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HYDROGEOLOGIC UPDATE

# EL TORO AREA

MONTEREY COUNTY, CALIFORNIA

FOR

MONTEREY COUNTY
WATER RESOURCES AGENCY

AUGUST 1991

STAAL
GARDNER
& DUNNE
INC
Geotechnical,
Hydrogeological
& Environmental
Consultants

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## EXECUTIVE SUMMARY

A preliminary assessment of the ground water resources of the El Toro Area of Monterey County was originally provided in 1981 by the firm of Anderson-Nichols (A-N). The El Toro Area consists of five subareas, which include El Toro Creek, Corral de Tierra, San Benancio Gulch, Watson Creek, and Calera Canyon. The A-N study provided an estimate of the average annual recharge to the five subareas of approximately 6,000 acre-feet. Annual water demand in the area, at the time of the completion of A-N report, was estimated at approximately 680 acre-feet. These findings were incorporated in the Toro Area Plan portion of the Monterey County General Plan.

Recent concern of residents within the area regarding the adequacy of the ground water supply prompted a reassessment of the ground water resources available to the area. Water supply problems reported by residents are primarily associated with declining water levels and deteriorating water quality. This report presents an update of the ground water resources of the El Toro area and included a review of the A-N report, the methodologies used by A-N to estimate recharge, and incorporation of hydrogeologic data collected by the Monterey County Water Resource Agency since the publication of the A-N report.

This study has concluded that the average annual recharge to the El Toro Area is approximately 2,100 acre-feet. The value of 2,100 acre-feet is distributed unevenly between the five subareas, due to differences in the recharge area. The average annual recharge to each subarea ranges from 49 to 855 acre-feet per year (afy). The overall estimate of recharge to the study area is approximately 30 percent of the values advanced by A-N.

The reduction in the estimated recharge volume results from the consideration of the water lost to evapotranspiration from soil storage during months when evapotranspiration exceeds precipitation. This process was not accounted for by A-N. Consideration of this process results in a one-third reduction in the annual areal recharge rate. The annual volume of recharge was also reduced by a reduction in the area assumed to be receive recharge. A significant portion of the study area is underlain by geologic formations that are considered nonwater-bearing. The area available for recharge utilized in the A-N study was the entire study area. This report utilized the areas underlain by geologic formations considered to be water-bearing. The use of this reduced recharge area results in an additional one-third reduction in annual recharge.

Existing and future water demands for each subarea were also estimated. Future water demand was estimated based on build-out density estimates provided by the Monterey County Planning Department and recent per-capita water consumption data from the area. Existing and future water balance inventories were then performed. Currently, a water surplus exists in all of the subareas except for Calera Canyon, where there is an annual deficit of approximately 49 afy. The Calera Canyon subarea, however, is a small alluvial basin with approximately 700 acre-feet of storage. Short-term deficits, resulting in removal of ground water from storage, will continue to develop during periods of deficient precipitation. However, during periods of runoff, the alluvial basin will recover rapidly.

The data presented in this report indicate that local ground water supply problems exist in some portions of the area and will occur in additional areas unless build-out densities are reduced or reapportioned. However, significant data gaps and hydrogeologic uncertainty exist in some areas of the study area. Given these data gaps and uncertainties, focused hydrogeologic studies should be performed in these areas before adopting permanent policies restricting development.

Specific recommendations of the report are as follows:

1) Reconfigure the subareas to appropriately reflect the hydrogeology of the areas. At a minimum, the areas south of the Chupines fault should be considered a separate area from the areas north of the fault.

2) Expand and redesign the existing ground water monitoring network to allow monitoring of individual aquifer systems within a given area. Monitoring locations should be selected to represent general water level conditions within a given aquifer and not localized pumping stresses.

3) Install stream gages at several locations within the study area to allow quantification of the volume of streambed infiltration that is occurring within each subarea. At a minimum, a gage should be installed on Calera Creek in the Four Corners area.

4) Ground water extraction facilities with annual production greater than 5 acre-feet should be metered to provide data to allow estimation of safe yield.

5) Investigation into the viability of development of ground water from bedrock aquifer systems within the study area should be performed. These investigations should be performed on a site-specific basis and focus on demonstrating the long-term reliability of the aquifer.

6) Additional hydrogeologic studies should be performed to reduce the uncertainty within the study area. These studies should include a further investigation into the interaction between Laguna Seca subarea and El Toro area, the refinement of the relationship between the El Toro area and areas downgradient to the east, and a detailed well inventory of the entire area.

7) Develop a ground water management plan to assure proper utilization and protection of existing ground water supplies. Data from the stream gages and expanded ground water monitoring program should be used to verify the conclusions of this report and better establish the distribution and recharge available.

8) Review and revise the proposed build-out development for each area to assure that build-out is consistent with estimated ground water supplies. Some modification of the General Plan may be necessary to match water demand with available supply.

# INTRODUCTION

## GENERAL STATEMENT

This report presents the findings, conclusions, and recommendations developed as part of an assessment of ground water supply available in the El Toro Area of Monterey County. This report constitutes a review and update of a previous report prepared for the County of Monterey (County) in 1981 by the firm of Anderson-Nichols (A-N). This report is based on a compilation and review of hydrogeologic data collected by the County since the completion of the A-N report and identifying existing and potential ground water quantity and quality problems in the area and verifying previous assumptions and conclusions contained in the A-N report.

In the report, the study area is referred to as the "El Toro Area" and includes the area encompassed by Calera Creek, Corral de Tierra, San Benancio Canyon, and Harper Canyon. The study area is shown on Figure 1 - Study Area.

## PURPOSE AND SCOPE

The purpose of this report is to review the methodology and conclusions of the A-N report and, in light of land use changes and data collected since the completion of the report, update findings and conclusions relative to the water resources of the El Toro area.

The scope of work was developed through discussions with staff of the Monterey County Water Resource Agency (Agency), the Monterey County Environmental Health Department, and the Monterey County Planning and Building Department. The scope of work was presented in a letter of proposal dated February 6, 1991. Notice to proceed was received on April 2, 1991. Work performed included:

- Review of the A-N report and the subsequent addenda, and review of public comment records received at the time of publication.
- Attendance at a public meeting to solicit input from area residents regarding ground water conditions and water supply concerns.

- Identification of data gaps and provision of recommendations to acquire additional data. Other than a reconnaissance of the area, no specific well testing, water level measurements, or field data were collected as part of the study.

- Review of water level and water quality data from Agency monitoring network wells. Preparation of water level and water quality hydrographs for the period from 1960 to 1990.

- Updating of water demand estimates for the area based on existing and projected land uses and applicable water duty factors.

- Compilation, cataloging, and assessment of reported water well problems in the study area..

- Comparison of estimated supply and demand in the study area.

- Assessment of the need for a ground water management plan.

- Preparation of this report presenting the findings, conclusions, and recommendations arising from the work performed.

Included with this report are a number of maps, figures, and tables developed as part of the work performed. Plate 1 - El Toro Area - Subarea Designations, presents the study area and the subarea designations. The general surficial hydrogeology of the area is shown on Plate 2 - Hydrogeologic Map. Water level and water quality hydrographs are presented as Plates 3 through 12 - Water Level Hydrographs - El Toro Area - Monterey County, and Chemical Hydrographs - El Toro Area - Monterey County. Summaries of estimates of recharge and water budget are presented as Tables 1 and 2, Average Annual Recharge - El Toro Area, and Summary of Water Supply and Demand - El Toro Area, respectively. Soil moisture balance calculations for the study area are included in Appendix A - Soil Moisture Balance Calculations. Miscellaneous documentation regarding rainfall, water demand, and build-out projections are contained in Appendix B - Miscellaneous Documentation. Water demand calculations for each subarea are contained in Appendix C - Water Demand Calculations. Appendix D - Ground Water Problems, contains a summary of the water supply questionnaires returned by area residents.

**BACKGROUND**

The A-N report was prepared for the Monterey County Flood Control and Water Conservation District (now the Monterey County Water Resources Agency [Agency]) to provide an assessment of the ground water resources of the El Toro Area of Monterey County. The need for the 1981 report was based on a general concern by the Agency regarding the adequacy of the available water supply in light of the 1975-76 drought and increasing development pressure in the area. The population of the area at that time was estimated at 2,775 and was anticipated to increase to 15,381 at build-out, based on population estimates provided by the Monterey County Planning Department. Water levels in the majority of wells in the area had fallen in response to this drought, causing a general concern regarding the adequacy of the supply. In response to this concern, a moratorium on additional development was adopted for the study area, pending the outcome of the study.

The A-N report was completed in 1981 and was based on a review of available hydrogeologic data from 1960 through 1980. The report included a general description of the hydrogeology of the area and attempted to quantify the long-term ground water yield. It also included a comparison of supply and existing and projected water demand, and concluded that the study area, at build-out, would have an adequate supply. The report cautioned, however, that although overall ground water resources in the area were apparently adequate, there were local areas with very limited resources. Included in the A-N report were maps delineating areas with varying limitations of water availability.

The findings of the A-N report were incorporated in the Toro Area Plan portion of the General Plan prepared by the County of Monterey (Monterey County, 1983). Although the General Plan includes a discussion of the availability and distribution of ground water resources in the area, no attempt was apparently made to link zoning of the area in accordance with the local availability of ground water resources. It is likely that lower development densities were not recommended in areas of low water availability because the necessity for redistributing water supplies was recognized as a long-term solution.

The need for the current study was derived from a concern by residents within the study area regarding the adequacy of supply for the implementation of the General Plan. Water levels in the area have declined in response to the current drought (1985-1991) and, as a result, residents have questioned the merits of additional development. These concerns resulted in the downsizing of a proposed development in the Pattee Ranch area of Corral de Tierra.

# FINDINGS

## GENERAL STATEMENT

The focus of this report is a review of the A-N report to assess whether the methodologies previously utilized were appropriate and whether the conclusions previously developed can still be supported. In addition, the conclusions of the A-N report were compared with data collected since the completion of the report to determine whether, in the light of additional data, the conclusions of the report remain valid.

## REVIEW OF THE 1981 ANDERSON-NICHOLS REPORT

**Adequacy of Methodologies.** The methodologies used by A-N are, in general, sound, and the resulting report represents a reasonable assessment of the hydrogeology of the study area. The analysis of water quality trends and water demand contained in the report were thorough and are supported by the data available at that time. Review of the water level data now available, however, suggests that an alternative, more conservative method of determining recharge may be appropriate. Several additional years of precipitation data are available subsequent to the A-N report, giving the "soil moisture accounting method" a higher level of confidence. The "soil moisture accounting method" yields a substantially lower estimate of ground water recharge when compared to the method utilized by A-N for determining recharge. In addition, much of the area used for recharge calculation by A-N is underlain by geologic formations considered to be nonwater-bearing. Removal of these areas from the recharge area also results in a lower estimate of the volume of recharge. The basis for these determinations is discussed below under Water Supply.

**Hydrogeology.** The hydrogeology of the area was discussed in detail in the A-N report. The interpretation of the hydrogeology was based on available water well logs and the previous work of Dibblee (1973) and Thorup (1977). No data were reviewed as part of the preparation of this report that would change the hydrogeologic interpretation presented by A-N. The general hydrogeology of the area and the designated subareas are presented below.

**General Hydrostratigraphy.** As discussed in the A-N report, ground water occurs in the study area within six hydrostratigraphic units. These units, in order of increasing geologic age and depth, are: 1) the alluvial deposits along stream courses, 2) the Paso Robles Formation, 3) the Santa Margarita Formation, 4) the Monterey Shale, 5) the basal sand deposits (locally named sandstone units underlying the Monterey Formation including the Los Laureles, Chamisal, and Turlacitos Sandstones), and 6) the granitic bedrock. Of these six rock units, only the alluvial deposits and the Paso Robles and Santa Margarita Formations constitute aquifers that provide a quantifiable supply to the study area. Wells in the Monterey Shale typically display poor yields and are commonly demerited by elevated mineral content (i.e., poor water quality). The basal sand deposits are spatially restricted and, due to a lack of understanding of the mechanism of recharge to these units, are considered an unreliable supply. Recent attempts to produce water from the basal sands have shown large declines in yields within months of well construction. The granitic bedrock can occasionally constitute a minor ground water supply; however, because ground water movement within the granite is controlled by the occurrence of fractures, the distribution and the long-term reliability of the resource within the granite is unpredictable.

**Appropriateness of Hydrogeologic Subareas.** The El Toro Area designation in large part derives from a hydrologic area encompassing the watershed of El Toro Creek. The study area was subdivided by A-N into five subareas based on smaller subdivisions of the watershed. The subareas represent areas between significant topographic divides that control the movement of surface water. The subareas were considered planning units and not intended to delineate hydrogeologic subbasins. The subareas, as defined, are not completely appropriate on a hydrogeologic (i.e., subsurface flow) basis. The five subareas, however, were used as planning area subunits and, in effect, have been "institutionalized." For purposes of this report and in the interest of consistency, the previously designated subunits will be used. The five subareas and their general hydrogeology are discussed below. Each subarea is shown on Plate 1.

El Toro Creek. The El Toro Creek subarea includes approximately 408 acres straddling Highway 68 downstream of the confluence of El Toro Creek and San Benancio Creek, and upstream of the larger Bingham Ranch area. The two water-bearing aquifer units in the subarea are the alluvial deposits flanking the creek and the Paso Robles Formation. Review of well logs from recently constructed wells in the Ambler Park area reveals the presence of the Santa Margarita Formation underlying the Paso Robles Formation in this area.

Corral de Tierra. The Corral de Tierra subarea includes the area east of Los Laureles divide, south of the watershed divide separating Fort Ord from the El Toro watershed, west of the ridge between San Benancio and El Toro Creeks, and north of the Chupines fault. The subarea encompasses approximately 3,344 acres. Water-bearing formations within the subarea include the alluvium along El Toro Creek and the Paso Robles and Santa Margarita Formations. Ground water flow in the subarea is generally to the north. However, recent investigations (Staal, Gardner & Dunne, Inc. [SGD], 1988) have demonstrated a component of westerly subsurface flow to the adjacent Laguna Seca subarea within the Santa Margarita Formation in the southern portion of the subarea.

San Benancio Gulch. The San Benancio Gulch encompasses approximately 3,820 acres, and is bounded on the west, north, and south by the Corral de Tierra, El Toro Creek, and Watson Creek subareas, respectively. The western portion of the subarea contains the water-bearing units of alluvial deposits, and the Paso Robles and Santa Margarita Formations. In the southeastern portion of the subarea, uplift along the Harper fault has brought granitic bedrock to the surface. Ground water flow within the alluvial deposits and the Paso Robles and Santa Margarita Formations is generally northerly. The direction of ground water flow within the granite is unknown.

Watson Creek Subarea. The Watson Creek subarea is north of the Watson/Calera Creek topographic divide and south of the San Benancio/Corral de Tierra divide. The subarea encompasses the drainage area of Watson Creek and includes the area of Upper Corral De Tierra. The total area is approximately 4,708 acres. Water-bearing units present in the area include the alluvial aquifer underlying and flanking Watson Creek, and the aquifer units within the Paso Robles and Santa Margarita Formations. However, the aquifers within the Paso Robles and Santa Margarita Formations are only saturated in the northern portion of the subarea. Currently, no significant ground water production occurs from this northern area. Most of the ground water production in the subarea is currently produced from the alluvial aquifer, with a minor component of the production being derived from the Paso Robles Formation in those wells that are also completed in that formation. Ground water flow in this subarea is from south to north, generally following the alluvial deposits along Watson Creek. The direction of flow within the Paso Robles and Santa Margarita Formations in the subarea is unknown, largely due to limited well control.

Calera Canyon. The Calera Canyon subarea encompasses approximately 8,155 acres, and is defined as the area north of the watershed divide with Carmel Valley and south of the watershed separating Calera and Watson Creek drainages. The two structural highs that form the watershed divides are the result of uplift along the two traces of the Chupines fault, which trends through the study area. As a result of the uplift along these two fault traces, the geology of the subarea is dominated by outcrops of nonwater-bearing granite and Monterey Shale. Ground water, in quantities sufficient to sustain even modest well yields, is found only in the alluvial aquifer underlying and flanking the lower reaches of Calera Creek. Review of available well log data reveals this aquifer unit to be less than 100 feet thick. Ground water resources within the bedrock formations of the granite and Monterey Shale are considered limited.

Ground water produced from the Monterey Shale is commonly demerited by high mineral content and hydrogen sulfide gas. Ground water flow within this subarea is limited to flow within the alluvial aquifer. Ground water flow within the bedrock formations is restricted due to extremely low permeability and faulting. As a result of the limited ground water flow, little, if any, ground water leaves this subarea to downgradient subareas. Surface water leaving the subarea becomes streambed percolation in the Corral de Tierra subarea or leaves the study area through El Toro Creek.

## WATER SUPPLY

**Recharge Assessment by A-N.** Ground water supply to the El Toro area was estimated by A-N through a comparison of average monthly rainfall falling in the area and the amount of water lost from the area by evapotranspiration and runoff. Rainfall data were compiled from available records within the El Toro area. During periods when local records were not available, the record was extrapolated from the Salinas record. From the available records, an isohyetal map of annual average rainfall was created. The average annual rainfall was then distributed throughout the year based on the average distribution from the available long-term records.

Evapotranspiration values for the area were estimated by adjusting evaporation pan data from a station most comparable in climatic conditions. The evaporation pan data were adjusted to potential evapotranspiration (PET) for a grassland environment. The resulting annual PET for the area was estimated at 37.7 inches, and ranged on a monthly basis from a high of 5.17 inches in July to a low of 1.33 inches in January.

The average monthly rainfall data were then compared to average monthly evapotranspiration values to calculate the "excess" water on a monthly basis. The fundamental assumption of this comparison was that all available water in excess of evapotranspiration and runoff becomes recharge to the underlying ground water reservoirs. Using this methodology, mean annual recharge in the differing subareas ranged from 4.6 to 0.6 inches and averaged 3.5 inches for the entire study area. Using these values, the annual recharge for the study area was estimated at approximately 6,000 acre-feet per year (afy).

$\frac{3.5'' \text{ recharge}}{13.4 \;\bar{x}\text{ precip (App B)}}$ = Recharge is 26% of precip

The assumption that all excess water becomes recharge is optimistic, however, because percolating water is initially stored in the soil matrix until the storage of the soil column is exceeded (i.e., when the water content of the soil exceeds "field capacity"). The water stored in the soil matrix is then extracted by vegetation during periods when rainfall is less than the PET. The omission of soil storage in A-N recharge calculations received comment by the California Department of Water Resources (DWR) in their review of the A-N report, although they agreed with the general conclusions of the report (DWR, 1982). A-N responded to the DWR's comment by stating that the phenomenon of moisture removal by plants in dry season months was poorly understood and believed to be insignificant.

The omission of soil storage in the recharge calculation results in overestimation of annual recharge. The upper 3 to 4 feet of soil column (the average rooting depth of native grasses) can hold between 3 to 8 inches of water, depending on the soil type and structure. Sandy soils typically have a field capacity of approximately 1 inch per foot. Clay-rich soils can hold as much as 3 inches per foot of soil column. Assuming that vegetation removes all available moisture (available moisture is that moisture between the water content at field capacity and the water content at permanent wilting point) during the dry season, the first 6 inches of precipitation is likely retained in soil storage and then transpired. Recharge, therefore, only occurs when soil storage is exceeded.

**Recalculation of Recharge.** Recharge resulting from infiltration of precipitation falling on pervious surfaces within the El Toro area can be estimated utilizing soil moisture balance methods developed by the Soil Conservation Service (SCS). This method models, on a monthly basis, the upper portion of the soil zone, defined by the average rooting depth of the vegetation supported, as a reservoir with a known capillary storage. Input of water to the reservoir occurs episodically in the form of infiltration of precipitation, as well as by irrigation. This latter component of soil moisture and recharge is, however, accounted for as artificial recharge through a reduction in gross demand.

Extraction of water retained within the root zone is in the form of evapotranspiration. Evapotranspirative demands are assumed to be continuous and the rate is dependent on seasonal climatic factors. Utilizing this model, deep percolation occurs only when the storage capacity of the root zone is exceeded.

Review of the Soil Survey of Monterey County, California (USDA-SCS, 1978) reveals that soils within the El Toro area consist of clay to sandy loams assigned to the Santa Ynez, San Andreas, Gorgonio, Santa Lucia, and Sheridan Soil Series. Physical property data included in the Soil Survey document indicate the water-holding capacities for these soils range from 1.4 to 1.8 inches per foot and average approximately 1.5 inches per foot. Native vegetation in the area consists mainly of low grasses, shrubs, and trees, with rooting depths averaging approximately 4 feet (Dunne, 1978). Using these figures, the average storage capacity of the soil reservoir within the study area is approximately 6 inches or 0.5 feet (1.5 inches per foot x 4 feet = 6 inches).

Specific evapotranspiration data are not available for the El Toro area. California Irrigation Management Information System (CIMIS) data are, however, available for the nearby Soledad area and are presented in Appendix B. These evapotranspiration data represent potential evapotranspiration of a reference crop (short, well-watered grass) and are designed to be corrected with a coefficient that represents a particular crop ("crop coefficient"). Crop coefficients have not been formally derived for native grasses and shrubs; however, current estimates average approximately 0.7 (Dunne, 1978). For purposes of modeling the soil reservoir, the monthly CIMIS data were corrected by this value. The corrected evapotranspiration data for the area ranges from 3.25 inches in July to 0.98 inches in December. These values are lower than the values utilized by A-N.

Precipitation data used as a model input were derived from the Los Laureles gage located west of Los Laureles Grade in the upper portion of the Hidden Hills housing development. Precipitation data for the 21-year period from 1968 to 1989 are available from this gage. This gage was selected based on the duration and completeness of the record. The soil moisture model assumes that recharge occurs on an episodic basis in response to the temporal distribution of rainfall rather than the total, and therefore requires monthly rainfall data. The Los Laureles gage record is the most complete of the gages in the area and, although rainfall varies within the study area, with the southern portion receiving 2 to 4 inches more on an annual basis and the northern portion receiving approximately 1-inch less, is considered a reasonable average for the area.

In order to determine if the period from 1968 through 1989 was representative of long-term precipitation patterns, the precipitation records from 1968 through 1989 at the Salinas airport station were compared to the 117-year period of record at this station. The comparison of the mean rainfall from the 21-year period of record with the mean rainfall from the entire period of record indicates the mean rainfall for the shorter period is approximately 7 percent less than the long-term mean. Comparison of the mean annual rainfall for the slightly longer period from 1960 to 1989 (the period presented on the hydrographs on Plates 3 through 7) reveals this period to be approximately 8 percent deficient in rainfall. The precipitation record and the long-term averages for differing periods are presented in Appendix B.

Additional analyses of the long-term trend at the Salinas station included the calculation of the cumulative deviation from the long-term mean, which is presented as Figure 2 - Cumulative Deviation from Mean-Precipitation-Salinas Airport. Review of Figure 2 reveals the presence of several cycles in the long-term record. Evident in the graph of these data are three periods of above average precipitation; the periods between 1889 through 1896, 1903 through 1915, and 1933 through 1943. Also evident are several dry periods; the periods between 1895 through 1902, 1923 through 1932, 1957 through 1965, and 1984 through 1989. Of particular importance to this study is the evidence that, with the exception of a few isolated years of above-average precipitation, precipitation at the Salinas station has been approximately average or below average since 1945. Given this trend over the last 45 years, the precipitation record at the Los Laureles gage is considered relatively representative.

All precipitation that falls in the study area does not infiltrate into the soil. Some volume of the rainfall, depending on storm intensity and timing, becomes runoff and leaves the study area. The volume of runoff leaving the study area is measured at the gaging station on El Toro Creek, which is operated by the United States Geological Survey. Data from this gage was used to adjust gross rainfall in the study area to effective rainfall; effective

$\frac{2.8'' \text{ recharge}}{13.4'' \ \bar{x} \text{ precip (App B)}}$ = Recharge is 21 % of precip



rainfall being that portion remaining in the watershed. The gross rainfall within the area was adjusted downward by assuming that the volume of runoff was uniformly derived throughout the study area (total runoff divided by total area). This assumption is a simplification; however, for purposes of modeling the entire study area, the assumption is considered appropriate.

Utilizing the above data, a monthly soil moisture balance was calculated for the last 21 years. The resulting recharge rate for each year is presented in Figure 3 - Infiltration of Rainfall-El Toro Area, Monterey County. Review of Figure 3 indicates that the annual recharge rate is highly variable and fluctuates from 0 to 11.28 inches, averaging 2.18 inches. In years of average or below average rainfall, annual infiltration is, depending on temporal distribution, typically less than 2 inches and, in fact, in most years, is zero. In years of above average rainfall, recharge is significantly greater, typically 4 to 8 inches. Soil moisture balance calculations for the years 1968 through 1989, as well as a sample calculation, are included in Appendix A.

Given the above estimates of average infiltration, the average annual "water crop" (i.e., available supply in accordance with the safe yield concept) was calculated using the estimated acreage of each subarea. The area available for recharge was considered to be those areas underlain by alluvium, Paso Robles Formation, or Santa Margarita Formation. The portions of the subareas underlain by Monterey Formation, the basal sands, or granite were not included in the acreage because water infiltrating into these units is difficult to extract in usable quantities and quality is typically degraded by residence time in these formations. These areas are delineated on Plate 2. Using these criteria, the total acreage of the San Benancio Gulch and Calera Canyon subareas were reduced. The acreage of the San Benancio Gulch subarea was reduced by the area underlain by granite east of the Harper fault, an area of approximately 1,144 acres. The acreage of the Calera Canyon subarea was reduced from the watershed area of 8,136 acres to an area of 271 acres. The acreage used for each subarea, the recharge rate, and the resulting volume of water is presented on Table 1 - Annual Average Recharge. For comparison, the acreages, recharge rates, and resulting recharge used in the A-N report are also presented. Figure 4 - Recharge Area Comparison, and Figure 5 - Average Annual Recharge Comparison, contrasts the recharge areas used by A-N and SGD, and the resulting estimates of average annual recharge, respectively.

Comparison of the values presented on Table 1 shows the recharge estimates advanced by A-N to be significantly higher than the values resulting from the above analysis. The reasons for the reduction derive equally from consideration of the water removed from soil storage by vegetation and revision of the area available for recharge. Consideration of the soil moisture storage results in an approximate 38 percent reduction in average annual recharge rates (approximately 2,280 acre-feet of recharge). The exclusion of the areas of the study area that are not water-bearing from the areal recharge estimates results in an additional reduction in study area recharge by approximately 1,640 acre-feet (9,009 acres x 2.18 inches). This exclusion is considered reasonable because most of the recent development in areas underlain by nonwater-bearing formations have obtained their water supply from off-site wells completed in traditional water-bearing formations.

Uncertainties also exist in the soil moisture method of recharge analysis. The majority of the uncertainties are contained in the assumptions of the vegetation evapotranspiration rates under conditions when soil moisture is limited and in the selection of representative rooting depth for the vegetative cover of an area. Additional uncertainties are contained in the assumption that precipitation can be assumed to be equally distributed in the study area. Given these uncertainties, we believe the assumptions used in the current analysis are adequately conservative and may fall within a range of accuracy of 20 percent.

The above analysis assumes that ground water supply in the El Toro area is derived predominately from infiltration of precipitation. An additional component of recharge, particularly to the alluvial aquifers of Calera and Watson Creeks, is streambed percolation. The recharge analysis performed by both A-N and above integrates these two components of recharge into a watershed model that assumes that all water not leaving the watershed as either runoff or evapotranspiration becomes recharge. This approach is believed appropriate in an area of uniform geology. However, in the El Toro area, several of the subareas, particularly Calera Canyon, derive the large majority of their recharge from streambed percolation. The volume of the recharge is a function of the duration of streamflow rather than gross runoff. The magnitude of this component is, however, extremely difficult to estimate without detailed streamflow records, which are not available. However, in the areas supported by alluvial aquifers within the upper watersheds of the study area, this component is likely the primary component of recharge. Although it is difficult to estimate this component of recharge, review of the hydrographs and anecdotal evidence from area residents suggest that the alluvial aquifers in these areas fill relatively quickly in response to as little as 2 weeks of continuous streamflow. After filling, additional recharge is rejected. Because the duration of sustained streamflow in these areas cannot be documented, the component of streambed infiltration cannot be distributed between subareas. Streambed infiltration is, however, on an areawide basis, accounted for in the overall water balance of the study area by adjusting the total volume of precipitation in the watershed by the discharge through the El Toro Creek gage.

**WATER DEMAND**

Current water demand for each subarea was calculated as part of the A-N report utilizing the estimated number of existing housing units and an average water duty factor derived from Toro Water Service consumption records for the area. Utilizing a per capita use of 150 gallons per day and an average occupancy of 3.34 persons, an annual water duty value of 0.56 acre-feet per residence was derived. This value was then reduced by one-half based on the assumptions that 50 percent of domestic water demand is used outside with a 20 percent return flow, and that of the remaining 50 percent, 80 percent is return flow through septic systems (Johnson, 1980). The resulting net water duty factor of $\boxed{0.23}$ acre-feet per unit was then used to calculate current and projected water demand. A-N assumed that population in the study area would grow to a saturated residential population of 15,381 people based on estimated housing densities provided by Monterey County Planning Department. A-N concluded that total build-out water demand would be 1,735 acre-feet/year. The current and estimated build-out demand advanced by A-N is presented on Table 2 - Summary of Water Supply and Demand-El Toro Area.

Gross = 0.56 × 50% for indoor = 0.28 af/yr
Gross = 0.56 × 50% for outdoor = 0.28 af/yr

Outdoor = 0.28 × 0.8 = 0.224 net outdoor demand
Indoor = 0.28 × 0.2 = 0.056 net indoor demand
$\boxed{0.28}$ total net demand

Water demand for the subareas were recalculated as part of this study based on revised estimates of the number of existing units and build-out densities provided by the Monterey County Planning Department (included in Appendix B). Review of the figures provided by the Planning Department reveals that an additional 1,707 units would exist in the study area at build-out. Assuming a housing occupancy rate of 3.34 persons per unit, the resulting population increase would be approximately 5,700 persons. The build-out estimates, however, are based solely on zoning and have not been adjusted to include areas that are not suitable for development based on slope stability, viewshed, and other planning considerations. If these factors are considered, actual build-out may be substantially less.

Water duty factors for the study area were also adjusted to reflect more recent data and reflect differing lot sizes. A water duty factor for high density (more than two housing units per acre) was derived from review of water deliveries from Ambler Park Water Company over the last 5 years, as presented in Appendix B. Water consumption data from homes within the Toro Water Service Company's service area were unavailable. Water duty factors for larger lots were derived from data developed by the County of Santa Barbara Planning Department (County of Santa Barbara, 1986) for the Carpinteria area of Santa Barbara County. The water duty factors used for larger lots are substantially higher than the value used by A-N. This was considered appropriate because most large lots will also support expanded exterior uses (i.e., landscaping, agricultural, or livestock). The assumption that net water demand is half of gross demand was retained for most areas. However, in areas where developments overlie nonwater-bearing formations, return flows do not replenish the principal aquifer units. Therefore, gross demand is assumed from these units in these areas. The distribution of new development is largely unknown. However, in the Calera Canyon subarea, all new development will likely be built on nonwater-bearing formations. Water duty for this area has therefore been used as the gross value. If future development is based on expansion of the Salinas Utilities Service Company's service area, similar to Markam Ranch, water demand for these units will also be at a gross demand because wastewater will be transferred into the Salinas basin. The estimated current and build-out water demand for each subarea is presented on Table 2. Detailed water demand calculations for each subarea are included in Appendix C.

**WATER LEVEL DATA**

Water level data for the study area are relatively sparse and are limited to periodic measurements by the Agency. The locations of wells monitored by the Agency are shown on Plate 1. The Agency has collected water level data from six "key" wells within the study area on a monthly basis since 1977, and on an annual basis from an additional 23 wells since prior to 1960. Annual water level measurements are made in December of each year. The collected data for the 31-year time interval from 1960 to 1991 are presented as water level hydrographs on Plates 3 through 7.

Review of the water level hydrographs reveals a general trend of declining water levels in most subareas. This trend is also apparent in the summary hydrograph presenting the aggregate trend of all wells in the study area prepared by the Agency, presented as Figure 6 - Summary Water Level Hydrograph-El Toro Area. The summary hydrograph reveals that water levels in the El Toro area have fallen at an average rate of approximately 0.94 feet per year since 1960. The summary hydrograph, however, was developed from water level data from all wells within the El Toro Area, and represents blended data from differing aquifer units and subareas. As part of this study, the long-term trend in water level for each "study well" was determined and analyzed with respect to the subarea and, when sufficient data were available, aquifer unit. The long-term trend for each well, as well as the well depth, perforations, and producing aquifer, is presented on Table 3 - Summary of Monterey County Water Resource Agency Study Area Wells. A discussion of results of the analysis of each subarea is presented below.

**El Toro Creek.** No wells monitored by the Agency are located within the boundaries of this subarea. The Agency has, however, historically monitored one well to the east of the subarea. This well, State Well No. T15S/R2E-25A1, was monitored through the period from 1960 to 1983 when the well was destroyed. The well served as a production well for the Serra Village subdivision during this period; therefore, the water level record fluctuates in response to short-term production demands and is not indicative of a trend. The hydrograph for this well is included in Appendix B. Also included in Appendix B are hydrographs of two wells operated and monitored by the California Water Service in the Toro Park subdivision. These two wells are designated State Well Nos. 15S/2E-25C1 and 15S/2E-25F1, and are located approximately 6,000 feet to the east and down-gradient of the subarea. Review of the hydrographs from these two wells reveals an average decline in water levels since 1982 of approximately 4.8 feet per year. Declines of this magnitude strongly suggest a depletion of ground water in storage.

**Corral De Tierra.** The Agency collects water level data from 14 wells in the Corral de Tierra subarea. Review of the hydrographs from 12 of these wells (the records from the other 2 wells are relatively limited) reveals long-term water level trends in the subarea range from 0 to -2 feet per year and average -1.05 feet per year. The wells included in the analysis are completed in the alluvial deposits, and the Paso Robles and Santa Margarita Formations. Based on the available data, the water level declines do not appear to be of a greater or lesser magnitude in any particular aquifer unit. However, the majority of the wells are completed in more than one aquifer unit and water levels therefore may mask individual aquifer response. The range in water level decline, and therefore the average water level decline in the subarea, is likely slightly skewed by the inclusion of the production wells of Toro Water Service and Ambler Park Water Company in the data set. These wells are among the largest producers in the study area and consequently display the greatest residual drawdown effects; therefore, the magnitude of the water level declines may be slightly exaggerated. Nevertheless, the general trend in the subarea is one of falling water levels, suggesting a depletion of ground water in storage.

**San Benancio Gulch.** Eleven wells in the San Benancio Gulch subarea are monitored by the Agency. The hydrographs of these wells also display a general downward trend. Of the 10 wells with water level records of sufficient duration to analyze, long-term trends in water level range indicate declines of 0.3 to 1.5 feet per year and average 0.85 feet/year for the subarea. The data do not suggest a significant difference in decline rates between aquifer units. Again, the data suggest that ground water storage depletion is occurring.

**Watson Creek.** Eight wells in the Watson Creek subarea are monitored by the Agency and, of these, six have sufficient records to analyze. Of the six wells, one is completed in granite, two are completed in the alluvial deposits, one is completed in both the alluvium and the Santa Margarita Formation, and the remaining two completed in the alluvium and the underlying Monterey Formation. Over the last 31 years, all of these wells have shown fluctuations in response to drought and precipitation, but water levels have remained relatively stable. No evidence of long-term storage depletion is evident in the records of these wells. In fact, water levels in State Well No. T16S/R2E-24C1 have risen at the average rate of 2 feet per year during the period of record.

**Calera Canyon.** Four wells are measured by the Agency in the Calera Canyon subarea. Two of the wells are completed in the Santa Margarita Formation, one in the alluvial deposits along Calera Creek, and one in both the alluvium and the Santa Margarita Formation. Review of the hydrographs for these wells reveals that, although these wells decline quickly in response to periods of deficient rainfall, water levels appear to recover in response to significant rainfall and streamflow.

## COMPARISON OF SUPPLY AND DEMAND

Comparison of the revised estimates of annual recharge and current demand for each of the subareas presented on Table 2 reveals that all of the subareas, with the exception of Calera Canyon, <u>presently</u> contain surplus ground water. Calera Canyon displays a 59 acre-foot deficit in supply; however, supply estimates to this subarea do not include the component of recharge derived from streambed infiltration. Given Calera Canyon subarea's location in the watershed, the proportion of recharge derived from streambed percolation in this subarea is likely higher than the areas downstream. The Corral de Tierra subarea is essentially in equilibrium with available supply. The subareas of El Toro, San Benancio Gulch, and Watson Creek, based on the analyses presented, have substantial surpluses of ground water.

Review of the annual recharge and build-out demand estimates indicate that <u>at build-out</u>, in accordance with the Toro Area Plan, three of the five subareas will display significant water supply deficits. At build-out, the

Corral de Tierra, El Toro Creek, and Calera Canyon subareas are projected to display water supply deficits of 359, 10, and 450 acre-feet, respectively. The deficit estimated for Calera Canyon is likely high because it assumes no water can be developed in the bedrock formations of the granite and Monterey Shale. It is likely that water can be developed from these formations at some locations; however, for planning purposes, water supply should be considered extremely limited. If development in these areas is permitted, more stringent testing and standards for demonstrating long-term well yields should be required.

The current and projected water supply shortfalls are supported by the general trend in water levels discussed above. Long-term water level declines in subareas without current shortfalls are likely the result of localized pumping troughs. The lack of a projected shortfall in San Benancio Gulch with the observed water level declines may be due to the distribution, both spatially and in depth, of the wells monitored or a lack of understanding of the hydrogeology of the area.

**WATER QUALITY DATA**

The A-N report discussed the ground water quality of the area in detail. In general, A-N characterized ground water in the area as fair to poor quality, with significant variability between and within separate aquifer units. No significant new data were reviewed as part of this report that would suggest that this characterization should be changed.

**Assessment of Collected Water Quality Data.** The work scope for this report was limited to the review of water quality data from Agency study wells in the area. These data were collected and hydrographs for selected constituents are presented as Plates 8 through 12. The data were reviewed for apparent trends in water quality in the area. Generally, the quality of ground water in the study area has become poorer within the last 5 years. This trend is believed to be the result of falling water levels and a lack of recharge. Review of the chemical and water level hydrographs for a given study well reveals a general inverse relationship between specific conductance and water levels. The increase in conductance is likely the result of the lack of dilution from recharge and general increase in conductance that often occurs with increased residence time.

An increase in conductance can also be the result of increased production from lower aquifer units (with poorer water quality) in wells perforated in multiple aquifers, during periods of declining water levels.

A relationship between water levels and nitrate ion concentrations is not as apparent. At some locations, nitrate ion concentrations ($NO_3$) increase with rising water levels, while at others, the concentrations decrease with rising water levels. Whether nitrate ion concentrations increase or decrease with recharge is likely a function of the nature of the surrounding land use. If the density of septic systems is high, percolating water will contain higher concentrations of nitrate ions than in areas where septic system density is lower. Although nitrate ion concentrations in the ground water in the area appear to fluctuate in response to recharge, the concentration of this constituent does not approach the State Maximum Contaminant Level (MCL) of 45 milligrams per liter (as $NO_3$) in any of the Agency study wells.

NITRATE EQUILIBRIUM ASSESSMENT

The A-N report included a projection of the nitrate ion equilibrium concentrations that would be found in the study area at build-out. Their projections were based on the assumptions that all development in the study area would be developed on septic systems and that return flows from all septic systems were tributary to the water-bearing formations. Each subareas was assumed to be a single water-bearing unit, and influent sources of nitrogen were assumed to mix completely with the volume of ground water in storage in the subarea (current Monterey County Health Department guidelines for nitrate equilibrium analysis do not allow dilution by storage). A-N calculations also assumed a mass transfer associated with 2,000 acre-feet of subsurface flow to the Laguna Seca subarea. Given these assumptions, A-N calculated a nitrate equilibrium concentration for each subarea. At build-out, nitrate ion equilibrium concentrations were projected to range from a low of 3.5 milligrams per liter (as nitrogen) in the Calera Canyon subarea to a high of 9.4 mg/l in the Watson Creek subarea. No water quality data were reviewed that suggest these values are invalid.

Given the uncertainties regarding the nature and distribution of long-term development in the study area, a nitrate equilibrium concentration for the study area was not performed as part of this study. The recharge analysis performed as part of the study suggests that the build-out scenario for the area may be relatively optimistic; therefore, build-out may be significantly different than now planned. In addition, none of the subareas can be considered as a single aquifer unit; therefore, an accurate assessment of the mass loading to each aquifer would require a more complete accounting of the number of septic systems in each subarea discharging to a given aquifer unit. Additionally, the volume and origin of the subsurface flow leaving the study area, both through the El Toro area and to the Laguna Seca subarea, will need to be better quantified to determine the current volume of mass transfer. These additional uncertainties make the calculation of a nitrate equilibrium value for each subarea extremely difficult and, without additional data, little more than a guess.

**GROUND WATER PROBLEMS**

Prior to beginning this study, a public meeting was held at the Los Laureles Grade Fire Station to solicit input from area residents regarding the water supply problems in the study area and to present the intended work scope of the study. The meeting was well received, with over 150 people in attendance. At the meeting, questionnaires were distributed and area residents were asked to provide specific input as to the water supply problems that were being experienced. Unfortunately, only 13 responses were received by the Agency.

Responses were received from residents deriving water from private wells, small water systems, and the larger Toro Water Service. Of the 13 responses, 6 of the responses were from Calera Canyon residents, 2 from San Benancio Gulch residents, and 2 from Watson Creek residents. The remaining 3 responses were from residents in the Corral De Tierra subarea. Concerns expressed included those of water level declines and long-term water availability, as well as specific problems regarding water quality, sand production, and well performance. The questionnaire responses are summarized in Appendix D.

Each questionnaire was reviewed as part of this study and, where possible, the respondent contacted for more details regarding a specific problem. Reported problems and their associated causes are discussed below.

**Sand Production.** Six of the respondents cited sand production as a water problem. Sand production from wells is predominately a well design, construction, or pump setting problem. A properly designed, constructed, and developed well will produce sand-free water. Sand is produced from a well when the gravel pack has not been properly sized for the formation in which the well is producing, or was not adequately placed in the annular space surrounding the casing. The problem is aggravated by declining water levels, which may require the pump to be placed within the perforated interval. Sand production can typically be reduced by equipping the pump with a "shroud" (which slows entrance velocities) or by reducing production rates.

**Water Quality.** Seven of the respondents expressed concern regarding water quality. Three of these seven derive water from wells in Calera Canyon. These wells produce water from the Monterey Formation, an aquifer unit with very poor water quality. Several of these wells are deep and produce entirely from the Monterey Formation. The others were drilled and completed without regard to geologic stratigraphy and, as a result, were completed in both the Santa Margarita and Monterey Formations, the latter formation degrading the water produced from the Santa Margarita Formation.

The other respondents concerns were more general and reflect the fact that the majority of the ground water in the study area is only of fair to poor quality. One individual commented that the residual chlorine in water provided by Toro Water Service was excessive.

**Water Level/Production Declines.** Most respondents also commented on declining water levels and an associated decline in well yield. At the time of the public meeting and distribution of questionnaires, water levels had declined significantly in all parts of the study area, at least in part as a result of the current drought. When respondents were contacted in June 1991, many commented that, although they had no way to measure water levels, they believed water levels had recovered to some extent. Water levels in Calera Canyon were reported to have risen approximately 12 feet in response to the March rains (personal communication, Maxwell Chaplin, 1991).

# CONCLUSIONS AND RECOMMENDATIONS

## 1.0 GENERAL STATEMENT

This study was limited to a review of hydrogeologic data collected by the Agency and input from residents in the study area. The existing data are limited, both in spacial distribution and frequency. However, based on these data, it is apparent that local ground water supply problems currently exist in some portions of the study area. Ground water supply problems will occur in additional parts of the study area unless build-out densities are reduced where appropriate. The water supply problems appear to derive from an overestimate of the magnitude of ground water recharge to the subareas and adoption of inappropriate hydrogeologic subareas. The current ground water shortages have been aggravated by a prolonged period of deficient precipitation. Anticipated water shortages at build-out may be the result of the adoption of a land use plan for the area that did not fully consider the distribution of water resources in the area or the recommendations of the A-N report. Unless additional water supplies can be developed, some modification of the General Plan for the area may be necessary to match projected water demand with estimated ground water supplies in the area.

## 2.0 ANDERSON-NICHOLS 1981 REPORT

The A-N report provides a reasonable overall assessment of the hydrogeology of the area. Conclusions contained in the report were relatively well-supported by the data available at the time of preparation of the report. Based on our review of the report and the more recent data, we believe that the report overestimates the magnitude and mechanisms of ground water recharge and that the selection of subareas within the study area are inappropriate.

2.1 **Recharge Estimates.** Recharge to the study area was estimated as the difference between the volume of precipitation that falls in the study area and the volume of water that is lost to the area as surface runoff or evapotranspiration. Average monthly values for precipitation and evapotranspiration in the study area were compared and recharge was assumed to be the sum of the difference between the two values in months that had surplus precipitation. Based on this approach, an average annual recharge value of 3.5 inches was calculated. This value applied to the acreage of the study area resulted in an estimate of annual recharge of approximately 6,000 acre-feet per year.

A-N's approach, however, fails to include the loss of water from the ground water system that results due to the removal of water from soil storage by vegetation during months when evapotranspiration exceeds precipitation. Recalculation of recharge to the area, considering soil/root zone storage, results in an average annual recharge value of approximately 2.2 inches, a value approximately 1-inch or 38 percent lower than the value advanced by A-N.

2.2 **Appropriateness of Subareas.** A significant deficiency in the A-N report is their assumption that the area behaves as one hydrogeologic unit. Implicit in the consideration of the area as one unit is the premise that inflow and outflow of ground water is from a common pool. This, however, is not the case. Ground water resources in the area are contained in minor lens-shaped aquifer systems comprised of alluvium within creeks and within structural blocks containing geologic formations that are generally considered water-bearing. Many of these structural blocks are hydraulically isolated from each other by faulting or folding. Water within one block may or may not be tributary to an adjacent block. The extremely different nature of the alluvial and formational aquifers is most pronounced in the volume of storage and the aquifers response to recharge. The alluvial aquifers go dry relatively quickly, but fill in response to minimal runoff. The more extensive formational aquifer units contain orders of magnitude more storage, but recharge only occurs in response to significant rainfall.

The differences in these two aquifer types is reflected in the nature of the complaints received from the water-users served from these aquifers. Those dependent on alluvial aquifers complain of wells going seasonally dry, with the problem being relieved with seasonal rainfall. Complaints from the water-users served from the formational aquifers are focused on a continued trend of declining water levels, problems that are not quickly resolved in response to rainfall.

Based on the data reviewed and the current level of understanding of the hydrogeology of the area, we believe that the subareas of El Toro Creek, Corral de Tierra, San Benancio Gulch, and the northern portion of Watson Creek subarea are hydraulically contiguous and represent an area with definable hydrogeologic boundaries on three sides. The area is bounded on the north by the Laguna Seca Anticline, on the south by the northern trace of the Chupines fault, and on the east by the Harper fault. The contiguous portions of these areas are the water-bearing units within the Paso Robles and Santa Margarita Formations. The alluvial aquifers underlying and flanking the drainages in each of these areas can be considered separate minor aquifer units with limited hydraulic communication with the underlying formational aquifers. The surface area of this contiguous area was used to determine areal recharge. Infiltration of rainfall in areas underlain by either Monterey Shale or granite were not considered in the current recharge estimates. Utilizing the revised area and the revised areal recharge rate, annual average recharge to the study area was estimated at 2,076 acre-feet. Use of the smaller area for areal recharge results in an additional reduction in the volume of recharge equally significant to that resulting from a revised areal recharge rate. The revised estimate for annual recharge is about one-third of the estimate made by A-N.

The southeastern portions of the Watson Creek subarea are excluded from the larger area described above because the ground water in this area is contained predominately in the shallow alluvial aquifer along Watson Creek and locally within the basal sand and granite formations. Minimal storage exists in the alluvial aquifer and the long-term reliability of the bedrock formations is unproven.

The Calera Canyon subarea is clearly not part of the larger area described above. Ground water resources in this area are essentially limited to the storage capacity of the alluvial aquifer (approximately 700 acre-feet). The area is hydraulically isolated from the areas to the north due to the structural uplift associated with the Chupines fault, which brings low permeability Monterey Formation to the surface. Little, if any, subsurface flow is believed to occur between this subarea and those subareas to the north.

Given the above, we believe that the hydrogeologic boundaries of the area should be revised to be consistent with other areas in the County. Those portions of the study area underlain by bedrock formations that have traditionally been considered essentially nonwater-bearing should not be considered as part of the local ground water system. This approach has been adopted by the County Board of Supervisors as part of the Laguna Seca Subarea Hydrogeologic Investigation prepared by SGD (1988). This approach is also used by the Monterey Peninsula Water Management District in the Carmel Valley area. Adoption of a consistent policy would remove Calera Canyon and southeastern Watson Creek subareas from the greater El Toro area.

2.3 **Implementation of A-N Recommendations.** The A-N report contained specific recommendations to manage the ground water resources of the area. The primary recommendation was to allow the development moratorium to expire and allow further development. This, of course, was allowed to occur. In addition, the report recommended that a 72-hour aquifer test be required to assess the impacts of additional extractions on the available ground water supply. This recommendation has been implemented by the Monterey County Environmental Health Department. However, limited requirements of the testing procedures limit the usefulness of the data generated in terms of determining the impacts on the regional ground water supplies. The A-N report contained several other specific recommendations that have not been implemented. The A-N report included a recommendation to expand the water level and water quality network in the area, specifically in the area of the basal sands formations. To our knowledge, this has not been implemented. These data are considered important since the long-term behavior of the basal sandstones is still poorly understood. The final recommendation of the A-N report was that the areal distribution of ground water resources be considered in the long-range planning for the area. Review of the Toro Area Plan suggests that this recommendation was not adequately implemented.

## 3.0 DATA GAPS

The conclusions of this report are based on hydrogeologic data obtained from the Agency. Significant data gaps still exist. With additional data, the conclusions may be subject to revision. A more formal ground water management plan for the area should be developed and implemented. The plan should include expansion of the existing water level data collection network to include wells selected based on their location and the aquifer system from which they produce. Where possible, wells that are completed in a single aquifer unit should be added to the existing network to allow determination of the hydraulic relationships between the differing aquifer units. If possible, the Agency should enlist the assistance of well owners in reporting water levels from key wells; utilizing a system similar to the volunteer weather observers. Although there would be questions regarding quality assurance of data collected by volunteers, the data would complement the data being collected by Agency staff. Water level data collected could be utilized to prepare formation-specific water level maps, and would assist in understanding the regional patterns of lateral and vertical ground water flow. These data would also allow quantification of the volume of ground water in storage in the study area.

In addition, a detailed inventory of the location, use, and perforated aquifers of all water wells in the area must be performed. These data would allow a better estimation of demand and demand distribution. Consideration should also be given to requiring production meters on extraction facilities pumping more than an annual volume of greater than 5 acre-feet.

In addition to the collection of additional hydrogeologic data, several streamflow gaging stations should be established in the study area. At a minimum, stations should be established at the Four Corners Area and on the upper portions of Watson and Calera Creeks. Data developed from these stations would allow apportionment of streambed percolation into appropriate subareas. The accumulated data would assist in estimating safe-yield for the alluvial aquifer systems.

## 4.0 SUPPLY AND DEMAND

Water demand for each subarea was calculated based on current estimates of the number of housing units in the study area provided by the Monterey County Planning Department. Per unit water use estimates were developed from review of records from water purveyors within the study area and from previous studies. Water demand was also calculated for the number of housing units proposed for each subarea at build-out. At the present level of development, four of the five subareas have adequate supply of ground water. Calera Canyon currently shows a deficit supply. At build-out, El Toro Creek, Corral de Tierra, and Calera Canyon are estimated to have significant shortfalls in ground water supply.

4.1 **El Toro Creek.** Water demand in this small subarea is currently less than 1 acre-foot per year. Recharge to this subarea is estimated at approximately 74 acre-feet per year, resulting in a current surplus of 73 acre-feet. At build-out, water demand in this subarea rises to approximately 84 acre-feet, leaving the subarea with an annual water supply deficit of approximately 10 acre-feet.

4.2 **Corral de Tierra Subarea.** Current annual water demand in this subarea is estimated at 608 acre-feet. Annual average recharge for the subarea is estimated at approximately 609 acre-feet, revealing the area to essentially be in equilibrium with supply. At build-out, demand is estimated to increase to approximately 968 acre-feet, leaving the subarea with an annual ground water supply short-fall of approximately 359 acre-feet.

4.3 **San Benancio Gulch Subarea.** Annual average recharge for the San Benancio Gulch subarea is estimated at about 487 acre-feet. Current annual water demand in the subarea is estimated at 248 acre-feet, with demand increasing to 352 acre-feet at build-out. Comparison of these estimates reveals a current surplus of ground water, a condition that continues at build-out. Water level data from wells in the subarea, however, display significant long-term declines, suggesting that the analyses may be overstating recharge. A more detailed study of this portion of the study area will be required to resolve this uncertainty.

4.4 **Watson Creek Subarea.** Water demand in the Watson Creek subarea is estimated to be 160 acre-feet per year at the current level of development. If the area is built-out as planned, annual water demand is estimated to increase to approximately 256 acre-feet. Annual average recharge in the subarea is estimated at 857 acre-feet. Comparison of the supply and demand in this subarea reveals significant surplus of ground water at build-out. However, it is believed that this surplus ground water may support the estimated 500 acre-feet per year subsurface flow to the adjacent Laguna Seca subarea (SGD, 1988).

Additional development in the Watson Creek area may reduce the surplus of water in this area and thereby reduce the volume of subsurface flow to the Laguna Seca subarea. A reduction in the volume of subsurface flow will impact build-out in the Laguna Seca subarea. A detailed hydrogeologic study should be prepared further defining the nature of subsurface flow between the El Toro and Laguna Seca areas.

4.5 **Calera Canyon Subarea.** Current annual water demand in the Calera Canyon subarea is estimated at 109 acre-feet. This estimate may be high because some of the residences in Calera Canyon area are supplied water from wells that are actually in the Corral de Tierra subarea (i.e., the wells in the Four Corners area). At planned build-out, annual water demand is estimated to increase to approximately 500 acre-feet. Although the total acreage of the subarea is large, annual average recharge to the Calera Canyon area is estimated to be only 49 acre-feet. The low value is the result of, with the exception of the alluvium within Calera Canyon, the entire subarea being underlain by nonwater-bearing formations. Water that infiltrates into these formations does not, for the most part, replenish the principal aquifer systems. Comparison of the supply and demand for this subarea reveals significant short-falls, both currently and at build-out. Besides areal recharge from precipitation, additional supply in Calera Canyon is derived from streambed infiltration. The amount of this component of recharge is difficult to estimate without the establishment of stream gaging stations, but would be limited to the volume of maximum storage in the alluvium (approximately 700 acre-feet). When the alluvial aquifer is full, a condition that would likely only occur in years of above average rainfall, the ratio of total ground water in storage to current demand is approximately 7 to 1. Not all of the ground water in storage is retrievable. Given this limitation, the water in the alluvium likely represents a minimal drought reserve, likely no more than 5 years of supply.

It is possible that some additional water supplies could be developed within the bedrock aquifers in the subarea. For planning purposes, it should be assumed that development of such supplies would be the exception, and development based on such supplies should only be permitted after extensive hydrogeologic study and aquifer testing. Development of water supplies within the bedrock formations will likely result in the production of water of poor quality not meeting Title 22 requirements for domestic water supply. Development of water supplies for other than a single connection may require significant water treatment to meet quality standards. Water supplies developed in the Monterey shale will likely require demineralization through reverse osmosis or similar processes. It is our understanding that the Monterey County Environmental Health Department desalination ordinance restricts ownership and operation of such water treatment facilities for domestic water supply to public agencies. This requirement will likely limit development of marginal water supplies in the area.

## 5.0 WATER SUPPLY OPTIONS

The data reviewed as part of the preparation of this report suggest that storage depletion is occurring in portions of the study area. In order to meet existing and proposed demand, it may be possible to develop a regional water distribution system that would distribute pumping stress throughout the area and balance extractions between differing aquifer units. A regional distribution system could alleviate the localized occurrence of pumping troughs and could improve general water quality for residents currently on marginal wells. Water wells recently constructed by Ambler Park are perforated in the Santa Margarita Formation. Extractions from this aquifer unit have previously been limited to a few wells in the Four Corners area and several of the deep wells at the Corral de Tierra Golf Course. It may be possible to relieve some pumping stress on the Paso Robles Formation through the development of deeper Santa Margarita Formation wells. However, data from test wells recently constructed on Fort Ord, at a location directly north of Toro Water Service wells, suggest that water levels in the Santa Margarita Formation are 30 to 40 feet lower than those in the Paso Robles Formation at the same location, suggesting a net downward flow between these formations. The relationship between these aquifer units at other locations in the study area is not known. If feasible, development of a regional distribution system would have significant costs.

## 6.0 CLOSURE

This report has been prepared for the exclusive use of the Monterey County Water Resource Agency and the Monterey County Board of Supervisors for specific application to the El Toro Area of Monterey County. The report is based predominately on data provided by the Agency. The findings, conclusions, and recommendations presented herein were prepared in accordance with generally accepted hydrogeologic engineering practices. No other warranty, express or implied, is made.

The attachments that complete this report are listed in the Table of Contents.

Sincerely,

**STAAL, GARDNER & DUNNE, INC.**

David A. Gardner
Engineering Geologist 969

Martin B. Feeney
Engineering Geologist 1454

MBF:DG:tg/42

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**TABLE 1**

**ANNUAL AVERAGE RECHARGE**

| SUBAREA | SGD AREA (acres) | SGD RECHARGE RATE (inches/year) | SGD RECHARGE (acre-feet) |
|---|---|---|---|
| El Toro Creek | 408 | 2.18 | 74 |
| Corral de Tierra | 3344 | 2.18 | 607 |
| San Benancio Gulch | 2676 | 2.18 | 486 |
| Watson Creek | 4708 | 2.18 | 855 |
| Calera Canyon | 271 | 2.18 | 49 |
| TOTAL | | 2.18 | 2072 |

| SUBAREA | A-N AREA (acres) | A-N RECHARGE RATE (inches/year) | A-N RECHARGE (acre-feet) |
|---|---|---|---|
| El Toro Creek | 408 | 0.6 | 20 |
| Corral de Tierra | 3344 | 2.4 | 669 |
| San Benancio Gulch | 3820 | 3.3 | 1051 |
| Watson Creek | 4708 | 2.9 | 1138 |
| Calera Canyon | 8136 | 4.6 | 3119 |
| TOTAL | | 3.5 | 5996 |

**TABLE 2**

**SUMMARY OF WATER SUPPLY AND DEMAND**

| SUBAREA | A-N RECHARGE (acre-feet) | A-N CURRENT (1980) DEMAND (acre-feet) | A-N BUILD-OUT DEMAND (acre-feet) |
|---|---|---|---|
| El Toro Creek | 19 | 1 | 66 |
| Corral de Tierra | 674 | 522 | 738 |
| San Benancio | 1063 | 94 | 328 |
| Watson Creek | 1126 | 38 | 384 |
| Calera Canyon | 3126 | 22 | 219 |
| TOTAL | 6008 | 677 | 1735 |
| ESTIMATED POPULATION | | 2775 | 15381 |

| SUBAREA | SGD RECHARGE (acre-feet) | SGD CURRENT (1991) DEMAND (acre-feet) | SGD CURRENT SURPLUS/DEFICIT (acre-feet) | SGD BUILD-OUT DEMAND (acre-feet) | SGD BUILD-OUT SURPLUS/DEFICIT (acre-feet) |
|---|---|---|---|---|---|
| El Toro Creek | 74 | 1 | 73 | 84 | -10 |
| Corral de Tierra | 609 | 608 | 1 | 968 | -359 |
| San Benancio | 487 | 248 | 239 | 352 | 135 |
| Watson Creek | 857 | 160 | 697 | 256 | 601 |
| Calera Canyon | 49 | 109 | -60 | 500 | -451 |
| TOTAL | 2076 | 1126 | 950 | 2160 | -84 |
| ESTIMATED POPULATION | | 4080 | | 9780 | |

# TABLE 3

## SUMMARY OF MONTEREY COUNTY WATER RESOURCE AGENCY STUDY AREA WELLS

| WELL NUMBER | WELL NAME | AREA | ELEV. (feet) | DEPTH (feet) | AQUIFER | TREND 1960-1991 (feet/year) | AVERAGE TREND IN EACH SUBAREA |
|---|---|---|---|---|---|---|---|
| T16S/R2E-15P1 | Marchand | CL | 450 | 65 | Qal | 0 | |
| T16S/R2E-15F2 | Bird | CL | 431.5 | 126 | Qal | 0 | |
| T16S/R2E-10Q1 | Neufield | CL | 397 | 160 | Qal/Tsm | | |
| T16S/R2E-10Q2 | Munsen | CL | 420 | 210 | Tsm | 0 | ND |
| T16S/R2E-04L1 | Xum Spegle | CT | 430 | 603 | QTp | | |
| T16S/R2E-10H1 | Markham | CT | 390 | 187 | QTp | | |
| T16S/R2E-03G1 | Deane | CT | 360 | 100 | QTp | -1 | |
| T16S/R2E-10B1 | Patte Ranch | CT | 370 | 293 | QTp | 0 | |
| T16S/R2E-04H1 | Toro Water Service #1 | CT | 450 | 773 | QTp | -1.8 | |
| T16S/R2E-03K1 | Tierra Verde | CT | 370 | 452 | QTp | | |
| T16S/R2E-03H1 | CT Golf and County Club | CT | 316 | 948 | QTp/Tsm | -1 | |
| T16S/R2E-09H1 | Robley | CT | 482 | 600 | QTp/Tsm | -1.8 | |
| T16S/R2E-09J1 | Chamisal Tennis Club | CT | 440 | 300 | QTp/Tsm | -0.4 | |
| T16S/R2E-03J2 | CT Golf and County Club | CT | | 812 | QTp/Tsm | | |
| T16S/R2E-03J1 | CT Golf and County Club | CT | 321 | 300 | Qal/QTp | 0 | |
| T16S/R2E-02D3 | Ambler Park Water Co. | CT | 280 | 240 | Qal/QTp | -1.5 | |
| T16S/R2E-03A1 | Hargis | CT | 300 | 183 | Qal/Qtp | -0.95 | |
| T16S/R2E-02D5 | Ambler Park Water Co. #3 | CT | 275.4 | 615 | Qal/Qtp | -2 | -1.045 |
| T15S/R2E-24J1 | Guidotti | ET | 111.4 | 160 | Qal/QTp | | ND |
| T16S/R2E-02G1 | Cappe | SB | 371 | 440 | QTp | -1.5 | |
| T16S/R3E-07N2 | Ben | SB | 750 | 385 | QTp | | |
| T16S/R2E-02H1 | Hanson | SB | 380 | 204 | QTp | -0.3 | |
| T16S/R3E-07N1 | Scovil | SB | 741 | 200 | QTp/Tsm | -0.4 | |
| T16S/R3E-07L1 | Culligan | SB | 880 | 260 | QTp/Tsm | -1.1 | |
| T16S/R2E-01L1 | Hugo | SB | 466 | 160 | Qal/QTp | -1.23 | |
| T16S/R2E-02D1 | Reeves | SB | 285 | 116 | Qal/QTp | -1 | |
| T16S/R2E-12G1 | Phillip | SB | 581 | 120 | Qal/QTp | -0.9 | |
| T16S/R2E-01E1 | Smith | SB | 440 | 155 | Qal/QTp | -0.8 | |
| T16S/R2E-01M1 | Titus Park Ass. | SB | 406 | 294 | Qal/QTp | -0.95 | |
| T16S/R2E-02D2 | Cronia | SB | 270 | 150 | Qal/QTp | -0.35 | -0.853 |
| T16S/R3E-17N1 | Decker | WC | 1002 | 160 | Granite | -0.9 | |
| T16S/R3E-17F2 | Diaz | WC | 1328 | Dug | Qal | 0 | |
| T16S/R3E-17F1 | Diaz | WC | 1330 | Dug | Qal | | |
| T16S/R2E-15J1 | Corral de Tierra Church | WC | 483 | 154 | Qal | 0 | |
| T16S/R3E-19L1 | Pattee | WC | 882 | | Qal | | |
| T16S/R2E-24C1 | Hiller | WC | 665 | 165 | Qal/Tm | 2 | |
| T16S/R2E-23H1 | Early | WC | 625 | 200 | Qal/Tm | 0 | |
| T16S/R3E-19L2 | | WC | 877.5 | | Qal/Tsm | 0 | ND |

SB San Benicio Gulch
CT Corral de Tierra
WC Watson Creek
CL Calera Canyon
ET El Toro Creek

* - ND Not Determined, Insufficient Data

FIGURE 1

STUDY AREA

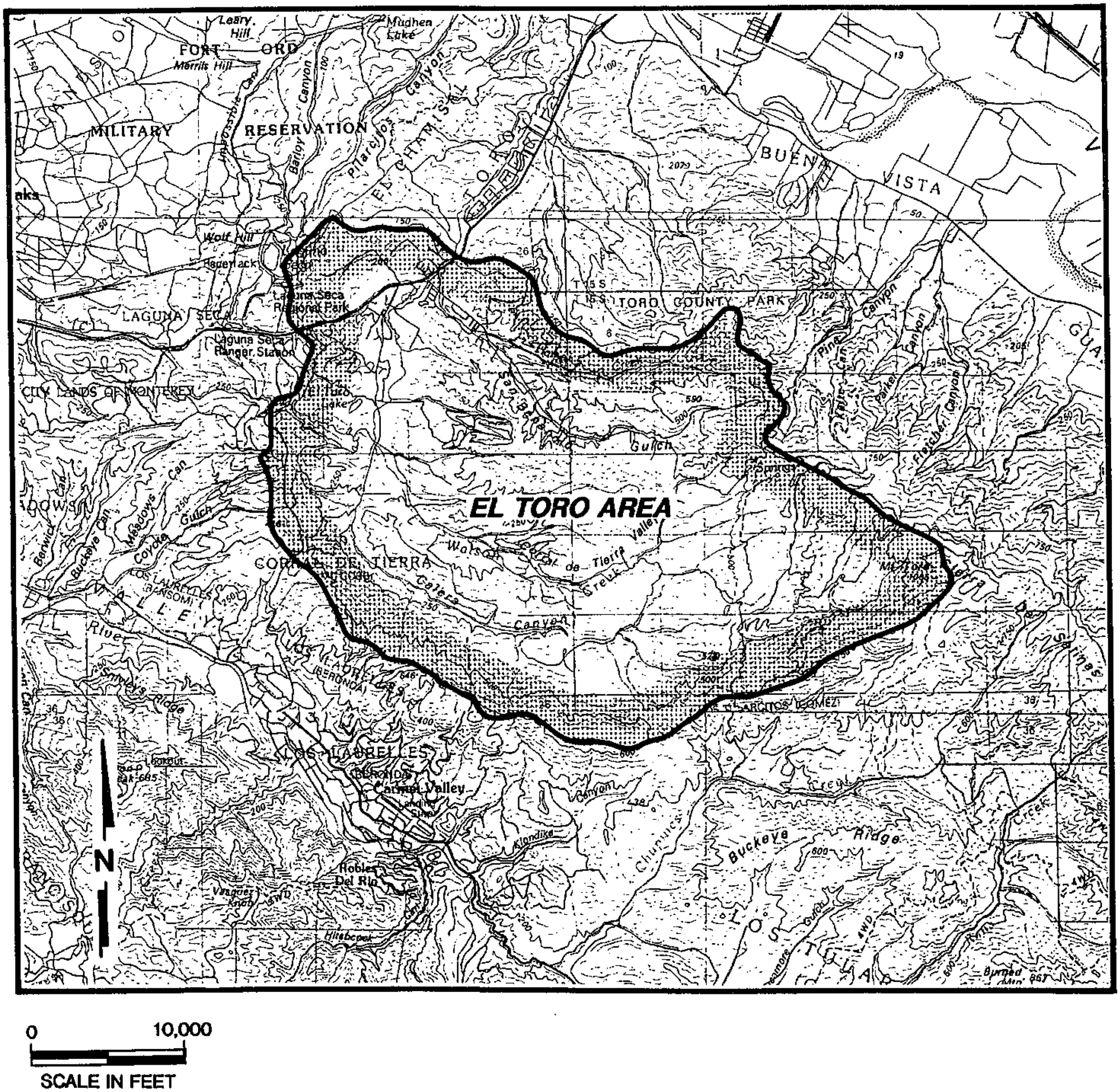


FIGURE 2

CUMULATIVE DEVIATION FROM MEAN PRECIPITATION
SALINAS AIRPORT

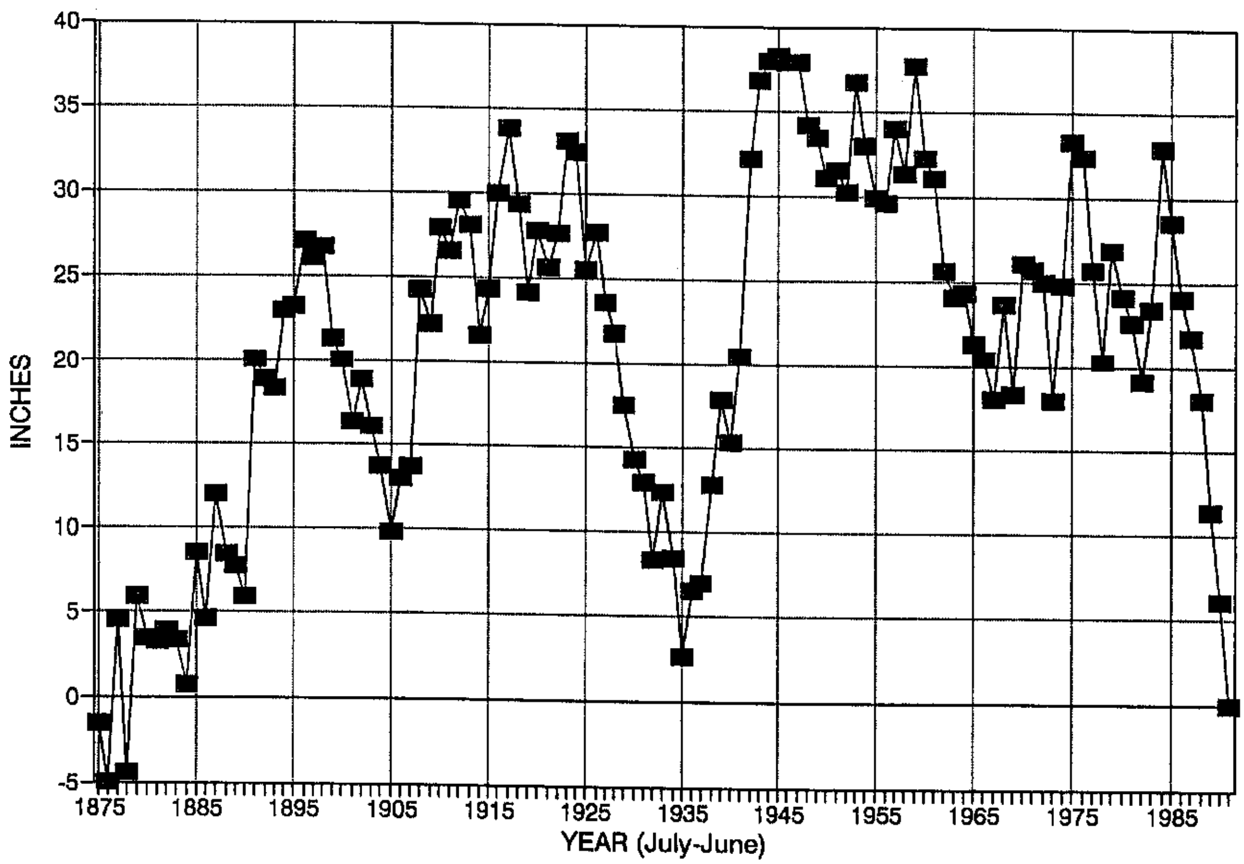


FIGURE 3

INFILTRATION OF RAINFALL

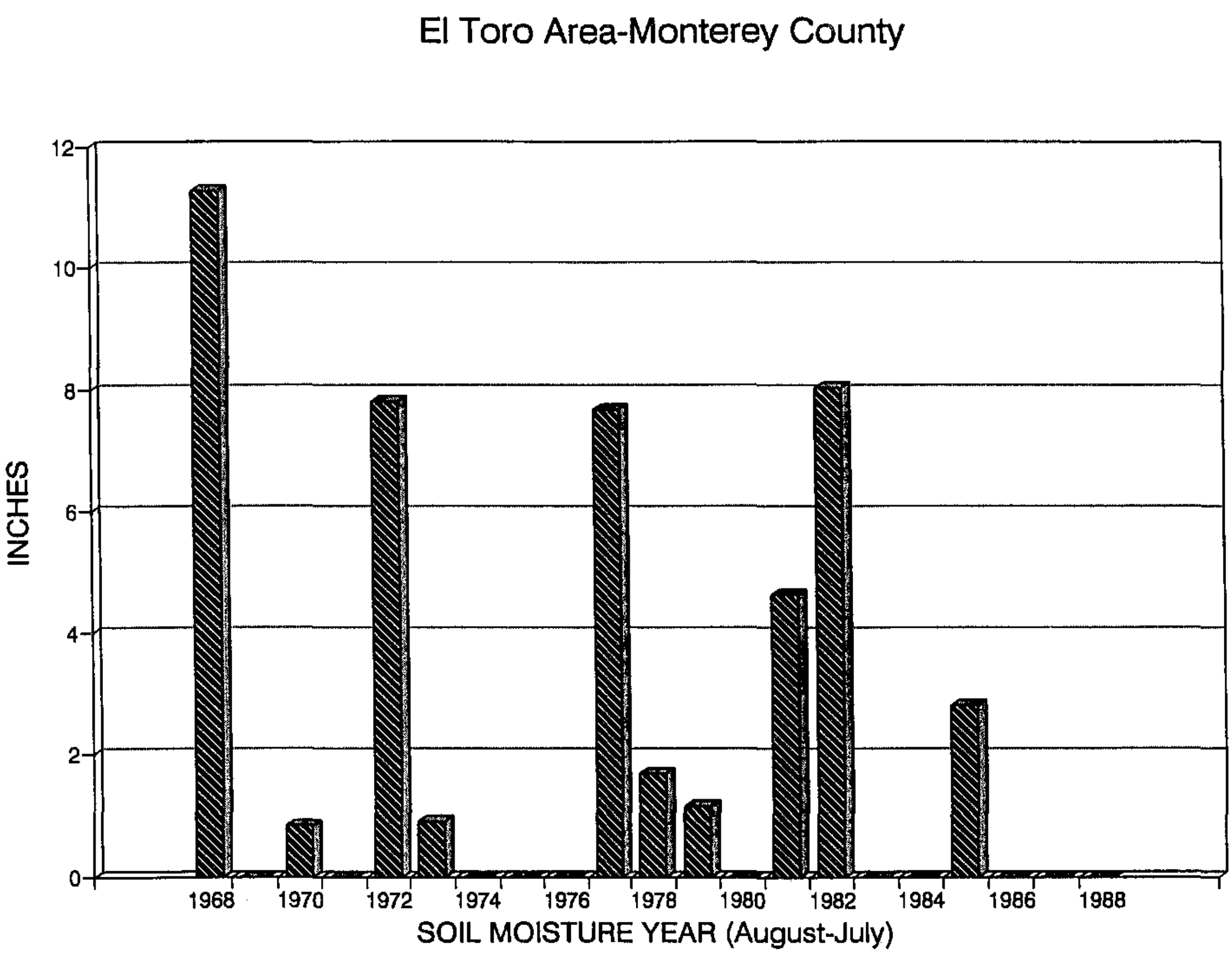


FIGURE 4

RECHARGE AREA COMPARISON

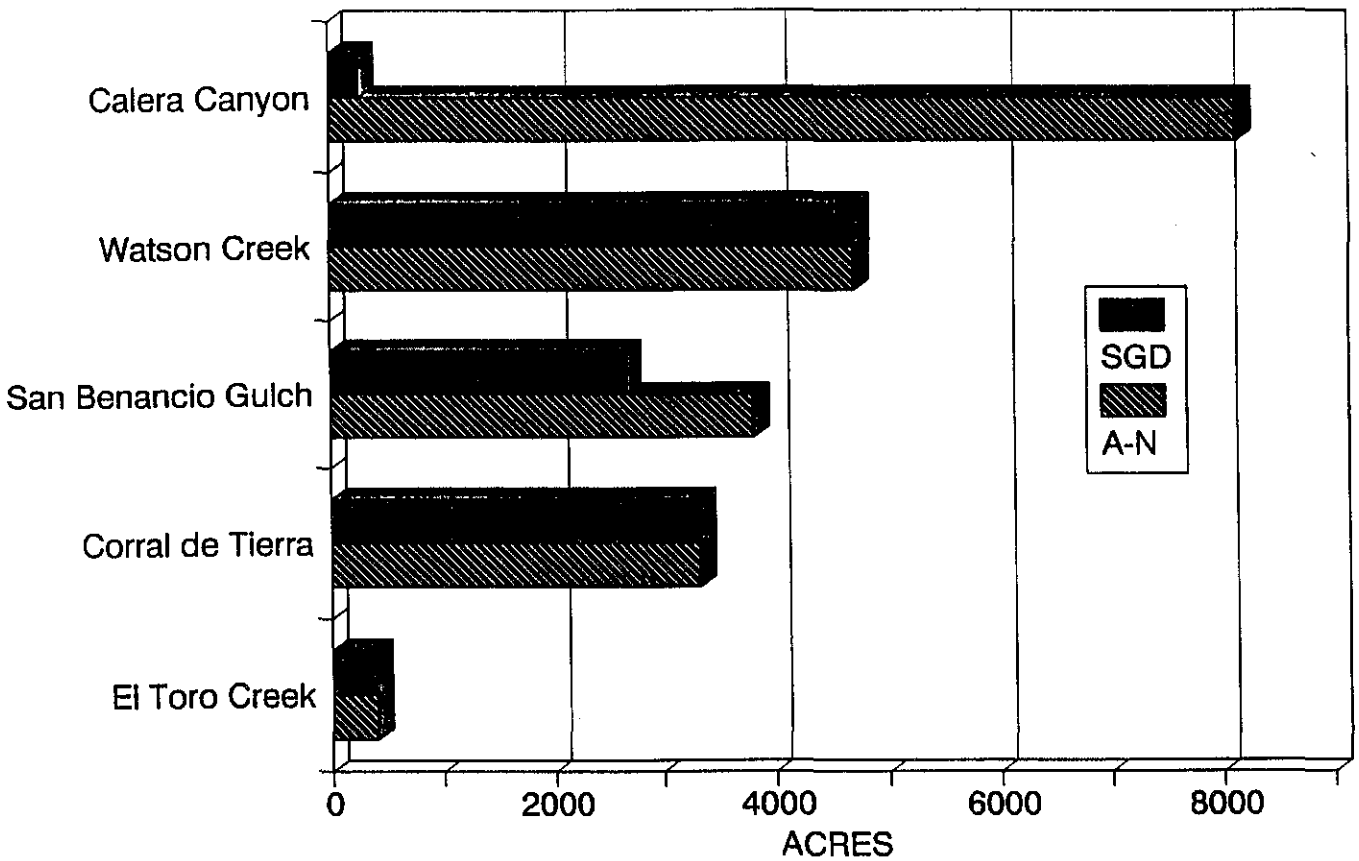


FIGURE 5

AVERAGE ANNUAL RECHARGE COMPARISON

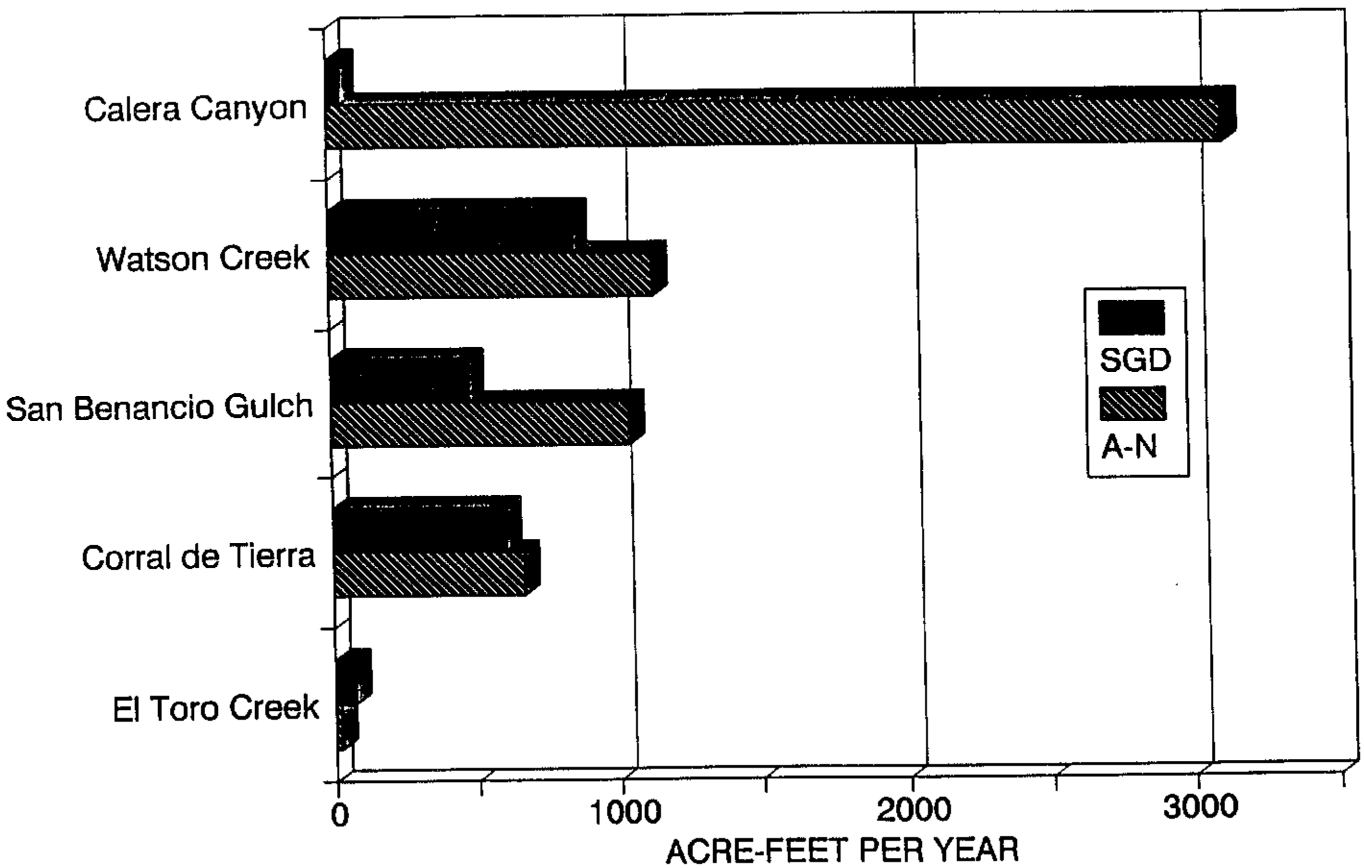
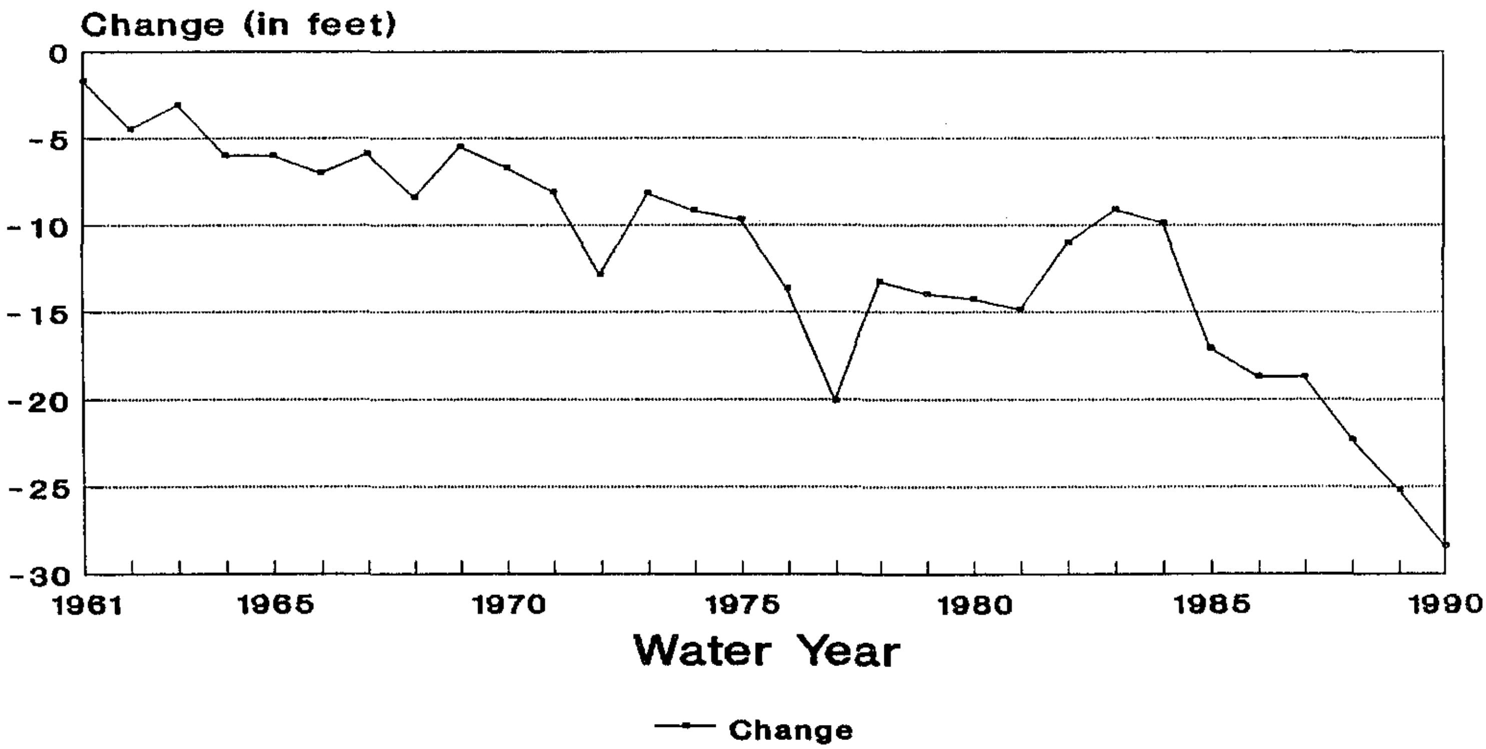


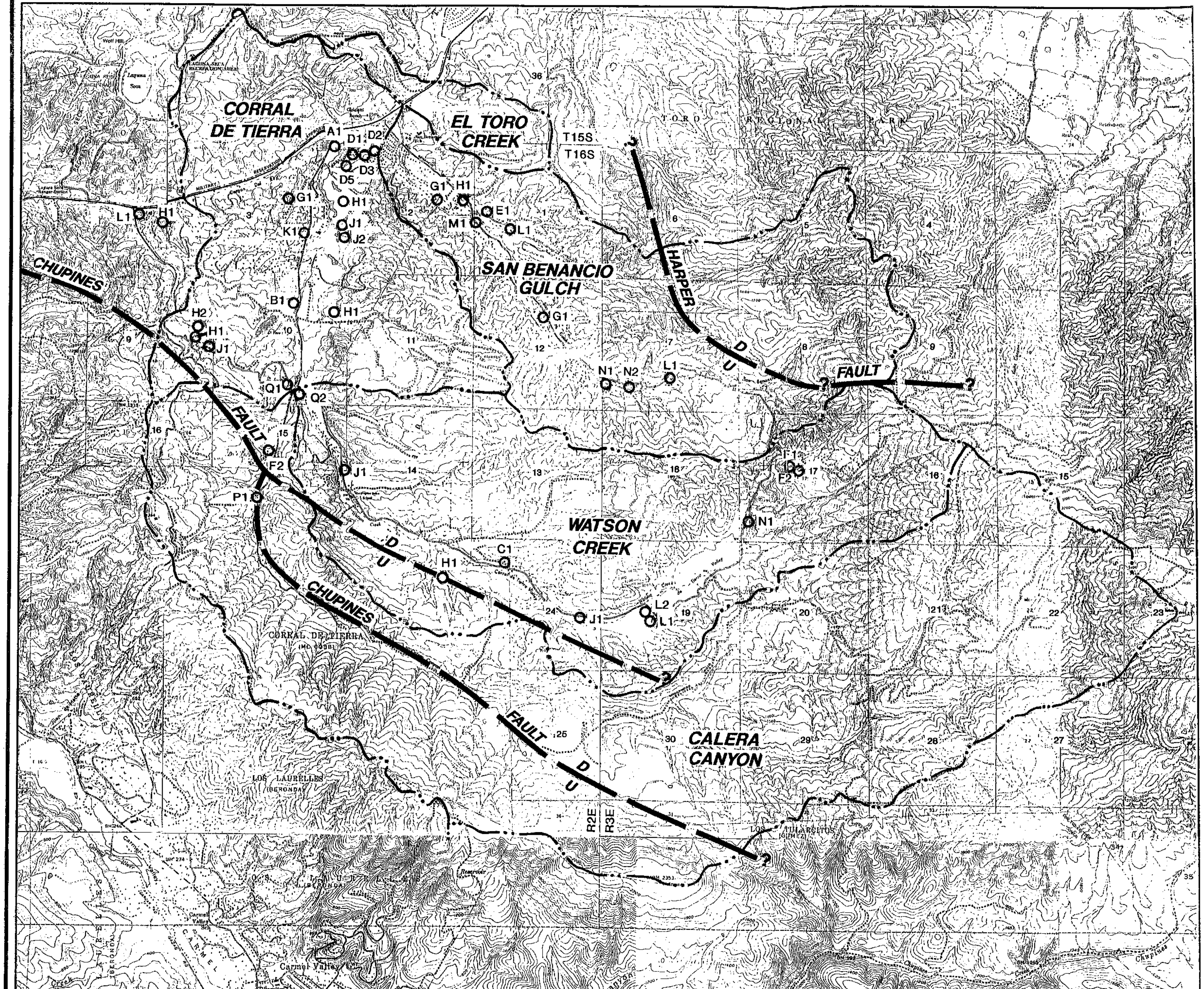
FIGURE 6

SUMMARY WATER LEVEL HYDROGRAPH




Includes San Benancio, Corral de Tierra, and Calera Canyons.

SOURCE: MONTEREY COUNTY WATER RESOURCE AGENCY




LEGEND

SUBAREA BOUNDARY

FAULT, APPROXIMATELY LOCATED, QUERIED WHERE IN DOUBT, SHOWING RELATIVE DISPLACEMENT

N1 WATER WELL MONITORED BY THE MONTEREY COUNTY WATER RESOURCES AGENCY

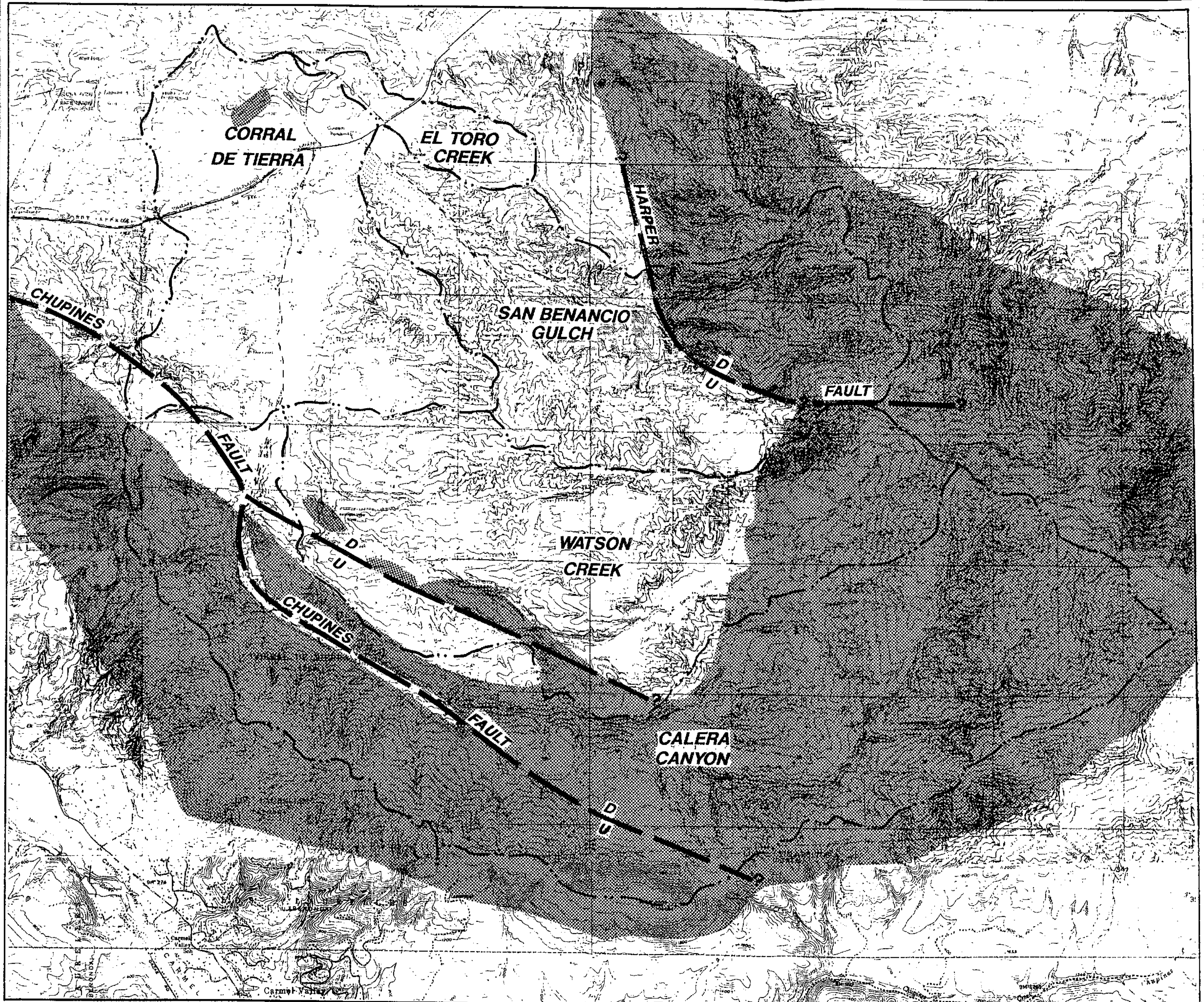
SOURCE: FAULT LOCATION FROM DIBBLEE (1973)

# EL TORO AREA
# SUBAREA DESIGNATIONS

For: COUNTY OF MONTEREY

M91002 August 1991 Plate 1

Staal, Gardner & Dunne, Inc.
Consulting Engineers and Geologists




LEGEND

SUBAREA BOUNDARY

D U FAULT, APPROXIMATELY LOCATED, QUERIED WHERE IN DOUBT, SHOWING RELATIVE DISPLACEMENT

AREAS UNDERLAIN BY TRADITIONAL AQUIFER UNITS (ALLUVIUM, PASO ROBLES FORMATION, SANTA MARGARITA FORMATION).

AREAS UNDERLAIN BY NONTRADITIONAL "AQUIFER" UNITS (GRANITE, MONTEREY FORMATION, BASAL SANDSTONE).

N

0 4000 8000 12,000

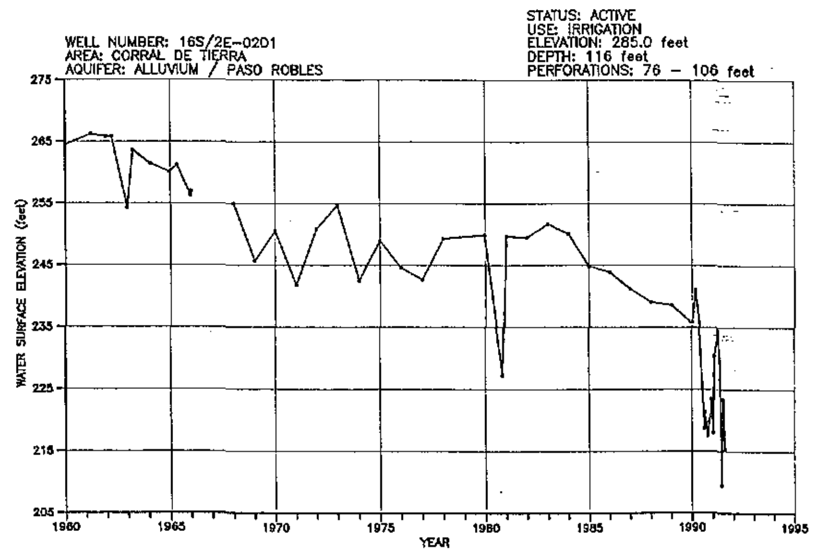
Scale in Feet

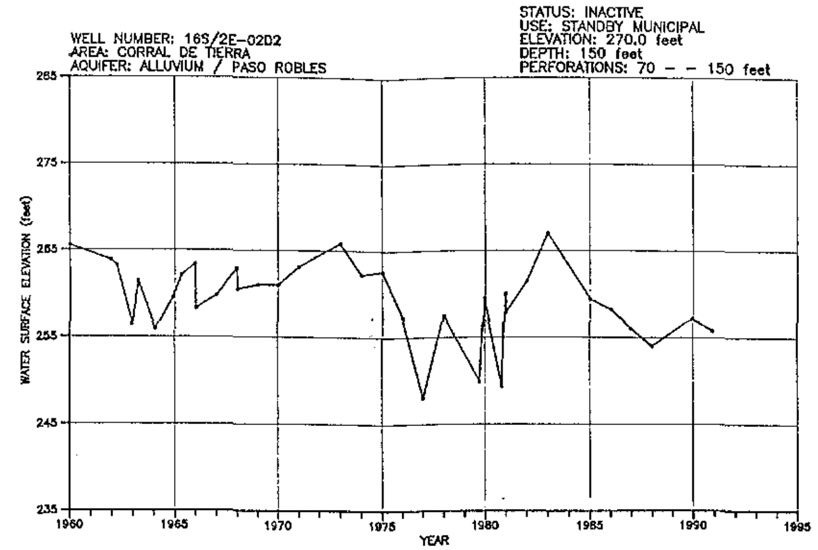
## HYDROGEOLOGIC MAP

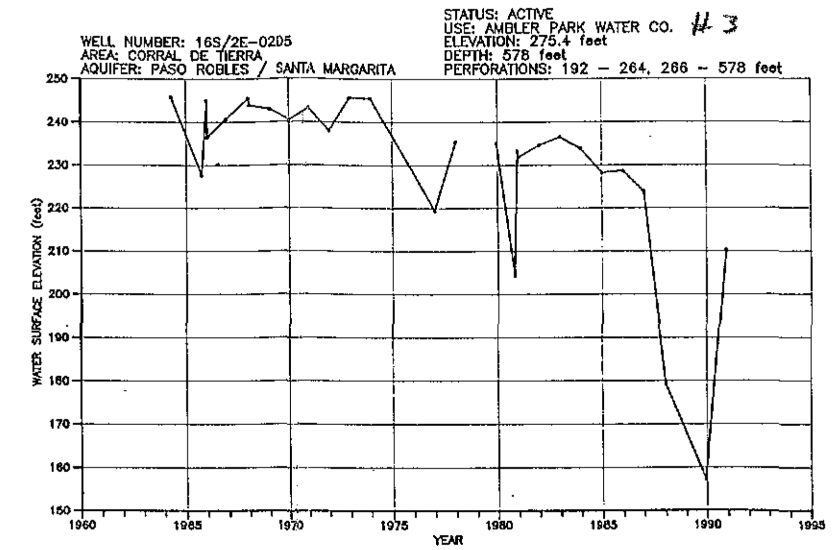
For: COUNTY OF MONTEREY

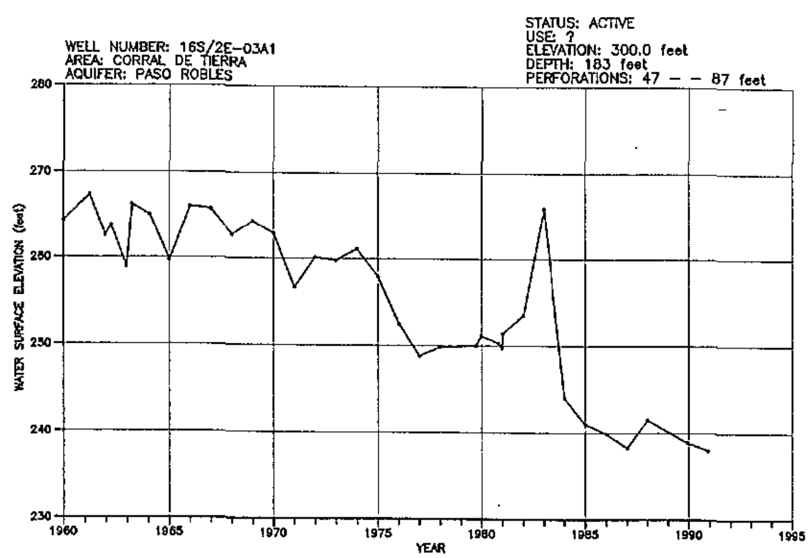
M91002 August 1991 Plate 2

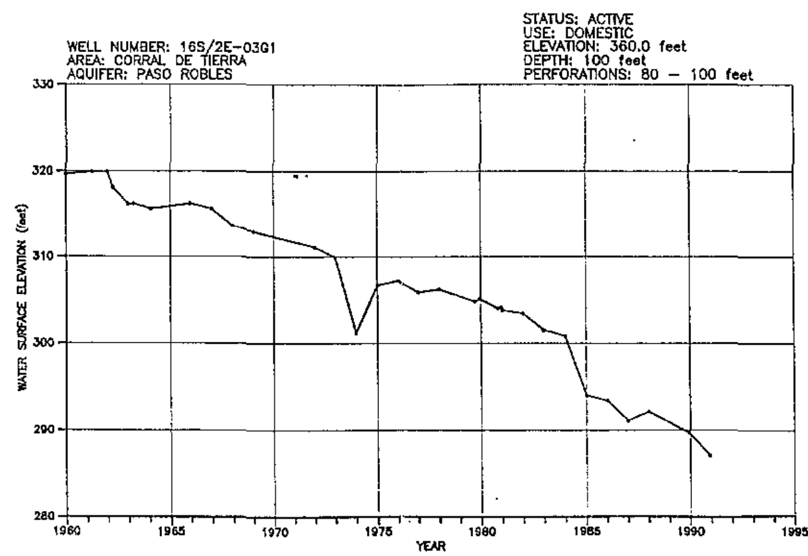
SGD Staal, Gardner & Dunne, Inc.
Consulting Engineers and Geologists

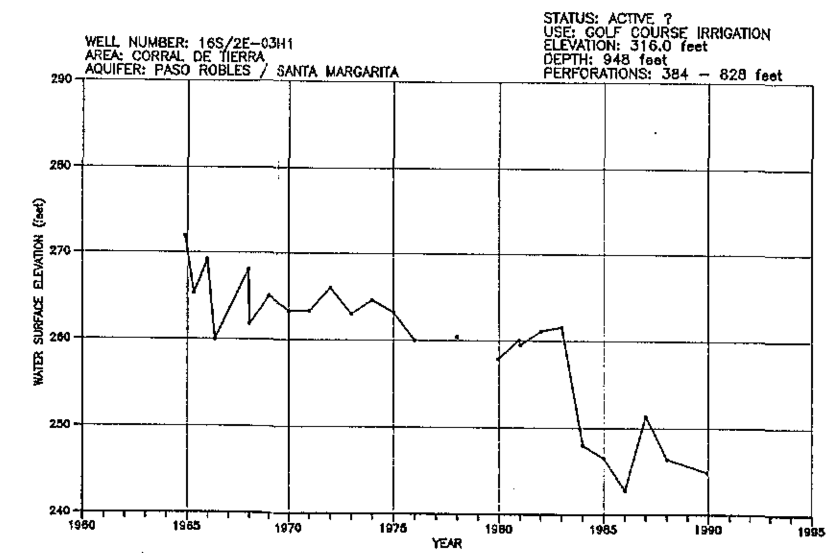


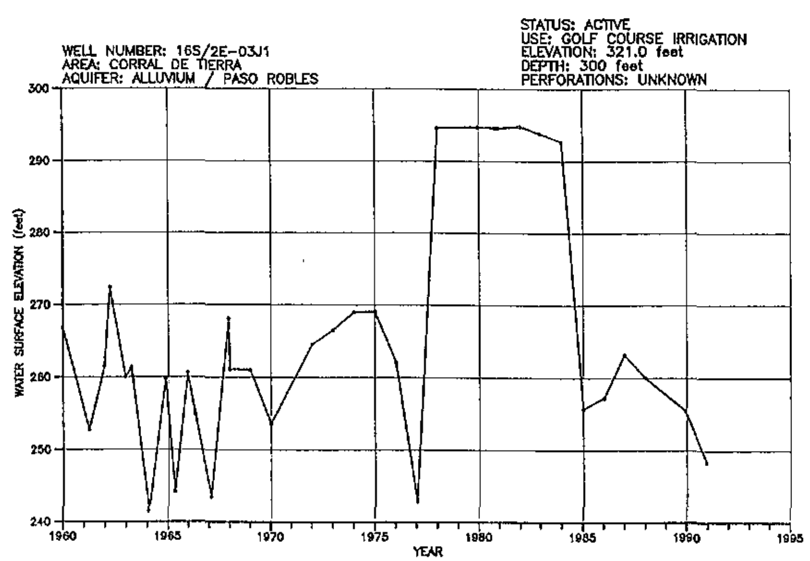



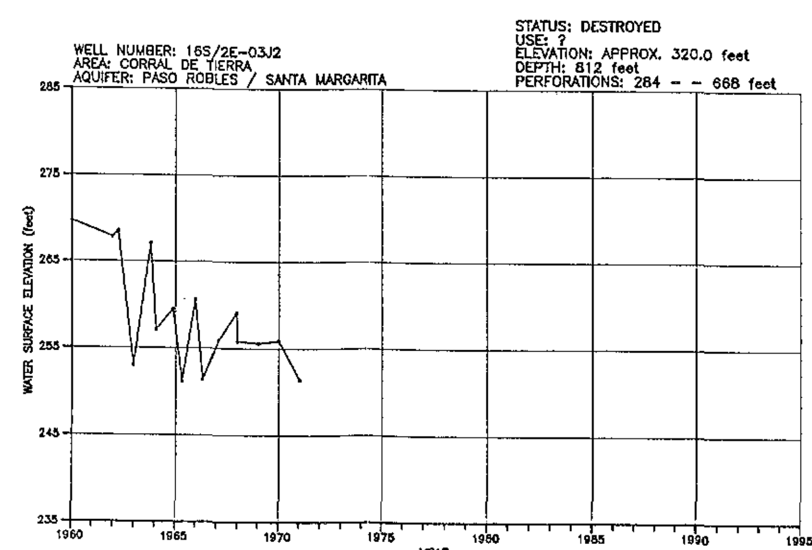



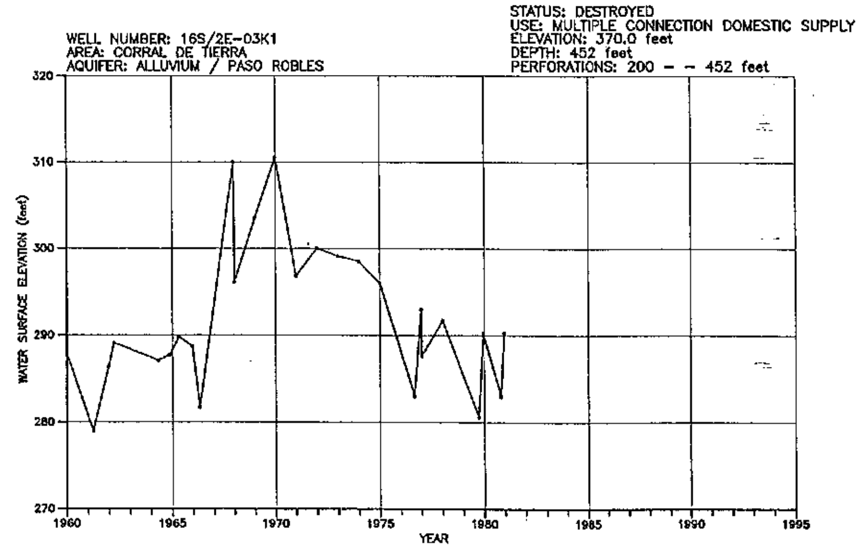

NOTE: DOUBLE HYPHEN IN PERFORATED INTERVAL INDICATES PERFORATIONS IN CASING NOT CONTINUOUS.

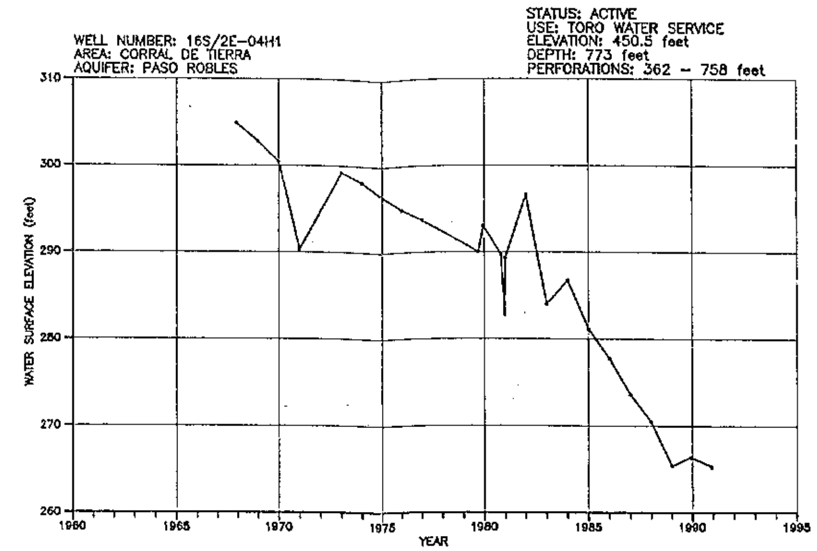
# WATER LEVEL HYDROGRAPHS
# EL TORO AREA
# MONTEREY COUNTY
# CORRAL DE TIERRA SUBAREA

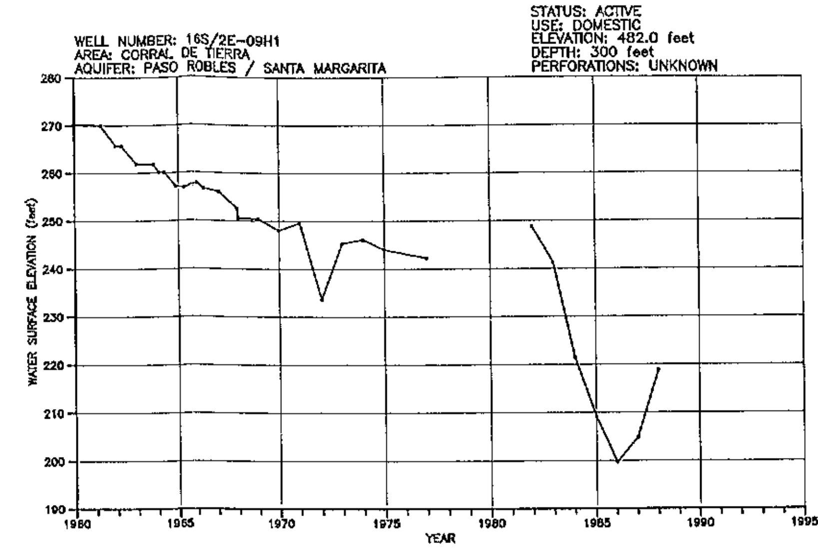
For: COUNTY OF MONTEREY

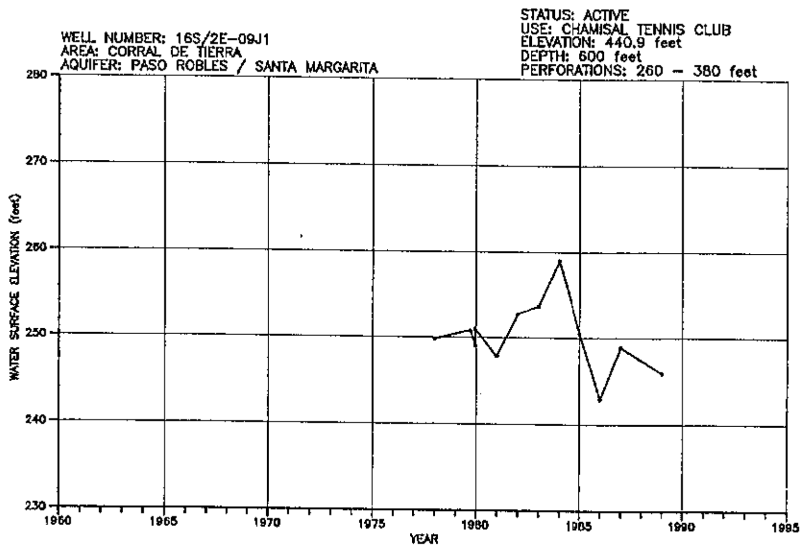
M91002 August 1991 Plate 3

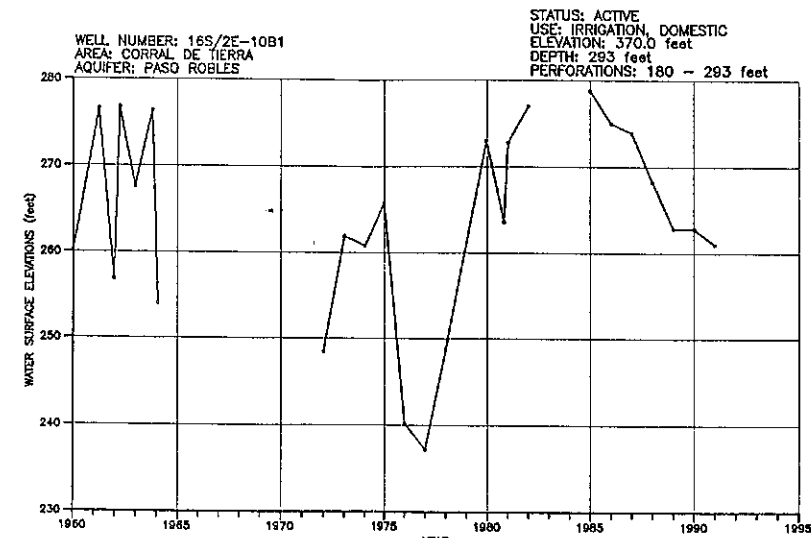
*Staal, Gardner & Dunne, Inc.*
*Consulting Engineers and Geologists*

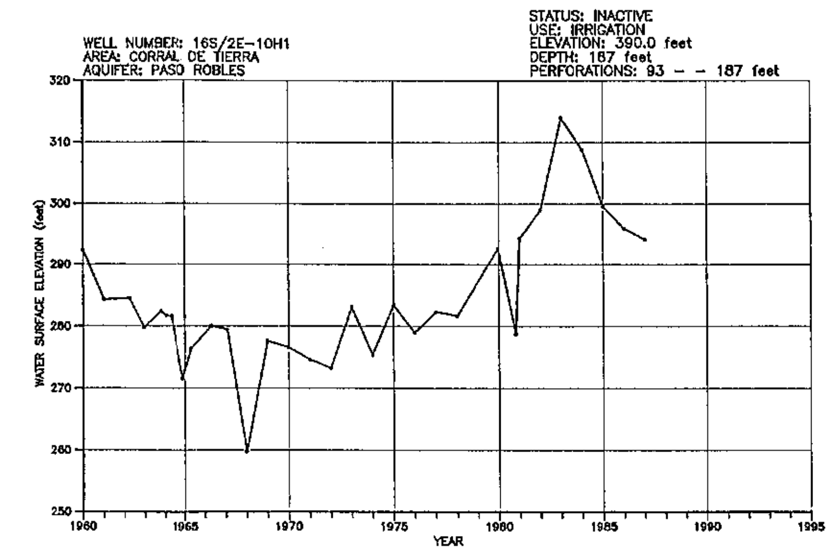


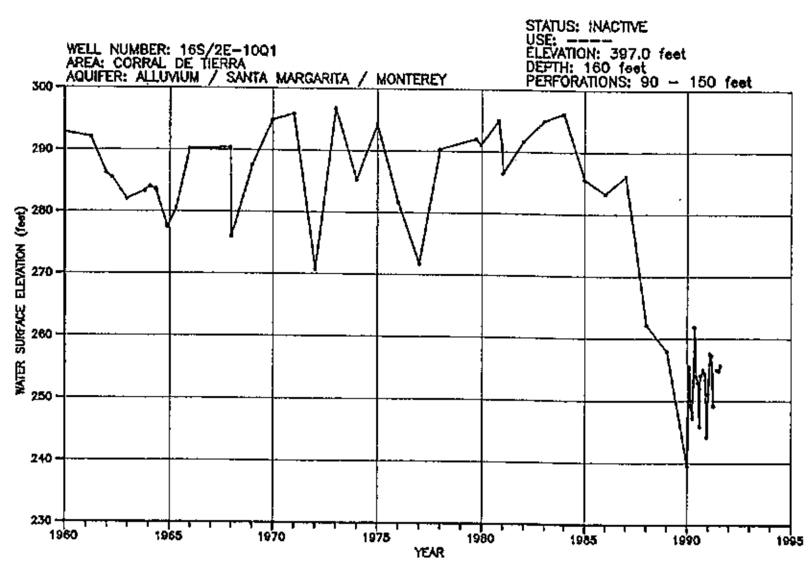



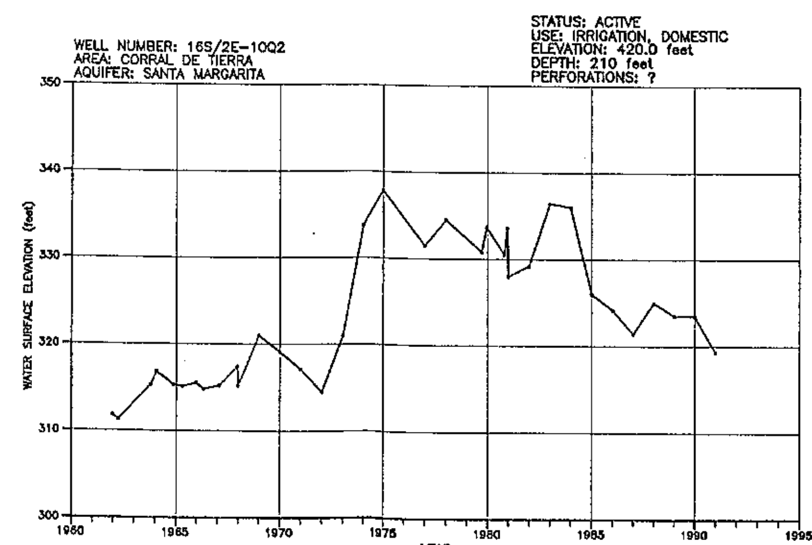




NOTE: DOUBLE HYPHEN IN PERFORATED INTERVAL INDICATES PERFORATIONS IN CASING NOT CONTINUOUS.

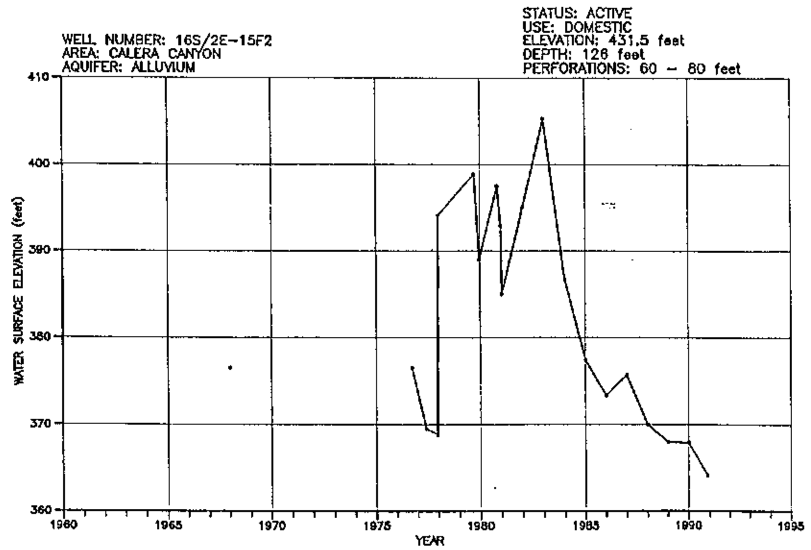
# WATER LEVEL HYDROGRAPHS
# EL TORO AREA
# MONTEREY COUNTY
# CORRAL DE TIERRA SUBAREA

For: COUNTY OF MONTEREY

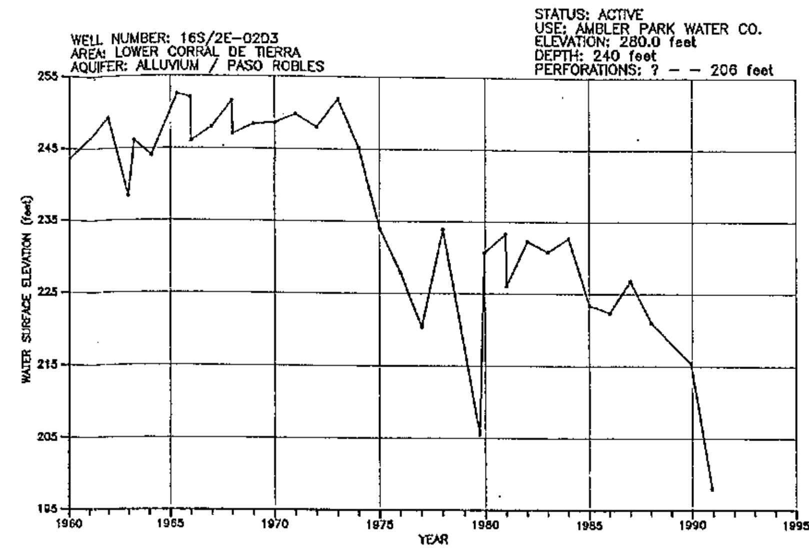
| M91002 | August 1991 | Plate 4 |
|---|---|---|

SGD Staal, Gardner & Dunne, Inc.
Consulting Engineers and Geologists

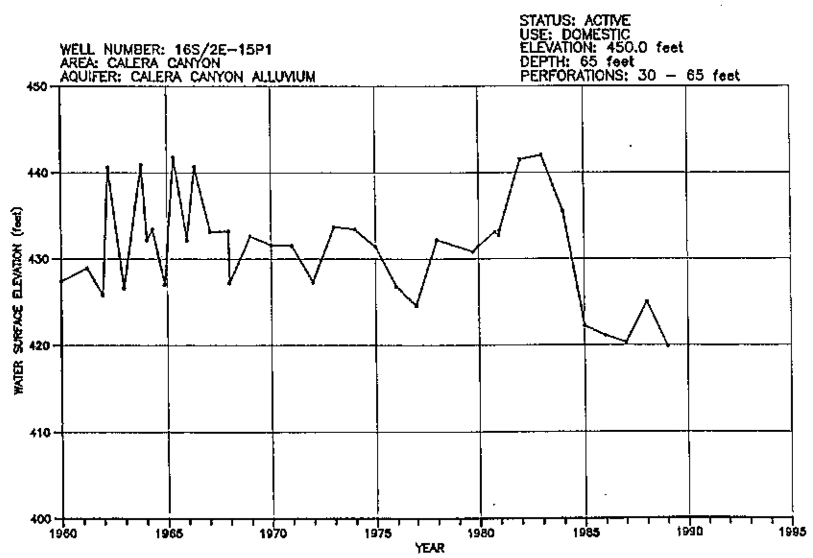
## CALERA CANYON



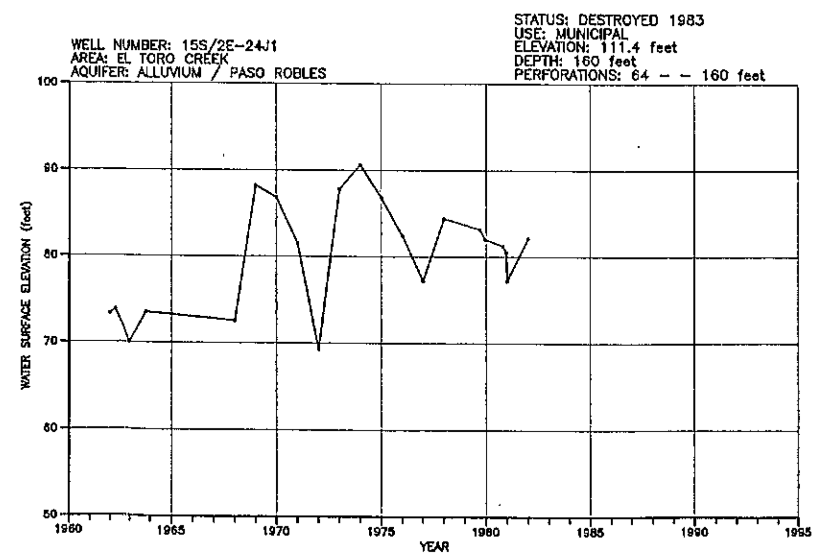

## LOWER CORRAL DE TIERRA




## CALERA CANYON




## EL TORO CREEK




NOTE: DOUBLE HYPHEN IN PERFORATED INTERVAL INDICATES PERFORATIONS IN CASING NOT CONTINUOUS.

**WATER LEVEL HYDROGRAPHS**
**EL TORO AREA**
**MONTEREY COUNTY**

For: COUNTY OF MONTEREY

M91002 | August 1991 | Plate 5

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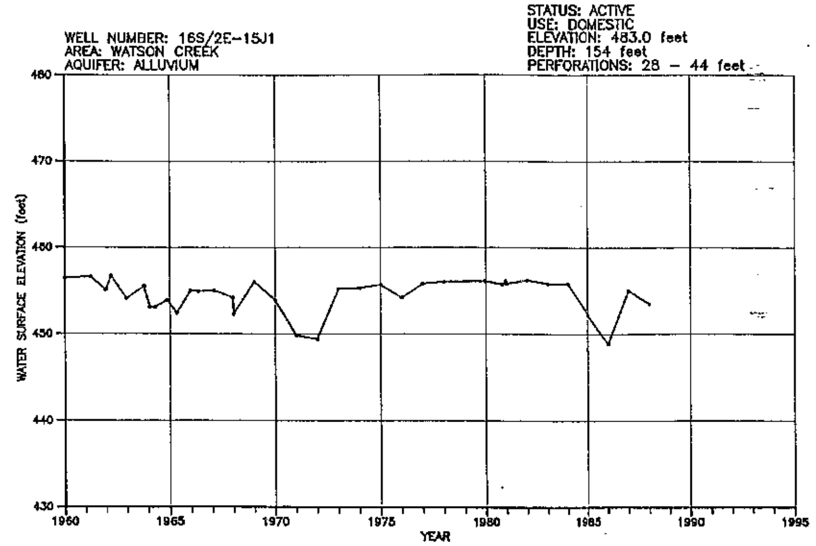
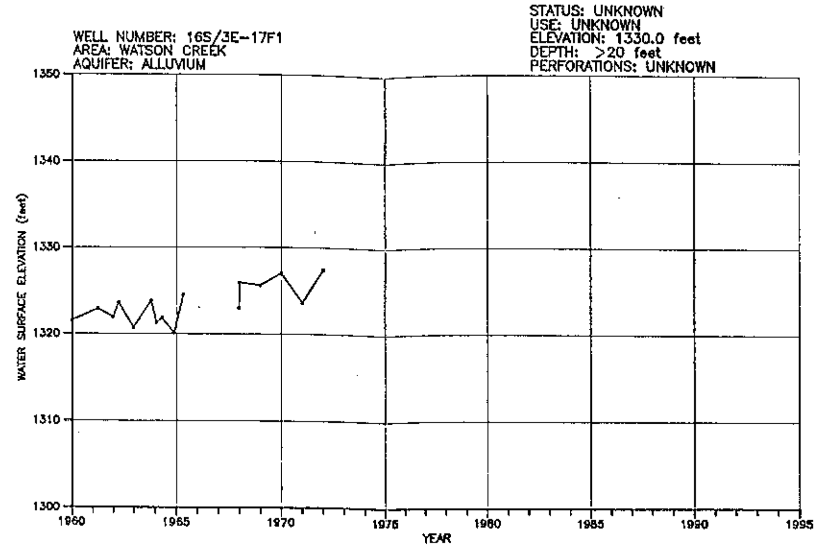
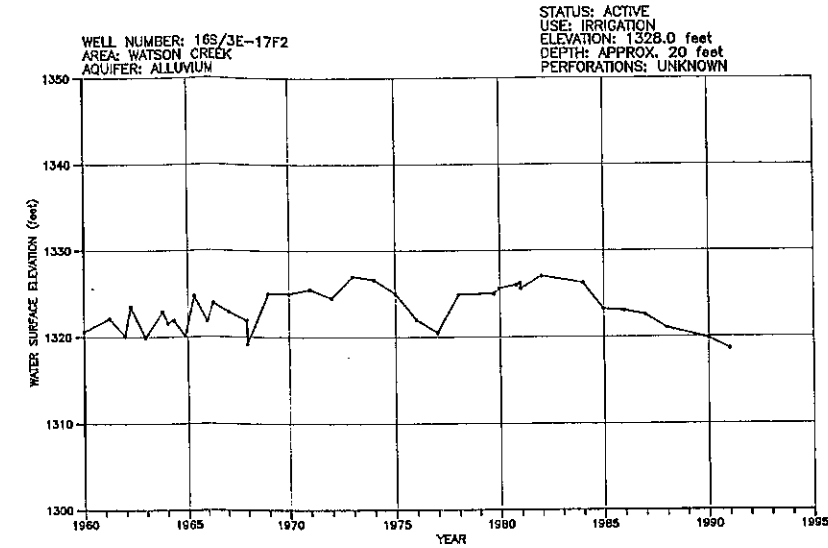
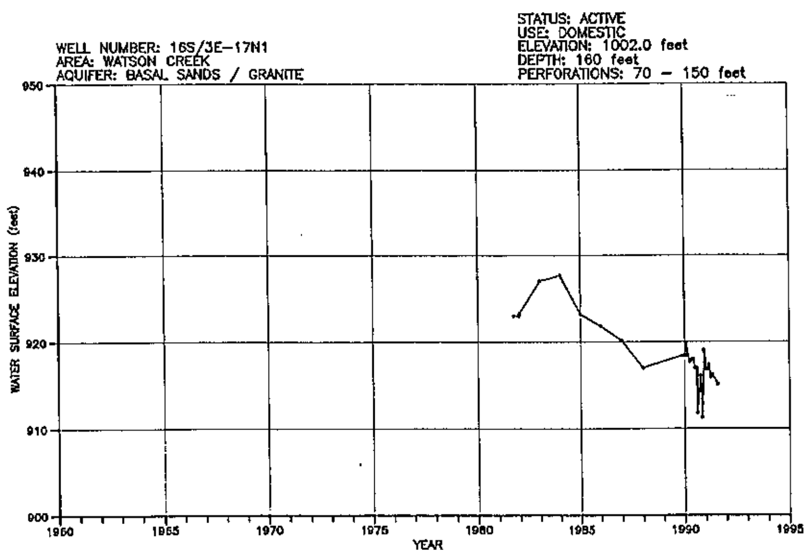
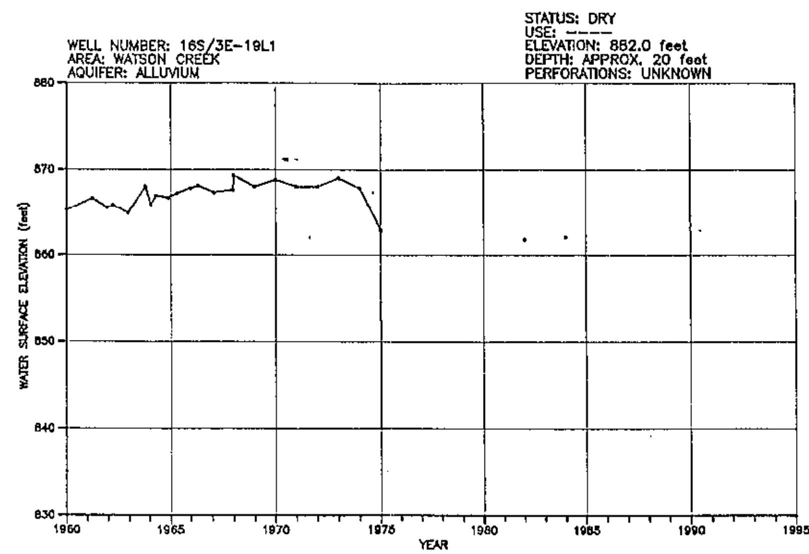
*Consulting Engineers and Geologists*

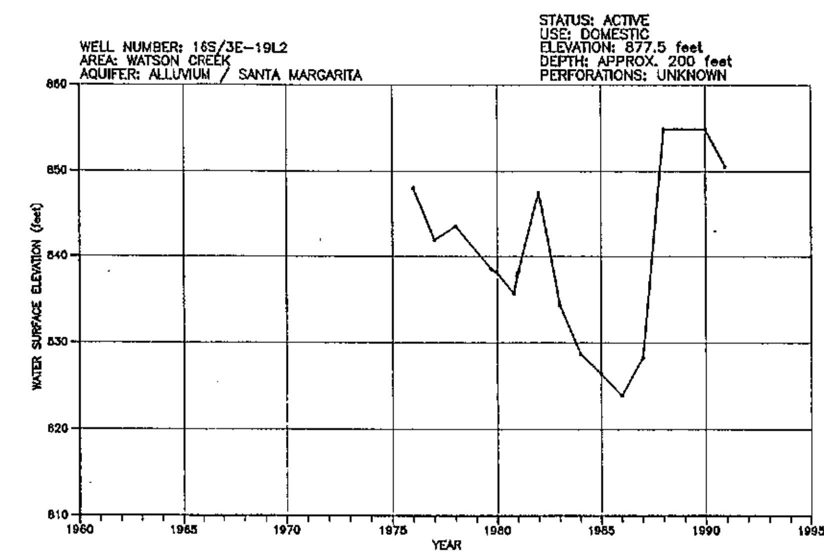


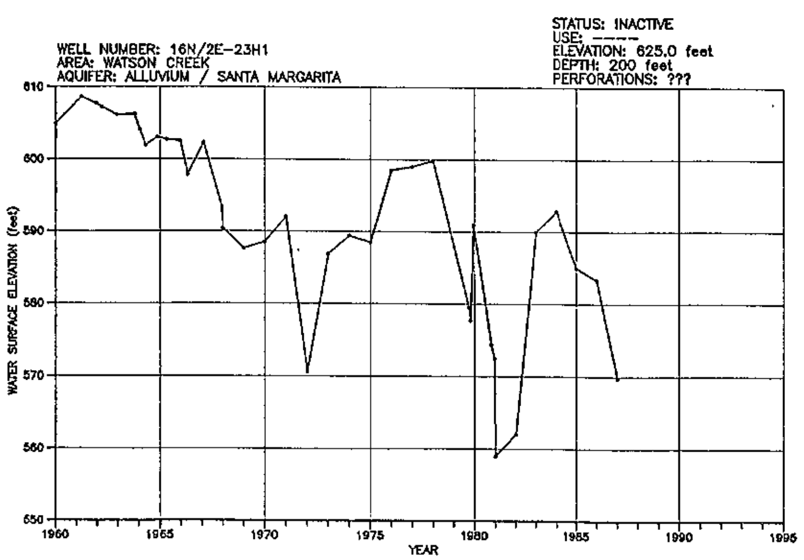



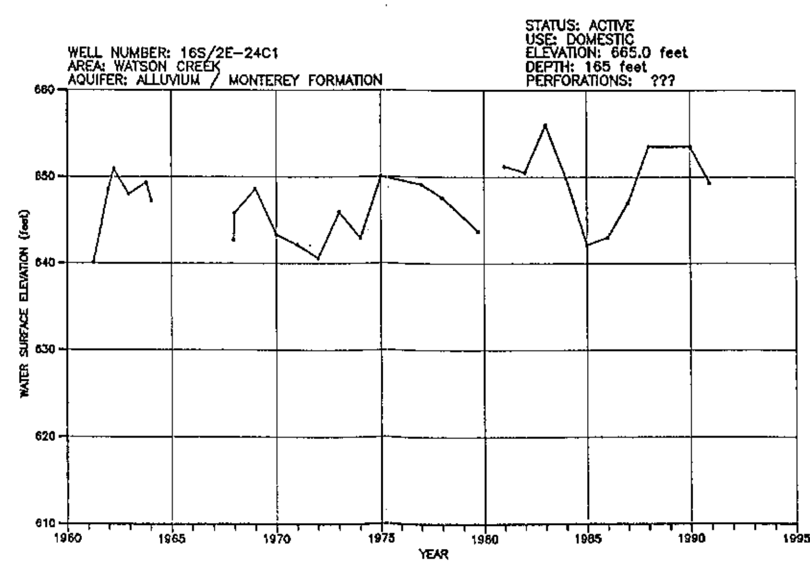




NOTE: DOUBLE HYPHEN IN PERFORATED INTERVAL INDICATES PERFORATIONS IN CASING NOT CONTINUOUS.

# WATER LEVEL HYDROGRAPHS
# EL TORO AREA
# MONTEREY COUNTY
# WATSON CREEK SUBAREA

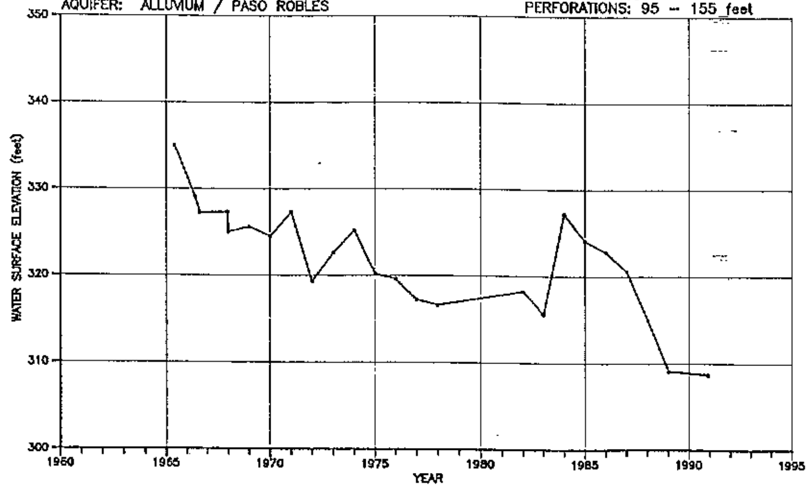
For: COUNTY OF MONTEREY

M91002 August 1991 Plate 6

*Staal, Gardner & Dunne, Inc.*
*Consulting Engineers and Geologists*

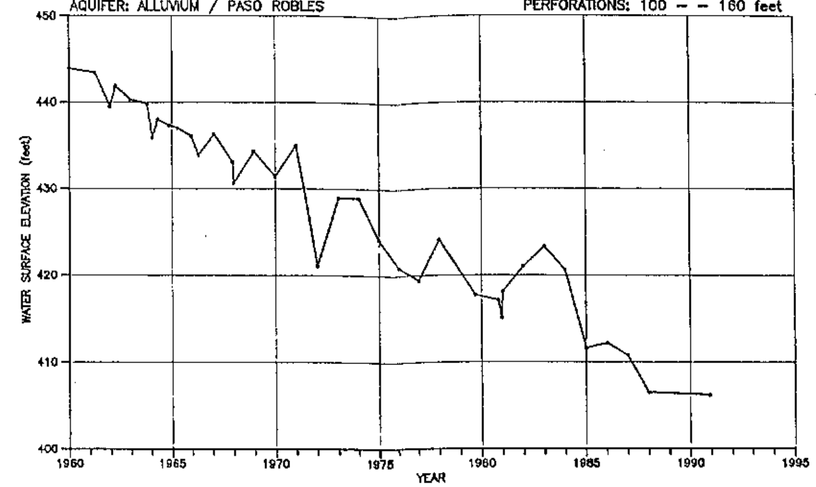
WELL NUMBER: 16S/2E-01E1
AREA: SAN BENANCIO GULCH
AQUIFER: ALLUVIUM / PASO ROBLES

STATUS: ACTIVE
USE: DOMESTIC
ELEVATION: 440.0 feet
DEPTH: 155 feet
PERFORATIONS: 95 -- 155 feet



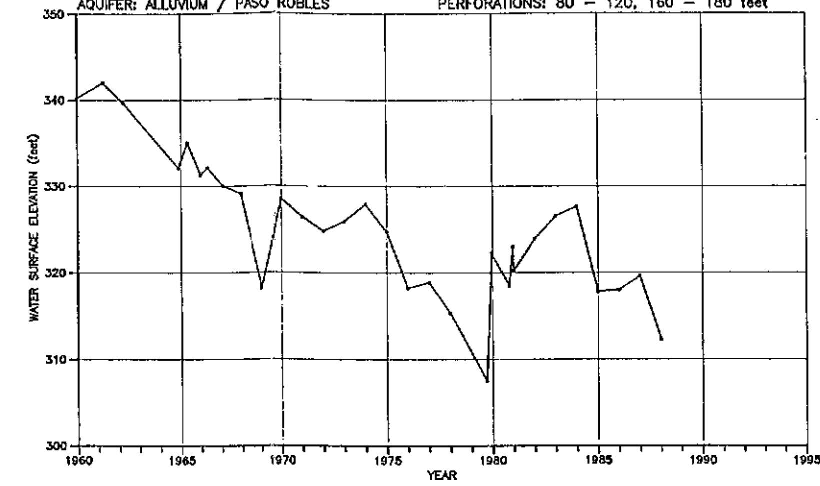

WELL NUMBER: 16S/2E-01L1
AREA: SAN BENANCIO GULCH
AQUIFER: ALLUVIUM / PASO ROBLES

STATUS: ACTIVE
USE: DOMESTIC
ELEVATION: 466.0 feet
DEPTH: 160 feet
PERFORATIONS: 100 - - 160 feet



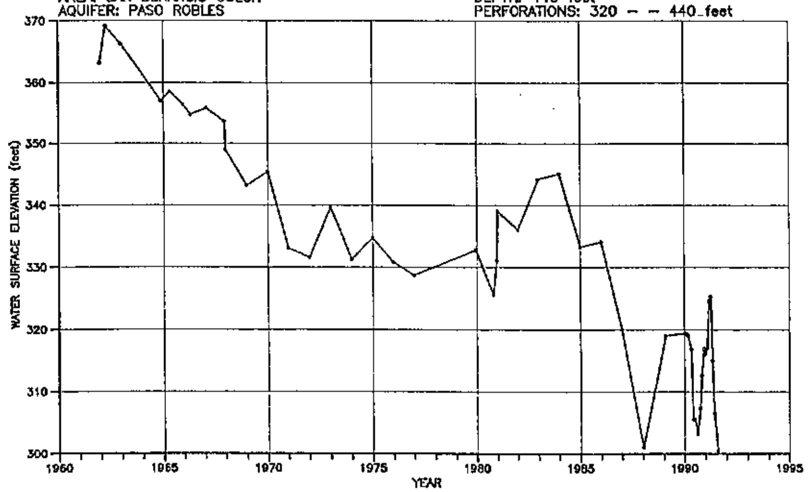

WELL NUMBER: 16S/2E-01M1
AREA: SAN BENANCIO GULCH
AQUIFER: ALLUVIUM / PASO ROBLES

STATUS: ACTIVE
USE: TITUS PARK COUNTRY CLUB
ELEVATION: 406.0 feet
DEPTH: 294 feet
PERFORATIONS: 80 - 120, 160 - 180 feet



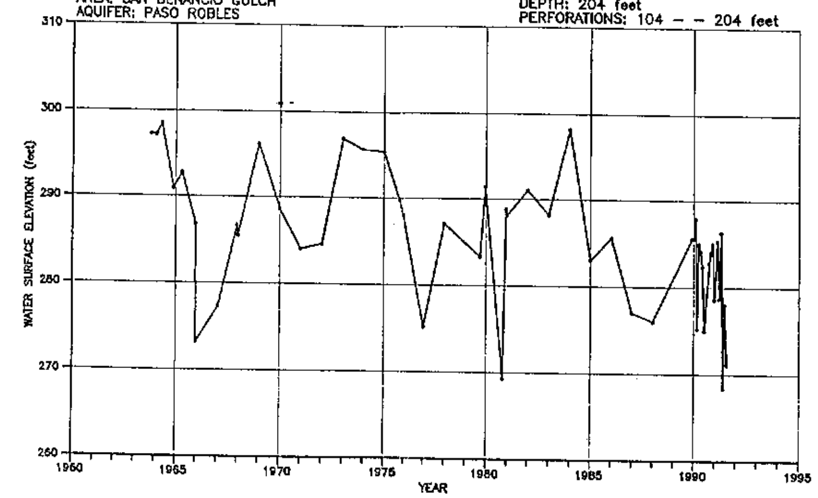

WELL NUMBER: 16S/2E-02G1
AREA: SAN BENANCIO GULCH
AQUIFER: PASO ROBLES

STATUS: ACTIVE
USE: MULTIPLE CONNECTION DOMESTIC SUPPLY
ELEVATION: 371.0 feet
DEPTH: 440 feet
PERFORATIONS: 320 - - 440 feet



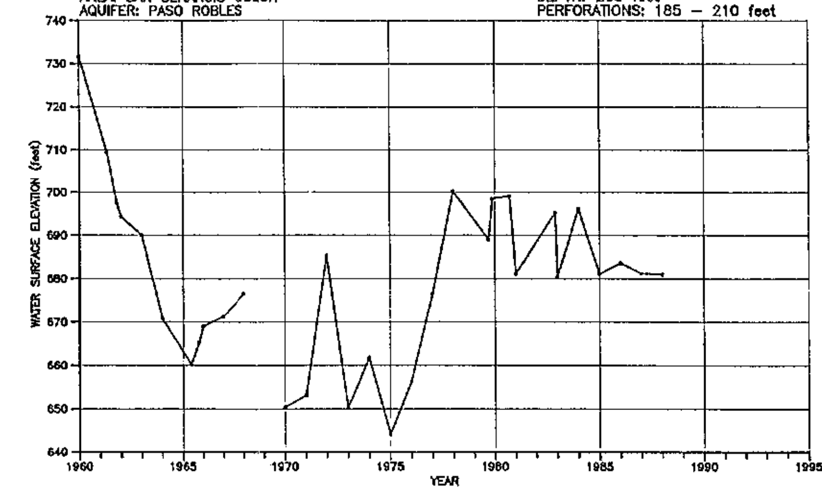

WELL NUMBER: 16S/2E-02H1
AREA: SAN BENANCIO GULCH
AQUIFER: PASO ROBLES

STATUS: ACTIVE
USE: DOMESTIC
ELEVATION: 380.0 feet
DEPTH: 204 feet
PERFORATIONS: 104 - - 204 feet



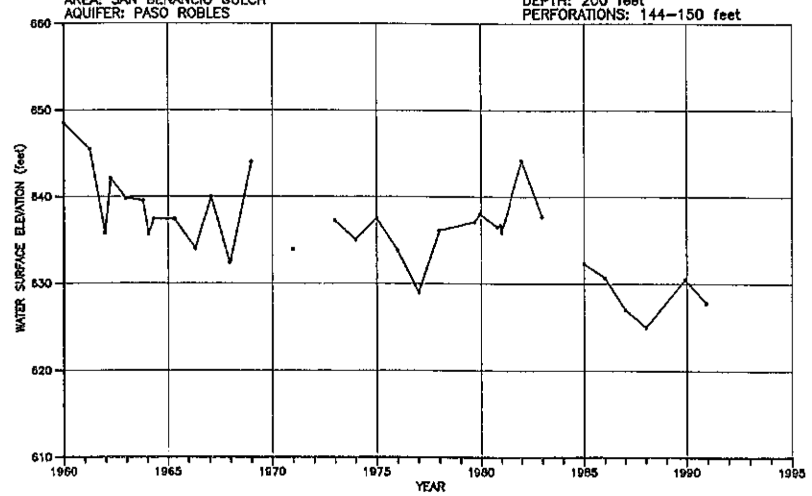

WELL NUMBER: 16S/3E-07L1
AREA: SAN BENANCIO GULCH
AQUIFER: PASO ROBLES

STATUS: ACTIVE
USE: DOMESTIC
ELEVATION: 880.0 feet
DEPTH: 260 feet
PERFORATIONS: 185 - 210 feet



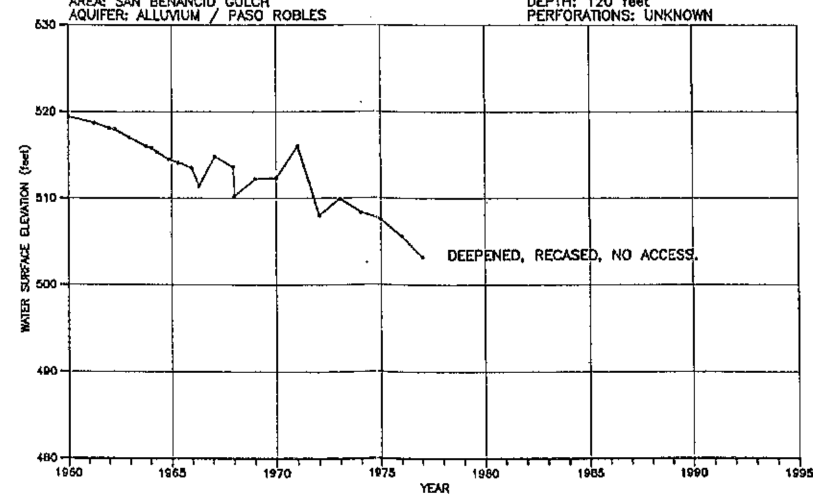

WELL NUMBER: 16S/3E-07N1
AREA: SAN BENANCIO GULCH
AQUIFER: PASO ROBLES

STATUS: ACTIVE
USE: DOMESTIC
ELEVATION: 741.0 feet
DEPTH: 200 feet
PERFORATIONS: 144-150 feet




WELL NUMBER: 16S/2E-12G1
AREA: SAN BENANCIO GULCH
AQUIFER: ALLUVIUM / PASO ROBLES

STATUS: ACTIVE
USE: DOMESTIC
ELEVATION: 581.0 feet
DEPTH: 120 feet
PERFORATIONS: UNKNOWN



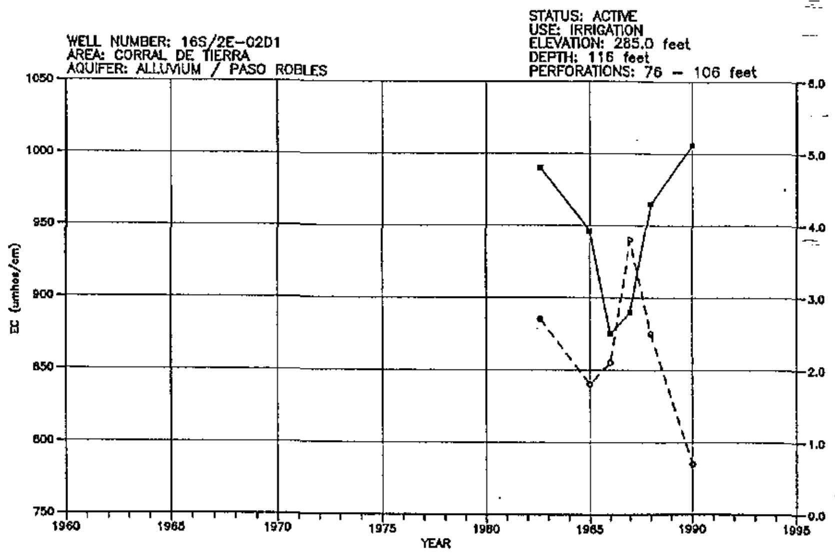

NOTE: DOUBLE HYPHEN IN PERFORATED INTERVAL INDICATES PERFORATIONS IN CASING NOT CONTINUOUS.

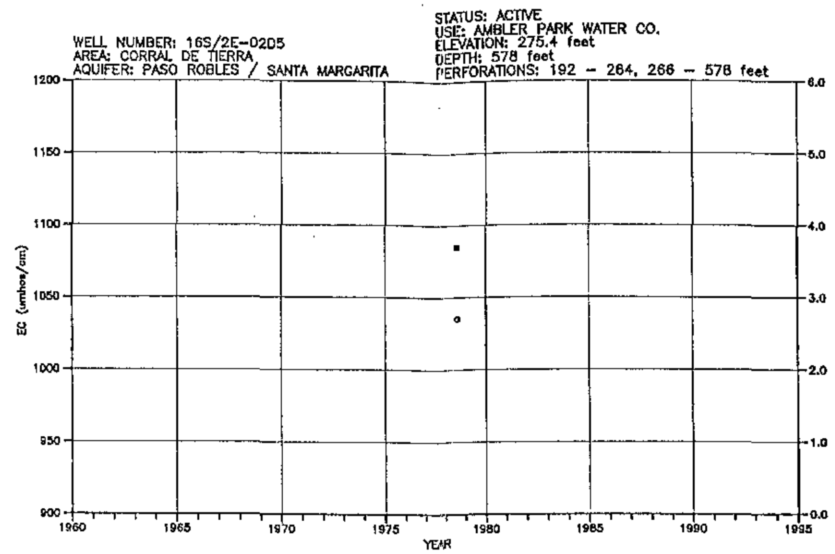
# WATER LEVEL HYDROGRAPHS
# EL TORO AREA
# MONTEREY COUNTY
# SAN BENANCIO GULCH SUBAREA

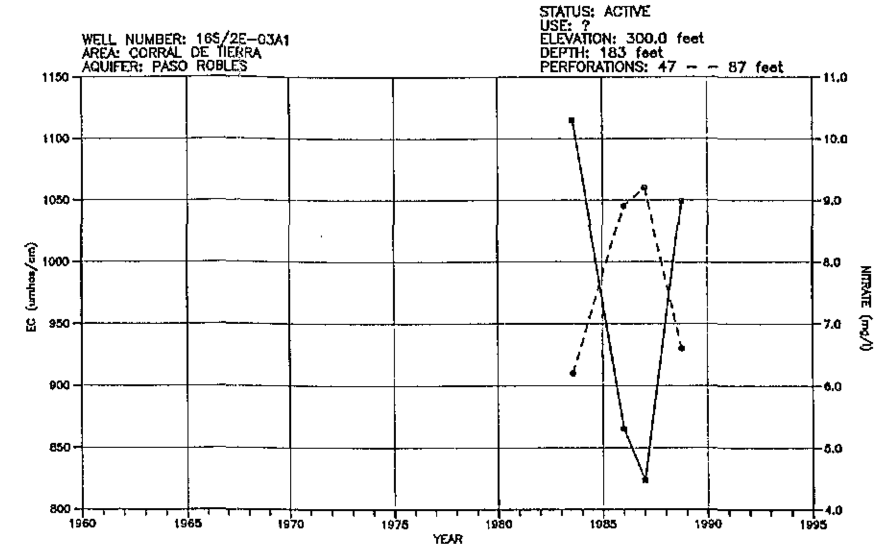
For: COUNTY OF MONTEREY

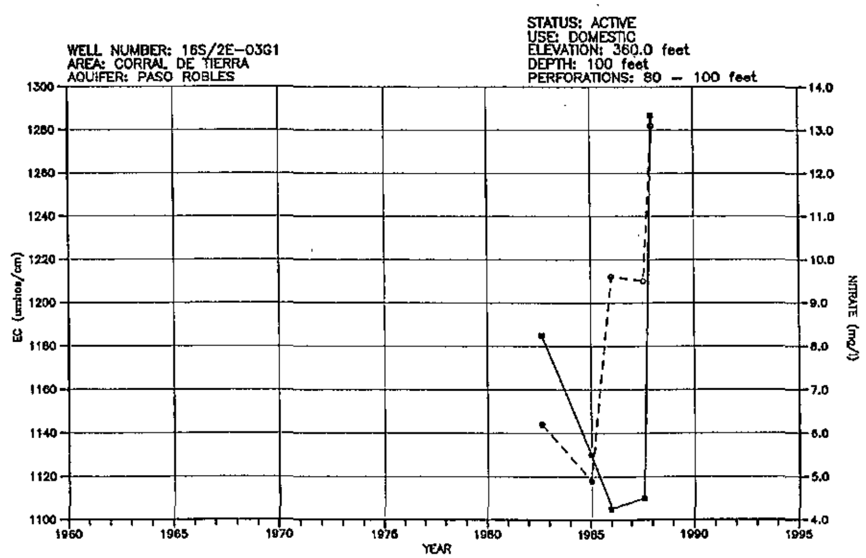
M91002 | August 1991 | Plate 7

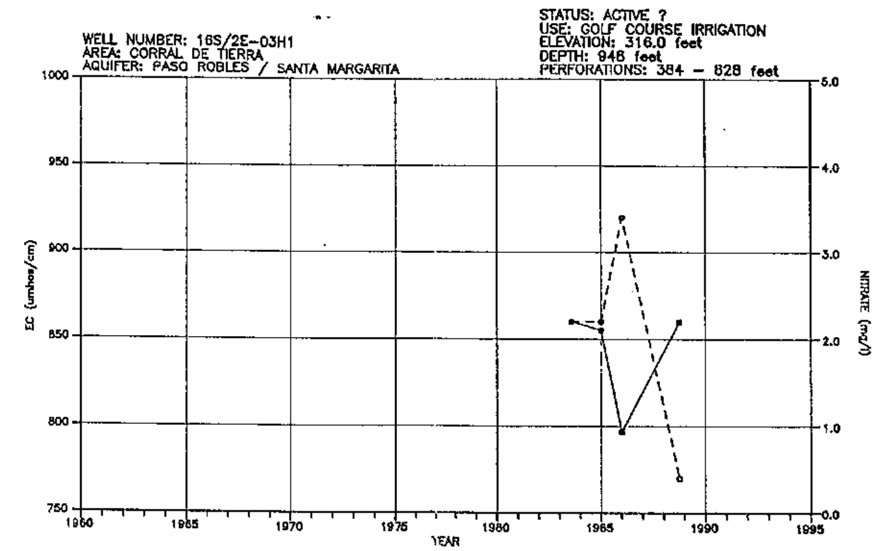
SGD *Staal, Gardner & Dunne, Inc.*
*Consulting Engineers and Geologists*

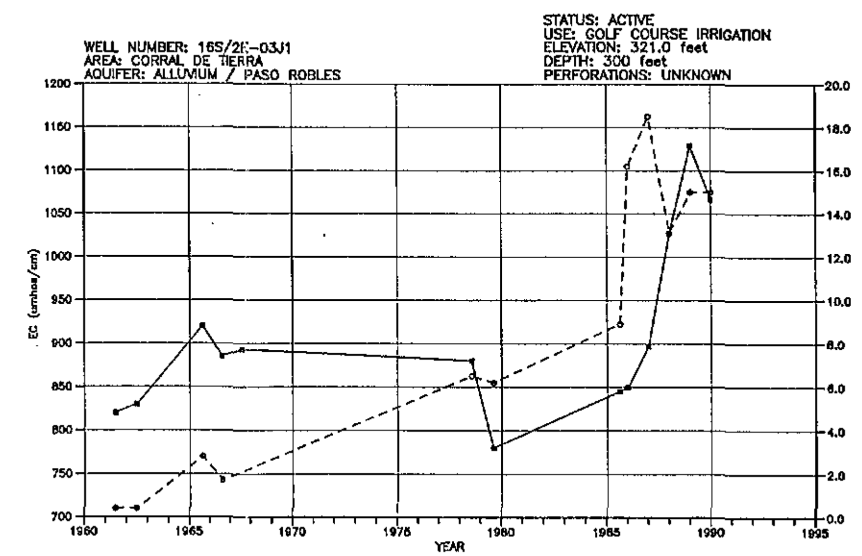



LEGEND

■—■ ELECTRICAL CONDUCTANCE EC (umhos/cm)

○- -○ (NITRATE (mg/l)

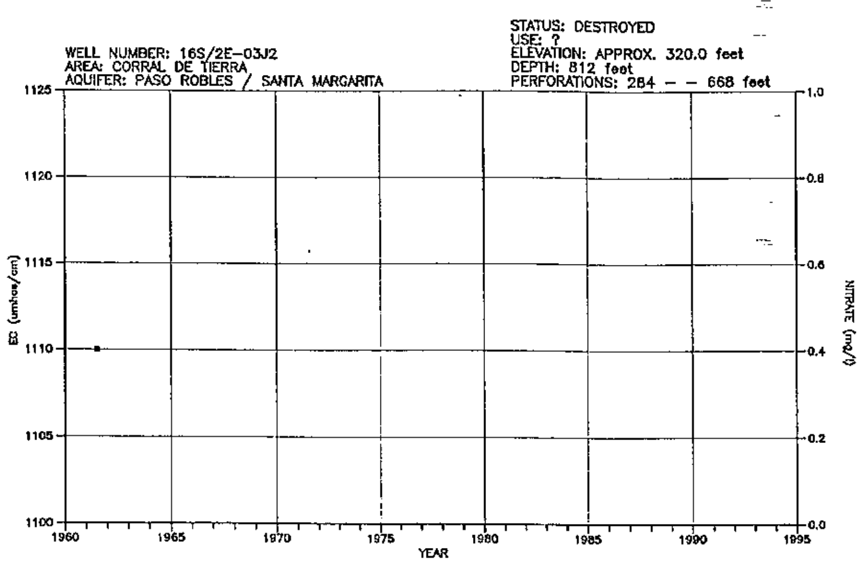
NOTE: DOUBLE HYPHEN IN PERFORATED INTERVAL INDICATES PERFORATIONS IN CASING NOT CONTINUOUS.

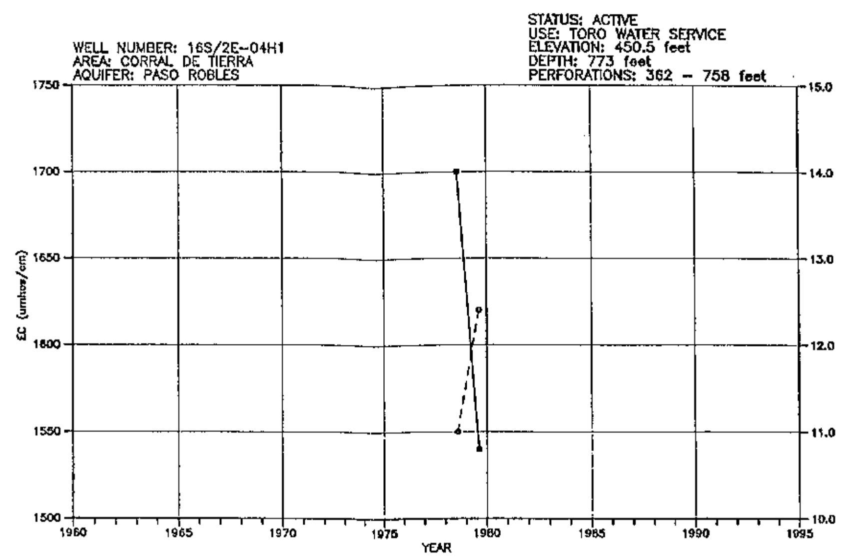
# CHEMICAL HYDROGRAPHS
# EL TORO AREA
# MONTEREY COUNTY
# CORRAL DE TIERRA SUBAREA

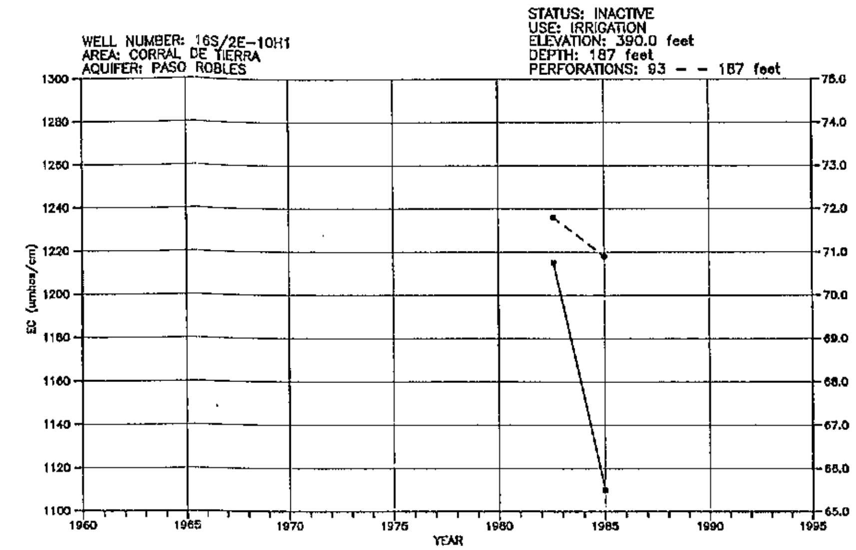
For: COUNTY OF MONTEREY

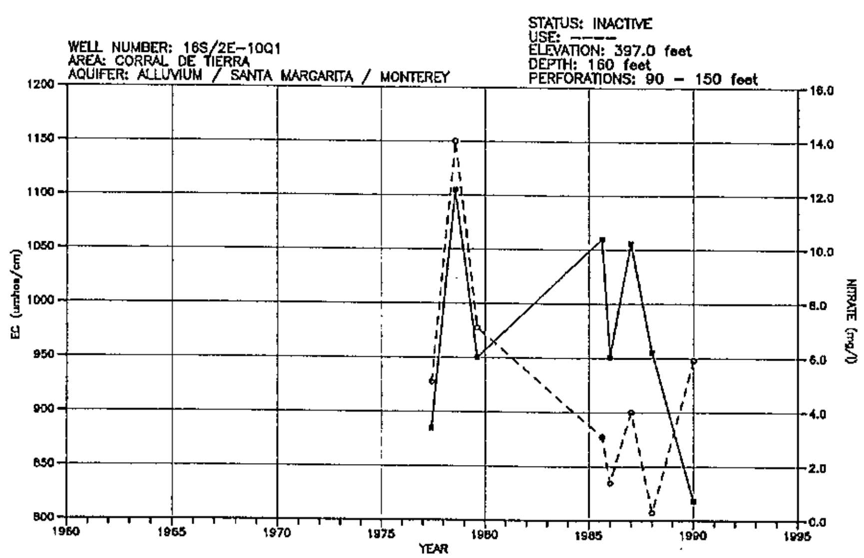
M91002 August 1991 Plate 8

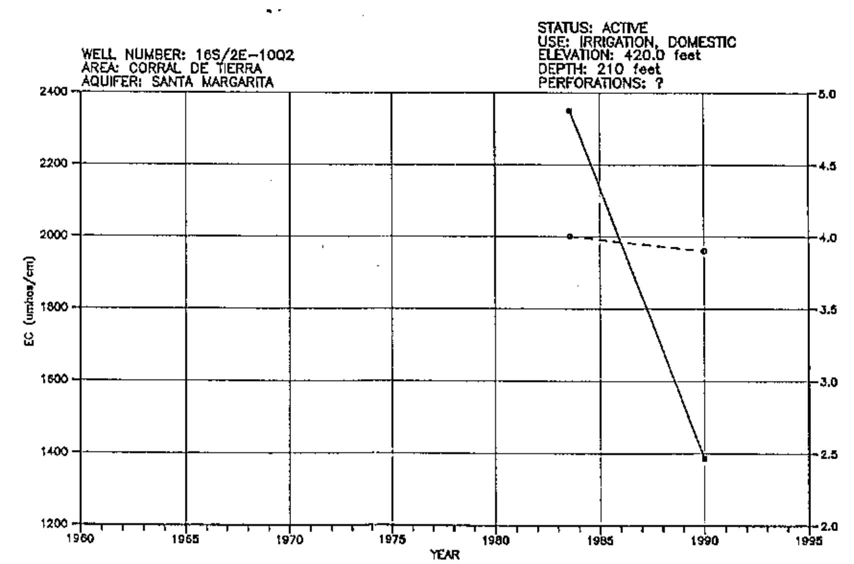
SGD *Staal, Gardner & Dunne, Inc.*
*Consulting Engineers and Geologists*




LEGEND

■—■ ELECTRICAL CONDUCTANCE EC (umhos/cm)

○- -○ (NITRATE (mg/l)

NOTE: DOUBLE HYPHEN IN PERFORATED INTERVAL INDICATES PERFORATIONS IN CASING NOT CONTINUOUS.

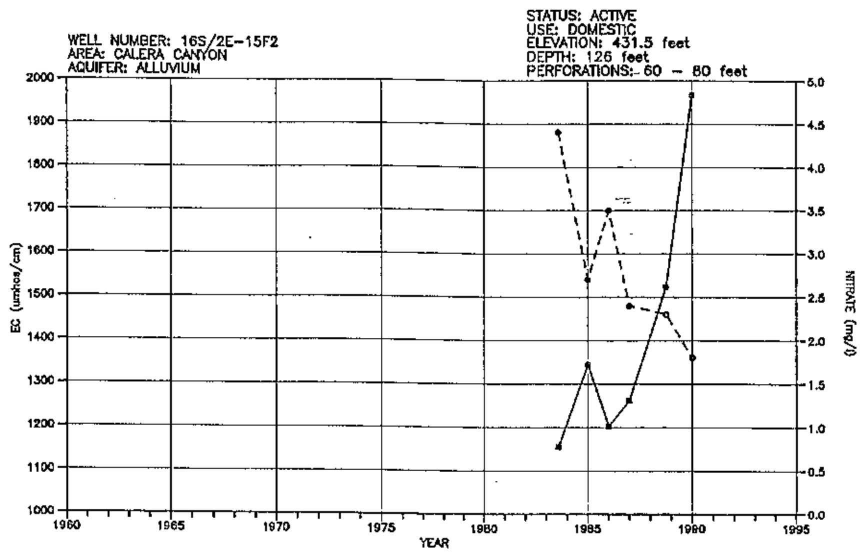
# CHEMICAL HYDROGRAPHS
# EL TORO AREA
# MONTEREY COUNTY
# CORRAL DE TIERRA SUBAREA

For: COUNTY OF MONTEREY

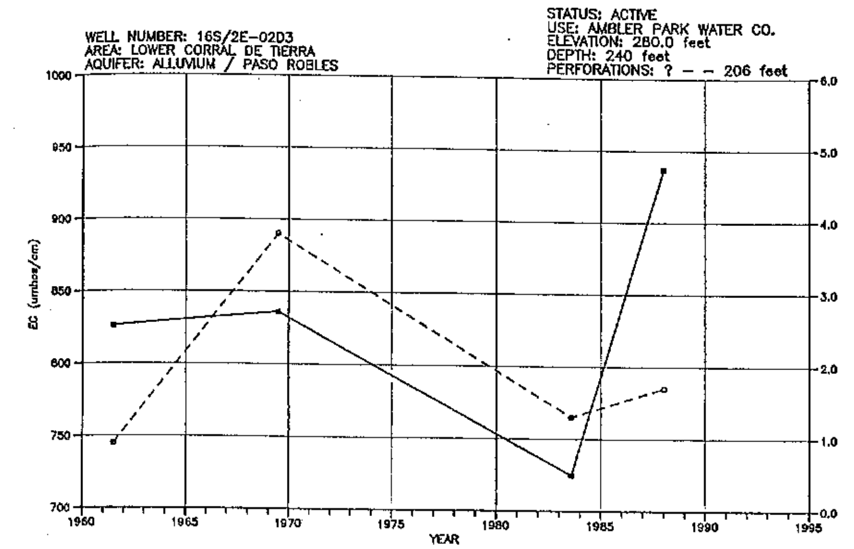
M91002 August 1991 Plate 9

Staal, Gardner & Dunne, Inc.
Consulting Engineers and Geologists

## CALERA CANYON




## LOWER CORRAL DE TIERRA



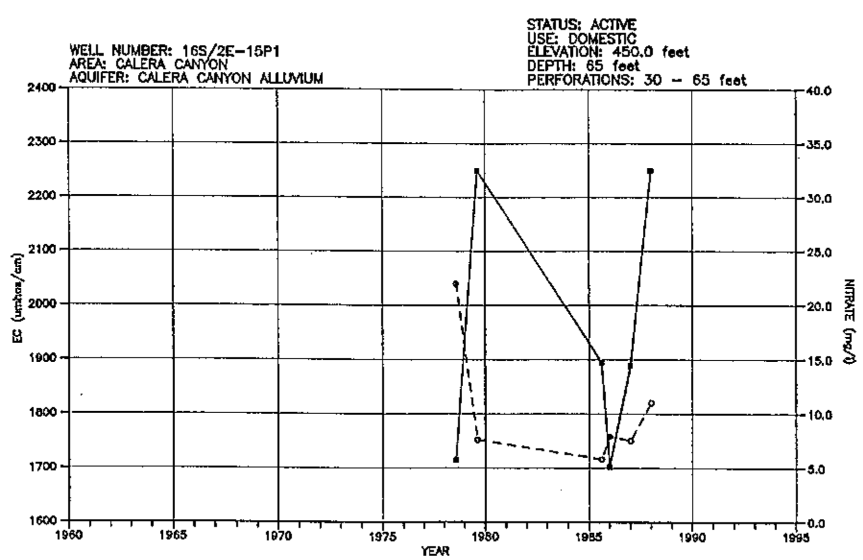

## LEGEND

■—■ ELECTRICAL CONDUCTANCE EC (umhos/cm)

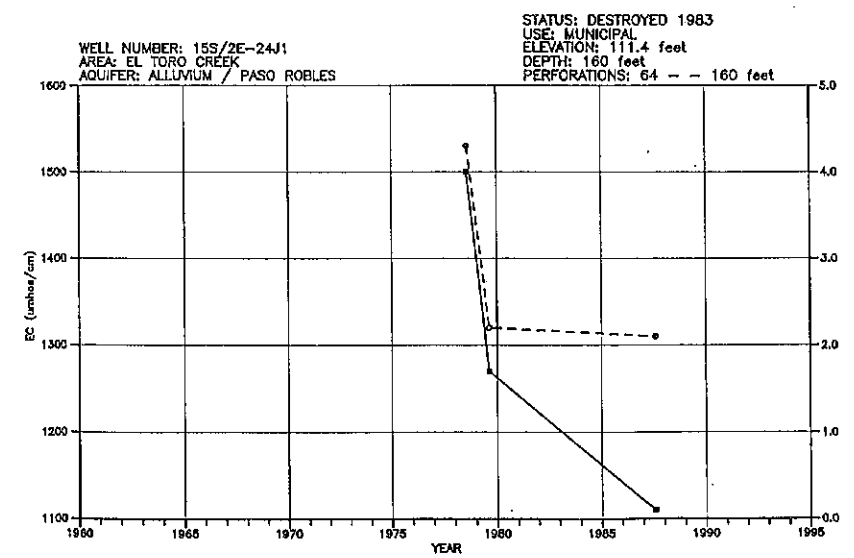
o- -o (NITRATE (mg/l)

NOTE: DOUBLE HYPHEN IN PERFORATED INTERVAL INDICATES PERFORATIONS IN CASING NOT CONTINUOUS.

## CALERA CANYON




## EL TORO CREEK

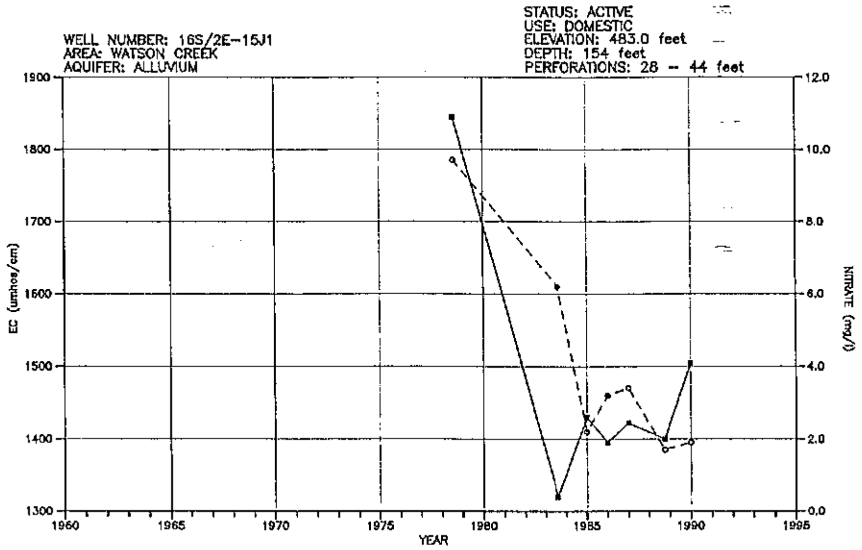


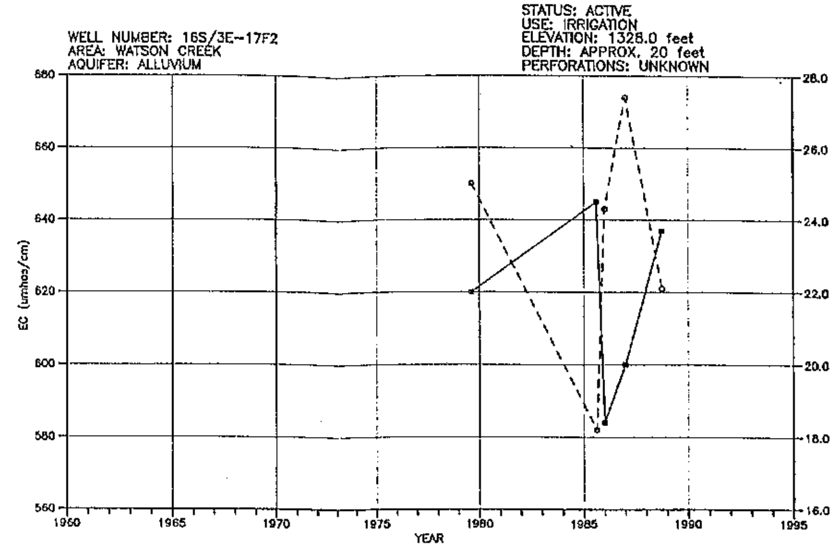

# CHEMICAL HYDROGRAPHS
# EL TORO AREA
# MONTEREY COUNTY

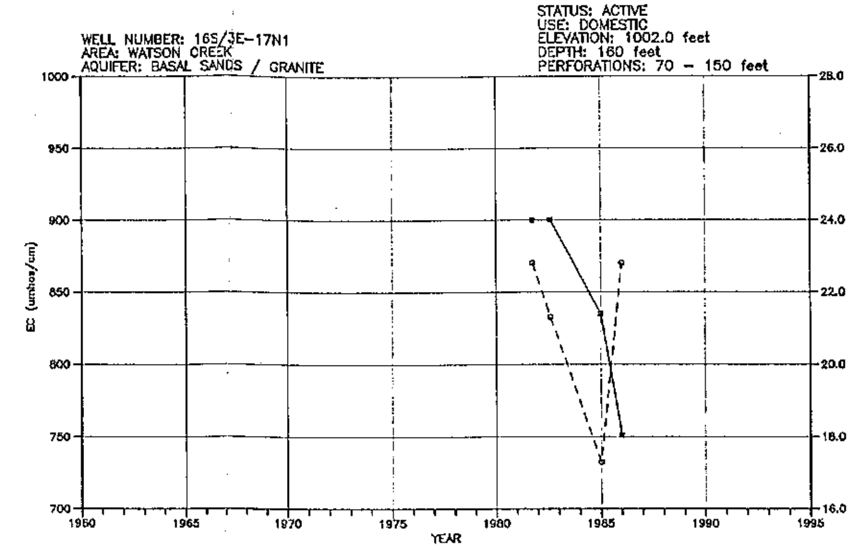
For: COUNTY OF MONTEREY

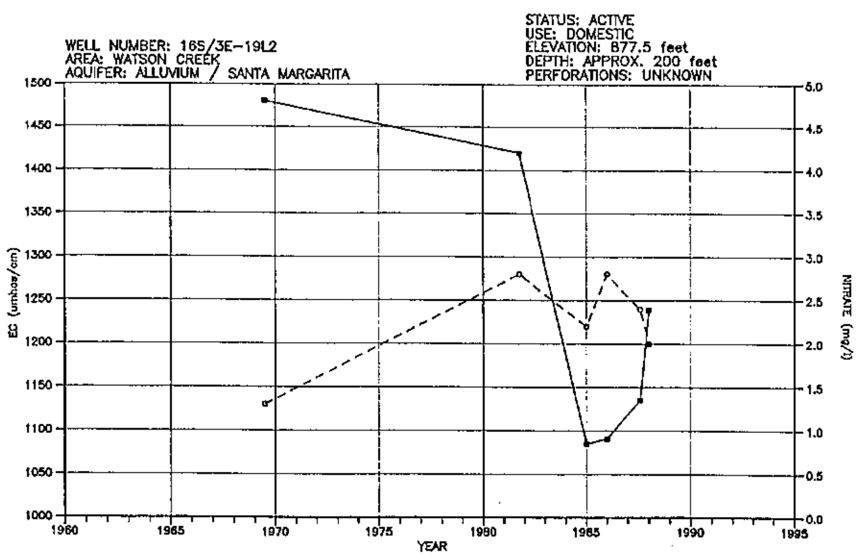
M91002 | August 1991 | Plate 10

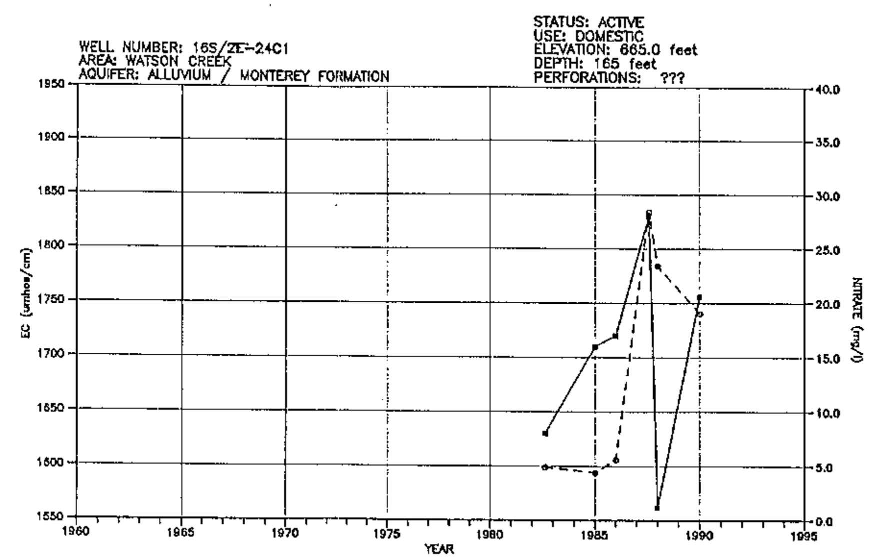
SGD *Staal, Gardner & Dunne, Inc.*
*Consulting Engineers and Geologists*




LEGEND

■—■ ELECTRICAL CONDUCTANCE EC (umhos/cm)

○- -○ (NITRATE (mg/l)

NOTE: DOUBLE HYPHEN IN PERFORATED INTERVAL INDICATES PERFORATIONS IN CASING NOT CONTINUOUS.

# CHEMICAL HYDROGRAPHS
# EL TORO AREA
# MONTEREY COUNTY
# WATSON CREEK SUBAREA

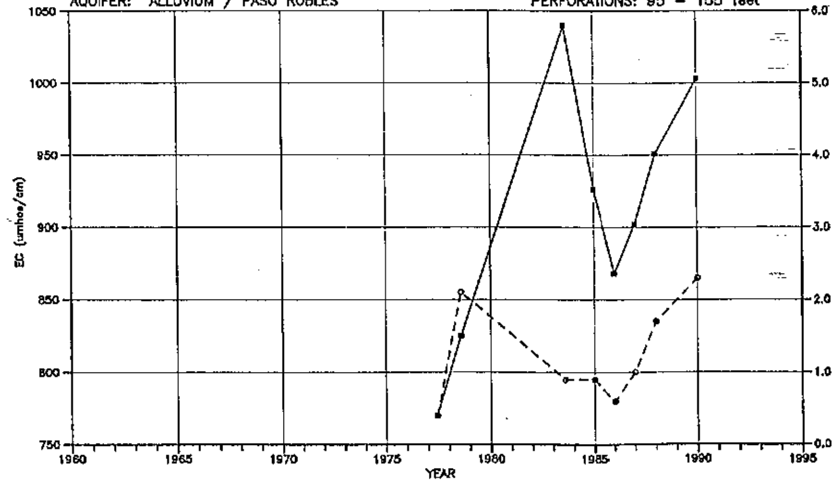
For: COUNTY OF MONTEREY

M91002 August 1991 Plate 11

Staal, Gardner & Dunne, Inc.
*Consulting Engineers and Geologists*

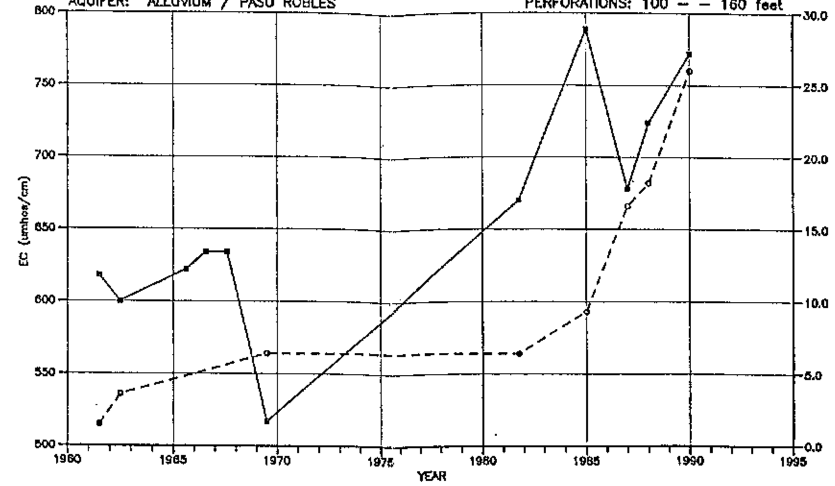
WELL NUMBER: 16S/2E-01E1
AREA: SAN BENANCIO GULCH
AQUIFER: ALLUVIUM / PASO ROBLES

STATUS: ACTIVE
USE: DOMESTIC
ELEVATION: 440.0 feet
DEPTH: 155 feet
PERFORATIONS: 95 – 155 feet



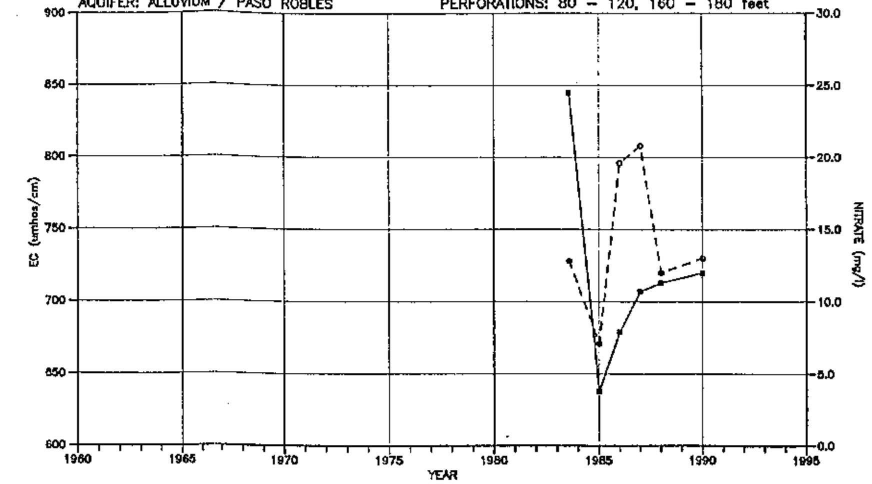

WELL NUMBER: 16S/2E-01L1
AREA: SAN BENANCIO GULCH
AQUIFER: ALLUVIUM / PASO ROBLES

STATUS: ACTIVE
USE: DOMESTIC
ELEVATION: 466.0 feet
DEPTH: 160 feet
PERFORATIONS: 100 – – 160 feet



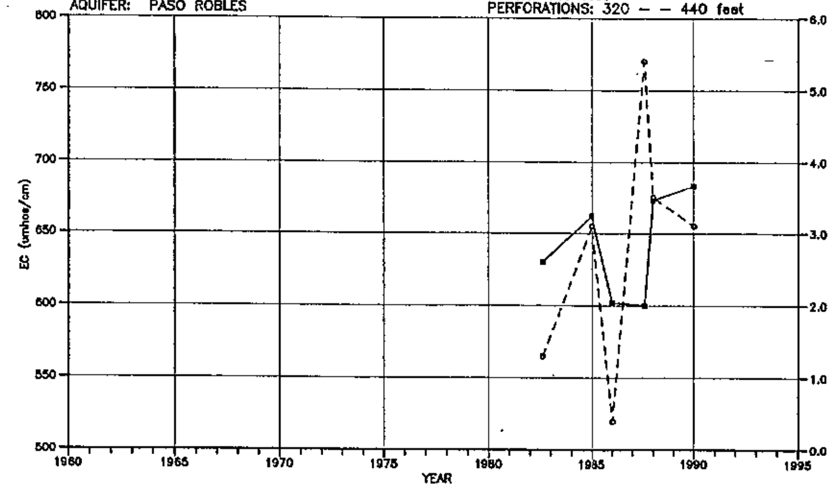

WELL NUMBER: 16S/2E-01M1
AREA: SAN BENANCIO GULCH
AQUIFER: ALLUVIUM / PASO ROBLES

STATUS: ACTIVE
USE: TITUS PARK COUNTRY CLUB
ELEVATION: 406.0 feet
DEPTH: 294 feet
PERFORATIONS: 80 – 120, 160 – 180 feet



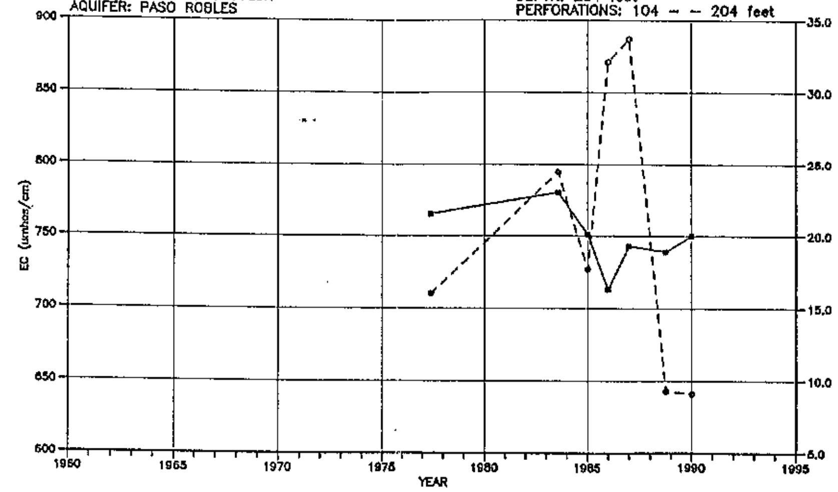

WELL NUMBER: 16S/2E-02G1
AREA: SAN BENANCIO GULCH
AQUIFER: PASO ROBLES

STATUS: ACTIVE
USE: MULTIPLE CONNECTION DOMESTIC SUPPLY
ELEVATION: 371.0 feet
DEPTH: 440 feet
PERFORATIONS: 320 – – 440 feet



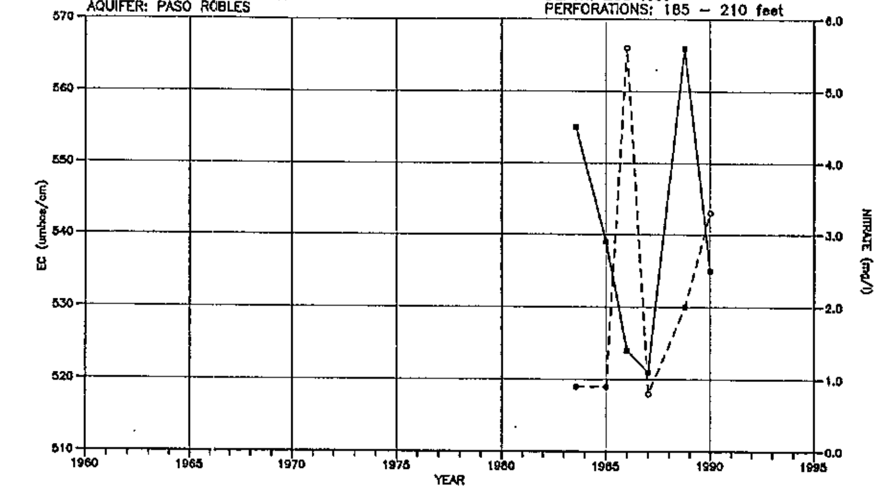

WELL NUMBER: 16S/2E-02H1
AREA: SAN BENANCIO GULCH
AQUIFER: PASO ROBLES

STATUS: ACTIVE
USE: DOMESTIC
ELEVATION: 380.0 feet
DEPTH: 204 feet
PERFORATIONS: 104 – – 204 feet



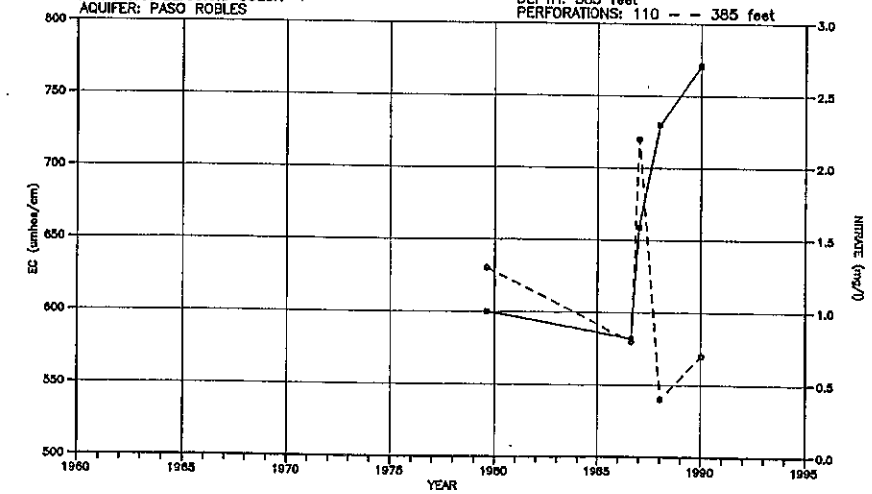

WELL NUMBER: 16S/3E-07L1
AREA: SAN BENANCIO GULCH
AQUIFER: PASO ROBLES

STATUS: ACTIVE
USE: DOMESTIC
ELEVATION: 880.0 feet
DEPTH: 260 feet
PERFORATIONS: 185 – 210 feet



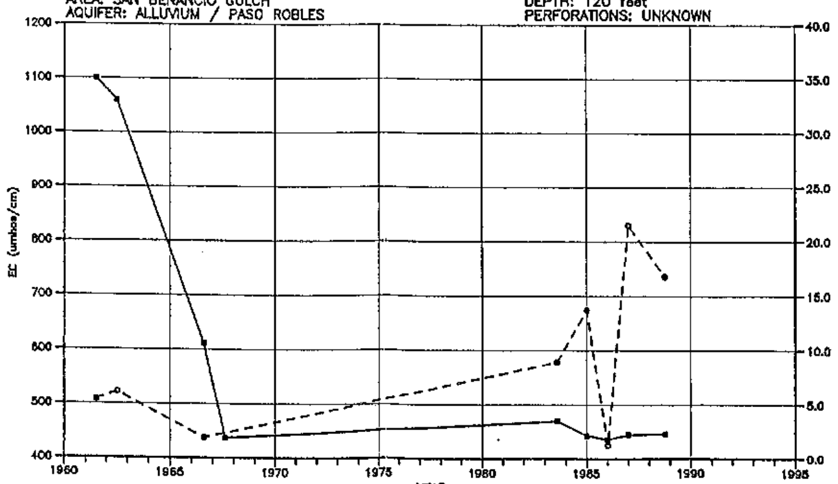

WELL NUMBER: 16S/3E-07N2
AREA: SAN BENANCIO GULCH
AQUIFER: PASO ROBLES

STATUS: ACTIVE
USE: DOMESTIC
ELEVATION: 750.0 feet
DEPTH: 385 feet
PERFORATIONS: 110 – – 385 feet




WELL NUMBER: 16S/2E-12G1
AREA: SAN BENANCIO GULCH
AQUIFER: ALLUVIUM / PASO ROBLES

STATUS: ACTIVE
USE: DOMESTIC
ELEVATION: 581.0 feet
DEPTH: 120 feet
PERFORATIONS: UNKNOWN




## LEGEND

■——■ ELECTRICAL CONDUCTANCE EC (umhos/cm)

o– –o (NITRATE (mg/l)

NOTE: DOUBLE HYPHEN IN PERFORATED INTERVAL INDICATES PERFORATIONS IN CASING NOT CONTINUOUS.

# CHEMICAL HYDROGRAPHS
# EL TORO AREA
# MONTEREY COUNTY
# SAN BERNANCIO GULCH SUBAREA

For: COUNTY OF MONTEREY

M91002 | August 1991 | Plate 12

S G D *Staal, Gardner & Dunne, Inc.*
*Consulting Engineers and Geologists*

# APPENDIX A

## SOIL MOISTURE BALANCE CALCULATIONS

**SAMPLE**

**SOIL MOISTURE ACCOUNTING CALCULATION**

Year: 1969
Month: January

| | | |
|---|---|---|
| Rainfall | = | 10.3 inches |
| Runoff | = | 1,690 acre-feet = 73,616,400 $ft^3$ |
| Drainage Area | = | 31.9 square miles |
| Initial Soil Moisture | = | 2.74 inches (December 1968) |
| January Evapotranspiration | = | 1.16 inches |
| Soil Storage at Field Capacity | = | 6.0 inches |

<u>Effective Rainfall = Rainfall - (runoff ÷ drainage area)</u>

= 10.3 inches (73,616,400 $ft^3$/8.8932 x $10^8$ $ft^2$)
= 10.3 inches - 0.99 inches
= 9.31 inches

<u>Total Soil Moisture = Effective Rainfall + Initial Soil Moisture</u>

= 9.31 inches + 2.74 inches
= 12.05 inches

<u>Residual Soil Moisture = Total Soil Moisture - Monthly Evapotranspiration</u>

= 12.05 inches - 1.16 inches
= 10.9 inches

<u>Deep Percolation = Residual Soil Moisture - Field Capacity</u>

= 10.9 inches - 6.0 inches
= 4.9 inches

AREA: EL TORO

DRAINAGE AREA: 31.9 sq. mi.

SOIL TYPE:

WATER HOLDING CAPACITY: 1.5 inches/foot

AVERAGE ROOTING DEPTH: 4 feet

CROP COEFFICIENT: 0.7

SGD

AVERAGE RECHARGE : 2.18 inches/year

SOIL MOISTURE YEAR: 1968

| Month | Rainfall (Inches) | Runoff (acre-feet) | Effective Rainfall (Inches) | Initial Soil Moisture (Inches) | Total Available Moisture (Inches) | Potential ET (Inches) | Actual ET (Inches) | Final Soil Moisture (Inches) | Water Yield (Inches) |
|---|---|---|---|---|---|---|---|---|---|
| Aug | 0.06 | 1.8 | 0.06 | 0.00 | 0.06 | 4.43 | 3.10 | 0.00 | 0.00 |
| Sept | 0.00 | 0.9 | 0.00 | 0.00 | 0.00 | 3.78 | 2.65 | 0.00 | 0.00 |
| Oct | 0.38 | 1.7 | 0.38 | 0.00 | 0.38 | 2.87 | 2.01 | 0.00 | 0.00 |
| Nov | 1.83 | 4.9 | 1.83 | 0.00 | 1.83 | 1.89 | 1.32 | 0.50 | 0.00 |
| Dec | 3.23 | 17 | 3.22 | 0.50 | 3.72 | 1.40 | 0.98 | 2.74 | 0.00 |
| Jan | 10.30 | 1690 | 9.31 | 2.74 | 12.05 | 1.65 | 1.16 | 10.90 | 4.90 |
| Feb | 10.20 | 4320 | 7.66 | 6.00 | 13.66 | 1.82 | 1.27 | 12.39 | 6.39 |
| Mar | 0.80 | 995 | 0.22 | 6.00 | 6.22 | 2.71 | 1.90 | 4.32 | 0.00 |
| Apr | 1.70 | 48 | 1.67 | 4.32 | 5.99 | 3.66 | 2.56 | 3.43 | 0.00 |
| May | 0.15 | 57 | 0.12 | 3.43 | 3.54 | 4.40 | 3.08 | 0.46 | 0.00 |
| June | 0.20 | 22 | 0.19 | 0.46 | 0.65 | 4.43 | 3.10 | 0.00 | 0.00 |
| Jul | 0.00 | 30 | 0.00 | 0.00 | 0.00 | 4.64 | 3.25 | 0.00 | 0.00 |
| | | | | | | | | TOTAL | 11.28 |

SOIL MOISTURE YEAR: 1969

| Month | Rainfall (Inches) | Runoff (acre-feet) | Effective Rainfall (Inches) | Initial Soil Moisture (Inches) | Total Available Moisture (Inches) | Potential ET (Inches) | Actual ET (Inches) | Final Soil Moisture (Inches) | Water Yield (Inches) |
|---|---|---|---|---|---|---|---|---|---|
| Aug | 0.00 | 14 | 0.00 | 0.00 | 0.00 | 4.43 | 3.10 | 0.00 | 0.00 |
| Sept | 0.00 | 12 | 0.00 | 0.00 | 0.00 | 3.78 | 2.65 | 0.00 | 0.00 |
| Oct | 0.70 | 7.4 | 0.70 | 0.00 | 0.70 | 2.87 | 2.01 | 0.00 | 0.00 |
| Nov | 0.70 | 8.2 | 0.70 | 0.00 | 0.70 | 1.89 | 1.32 | 0.00 | 0.00 |
| Dec | 1.60 | 21 | 1.59 | 0.00 | 1.59 | 1.40 | 0.98 | 0.61 | 0.00 |
| Jan | 3.90 | 76 | 3.86 | 0.61 | 4.46 | 1.65 | 1.16 | 3.31 | 0.00 |
| Feb | 3.60 | 24 | 3.59 | 3.31 | 6.89 | 1.82 | 1.27 | 5.62 | 0.00 |
| Mar | 2.10 | 448 | 1.84 | 5.62 | 7.46 | 2.71 | 1.90 | 5.56 | 0.00 |
| Apr | 0.84 | 14 | 0.83 | 5.56 | 6.39 | 3.66 | 2.56 | 3.83 | 0.00 |
| May | 0.09 | 18 | 0.08 | 3.83 | 3.91 | 4.40 | 3.08 | 0.83 | 0.00 |
| June | 0.00 | 9.6 | 0.00 | 0.83 | 0.83 | 4.43 | 3.10 | 0.00 | 0.00 |
| Jul | 0.00 | 2.5 | 0.00 | 0.00 | 0.00 | 4.64 | 3.25 | 0.00 | 0.00 |
| | | | | | | | | TOTAL | 0.00 |

SOIL MOISTURE YEAR: 1970

| Month | Rainfall (Inches) | Runoff (acre-feet) | Effective Rainfall (inches) | Initial Soil Moisture (Inches) | Total Available Moisture (Inches) | Potential ET (Inches) | Actual ET (Inches) | Final Soil Moisture (Inches) | Water Yield (Inches) |
|---|---|---|---|---|---|---|---|---|---|
| Aug | 0.00 | 4.4 | 0.00 | 0.00 | 0.00 | 4.43 | 3.10 | 0.00 | 0.00 |
| Sept | 0.00 | 2.3 | 0.00 | 0.00 | 0.00 | 3.78 | 2.65 | 0.00 | 0.00 |
| Oct | 0.17 | 7.9 | 0.17 | 0.00 | 0.17 | 2.87 | 2.01 | 0.00 | 0.00 |
| Nov | 3.91 | 38 | 3.89 | 0.00 | 3.89 | 1.89 | 1.32 | 2.56 | 0.00 |
| Dec | 5.08 | 122 | 5.01 | 2.56 | 7.57 | 1.40 | 0.98 | 6.59 | 0.59 |
| Jan | 1.42 | 50 | 1.39 | 6.00 | 7.39 | 1.65 | 1.16 | 6.24 | 0.24 |
| Feb | 0.90 | 25 | 0.89 | 6.00 | 6.89 | 1.82 | 1.27 | 5.61 | 0.00 |
| Mar | 0.80 | 30 | 0.78 | 5.61 | 6.39 | 2.71 | 1.90 | 4.50 | 0.00 |
| Apr | 1.43 | 32 | 1.41 | 4.50 | 5.91 | 3.66 | 2.56 | 3.35 | 0.00 |
| May | 0.25 | 15 | 0.24 | 3.35 | 3.59 | 4.40 | 3.08 | 0.51 | 0.00 |
| June | 0.00 | 6 | 0.00 | 0.51 | 0.51 | 4.43 | 3.10 | 0.00 | 0.00 |
| Jul | 0.03 | 4.3 | 0.03 | 0.00 | 0.03 | 4.64 | 3.25 | 0.00 | 0.00 |
| | | | | | | | | TOTAL | 0.83 |

SOIL MOISTURE YEAR: 1971

| Month | Rainfall (Inches) | Runoff (acre-feet) | Effective Rainfall (inches) | Initial Soil Moisture (Inches) | Total Available Moisture (Inches) | Potential ET (Inches) | Actual ET (Inches) | Final Soil Moisture (Inches) | Water Yield (Inches) |
|---|---|---|---|---|---|---|---|---|---|
| Aug | 0.02 | 3.8 | 0.02 | 0.00 | 0.02 | 4.43 | 3.10 | 0.00 | 0.00 |
| Sept | 0.19 | 1 | 0.19 | 0.00 | 0.19 | 3.78 | 2.65 | 0.00 | 0.00 |
| Oct | 0.18 | 8.4 | 0.18 | 0.00 | 0.18 | 2.87 | 2.01 | 0.00 | 0.00 |
| Nov | 1.30 | 12 | 1.29 | 0.00 | 1.29 | 1.89 | 1.32 | 0.00 | 0.00 |
| Dec | 3.40 | 14 | 3.39 | 0.00 | 3.39 | 1.40 | 0.98 | 2.41 | 0.00 |
| Jan | 1.00 | 8.3 | 1.00 | 2.41 | 3.41 | 1.65 | 1.16 | 2.25 | 0.00 |
| Feb | 0.80 | 10 | 0.79 | 2.25 | 3.05 | 1.82 | 1.27 | 1.77 | 0.00 |
| Mar | 0.10 | 6.6 | 0.10 | 1.77 | 1.87 | 2.71 | 1.90 | 0.00 | 0.00 |
| Apr | 0.50 | 6.3 | 0.50 | 0.00 | 0.50 | 3.66 | 2.56 | 0.00 | 0.00 |
| May | 0.20 | 3 | 0.20 | 0.00 | 0.20 | 4.40 | 3.08 | 0.00 | 0.00 |
| June | 0.00 | 2 | 0.00 | 0.00 | 0.00 | 4.43 | 3.10 | 0.00 | 0.00 |
| Jul | 0.00 | 0.7 | 0.00 | 0.00 | 0.00 | 4.64 | 3.25 | 0.00 | 0.00 |
| | | | | | | | | TOTAL | 0.00 |

SOIL MOISTURE YEAR: 1972

| Month | Rainfall (Inches) | Runoff (acre-feet) | Effective Rainfall (inches) | Initial Soil Moisture (Inches) | Total Available Moisture (Inches) | Potential ET (Inches) | Actual ET (Inches) | Final Soil Moisture (Inches) | Water Yield (Inches) |
|---|---|---|---|---|---|---|---|---|---|
| Aug | 0.10 | 0.5 | 0.10 | 0.00 | 0.10 | 4.43 | 3.10 | 0.00 | 0.00 |
| Sept | 0.00 | 0.9 | 0.00 | 0.00 | 0.00 | 3.78 | 2.65 | 0.00 | 0.00 |
| Oct | 2.10 | 5.2 | 2.10 | 0.00 | 2.10 | 2.87 | 2.01 | 0.09 | 0.00 |
| Nov | 5.60 | 63 | 5.56 | 0.09 | 5.65 | 1.89 | 1.32 | 4.33 | 0.00 |
| Dec | 2.20 | 14 | 2.19 | 4.33 | 6.52 | 1.40 | 0.98 | 5.54 | 0.00 |
| Jan | 4.60 | 414 | 4.36 | 5.54 | 9.90 | 1.65 | 1.16 | 8.74 | 2.74 |
| Feb | 5.70 | 1670 | 4.72 | 6.00 | 10.72 | 1.82 | 1.27 | 9.44 | 3.44 |
| Mar | 4.40 | 1520 | 3.51 | 6.00 | 9.51 | 2.71 | 1.90 | 7.61 | 1.61 |
| Apr | 0.20 | 109 | 0.14 | 6.00 | 6.14 | 3.66 | 2.56 | 3.57 | 0.00 |
| May | 0.10 | 15 | 0.09 | 3.57 | 3.67 | 4.40 | 3.08 | 0.59 | 0.00 |
| June | 0.00 | 11 | 0.00 | 0.59 | 0.59 | 4.43 | 3.10 | 0.00 | 0.00 |
| Jul | 0.00 | 13 | 0.00 | 0.00 | 0.00 | 4.64 | 3.25 | 0.00 | 0.00 |
| | | | | | | | | TOTAL | 7.80 |

SOIL MOISTURE YEAR: 1973

| Month | Rainfall (Inches) | Runoff (acre-feet) | Effective Rainfall (inches) | Initial Soil Moisture (Inches) | Total Available Moisture (Inches) | Potential ET (Inches) | Actual ET (Inches) | Final Soil Moisture (Inches) | Water Yield (Inches) |
|---|---|---|---|---|---|---|---|---|---|
| Aug | 0.00 | 12 | 0.00 | 0.00 | 0.00 | 4.43 | 3.10 | 0.00 | 0.00 |
| Sept | 0.20 | 9.1 | 0.19 | 0.00 | 0.19 | 3.78 | 2.65 | 0.00 | 0.00 |
| Oct | 1.90 | 12 | 1.89 | 0.00 | 1.89 | 2.87 | 2.01 | 0.00 | 0.00 |
| Nov | 3.90 | 25 | 3.89 | 0.00 | 3.89 | 1.89 | 1.32 | 2.56 | 0.00 |
| Dec | 3.30 | 43 | 3.27 | 2.56 | 5.84 | 1.40 | 0.98 | 4.86 | 0.00 |
| Jan | 3.40 | 966 | 2.83 | 4.86 | 7.69 | 1.65 | 1.16 | 6.53 | 0.53 |
| Feb | 0.60 | 54 | 0.57 | 6.00 | 6.57 | 1.82 | 1.27 | 5.29 | 0.00 |
| Mar | 3.10 | 205 | 2.98 | 5.29 | 8.27 | 2.71 | 1.90 | 6.38 | 0.38 |
| Apr | 1.90 | 564 | 1.57 | 6.00 | 7.57 | 3.66 | 2.56 | 5.01 | 0.00 |
| May | 0.00 | 19 | 0.00 | 5.01 | 5.01 | 4.40 | 3.08 | 1.93 | 0.00 |
| June | 0.00 | 26 | 0.00 | 1.93 | 1.93 | 4.43 | 3.10 | 0.00 | 0.00 |
| Jul | 0.00 | 10 | 0.00 | 0.00 | 0.00 | 4.64 | 3.25 | 0.00 | 0.00 |
| | | | | | | | | TOTAL | 0.91 |

SOIL MOISTURE YEAR: 1974

| Month | Rainfall (inches) | Runoff (acre-feet) | Effective Rainfall (inches) | Initial Soil Moisture (inches) | Total Available Moisture (inches) | Potential ET (inches) | Actual ET (inches) | Final Soil Moisture (inches) | Water Yield (inches) |
|---|---|---|---|---|---|---|---|---|---|
| Aug | 0.10 | 3.6 | 0.10 | 0.00 | 0.10 | 4.43 | 3.10 | 0.00 | 0.00 |
| Sept | 0.00 | 8 | 0.00 | 0.00 | 0.00 | 3.78 | 2.65 | 0.00 | 0.00 |
| Oct | 1.20 | 9 | 1.19 | 0.00 | 1.19 | 2.87 | 2.01 | 0.00 | 0.00 |
| Nov | 0.60 | 11 | 0.59 | 0.00 | 0.59 | 1.89 | 1.32 | 0.00 | 0.00 |
| Dec | 1.80 | 20 | 1.79 | 0.00 | 1.79 | 1.40 | 0.98 | 0.81 | 0.00 |
| Jan | 1.20 | 16 | 1.19 | 0.81 | 2.00 | 1.65 | 1.16 | 0.84 | 0.00 |
| Feb | 2.80 | 32 | 2.78 | 0.84 | 3.63 | 1.82 | 1.27 | 2.35 | 0.00 |
| Mar | 4.70 | 484 | 4.42 | 2.35 | 6.77 | 2.71 | 1.90 | 4.87 | 0.00 |
| Apr | 1.50 | 55 | 1.47 | 4.87 | 6.34 | 3.66 | 2.56 | 3.78 | 0.00 |
| May | 0.00 | 14 | 0.00 | 3.78 | 3.78 | 4.40 | 3.08 | 0.70 | 0.00 |
| June | 0.40 | 5.9 | 0.40 | 0.70 | 1.09 | 4.43 | 3.10 | 0.00 | 0.00 |
| Jul | 0.10 | 5.8 | 0.10 | 0.00 | 0.10 | 4.64 | 3.25 | 0.00 | 0.00 |
| | | | | | | | | TOTAL | 0.00 |

SOIL MOISTURE YEAR: 1975

| Month | Rainfall (inches) | Runoff (acre-feet) | Effective Rainfall (inches) | Initial Soil Moisture (inches) | Total Available Moisture (inches) | Potential ET (inches) | Actual ET (inches) | Final Soil Moisture (inches) | Water Yield (inches) |
|---|---|---|---|---|---|---|---|---|---|
| Aug | 0.30 | 6.6 | 0.30 | 0.00 | 0.30 | 4.43 | 3.10 | 0.00 | 0.00 |
| Sept | 0.00 | 6.7 | 0.00 | 0.00 | 0.00 | 3.78 | 2.65 | 0.00 | 0.00 |
| Oct | 1.50 | 7 | 1.50 | 0.00 | 1.50 | 2.87 | 2.01 | 0.00 | 0.00 |
| Nov | 0.70 | 9 | 0.69 | 0.00 | 0.69 | 1.89 | 1.32 | 0.00 | 0.00 |
| Dec | 0.40 | 14 | 0.39 | 0.00 | 0.39 | 1.40 | 0.98 | 0.00 | 0.00 |
| Jan | 0.10 | 11 | 0.09 | 0.00 | 0.09 | 1.65 | 1.16 | 0.00 | 0.00 |
| Feb | 1.80 | 12 | 1.79 | 0.00 | 1.79 | 1.82 | 1.27 | 0.52 | 0.00 |
| Mar | 1.50 | 13 | 1.49 | 0.52 | 2.01 | 2.71 | 1.90 | 0.11 | 0.00 |
| Apr | 1.20 | 11 | 1.19 | 0.11 | 1.31 | 3.66 | 2.56 | 0.00 | 0.00 |
| May | 0.40 | 6.6 | 0.40 | 0.00 | 0.40 | 4.40 | 3.08 | 0.00 | 0.00 |
| June | 0.00 | 1.9 | 0.00 | 0.00 | 0.00 | 4.43 | 3.10 | 0.00 | 0.00 |
| Jul | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 4.64 | 3.25 | 0.00 | 0.00 |
| | | | | | | | | TOTAL | 0.00 |

SGD

SOIL MOISTURE YEAR: 1976

| Month | Rainfall (Inches) | Runoff (acre-feet) | Effective Rainfall (inches) | Initial Soil Moisture (Inches) | Total Available Moisture (Inches) | Potential ET (Inches) | Actual ET (Inches) | Final Soil Moisture (Inches) | Water Yield (Inches) |
|---|---|---|---|---|---|---|---|---|---|
| Aug | 0.80 | 0 | 0.80 | 0.00 | 0.80 | 4.43 | 3.10 | 0.00 | 0.00 |
| Sept | 0.50 | 0.5 | 0.50 | 0.00 | 0.50 | 3.78 | 2.65 | 0.00 | 0.00 |
| Oct | 0.70 | 5.3 | 0.70 | 0.00 | 0.70 | 2.87 | 2.01 | 0.00 | 0.00 |
| Nov | 0.80 | 4.6 | 0.80 | 0.00 | 0.80 | 1.89 | 1.32 | 0.00 | 0.00 |
| Dec | 2.30 | 8.1 | 2.30 | 0.00 | 2.30 | 1.40 | 0.98 | 1.32 | 0.00 |
| Jan | 2.00 | 24 | 1.99 | 1.32 | 3.30 | 1.65 | 1.16 | 2.15 | 0.00 |
| Feb | 0.60 | 8.3 | 0.60 | 2.15 | 2.74 | 1.82 | 1.27 | 1.47 | 0.00 |
| Mar | 1.60 | 9.3 | 1.59 | 1.47 | 3.06 | 2.71 | 1.90 | 1.16 | 0.00 |
| Apr | 0.00 | 5.6 | 0.00 | 1.16 | 1.16 | 3.66 | 2.56 | 0.00 | 0.00 |
| May | 0.40 | 5.5 | 0.40 | 0.00 | 0.40 | 4.40 | 3.08 | 0.00 | 0.00 |
| June | 0.20 | 1.7 | 0.20 | 0.00 | 0.20 | 4.43 | 3.10 | 0.00 | 0.00 |
| Jul | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 4.64 | 3.25 | 0.00 | 0.00 |
| | | | | | | | | TOTAL | 0.00 |

SOIL MOISTURE YEAR: 1977

| Month | Rainfall (Inches) | Runoff (acre-feet) | Effective Rainfall (inches) | Initial Soil Moisture (Inches) | Total Available Moisture (Inches) | Potential ET (Inches) | Actual ET (Inches) | Final Soil Moisture (Inches) | Water Yield (Inches) |
|---|---|---|---|---|---|---|---|---|---|
| Aug | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 4.43 | 3.10 | 0.00 | 0.00 |
| Sept | 0.20 | 0 | 0.20 | 0.00 | 0.20 | 3.78 | 2.65 | 0.00 | 0.00 |
| Oct | 0.10 | 0 | 0.10 | 0.00 | 0.10 | 2.87 | 2.01 | 0.00 | 0.00 |
| Nov | 0.40 | 0.3 | 0.40 | 0.00 | 0.40 | 1.89 | 1.32 | 0.00 | 0.00 |
| Dec | 4.10 | 24 | 4.09 | 0.00 | 4.09 | 1.40 | 0.98 | 3.11 | 0.00 |
| Jan | 5.20 | 287 | 5.03 | 3.11 | 8.14 | 1.65 | 1.16 | 6.98 | 0.98 |
| Feb | 3.90 | 752 | 3.46 | 6.00 | 9.46 | 1.82 | 1.27 | 8.18 | 2.18 |
| Mar | 4.60 | 551 | 4.28 | 6.00 | 10.28 | 2.71 | 1.90 | 8.38 | 2.38 |
| Apr | 5.00 | 551 | 4.68 | 6.00 | 10.68 | 3.66 | 2.56 | 8.11 | 2.11 |
| May | 0.20 | 22 | 0.19 | 6.00 | 6.19 | 4.40 | 3.08 | 3.11 | 0.00 |
| June | 0.00 | 8.4 | 0.00 | 3.11 | 3.11 | 4.43 | 3.10 | 0.01 | 0.00 |
| Jul | 0.00 | 6 | 0.00 | 0.01 | 0.01 | 4.64 | 3.25 | 0.00 | 0.00 |
| | | | | | | | | TOTAL | 7.66 |

SOIL MOISTURE YEAR: 1978

| Month | Rainfall (Inches) | Runoff (acre-feet) | Effective Rainfall (inches) | Initial Soil Moisture (Inches) | Total Available Moisture (Inches) | Potential ET (Inches) | Actual ET (Inches) | Final Soil Moisture (Inches) | Water Yield (Inches) |
|---|---|---|---|---|---|---|---|---|---|
| Aug | 0.00 | 5 | 0.00 | 0.00 | 0.00 | 4.43 | 3.10 | 0.00 | 0.00 |
| Sept | 0.30 | 4.4 | 0.30 | 0.00 | 0.30 | 3.78 | 2.65 | 0.00 | 0.00 |
| Oct | 0.00 | 4.8 | 0.00 | 0.00 | 0.00 | 2.87 | 2.01 | 0.00 | 0.00 |
| Nov | 2.10 | 10 | 2.09 | 0.00 | 2.09 | 1.89 | 1.32 | 0.77 | 0.00 |
| Dec | 1.50 | 16 | 1.49 | 0.77 | 2.26 | 1.40 | 0.98 | 1.28 | 0.00 |
| Jan | 4.10 | 38 | 4.08 | 1.28 | 5.36 | 1.65 | 1.16 | 4.20 | 0.00 |
| Feb | 3.40 | 269 | 3.24 | 4.20 | 7.45 | 1.82 | 1.27 | 6.17 | 0.17 |
| Mar | 3.60 | 357 | 3.39 | 6.00 | 9.39 | 2.71 | 1.90 | 7.49 | 1.49 |
| Apr | 0.50 | 78 | 0.45 | 6.00 | 6.45 | 3.66 | 2.56 | 3.89 | 0.00 |
| May | 0.30 | 12 | 0.29 | 3.89 | 4.19 | 4.40 | 3.08 | 1.11 | 0.00 |
| June | 0.00 | 6.5 | 0.00 | 1.11 | 1.11 | 4.43 | 3.10 | 0.00 | 0.00 |
| Jul | 0.00 | 6.6 | 0.00 | 0.00 | 0.00 | 4.64 | 3.25 | 0.00 | 0.00 |
| | | | | | | | | TOTAL | 1.67 |

SOIL MOISTURE YEAR: 1979

| Month | Rainfall (Inches) | Runoff (acre-feet) | Effective Rainfall (inches) | Initial Soil Moisture (Inches) | Total Available Moisture (Inches) | Potential ET (Inches) | Actual ET (Inches) | Final Soil Moisture (Inches) | Water Yield (Inches) |
|---|---|---|---|---|---|---|---|---|---|
| Aug | 0.00 | 2.9 | 0.00 | 0.00 | 0.00 | 4.43 | 3.10 | 0.00 | 0.00 |
| Sept | 0.00 | 1.6 | 0.00 | 0.00 | 0.00 | 3.78 | 2.65 | 0.00 | 0.00 |
| Oct | 1.10 | 94 | 1.04 | 0.00 | 1.04 | 2.87 | 2.01 | 0.00 | 0.00 |
| Nov | 1.60 | 8.7 | 1.59 | 0.00 | 1.59 | 1.89 | 1.32 | 0.27 | 0.00 |
| Dec | 2.30 | 23 | 2.29 | 0.27 | 2.56 | 1.40 | 0.98 | 1.58 | 0.00 |
| Jan | 3.40 | 184 | 3.29 | 1.58 | 4.87 | 1.65 | 1.16 | 3.72 | 0.00 |
| Feb | 5.00 | 728 | 4.57 | 3.72 | 8.29 | 1.82 | 1.27 | 7.01 | 1.01 |
| Mar | 2.30 | 434 | 2.04 | 6.00 | 8.04 | 2.71 | 1.90 | 6.15 | 0.15 |
| Apr | 1.90 | 19 | 1.89 | 6.00 | 7.89 | 3.66 | 2.56 | 5.33 | 0.00 |
| May | 0.60 | 11 | 0.59 | 5.33 | 5.92 | 4.40 | 3.08 | 2.84 | 0.00 |
| June | 0.00 | 6.7 | 0.00 | 2.84 | 2.84 | 4.43 | 3.10 | 0.00 | 0.00 |
| Jul | 0.80 | 13 | 0.79 | 0.00 | 0.79 | 4.64 | 3.25 | 0.00 | 0.00 |

SGD

SOIL MOISTURE YEAR: 1980 TOTAL 1.16

| Month | Rainfall (Inches) | Runoff (acre-feet) | Effective Rainfall (Inches) | Initial Soil Moisture (Inches) | Total Available Moisture (Inches) | Potential ET (Inches) | Actual ET (Inches) | Final Soil Moisture (Inches) | Water Yield (Inches) |
|---|---|---|---|---|---|---|---|---|---|
| Aug | 0.00 | 6.5 | 0.00 | 0.00 | 0.00 | 4.43 | 3.10 | 0.00 | 0.00 |
| Sept | 0.10 | 4.2 | 0.10 | 0.00 | 0.10 | 3.78 | 2.65 | 0.00 | 0.00 |
| Oct | 0.00 | 3.8 | 0.00 | 0.00 | 0.00 | 2.87 | 2.01 | 0.00 | 0.00 |
| Nov | 0.10 | 4.8 | 0.10 | 0.00 | 0.10 | 1.89 | 1.32 | 0.00 | 0.00 |
| Dec | 1.30 | 9.4 | 1.29 | 0.00 | 1.29 | 1.40 | 0.98 | 0.31 | 0.00 |
| Jan | 4.30 | 33 | 4.28 | 0.31 | 4.60 | 1.65 | 1.16 | 3.44 | 0.00 |
| Feb | 1.80 | 28 | 1.78 | 3.44 | 5.22 | 1.82 | 1.27 | 3.95 | 0.00 |
| Mar | 3.80 | 185 | 3.69 | 3.95 | 7.64 | 2.71 | 1.90 | 5.74 | 0.00 |
| Apr | 0.90 | 21 | 0.89 | 5.74 | 6.63 | 3.66 | 2.56 | 4.07 | 0.00 |
| May | 0.00 | 7.3 | 0.00 | 4.07 | 4.07 | 4.40 | 3.08 | 0.99 | 0.00 |
| June | 0.00 | 2.3 | 0.00 | 0.99 | 0.99 | 4.43 | 3.10 | 0.00 | 0.00 |
| Jul | 0.00 | 1.4 | 0.00 | 0.00 | 0.00 | 4.64 | 3.25 | 0.00 | 0.00 |

TOTAL 0.00

SOIL MOISTURE YEAR: 1981

| Month | Rainfall (Inches) | Runoff (acre-feet) | Effective Rainfall (Inches) | Initial Soil Moisture (Inches) | Total Available Moisture (Inches) | Potential ET (Inches) | Actual ET (Inches) | Final Soil Moisture (Inches) | Water Yield (Inches) |
|---|---|---|---|---|---|---|---|---|---|
| Aug | 0.00 | 0.7 | 0.00 | 0.00 | 0.00 | 4.43 | 3.10 | 0.00 | 0.00 |
| Sept | 0.00 | 0.5 | 0.00 | 0.00 | 0.00 | 3.78 | 2.65 | 0.00 | 0.00 |
| Oct | 0.90 | 5.8 | 0.90 | 0.00 | 0.90 | 2.87 | 2.01 | 0.00 | 0.00 |
| Nov | 3.40 | 27 | 3.38 | 0.00 | 3.38 | 1.89 | 1.32 | 2.06 | 0.00 |
| Dec | 1.60 | 13 | 1.59 | 2.06 | 3.65 | 1.40 | 0.98 | 2.67 | 0.00 |
| Jan | 4.40 | 542 | 4.08 | 2.67 | 6.75 | 1.65 | 1.16 | 5.60 | 0.00 |
| Feb | 2.10 | 177 | 2.00 | 5.60 | 7.60 | 1.82 | 1.27 | 6.32 | 0.32 |
| Mar | 6.40 | 337 | 6.20 | 6.00 | 12.20 | 2.71 | 1.90 | 10.30 | 4.30 |
| Apr | 1.30 | 883 | 0.78 | 6.00 | 6.78 | 3.66 | 2.56 | 4.22 | 0.00 |
| May | 0.00 | 13 | 0.00 | 4.22 | 4.22 | 4.40 | 3.08 | 1.14 | 0.00 |
| June | 0.30 | 7.7 | 0.30 | 1.14 | 1.43 | 4.43 | 3.10 | 0.00 | 0.00 |
| Jul | 0.00 | 6.7 | 0.00 | 0.00 | 0.00 | 4.64 | 3.25 | 0.00 | 0.00 |

TOTAL 4.63

SOIL MOISTURE YEAR: 1982

| Month | Rainfall (Inches) | Runoff (acre-feet) | Effective Rainfall (Inches) | Initial Soil Moisture (Inches) | Total Available Moisture (Inches) | Potential ET (Inches) | Actual ET (Inches) | Final Soil Moisture (Inches) | Water Yield (Inches) |
|---|---|---|---|---|---|---|---|---|---|
| Aug | 0.00 | 7 | 0.00 | 0.00 | 0.00 | 4.43 | 3.10 | 0.00 | 0.00 |
| Sept | 1.10 | 7.8 | 1.10 | 0.00 | 1.10 | 3.78 | 2.65 | 0.00 | 0.00 |
| Oct | 1.80 | 11 | 1.79 | 0.00 | 1.79 | 2.87 | 2.01 | 0.00 | 0.00 |
| Nov | 4.50 | 133 | 4.42 | 0.00 | 4.42 | 1.89 | 1.32 | 3.10 | 0.00 |
| Dec | 2.90 | 435 | 2.64 | 3.10 | 5.74 | 1.40 | 0.98 | 4.76 | 0.00 |
| Jan | 5.50 | 1230 | 4.78 | 4.76 | 9.54 | 1.65 | 1.16 | 8.39 | 2.39 |
| Feb | 4.30 | 1430 | 3.46 | 6.00 | 9.46 | 1.82 | 1.27 | 8.19 | 2.19 |
| Mar | 7.60 | 3820 | 5.35 | 6.00 | 11.35 | 2.71 | 1.90 | 9.46 | 3.46 |
| Apr | 2.80 | 731 | 2.37 | 6.00 | 8.37 | 3.66 | 2.56 | 5.81 | 0.00 |
| May | 0.60 | 318 | 0.41 | 5.81 | 6.22 | 4.40 | 3.08 | 3.14 | 0.00 |
| June | 0.40 | 37 | 0.38 | 3.14 | 3.52 | 4.43 | 3.10 | 0.42 | 0.00 |
| Jul | 0.00 | 19 | 0.00 | 0.42 | 0.42 | 4.64 | 3.25 | 0.00 | 0.00 |
| | | | | | | | | TOTAL | 8.03 |

SOIL MOISTURE YEAR: 1983

| Month | Rainfall (Inches) | Runoff (acre-feet) | Effective Rainfall (Inches) | Initial Soil Moisture (Inches) | Total Available Moisture (Inches) | Potential ET (Inches) | Actual ET (Inches) | Final Soil Moisture (Inches) | Water Yield (Inches) |
|---|---|---|---|---|---|---|---|---|---|
| Aug | 0.10 | 18 | 0.09 | 0.00 | 0.09 | 4.43 | 3.10 | 0.00 | 0.00 |
| Sept | 0.10 | 13 | 0.09 | 0.00 | 0.09 | 3.78 | 2.65 | 0.00 | 0.00 |
| Oct | 0.40 | 13 | 0.39 | 0.00 | 0.39 | 2.87 | 2.01 | 0.00 | 0.00 |
| Nov | 3.70 | 42 | 3.68 | 0.00 | 3.68 | 1.89 | 1.32 | 2.35 | 0.00 |
| Dec | 3.60 | 219 | 3.47 | 2.35 | 5.82 | 1.40 | 0.98 | 4.84 | 0.00 |
| Jan | 0.10 | 243 | 0.00 | 4.84 | 4.84 | 1.65 | 1.16 | 3.69 | 0.00 |
| Feb | 1.90 | 251 | 1.75 | 3.69 | 5.44 | 1.82 | 1.27 | 4.17 | 0.00 |
| Mar | 1.10 | 48 | 1.07 | 4.17 | 5.24 | 2.71 | 1.90 | 3.34 | 0.00 |
| Apr | 0.60 | 33 | 0.58 | 3.34 | 3.92 | 3.66 | 2.56 | 1.36 | 0.00 |
| May | 0.10 | 28 | 0.08 | 1.36 | 1.44 | 4.40 | 3.08 | 0.00 | 0.00 |
| June | 0.30 | 6.2 | 0.30 | 0.00 | 0.30 | 4.43 | 3.10 | 0.00 | 0.00 |
| Jul | 0.00 | 2.6 | 0.00 | 0.00 | 0.00 | 4.64 | 3.25 | 0.00 | 0.00 |
| | | | | | | | | TOTAL | 0.00 |

SGD

SOIL MOISTURE YEAR: 1984

| Month | Rainfall (Inches) | Runoff (acre-feet) | Effective Rainfall (inches) | Initial Soil Moisture (Inches) | Total Available Moisture (Inches) | Potential ET (Inches) | Actual ET (Inches) | Final Soil Moisture (Inches) | Water Yield (Inches) |
|---|---|---|---|---|---|---|---|---|---|
| Aug | 0.00 | 1.1 | 0.00 | 0.00 | 0.00 | 4.43 | 3.10 | 0.00 | 0.00 |
| Sept | 0.00 | 1 | 0.00 | 0.00 | 0.00 | 3.78 | 2.65 | 0.00 | 0.00 |
| Oct | 1.60 | 9.1 | 1.59 | 0.00 | 1.59 | 2.87 | 2.01 | 0.00 | 0.00 |
| Nov | 3.50 | 22 | 3.49 | 0.00 | 3.49 | 1.89 | 1.32 | 2.16 | 0.00 |
| Dec | 1.40 | 22 | 1.39 | 2.16 | 3.55 | 1.40 | 0.98 | 2.57 | 0.00 |
| Jan | 1.20 | 18 | 1.19 | 2.57 | 3.76 | 1.65 | 1.16 | 2.61 | 0.00 |
| Feb | 1.00 | 21 | 0.99 | 2.61 | 3.59 | 1.82 | 1.27 | 2.32 | 0.00 |
| Mar | 3.00 | 23 | 2.99 | 2.32 | 5.31 | 2.71 | 1.90 | 3.41 | 0.00 |
| Apr | 0.50 | 11 | 0.49 | 3.41 | 3.90 | 3.66 | 2.56 | 1.34 | 0.00 |
| May | 0.30 | 3.8 | 0.30 | 1.34 | 1.64 | 4.40 | 3.08 | 0.00 | 0.00 |
| June | 0.10 | 2.5 | 0.10 | 0.00 | 0.10 | 4.43 | 3.10 | 0.00 | 0.00 |
| Jul | 0.00 | 0.3 | 0.00 | 0.00 | 0.00 | 4.64 | 3.25 | 0.00 | 0.00 |

TOTAL 0.00

SOIL MOISTURE YEAR: 1985

| Month | Rainfall (Inches) | Runoff (acre-feet) | Effective Rainfall (inches) | Initial Soil Moisture (Inches) | Total Available Moisture (Inches) | Potential ET (Inches) | Actual ET (Inches) | Final Soil Moisture (Inches) | Water Yield (Inches) |
|---|---|---|---|---|---|---|---|---|---|
| Aug | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 4.43 | 3.10 | 0.00 | 0.00 |
| Sept | 0.10 | 0 | 0.10 | 0.00 | 0.10 | 3.78 | 2.65 | 0.00 | 0.00 |
| Oct | 1.00 | 3.5 | 1.00 | 0.00 | 1.00 | 2.87 | 2.01 | 0.00 | 0.00 |
| Nov | 4.10 | 18 | 4.09 | 0.00 | 4.09 | 1.89 | 1.32 | 2.77 | 0.00 |
| Dec | 0.80 | 11 | 0.79 | 2.77 | 3.56 | 1.40 | 0.98 | 2.58 | 0.00 |
| Jan | 1.90 | 15 | 1.89 | 2.58 | 4.47 | 1.65 | 1.16 | 3.32 | 0.00 |
| Feb | 5.40 | 180 | 5.29 | 3.32 | 8.61 | 1.82 | 1.27 | 7.34 | 1.34 |
| Mar | 3.80 | 725 | 3.37 | 6.00 | 9.37 | 2.71 | 1.90 | 7.48 | 1.48 |
| Apr | 0.20 | 18 | 0.19 | 6.00 | 6.19 | 3.66 | 2.56 | 3.63 | 0.00 |
| May | 0.20 | 8.7 | 0.19 | 3.63 | 3.82 | 4.40 | 3.08 | 0.74 | 0.00 |
| June | 0.00 | 3.8 | 0.00 | 0.74 | 0.74 | 4.43 | 3.10 | 0.00 | 0.00 |
| Jul | 0.00 | 2.9 | 0.00 | 0.00 | 0.00 | 4.64 | 3.25 | 0.00 | 0.00 |

TOTAL 2.81

SOIL MOISTURE YEAR: 1986

| Month | Rainfall (Inches) | Runoff (acre-feet) | Effective Rainfall (inches) | Initial Soil Moisture (Inches) | Total Available Moisture (Inches) | Potential ET (Inches) | Actual ET (Inches) | Final Soil Moisture (Inches) | Water Yield (Inches) |
|---|---|---|---|---|---|---|---|---|---|
| Aug | 0.60 | 1.8 | 0.60 | 0.00 | 0.60 | 4.43 | 3.10 | 0.00 | 0.00 |
| Sept | 0.00 | 8 | 0.00 | 0.00 | 0.00 | 3.78 | 2.65 | 0.00 | 0.00 |
| Oct | 0.30 | 4.5 | 0.30 | 0.00 | 0.30 | 2.87 | 2.01 | 0.00 | 0.00 |
| Nov | 1.10 | 5.9 | 1.10 | 0.00 | 1.10 | 1.89 | 1.32 | 0.00 | 0.00 |
| Dec | 2.60 | 10 | 2.59 | 0.00 | 2.59 | 1.40 | 0.98 | 1.61 | 0.00 |
| Jan | 2.50 | 17 | 2.49 | 1.61 | 4.10 | 1.65 | 1.16 | 2.95 | 0.00 |
| Feb | 2.40 | 23 | 2.39 | 2.95 | 5.34 | 1.82 | 1.27 | 4.06 | 0.00 |
| Mar | 0.50 | 17 | 0.49 | 4.06 | 4.55 | 2.71 | 1.90 | 2.65 | 0.00 |
| Apr | 0.30 | 4.4 | 0.30 | 2.65 | 2.95 | 3.66 | 2.56 | 0.39 | 0.00 |
| May | 0.00 | 3.6 | 0.00 | 0.39 | 0.39 | 4.40 | 3.08 | 0.00 | 0.00 |
| June | 0.00 | 1.2 | 0.00 | 0.00 | 0.00 | 4.43 | 3.10 | 0.00 | 0.00 |
| Jul | 0.00 | 0.8 | 0.00 | 0.00 | 0.00 | 4.64 | 3.25 | 0.00 | 0.00 |

SOIL MOISTURE YEAR: 1987

TOTAL 0.00

| Month | Rainfall (Inches) | Runoff (acre-feet) | Effective Rainfall (inches) | Initial Soil Moisture (Inches) | Total Available Moisture (Inches) | Potential ET (Inches) | Actual ET (Inches) | Final Soil Moisture (Inches) | Water Yield (Inches) |
|---|---|---|---|---|---|---|---|---|---|
| Aug | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 4.43 | 3.10 | 0.00 | 0.00 |
| Sept | 0.70 | 0 | 0.70 | 0.00 | 0.70 | 3.78 | 2.65 | 0.00 | 0.00 |
| Oct | 1.20 | 0.02 | 1.20 | 0.00 | 1.20 | 2.87 | 2.01 | 0.00 | 0.00 |
| Nov | 3.30 | 2 | 3.30 | 0.00 | 3.30 | 1.89 | 1.32 | 1.98 | 0.00 |
| Dec | 1.40 | 10 | 1.39 | 1.98 | 3.37 | 1.40 | 0.98 | 2.39 | 0.00 |
| Jan | 0.20 | 15 | 0.19 | 2.39 | 2.58 | 1.65 | 1.16 | 1.43 | 0.00 |
| Feb | 0.80 | 6.2 | 0.80 | 1.43 | 2.22 | 1.82 | 1.27 | 0.95 | 0.00 |
| Mar | 1.20 | 4.5 | 1.20 | 0.95 | 2.15 | 2.71 | 1.90 | 0.25 | 0.00 |
| Apr | 0.50 | 4.2 | 0.50 | 0.25 | 0.75 | 3.66 | 2.56 | 0.00 | 0.00 |
| May | 0.10 | 2 | 0.10 | 0.00 | 0.10 | 4.40 | 3.08 | 0.00 | 0.00 |
| June | 0.00 | 0.7 | 0.00 | 0.00 | 0.00 | 4.43 | 3.10 | 0.00 | 0.00 |
| Jul | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 4.64 | 3.25 | 0.00 | 0.00 |

TOTAL 0.00

SGD

SOIL MOISTURE YEAR: 1988

| Month | Rainfall (inches) | Runoff (acre-feet) | Effective Rainfall (inches) | Initial Soil Moisture (Inches) | Total Available Moisture (Inches) | Potential ET (Inches) | Actual ET (Inches) | Final Soil Moisture (Inches) | Water Yield (Inches) |
|---|---|---|---|---|---|---|---|---|---|
| Aug | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 4.43 | 3.10 | 0.00 | 0.00 |
| Sept | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 3.78 | 2.65 | 0.00 | 0.00 |
| Oct | 1.30 | 0 | 1.30 | 0.00 | 1.30 | 2.87 | 2.01 | 0.00 | 0.00 |
| Nov | 2.60 | 0 | 2.60 | 0.00 | 2.60 | 1.89 | 1.32 | 1.28 | 0.00 |
| Dec | 1.00 | 5.4 | 1.00 | 1.28 | 2.27 | 1.40 | 0.98 | 1.29 | 0.00 |
| Jan | 1.40 | 5.9 | 1.40 | 1.29 | 2.69 | 1.65 | 1.16 | 1.54 | 0.00 |
| Feb | 2.00 | 8.3 | 2.00 | 1.54 | 3.53 | 1.82 | 1.27 | 2.26 | 0.00 |
| Mar | 0.70 | 7.6 | 0.70 | 2.26 | 2.95 | 2.71 | 1.90 | 1.06 | 0.00 |
| Apr | 0.00 | 2.6 | 0.00 | 1.06 | 1.06 | 3.66 | 2.56 | 0.00 | 0.00 |
| May | 0.00 | 1.5 | 0.00 | 0.00 | 0.00 | 4.40 | 3.08 | 0.00 | 0.00 |
| June | 0.00 | 0.3 | 0.00 | 0.00 | 0.00 | 4.43 | 3.10 | 0.00 | 0.00 |
| Jul | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 4.64 | 3.25 | 0.00 | 0.00 |
| | | | | | | | | TOTAL | 0.00 |

# DOMINANT SOIL TYPES

## FROM: SOIL CONSERVATION SERVICE SOIL SURVEY, MONTEREY COUNTY, 1978, PAGES 31, 32, AND 53

| Soil Type Symbol | Soil Type Name | Water-Holding Capacity (inches/inch) | Mean Water-Holding Capacity (inches/inch) | Mean Water-Holding Capacity (inches/foot) |
|---|---|---|---|---|
| ShE | Santa Ynez Sandy Loam | 0.04 - 0.16 | 0.12 | 1.44 * |
| Am | Arnold-San Andreas Complex | 0.05 - 0.09 | 0.07 | 0.89 |
| GkB | Gorgonio Sandy Loam | 0.1 - 0.13 | 0.11 | 1.32 * |
| Ps | Psamments & Fluvents | -0.03 - 0.05 | 0.04 | 0.48 |
| ScG | San Andreas Fine Sandy Loam | 0.11 - 0.17 | 0.14 | 1.68 * |
| ScE | San Andreas Fine Sandy Loam | 0.11 - 0.17 | 0.14 | 1.68 |
| SfF | Santa Lucia Shaly Clay Loam | 0.1 - 0.14 | 0.12 | 1.49 * |
| Ba | Badlands | NA | NA | NA |
| Xd | Xerorthents, Dissected | NA | NA | NA * |
| AkF | Arnold Loamy Sand | 0.05 - 0.09 | 0.07 | 0.84 |
| PnD | Placentia Sandy Loam | 0.17 - 0.19 | 0.12 | 1.44 |
| PnE | Placentia Sandy Loam | 0.17 - 0.19 | 0.18 | 2.16 |
| Sg | Santa Lucia/Reliz Assemblage | 0.1 - 0.14 | 0.18 | 1.44 |
| SoG | Sheridan Coarse Sandy Loam | 0.1 - 0.14 | 0.12 | 1.44 |
| Rc | Rock Outcrop | NA | NA | NA |
| | | | Average: | 1.48 |

* Dominant Soil Type
NA Not Available

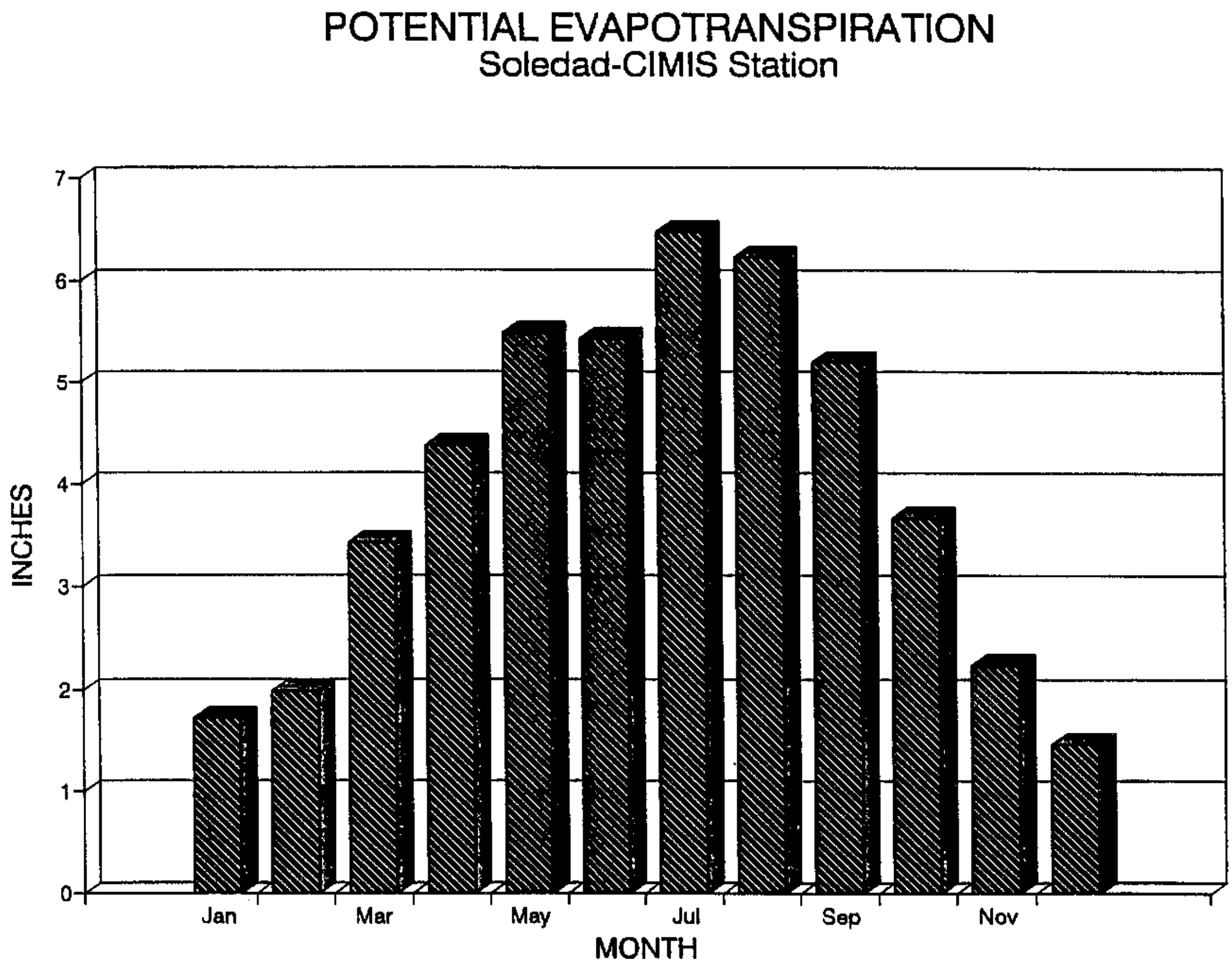
# APPENDIX B

# MISCELLANEOUS DOCUMENTATION

SALINAS RAINFALL DATA ANALYSIS

| JULY-JUNE | RAINFALL | DEVIATION | CUMMULATIVE DEVIATION |
|---|---|---|---|
| 1872 | 13.13 | -0.29 | |
| 1873 | 12.2 | -1.22 | -1.52 |
| 1874 | 9.98 | -3.44 | -4.96 |
| 1875 | 22.94 | 9.52 | 4.56 |
| 1876 | 4.44 | -8.98 | -4.43 |
| 1877 | 23.82 | 10.40 | 5.97 |
| 1878 | 10.92 | -2.50 | 3.47 |
| 1879 | 13.22 | -0.20 | 3.26 |
| 1880 | 14.07 | 0.65 | 3.91 |
| 1881 | 12.93 | -0.49 | 3.42 |
| 1882 | 10.74 | -2.68 | 0.73 |
| 1883 | 21.29 | 7.87 | 8.60 |
| 1884 | 9.48 | -3.94 | 4.66 |
| 1885 | 20.81 | 7.39 | 12.04 |
| 1886 | 9.88 | -3.54 | 8.50 |
| 1887 | 12.7 | -0.72 | 7.78 |
| 1888 | 11.6 | -1.82 | 5.96 |
| 1889 | 27.59 | 14.17 | 20.12 |
| 1890 | 12.19 | -1.23 | 18.89 |
| 1891 | 12.93 | -0.49 | 18.40 |
| 1892 | 18.03 | 4.61 | 23.00 |
| 1893 | 13.7 | 0.28 | 23.28 |
| 1894 | 17.25 | 3.83 | 27.11 |
| 1895 | 12.42 | -1.00 | 26.10 |
| 1896 | 14.02 | 0.60 | 26.70 |
| 1897 | 8.07 | -5.35 | 21.35 |
| 1898 | 12.18 | -1.24 | 20.10 |
| 1899 | 9.65 | -3.77 | 16.33 |
| 1900 | 15.98 | 2.56 | 18.89 |
| 1901 | 10.6 | -2.82 | 16.06 |
| 1902 | 11.05 | -2.37 | 13.69 |
| 1903 | 9.6 | -3.82 | 9.87 |
| 1904 | 16.57 | 3.15 | 13.01 |
| 1905 | 14.14 | 0.72 | 13.73 |
| 1906 | 23.99 | 10.57 | 24.30 |
| 1907 | 11.41 | -2.01 | 22.28 |
| 1908 | 18.99 | 5.57 | 27.85 |
| 1909 | 12.1 | -1.32 | 26.53 |
| 1910 | 16.42 | 3.00 | 29.52 |
| 1911 | 11.94 | -1.48 | 28.04 |
| 1912 | 7.03 | -6.39 | 21.65 |
| 1913 | 16.12 | 2.70 | 24.34 |
| 1914 | 19.07 | 5.65 | 29.99 |
| 1915 | 17.21 | 3.79 | 33.78 |
| 1916 | 8.98 | -4.44 | 29.34 |
| 1917 | 8.3 | -5.12 | 24.21 |
| 1918 | 17.01 | 3.59 | 27.80 |
| 1919 | 11.22 | -2.20 | 25.60 |
| 1920 | 15.48 | 2.06 | 27.65 |
| 1921 | 18.79 | 5.37 | 33.02 |
| 1922 | 12.84 | -0.58 | 32.44 |
| 1923 | 6.53 | -6.89 | 25.54 |
| 1924 | 15.55 | 2.13 | 27.67 |
| 1925 | 9.35 | -4.07 | 23.60 |
| 1926 | 11.67 | -1.75 | 21.84 |
| 1927 | 9.15 | -4.27 | 17.57 |
| 1928 | 10.1 | -3.32 | 14.25 |
| 1929 | 12.11 | -1.31 | 12.93 |
| 1930 | 8.85 | -4.57 | 8.36 |
| 1931 | 17.47 | 4.05 | 12.41 |
| 1932 | 9.52 | -3.90 | 8.50 |
| 1933 | 7.58 | -5.84 | 2.66 |
| 1934 | 17.29 | 3.87 | 6.53 |
| 1935 | 13.96 | 0.54 | 7.06 |
| 1936 | 19.21 | 5.79 | 12.85 |
| 1937 | 18.52 | 5.10 | 17.95 |
| 1938 | 10.83 | -2.59 | 15.35 |
| 1939 | 18.62 | 5.20 | 20.55 |
| 1940 | 25.04 | 11.62 | 32.17 |
| 1941 | 18.01 | 4.59 | 36.75 |
| 1942 | 14.63 | 1.21 | 37.96 |
| 1943 | 13.66 | 0.24 | 38.20 |
| 1944 | 13.07 | -0.35 | 37.84 |
| 1945 | 13.47 | 0.05 | 37.89 |
| 1946 | 9.67 | -3.75 | 34.14 |
| 1947 | 12.73 | -0.69 | 33.45 |
| 1948 | 11.08 | -2.34 | 31.10 |
| 1949 | 13.82 | 0.40 | 31.50 |
| 1950 | 12.14 | -1.28 | 30.22 |
| 1951 | 19.86 | 6.44 | 36.65 |
| 1952 | 9.76 | -3.66 | 32.99 |
| 1953 | 10.31 | -3.11 | 29.88 |
| 1954 | 13.13 | -0.29 | 29.58 |
| 1955 | 17.79 | 4.37 | 33.95 |
| 1956 | 10.85 | -2.57 | 31.38 |
| 1957 | 19.74 | 6.32 | 37.69 |
| 1958 | 8.01 | -5.41 | 32.28 |
| 1959 | 12.19 | -1.23 | 31.05 |
| 1960 | 7.99 | -5.43 | 25.61 |
| 1961 | 11.9 | -1.52 | 24.09 |
| 1962 | 13.7 | 0.28 | 24.37 |
| 1963 | 10.4 | -3.02 | 21.34 |
| 1964 | 12.51 | -0.91 | 20.43 |
| 1965 | 11.04 | -2.38 | 18.05 |
| 1966 | 19.08 | 5.66 | 23.70 |
| 1967 | 8.1 | -5.32 | 18.38 |
| 1968 | 21.14 | 7.72 | 26.10 |
| 1969 | 13 | -0.42 | 25.67 |
| 1970 | 12.71 | -0.71 | 24.96 |
| 1971 | 6.45 | -6.97 | 17.99 |
| 1972 | 20.27 | 6.85 | 24.83 |
| 1973 | 21.8 | 8.38 | 33.21 |
| 1974 | 12.55 | -0.87 | 32.34 |
| 1975 | 6.83 | -6.59 | 25.75 |
| 1976 | 8.02 | -5.40 | 20.34 |
| 1977 | 19.94 | 6.52 | 26.86 |
| 1978 | 10.73 | -2.69 | 24.17 |
| 1979 | 11.86 | -1.56 | 22.60 |
| 1980 | 10 | -3.42 | 19.18 |
| 1981 | 17.69 | 4.27 | 23.45 |
| 1982 | 22.83 | 9.41 | 32.85 |
| 1983 | 9.11 | -4.31 | 28.54 |
| 1984 | 8.98 | -4.44 | 24.10 |
| 1985 | 11.1 | -2.32 | 21.77 |
| 1986 | 9.73 | -3.69 | 18.08 |
| 1987 | 6.74 | -6.68 | 11.40 |
| 1988 | 8.13 | -5.29 | 6.10 |
| 1989 | 7.32 | -6.10 | 0.00 |

| | |
|---|---|
| AVERAGE 1872-1989 | 13.42 |
| AVERAGE 1968-1989 | 12.59 |
| AVERAGE 1940-1989 | 13.01 |
| AVERAGE 1920-1989 | 13.06 |
| AVERAGE 1900-1989 | 13.24 |
| AVERAGE 1900-1960 | 13.58 |
| AVERAGE 1930-1960 | 13.83 |
| AVERAGE 1960-1989 | 12.39 |


POTENTIAL EVAPOTRANSPIRATION
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Jul
Sep
Nov
MONTH

# MONTEREY COUNTY
## WATER RESOURCES AGENCY

855 E. LAUREL DRIVE (BLDG. G)
SALINAS, CA 93905
(408) 755-4860
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WILLIAM F. HURST
GENERAL MANAGER

MONTEREY COUNTY CALIFORNIA • 1850 •

MAILING ADDRESS
PO BOX 930
SALINAS, CA 93902-0930

July 24, 1991

TO: Martin Feeney, Director
Senior Hydrologist
Staal, Gardner & Dunne Inc.

FROM: Al Mulholland, Hydrologist Allen R. Mulholland

SUBJECT: Existing and Maximum Build Out Figures for El Toro Area Sub-Basins

Enclosed are the existing and maximum build out figures for the El Toro Area, furnished to us by the Monterey County Planning Department. The figures are given by sub-basin areas, named by the Planning Department in a memo to Gene Taylor dated 1-22-91.

I have also included a copy, of Page 60, of the El Toro Groundwater Study done by Anderson - Nichols and Company dated 1981. Notice that I wrote the sub-basin numbers by the sub area names.

If we can be of any further assistance please let us know.

AM/ce

cc: Gene Taylor
Lauran Howard

qa3/feeney.am

07/17/91

TORO AREA

SUB-BASIN '1' EL TORO CREEK

| LAND USE CATEGORY | TOTAL ACREAGE | MAXIMUM BUILD-OUT | - | 1991 EXISTING UNITS | = | REMAINING UNITS | - | 1991 FINALED STATUS | = | AVAILABLE BALANCE |
|---|---|---|---|---|---|---|---|---|---|---|
| LOW DENSITY 1 AC/UNIT | 10 | 10 | | 0 | | 10 | | | | |
| LOW DENSITY 3.4 UNITS/AC | 40 | 136 | | 0 | | 136 | | | | |
| LOW DENSITY 5 AC/UNIT | 11 | 2 | | 1 | | 1 | | | | |
| PUBLIC/QUASI-PUBLIC | 122 | 0 | | 0 | | 0 | | | | |
| RESOURCE CONSERVATION 10 AC. MIN. | 119 | 11 | | 0 | | 11 | | | | |
| RURAL DENSITY 5+ AC/UNIT | 164 | 32 | | 0 | | 32 | | | | |
| TOTAL | 466 | 191 | | 1 | | 190 | | 0 | | 190 |

PERCENTAGE OF REMAINING ALLOWED BUILD-OUT 99% (190 UNITS)

TOTAL VACANT PARCELS 3

07/12/91

TORO AREA
SUB-BASIN '2' Lower Corral de Tierra

| LAND USE CATEGORY | TOTAL ACREAGE | MAXIMUM BUILD-OUT | - | 1991 EXISTING UNITS | = | REMAINING UNITS | - | 1991 FINALED STATUS | = | AVAILABLE BALANCE |
|---|---|---|---|---|---|---|---|---|---|---|
| COMMERCIAL | 21 | 0 | | 3 | | -3 | | | | |
| LOW DENSITY 1 AC/UNIT | 605 | 605 | | 311 | | 294 | | | | |
| LOW DENSITY 2 AC/UNIT | 11 | 5 | | 1 | | 4 | | | | |
| LOW DENSITY 5 AC/UNIT | 92 | 18 | | 3 | | 15 | | | | |
| MED. DENSITY 1-5 UNIT/AC | 140 | 700 | | 144 | | 556 | | | | |
| PUBLIC/QUASI-PUBLIC | 1,046 | 0 | | 0 | | 0 | | | | |
| RESOURCE CONSERVATION 40 AC/UNIT | 432 | 10 | | 0 | | 10 | | | | |
| RURAL DENSITY 5+ AC/UNIT | 270 | 54 | | 45 | | 9 | | | | |
| RURAL DENSITY 10 AC/UNIT | 745 | 74 | | 39 | | 35 | | | | |
| TOTAL | 3,362 | 1,466 | | 546 | | 920 | | 232 | | 688 |
| PERCENTAGE OF REMAINING ALLOWED BUILD-OUT | 47% | (688 UNITS) | | | | | | | | |
| TOTAL VACANT PARCELS | 210 | | | | | | | | | |

07/12/91

TORO AREA
SUB-BASIN '5' San Benancio Gulch

| LAND USE CATEGORY | TOTAL ACREAGE | MAXIMUM BUILD-OUT | - | 1991 EXISTING UNITS | = | REMAINING UNITS | - | 1991 FINALED STATUS | = | AVAILABLE BALANCE |
|---|---|---|---|---|---|---|---|---|---|---|
| LOW DENSITY 1 AC/UNIT | 294 | 294 | | 146 | | 148 | | | | |
| LOW DENSITY 5 AC/UNIT | 930 | 186 | | 209 | | -23 | | | | |
| PUBLIC/QUASI-PUBLIC | 790 | 0 | | 0 | | 0 | | | | |
| RESOURCE CONSERVATION 10 AC/UNIT | 46 | 4 | | 0 | | 4 | | | | |
| RESOURCE CONSERVATION 40 AC/UNIT | 1,603 | 40 | | 17 | | 23 | | | | |
| RURAL DENSITY 5+ AC/UNIT | 110 | 22 | | 0 | | 22 | | | | |
| TOTAL | 3,773 | 546 | | 372 | | 174 | | 92 | | 82 |

PERCENTAGE OF REMAINING ALLOWED BUILD-OUT 15% (82 UNITS)

TOTAL VACANT PARCELS 96

07/12/91

TORO AREA
SUB-BASIN '4' WATSON CREEK

| LAND USE CATEGORY | TOTAL ACREAGE | MAXIMUM BUILD-OUT | - | 1991 EXISTING UNITS | = | REMAINING UNITS | - | 1991 FINALED STATUS | = | AVAILABLE BALANCE |
|---|---|---|---|---|---|---|---|---|---|---|
| PERMANENT GRAZING 40 AC/UNIT | 818 | 20 | | 4 | | 16 | | | | |
| PUBLIC/QUASI-PUBLIC | 21 | 0 | | 0 | | 0 | | | | |
| RESOURCE CONSERVATION 10 AC/UNIT | 2,033 | 203 | | 119 | | 84 | | | | |
| RESOURCE CONSERVATION 40 AC/UNIT | 1,370 | 34 | | 27 | | 7 | | | | |
| RURAL DENSITY 5+ AC/UNIT | 163 | 32 | | 36 | | -4 | | | | |
| RURAL DENSITY 10 AC/UNIT | 78 | 7 | | 0 | | 7 | | | | |
| RURAL DENSITY 20 AC/UNIT | 250 | 12 | | 9 | | 3 | | | | |
| TOTAL | 4,733 | 308 | | 195 | | 113 | | 65 | | 48 |

PERCENTAGE OF REMAINING ALLOWED BUILD-OUT 16% (48 UNITS)

TOTAL VACANT PARCELS 69

07/12/91

TORO AREA
SUB-BASIN '3' Calera Canyon

| LAND USE CATEGORY | TOTAL ACREAGE | MAXIMUM BUILD-OUT | - | 1991 EXISTING UNITS | = | REMAINING UNITS | - | 1991 FINALED STATUS | = | AVAILABLE BALANCE |
|---|---|---|---|---|---|---|---|---|---|---|
| LOW DENSITY 2.5 AC/UNIT | 17 | 6 | | 14 | | -8 | | | | |
| LOW DENSITY 5 AC/UNIT | 92 | 18 | | 0 | | 18 | | | | |
| RESOURCE CONSERVATION 10 AC/UNIT | 128 | 12 | | 20 | | -8 | | | | |
| RESOURCE CONSERVATION 40 AC/UNIT | 459 | 11 | | 1 | | 10 | | | | |
| PERMANENT GRAZING 40 AC/UNIT | 6,041 | 151 | | 10 | | 141 | | | | |
| RURAL DENSITY 5+ AC/UNIT | 1,103 | 220 | | 63 | | 157 | | | | |
| TOTAL | 7,840 | 418 | | 108 | | 310 | | 45 | | 265 |

PERCENTAGE OF REMAINING ALLOWED BUILD-OUT 63% (265 UNITS)

TOTAL VACANT PARCELS 75

## EL TORO AREA
## HISTORIC ANNUAL CHANGES IN FALL WATER LEVELS

| WATER YEAR | BASIN | NUMBER OF COMPARISONS | ANNUAL CHANGE | CUMULATIVE CHANGE S.B. | CUMULATIVE CHANGE C.T. | CUMULATIVE CHANGE TOTAL |
|---|---|---|---|---|---|---|
| 1960-61 | San Benancio | 6 | -1.6 | -1.6 | | |
| | Corral De Tierra | 12 | -1.8 | | -1.8 | |
| | Total | 18 | -1.7 | | | -1.7 |
| 1961-62 | San Benancio | 10 | -3.4 | -5.0 | | |
| | Corral De Tierra | 11 | -2.2 | | -4.0 | |
| | Total | 21 | -2.8 | | | -4.5 |
| 1962-63 | San Benancio | 8 | +1.1 | -3.9 | | |
| | Corral De Tierra | 10 | +1.5 | | -2.5 | |
| | Total | 18 | +1.4 | | | -3.1 |
| 1963-64 | San Benancio | 9 | -3.3 | -7.2 | | |
| | Corral De Tierra | 10 | -2.5 | | -5.0 | |
| | Total | 19 | -2.9 | | | -6.0 |
| 1964-65 | San Benancio | 9 | -1.2 | -8.4 | | |
| | Corral De Tierra | 12 | +1.0 | | -4.0 | |
| | Total | 21 | 0 | | | -6.0 |
| 1965-66 | San Benancio | 11 | -1.3 | -9.7 | | |
| | Corral De Tierra | 10 | -.7 | | -4.7 | |
| | Total | 21 | -1.0 | | | -7.0 |
| 1966-67 | San Benancio | 10 | +0.5 | -9.2 | | |
| | Corral De Tierra | 12 | +1.7 | | -3.0 | |
| | Total | 22 | +1.1 | | | -5.9 |
| 1967-68 | San Benancio | 10 | -2.5 | -11.7 | | |
| | Corral De Tierra | 12 | -2.4 | | -5.4 | |
| | Total | 22 | -2.5 | | | -8.4 |
| 1968-69 | San Benancio | 13 | +2.9 | -8.8 | | |
| | Corral De Tierra | 15 | +2.8 | | -2.6 | |
| | Total | 28 | +2.9 | | | -5.5 |
| 1969-70 | San Benancio | 10 | -0.8 | -9.6 | | |
| | Corral De Tierra | 14 | -1.4 | | -4.0 | |
| | Total | 24 | -1.2 | | | -6.7 |
| 1970-71 | San Benancio | 14 | -0.8 | -10.4 | | |
| | Corral De Tierra | 13 | -1.9 | | -5.9 | |
| | Total | 27 | -1.4 | | | -8.1 |
| 1971-72 | San Benancio | 12 | -4.0 | -14.4 | | |
| | Corral De Tierra | 12 | -5.3 | | -11.2 | |
| | Total | 24 | -4.7 | | | -12.8 |
| 1972-73 | San Benancio | 13 | +2.9 | -11.5 | | |
| | Corral De Tierra | 17 | +5.9 | | -5.3 | |
| | Total | 30 | +4.6 | | | -8.2 |
| 1973-74 | San Benancio | 17 | -0.8 | -12.3 | | |
| | Corral De Tierra | 14 | -1.3 | | -6.6 | |
| | Total | 31 | -1.0 | | | -9.2 |
| 1974-75 | San Benancio | 13 | -2.5 | -14.8 | | |
| | Corral De Tierra | 17 | +1.1 | | -5.5 | |
| | Total | 30 | -0.5 | | | -9.7 |

EL TORO AREA TABLE (CONT.)

| WATER YEAR | BASIN | NUMBER OF COMPARISONS | ANNUAL CHANGE | CUMULATIVE CHANGE | | |
|---|---|---|---|---|---|---|
| | | | | S.B. | C.T. | TOTAL |
| 1975-76 | San Benancio | 13 | -4.6 | -19.4 | | |
| | Corral De Tierra | 11 | -3.1 | | -8.6 | |
| | Total | 24 | -3.9 | | | -13.6 |
| 1976-77 | San Benancio | 13 | -5.5 | -24.9 | | |
| | Corral De Tierra | 13 | -7.5 | | -16.1 | |
| | Total | 26 | -6.5 | | | -20.1 |
| 1977-78 | San Benancio | 11 | +9.4 | -15.5 | | |
| | Corral De Tierra | 13 | +4.8 | | -11.3 | |
| | Total | 24 | +6.9 | | | -13.2 |
| 1978-79 | San Benancio | 9 | +0.2 | -15.3 | | |
| | Corral De Tierra | 11 | -1.4 | | -12.7 | |
| | Total | 20 | -0.7 | | | -13.9 |
| 1979-80 | San Benancio | 10 | -0.5 | -15.8 | | |
| | Corral De Tierra | 14 | -0.2 | | -12.9 | |
| | Total | 24 | -0.3 | | | -14.2 |
| 1980-81 | San Benancio | 8 | -1.1 | -16.9 | | |
| | Corral De Tierra | 13 | -0.3 | | -13.2 | |
| | Total | 21 | -0.6 | | | -14.8 |
| 1981-82 | San Benancio | 9 | +4.1 | -12.8 | | |
| | Corral De Tierra | 16 | +3.6 | | -9.6 | |
| | Total | 25 | +3.8 | | | -11.0 |
| 1982-83 | San Benancio | 8 | +0.9 | -11.9 | | |
| | Corral De Tierra | 16 | +2.3 | | -7.3 | |
| | Total | 24 | +1.9 | | | -9.1 |
| 1983-84 | San Benancio | 6 | -0.5 | -12.4 | | |
| | Corral De Tierra | 14 | -0.9 | | -8.2 | |
| | Total | 20 | -0.8 | | | -9.9 |
| 1984-85 | San Benancio | 8 | -7.1 | -19.5 | | |
| | Corral De Tierra | 18 | -7.3 | | -15.5 | |
| | Total | 26 | -7.2 | | | -17.1 |
| 1985-86 | San Benancio | 12 | 0 | -19.5 | | |
| | Corral De Tierra | 19 | -2.7 | | -18.2 | |
| | Total | 31 | -1.6 | | | -18.7 |
| 1986-87 | San Benancio | 11 | -2.0 | -21.5 | | |
| | Corral De Tierra | 18 | +1.1 | | -17.1 | |
| | Total | 29 | 0 | | | -18.7 |
| 1987-88 | San Benancio | 12 | -8.0 | -29.5 | | |
| | Corral De Tierra | 17 | -.4 | | -17.5 | |
| | Total | 29 | -3.6 | | | -22.3 |
| 1988-89 | San Benancio | 4 | -4.0 | -33.5 | | |
| | Corral De Tierra | 9 | -2.5 | | -20.0 | |
| | Total | 13 | -2.9 | | | -25.2 |
| 1989-90 | San Benancio | 7 | -5.2 | -38.7 | | |
| | Corral De Tierra | 13 | -2.2 | | -22.2 | |
| | Total | 20 | -3.2 | | | -28.4 |

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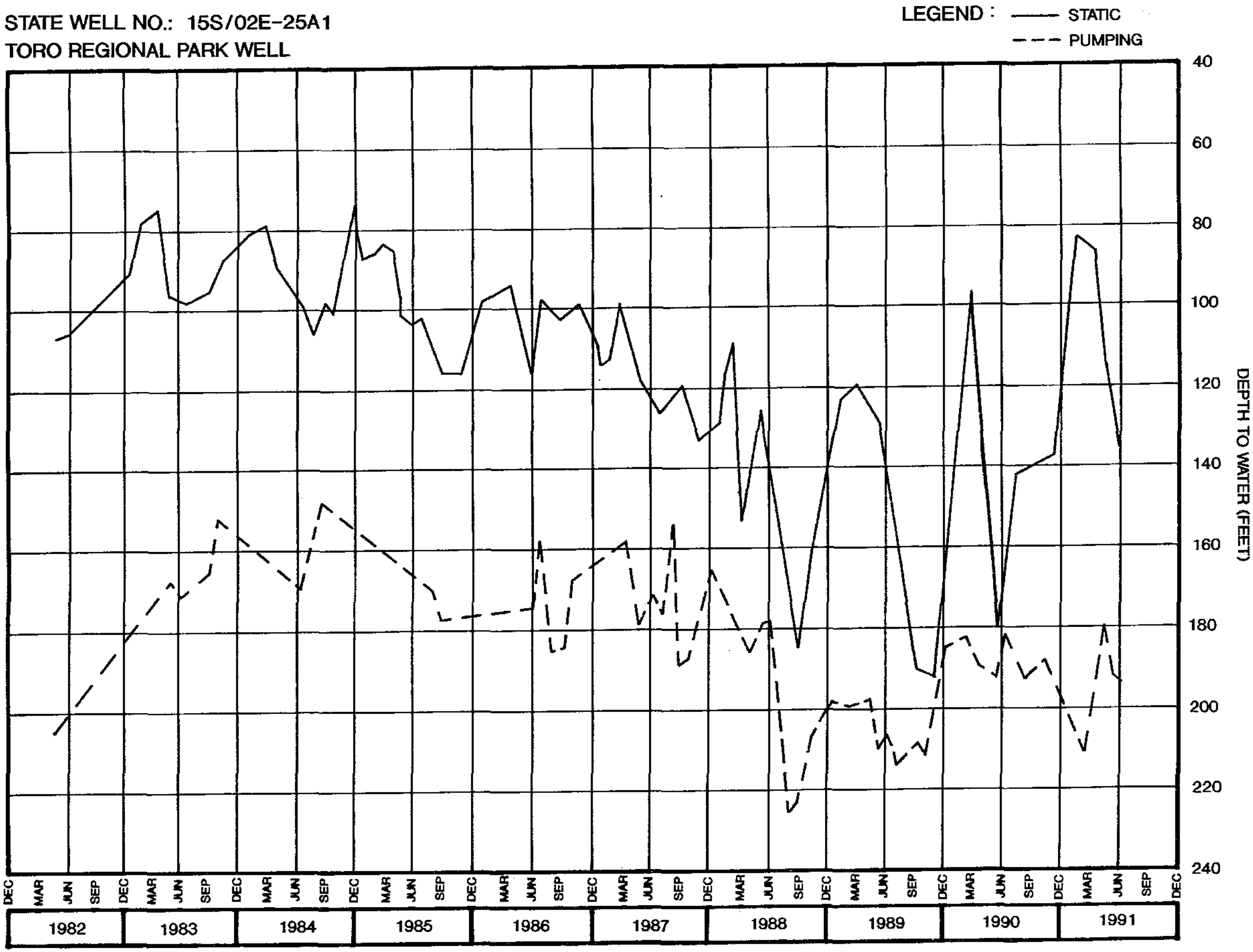
SGD

WATER DEMAND TORO AREA

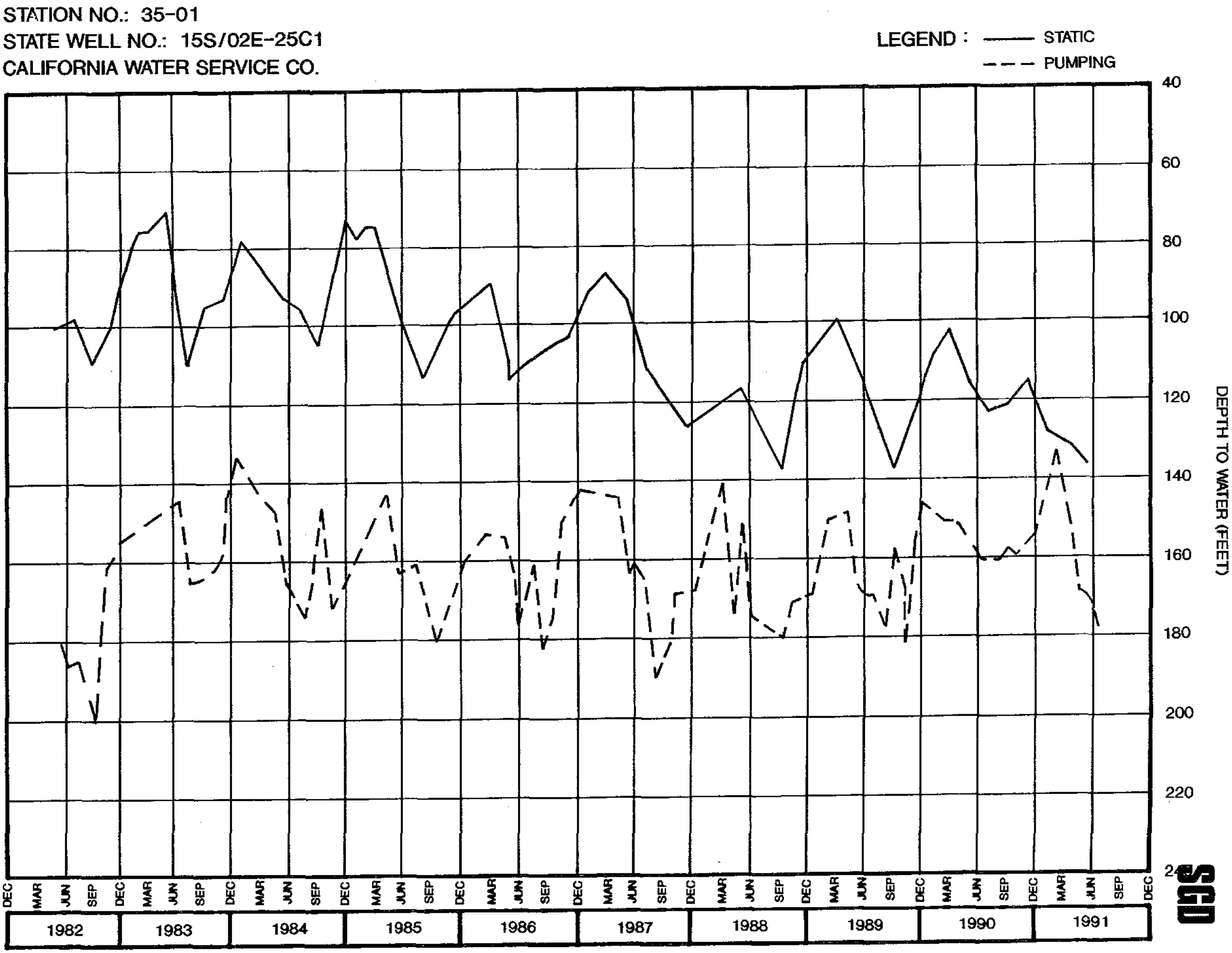
Ambler Park Water Company

| YEAR | PRODUCTION (hcf) | CONNECTIONS | UNIT DEMAND (acre-feet/unit) |
|---|---|---|---|
| 1984 | 70353 | 252 | 0.64 |
| 1985 | 72781 | 273 | 0.61 |
| 1986 | 80185 | 283 | 0.65 |
| 1987 | 79196 | 284 | 0.64 |
| 1988 | 82866 | 287 | 0.66 |
| 1989 | 75135 | 289 | 0.60 |
| 1990 | 73138 | 291 | 0.58 |
| Average | | | 0.63 |

STATE WELL NO.: 15S/02E-25A1
TORO REGIONAL PARK WELL

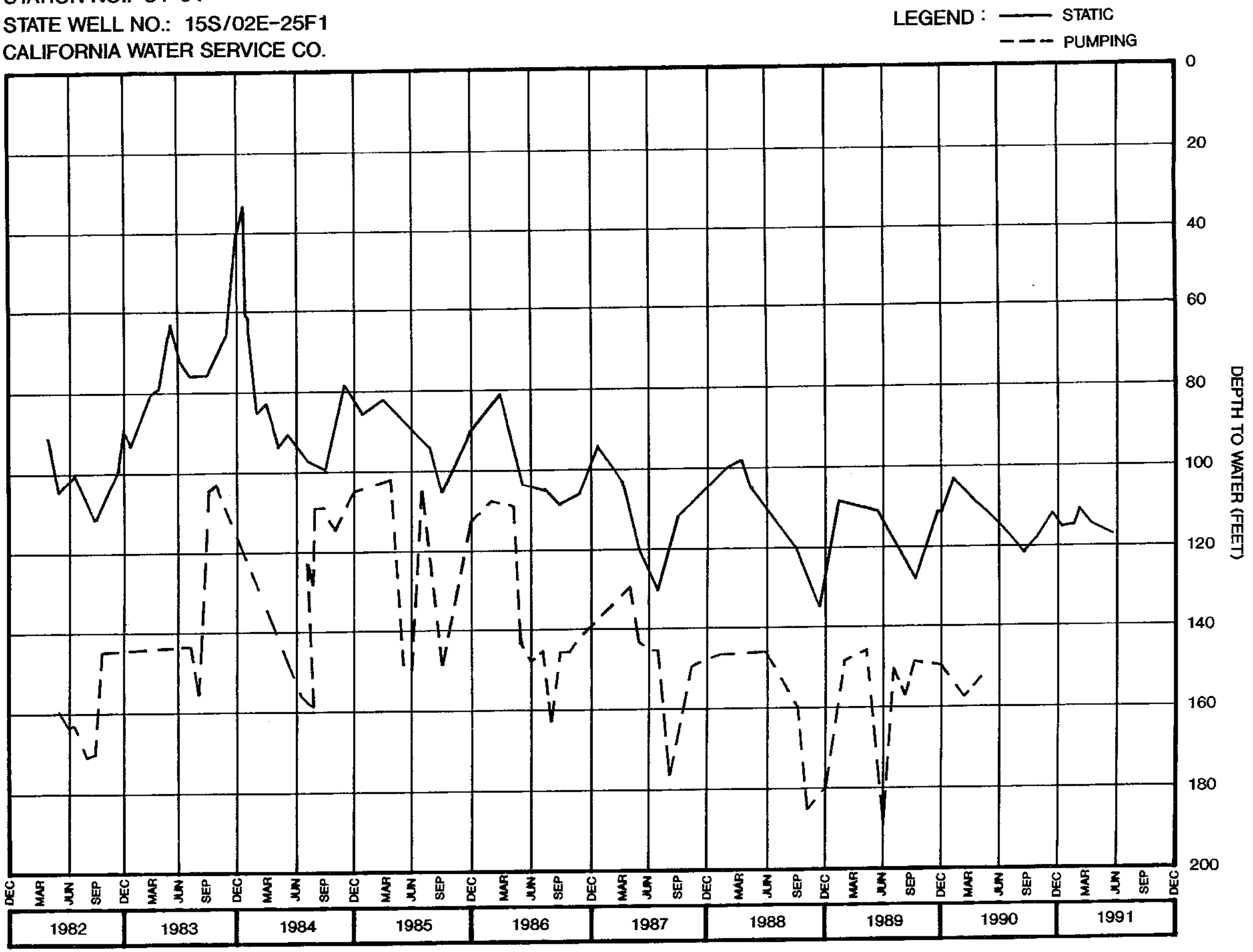



REPRODUCED FROM CALIFORNIA WATER SERVICE CO. HYDROGRAPHS.




REPRODUCED FROM CALIFORNIA WATER SERVICE CO. HYDROGRAPHS.

STATION NO.: 34-01
STATE WELL NO.: 15S/02E-25F1
CALIFORNIA WATER SERVICE CO.

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# APPENDIX C

# WATER DEMAND CALCULATIONS

EL TORO AREA-WATER BUDGET

SGD

AVERAGE AREAL RECHARGE FACTOR= 2.18 INCHES/YEAR

SUBAREA: EL TORO CREEK

| | | |
|---|---|---|
| AREA | (acres) | 408 |
| RECHARGE | (acre-feet) | 74.25 |

CURRENT DEMAND (acre-feet)

| Land Use | Units | Water Duty (AF/unit) | Return Flow Percent | Water Demand (AF) |
|---|---|---|---|---|
| Low Density 1 acre/unit | 0.00 | 0.86 | 50% | 0.00 |
| Low Density 3.4 units/acre | 0.00 | 0.63 | 50% | 0.00 |
| Low Density 5 acre/unit | 1.00 | 1.64 | 50% | 0.82 |
| Public/Quasi-public | 0.00 | 1.00 | 50% | 0.00 |
| Resource Conservation 10 Acre Minimum | 0.00 | 1.64 | 50% | 0.00 |
| Rural Density 5+acre/unit | 0.00 | 1.64 | 50% | 0.00 |
| | | | | |
| TOTAL SUPPLY | | | | 74.25 |
| TOTAL DEMAND | | | | 0.82 |
| SURPLUS (DEFICIT) | | | | 73.43 |

BUILD-OUT DEMAND (acre-feet)

| Land Use | Units | Water Duty (AF/unit) | Return Flow Percent | Water Demand (AF) |
|---|---|---|---|---|
| Low Density 1 acre/unit | 10.00 | 0.86 | 50% | 4.30 |
| Low Density 3.4 units/acre | 136.00 | 0.63 | 50% | 42.84 |
| Low Density 5 acre/unit | 2.00 | 1.64 | 50% | 1.64 |
| Public/Quasi-public | 0.00 | 1.00 | 50% | 0.00 |
| Resource Conservation 10 Acre Minimum | 11.00 | 1.64 | 50% | 9.02 |
| Rural Density 5+acre/unit | 32.00 | 1.64 | 50% | 26.24 |
| | | | | |
| TOTAL SUPPLY | | | | 74.25 |
| TOTAL DEMAND | | | | 84.04 |
| SURPLUS (DEFICIT) | | | | -9.79 |

SUBAREA: SAN BENANCIO GULCH

| | | |
|---|---|---|
| AREA | (acres) | 2676 |
| RECHARGE | (acre-feet) | 487.00 |

CURRENT DEMAND (acre-feet)

| Land Use | Units | Water Duty (AF/unit) | Return Flow Percent | Water Demand (AF) |
|---|---|---|---|---|
| Low Density 1 acre/unit | 146.00 | 0.86 | 50% | 62.78 |
| Low Density 5 acre/unit | 209.00 | 1.64 | 50% | 171.38 |
| Public/Quasi-public | 0.00 | 1.00 | 50% | 0.00 |
| Resource Conservation 10 Acre Minimum | 0.00 | 1.64 | 50% | 0.00 |
| Resource Conservation 40 Acre Minimum | 17.00 | 1.64 | 50% | 13.94 |
| Rural Density 5+acre/unit | 0.00 | 1.64 | 50% | 0.00 |
| | | | | |
| TOTAL SUPPLY | | | | 487.00 |
| TOTAL DEMAND | | | | 248.10 |
| SURPLUS (DEFICIT) | | | | 238.90 |

BUILD-OUT DEMAND (acre-feet)

| Land Use | Units | Water Duty (AF/unit) | Return Flow Percent | Water Demand (AF) |
|---|---|---|---|---|
| Low Density 1 acre/unit | 294.00 | 0.86 | 50% | 126.42 |
| Low Density 5 acre/unit | 209.00 | 1.64 | 50% | 171.38 |
| Public/Quasi-public | 0.00 | 1.00 | 50% | 0.00 |
| Resource Conservation 10 Acre Minimum | 4.00 | 1.64 | 50% | 3.28 |
| Resource Conservation 40 Acre Minimum | 40.00 | 1.64 | 50% | 32.80 |
| Rural Density 5+acre/unit | 22.00 | 1.64 | 50% | 18.04 |
| | | | | |
| TOTAL SUPPLY | | | | 487.00 |
| TOTAL DEMAND | | | | 351.92 |
| SURPLUS (DEFICIT) | | | | 135.08 |

SUBAREA: CALERA CANYON

SGD

| | | | |
|---|---|---|---|
| AREA | (acres) | 271 | (Area underlain by water-bearing formations) |
| RECHARGE | (acre-feet) | 49.32 | |

CURRENT DEMAND (acre-feet)

| Land Use | Units | Water Duty (AF/unit) | Return Flow Percent | Water Demand (AF) |
|---|---|---|---|---|
| Low Density 2.5 acre/unit | 14.00 | 0.86 | 50% | 6.02 |
| Low Density 5 acre/unit | 0.00 | 1.64 | 50% | 0.00 |
| Resource Conservation 10 Acre/Unit | 20.00 | 1.64 | 0% | 32.80 |
| Resource Conservation 40 Acre/Unit | 1.00 | 1.64 | 0% | 1.64 |
| Permanent Grazing 40 Acre/Unit | 10.00 | 1.64 | 0% | 16.40 |
| Rural Density 5+acre/unit | 63.00 | 1.64 | 50% | 51.66 |
| | | | | |
| TOTAL SUPPLY | | | | 49.32 |
| TOTAL DEMAND | | | | 108.52 |
| SURPLUS (DEFICIT) | | | | -59.20 |

BUILD-OUT DEMAND (acre-feet)

| Land Use | Units | Water Duty (AF/unit) | Return Flow Percent | Water Demand (AF) |
|---|---|---|---|---|
| Low Density 2.5 acre/unit | 14.00 | 0.86 | 50% | 6.02 |
| Low Density 5 acre/unit | 18.00 | 1.64 | 50% | 14.76 |
| Resource Conservation 10 Acre/Unit | 20.00 | 1.64 | 0% | 32.80 |
| Resource Conservation 40 Acre/Unit | 11.00 | 1.64 | 0% | 18.04 |
| Permanent Grazing 40 Acre/Unit | 151.00 | 1.64 | 0% | 247.64 |
| Rural Density 5+acre/unit | 220.00 | 1.64 | 50% | 180.40 |
| | | | | |
| TOTAL SUPPLY | | | | 49.32 |
| TOTAL DEMAND | | | | 499.66 |
| SURPLUS (DEFICIT) | | | | -450.34 |

SUBAREA: WATSON CREEK

| | | |
|---|---|---|
| AREA | (acres) | 4708 |
| RECHARGE | (acre-feet) | 856.80 |

CURRENT DEMAND (acre-feet)

| Land Use | Units | Water Duty (AF/unit) | Return Flow Percent | Water Demand (AF) |
|---|---|---|---|---|
| Permanent Grazing 40 Acre/Unit | 4.00 | 1.64 | 50% | 3.28 |
| Public/Quasi-public | 0.00 | 1.00 | 50% | 0.00 |
| Resource Conservation 10 Acre Minimum | 119.00 | 1.64 | 50% | 97.58 |
| Resource Conservation 40 Acre Minimum | 27.00 | 1.64 | 50% | 22.14 |
| Rural Density 5+acre/unit | 36.00 | 1.64 | 50% | 29.52 |
| Rural Density 10 acre/unit | 0.00 | 1.64 | 50% | 0.00 |
| Rural Density 20 acre/unit | 9.00 | 1.64 | 50% | 7.38 |
| | | | | |
| TOTAL SUPPLY | | | | 856.80 |
| TOTAL DEMAND | | | | 159.90 |
| SURPLUS (DEFICIT) | | | | 696.90 |

BUILD-OUT DEMAND (acre-feet)

| Land Use | Units | Water Duty (AF/unit) | Return Flow Percent | Water Demand (AF) |
|---|---|---|---|---|
| Permanent Grazing 40 Acre/Unit | 20.00 | 1.64 | 50% | 16.40 |
| Public/Quasi-public | 0.00 | 1.00 | 50% | 0.00 |
| Resource Conservation 10 Acre Minimum | 203.00 | 1.64 | 50% | 166.46 |
| Resource Conservation 40 Acre Minimum | 34.00 | 1.64 | 50% | 27.88 |
| Rural Density 5+acre/unit | 36.00 | 1.64 | 50% | 29.52 |
| Rural Density 10 acre/unit | 7.00 | 1.64 | 50% | 5.74 |
| Rural Density 20 acre/unit | 12.00 | 1.64 | 50% | 9.84 |
| | | | | |
| TOTAL SUPPLY | | | | 856.80 |
| TOTAL DEMAND | | | | 255.84 |
| SURPLUS (DEFICIT) | | | | 600.96 |

SUBAREA: LOWER CORRAL DE TIERRA

SGD

| | | |
|---|---|---|
| AREA | (acres) | 3344 |
| RECHARGE | (acre-feet) | 608.57 |

CURRENT DEMAND (acre-feet)

| Land Use | Units | Water Duty (AF/unit) | Return Flow Percent | Water Demand (AF) |
|---|---|---|---|---|
| Commercial | 3.00 | 1.00 | 50% | 1.50 |
| Low Density 1 acre/unit | 311.00 | 0.86 | 50% | 133.73 |
| Low Density 2 acre/unit | 1.00 | 0.86 | 50% | 0.43 |
| Low Density 5 acre/unit | 3.00 | 1.64 | 50% | 2.46 |
| Med. Density 1-5 unit/acre | 144.00 | 0.63 | 50% | 45.36 |
| Public/Quasi-public | 0.00 | 1.00 | 50% | 0.00 |
| Resource Conservation 40 Acre Minimum | 0.00 | 1.64 | 50% | 0.00 |
| Rural Density 5+acre/unit | 45.00 | 1.64 | 50% | 36.90 |
| Rural Density 10 acre/unit | 39.00 | 1.64 | 50% | 31.98 |
| Golf Course | 114 | 3.9 | 20% | 355.68 |
| | | | | |
| TOTAL SUPPLY | | | | 608.57 |
| TOTAL DEMAND | | | | 608.04 |
| SURPLUS (DEFICIT) | | | | 0.53 |

BUILD-OUT DEMAND (acre-feet)

| Land Use | Units | Water Duty (AF/unit) | Return Flow Percent | Water Demand (AF) |
|---|---|---|---|---|
| Commercial | 3.00 | 1.00 | 50% | 1.50 |
| Low Density 1 acre/unit | 605.00 | 0.86 | 50% | 260.15 |
| Low Density 2 acre/unit | 5.00 | 0.86 | 50% | 2.15 |
| Low Density 5 acre/unit | 18.00 | 1.64 | 50% | 14.76 |
| Med. Density 1-5 unit/acre | 700.00 | 0.63 | 50% | 220.50 |
| Public/Quasi-public | 0.00 | 1.00 | 50% | 0.00 |
| Resource Conservation 40 Acre Minimum | 10.00 | 1.64 | 50% | 8.20 |
| Rural Density 5+acre/unit | 54.00 | 1.64 | 50% | 44.28 |
| Rural Density 10 acre/unit | 74.00 | 1.64 | 50% | 60.68 |
| Golf Course | 114 | 3.9 | 20% | 355.68 |
| | | | | |
| TOTAL SUPPLY | | | | 608.57 |
| TOTAL DEMAND | | | | 967.90 |
| SURPLUS (DEFICIT) | | | | -359.33 |

# APPENDIX D

## GROUND WATER PROBLEMS

EL TORO GROUNDWATER BASIN
WELL/WATER SUPPLY PROBLEMS

REPORTED WATER PROBLEMS

| NAME AND ADDRESS | WELL NAME / SYSTEM NAME | SUBAREA | AQUIFER | LONG TERM AVAILABILITY | WATER QUALITY | SAND PRODUCTION | DECLINING WATER LEVELS | DECLINING PRODUCTION | CURRENT CONDITION |
|---|---|---|---|---|---|---|---|---|---|
| JIM & ANITA KOWALSKI<br>14 CALERA CANYON RD.<br>SALINAS, CA 93908<br>484-1975 | CALERA CANYON WATER SYSTEM #1 | CL | Qal/Tsm/Tm | | Q | S | W | P | UNKNOWN AT TIME OF PUBLICATION |
| FRAN BELL<br>2 ROBLEY RD.<br>SALINAS, CA 93908<br>484-9788 | CALERA CANYON WATER SYSTEM #1 | CL | Qal/Tsm/Tm | | Q | S | W | | UNKNOWN AT TIME OF PUBLICATION |
| BOB KUHNAU<br>33 CALERA CANYON RD.<br>SALINAS, CA 93908<br>484-1928 | CALERA CANYON MUTUAL WATER COMPANY | CL | Qal/Tm | | | S | W | P | UNKNOWN AT TIME OF PUBLICATION |
| JOHN C. HARPER<br>62 CALERA CANYON<br>SALINAS, CA 93908<br>372-3494 | PRIVATE WELL | CL | Qal | | Q | | W | | UNKNOWN AT TIME OF PUBLICATION |
| GORDON MAYFIELD<br>77 CALERA CYN. RD.<br>SALINAS, CA<br>484-1967 | CALERA CANYON WATER SYSTEM #2 | CL | Qal/Tm | L | | S | W | | WATER LEVEL INCREASED W/ RAIN |
| MAXWELL CHAPLIN<br>26250 RINCONADA DRIVE<br>CARMEL VALLEY, CA 93924<br>659-3869 | CALERA CANYON WATER SYSTEM #3 (WOODSIDE WATER SYSTEM) | CL | Tsm/Tm | | Q | | W | | WATER LEVELS HAVE INCREASED |
| C.A. TEETERS<br>13680 PASEO TERRANO<br>SALINAS, CA 93908<br>408-422-6860 | TORO WATER CO. | CT | NA | | Q | S | | | UNKNOWN AT TIME OF PUBLICATION |
| FRED JOHNSON<br>25334 CAMINO DE CHAMISAL<br>SALINAS, CA 93908<br>373-6236 | CHAMISAL WATER ASSOCIATION | CT | QTp/Tsm | L | Q | | W | | UNKNOWN AT TIME OF PUBLICATION |
| DONALD WOLF<br>22675 COLETA DRIVE<br>SALINAS, CA 93908<br>484-1542 | TORO WATER CO. | CT | NA | L | | | | | UNKNOWN AT TIME OF PUBLICATION |
| ROBERT L. JUHLER<br>134 SAN BENANCO RD.<br>484-9208 | PRIVATE WELL | SB | QTp? | | | | W | | UNKNOWN AT TIME OF PUBLICATION |

EL TORO GROUNDWATER BASIN
WELL/WATER SUPPLY PROBLEMS - CONTINUED

REPORTED WATER PROBLEMS

| NAME AND ADDRESS | WELL NAME / SYSTEM NAME | SUBAREA | AQUIFER | LONG TERM AVAILABILITY | WATER QUALITY | SAND PRODUCTION | DECLINING WATER LEVELS | DECLINING PRODUCTION | CURRENT CONDITION |
|---|---|---|---|---|---|---|---|---|---|
| JACK CAMPBELL<br>84 HARPER CYN. RD.<br>SALINAS, CA 93908 | PRIVATE WELL | SB | Qal | | | | W | | UNKNOWN AT TIME OF PUBLICATION |
| PATT PATTERSON<br>18341 CORRAL DEL CIELO<br>SALINAS,CA 93908<br>484-1281 | CORRAL DEL CIELO WATER SYSTEM #1 | WC | Tts/GRAN | | | S | W | P | UNKNOWN AT TIME OF PUBLICATION |
| EMILE & SABINA ESTASSI<br>259 CORRAL DE TIERRA<br>SALINAS, CA 93908<br>484-1224 | PRIVATE WELL | WC | QTp | | Q | | W | | UNKNOWN AT TIME OF PUBLICATION |

PROBLEM KEY:

LONG TERM AVAILABILITY ------- (L)
WATER QUALITY ---------------- (Q)
SAND PRODUCTION -------------- (S)
DECLINING WATER LEVELS ------- (W)
DECLINING PRODUCTION --------- (P)

SUBAREA/AQUIFER KEY:

ALLUVIUM -----------------(Qal)
PASO ROBLES FORMATION ----(QTp)
SANTA MARGARITA ----------(Tsm)
MONTEREY FORMATION -------(Tm)
BASAL SANDS --------------(Tts)
GRANITE ------------------(GRAN)

SAN BENANCIO GULCH -------(SB)
WATSON CREEK -------------(WC)
CORRAL DE TIERRA ---------(CT)
CALERA CANYON ------------(CL)
NOT AVAILABLE ------------(NA)