0.00
8/13/2006	54.7	64.0	58.1	13.2	4.8	96	69	84.0	5.415	0.00
8/14/2006	51.8	66.4	60.4	12.4	5.1	100	73	80.3	6.607	0.00
8/15/2006	49.6	65.1	57.8	20.0	8.5	100	73	89.9	7.283	0.00
8/16/2006	49.3	65.1	56.7	23.2	8.2	100	74	90.6	6.701	0.00
8/17/2006	48.9	62.6	56.0	14.2	5.5	100	75	89.7	7.069	0.00
8/18/2006	50.9	63.3	56.6	12.4	4.9	100	72	90.2	6.399	0.00
8/19/2006	47.3	63.7	56.3	19.6	7.5	100	71	89.0	6.563	0.00
8/20/2006	55.9	65.3	59.0	22.8	9.0	94	73	85.8	5.978	0.00
8/21/2006	52.5	64.2	58.8	25.3	11.5	100	76	88.1	6.939	0.00
8/22/2006	47.7	65.7	57.2	27.5	9.9	100	71	89.4	6.581	0.00
8/23/2006	45.3	64.0	55.8	27.1	9.9	100	74	91.8	7.273	0.00
8/24/2006	51.1	62.6	56.7	24.6	9.4	100	75	92.4	7.185	0.00
8/25/2006	54.5	62.1	57.6	12.1	4.8	100	79	93.8	3.286	0.00
8/26/2006	55.9	65.1	59.2	7.1	1.2	99	72	88.1	5.023	0.00
8/27/2006	52.9	64.0	58.1	0.0	0.0	100	75	93.7	5.890	0.00
8/28/2006	51.6	63.3	57.5	0.0	0.0	100	80	93.5	7.104	0.00
8/29/2006	47.3	64.0	55.9	31.8	12.9	100	76	92.3	7.004	0.00
8/30/2006	45.1	65.5	54.8	22.1	8.8	100	76	93.1	7.076	0.00
8/31/2006	46.0	62.4	54.4	9.6	4.6	100	82	97.2	5.109	0.00
Average/ Total	**50.7**	**65.3**	**58.1**	**18.3**	**7.1**	**99**	**73**	**89**	**6,396**	**0.00**

El Sur Ranch Weather Station Data

September, 2006

September, 2006	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
9/1/2006	50.9	62.2	55.3	14.9	5.5	100	82	96.7	5.396	0.00
9/2/2006	43.7	63.1	54.4	27.1	10.4	100	97	99.8	6.981	0.00
9/3/2006	45.9	62.4	54.8	26.4	10.7	100	100	100.0	6.956	0.00
9/4/2006	46.0	64.0	55.1	30.0	11.4	100	100	100.0	6.905	0.00
9/5/2006	46.6	63.1	54.7	23.9	8.4	100	100	100.0	6.728	0.00
9/6/2006	47.8	63.5	55.0	24.2	8.2	100	100	100.0	6.810	0.00
9/7/2006	50.4	61.7	55.0	18.2	5.3	100	100	100.0	4.988	0.00
9/8/2006	53.8	61.7	56.9	16.0	6.3	100	100	100.0	2.479	0.00
9/9/2006	48.9	65.1	57.8	26.7	10.5	100	100	100.0	6.204	0.00
9/10/2006	52.3	62.6	56.5	17.4	7.4	100	100	100.0	6.068	0.00
9/11/2006	50.4	68.9	56.6	15.3	4.9	100	90	99.3	5.939	0.00
9/12/2006	46.9	65.7	56.3	12.8	4.0	100	97	99.8	5.676	0.00
9/13/2006	52.9	63.7	56.9	19.2	6.5	100	97	99.9	5.263	0.00
9/14/2006	53.6	61.0	56.5	14.2	5.1	100	100	100.0	2.647	0.00
9/15/2006	51.1	64.9	58.2	30.0	12.9	100	100	100.0	6.528	0.00
9/16/2006	46.0	72.3	60.3	33.5	12.2	100	49	80.4	6.575	0.00
9/17/2006	51.1	77.5	63.9	22.1	7.6	82	29	48.8	6.420	0.00
9/18/2006	49.8	70.5	58.1	18.9	7.8	100	72	93.5	5.970	0.00
9/19/2006	47.3	64.4	56.7	30.3	11.4	100	100	100.0	6.412	0.00
9/20/2006	45.0	73.2	58.1	32.8	9.6	100	40	84.6	6.044	0.00
9/21/2006	47.1	67.5	57.3	33.2	10.4	100	67	94.6	5.849	0.00
9/22/2006	53.2	64.0	57.2	18.2	6.1	100	100	100.0	4.215	0.00
9/23/2006	53.2	71.4	61.5	12.1	5.5	100	94	99.5	5.828	0.00
9/24/2006	54.1	69.6	61.3	13.5	6.5	100	96	99.6	5.951	0.00
9/25/2006	48.0	63.7	56.1	13.2	4.4	100	100	100.0	3.603	0.00
9/26/2006	52.7	63.1	58.0	12.4	4.6	100	100	100.0	2.753	0.00
9/27/2006	51.6	64.8	58.3	17.8	7.2	100	100	100.0	4.805	0.00
9/28/2006	53.1	62.6	57.4	17.1	7.2	100	100	100.0	4.748	0.00
9/29/2006	50.9	62.2	56.1	17.8	7.3	100	100	100.0	4.228	0.00
9/30/2006	48.4	62.8	56.6	21.7	8.3	100	100	100.0	3.366	0.00
Average/ Total	**49.8**	**65.4**	**57.2**	**21.0**	**7.8**	**99**	**90**	**97**	**5.411**	**0.00**

El Sur Ranch Weather Station Data

October, 2006

October. 2006	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
10/1/2006	49.1	63.3	57.3	17.8	6.6	100	93	99.3	1.928	0.00
10/2/2006	50.0	68.4	58.0	17.1	7.3	100	59	87.5	5.204	0.00
10/3/2006	49.1	67.1	57.6	14.6	6.1	100	62	90.8	5.135	0.00
10/4/2006	51.6	62.6	56.5	13.2	5.5	100	93	99.7	2.844	0.01
10/5/2006	50.5	63.1	57.3	13.5	5.3	100	100	100.0	5.485	0.09
10/6/2006	48.2	64.2	56.6	31.4	11.3	100	100	100.0	5.653	0.00
10/7/2006	47.5	63.3	56.3	22.1	8.9	100	90	99.3	5.591	0.00
10/8/2006	49.8	72.9	58.4	19.6	5.5	100	69	97.3	5.662	0.00
10/9/2006	46.9	62.4	55.1	19.2	6.5	100	100	100.0	4.257	0.00
10/10/2006	57.0	65.3	60.5	21.7	10.4	100	92	99.3	4.348	0.00
10/11/2006	51.8	67.6	58.4	12.1	6.3	100	80	94.6	3.847	0.00
10/12/2006	52.5	64.8	57.5	12.8	5.9	100	87	97.0	2.732	0.00
10/13/2006	50.9	63.5	56.9	15.7	5.8	100	97	99.8	2.717	0.00
10/14/2006	48.7	61.9	56.6	16.7	6.8	100	94	99.5	2.511	0.00
10/15/2006	54.7	61.2	57.2	25.3	11.6	100	88	94.6	4.587	0.00
10/16/2006	50.2	65.5	57.8	32.1	12.0	100	91	96.5	4.216	0.00
10/17/2006	49.6	64.8	58.2	30.0	13.7	99	73	88.5	5.359	0.00
10/18/2006	48.6	71.2	60.1	18.2	7.4	81	35	53.7	5.437	0.00
10/19/2006	47.8	69.3	59.6	17.4	6.3	72	36	49.5	5.144	0.00
10/20/2006	50.7	75.7	62.5	14.6	5.5	91	31	54.2	5.172	0.00
10/21/2006	52.0	68.0	59.7	23.2	8.0	100	44	73.0	4.940	0.00
10/22/2006	46.9	59.0	52.2	12.4	4.4	100	93	99.4	3.659	0.00
10/23/2006	43.5	67.5	54.4	12.1	4.6	100	96	100.0	4.814	0.01
10/24/2006	43.5	62.1	53.6	21.7	5.7	100	100	100.0	4.128	0.00
10/25/2006	43.5	65.3	54.0	11.0	4.9	100	62	97.1	5.080	0.00
10/26/2006	49.5	72.9	59.5	16.7	6.6	78	22	43.9	5.048	0.00
10/27/2006	57.0	75.6	64.3	17.4	7.9	65	23	34.5	5.052	0.00
10/28/2006	47.5	75.0	61.4	16.0	6.9	100	23	55.5	4.873	0.00
10/29/2006	43.3	59.5	51.3	22.8	8.3	100	54	84.7	4.704	0.00
10/30/2006	41.9	60.6	50.5	16.7	6.9	100	88	97.5	4.129	0.00
10/31/2006	44.6	59.0	51.0	18.5	8.1	100	84	95.1	4.299	0.00
Average/ Total	**49.0**	**65.9**	**57.1**	**18.5**	**7.3**	**96**	**73**	**87**	**4.470**	**0.11**

El Sur Ranch Weather Station Data November, 2006

November, 2006	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
11/1/2006	44.1	61.3	53.8	12.1	4.3	100	80	96.8	3.628	0.00
11/2/2006	54.3	65.5	59.8	18.5	7.4	100	97	100.0	2.663	0.06
11/3/2006	56.7	66.2	60.0	19.6	5.3	100	100	100.0	2.828	0.00
11/4/2006	51.4	68.4	59.8	30.3	9.5	100	100	100.0	4.437	0.00
11/5/2006	49.3	73.6	62.0	31.8	10.4	100	80	94.1	4.413	0.00
11/6/2006	54.5	77.0	63.1	29.6	8.3	100	72	94.3	4.125	0.00
11/7/2006	53.2	83.3	65.8	33.5	14.2	100	67	94.4	4.496	0.00
11/8/2006	55.9	69.4	60.7	35.0	17.9	100	74	95.5	4.130	0.00
11/9/2006	46.9	63.3	55.7	33.9	13.9	95	65	81.0	4.563	0.00
11/10/2006	45.3	64.6	54.2	20.3	8.5	88	32	58.8	3.829	0.00
11/11/2006	45.3	59.2	53.4	26.4	10.6	100	40	90.8	1.951	0.13
11/12/2006	45.1	63.0	53.3	20.3	7.1	100	60	84.7	4.169	0.00
11/13/2006	46.4	57.9	54.9	13.9	5.0	100	48	83.5	728	0.64
11/14/2006	46.2	59.9	56.6	30.7	11.5	100	100	100.0	4.327	0.56
11/15/2006	45.9	65.1	54.9	20.0	7.9	100	92	100.0	4.126	0.00
11/16/2006	47.5	66.0	58.8	30.7	10.8	100	88	98.6	4.199	0.00
11/17/2006	54.7	68.5	59.7	25.7	9.0	100	100	100.0	4.088	0.00
11/18/2006	50.5	72.3	58.5	21.4	6.1	100	86	99.5	4.111	0.00
11/19/2006	49.1	69.1	58.2	25.3	10.5	100	100	100.0	4.103	0.00
11/20/2006	46.8	69.8	56.5	18.5	4.9	100	82	98.6	2.702	0.00
11/21/2006	49.1	59.2	54.5	17.8	4.8	100	100	100.0	1.437	0.00
11/22/2006	51.6	63.0	56.7	22.8	7.6	100	88	99.2	1.820	0.00
11/23/2006	48.7	68.5	55.7	26.4	10.1	100	24	73.8	4.268	0.00
11/24/2006	39.2	59.0	51.8	33.9	12.3	86	25	54.4	3.990	0.00
11/25/2006	50.9	58.6	54.2	28.5	14.0	100	69	90.0	3.981	0.00
11/26/2006	44.8	57.7	51.7	18.5	7.5	100	64	86.0	1.750	0.20
11/27/2006	45.0	57.9	50.8	17.4	7.4	100	100	100.0	2.986	0.14
11/28/2006	44.1	54.1	48.7	31.4	11.5	100	66	86.2	4.004	0.00
11/29/2006	37.0	56.7	46.8	13.9	6.7	100	54	78.6	4.020	0.00
11/30/2006	41.5	58.1	47.9	15.3	8.2	83	47	62.0	3.966	0.00
Average/ Total	**48.0**	**64.5**	**56.0**	**24.1**	**9.1**	**98**	**73**	**90**	**3.528**	**1.73**

El Sur Ranch Weather Station Data

December, 2006

December, 2006	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
12/1/2006	45.0	62.1	51.1	23.9	8.2	90	42	64.9	2,083	0.00
12/2/2006	42.4	64.0	52.9	14.9	7.2	86	42	60.3	3,318	0.00
12/3/2006	50.0	65.7	56.6	18.2	8.6	62	32	42.3	3,641	0.00
12/4/2006	50.4	70.5	57.4	14.6	8.1	70	19	37.4	3,258	0.00
12/5/2006	46.6	65.1	56.5	17.4	7.4	69	31	44.0	3,102	0.00
12/6/2006	45.3	62.6	53.6	16.0	6.9	76	31	45.3	3,335	0.00
12/7/2006	41.9	61.5	52.0	14.9	5.1	100	27	70.4	2,544	0.00
12/8/2006	37.9	68.4	55.0	33.2	12.9	100	27	86.4	686	0.31
12/9/2006	48.9	58.3	55.1	36.0	11.8	100	100	100.0	2,178	1.51
12/10/2006	46.8	59.2	51.3	28.2	7.6	100	100	100.0	3,109	0.52
12/11/2006	44.4	59.2	50.7	14.6	7.3	100	100	100.0	2,317	0.00
12/12/2006	50.7	57.2	54.4	12.4	4.7	100	100	100.0	1,211	0.23
12/13/2006	51.1	66.6	57.8	26.0	9.6	100	100	100.0	2,658	0.01
12/14/2006	48.7	67.1	57.0	26.4	8.6	100	100	100.0	2,925	0.00
12/15/2006	45.5	56.8	53.7	30.7	11.9	100	84	97.7	3,210	0.03
12/16/2006	45.7	52.9	49.1	27.8	9.4	100	67	86.5	3,116	0.01
12/17/2006	40.1	52.5	46.7	31.0	9.1	100	88	99.9	2,368	0.47
12/18/2006	37.0	55.2	44.4	21.7	8.3	100	47	81.2	1,756	0.00
12/19/2006	36.9	54.7	44.3	17.8	10.1	100	58	78.0	2,363	0.00
12/20/2006	39.7	54.7	45.7	14.6	8.2	100	79	98.0	2,606	0.00
12/21/2006	41.0	56.1	49.2	19.6	6.8	100	62	84.2	1,865	0.31
12/22/2006	43.9	59.9	51.8	30.7	12.4	100	61	89.6	1,765	0.22
12/23/2006	41.4	61.9	50.0	25.3	8.2	100	48	83.4	2,368	0.00
12/24/2006	49.3	61.2	54.5	13.9	5.7	100	80	98.3	3,231	0.00
12/25/2006	49.1	65.3	55.3	15.3	7.1	100	61	85.4	1,822	0.00
12/26/2006	53.4	64.6	58.4	28.9	10.3	100	42	77.3	1,531	0.39
12/27/2006	49.5	56.7	52.1	46.1	20.7	100	91	97.8	1,056	0.27
12/28/2006	39.9	58.1	49.5	38.2	14.1	95	27	49.1	1,126	0.00
12/29/2006	38.5	61.0	46.3	16.4	7.7	82	37	62.1	2,404	0.00
12/30/2006	37.4	57.9	49.4	23.5	9.4	100	46	70.9	580	0.00
12/31/2006	44.6	56.5	51.0	28.5	11.9	100	87	98.7	2,439	0.00
Average/ Total	**44.6**	**60.4**	**52.0**	**23.4**	**9.2**	**95**	**62**	**80**	**2,321**	**4.28**

El Sur Ranch Weather Station Data

January, 2007

January, 2007	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
1/1/2007	41 2	60 1	48 8	32.8	8.8	100	73	97 4	1.568	0 00
1/2/2007	42 6	60 1	49 3	13 2	4 8	100	63	89 7	742	0 00
1/3/2007	43 5	62 1	53 2	28.2	12.4	100	95	99 7	2.216	0 00
1/4/2007	48.6	56 7	52 7	41.0	12.9	100	96	99.8	3.027	0.31
1/5/2007	44 6	54 5	48 3	35.3	17 4	95	36	56.3	2.017	0.01
1/6/2007	38 1	56 5	49 4	36 4	14.1	73	35	55 7	2.880	0 00
1/7/2007	43 2	58 8	50.8	19.2	4.8	94	58	72.3	1.975	0.00
1/8/2007	43 9	74 7	56 4	14 6	5.6	82	29	49 4	2.203	0.00
1/9/2007	45 3	74 1	59 8	15.7	6.0	73	24	40 7	2.222	0 00
1/10/2007	42 1	62 1	50 6	34.3	13.3	97	35	64.7	2.375	0.00
1/11/2007	44 1	49 6	46 7	28.9	16.5	68	49	59 9	2.180	0 00
1/12/2007	34 7	47 8	41 5	28.5	9.8	79	25	49.4	3.987	0 04
1/13/2007	30.2	49.3	39 6	16.7	6.2	60	23	36.5	2.174	0 00
1/14/2007	32.5	51 8	40 6	24.6	10.4	86	39	55 2	2.358	0.00
1/15/2007	35.6	53 1	42 9	16.7	9.5	76	44	55 3	3.608	0.00
1/16/2007	36.9	53 8	44 8	31.8	13.2	92	31	55.5	3.410	0.00
1/17/2007	38.8	58 3	46 6	30.3	8.3	100	32	74 8	2.663	0.23
1/18/2007	38.7	55 4	46 2	15.3	7.5	90	49	63 3	2.852	0.00
1/19/2007	41.4	56.5	48 1	31.4	12.8	100	45	75.0	3.583	0 00
1/20/2007	38 1	54 7	49 1	30.3	10.5	100	82	98 9	3.965	0 00
1/21/2007	43 0	58.3	51 8	29.2	13.1	95	34	61 9	3.541	0 00
1/22/2007	41.0	57 9	48 1	14.2	7.4	73	38	50.0	3.632	0.00
1/23/2007	41.4	61 9	49 8	14.2	6.4	87	26	50 5	3.790	0 00
1/24/2007	40.5	57 2	48.3	18.5	6.6	100	43	71 1	3.823	0.00
1/25/2007	37.2	52 5	44 5	14.6	6.0	100	100	100.0	2.117	0 00
1/26/2007	37.4	52 7	46 4	16.7	7.8	100	88	99 9	3.250	0.29
1/27/2007	46.6	58.3	51 7	24.2	8 1	100	100	100 0	2.686	0.04
1/28/2007	45 1	57 6	50 3	11 0	5 5	100	100	100.0	2.937	0.03
1/29/2007	46 9	58 8	51 1	13.2	6 6	100	100	100 0	3.626	0 01
1/30/2007	44 8	55 9	50 2	13.9	5 9	100	100	100 0	3.191	0 00
1/31/2007	44.6	55 2	50 2	19.6	8.4	100	96	99 8	3.884	0 00
Average/ Total	**41.1**	**57.3**	**48.6**	**23.0**	**9.2**	**91**	**58**	**74**	**2.854**	**0.96**

El Sur Ranch Weather Station Data

February, 2007

February, 2007	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
2/1/2007	39.0	54.9	47.1	28.9	11.1	86.5	48	70.7	4.110	0.13
2/2/2007	40.3	55.2	46.7	13.5	6.7	79.5	52.5	64.5	3.950	0.00
2/3/2007	39.6	59.7	48.5	16.7	6.6	82	54.5	67.0	4.213	0.00
2/4/2007	43.7	64.6	53.1	14.6	5.5	84	60.5	72.1	3.627	0.00
2/5/2007	45.5	62.4	53.9	16.0	7.0	83	63.5	73.6	4.176	0.00
2/6/2007	41.4	56.5	49.6	13.2	5.0	82	55	70.1	3.854	0.00
2/7/2007	47.8	58.1	54.1	21.7	8.4	88.5	61.5	73.1	3.300	0.16
2/8/2007	54.5	57.2	55.5	22.8	11.4	76	44	59.5	4.373	0.27
2/9/2007	54.3	58.8	56.2	22.5	10.6	77.5	46.5	60.6	4.385	0.21
2/10/2007	56.1	58.3	57.0	30.7	15.0	84	59	70.7	3.416	0.88
2/11/2007	45.9	59.0	54.2	21.0	8.2	91	63	75.5	2.987	0.30
2/12/2007	42.6	56.8	49.3	16.7	7.7	91	67	80.7	4.084	0.34
2/13/2007	46.6	56.3	51.5	27.1	10.7	89.5	61.5	72.4	2.815	0.27
2/14/2007	46.9	57.0	52.2	32.5	12.8	88.5	64	77.9	3.800	0.00
2/15/2007	45.9	58.6	53.6	33.5	11.2	87	70	79.0	2.835	0.00
2/16/2007	45.1	72.5	57.0	26.7	7.9	88.5	64	78.9	4.000	0.00
2/17/2007	51.6	75.0	61.9	24.2	7.9	92.5	73.5	84.4	1.658	0.00
2/18/2007	50.4	55.2	52.0	37.1	19.5	90	69	83.5	3.410	0.00
2/19/2007	48.6	55.9	51.7	35.3	18.7	92	73.5	83.3	3.311	0.00
2/20/2007	43.5	57.6	51.8	31.8	14.2	89.5	61.5	77.2	3.321	0.00
2/21/2007	43.5	57.2	50.1	18.5	9.4	90.5	71.5	81.9	3.726	0.00
2/22/2007	40.3	55.2	48.7	30.0	8.8	89.5	57	76.5	4.987	1.28
2/23/2007	40.6	52.3	46.0	25.7	10.4	84.5	61.5	74.7	5.030	0.26
2/24/2007	38.3	55.8	47.5	14.6	7.0	86.5	63	80.9	5.171	0.00
2/25/2007	49.1	55.8	51.8	23.9	6.5	86.5	67	80.0	5.040	0.40
2/26/2007	47.1	55.0	51.0	19.6	8.0	87.5	58.5	75.9	2.778	0.33
2/27/2007	41.4	53.1	46.4	23.5	7.4	87	70.5	78.2	1.269	0.51
2/28/2007	40.6	51.8	46.2	25.0	10.2	88	45.5	71.4	5.182	0.22
Average/ Total	**45.4**	**58.1**	**51.6**	**23.8**	**9.8**	**87**	**61**	**75**	**3.743**	**5.56**

El Sur Ranch Weather Station Data

March, 2007

March, 2007	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
3/1/2007	41.5	53.4	48.1	26.0	11.2	91	65.5	79.7	4.942	0.00
3/2/2007	42.8	59.2	50.7	34.3	14.5	94.5	66	79.1	4.801	0.00
3/3/2007	45.1	63.7	53.9	16.7	6.9	94.5	64	83.1	3.679	0.00
3/4/2007	49.1	64.2	56.4	18.2	6.7	92	72.5	83.9	2.942	0.00
3/5/2007	46.0	64.6	55.0	23.9	8.4	93	67	79.3	4.010	0.00
3/6/2007	39.4	57.4	49.6	19.2	6.2	94.5	66.5	83.3	5.173	0.00
3/7/2007	46.9	56.5	52.3	25.7	10.2	93	63	83.6	4.651	0.00
3/8/2007	43.5	56.8	51.3	27.8	11.9	95.5	76	85.6	4.989	0.00
3/9/2007	41.9	58.3	51.4	32.8	12.2	96.5	65.5	82.7	4.965	0.00
3/10/2007	45.0	66.6	55.8	30.7	9.5	89	51	69.6	4.539	0.00
3/11/2007	49.8	73.2	60.3	20.3	5.3	85.5	56	74.7	5.266	0.00
3/12/2007	52.5	76.5	62.2	19.6	9.0	82.5	39.5	62.2	2.888	0.00
3/13/2007	47.1	60.6	53.7	30.0	11.1	73	40.5	60.6	3.460	0.00
3/14/2007	41.2	59.2	51.3	31.4	11.3	89	53.5	75.0	5.201	0.00
3/15/2007	41.5	63.0	53.3	24.2	6.9	85	50	70.6	5.870	0.00
3/16/2007	44.2	57.4	50.7	12.1	4.2	86.5	52	71.4	4.869	0.00
3/17/2007	43.3	57.4	51.0	34.3	11.6	85.5	60.5	72.9	3.605	0.01
3/18/2007	50.0	59.2	53.7	33.2	17.9	88	65.5	76.0	3.986	0.00
3/19/2007	43.2	57.7	50.8	24.2	8.6	87.5	65	75.7	4.787	0.00
3/20/2007	47.8	55.4	51.5	24.2	8.2	89.5	68	80.2	3.247	0.19
3/21/2007	43.3	59.0	51.2	31.4	13.8	89.5	66	81.5	3.142	0.00
3/22/2007	42.8	65.3	53.0	25.0	8.2	88	55.5	75.7	3.598	0.00
3/23/2007	40.5	59.4	51.3	27.1	9.2	91	62	78.4	4.720	0.00
3/24/2007	43.7	56.1	51.7	17.4	5.9	88.5	52	74.2	5.284	0.00
3/25/2007	48.4	60.1	53.3	31.0	9.4	86	59.5	73.4	5.638	0.00
3/26/2007	46.0	58.5	52.4	24.2	8.6	90.5	52.5	72.8	5.510	0.29
3/27/2007	44.8	53.4	49.1	37.1	17.8	90.5	72.5	83.5	3.060	0.07
3/28/2007	45.3	56.1	50.9	34.6	15.2	85.5	55	77.1	4.314	0.00
3/29/2007	43.3	61.2	53.1	21.0	8.2	87	63.5	78.5	3.998	0.00
3/30/2007	41.7	64.4	50.4	19.6	7.1	86	62	75.6	4.956	0.00
3/31/2007	38.7	61.9	51.5	28.5	10.1	83	51.5	70.6	5.152	0.00
Average/ Total	**44.5**	**60.5**	**52.6**	**26.0**	**9.8**	**89**	**60**	**76**	**4.427**	**0.56**

El Sur Ranch Weather Station Data

April, 2007

April, 2007	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
4/1/2007	48.4	59.2	52.8	33.2	19.4	86.5	49	69.8	6.656	0.00
4/2/2007	48.0	63.3	53.9	36.0	15.3	85	60	74.6	4.582	0.00
4/3/2007	42.4	63.5	52.6	26.7	11.6	88	72.5	80.0	2.707	0.00
4/4/2007	46.9	62.1	53.6	27.1	9.5	88	66	77.0	3.786	0.00
4/5/2007	48.6	59.4	52.9	26.0	10.5	90.5	58	74.6	5.825	0.00
4/6/2007	46.6	60.3	52.3	31.0	13.1	91.5	61.5	79.6	6.253	0.00
4/7/2007	50.0	62.8	55.6	26.0	11.3	91	62	79.8	4.688	0.00
4/8/2007	48.9	63.1	54.8	31.8	16.0	89.5	63.5	79.2	4.387	0.00
4/9/2007	50.4	59.4	55.1	40.3	17.0	87.5	63.5	78.9	5.104	0.00
4/10/2007	44.4	65.5	55.5	37.8	16.9	87.5	67	79.6	6.109	0.00
4/11/2007	50.5	58.8	53.8	30.0	14.1	84	71	77.2	4.318	0.11
4/12/2007	48.0	56.3	51.4	37.1	19.1	84.5	68.5	75.7	3.881	0.00
4/13/2007	37.9	58.5	51.2	28.2	11.3	82	51.5	70.9	7.150	0.00
4/14/2007	49.3	57.4	53.1	27.8	12.1	82	67.5	76.5	4.259	0.65
4/15/2007	47.3	56.5	51.7	37.1	19.4	85.5	60.5	75.9	5.436	0.00
4/16/2007	48.0	61.9	53.8	28.2	12.4	86.5	63.5	79.3	4.834	0.00
4/17/2007	48.2	58.6	52.4	36.4	18.5	81.5	58.5	71.0	7.184	0.00
4/18/2007	45.7	55.2	49.6	33.5	15.4	79	55.5	67.1	6.586	0.01
4/19/2007	44.1	54.5	48.7	22.5	8.6	83.5	49.5	70.5	7.450	0.00
4/20/2007	44.4	56.8	49.8	21.4	7.2	91	71	80.7	6.869	0.27
4/21/2007	40.3	57.0	50.1	13.2	4.9	89.5	71.5	81.1	5.116	0.04
4/22/2007	48.7	59.0	53.6	22.8	11.1	88.5	67.5	77.1	4.631	0.28
4/23/2007	45.9	58.8	53.1	29.6	13.3	90	68.5	81.3	4.261	0.00
4/24/2007	41.4	60.8	53.0	31.0	12.9	88.5	64.5	79.8	5.760	0.00
4/25/2007	49.6	59.5	53.1	42.1	19.5	86.5	71	80.3	4.320	0.00
4/26/2007	48.6	60.4	53.7	35.7	19.6	90.5	69	81.5	4.595	0.00
4/27/2007	41.0	65.1	54.2	21.4	5.2	94.5	74.5	85.1	3.605	0.00
4/28/2007	44.4	62.8	53.0	19.6	6.1	100	75	90.7	4.760	0.00
4/29/2007	43.3	58.8	50.6	23.9	7.7	100	79	95.0	5.595	0.00
4/30/2007	40.8	72.0	53.8	31.0	11.5	100	38	76.1	5.858	0.00
Average/ Total	**46.1**	**60.2**	**52.8**	**29.6**	**13.0**	**88**	**64**	**78**	**5.219**	**1.36**

El Sur Ranch Weather Station Data May, 2007

May, 2007	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
5/1/2007	49.1	64.0	55.8	31.8	14.6	96	44	66.9	7.173	0.00
5/2/2007	49.8	63.7	55.4	22.1	9.0	100	65	87.6	5.288	0.05
5/3/2007	47.7	58.3	52.8	27.8	12.7	81	59	70.9	5.984	0.00
5/4/2007	48.0	59.5	52.8	31.4	11.5	100	69	88.8	6.691	0.16
5/5/2007	48.2	60.6	53.9	35.7	17.5	90	52	73.0	7.453	0.00
5/6/2007	44.2	74.8	57.1	24.6	7.9	91	36	68.4	7.751	0.00
5/7/2007	46.4	75.6	60.0	14.2	3.6	100	28	68.2	7.729	0.00
5/8/2007	46.6	76.8	60.3	18.9	7.0	100	37	73.0	7.787	0.00
5/9/2007	41.9	59.5	51.9	21.4	6.5	100	80	93.8	6.874	0.00
5/10/2007	46.4	58.5	52.8	25.7	10.0	100	74	87.8	7.525	0.00
5/11/2007	42.6	57.9	51.3	22.8	9.7	100	74	87.8	6.574	0.00
5/12/2007	48.4	59.9	53.6	37.1	19.1	89	57	74.3	7.800	0.00
5/13/2007	46.4	63.0	53.2	31.4	15.9	91	60	79.0	7.749	0.00
5/14/2007	44.4	57.2	52.6	33.2	15.7	93	74	83.2	7.540	0.00
5/15/2007	48.2	58.1	52.7	34.6	14.8	100	73	88.0	6.418	0.00
5/16/2007	48.7	60.8	53.8	40.0	20.7	98	56	79.8	7.793	0.00
5/17/2007	49.6	60.4	54.3	37.8	23.2	96	67	81.7	7.617	0.00
5/18/2007	50.9	65.7	58.5	38.5	18.9	86	43	64.6	7.641	0.00
5/19/2007	51.6	62.8	56.2	45.3	24.5	92	63	78.3	7.863	0.00
5/20/2007	50.7	63.0	56.1	41.4	24.8	99	48	69.7	7.580	0.00
5/21/2007	50.4	62.2	55.5	36.4	20.4	100	49	81.0	7.819	0.00
5/22/2007	40.1	66.0	54.4	30.3	12.7	99	46	72.1	7.861	0.00
5/23/2007	43.2	59.5	51.5	20.7	6.9	100	71	90.5	7.340	0.00
5/24/2007	45.5	58.6	50.8	22.1	6.1	100	78	95.1	5.947	0.00
5/25/2007	47.8	59.4	52.0	26.0	9.2	100	77	94.3	5.872	0.00
5/26/2007	46.6	57.7	52.6	15.3	6.9	100	78	94.8	3.719	0.00
5/27/2007	50.0	61.3	54.6	27.8	13.0	100	71	87.5	7.201	0.00
5/28/2007	50.2	57.0	52.8	15.3	6.4	96	77	88.5	4.144	0.00
5/29/2007	50.4	57.9	53.1	16.7	6.5	98	76	90.5	4.131	0.00
5/30/2007	46.6	57.7	54.1	11.7	4.4	100	75	84.8	3.503	0.00
5/31/2007	47.5	61.0	55.1	25.7	11.8	100	69	84.4	7.131	0.00
Average/ Total	**47.4**	**61.9**	**54.2**	**27.9**	**12.6**	**97**	**62**	**82**	**6.758**	**0.21**

El Sur Ranch Weather Station Data June, 2007

June, 2007	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
6/1/2007	51.6	60.8	54.4	20.0	10.2	100	75	91.0	5,174	0.00
6/2/2007	47.1	60.4	53.9	26.4	11.3	100	73	90.4	7,403	0.00
6/3/2007	44.6	59.5	53.6	27.8	10.4	100	83	96.7	6,856	0.00
6/4/2007	48.9	66.2	57.9	27.1	13.1	100	68	89.8	7,208	0.00
6/5/2007	55.4	63.7	59.2	31.0	17.3	100	59	83.7	7,234	0.00
6/6/2007	51.8	62.2	56.5	32.1	16.3	85	59	70.9	7,907	0.00
6/7/2007	49.3	61.9	55.4	35.3	17.4	100	69	81.0	7,830	0.00
6/8/2007	49.3	60.4	54.7	30.3	16.3	100	70	84.5	7,846	0.00
6/9/2007	42.1	68.5	55.6	36.8	13.8	100	50	82.6	7,725	0.00
6/10/2007	54.1	71.2	60.0	38.2	19.5	100	59	83.1	7,180	0.00
6/11/2007	50.9	62.4	55.9	37.8	18.6	100	61	81.8	7,757	0.00
6/12/2007	42.4	66.4	56.4	30.7	11.0	100	53	76.2	7,858	0.00
6/13/2007	46.0	72.7	58.6	30.7	9.9	100	50	78.3	7,672	0.00
6/14/2007	47.5	69.4	58.2	14.2	3.9	100	54	82.0	7,594	0.00
6/15/2007	46.6	61.5	54.6	25.3	8.0	100	88	96.9	7,646	0.00
6/16/2007	46.9	61.5	54.3	30.3	12.5	100	79	94.6	7,751	0.00
6/17/2007	46.0	58.5	53.0	20.7	6.9	100	78	94.4	7,344	0.00
6/18/2007	45.7	60.3	52.9	23.9	8.9	100	89	99.3	5,882	0.00
6/19/2007	51.8	62.6	55.8	24.2	12.1	100	81	97.2	4,905	0.00
6/20/2007	52.7	62.1	56.7	21.4	7.7	100	69	91.6	7,219	0.00
6/21/2007	46.8	68.9	58.7	36.8	15.6	100	46	78.8	7,925	0.00
6/22/2007	55.0	69.6	61.9	40.0	19.3	95	50	64.4	8,028	0.00
6/23/2007	53.4	66.6	58.8	40.3	21.6	93	50	71.5	7,690	0.00
6/24/2007	53.6	65.3	59.0	40.7	23.4	81	52	65.4	7,907	0.00
6/25/2007	51.1	69.3	58.8	32.8	16.2	92	43	72.2	7,925	0.00
6/26/2007	45.1	61.3	55.1	35.0	15.2	100	70	91.0	7,880	0.00
6/27/2007	48.4	66.7	58.6	38.9	18.3	100	55	82.5	7,828	0.00
6/28/2007	55.9	68.7	63.1	38.9	18.7	100	57	78.8	7,690	0.00
6/29/2007	56.7	70.3	64.2	36.0	19.3	97	60	79.3	7,633	0.00
6/30/2007	56.3	66.6	61.0	39.3	20.0	91	49	67.8	7,701	0.00
Average/ Total	**49.8**	**64.9**	**57.2**	**31.4**	**14.4**	**98**	**63**	**83**	**7,407**	**0.00**

El Sur Ranch Weather Station Data July, 2007

July, 2007	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
7/1/2007	54.9	68.4	61.3	40.7	20.2	90	48	64.3	7.819	0.00
7/2/2007	57.4	76.1	67.9	38.9	17.7	70	39	50.6	7.758	0.00
7/3/2007	54.7	70.9	64.5	38.9	18.0	100	55	73.9	7.892	0.00
7/4/2007	54.3	63.7	59.5	30.0	15.4	100	76	89.5	7.683	0.00
7/5/2007	48.2	63.1	55.8	23.9	7.3	100	89	98.7	7.398	0.00
7/6/2007	50.2	61.0	54.7	16.4	6.9	100	100	100.0	6.633	0.00
7/7/2007	53.4	62.6	57.1	37.5	17.9	100	81	95.5	7.662	0.00
7/8/2007	52.9	59.4	55.4	23.2	8.6	100	98	99.9	5.938	0.00
7/9/2007	52.3	64.0	57.1	27.5	11.2	100	89	99.5	6.217	0.00
7/10/2007	56.5	63.0	58.5	24.6	10.3	100	96	99.8	3.080	0.00
7/11/2007	53.4	66.0	60.8	17.1	8.0	100	77	94.7	6.194	0.00
7/12/2007	51.8	68.9	60.6	16.7	7.8	100	56	83.6	7.699	0.00
7/13/2007	52.2	70.5	60.6	26.7	11.5	100	67	91.3	7.797	0.00
7/14/2007	49.8	64.4	58.8	32.1	13.5	100	96	99.9	7.784	0.00
7/15/2007	51.6	71.2	62.6	35.7	15.1	100	68	90.2	7,583	0.00
7/16/2007	56.1	67.1	61.7	34.3	17.6	100	61	89.2	7.618	0.00
7/17/2007	53.8	68.5	62.9	29.2	14.7	100	81	94.5	7.593	0.00
7/18/2007	54.7	70.3	63.3	30.3	10.9	100	61	92.1	7.129	0.00
7/19/2007	57.9	68.5	63.9	42.5	20.2	92	63	79.2	7.712	0.00
7/20/2007	59.0	70.7	65.1	38.5	18.2	93	64	78.2	7.574	0.00
7/21/2007	59.0	70.9	65.8	35.0	17.0	100	74	87.1	7.602	0.00
7/22/2007	51.6	70.3	63.4	35.7	16.0	100	88	97.8	7.665	0.00
7/23/2007	59.5	70.9	65.3	36.0	16.8	100	82	95.7	6.730	0.00
7/24/2007	57.2	65.7	61.3	34.3	19.1	100	99	100.0	7.368	0.00
7/25/2007	54.3	64.8	59.5	35.7	16.1	100	88	97.8	7.737	0.00
7/26/2007	53.1	63.1	58.1	32.1	15.0	100	94	99.4	7.759	0.00
7/27/2007	47.8	63.9	56.9	26.7	10.9	100	98	100.0	7,736	0.00
7/28/2007	47.8	66.6	57.2	31.4	13.2	100	61	96.5	7.794	0.00
7/29/2007	55.4	63.3	58.3	37.8	19.9	100	95	100.0	7.579	0.00
7/30/2007	50.9	61.5	56.6	29.2	16.8	100	100	100.0	7.548	0.00
7/31/2007	51.3	62.8	56.1	22.5	8.1	100	100	100.0	6.268	0.00
Average/ Total	**53.6**	**66.5**	**60.3**	**31.0**	**14.2**	**98**	**79**	**92**	**7.244**	**0.00**

El Sur Ranch Weather Station Data August, 2007

August, 2007	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
8/1/2007	52.2	63.3	57.6	9.9	4.5	100	95	99.9	5,976	0.00
8/2/2007	53.2	64.2	58.3	21.4	6.2	100	97	99.9	6,422	0.00
8/3/2007	52.0	62.4	56.6	20.7	7.6	100	100	100.0	6,651	0.00
8/4/2007	51.1	61.7	55.5	23.2	7.1	100	100	100.0	6,199	0.00
8/5/2007	53.8	65.3	59.1	25.7	11.3	100	81	96.3	7,159	0.00
8/6/2007	53.8	65.1	60.2	27.8	15.0	100	66	86.0	7,356	0.00
8/7/2007	49.1	64.6	59.8	31.4	15.3	100	67	85.5	7,333	0.00
8/8/2007	50.4	64.2	59.1	31.8	15.1	100	80	93.8	7,326	0.00
8/9/2007	46.9	63.7	56.5	25.3	11.0	100	99	100.0	7,318	0.00
8/10/2007	46.8	62.4	56.6	30.7	11.2	100	84	98.6	7,478	0.00
8/11/2007	50.0	64.9	58.4	37.8	16.5	100	85	97.4	7,361	0.00
8/12/2007	45.9	66.4	58.7	32.5	14.5	100	62	88.1	7,270	0.00
8/13/2007	50.4	68.0	60.7	33.5	13.5	99	61	76.2	7,330	0.00
8/14/2007	46.0	65.3	58.7	33.2	14.3	100	68	88.2	7,202	0.00
8/15/2007	56.5	68.4	61.9	37.1	18.5	100	57	88.2	7,136	0.00
8/16/2007	60.1	69.4	65.3	45.0	22.8	100	43	71.3	7,071	0.00
8/17/2007	59.5	68.4	64.2	40.3	22.3	76	50	62.8	7,314	0.00
8/18/2007	58.3	69.8	63.8	40.3	21.0	94	52	68.6	7,291	0.00
8/19/2007	52.3	71.1	64.0	32.5	14.0	100	54	77.9	7,136	0.00
8/20/2007	51.6	70.2	61.9	29.2	11.5	100	75	95.3	7,029	0.00
8/21/2007	52.3	70.0	62.0	33.5	13.4	100	83	97.0	7,106	0.00
8/22/2007	56.5	64.9	59.9	27.8	13.7	100	94	99.5	7,152	0.00
8/23/2007	53.8	62.6	58.1	19.2	8.8	100	96	99.9	5,733	0.00
8/24/2007	52.7	64.8	59.4	19.2	8.9	100	90	98.3	6,244	0.00
8/25/2007	52.0	67.5	60.0	17.8	7.1	100	83	95.8	6,348	0.00
8/26/2007	58.1	67.1	62.0	11.0	4.8	100	87	98.3	5,658	0.00
8/27/2007	54.0	62.6	59.1	13.5	4.7	100	100	100.0	5,902	0.00
8/28/2007	52.2	62.4	57.1	8.9	3.8	100	100	100.0	5,502	0.00
8/29/2007	55.2	65.7	59.2	14.2	4.6	100	100	100.0	6,058	0.00
8/30/2007	57.2	74.1	63.7	23.5	6.5	100	64	94.8	5,648	0.01
8/31/2007	58.1	69.1	62.7	31.0	9.2	100	82	97.8	6,553	0.00
Average/ Total	**53.0**	**66.1**	**60.0**	**26.7**	**11.6**	**99**	**79**	**92**	**6,750**	**0.01**

El Sur Ranch Weather Station Data

September, 2007

September. 2007	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
9/1/2007	52.3	82.8	66.1	31.4	10.3	100	20	73.0	6.843	0.00
9/2/2007	57.0	73.4	65.0	33.2	17.6	98	55	73.1	6.966	0.00
9/3/2007	57.7	69.8	63.4	35.3	18.8	100	71	87.5	7.031	0.00
9/4/2007	59.4	72.0	65.5	39.6	22.3	100	64	88.3	6.987	0.00
9/5/2007	45.1	67.5	57.8	28.2	7.1	100	76	97.3	6.833	0.00
9/6/2007	48.0	65.7	57.7	25.7	10.0	100	93	99.9	4.362	0.00
9/7/2007	54.1	66.7	62.3	13.9	6.5	100	81	94.4	5.933	0.00
9/8/2007	50.7	64.8	58.2	15.3	6.1	100	93	98.9	6.452	0.00
9/9/2007	53.1	66.2	59.3	9.6	4.5	100	80	98.9	6.549	0.00
9/10/2007	50.4	68.0	59.9	22.5	8.2	100	79	97.9	6.509	0.00
9/11/2007	51.6	66.0	59.7	30.7	12.3	100	87	97.8	6.521	0.00
9/12/2007	53.1	70.2	62.4	25.0	11.3	100	59	87.5	5.947	0.00
9/13/2007	56.7	71.2	64.7	27.5	13.4	100	60	79.2	6.620	0.00
9/14/2007	53.1	70.9	63.9	25.0	11.3	100	64	90.3	6.425	0.00
9/15/2007	52.7	70.7	63.0	31.0	13.3	100	55	77.8	6.556	0.00
9/16/2007	56.5	66.7	61.7	34.6	18.6	96	69	85.3	6.472	0.00
9/17/2007	57.6	67.5	61.5	33.5	19.2	100	66	89.8	6.480	0.00
9/18/2007	51.8	63.5	58.6	31.8	15.5	100	83	95.5	6.563	0.00
9/19/2007	52.0	64.0	58.6	25.3	12.4	100	70	88.2	4.414	0.00
9/20/2007	47.1	61.5	54.4	15.7	6.3	100	66	95.0	5.136	0.10
9/21/2007	50.0	67.3	57.8	17.1	5.2	100	42	82.7	5.140	0.06
9/22/2007	52.7	65.8	57.1	13.9	4.6	100	83	98.9	3.648	0.09
9/23/2007	51.8	65.8	58.2	21.4	8.0	100	72	92.7	5.141	0.00
9/24/2007	51.1	70.9	61.6	20.0	7.7	100	50	76.1	6.312	0.00
9/25/2007	57.0	75.0	66.0	21.4	8.2	79	34	55.7	6.230	0.00
9/26/2007	56.1	77.2	66.0	17.1	5.8	82	43	58.0	5.979	0.00
9/27/2007	46.9	61.2	55.6	16.7	5.0	100	67	97.5	3.431	0.00
9/28/2007	54.5	63.5	59.0	22.8	6.6	100	90	98.5	2.672	0.02
9/29/2007	47.1	65.7	57.1	33.5	11.8	100	45	76.2	5.848	0.00
9/30/2007	47.5	69.1	59.0	24.6	10.4	91	40	61.0	5.696	0.00
Average/ Total	**52.5**	**68.4**	**60.7**	**24.8**	**10.6**	**98**	**65**	**86**	**5.857**	**0.27**

El Sur Ranch Weather Station Data October, 2007

October, 2007	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
10/1/2007	57.2	67.3	61.1	37.5	15.2	100	64	81.5	5.561	0.00
10/2/2007	55.8	71.4	62.6	26.4	9.1	91	48	68.3	5.562	0.00
10/3/2007	54.0	66.2	59.9	40.0	17.9	100	47	81.8	5.531	0.00
10/4/2007	54.0	62.8	57.9	31.4	17.0	100	52	80.0	5.514	0.00
10/5/2007	48.7	60.6	54.8	26.4	11.8	100	60	86.9	5.147	0.00
10/6/2007	41.4	65.1	53.9	30.0	10.1	100	38	67.0	5.505	0.00
10/7/2007	50.4	70.3	59.1	24.6	8.7	73	29	46.0	5.433	0.00
10/8/2007	42.6	66.4	53.7	14.6	5.0	100	47	87.4	5.392	0.00
10/9/2007	40.3	65.5	54.7	19.6	8.2	100	59	87.6	4.701	0.00
10/10/2007	51.3	63.3	58.1	26.4	10.6	100	56	90.8	4.709	0.31
10/11/2007	48.4	63.1	55.6	27.1	7.8	100	62	90.5	4,792	0.00
10/12/2007	48.7	59.7	54.8	25.0	8.1	100	88	99.3	1.272	0.62
10/13/2007	50.7	63.9	57.2	18.9	6.0	100	87	99.4	3.948	0.01
10/14/2007	50.4	61.2	55.7	18.5	7.2	100	100	100.0	5.028	0.00
10/15/2007	48.4	61.9	55.4	16.0	5.9	100	94	100.0	3.180	0.00
10/16/2007	50.7	63.7	57.4	22.1	7.9	100	55	89.6	2.865	0.22
10/17/2007	52.7	64.8	58.0	18.2	8.7	100	63	90.5	3.812	0.01
10/18/2007	48.7	70.2	59.3	26.0	10.5	100	38	72.5	4.804	0.00
10/19/2007	53.2	71.2	63.0	30.7	10.9	100	62	91.1	4.803	0.00
10/20/2007	54.5	63.9	58.1	40.0	17.9	100	51	75.8	4.828	0.01
10/21/2007	48.9	70.5	60.2	27.1	8.4	81	30	45.5	4.915	0.00
10/22/2007	54.5	74.7	64.4	15.3	6.0	55	18	31.1	4.845	0.00
10/23/2007	58.3	86.4	70.3	14.9	6.5	57	14	33.0	4.792	0.00
10/24/2007	54.0	81.5	66.3	18.9	7.9	100	27	59.4	4.738	0.00
10/25/2007	47.3	60.6	54.2	30.7	11.7	100	98	99.8	4.454	0.00
10/26/2007	44.8	59.7	52.6	18.9	5.9	100	80	95.4	4.473	0.00
10/27/2007	47.5	64.8	55.2	19.2	7.7	100	75	95.7	3.586	0.00
10/28/2007	50.0	66.4	57.1	22.1	6.5	100	76	97.6	3.360	0.00
10/29/2007	50.5	63.7	56.2	21.7	9.4	100	75	98.8	1,968	0.01
10/30/2007	49.8	63.5	57.0	26.0	12.8	100	66	90.9	4,249	0.00
10/31/2007	45.3	59.5	52.6	25.7	9.0	100	100	100.0	4,271	0.00
Average/ Total	**50.1**	**66.3**	**57.9**	**24.5**	**9.6**	**95**	**60**	**82**	**4,453**	**1.19**

El Sur Ranch Weather Station Data

November, 2007

November, 2007	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
11/1/2007	44.6	62.4	52.2	25.7	7.5	100	88	99.3	4.348	0.00
11/2/2007	44.8	67.1	56.9	15.3	5.1	100	42	79.0	4.216	0.00
11/3/2007	57.9	79.9	65.0	14.6	6.4	90	30	49.5	4.290	0.00
11/4/2007	50.7	66.7	55.3	17.8	5.7	100	31	80.7	3.865	0.00
11/5/2007	48.6	54.0	51.1	9.2	3.7	100	100	100.0	1.029	0.00
11/6/2007	46.8	57.9	52.9	18.9	5.8	100	100	100.0	2.888	0.00
11/7/2007	50.0	56.8	52.7	12.8	4.6	100	100	100.0	1.822	0.00
11/8/2007	50.9	59.9	54.1	13.5	5.3	100	83	97.1	2.688	0.00
11/9/2007	50.4	62.1	56.7	21.0	8.1	100	91	99.7	3.234	0.20
11/10/2007	47.5	61.0	54.3	12.8	6.1	100	90	99.8	3.133	0.05
11/11/2007	49.3	64.0	57.2	36.0	14.5	100	84	98.1	3.888	0.23
11/12/2007	46.0	70.2	57.6	30.7	9.0	100	20	55.0	3.954	0.00
11/13/2007	51.8	71.6	61.5	24.6	6.4	100	32	68.1	3.777	0.00
11/14/2007	52.0	73.4	61.7	20.7	6.0	100	54	84.5	3.837	0.00
11/15/2007	50.5	69.4	58.7	28.5	9.6	100	52	89.1	3.798	0.00
11/16/2007	47.7	62.8	55.7	30.7	12.1	100	89	100.0	3.451	0.00
11/17/2007	43.5	63.5	52.4	23.5	6.0	100	88	99.3	3.695	0.00
11/18/2007	43.3	70.0	55.0	26.4	7.6	100	55	95.0	3.746	0.00
11/19/2007	47.8	69.8	59.1	34.3	13.4	100	51	88.1	3.594	0.00
11/20/2007	42.4	65.7	54.2	25.0	7.3	100	53	80.0	3.741	0.00
11/21/2007	45.5	64.6	53.4	13.9	6.6	85	31	51.8	3.600	0.00
11/22/2007	45.1	58.6	51.4	13.5	6.4	100	44	78.9	3.632	0.00
11/23/2007	41.9	60.8	51.2	14.6	6.3	100	37	66.3	3.708	0.00
11/24/2007	45.0	61.3	51.7	16.4	6.7	100	24	57.7	3.087	0.00
11/25/2007	45.3	59.7	53.0	21.4	5.2	100	34	64.2	1.780	0.00
11/26/2007	43.7	61.7	52.1	13.5	5.4	100	45	70.9	3.467	0.00
11/27/2007	44.4	67.1	56.0	31.4	9.8	98	34	58.8	3.322	0.00
11/28/2007	48.7	71.2	60.6	31.4	7.2	70	14	38.0	3.476	0.00
11/29/2007	49.8	61.2	55.0	25.3	9.3	95	24	50.8	3.434	0.00
11/30/2007	45.9	53.2	49.4	36.4	19.0	99	63	83.8	3.565	0.00
Average/ Total	**47.4**	**64.3**	**55.3**	**22.0**	**7.7**	**98**	**56**	**79**	**3.402**	**0.48**

El Sur Ranch Weather Station Data   December, 2007

December, 2007	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
12/1/2007	42.8	55.2	48.0	21.4	7.3	100	67	88.5	3,157	0.01
12/2/2007	43.7	58.5	51.4	29.2	11.9	100	60	87.9	2,017	0.01
12/3/2007	47.7	62.4	54.3	21.7	8.5	100	49	81.8	3,379	0.00
12/4/2007	51.1	67.3	58.8	23.5	9.9	100	80	94.4	2,819	0.00
12/5/2007	50.7	73.4	58.3	26.7	10.0	100	40	82.2	3,338	0.00
12/6/2007	50.4	57.2	54.1	41.4	9.9	100	64	96.4	939	0.46
12/7/2007	49.1	55.0	51.3	33.2	15.9	100	95	99.9	736	0.11
12/8/2007	45.1	51.8	49.0	27.5	12.9	100	58	81.9	2,302	0.00
12/9/2007	37.8	56.8	47.5	17.1	6.5	100	39	67.4	3,369	0.00
12/10/2007	41.2	56.5	49.3	29.2	9.0	94	43	68.6	3,304	0.00
12/11/2007	41.5	58.5	49.6	23.5	6.4	100	23	62.0	3,229	0.00
12/12/2007	41.5	58.5	48.6	19.2	9.1	85	32	50.8	3,292	0.00
12/13/2007	41.4	56.1	47.2	21.0	9.1	100	45	67.3	3,228	0.00
12/14/2007	39.9	55.9	46.4	20.7	7.6	100	47	77.4	3,136	0.00
12/15/2007	39.6	57.6	46.6	20.7	6.4	100	58	91.5	3,275	0.00
12/16/2007	41.5	57.6	48.4	16.4	7.8	100	61	86.3	2,449	0.00
12/17/2007	49.8	55.8	52.6	21.0	8.4	100	80	99.3	1,717	0.21
12/18/2007	44.6	55.9	52.9	22.1	8.8	100	97	100.0	378	0.85
12/19/2007	41.7	57.0	48.1	15.3	6.5	100	76	96.4	2,963	0.01
12/20/2007	47.8	55.6	51.5	29.2	12.0	100	66	92.4	2,952	0.22
12/21/2007	38.8	54.9	46.0	28.5	11.1	100	43	74.0	2,995	0.00
12/22/2007	38.7	55.9	45.7	16.4	7.9	100	48	71.3	3,106	0.00
12/23/2007	42.6	63.7	51.3	22.8	6.7	100	44	65.0	2,993	0.00
12/24/2007	44.2	62.1	53.3	42.8	20.7	100	58	94.2	3,371	0.00
12/25/2007	41.4	57.2	50.2	28.5	9.3	100	32	61.8	3,335	0.00
12/26/2007	45.3	52.7	48.9	38.2	16.8	100	49	74.9	3,364	0.00
12/27/2007	39.7	51.1	46.0	23.2	11.5	68	38	50.3	2,369	0.00
12/28/2007	42.8	52.2	47.4	20.0	7.0	100	71	98.6	1,334	0.00
12/29/2007	45.7	52.5	49.4	13.9	5.6	100	100	100.0	1,328	0.00
12/30/2007	45.1	55.2	51.3	35.3	13.5	100	38	92.3	3,389	0.00
12/31/2007	39.9	59.7	48.0	14.2	6.0	96	43	66.9	3,433	0.00
Average/ Total	**43.6**	**57.4**	**50.0**	**24.6**	**9.7**	**98**	**56**	**81**	**2,677**	**1.88**

El Sur Ranch Weather Station Data January, 2008

January, 2008	Min. Temp (F)	Max. Temp (F)	Ave. Temp (F)	Max. Wind Speed (mph)	Ave. Wind Speed (mph)	Max. Rel. Humidity (%)	Min. Rel. Humidity (%)	Ave. Rel. Humidity (%)	Tot. Solar Radiance (W/m2/day)	Tot. Rainfall (in)
1/1/2008	42.1	71.8	54.8	15.3	7.4	100	20	47.5	3,334	0.00
1/2/2008	46.0	57.2	51.4	17.4	9.4	100	34	72.8	3,127	0.00
1/3/2008	49.5	59.0	54.7	34.3	14.1	100	77	94.5	1,048	0.62
1/4/2008	52.3	55.6	53.6	52.5	28.0	100	49	84.1	52	4.85
Average/ Total	**47.5**	**60.9**	**53.6**	**29.9**	**14.7**	**100**	**45**	**75**	**1,890**	**5.47**

APPENDIX D

APPENDIX D

Reference Evapotranspiration

The daily reference evapotranspiration (ETref) was calculated as a function of the solar radiation, maximum air temperature, minimum air temperature, dew point temperature, total sky cover, and wind speed using the FAO Penman-Monteith equation for the reference crop of clipped, cool season grass (FAO, 1998).

Reference ET Equation

The FAO Penman-Monteith equation is:

$$ET_o = \frac{0.408\Delta(Rn - G) + \gamma \frac{900}{T + 273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34 u_2)}$$

where:

ETo	=	reference crop evapotranspiration (mm/day)
Rn	=	net radiation at the crop surface (MJ/m2/day)
G	=	soil heat flux density (MJ/m2/day)
T	=	mean daily air temperature at 2 m height (oC)
u2	=	wind speed at 2 m height (m/s)
es	=	saturation vapor pressure (kPa)
ea	=	actual vapor pressure (kPa)
es-ea	=	saturation vapor pressure deficit (kPa)
Δ	=	slope vapor pressure curve (kPa/oC)
γ	=	psychrometric constant (kPa/oC)

Equations used in calculating the required inputs into the FAO Penman-Monteith equation are provided below.

The **latent heat of vaporization,** λ, varies only slightly over normal temperature ranges and is taken as 2.45 MJ/kg in the simplified FAO Penman-Monteith equation assuming an average air temperature of about 20°C.

The **saturated vapor pressure,** e_s (in kiloPascals (kPa)), is calculated from the maximum and minimum daily temperatures as:

$$e_s = \frac{e_s^{T_{max}} + e_s^{T_{min}}}{2}$$, where $e_s^{T_{max}}$ and $e_s^{T_{min}}$, both in kPa, are given by:

$$e_s^{T_{max}} = 0.6108 \exp\left[\frac{17.27 T_{max}}{T_{max} + 237.3}\right], \quad e_s^{T_{min}} = 0.6108 \exp\left[\frac{17.27 T_{min}}{T_{min} + 237.3}\right],$$

where T_{max} and T_{min} are the maximum and minimum daily temperatures in degrees Celsius.

The **actual vapor pressure,** e_a (in kPa), is calculated from the dew point temperature as:

$$e_a = 0.6108 \exp\left[\frac{17.27 T_{dew}}{T_{dew} + 237.3}\right],$$

where T_{dew} is the dew point temperature in degrees Celsius.

The **slope of the saturation vapor pressure versus temperature curve,** Δ (in kPa/CE), is calculated as:

$$\Delta = \frac{4098\left(0..6108 \exp\left(\frac{17.27T}{T + 237.3}\right)\right)}{(T + 237.3)^2}$$

The **psychrometric constant,** γ (in kPa/KE), is calculated as:

$$\gamma = \frac{C_p P_{atm}}{0.622\lambda} = 0.000665 P_{atm}$$

where $C_p = 0.001013$ MJ/(kg KE) is the specific heat of air at constant pressure, λ is the latent height of vaporization (assumed as 2.45 MJ/kg), and P_{atm} is the atmospheric pressure in kPa. KE indicates Kelvin degrees.

P_{atm} is approximately constant in time for a given elevation and is calculated as:

$$P_{atm_1} = P_{atm_0}\left[\frac{T_o^K + L_T(z_1 - z_0)}{T_o^K}\right]^{g/\alpha R},$$

where $g = 9.81$ m/s^2 is the acceleration due to gravity, $R = 287$ J/(kg KE) is the specific gas constant, $L_T = -0.0065$ KE/m is the lapse rate for saturated air, $T_o^K = 293$ KE is the average temperature at the sea level, $z_0 = 0$ m is the elevation at the sea level, z_1 is the elevation in m, $P_{atm_0} = 101.3$ kPa is the average atmospheric pressure at the sea level, and P_{atm_1} is the average atmospheric pressure, in kPa, at elevation z_1.

The **net emissivity,** ε, between the atmosphere and the ground is calculated from the actual vapor pressure as:

$$\varepsilon = 0.34 - 0.14\sqrt{e}.$$

The **net clear sky long-wave radiation**, R_{nlo} (in MJ/(m^2 day)), is calculated as:

$$R_{nlo} = -\varepsilon\sigma \frac{\left(T_{\max}^{K}\right)^4 + \left(T_{\min}^{K}\right)^4}{2},$$

where $T_{\max}^{K}$ and $T_{\min}^{K}$ are the maximum and minimum daily temperatures in degrees Celsius and σ = 4.903×10^{-9} MJ/(m^2 day KE) is the Stefan-Boltzmann constant.

The **net long-wave radiation**, adjusted to account for the effect of the cloud cover, is given by:

$$R_{nl} = R_{nlo}\left(1.35\frac{R_s}{R_{so}} - 0.35\right),$$

where R_s is the short wave solar radiation in MJ/m^2/day (measured at weather station) and R_{so} is the short wave solar radiation for clear skies in MJ/m^2/day.

The **net radiation**, R_n (in MJ/(m^2 day)), is then calculated as:

$$R_n = (1 - \alpha)R_s - R_{nl},$$

where the α is albedo, set to 0.23 for general land surfaces.

The **soil heat flux** is relatively small beneath the grass reference surface for a daily time step and thus is taken as:

$$G_{day} \approx 0$$

The **short wave solar radiation for clear skies,** Rso, is calculated as follows when turbidity and water vapor effects are not considered:

$$R_{so} = (0.75 + 0.00002z)R_a$$

where R_a is the extraterrestrial solar radiation and z is the elevation above sea level in meters.

The daily **extraterrestrial solar radiation**, R_a, is based upon the day of the year and latitude of the site and is calculated as follows:

$$R_a = \frac{24(60)}{\pi} G_{sc} d_r \left[\omega_s \sin(\varphi)\sin(\delta) + \cos(\varphi)\cos(\delta)\sin(\omega_s)\right]$$

where:

R_a	=	extraterrestrial solar radiation ($MJ/m^2/day$)
G_{sc}	=	solar constant = 0.0820 $MJ/\ m^2/day$
d_r	=	inverse relative distance Earth-Sun
ω_s	=	sunset hour angle (rad)
φ	=	latitude (rad)
δ	=	solar declination (rad)

The **inverse relative distance Earth-Sun**, d_r, is given by:

$$d_r = 1 + 0.033 \cos\left(\frac{2\pi}{365} J\right)$$

Where J is the number of the day of the year between 1 (January 1) and 365 or 366 (December 31). The denominator in this equation remains at 365 even for leap years.

The **solar declination**, δ, is given by:

$$\delta = 0.409 \sin\left(\frac{2\pi}{365} J - .3.19\right)$$

The **sunset hour angle**, ω_s, is then calculated as:

$$\omega_s = \arccos\left[-\tan(\varphi)\tan(\delta)\right]$$