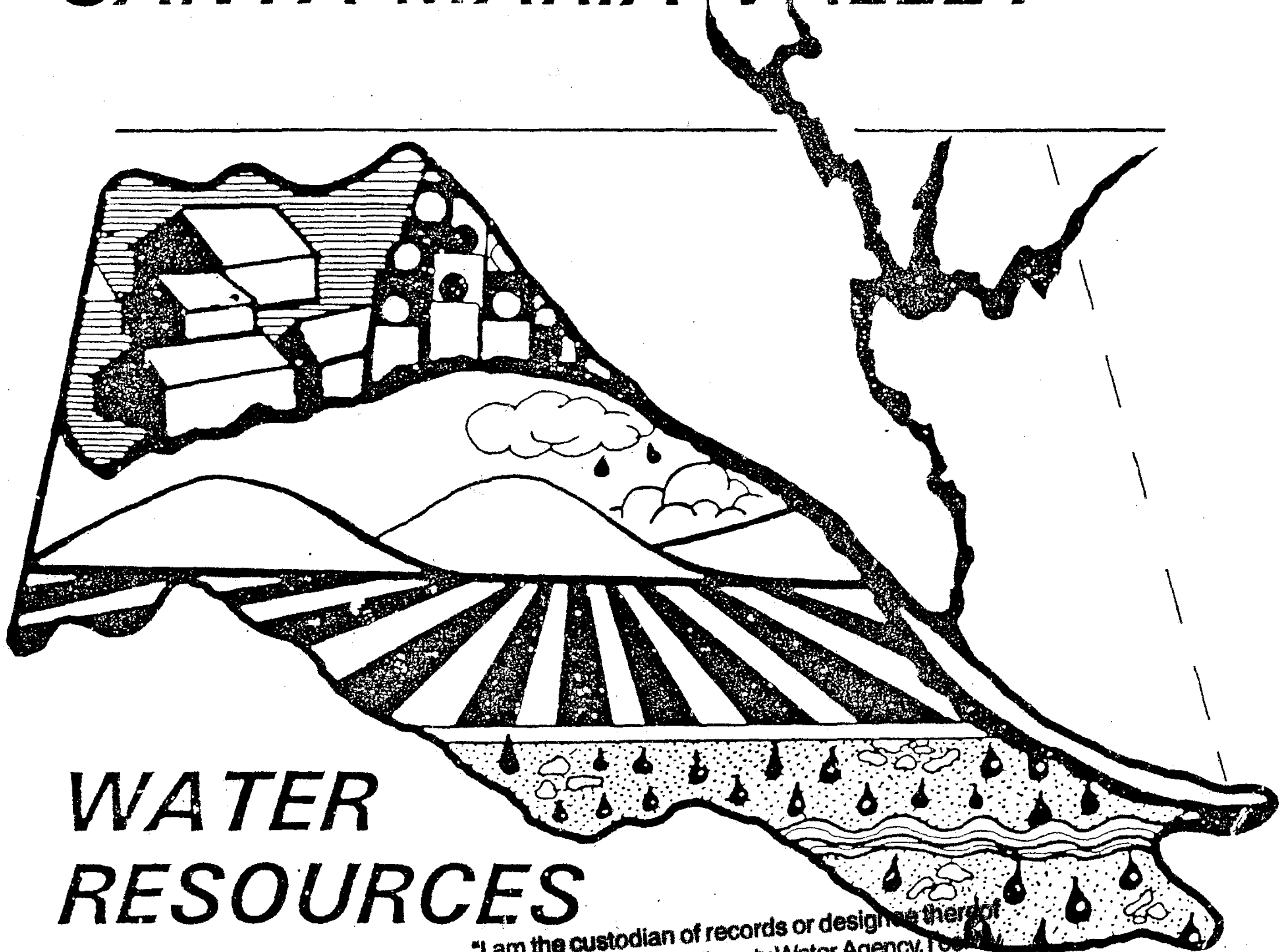
A-165

SANTA MARIA VALLEY



WATER RESOURCES REPORT

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Laurie Meza-Crossland   7/7/03
Date

Santa Barbara County Water Agency
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1994

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Cover Art by Sadnah Lembo

SANTA MARIA VALLEY
WATER RESOURCES REPORT

April 1994

SANTA BARBARA COUNTY WATER AGENCY

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SECTION I - INTRODUCTION

There is a critical need for Santa Maria Valley interests to make a cooperative effort toward developing a comprehensive ground water basin management plan. The urgency is due to the fact that the basin has long been pumped at a rate which exceeds replenishment by natural sources. The consequences of continuing this practice include degradation of water quality, possible land subsidence and economic hardship due to the expense of recovering ground water from ever increasing depths. In addition, failure to develop and enforce a ground water management plan at the local level may result in the imposition of a plan developed by Federal agencies (see Section IX, Institutional Considerations). It is likely that such a plan would poorly represent the interests of some or all of the Santa Maria Valley ground water users.

The Santa Maria Valley Water Resources Report is intended as a precursor to a ground water management plan. As such, it organizes and updates much of the information compiled previously and identifies areas and projects that need further study. Where possible, original data and calculations are included. The report discusses the current conditions existing in the valley including land use and overdraft, and potential new water sources and management opportunities.

Section II describes the valley and its surface and subsurface water resources. Section III examines population trends, municipal and agricultural water use and future water demand. Precipitation and runoff are characterized in Section IV, including the contribution from cloud seeding. Existing and expected surface water resources are discussed in Section V and ground water resources are examined in detail in Section VI. Section VI also contains a discussion of return flows and overdraft status. Section VII describes water quality including water quality trends, state water and sea water intrusion. Section VIII introduces the various water supply and management opportunities available and Section IX discusses ground water management legislation and institutional considerations. Superscripted numbers correspond to the information source listed under "Sources" on page 114.

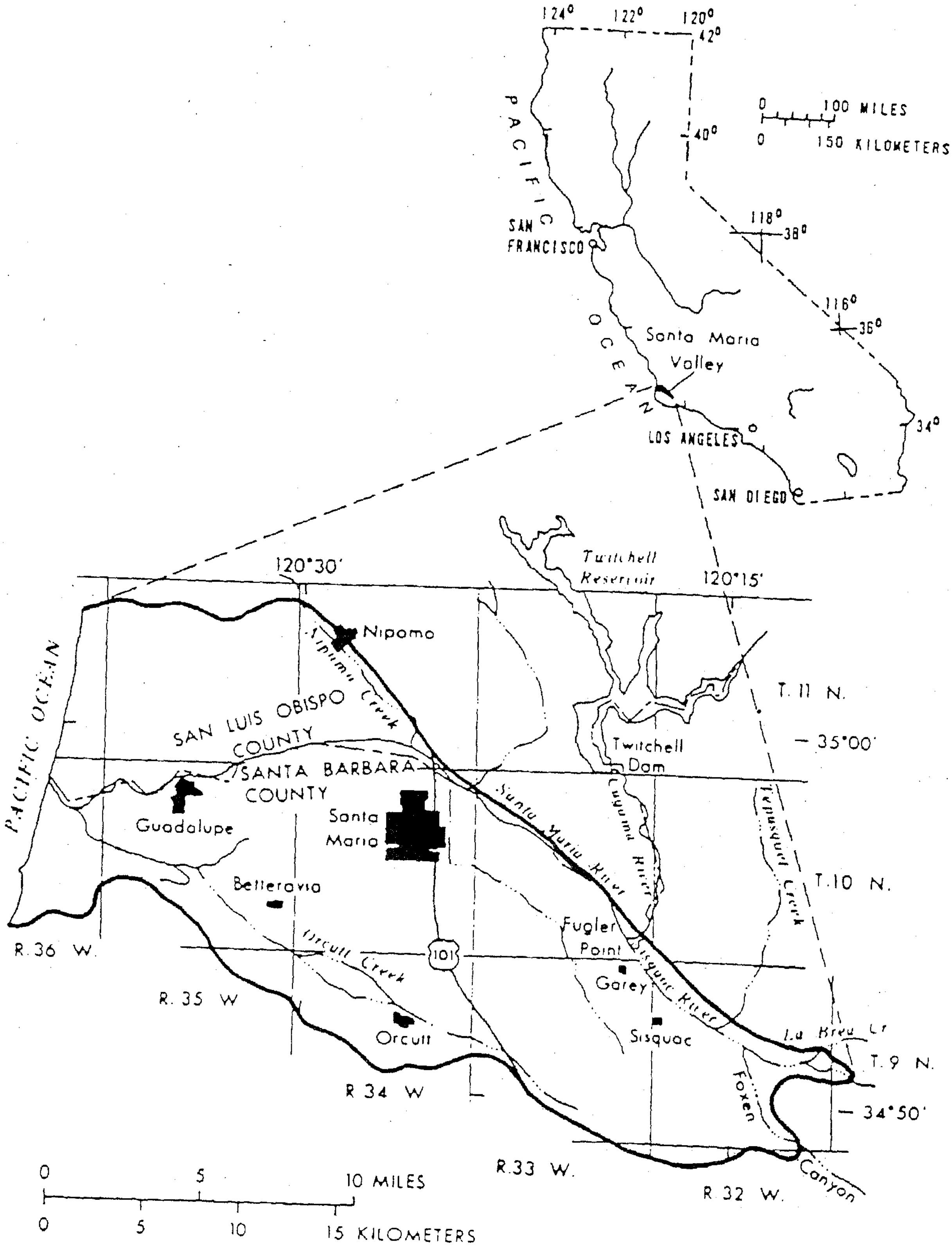
The information compiled in this report points to the following conclusions: 1) There appears to be several water supply\management opportunities, various combinations of which could offset the entire overdraft currently existing in the Santa Maria Ground Water Basin, 2) Much of the data available for the valley is incomplete and out of date. No comprehensive effort to collect original data has been made recently. In order to accurately assess changes to the valley's water resources and determine the feasibility and priority of the various options, further study may be warranted.

SECTION II - SANTA MARIA VALLEY BASIN DESCRIPTION

Santa Maria Valley is an alluvial basin situated in the northwest portion of Santa Barbara County which extends into southwest San Luis Obispo County. The valley trends northwest and occupies about 200 square miles bordered by the Nipomo Mesa and the San Rafael Mountains to the north and east, by the Casmalia and Solomon Hills to the south, and the Pacific Ocean to the west (Figure II-1).[4] The adjacent hills of the valley are the topographic expression of the limbs of a "concave upward" fold (syncline) which is filled with sediments. The trend of the fold parallels the valley.[6] The valley is approximately 28 miles in length and 12 miles at its greatest width.

The climate of the valley is typically dry in the summer with the majority of the rainfall occurring between October and April (see Section V for precipitation data). Average rainfall values vary depending on location and elevation. Heavy fog brought by moist marine air is common during summer months in the coastal part of the valley. Both summer and winter temperatures are moderate with a mean annual temperature of about 60° Fahrenheit (F).[6] Freezing temperatures are rare, but their incidence increases with distance from the coast. Similarly, temperatures exceeding 100° F. occur infrequently and are associated with Santa Ana winds originating in the deserts of lower eastern California.

SANTA MARIA VALLEY AND VICINITY



Source: U.S. Geological Survey Report 76-128

Figure II-1

The principal urban centers within the valley include the City of Santa Maria, the City of Guadalupe and the unincorporated area of Orcutt. Agriculture and ranching are supported by the favorable soil, climate, and topography. In addition, the petroleum industry contributed significantly to the development of the valley economy. Virtually all water currently used within the valley for agricultural, domestic, municipal and industrial purposes is obtained from locally extracted ground water.

The major water purveyors within the valley include the City of Santa Maria, the City of Guadalupe, and the Southern California Water Company. Although not a water purveyor, the Santa Maria Valley Water Conservation District represents agriculture and urban water interests in the northern half of the valley, as well as the City of Guadalupe and most of the City of Santa Maria. The City of Santa Maria is approximately 10,880 acres in area and supplies water to about 15,372 municipal and industrial customers.[34] The city of Guadalupe has an area of about 550 acres and supplies 1,579 customers.[34] Southern California Water Company encompasses Orcutt, Nipomo, Sisquoc and Tanglewood. It supplies roughly 12,000 customers (not all of them in the Santa Maria Valley as defined in this report).

Surface Water

The watersheds of two major rivers drain into the Santa Maria Valley: the Cuyama and Sisquoc Rivers. The Santa Maria River extends northwest from the convergence of the Cuyama and Sisquoc Rivers at Fugler Point (Figure II-1). It runs a little over 23 miles northwest and then west into the Pacific Ocean. The Cuyama River serves as drainage for the northern slope of the Sierra Madre Mountain Range and the southern slope of the Caliente Mountain Range. In addition, the Cuyama River watershed encompasses the Huasna and Alamo Creek drainages located north of Twitchell Reservoir. These two drainages are the most productive watersheds feeding Twitchell Reservoir. The total watershed area of the Cuyama River is 1,130 square miles[1] and includes large portions of southern San Luis Obispo County and smaller portions of Ventura and Kern Counties.

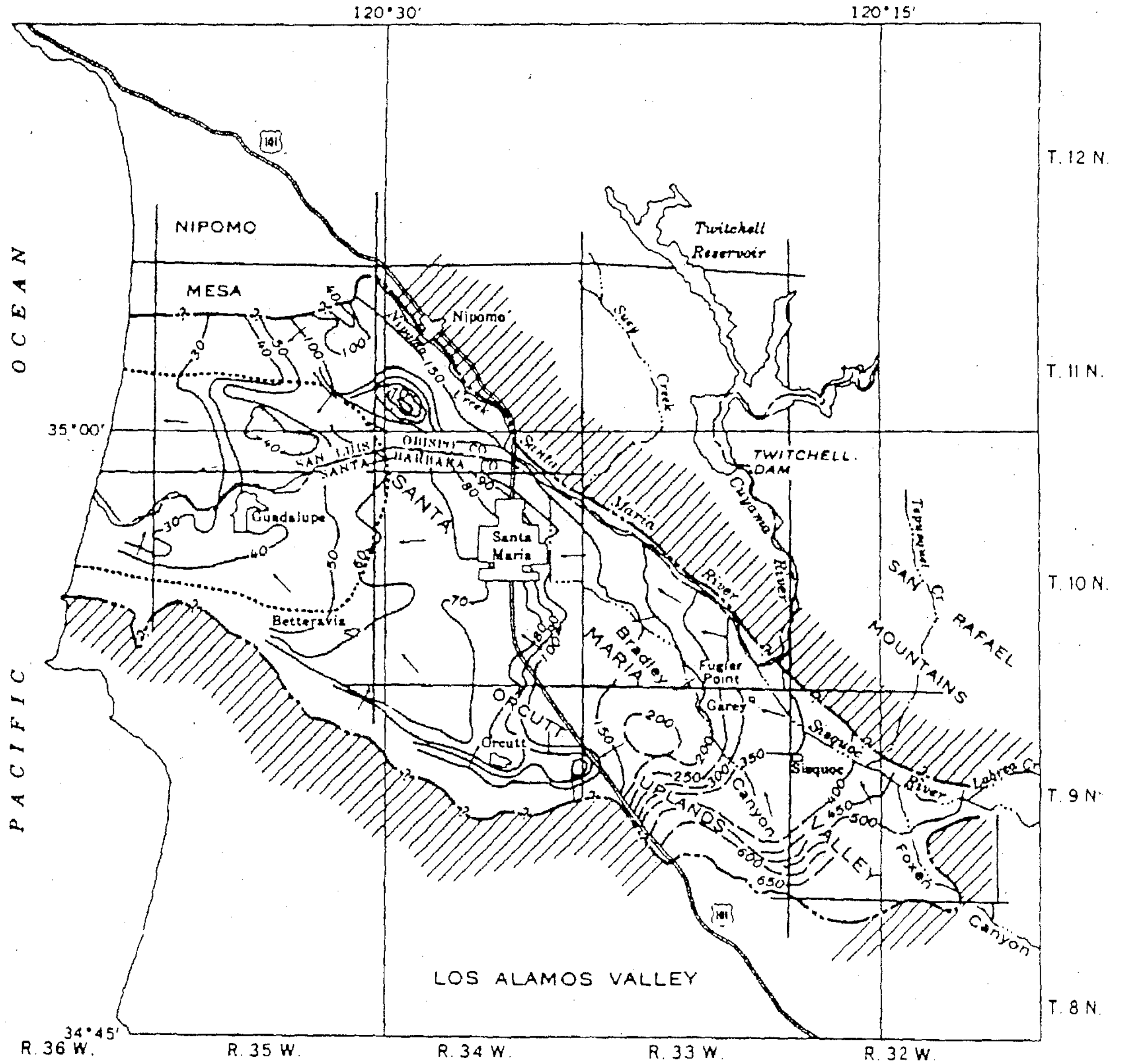
Twitchell Dam was constructed in 1959 about 7.7 river-miles north of Fugler Point on the Cuyama River. It is both a flood control and water conservation reservoir, with a total capacity of 224,000 acre feet, 135,615 acre feet of which are used for water conservation. Water conserved in Twitchell Reservoir is released to the Santa Maria River during dry months for the purpose of recharging the ground water basin. No water is diverted directly from the lake for other uses (see Section V, Surface Water Resources).

The Sisquoc River drains a central portion of Santa Barbara County which encompasses portions of the south and west slope of the Sierra Madre Mountain Range and the north slope of the San Rafael Mountain Range. The total area of the watershed above Garey Bridge is 471 square miles, the majority of which lies within the Los Padres National Forest.

Ground Water

The Santa Maria Ground Water Basin is composed of unconsolidated dune sand, river channel, and alluvial sediments which overlie the relatively impermeable bedrock comprising the basement syncline (see Section VI for a detailed geologic description). Thus, the boundary of the water bearing units is roughly equivalent to that of the Santa Maria Valley as described in this report except that the aquifer extends as much as 10 miles beyond the coastline beneath the Pacific Ocean and some distance northward beneath the Nipomo area (Figure II-2).[5]

SANTA MARIA VALLEY AQUIFER BOUNDARY



Source: U.S. Geological Survey Water Supply Paper 1819-A

Figure II-2

Although the gravel and sand deposits within the basin are locally interbeded with less permeable silt and clay deposits, there is general hydraulic continuity between all parts of the aquifer. From the east the aquifer gradually thickens to a maximum of 2,800 feet near the town of Orcutt, hence thinning somewhat further west to about 2000 feet near Guadalupe and about 1300 feet at the coastline. The average thickness is about 1,000 feet.[7] The western portion of the aquifer is mostly confined by overlying silt and clay deposits which has caused artesian conditions (a static water level which is higher than the top of the water bearing unit) in some of the wells.

Although hydraulically contiguous, the Santa Maria Ground Water Basin has been divided into discrete storage units for the purposes of this study. These units, which are identical to those used by the United States Geological Survey (USGS) in Water Supply Paper 1819-A, are for convenience only and do not represent actual geologic or hydrologic distinctions. The following units have been designated and are shown in Figure II-2: Nipomo, Guadalupe, Santa Maria, Fugler Point, Betteravia, Orcutt, Bradley Canyon, and Sisquoc.

The sources of aquifer recharge are percolation of rainfall, stream bed seepage, direct rainfall percolation and subsurface inflow from the foothills surrounding the basin. Stream bed seepage comprises the most significant element of recharge and includes water detained in Twitchell Reservoir and released at a rate that insures complete percolation. Sources of discharge include ground water pumpage and subsurface outflow to the ocean.

SECTION III - PAST, PRESENT AND PROJECTED WATER USE

Several factors influence water demand within the Santa Maria Valley. Among them are growth of the valley's urban centers, the changes in industrial and agricultural development and the implementation of water efficiency technology. Although examination of past trends is an important planning technique, the past is not always a reliable harbinger of future trends. For example, agricultural water use, which increased dramatically in the years following World War II, probably declined somewhat between 1958 and 1975, although the irrigated acreage increased substantially over the same period (possibly due to changes in irrigation methods). This section examines past trends and discusses likely influences on future water use.

Municipal and Industrial Water Use

This category includes all residential, municipal, commercial and industrial water use in the Santa Maria Valley. Currently, municipal and industrial use accounts for roughly one quarter of the total water used in the valley. Most of the figures reported herein are taken from "Santa Barbara County Growth Inducement Potential of State Water" prepared by Santa Barbara County Water Agency (SBCWA).

Population Trends

Municipal and industrial water use is clearly related to population. The Santa Maria Valley, which nearly doubled in population from 1970 to 1990, was one of the fastest growing regions in Santa Barbara County.[9] The majority of growth has occurred in Santa Maria and Guadalupe, the valley's two incorporated cities and in Orcutt, a large unincorporated urban area south of the City of Santa Maria.

In determining population trends for Santa Barbara County, four sources were considered: 1) U.S. Census Bureau, 2) California Department of Finance (DOF), 3) Santa Barbara County Association of Governments (Forecast '89), 4) General Plans prepared by Santa Barbara County, and 5) City of Santa Maria Growth Mitigation/Management Report. The total population of the Santa Maria Valley was 98,541 according to the 1990 Census.[9] It is forecast to be 130,343 by the year 2,000 and 158,856 by 2010.[9] These forecasts are based on the General Plan population modified to account for the 1990 Census and the City of Santa Maria Growth Mitigation/Management Report. Table III-1 shows population projections for the valley by purveyor service area. Users of private water systems are also included.

TABLE III-1
POPULATION TRENDS[a]

	CENSUS			PROJECTED	
AREA	**1970**	**1980**	**1990**	**2000**	**2010**
SANTA MARIA	32,340	39,685	60,229	83,160[b]	100,870[b]
SO. CAL. WATER	13,608	23,215	31,469	38,739	45,079
GUADALUPE	3,115	3,700	5,695	7,020	11,379
PRIVATE	472	836	984	1,260	1,364
CASMALIA CSD	230	226	164	164	164
TOTAL	49,765	67,662	98,541	130,343	158,856

a) From Santa Barbara County Growth Inducement of Potential of State Water, SBCWA, March 1991

b) From City of Santa Maria Growth Mitigation/Management Report, City of Santa Maria, August 1992

Per Capita Demand

Demand estimates expressed as gallons per capita per day (GPCD) were estimated for the Santa Maria Valley using 1970 as a base year. Because this is considered to be prior to recent water conservation efforts, and subsequent to a very wet year, it is assumed that no significant conservation measures were in effect at that time. The base year, as well as actual GPCD for 1990 is listed in Table III-2. Also listed is the projected GPCD subsequent to the year 2000 assuming conservation of 10 to 20%.

TABLE III-2
PER CAPITA WATER DEMAND
(Gallons Per Day)[a]

				CONSERVATION	
AREA	**1970**	**1980**	**1990**	**10%**	**20%**
Santa Maria	204	197[b]	179	184	163
So. Cal. Water	275	193	250	248	220
Guadalupe	200	183	113	180	160
Private	155	155[b]	155	140	124
Casmalia CSD	75	65	72	68	60
AVERAGES[c]	-	194	197	200	178

a) From Santa Barbara County Growth Inducement Potential of State Water" prepared by SBCWA, March 1991, Table 3

b) Population used for calculation has been adjusted from Table III-1 to account for City boundaries.

c) Weighted averages excluding Santa Maria industrial water use outside cities and district service areas.

Table III-2 shows that per capita water use declined by approximately 12.5% during the 1980's. Estimates of future GPCD vary depending on the assumed level of water use efficiency. For the purposes of this study, future efficiency is assumed to remain constant at 10% below 1970 per capita use. Table III-3 shows future demand estimates using population projections from Table III-1.

TABLE III-3
FUTURE DEMAND ESTIMATES

	2000			2010		
AREA	POPUL.	GPCD	DEMAND (AFY)	POPUL.	GPCD	DEMAND (AFY)
Industrial[a]	NA	NA	5,400	NA	NA	5,400
Santa Maria	83,160	184	17,139	100,870	184	20,789
So. Cal. Water	38.739	248	10,762	45,079	248	12,523
Guadalupe	7,020	180	1,415	11,379	180	2,294
Private	1,260	140	198	1,364	140	214
Casmalia CSD	164	68	12	164	68	12
TOTAL	130,343	-	34,926	158,856	-	41,232

a) From Santa Barbara County Growth Inducement Potential of State Water" prepared by SBCWA, March 1991, Table 3

Agricultural Water Use

Agriculture within the valley consists of various types of crops, only a small portion of which are farmed without irrigation. Aside from a minimal amount of reclaimed water, all of the water used for agricultural irrigation is pumped from the Santa Maria Ground Water Basin. Since the water needs of different irrigated crops vary greatly, examination of the amount and type of cropped acreage is germane to agricultural water use within the valley.

Irrigated Land Acres

By most estimates, agricultural land acreage will neither increase nor decrease significantly in the foreseeable future. The SBCWA projects changes in the total irrigated acreage in the valley of less than two percent between 1990 and 2010. (This estimate does not include that part of the valley located in San Luis Obispo County).[9] Similarly, the Toups Report estimates increases in irrigated acres during the same period of about 3.5%. (Includes San Luis Obispo County).[1]

The total irrigated acreage in the valley includes lands on which multiple crops are produced. Therefore, the total irrigated crop acres will be greater than the actual number of irrigated land acres at any given time. The 1991 Water Agency study estimates net irrigated crop acres in 1990 at 50,920.[9] A more recent Department of Water Resources (DWR) estimate for 1990 cropping is 54,600 acres. However, these estimates do not include crops grown within the valley but outside of Santa Barbara County. DWR estimates irrigated crop acres in that part of the valley located in San Luis Obispo County at 21,090.[13] Thus, using DWR preliminary estimates gives total combined cropped acreage of about 75,700 acres.

Water Demand

The amount of water needed by individual crops depends on many factors. Of primary importance is the amount of water consumed by the plants. However, other factors include soil characteristics, precipitation, temperatures, and irrigation efficiency. In addition, the water applied to a crop must be sufficient to flush salts from the root zone of the plants.

Agricultural Pumpage and Land Use Trends

Ground water pumpage for agriculture began in the Santa Maria Valley in 1898 with the inception of the sugar beet industry. Irrigated lands gradually expanded to about 10,700 acres by 1922. From the early 1920's to the early 1930's, irrigated acreage rapidly increased to about 28,000 acres with the introduction of vegetable farming in the valley. By 1944, irrigated lands totalled about 35,000 acres, with an estimated ground water pumpage of 71,000 acre feet. After World War II (1945 to 1958), irrigation pumpage jumped upward to levels estimated by the USGS as varying between a low of 93,000 acre feet per year (AFY) in 1951 to a high of 139,000 AFY in 1958, and averaging almost 109,000 AFY.

Preliminary estimates by DWR indicate that 1990 agricultural pumpage was about 172,500 AFY. However, the University of California Cooperative Extension, Farm Advisor uses water duty factors for crops which yield a lower 1990 agricultural pumpage of 130,619. Table III-4 shows 1990 land use and applied water for crops in the valley using DWR cropped acreage estimates with Farm Advisor water duty factors.

Table III – 4

IRRIGATION WATER USE IN SANTA MARIA VALLEY CIRCA 1990							
IRRIGATED CROP	Santa Maria DAU Cropped acres	Applied Water (ft/crop)	Applied Water (ac ft)	South SL Obispo DAU cropped ac.	Applied Water (ft/crop)	Applied Water (ac ft)	Total Applied Water SM Valley (ac ft)
Grain	1690	0.5	845	220	0.5	110	955
Corn	1050	1.8	1890	40	1.5	60	1950
Other Field	2430	1.8	4374	300	1.5	450	482[illegible]
Alfalfa	890	3.0	2670	110	2.6	286	2956
Pasture	2840	3.0	8520	230	2.8	644	9164
Tomatoes	0	1.7	0	80	1.5	120	120
Other Truck	41260	1.7	70142	18800	1.6	30080	100222
Deciduous	10	1.7	17	0	1.2	0	17
Citrus & Subtropical	70	1.7	119	1110	1.2	1332	1451
Vineyards	4360	2.0	8720	200	1.2	240	8960
TOTALS	54600		97297	21090		33322	130[illegible]

NOTES: The above applied water estimates are derived by using California Department of Water Resources (DWR) preliminary 1990 cropped acreages combined with the University of California Cooperative Extension (Farm Advisor) unit water duty factors for crops grown in the Santa Maria Valley area.

"Other Truck" is assumed to be Broccoli, Cabbage, Cauliflower, Carrots, Celery, Lettuce, Potatoes, and Strawberries as per the Crops listed under "Vegetables" in the Farm Advisors "IRRIGATION WATER USE TABLE" (see Appendix C).

The Santa Maria value for Cauliflower (or the Sisquoc value for Broccoli) from the Farm Advisor Table was used to reflect the average "Other Truck" crop unit duty factor for the Santa Barbara County part of Santa Maria Valley. For the San Luis Obispo part of Santa Maria Valley the "Other Truck" average crop unit duty factor is reduced by one tenth foot (1.7 to 1.6 feet) as most of these plantings are in the Oso Flaco alluvial wing of the ground water basin.

The Sisquoc Range unit duty value (2 ft/yr) for grapes was used to reflect vineyard use in the Santa Barbara County part of Santa Maria Valley, while the lower Santa Maria and Lompoc Range value (1.2 ft/yr) was used for vinyards in the San Luis Obispo part of the valley.

Note that the preliminary 1990 total applied ag water estimated by DWR (172,528 ac ft, as seen in Appendix C) is 41909 ac ft higher than the above estimate of 130,619 ac ft due to the larger unit duty factors used by DWR.

Projected Demand

Table III-5 provides an estimate of agricultural demand in the years 2,000 and 2,010. Agricultural acreage and crop type is expected to remain relatively constant. However, improved irrigation methods are assumed to result in a five percent savings in applied water by the year 2,000 and a 10% savings in applied water by the year 2,010 over 1990 demand. Crop types are assumed to remain constant. Table III-5 shows the resulting demand using values from Table III-4.

TABLE III-5
PROJECTED AGRICULTURAL APPLIED WATER (Acre Feet)

	YEAR	
AREA	**2000**	**2010**
Santa Maria Valley, Santa Barbara County	92,432	87,567
Santa Maria Valley, San Luis Obispo County	31,656	29,990
TOTAL	124,088	117,557

Combining the demand values for municipal, industrial and agricultural uses from Tables III-3 and III-5, gives a total water demand in the Santa Maria Valley of 158,864 AFY and 158,195 AFY for 2,000 and 2,010, respectively.

SANTA MARIA VALLEY WATER RESOURCES REPORT

SECTION IV - PRECIPITATION

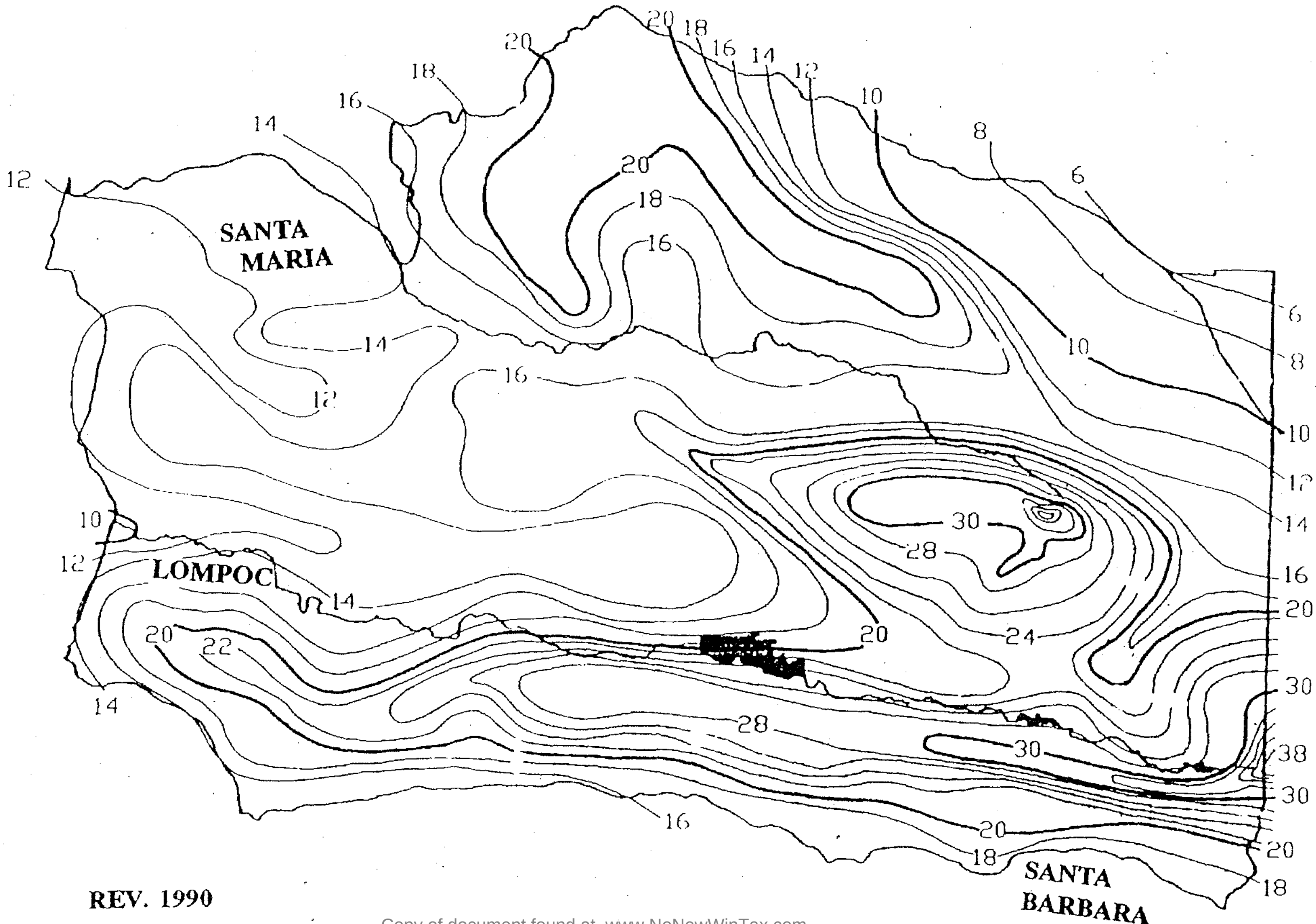
Precipitation controls the amount of water available for direct recharge and stream recharge of the Santa Maria Ground Water Basin. In addition, it influences the amount of natural irrigation available to agriculture and thus the demand placed upon the aquifer. Analysis of historical rainfall data allows for determination of "critical" or drought periods which facilitates water supply planning. Because Twitchell Reservoir directly influences the amount of water available for stream recharge of the aquifer through enhanced stream bed percolation, a discussion of portions of its watershed is included herein.

Santa Maria Valley

Average annual rainfall values within the valley range from about 12 to 16 inches with higher values occurring to the east at higher elevations. Figure IV-1 is an isohyetal map showing contours of equal precipitation. Data from three gages were used to determine average valley precipitation and drought periods: Santa Maria City, Betteravia, and Sisquoc Ranch.

Gage records were checked for accuracy by "double massing" (plotting data from two gages against each other). Comparison of the three gages by this method indicates a discrepancy in the Santa Maria City gage record around 1951, possibly due to relocation of the gage (Figures IV-2A and IV-2B). Therefore, for the purposes of this document, the Betteravia gage is considered the most representative of valley conditions and is used for calibration of the other gages. Monthly data for each of these gages is listed in Appendix A.

SANTA BARBARA COUNTY ANNUAL MEAN ISOHYETAL MAP



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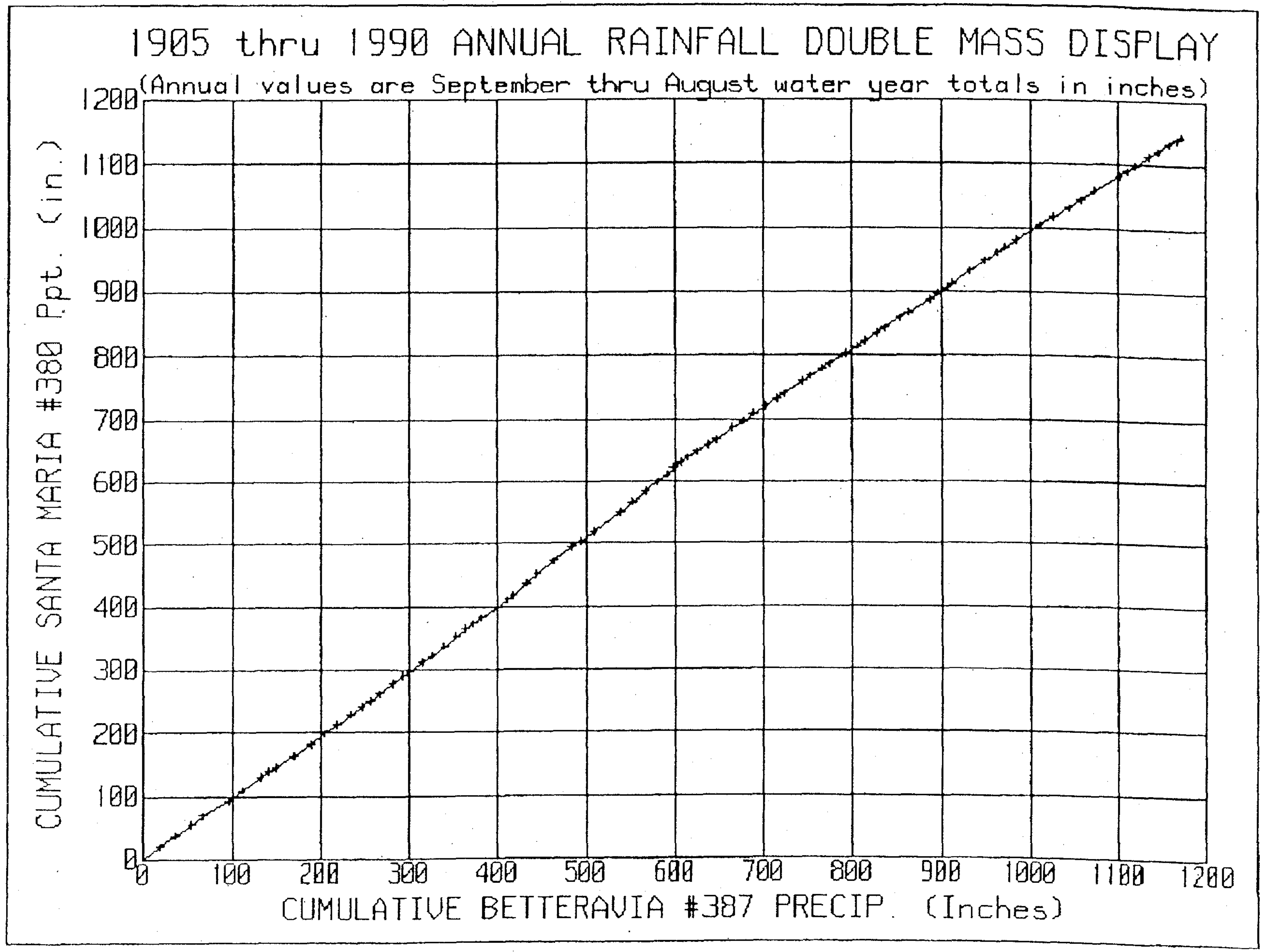
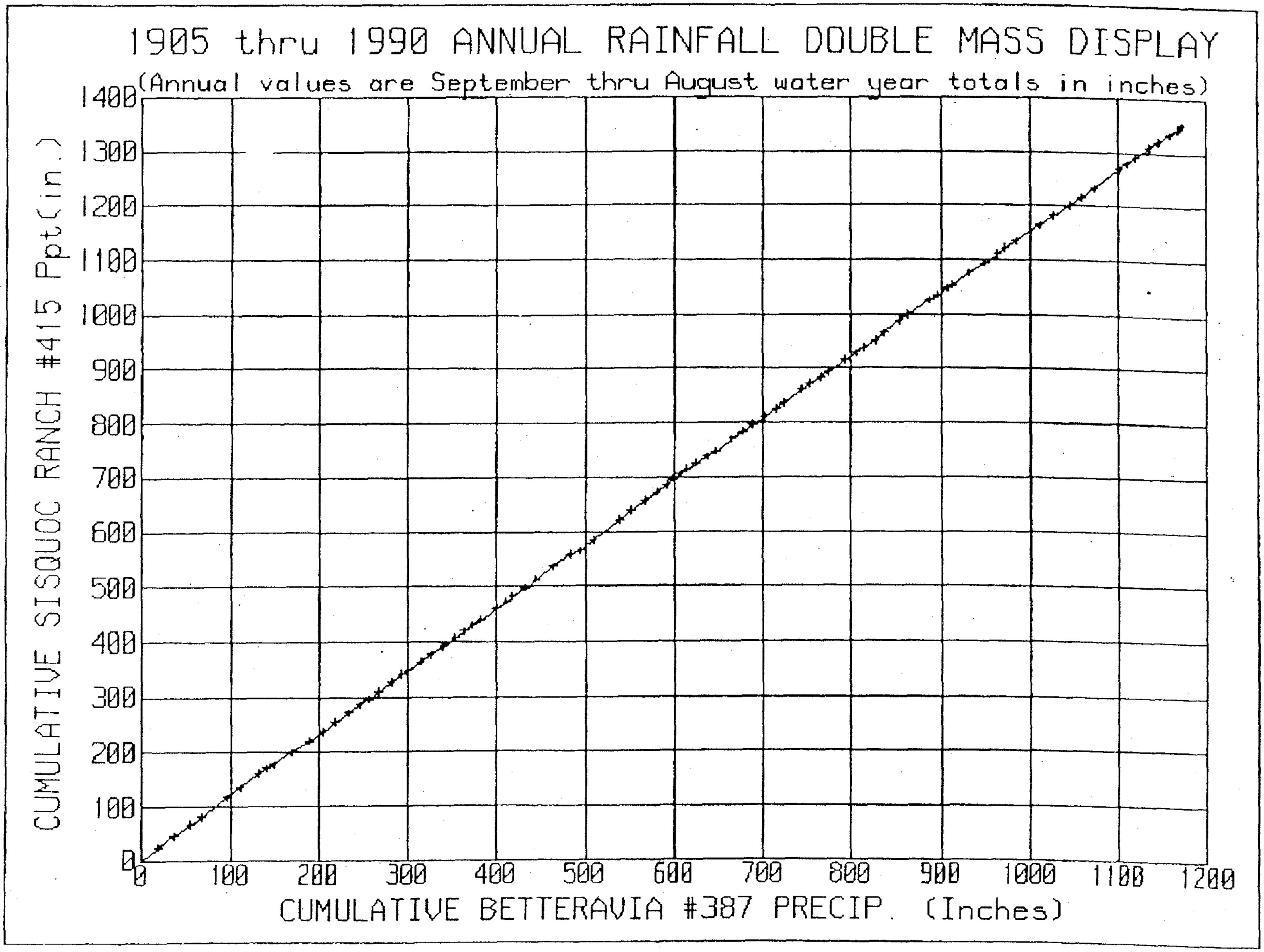
Source: Santa Barbara County Flood Control District Precipitation Report

Figure IV-1



Source: Santa Barbara County Water Agency

Figure IV-2A



Source: Santa Barbara County Water Agency

Figure IV-2B

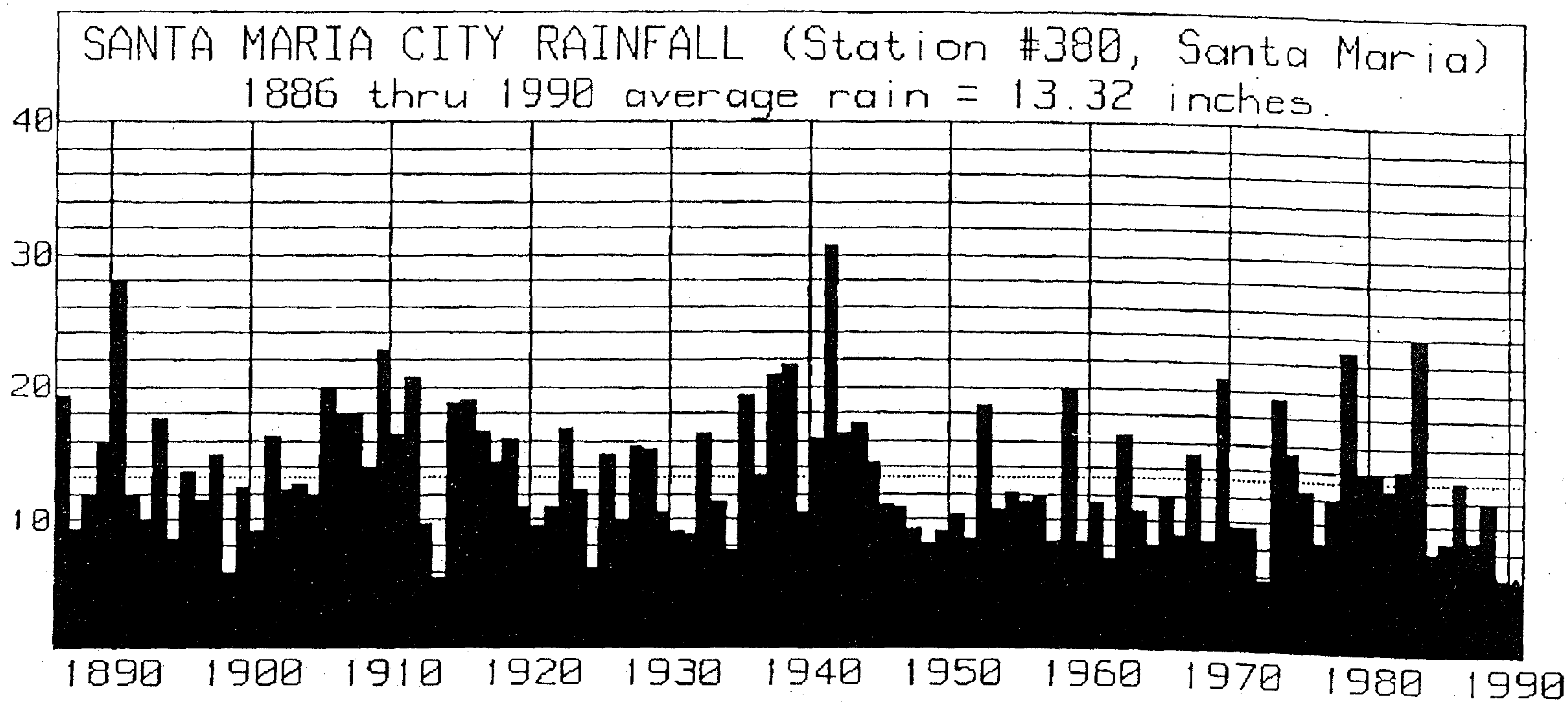
Historic Record

Figures IV-3A through IV-3F show the historic annual rainfall record and accumulated deviation from mean for each gage. A valley wide average annual rainfall value of 14.09 inches was determined using the three gages weighted according to the approximate area of the valley they represent. Betteravia and the City of Santa Maria were weighted 40 percent each and Sisquoc 20% of the total.

Examination of Figure IV-3B reveals that the "critical dry period", or most severe historic drought, occurred from 1946 to 1966. During that time, the average annual rainfall at Betteravia was 11.7 inches, approximately 1.83 inches below normal. Ground water well hydrographs from that period also demonstrate a severe reduction in ground water replenishment (Figure IV-4).

Twitchell Watershed

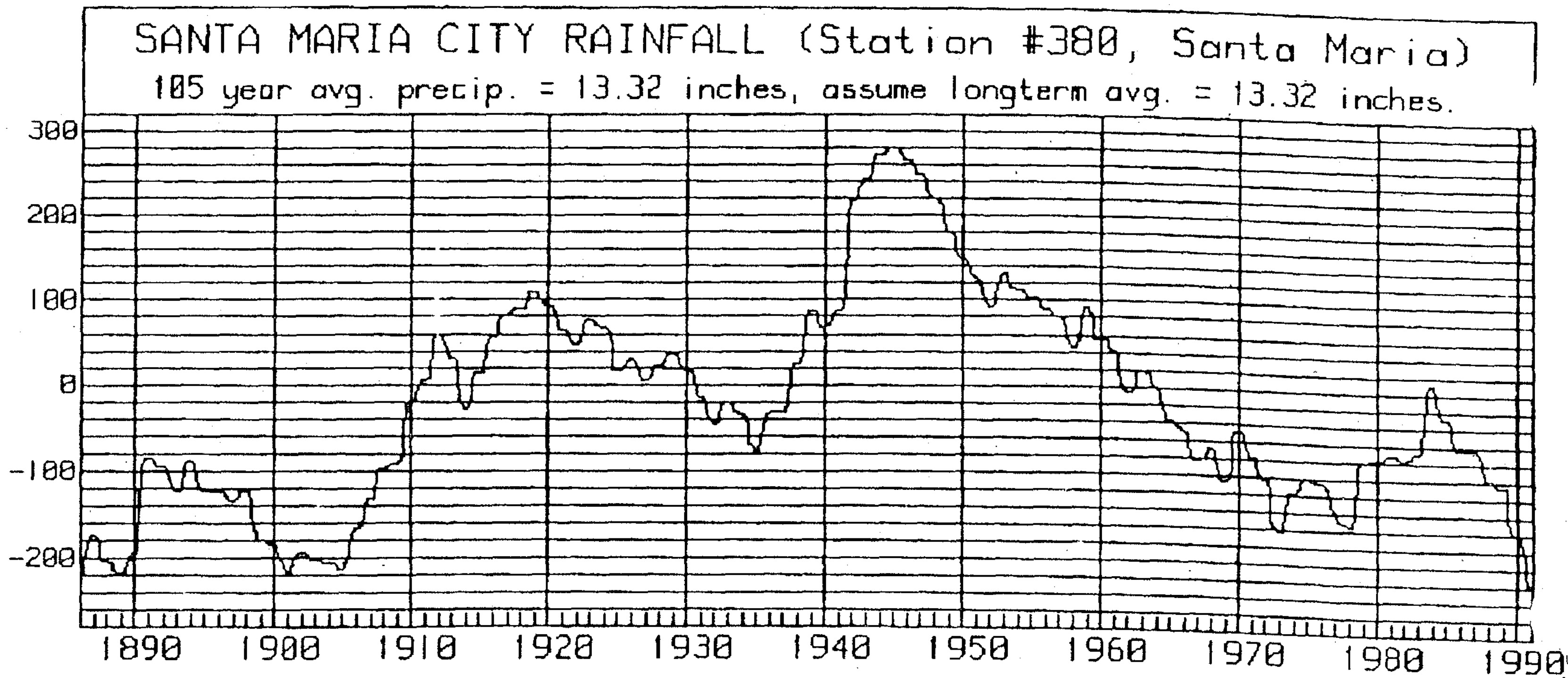
Rainfall within the Twitchell Reservoir Watershed is important because the water stored in the reservoir is released to replenish the aquifer. However, rainfall is highly variable ranging from about six inches in the arid eastern portion of the watershed to over 20 inches in the west. Due to the coarse alluvial deposits and low annual precipitation of the eastern Cuyama River, during years of low to moderate precipitation, most of the runoff percolates into the ground before reaching the reservoir.



RAINFALL VALUES IN INCHES; TIME SCALE = SEP-AUG WATER YEARS.

Source: Santa Barbara County Water Agency

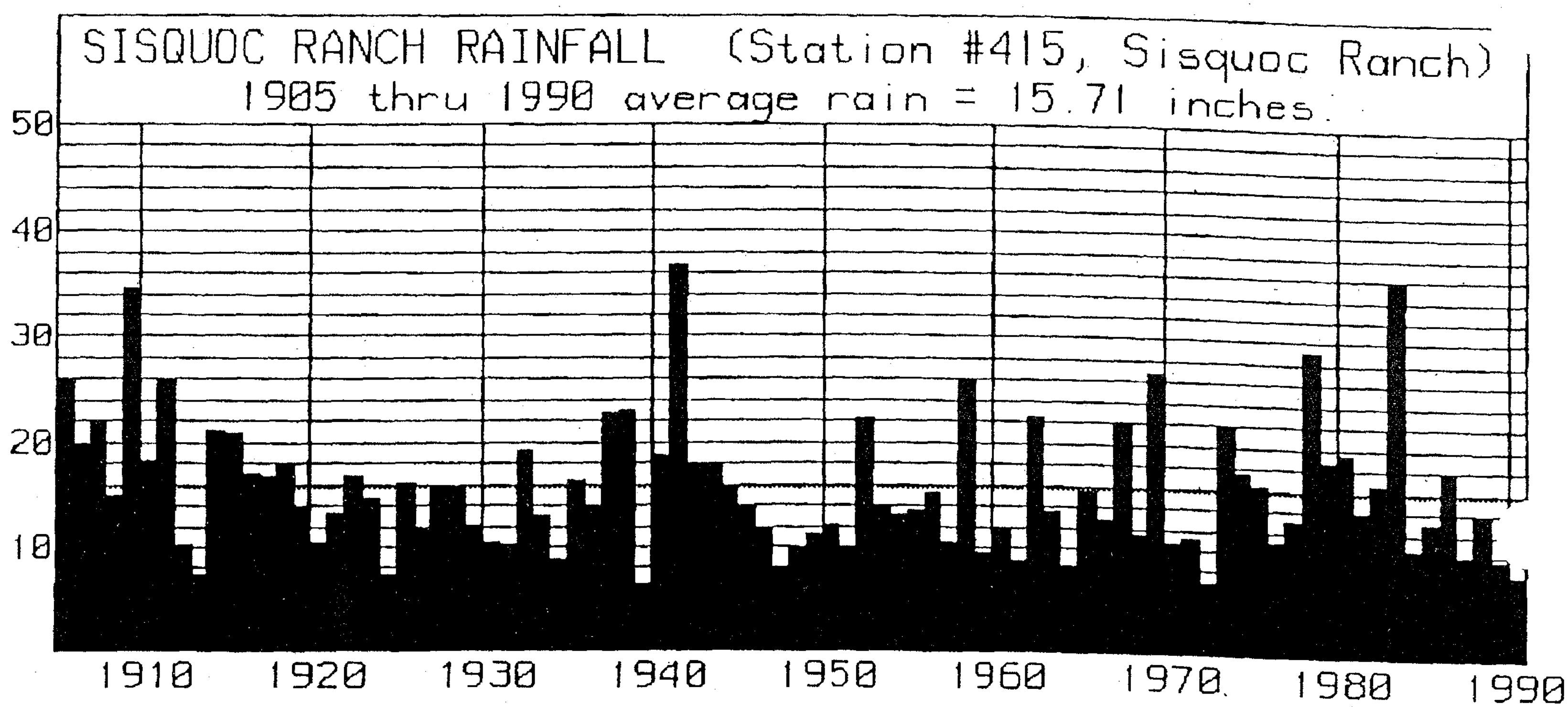
Figure IV-3A



DEVIATION FROM MEAN IN %; TIME SCALE = SEP-AUG WATER YEARS.

Source: Santa Barbara County Water Agency

Figure IV-3B

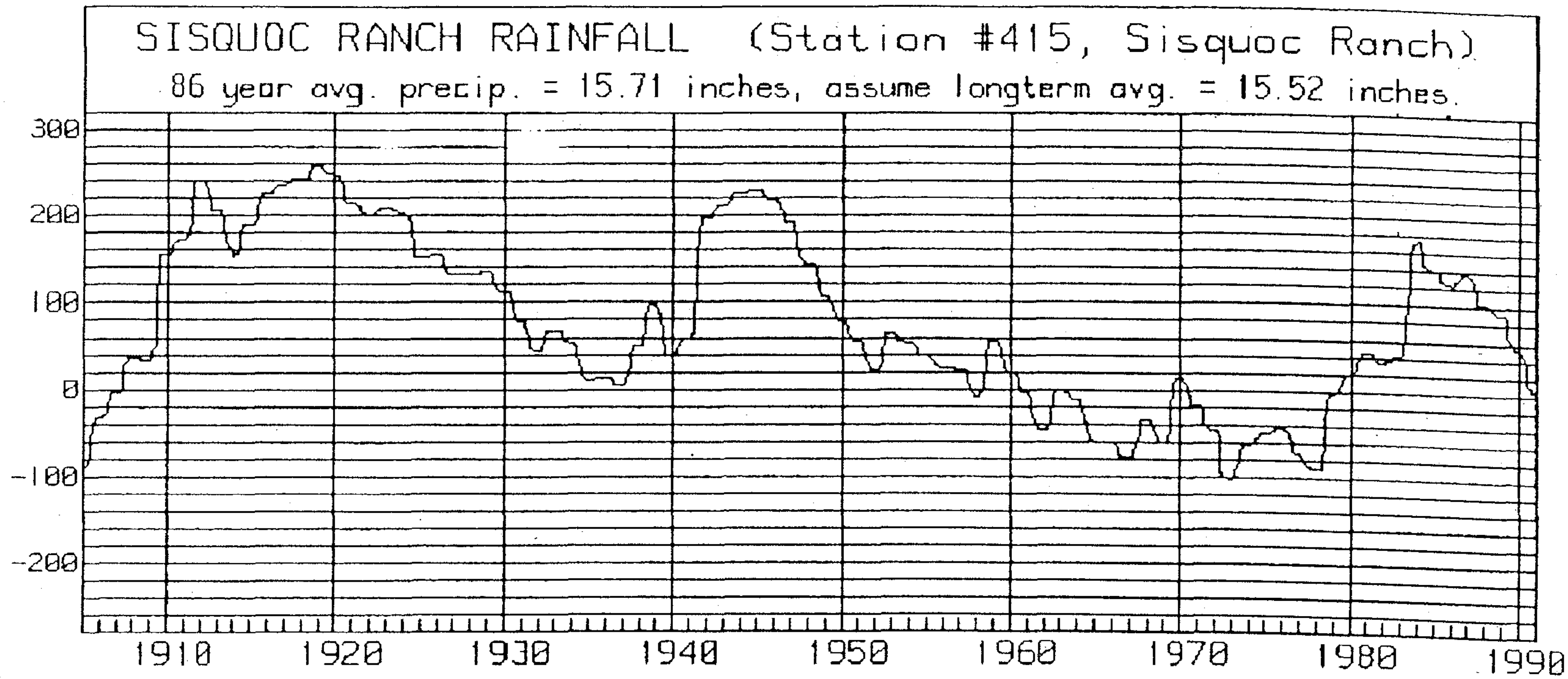


RAINFALL VALUES IN INCHES; TIME SCALE = SEP-AUG WATER YEARS.

Source: Santa Barbara County Water Agency

Figure IV-3C

Source: Santa Barbara County Water Agency



DEVIATION FROM MEAN IN %; TIME SCALE = SEP-AUG WATER YEARS.

Figure IV-3D

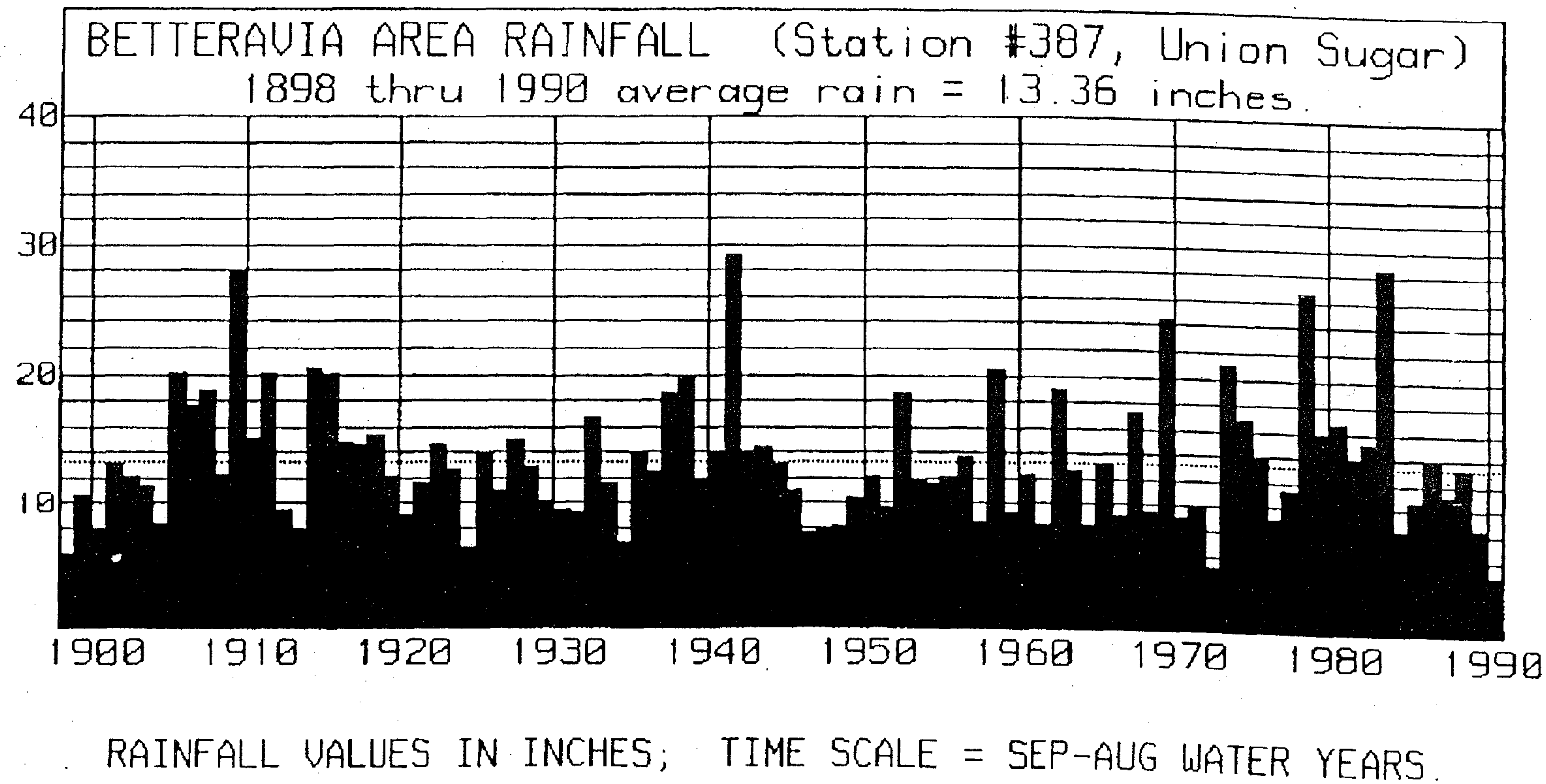
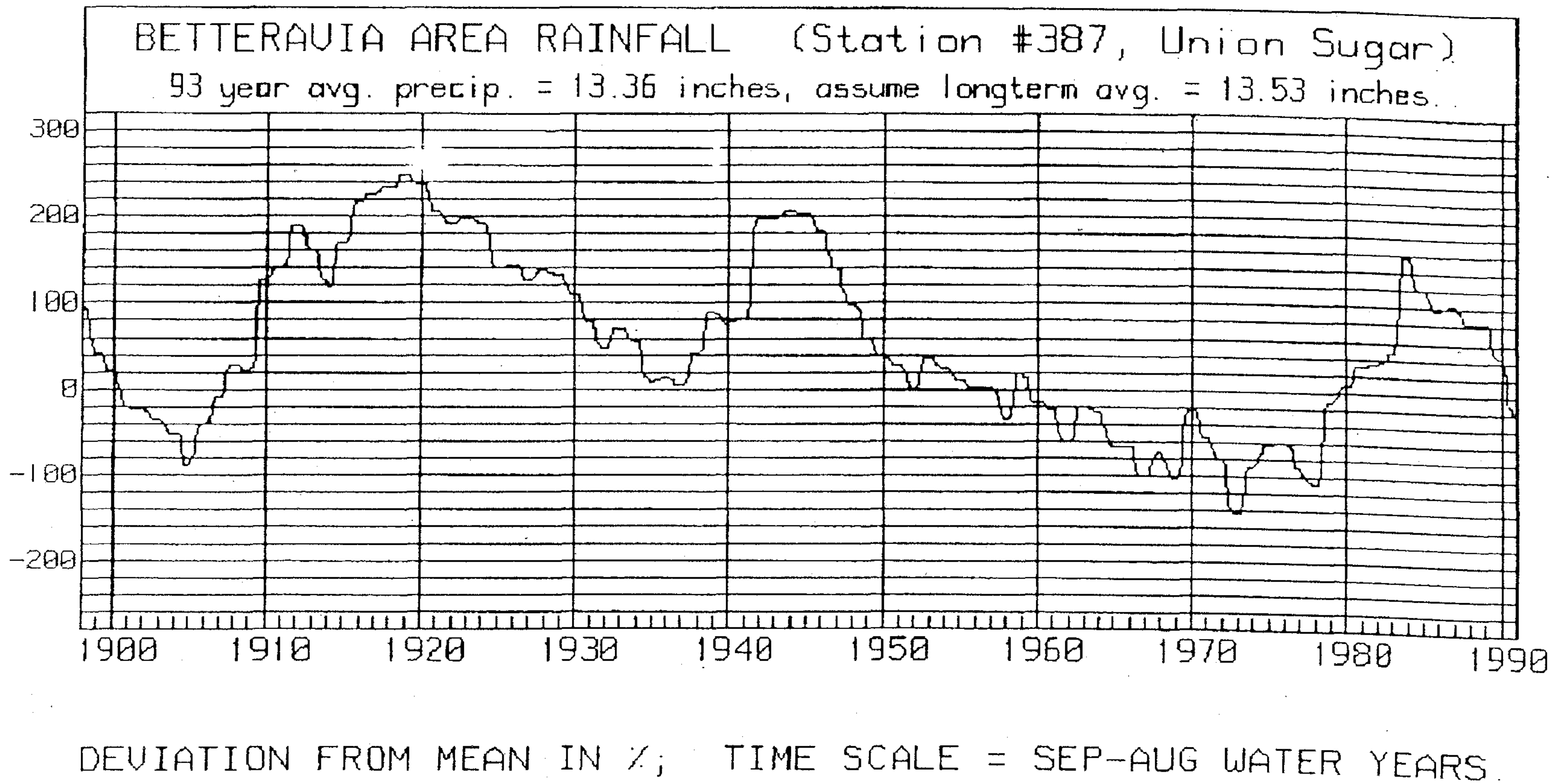


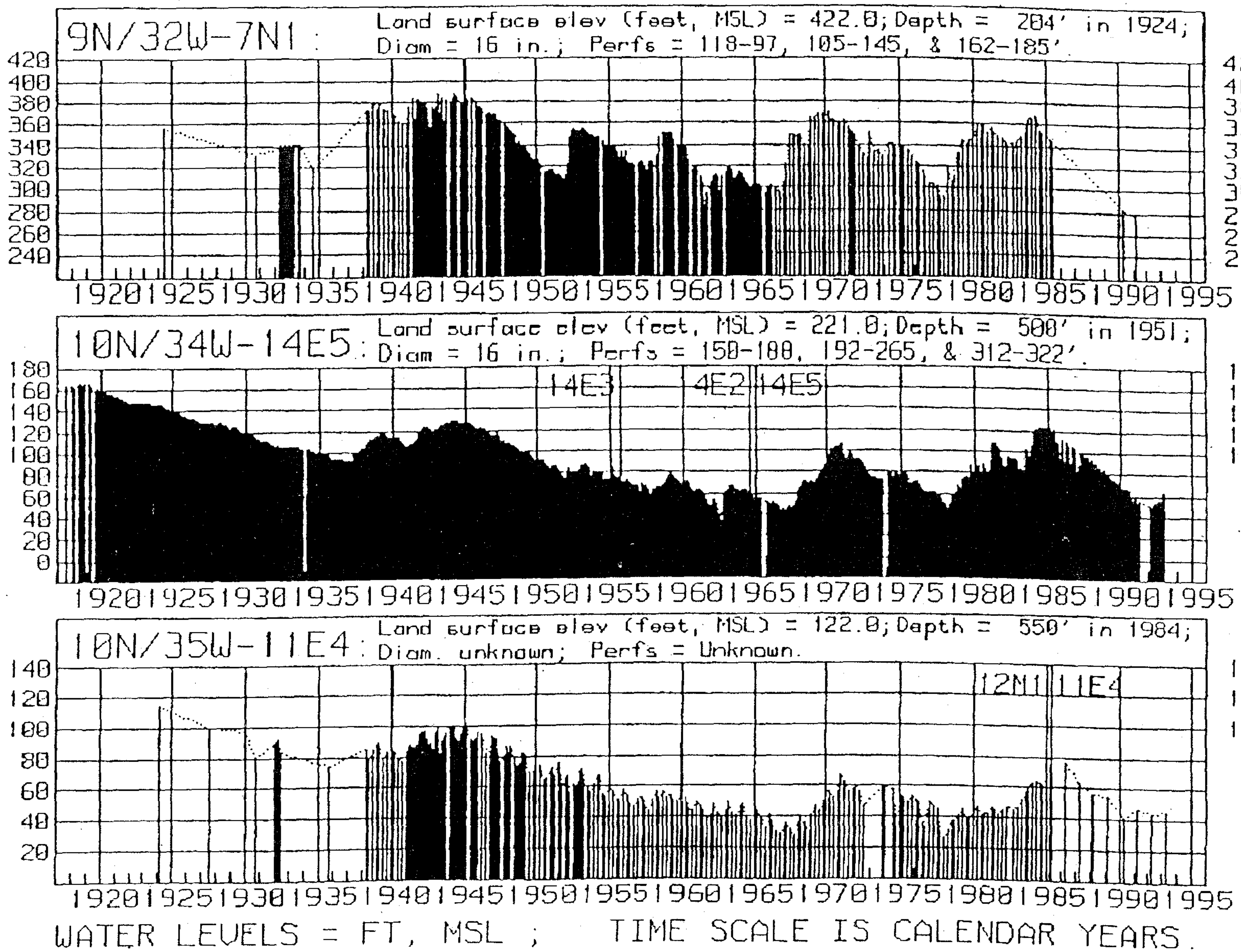
Figure IV-3E

Source: Santa Barbara County Water Agency



Source: Santa Barbara County Water Agency

Figure IV-3F



Source: Santa Barbara County Water Agency

Figure IV-4

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Only in years of high precipitation is there a significant contribution to Twitchell Reservoir inflow from the eastern Cuyama River. In years of average rainfall, most of the runoff is from the Huasna and Alamo watersheds directly north of Twitchell. Rainfall at Twitchell Dam has averaged 16.4 inches per year since 1961. According to a gage that recorded data from 1938 to 1976, the average annual rainfall within the lower portion of the Huasna Watershed is 18.08 inches.

Cloud Seeding

Cloud seeding has been conducted within Santa Barbara County on an experimental or operational basis for the majority of winters since 1950. Operational programs aimed at increasing water supply have been conducted by Santa Barbara County during all of the winters (except for 1985-86) since 1981. Until 1992, the program was strictly limited to avoid affecting areas outside Santa Barbara County, thus excluding productive portions of the Twitchell Reservoir Watershed.

The effects of cloud seeding have not been removed from rainfall calculations presented above because operations affecting the Santa Maria Valley are considered minimal when averaged over the total period of record. This is because records for Santa Maria Valley are available for over a century, whereas operational cloud seeding in that area has only been conducted for about a decade. However, if a program is conducted consistently in the future, average rainfall values may be somewhat higher than those reported in this document.

SECTION V - SURFACE WATER SUPPLIES

Twitchell Reservoir

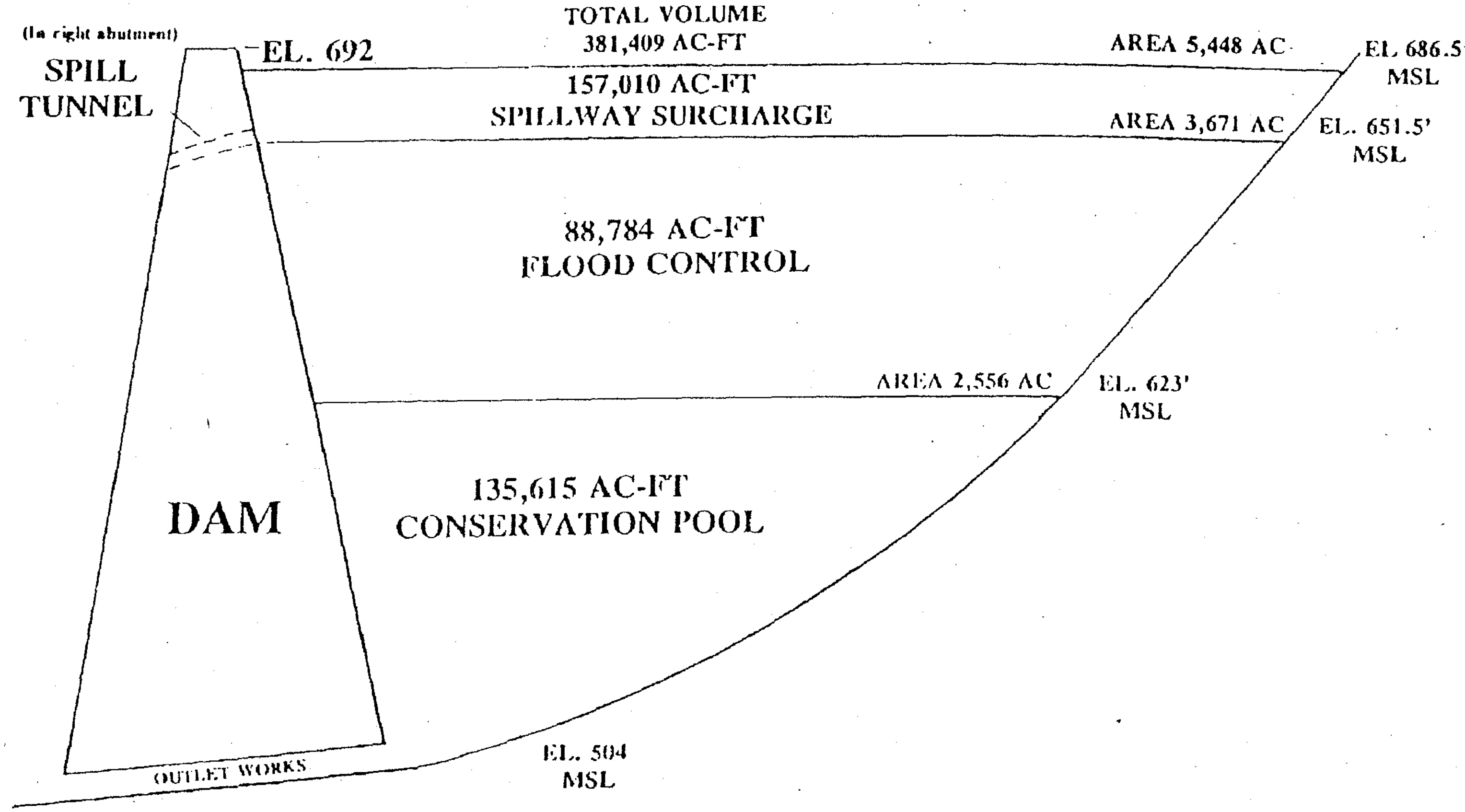
Since constructed in 1959, Twitchell Reservoir has been an integral part of the Santa Maria Valley water supply, capturing flood flows and providing a supplemental source of ground water recharge. Water conserved in the reservoir (up to 135,615 AF) is released down the Santa Maria River where it percolates into the ground water basin. An additional 89,000 acre feet of storage is available for flood control purposes (Figure V-1).

The yield of the Twitchell Project has been estimated independently by several sources. The SBCWA did an analysis in 1992 which indicated an average yield of 19,882 AFY based on a daily inflow model.[15] Prior to its construction, the United States Bureau of Reclamation (USBR) calculated the yield of a theoretical Twitchell Reservoir to be approximately 20,400 AFY.[16] Similarly, the Toups Corporation analysis, conducted in 1976, estimated the yield to be 19,750 AFY.[1] The average yield that may be expected with cloud seeding is as much as 23,500 (See Section IV). Potential yield increases due to operational modifications are discussed in Section VIII.

State Water Project

In 1991 the City of Santa Maria and the City of Guadalupe committed to participating in the construction of the Coastal Branch of the State Water Project, Phase II, an 87-mile pipeline extending from the California Aqueduct in Kern County to the Santa Maria River, including necessary power and pumping plants. The Mission Hills extension, a 23-mile long addition, will deliver State Water to communities within the Santa Maria Valley.

TWITCHELL RESERVOIR



Source: Santa Barbara County Water Agency

Figure V-1

Currently, the Cities of Santa Maria and Guadalupe are scheduled to receive 16,200 AFY and 550 AFY of State Water, respectively. The Southern California Water Company, purveyor for Orcutt and surrounding areas, is currently considering an option to receive 500 AFY of water in addition to purchasing up to 2,500 AFY of excess project water, if available from other project participants.

The amount of State Water actually received by each entity depends upon the availability of project water (during extended droughts, the project may be unable to fulfill the total project commitment), the demand within the participating districts and the ability of the districts to accept excess water. State Water is expected to be available to the Santa Maria Valley by mid-1996. Section VIII discusses conjunctive use opportunities utilizing State Water.

SECTION VI - GROUND WATER RESOURCES

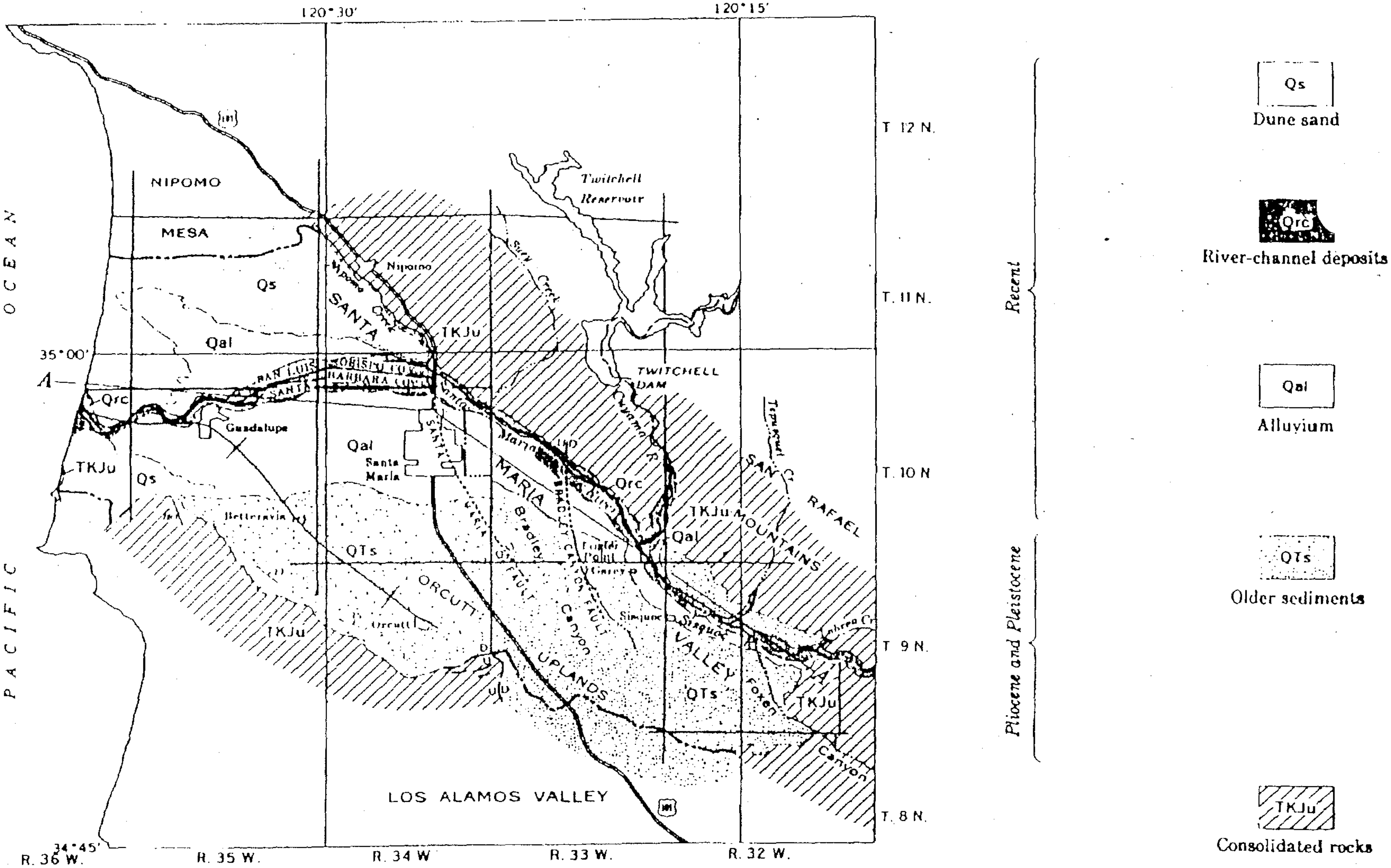
Virtually all of the water used within the Santa Maria Valley is pumped from the ground water basin. The valley's economy and domestic well-being depends on the availability and quality of the ground water supply. Section VI describes the physical characteristics of the aquifer, the ground water pumpage and overdraft status.

Description of Water Bearing Units

Ground water beneath the Santa Maria Valley is contained in permeable gravel and sand deposits which are locally interbeded with impermeable beds of clay and silt. These deposits are contained within the consolidated bedrock of the underlying syncline (Figure VI-1). The northern limb of the syncline is exposed at the ground surface east of Nipomo Creek and along the north side of the Santa Maria River. The southern limb forms the boundary between the Santa Maria and Los Alamos Valleys. Following is a description of the deposits, from youngest to oldest (shallow to deep), which comprise the aquifer:

Dune Sand - Deposited in the last 10,000 years, this medium to coarse grained, highly porous, highly permeable sand exists exclusively in the western part of the valley. Although water is contained within the base of this formation, none is pumped for economic use. The maximum thickness of this formation is about 200 feet.

Source: U.S. Geological Survey Water Supply Paper 1819-A



VALLEY GEOLOGIC MAP

Geology modified from Worts (1951)

Figure VI-1

River Channel Deposits - Also deposited in the last 10,000 years, these deposits consist of boulders, gravel, sand, silt and clay which are confined to the channels of the Santa Maria, Cuyama, and Sisquoc Rivers. The deposits become finer grained westward, across the valley. These sediments provide the main conduit for recharge of the aquifer by Santa Maria River flows. This formation is less than 25 feet thick.

Alluvium - Although older than the river channel deposits, the alluvium was also deposited within the last 10,000 years. It is composed of earlier river channel deposits deposited as the rivers meandered back and forth across the valley floors of the Cuyama, Sisquoc and Santa Maria drainages. The alluvium is comprised of gravel, sand, silt and clay which become finer grained to the west. This is the primary water bearing formation in the valley. A clay layer in the upper 100 feet of this formation acts as a confining layer in the west part of the basin. The formation has a maximum thickness of about 200 feet.

Older Sediments - These unconsolidated, undifferentiated deposits were emplaced from about four million to 40,000 years ago. Deposits include gravel, sand, silt and clay. This formation may form several distinct confined aquifer zones in the west part of the valley. Significant amounts of water are stored in these deposits which may be as thick as 2,300 feet in the west part of the basin.

Consolidated Rocks - These impermeable sandstone, shale, mudstone and pyroclastic rocks underlie and form the base of the aquifer and were deposited more than four million years ago. The thickness of this formation is approximately 10,000 feet.

Storage Capacity

The total volume of saturated deposits within the Santa Maria Ground Water Basin has been estimated to be about ~~[illegible]~~ 1,500,000 million acre feet.[7] However, this number means little in terms of usable ground water. The amount of usable water depends on the ratio of solid material to pore space, the "specific yield" (ratio of the total volume of sediment to the volume of water that drains by gravity), and the volume below which seawater encroaches or pumpage becomes physically or economically infeasible.

The total usable ground water stored in the basin was estimated to be ten million acre feet (AF).[5] However, it is more practical to deal with the volume of water above sea level relative to storage levels of a base year because the fluctuations in storage are more easily quantifiable. The year 1918 provides a suitable base year because ground water levels were at an historic high. Table VI-1 shows estimated ground water in storage, above sea level, for the eight storage units.

TABLE VI-1
SANTA MARIA GROUND WATER BASIN
ESTIMATED STORAGE ABOVE SEA LEVEL

		AF in Storage (x 1,000)					
STORAGE UNIT	SURFACE AREA (AC)	1918[b]	1950[b]	1959[b]	1977[c]	1984[c]	1991[c]
Guadalupe[a]	25,000	235	171	145	125	165	131
Nipomo	10,500	250	160	140	136	167	134
Betteravia	6,100	82	65	47	34	53	37
Santa Maria	17,400	540	292	265	190	392	180
Fugler Point	5,500	230	153	170	151	214	138
Orcutt	16,200	460	277	290	151	231	161
Bradley Cny.	22,000	1,020	992	900	931	1,010	923
Sisquoc	4,200	255	252	250	270	302	263
TOTAL	106,900	3,072	2,362	2,207	1,988	2,534	1,967

a) Ground water in storage from 10 ft. above sea level to top of saturated zone

b) From USGS Water Supply Paper 1819-A, Pg. A7

c) From Santa Maria Ground Water Basin Budget Status, Jon Ahlroth, SBCWA 1992

The table indicates that ground water levels have declined significantly since 1918. Levels in 1991 were about 1.1 million AF lower than in 1918; an average of about 15,000 AFY. Levels in 1984 were significantly higher due to an exceptionally wet period beginning in 1978, then declined dramatically in the pursuant dry period. Table VI-2 shows the change in storage within the basin based on storage values from Table VI-1. The column entitled Average Annual Change represents the overdraft (or surplus).

TABLE VI-2 STORAGE CHANGE		
TIME PERIOD	NET CHANGE (AF)	AVERAGE ANNUAL CHANGE (AF)
1950-59	-155,000	-17,000
1959-77	-219,000	-12,000
1977-84	+546,000	+78,000
1984-91	-567,000	-81,000

Figure IV-4 shows selected hydrographs for storage units in the Santa Maria Basin. These hydrographs illustrate that water levels in wells located in the eastern part of the Santa Maria Basin respond more dramatically to changes in storage than do water levels in wells located in the west. This is because the west part of the Basin is confined. Therefore, changes in storage manifest as pressure fluctuations with only small accompanying ground water storage changes. In the eastern part of the Basin, the water levels recorded in 1991 and 1992 were the lowest in recorded history which indicates that the overall basin storage at that time was the lowest in recorded history.

Safe Yield and Overdraft Status

The overdraft status of the Santa Maria Basin has been much debated. Estimation of overdraft and safe yield of any basin requires an understanding of the sources of water into and out of the basin.

Sources of recharge in the Santa Maria Basin include percolation of stream flow and rainfall, return flows from agriculture, return flows from municipal and industrial operations, and subsurface water that flows into the basin from adjacent aquifers. Sources of basin depletion include agricultural, municipal, and industrial pumpage and subsurface outflow. In order to determine the safe yield and overdraft status of the basin, all of these influences must be quantified as precisely as possible.

The SBCWA developed a water budget model to estimate basin overdraft using hydrologic data based on average climatic conditions over a 45 year period.[2] The model incorporates measurements and estimates of the sources of recharge and depletion discussed above. The model was calibrated by adjusting pumpage return flows to agree with historic water level data at various points throughout the modelling period.

Much of the municipal and industrial pumpage and return flows in the valley have been metered. Therefore, estimates used in the SBCWA model make use of existing records (see Section III, Municipal and Industrial Water Use). Municipal and Industrial water use for 1990 was estimated to be 27,827 AF with 40% return flows yielding a net use of 16,696 AF.[9]

The contribution to the basin from surface water is estimated based on historic records of stream flow and rainfall. Basically, water percolating to the basin from streams is determined by subtracting outflow to the ocean from gaged flow at various points within the valley. Direct recharge from rainfall is determined using methods described by the USGS in Water Supply Paper 1,000.[6]

Agricultural pumpage and return flows are mostly un-metered and require an indirect method of estimation. Irrigated acres, a measurable quantity, and crop water use, are used to determine the consumptive, or net, use by agriculture (see Section III, Agricultural Water Use). Table VI-3 shows 1990 estimates of agricultural use and return flows by DWR and SBCWA.

TABLE VI-3
1990 AGRICULTURAL WATER USE AND RETURN FLOWS (AF)

	DWR[a]	SBCWA[b]
Gross Water Use	172,528	130,619
Net Water Use	139,100	83,974
Return Flow	33,428	46,645
Percent Return Flow	19.4%	35.7%

a) DWR Preliminary 1990 crop estimates

b) Table III-4 of this report and SBCWA Santa Maria Valley Report of August 1992, Fig. 14, assuming that the 75,700 cropped acres of Table III-4 is being farmed (on average) on 50,000 acres of land.

The reason for the difference between DWR and SBCWA estimates is that the SBCWA uses agricultural duty factors (crop use factors) from the UCSB Cooperative Extension, Farm Advisor rather than DWR. These produce results that more closely match observed water level changes in the basin.

Estimates of subsurface inflow and outflow are made using studies of the geologic composition of the basin and the gradient of the aquifer. The cross sectional area of the aquifer is known and the ability of the aquifer to transmit water is used to determine the flow at different storage volumes. For the Santa Maria Ground Water Basin, the groundwater underflow loss to the Pacific Ocean has been estimated to be significant (as high as 16,000 AFY in 1918 with a very full basin). With a 1991 basin storage volume, the subsurface outflow is calculated to be about 5,500 AFY.

A consequence of this relationship is that the basin storage directly influences the amount of subsurface water that flows into and out of the basin, and thus the overdraft. As the storage of the basin drops, the ground water gradient toward the ocean within the aquifer decreases and subsurface outflow also decreases, thus increasing the basin yield. The higher the ground water level in storage, the higher the sub-surface outflow to the ocean, and the lower the yield.

It may thus seem desirable to have the average basin storage maintained at low levels, but such a policy would likely be unwise. Low operating levels could induce seawater encroachment into the aquifers, seriously reduce water well pumping rates, substantially increase pumping costs, attract poor quality connate water (water trapped in sediments during deposition) into the basin, reduce the export of salts from the basin to the sea, and possibly cause land subsidence.

Using the water budget model, the SBCWA estimates the current overdraft within the basin to be about 20,000 AFY, accurate to one significant figure (20,000 AFY plus or minus 5,000 AFY). As previously mentioned, this estimate makes use of data from earlier studies by the USGS and others, and ongoing surface and ground water monitoring programs. Estimates of the sources of basin recharge made by the USGS in 1945 conform closely to those made by the SBCWA in 1977 and 1992.[6] As expected, the overdraft estimated in the 1945 USGS study is different (12,000 AFY) due mainly to the increased pumpage and the addition of Twitchell Reservoir since that time.

In the 1976 Santa Maria Valley Water Resources Study, the Toups Corporation estimated that, under 1975 conditions, the basin was overdrafted at a rate of 6,000 AFY.[1] However, the Toups study excluded that part of the ground water basin east and southeast of Fugler Point, whereas the USGS and SBCWA studies include it (Figure II-1). Furthermore, Toups calculated subsurface outflow to the ocean under 1975 conditions using an overall ground water basin gradient to the ocean which is not representative of the actual outflow to the ocean. The SBCWA used a specific gradient localized at a cross-section (north-south, through Guadalupe) where underflow is being calculated, then subtracted consumptive use west of that cross-section, to determine underflow to the ocean.

A rough test of the magnitude of the SBCWA overdraft figure of 20,000 AFY can be made by observing ground water basin levels over the very dry seven year period from 1984 to 1991. The estimated ground water basin recharge for this period is displayed on Table VI-4 below, extending from the spring of 1984 to the spring of 1991.

TABLE VI-4
BASIN BALANCE DATA
(All Values in Acre Feet)

Water Year	Rainfall Infiltration	Stream Seepage[a)]	Underflow[b)] In	Underflow[b)] Out	Total Net Recharge
½ 1984	0	10,000	1,600	5,100	6,500
1985	0	8,000	3,500	9,900	1,600
1986	4,000	31,000	4,000	9,000	30,000
1987	0	3,000	4,400	8,200	-800
1988	0	8,000	4,800	7,500	5,300
1989	0	4,000	5,300	6,800	2,500
1990	0	1,000	5,800	6,100	700
½ 1991	0	10,000	3,000	2,800	10,200
Subtotal	4,000	75,000	32,400	55,400	56,000
Add April-August, 1984 Twitchell Contribution[c)]					80,000
Total Spring, 1984 - Spring, 1991 GWB Recharge					136,000

a) Used rainfall data with Blaney percolation curves to estimate infiltration of rainfall. Used USGS stream gage records to develop stream seepage estimates.

b) Calculated, based on total GWB storage, from algorithms used in the August, 1992 water budget model.

c) Leftover Twitchell contribution from 1983 winter which was perked into the GWB from April, 1984 to September, 1984.

Table VI-4 shows a total net recharge for the seven year period of 136,000 AF. The estimated change in ground water basin storage is 567,000 AF (see Table VI-1). Therefore, the total quantity of water consumed by ground water pumping during this period is 136,000 + 567,000 = 703,000 AF, and the average annual pumpage consumptive use is 703,000/7 or about 100,400 AF/Yr.

Municipal and industrial net pumpage probably averaged between 14,000 and 16,700 AFY during this period (an average of about 15,400).[9] Therefore, the agricultural consumptive use over this period is the total pumpage consumptive use less municipal and industrial consumptive use or 100,400 - 15,400 ≐ 85,000 AF/yr. This is very close to the agricultural consumptive use value calculated with the SBCWA water budget model described above (about 84,000 AFY; see net agricultural water use in Table VI-3).

The municipal consumptive use, rainfall infiltration and stream seepage are all fairly well metered or measured quantities. Although underflow into and out of the basin are not measured, the net influence of underflow during this period is likely very small and would not influence the outcome of these calculations significantly. Thus the basin dewatering during the recent drought supports the SBCWA groundwater model agricultural consumptive use magnitude. Therefore, overdraft estimates using the model are likely of the right order of magnitude (to one significant figure).

Some local farmers have questioned the return flow estimates shown in Table VI-3 on the basis that water levels in some wells are now the same as they were 30 years ago. However, 30 years ago (1964) ground water levels in Santa Maria Valley were approaching all time lows (levels were lowest in 1966). These levels were again approached in 1977 and in 1992 (see Storage Capacity).

The main determinants of ground water storage changes are ground water recharge (a function of climate) and net pumpage. Therefore, errors in return flow estimates would affect estimates of net agricultural water use and basin overdraft calculations. The SBCWA return flow rates were determined empirically using a sliding function, wherein the percent return flow is increased as a function of the basin wide average unit applied water rate (see Section III - Water Demand). This function was developed so that modelled basin storage levels over a selected base period agreed with basin storage calculations using well level-storage coefficient methods. In addition, return flows used in this report are significantly higher than those used in USGS and DWR studies (usually 20%) and closely match those used by San Luis Obispo County.

SECTION VII - WATER QUALITY

Because its economy is based on irrigated agriculture, the prosperity of the Santa Maria Valley is dependent upon water quality. Degradation of water quality reduces the productivity of crops and forces the application of greater quantities of water. In addition, reclamation and treatment facilities become less efficient and cost more to maintain with worsening water quality. Currently, there is limited water quality data available for the valley. The data that does exist provides an indication of lateral variations in water quality but little is known about vertical variations. This is because most of the sampling is conducted from wells which are cased through multiple water bearing zones. A comprehensive study, such as that conducted by the USGS in 1975, would be very useful to determine water quality trends and current conditions.

Sources of Quality Degradation

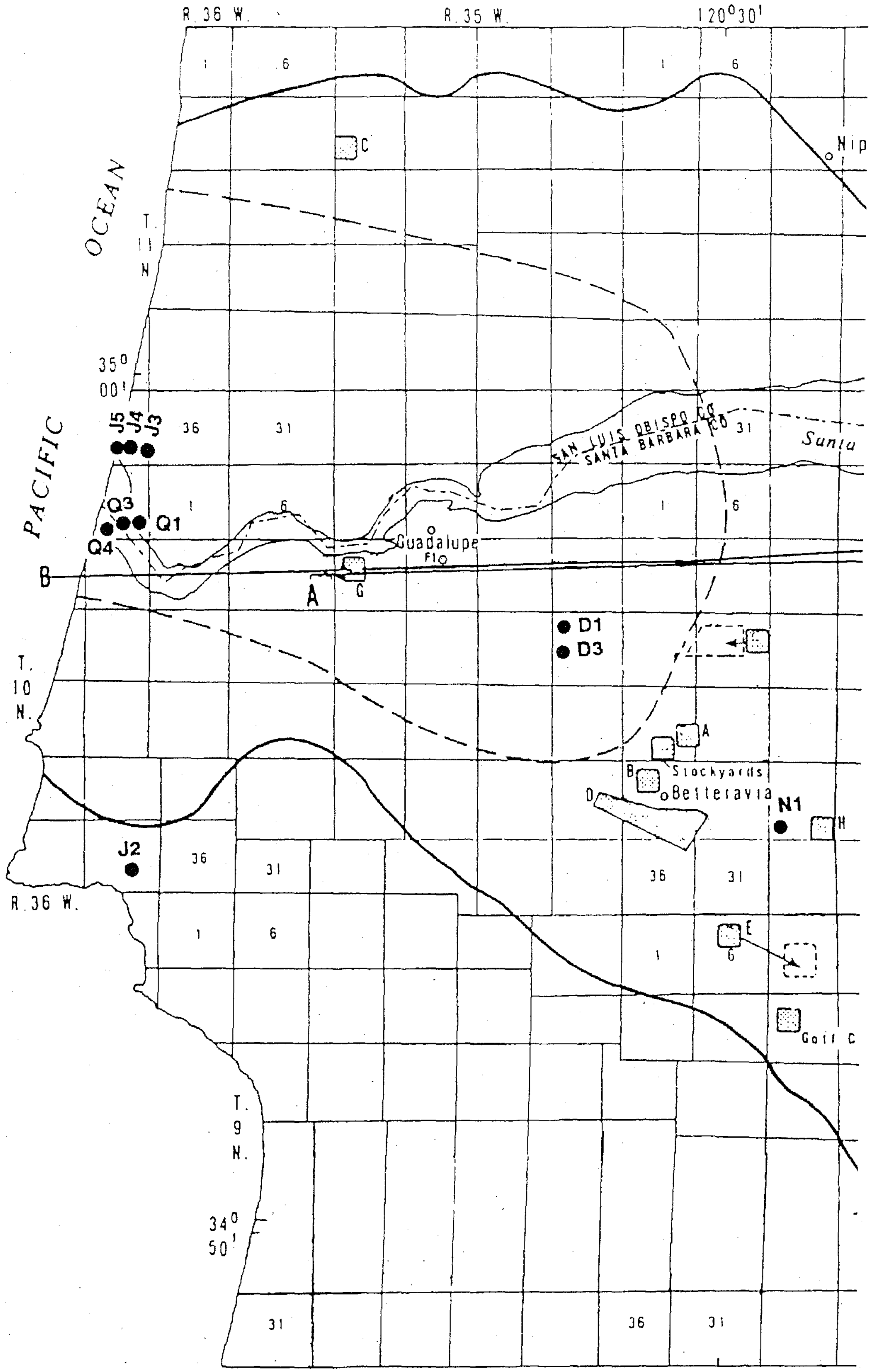
Sources of water quality degradation may result from point sources such as leaking underground storage tanks or non-point sources such as sea water intrusion.

Point Sources

Due, in part, to the absence of major industrial areas within the valley, there are relatively few cases of ground water contamination from industrial pollutants. Most of those that have been documented are the result of leaking underground fuel storage tanks.

Because many of the constituents of petroleum fuels float on ground water, contamination of this type tends to be confined to shallow depths. Similarly, in areas of confined ground water, contamination is often contained above impermeable (confining) layers. Therefore, it is unlikely that contaminants from these sources would pass rapidly to deeper aquifers from which much of the domestic water supply is obtained. Records obtained from the Santa Barbara County Environmental Health Department show 11 active ground water contamination sites within the valley. Active sites are those that have been identified and are in the process of being studied or cleaned up. One of these is located in Orcutt and ten in Guadalupe.[19] Parts of the valley located in San Luis Obispo County were not included in this part of the study.

The valley's waste water treatment facilities represent four additional point sources Figure VII-1. The average concentrations of total dissolved solids (TDS) discharged from the City of Santa Maria, Santa Maria Airport, Laguna Sanitation District, and the City of Guadalupe plants for the years 1960 to 1974 (1961 to 1975 for Laguna Sanitation District) were 1,480 ppm, 1,090 ppm, 1,245 ppm, and 2,023 ppm, respectively.[20] Current discharge data for the facilities are listed in Table VII-1.



Source: U.S. Geological Sur port 76-128

WELL LOCATION MAP

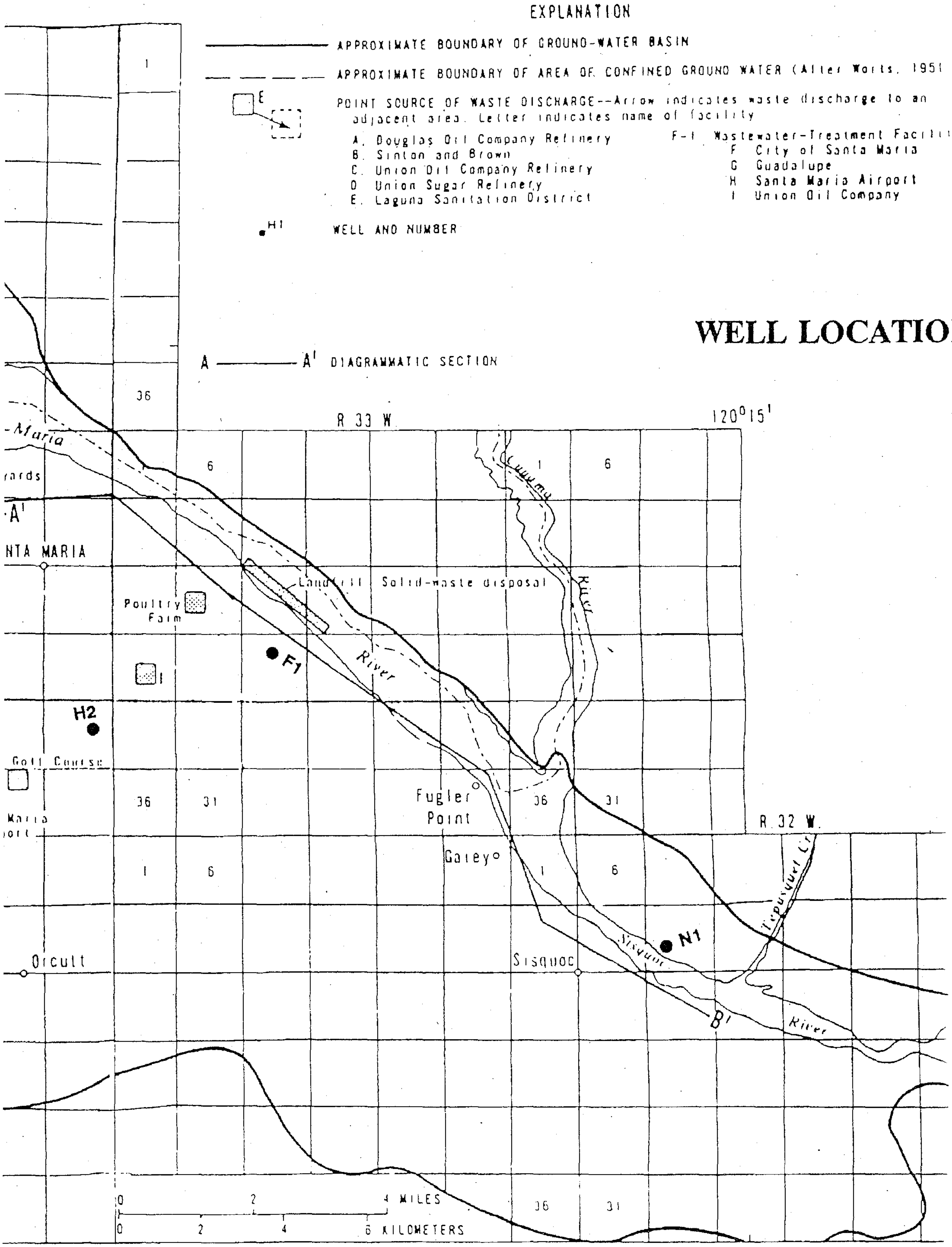


Figure VII-1

TABLE VII-1 WATER TREATMENT PLANT DISCHARGE		
	DISCHARGE (AFY)	TDS (PPM)
City of Santa Maria	6720[a]	1465[a]
Laguna Sanitation District	2400[c]	1200[c]
City of Guadalupe	335[b]	1380[b]
TOTAL	9455	

a) Personal Communication, Mark Moya, Santa Maria Water Treatment Plant

b) Personal Communication, Fernando Guzman, Guadalupe Public Works Department

c) R.C. Upham, Ground water Management Task Force notes, April 22, 1992

Effluent from the plants are released to streams and percolation ponds or used for irrigation of grazing land or crops. Thus, the effluent from these sources impacts the quality of ground water to wich it is discharged. The DOHS recommends a maximum TDS concentration of 500 ppm for drinking water.[21]

Non-point Sources

The most important non-point source of water quality degradation in the valley is "recirculation" of irrigation water. With repeated application and evaporation of ground water, minerals are deposited in shallow soils. As these minerals are flushed through to the aquifer, the TDS concentration in the aquifer increases resulting in a cycle of quality degradation.

Other non-point sources related to agriculture and live stock include pesticides, fertilizers and animal waste. The impact of fertilizer percolation is often detectable in ground water by a build-up of nitrates. In some coastal areas, sea water intrusion may be indicated by increased TDS, chloride, sodium and boron.

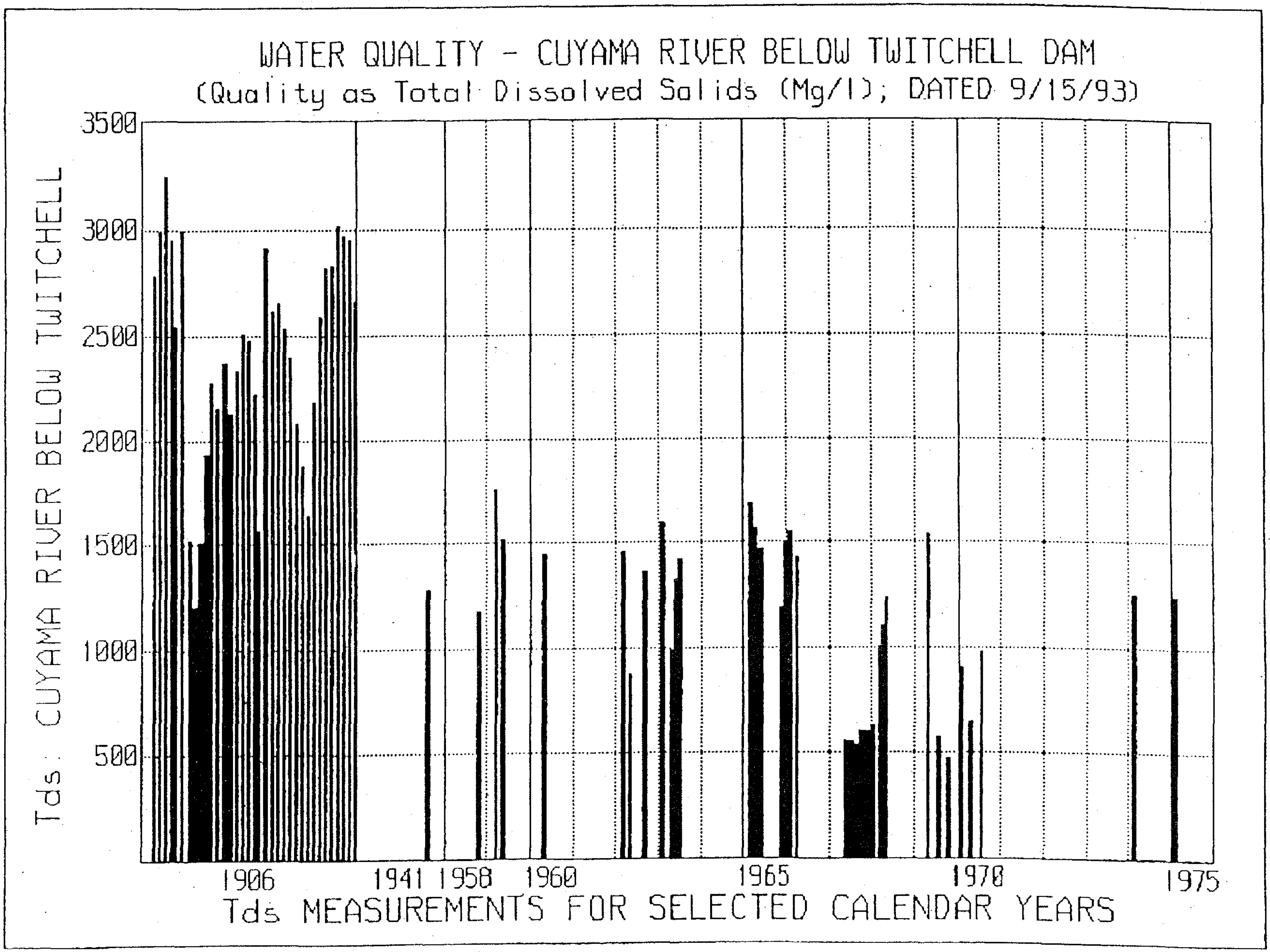
Surface Water Quality

Surface and ground water within the Santa Maria Valley are interconnected through pumpage and recharge of the aquifer via rivers and irrigation. Therefore, degradation of one ultimately leads to degradation of the other. Conversely, any improvement of surface water quality results in better ground water quality. There are two main sources of surface inflow to the Santa Maria Valley: Twitchell Reservoir water, (principally from the Cuyama and Huasna watersheds), and the Sisquoc River.

Twitchell Reservoir

Twitchell Reservoir acts to increase the quality of water which percolates to the aquifer. This is because the TDS within local rivers is generally inversely proportional to flow; i.e. the higher the flow, the lower the TDS. By capturing high flow water, which would have been lost to the ocean, the project retains higher quality water for later release and percolation to the aquifer. Although evaporation of standing water tends to accumulate dissolved solids, the effect is insignificant.

Figure VII-2 is a graph of TDS concentration measured in the Cuyama River below Twitchell Dam from 1906 through 1975. The general trend is toward decreasing TDS. There is a large gap in the record between 1906 and 1941 and a corresponding decrease in TDS. The reason for this is unclear; it may simply be the result of improved laboratory techniques.



Source: Santa Barbara County Water Agency

Figure VII-2

However, the graph indicates important information about the effect of the construction of Twitchell Reservoir in 1959. Samples obtained following very wet years, during months in which releases were made, exhibit low TDS concentrations. This is illustrated by the samples obtained during 1969. Conversely, samples obtained during dryer periods exhibited higher TDS (1959 to 1964).

There are two major sources of inflow to Twitchell Reservoir: Huasna and Alamo Creeks and that portion of the Cuyama River upriver of the Reservoir. The Huasna watershed extends north of Twitchell Reservoir and the Cuyama River watershed extends east into Ventura County (Figure IV-5). The Sisquoc River watershed encompasses a large portion of central Santa Barbara County and empties into the Santa Maria Valley at its east end. Recent water quality records for each watershed are included in Table VII-2 and the location of each gage is shown on Figure VII-1.

Figures VII-3A and VII-3B are graphs of water quality versus flow for the Sisquoc River near Sisquoc gage, and the Huasna River near Arroyo Grande gage. These graphs illustrate that higher flows tend to produce better quality water in these areas, as well.

<u>State Water</u>

For the most part, the quality of State Water will exceed that of other water sources currently available within the valley. The expected TDS of State Water to be delivered to the valley is approximately 300 ppm. Nitrate concentrations will likely be about 1.9 ppm.[21] These data were obtained by DWR (TDS) and the Metropolitan Water District (nitrates) based on sampling of State Water conducted periodically since 1980. As with local water, TDS concentrations in State Water tend to increase during dry years and decrease in years with above normal precipitation.

CUYAMA RIVER BELOW BUC... ANYON

DATE	DISC	TDS
Jul 7 1988		1480
Sep 12,1988	0.01	1340
Feb 13 1990	0.01	1320
Nov 6 1988	0.01	1280
Nov 28 1988	0.02	1390
Jun 12 1989	0.02	1410
Oct 4 1989	0.02	1360
Jan 3 1990	0.03	1620
Mar 12 1990	0.04	1360
Apr 11 1989	0.09	1390
May 31 1988	0.11	1410
May 8 1989	0.14	1340
Jan 30,1989	0.14	1510
Nov 30,1981	0.15	1070
Sep 23 1986	0.15	1100
Sep 5,1984	0.16	1140
Apr 5 1988	0.17	1380
Sep 3 1991	0.2	1340
Nov 7 1984	0.23	1080
Dec 3 1979	0.25	1040
Jan 4 1982	0.25	1060
Aug 31 1981	0.25	1050
Oct 17,1985	0.27	1280
Aug 15 1986	0.27	1130
Oct 5 1981	0.28	1060
Jan 15,1986	0.28	1200
Nov 19 1985	0.28	1220
Aug 3 1981	0.29	1120
Aug 9 1984	0.29	1160
Nov 6,1979	0.31	994
May 4 1988	0.32	1430
Sep 17 1985	0.34	1240
Aug 31 1982	0.34	951
Aug 12 1991	0.36	1210
Dec 1 1980	0.37	1000
Jul 17 1986	0.37	1190
Jul 16 1985	0.39	1410
Oct 4 1979	0.41	1110
Dec 19 1985	0.41	1290
Aug 15 1985	0.44	1360
May 15 1985	0.45	1420
Oct 29 1980	0.47	813
Jul 12 1984	0.51	1290
Mar 1 1982	0.51	1040
Jun 19 1986	0.52	1400
Oct 30,1978	0.53	1170
Sep 9 1979	0.53	1190
Oct 1 1982	0.53	949
Oct 1 1980	0.55	974
Dec 29,1980	0.57	1010
Oct 11 1978	0.6	1180
Feb 1 1982	0.61	1100
Jun 7 1984	0.63	1380
Aug 1 1979	0.66	1130
Jun 19 1984	0.67	1230
Sep 9 1987	0.82	810
Jan 3 1989	0.83	1670
Jun 30 1981	0.84	1190
Jul 9,1981	0.89	1120
Nov 29 1978	0.91	1180
Aug 11 1987	0.99	861
Apr 17,1986	1.1	1480
Aug 27 1980	1.1	1040
Aug 3 1982	1.2	932
Oct 29 1986	1.4	793
Feb 27 1989	1.4	2270
Jul 8 1987	1.4	821
Dec 8 1987	1.4	2190
May 8 1984	1.4	1510
Jul 29,1980	1.5	1020
Jun 10 1991	1.6	1110
Dec 4 1986	1.7	705
Feb 2,1988	1.8	2410
Jun 10,1987	1.9	730
Feb 10 1987	2	821
Jun 1 1981	2	1160
Jun 25 1979	2.2	1180
May 15 1986	2.2	1300
Jan 6 1987	2.2	794
Jul 1 1982	2.3	1050
May 12 1987	2.4	811
Apr 30 1981	2.6	1670
Jun 5 1978	3.3	1290
Dec 6 1984	3.3	2530
Mar 18 1985	3.3	2130
Dec 27 1978	3.6	1920
Apr 13 1984	3.8	1940
Sep 8 1983	3.8	1520
Jan 30 1979	4.2	2290
Jun 2 1982	4.2	1170
May 6,1981	4.4	1350
Feb 12 1986	4.9	2220
Apr 15 1986	5	1870
Aug 2 1983	5.6	1430
Feb 3 1981	6.1	2380
Jan 5 1983	6.4	1540
Feb 29 1984	6.9	2040
Apr 8 1987	7	797
Apr 1 1981	7.5	1760
Jun 2 1980	7.7	1710
Feb 3 1986	8.5	2020
Jan 30 1980	8.5	2670
May 2 1979	8.9	1600
May 3 1982	9.6	1370
Nov 30 1983	10	2160
Jul 6 1983	11	1520
Mar 3,1981	13	2110
Oct 3 1983	14	2510
Jan 4 1984	15	2290
Jan 7 1988	15	1880
Mar 2,19..	18	1470
Feb 28 19..	22	1640
Jun 9 1983	27	1600
Mar 9 1987	29	884
Apr 30 1980	34	250
Mar 29,1980	36	1510
Apr 2 1981	55	1360
Apr 5 1982	64	847
May 6 1983	78	1140
Feb 14 1986	118	2100
Dec 1 1982	134	1770
Apr 5,1983	175	960
Mar 3 1980	200	1590
Mar 10 1983	229	1020
Mar 28 1978	408	1290

*TDS = Solids Residue at 180 Deg. C Dissolved (Mg/L)

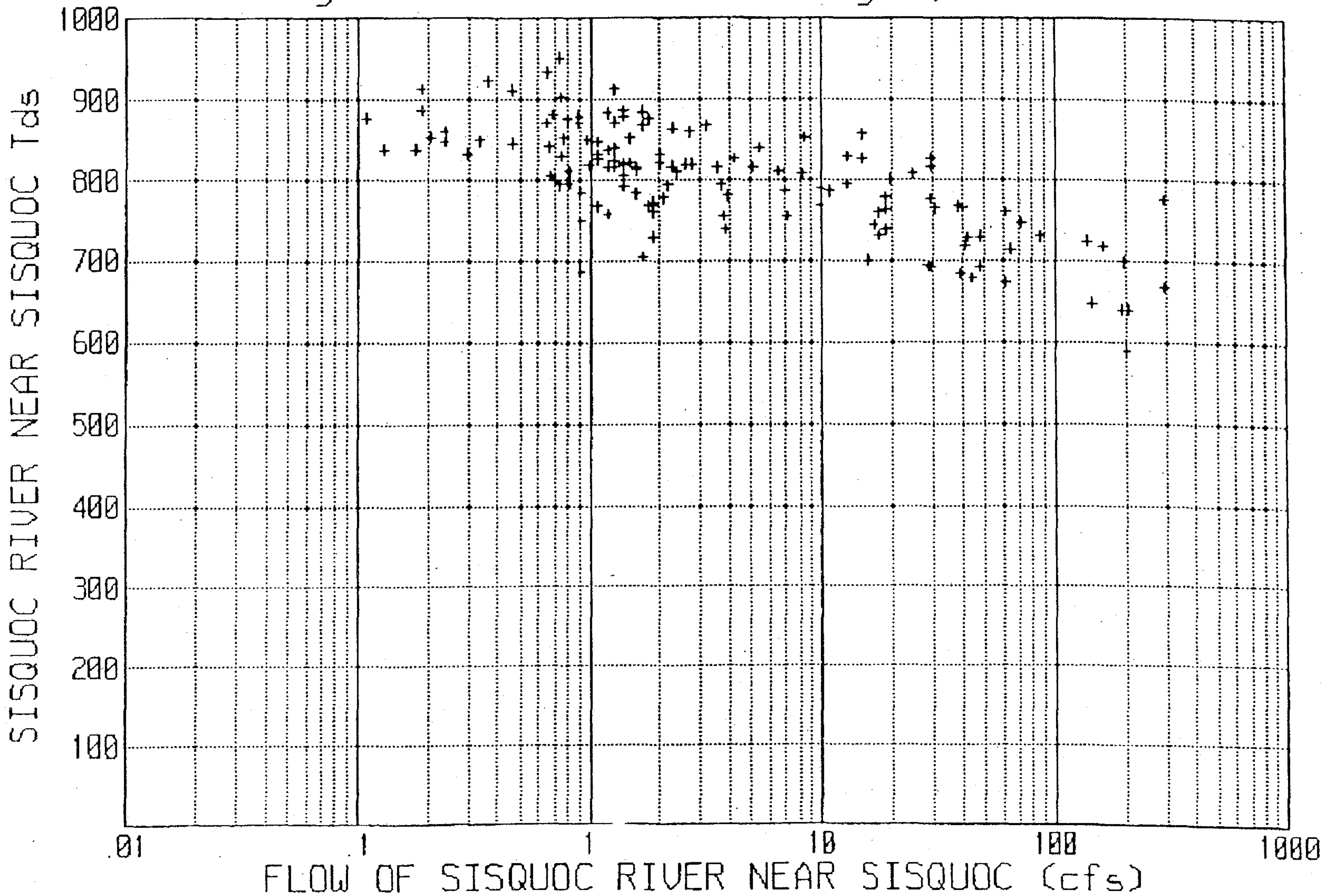
HUASNA RIVER NEAR ARROYO GRANDE

DATE	DISCHARGE	TDS
Nov 6 1985	0.08	844
Aug 7 1986	0.15	809
Oct 29 1980	0.18	802
Sep 15 1981	0.21	804
Oct 7 1981	0.22	589
Aug 11 1981	0.24	636
Oct 8 1985	0.26	648
Jul 16 1981	0.29	612
Dec 4 1985	0.29	646
Jan 7 1986	0.31	604
Sep 21 1982	0.33	628
Jul 9 1984	0.34	646
Jun 3 1985	0.36	547
Aug 1 1986	0.36	625
Oct 7 1982	0.34	652
Nov 4 1981	0.38	664
Jul 31 1984	0.41	584
Feb 11 1984	0.42	630
Dec 9 1981	0.44	652
Nov 6 1984	0.47	664
Oct 3 1984	0.51	646
Sep 11,1980	0.56	684
Aug 18 1980	0.56	631
Dec 10 1984	0.59	602
Dec 11 1980	0.62	616
Jun 4 1984	0.64	640
Jan 27,1982	0.66	648
Nov 28 1980	0.68	630
Aug 18,1982	0.71	632
Feb 17,1982	0.74	618
May 6 1986	0.78	568
Nov 17 1982	0.82	634
May 8 1984	0.88	645
Jul 22 1984	0.9	597
Feb 4 1985	1.1	611
Jul 1 1982	1.1	612
Jun 3 1981	1.1	603
Feb 18 1981	1.2	604
Mar 5 1985	1.3	562
Jul 17 1980	1.3	593
Jun 3 1984	1.4	582
Sep 22 1983	1.4	552
Jun 15 1982	1.6	582
Nov 8 1983	2.1	566
Oct 6 1983	2.2	567
May 6,1986	2.4	573
Apr 11 1984	2.4	537
Mar 6 1984	2.8	531
Jun 5 1980	3	530
Dec 14 1982	3.4	667
Jan 8 1986	4.1	477
Jul 13 1983	4.3	538
May 20 1982	5.2	543
Jan 9 1983	5.3	519
Apr 1 1985	5.4	534
Feb 6 1984	5.2	595
Apr 15 1981	7	571
Dec 4 1983	8.5	564
Jun 10 1983	13	509
Apr 9 1986	19	493
Mar 25 1982	26	433
Apr 11 1983	66	478
May 4 1983	81	434
Mar 24 1981	124	411
Apr 14,1982	182	318
Jan 31,1983	199	313
Mar 11 1986	204	249
Mar 3 1983	1000	264

SISQUOC RIVER NEAR SISQUOC

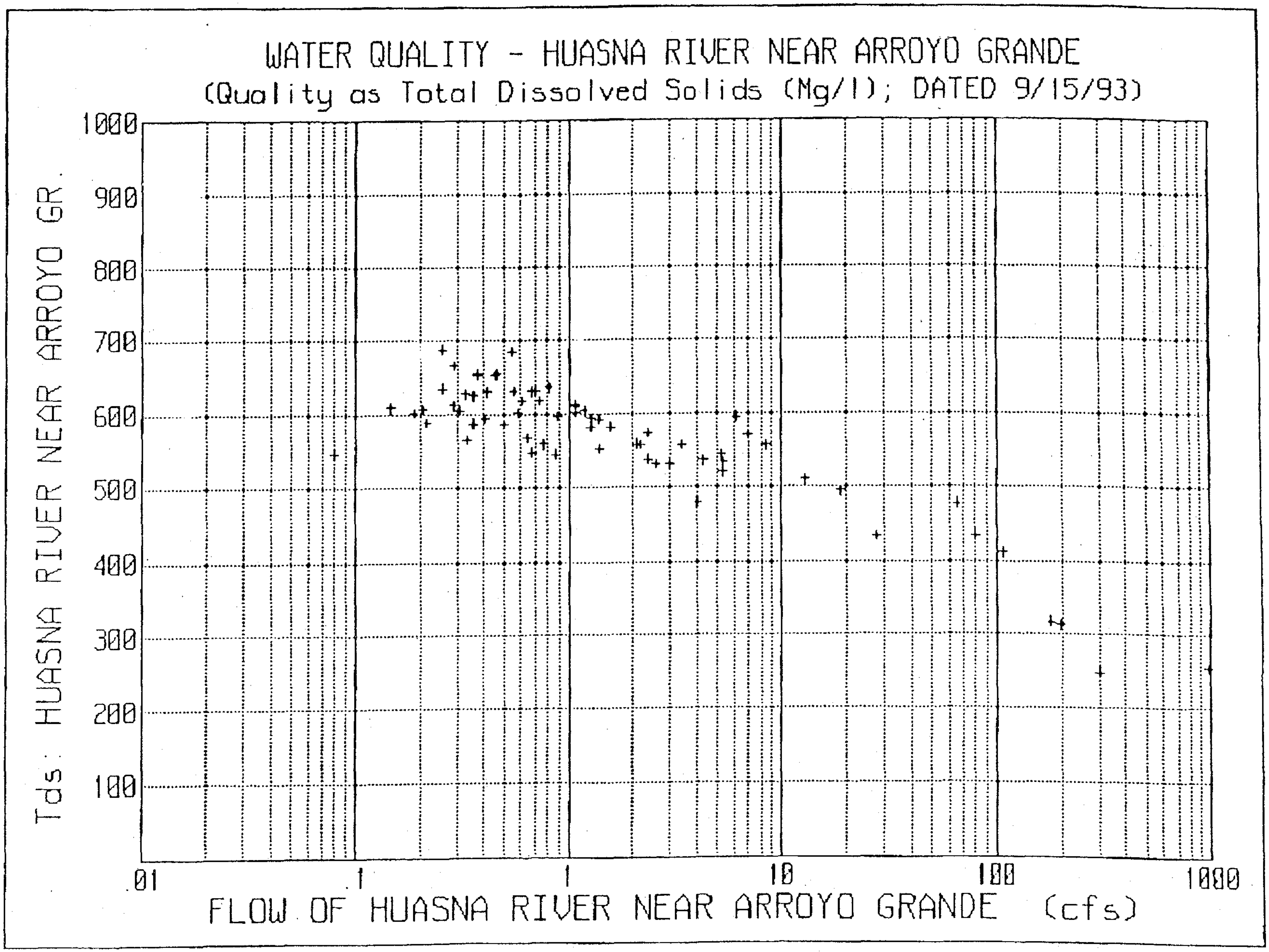
DATE	DISCHARGE	TDS
Oct 6 1989	0.11	878
Sep 13 1989	0.13	838
Nov 7 1989	0.18	834
Sep 6 1990	0.18	814
Nov 30,1989	0.19	846
Aug 18 1989	0.21	854
May 10,1990	0.24	848
Jul 31 1990	0.24	840
Jul 18 1989	0.3	833
Jan 8 1990	0.34	860
Jan 15 1991	0.37	824
Apr 11 1990	0.47	812
Sep 6 1991	0.47	846
Feb 6 1991	0.65	834
Jun 5,1990	0.66	872
Oct 6 1967	0.67	642
Aug 18,1988	0.68	606
Sep 7,1984	0.7	882
Jul 13 1990	0.74	962
Aug 31 1981	0.75	784
Aug 18 1991	0.78	830
Nov 7 1984	0.78	904
Aug 9,1984	0.78	852
Oct 17 1985	0.81	878
Sep 9 1987	0.82	810
Oct 5 1981	0.82	796
Aug 18 1986	0.91	873
Sep 17 1985	0.91	841
Dec 29 1980	0.93	765
Dec 1,1980	0.93	684
Oct 1,1980	0.93	749
Aug 11 1987	0.99	851
Oct 11 1988	1	819
Nov 1,1988	1.1	831
Oct 4,1979	1.1	826
Jul 24,1984	1.1	848
Aug 3 1981	1.1	768
Oct 4 1982	1.2	756
Nov 19 1968	1.2	864
Sep 7 1988	1.2	837
Nov 30 1981	1.2	817
Nov 28,1988	1.3	824
Jul 16,1985	1.3	873
Feb 15,1990	1.3	913
Jul 7,1988	1.3	817
Nov 5,1987	1.3	839
Jul 8 1987	1.4	821
Oct 29,1986	1.4	793
Dec 11,1984	1.4	847
Sep 23 1986	1.4	807
Jan 4 1982	1.4	820
Dec 8 1987	1.4	881
Dec 3,1979	1.5	822
Jun 19 1985	1.5	852
Sep 7 1979	1.6	813
Jul 12,1991	1.6	784
Jun 13 1989	1.6	818
Dec 19 1985	1.7	848
Dec 4,1986	1.7	705
Jan 15 1986	1.7	864
Aug 15,1986	1.8	769
Mar 13 1990	1.8	876
Jun 30 1981	1.8	773
Aug 31,1982	1.8	760
Jul 17 1986	1.9	772
Jun 10,1987	1.9	730
Feb 10 1987	2	821
Jan 4 1988	2	833
Aug 5,1982	2.1	778
Jan 6,1987	2.2	794
Feb 4,1988	2.3	817
Jan 8 1988	2.3	865
May 12,1987	2.4	811
Nov 6,1979	2.4	810
Jun 6 1984	2.6	820
Oct 30 1978	2.7	860
May 11 1989	2.8	820
Oct 11 1978	3.2	868
May 31,1988	3.6	815
Feb 1 1982	3.7	784
Jun 18 1986	3.8	754
Jun 30,1982	3.9	740
Jan 30 1980	4	781
Apr 13 1989	4.2	827
Jun 17 1991	5.1	816
May 15 1985	5.5	840
May 9 1984	6.6	811
Apr 8 1987	7	787
Jun 1 1981	7.2	755
Apr 4 1986	8.3	808
Nov 29 1978	8.6	853
Mar 1 1982	10	790
Jun 28 1979	10	784
Apr 12 1984	11	784
Apr 17,1986	13	829
Sep 8 1983	13	795
Dec 27,1978	15	864
Feb 1 1986	15	827
Jun 2 1982	16	701
Jun 6 1979	17	745
Aug 2 1983	18	760
May 16 1984	18	732
May 3 1986	18	764
Apr 30,1981	19	738
Mar 1 1989	19	778
Feb 29,1984	20	801
Mar 18 1985	25	806
Mar 9 1987	29	694
Jan 30,1979	30	827
Feb 2 1981	30	777
May 7 1991	30	818
Jun 4 1980	30	692
Feb 1,1984	31	768
Feb 12,1986	38	768
Dec 7 1982	40	684
Oct 3,1983	41	764
Jul 6,1983	42	718
Mar 7 1988	43	729
Jan 6,1983	46	679
May 3,1982	44	983
Nov 30 1983	44	730
May 1,1980	63	761
Apr 1 1981	63	674
May 3 1979	65	714
Jan 3,1984	72	748
Jun 9 1983	94	731
Feb 27 1979	140	725
Mar 4 1981	148	644
Mar 26 1980	162	719
Feb 22 1983	197	640
May 13 1983	201	699
Apr 5 1982	207	588
Apr 4 1979	219	640
Apr 11,1983	298	777
Mar 16 1980	301	668

WATER QUALITY - SISQUOC RIVER NEAR SISQUOC
(Quality as Total Dissolved Solids (Mg/l); DATED 9/15/93)



Source: Santa Barbara County Water Agency

Figure VII-3A



Source: Santa Barbara County Water Agency

Figure VII-3B

Ground Water Quality

Accurate water quality information in the valley is difficult to obtain due to the lack of adequate sampling wells. Most samples are recovered from wells which are cased through multiple aquifers, both shallow and deep, which allows for the mixing of water of varying quality. In general, available data suggests that most of the water quality degradation has occurred in the shallow aquifers which are most affected by agricultural and domestic return flows.

Ground water quality tends to decrease from east to west (the regional flow direction) with the accumulation of poor quality water in the confined region.[20] Similarly, ground water quality tends to improve toward recharge zones of the Santa Maria River in response to percolation of higher quality water released from Twitchell Reservoir. Additionally, the Santa Maria River recharge mound inhibits movement of ground water from the Nipomo Mesa to the portion of the valley south of the river.[20]

Water Quality Trends

Long term changes in water quality throughout the valley may be examined by comparing data compiled in 1931 (Lippincott) and 1975 (Hughes). Figures VII-4 and VII-5 are water quality maps of the valley showing lines of equal TDS. Comparison of the maps indicates a general worsening of water quality, particularly in areas immediately east and west of Guadalupe. For example, TDS concentrations east of Guadalupe increased from about 950 ppm in 1930 to over 3,000 ppm in 1975.

TDS concentrations appear to have increased little since 1975. Table VII-3 shows TDS and nitrogen concentrations for 13 wells throughout the valley for available years through 1992. Seven of these wells are located on or near the coast. The remaining six are dispersed


RANCHO NIPOMO
RANCHO GUADALUPE
PACIFIC OCEAN
SAN LUIS OBISPO COUNTY
SANTA BARBARA COUNTY
SANTA MARIA RIVER
GUADALUPE
BETTERAVIA
Corralitos Canyon
RANCHO GUADALUPE
200
300
400
500
600
700
800
900
1000
1100
1200

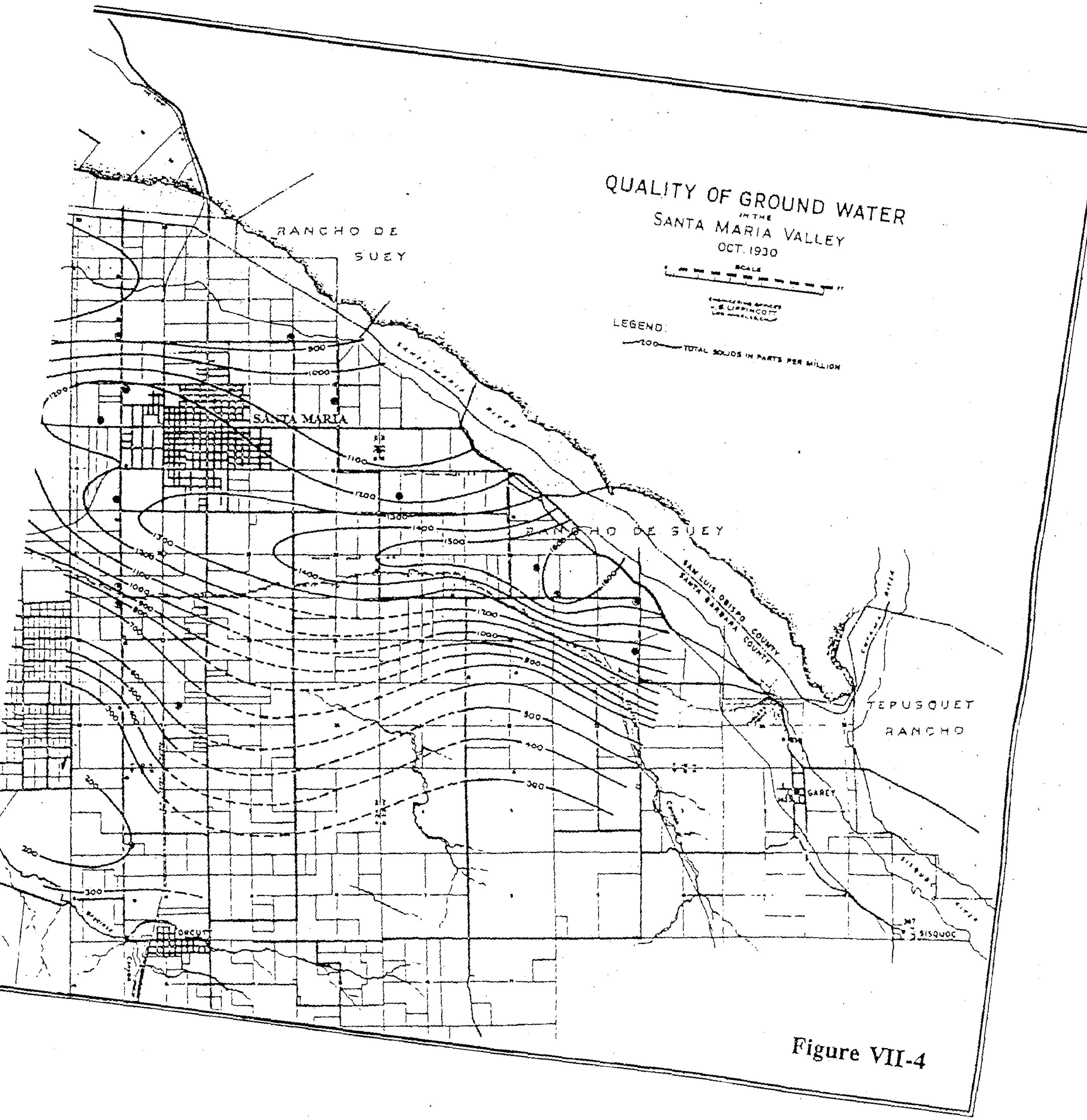
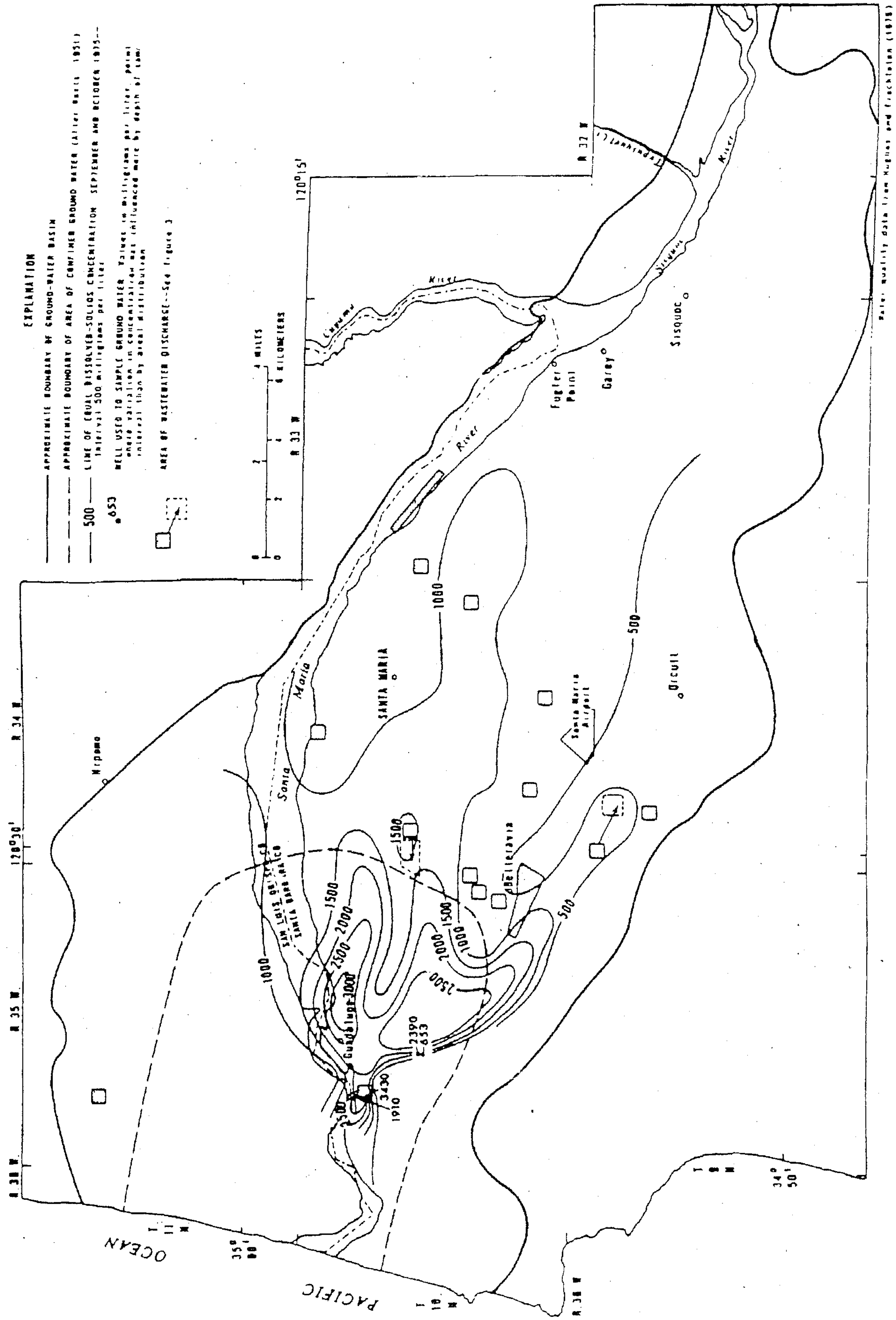

QUALITY OF GROUND WATER
IN THE
SANTA MARIA VALLEY
OCT. 1930
SCALE
LEGEND:
200 TOTAL SOLIDS IN PARTS PER MILLION
RANCHO DE SUEY
RANCHO DE SUEY
SANTA MARIA
SANTA MARIA RIVER
SAN LUIS OBISPO COUNTY
SANTA BARBARA COUNTY
TEPUSQUET RANCHO
GAREY
SISQUOC
ORCUTT

Figure VII-4

GROUND WATER QUALITY (1975)



Source: U.S. Geological Survey Report 76-128

Figure VII-5

TDS CONCENTRATIONS

WEll #	1954	1955	1958	1959	1960	1961	1962	1963	1
9N032W08N01S									
10N033W20F01S									
10N034W26H02S	834		857	840	820	996			1
10N034W29N01S					820		702	848	1
10N035W14D03S									
10N035W14D01S									
10N036W02Q01S									
10N036W02Q03S									
10N036W02Q04S									
10N036W35J02S									
11N036W35J03S									
11N036W35J04S									
11N036W35J05S									

NITRATE CONCENTRATIONS

WELL #	1954	1955	1958	1959	1960	1961	1962	1963	1[illegible]
9N032W08N01S									
10N033W20F01S									
10N034W26H02S	7.9		16	10		20	16		
10N034W29N01S					4		3.2	3.6	
10N035W14D03S									
10N035W14D01S									
10N036W02Q01S									
10N036W02Q03S									
10N036W02Q04S									
10N036W35J02S									
11N036W35J03S									
11N036W35J04S									
11N036W35J05S									

TABLE VII-3

WATER QUALITY OF WELLS LOCATED IN THE SANTA MARIA VALLEY

969	1971	1974	1975	1976	1977	1978	1985	1986	1987	1988	1989	1990	1991	1992
							730	730	699	723	689			
		-					860	910	745	945	1050			
							1200	1200	1390	1370	1340	1260		1020
620							650	630	675	698	719	704		631
							1500	1800	1400	1330	1340	1420		
		1430		1320				1800						2
								780	785	795	772	788	814	798
								700	680	703	689	743	725	730
								670	639	670	669	675	709	690
								760	788	772	742	743	788	746
								1200	1150	1040	1180	1070	1210	1060
								1400	1390	1450	1450	1440	1530	1480
								1100	1070	1170	1130	1210	1260	1190

969	1971	1974	1975	1976	1977	1978	1985	1986	1987	1988	1989	1990	1991	1992
							0.26	0.62	0.4	0.76	1.9	1.9		
							2.8	2.8	1	4.3	9.7			
							14	14	3.2	23	17	21		15
5.5							3.5	3.6	4.1	5.1	5.5	8.4		0.54
							12	21	12	12	10	13		
		52		12				21						
								0.46	0.46	0.47	0.44	0.4	0.48	0.49
								0.47	0.44	0.45	0.46	0.5	0.44	0.46
								0.53	0.54	0.55	0.53	0.5	0.53	0.55
								0.49	0.49	0.63	0.47	0.5	0.47	0.48
								3.2	3.1	3.3	4.2	3.9	4.7	4.6
								2.5	2.5	3.2	3.3	3.4	3.8	3.9
								1	1.1	1.5	1.4	1.8	1.7	1.8

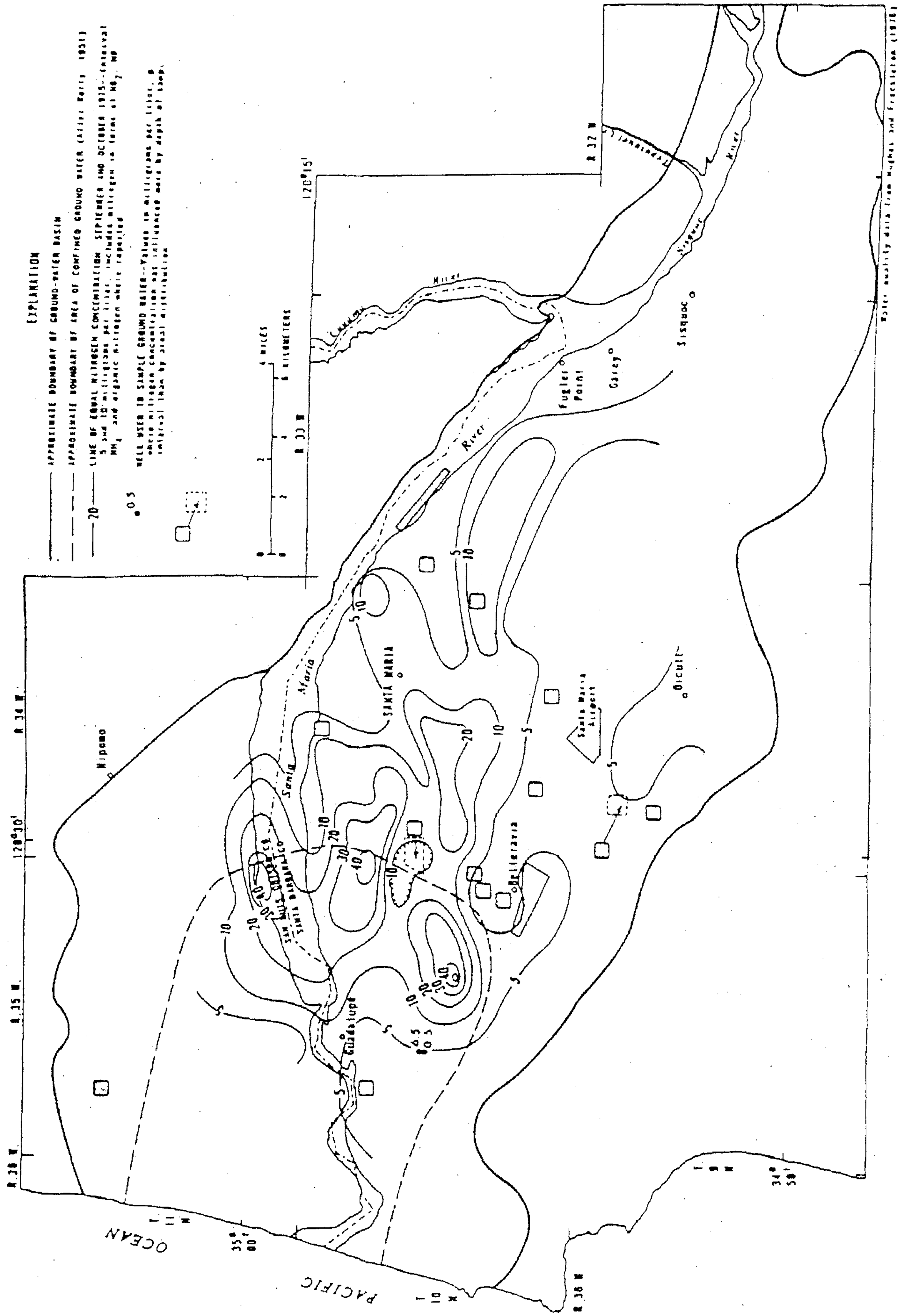
throughout the valley. The location of these wells are plotted on Figure VII-1. Although the data is too sparse to draw concrete conclusions regarding water quality trends, it suggests that there has been no significant regional change in TDS concentrations in nearly a decade.

Data regarding nitrogen concentrations within the valley is unavailable in the 1931 Lippincott study. However, Figure VII-6 is a water quality map showing nitrogen concentrations throughout the valley in 1975. As with TDS, increased nitrogen concentration occurs westward and in the area of confined ground water. The DOHS maximum contaminant level for drinking water for nitrate as nitrogen is ten ppm.[21]

Comparison of Table VII-3 with Figure VII-6 shows a significant increase in nitrogen concentrations in well 10N-34W-26H2, located north east of the Santa Maria Airport and a slight decrease in 10N-35W-14D3, southeast of Guadalupe since 1975. For the most part, samples from the thirteen wells indicate no significant increase or decrease in nitrogen concentrations since the 1975 USGS study.

Currently, wells located along the coast, near the mouth of the Santa Maria River do not indicate the presence of sea water intrusion (Table VII-4). However, the Santa Maria aquifer extends offshore and it is possible that encroachment is occurring further to the west below the Pacific ocean. Both the prevailing ground water gradient (east to west) and the indications of underflow out, support the conclusion that encroachment is not taking place.

NITROGEN CONCENTRATION (1975)



Source: U.S. Geological Survey Report 76-128

Figure VII-6

TABLE VII-4
SEA WATER CONSTITUENTS IN COASTAL WELLS - 1992

WELL #	CHLORIDE (PPM)	SODIUM (PPM)	BORON (PPB)
10N/36W-2Q1	31	54	140
10N/36W-2Q3	25	50	180
10N/36W-2Q4	48	48	120
10N/36W-35J2	31	57	140
11N/36W-35J3	59	83	210
11N/36W-35J4	77	93	204
11N/36W-J5	58	74	200
STATE STANDARDS[a]	250	None Established	None Established
STATE WATER AVGS.[b]	73	55	NA

a) State standard for drinking water (DOHS)

b) Expected concentrations of State Water From Source #21

SECTION VIII - EXISTING AND POTENTIAL MANAGEMENT PROGRAMS

There are several potential water projects and management strategies to increase the amount of water available to Santa Maria Valley users. These fall into general categories of conjunctive use, efficiency and conservation, and new water sources. The following section discusses many alternatives, not all of which appear to be feasible.

Twitchell Reservoir Operational Modifications

Currently, Twitchell Reservoir is operated as a flood control and water conservation reservoir. The conservation pool is approximately 136,000 AF and is regulated by the USBR. The flood control pool is nearly 89,000 AF and is regulated by the United States Army Corps of Engineers (Army Corps). The total storage capacity of the reservoir is about 224,000 AF (see Figure VI-4). An additional 157,000 AF of potential storage exists above the spillway by surcharging. The average yield of the project (without cloud seeding or operational modifications) is about 20,000 AFY.

Water stored in the conservation pool is released to the Santa Maria River where it percolates into the ground to recharge the aquifer. Under normal circumstances, Army Corps and USBR regulations do not allow surcharging of the flood control pool for water conservation purposes prior to March 15.[17] However, operations could be modified to allow surcharge of the flood control pool based on the likelihood of the occurrence of flooding. Operated in this manner, the yield of the project could increase significantly. (Studies have indicated that the long term yield of the project could be increased by as much as 2,000 AFY.)[17]

Implementation

Implementation of a surcharge program would require establishment of a modified "rule curve" based on historic precipitation and runoff data. The curve would allow for greater encroachment into the flood control pool during the later months of the rainy season. The later in the season, the less chance there is of having sufficient rainfall to cause flooding that would exceed the available storage.

Operations under such a rule curve would require careful monitoring of watershed and flow conditions as well as flood forecasting. Therefore, some additional stream flow and precipitation gages may be required within the Twitchell Watershed. Current flood forecast technology is sufficient to predict potential flood conditions in advance of their occurrence. This would allow for release of stored water prior to flooding, if necessary. The reservoir is capable of releasing approximately 25,000 AF of water per day.[18] Thus, in the absence of reservoir inflow, the entire flood control pool of the reservoir could be dewatered in about three and a half days.

There is a precedent for surcharging the flood control pool of Twitchell Reservoir. In April of 1978, the Army Corps approved surcharging the flood control pool of the reservoir up to 25,000 AF for the remainder of the 1977 - 1978 water year. This allowance was made with the condition that the Army Corps, Santa Maria Valley Water Conservation District, and Santa Barbara County Flood Control District coordinate in determining the appropriate amount of surcharge based on weather forecasting and any flood control releases required.[18]

In addition, the Army Corps specified requirements for establishing an ongoing policy of surcharging:

Subsequent to this year [1978], a study will be initiated, as funding becomes available, to develop and formalize a flood control operation plan incorporating judicious encroachment of flood control storage for water conservation. This study would address flood potential as a function of month of the year, basin antecedent rainfall, and watershed runoff characteristics. Also covered by the study, would be an appropriate precipitation forecasting procedure, hydrologic instrumentation (telemetry of rain gage, stream gage, and reservoir water surface indicator data), analysis of the "real-time" hydrologic data gathered, decision making procedures, and coordination among agencies involved.

Finally, the flood control operation plan selected will be documented in a water control manual prepared by the Corps. In addition, a water control agreement will be consummated among the Corps, and project owner, and designated operating agency as per Part 208 - Flood Control Regulations...18

Apparently, no such study was initiated. However, this interaction between the Army Corps and the county may serve as the basis for developing an ongoing surcharge policy.

Operational modifications of Twitchell Reservoir could substantially increase the amount of water available for recharge of the Santa Maria Ground Water Basin. Because most of the required facilities already exist, this project could be implemented at relatively little expense when compared to the development of new water sources. However, the feasibility of the project depends upon the perceived degree of safety and the support of the necessary agencies.

Desalination

Major considerations involved in constructing and operating a desalination facility include cost, site selection, process design, waste disposal, and water distribution. In addition, the construction of a desalination plant would require compliance with the California Environmental Quality Act (CEQA) as well as acquisition of permits from several federal, state, and local agencies.

Source Water Options

There are three potential sources of water for a Santa Maria Valley desalination facility: ground water, agricultural runoff (tail water), and ocean water. Poor quality ground water could be extracted from the upper alluvium near the west end of the valley for treatment. However, the removal of water from the aquifer does not comprise a new source of water and would result in lowering of the water table possibly exacerbating problems of sea water intrusion and water quality.

Agricultural tail water is another potential source. However, it is unlikely that the supply of tail water would be consistent enough to make the project feasible (see Section VIII, Waste Water Reclamation). Past studies indicate that in times of drought, when desalination may be most needed, tail water decreases, probably due to increased drying and absorption capacity of the soil.[4]

Furthermore, the source water would likely be diverted from a point near the Santa Maria River, three miles west of Guadalupe, depleting the Santa Maria River of flow from that source. Possible negative effects upon the natural habitat could occur and would need to be assessed. Finally, tail water may contain traces of pesticides, fertilizers or other chemicals which may not be effectively removed by the desalination process and which may render the water unusable for domestic or other purposes.

Presumably, the most viable source water is the Pacific Ocean. The supply is endless and the quality consistent. However, the considerable distance that the treated water must be transported to areas where it may be used would increase the cost of the project. It is likely that the principal areas of use would be the City of Santa Maria and Orcutt, over ten miles east of the coast.

Process Options

The selection of a desalination process is site specific, depending on various factors such as the source and quality of the feed water, availability and cost of energy, and required capacity. Some of the desalination processes available are listed in Table VIII-1.

TABLE VIII-1
CONVERSION PROCESSES

DISTILLATION	MEMBRANE	CRYSTALLIZATION	CHEMICAL
Vertical Tube Multi-Effect	Electrodialysis	Vacuum Freezing- Vapor Compression	Ion Exchange
Multi-Stage Flash	Transport Depletion	Secondary Refrigerant Freezing	
Multi-Effect	Reverse Osmosis	Hydrate Formation	
Horiz. Tube Multi-Effect			
Vapor Compression			
Solar			

In 1991, there were nine coastal desalination plants in California and twelve more proposed.[40] Virtually all of these use or propose to use either reverse osmosis or distillation technology. The most common methods of distillation are multistage flash, multi-effect distillation, and vapor compression. These methods are described briefly below.

Reverse Osmosis: By this method, pressure is applied to seawater to force it through semipermeable membranes which trap the salt. Pretreatment is required to remove particles that would clog the membranes. The process is relatively inexpensive when compared to other desalination technologies. In addition, it operates at ambient temperatures in contrast to distillation processes which require heat. The quality of the product water depends upon the pressure applied, the quality of the source water, and the type of membrane used. Seventy five percent of the existing California desalination plants, including the City of Santa Barbara plant use reverse osmosis.[40]

Distillation Processes: Distillation separates salts by the heating and evaporation of seawater. In general, distillation yields product water of higher quality than other technologies.[41]

Multi-stage flash distillation: Multi-stage flash distillation has been used commercially for over 20 years. Seawater that is purified by this process is heated and discharged to a chamber with lower pressure, causing part of the water to "flash" into steam. The steam is passed through a mist eliminator to strip it of suspended brine and condensed on the surface of heated tubing. The remaining brine enters a second chamber in which it flashes to steam at a lower temperature. This process may be continued through several chambers or "stages".

Multi-Effect Distillation: Multi-Effect Distillation is the oldest evaporation process for large scale operations.[41] The process uses several evaporators in series, and the vapor from one is used to evaporate source water in the next. Several configurations may be used including vertical or horizontal tube plants.

Vapor Compression Distillation : The vapor compression process involves evaporation of the source water and subsequent compression of the vapor. The compression of the vapor causes it to condense, resulting in the release of heat. This heat is used to evaporate more source water. Vapor Compression Distillation is one of the least expensive technologies for desalination.[41]

Comparable Projects

The desalination plant constructed by the City of Santa Barbara was designed to fulfill similar needs to those of the Santa Maria Valley area. Therefore, the Santa Barbara plant may provide a reasonable project for comparison purposes. It is likely that water taken from the ocean near Santa Maria Valley would be of similar quality to that processed by the Santa Barbara's plant. Therefore, similar treatment technology could be applicable. The Santa Barbara plant, completed in 1991, has a maximum production capacity of 7,500 AF per year. It is a "single pass" reverse osmosis type, the production of which meets state drinking water "recommended" standards. Although the City of Santa Barbara distribution system results in blending of some of the product water, such blending is not necessary to comply with health regulations.

The total cost of the desalination plant was $34 million. Cost per acre foot, including capital costs, is approximately $1,900 (based on a five year payment schedule).[36] When the plant is non-operational, the cost per acre foot of capacity is $1300. Therefore, the marginal cost of the water (includes chemicals and energy for water production) is about $600 per acre foot. Energy consumption is about 6,600 kilowatt hours (kwh) per AF produced. Waste from the plant consists primarily of reject brine and a small amount of solid waste. The brine is discharged to the ocean through the city's sewage out fall and mixed with the sewage effluent. The solid waste is disposed of as non-hazardous land fill.

A Santa Maria Valley desalination project would differ from the City of Santa Barbara's project in several ways. Santa Barbara's plant is located very close to its source water and utilizes pre-existing intake and discharge structures. Santa Maria would likely have to locate the facility one to two miles inland to avoid placing facilities in sensitive beach and dune areas. In this case, approximately two to four miles of pipeline would be needed for the intake of ocean water and discharge waste brine. Eight to ten miles of additional pipeline would need to be constructed in order to deliver product water from the plant to areas where it may be used.

Permits and Approvals

Construction of a desalination plant would require permitting from the Regional Water Quality Board, Central Coast Region which has the authority to monitor and protect the ocean waters receiving the discharged brine from a desalination plant. In addition, a permit would be required from the Coastal Commission and State Lands Commission and an Environmental Impact Report (EIR) would need to be completed which addresses, among other things, possible impacts upon marine organisms. The Army Corps of Engineers is responsible for approval of structures to be placed in the ocean.

Drawing water from the Pacific Ocean poses a unique environmental problem in the area of the Guadalupe Dunes. The dunes support a number of threatened or endangered plant and animal species. Therefore, significant mitigation measures may be required by regulatory agencies for placement of intake and discharge pipelines.

There are numerous federal, state, and local regulations which may be applicable to a Santa Maria desalination project. These include the following:

Federal Regulations:

- Endangered Species Act of 1973. Protects species listed under the act and their critical habitat.
- Marine Mammal Protection Act. Prohibits accidental and intentional harassment, disturbance, capture, and death of any marine mammals.
- Migratory Bird Treaty Act of 1972. Protects birds, including all seabirds.

State Regulations:

- The California Endangered Species Act of 1970. Protects species designated as threatened or endangered and requires consultation between the lead CEQA agency and the California Department of Fish and Game (Fish and Game) for projects that may affect state-listed species.
- CEQA protects animal or plant species which meet criteria for "rare" or "endangered" as defined in Section 15380 of the Act.
- The Coastal Act of 1976. Regulates development and provides protection for biological resources in the coastal zone.

Local Regulation:

- The Santa Barbara County Comprehensive Plan (1982). Regulates land use, resource management, and conservation for Santa Barbara County.
- The Santa Barbara Local Coastal Program (1982). Provides for the preservation of dunes and other resources.

An EIR/EIS was completed for the San Miguel Project, concerning development of a Northern Santa Maria Basin offshore oil field. One of the project alternatives described in the report assesses impacts associated with pipelines crossing the beach and sand dunes, similar to those which may be constructed for a Santa Maria desalination plant.[37] The document recognizes several areas of concern associated with such pipelines including protection of marine and coastal ecological resources, effects on plant life, and impacts on dunes and marshlands.

Specific impacts associated with desalination project pipelines routed through the Guadalupe Dunes may include the following:

- Increased erosion of exposed excavation areas.
- Impacts on coastal foredune and coastal dune scrub vegetation which include several "special interest" species.
- Impacts to riparian/marsh vegetation.
- Impacts on wintering and migrating waterfowl and shorebirds.
- Removal of vegetation comprising nesting habitat for the California Least Tern.
- Impacts to subtidal reefs.
- Impacts on marine mammals and California Brown Pelican.

Costs

A reconnaissance level cost estimate for a Santa Maria Desalination facility was made in 1984 by the SBCWA. What follows is that estimate, updated to current economic conditions. This estimate assumes a plant with capacity to produce about 10,000 AFY, 13 miles of pipeline (intake, discharge and delivery) and energy costs of 85 mils/kwh. The capital cost for the plant would be roughly $58 million with an annual operations cost of about $5.3 million. Energy consumption at 7,550 kwh/AF would be about $640/AF.

Capital costs for local transportation facilities, including pipelines and a pump station would be about $17.4 million. Annual operations and maintenance would be $109,000 and energy consumption would cost $76/AF. The total unit cost, assuming 30 year revenue bonds and a capital recovery factor of .08098 would be about $1850/AF. Notice that this estimate yields a unit cost very close to that of the Santa Barbara plant, which required less pumping and transportation facilities. The reason for this is that the City's plant is on a five year capital facilities payoff schedule. If a 30 year schedule were used, the unit cost would be closer to $1300/AF.[36]

State Water Banking

The imminent importation of State Water presents unique opportunities for water banking and conjunctive use. This would allow storage of water during times of high supply and/or low demand, thus maximizing the yield and minimizing the unit cost of State Water. By this program, surplus State Water would be stored in the ground water basin by injection or spreading. There are many potential benefits to this program. Because the quality of State Water is generally better than that existing in the aquifer, injection of State Water would result in improved ground water quality.

Furthermore, within the aquifer there are areas that are dewatered creating a cone of depression near which the direction of flow is anomalous. This may create dewatered storage into which poor quality water may accumulate. Therefore, by filling the depression, injection of State Water could restore the former flow direction. On the other hand, mounding of State Water may again result in anomalous flow, away from the area of recharge. Another benefit is that banking of State Water would act as a "drought buffer" by providing an available supply of water during reduced State Water Project Deliveries. This is particularly important since the State Water Project may be forced to reduce deliveries to contractors during times of drought in the Feather River watershed.

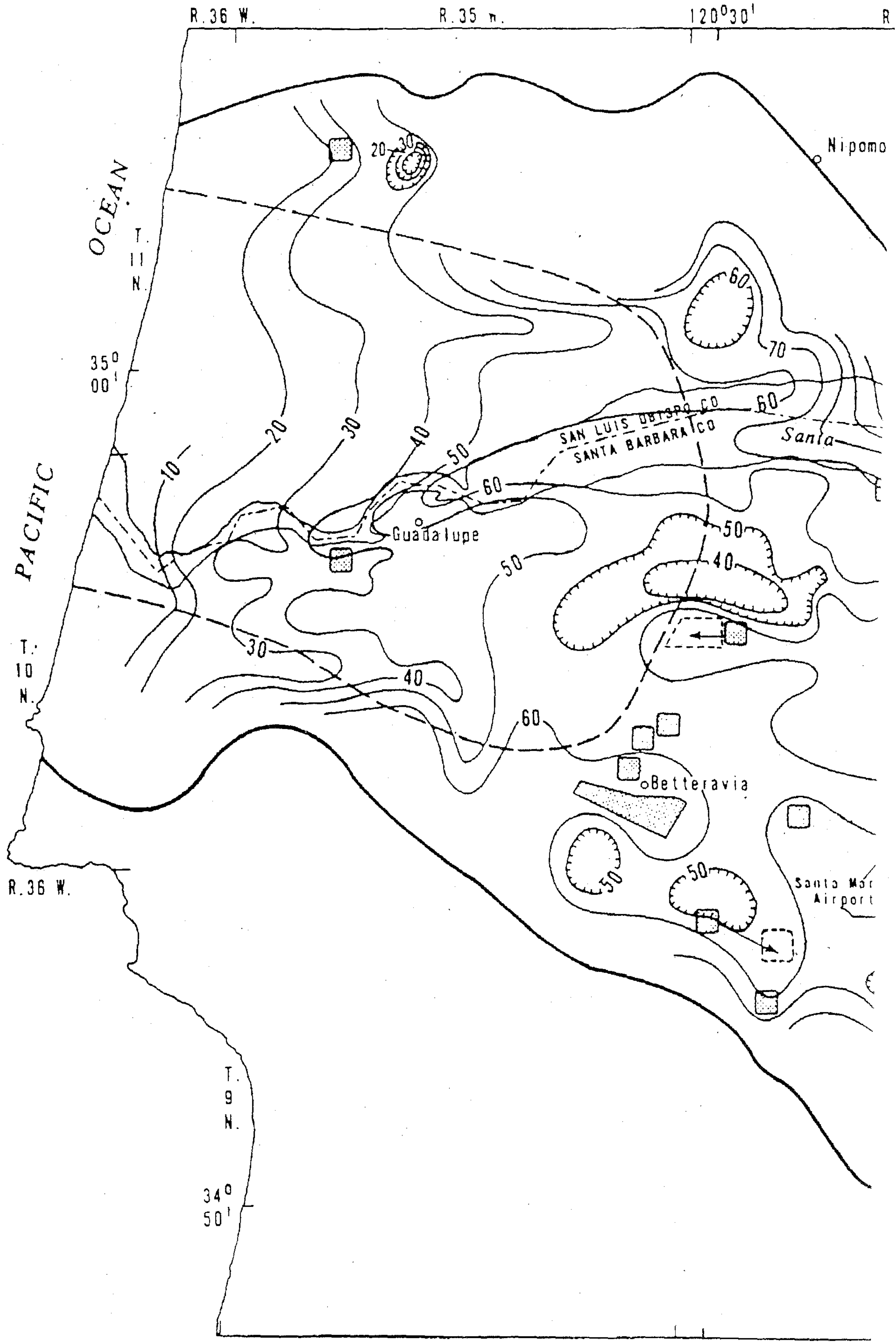
Implementation

Storage of State Water within the ground water basin may be accomplished either by injection or spreading. In either case, a significant amount of study would be required to determine if such a program would meet the needs of the Santa Maria Valley and purchasers of State Water. Preliminary studies would include both field work and data analysis (see Appendix B).

Injection

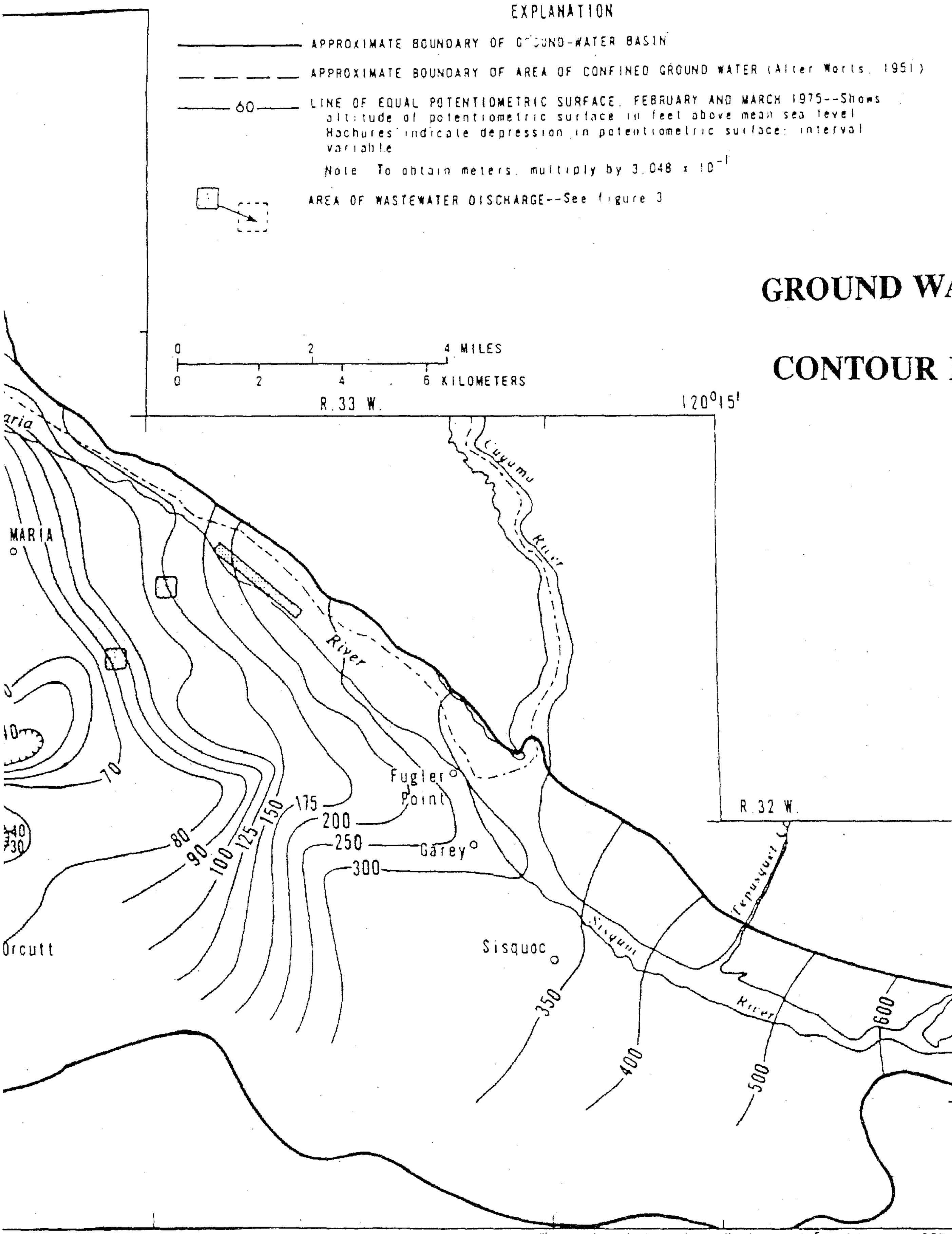
Parts of the Santa Maria Ground Water Basin have been more intensely drafted relative to the surrounding areas causing a distinct area of depression in the water table. The most notable depressions occur north of Orcutt, near the Santa Maria Airport and west of the City of Santa Maria (Figure VIII-1). Injection of water into these depressions would probably allow for maximum water storage and reduce losses due to migration.

Accurate assessment of the storage capacity of these areas would require analysis of available water level records for existing wells. (Some of these records are available through the SBCWA and USGS.) In addition, an estimate of potential mounding volume should be made. Excessive mounding will result in accelerated water losses to surrounding, and possibly inaccessible, areas.



Source: U.S. Geological Survey Report 76-128

GROUND WATER CONTOUR MAP



Water-level data from Hughes and Freckleton (1976)

Figure VIII-1

In order to assess the feasibility of recharge, the characteristics of the aquifer must be studied. This would include a detailed description of the basin geology, as this controls the storage capacity of the basin and its ability to transmit water in and out of storage. In areas where insufficient data exists, test wells may be drilled and lithologic logs recorded. In addition, recharge tests would be required to accurately determine injection rates. These may be conducted through existing wells, if available. Recharge rates throughout California have been measured at 55 gallons per minute to nearly 3,000 gallons per minute.

The appropriate number of injection wells would be determined based on the results of preliminary studies and the desired rate of injection. The wells would then be completed and the injection program initiated. Implementation of an injection program would require examination of legal, economic, and institutional issues, not the least of which are selection of a lead agency for managing the program, funding sources for the preliminary work and selection of contractors to conduct it.

Furthermore, the issue of water rights may be particularly complicated because there cannot be 100% recovery of the same water that was banked. It is likely that the project will involve private entities to the extent that the injected water would be located, or migrate, below private lands where it may be extracted for private use. In addition, depending on the required spacing, it may be necessary to place some of the injection wells on private property. For a more detailed study program outline see Appendix B, Santa Maria Valley Ground Water Injection Proposal Memorandum.

Spreading

By this method, State Water would be allowed to percolate to the aquifer through spreading grounds or percolation pits. Percolation of State Water in pits or spreading grounds would be far more effective than percolation of river water due to the low content of silt. Percolation of State Water may be conducted via several methods. State Water may be diverted to the east from the Coastal Branch conduit where it turns west along the Santa Maria River. It may then be percolated through recharge pits within the river channel as proposed by Coast Rock (see Spreading Ground Improvements) or simply released to the Santa Maria River during low flows. This type of program may benefit a larger area of the aquifer than injection. On the other hand, recovery of this water would be more difficult and some of this water would likely be lost due to migration.

Watershed Management

For the purpose of water supply, the primary benefit of watershed management would be derived by the prescribed burning of the Twitchell Reservoir and/or Sisquoc watersheds. By reducing the amount or age of vegetation, or converting existing vegetation to a less water intensive variety, runoff to Twitchell Reservoir and the Santa Maria River (and consequently percolation to the aquifer) may be increased significantly. Similarly, replacement of tree and shrub vegetation with herbaceous cover, such as grasses, results in a decrease in evapotranspiration and an increase in the water available for percolation.

There are many benefits of watershed management which are unrelated to water supply. The majority of land within the Twitchell Reservoir, Cuyama River, and Santa Maria watersheds lies within the Los Padres National Forest boundary. About 50 percent of the sediment produced in the Forest results from erosion after wild fires which claim an average of 27,000 acres of the Forest per year.[42]

Prescribed burning reduces the frequency and intensity of wild fires and helps prevent burning of excessively steep terrain, thus significantly reducing erosion. It is estimated that prescribed burning results in erosion and sedimentation rates which are half those of wild fires.[43] Consequently, the quality of surface water is improved and the life of reservoir projects within the watersheds is extended with the reduction in sediment.

In addition, watershed management may promote improved habitat and bio-diversity, protect cultural resources, and increase grazing lands. Prescribed burning of chaparral produces vegetation suitable for grazing for a period of up to ten years subsequent to burning.[42]

Potential Yield

Estimates of potential water yields vary greatly. The United States Forest Service (USFS) has published a study indicating that one additional acre foot of water is produced for every ten acres treated, assuming 30 to 70 percent of the treated area is blackened (the remaining area is left unburned) and a zero to five year treatment interval. This figure applies to Chaparral-Chamise vegetation, the type most common in the Twitchell Reservoir and Santa Maria Watersheds.[44] The same study indicates that converting chaparral to grasses may increase water yield by 1.7 acre feet per ten acres burned, approximately a 59% increase over un-treated conditions. However, the ability to convert to grasses depends largely on the local geology and characteristics of the terrain. Conversion may not be possible or desirable in rocky soils or steep terrain. The USFS estimates that only 6.5% of the Forest is suitable for converting from chaparral to grass.[42]

An estimated seven percent increase in water supply within the Forest may be possible with an intensive prescribed burning and type conversion program.[42] Current USFS policy does not permit that level of effort. The Range Improvement Association (RIA) has successfully converted approximately 10% of prescribed burn areas to grasses.[45]

Herbicide application may be a more efficient method than prescribed burning to achieve long-term vegetation conversion.[38] This is because burns are a natural part of the chaparral ecosystem and serve to stimulate the growth of some types of plants. While herbicide application may be feasible on private land, the USFS has had difficulty using herbicide on public land due to public perception and permitting obstacles. Even on private land, the use of herbicide may prove to be controversial.

Although analysis of watershed management and yield for environments similar to the Santa Maria Valley are limited, a number of general principals have been revealed. For example, it is clear that the increase in runoff is not directly proportional to the amount of tree and shrub removal because the remaining trees and shrubs are capable of increasing their water use. Therefore, clearing of a significant percentage of the existing vegetation would be necessary before there would be a substantial increase in runoff.[24] Similarly, studies indicate that to maintain the necessary level of tree and shrub removal requires relatively frequent burn intervals (20 years or less).[24] USFS studies indicate that, for many local watersheds, runoff and percolation may return to pre-burn levels after only five years.[38] Currently, USFS policy is to treat lands using a treatment interval of about 30 years.[42] On average, the RIA uses a treatment interval of between five and ten years.[45]

Treatable Area

There are several factors governing the amount of land which may be included in a watershed management program to benefit the Santa Maria Ground Water Basin. These include the following:

1) **Land located within private and USFS jurisdiction:** Projects conducted in privately owned land are generally subject to less rigorous regulatory and monitoring requirements than those on USFS land. Currently, all actions which effect USFS land must comply with the Land and Resource Management Plan.

2) **Land located within National Forest which is designated Wilderness:** There are stricter controls on prescribed burning in Wilderness areas.

3) **Land located in remote areas, the treatment of which would not benefit the Santa Maria Valley:** For example, the eastern portion of the Cuyama River Watershed is composed of highly permeable sediments and receives little rainfall. Therefore, this region rarely contributes to percolation into the Santa Maria Ground Water Basin.

4) **Land which is barren in its natural state:** There would be no benefit in prescribed burning oı desert areas located in the north and central Cuyama watershed since they have little vegetation and contribute little to evapotranspiration.

5) **Land which is currently used for agriculture or other purposes which makes it untreatable.**

6) **Land which is rugged or steep:** Treatment of these areas would contribute to excessive erosion and sedimentation.

7) Regulatory considerations (see Feasibility below).

There are 2,739 square miles of land within the Los Padres National Forest. The part of the Forest within the Cuyama River Watershed and Sisquoc Watershed (above Garey Bridge) is 1,130 and 471 square miles, respectively. About 1,010 square miles of these watersheds are under USFS jurisdiction, roughly 428 square miles of which are designated wilderness areas. Private land comprises about 570 square miles of the watersheds.

Currently, the USFS treats nearly 8,000 acres per year throughout the Los Padres National Forest. Up to 60% of treated land is blackened. Under current policy, the USFS program could be expanded to include treatment of as much as 25,000 acres per year.[43] The RIA blackens about 8,000 acres per year.[45] If it is assumed that half of the USFS expanded program and all of the RIA program could be conducted in these watersheds, a total of about 16,000 acres (less than 2% of the watersheds) may be burned to benefit the Santa Maria Ground Water Basin. Prescribed burning of appreciably more than this would likely require modification of USFS and regulatory agency goals and policies.

Feasibility

The primary physical problems which may be encountered in the implementation of a watershed management program include increased erosion and siltation and temporary increases in air pollution. In addition, there are several regulatory constraints associated with implementation of a watershed management program.

The impacts of increased siltation may be remediated in several ways. Assuming a burn cycle of twenty years, only a twentieth of the watershed may be burned at a time. The USFS conducts prescribed burns in patches so as to vary the age and density of chaparral. Where feasible, immediate reseeding of burn areas with grasses has been shown to reduce excessive erosion. USFS policy does not permit seeding in Wilderness areas. Siltation is less of a concern on the Sisquoc River Watershed which is unobstructed by reservoirs. However, the impact of siltation on wildlife in a fluvial environment would also need to be considered.

Conducting prescribed burn programs in winter minimizes the dangers associated with uncontrolled burns and reduces the impact of air pollution. However, erosional forces are maximized in winter when rainfall is highest and grass seeds may have not yet taken root. Coupled with reseeding is the issue of competition for habitat; reseeding may result in permanent replacement of the existing vegetation. In areas where reseeding may be impractical or ineffective (such as steep terrain), it may be necessary to construct debris basins at substantial cost.

Air pollution is a concern that governs the times of year that controlled burns can be conducted. USFS lands are subject to air quality regulations which greatly restrict the number of days prescribed burning can be conducted. In addition, much of the Sisquoc River Watershed is Class I area which is subject to more stringent regulations than other areas. Burns conducted on private land by private land owners may be subject to less stringent air pollution standards than those on public land. The Twitchell Reservoir and Sisquoc Watersheds extend into four separate counties, the air pollution control districts of which would need to be consulted prior to conducting a program.

An effective watershed management program would likely include both private and federal lands because both are present in the valley's critical watersheds. Involved agencies would include the USFS, Air Pollution Control District, California Department of Fish and Game (CDFG), Santa Barbara County Planning and Development, Santa Barbara County Flood Control District and the Santa Barbara County Fire Department. In addition, the U.S. Environmental Protection Agency would be involved in regulating particulate emissions from prescribed burns. If endangered species would be affected by the program, the United States Fish and Wildlife Service may also have jurisdiction. Prescribed burns conducted by public agencies would require completion of an Environmental Impact Statement.

As part of a vegetation management program conducted by the Santa Barbara County Fire Department on the Sisquoc Ranch, CDFG conducted a review of potential endangered species and the Department of Forestry and Fire Protection conducted a review of archeological resources. In addition, a smoke management, visual resource, water resource and fisheries and soils plan was designed by the County Fire Department.

Costs

Cost estimates for prescribed burns vary widely, partly due to the difference in regulatory requirements for private and public projects. Low estimates of $15 to $20 per acre have been provided by the RIA. This presumes that ranchers cooperate to supply much of the necessary equipment and labor. The USFS estimates costs to be $300 to $400 per acre, which includes organization, labor, planning, environmental compliance, and post fire monitoring, much of which is not required for projects on private land.[38] By Assembly Bill 1704, approximately $5 per acre may be subsidized for burns on private land.

Following are preliminary unit cost estimates for both public and private prescribed burning programs which assume that 10,000 acres are blackened each year of a five year program, for a total of 50,000 acres. The number of acres burned does not affect the unit cost) A five year regrowth cycle is assumed, i.e. maximum water production occurs the first year and tappers off to zero by the fifth year. (Note that increasing the burn cycle will lower the unit cost. Therefore, using a five year cycle provides a conservative estimate). A linear regression is assumed for the reduction of yield during the five year period. Finally, the estimates assume that one acre foot of water is produced for every ten acres burned, and that all water produced by the project benefits the ground water basin. While this is probably nearly true for the Cuyama Watershed due to the presence of Twitchell Reservoir, some loss would be expected from the Sisquoc Watershed.

For private land, 50,000 acres are assumed to be burned in a five year period at a cost of $20 dollars per acre. The water produced over that same period is about 15,000 acre feet. Therefore, the unit cost is about $67 per acre foot. The cost for a USFS program is assumed to be $350.00 per acre burned, for 50,000 acres burned in five years. Therefore, the unit cost for public land is about $1,165 per acre foot.

Artificial Recharge

There are various methods used to increase recharge to ground water. These include injection wells (see Section VIII, State Water Banking), spreading basins, percolation pits, and in-stream modifications. Each method requires permeable substrate and is dependent on the infiltration and percolation rates that can be maintained. Of primary importance is the quality of the source water used. Water with high concentrations of silt greatly reduces infiltration rates and necessitates frequent maintenance of any project.

Many water districts throughout California, including Los Angeles and Orange Counties, successfully utilize artificial recharge.

Orange County conjunctively uses retention reservoirs, in-stream spreading basins, water channeling and off-stream percolation basins.[39] These projects have demonstrated the importance of facility maintenance and silt removal. In some cases, storm water is delayed in reservoirs prior to releasing it for recharge. This allows sediment to settle out, reducing the frequency of maintenance required on recharge facilities.

In addition, the Los Angeles County project uses chemical flocculants to reduce the silt content of water released for recharge. Despite such measures, frequent silt removal is required for most projects. Discing of soils may be temporarily effective, but silt removal is eventually required. Fine grained clays have been found to clog soil pores tens of feet below surface. Filters such as pea gravel have been effective in some cases, especially in percolation basins. However, these are most effective in very coarse soils and the filter eventually clogs with mud which must be removed.

In rare cases, plants (usually grasses) help maintain infiltration rates. Unfortunately, most plants cannot be preserved in active stream environments. Biologic growth may also cause clogging of pores and reduce infiltration rates. Thorough drying of sediments is usually required to alleviate this problem. Another problem frequently associated with spreading grounds and percolation ponds is that they may provide breeding grounds for insects such as mosquitoes.

Spreading grounds and percolation basins have been proposed to increase percolation to the Santa Maria Aquifer. It is generally recognized that percolation rates within the Santa Maria

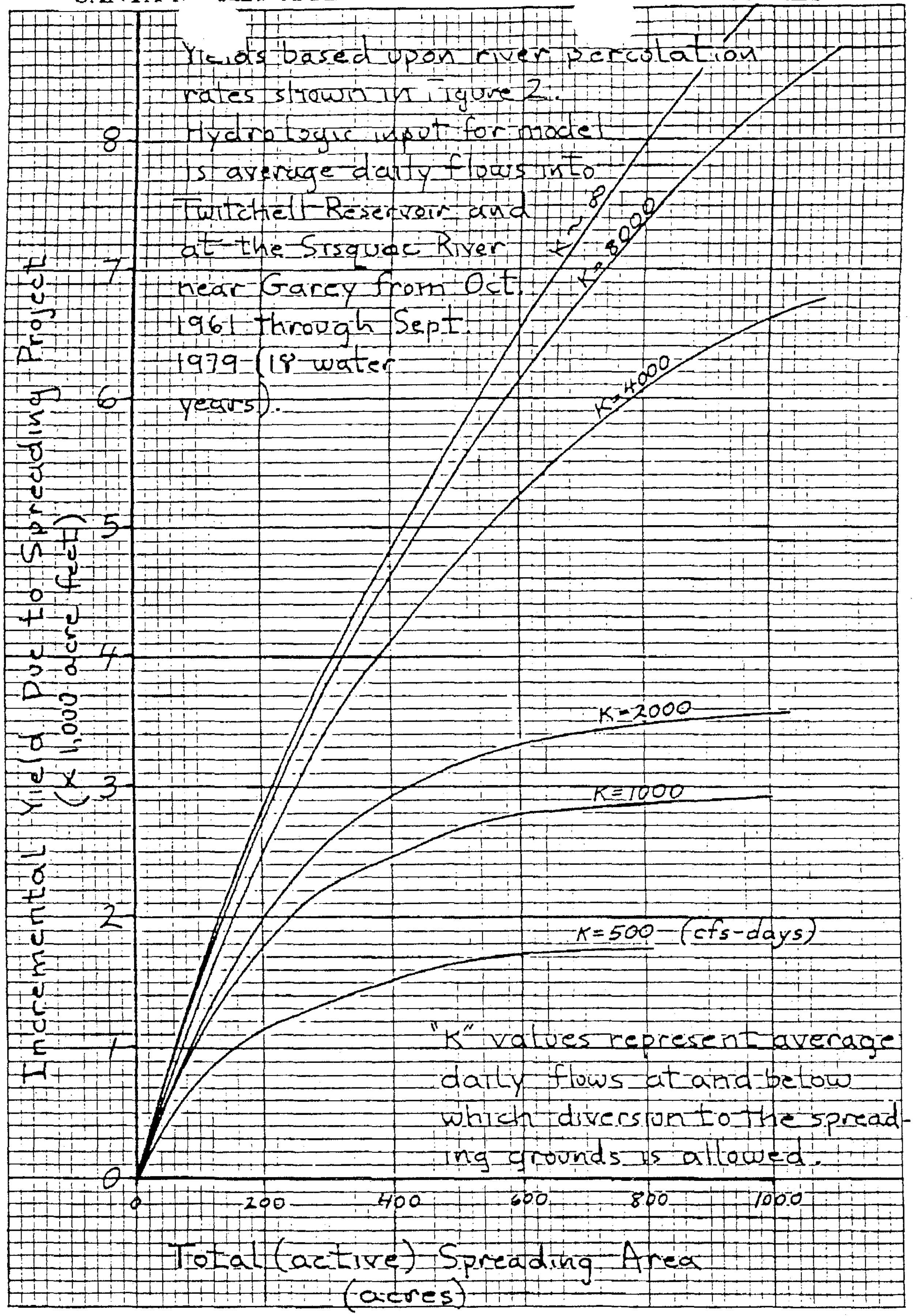
River are good and low to moderate flows within the river percolate efficiently. Therefore, increased percolation would require diversion of higher flows. As a result, in-river percolation facilities are less practical because they tend to be destroyed by high flows and would need to be rebuilt frequently. By diverting high flows on the Cuyama River, the Twitchell Reservoir project has increased percolation by an average of about 20,000 AFY (see Section V, Twitchell Reservoir).

The SBCWA has conducted a study of percolation rates based on an eighteen year model of daily river flows.[29] The study indicates that with Twitchell Reservoir in place, an average of about 17,000 AFY of water is lost to the ocean from the Santa Maria River. Some of this could be used to recharge the aquifer if sufficient spreading area and diversion capabilities were available. For example, 3,000 AFY could be percolated to the ground water basin using about 400 acres of active spreading grounds. This would require facilities which are capable of diverting water to spreading grounds when flows in the river are as high as 2,000 cfs.

Similarly, an average of 5,000 AFY could be percolated with over 550 acres of active spreading grounds and diversion facilities capable of diverting water when flows in the river are as high as 4,000 cfs.[29] The study shows that approximately 500 acres of active spreading grounds would be required to enhance percolation by 1,500 to 5,000 AFY, depending on the maximum river flows under which diversions could occur (Figure VIII-2).

It should be realized that the amount of water percolated in spreading grounds or percolation basins is higher than the actual yield of the project. Some of the water diverted for percolation would have percolated into the basin if not diverted. This is because, in the unobstructed river,

SANTA MARIA SPREADING GROUNDS - YIELD STUDIES



Source: Santa Barbara County Water Agency

Figure VIII-2

the wetted surface area increases with an increase in flows. Therefore, percolation also increases. Only in extremely high flows does the diversion approach the project yield.

In order to maintain 500 acres of active spreading grounds, nearly twice that would be required for rotation and maintenance. Diversions would require a large structure such as an inflatable dam which would allow both small and large flows to pass. In-stream diversion structures such as berms are often used. However, these get washed out in high flows and require frequent rebuilding. A project such as this would probably require taking significant amounts of agricultural land out of production or constructing in-stream facilities and therefore, may not be cost effective.

Coast Rock has submitted a proposal to Planning and Development for construction of a recharge pit with an area of 56 acres at the bottom and 100 acres at the top. Part of the 50 foot deep pit would be subject to inundation at times during the natural fluctuations of the water table. The proposed pit would be located about a mile downstream of Fugler Point on the north side of the Santa Maria River.[27] While such recharge pits can and have been used for percolation, they require regular upkeep to maintain their yield. Similarly, multiple pits may be required to produce significant yield.

Data indicates that an average of 17,000 AFY of river flow is lost to the ocean. Coast Rock estimates that, by diverting high flows to the recharge pit, from 4,500 to 10,000 AFY could be percolated to the aquifer[28] In making these calculations, they assumed a percolation rate of 66.8 AF/Ac/day, a value reported by the USGS for laboratory measurements for Santa Maria River deposits.[6]

However, estimates made by the SBCWA indicate a much lower recharge potential (approximately one twentieth of the values derived by Coast Rock; a percolation gain of 225 to 500 AFY).[29] This is because the values used for percolation rates by Coast Rock assume silt free water. As discussed above, actual recharge projects have shown silt, especially in high flows, to be a major factor limiting percolation. The SBCWA study indicates percolation rates of less than four AF/acre/day for flowing water. Even with the detention (stilling) basins proposed by Coast Rock, it appears unlikely that percolation rates would be much higher than that.

In addition, Coast Rock has indicated that the recharge basin would be within the fluctuation zone of the ground water table. When the water table encroaches into the pit, the surface area available for recharge would be restricted and percolation rates would decrease further. Coast Rock has also proposed using the recharge pit to percolate State Water. In this case, it is likely that higher percolation rates would occur due to the low silt content. However, the water would be percolated far from City production wells and the benefit of increased water quality to urban users would be lost.

In 1983, the Santa Barbara County Flood Control District completed construction of the Orcutt Regional Recharge Project which collects and percolates storm and watershed runoff. Several retention basins are located throughout Orcutt and the southern Santa Maria Valley which overlies relatively impermeable sediments. Storm water from urban areas and surrounding watersheds is collected in these basins and transported by gravity northward to larger basins where it is allowed to percolate through the permeable alluvial sediments of the northern valley to the Santa Maria Ground Water Basin.

The two main percolation basins are the Orcutt Basin and the Getty Basin. (The Getty Basin receives inflow from parts of the City of Santa Maria as well as overflow from the up-gradient Orcutt Basin). The Orcutt and Getty Basins hold about 100 and 300 acre feet of water, respectively. Accumulated silt is excavated from the Basins by contractors in need of fill material. The project effectively percolates over 90% percent of the available runoff; a yearly average of about 1,200 acre feet.

When the capacity of the Getty Basin has been exceeded, excess water spills into land northwest and flows unrestricted toward the Santa Maria River. The Flood Control District has identified locations for additional basins down-gradient from the Getty Basin to collect and percolate the systems overflow. In addition, the expansion would help percolate urban runoff from the City of Santa Maria.

New Reservoirs

A study of 14 possible reservoir sites conducted by the USBR in the 1950's indicated that the three most feasible sites were for the Vaquero, Fugler Point and Round Corral Reservoirs.[16] The Vaquero Reservoir is the current location of Twitchell Reservoir. The Fugler Point option was rendered impractical by the construction of Twitchell Reservoir (the sites are too close together to efficiently capture and release runoff). Therefore, the remaining possibility is the Round Coral Reservoir.

The dam would be located a few hundred feet downstream from Round Coral Canyon on the Sisquoc River. The watershed feeding the reservoir would be approximately 282 square miles with an average annual discharge of about 35,300 AF.[16] Studies by the USBR examined storage capacities of either 50,000 or 82,000 AF corresponding to average annual yields of 5,500 to

6,700 AF. The initial capital cost in 1985 dollars was estimated at $83 million with a unit cost of $900 per AF.[31] Today's cost, assuming State Water Project funding, would be about $100 million dollars. The unit cost would be about the same as the 1985 estimate.

Favorable consequences of the project would include the creation of wet land habitat and added flood control on the Sisquoc River. However, due to the low yield and high cost, together with the significant regulatory and environmental constraints involved in such a project, it seems unlikely that the Round Corral Reservoir is a viable option. The reservoir site is relatively pristine and may support rare or endangered plants and animals. The site is known to be within range of the endangered Peregrine Falcon and the Sisquoc River is known to provide habitat for native trout.[12] Considering the current regulatory climate, which does not favor construction of reservoir projects, and local concerns regarding trout habitat, it seems unlikely that obstruction of the County's last un-dammed major river would be feasible.

In addition, as a ground water recharge project, the reservoir would provide no recreational or fishery opportunities and the existence of the Twitchell Reservoir project would limit the potential for percolation of captured water. Therefore, the project would necessitate construction of percolation ponds or other facilities which may raise the cost of the project substantially.

Waste Water Reclamation

Since waste water/sewage effluent is not discharged directly to the ocean, the potential benefits from waste water reclamation lie mostly in waste water quality improvement and do not constitute a "new" supply of water. State standards require that effluent from waste water treatment plants must be of equal or better quality than the receiving water. Therefore, water discharged from treatment plants in the Santa Maria Valley is not permitted to be discharged to the valley's main aquifer due to high TDS concentrations (Table VII-1). Instead, it is used for for irrigation of non-ingestible plants or grazing land, or percolated to perched aquifers which are of inferior quality.

New laws restricting the use of water softeners combined with the importation of State Water will likely result in waste water effluent of higher quality in the near future. This will increase the number of allowable uses for the water. With sufficient treatment, effluent may be purchased for use by agriculture.

A possible use for water of varying quality may be creation of wetland habitat, perhaps in the vicinity of Guadalupe Lake near the location of the defunct Union Sugar plant. A two to three mile pipeline may be sufficient to carry effluent from the Laguna Sanitation Plant to the Guadalupe Lake area using gravity only. Presumably, such a plan would be feasible only if it did not take existing agricultural land out of production. Wetlands creation would likely require permitting by Fish and Game, U.S. Fish and Wildlife Service and possibly the County Flood Control District.

Agricultural tail water and runoff which empties into Green Canyon may also be a potential source of additional water. Approximately 2,500 to 4,000 AFY would be available for treatment and use. (It is likely that the cost of the treated water would make it practical for municipal or industrial uses only).[4] Sampling conducted from 1982 to 1991 show average TDS concentrations of about 1600 ppm. In addition, pesticides and fertilizer concentrations may be present in the water and would need to be eliminated by the treatment process selected. Therefore, thorough analysis of this water would be necessary to determine treatability and costs. Use of this water may prove to be detrimental to the natural habitat which has been established downstream. This concern would need to be addressed in an environmental document.

Cloud Seeding

Cloud seeding is known to produce some of the least expensive supplemental water available. In the Santa Maria Valley, a consistent cloud seeding program could increase the yield of Twitchell Reservoir by as much as 3,500 AFY.[4] The total yield, including the benefit to ground water would be higher (See Cloud Seeding, Section IV) Average unit costs for the north county under the existing program are likely to be less than $20 per acre foot.[4]

Even without the current cost sharing program which divides costs between the County and the purveyors, the unit cost for the Santa Maria Valley would probably be less than $60.00 per acre foot. (In this case, the total yield would likely be somewhat higher.) Studies conducted for Santa Ynez River reservoirs indicate unit costs during productive years of less than $10 per acre foot. All of the calculations above consider only surface water in storage as the result of cloud seeding. If areal recharge benefits to ground water are considered, the unit costs would be substantially lower.

Municipal Water Conservation

There are a variety of programs which are typically implemented by urban water utilities to promote the efficient use of water. Most efforts fall into the general categories of public education, financial incentive programs, customer services, and regulations. Most of these programs apply in times of plentiful water supplies, as well as in times of drought. All of these programs are applicable to water users in the Santa Maria Valley. Some of them have already been implemented, while others are being considered for the future. The programs being implemented are described in the Current Efforts section and detailed in Appendix C-1.

In 1991 the City of Santa Maria adopted the Long Term Water Management Plan. This plan contains recommendations for appropriate water conservation measures for urban water users. The recommended list of urban water conservation programs/actions follows:

- Maintain the City's current public information and education program for water conservation.
- Require automatic landscape irrigation systems, with soil moisture probes and time clocks, for new commercial development and common areas of new residential development. Encourage them for new single family residential development.
- Develop a residential water audit program to be conducted by the City Water Division.
- Hire consultant to perform a water audit and leak detection survey of the City's water distribution system.
- Continue to encourage and require retention/recharge basins in new development to enhance recharge.
- Require ultra-low flow plumbing fixtures in all new development (State law now requires this).

Further recommendations for programs that are more costly or would impact customers to a greater degree included:

- Adopt a water conservation oriented pricing structure (i.e. increasing block).
- Adopt a development offset program where developer retrofit existing units to save water (2 to 1) to be used by the new development.
- Examine the feasibility of a rebate program for water efficient plumbing devices.
- Consider requiring more efficient reverse osmosis water treatment units to eliminate or reduce waste.
- Consider replacing Orcutt Sub-basin water with water from downtown wells to irrigate some of the City's parks.
- Consider drilling new water wells to use for irrigation of other City facilities such as the dump and designated parks.
- Investigate equipping its water wells with storage and reinjection pump systems to recover start up water which is currently wasted.

Legislation and Requirements

During the past five years a number of state and local laws have been created which require more efficient use of water. Appendix C-2 contains a summary of requirements at the state and local level for efficient use of water.

Current Efforts in Santa Maria Valley

Municipal (urban) water conservation programs have intensified throughout the county during the past 10 years due to an extended drought and other water supply limitations. Most of the water conservation programs implemented involve public education and direct customer contact regarding ways to use water more efficiently. Table VIII-2 contains a matrix identifying the types of municipal water conservation activities, and the level of implementation throughout the county.

To date, these purveyors have not perceived a need to adopt restrictions with penalties or financial incentive (ie. rebate) programs to achieve water use reductions, relying instead on public education and voluntary efforts by customers. There are, however, several State mandated conservation measures (water efficient plumbing devices in new construction, water efficient landscape design criteria for new development) which city and county officials are enforcing through the building and planning departments (see Water Conservation Legislation and Requirements Section).

In 1991, a task force was created to review the water conservation efforts of water users in the Santa Maria Valley, and to recommend appropriate future water conservation actions for water purveyors and users. One purpose of the task force was to provide input into the Santa Maria Valley Groundwater Management Plan. The recommendations of the task force are contained in Appendix C-3.

Water Savings Potential

It is very difficult to precisely determine the water savings potential of individual water conservation programs carried out by water purveyors. The potential for reduction in urban water demand, as proven in areas with aggressive conservation programs, can be as great as 50% below previous water use levels. In the Santa Maria Valley, past estimates for reduction in per capita demand due to conservation have been assumed to be 10% of 1980 demand levels.[9]

WATER CONSERVATION PROGRAMS AS OF MARCH 1993					
CURRENT PROGRAMS 1993	CARPINTERIA WTR. DIST.	*City of BUELLTON	City of GUADALUPE	City of LOMPOC	City (S.BARB
In-School Education Program **	R	R	R	X/R	X/F
Landscape Education Program **	R	R	R	X/R	X/F
Landscape Review Guidelines **	R	R	R	X/R	X/F
Promotion of Drought Tolerant Plants **	R	R	R	X/R	X/F
Water Conservation Literature **	X/R	R	R	X/R	X/F
Speakers Bureau **	R	R	R	X/R	X/F
Water Audits-Residential **	X			X	X
CIMIS/ET Information					X
Efficient Fixture Ordinance (State Law)				X	X
Showerhead Program **	X			X	X
Toilet Rebate Program **				X	X
Advertising/Bill Inserts **	X				X
Emergency Rationing Ordinance	X				X
Increasing Block Rates **					X
Water Awareness Month **	X/R	R	R	X/R	X/F
Conservation Kits (Retrofit devices)				X	
Customer Leak Detection	X				X
Water Waste Ordinance **	X			X	X
Required Reclaimed Water Use				X	X
Retrofit/Offset - New Construction				X	X
Meter Replacement			X	X	X
Voluntary Conservation (Goals)				X	X
Water Conservation Awards				X	X
Mandatory Retrofit-Toilets(Com/Indst)					
District System Leak Detection **				X	X
Restaurant/Hotel Education Program **				X	X
Conservation Hotline					X
Landscape Rebate					
Water Reclamation (Voluntary)					X
Commercial/Industrial Water Audits **				X	X
Greywater Ordinance/Education	R	R	R	X/R	X
Displays (Xeriscape/Demo Gardens) **				X	[illegible]
Countywide Advisory Committee		R		R	[illegible]
Participation in State MOU					[illegible]

*Buellton CSD has merged with City. Conservation Program is on hold until City determines level of effort.

Source

**Represents Best Management Practice
R = Participation in Regional Program - Conducted by County Water Agency

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ity of MARIA	City of SOLVANG	GOLETA WD	LA CUMBRE MWC	MISSION HILLS CSD	MONTECITO WD	S.B.Co.*** WATER AGENCY	SANTA YNEZ RWCD	SO. CAL. WTR. CO.	SUMMER-LAND CWD	VAFB	VVCSD
R	R	R	R	R	R	R	X/R	R	R		X/R
X/R	R	R	R	R	R	R	X/R	R	R		X/R
X/R	R	X/R	X/R	R	X/R	R	R	R	R	X	X/R
X/R	X/R	X/R	X/R	X/R	X/R	R	X/R	X/R	X/R	X	R
X/R	X/R	X/R	X/R	X/R	X/R	R	R	X/R	X/R		X/R
R	R	R	R	R	R	R	X/R	R	R		R
X					X			X		X	
X		X									
X		X	X	X				X	X	X	X
		X	X		X					X	X
									X		
X						R		X			X
									X	X	
X				X	X				X		
X/R	X/R	R	X/R	R	X/R	R	X/R	R	X/R		R
X					X			X		X	X
X		X	X	X	X			X			
X	X		X		X		X	X	X		
		X		X					X		
											X
X		X		X	X		X	X			
X	X	X		X						X	
									R		
X		X	X	X	X		X	X	X	X	X
	X						X				
		X						X			
X		X		X							
X								X			
R	R	R	R	X/R	R	R	R	R	X/R		R
X		X			X	R		X			
R	R	R	R		R	R		R			R
		X			X	R		X			

arbara County Water Agency – Regional Water Conservation Program

TABLE VIII-2

(Table VIII-3) The actual potential for additional water savings in the Santa Maria Valley beyond current levels may be as high as 20%; if more aggressive conservation efforts are justified and implemented.

Agricultural Water Conservation

There are a variety of water conservation measures which can be used to improve the efficiency of agricultural water use. Some measures involve actions taken by growers in their operations to manage their irrigation systems and properly schedule irrigations. Other measures include programs that are sponsored by local agricultural agencies, such as the USDA Soil Conservation Service and resource conservation districts.

Measures Taken By Growers

Many technologies and practices are available to assist growers in using irrigation water efficiently. Efficiency can be enhanced through the irrigation system itself (type of system selected, system modifications or conversions), and through management of the system and timing of irrigations (use of soil moisture and weather data in irrigation scheduling). A list of conservation strategies for growers is included in Appendix C-4. Some examples include proper irrigation system design and maintenance, sprinkler set orientation, leak detection for irrigation systems, pressure differential measuring, regulating reservoirs (frost protection), subterranean drip systems, conversion to more efficient irrigation system design, tailwater recovery systems, voluntary use of water meters, laser land leveling, and surge valves.

It should be noted that agricultural operations are a business venture, and decisions regarding water use and the implementation of specific irrigation management technologies or techniques, as with other operational "inputs", are made in the context of their cost effectiveness and their

HISTORICAL WATER DEMAND AND CONSERVATION POTENTIAL

DAU and Subareas	1970 Populatn	1970 Gross Wtr	1970 GPCD	1980 Populatn	1980 Gross Wtr	1980 GPCD	1990 Populatn	1990 Gross Wtr	1990 GPCD	Projected GPBO M & I Gross Water Demand (AFY & PerCapita) with Conservation @: 0%:Total	GPCD	5%:Total	GPCD	10%:Total	GPCD	20%:Total	GPCD
DAU 71:																	
City of Santa Maria	32,340	7,391	204	39,721	8,754	197	60,229	12,058	179	22,395	204	21,275	194	20,156	184	17,916	163
Southern Calif Water Co	13,608	NA	275	23,215	5,020	193	31,469	8,818	250	13,886.	275	13,192	261	12,497	248	11,109	220
City of Guadalupe	3,115	NA	200	3,700	757	183	5,695	723	113	4,079	200	3,846	190	3,671	180	3,263	160
S M Valley Industrial	0	7,200	NA	0	7,120	NA	0	6,000	NA	6,000	NA	5,700	NA	5,400	NA	4,800	NA
Private SMV M&I, Ag	472	NA	155	800	89,739	155	984	122,379	155	237	155	225	147	213	140	189	124
Casmalia CSD	230	NA	75	226	16	65	164	13	72	14	75	13	71	12	68	11	60
TOTAL SANTA MARIA	49,765	NA	NA	67,662	111,406	288	98,541	149,991	252	46,610	256	44,251	243	41,949	230	37,288	204
DAU 73:																	
Los Alamos CSD	722	NA	280	734	230	280	890	256	257	635	280	603	266	571	252	508	224
Vandenberg AFB	10,705	NA	515	5,421	3,129	515	6,544	3,600	491	6,896	627	6,551	596	6,206	564	5,516	502
Private SAV M&I, Ag	346	NA	162	460	16,260	155	543	17,405	155	127	162	121	154	114	146	102	130
TOTAL SAN ANTONIO	11,773	NA	NA	6,615	19,619	464	7,977	21,261	442	7,657	545	7,274	518	6,891	491	6,126	436
DAU 74:																	
City of Lompoc	24,084	3,511	130	26,270	3,638	124	35,711	5,252	131	7,878	160	7,484	124	7,090	117	6,302	104
Vandenberg Village CSD	4,523	1,408	278	5,839	1,527	233	6,793	1,500	197	2,848	278	2,706	264	2,563	250	2,278	222
Mission Hills CSD	3,000	NA	200	2,755	583	189	3,121	629 700	180	1,371	200	1,302	190	1,234	180	1,097	160
Vandenberg AFB	5,362	NA	500	2,715	1,567	515	3,277	1,600	491	2,367	500	2,249	475	2,130	450	1,894	400
Buellton CSD	1,500	NA	300	2,242	752	299	3,688	1,083	262	1,788	300	1,699	285	1,609	270	1,431	
City of Solvang	2,100	919	391	2,899	1,146	353	4,755	1,963	369	3,243	369	3,080	371	2,918	352	2,594	
Santa Ynez RWCD ID# 1	5,500	4,341	211	7,712	6,118	212	8,298	6,475	215	3,173	215	3,014	204	2,856	193	2,538	
Private SY–Lom M&I, Ag	1,378	NA	164	1,824	55,120	157	2,192	56,334	155	519	164	493	156	467	148	415	[illegible]
TOTAL SANTA YNEZ	47,445	NA	NA	52,258	70,449	173	67,835	75,039	192	23,186	223	22,027	212	20,868	201	18,549	179
DAU 75:																	
Carpinteria CWD	9,400	4,303	139	13,410	5,208	143	17,102	5,362	109	3,416	139	3,245	132	3,075	125	2,733	111
Summerland CWD	1,000	173	112	1,245	249	108	1,442	354	115	278	135	264	128	250	122	223	108
Montecito WD	8,900	4,349	366	9,964	3,702	278	11,719	4,024	265	5,129	366	4,873	348	4,616	329	4,103	293
City of Santa Barbara	69,700	13,522	167	76,705	14,148	153	84,170	13,461	132	17,836	167	16,944	158	16,052	150	14,269	133
LaCumbre Mutual Water Co	3,363	1,846	424	4,000	1,716	345	4,141	1,297	260	2,214	424	2,104	402	1,993	381	1,772	339
Goleta WD	61,000	14,863	170	64,503	16,455	170	70,348	14,500	143	15,621	170	14,840	161	14,058	153	12,496	136
Private SC M&I, Ag	1,003	NA	158	1,330	9,225	151	4,951	19,415	155	998	158	949	150	899	142	799	126
Morehart Land Co.	0	900	NA	0	900	NA	0	900	NA	0	NA	0	0	0	NA	0	NA
Santa Barbara Research	0	NA	NA	0	100	NA	0	100	NA	167	NA	159	NA	150	NA	134	NA
TOTAL SOUTH COAST	154,366	NA	NA	171,157	51,703	173	193,873	59,413	146	45,660	182	43,377	173	41,094	164	36,528	145
DAU 76:																	
Cuyama CSD	1,114	NA	282	625	282	403	662	185	249	272	282	258	268	245	254	218	226
Private CV M&I, Ag	452	NA	130	601	28,604	125	718	20,925	155	138	155	131	124	124	117	110	104
TOTAL CUYAMA VALLEY	1,566	NA	NA	1,226	28,886	267	1,380	21,110	200	410	221	389	210	369	199	328	177
SANTA BARBARA COUNTY	264,915	NA	NA	298,916	282,063	206	369,606	326,813	189	123,524	223	117,319	212	111,171	201	98,819	179

NOTES ON TABLE 3:

... General Plan "GPBO" modified population figures from TABLE 2 are used to generate the GPBO water demand and values.

(PLEASE SEE FOLLOWING SHEET FOR FURTHER NOTES ON TABLE 3)

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NOTES ON TABLE 3 (continued):

3) Agricultural water demand has been excluded from per capita water calculations. The only districts which serve agricultural customers are Santa Ynez RWCD ID # 1, Carpinteria CWD, Summerland CWD, Montecito WD, City Santa Barbara, La Cumbre MWC, Goleta WD, and Morehart Land Company. Agricultural water demand has been included in the Santa Ynez River Water Conservation District ID # 1 1990 water demand, but left out of the 1970 and 1980 estimates. Since a breakout of agricultural water demand was not available for Montecito WD, the gpcd estimates were not adjusted. Agricultural consumption is taken from Table 4.

4) Water consumption figures are provided by the water purveyors with the following exceptions: Vandenberg Air Force Base consumption was taken from the Draft Environmental Impact Statement, Proposed Closure of Los Angeles AFB, California and Relocation of Space Systems Division, U.S. Air Force, July 1990; Morehart Land Company was estimated at 3.0 AF/acre, based on DWR irrigation rates for pasture, for an estimated 300 acres under production.

5) Some error exists in the district population and per capita water estimates since residents on private wells could not always be excluded from the district population estimates.

6) Where insufficient data is available to calculate 1970 per capita water demand to represent the pre-conservation condition, a value has been assumed. Districts where 1970 gpcd estimates are assumed include: Southern California Water Company, Guadalupe, Casmalia, Los Alamos, Vandenberg AFB, Mission Hills CSD, Buellton CSD, and the private well areas outside the water districts.

7) Casmalia CSD obtains its water from the Santa Maria GWB, and also is NOT within the San Antonio Creek watershed. Therefore, Casmalia is included in the Santa Maria study area DAU 71.

8) Lompoc's 0% conservation GPCD is taken from 1989 district water consumption data.

9) Summerland CWD's 1970 water demand of 114 gpcd is not representative of average pre-conservation water demand. 135 gpcd was substituted since it is a representative gpcd figure based on the average M & I water demand of 210 AF/year for FY 86 to FY90 and the 1987 estimated population of 1392.

10) Some water districts have unusually high per capita water demands because of large daytime populations (VAFB), large industrial operations (Santa Maria Valley Industrial) or tourism (Solvang and Buellton CSD.)

11) The per capita water demand estimates include a per capita share for commercial and industrial uses in addition to residential use.

12) The 1990 GPCD figures are unusually low because many districts had voluntary or mandatory water rationing during the extended drought. As a consequence, these figures are not the same as the theoretical 1990 GPCD in TABLE 4.

13) Several districts have drought buffer or safety margins which are a part of their water supply they hold in reserve as district policy (Goleta WD-2000 AF, City of Santa Barbara-1800 AF, and Summerland CWD-5% of water supply). Forecasted water demand should be increased by the safety margin for these districts and all others to account for uncertainty in predicting droughts, water supply reliability and population growth.

14) The City of Santa Barbara, using their own methodology, forecasts a combined M&I and agricultural water demand of 17,900 AF/yr at GPBO. This is roughly the same as the 0% conservation GPBO estimate of M&I water in TABLE 4 plus agricultural demand from TABLE 6.

Source: Santa Barbara County Growth Inducement Potential of State Water, SBCWA

Table VIII-3

impact on crop yields. While there may be a number of improvements that farmers could make to increase the efficiency of their irrigation and save additional amounts of water, some of these improvements are very costly and not justifiable. As the cost of producing water rises, or the improvements are subsidized (perhaps by urban water suppliers as was done by the Metropolitan Water District of Southern California for lining of irrigation canals in Imperial County) some of these measures may become cost effective in the future.

Services and Programs Offered by Agencies

There are a number of local agencies which provide technical assistance and information to growers about agricultural practices, including irrigation management. Most of the these are based or have offices in the Santa Maria Valley. These agencies include: the Soil Conservation Service (SCS), the Cachuma Resource Conservation District (RCD), the U.C. Cooperative Extension/Farm Advisor, the County Agricultural Commissioner, DWR and the Santa Maria Water Conservation District.

These agencies have trained, professional staff (agricultural engineers, soil scientists, irrigation specialists, etc) that advise growers about many aspects of planting, cultivating, irrigating and harvesting a variety of crops. Some of the specific services they offer to growers regarding irrigation management are listed below. In addition, the energy utilities offer services to help growers improve energy use efficiency, which results in more efficient water use in most cases.

The principal technical assistance programs currently available to growers in the Santa Maria Valley are discussed below.

CIMIS: DWR operates weather stations throughout California as part of the California Irrigation Management Information System (CIMIS). Information from these stations is used to develop accurate, area-specific evapotranspiration data. This allows for a more efficient determination of the amount of irrigation required on a day-to-day basis.

There are several CIMIS stations in the Santa Maria Valley. The weather data from these stations is available through a telephone "hotline" operated by the U.C. Cooperative Extension office. CIMIS data is also available, through modem, from DWR in Sacramento.

Irrigation Management Program (Mobile Lab): On-farm water use efficiency can be improved through evaluation of the operation and management of irrigation systems. Trained specialists from the USDA Soil Conservation Service, working with the RCD, evaluate system performance locally by offering free on-site evaluations of irrigation systems. The U.C. Cooperative Extension also offers assistance to growers in managing irrigations through field visits and demonstrations. See "Irrigation Efficiency" section for more information.

Pump Electrical Meter Efficiency Testing: Trained staff from PG&E (in the Santa Maria Valley) provide growers with a pump efficiency analysis which includes a measurement of the efficiency of the pump, and a calculation of the amount of water that is being pumped. This is especially helpful if the grower's water flow is not metered, as is largely the case in the Santa Maria Valley. PG&E also offers rebates for implementing methods or installing equipment which improves energy efficiency.

Grower Education Programs: The local agencies (mentioned above) providing technical assistance often conduct field demonstrations or workshops for growers to enhance their knowledge about irrigation management practices and new technologies. Other means used to advise growers include newsletters, reports and brochures which describe these practices and technologies.

Growers in the Santa Maria Valley have access to these technical assistance programs and technologies to help them become more efficient; many take advantage of these services and techniques.

Legislation and Requirements

Very little exists in the way of water use regulation for agricultural water users. Most growers use groundwater, from their own wells. There is, however, recent legislation which addresses the operations of water purveyors which supply water to farmers. AB3616, passed by the State legislature in 1992, directed DWR to put together a committee to create efficient water management practices (EWMPs) for agricultural water purveyors, comparable to the Best Management Practices (BMPs) that have been developed for urban water purveyors.

The AB3616 committee has created a Memorandum of Understanding (MOU) directed towards purveyors of water to agriculture, rather than to individual growers, and adoption is voluntary. The intent of the MOU is to shift agricultural water purveyors from *serving* water to actively *managing* water.

Even though most water used for agriculture in the Santa Maria Valley is pumped from private wells, some of the EWMPs would still be appropriate for consideration in groundwater basin management planning, as cooperative efforts among growers or agencies serving growers.

Current Efforts in Santa Maria Valley

There is currently no detailed analysis of the effectiveness or level of existing water conservation efforts by all growers in the Santa Maria Valley. There are also no formal procedures for metering or reporting agricultural water use within the valley. It is therefore very difficult to quantify irrigation efficiency. As described later in this section, however, some general review of the effectiveness of irrigation management is possible through the Irrigation Management Program carried out by the RCD.

Technologies currently in widespread use in the area include: laser land leveling, drip and buried drip irrigation systems, soil moisture sensing systems, tailwater recovery, transplant of seedlings to fields, energy pump tests, irrigation scheduling and use of weather data in scheduling. The extent to which these techniques are applied in the field has not been quantified, and may be misleading due to the variation in how these techniques are applied in the field.

There are several reasons why farmers in the valley are making a concerted effort to improve irrigation efficiency: ongoing concerns about depletion of groundwater resources, water quality concerns, relatively high energy costs to pump groundwater ($25 - $75 per acre foot), and improvements in irrigation technology which have reduced the cost while increasing crop yield. Many growers in the Santa Maria Valley have employed state-of-the-art irrigation techniques, as described in the previous paragraph.

Irrigation Efficiency

While it is difficult to determine the efficiency of all irrigation systems, it is possible to evaluate the efficiency of individual irrigation systems, and in fact this has been accomplished on a number of acres within the valley. As described in a previous section addressing agency programs for growers, evaluations of irrigation systems have been performed by the Soil Conservation Service (SCS) and Resource Conservation District (RCD) through the Irrigation Management Program (Mobile Lab). These field evaluations measure the distribution uniformity (a key indicator of efficiency) of irrigation system applications. The program assists farmers, at no cost, to improve the efficiency of their irrigation systems.

The services provided by this program include: evaluation of a farmer's irrigation systems (including how it is managed), development of a water budget and other specific recommendations to increase efficiency, and documentation of potential (and later, actual) water and energy savings after implementation of recommendations.

To date the program has conducted over 300 evaluations throughout the county. Approximately 20% of these evaluations were conducted in the Santa Maria Valley (including San Luis Obispo County). The results of the evaluations within the Santa Maria Valley (about 7,356 acres evaluated) conclude that approximately 1,825 acre feet of water per year could be saved on those sites alone if the recommendations were followed and improvements were made. SCS staff estimate that about 10% of the irrigated acres in the Santa Maria Basin have been evaluated through this program.

Water Savings Potential

As mentioned above, precisely determining the efficiency of agricultural water use, and therefore the opportunity for additional water savings, is difficult due to the lack of data. Most growers do not have water meters on their wells. While it is possible to estimate water consumption by looking at pump energy consumption or by using a general consumptive use factor for each crop type, the most accurate method is to use a totalizing flow meter.

If the savings estimates for those systems already evaluated through the Irrigation Management Program were applied to the valley as a whole, an additional 16,425 acre feet per year might be saved in the valley following further evaluations and associated improvements. There is, however, a wide variation between different growers' operations and conditions, so these estimates are general in nature, and should not be used as precise figures.

Tables VIII-4 and VIII-5 contain results of these evaluations including estimates of average distribution uniformity (du), potential annual water savings, and potential annual cost savings from improving the irrigation system efficiency. These tables were taken from the RCD and SCS Annual Report (Fiscal Year 1993) on the Irrigation Water Management Program.

TABLE VIII-4

SUMMARY OF IRRIGATION SYSTEM EVALUATIONS

Type of Irrigation System	Number of Tests*	Average H2O Costs ($/AF)	Average Depth (ft/yr)	Average DU (%)	Total Impacted (Ac)	Potential Annual Savings (AF/yr)	Potential Annual Savings ($/yr)
Drip	56	132	1.2	72	5,794	597	59,172
Microsprayer	45	295	1.4	59	1,210	372	83,189
Sprinkler	56	88	1.9	61	6,765	2,326	169,160
Furrow	13	28	2.5	72	3,788	545	8,680
Landscape	18	386	3.6	51	105	105	18,698
Averages		186	2.1	63			
Totals	188				17,662	3,945	338,899

* Does not include retests

Source: Annual Report, Fiscal Year 1993 - Irrigation Management Program, Santa Barbara and San Luis Obispo Counties: Prepared by USDA Soil Conservation Service

TABLE VIII-5

SUMMARY OF IRRIGATION SYSTEM RE-TESTS

Crop	Area Impacted (AC)	Type of Irrigation System	DU Before (%)	DU After (%)	Applied Depth (ft/yr)
Avacado	2	Microspray	62	71	1.2*
Flowers	45	Sprinkler	60	89	2.3
Wine Grapes	100	Sprinkler	31	53	1.2*
Eucalyptus	120	Drip	36	66	2.9*
Wine Grapes	214	Drip	73	78	.7*
Avocado	5	Microspray	78	96	1.4
Avocado	12	Drip	77	73	1.0**
Avocado	2	Microspray	47	62	2.5*
Flowers	75	Sprinkler	60	89	3.0*
Avocado	35	Microspray	27	62	1.4*
Raspberries	4	Drip	70	68	2.5*
Raspberries	4	Drip	62	74	2.5*
Broccoli	500	Sprinkler	26	90	3.0
Raspberries	4	Drip	69	74	2.5*
Total			56	75	

* (Indicates only part of the recommendations were implemented)

** (Indicates additional problems had developed since original evaluation, i.e. emitter plugging)

Source: Annual Report, Fiscal Year 1993 - Irrigation Management Program, Santa Barbara and San Luis Obispo Counties: Prepared by USDA Soil Conservation Service

Based on the evaluations performed and assumptions made by local irrigation experts, it is reasonable to assume that irrigation efficiency could be increased by as much as 5% by the year 2000 and 10% by the year 2010, as compared to 1990. The current trend toward replacing traditional irrigation systems with micro-irrigation equipment could, alone, result in these savings if it continues.

Local experts agree that, while growers are making great strides toward irrigation efficiency, there is still room for improvements and additional savings through modifications to individual farm operations. Local agencies and the agricultural industry continue to direct their efforts at achieving those improvements, both in the valley and elsewhere in the county.

SECTION IX - INSTITUTIONAL CONSIDERATIONS

The Groundwater Management Act (AB 3030), signed into law in 1992, addresses the quality and supply of ground water basins in California. The Act allows local agencies to prepare, adopt, and enforce ground water management plans and specifies the elements that may be included in such a plan. Following is a list of those elements:[32 p. 2]

a) Control of saline water intrusion.

b) Identification and management of wellhead protection areas and recharge areas.

c) Regulation of the migration of contaminated ground water.

d) The administration of a well abandonment and well destruction program.

e) Mitigation of conditions of overdraft.

f) Replenishment of ground water extracted by water producers.

g) Monitoring of ground water levels and storage.

h) Facilitating conjunctive use opportunities.

i) Identification of well construction policies.

j) The construction and operation by the local agency of ground water contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects.

k) The development of relationships with state and federal regulatory agencies.

l) The review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of ground water contamination.

In addition, the legislation requires public involvement in the preparation of a ground water management plan. The agency preparing the management plan is required to hold a public hearing on the Resolution of Intent to draft a ground water management plan prior to issuing the

Resolution. The agency then has two years to prepare a draft of the ground water management plan after which they must hold a public hearing on the draft.

The land owners affected by the plan may protest it. If the majority (more than 50% of assessed land value) of land owners protest, the plan can not be adopted. Once adopted, the local agency may collect fees for the cost of ground water management if authority is approved by a majority of voters in an election.

A bill to modify AB 3030 was recently passed by the Legislature. The effect of Assembly Bill 1152 is to provide more agencies the authority to develop a ground water management plan. AB 3030 gives local agencies providing water service, whose service area includes part of the ground water basin, the authority to develop a ground water management plan. AB 1152 extends that authority to other agencies providing flood control, ground water management, or ground water replenishment if agreeable to the local agencies. One of the consequences of AB 1152 is to allow county agencies to implement or assist with development of ground water management plans. It also allows the County to act cooperatively with local water districts in the development of a plan.

Although AB 3030 enables agencies to prepare and enforce ground water management plans, it does not allow the local agency to make binding determinations of water rights. The laws currently governing water use specify that land owners own the ground water below their land. However, users not overlying the basin may use surplus water from the basin. In the event of a shortage, those not owning land overlying the basin must relinquish their use.

Due to the complex nature of water rights issues, agreement on a ground water basin management plan may be difficult. In the event that agreement cannot be reached, it is likely that authority to impose water management would go to State or Federal entities.

Local Coordination

There are many options for organization and coordination of efforts to produce a ground water management plan. For example, the Santa Maria Valley Water Conservation District could adopt and implement a ground water management plan. However, as a non-purveyor of water, it may be desirable for the Conservation District to act as an organizational agency. Because the Conservation District boundaries overlap those of other agencies overlying the basin, agreement between these agencies would be required and could take the form of a memorandum of understanding or a joint powers agreement. Alternatively, other agencies may act as coordinators with input from all of the agencies sharing the basin.

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APPENDIX A

MONTHLY RAIN DATA

SANTA BARBARA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
123 East Anapamu Street, Santa Barbara, California 93101.

MAP COORDINATES: A2

LAT. 35 06'N
LONG. 120 23'W
EL. 715'

RAINFALL RECORDS BY WATER YEAR

STATION: HUASNA

NUMBER: HUA247

YEAR	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	W.Y.
1937-38													28.71
1938-39													12.00
1939-40													22.80
1940-41	0.00	0.53	0.14	6.64	5.04	10.72	7.92	3.56	0.15	0.00	0.04	0.06	34.80
1941-42	0.00	0.89	0.37	9.50	1.78	1.62	2.04	3.88	0.43	0.00	0.00	0.08	20.59
1942-43	0.00	0.38	1.62	2.66	11.13	1.93	6.36	1.21	0.00	0.00	0.00	0.00	25.29
1943-44	0.00	1.09	0.44	3.93	1.67	6.12	1.55	1.82	0.10	0.00	0.00	0.00	16.72
1944-45	0.00	0.52	3.35	1.59	0.82	4.65	5.19	0.10	0.07	0.05	0.00	0.00	16.34
1945-46	0.00	1.43	0.82	3.92	0.53	2.59	5.78	0.11	0.14	0.00	0.00	0.02	15.34
1946-47	0.00	0.43	5.88	2.71	0.76	0.56	1.89	0.31	0.19	0.08	0.00	0.00	12.81
1947-48	0.00	0.77	0.08	1.07	0.05	2.48	4.44	3.11	0.92	0.00	0.00	0.00	12.92
1948-49	0.00	0.17	0.00	3.14	1.47	2.65	4.03	0.07	0.85	0.03	0.00	0.00	12.41
1949-50	0.00	0.00	2.51	3.27	3.95	3.13	2.16	1.05	0.24	0.00	0.60	0.00	16.91
1950-51	0.03	2.18	4.47	1.50	2.24	1.98	0.34	1.49	0.08	0.00	0.00	0.00	14.31
1951-52	0.09	0.71	2.02	6.12	8.36	1.03	6.11	1.09	0.05	0.03	0.00	0.00	25.61
1952-53	0.00	0.13	3.84	6.31	2.25	0.00	1.62	1.89	0.00	0.00	0.00	0.00	16.04
1953-54	0.00	0.00	2.02	0.33	5.84	2.43	4.80	0.91	0.16	0.00	0.00	0.00	16.49
1954-55	0.00	0.00	1.86	2.29	6.20	2.35	0.24	2.62	0.39	0.00	0.00	0.00	15.95
1955-56	0.00	0.00	1.64	6.96	5.03	0.66	0.00	2.79	0.90	0.00	0.00	0.00	17.98
1956-57	0.00	0.48	0.00	0.85	3.60	2.65	0.63	2.34	2.03	0.04	0.00	0.00	12.62
1957-58	0.00	2.08	0.59	4.25	5.12	7.30	8.28	5.93	0.28	0.00	0.00	0.00	33.83
1958-59	0.89	0.00	0.20	0.16	2.03	5.77	0.00	0.57	0.00	0.00	0.00	0.00	9.62
1959-60	0.62	0.00	0.00	0.50	3.92	6.81	1.66	3.20	0.00	0.00	0.00	0.00	16.71
1960-61	0.00	1.26	4.98	1.23	1.72	0.07	1.42	0.33	0.16	0.00	0.00	0.00	11.17
1961-62	0.00	0.00	3.30	2.08	4.47	12.23	1.97	0.04	0.09	0.00	0.00	0.00	24.18
1962-63	0.00	0.77	0.00	0.44	1.79	4.51	3.14	3.88	0.58	0.00	0.00	0.00	15.11
1963-64	0.40	1.30	3.47	0.15	2.20	0.03	3.26	0.40	0.24	0.28	0.04	0.18	11.95
1964-65	0.00	1.68	2.70	2.59	2.91	0.72	2.24	4.13	0.00	0.00	0.00	0.00	16.97
1965-66	0.00	0.00	6.87	3.61	1.36	0.91	0.11	0.07	0.00	0.00	0.04	0.00	12.97
1966-67	0.74	0.00	3.43	8.82	5.51	0.64	4.42	6.25	0.21	0.17	0.00	0.00	30.19
1967-68	0.88	0.00	3.68	1.68	1.40	1.06	3.15	0.98	0.05	0.00	0.00	0.00	12.88
1968-69	0.00	2.23	1.19	2.46	15.36	10.41	0.97	2.30	0.00	0.04	0.00	0.00	34.96
1969-70	0.00	0.43	0.68	0.73	4.36	2.88	2.51	0.05	0.00	0.03	0.00	0.00	11.67
1970-71	0.00	0.15	4.64	4.95	2.23	0.10	1.20	1.24	1.15	0.00	0.00	0.00	15.66
1971-72	0.13	0.05	1.13	4.12	0.26	0.57	0.00	0.65	0.35	0.05	0.00	0.00	7.31
1972-73	0.05	1.93	4.52	1.97	5.93	8.44	4.05	0.00	0.00	0.00	0.00	0.00	26.89
1973-74	0.00	0.66	4.06	2.67	5.65	0.23	5.89	1.23	0.00	0.00	0.00	0.00	20.39
1974-75	0.00	1.22	0.30	3.87	0.15	4.40	3.27	1.55	0.00	0.00	0.00	0.00	14.76
1975-76	0.00	1.76	0.34	0.17	0.00	4.96	1.52	1.27	0.03	0.05	0.00	1.01	11.11
N	36	36	36	36	36	36	36	36	36	36	36	36	39
MEAN	0.11	0.70	2.14	3.03	3.53	3.32	2.89	1.73	0.27	0.02	0.02	0.04	18.08
MAX	0.89	2.23	6.87	9.50	15.36	12.23	8.28	6.25	2.03	0.28	0.60	1.01	34.96
MIN	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.31
STD	0.25	0.71	1.89	2.39	3.18	3.23	2.24	1.62	0.42	0.05	0.10	0.17	7.10
Z	2.75	1.70	2.14	2.54	3.72	2.71	2.14	2.35	3.51	3.73	7.61	6.33	2.12
CV	2.37	1.02	0.88	0.79	0.90	0.97	0.78	0.93	1.53	2.31	4.93	4.47	0.39
Reg CV	2.68	1.28	1.03	0.84	0.90	0.99	0.87	1.11	1.83	2.91	3.81	4.10	0.44
Reg Skew	3.80	1.80	1.40	1.00	1.60	1.10	1.10	1.70	2.60	3.60	4.40	4.80	1.10
FIC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
RP2	0.00	0.45	1.65	2.62	2.74	2.73	2.44	1.21	0.09	0.00	0.00	0.00	16.64
RP5	0.18	1.28	3.70	4.97	5.67	5.77	4.77	3.00	0.51	0.04	0.03	0.05	24.00
RP10	0.40	1.88	5.09	6.45	7.76	7.73	6.27	4.27	0.88	0.10	0.09	0.17	28.73
RP25	0.75	2.67	6.84	8.23	10.39	10.10	8.08	5.93	1.41	0.18	0.19	0.37	34.46
RP50	1.04	3.26	8.10	9.51	12.36	11.84	9.41	7.14	1.82	0.25	0.27	0.54	38.68
RP100	1.34	3.84	9.36	10.73	14.30	13.48	10.67	8.35	2.24	0.32	0.36	0.74	42.65
RP200	1.65	4.42	10.60	11.93	16.21	15.10	11.90	9.57	2.66	0.39	0.45	0.94	46.55
RP500	2.28	5.40	12.54	13.66	19.35	17.46	13.72	11.57	3.40	0.53	0.65	1.36	52.28
RP1000	2.40	5.76	13.40	14.58	20.59	18.68	14.65	12.34	3.67	0.56	0.68	1.43	55.22
RP10000	3.52	7.67	17.31	18.23	26.79	23.68	18.47	16.25	5.14	0.82	1.02	2.17	67.31

SANTA BARBARA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
123 East Anapamu Street, Santa Barbara, California 93101.

MAP COORDINATES:
B2

LAT. 34 57′
LONG. 120 26′
EL. 224

RAINFALL RECORDS BY WATER YEARS.

STATION: SANTA MARIA CITY

NUMBER: SMC380

YEAR	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEASON
1885-86	0.30	0.00	8.80	1.60	1.83	0.97	2.55	3.37	0.00	0.00	0.00	0.00	19.42
1886-87	0.00	0.06	0.59	0.72	0.50	5.95	0.25	1.07	0.22	0.00	0.00	0.00	9.36
1887-88	0.30	0.40	1.09	2.69	4.62	0.43	1.98	0.12	0.14	0.00	0.00	0.00	11.77
1888-89	0.00	0.00	2.59	5.86	0.42	1.35	4.20	0.97	0.60	0.05	0.00	0.00	16.04
1889-90	0.00	7.53	1.80	6.71	7.02	3.64	0.88	0.10	0.13	0.00	0.06	0.00	27.87
1890-91	0.55	0.70	0.70	3.40	0.63	3.57	0.71	1.58	0.20	0.00	0.00	0.00	12.04
1891-92	0.03	0.00	0.33	2.77	0.56	2.18	2.36	0.45	1.15	0.00	0.00	0.00	9.83
1892-93	0.00	0.35	1.95	2.52	2.08	3.10	6.84	0.80	0.05	0.00	0.00	0.00	17.69
1893-94	0.00	0.65	0.22	2.95	1.16	1.78	0.62	0.25	0.73	0.16	0.06	0.00	8.58
1894-95	1.05	0.68	0.07	3.86	4.43	1.22	1.25	0.53	0.51	0.00	0.00	0.00	13.60
1895-96	0.01	0.65	1.26	0.60	4.60	0.00	2.59	1.77	0.03	0.00	0.11	0.03	11.65
1896-97	0.02	0.60	1.82	2.34	3.55	4.00	2.52	0.14	0.01	0.00	0.03	0.00	15.03
1897-98	0.10	0.67	0.03	0.55	1.44	1.06	0.65	0.02	1.14	0.00	0.00	0.00	5.66
1898-99	0.96	0.30	0.05	0.64	3.49	0.46	4.88	0.99	0.75	0.00	0.00	0.00	12.52
1899-90	0.00	1.86	1.21	0.89	0.87	0.05	1.41	0.97	1.97	0.00	0.00	0.00	9.23
1900-01	0.00	0.65	5.40	0.35	4.51	3.17	0.25	1.82	0.13	0.00	0.00	0.00	16.28
1901-02	0.12	1.60	0.56	0.01	1.73	4.03	2.37	1.70	0.20	0.00	0.00	0.00	12.32
1902-03	0.00	1.02	2.59	0.79	1.80	1.91	3.97	0.71	0.00	0.00	0.00	0.00	12.79
1903-04	0.00	0.00	0.19	0.16	0.55	5.39	3.06	1.73	0.10	0.00	0.00	0.86	12.04
1904-05	2.55	1.25	0.03	1.55	1.85	5.83	4.46	0.69	1.58	0.00	0.02	0.00	19.81
1905-06	0.07	0.15	1.37	0.31	2.64	3.40	6.94	0.55	2.39	0.02	0.00	0.01	17.85
1906-07	0.01	0.00	0.63	4.35	7.78	1.02	3.95	0.23	0.00	0.04	0.00	0.00	18.01
1907-08	0.06	3.57	0.00	1.80	3.98	3.76	0.35	0.26	0.18	0.00	0.00	0.00	13.96
1908-09	1.03	0.52	0.97	0.61	10.31	4.98	4.39	0.00	0.00	0.00	0.00	0.00	22.81
1909-10	0.00	0.75	2.14	5.89	3.47	0.50	3.82	0.01	0.00	0.00	0.00	0.00	16.58
1910-11	0.65	0.72	0.15	0.45	6.42	3.80	6.68	1.82	0.00	0.00	0.00	0.00	20.69
1911-12	0.00	0.00	0.00	1.77	1.34	0.10	4.13	0.69	1.60	0.00	0.00	0.00	9.63
1912-13	0.00	0.00	0.40	0.20	2.20	1.27	0.63	0.42	0.00	0.34	0.00	0.00	5.46
1913-14	0.00	1.00	2.45	2.95	9.36	2.20	0.90	0.00	0.00	0.00	0.00	0.00	18.86
1914-15	0.00	0.00	0.00	5.40	4.05	6.31	0.54	1.11	1.52	0.00	0.00	0.00	18.93
1915-16	0.00	0.00	0.60	3.31	8.95	2.12	1.49	0.19	0.00	0.00	0.00	0.00	16.66
1916-17	2.51	1.92	0.52	4.15	2.53	2.01	0.50	0.11	0.23	0.00	0.00	0.00	14.48
1917-18	0.00	0.09	0.00	0.31	0.53	9.39	5.87	0.00	0.00	0.00	0.00	0.00	16.19
1918-19	0.00	0.63	3.55	1.46	0.68	2.36	1.57	0.00	0.74	0.00	0.00	0.00	10.99
1919-20	0.41	0.00	0.15	1.88	0.24	1.78	4.02	1.12	0.00	0.00	0.00	0.00	9.60
1920-21	0.00	0.73	0.94	1.24	3.13	1.65	1.57	0.32	1.45	0.01	0.00	0.00	11.04
1921-22	0.44	0.05	0.13	5.32	4.90	2.97	2.50	0.22	0.35	0.00	0.00	0.00	16.88
1922-23	0.00	0.32	1.34	3.59	1.91	1.06	0.18	3.97	0.05	0.01	0.01	0.00	12.44
1923-24	0.22	0.30	0.00	0.62	0.64	0.46	3.01	1.00	0.01	0.00	0.00	0.03	6.29
1924-25	0.04	0.76	0.78	1.85	2.56	1.67	3.28	2.34	1.71	0.05	0.02	0.01	15.07
1925-26	0.01	0.16	0.12	1.81	1.72	2.99	0.41	2.68	0.11	0.01	0.02	0.01	10.05
1926-27	0.04	0.55	3.37	0.91	1.88	5.21	2.10	1.26	0.06	0.20	0.02	0.01	15.61
1927-28	0.02	3.08	0.81	3.80	0.22	2.51	3.99	0.19	0.71	0.00	0.00	0.01	15.34
1928-29	0.02	0.04	2.31	2.16	2.28	1.22	1.61	0.94	0.00	0.16	0.00	0.00	10.74
1929-30	0.01	0.02	0.00	0.15	3.42	1.18	2.70	0.94	0.68	0.08	0.00	0.00	9.18
1930-31	0.16	0.02	1.55	0.00	4.16	1.13	0.28	0.42	0.94	0.06	0.01	0.31	9.04
1931-32	0.09	0.04	2.46	6.56	4.25	2.14	0.31	0.31	0.26	0.04	0.02	0.02	16.50
1932-33	0.07	0.09	0.09	1.31	6.08	0.30	0.94	0.18	0.38	1.96	0.00	0.00	11.40
1933-34	0.02	0.32	0.03	2.91	1.11	1.52	0.20	0.00	0.26	1.30	0.01	0.01	7.69
1934-35	0.01	3.14	2.19	1.78	4.16	1.64	3.11	3.09	0.00	0.00	0.01	0.26	19.39
1935-36	0.17	0.50	2.02	1.71	1.31	5.32	1.23	1.06	0.13	0.03	0.02	0.01	13.51
1936-37	0.14	1.83	0.00	5.69	3.59	4.83	4.65	0.22	0.00	0.00	0.01	0.00	20.96
1937-38	0.00	0.16	0.26	2.88	4.72	7.39	4.09	2.01	0.04	0.02	0.00	0.02	21.59
1938-39	0.59	0.18	0.23	1.53	3.25	2.18	2.39	0.22	0.03	0.00	0.00	0.00	10.60
1939-40	1.50	0.46	1.03	1.30	5.41	2.67	1.98	1.74	0.00	0.00	0.00	0.00	16.09
1940-41	0.02	0.73	0.12	5.25	5.04	6.83	8.72	3.86	0.07	0.00	0.09	0.03	30.76
1941-42	0.01	1.04	0.32	7.50	1.35	1.30	2.04	2.82	0.08	0.00	0.00	0.02	16.48
1942-43	0.02	0.82	0.84	2.94	7.23	1.27	3.04	1.06	0.02	0.00	0.00	0.00	17.24
1943-44	0.00	1.05	0.47	3.09	1.32	4.69	1.26	2.46	0.11	0.01	0.00	0.00	14.46
1944-45	0.00	0.12	2.26	1.90	0.61	2.87	3.27	0.11	0.04	0.11	0.00	0.02	11.31

1945-46	0.00	0.53	0.88	3.11	0.50	1.63	4.13	0.20	0.10	0.00	0.00	0.00	11.08
1946-47	0.00	0.24	3.71	1.98	0.35	1.10	1.27	0.28	0.30	0.13	0.00	0.00	9.36
1947-48	0.06	0.58	0.04	0.29	0.06	1.29	3.21	1.89	0.81	0.03	0.00	0.00	8.26
1948-49	0.00	0.08	0.01	2.92	1.37	1.29	2.54	0.06	0.82	0.00	0.00	0.00	9.09
1949-50	0.00	0.03	0.71	2.78	2.54	1.50	1.37	0.73	0.15	0.00	0.62	0.00	10.43
1950-51	0.04	0.85	1.50	0.88	2.01	1.10	0.87	1.36	0.01	0.00	0.00	0.01	8.63
1951-52	0.07	0.57	1.17	4.05	5.69	0.69	5.30	0.42	0.00	0.68	0.00	0.00	18.64
1952-53	0.00	0.02	2.97	4.73	1.45	0.00	0.27	1.23	0.12	0.07	0.00	0.00	10.86
1953-54	0.01	0.01	2.34	0.29	3.48	1.44	4.20	0.33	0.00	0.02	0.01	0.00	12.13
1954-55	0.00	0.00	0.97	2.08	3.95	1.35	0.40	1.98	0.60	0.01	0.00	0.00	11.34
1955-56	0.00	0.00	1.60	4.50	2.84	0.64	0.00	1.89	0.54	0.00	0.00	0.00	12.01
1956-57	0.00	0.61	0.00	0.74	2.17	1.95	0.79	1.00	0.98	0.22	0.00	0.00	8.46
1957-58	0.00	1.70	0.55	1.78	2.41	4.70	4.25	4.27	0.18	0.00	0.00	0.00	19.84
1958-59	1.43	0.00	0.30	0.13	1.75	4.57	0.00	0.23	0.00	0.00	0.00	0.00	8.41
1959-60	0.00	0.00	0.00	0.65	3.55	4.13	0.85	2.15	0.00	0.00	0.00	0.00	11.33
1960-61	0.00	1.75	2.50	0.80	0.80	0.10	0.68	0.23	0.21	0.00	0.02	0.00	7.09
1961-62	0.02	0.00	1.63	1.50	2.13	10.08	1.02	0.04	0.03	0.02	0.00	0.00	16.47
1962-63	0.00	0.36	0.00	0.21	0.54	3.75	3.15	2.29	0.53	0.01	0.00	0.00	10.84
1963-64	0.46	1.49	1.92	0.19	1.00	0.00	1.70	1.13	0.31	0.07	0.00	0.00	8.27
1964-65	0.00	1.64	2.41	1.63	0.84	0.51	1.59	2.87	0.00	0.00	0.10	0.12	11.71
1965-66	0.00	0.00	4.34	2.37	0.95	0.80	0.26	0.03	0.00	0.14	0.00	0.00	8.89
1966-67	0.22	0.00	2.10	2.88	2.90	0.39	2.57	3.68	0.21	0.26	0.00	0.00	15.21
1967-68	0.36	0.00	2.78	1.35	0.63	0.91	2.03	0.51	0.04	0.00	0.00	0.00	8.61
1968-69	0.00	1.95	1.05	1.58	7.47	6.92	0.45	1.36	0.00	0.00	0.00	0.00	20.78
1969-70	0.06	0.33	0.98	0.53	2.65	0.42	4.64	0.04	0.00	0.00	0.00	0.00	9.65
1970-71	0.00	0.00	3.45	3.46	0.77	0.09	0.25	1.02	0.74	0.00	0.00	0.00	9.78
1971-72	0.04	0.38	0.64	3.37	0.19	0.45	0.00	0.26	0.16	0.00	0.00	0.00	5.49
1972-73	0.00	0.53	3.56	1.73	4.92	5.44	3.20	0.00	0.05	0.00	0.00	0.00	19.43
1973-74	0.16	0.64	2.50	2.36	3.90	0.15	4.78	0.88	0.00	0.00	0.00	0.00	15.37
1974-75	0.00	1.87	0.13	4.05	0.04	3.22	2.39	0.75	0.00	0.00	0.00	0.00	12.45
1975-76	0.00	0.72	0.15	0.06	0.00	4.47	0.61	1.25	0.00	0.02	0.02	1.20	8.50
1976-77	3.47	1.37	0.32	0.55	2.48	0.02	1.59	0.05	2.09	0.00	0.00	0.00	11.94
1977-78	0.04	0.00	0.13	3.94	4.94	7.30	4.62	1.98	0.00	0.00	0.00	0.00	22.95
1978-79	1.55	0.00	1.10	1.29	4.02	3.04	2.65	0.16	0.07	0.00	0.00	0.00	13.88
1979-80	0.18	0.45	0.21	0.98	4.19	5.08	2.14	0.46	0.28	0.00	0.00	0.00	13.97
1980-81	0.00	0.00	0.00	1.19	3.57	3.79	3.77	0.49	0.00	0.00	0.00	0.00	12.81
1981-82	0.00	0.90	1.26	0.85	2.90	1.27	5.04	1.76	0.00	0.23	0.00	0.07	14.28
1982-83	0.59	1.27	3.67	1.21	5.52	5.43	3.82	2.24	0.02	0.00	0.00	0.27	24.04
1983-84	1.41	0.35	2.10	2.63	0.02	0.37	0.48	0.57	0.00	0.00	0.00	0.00	7.93
1984-85	0.00	0.60	1.93	2.91	0.98	0.85	1.38	0.04	0.00	0.00	0.00	0.00	8.69
1985-86	0.04	0.39	2.72	0.78	1.12	2.96	4.62	0.80	0.00	0.00	0.00	0.00	13.43
1986-87	0.88	0.00	0.44	1.29	1.26	1.15	3.45	0.35	0.02	0.03	0.00	0.00	8.87
1987-88	0.00	2.32	0.61	2.60	1.71	2.36	0.02	2.21	0.05	0.03	0.00	0.00	11.91
1988-89	0.00	0.00	0.75	3.87	0.21	0.59	0.62	0.08	0.06	0.00	0.00	0.00	6.18
1989-90	0.57	0.16	0.49	0.01	2.27	1.55	0.18	0.23	0.48	0.00	0.00	0.00	5.94
SUM	25.99	69.52	130.50	226.68	287.41	262.93	245.59	105.49	33.75	6.63	1.29	3.34	1399.12
N	105	105	105	105	105	105	105	105	105	105	105	105	105
MEAN	0.25	0.66	1.24	2.16	2.74	2.50	2.34	1.00	0.32	0.06	0.01	0.03	13.32
MAX	3.47	7.53	8.80	7.50	10.31	10.08	8.72	4.27	2.39	1.96	0.62	1.20	30.76
MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.46
STD	0.57	0.99	1.38	1.70	2.20	2.14	1.84	1.01	0.51	0.24	0.06	0.15	4.87
Z	4.86	8.10	5.90	2.95	3.07	3.06	3.14	2.93	3.52	10.32	12.98	8.96	2.97
CV	2.30	1.49	1.11	0.79	0.80	0.86	0.79	1.00	1.59	3.80	5.09	4.69	0.37
Reg CV	2.68	1.28	1.03	0.84	0.90	0.99	0.87	1.11	1.83	2.91	3.81	4.10	0.44
Reg Skew	3.80	1.80	1.40	1.00	1.60	1.10	1.10	1.70	2.60	3.60	4.40	4.80	1.10
FIC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
RP2	0.00	0.42	0.95	1.86	2.12	2.06	1.97	0.70	0.10	0.00	0.00	0.00	12.27
RP5	0.42	1.21	2.15	3.53	4.40	4.35	3.85	1.74	0.60	0.12	0.02	0.04	17.69
RP10	0.94	1.78	2.95	4.59	6.01	5.83	5.07	2.48	1.04	0.26	0.06	0.14	21.18
RP25	1.74	2.52	3.97	5.86	8.06	7.61	6.53	3.44	1.66	0.48	0.12	0.31	25.40
RP50	2.41	3.08	4.70	6.76	9.59	8.92	7.61	4.14	2.14	0.66	0.17	0.46	28.51
RP100	3.11	3.63	5.43	7.64	11.58	10.16	8.63	4.84	2.63	0.85	0.22	0.62	31.44
RP200	3.84	4.18	6.15	8.49	12.57	11.38	9.62	5.54	3.13	1.04	0.28	0.79	34.31
RP500	5.30	5.10	7.05	9.58	14.51	12.94	10.91	6.70	4.07	1.42	0.40	1.15	38.01
RP1000	5.58	5.44	7.77	10.37	15.97	14.08	11.84	7.15	4.32	1.50	0.42	1.21	40.71
RP10000	8.19	7.25	10.04	12.97	20.77	17.85	14.93	9.41	6.04	2.19	0.63	1.84	49.62

SANTA BARBARA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
123 East Anapamu Street, Santa Barbara, California 93101.

MAP COORDINATES: B3

LAT. 34 51'
LONG. 120 13'
EL. 600

RAINFALL RECORDS BY WATER YEARS.

STATION: SISQUOC RANCH NUMBER: SIR415

YEAR	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEASON
1904-05	3.73	1.00	0.05	1.78	1.42	6.63	8.71	0.75	2.10	0.00	0.00	0.00	26.17
1905-06	0.01	0.27	1.10	0.00	2.70	5.02	8.76	0.52	1.30	0.00	0.00	0.00	19.68
1906-07	0.00	0.00	0.25	4.86	11.79	1.48	3.48	0.00	0.00	0.10	0.00	0.00	21.96
1907-08	0.00	3.73	0.00	1.38	4.97	4.18	0.34	0.32	0.00	0.00	0.00	0.00	14.92
1908-09	1.90	1.13	1.25	1.66	15.80	7.63	5.15	0.00	0.00	0.00	0.00	0.00	34.52
1909-10	0.00	0.95	2.09	8.42	2.15	0.45	4.14	0.00	0.00	0.00	0.10	0.00	18.30
1910-11	1.09	0.36	0.10	0.55	7.85	4.34	11.11	0.48	0.00	0.00	0.00	0.00	25.88
1911-12	0.00	0.00	0.17	1.40	0.80	0.00	5.46	1.92	0.41	0.00	0.00	0.00	10.16
1912-13	0.00	0.00	0.36	0.20	1.89	2.87	0.74	0.00	0.00	0.38	0.00	1.02	7.46
1913-14	0.10	0.00	2.28	2.37	11.06	4.02	0.96	0.00	0.00	0.41	0.00	0.00	21.20
1914-15	0.00	0.00	0.00	4.77	4.33	8.60	0.83	1.11	1.32	0.00	0.00	0.00	20.96
1937-38	0.00	0.42	3.08	4.59	8.43	4.89	1.60	0.00	0.00	0.00	0.00	0.00	23.01
1938-39	1.17	0.00	0.00	2.82	0.00	2.41	0.00	0.00	0.00	0.00	0.00	0.00	6.40
1939-40	1.70	0.00	0.85	1.95	6.66	2.82	2.44	2.22	0.00	0.00	0.00	0.00	18.64
1940-41	0.00	0.94	0.19	5.49	8.21	8.93	8.41	4.52	0.00	0.00	0.00	0.00	36.69
1941-42	0.20	1.01	0.36	8.32	1.57	0.56	2.13	3.62	0.00	0.00	0.00	0.00	17.77
1942-43	0.00	0.76	1.42	3.54	5.68	1.75	3.46	1.35	0.00	0.00	0.00	0.00	17.96
1943-44	0.00	0.93	0.18	3.58	1.66	7.04	0.80	1.48	0.10	0.00	0.00	0.00	15.77
1944-45	0.00	0.41	3.63	1.73	0.00	4.05	3.75	0.13	0.05	0.00	0.00	0.00	13.75
1945-46	0.00	0.38	0.75	3.75	0.64	1.32	5.01	0.00	0.00	0.00	0.00	0.00	11.85
1946-47	0.00	0.62	3.44	1.51	0.43	0.65	0.81	0.43	0.13	0.00	0.00	0.00	8.02
1947-48	0.00	0.22	0.16	0.46	0.00	2.42	2.92	2.52	1.01	0.00	0.00	0.00	9.71
1948-49	0.00	0.00	0.00	3.01	1.15	2.00	3.75	0.15	1.04	0.00	0.00	0.00	11.10
1949-50	0.00	0.00	1.84	3.00	3.07	1.68	1.45	0.80	0.20	0.00	0.00	0.00	12.04
1950-51	0.05	0.83	2.35	0.91	1.58	2.42	0.22	1.55	0.00	0.00	0.00	0.20	10.11
1951-52	0.00	0.76	1.26	4.52	6.54	1.00	7.43	0.69	0.00	0.08	0.00	0.00	22.28
1952-53	0.00	0.00	3.66	5.57	1.61	0.00	1.36	1.48	0.00	0.00	0.00	0.00	13.68
1953-54	0.00	0.00	2.62	0.32	4.69	1.13	4.00	0.36	0.00	0.00	0.00	0.00	13.12
1954-55	0.00	0.00	1.28	3.37	4.33	1.63	0.35	1.34	1.26	0.00	0.00	0.00	13.56
1955-56	0.00	0.00	1.96	6.88	4.09	0.58	0.00	1.68	0.00	0.00	0.00	0.00	15.19
1956-57	0.00	0.46	0.00	0.25	3.15	3.15	0.55	1.20	1.50	0.18	0.00	0.00	10.44
1957-58	0.00	1.95	0.38	3.51	2.85	6.15	3.98	6.58	0.00	0.00	0.00	0.60	26.00
1958-59	0.75	0.00	0.27	0.30	2.56	4.39	0.00	1.37	0.00	0.00	0.00	0.00	9.64
1959-60	0.00	0.00	0.00	0.52	4.01	4.01	1.01	2.30	0.00	0.00	0.00	0.00	11.85
1960-61	0.45	0.63	3.61	1.17	1.05	0.10	1.10	0.40	0.27	0.00	0.00	0.00	8.78
1961-62	0.00	0.00	3.00	2.04	3.08	12.61	1.85	0.00	0.00	0.00	0.00	0.00	22.58
1962-63	0.00	1.48	0.00	0.21	0.35	4.93	3.30	2.80	0.38	0.05	0.00	0.16	13.66
1963-64	0.00	0.00	2.59	0.10	1.92	0.10	1.86	0.96	0.60	0.25	0.03	0.00	8.41
1964-65	0.00	2.03	3.22	2.03	1.33	0.41	1.72	4.59	0.00	0.00	0.00	0.00	15.33
1965-66	0.00	0.00	5.79	4.15	1.57	1.20	0.00	0.12	0.00	0.00	0.00	0.00	12.83
1966-67	0.22	0.00	2.45	5.39	3.72	0.46	2.61	6.87	0.17	0.27	0.00	0.00	22.16
1967-68	0.36	0.00	2.60	1.32	1.35	1.24	3.78	0.82	0.05	0.00	0.00	0.00	11.52
1968-69	0.00	1.93	1.00	2.17	9.75	8.68	1.42	1.80	0.10	0.00	0.00	0.00	26.85
1969-70	0.00	0.32	1.24	0.55	3.80	1.19	3.43	0.15	0.00	0.00	0.00	0.00	10.68
1970-71	0.00	0.07	3.37	4.07	0.76	0.36	0.53	0.93	0.99	0.00	0.00	0.00	11.08
1971-72	0.02	0.18	0.53	5.36	0.11	0.39	0.00	0.31	0.00	0.00	0.12	0.00	7.02
1972-73	0.00	0.43	4.95	1.39	4.86	6.03	4.12	0.00	0.00	0.00	0.00	0.00	21.78
1973-74	0.00	0.44	3.14	2.68	5.48	0.18	4.25	1.30	0.00	0.00	0.00	0.00	17.47
1974-75	0.07	1.75	0.20	3.96	0.14	3.82	4.94	1.43	0.00	0.00	0.00	0.00	16.31
1975-76	0.00	0.68	0.51	0.22	0.00	5.47	1.84	1.56	0.05	0.00	0.00	0.53	10.86
1976-77	5.14	0.20	0.49	0.62	2.46	0.18	1.85	0.00	2.08	0.03	0.00	0.00	13.05
1977-78	0.00	0.00	0.08	3.69	5.05	9.89	7.66	2.75	0.00	0.00	0.00	0.00	29.12
1978-79	2.03	0.00	1.73	1.73	4.70	4.35	4.18	0.00	0.10	0.00	0.00	0.00	18.82
1979-80	0.24	1.14	0.74	1.56	4.32	7.25	2.46	1.39	0.35	0.00	0.00	0.00	19.45
1980-81	0.00	0.00	0.00	0.55	4.79	2.65	5.37	0.66	0.00	0.00	0.00	0.00	14.02
1981-82	0.00	0.98	1.22	1.01	2.96	0.92	5.91	3.40	0.00	0.00	0.00	0.34	16.74
1982-83	0.49	1.99	4.85	1.94	8.21	5.02	9.96	2.94	0.26	0.00	0.00	0.34	36.00
1983-84	0.10	1.35	3.08	3.97	0.20	0.50	0.67	0.59	0.00	0.00	0.00	0.00	10.46
1984-85	0.00	0.94	3.47	4.04	0.69	1.48	2.17	0.06	0.00	0.00	0.00	0.18	13.03

1985-86	0.01	0.41	3.58	0.63	0.83	4.92	6.80	0.53	0.00	0.00	0.00	0.00	17.71
1986-87	0.95	0.00	0.75	1.28	1.73	1.54	3.60	0.00	0.00	0.00	0.00	0.00	9.85
1987-88	0.00	1.41	1.19	3.67	2.07	1.73	0.80	2.68	0.29	0.15	0.00	0.00	13.99
1988-89	0.00	0.00	1.24	4.99	0.46	1.25	0.73	0.37	0.44	0.00	0.00	0.00	9.48
1989-90	1.07	0.22	0.45	0.02	2.68	2.34	0.38	0.13	0.63	0.00	0.00	0.00	7.92
SUM	21.85	35.71	98.40	163.80	218.09	201.39	194.40	80.41	17.18	1.90	0.25	3.37	1036.75
N	64	64	64	64	64	64	64	64	64	64	64	64	64
MEAN	0.34	0.56	1.54	2.56	3.41	3.15	3.04	1.26	0.27	0.03	0.00	0.05	16.20
MAX	5.14	3.73	5.79	8.42	15.80	12.61	11.11	6.87	2.10	0.41	0.12	1.02	36.69
MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.40
STD	0.88	0.71	1.46	2.03	3.20	2.83	2.68	1.49	0.50	0.09	0.02	0.17	6.99
Z	5.24	4.44	2.69	2.73	4.04	3.04	3.05	4.03	3.73	4.40	7.80	4.48	2.87
CV	2.57	1.28	0.95	0.79	0.94	0.90	0.88	1.19	1.87	2.87	4.99	3.21	0.43
Reg CV	2.68	1.28	1.03	0.84	0.90	0.99	0.87	1.11	1.83	2.91	3.81	4.10	0.44
Reg Skew	3.80	1.80	1.40	1.00	1.60	1.10	1.10	1.70	2.60	3.60	4.40	4.80	1.10
FIC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
RP2	0.00	0.36	1.18	2.21	2.64	2.59	2.56	0.88	0.09	0.00	0.00	0.00	14.92
RP5	0.58	1.02	2.65	4.19	5.48	5.47	5.01	2.18	0.50	0.06	0.01	0.07	21.51
RP10	1.29	1.50	3.65	5.44	7.49	7.32	6.58	3.10	0.87	0.12	0.02	0.23	25.75
RP25	2.40	2.12	4.91	6.95	10.03	9.56	8.48	4.30	1.38	0.22	0.04	0.52	30.88
RP50	3.32	2.59	5.81	8.02	11.93	11.22	9.88	5.18	1.79	0.31	0.05	0.77	34.66
RP100	4.28	3.06	6.72	9.05	13.80	12.77	11.20	6.05	2.20	0.40	0.07	1.03	38.22
RP200	5.29	3.52	7.60	10.06	15.64	14.30	12.50	6.93	2.62	0.49	0.09	1.31	41.72
RP500	7.31	4.30	8.73	11.35	18.65	16.26	14.16	8.38	3.40	0.67	0.13	1.91	46.21
RP1000	7.70	4.59	9.61	12.30	19.88	17.69	15.38	8.94	3.60	0.71	0.13	2.00	49.49
RP10000	11.29	6.11	12.42	15.37	25.86	22.43	19.40	11.77	5.05	1.03	0.20	3.04	60.32

(7)

SANTA BARBARA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
123 East Anapamu Street, Santa Barbara, California 93101.

MAP COORDINATES:
83

LAT. 34 59'
LONG. 120 19'
EL. 582

RAINFALL RECORDS BY WATER YEARS.

STATION: TWITCHELL DAM

NUMBER: TWI356

YEAR	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEASON
1961-62	0.00	0.00	0.00	0.00	0.00	0.00	1.13	0.03	0.15	0.01	0.00	0.00	1.32
1962-63	0.00	0.66	0.00	0.26	1.01	3.94	3.40	3.39	0.73	0.03	0.00	0.07	13.49
1963-64	0.45	1.98	2.93	0.13	1.30	0.05	2.29	1.19	0.43	0.32	0.00	0.00	11.07
1964-65	0.14	1.76	3.00	2.18	1.47	0.74	1.53	4.14	0.00	0.00	0.00	0.00	14.96
1965-66	0.00	0.00	5.10	3.92	1.22	1.09	0.27	0.13	0.00	0.00	0.07	0.00	11.80
1966-67	0.33	0.02	2.84	5.75	4.04	0.41	3.05	6.63	0.32	0.30	0.00	0.00	23.69
1967-68	0.49	0.00	2.69	1.90	1.37	1.68	3.18	0.79	0.13	0.00	0.00	0.00	12.23
1968-69	0.00	2.40	1.08	2.51	11.44	8.36	1.09	1.77	0.01	0.00	0.09	0.00	28.75
1969-70	0.09	0.44	1.11	0.93	3.77	1.75	1.86	0.03	0.00	0.10	0.00	0.00	10.08
1970-71	0.00	0.12	4.26	3.99	1.20	0.13	0.79	1.24	1.70	0.00	0.00	0.00	13.43
1971-72	0.06	0.78	1.05	3.80	0.29	0.74	0.00	0.51	0.16	0.00	0.08	0.00	7.47
1972-73	0.00	0.53	4.95	1.81	5.43	8.08	4.97	0.00	0.03	0.06	0.00	0.00	25.86
1973-74	0.00	0.84	4.14	2.65	5.95	0.19	5.83	2.05	0.00	0.00	0.04	0.00	21.69
1974-75	0.00	1.80	0.59	3.95	0.15	4.20	5.00	2.36	0.00	0.00	0.00	0.00	18.05
1975-76	0.00	1.50	0.39	0.09	0.01	4.76	2.49	1.46	0.05	0.00	0.12	1.09	11.96
1976-77	4.69	1.48	0.44	1.38	1.77	0.06	2.06	0.02	1.84	0.05	0.00	0.00	13.79
1977-78	0.00	0.04	0.24	5.28	5.87	9.85	5.61	2.61	0.00	0.00	0.01	0.00	29.51
1978-79	1.95	0.00	1.47	2.17	4.17	3.98	4.94	0.16	0.06	0.00	0.00	0.00	18.90
1979-80	0.22	1.34	0.62	1.61	7.17	7.10	2.67	1.24	0.50	0.00	0.07	0.00	22.54
1980-81	0.00	0.00	0.00	1.24	5.65	2.77	6.47	1.18	0.03	0.00	0.00	0.00	17.34
1981-82	0.00	1.19	1.58	1.85	4.07	1.36	5.87	4.35	0.02	0.22	0.00	0.00	20.51
1982-83	0.73	1.93	5.88	1.73	7.39	6.23	7.59	2.78	0.56	0.05	0.00	0.32	35.19
1983-84	0.24	0.92	3.47	3.75	0.10	0.60	0.81	0.59	0.00	0.04	0.00	0.02	10.54
1984-85	0.03	1.31	2.12	3.45	1.18	2.30	3.23	0.20	0.00	0.00	0.00	0.00	13.82
1985-86	0.13	0.49	3.32	0.67	1.76	3.21	6.28	0.48	0.00	0.00	0.00	0.00	16.34
1986-87	1.81	0.00	0.37	1.61	2.36	2.47	4.22	0.42	0.02	0.06	0.03	0.00	13.37
1987-88	0.00	1.66	0.88	3.26	2.36	2.28	0.13	3.69	0.14	0.01	0.00	0.00	14.41
1988-89	0.06	0.00	1.77	6.59	0.63	1.36	1.48	0.24	0.17	0.00	0.00	0.00	12.30
1989-90	0.87	0.37	0.73	0.05	4.12	2.38	0.43	0.25	0.58	0.00	0.00	0.00	9.78
	.39	.75	[illegible]	2.35	3.17	[illegible]	[illegible]						
SUM	12.29	23.56	57.02	68.51	87.25	82.07	88.67	43.93	7.63	1.25	0.51	1.50	474.19
N	29	29	29	29	29	29	29	29	29	29	29	29	29
MEAN	0.42	0.81	1.97	2.36	3.01	2.83	3.06	1.51	0.26	0.04	0.02	0.05	16.35
MAX	4.69	2.40	5.88	6.59	11.44	9.85	7.59	6.63	1.84	0.32	0.12	1.09	35.19
MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.32
STD	0.94	0.75	1.69	1.73	2.73	2.71	2.16	1.62	0.46	0.09	0.03	0.20	7.16
Z	3.76	1.53	1.93	2.13	3.11	2.51	1.70	3.04	3.28	2.21	1.53	4.90	2.62
CV	2.23	0.92	0.86	0.73	0.91	0.96	0.71	1.07	1.74	1.98	1.90	3.96	0.44
Reg CV	2.68	1.28	1.03	0.84	0.90	0.99	0.87	1.11	1.83	2.91	3.81	4.10	0.44
Reg Skew	3.80	1.80	1.40	1.00	1.60	1.10	1.10	1.70	2.60	3.60	4.40	4.80	1.10
FIC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
RP2	0.00	0.52	1.51	2.04	2.33	2.33	2.58	1.06	0.08	0.00	0.00	0.00	15.06
RP5	0.72	1.48	3.39	3.87	4.84	4.92	5.04	2.62	0.49	0.08	0.03	0.07	21.71
RP10	1.60	2.19	4.67	5.02	6.61	6.58	6.62	3.73	0.85	0.18	0.08	0.23	25.99
RP25	2.98	3.09	6.28	6.41	8.86	8.60	8.54	5.18	1.36	0.33	0.16	0.51	31.17
RP50	4.13	3.78	7.43	7.40	10.54	10.09	9.95	6.24	1.75	0.45	0.24	0.75	34.99
RP100	5.32	4.45	8.59	8.36	12.19	11.49	11.28	7.30	2.16	0.58	0.32	1.01	38.58
RP200	6.57	5.13	9.72	9.29	13.81	12.86	12.58	8.36	2.56	0.71	0.40	1.29	42.11
RP500	9.08	6.26	11.16	10.48	16.47	14.63	14.26	10.11	3.33	0.97	0.57	1.88	46.64
RP1000	9.56	6.68	12.29	11.35	17.55	15.91	15.48	10.78	3.53	1.03	0.60	1.97	49.95
RP10000	14.02	8.89	15.88	14.19	22.83	20.17	19.52	14.19	4.95	1.49	0.90	2.99	60.89

SANTA BARBARA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
123 East Anapamu Street, Santa Barbara, California 93101

MAP COORDINATES: B1

RAINFALL RECORDS BY WATER YEARS.

LAT. 34 55'
LONG. 120 31'
EL. 160

STATION: UNION SUGAR CO.

NUMBER: BET387

YEAR	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEASON
1897-98	0.10	0.67	0.03	0.55	1.44	1.06	0.65	0.02	1.14	0.00	0.00	0.00	5.66
1898-99	0.36	0.30	0.05	0.64	3.49	0.52	3.88	1.02	0.00	0.44	0.00	0.00	10.70
1899-00	0.00	1.36	1.02	0.73	0.83	0.13	1.94	0.67	1.10	0.00	0.00	0.00	7.78
1900-01	0.00	0.47	3.53	0.11	3.96	2.75	0.31	1.53	0.45	0.00	0.00	0.00	13.11
1901-02	0.00	1.77	0.74	0.00	1.47	4.03	2.07	1.92	0.04	0.00	0.00	0.03	12.07
1902-03	0.00	0.81	1.75	1.00	1.76	1.87	3.36	0.87	0.00	0.00	0.00	0.00	11.42
1903-04	0.00	0.00	0.08	0.15	0.38	3.84	2.38	1.20	0.10	0.00	0.00	0.18	8.31
1904-05	2.44	1.32	0.00	1.30	1.95	6.12	4.46	0.49	2.00	0.00	0.03	0.00	20.11
1905-06	0.10	0.00	1.36	0.29	3.25	3.21	6.39	0.73	2.30	0.00	0.00	0.00	17.63
1906-07	0.12	0.00	0.73	4.59	8.60	0.68	3.82	0.19	0.11	0.00	0.00	0.00	18.84
1907-08	0.11	0.95	0.00	2.33	4.54	3.86	0.23	0.24	0.18	0.00	0.00	0.00	12.44
1908-09	1.02	0.40	0.98	0.66	13.27	6.73	5.03	0.00	0.00	0.00	0.00	0.00	28.09
1909-10	0.00	0.54	1.60	6.72	2.38	0.25	3.52	0.15	0.00	0.00	0.00	0.00	15.16
1910-11	0.49	0.63	0.32	0.42	6.75	4.52	5.89	1.10	0.08	0.00	0.00	0.00	20.20
1911-12	0.00	0.00	0.19	1.91	1.44	0.14	3.50	1.18	1.19	0.00	0.00	0.00	9.55
1912-13	0.08	0.02	0.42	0.25	2.86	1.66	0.60	0.48	0.00	0.15	0.36	0.97	7.85
1913-14	0.00	0.00	2.32	3.40	10.30	3.04	1.06	0.24	0.10	0.00	0.00	0.00	20.46
1914-15	0.00	0.00	0.71	4.85	4.82	7.08	0.20	1.04	1.35	0.00	0.00	0.00	20.05
1915-16	0.00	0.00	0.56	3.74	7.86	1.20	1.33	0.10	0.00	0.00	0.00	0.00	14.79
1916-17	2.09	1.78	0.49	6.06	1.69	1.87	0.37	0.07	0.26	0.00	0.00	0.00	14.68
1917-18	0.00	0.08	0.12	0.36	0.36	8.55	5.77	0.05	0.00	0.00	0.00	0.12	15.41
1918-19	0.23	0.67	3.46	2.01	0.91	2.45	1.77	0.00	0.47	0.00	0.00	0.12	12.09
1919-20	0.21	0.17	0.12	1.99	0.18	1.43	4.16	0.85	0.00	0.00	0.00	0.00	9.11
1920-21	0.00	0.65	1.08	1.57	3.11	1.96	1.60	0.26	1.32	0.00	0.00	0.00	11.55
1921-22	0.49	0.12	0.17	3.68	3.71	3.18	2.44	0.31	0.47	0.00	0.00	0.00	14.57
1922-23	0.00	0.45	1.16	3.06	1.87	1.39	0.09	4.66	0.00	0.07	0.00	0.00	12.75
1923-24	0.18	0.10	0.10	0.54	0.90	0.38	3.21	1.04	0.00	0.00	0.00	0.00	6.45
1924-25	0.00	0.69	0.56	1.92	1.73	1.73	3.40	2.63	1.30	0.17	0.00	0.00	14.13
1925-26	0.00	0.15	0.26	2.06	1.95	3.75	0.64	2.15	0.05	0.00	0.00	0.00	11.01
1926-27	0.00	0.63	3.37	0.98	2.10	5.02	1.24	1.46	0.11	0.06	0.00	0.00	14.97
1927-28	0.00	2.14	1.01	3.88	0.19	2.70	2.28	0.16	0.61	0.00	0.00	0.00	12.97
1928-29	0.00	0.00	2.26	2.56	1.62	1.63	1.37	0.74	0.00	0.16	0.00	0.00	10.34
1929-30	0.00	0.00	0.00	0.08	3.86	1.19	2.80	0.94	0.49	0.07	0.00	0.00	9.43
1930-31	0.28	0.00	2.10	0.04	4.18	1.43	0.16	0.56	0.57	0.00	0.00	0.00	9.32
1931-32	0.00	0.11	2.24	6.56	3.25	3.26	0.23	0.09	0.22	0.00	0.00	0.67	16.63
1932-33	0.32	0.00	0.06	1.29	6.60	0.39	0.71	0.20	0.25	1.80	0.00	0.00	11.62
1933-34	0.00	0.30	0.00	2.79	1.07	1.80	0.29	0.00	0.03	0.60	0.00	0.00	6.88
1934-35	0.00	1.84	2.19	1.01	3.92	1.25	3.23	0.70	0.00	0.00	0.00	0.00	14.14
1935-36	0.25	0.35	2.03	1.44	1.20	5.20	0.77	0.72	0.02	0.13	0.00	0.40	12.51
1936-37	0.00	1.32	0.00	5.84	3.28	3.93	3.76	0.34	0.00	0.00	0.11	0.07	16.65
1937-38	0.00	0.33	0.41	2.79	4.38	6.49	4.01	1.41	0.00	0.00	0.00	0.00	19.82
1938-39	0.93	0.31	0.31	1.79	3.56	1.99	2.72	0.26	0.04	0.00	0.00	0.00	11.91
1939-40	2.01	0.53	0.86	1.50	3.96	2.76	1.89	0.54	0.00	0.00	0.00	0.00	14.05
1940-41	0.00	0.62	0.16	5.16	5.09	7.48	7.55	3.03	0.07	0.00	0.00	0.00	29.16
1941-42	0.00	1.04	0.32	7.33	1.48	1.19	2.26	0.15	0.00	0.00	0.04	0.09	13.90
1942-43	0.00	1.05	0.71	1.68	6.39	1.24	2.20	1.08	0.10	0.00	0.00	0.00	14.45
1943-44	0.00	1.05	0.22	3.20	1.29	4.99	0.66	1.59	0.09	0.00	0.00	0.00	13.09
1944-45	0.00	0.32	2.03	1.33	0.87	2.43	3.76	0.09	0.00	0.16	0.00	0.00	10.99
1945-46	0.00	0.52	0.64	2.94	0.45	1.69	0.97	0.21	0.18	0.00	0.00	0.00	7.60
1946-47	0.27	0.14	3.38	1.43	0.34	0.83	1.22	0.18	0.18	0.03	0.00	0.00	8.00
1947-48	0.04	0.46	0.07	0.52	0.03	1.42	3.27	1.70	0.65	0.00	0.00	0.00	8.16
1948-49	0.00	0.07	0.00	3.26	1.48	2.04	2.57	0.22	0.91	0.00	0.00	0.00	10.55
1949-50	0.00	0.17	0.92	2.35	2.78	3.39	1.61	0.76	0.09	0.00	0.00	0.00	12.07
1950-51	0.00	0.77	1.00	0.70	2.57	1.81	0.16	1.79	0.01	0.00	0.98	0.00	9.79
1951-52	0.13	0.75	1.37	4.34	5.66	0.72	5.21	0.34	0.00	0.06	0.00	0.00	18.58
1952-53	0.00	0.00	3.63	4.36	1.37	0.00	1.04	1.62	0.00	0.00	0.00	0.00	12.02
1953-54	0.00	0.00	2.51	0.12	3.39	1.57	3.54	0.38	0.00	0.04	0.00	0.00	11.55
1954-55	0.00	0.00	1.00	1.91	4.47	1.70	0.39	2.44	0.29	0.00	0.00	0.00	12.20
1955-56	0.00	0.00	2.05	5.15	3.81	0.81	0.00	1.48	0.37	0.00	0.00	0.00	13.67
1956-57	0.00	0.50	0.00	0.61	2.55	2.02	0.58	1.21	0.97	0.19	0.00	0.00	8.63

1957-58	0.00	1.07	0.33	2.34	2.68	5.09	5.90	3.03	0.13	0.00	0.00	0.00	20.57
1958-59	0.93	0.00	0.31	0.22	2.05	5.34	0.00	0.41	0.00	0.00	0.00	0.00	9.26
1959-60	0.32	0.00	0.00	0.32	3.38	5.50	0.88	1.95	0.00	0.00	0.00	0.00	12.35
1960-61	0.00	1.24	3.64	0.93	0.94	0.17	0.97	0.25	0.15	0.00	0.00	0.00	8.29
1961-62	0.03	0.00	2.11	1.51	3.12	10.26	1.60	0.00	0.20	0.05	0.00	0.07	18.95
1962-63	0.00	0.72	0.06	0.41	1.59	3.47	3.84	2.19	0.45	0.00	0.00	0.00	12.73
1963-64	0.40	1.39	1.71	0.22	1.13	0.05	2.87	0.15	0.27	0.14	0.00	0.05	8.38
1964-65	0.00	1.87	2.75	1.86	0.96	0.58	1.82	3.28	0.00	0.00	0.01	0.14	13.27
1965-66	0.00	0.10	3.72	2.97	1.07	0.94	0.23	0.00	0.00	0.06	0.00	0.00	9.09
1966-67	0.15	0.00	2.31	3.83	3.28	0.54	2.72	3.83	0.23	0.30	0.00	0.00	17.19
1967-68	0.29	0.00	2.57	1.68	0.96	0.98	2.37	0.57	0.04	0.00	0.00	0.00	9.46
1968-69	0.00	1.90	1.13	2.12	9.10	7.72	0.59	1.89	0.00	0.00	0.00	0.00	24.45
1969-70	0.10	0.28	1.10	0.47	2.66	3.03	1.36	0.00	0.00	0.05	0.00	0.00	9.05
1970-71	0.00	0.05	3.13	3.67	1.01	0.12	0.45	0.94	0.67	0.00	0.00	0.00	10.04
1971-72	0.10	0.30	0.80	2.99	0.21	0.45	0.00	0.28	0.00	0.00	0.00	0.00	5.13
1972-73	0.00	1.19	4.20	1.20	5.40	5.99	3.06	0.00	0.02	0.00	0.00	0.00	21.06
1973-74	0.09	0.58	2.64	2.61	4.65	0.08	5.74	0.56	0.00	0.00	0.00	0.00	16.95
1974-75	0.00	1.02	0.16	4.33	0.08	3.75	3.55	1.02	0.00	0.00	0.00	0.00	13.91
1975-76	0.00	0.80	0.39	0.47	0.00	3.90	1.40	1.06	0.00	0.00	0.00	1.08	9.10
1976-77	2.75	0.44	0.59	1.35	2.59	0.10	1.35	0.00	2.19	0.00	0.00	0.00	11.36
1977-78	0.00	0.00	0.29	4.18	6.01	7.00	6.56	2.67	0.00	0.00	0.00	0.00	26.71
1978-79	1.62	0.00	1.04	1.45	4.10	3.99	3.57	0.09	0.10	0.00	0.00	0.00	15.96
1979-80	0.30	0.58	0.43	1.28	4.63	6.13	2.35	0.64	0.38	0.06	0.00	0.00	16.78
1980-81	0.00	0.02	0.00	1.43	3.49	2.45	6.25	0.29	0.00	0.00	0.00	0.00	13.93
1981-82	0.00	1.00	1.05	0.92	2.95	1.29	4.15	3.51	0.00	0.20	0.00	0.21	15.28
1982-83	0.31	1.39	3.84	1.48	6.64	6.26	6.04	2.23	0.10	0.00	0.00	0.33	28.62
1983-84	0.00	1.71	1.89	3.08	0.59	0.55	0.61	0.00	0.00	0.00	0.00	0.00	8.43
1984-85	0.00	0.60	2.36	2.98	1.15	1.34	2.13	0.12	0.00	0.00	0.00	0.00	10.68
1985-86	0.00	0.43	2.02	2.06	0.85	3.64	4.55	0.46	0.00	0.00	0.00	0.00	14.01
1986-87	0.98	0.00	1.19	1.24	1.87	1.97	3.64	0.24	0.00	0.00	0.00	0.00	11.13
1987-88	0.00	2.13	1.18	2.59	1.80	1.97	0.36	2.88	0.15	0.15	0.00	0.00	13.21
1988-89	0.00	0.00	1.27	4.37	0.55	1.29	0.79	0.15	0.06	0.00	0.00	0.00	8.48
1989-90	0.82	0.01	0.58	0.03	2.34	0.66	0.00	0.00	0.37	0.00	0.00	0.00	4.81
SUM	21.44	50.24	111.55	198.42	268.78	250.35	218.22	86.27	25.77	5.14	1.53	4.53	1242.25
N	93	93	93	93	93	93	93	93	93	93	93	93	92
MEAN	0.23	0.54	1.20	2.13	2.89	2.69	2.35	0.93	0.28	0.06	0.02	0.05	13.36
MAX	2.75	2.14	4.20	7.33	13.27	10.26	7.55	4.66	2.30	1.80	0.98	1.08	29.16
MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.81
STD	0.53	0.58	1.14	1.71	2.39	2.24	1.87	1.00	0.48	0.20	0.11	0.17	5.08
Z	4.08	2.31	2.43	2.90	3.99	2.84	2.55	3.62	3.99	10.85	15.37	5.16	2.69
CV	2.28	1.08	0.95	0.80	0.83	0.83	0.80	1.08	1.74	3.69	6.55	3.53	0.38
Reg CV	2.68	1.28	1.03	0.84	0.90	0.99	0.87	1.11	1.83	2.91	3.81	4.10	0.44
Reg Skew	3.80	1.80	1.40	1.00	1.60	1.10	1.10	1.70	2.60	3.60	4.40	4.80	1.10
FIC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
RP2	0.00	0.35	0.92	1.84	2.24	2.21	1.98	0.65	0.09	0.00	0.00	0.00	12.30
RP5	0.39	0.98	2.07	3.49	4.65	4.68	3.87	1.61	0.52	0.10	0.03	0.07	17.74
RP10	0.87	1.45	2.85	4.54	6.35	6.26	5.08	2.29	0.90	0.23	0.07	0.22	21.23
RP25	1.62	2.05	3.83	5.79	8.51	8.18	6.55	3.17	1.43	0.42	0.15	0.48	25.46
RP50	2.24	2.51	4.54	6.69	10.12	9.59	7.63	3.82	1.84	0.58	0.22	0.71	28.58
RP100	2.89	2.96	5.24	7.55	11.71	10.93	8.65	4.47	2.27	0.74	0.30	0.96	31.52
RP200	3.57	3.41	5.93	8.39	13.27	12.23	9.65	5.12	2.70	0.91	0.37	1.22	34.40
RP500	4.94	4.16	6.81	9.46	15.82	13.91	10.94	6.19	3.51	1.25	0.53	1.77	38.10
RP1000	5.20	4.44	7.50	10.25	16.86	15.14	11.88	6.60	3.72	1.31	0.56	1.85	40.80
RP10000	7.63	5.91	9.69	12.82	21.93	19.19	14.98	8.69	5.21	1.92	0.84	2.82	49.74

APPENDIX B

GROUND WATER INJECTION PROPOSAL

MEMORANDUM

TO: ROB ALMY, WATER AGENCY MANAGER

FROM: CHRIS DAHLSTROM, HYDROLOGIST

DATE: February 1, 1993

SUBJECT: **REVISED SANTA MARIA VALLEY GROUND WATER INJECTION PROPOSAL**

The following outline has been revised to reflect modifications or comments by Water Agency Staff. The outline contains a revised compilation of information and data which may be necessary to prepare a ground water injection program (GWIP) in the Santa Maria Valley. The primary assump on and basis of the proposed program is to use unscheduled or surplus State Water Project water for injection into specific zones in the Santa Maria ground water basin. The proposed action would provide future benefits such as conjunctive use, improvement to water quality, drought buffers, emergency supplies, and long-term storage. Similar water bank techniques and programs exist in other areas of California.

I prepared this outline utilizing technical observations and references, practical field experience, consultation with hydrogeologic engineers, collaboration with Jon Ahlroth and Matt Naftaly and incorporated comments by the Water Agency Manager.

A) PROPOSAL OBJECTIVE:

1) To examine the Santa Maria Valley ground water basin as a possible source for banking an undetermined amount of SWP water as surplus and for future use.

2) Prepare a methodology and working program to develop the basis of a detailed plan and implementation program for the storage and utilization of SWP banked water.

B) DESCRIBE THE GROUND WATER BASIN

1) Prepare generalized description of the basin, geologic formations for suitability from USGS maps, hydrologic studies or other technical reference;

2) Research and reference ground water documents and data from City of Santa Maria, Cal Cities or private records;

3) Prepare geologic and formation cross sectional maps of the injection sites;

4) Define Aquifer boundary and its conditions;

5) Prepare maps based on hydrologic data.

C) DERIVE KEY HYDROLOGIC PARAMETERS FROM AVAILABLE INFORMATION (CONTAINED IN THE WATER AGENCY AND OTHER WELL DATA RECORDS):

1) Define source of information;

a) describe the hi ' data, dates, how information wa ;ned and by what method;

b) describe well observations, depth to water, geologic or electric log and driller comments

c) develop lotus spreadsheet and input data

D) PREPARE SCOPE OF GROUND WATER INJECTION AND BANKING ASSESSMENT

1) Identify the potential areas of artificial recharge based on well observation data and geologic formation information;

2) Initiate a record search for wells in the potential field of influence, including specific locations, existing capacities, rates of extraction, and relevant hydrogeologic parameters;

a) Categorize each well within the field of influence as active, stand-by, not used, or abandoned;

b) Identify well pump tests, pump approximate horsepower and ground water level data;

c) Test drilling information Geologic logs or electric logs;

3) Acquire historical records or develop tabulation of natural recharge rates;

4) Identify irrigated lands and quantity of water applied to irrigated acreage both historic and future estimates;

5) Determine historic and projected ground water pumping/return flows

6) Inventory tanks, pipelines or reservoirs;

7) Determine the availability of seasonal, abandoned or active wells for conversion to injection wells;

8) Define relevant formulas or models;

a) Determine the best mathematical formulas or methodology to be used to evaluate the effectiveness of an existing site based on chemical, physical (geologic) and biologic properties including:

b) soil, subsurface permeability, subsoil horizon (clay-pan, iron), depth of soil profile, organic matter and conditions within the soil profile, chemistry interactions between soil and recharge water;

9) Determine the formulas or methodology to evaluate the following;

a) sustained infiltration capacity, maximum storage, and transmission rates of underlying subsurface deposits: physical character and permeability of deposits above the water table; permeability, specific yield, thickness of the deposits, position of water table; transmissivity of aquifer and hydraulic gradients which effect the rate of movement in groundwater injection zone; structural barriers; chemistry of native and natural ground water in relationship to recharge water;

10) Develop short and l   m recharge rates; capacity of deli   ystems; limitations of recharge ra   sulting from natural recharge or seasonal use; ability of the underground formations to accept and transmit recharged water to the areas of pumpage.

11) Develop basic alternative methodologies for each potential area;

a) assess various methods of recharge including low and high pressure injection, percolation basins, modified stream beds, diversion structures and ditch and flooding spreading grounds.

12) Assess potential ground water, geologic and hydrologic considerations;

a) siltation of injection well
b) chemical reaction between import water and native water
c) bacterial/algae growth
d) interference
e) air entrainment
f) precipitants in aquifer
g) release of dissolved gases
h) well casing perforations
i) rearrangement of soil particles

13) Identify and explain the equipment, operational and physical constraints for each site;

E) EVALUATION OF POTENTIAL INJECTION RATE TO EXTRACTION RATE:

1) Evaluate the acceptance rate of aquifer using the following functions:

a) hydraulic conductivity, gradient, length of well casing perforations, casing penetration in the aquifer, perforations open area.

2) Inventory existing extraction and distribution systems and any artificial recharge programs;

3) Develop conceptual modelling and numerical simulations;

a) Use of existing data; and

b) subsequent hydrologic and geologic investigations.

4) Prepare ground water report.

F) LEGAL AND ORGANIZATIONAL EVALUATION FOR STUDY:

1) Establish an agency task force with all potential parties involved (CCWA, City of Santa Maria, City of Guadalupe, Cal Cities, SMWCD, Co of SB);

2) Identify funding source for the preparation of a ground water injection study

a) develop repayment contracts;

3) Acquire permits for evaluation from Dept of Health Service; State Health (John Curfey);

4) Prepare and release R ` well pump test/injection well ret: ı determine accurate rates;

5) Identify land owners; Solicit land owner cooperation and notification;

6) Prepare a draft technical and engineering ground water injection plan;

7) Identify and describe the use of existing facilities including abandoned wells for conversion to injection wells, distribution infrastructure and treatment facilities.

G) DISCUSS POTENTIAL LEGAL AND PUBLIC PERCEPTION ISSUES:

1) Identify potential water rights issues;

2) Discuss potential conflicts with farming and private interests;

3) Displacement of existing ground water;

a) Twitchell recharge and the effects of artifical recharge;

b) Natural changes in the aquifer and effect of artifical recharge;

4) The ramifications of overdraft or mining during drought periods by overlying land owners;

a) Right to water

H) ECONOMIC AND INSTITUTIONAL RELATED FACTORS THAT EFFECT GROUND WATER USE:

1) Identify permits and water quality standards required to inject and extract banked water;

2) Prepare cost estimate

a) well test;

b) developing a well field injection program;

c) operations and maintenance costs;

3) Identify agency in charge of administering and managing program;

a) agency to prepare study;

b) define agency to coordinate field tests and construction manage;

c) coordinate ground water injection program (GWIP).

4) Identify participants and beneficiaries of program.

I) PREPARE COST/BENEFIT AND CONSTRAINTS ANALYSIS:

1) Identify and describe ential benefits of the program;

a) Santa Maria Valley appears to have have sufficient capacity, water levels, gradient and water quality to store surplus SWP water (ag, urban and waste water treatment);

b) CCWA: reliability, cost, operational flexibility, and conjunctive use.

2) Farming and private interests may receive benefits from injection;

a) indicate both long and short-term benefits

gndwater\smvalley.rpt

SUMMARY OF EVENTS ASSOCIATED WITH THE SANTA MARIA GROUND WATER INJECTION PROGRAM

#1. MEMORANDUM DESCRIBING POTENTIAL INJECTION

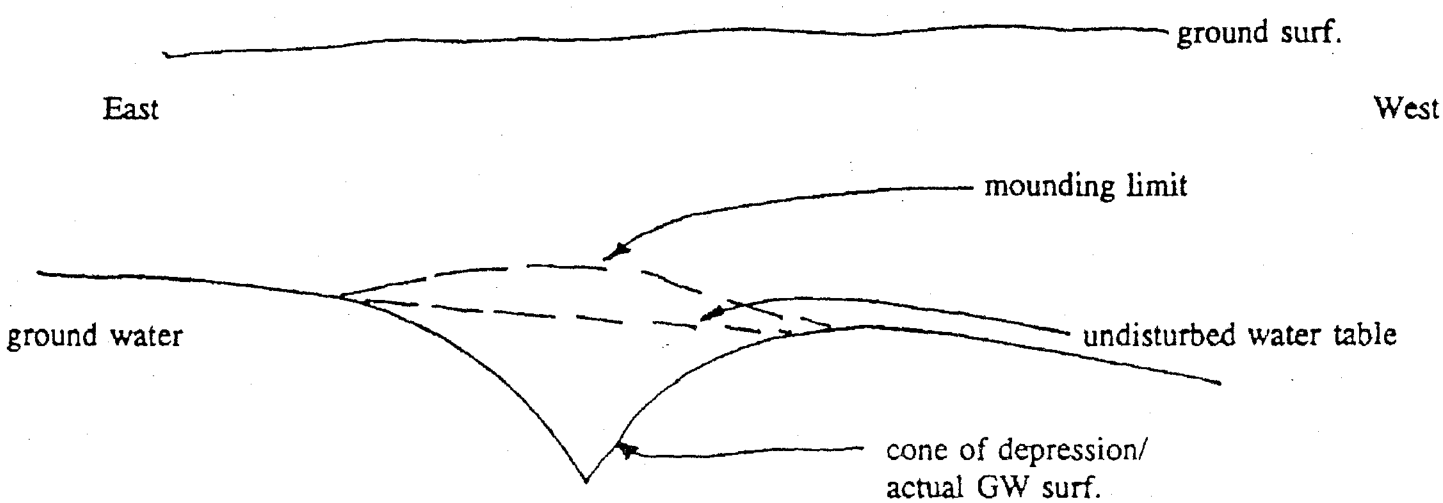
PREPARED BY: Matt Naftaly and Jon Ahlroth

SUBJECT: GROUND WATER INJECTION STUDY

ORIGINAL MEMORANDUM DATE: 11/19/92

<u>SCENARIO 1</u>: Placement of water where it may be recovered by pumping, i.e. area of Orcutt, So. Cal Water Co., and Santa Maria City wells.

Approach - 1) Estimate volume of water table depression and add to it a reasonable estimate of mounding



- Volume of cone of depr[illegible] ;an be found by researching wate[illegible] , in existing wells to define the area of depression and approximate depth.

- Estimate mounding volume (1/3 to 1/2 of cone volume); note that mounding will tend to lose water to unrecoverable areas.

- Rough estimate of available storage for this area including mounding is 10,000 af.

2) To determine feasibility of recharge, examine potential injection rates (see table attached).

* Injection rates can not be determined by pump rates.

- A recharge test would be necessary to accurately predict feasibility. The value of hydraulic conductivity (K) may be found from old pump tests.

Injection Rate: $$Q = \frac{K(hw^2 - ho^2)}{\ln(ro/rw)}$$

h = height of inverted cone

r = radius of inverted cone

- If we assume that the recharge rate is less than 1,000 m^3/day (San Fernando Valley rate is 700 m^3/day), it would take 20 large injection wells to recharge 6,000 af/year.

*** - This scenario depends on how much water is needed to store and in what length of time.

SCENARIO 2: Injecting water anywhere it will fit i.e. alluvial valley near City of Santa Maria.

- Most effectively done by spreading.

- Again depends on how much water is required to store in what period of time.

- Would lose a lot of stored water.

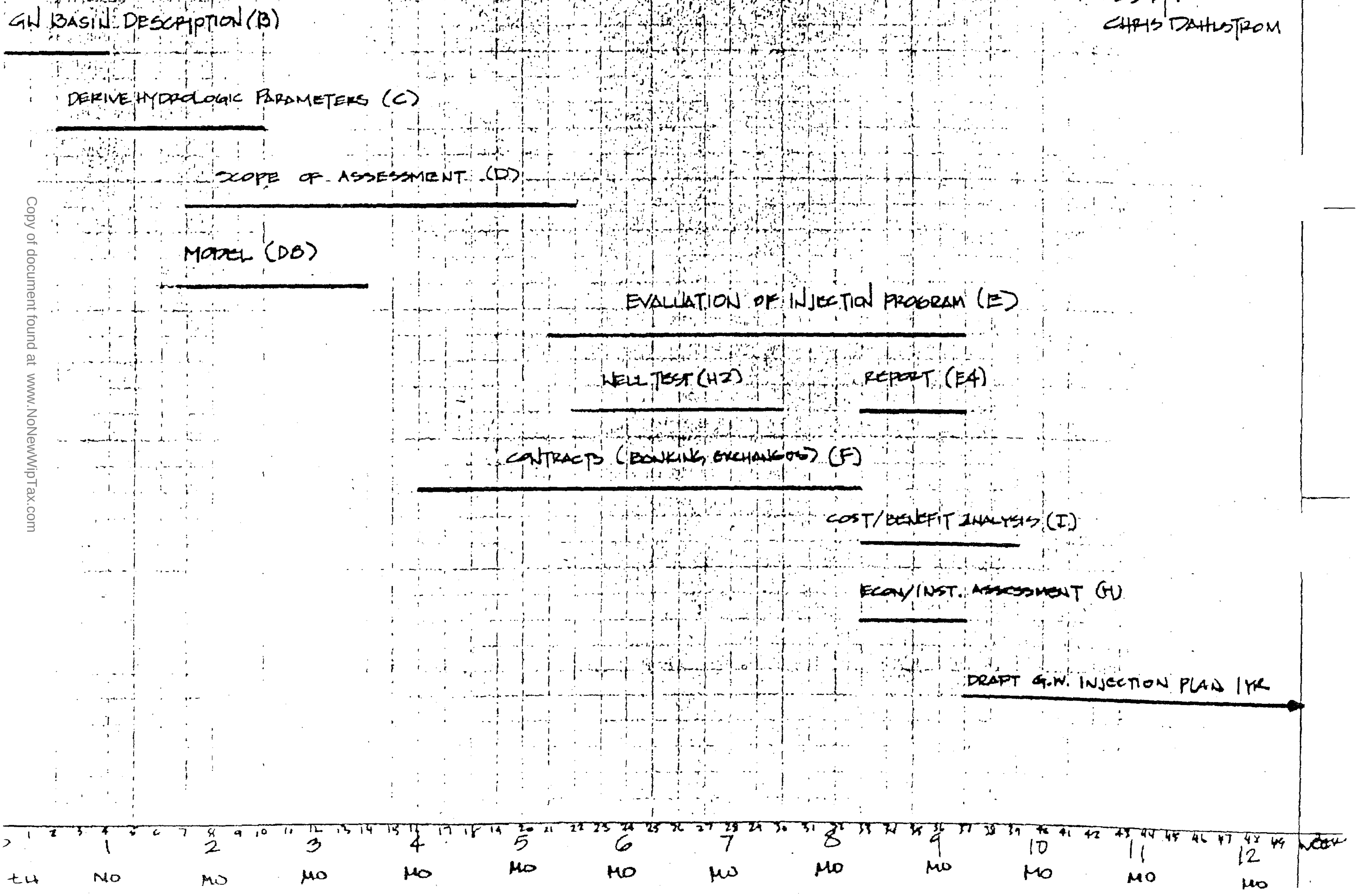
- Would mostly benefit agriculture.

- Removing stored water may exacerbate overdraft?

SANTA MARIA GROUND WATER INJECTION PROGRAM
TIME LINE

2/1/93

PREPARED BY:
CHRIS DAHLSTROM



APPENDIX C

WATER CONSERVATION INFORMATION

Types of Municipal Water Efficiency Programs

There are a variety of water conservation programs which are typically used by urban water utilities to promote the efficient use of water. These are listed, and briefly described, below.

In-School Education Program: In-school education programs for kindergarten through 12th grade levels include providing information to students, teachers and administrators regarding water resources and conservation. The primary aspects of school programs include: development of locally applicable curriculum materials, conducting teacher training workshops or in-servicing, providing teachers with a newsletter or other materials promoting activities and awareness campaigns, and offering classroom presentations.

Landscape Education Program: There are a variety of ways to educate water users about efficient use of irrigation water for landscapes. The primary vehicles are written literature, seminars and demonstration gardens. These can be carried out by an individual purveyor o city, or can be a joint effort among several agencies. There are two areas where education of landscape water conservation are useful: homeowners/renters and professional landscape maintenance personnel. There are many ways to inform the public about wise landscape water management. Some of these include: conducting workshops, preparing written guidelines or manuals, encouraging property owners to make water use (from the meter) information available to maintenance personnel, preparing articles for trade or local publications, attending professional organization meetings and offering certification programs in water management.

Landscape Review Guidelines and Ordinances: Water efficient landscape guidelines or ordinances address the types of plants and irrigation systems to be installed in landscapes in new development. Typically such ordinances/guidelines are developed and adopted by land use planning agencies for city and county government. They guide or regulate landscape design for new development. Landscape plans undergo review before the project is approved and installed, and a follow-up inspection is conducted upon completion. Recent state law requires all city and county planning departments to adopt and implement a water efficient landscape ordinance.

Promotion of Drought Tolerant Plants: The promotion of low water using or drought tolerant plants in new and existing landscapes through education. This can include: nursery plant tagging programs, written materials and plant displays at fairs and seminars.

Water Conservation Literature: Newsletters, water bill inserts, brochures, and guidebooks are a few examples of written materials. These can be distributed at meetings, displays in offices or public facilities and direct mail. This information can help make the public aware of the local water situation, the limits of water supplies and provide them the information and encouragement they need to conserve.

Speakers Bureau: A specialized speaker's bureau is an effective way to educate groups of people about water. Topics can range from general conservation information to water supply options, water quality, and low water use plants. Speakers for a particular group are selected based on knowledge of the topic requested by the group.

Water Audits/Residential: On-site water audits consist of trained staff analyzing a particular property and water use habits to make conservation recommendations. Typical procedure for a residence can include: showing the customer how to read the water meter; checking for leaks in toilets and faucets; checking use of clothes- and dishwashers; checking water pressure; measuring showerhead flow rate/and installing low-flow showerhead if needed; checking for faucet aerators; checking use of reverse osmosis and water softener systems; checking for efficient use of landscape water. Audits of businesses involve some combination of these same techniques, modified to suit specific situations.

Turf Water Audits and CIMIS/ET Information: Landscape water audits are a tool to evaluate water consumption and irrigation management practices, primarily on large areas of turf grass (ie. parks, golf courses, school grounds). A landscape audit evaluates the irrigation equipment and the management of that irrigation system to identify problems and possible inefficiencies.

Landscape water audits can be conducted by consultants or specially trained staff within the organization. The State Department of Water Resources conducts a master water auditor training course. An audit should include measuring the delivery rate of the current irrigation system, suggestions modifying or repairing the system to improve irrigation efficiency, a review of the irrigation schedule, evapotranspiration rate data (available locally through CIMIS weather stations - see section on CIMIS in Agricultural programs described below), and possible alternatives to large lawn areas if they are not actively used. This service is currently offered free of charge (as a pilot project by the Resource Conservation District) to municipalities and schools with large landscaped areas.

Rebates for Efficient Fixtures: Rebates can be offered to customers who replace their toilets with ultra low flow (ULF) toilets. The amount of the rebate must take into account the cost of water, the cost of ULF toilets locally, and the financial circumstances of the water purveyor. Water saved by toilet replacement rebate programs is usually one of the cheapest water sources available to a water purveyor.

Advertising/Bill Inserts: Paid advertising can be obtained through local media including newspapers, radio and television. This approach is most efficient on a regional basis. Water bill inserts may be a cheaper and more effective means of reaching customers in a specific water service area. Information on water consumption, water conservation techniques or upcoming events can be included on billing inserts.

Emergency Rationing Ordinance: When a water supply shortage requires immediate demand reduction, an emergency rationing ordinance can be passed by water purveyor officials. Such an ordinance can reduce demand through customer allocations and excess water use charges, or specific water use restrictions.

Increasing Block Rates: In this type of rate structure, the unit price of water increases with the quantity used. Such rate structures encourage more efficient use by customers in order to manage their water bill.

Water Awareness Month Campaign: This campaign is part of a statewide promotion of efficient water use. The public can be made aware of the ongoing need for water use efficiency through special promotions such as events, posters, advertising, tours of water facilities or special school programs. These campaigns are most efficient on a regional basis.

Conservation Kits: Conservation kits can be made available to customers at water purveyor offices or can be delivered to customers. Such kits typically include a low flow showerhead, faucet aerators, toilet tank reduction device such as a dam or bag, toilet leak test tablets, and water conservation literature.

Customer Leak Detection: Customers can be educated on residential leak detection through literature, toilet leak test tablets, and meter reading information. (see residential water audits above).

Water Waste Ordinance: Water purveyors can pass ordinances banning the wasteful use of water. Such bans usually include allowing water to run off an irrigated site, watering during afternoon hours, spraying down hard surfaces, and allowing leaks to continue for more than 24 hours after detection.

Required Reclaimed Water Use: In service areas where reclaimed water is available, reclaimed water use can be made mandatory for new customers with large landscape irrigation areas.

Gray Water Use Ordinance: For some residential uses, greywater can be substituted for potable water. This can reduce residential water costs for landscaping substantially, or keep landscaping alive when irrigation with potable water is prohibited. Implementation of greywater use must be accompanied by an active public education program to guide its safe use. In Santa Barbara County, greywater use is regulated by a county ordinance which includes safety restrictions. A greywater ordinance can also include provisions for the installation of greywater systems in new single family homes at the time of construction.

Retrofit/Offset Requirements in New Construction: This type of program requires developers to offset the projected water use of their new project by retrofitting existing residences and businesses with efficient plumbing fixtures. The developer may be required to implement these retrofits, or may be required to pay a fee to the water purveyor who would then use this revenue to carry out customer retrofits.

Meter Calibration & Replacement: A meter program involves the routine checking and replacement of meters to insure accurate water use measurement. The frequency of meter replacement depends on water quality.

Voluntary Conservation Goals: Voluntary conservation goals are implemented through public information and requests for customers to reduce demand to a target level. These goals are typically not enforced by ordinance or penalty pricing.

Water Conservation Awards: Awards provide incentives for customers to use water efficiently. These awards can be made on the basis of water use or landscaping changes, and can be applied to residential or commercial customers.

Mandatory Retrofit of Toilets: This type of program can include both toilet and showerhead replacement. Mandatory programs are difficult to implement because of enforcement requirements, and are not as popular with the public as voluntary programs, although they have the potential for greater penetration within a service area. Either the water purveyor or the customer may supply the new fixtures.

System Leak Detection: Undetected leaks are one of the largest sources of unaccounted for water. To eliminate leaks, leak detection programs are needed on both the agency and the customer sides of the meter. Once leaks are identified they can be repaired. Undetected leaks, particularly large ones, result in a great deal of lost revenue, as well as lost water supplies.

Restaurant/Hotel Education and Incentive Program: Restaurants and hotels can be provided with conservation information for increasing the water efficiency of their operations, including dish washing, laundry, and swimming pools. These businesses can also provide information to their customers. Programs such as showerhead replacement or toilet rebates can also be utilized by these customers.

Conservation Hotline: A phone line specifically for water conservation information can be installed and staffed. This line can handle water waste reports, disseminate general conservation information, assist customers with rebates or other programs, and field questions on abnormal water bills.

Landscape Rebates: Some communities offer a rebate to water customers that replace higher water using plant materials or irrigation equipment with more efficient varieties. One term for a landscape incentive created in Marin County is "cash for grass".

Water Reclamation (voluntary): Water purveyors can work with local sanitary districts to construct water reclamation facilities. Once these facilities are in place, reclaimed water can be offered to large landscape irrigators. Reclaimed water is usually offered at a subsidized price to encourage its use.

Commercial and Industrial Water Audits: Commercial and industrial water audits can require special procedures and knowledge, depending on the nature of the business or industrial process. Staff can be trained to perform such audits, but in some cases consultants specializing in industrial efficiency (usually energy and water) may be needed. In many areas, energy utilities offer rebates to industrial customers as an incentive to install efficient equipment; energy efficiency often improves water efficiency. The possibility exists for coordinated effort between water and energy utilities in implementing such rebate programs.

Displays (Xeriscape gardens, etc): Demonstration gardens can be installed to provide information and encouragement for customers to use water efficient landscaping on their properties. These gardens can be installed at water purveyor offices, public buildings, botanic gardens, and schools. Other conservation displays include low flow plumbing fixtures installed at purveyor offices.

Regional Water Conservation Committee: The Regional Water Conservation Advisory

Committee provides a regular forum for the exchange of water conservation information. Regular features include the distribution of information and publications, updates on local conservation efforts, and presentations by specialists on relevant topics.

Adoption of Statewide MOU for Urban Water Conservation: In 1992 over 100 urban water purveyors in the state signed an agreement to implement urban best management practices -- BMPs (water conservation measures). These BMPs include innovative and intensive demand management practices. There are 16 BMPs in the MOU targeted for immediate implementation due to their proven water savings potential. To date, six water purveyors in the County have signed the MOU. For the Santa Maria Valley, the Southern California Water Company (parent company of Cal-Cities in Orcutt) has signed the MOU. In order to facilitate implementation of the MOU in the County, coordinate other local efforts to promote efficient use of water, and to eliminate duplication of efforts, the County Water Agency's regional water conservation program includes implementation of several BMPs on a regional basis.

WATER CONSERVATION LEGISLATION AND REQUIREMENTS

PENDING AND APPROVED LEGISLATION REQUIRING EFFICIENT USE OF WATER

Water Code Section 10610, Part 2.6 - Urban Water Management Planning (AB 797, Klehs, 1985) - Requires urban water purveyors serving 3,000 customers or 3,000 acre feet per year of water to prepare water management plan to acheive conservation and efficient use. Update to these plans was due after 5 years.

AB 2662 - Amended the above referenced section of the Water Code to require updates of urban water management plans to be submitted to the Department of Water Resources every 5 years, beginning December 31, 1990.

Article 10.8 (commencing with Section 65590), Chapter 3 of Division 1 of Title 7 of the Government Code (AB 325, Clute, Chapter 1145) - Requires adoption of water efficient landscape ordinances for new development. Affects all cities unless they make findings that due to geologic and topographical conditions, such an ordinance is not necessary in their area. Ordinances must be adopted by January 1, 1993.

AB 2355 - Requires installation of water efficient plumbing fixtures (ie. 1.6 gallon per flush toilets and 2.0 gallons per minute showerheads) in all new construction beginning January 1, 1992.

AB 11 - Water Shortage Contingency Plans. - Requires urban water purveyors serving minimum number of customers (3,000) to prepare water shortage contigency plans with phased approach for reducing demand during droughts. Plans were due in January 1992.

SB 1520 - Requires installation of water efficient plumbing fixtures in all new public facilities beginning January 1, 1992.

SB 2334 - Requires automatic shutoff valves for in-home reverse osmosis devices installed after January 1, 1991.

Water Code Section 10520 et seq. (AB 3616, Kelley, Chapter 739, Statutes of 1990) - Requires DWR to develop a list of efficient water management practices for agriculture. Advisory committee to be created to accomplish this.

CURRENT REQUIREMENTS AND VOLUNTARY AGREEMENTS

Bureau of Reclamation: Requires preparation of water conservation plans by agencies receiving construction funds for water projects, or those managing or operating Bureau facilities (reservoirs) serving a designated minimum of acres of agriculture. Updates to these plans are due every five years. New criteria for these plans is being developed in response to HR 429 regarding the Central Valley Project.

State Water Resources Control Board: Requires preparation and implementation of water conservation plans as condition of recieving loans or grants from the Board, or for new water rights permits.

Department of Water Resources: As required by the Governor in 1991, due to the drought all urban water purveyors of designated size must prepare and submit a drought (water shortage) response plan to DWR. The plans must include specific programs to reduce water demand during periods of severe water shortage, as defined in the Plan. DWR also admininsters the requirement for urban water utilities to prepare an urban water management plan and updates (evert five years).

Memorandum of Understanding for Best Management Practices (MOU) - Urban: The MOU is a voluntary agreement to implement 16 identified urban best management practices and consider potential best management practices for future adoption. This MOU is now under consideration by the State Water Resources Control Board to become mandatory standards for all affected parties in water rights decisions regarding the Bay-Delta.

Source: Santa Barbara County Water Agency, 1993

RECOMMENDED WATER CONSERVATION PROGRAMS FOR SANTA MARIA VALLEY
1/9/92
Santa Maria Valley Water Conservation Committee

URBAN WATER CONSERVATION

1. **Best Management Practices:** Recommend that local water purveyors and interested parties adopt the Memorandum of Understanding for urban water conservation - The Urban Water Conservation Charter.

2. **Regional Coordination:** Recommend that efforts between water purveyors and the regional water conservation program (County Water Agency) be coordinated. These efforts would include public education on landscape water conservation, school outreach and education programs, and other general public information.

3. **Management Plans - Implementation:** Recommend the implementation of adopted water conservation measures contained in the local Urban Water Management Plan and the Long-Term Water Management Plan for the City of Santa Maria.

4. **Efficient Landscape Ordinances:** Recommend the development of local ordinances to comply with AB 325, the Water Efficient Landscaping Act. Develop associated education programs such as efficient landscaping demonstration gardens.

AGRICULTURAL WATER CONSERVATION

1. **Document Efficiency Efforts By Growers:** Recommend documentation of the water efficiency practices being implemented by local growers.

2. **Education Programs For Growers:** Coordinate ongoing efforts by the Soil Conservation Service, U.C. Cooperative Extension, and the County to promote efficient agricultural water use.

3. **Water Use Data Refinements:** Develop a more accurate data base on applied water use by agriculture within the Santa Maria Basin. Work with Agricultural Commissioner, U.C. Cooperative Extension and Soil Conservation Service.

Source: Santa Maria Valley Water Conservation Advisory Committee, Final Recommendations. 1991.

APPENDIX C-4

A. Irrigation Management and Crop Decisions - On Site

1. Irrigation scheduling/management
2. Soil evaluation and moisture monitoring
3. Weather data monitoring
4. Crop variety selection

B. Grower Education Programs and Public Information

1. Workshops
2. Field demonstrations
3. Irrigation efficiency evaluations (Mobile Lab)
4. School education programs

C. Regulations and Agency/Purveyor Grower Assistance Assistance Programs

1. Pump electrical meter efficiency testing
2. Weather monitoring stations
3. Water pricing
4. Restrictions against wasteful use
5. Water meter requirement
6. Meter loan program
7. On-demand water deliveries
8. Coordination among agricultural irrigation experts/agencies

D. Technologies

1. Proper irrigation system design and maintenance
2. Sprinkler set orientation
3. Leak detection for irrigation system
4. Pressure differential measuring
5. Regulating reservoirs (frost protection)
6. Subterranean drip systems
7. Irrigation system conversions to more efficient system
8. Tailwater recovery systems
9. Water meters - voluntary
10. Laser land leveling
11. Surge valves