

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES
San Joaquin District

WATER SUPPLY AND DEMAND IN THE
COOPERSTOWN AND MONTPELIER SUBAREAS,
EASTERN STANISLAUS AND
NORTHERN MERCED COUNTIES

Memorandum Report

June 1979

CONVERSION FACTORS

Quantity	To Convert from Metric Unit	To Customary Unit	Multiply Metric Unit By	To Convert to Metric Unit Multiply Customary Unit By
Length	millimetres (mm)	inches (in)	0.03937	25.4
	centimetres (cm) for snow depth	inches (in)	0.3937	2.54
	metres (m)	feet (ft)	3.2808	0.3048
	kilometres (km)	miles (mi)	0.62139	1.6093
Area	square millimetres (mm ²)	square inches (in ²)	0.00155	645.16
	square metres (m ²)	square feet (ft ²)	10.764	0.092903
	hectares (ha)	acres (ac)	2.4710	0.40469
	square kilometres (km ²)	square miles (mi ²)	0.3861	2.590
Volume	litres (L)	gallons (gal)	0.26417	3.7854
	megalitres	million gallons (10 ⁶ gal)	0.26417	3.7854
	cubic metres (m ³)	cubic feet (ft ³)	35.315	0.028317
	cubic metres (m ³)	cubic yards (yd ³)	1.308	0.76455
	cubic dekametres (dam ³)	acre-feet (ac-ft)	0.8107	1.2335
Flow	cubic metres per second (m ³ /s)	cubic feet per second (ft ³ /s)	35.315	0.028317
	litres per minute (L/min)	gallons per minute (gal/min)	0.26417	3.7854
	litres per day (L/day)	gallons per day (gal/day)	0.26417	3.7854
	megalitres per day (ML/day)	million gallons per day (mgd)	0.26417	3.7854
	cubic dekametres per day (dam ³ /day)	acre-feet per day (ac-ft/day)	0.8107	1.2335
Mass	kilograms (kg)	pounds (lb)	2.2046	0.45359
	megagrams (Mg)	tons (short, 2,000 lb)	1.1023	0.90718
Velocity	metres per second (m/s)	feet per second (ft/s)	3.2808	0.3048
Power	kilowatts (kW)	horsepower (hp)	1.3405	0.746
Pressure	kilopascals (kPa)	pounds per square inch (psi)	0.14505	6.8948
	kilopascals (kPa)	feet head of water	0.33456	2.989
Specific Capacity	litres per minute per metre drawdown	gallons per minute per foot drawdown	0.08052	12.419
Concentration	milligrams per litre (mg/L)	parts per million (ppm)	1.0	1.0
Electrical Conductivity	microsiemens per centimetre (uS/cm)	micromhos per centimetre	1.0	1.0
Temperature	degrees Celsius (°C)	degrees Fahrenheit (°F)	$(1.8 \times ^\circ\text{C}) + 32$	$(^\circ\text{F} - 32)/1.8$

Memorandum

To : James U. McDaniel, Chief
Statewide Planning Branch

Date : June 20, 1979

File No.:

Subject: Water Supply and
Demand in the
Cooperstown and
Montpelier Subareas

Carl L. Stetson, Chief
San Joaquin District

From : Department of Water Resources

This report summarizes our study of the Cooperstown area in eastern Stanislaus County and the adjoining Montpelier area, which straddles the Stanislaus-Merced County line. The purpose of the study was to develop information that will assist in determining reasonable water demands in this portion of the east side of the San Joaquin Valley for Bulletin 4.

To date, the high-value tree and vineyard crops produced in the areas have been entirely dependent on ground water, and there is some doubt among local people that local ground water supplies are adequate to meet increasing agricultural demands. Consequently, there is considerable support for the importation of surface water from the Federal New Melones Project.

The determination of how much surface water should be imported to support agriculture in Cooperstown and Montpelier requires knowledge regarding what rate agricultural development occurs, how much development local ground water supplies can support, what other sources of surface water are available besides New Melones, and how any imported surface water can best be integrated with ground water use.

This report answers these and other questions by comparing present and projected water demands with present and projected water supplies. The report also summarizes geological information on local ground water basins, with emphasis on the hydrogeological impact of prolonged pumping and subsequent recharge.

The report concludes that water supply and demand conditions in Cooperstown and Montpelier are such that no long-term overdrafts will occur in either area in the foreseeable future.

SURNAME

DWR 155 (REV. 4-62)

T. L. Eiler
6-19-79

Hubbart
6-19-79

Meffley 6-19-79
Chavez 6/19

Carl L. Stetson
6/20/79

TABLE OF CONTENTS

	<u>Page</u>
ORGANIZATION	vii
CHAPTER I. INTRODUCTION AND SUMMARY	1
Area of Study	1
Background	1
Summary	4
Cooperstown Subarea	4
Montpelier Subarea	4
CHAPTER II. LAND CLASSIFICATION AND USE	7
Land Classification	7
Land Use	9
Trends	12
Projected Crop Acreages	14
CHAPTER III. WATER DEMANDS AND SUPPLIES	15
Water Use	15
Urban Water Use	16
Agricultural Water Use	16
Unit Use Values and Irrigation Efficiencies	16
Agricultural Water Demand	18
Net Water Demands	18
Water Supplies	18
Geology	19
Ground Water Levels	22
Ground Water Storage Change	24
Ground Water Recharge	24
Precipitation	26
Undiverted Streamflow	27
Reservoirs	28
Canals	29
Subsurface Flows	30
Analysis of Water Supplies and Demands	30
Projected Water Supplies	32

TABLE OF CONTENTS (continued)

	<u>Page</u>
APPENDIX A. GROUND WATER LEVELS AT WELLS	35
BIBLIOGRAPHY	47

FIGURES

<u>Number</u>		
1	Location of the Cooperstown and Montpelier Subareas	2
2	1958 Irrigated Crops in Montpelier Subarea . . .	10
3	1978 Irrigated Crops in Montpelier Subarea . . .	11
4	Schematic Geologic Section	19
5	Geologic Formations in Cooperstown and Montpelier	20
6	Lines of Equal Elevation of Water in Wells, Cooperstown Subarea, Winter 1971	22
7	Lines of Equal Elevation of Water in Wells, Montpelier Subarea, Spring 1978	23
8	Four Water Level Hydrographs in the Montpelier Subarea	25

TABLES

1	Land Classification Legend	8
2	Land Classification, DAU 207 (Cooperstown) and DAU 209 (Montpelier)	9
3	Historical Cropping Patterns, Cooperstown and Montpelier Subareas	12
4	Projected Cropping Patterns, Cooperstown and Montpelier Subareas	14
5	Present and Projected Applied Water Demands and Evapotranspiration of Applied Water, Cooperstown and Montpelier Subareas	15

TABLE OF CONTENTS (continued)

TABLES (continued)

<u>Number</u>		<u>Page</u>
6	Vegetative Unit Water Use, Cooperstown and Montpelier Subareas	17
7	Estimated Average Annual Riparian Diversions to Cooperstown and Montpelier Subareas	18
8	Summary of Estimated Ground Water Recharge to the Cooperstown and Montpelier Subareas	26
9	50-Year (1926-76) Average Precipitation and Record Extreme Annual Precipitation at Selected Stations	26
10	1971-75 Base Period Hydrologic Balances, Cooperstown and Montpelier Subareas	31

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES
San Joaquin District

Carl L. Stetson District Chief
John W. Masier Chief, Planning and
Investigations Branch
Richard W. Meffley Chief, Investigations Section
Wendell M. Hubbart Associate Engineer, Water Resources

by

Terry L. Erlewine Assistant Engineer, Water Resources

Assisted by

Frederick E. Stumpf Chief, Water Utilization Section
Arvey A. Swanson Senior Engineering Geologist
Steve E. Gentry Assistant Engineer, Water Resources
Daniel J. Wightman Research Writer
Kenneth W. Winden Delineator
Carlynn J. Moreno Senior Stenographer

CHAPTER I. INTRODUCTION AND SUMMARY

This report summarizes a Department of Water Resources (DWR) study of the Cooperstown and Montpelier subareas, which comprise lands in eastern Stanislaus County and an adjoining part of Merced County that lie outside of established irrigation districts. The purpose of this study was to develop information that will assist in determining whether Cooperstown and Montpelier subareas need surface water supplies from the New Melones Project to augment their existing water supplies. Additionally, this study was to determine reasonable water demands in part of the east side area for DWR Bulletin 4. The following factors were evaluated in developing this information:

- Land resources.
- Present land use and cropping patterns.
- Recent trends in land use.
- Projected land use.
- Present and projected water demands.
- Present and projected water supplies.

Area of Study

Cooperstown and Montpelier subareas are located in eastern Stanislaus and northern Merced Counties (Figure 1). Cooperstown subarea is the part of Stanislaus County south of the Stanislaus River, north of the Tuolumne River, and east of Oakdale and Modesto Irrigation Districts. Montpelier subarea is south of the Tuolumne River and includes lands in both Merced and Stanislaus Counties, which lie east of Turlock Irrigation District and north of the Merced River and the Northside Canal unit of Merced Irrigation District. Several "islands" of the older irrigation districts are entirely surrounded by and excluded from Cooperstown and Montpelier subareas.

The definition and delineation of Cooperstown and Montpelier subareas were developed by the U. S. Bureau of Reclamation (USBR) in its Stanislaus River basin study and are used in this report for purposes of comparability. Hereafter, these subareas will be referred to only as Cooperstown and Montpelier.

Background

Cooperstown and Montpelier do not correspond to any existing public agencies, although they do have one common characteristic -- a lack of any firm surface water supply.

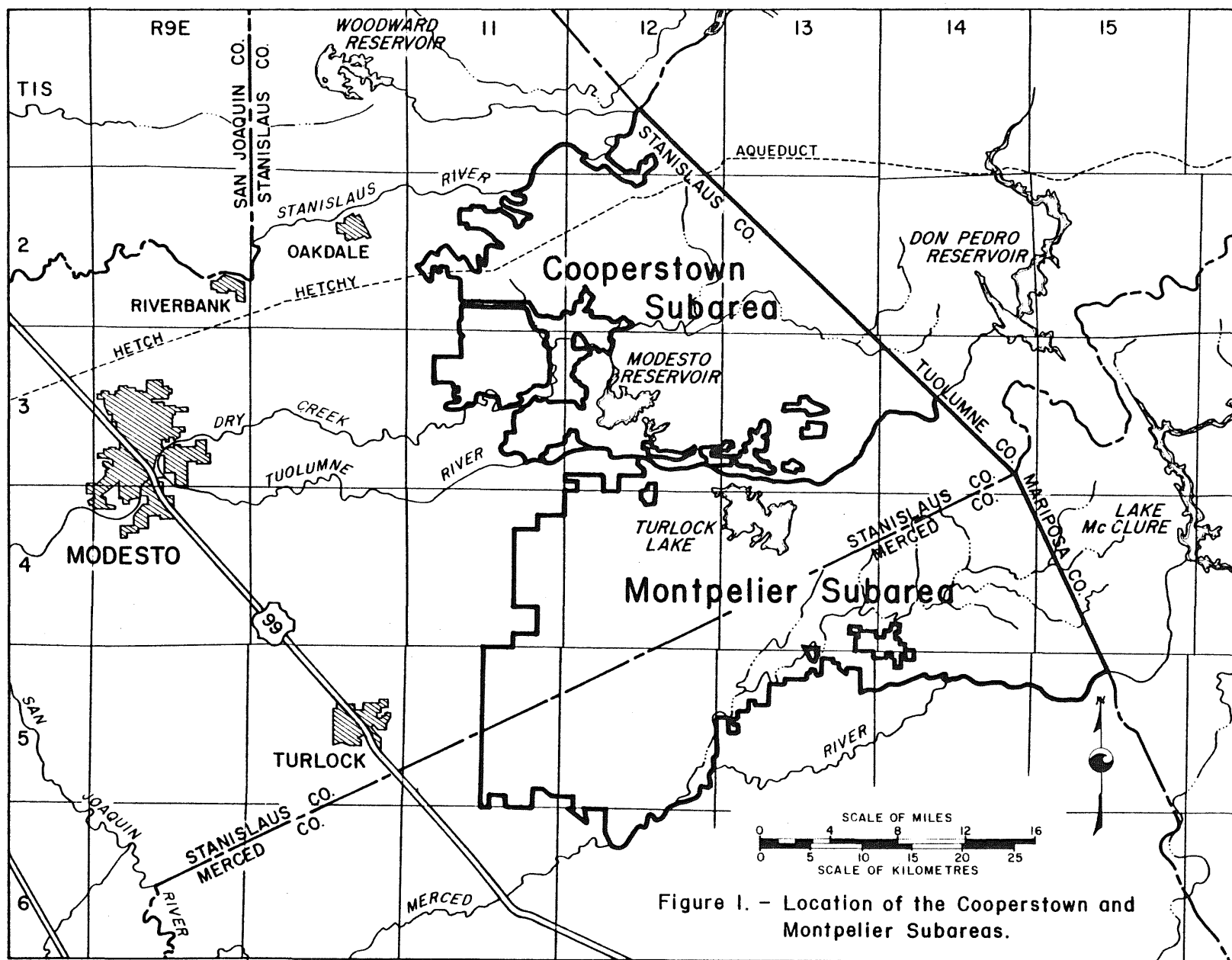


Figure 1. - Location of the Cooperstown and Montpelier Subareas.

Lands in Cooperstown and Montpelier were originally considered to be unirrigable and were therefore excluded from Modesto, Turlock, and Oakdale Irrigation Districts. In recent years, Montpelier has had a rapid growth in irrigated cropland, nearly all of which is irrigated with ground water. This rapid growth has aroused concern among Montpelier growers over the adequacy of ground water supplies, and local officials have begun investigating surface water supply sources as an alternative to continued ground water extractions.

The search for a dependable surface water supply has drawn Cooperstown and Montpelier into the controversy over the New Melones Project. The State Water Resources Control Board's ruling on New Melones, Decision 1422, limits consumptive use of the project's 271 000-cubic-dekametre (220,000-acre-foot) annual new yield to lands lying within the reservation area, the "Stanislaus River basin". The ruling further stipulates that the yield may not be used until the demand for that water has been proven to exist. Although the definition of the Stanislaus River basin is not yet final, USBR's original area of reservation includes Cooperstown; so a firm supply of surface water would seem to be assured if a demand develops.

Montpelier, on the other hand, already has a large demand for water that could be met by the New Melones Project. But Montpelier was excluded from USBR's original area of reservation, although subsequent efforts have been made by local interests to include all of Montpelier. USBR's regional director, Billy E. Martin, has responded to these efforts in two memoranda. He proposed, in May 1976, that all of Stanislaus County, including about half of Montpelier, be included in the area of reservation. A second memorandum, dated January 7, 1977, included the remainder of Montpelier -- the portion lying in Merced County -- in the reservation area. But the final decision rests with the U. S. Department of Interior, and that agency has not made a final determination.

USBR and other agencies have prepared several reports concerning the timing and demand for New Melones Project water. Some of these reports are listed below:

- U. S. Bureau of Reclamation. "Stanislaus River Basin, Proposed Reservation Area and Project Water Requirements". June 1975.
- Jones, Marshall. "Water Needs in Stanislaus County Subject to Service from New Melones Project". June 1974.
- California Department of Water Resources. "Land and Water Resource Utilization in Calaveras County". Central District report. July 1975.
- Calaveras County Water District. "Calaveras County Water -- Master Plan". May 1974.

Summary

Cooperstown and Montpelier have greatly different water demands and supplies. Hence, the following summary deals with Cooperstown and Montpelier separately.

Cooperstown Subarea

DWR determined that demand for water is presently very small in Cooperstown; furthermore, this demand is not likely to increase significantly. Cooperstown's water demand is met at present with ground water supplies with no overdraft, and these supplies are deemed sufficient to meet any foreseeable increase in demand for water. Agricultural development will probably not increase in Cooperstown because of the marginal nature of the subarea's irrigable lands. These lands are generally underlain at shallow depth by hard, consolidated, sedimentary rock that limits agriculture to low-value, shallow-rooted forage crops. This limitation, plus the scattering of the irrigable lands in small, uneconomical parcels, hinders any increase in agriculture in Cooperstown.

Montpelier Subarea

In Montpelier, an extensive demand for water already exists, and DWR predicts this demand will escalate in the future. The water demand is presently met with ground water withdrawals, and some overdrafting has occurred. The overdrafting, however, has not been nearly as serious as might be expected for an area without surface water supplies, since lowered water levels in Montpelier have accelerated ground water replenishment. DWR predicts the increased agricultural development and water demands expected in Montpelier to the year 1990 can be met with ground water pumpage alone, and no long-term local overdraft will result because of increased ground water replenishment. Development beyond the 1990 level, into the eastern part of Montpelier, will require supplemental surface water supplies, as ground water aquifers in that area are thinner and less permeable than those in the presently developed western part of Montpelier.

The increase in ground water replenishment to Montpelier, which will continue to occur if irrigated agriculture keeps expanding, has been mainly at the expense of reduced streamflows in the Tuolumne and Merced Rivers. All the water used consumptively in Montpelier is water that formerly would have flowed into area streams and ultimately would have made its way into the lower San Joaquin River and the Sacramento-San Joaquin Delta. Streamflow losses resulting from the current mode of operation could be replaced by greater use of winter power release from New Don Pedro Dam on the Tuolumne

River and from New Exchequer Dam on the Merced River. To the extent that these releases are in excess of instream needs, these winter flows could be conserved for use in Montpelier either through some intentional recharge operation or through offstream storage. An examination of the instream needs of these rivers, along with the amount of water that would be available for conservation, is merited and should be evaluated before any importation of New Melones water.

CHAPTER II. LAND CLASSIFICATION AND USE

In recent years Montpelier has been one of the San Joaquin Valley's fastest growing agricultural areas. This chapter presents Department of Water Resources land use surveys that chronicle this growth between 1958 and 1974-75 and also includes estimates of 1990 and 2020 land use in Cooperstown and Montpelier.

Land Classification

Although many factors determine the suitability of land for irrigation development, DWR considers only the inherent factors (soil characteristics and physiography) of the land itself in its land classification survey. Indirect factors such as the economics of production and marketing, climatic conditions, water supply, and farmer preference are considered later in estimating future land use.

DWR conducted a land classification survey in Cooperstown and Montpelier between 1957 and 1960, and Table 1 shows the standards that were used. Generally, lands were segregated into two major categories: irrigable and non-irrigable. Within the irrigable category, a wide range of conditions occurs. These conditions are further segregated and identified as the various irrigable land classes. Nonirrigable lands are those that fail to meet irrigability requirements due to physical constraints such as steepness of slope, stream channels, depth of soil, or existing urban development.

DWR determined land characteristics by field examination, including slope measurement, examination of test hole borings of soil augers, examinations of road cuts, and observations of crops and native vegetation. The results of this land classification survey are tabulated by DWR's detailed analysis units (DAU's), and Table 2 presents these classifications for DAU's 207 and 209, which roughly correspond to Cooperstown and Montpelier, respectively. This table shows that a substantial amount of irrigable land in both Cooperstown and Montpelier has a shallow effective root zone (the classification symbols for these lands include the letter "P"). Normally this modifying condition restricts lands to the production of only shallow-rooted crops, such as irrigated pasture. In Montpelier, growers have converted many of these lands to deep-rooted orchards and vineyards by ripping the underlying hardpan layer to facilitate root penetration, and other Montpelier lands could be improved in this manner. The same is not true in Cooperstown, however, where most shallow soils are underlain by hard, consolidated rock and agriculture is for the most part limited to shallow-rooted crops.

TABLE 1

LAND CLASSIFICATION LEGEND

URBAN AND RECREATIONAL LANDS

- RR Existing and potential permanent and summer home tracts within a primarily recreational area. The estimated number of houses, under conditions of full development, is indicated by a number in the symbol, i.e., RR-3 is suitable for three houses per acre.
- RT Existing and potential picnic, camp and trailer sites within a primarily recreational area.
- RC Existing and potential commercial areas which occur within a primarily recreational area and which include motels, resorts, hotels, stores, etc.
- PP Existing race tracks, fairgrounds, and private, city, county, state, and federal parks.
- UD The total area of cities, towns and small communities presently used for residential commercial, recreational, and industrial purposes.

IRRIGABLE LANDS

Irrigable lands are identified by notations which begin with a letter "V", "H", or "M". These symbols indicate the general slope conditions, and may appear along or followed by (other) modifying symbols. The slope conditions indicated by these letters are:

- V These lands are level or slightly sloping and vary from smooth to hummocky or gently undulating relief. The maximum slope is 6 percent for smooth, reasonably large bodies lying in the same plane.
- H These are lands with greater slope and/or relief than those of the "V" class. They vary from smooth to moderately rolling or undulating relief. The maximum slope is 20 percent for smooth, reasonably large bodies lying in the same plane.
- M These are lands with greater slope and/or relief than those of the "H" class. They vary from smooth to steeply rolling or undulating relief. The maximum slope is 30 percent for smooth, reasonably large bodies lying in the same plane.

The description below applies to all "V", "H", and "M" lands on which these slope symbols appear by themselves:

Have soils of medium or deep effective root zones; are permeable throughout; are relatively free of salinity, alkalinity, rock, or other conditions which would limit crop adaptability; are suitable for all climatically adapted crops, being limited only by topographic conditions.

The symbols below, appended to "V", "H", or "M", indicate the described modifying conditions.

- S Indicates the presence of an excess of soluble salts or exchangeable sodium in slight amounts.
- SS Indicates the presence of an excess of soluble salts or exchangeable sodium in moderate amounts.
- SA Indicates the presence of an excess of soluble salts or exchangeable sodium in large amounts.
- P Indicates shallow depth of the effective root zone.
- W Indicates the presence of a high water table.
- L Indicates fairly coarse textures and low moisture-holding capacities.
- H Indicates very fine textures.
- R Indicates enough rock on the surface or within the plow zone to limit use of the land for cultivated crops.
- B Indicates low-lying basin and seep areas.
- 2, -4, -6, or -8 Number indicates, in feet, the average difference between highs and lows due to microrelief.

MISCELLANEOUS LANDS

- F Presently forested lands, or lands subject to forest management, which meet the requirements for irrigable land but which, because of climatic conditions and physiographic position, are better suited for timber production or some type of forest management program rather than for irrigated agriculture.
- VM Swamp and marsh lands which usually support a heavy growth of phreatophytes and are covered by water most of the time.
- N Includes all lands which fail to meet the requirements of any of the foregoing classes.

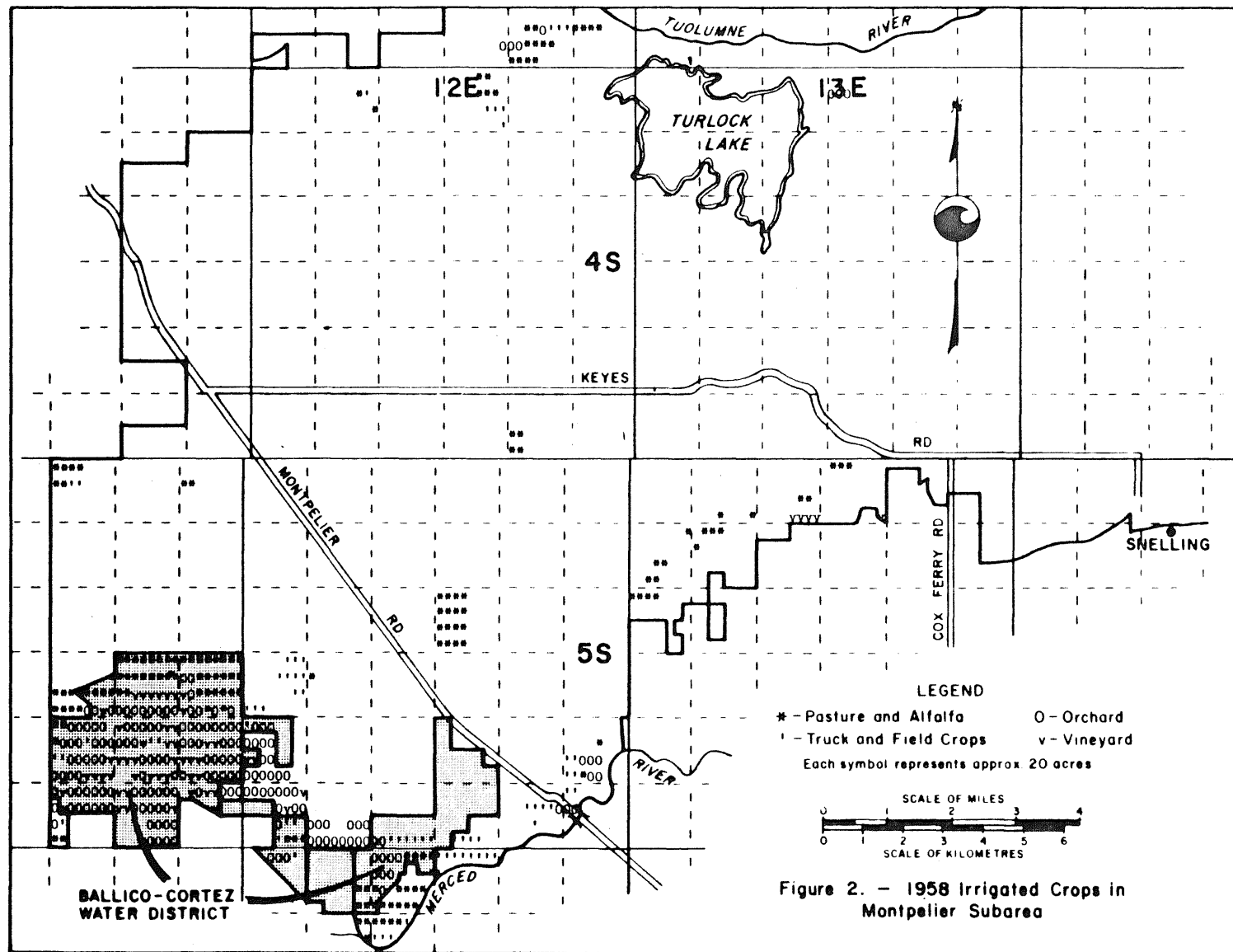
TABLE 2

LAND CLASSIFICATION
DAU 207 (COOPERSTOWN)
AND DAU 209 (MONTPELIER)
(in acres)

Land Class	DAU 207	DAU 209		Total
		Merced County	Stanislaus County	
V	3,019	14,339	1,334	15,673
VH	514	0	447	447
VL	824	4,001	147	4,148
VP	22,092	14,811	9,454	24,265
VPR	186	0	0	0
VS	0	221	0	221
VSS	0	40	0	40
Subtotal	26,635	33,412	11,382	44,794
H	685	1,179	380	1,559
HL	254	741	0	741
HP	39,678	30,537	18,670	49,207
HPR	352	38	10	48
M	18	17	0	17
MP	12,922	12,087	16,592	28,679
MPR	25	411	0	411
Subtotal	53,934	45,010	35,652	80,662
Total Irrigable	80,569	78,422	47,034	125,456
N	28,270	13,117	7,266	20,383
PP	0	14	216	230
UD	43	54	30	84
Total Area	108,882	91,607	54,546	146,153

Land Use

DWR made land use surveys for Cooperstown and Montpelier in 1958, for the Merced County part of Montpelier in 1974, and for Cooperstown and the Stanislaus County part of Montpelier in 1975. DWR also made a reconnaissance survey of land use changes in Montpelier in late summer 1978. Table 3 lists historical cropping patterns in Cooperstown and Montpelier, and Figures 2 and 3 show the extent of Montpelier's 1958 and 1978 irrigated agricultural development. The large amount of grain listed in Table 3 for 1974-75 and 1978 is somewhat misleading because the surveys make no distinction between irrigated and nonirrigated grain. Only a small portion of the total grain acreage is actually irrigated.



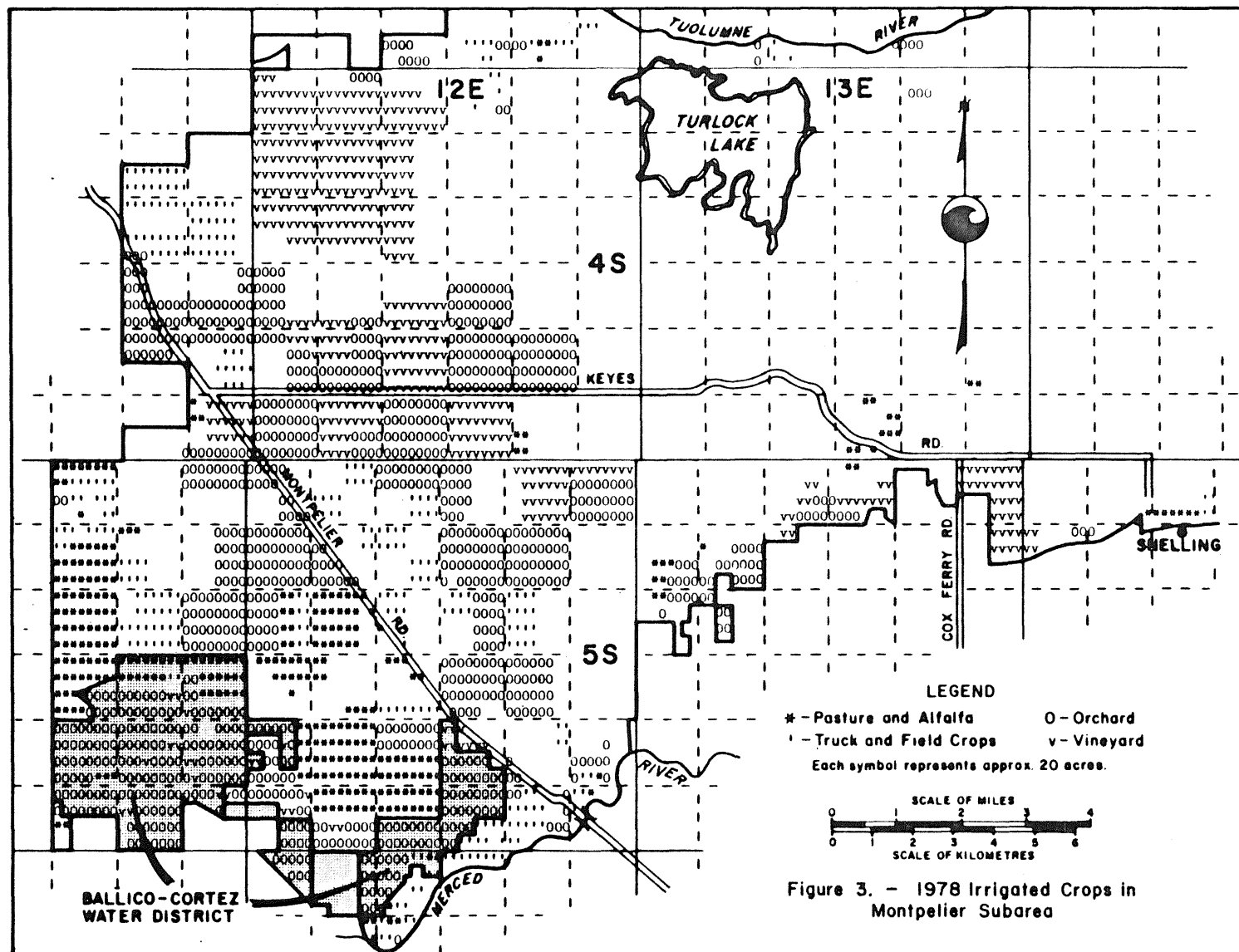


TABLE 3
HISTORICAL CROPPING PATTERNS
COOPERSTOWN AND MONTPELIER SUBAREAS
(in acres)

Irrigated Crop	Cooperstown		Montpelier		
	1958	1975	1958	1974-75	1978
Grain and hay	0	1,700	100	7,200	7,200
Corn	100	200	600	1,100	900
Beans	0	0	500	2,500	4,600
Miscellaneous field	0	0	0	200	200
Alfalfa	0	0	700	200	200
Pasture	2,500	2,500	3,500	7,300	7,300
Tomatoes	0	0	0	100	0
Miscellaneous truck	100	0	600	300	300
Almonds	0	1,300	1,100	13,200	14,800
Other deciduous	100	200	2,200	3,800	3,900
Vineyard	100	0	1,200	8,800	8,800
Olives	0	0	100	100	100
Total historical net land acreage in crops	2,900	5,900	10,600	44,800	48,300

Trends

The main land use trend in Cooperstown and Montpelier in recent years has been toward increased irrigated crop acreages. Table 3 reflects this trend and shows that net irrigated lands in Montpelier rose from 4 300 hectares (10,600 acres) in 1958 to 18 100 hectares (44,800 acres) in 1974-75 -- an increase of 13 800 hectares (34,200 acres). During the same period Cooperstown's net irrigated lands rose from 1 150 hectares (2,900 acres) to 2 350 hectares (5,900 acres) -- an increase of 1 200 hectares (3,000 acres).

In 1958, irrigated agriculture in Montpelier was confined mainly to the southwestern part of the subarea, which was incorporated in 1970 as the Ballico-Cortez Water District. The low slopes and deep soils of this area are well-suited to high-value crops, such as grapes and peaches, which are furrow or basin irrigated with pumped ground water. In 1958, Montpelier's other irrigated lands were located in the Merced and Tuolumne River bottoms, in the Dry Creek Valley, and adjacent to Turlock Irrigation District. Growers considered the rest of Montpelier unsuitable for irrigation because of steep hills and uncertain water supplies. Land use in the bulk of Montpelier was thus limited to dry-land grain farming and cattle grazing.

In recent years, growers have extensively developed Montpelier's dissected uplands, mostly with high-value crops. The increase in almond orchards, as shown in Table 3, is especially striking -- from 450 hectares (1,100 acres) in 1958 to 5 350 hectares (13,200 acres) in 1975. Other crops with large acreage increases were vineyards, dry beans, and miscellaneous deciduous orchards. This increase in irrigated agriculture in Montpelier was made possible by sprinkler irrigation, which permitted the irrigation of lands on steep slopes. Growers also overcame the other hindrance to development, uncertain water supplies, by drilling deep irrigation wells to tap the waters in the Mehrten formation. The necessity of expensive drilling to obtain a dependable water supply precluded development of lands to low-value crops, such as pasture and alfalfa. Between 1958 and 1975, the increase in these crops was isolated to a small area near the Ballico-Cortez Water District, and growers most likely will not increase acreages of these crops in the future.

DWR conducted a land use survey in Montpelier in September 1978. The purpose of this survey was to record large trends in recent agricultural development. No attempt was made to tabulate small land use changes in areas like the Ballico-Cortez Water District, which have long been essentially completely developed. Rather, the survey concentrated on lands east of Montpelier Road, where agricultural development is far from complete and where growth has been rapid in recent years.

This survey, summarized in Table 3, shows two recent trends. The first is the continued increase in irrigated almonds, prompted by the previous success of almond orchards in the area, as well as a continued good demand for the nuts. The second trend is a large increase in development in dry beans, which increased by about 850 hectares (2,100 acres) from 1974-75 to 1978. Another recent trend, noted but not reflected in the table, was a move toward replacing grapes and peaches with almonds in the Ballico-Cortez Water District.

Cooperstown's agricultural land use changed little from 1958 to 1975, with only a small increase in almonds -- 550 hectares (1,300 acres). The almond orchards are located in southwestern Cooperstown, adjacent to Modesto Lake, where soil and ground water conditions are somewhat similar to those in Montpelier. Pasture, the predominant crop in Cooperstown, is grown in the valley of Dry Creek and in some areas next to Oakdale Irrigation District to the west. Pasture acreage was unchanged from 1958 to 1975, and further development of pasture will probably be precluded by the high cost of developing a good water supply.

Projected Crop Acreages

Information from the land use surveys provided the basis for DWR's projected future crop acreages. A comparison of survey data from the different time periods indicates rates of development as well as short-term trends in cropping patterns.

DWR projects future crop acreages in Cooperstown and Montpelier, as well as the San Joaquin basin and Tulare basin hydrologic study areas, within the framework of the estimated future crop market outlook for the entire State. DWR bases its estimates of California's share of future production of food and fiber on forecasts of future population, per capita consumption of food and fiber, and net foreign trade expectations.

Bulletin 160-74 explains DWR's crop market outlook study, the assumptions employed, and the four sets of alternative future crop acreages derived in the course of the study. For Cooperstown and Montpelier, DWR selected Alternative Future II, which assumes a 2.5 fertility rate and a net migration of 150,000 people annually.

DWR projects future crop acreages by correlating the factors discussed above. The crop market outlook data provide reasonable crop acreage guidelines and limits; land use surveys indicate short-term trends, rates of development, and present cropping practices; and land classification measures the physical limits to which crop acreages can be projected. Table 4 lists these projections.

TABLE 4
PROJECTED CROPPING PATTERNS
COOPERSTOWN AND MONTPELIER SUBAREAS
(in acres)

Irrigated Crop	Cooperstown		Montpelier	
	1990	2020	1990	2020
Grain and hay	0	0	1,000	1,000
Miscellaneous field	1,000	2,000	8,000	11,000
Alfalfa	1,000	1,000	1,000	1,000
Pasture	3,000	4,000	8,000	8,000
Miscellaneous truck	1,000	1,000	2,000	3,000
Deciduous orchard	4,000	5,000	27,000	34,000
Vineyard	1,000	2,000	14,000	17,000
Total projected net land acreage in crops	11,000	15,000	61,000	75,000

CHAPTER III. WATER DEMANDS AND SUPPLIES

The adequacy of ground water supplies to meet estimated water demands may best be determined by hydrologic balance, which is simply an accounting of all water demands and supplies in an area during a specified period of time. In Cooperstown and Montpelier, the Department of Water Resources used a 1971-75 base period, the length of time being dictated by the availability of information on ground water storage changes. This chapter presents DWR estimates of present and future water demands and base period water supplies. It continues with an explanation of the base period hydrologic balance and a projection of future water supplies in Cooperstown and Montpelier.

Water Use

DWR separately estimated urban and agricultural water demands of Cooperstown and Montpelier and then combined the estimates to derive a total water demand. Table 5 shows applied water and evapotranspiration of applied water demands.

TABLE 5
PRESENT AND PROJECTED APPLIED WATER DEMANDS
AND EVAPOTRANSPIRATION OF APPLIED WATER
COOPERSTOWN AND MONTPELIER SUBAREAS
(in acre-feet)

Year	Cooperstown		Montpelier	
	AWD*	ETAW**	AWD*	ETAW**
<u>Urban</u>				
1975	100	100	300	100
1990	200	100	400	200
2020	200	100	500	200
<u>Agriculture</u>				
1975	18,300	11,100	128,600	80,300
1990	36,100	22,100	185,600	123,200
2020	47,800	30,100	220,500	142,100
<u>Total</u>				
1975	18,400	11,200	128,900	80,400
1990	36,300	22,200	186,000	123,400
2020	48,000	30,200	221,000	142,300

*Applied water demand.

**Evapotranspiration of applied water.

Urban Water Use

Cooperstown and Montpelier are both sparsely populated areas without any real urban centers. In 1970, DWR estimated that 500 people lived in Cooperstown and 1,500 in Montpelier. By 1990, DWR expects these populations to be 1,000 in Cooperstown and 2,000 in Montpelier. DWR puts the daily per-capita applied water use at 760 litres (200 gallons) in Cooperstown and Montpelier, a rate thought to be representative of water use in small Central California communities (population generally less than 1,000). Per-capita use is projected to remain essentially constant in the future, as possible water savings through conservation would be negligible compared with total water use. Table 5 presents the estimates of Cooperstown's and Montpelier's urban applied water demands.

DWR estimates that about 40 percent of the total urban applied water in Cooperstown and Montpelier is evapotranspired. This percentage is somewhat higher than normally occurs in urban areas because of the absence of private-industry-produced water. Table 5 shows the estimates of urban evapotranspiration of applied water.

Agricultural Water Use

Water applied for irrigation presently accounts for over 99 percent of all applied water in Cooperstown and Montpelier. This percentage is not expected to change appreciably in the future.

Unit Use Values and Irrigation Efficiencies.

DWR makes agricultural water use estimates by multiplying the net crop acreages by the appropriate unit values of water use. The unit values of evapotranspiration are taken from DWR's Bulletin 113-3, "Vegetative Water Use in California, 1974", dated April 1975. The bulletin presents unit values of evapotranspiration of applied water by precipitation zones. Cooperstown lies in the 360-to-410-millimetre (14-to-16-inch) zone, and Montpelier is in the 300-to-360-millimetre (12-to-14-inch) zone. Zone designations are based upon the mean annual precipitation for the 50-year period from July 1920 through June 1970.

Irrigation efficiencies in Cooperstown and Montpelier are generally high because sprinkler-irrigated cropland predominates in the subareas. In Montpelier, nearly all orchards and vineyards developed since 1958 are irrigated with sprinklers, with an estimated irrigation efficiency of 70 percent. Lands in production in 1958, and some small sections developed more recently, are basin irrigated with estimated efficiencies of about 65 percent. DWR anticipates that new lands developed will be sprinkler irrigated, although drip irrigation may become more prevalent in the future.

TABLE 6

VEGETATIVE UNIT WATER USE
COOPERSTOWN AND MONTPELIER SUBAREAS
(in acre-feet per acre per year)

Crop	Cooperstown			Montpelier		
	AWD**			AWD**		
	ETAW*	Surface	Sprinkler	ETAW*	Surface	Sprinkler
		Irrigated	Irrigated		Irrigated	Irrigated
Grain	0.4	0.7	0.6	0.6	1.0	0.9
Corn	1.8	3.3	--	1.9	3.5	2.7
Beans	--	--	--	1.2	2.2	1.7
Miscellaneous field	1.8	3.3	2.6	1.6	2.8	2.0
Alfalfa	2.6	4.3	3.7	2.8	4.6	4.0
Pasture	3.0	6.0	4.3	3.0	6.0	4.3
Tomatoes	--	--	--	2.0	3.0	--
Miscellaneous truck	1.0	--	1.4	1.2	2.2	1.7
Average deciduous	1.5	2.7	2.1	1.9	3.0	2.4
Almonds	1.5	2.6	2.1	1.6	2.8	2.3
Other deciduous	2.3	--	3.3	2.5	3.8	3.6
Vineyard	1.7	--	2.7	1.7	3.5	3.2
Olives	--	--	--	1.9	2.6	2.4

*Evapotranspiration of applied water.

**Applied water demand.

Agricultural Water Demand. Estimates of evapotranspiration of applied water and applied water are computed by multiplying the net crop acreages shown in Tables 3 and 4 by the unit water use values shown in Table 6. Table 5 shows the applied water demands and the evapotranspiration of applied water for the year 1975 and the estimated water demands for the years 1990 and 2020. The Merced County part of Montpelier was surveyed for land use in 1974; however, land use change between 1974 and 1975 was slight.

Net Water Demands. Net water demands of an area are defined as evapotranspiration of applied water, plus those losses associated with the conveyance and application of water that cannot be recovered for reuse within that area. Thus, evaporation from a conveyance system is a consumptive loss from the area, while return flows to the stream system from conveyance system spills, tailwater runoff from irrigated lands, and subsurface outflow are nonconsumptive losses from the area and may serve as a source of supply to downslope areas. Cooperstown and Montpelier are very efficient in their use of water because water demands are met by ground water that is distributed through closed pipelines, which prevent conveyance system spills and seepage losses. Tailwater runoff from irrigated lands is also kept to a minimum through efficient application with sprinklers and the use of tailwater reuse systems. Net water demands are evaluated in the summary of this report.

Water Supplies

Presently Cooperstown and Montpelier derive almost all their water from the ground. Some water is pumped from the Merced and Tuolumne Rivers by riparian diverters, but the use of this water is restricted to riparian lands so the quantities of these diversions are minor. Table 7 presents estimates of these diversions for the base period 1971-75.

TABLE 7
ESTIMATED AVERAGE ANNUAL RIPARIAN DIVERSIONS
TO COOPERSTOWN AND MONTPELIER SUBAREAS

Subarea	Source	Diversion in cubic dekametres (acre-feet)
Cooperstown	Tuolumne River	1,400 (1,100)
Montpelier	Tuolumne River	1,700 (1,400)
	Merced River	1,500 (1,200)

In evaluating an area's water resources, only net water supplies that enter an area to meet net water demands are considered. Such supplies consist of surface water diversions, net subsurface inflow, and deep percolation of precipitation and undiverted streamflow. The latter items of supply, which constitute ground water replenishments, are by far the greatest part of the net supplies to Cooperstown and Montpelier.

Geology

This report provides only a brief description of the subsurface geology in eastern Stanislaus and northern Merced Counties, with an emphasis on the effects of the geology on ground water occurrence and use. Figure 4 is a representation of a generalized east-west geological cross section in Cooperstown and Montpelier, and Figure 5 shows the areal extent of the various geologic formations.

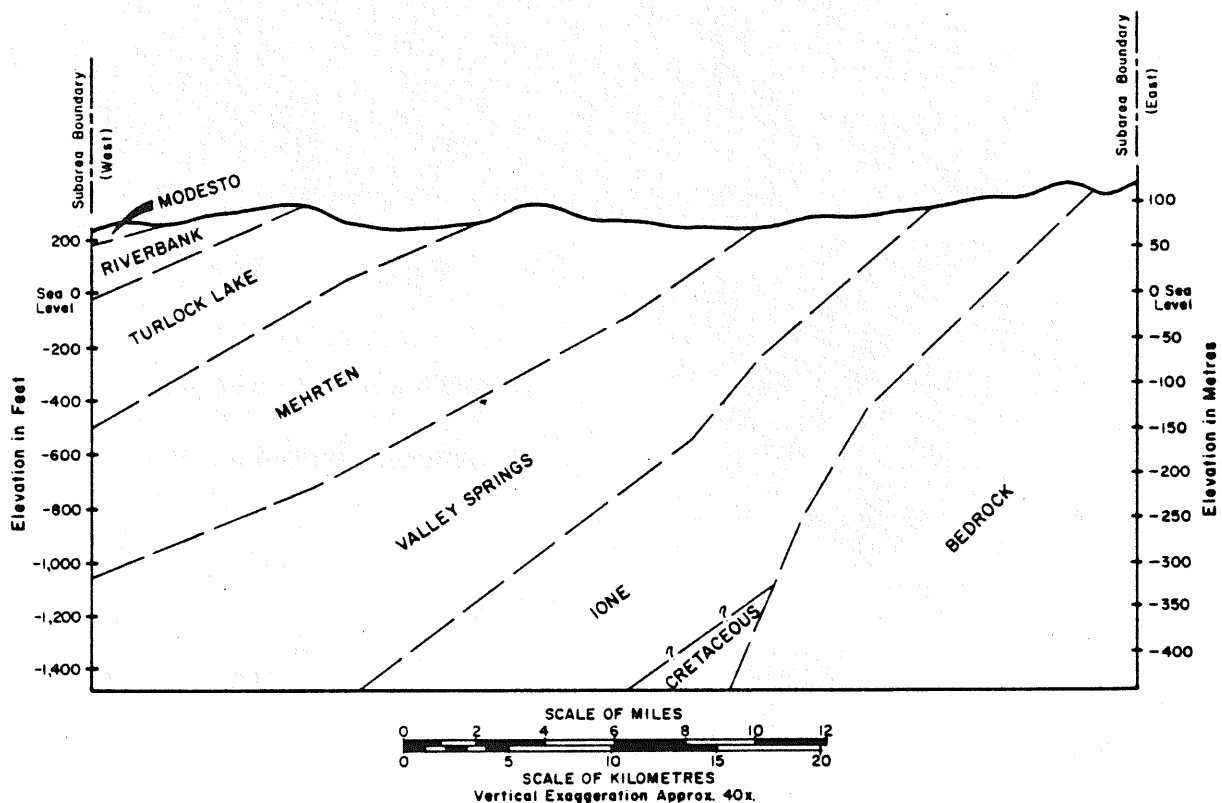


Figure 4. Schematic Geologic Section

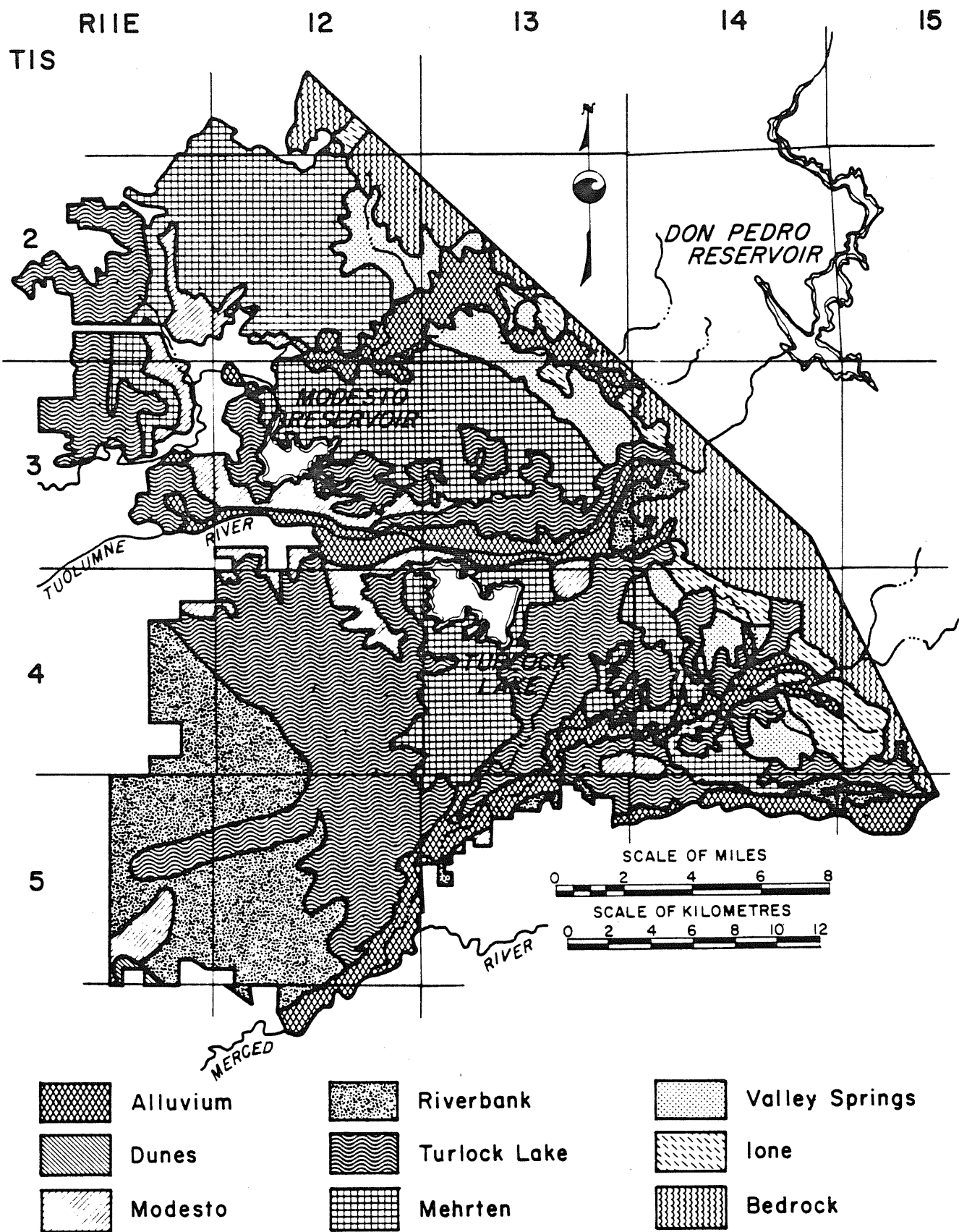


Figure 5. – Geologic Formations in Cooperstown and Montpelier.

Water-bearing deposits in Cooperstown and Montpelier are the erosive debris of the Sierra Nevada mountain range to the east. Most of the deposition has taken place under fluvial conditions, and constant stream channel migration has resulted in a heterogeneous mixture of valley fill that lies above a base of crystalline, granitic, and metamorphic material.

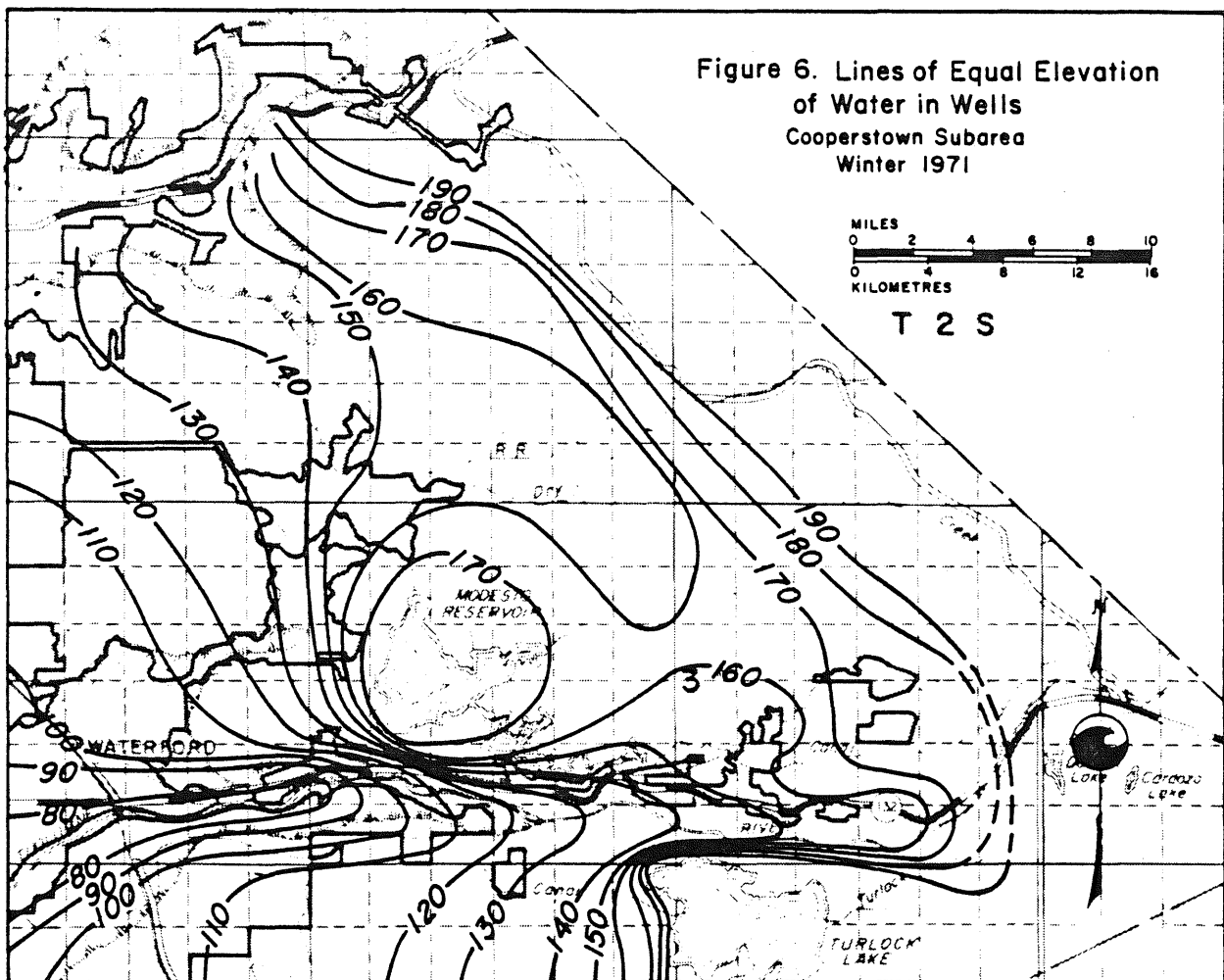
Two consolidated sedimentary formations outcrop in the eastern portions of Cooperstown and Montpelier -- the Valley Springs and the Ione. The Ione, older of the two, lies just above the crystalline bedrock. It contains compacted, moderately cemented, yellow, red, and gray sandstones, along with conglomerates, and white sandy claystones. Some of the Ione formation was deposited under marine conditions, as indicated by marine fossils and saline water in a few wells. The Valley Springs formation is more recent than the Ione and contains fluvial deposits of rhyolitic ash, sandy clays, and siliceous gravels. A high percentage of clay restricts water movement in this formation, and well yields have been poor. Water movement in the Ione is similarly hampered by clayey beds, although some successful irrigation wells have been drilled solely in this formation. Still, extensive development of agriculture is probably not possible with wells drilled only in these two formations because of the low well yields and incidence of saline water in the Ione.

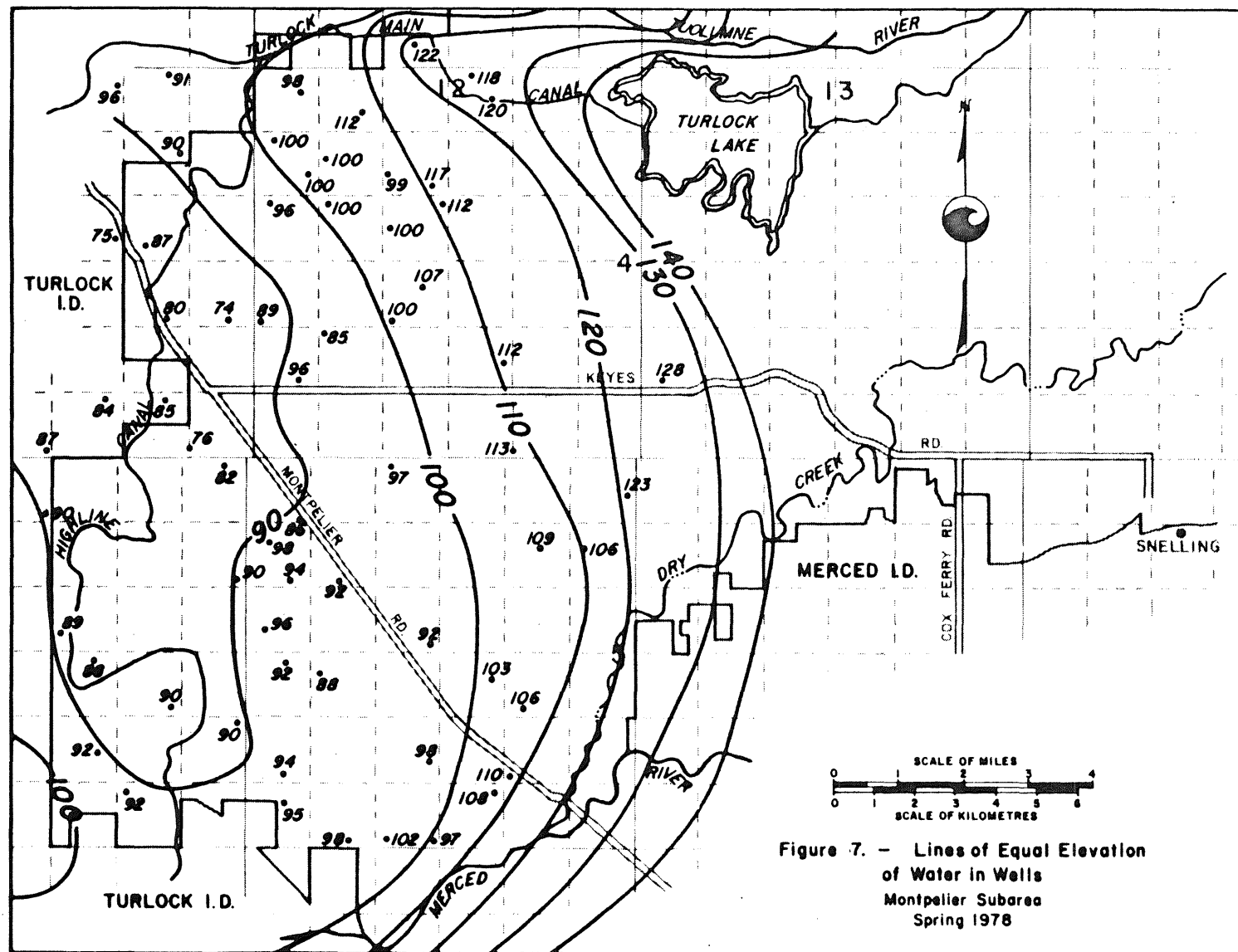
Deposited on top of the Valley Springs formation by streamflows, the Mehrten formation outcrops over the central portions of Cooperstown and Montpelier. The Mehrten is a consolidated formation of fine-to-coarse-grained sediments, distinguished from the two older formations by the presence of large quantities of andesitic debris. Resulting black andesitic sandstones common in the Mehrten are highly permeable, and wells that penetrate thick sequences of these consolidated sands produce yields in the range of 5 700 to 7 600 litres per minute (1,500 to 2,000 gallons per minute). Interbedded clays, especially in the upper part of the formation, create a state of semiconfinement in the Mehrten.

More recent alluvial deposits, lying in the western part of the subareas, have remained unconsolidated and are divided into the Turlock Lake, Riverbank, and Modesto formations by their ages of deposition. These alluvial deposits contain mixtures of gravel, sand, silt, and clay, with permeability decreasing with depth as the deeper, older layers are more cemented. Irrigation wells that penetrate these sediments and the underlying Mehrten formation have produced yields of more than 11 000 litres per minute (3,000 gallons per minute) in some areas of Montpelier. The Corcoran clay, an ancient lakebed deposit, lies in these sediments, with its eastern boundary near the Santa Fe Railroad in Montpelier. This confining layer occurs in the extreme southwestern part of Montpelier, and while it does not affect ground water movement in the subarea, it greatly affects subsurface flows at the western boundary.

Ground Water Levels

A survey of wells by the U. S. Geological Survey in both Cooperstown and Montpelier in the winter of 1971 was the first survey to yield sufficient information for a ground water level contour map. Since the fall of 1975, DWR has measured fall and spring ground water levels and prepared biannual ground water elevation contour maps from these measurements. Appendix A lists these measurements. Figure 6 is a contour map prepared from USGS ground water level measurements of winter 1971 in Cooperstown. Figure 7 was drawn using spring 1978 measurements of Montpelier ground water levels.





Hydrographs of water levels in wells are probably the best way to illustrate ground water level changes, and Figure 8 presents hydrographs typical of ground water level changes in different parts of Montpelier. The most noticeable characteristic of these hydrographs is the small change in water level from spring 1976 to spring 1979. The only well with a consistent lowering of spring ground water level is Well 4S/11E-23Q, where an average annual drop of about 1.2 metres (4 feet) occurred between 1975 and 1978.

Wells 5S/12E-19B and 5S/11E-22B are located in the southwestern part of Montpelier, which has long had extensive agricultural development. No surface water supplies are used in the vicinity of the wells, but local water levels appear stable, as evidenced by the lack of any year-to-year well lowering. The large winter rebounds in these two wells indicate that the producing aquifer is confined. Since the main confining layer in the San Joaquin Valley, the Corcoran clay, lies west of Wells 5S/12E-19B and 5S/11E-22B, clayey beds in the Mehrten formation are probably the cause of the confinement.

Ground Water Storage Change

DWR estimates that the overdraft in Montpelier for the 1971-75 base period was 8,900 cubic dekametres (7,200 acre-feet).annually. This estimate is a direct calculation of the overdraft using average ground water level changes and specific yield values for quarter townships. Ground water level change in each quarter township was estimated by planimentering ground water level contour maps for winter 1971 and spring 1976. Average specific yield values by depth zones for quarter townships are from a DWR computer program that uses well drillers' logs in estimating specific yields for each section and averages these for the entire quarter township.

Ground Water Recharge

Surface water supplies are limited in Cooperstown and Montpelier, and the main sources of net water supplies are ground water replenishments -- ground water recharge and subsurface inflow. Although Cooperstown and Montpelier are surrounded and overlain by recharge sources, the high water levels around Cooperstown restrict recharge, and most seepage that percolates to ground water leaves the area as river accretion or subsurface outflow. In Montpelier, extractions have lowered ground water levels, thereby increasing recharge from Turlock Irrigation District canals, Turlock Lake, Merced River, and rainfall. DWR has made estimates of the 1971-75 base period recharge to Cooperstown

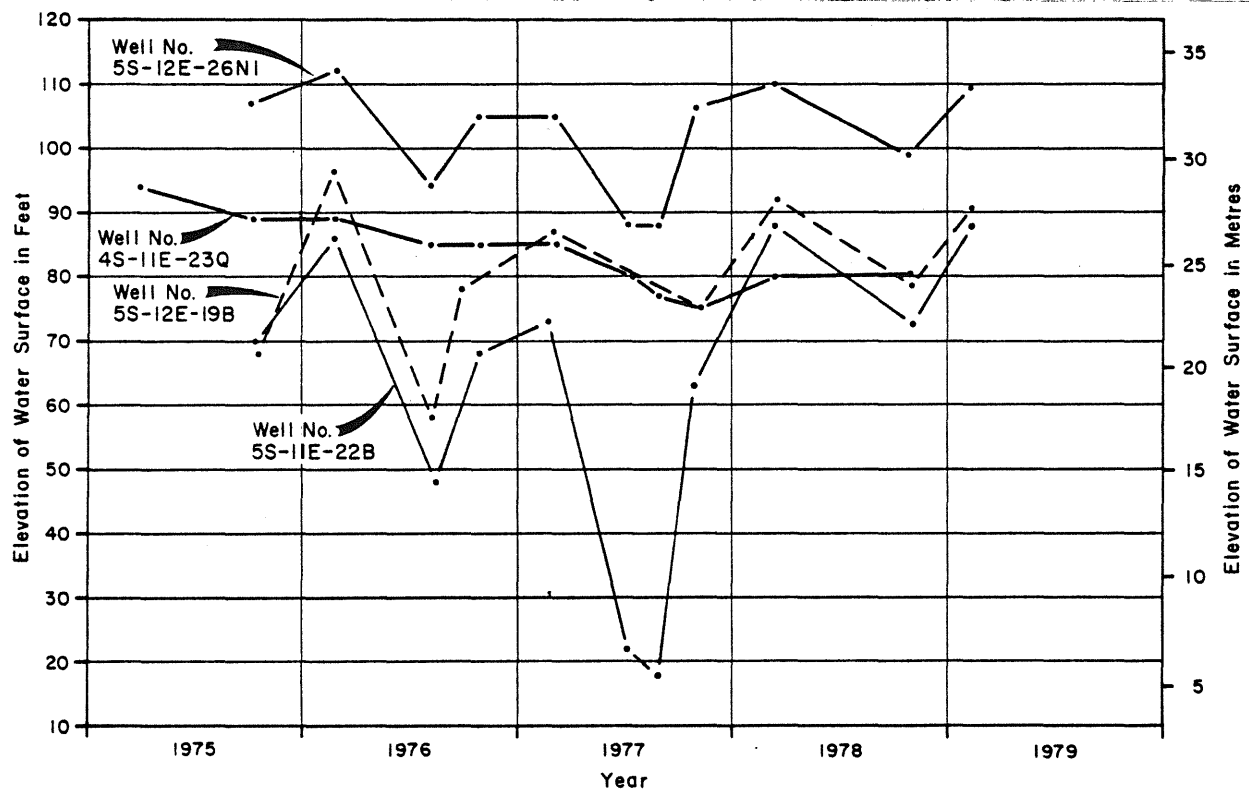
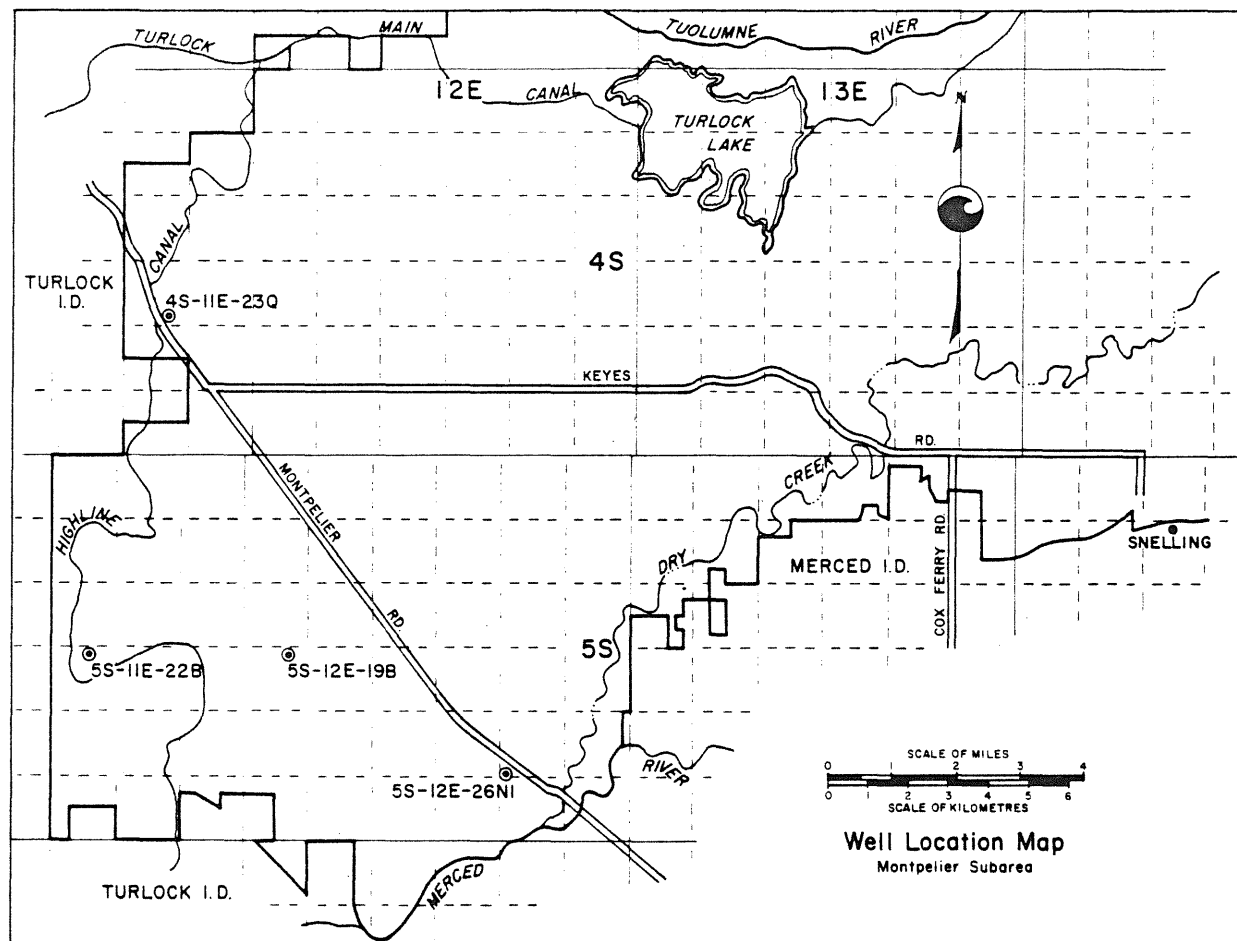


Figure 8. - Four Water Level Hydrographs in the Montpelier Subarea

and Montpelier from each of the above sources, and explanations of these estimates are given below. These estimates were adjusted to conform with the base period hydrologic balance as will be explained more fully later in this chapter. Table 8 summarizes estimated recharge to Cooperstown and Montpelier.

TABLE 8
SUMMARY OF ESTIMATED GROUND WATER RECHARGE
TO THE COOPERSTOWN AND MONTPELIER SUBAREAS

Subarea	Recharge Source	Average Annual Recharge in cubic dekametres (acre-feet)
Cooperstown	Precipitation	34 500 (28,000)
	Modesto Reservoir	6 000 (5,000)
Montpelier	Precipitation	28 700 (23,300)
	Turlock Lake	12 000 (10,000)
	Turlock ID Highline Canal	9 900 (8,000)
	Turlock ID Main Canal	1 500 (1,200)
	Merced River	7 400 (6,000)
	Dry Creek	2 500 (2,000)

Precipitation. The average annual rainfall in Cooperstown and Montpelier ranges from about 300 millimetres (12 inches) in the southwestern part of Montpelier to about 430 millimetres (17 inches) in northern Cooperstown near the Sierra Nevada foothill line. Table 9 lists the 50-year (1926-76) average precipitation at selected recording stations near Cooperstown and Montpelier.

TABLE 9
50-YEAR (1926-76) AVERAGE PRECIPITATION AND
RECORD EXTREME ANNUAL PRECIPITATION AT SELECTED STATIONS

Station	Average in millimetres (inches)	Maximum in millimetres (inches)	Year	Minimum in millimetres (inches)	Year
Denair	314 (12.35)	554 (21.80)	1969	129 (5.07)	1924
Knights Ferry	443 (17.44)	746 (29.36)	1969	222 (8.75)	1924
Oakdale	357 (14.05)	644 (25.36)	1907	167 (6.58)	1976
Snelling	370 (14.58)	656 (25.83)	1969	185 (7.27)	1913

Because of the slope of the dissected uplands in Cooperstown and Montpelier, some of the precipitation runs off the uplands and out of the subareas. A great deal of precipitation infiltrates the soil, however, and once in the soil, portions of this water evaporate directly from the moist soil surface, transpire from vegetation, and percolate into the ground water basin.

Only the precipitation that remains in an area and percolates to usable ground water is considered a net water supply. In Cooperstown and Montpelier, DWR estimates that these annual supplies average 34 500 cubic dekametres (28,000 acre-feet) and 28 700 dam³ (23,300 ac-ft), respectively. These estimates of the base period (1971-75) net water supply from precipitation amount to 82 percent and 33 percent of the total net water supply in Cooperstown and Montpelier, respectively.

The amount of rainfall percolating underground in Cooperstown and Montpelier is estimated to be about 20 percent of the total. This percentage may rise in the future, as increased agricultural development reduces runoff by ripping underlying hardpan layers to improve infiltration.

Undiverted Streamflow. Three major rivers skirt Cooperstown and Montpelier -- the Stanislaus, the Tuolumne, and the Merced. Of the three, the Stanislaus and Tuolumne are at elevations below local ground water levels and receive accretions from Cooperstown and Montpelier. The Merced River, conversely, is a source of recharge to Montpelier in the stretch from Cressey Bridge to Shafer Bridge where the river forms Montpelier's southern boundary. This recharge is the result of lowered ground water levels in Montpelier and is reflected in the ground water level contours that parallel the river. DWR estimates seepage from the Merced River to be 7 400 dam³ (6,000 ac-ft) on the basis of local ground water gradients.

In addition to the major rivers, several small ephemeral streams flow across Cooperstown and Montpelier. The two largest streams are both named Dry Creek -- one flows across Cooperstown and is tributary to the Tuolumne River, while the other flows across Montpelier before feeding the Merced River. DWR measures Dry Creek (tributary to the Tuolumne River) at a gaging station near Modesto. This station is several miles downstream from Cooperstown, and streamflows at that point contain large amounts of agricultural surface return flows and ground water accretions that make the station useless for determining water supply. In any case, DWR estimates that recharge to Cooperstown from Dry Creek is negligible because of the high ground water levels.

The other Dry Creek (tributary to the Merced River) enters Montpelier north of Snelling and is measured by the U. S. Geological Survey just after it crosses the subarea's boundary, at the Montgomery Dam site. Average flows at this station during the base period 1971-75 were 12 400 dam³ (10,050 ac-ft). DWR estimates that about 2 500 dam³ (2,000 ac-ft) of this flow seeps into Montpelier's ground water.

Seepage to Cooperstown and Montpelier from the other small streams is difficult to estimate. But these streams have small drainage areas, and the runoff occurs during periods of high rainfall when the soil is saturated, so the amount of seepage is probably insignificant.

Reservoirs. Turlock Lake and Modesto Reservoir supply Cooperstown and Montpelier with a large amount of water. Turlock and Modesto Irrigation Districts operate these reservoirs, which have been used for fifty years, to regulate their Tuolumne River diversions. Seepage from the reservoirs goes to the Mehrten formation, where a portion of it stays, while the remainder returns to the Tuolumne River.

Turlock Irrigation District has estimated that the total annual seepage from Turlock Lake is 42 000 dam³ (34 000 ac-ft). A DWR flow-net analysis of this seepage showed that 70 percent of the total, or 30 000 dam³ (24,000 ac-ft), returned to the Tuolumne River, while the remaining 30 percent, or 12 000 dam³ (10,000 ac-ft), recharged the Mehrten formation. Turlock Irrigation District's estimate of 42 000 dam³ (34,000 ac-ft) seepage loss from Turlock Lake is based on a 1967 ponding study. Possibly, in the last 12 years, lowered ground water levels in Montpelier have induced additional seepage from the lake. DWR attempted to compare inflow to outflow, with adjustments for storage, for more recent periods, but the results were inconclusive for the following reasons:

- Inflow to Turlock Lake is measured at La Grange, 16 kilometres (10 miles) upstream on the unlined Turlock Irrigation District Main Canal.
- Measurements of outflow from the lake are made only during the irrigation season and do not include winter power releases that flow through the lake in most years.
- Seepage losses from the lake amount to only about 5 percent of the total water diverted at La Grange; therefore, any small error in measurement of these diversions will result in a large error in calculated seepage.

The estimated amount of seepage from Turlock Lake -- 42 000 dam³ (34,000 ac-ft) -- is based on the assumption that the controlling factor is the permeability of the lakebed and not the surrounding ground water levels. A new ponding study would be useful to see if this assumption is valid.

Modesto Irrigation District estimates that seepage from Modesto Reservoir is 31 000 dam³ (25,000 ac-ft) annually. High ground water levels in the vicinity of Modesto Reservoir limit the amount of recharge to Cooperstown's ground water, and DWR estimated this recharge to be only about 6 000 dam³ (5,000 ac-ft) annually, with the remaining 25 000 dam³ (20,000 ac-ft) of annual seepage flowing into the Tuolumne River.

Canals. Seepage from overlying distribution systems is an additional source of recharge to Cooperstown and Montpelier. These canals carry water from diversion points in the foothills on the Stanislaus and Tuolumne Rivers to the established irrigation districts west of Cooperstown and Montpelier. Two Turlock Irrigation District facilities overlie Montpelier -- the Main Canal in the north and the Highline Canal near the western boundary. DWR seepage estimates for these canals are based on Turlock Irrigation District records of canal inflows, outflows, and diversions. The Main Canal, in the stretch from Turlock Lake to the Division Gates just west of Montpelier, loses about 3 800 dam³ (3,100 ac-ft) of water annually, with 1 500 dam³ (1,200 ac-ft) of this seepage recharging ground water in Montpelier. The Highline Canal traverses the western part of Montpelier before entering the Turlock Irrigation District near Ballico. DWR estimates seepage losses for the whole canal to be 15 000 dam³ (12,000 ac-ft) annually -- 10 000 dam³ (8,000 ac-ft) of which percolates into Montpelier's ground water reserves. Seepage from the Highline Canal is a major water supply source, especially to the Ballico-Cortez area. Most likely, Montpelier's lowered ground water levels induce a great deal of this seepage. Continued lowering of levels may induce more seepage from these two canals and decrease the percentage of existing seepage in the Turlock Main Canal that goes to the Tuolumne River.

Cooperstown is in a position similar to Montpelier in that extensive overlying distribution systems are a potentially large source of seepage. This seepage can come from Modesto Irrigation District's lined Main Canal and many small laterals in the southern part, and from Oakdale Irrigation District's Main Canal and Paulsell Lateral in the central and northern part of Cooperstown. Relatively high water levels in Cooperstown limit seepage from these canals, and the seepage which does occur probably returns back into the Tuolumne and Stanislaus Rivers.

Subsurface Flows

Subsurface flows across boundaries can account for a water supply or a nonrecoverable loss, depending on their direction. In Cooperstown, the Stanislaus and Tuolumne Rivers are barriers to flow on the north and south boundaries, and no subsurface flows enter or leave the subarea through the impermeable Sierra Nevada to the east. The limited agricultural development and resulting high water levels in Cooperstown create a downward ground water elevation gradient to the west and result in a net subsurface outflow from the subarea of about 10 200 dam³ (8,300 ac-ft) annually.

In Montpelier the situation is much different, with subsurface inflows from Turlock Irrigation District on the west and Merced Irrigation District on the southeast. Montpelier serves as a forebay for the deep, confined aquifer underlying Turlock Irrigation District, and some subsurface water escapes through the forebay's lower layers. This loss is more than balanced by the subsurface inflow from Turlock Irrigation District's upper, unconfined aquifer, and the net subsurface inflow from the west amounts to about 11 800 dam³ (9,600 ac-ft) annually. The other source of subsurface inflow to Montpelier is from the southeast, where Merced Irrigation District's North Side Canal service area supplies an estimated 6 800 dam³ (5,500 ac-ft). These inflows are directly related to local ground water gradients, and the continued steepening of such gradients toward Montpelier is certain to increase the subsurface inflow.

Analysis of Water Supplies and Demands

A base period hydrologic balance is normally used to determine an area's water deficiency, which is manifested as ground water overdraft. In such an analysis, the water supplies and demands are considered to be determinable quantities, and overdraft is the difference between these two quantities. The overdraft calculated in this way may then be compared to a direct calculation of base period ground water storage change as a check on the reasonableness of the water supplies and demands.

In Cooperstown and Montpelier, the hydrologic balance has been used differently because virtually all the water supplies are from ground water recharge and the determination of quantities of this recharge is subject to a large amount of error. Therefore, DWR has used the hydrologic balance to derive the total net water supplies by subtracting the base period ground water storage change from the base period water demands. The total net water supplies computed this way were then compared to the sum of DWR's separate calculations of ground water recharge from the various sources of supply.

The total net water supplies calculated by both these methods were in relatively close agreement, but the relative magnitude of recharge from the individual sources should still be considered subject to error. Table 10 shows the 1971-75 base period hydrologic balances in Cooperstown and Montpelier.

TABLE 10

1971-75 BASE PERIOD HYDROLOGIC BALANCES
COOPERSTOWN AND MONTPELIER SUBAREAS
(in cubic dekametres [acre-feet])

Water Supply and Demand :		Cooperstown	:	Montpelier
<u>Supply</u>				
Local supplies				
Streamflow diversion				
Tuolumne River	1 400	(1,100)	1 700	(1,400)
Merced River	0	(0)	1 500	(1,200)
Ground water recharge				
Precipitation	34 500	(28,000)	28 700	(23,300)
Overlying canals	0	(0)	11 400	(9,200)
Overlying lakes	6 000	(5,000)	12 000	(10,000)
Merced River	0	(0)	7 400	(6,000)
Dry Creek	0	(0)	2 500	(2,000)
Net subsurface inflow	0	(0)	18 600	(15,100)
Overdraft of ground water	0	(0)	8 900	(7,200)
	41 900	(34,100)	92 700	(75,400)
<u>Demand</u>				
Evapotranspiration of applied water	13 300	(10,800)	91 200	(74,200)
Nonrecoverable losses				
Losses to channel accretions				
Tuolumne River	3 400	(2,800)	0	(0)
Stanislaus River	14 800	(12,000)	0	(0)
Evaporation	200	(200)	1 500	(1,200)
Net subsurface outflow	10 200	(8,300)	0	(0)
	41 900	(34,100)	92 700	(75,400)

Projected Water Supplies

Future water supplies in an area will be the same as base period water supplies if hydrologic conditions in the base period are similar to what can be expected in the future. In calculating surface water supplies, the base period should have average runoff and precipitation values close to those occurring over a long period (such as the 50-year 1922-72 period that DWR usually uses). The 1971-75 base period in Cooperstown and Montpelier meets these criteria, with an analysis showing that the average precipitation during that period is close to the average precipitation for the long-term period 1922-72. Since this is the case, the base period surface water supplies to Cooperstown and Montpelier may be considered representative of future surface water supplies.

The greater part of Cooperstown and Montpelier's water supplies is replenishment to ground water. These supplies, unlike surface water supplies, are controlled by the elevation of an area's ground water levels. Any decrease in an area's ground water levels relative to surrounding levels will increase subsurface inflows, decrease subsurface outflows, and increase ground water recharge. For an area like Montpelier, overdrafting to support new agricultural development will lower ground water levels, thereby increasing ground water recharge and net subsurface inflow. The net water supplies to Montpelier are thus dependent on the quantity of water demands.

DWR estimates that recharge sources in Cooperstown and Montpelier are capable of supporting some increase in agricultural development. In Montpelier, water demands in the area south and west of Turlock Lake can probably be met without any long-term overdraft -- that is, any development in the area will overdraft the basin temporarily, lower water levels, and increase net water supplies until the new water demands have been met, whereupon ground water levels will stabilize. The total acreage in Montpelier that can be supplied in this manner is about 24 000 hectares (60,000 acres), which is the level of development DWR projects for 1990. By comparing base period water supplies and demands to the 1990 water demands, the increase in net water supplies to Montpelier would be 53 200 dam³ (43,100 ac-ft). Montpelier's recharge sources have the potential to supply this much water, but the ability of the aquifer to transmit this water is somewhat suspect. Ground water levels in Montpelier should be continually monitored to verify that the aquifer is receiving the projected increases in recharge.

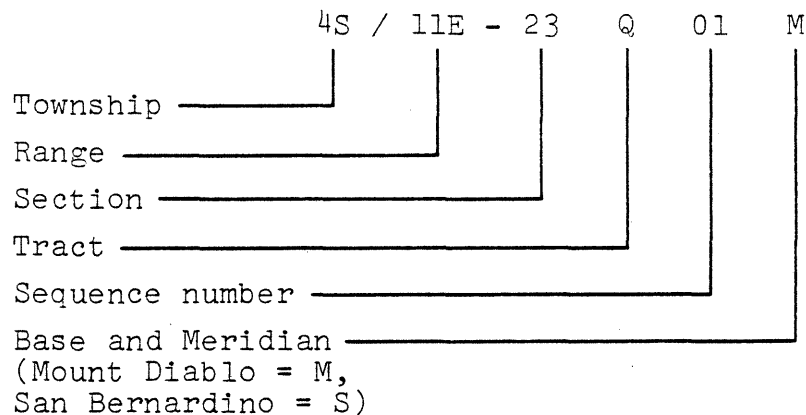
Water demands in the area of Montpelier generally east of Turlock Lake probably cannot be supplied by ground water. The aquifer thins out and becomes less permeable there, and recharge potential is limited. For these reasons, any irrigated agricultural development in these areas would depend on a steady supply of surface water.

In Cooperstown, existing ground water recharge is capable of supporting a considerable increase in irrigated agriculture, but the characteristics of the irrigable land are such that extensive agricultural development is not likely. DWR estimates that future water demands in the area can be met with present levels of water supply.

APPENDIX A. GROUND WATER LEVELS AT WELLS

This appendix presents measurements of ground water levels that have been made by the Department of Water Resources in the Montpelier subarea. Wells were measured initially in fall 1975, and regular measurements have been made in the spring and fall of each year since, most recently in spring 1979. These measurements are also published for the water year, October 1 through September 30, in a series of San Joaquin District memorandum reports entitled "Basic Data of Surface Water Flow, Diversions, Surface Water Quality, Ground Water Measurements, Ground Water Quality".

The well measurements are presented with identification of these wells by the State well numbering system. The State well numbering system is based on township, range, and section subdivisions of the Public Land Survey. The number of the well, assigned in accordance with this system, is referred to as the State Well Number, as illustrated below.



This number identifies and locates the well. In the example, the well is in Township 4 south, Range 11 east, Tract Q of Section 23, located in the Mount Diablo Base and Meridian. A section is divided into 40-acre tracts as follows:

D	C	B	A
E	F	G	H
M	L	K	J
N	P	Q	R

Sequence numbers in a tract are generally assigned in chronological order. The example designates the first well to be assigned a number in Tract Q.

Explanation of Column Headings and Code Symbols

State Well Number is explained above.

County (CO) codes represent the county in which the well is located:

24 Merced
50 Stanislaus

Ground surface elevation represents the elevation in feet above mean sea level (U. S. Geological Survey and National Geodetic Survey data) of the ground surface at the well. Elevations are usually taken from topographic maps, and the accuracy is controlled by topographic standards.

Date is the date the depth measurement was made. Where "00" appears in the date, day of measurement is unknown.

Ground to water is the measured depth in feet from the ground surface to the water surface in the well. Other code symbols used in this column are as follows:

NM	No measurement
0	Measurement discontinued
1	Pumping
2	Pump house locked
3	Tape hung up
4	Cannot get tape in casing
5	Unable to locate well
6	Well has been destroyed
7	Special
8	Casing leaking or wet
9	Temporarily inaccessible
QM	Questionable measurement
0	Caved or deepened
1	Pumping
2	Nearby pump operating
3	Casing leaking or wet
4	Pumped recently
5	Air or pressure gage measurement
6	Other
7	Recharge operation at or nearby well
8	Oil in casing

The words "flow" and "dry" are shown in this column to indicate a flowing or dry well.

Water surface elevation is the elevation of the water surface above mean sea level.

Agency codes represent the agency supplying water level data. All the listed measurements were made by DWR, whose code number is 5050.

DATE 04/16/79

WDIS GROUND WATER LEVELS AT WELLS

PAGE 1

STATE WELL NUMBER	GROUND SURFACE ELEVATION	DATE	GROUND TO WATER	WATER SURFACE ELEV.	AGENCY	STATE WELL NUMBER	GROUND SURFACE ELEVATION	DATE	GROUND TO WATER	WATER SURFACE ELEV.	AGENCY
5 5-22 5-22.56	CENTRAL VALLEY REGION SAN JOAQUIN VALLEY SOUTH MERCED PLAINS					5 5-22 5-22.56	CENTRAL VALLEY REGION SAN JOAQUIN VALLEY SOUTH MERCED PLAINS				
04S/11E-23Q01 M 50	185.0	04/11/74	89.0	96.0	5050	04S/12E-05A01 M 50	192.0	02/25/76	77.0	115.0	5050
		03/26/75	91.0	94.0				10/25/78	NM-7		
		10/06/75	96.0	89.0							
		02/24/76	96.0	89.0		04S/12E-05A02 M 50	190.0	10/07/75	78.0	112.0	5050
		08/06/76	100.0	85.0				08/06/76	84.0	106.0	
		10/28/76	100.0	85.0				10/29/76	81.0	109.0	
		03/02/77	100.0	85.0				03/01/77	79.0	111.0	
		07/13/77	105.0	80.0				07/13/77	87.0	103.0	
		08/24/77	108.0	77.0				08/24/77	87.0	103.0	
		11/04/77	110.0	75.0				11/04/77	84.0	106.0	
		03/01/78	104.5	80.5				02/28/78	81.0	109.0	
		10/24/78	104.5	80.5				10/25/78	84.0	106.0	
04S/11E-24Q01 M 50	213.0	03/02/77	138.0	75.0	5050	04S/12E-05K01 M 50	230.0	03/01/77	102.0	128.0	5050
		11/08/77	141.0	72.0				02/28/78	118.5	111.5	
		03/01/78	139.0	74.0				10/25/78	112.5	117.5	
		10/25/78	145.0	68.0							
04S/11E-36N01 M 50	211.0	10/06/75	133.0	78.0	5050	04S/12E-06E01 M 50	225.0	07/13/77	97.0	128.0	5050
		02/25/76	128.0	83.0				08/24/77	97.0	128.0	
		08/06/76	157.0	54.0				10/25/78	89.0	136.0	
		02/28/77	134.0	77.0		04S/12E-06G01 M 50	197.0	04/11/74	91.0	106.0	5050
		03/01/78	135.5	75.5				03/25/75	90.0	107.0	
		10/25/78	145.5	65.5				02/25/76	95.0	102.0	
04S/12E-03G01 M 50	200.0	10/07/75	80.0	120.0	5050			08/06/76	107.0	90.0	
		10/29/76	83.0	117.0				10/29/76	98.0	99.0	
		02/28/77	78.0	122.0				03/01/77	97.0	100.0	
	201.0	11/02/77	80.0	121.0				08/24/77	102.0	95.0	
		02/28/78	81.3	119.7				11/02/77	101.0	96.0	
		10/25/78	85.3	115.7				02/28/78	98.5	98.5	
								10/25/78	100.5	96.5	
04S/12E-03J01 M 50	193.0	04/11/74	66.0	127.0	5050	04S/12E-07C01 M 50	190.0	10/29/76	89.0	101.0	5050
		03/25/75	66.0	127.0				03/01/77	80.0	102.0	
		02/25/76	69.0	124.0				02/28/78	90.5	99.5	
		02/28/77	71.0	122.0				10/25/78	94.5	95.5	
04S/12E-04L01 M 50	240.0	03/01/77	115.0	125.0	5050	04S/12E-07J01 M 50	193.0	03/25/75	83.0	110.0	5050
		11/04/77	120.0	120.0				10/08/75	91.0	102.0	
		02/28/78	122.0	118.0				02/25/76	87.0	105.0	
		10/25/78	121.0	119.0				02/28/78	92.5	100.5	
04S/12E-05A01 M 50	192.0	10/07/75	78.0	114.0	5050			10/25/78	97.5	95.5	

DATE 04/16/79

WDIS GROUND WATER LEVELS AT WELLS

PAGE 2

STATE WELL NUMBER	CO	GROUND SURFACE ELEVATION	DATE	GROUND TO WATER	WATER SURFACE ELEV.	AGENCY	STATE WELL NUMBER	CO	GROUND SURFACE ELEVATION	DATE	GROUND TO WATER	WATER SURFACE ELEV.	AGENCY
5		CENTRAL VALLEY REGION					5		CENTRAL VALLEY REGION				
5-22		SAN JOAQUIN VALLEY					5-22		SAN JOAQUIN VALLEY				
5-22.56		SOUTH MERCED PLAINS					5-22.56		SOUTH MERCED PLAINS				
04S/12E-08E01 M	50	205.0	10/08/75	103.0	102.0	5050	04S/12E-16E01 M	50		10/26/78	NM-1		5050
			03/01/77	103.0	102.0								
			11/08/77	108.0	97.0		04S/12E-17D01 M	50	230.0	10/08/75	130.0	100.0	5050
			02/28/78	105.0	100.0					03/01/77	128.0	102.0	
			10/25/78	114.0	91.0					07/13/77	137.0	93.0	
04S/12E-08G01 M	50	245.0	10/08/75	141.0	104.0	5050				02/28/78	130.0	100.0	
			10/26/78	148.5	96.5					10/26/78	141.0	89.0	
04S/12E-08P01 M	50	205.0	04/11/74	90.0	115.0	5050	04S/12E-17G01 M	50	230.0	10/08/75	144.0	86.0	5050
			03/25/75	103.0	102.0					03/01/77	140.0	90.0	
04S/12E-09M01 M	50	265.0	03/01/77	160.0	105.0	5050				11/08/77	149.0	81.0	
			02/28/78	166.0	99.0					10/26/78	NM-1		
			10/26/78	172.0	93.0		04S/12E-18C01 M	50	187.0	10/08/75	87.0	100.0	5050
04S/12E-09Q02 M	50	220.0	10/08/75	104.0	116.0	5050				03/01/77	88.0	99.0	
			02/25/76	99.0	121.0					02/28/78	91.0	96.0	
			08/06/76	108.0	112.0					10/26/78	NM-1		
			10/29/76	104.0	116.0		04S/12E-19N01 M	50	235.0	10/09/75	144.0	91.0	5050
			02/28/77	104.0	116.0					02/25/76	140.0	95.0	
			07/13/77	108.0	112.0					10/28/76	145.0	90.0	
			08/24/77	108.0	112.0					03/02/77	147.0	88.0	
			11/08/77	108.0	112.0					11/08/77	151.0	84.0	
			02/28/78	103.0	117.0					03/01/78	146.0	89.0	
			10/26/78	104.0	116.0					10/26/78	151.0	84.0	
04S/12E-16A01 M	50	209.0	04/11/74	88.0	121.0	5050	04S/12E-21G01 M	50	266.0	10/08/75	160.0	106.0	5050
			03/26/75	97.5	111.5					02/25/76	155.0	111.0	
			10/08/75	95.0	114.0					08/06/76	165.0	101.0	
			02/25/76	93.0	116.0					10/29/76	162.0	104.0	
			08/06/76	96.0	113.0					02/28/77	160.0	106.0	
			10/29/76	96.0	113.0					07/13/77	169.0	97.0	
			02/28/77	97.0	112.0					08/24/77	167.0	99.0	
			07/13/77	98.0	111.0					11/08/77	166.0	100.0	
			08/24/77	99.0	110.0					02/28/78	159.0	107.0	
04S/12E-16A02 M	50	209.0	02/28/78	97.0	112.0	5050	04S/12E-21N01 M	50	255.0	03/02/77	153.0	102.0	5050
			10/26/78	99.0	110.0					11/08/77	160.0	95.0	
04S/12E-16E01 M	50	270.0	03/01/77	167.0	103.0	5050				03/01/78	155.0	100.0	
			11/08/77	174.0	96.0					10/26/78	160.0	95.0	
			02/28/78	170.0	100.0		04S/12E-25B01 M	50	232.0	11/08/77	100.0	132.0	5050

WDIS GROUND WATER LEVELS AT WELLS

52

STATE WELL NUMBER	GROUND CO SURFACE ELEVATION	DATE	GROUND TO WATER	WATER SURFACE ELEV.	AGENCY	STATE WELL NUMBER	GROUND CO SURFACE ELEVATION	DATE	GROUND TO WATER	WATER SURFACE ELEV.	AGENCY		
5-22 5-22.56	CENTRAL VALLEY REGION SAN JOAQUIN VALLEY SOUTH MERCED PLAINS					5-22 5-22.56	CENTRAL VALLEY REGION SAN JOAQUIN VALLEY SOUTH MERCED PLAINS						
04S/12E-25B01 M	50	10/26/78	NM-7		5050	04S/12E-36N01 M	24	10/26/78	NM-9		5050		
04S/12E-26K01 M	50	10/26/78	NM-9		5050	04S/12E-36R01 M	24	278.0	10/11/74	139.0	5050		
04S/12E-27E01 M	50	245.0	03/02/77	153.0	92.0	5050		10/09/75	147.0	131.0			
			10/26/78	NM-9				02/25/76	144.0	134.0			
								03/03/77	149.0	129.0			
04S/12E-27J01 M	50	265.0	10/09/75	127.0	138.0	5050		08/24/77	157.0	121.0			
			02/25/76	150.0	115.0			11/03/77	152.0	126.0			
			10/29/76	157.0	108.0			10/26/78	NM-9				
			03/02/77	154.0	111.0								
			11/08/77	162.0	103.0	04S/13E-03D01 M	50	270.0	10/07/75	76.5 (1)	193.5	5050	
			03/01/78	153.0	112.0								
			10/26/78	162.0	103.0	04S/13E-11D01 M	50	255.0	10/07/75	46.0	209.0	5050	
04S/12E-28D01 M	50	03/26/75	NM-9		5050	04S/13E-14J01 M	24	300.0	10/09/75	116.0	184.0	5050	
		02/28/77	NM-6			04S/13E-15D01 M	50	290.0	10/07/75	98.0	192.0	5050	
04S/12E-28Q01 M	50	245.0	10/25/78	151.0	94.0	5050	04S/13E-17D01 M	50	265.0	10/29/76	2.0	263.0	5050
04S/12E-29D01 M	50	245.0	03/02/77	160.0	85.0	5050	04S/13E-18J02 M	50	285.0	10/07/75	115.0	170.0	5050
			11/08/77	173.0	72.0								
			03/01/78	160.0	85.0								
			10/26/78	169.0	76.0	04S/13E-20M01 M	50	295.0	10/07/75	137.0	158.0	5050	
04S/12E-30Q01 M	50	245.0	10/09/75	154.0	91.0	5050		10/29/76	139.0	156.0			
			02/28/77	151.0	94.0								
			11/08/77	152.0	93.0	04S/13E-23C01 M	24	325.0	10/09/75	132.0	193.0	5050	
			03/01/78	144.0	101.0								
			10/26/78	152.0	93.0	04S/13E-28Q01 M	24	255.0	10/09/75	87.0	168.0	5050	
								10/29/76	94.0	161.0			
04S/12E-33E01 M	50	227.0	10/09/75	128.0	99.0	5050	04S/13E-29P01 M	24	245.0	10/09/75	88.0	157.0	5050
		10/26/78	141.0	86.0			04S/13E-30P01 M	24	325.0	10/09/75	187.0	138.0	5050
04S/12E-35N01 M	24	240.0	04/11/74	114.0	126.0	5050			02/25/76	184.0	141.0		
			02/25/76	119.0	121.0				08/06/76	189.0	136.0		
			08/06/76	138.0	102.0				10/29/76	190.0	135.0		
			10/29/76	120.0	120.0				03/02/77	196.0	129.0		
			03/03/77	125.0	115.0				07/01/77	192.0	133.0		
			07/13/77	138.0	102.0				08/24/77	215.0	110.0		
			03/01/78	127.0	113.0				11/07/77	207.0	118.0		
			10/26/78	147.0									

DATE 04/16/79

WDIS GROUND WATER LEVELS AT WELLS

PAGE 4

STATE WELL NUMBER	CO	GROUND SURFACE ELEVATION	DATE	GROUND TO WATER	WATER SURFACE ELEV.	AGENCY	STATE WELL NUMBER	CO	GROUND SURFACE ELEVATION	DATE	GROUND TO WATER	WATER SURFACE ELEV.	AGENCY
5 5-22 5-22.56		CENTRAL VALLEY REGION SAN JOAQUIN VALLEY SOUTH MERCED PLAINS					5 5-22 5-22.56		CENTRAL VALLEY REGION SAN JOAQUIN VALLEY SOUTH MERCED PLAINS				
04S/13E-36N01 M	24	280.0	10/09/75	93.0	187.0	5050	05S/11E-15M01 M	50	165.0	07/01/77	144.0	21.0	5050
04S/14E-21P01 M	24	258.0	10/09/75	84.0	174.0	5050				11/02/77	107.0	58.0	
04S/14E-30H01 M	24	248.0	10/09/75	39.0	209.0	5050				03/14/78	76.0	89.0	
04S/14E-31N01 M	24	290.0	10/09/75	115.0	175.0	5050				10/27/78	NM-1		
04S/14E-32P01 M	24	330.0	10/09/75	116.0	214.0	5050	05S/11E-22B01 M	24	185.0	10/07/75	115.0	70.0	5050
05S/11E-01B01 M	50	200.0	10/08/75	129.0	71.0	5050				02/26/76	99.0	86.0	
			02/28/77	116.0	84.0					08/06/76	137.0	48.0	
			03/01/78	118.0	82.0					10/28/76	117.0	68.0	
			10/27/78	NM-7						02/22/77	112.0	73.0	
										07/01/77	163.0	22.0	
										08/24/77	167.0	18.0	
										11/02/77	122.0 (6)	63.0	
										03/15/78	96.0	89.0	
										10/27/78	111.0	74.0	
42 05S/11E-11L01 M	50	201.0	10/08/75	122.0	79.0	5050	05S/11E-23R01 M	24	145.0	04/08/74	50.0	95.0	5050
			10/27/78	132.5	68.5					03/25/75	47.0	98.0	
05S/11E-12A01 M	50	190.0	10/08/75	104.0	86.0	5050				10/08/75	68.0	77.0	
			02/22/77	102.0	88.0					02/23/76	58.0	87.0	
			11/04/77	116.0	74.0					02/22/77	54.0	76.0	
			10/27/78	110.5	79.5					11/02/77	76.0	69.0	
										03/15/78	55.0	90.0	
05S/11E-12R01 M	50	200.0	10/08/75	114.0	86.0	5050	05S/11E-25A01 M	24	150.0	04/08/74	53.0	97.0	5050
			11/04/77	127.0	73.0					03/25/75	51.0	99.0	
			03/14/78	110.5	89.5					10/08/75	73.5	76.5	
			10/27/78	122.5	77.5					02/23/76	59.0	91.0	
05S/11E-13A01 M	24	230.0	10/08/75	144.0	86.0	5050				08/06/76	98.0	52.0	
			02/22/77	141.0	89.0					10/28/76	68.0	82.0	
05S/11E-13C01 M	24	215.0	02/22/77	130.0	85.0	5050				02/22/77	68.0	82.0	
05S/11E-13J01 M	24	167.0	04/08/74	67.0 (4)	100.0	5050				07/01/77	97.0	53.0	
			03/25/75	NM-9						08/24/77	101.0	49.0	
			10/08/75	86.0	82.0					11/02/77	85.0	65.0	
			02/22/77	84.0	83.0					03/15/78	60.0	90.0	
							05S/11E-26Q01 M	24	140.0	10/08/75	63.0	77.0	5050
05S/11E-13K01 M	24	166.0	10/08/75	87.0	79.0	5050				02/26/76	47.0	93.0	
										10/27/78	NM-4		
05S/11E-15M01 M	50	165.0	10/07/75	104.8	60.2	5050	05S/11E-27K01 M	24	135.0	10/08/75	54.0	81.0	5050
			02/25/76	80.0	85.0					02/28/77	59.0	76.0	
			02/22/77	97.0	68.0					11/02/77	61.0	74.0	

PAGE 5

STATE WELL NUMBER	GROUND SURFACE ELEVATION	DATE	GROUND TO WATER	WATER SURFACE ELEV.	AGENCY	STATE WELL NUMBER	GROUND SURFACE ELEVATION	DATE	GROUND TO WATER	WATER SURFACE ELEV.	AGENCY				
5 5-22 5-22,56	CENTRAL VALLEY REGION SAN JOAQUIN VALLEY SOUTH MERCED PLAINS					5 5-22 5-22,56	CENTRAL VALLEY REGION SAN JOAQUIN VALLEY SOUTH MERCED PLAINS								
05S/11E-27K01	M	24	135.0	03/15/78	42.5	92.5	5050	05S/12E-07F01	M	50	198.0	03/14/78	102.5	95.5	5050
05S/11E-35D01	M	24	138.0	10/08/75	53.5	84.5	5050				10/27/78	113.5	84.5		
				02/26/76	48.0	90.0		05S/12E-07G01	M	50	202.5	10/08/75	107.0	95.5	5050
				03/02/77	61.0	77.0					02/22/77	118.0	84.5		
				11/02/77	60.0	78.0		05S/12E-07H01	M	50	200.0	10/08/75	117.0	83.0	5050
				03/15/78	45.5	92.5					02/22/77	116.0	84.0		
				10/27/78	NM-3						11/03/77	127.0	68.0		
05S/12E-01J01	M	24	250.0	10/07/75	127.0	123.0	5050				10/27/78	122.5	72.5		
				03/03/77	133.0	117.0		05S/12E-07P01	M	24	208.0	10/08/75	126.0	82.0	5050
				11/03/77	140.0	110.0					11/03/77	133.0	75.0		
				03/14/78	127.0	123.0		05S/12E-07Q01	M	24	214.0	10/08/75	129.0	85.0	5050
				10/27/78	135.0	115.0					03/14/78	120.5	93.5		
05S/12E-01M01	M	24	252.0	10/07/75	140.0	112.0	5050				10/27/78	136.5	77.5		
				02/25/76	144.0	108.0		05S/12E-07R01	M	24	200.0	10/08/75	124.0	76.0	5050
				08/06/76	157.0	95.0					02/22/77	121.0	89.0		
				10/28/76	147.0	105.0		05S/12E-08P01	M	24	210.0	10/08/75	122.0	88.0	5050
				03/03/77	147.0	105.0					02/22/77	121.0	89.0		
				11/03/77	155.0	97.0					11/03/77	130.0	80.0		
				10/27/78	150.0	102.0					03/14/78	117.5	92.5		
05S/12E-02G01	M	24	252.0	10/07/75	130.0	122.0	5050				10/27/78	130.5	79.5		
				10/27/78	NM-7			05S/12E-11F01	M	24	245.0	10/07/75	115.0	130.0	5050
05S/12E-04C01	M	50	240.0	10/07/75	148.0	92.0	5050				10/27/78	147.0	98.0		
				03/01/78	143.0	97.0		05S/12E-11G01	M	24	252.0	04/08/74	130.0	122.0	5050
				10/27/78	153.0	87.0					03/25/75	133.0	119.0		
05S/12E-06R01	M	50	215.0	04/08/74	48.0 (6)	167.0	5050				10/07/75	141.0	111.0		
				03/25/75	118.0	97.0					02/26/76	143.0	109.0		
				02/26/76	113.0	102.0					10/28/76	148.0	104.0		
				08/06/76	125.0	90.0					11/03/77	152.0	100.0		
				10/28/76	127.0	88.0					03/14/78	143.0	109.0		
				02/28/77	126.0	89.0					10/27/78	150.0	102.0		
				07/01/77	126.0	87.0		05S/12E-11K01	M	24	250.0	10/07/75	131.0	119.0	5050
				08/24/77	131.0	84.0					02/26/76	128.0	122.0		
				03/14/78	129.0	86.0					08/06/76	148.0	102.0		
				10/27/78	NM-3						10/28/76	134.0	116.0		
05S/12E-07F01	M	50	200.0	10/08/75	108.0	92.0	5050				11/03/77	138.0	112.0		
				02/22/77	110.0	90.0									

DATE 04/16/79

WDIS GROUND WATER LEVELS AT WELLS

PAGE 6

STATE WELL NUMBER	CO	GROUND SURFACE ELEVATION	DATE	GROUND TO WATER	WATER SURFACE ELEV.	AGENCY	STATE WELL NUMBER	CO	GROUND SURFACE ELEVATION	DATE	GROUND TO WATER	WATER SURFACE ELEV.	AGENCY
5	CENTRAL VALLEY REGION						5	CENTRAL VALLEY REGION					
5-22	SAN JOAQUIN VALLEY						5-22	SAN JOAQUIN VALLEY					
5-22.56	SOUTH MERCED PLAINS						5-22.56	SOUTH MERCED PLAINS					
05S/12E-12E01 M	24	250.0	03/03/77	143.0	107.0	5050	05S/12E-19B01 M	24	168.0	03/15/78	76.5	91.5	5050
			07/01/77	150.0	100.0								
			08/24/77	154.0	96.0		05S/12E-20E01 M	24	170.0	02/22/77	83.0	87.0	5050
			03/14/78	144.0	106.0					11/04/77	98.0	72.0	
			10/27/78	149.0	101.0					03/15/78	82.5	87.5	
05S/12E-13N01 M	24		03/14/78	DRY		5050	05S/12E-21Q01 M	24	193.0	10/07/75	113.5	79.5	5050
			10/27/78	DRY						10/28/76	109.0	84.0	
05S/12E-14E01 M	24	219.0	04/08/74	108.0	111.0	5050				03/03/77	103.0	90.0	
			03/25/75	112.0	107.0					11/04/77	112.0	81.0	
			02/26/76	119.0	100.0					10/24/78	112.0	81.0	
			03/03/77	DRY			05S/12E-22H01 M	24	220.0	04/08/74	104.0	116.0	5050
			08/24/77	DRY						10/07/75	122.0	98.0	
			03/14/78	DRY						02/26/76	113.0	107.0	
			10/27/78	DRY						08/06/76	133.0	87.0	
05S/12E-14M01 M	24	208.0	03/03/77	112.0 (6)	96.0	5050				10/28/76	121.0	99.0	
			08/24/77	133.0	75.0					03/03/77	119.0	101.0	
			11/08/77	116.0	92.0					11/03/77	140.0	80.0	
			03/14/78	NM-9						03/14/78	117.0	103.0	
			10/27/78	119.0	89.0					10/24/78	NM-1		
05S/12E-16R01 M	24	202.0	03/03/77	110.0	92.0	5050	05S/12E-22J01 M	24	220.0	03/03/77	123.0	97.0	5050
			11/04/77	118.0	84.0					10/24/78	NM-1		
			03/14/78	108.0	94.0		05S/12E-23P01 M	24	225.0	11/04/77	127.0	98.0	5050
			10/27/78	118.0	84.0					03/14/78	119.5	105.5	
05S/12E-18C01 M	24	205.0	10/08/75	122.0	83.0	5050	05S/12E-25L01 M	24	140.0	10/07/75	18.8	121.2	5050
			03/03/77	120.0	85.0					03/03/77	20.0	120.0	
		204.5	11/04/77	146.0	58.5		05S/12E-26N01 M	24		04/08/74	NM-9		5050
05S/12E-18L01 M	24	175.0	10/08/75	89.0	86.0	5050			205.0	10/07/75	98.0	107.0	
			03/03/77	87.0	88.0					02/26/76	93.0	112.0	
			11/04/77	97.0	78.0					08/06/76	111.0	94.0	
			03/15/78	79.5	95.5					10/28/76	100.0	105.0	
05S/12E-19B01 M	24	168.0	10/07/75	100.0	68.0	5050				03/03/77	100.0	105.0	
			02/26/76	71.0	97.0					07/01/77	117.0	88.0	
			08/06/76	110.0	58.0					08/24/77	117.0	88.0	
			10/28/76	90.0	78.0					11/03/77	101.0	104.0	
			02/22/77	81.0	87.0					03/14/78	95.5	109.5	
			11/04/77	93.0	75.0					10/24/78	105.5	99.5	

DATE 04/16/79

WDIS GROUND WATER LEVELS AT WELLS

PAGE 7

STATE WELL NUMBER	CO	GROUND SURFACE ELEVATION	DATE	GROUND TO WATER	WATER SURFACE ELEV.	AGENCY	STATE WELL NUMBER	CO	GROUND SURFACE ELEVATION	DATE	GROUND TO WATER	WATER SURFACE ELEV.	AGENCY
5	CENTRAL VALLEY REGION						5	CENTRAL VALLEY REGION					
5-22	SAN JOAQUIN VALLEY						5-22	SAN JOAQUIN VALLEY					
5-22.56	SOUTH MERCED PLAINS						5-22.56	SOUTH MERCED PLAINS					
05S/12E-27A01 M	24	200.0	10/07/75	105.0	95.0	5050	05S/12E-33N01 M	24	168.0	04/08/74	59.0	109.0	5050
			02/26/76	85.0	115.0					10/07/75	73.0	95.0	
			03/03/77	92.0	108.0					02/26/76	63.0	105.0	
			07/01/77	116.0	84.0					11/02/77	78.0	90.0	
			08/24/77	119.0	81.0					03/15/78	66.5	101.5	
			11/04/77	95.0	105.0								
			10/24/78	NM-7			05S/12E-33R01 M	24	170.0	02/26/76	69.0	101.0	5050
05S/12E-28J01 M	24	189.0	03/03/77	90.0	99.0	5050				03/03/77	80.0	90.0	
			07/01/77	110.0	79.0					11/02/77	87.0	83.0	
			08/24/77	111.0	78.0					03/15/78	73.0	97.0	
			11/08/77	108.0	81.0		05S/12E-34A01 M	24		04/08/74	NM-1		5050
			03/15/78	90.5	98.5				190.0	10/07/75	106.0	84.0	
			10/24/78	99.5	89.5					02/26/76	80.0	110.0	
05S/12E-29H01 M	24	196.0	04/08/74	91.0	105.0	5050				10/28/76	90.9	100.0	
			10/24/78	NM-4						03/03/77	88.0	102.0	
										11/02/77	92.0	98.0	
										03/15/78	82.0	103.0	
05S/12E-30D01 M	24	155.0	10/07/75	84.5	70.5	5050	05S/13E-01H01 M	24	330.0	10/06/75	138.0	192.0	5050
			08/06/76	110.0	45.0								
05S/12E-30Q01 M	24		04/08/74	NM-1		5050	05S/13E-11C01 M	24	285.0	10/06/75	106.0	179.0	5050
		164.0	10/07/75	82.0	82.0								
			02/26/76	70.0	94.0		05S/13E-14J01 M	24	200.0	10/06/75	14.0	186.0	5050
			10/28/76	80.0	84.0								
			03/03/77	78.0	86.0		05S/13E-16K01 M	24	172.0	10/06/75	25.0	147.0	5050
			11/02/77	83.0	81.0								
			03/15/78	70.5	93.5		05S/13E-19Q01 M	24	216.0	10/06/75	77.0	139.0	5050
										11/03/77	78.0	138.0	
05S/12E-31G01 M	24	155.0	10/07/75	71.0	84.0	5050	05S/13E-22C01 M	24	180.0	10/06/75	25.5	154.5	5050
			03/02/77	71.0	84.0								
			03/15/78	60.0	95.0		05S/13E-23P01 M	24	188.0	10/06/75	21.5	166.5	5050
05S/12E-31Q01 M	24	166.0	10/07/75	77.0	89.0	5050							
			02/26/76	73.0	93.0		05S/13E-27D01 M	24	171.0	10/06/75	19.0	152.0	5050
			03/02/77	77.0(2)	89.0								
			11/02/77	94.0	72.0		05S/14E-02Q01 M	24	280.0	10/06/75	17.0	263.0	5050
			10/24/78	82.0	84.0								
05S/12E-32Q01 M	24	170.0	10/07/75	73.0	97.0	5050	05S/14E-08R01 M	24	240.0	10/06/75	13.0	227.0	5050
			11/02/77	87.0	83.0								
			03/15/78	72.0	98.0		05S/14E-18K01 M	24	221.0	10/06/75	8.5	212.5	5050

BIBLIOGRAPHY

- Balding, G. O., and R. W. Page. "Data for Wells in the Modesto-Merced Area, San Joaquin Valley, California". U. S. Geological Survey Open File Report. 1971.
- California Department of Water Resources. "The California Water Plan -- Outlook in 1974". Bulletin 160-74. 1974.
- . "Hydrologic Data, San Joaquin Valley". Bulletin 130 Series, Vol. IV. Through 1975.
- . "Vegetative Water Use in California". Bulletin 113-3. 1974.
- Davis, S. N., and F. R. Hall. "Water Quality of Eastern Stanislaus and Northern Merced Counties, California". Stanford University Publications [on] Geological Sciences, Vol. 6, No. 1. 1959.
- Esmaili, H., and Associates. "Hydrogeology of the Montpelier Area". Appendix E to Modesto Wastewater Treatment Facilities Plan, Draft Environmental Impact Statement. 1978.
- . "Identification of Prime Agricultural Lands in the Modesto Region". Appendix C to Modesto Wastewater Treatment Facilities Plan, Draft Environmental Impact Statement. 1978.
- Jones, Marshall. "Water Needs in Stanislaus County Subject to Service from New Melones Project". 1974.
- Linsley, Kohlen and Paulhus. Hydrology for Engineers. New York. 1975.
- Page, R. W., and G. O. Balding. "Geology and Quality of Water in the Modesto-Merced Area, San Joaquin Valley, California, with a Brief Section on Hydrology". U. S. Geological Survey Water Resources Investigations, 6-73. 1973.
- Rohwer, Carl, and Oscar Van Pelt Stout. "Seepage Losses from Irrigation Channels". Colorado A & M College Technical Bulletin 38. 1948.
- United States Bureau of Reclamation. "East Side Division, Ground Water Geology and Resources Appendix. 1971.
- . "Stanislaus River Basin, Proposed Reservation Area and Projected Water Requirements". 1973.

