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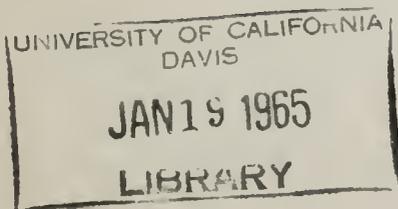


THE RESOURCES AGENCY OF CALIFORNIA
Department of Water Resources

BULLETIN No. 135-1

MADERA AREA INVESTIGATION

Progress Report



MARCH 1964

HUGO FISHER
Administrator
The Resources Agency of California

EDMUND G. BROWN
Governor
State of California

WILLIAM E. WARNE
Director
Department of Water Resources

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EDMUND G. BROWN
GOVERNOR

ADDRESS REPLY TO
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L M E. WARNE
DIRECTOR



STATE OF CALIFORNIA
Department of Water Resources
SACRAMENTO
December 30, 1963

Honorable Edmund G. Brown, Governor
and Members of the Legislature
of the State of California
State Capitol
Sacramento, California

I am pleased to transmit Bulletin No. 135-1, "Madera Area Investigation: Progress Report." This comprehensive water resources investigation was initiated in March 1961, under provisions of Section 12617 of the Water Code. It was given legislative sanction for study by the inclusion of funds in the Budget Act of 1960 and in subsequent department budget requests.

The investigation was originally scheduled for completion in June 1964; however, limitations of available funds and manpower have made it necessary to extend the completion date to June 1965. Its purpose is to formulate plans for the orderly and economical development and maximum utilization of the local water resources in conjunction with imports of water from outside the county.

This report is submitted at this time to inform all concerned of the progress made to date on the investigation. The report and available background material will also provide information which may be useful to interested local agencies and to the department in its continuing phases of the investigation.

Sincerely yours,

A handwritten signature in cursive script that reads "William J. Warner".

Director

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

EDMUND G. BROWN, Governor
HUGO FISHER, Administrator, The Resources Agency of California
WILLIAM E. WARNE, Director of Water Resources
ALFRED R. GOLZE, Chief Engineer
JOHN R. TEERINK, Assistant Chief Engineer

SAN JOAQUIN VALLEY BRANCH

Carl L. Stetson Branch Chief

The investigation leading to this report
was conducted under the direction
of

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by

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John E. Baugher Associate Engineer
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Assisted by

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Theodore H. Rhody Associate Engineer
Gordon Brown Assistant Civil Engineer
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*Participated in the investigation since September 1963, when
Branch relocated in Fresno.

CALIFORNIA WATER COMMISSION

RALPH M. BRODY, Chairman, Fresno

WILLIAM H. JENNINGS, Vice Chairman, La Mesa

JOHN W. BRYANT, Riverside

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MARION R. WALKER, Ventura

- - - - -

WILLIAM M. CARAH, Executive Secretary

ORVILLE ABBOTT, Engineer

CHAPTER I. INTRODUCTION

Madera County is a water deficient area which eventually will have to import additional supplies of water to permit its economy to continue to grow and prosper. If the growth of the county is to be on an orderly basis, it is necessary that local interests in the area have some idea of the present and probable future water requirements and of water-associated problems. Without knowledge of these factors, it is impossible to plan intelligently for the future needs of the county.

Since it is in the State's interest to provide assistance and guidance to local agencies in solving their water-associated problems, the Department of Water Resources initiated a three-year investigation of the water resources of Madera County. The purpose of the investigation is to develop plans for meeting the present and anticipated future demands for both the upper watershed areas and the valley floor portions of the county.

The purpose of this progress report is to inform the Legislature and other interested parties of the current status of the Madera Area Investigation. The report briefly summarizes historical background of the investigation, progress made to date, problems related to water resource development, and available basic data. Particular emphasis is placed on describing available basic data compiled to date. Also included are brief discussions on plans for development and on

remaining studies necessary to accomplish the objectives of the investigation as described in this chapter of the report.

Historical Background of Investigation

During the past two decades, Madera County has experienced a steadily increasing growth in population, as well as an expanding economy. Accompanying this growth has been an ever-increasing demand for water. Recognizing the problems connected with water development and the fact that local supplies are limited, the Board of Supervisors of Madera County in June of 1958, formed the Madera County Water Commission to act as an advisory group to the board. The commission was requested to recommend a course of action to be taken by the board to cope with water problems in the county.

Shortly after it was formed, the advisory group recommended to the Board of Supervisors that appropriate steps be taken to obtain authorization for the State Department of Water Resources to conduct a comprehensive water resources investigation of Madera County.

Subsequently, several meetings by department personnel and members of the commission were held for discussing the proposed investigation. The department decided to conduct a three-year investigation of the Madera area, and funds were provided for the first year's work in the 1960-61 budget.

This study of Madera County is the continuation of a series of investigations of the mountainous and foothill areas

of the Sierra Nevada. These investigations were initiated to provide a basis for continued development in the upper watershed areas consistent with utilization of the available water supplies for the more pressing needs downstream. The results of these investigations will provide local interests, both upstream and downstream, with a means of evaluating future water resource developments from an area-wide point of view.

Originally scheduled to begin in January 1961, actual commencement of work on the investigation was deferred until March of that year, with the completion date set for June 1964. However, during the course of the investigation limitations on available funds and manpower have made it necessary to extend the completion date to June 1965.

Numerous studies relative to water resource development in Madera County have been made by federal, state, and local governmental agencies. The U. S. Corps of Engineers has made extensive studies relating to flood control in the county, and as a result of proposals made by that agency, the federal government recently authorized the construction of Buchanan and Hidden projects located on Chowchilla and Fresno Rivers, respectively. A portion of Madera County lying below the Madera Canal is being studied by the U. S. Bureau of Reclamation as a part of the proposed East Side Division of the Central Valley Project. Water supplies developed under this division would serve lands along the east side of the San Joaquin Valley from Chowchilla River southward to the Bakersfield area.

The Department of Water Resources studied several reservoir sites in the upper Madera County area during development of The California Water Plan. Of the many sites considered by the department, some twelve reservoir and diversion projects were proposed in the final report. Mammoth Pool Reservoir located on the San Joaquin River was one of the projects proposed in The California Water Plan. This reservoir was constructed recently by Southern California Edison Company. In addition, plans have been made by the U. S. Forest Service and the U. S. Soil Conservation Service for certain small water development projects in the upper watershed.

Authorization for Investigation

The Department of Water Resources had considered the initiation of a comprehensive water resources investigation of Madera County for several years prior to the budgeting of funds for this investigation. The department's budget for the 1960-61 fiscal year included funds for the initiation of the investigation. Following legislative approval of that budget, discussions were held with the Board of Supervisors of Madera County regarding the scope and objectives of the investigation. Funds for continuing the investigation have been included in the department's annual budget requests to the current year. Funds to complete the investigation are included in the department's proposed budget for the 1964-65 fiscal year.

Objectives of Investigation

The primary objectives of the Madera Area Investigation are to determine the amount of available water supply, to determine the amount of water needed for continued development of the county, and to formulate a comprehensive water resource development plan for optimum development of all local supplies. It is necessary for an area-wide development program to be formulated within the next few years because several major projects have promise of construction in the near future, and the determination of all local water requirements of the area will allow for adequate provision in the final designs and planned operations of these projects. The area-wide concept should provide for maximum utilization of local water supplies in conjunction with imports of water from sources outside the county. It should include provisions for the rapidly expanding development of water related recreational activities, as well as for flood control, and other water resources benefits.

Basic data collected under this investigation will be available for use by either local interests or agencies in planning future projects for the Madera area.

Scope of Investigation

The Madera Area Investigation encompasses practically all aspects of water resource development. The scope of the investigation includes: (a) evaluation of available water

supply in the area, (b) determination of present and future water requirements, (c) consideration of potential water supply projects, (d) formulation of a comprehensive plan for water resources development in the area of study, (e) reconnaissance level flood control study, and (f) delineation of local drainage problems.

Area of Investigation

The area of investigation consists of: (1) all of the San Joaquin Valley Floor portion of Madera County, (2) all of the Chowchilla River Basin above the foothill line, (3) all of the Fresno River Basin, (4) those portions of the San Joaquin and Merced River Basins within Madera County above the valley floor, and (5) those areas in adjacent counties susceptible to joint development.

The investigational area is delineated on Plate 1, entitled "Madera Area Investigation Service Areas." The study area covers more than 2,140 square miles of which approximately 33 percent lies above an elevation of 4,000 feet.

Related Investigations and Reports

Madera County, or portions thereof, has been the subject of many previous investigations conducted by federal, state, and local governments, as well as by local public and private interests. The U. S. Corps of Engineers is currently engaged in developing plans for Buchanan and Hidden Reservoirs

as multi-purpose projects on the Chowchilla and Fresno Rivers, respectively. In addition, the U. S. Bureau of Reclamation, on May 28, 1962, released a report on the proposed East Side Division of the Central Valley Project. As previously stated, the bureau proposes to serve certain lands between the Chowchilla River and the Bakersfield area from the proposed East Side Canal, a feature of the East Side Division.

The Department of Water Resources presently is conducting studies of drainage problems in Madera County as a part of the San Joaquin Valley Drainage Investigation. This drainage investigation is in its final stage and a progress report on the investigation is expected to be published during 1963. Data and information obtained as a part of the drainage investigation will be utilized in carrying out the Madera Area Investigation.

There is set forth below a list of selected bibliography of relevant information concerning the Madera area:

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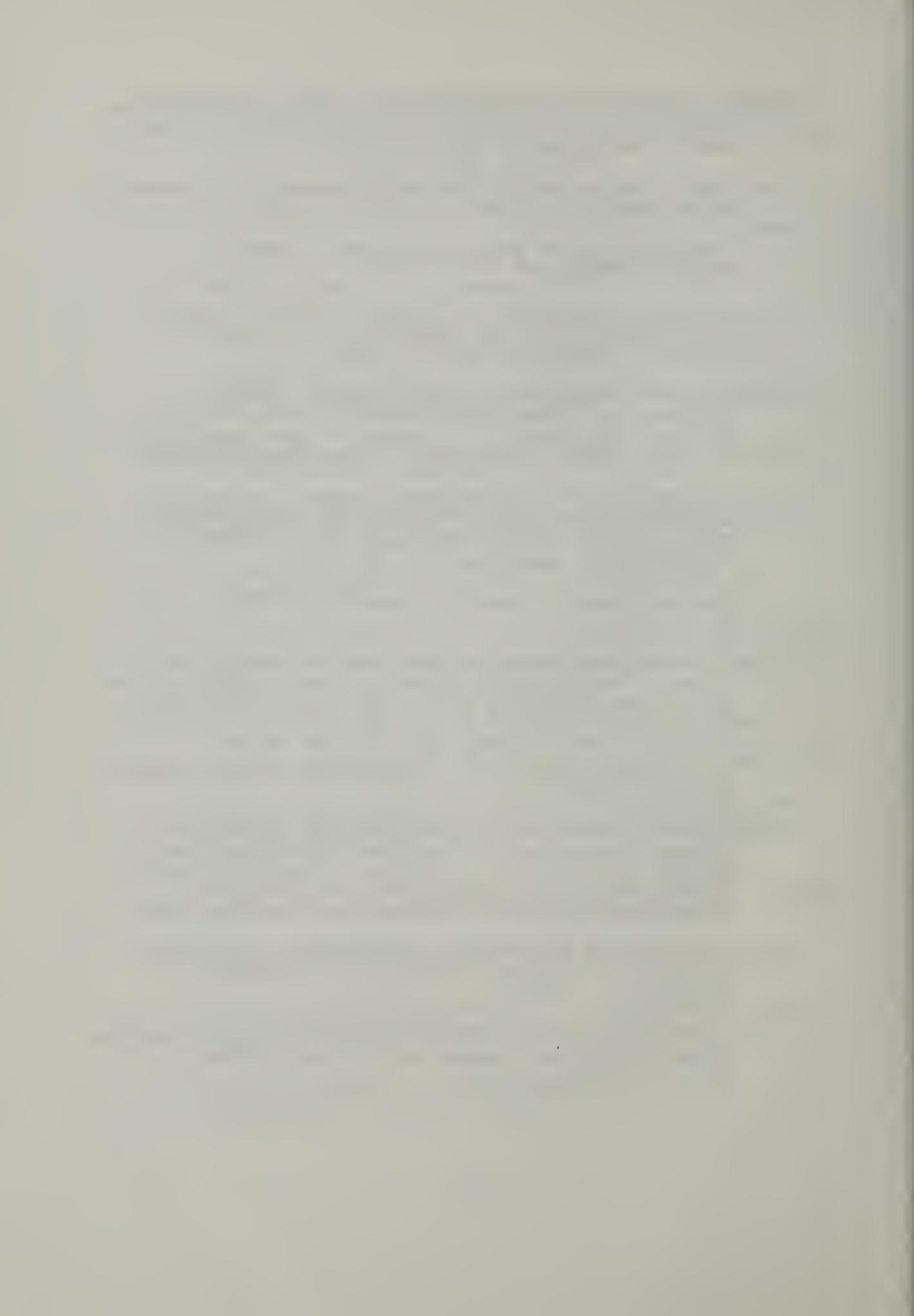
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Valley." 1916.

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unpublished reports and papers by Livingston,
Enclosure L, Volume 5, Appendix D. January 1944.

----"Water Supply Paper 1469, Ground Water Conditions
and Storage Capacity in the San Joaquin Valley,
California," 1959.

----"Use of Ground Water Reservoirs for Storage of Surface
Water in the San Joaquin Valley, California,"
Open file report, 1960.



CHAPTER II. WORK ACCOMPLISHED

Work accomplished to date (December 1962) on this investigation has to a great extent been directed toward collecting, compiling, and analyzing basic data. The status of work in this regard is summarized in this chapter.

For purpose of discussion this chapter is subdivided into nine sections: (1) Water Supply, (2) Land Classification and Use Surveys, (3) Service Areas, (4) Geology, (5) Fish and Wildlife Resources, (6) Topographic Mapping, (7) Recreation, (8) Economic Considerations, and (9) Water Rights.

Water Supply

For purpose of presentation this section of the report has been divided into seven general subsections, each pertaining to a particular topic. Items considered include: precipitation, runoff, floods and flood flows, surface water supply, ground water supply, imported and exported water, and water quality.

Precipitation

Average annual precipitation on the Madera area varies from about 10 inches on the valley floor to over 55 inches along the crest of the Sierra Nevada. Precipitation varies widely from season to season and increases generally from west to east with an increase in land elevations. Generally speaking, precipitation below an elevation of about

3,000 feet is in the form of rain, while above that elevation it falls in the form of both rain and snow.

Table 1 sets forth information on precipitation stations located in Madera area and vicinity, including location and elevation of station, and period of record.

At the beginning of this investigation there were 41 precipitation stations located either within or close to the study area. Since then one new climatological station, with standard rain gage and thermometers, has been established at Oakhurst. One standpipe precipitation gage was established on Chiquito Creek at an elevation of about 7,400 feet. In addition, thermometers and shelters have been established at five locations in the Sierra National Forest. Temperature records are being collected at these stations primarily for planning studies.

To date precipitation estimates for the period 1950 through 1960 have been made for the Oakhurst, Miami Creek, and Bass Lake areas. The purpose of these estimates was to attempt to develop a correlation between precipitation and runoff, since these areas are lacking in runoff records.

Runoff

The Madera area receives its annual water supply in most part from the three principal streams draining the mountainous area; the San Joaquin, Fresno, and Chowchilla Rivers. Elevations in the drainage basins of the latter two streams rise to a maximum of about 7,000 feet, while in the San Joaquin

TABLE 1

MADERA AREA
PRECIPITATION STATIONS

Station Name	:Twp:	:Range:	:Sec:	:40Ac Tract:	:Elev:	:Period of Record:	Remarks
Ahwahnee	T06S	R21E	31		2323	1955-59	
Ahwahnee 2NNW	T06S	R20E	24		2790	1959-	Replaces Ahwahnee
Ahwahnee Sanatorium	T06S	R21E	25	J	2360	1950-56	
Athlone	T08S	R15E	29		210	1885-98	
Auberry	T10S	R23E	8		2003	1915-	Temp.
Bass Lake	T07S	R22E	23		3300	1934-45	1934-39 not available
Berenda S.P.R.R.	T10S	R17E	30		256	1890-99	Broken record
Big Creek P.H. No. 1	T08S	R25E	28	N	4930	1913-	Temp.
Big Creek P.H. No. 2	T08S	R24E	25	N	3000	1913-	
Big Creek P.H. No. 3	T09S	R24E	17	E	1400	1922-	
Big Creek P.H. No. 4	T09S	R23E	20	C	1000	1951-	
Big Creek P.H. No. 8	T08S	R24E	27	G	2260	1921-	
Buchanan	T08S	R18E	28		450	1879-82	
Central Camp	T07S	R23E	5		5364	1940-48	
Chowchilla Farms	T10S	R14E	8		150	1887-1913, 1916-38	
Clover Meadows G.S.	T05S	R25E	6		7002	1946-	Storage gage
Coarsegold	T08S	R21E	5		2240	1952-	
Crane Valley P.H.	T07S	R22E	25		3500	1903-	RRnG*, Temp, Evap
Crane Valley 3WNW						1949-61	
Daulton	T09S	R18E	26	E	410	1946-	
Denair	T05S	R11E	6		124	1917-	Temp.
Fish Camp	T05S	R21E	26		5550	1929-33	Temp.
Florence Lake	T07S	R27E	36	N	7345	1940-	RRnG, Temp, Evap
Friant Government Camp	T11S	R21E	7	A	410	1897-	Temp, Evap
Huntington Lake	T08S	R25E	22		7020	1912-	RRnG, Temp, Evap
Le Grand Preston Ranch	T07S	R18E	7	K	984	1949-	RRnG in 1960
Le Grand	T08S	R16E	20		255	1899-	Temp.
Le Grand Turner Ranch	T07S	R17E	24		840	1953-60	
Logan Meadows	T07S	R24E	3		3000	1948-	Storage gage
Madera	T11S	R17E	13		270	1899-	Temp.
Mammoth Pass	T03S	R26E			9500	1947-	Storage gage
Meadow Lake	T10S	R23E	11		4485	1948-	
North Fork R.S.	T08S	R23E	18		2630	1904-	Temp.
Ostrander Lake	T03S	R22E			8600	1947-	Storage gage
Raymond 3 SSW	T09S	R19E	6	J	635	1940-	

TABLE 1

MADERA AREA
PRECIPITATION STATIONS
(continued)

Station Name	:	:	:	:40Ac :	:	:Period of:	:	Remarks
	:Twsp:	Range:	Sec:	Tract:	Elev:	Record :		
Raymond Whipple Ranch	T06S	R19E	33	K	1380	1957-62		Temp, Evap
Raymond 9N	T07S	R19E	3		1210	1962-		Replaces Whipple Ranch
Raymond 10N	T06S	R19E	32	A	1640	1957-		
Raymond Bar 7 Ranch	T06S	R19E	35	R	1150	1957-60		Temp.
Raymond 12NNE	T06S	R19E	25		1600	1954-		
San Joaquin Exp. Range	T10S	R21E	6		1100	1934-		RRnG*, Temp
South Entrance Y.N.P.	T05S	R21E	12		5120	1941-		Temp.
Sumnerdale	T05S	R21E	23		5270	1896-1912		See Fish Camp
Vignolo Ranch	T08S	R18E	33		440	1933-39		
Westfall R.S.	T05S	R21E	35	M	4795	1958-		
Windy Gap	T07S	R20E	2	P	1875	1952-55		Temp, Evap

Note - Records are available for the above stations in files of the Department of Water Resources

*RRnG = Recording Rain Gage

River drainage basin, which extends to the crest of the Sierra Nevada, elevations exceed 12,000 feet. Because of these topographical features, runoff from the Fresno and Chowchilla Rivers is due in most part to rainfall, while runoff from the San Joaquin River is prolonged into the March through July period because of snowmelt.

Prior to the initiation of this investigation, there were 45 active and 27 inactive stream gaging stations located in the study area having varying lengths of record. One automatic recording gaging station has been installed on the Lewis Fork of the Fresno River since the beginning of the investigation. This station provides a continuous record of actual runoff. Lewis Fork was considered as a typical stream of the area; therefore, these records will be used in estimating runoff on similar streams in the Fresno River basin. Three staff gages have been installed on small foothill streams for estimating runoff from the foothill area.

Two study periods were chosen for this investigation, 1907-08 through 1956-57 for study of water supply, and 1950-51 through 1959-60 for study of water use and utilization. The 50-year period, 1907-08 through 1956-57, corresponds to the department-recognized period for computing mean annual runoff. The 11-year base period 1950-60 was chosen for water use and utilization studies because records of the source and disposition of water are more complete for this period than for any other.

Moreover, the mean annual runoff during the 11-year period is roughly equal to the long term mean. Average runoff from the three major drainage areas for the 11-year period, 1950-60, is approximately 1,800,000 acre-feet annually, or about 98 percent of the 50-year period mean.

Estimates of runoff for ungaged streams were made by employing the area-precipitation method.

Floods and Flood Flows

With regard to floods and flood flows from the study area, the San Joaquin River is fairly well controlled by Millerton Lake, and other major reservoirs on the river. The Fresno and Chowchilla Rivers are presently uncontrolled. The recently authorized Buchanan and Hidden Reservoirs, however, will control floods on these two rivers. Flood flows onto the valley floor from smaller streams are not considered to be of great significance; however, consideration will be given to flood control aspects of reservoirs on these smaller streams during the course of this investigation.

Surface Water Supply

The Madera area receives its surface water supply from the Chowchilla, Fresno, and San Joaquin Rivers, and from smaller foothill streams. All records available on diversions and deliveries have been tabulated, and estimates of flow at different points of interest have been computed. The valley

floor portion of the study area receives water from the Madera Canal, Fresno and Chowchilla Rivers, and minor amounts from smaller streams.

Pertinent information regarding stream flow for the Madera area is contained in Table 2, "Stream Gaging Stations in and near the Madera area."

Ground Water Supply

For the past few years the Madera area has depended on ground water sources for the greater portion of its annual water supply. Available records of the ground water conditions on the valley floor portion of Madera County indicate a lowering of the ground water table during the past ten years. A map was prepared showing changes in the elevation of the ground water table during the period 1950 to 1960. Changes in the water table during that period varied from a rise of 10 feet in three comparatively small areas south of Chowchilla to a drop of 50 feet in the southwest portion of the study area. Ground water maps available for the base period, 1950 through 1960, include elevation of water surface and depths to water for the period 1950 through 1954 for each fall; elevation maps for 1955 through 1960 for spring and fall; and change in elevation for three selected five-year periods between 1949 and 1960. These maps show 5-foot contour intervals and generally include the area from the Madera Canal westerly to the San Joaquin River. The average annual decrease in ground water supply stored beneath the valley

TABLE 2

STREAM GAGING STATIONS IN AND NEAR MADERA COUNTY

Stream	Station	Drainage Area : In Square Miles	Periods of : Record	Source of : Record ^a
Chowchilla River	Buchanan damsite	238	1912-1930 1931- ^b	CE USGS
East Fork Chowchilla	Near Ahwahnee	57.7	1958- ^b	USGS
Middle Fork Chowchilla	Near Nipinnawasee	12.3	1959- ^b	USGS
West Fork Chowchilla	Near Mariposa	33.6	1958- ^b	USGS
Fresno River	Near Daulton	259	1942- ^b	USGS
Fresno River	Near Knowles	132	1912-1913 1916- ^b	USGS USGS
Miami Creek	Near Oakhurst	10.6	1960- ^{b,c}	DWR
Fine Gold Creek	Near Friant	92.8	1937-1958	USGS
North Fork Willow Creek	Near Bass Lake	50.8	1941- ^b	USGS
Chiquito Creek	Near Arnold Meadow	59.6	1922-1928 1953- ^{b,c}	USGS
Jackass Creek	Near Jackass Meadow	12.8	1922-1928 1952- ^{b,c}	USGS
Granite Creek	Near Cattle Mountain	48.8	1922-1928 1960- ^{b,c}	USGS USGS
South Fork Merced River	Near Wawona	131	1915-1916 1917-1922	USGS
South Fork Merced River	At Wawona	99.1	1959- ^b	USGS

^a = CE - U. S. Corps of Engineers
DWR - California Department of Water Resources
USGS - United States Geological Survey

^b = Record continues to present time

^c = Some monthly values are missing

floor portion of the study area during the period 1950 through 1960 was computed to be about 50,000 acre-feet by multiplying the average drop in feet of the water table by the estimated average specific yield of the unsaturated alluvium.

Imported and Exported Water

Although there are no actual imports or exports of water supplies into or from the area of investigation, there are several transfers of water from one drainage basin to another. These inter-basin transfers of water are discussed in this section.

The Madera Canal conveys water from Millerton Lake on the San Joaquin River to the Madera Irrigation District and to the Chowchilla Water District. Although in the strict sense this is not considered to be an imported water supply, deliveries by this canal involve transporting water from one drainage basin to another. The Madera Canal has delivered an average of approximately 158,300 acre-feet annually since it was put into operation in 1944.

There is one minor import to the Fresno River basin from the Merced River watershed of approximately 6,000 acre-feet annually. This water is diverted out of Big Creek, tributary to the South Fork of Merced River, in the southwest quarter of Section 30, Township 5 South, Range 22 East, Mt. Diablo Base and Meridian, at an elevation of about 5,600 feet

and delivered by canal to the upper reaches of the Lewis Fork of Fresno River, some one and one-half miles north of Sugar Pine.

Approximately 8,000 acre-feet are transferred annually from the San Joaquin River Basin into the Fresno River Basin. This diversion is made from Willow Creek, tributary to San Joaquin River, at Soquel Meadows. Again, this is neither import nor export to the study area, but rather inter-basin transfer of water within the county.

Water Quality

Much information has been compiled regarding the quality of both surface and ground water in the study area. An evaluation of available data on quality of both ground and surface waters in Madera County has indicated that existing water supplies are well suited for most beneficial uses.

Surface Water

The electrical conductivity of water is easily determined and is an indicator of the mineral quality of the water. For these reasons the electrical conductivity is often measured of samples of water for which quality information is desired. The following tabulation shows the average annual range of conductivity of water samples taken at 7 surface water quality sampling stations located in the study area during the period 1950 to 1960. The values shown were derived by simply taking the arithmetic average of the annual maximum and minimum

conductivity of water for the seven sampling stations for varying periods during 1950-60 and represent specific conductance in micromhos at 25° C.

Average Annual Range of Conductivity
(Micromhos at 25° C.)

Sampling Station	Conductivity		Agency
	Maximum	Minimum	
San Joaquin River at Friant	88	34	DWR
San Joaquin River at Biola	168	45	USGS
San Joaquin River at Whitehouse	135	52	USBR
San Joaquin River near Mendota	868	106	DWR
San Joaquin River near Dos Palos	732	139	DWR-USBR
Fresno River near Daulton	368	81	DWR
Chowchilla River at Buchanan Damsite	643	144	DWR

As stated previously in the section on water supply, the Madera area is divided into three principal drainage basins: Chowchilla, Fresno, and San Joaquin Rivers. The waters from the three drainage basins originate in a basically granitic terrain interspersed with areas of metamorphic rock and some minor areas of Tertiary continental deposits.

Chowchilla River. Flows in the Chowchilla River on the valley floor are usually nonexistent from about June to October of each year. During winter months and until the spring termination of flows, the character of the water is generally calcium-sodium bicarbonate-chloride. When fall runoff resumes, the water is generally sodium-calcium chloride.

Occasional chloride concentrations in excess of the Class 1 (excellent to good) agricultural limit of 175 parts per million have been found in the river water at the department's surface water quality monitoring program sampling station near Buchanan damsite. The water at this station has been consistently within the quality limits for drinking water and, with the exception of the above-mentioned chloride concentrations, has been Class 1 for irrigation uses. The existence of somewhat higher concentrations of most constituents in this water than in the waters of the Fresno and San Joaquin Rivers is probably because a greater percentage of the flow tributary to the Chowchilla River originates in the areas of metamorphic rocks. Two known springs on the headwaters of the Chowchilla River, which are in an area of metamorphic rock, are characteristic of much of the tributary flow to the river. An analysis of the water from one of the springs showed a sodium chloride type water containing 526 parts per million total dissolved solids, with calcium comprising 40 percent of the cations and bicarbonate comprising 29 percent of the anions. Although no analysis of the water from the other spring is available, the name "Salt Spring" implies a highly mineralized water. It is possible that other mineralized springs exist in the watershed and contribute to the concentration of mineral constituents.

Fresno River. Natural runoff in the Fresno River varies from little or no flow in late summer months to flood flows during the rainy season. Past quality records show the water at the department's surface water quality monitoring

program station near Daulton to be sodium-calcium bicarbonate-chloride during the winter months and calcium-sodium bicarbonate during the summer months. The waters at this station are considerably lower in concentration of mineral constituents than the waters of the Chowchilla River and consistently have been within the recommended limits for domestic use and for Class 1 irrigation water.

The lower concentrations of minerals in the Fresno River are probably the result of fewer and smaller areas of metamorphic rock. Almost all of the tributaries to the Fresno River originate in and flow through granitics throughout most of their length.

San Joaquin River. Flows in the San Joaquin River are divided into three general classes or reaches. From the headwaters to Friant Dam the waters are representative of native Sierra watershed effluent. Between Friant Dam and Mendota Pool the water begins to show a considerable increase in mineral content. Below Mendota Pool the flow consists mostly of flows from Delta-Mendota Canal, another source of water.

Samples of San Joaquin River water have been collected for the department's surface water quality monitoring program at the following stations: below Friant Dam, below Mendota Dam, and near Dos Palos. In addition, San Joaquin River water samples have been collected by the U. S. Bureau of Reclamation at Whitehouse and by the U. S. Geological Survey near Biola.

Water samples collected from the San Joaquin River below Friant Dam show the water to be calcium bicarbonate in character and of consistently good quality with low concentrations of mineral constituents. The water has met mineral quality requirements for domestic, irrigation, and most industrial uses.

Summer flow in the San Joaquin River below Mendota pool consists of a mixture of irrigation return flows, ground water accretions, and Delta-Mendota Canal water. The quality of water in this reach is usually degraded to such a degree that it is Class 2 for irrigation and questionable for domestic use.

Ground Water

Most of the available ground water in Madera County occurs beneath the valley floor area west of the foothill line (approximately the 500-foot contour). The ground water basin is divided into two zones (upper and lower) by a bed of diatomaceous clay called the Corcoran clay. The clay bed underlies approximately the western two-thirds of the basin. The upper ground water zone is unconfined to semi-confined while the lower zone is confined.

The department's ground water quality monitoring program maintains surveillance of 34 wells in the portion of Madera County west of Highway 99. Most of these wells pump from the upper ground water zone. Very few analyses of ground water of the lower zone are available. However, the analyses

that are available indicate no appreciable difference in quality between the two zones.

Ground water in Madera County is generally of good quality and suitable for most uses, except for a narrow band along the San Joaquin River in the reach between Whitehouse and the Madera-Merced County line. Most of this area lies between the San Joaquin River and Lone Willow Slough. The water in these wells is sodium bicarbonate in character with sodium in excess of 85 percent of the total cations. The increase in sodium as the ground water moves west is probably the result of the ion exchange capacity of the native ground waters and of the applied surface waters which percolate to the ground water basin.

In the higher portions of the study areas samples of native ground water were collected from two wells in the vicinity of Oakhurst and from a spring near Ahwahnee. Analyses of these three sources indicate waters of excellent quality with low concentrations of all mineral constituents and a high capacity for ionic exchange.

Waste Water

At present almost all wastes in Madera County are disposed of by discharge to land. The exceptions are wastes resulting from sand and gravel plants and from lumber mills. These industries dispose of their wastes by discharge to adjacent surface waters. Other sources of waste water are sewage treatment plants, wineries, and food processing plants.

The only incorporated cities operating sewage treatment plants are Chowchilla and Madera. These plants, which serve a total population of approximately 20,000 people, dispose of approximately 3.1 million gallons of waste per day by irrigation. Madera Air Force Station disposes of its waste in oxidation lagoons and septic tanks. Winery wastes are disposed of by irrigation or by evaporation and percolation. A portion of the waste from Oberti Olive Company is disposed of by discharge to evaporation and percolation ponds; the remainder is discharged to the Madera Sewage Treatment Plant.

Water Quality Problems

The only existing water quality problem in Madera County is the occurrence of Class 3 (injurious to unsatisfactory) irrigation water in the ground water basin on the western edge of the county between Willow Slough and the San Joaquin River (see Plate 1). This problem is attributed to the ion exchange accumulation of salts in applied irrigation water and native ground water as it percolates down and moves toward the valley trough.

A possible source of degradation of ground waters in the area around the City of Madera is industrial waste water. As reported to the Central Valley Regional Water Pollution Control Board (No. 5), the industrial wastes that are disposed of by discharge to ponds for evaporation are possibly infiltrating the ground water basin and constitute a threat to the quality of the ground water. Several shallow wells in the vicinity of

an olive processing plant were abandoned a few years ago because of degradation of quality. The degradation was attributed to percolation from the ponds.

Effect of Future Development on Water Quality

In the Madera area, as in all areas of the State, rapid growth and development in all fields of endeavor are desirable. Growth and development may constitute a threat to the quality of both surface and ground waters. Probably the greatest threat to the quality of waters in Madera area is the impending industrial development of the area. Development and growth in other fields such as population, recreation, mining, and agriculture also pose a threat to water quality. Suitable controls on the quality of wastes resulting from any of the aforementioned activities should prevent the occurrence of serious problems. The responsibility for exercising these controls is vested in the Central Valley Regional Water Pollution Control Board (No. 5).

Several additional water resource development projects are proposed for the Madera area. Among these are the recently authorized Buchanan and Hidden Projects on Chowchilla and Fresno Rivers, respectively. Other potential prospects under consideration include Chiquito Reservoir on Chiquito Creek, Windy Gap on Fresno River, Soquel Meadow Reservoir on Willow Creek and Miami Creek Reservoir on Miami Creek, as well as several other possible alternatives. The construction of the proposed facilities could endanger the water quality through

increased recreational activities. Such problems, however, can be prevented or avoided by proper control of waste discharges.

Land Classification and Use Surveys

All lands in the Madera County area, with the exception of those in Yosemite National Park, have been surveyed and classified in accordance with the department's land classification and use standards.

Land Classification

Field mapping of the study area was accomplished during two different periods. During the winter of 1959 and the spring of 1961, the valley floor portion of the area was mapped. Between the spring of 1961 and the summer of 1962, the remainder of the area was mapped.

During the course of the field work for the valley floor portion of the surveys, some 210 soil samples were taken at 115 different sites on lands having apparent salinity and/or alkalinity problems.

In addition to the work done by this department, the U. S. Bureau of Reclamation has, over the past few years, classified a portion of the lands lying down slope from the Madera Canal. This classification was made according to bureau standards and is shown in its report "East Side Division, Central Valley Project, California - A Report on the Feasibility of Water Supply Development," dated January 1962.

A report issued in May 1962 entitled "Soil Survey, Madera Area, California" by the U. S. Department of Agriculture,

Soil Conservation Service, in cooperation with California Agricultural Experiment Station, University of California, sets forth a rather detailed analysis of soils in Madera County from the San Joaquin River easterly to the Sierra National Forest boundary. Additional information on soils of Madera County may be found in Soil Survey No. 12, a report by the University of California, dated January 1956, titled "Soils of Madera County, California," by Walter W. Weir.

Present Land Use

Present land use mapping has been completed for the county, excluding lands in Yosemite National Park. The work was accomplished during two different periods. The valley floor portion was mapped during the summer of 1958, as a part of the department's land use survey of the San Joaquin Valley; the remainder of the county was mapped during the summer of 1962. Tabulation of the land use surveys is complete for the valley floor portion of the county. Tabulation of survey data has not been completed for the foothill and mountainous areas.

Projections of future crop patterns have been completed for the valley floor portion of the area. These projections are based upon the market outlook study, "Market Outlooks for Selected Crops, 1960-2020," made by the department in 1959.

Service Areas

For the purpose of this investigation the study area was divided into several subareas referred to hereafter as

service areas although not service areas in the strict sense. The valley floor portion was divided into nine service areas; the foothill and mountainous portion has not yet been subdivided. The boundaries of the service areas for the valley floor are shown on Plate 1 entitled "Madera Area Investigation Service Areas."

Land use and classification data have been processed and compiled for service areas on the valley floor. Work is in progress to determine present and future economic demands for supplemental water to serve these areas. It is planned that economic demands for present and future supplemental water supplies for the foothill and mountainous area will be determined during the 1963-64 fiscal year.

Geology

Geologic studies for this investigation have been restricted for the most part to preliminary reconnaissance of a number of dam and reservoir sites located in the upper reaches of the Fresno River basin. Some studies have been made of ground water conditions in the Oakhurst area, such as well yields, availability of water, and water quality. Information regarding the general geology of the county is in the process of being compiled.

Three office-type reports have been prepared describing the geology of six damsites in the upper Fresno and San Joaquin River basins. These reports contain regional and damsite geologic maps, geologic cross sections at the damsites, and general information regarding the availability of construction materials at or near the damsites. Estimated depths of

stripping, foundation conditions, and data on stability and seismicity are included in the reports.

In connection with the valley floor portion of the study area, geologic data on ground water recharge are being compiled. These data are needed to make an evaluation of recharge in the area with regard to conjunctive operation of surface and ground water reservoirs. In connection with the study of ground water occurrence and movement on the valley floor, geologic study and analysis, including preparation of maps and cross sections, is in progress.

Fish and Wildlife Resources

Any comprehensive water development project in Madera County should include appropriate measures to assure the preservation and possible enhancement of the fish and wildlife resources. Accordingly, field surveys and office studies are being conducted to determine ways by which these measures can be achieved. Water development in the Madera area could have harmful as well as beneficial effects on the wildlife habitat and on the utilization of wildlife resources. Canals pose a potential danger to wildlife where heavy losses of deer might occur at crossings of migratory deer herd routes. Serious adverse effects could also arise from the flooding of fawning grounds, winter range, and other key habitat areas. Benefits may accrue from wildlife enhancement features of water developments and in some cases appreciable enhancement may occur. Determination of the effects of water development

on wildlife and wildlife habitat requires study of each proposed development.

The Madera investigative area includes some important wildlife habitat. The higher elevations, particularly public lands, are very important to the state deer hunting picture. Lower elevations are utilized by pheasant, waterfowl, rabbit, quail, doves, and other species.

The "California Public Outdoor Recreation Plan, Part II," California State Printing Office, November 30, 1960, lists the estimated acreages possessing necessary requirements for sustenance of the wildlife species and the activity days of hunting expended in Madera County as follows:

<u>Species</u>	<u>Estimated Acreage</u>	<u>Activity Days (Estimated Hunting for 1958)</u>
Deer	810,000	26,000
Pheasant	35,000	19,431
Waterfowl	10,300	8,800
Rabbit	500	10,869
Quail	100	29,375
Dove	600	16,485
Other species		940

Based upon the figures presented in the above mentioned report, hunting accounted for about 3 percent of the total outdoor recreation activity, exclusive of sightseeing, in Madera County for the period shown.

Based on estimates made by the U. S. Forest Service of attendance in the Minarets and Bass Lake districts during 1960, it is believed that some 300,000 angler days were devoted to fishing. A survey of available data revealed that the

Minarets Ranger District, having an area of some 188,600 acres, contains more than 60 lakes and some 175 miles of streams that provide good fishing. The Bass Lake Ranger District, covering an area of about 85,500 acres, has very few lakes but many miles of streams, some of which provide good to fair fishing.

The various species of trout provide the most important fishery resources of the upper Madera area. Loss or severe reduction in this resource would have a detrimental effect on the economy of Madera County. Projects proposed for this area should provide for protection and enhancement of the fishery resources in so far as possible.

It is anticipated that future water development in the area will provide opportunities for considerable enhancement of the overall fishery resource. However, it is possible that certain developments could adversely affect existing fisheries unless precautionary measures are taken. A combination of stream releases, downstream channel improvements with emphasis on developing suitable spawning areas, and operation of reservoirs consistent with other project purposes are some of the methods by which the fisheries resources of the county may be preserved and enhanced.

In the initial phase of the fisheries resources investigation of the area, preliminary reconnaissance surveys were made on the Chowchilla and Fresno Rivers, Fine Gold Creek, North Fork of Willow Creek, and Chiquito and Jackass Creeks. These surveys were conducted in order to appraise physical

conditions that presently exist on these streams. Observations concerning the availability of certain critical habitat factors, such as food, shelter, and spawning areas, were also made. Estimates of streamflow were made and water temperatures were measured at several points along the streams visited.

Topographic Mapping

The mapping for the Madera area investigation was begun in the fall of 1961. Stereoscopic coverage with aerial photography was obtained in October 1961 for an area of approximately 350 square miles in the upper drainage of the Fresno and San Joaquin Rivers. In the fall of 1961 and the spring of 1962, sufficient field work was accomplished to provide control for the photogrammetric compilation of 175 square miles of topographic maps. Topographic mapping for four dam and reservoir sites has been completed. The following is a detailed tabulation of dam and reservoir sites mapped by the department during the course of this investigation.

Dam and Reservoir Site	Stream	Scale In Feet Per Inch	Contour Interval
Fine Gold	Fine Gold Creek	300	10 feet
Miami Creek	Miami Creek	300	10 feet
Soquel Meadow	Willow Creek	300	10 feet
Windy Gap	Fresno River	300	10 feet

Other agencies have made maps in the locality of the Madera area investigation. The U. S. Bureau of Reclamation mapped an area along the San Joaquin River from Powerhouse No. 8 to Iron Creek at a scale of 2,000 feet to the inch and

a contour interval of 50 feet. This mapping was completed in 1952 from aerial photographs taken in 1951.

The U. S. Geological Survey has completely mapped the area of interest at a scale of 1:62,500 and at contour intervals of 50 and 80 feet. Most of this mapping was completed in 1953. In addition, the U. S. Geological Survey has made two river surveys in Madera County. One was done in 1912 along the San Joaquin River from Friant to Blaney Hot Springs on the South Fork, to Fish Creek on the Middle Fork, and to Iron Creek on the North Fork. Maps resulting from this survey were prepared with a scale of 1:31,680 and a contour interval of 25 feet. The other river survey was done in 1947 along the Fresno River from Spangler Gold Creek to Mile 4 on the Lewis Fork. This mapping was done at a scale of 1:24,000 and a contour interval of 25 feet.

Recreation

Recreation studies to date for the Madera area investigation have been concerned primarily with determining the present pattern of recreation use and the probable future recreation demand. Information obtained is summarized in the following paragraphs. In addition to the recreation use studies, a brief field reconnaissance was made of several potential reservoir sites for recreation enhancement. Two reservoir sites situated within the Sierra National Forest were identified as having exceptionally good recreation enhancement

potential. These sites are the Soquel Meadow site on Willow Creek and the Chilicoot site on Chilicoot Creek.

The present recreation use in Madera County centers about three major recreational attractions, the predominant one being Yosemite National Park. Although only a small portion of the Yosemite recreation occurs in Madera County, almost one-half of the Yosemite visitors travel through the county in going to or from the park. Use during the past three years at Yosemite has averaged slightly more than 3 million visitor days per year.

The second major recreation attraction is the Bass Lake area in the Sierra National Forest. Use of the Sierra National Forest in recent years has amounted to more than 2-1/4 million visitor days annually, and it is estimated that about one-half of this use occurs in the Madera County portion of the forest. It is estimated that at least one-half of the Sierra National Forest use within Madera County occurs in the immediate vicinity of Bass Lake.

The third major recreation attraction is Millerton Lake State Park. The use of Millerton in recent years has amounted to about 800,000 visitor days annually. Most of this use occurs in the Fresno County portion of the state park.

Although the present recreation use occurs primarily within the coniferous forest portion of the county, the summer-cabin type of use has increased appreciably in the vicinity of Oakhurst. Very little data are available on this portion of

the recreation picture, but some indication of its importance can be gained by the increase in subdivision activity in this upper foothill region. Any conclusions concerning the growth of summer-cabin use in Madera County is highly speculative. The all-year accessibility and the lack of climatic extremes make this area quite attractive for both summer-cabin and retirement-home type developments.

Estimates contained in the "California Public Outdoor Recreation Plan, Part II," indicate that the recreation demand in Madera County will increase more than threefold by 1980 and that the greater portion of this predicted demand will require weekend and vacation type facilities. At present the facilities at Yosemite National Park and at Bass Lake are used to capacity throughout the recreation season and overused on weekends and holidays. Although some facilities are available at other locations throughout the Madera County portion of the Sierra National Forest, the number of facilities and the number of persons that can be accommodated are quite small in comparison to the facilities available at Bass Lake and Yosemite National Park.

The "California Public Outdoor Recreation Plan" points out that over 60 percent of all recreation use tallied in statewide surveys leading to the report were water-oriented. Further, the report states that the 1956 recreation use of reservoirs constructed by the United States Army Corps of Engineers and by the Tennessee Valley Authority exceeded that of the national parks.

It is interesting to note that the 1960 use of Folsom Reservoir amounted to about one-half of the use occurring at Yosemite National Park, and the use of Millerton Lake was about one-fourth of the use at Yosemite. On the basis of the foregoing information, it is readily apparent that a large growth in demand for water-associated recreation will occur in Madera County by 1980. In fact, it has been estimated that the present demand for facilities at Bass Lake is so great that a "new Bass Lake" would receive capacity recreation use if it were built immediately.

Economic Considerations

This section presents information on past and present economy of the Madera area and progress of economic studies to date.

Past and Present Economy

The economic history of the watershed area dates back to the pregold rush days of the late 1820's when Hudson's Bay Company trappers traversed the area. In 1849 the Mother Lode Gold Rush boom overflowed into the area. This was short-lived but was followed by further mining activities involving copper and gold. With the advent of large-scale lumber operations and with the construction of the Central Pacific Railroad and a stage road from Madera to Wawona in the 1870's, the area began to take on the characteristics of a diversified economy. Large increases in agricultural output and sales also began at about this time.

A major segment of the present economy, which has developed fairly recently is that associated with recreation. Preliminary studies indicate that tourist and recreational activities in 1960 supported about 60 percent of the total population in the mountain and foothill portion of the area as compared with about 45 percent in 1950 and 15 percent in 1930. Water development projects which have contributed materially to this segment of the economy include Millerton Reservoir and Bass Lake, both of which are located in the San Joaquin River Basin.

Progress of Economic Studies

Considerable progress has been made in the economic analysis of the portion of the investigation area located on the San Joaquin Valley floor. Water requirements for both agricultural and nonagricultural uses have been projected by decades to the year 2020. In developing urban, rural farm, and rural nonfarm water requirements, population projections of the area were estimated, taking into account the trend toward industrialization and total county projections as shown in Department of Water Resources Bulletin 78. Studies were then made to determine the per capita water deliveries in the area. From these studies and the population projections, estimates of water requirements were developed. It was assumed the present relationship between local population and numbers of livestock and poultry would continue. Therefore, water requirements for livestock and poultry were based on the projected population increase.

In developing agricultural water requirements, a crop pattern was projected. The projected crop pattern was based upon physical characteristics of the area such as soil and climate combined with economic considerations, such as market demand, transportation, and processing and marketing facilities. Unit water requirement for each crop, together with the projected acreages of each crop, were used to determine total water requirements. Payment capacities for water were also developed for irrigated agriculture in the study area.

In the foothill and mountain portions of the Madera area, studies thus far have been limited to evaluating the area's past and present economy. These studies indicate tourist and recreation activities are probably the most important activities in the economy. Other activities include lumbering, agriculture, mining, and related industry and trade.

Water Rights

Purpose of this section is to discuss the present status of applications to appropriate water from the three major streams tributary to the Madera area of investigation. The status of applications filed with the State Water Rights Board pursuant to Part II of Division II of the Water Code and the number of filings and status thereof will be discussed for each of the streams.

Chowchilla River

All available information relating to filings for water rights on the Chowchilla River has been collected and

analyzed. A tabulation has been prepared summarizing the filings on that stream for the period 1914 up to 1961. It should be noted that these tabulations do not enumerate all vested rights to appropriate water from the stream systems as there are undoubtedly riparian rights and appropriative rights initiated prior to December 19, 1914, the effective date of the Water Commission Act. However, many of the larger diversions of water presently made from the Chowchilla River, as well as the Fresno and San Joaquin Rivers, are being made under permitted and licensed water rights applications on file with the Water Rights Board.

Filings to appropriate water from the Chowchilla River as they appeared on the board's records on January 30, 1961, are summarized below.

<u>Status</u>	<u>Number</u>	<u>AF/Year</u>
<u>Above Buchanan Damsite</u>		
Licensed	26	739
Permit	88	3,717
Pending	3	17
Incomplete	3	71,000
<u>Below Buchanan Damsite</u>		
Licensed	2	351
Permit	6	64,828*

*Does not include a permit to divert up to 600 cubic feet per second from the Chowchilla River for irrigation and domestic purposes for the Chowchilla Water District.

Fresno River

Applications for water rights as of February 1, 1961, for the Fresno River are summarized below. These applications have been divided into "above Windy Gap site" and "below Windy Gap site."

<u>Status</u>	<u>Number</u>	<u>AF/Year</u>
<u>Above Windy Gap Damsite</u>		
Licensed	10	172
Permit	9	1,012
Pending	12	58
Incomplete	6	unknown
<u>Below Windy Gap Damsite</u>		
Licensed	7	21,770
Permit	10	170,765
Pending	4	111
Incomplete	1	90,000

San Joaquin River

It is estimated that the future water supply from the San Joaquin River to the Madera area will amount to 403,000 acre-feet annually. This would consist of 140,000 acre-feet per year, Class 1 water,^{1/} and an average of 164,000 acre-feet

^{1/} Class 1 water is that supply of water from Friant Dam and the San Joaquin River which will be available for delivery from Friant-Kern and Madera Canals and the San Joaquin River as a dependable water supply during each irrigation season. It is estimated that this supply is subject to an appreciable deficiency about twice in 50 years based on the past 53 years of record on the San Joaquin River.

per year of Class 2 deliveries,^{2/} plus diversions and seepage from that stream amounting to some 99,000 acre-feet per year.

Ungaged Foothill Streams

The mean annual runoff from the ungaged foothill areas is estimated to be 12,800 acre-feet per year. No investigation has been made of water rights on these minor streams.

^{2/} Class 2 water is that supply of water from Friant Dam and the San Joaquin River which becomes available in addition to the supply of Class 1 water and which because of its uncertainty as to availability and time of occurrence, will be undependable in character and will be furnished only if, as, and when said water is available.

CHAPTER III. PLANS FOR DEVELOPMENT

This chapter presents a brief summary of studies being made to evaluate various plans for development of the water resources of the Madera area. The following paragraphs present discussions of planning objectives, of formulation of project plans, of preliminary designs and cost estimates, of presently authorized federal projects, of and plans for development by other agencies.

Planning Objectives

As mentioned in Chapter I, one of the primary objectives of this investigation is to formulate plans for optimum development of local water supplies for use in the upper watershed area, as well as the valley floor portion of the study area, in conjunction with proposed plans for imports of water from sources outside the county. In connection with development of project plans, due consideration is also being given the following:

1. The development of water-associated recreation projects in foothill and mountainous area.
2. Development of plans for enhancement of fish and wildlife resources with particular emphasis placed on the improvement of the trout stream fishery, as well as the fishery of lakes and reservoirs.
3. Investigation of the feasibility of conjunctive operation of surface and ground water reservoirs in the study area.

4. Evaluation of the feasibility of further hydroelectric power development in the upper drainage basins of the study area.

Formulation of Project Plans

As stated in Chapter II the Department of Water Resources proposed a total of twelve water development projects in the Madera area as a part of the California Water Plan. Studies conducted by the department and its predecessor, the Division of Water Resources, in formulating the California Water Plan were not made in sufficient detail to determine economic justification and financial feasibility.

Specific project formulation involves considerably more detailed planning studies than those conducted for Bulletin No. 3. For example, service areas are established after considering physical, economic, legal, organizational, and other limitations which may be involved. In addition, studies are made of the engineering feasibility and economic justification of some proposed projects selected for more detailed study.

As of the date of this report, planning studies have not progressed to the point of actual project formulation, partially due to lack of estimates of present and future water requirements in the upper Madera area. Studies aimed at determining the most economical reservoir sites are well underway, and data needed for project formulation are being compiled for future project planning studies.

Preliminary Designs and Cost Estimates

This section briefly discusses project planning studies for the Madera Area investigation, methods employed in making the studies, and status of the present work program.

The first approach to the project planning studies was to review plans and estimates of projects as proposed in Department of Water Resources Bulletin No. 3, "The California Water Plan." Of the twelve reservoir sites proposed in Bulletin No. 3, Mammoth Pool Project, located on the San Joaquin River, has been constructed by the Southern California Edison Company; and Buchanan and Hidden projects on Chowchilla and Fresno Rivers, respectively, have recently been authorized for construction by the federal government. Two of the remaining sites listed in Bulletin No. 3 are being given further study as a part of project planning studies for this investigation.

The second phase of project planning involved a reconnaissance type study of a large number of possible dam-sites throughout the entire upper Madera area. The primary purpose of the study was to determine the best projects for further investigation. Rough estimates of cost were made from existing topographic maps with maps of the damsites enlarged to a scale of 1:12,000 for determining embankment quantities, and by applying a unit price per cubic yard of fill which would allow for appurtenances such as outlet works and spillways. Area-capacity curves were prepared using U. S. Geological Survey topographic sheets, and estimates of runoff were made by

planimetering iso-runoff maps at a scale of 1:250,000.

Yield-capacity curves were developed for four representative sites in the area. These curves were used for estimating annual yields for all sites by choosing the one deemed to be most applicable.

As a result of the reconnaissance study, certain sites were chosen for further investigation and a mapping program of the reservoir and damsites was initiated. Aerial photography for mapping purposes was performed during the summer of 1961; and mapping was started by the department during the fall of 1961. Four sites have been mapped to date and geologic studies made of the potential project sites. These are: Windy Gap site on the Fresno River, Soquel Meadow site on the North Fork of Willow Creek, Miami Creek site on Miami Creek, and Mountain View site on the Fine Gold Creek. Cost estimates have been prepared for dams and reservoirs with various capacities at Windy Gap and Miami Creek sites. Estimates are being prepared for dams and reservoirs at Soquel Meadows and Mountain View sites.

As a part of the second phase study, curves were developed for the many sites considered showing cost per acre-foot of yield at the damsite. These curves will be useful in future project formulation when specific projects are being studied as to their economic justification.

Presently Authorized Federal Projects

As part of the Flood Control Act of 1960, the federal government authorized the construction of Buchanan and Hidden projects on the Chowchilla and Fresno Rivers, respectively.

Buchanan Reservoir would have a capacity of 150,000 acre-feet with a minimum pool of 10,000 acre-feet. The reservoir would be operated for flood control, irrigation, fish and wildlife, and recreation purposes. The project would be operated by the U. S. Bureau of Reclamation as part of the Central Valley Project. The U. S. Bureau of Reclamation has estimated that it would produce an average annual yield of about 24,000 acre-feet. The estimated initial cost of the Buchanan Project is about \$13,285,000 based on July 15, 1960 prices.

Hidden Reservoir also would be operated as a part of the Central Valley Project. It would have a capacity of 90,000 acre-feet with a minimum pool of 5,000 acre-feet. The U. S. Bureau of Reclamation has estimated that the reservoir would produce an average annual yield of about 24,000 acre-feet. The estimated total initial cost of Hidden Dam and Reservoir is about \$13,658,000 based on July 1, 1959 prices.

Plans for Development by Other Agencies

In addition to plans being developed by the federal government for the Chowchilla and Fresno Rivers, the Bureau of Reclamation, United States Department of the Interior, has proposed the construction of the East Side Division of the

Central Valley Project, which during years of normal runoff would initially provide a supplemental annual water supply of 1,500,000 acre-feet to the east side of the San Joaquin Valley. The valley floor portion of Madera County lies within the service area of the proposed division. This division would ultimately provide a supplemental water supply of about 4,000,000 acre-feet annually. The East Side Division would be an integral part of the Central Valley Project and would be financed and constructed in accordance with federal reclamation law.

CHAPTER IV. FUTURE WORK PROGRAM

The future work program on this investigation, as presently scheduled, will consist of the following: (1) completion of the tabulation of land use and land classification data for the upper Madera area, (2) preparation of estimates of present and future water requirements for the investigative area, (3) delineation of flood problem areas caused by flooding from foothill streams, (4) evaluation of available data on local drainage problems, (5) compilation of data needed for study of conjunctive operation of surface and ground water reservoirs in the area, (6) formulation of projects, and (7) preparation of the final report on the investigation.

The following discussions describe in more detail the remaining work necessary to complete this investigation.

Land Use and Classification

As stated in Chapter II land classification and present land use studies and estimates of future land use have been completed for the valley floor portion of the study area. Similarly, land classification and use studies are being done for the upper Madera area, and tabulation of these data is underway.

Estimated Present and Future Water Requirements

Water requirements for the valley floor portion of Madera area for the present and for year 2020 have been estimated. These estimates are based on future land use

projections, assuming maximum use of the land irrespective of the cost of water. Future work will involve economic demand studies for purpose of determining projected water requirements, including irrigation, municipal, and industrial requirements, as well as recreation and fish and wildlife demands. In this phase of the work program it is planned to determine future water requirements by service area.

Flood Problems on Foothill Streams

As previously stated, one of the objectives of this investigation is to conduct a reconnaissance level flood control study of the investigative area. While this might seem to be inconsistent with the level or degree of work being done on project planning studies, it is not within the scope of this investigation to develop definite flood control projects for the foothill streams, but rather to collect and analyze data relating to flooding from these minor streams and to determine the necessary course of action to alleviate these problems. Although a review has been made of reports by the U. S. Corps of Engineers and the Department of Water Resources for histories of floods occurring in the years 1950, 1955, and 1958; and certain data have been compiled pertaining to these floods; there remains the problem of determining the extent and severity of floods from the foothill streams. It is anticipated that future surface water hydrology studies will provide a part of the information needed for determining the course of action necessary for solution of these flood problems.

Local Drainage Problems

One of the objectives of this investigation is to make a limited scope survey of local drainage problems. To date there are no known drainage problems of any significance within the study area; however, the Department of Water Resources is currently conducting the San Joaquin Valley Drainage Investigation, which embraces all of the San Joaquin Valley floor area from the Delta to the Tehachapi Mountains. Basic data developed during the drainage investigation will be utilized to evaluate present and probable future drainage problems in Madera County.

Conjunctive Operation of Surface and Ground Water Reservoirs

Although construction of Hidden and Buchanan projects would provide a high degree of conservation of local supplies, operation studies indicate that during wet periods spill would occur with these projects in operation. Since storage in the above-mentioned reservoirs would not conserve all the flow, should additional surface storage be provided for this purpose, or could the excess flows be captured and utilized through proper conjunctive operation of both surface and ground water reservoirs?

During the course of future studies on water supply for the investigative area, an effort will be made to determine the physical and economic problems that might be encountered in the conjunctive operation of surface and subsurface storage. This study will entail an analysis of infiltration rates of

soils overlying the ground water reservoirs, as well as other problems involved in cyclic storage of supplies underground. An attempt will be made to conduct operation studies utilizing surface and subsurface storage combined so as to determine the feasibility of storing excess water from heavy runoff periods underground for use during dry years.

Formulation of Projects

Final formulation of water development projects will involve further refinement of sizing and operation studies of a number of selected potential projects and determining the locations and sizes of the areas most likely to be developed during the period 1960 to 2020. These studies will, of necessity, entail comparing and evaluating benefits and costs of several alternative projects. Such studies will involve determining economic demands for water supply, sources of potential water supply, repayment capacities of potential water users, and project benefits for areas under consideration.

In formulating water development projects, irrigatic domestic, recreation, and fish and wildlife needs will be given due consideration, as well as any hydroelectric potential.

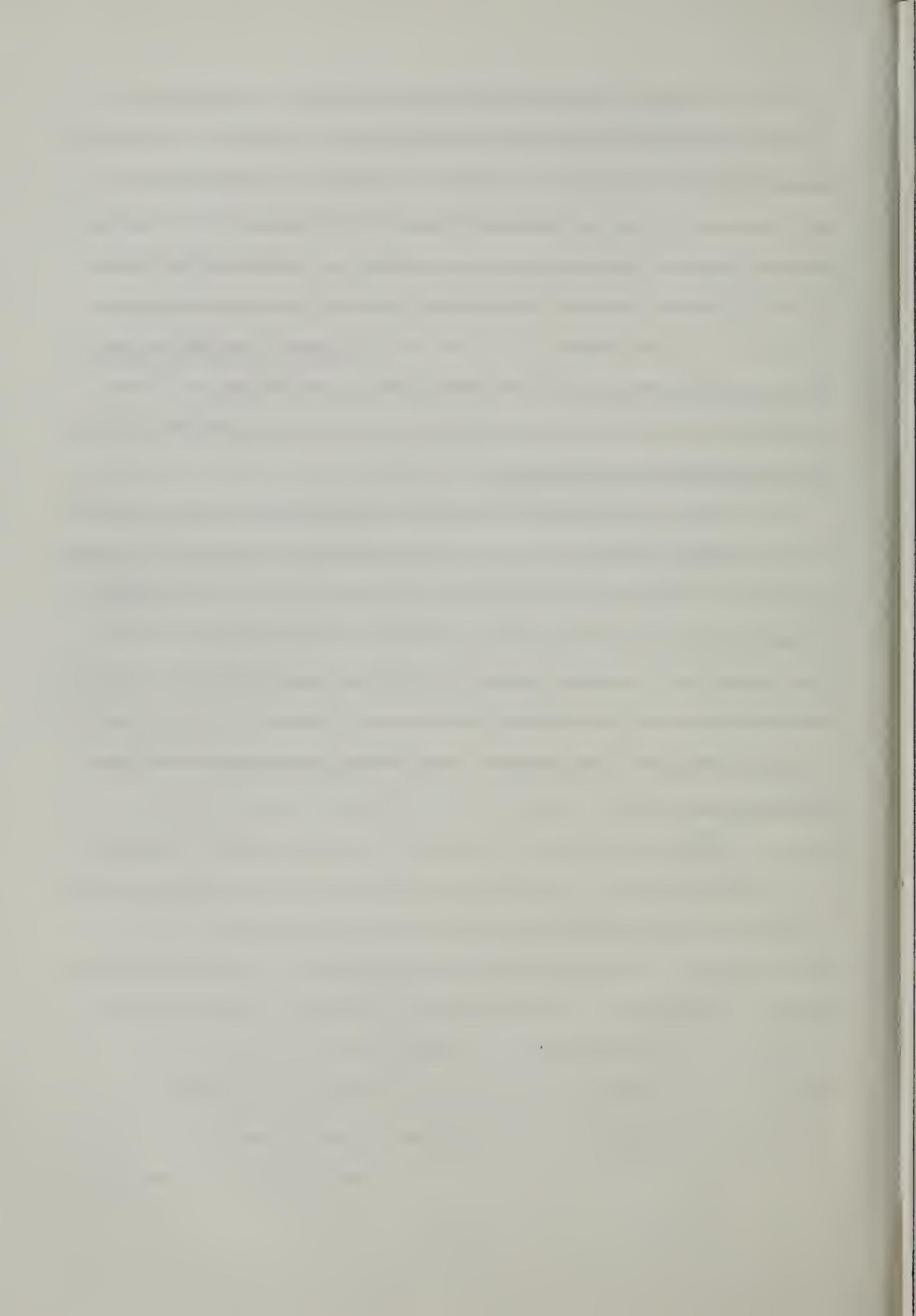
Additional surface water hydrology studies will be made to estimate runoff at the various damsites being considered. Flood hydrology studies of small foothill streams will be made.

Because of the rapidly increasing needs for outdoor type recreation facilities, particular emphasis will be directed toward planning for water-associated recreation facilities at proposed reservoir sites.

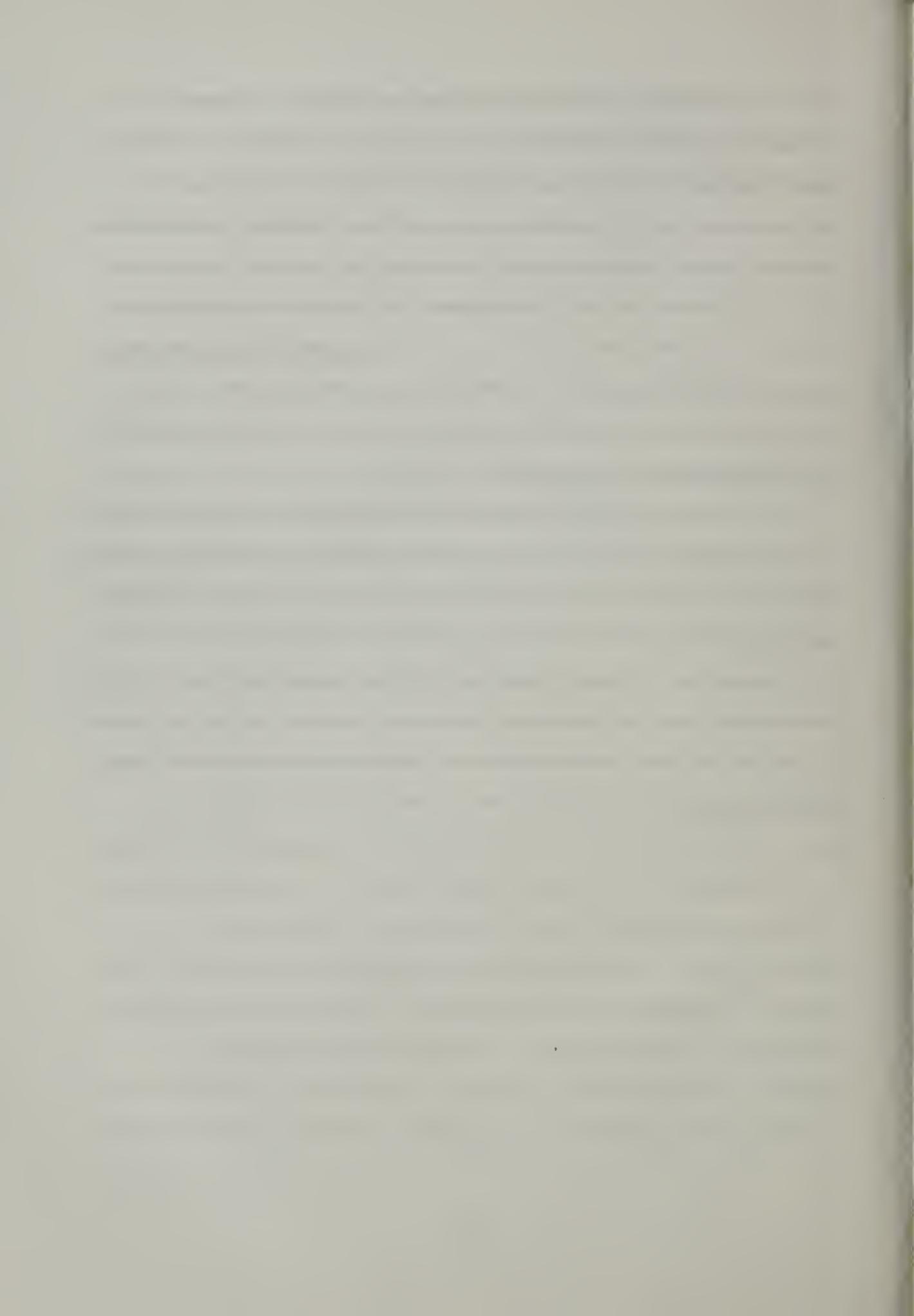
Fishery studies will involve further surveys of streams and lakes to develop information on streamflow requirements for maintaining the existing fishery. Consideration will also be given to enhancement of the fishery by increasing streamflows or by developing a streamflow regimen which will allow a greater natural development of the fish populations. Estimates of the probable future angling use of existing and proposed facilities will be developed. The effect of these facilities on the wildlife of the area will also be determined.

Final Report and Appendixes

The final report presently scheduled for publication in June 1965, will be supported by appendixes which will present such basic data as land classification and use, water supply, geology, economics, and other pertinent background material. The report will present results of this investigation, including recommendations for adoption of projects found to be economically justified to meet the present and future requirements of the Madera area.





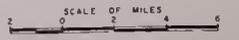


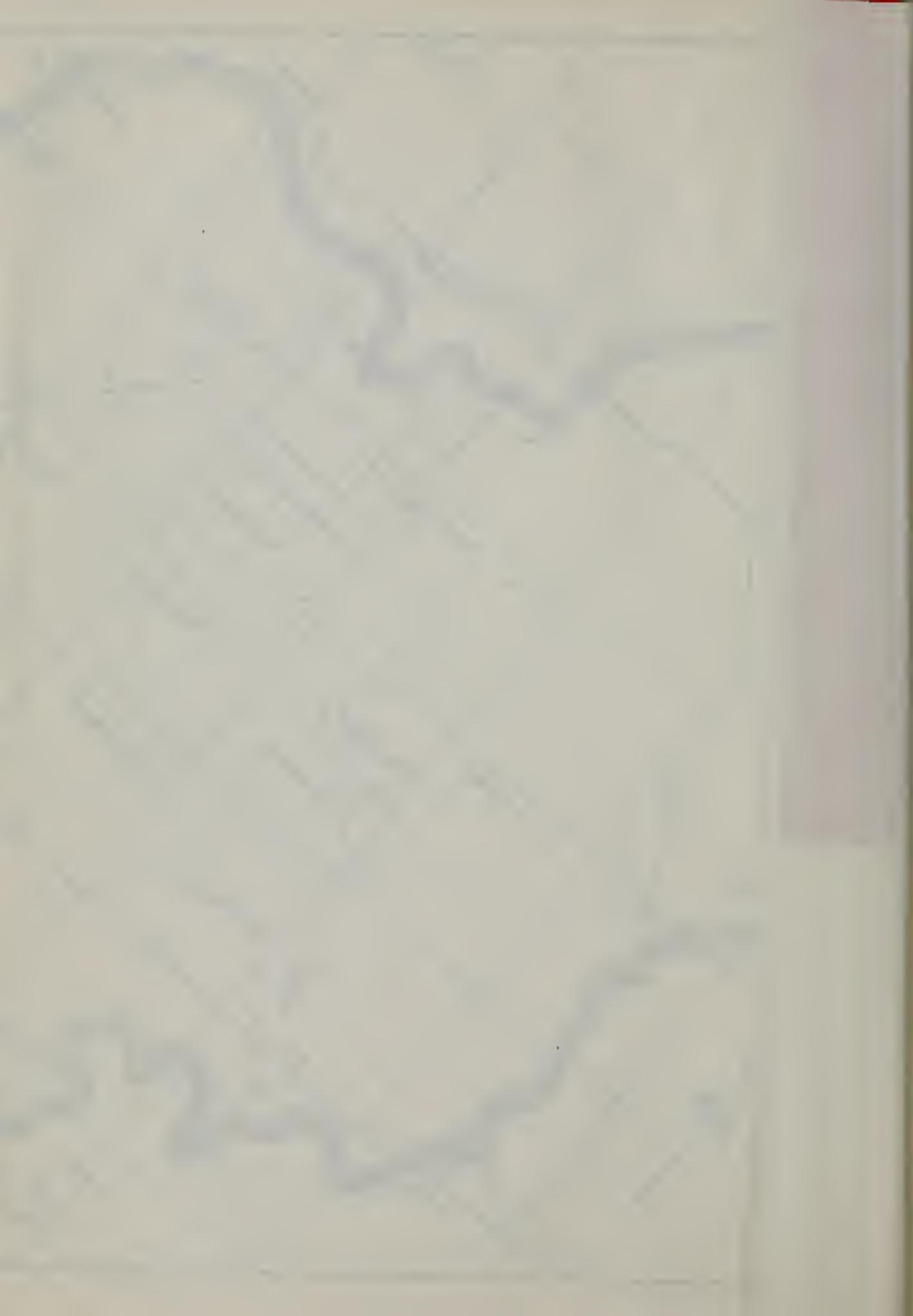


LEGEND

CODE NO	SERVICE AREA
05	RIVERSIDE
06	ALISO
01	CHOWCHILLA
02	MADERA
08	TRIGO
11	SHARON
09	ADDBE
10	DAULTON
11	UPPER AREA

STATE OF CALIFORNIA
 THE RESOURCES AGENCY OF CALIFORNIA
 DEPARTMENT OF WATER RESOURCES
 SAN JOAQUIN VALLEY BRANCH
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SERVICE AREAS
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