DWG: V:\Madera, County of\22203.00 IRWMP\CAD\FIGURES\Chapter 5\FIG 5-8.dwg USER: mthorne
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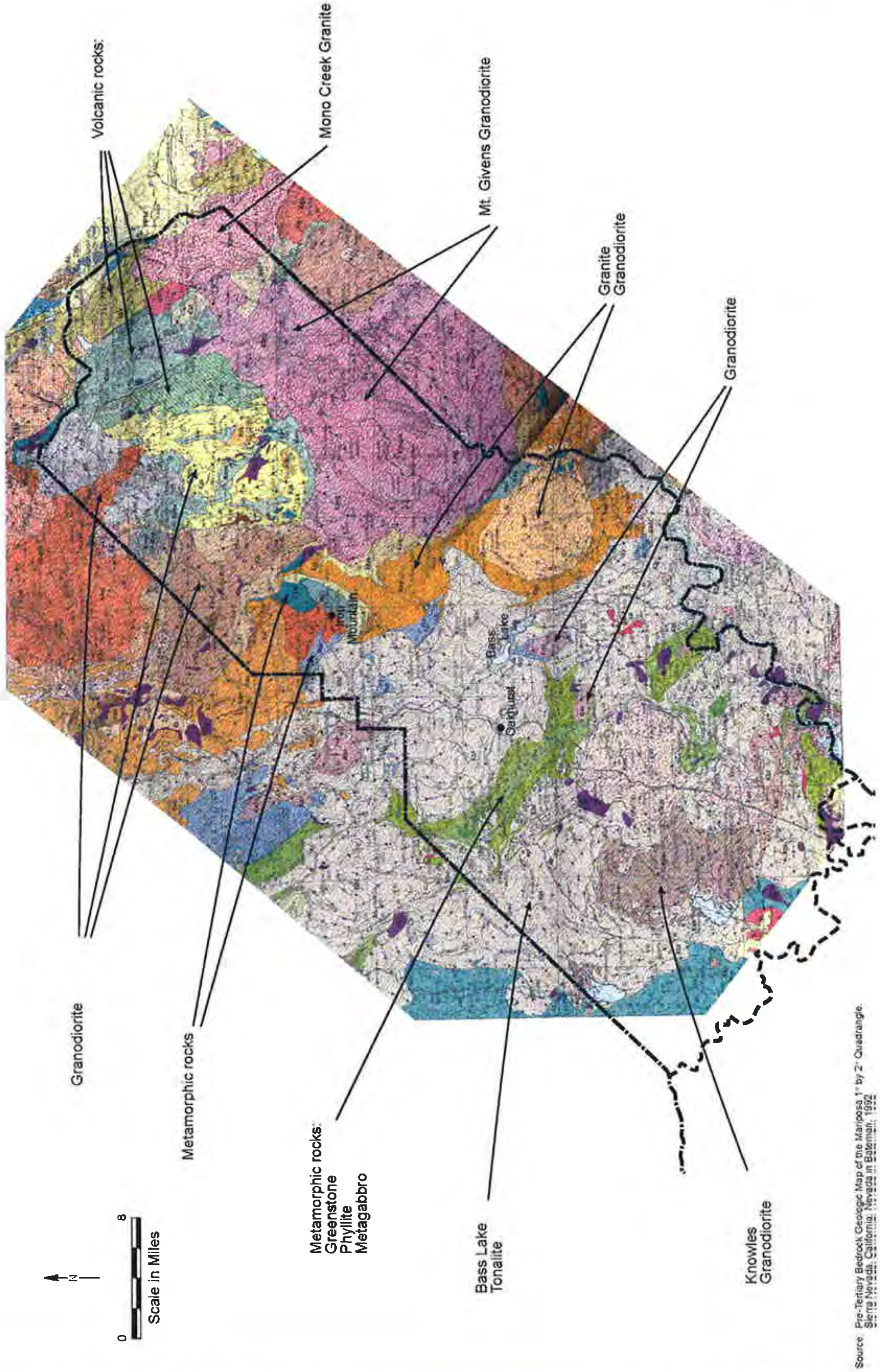


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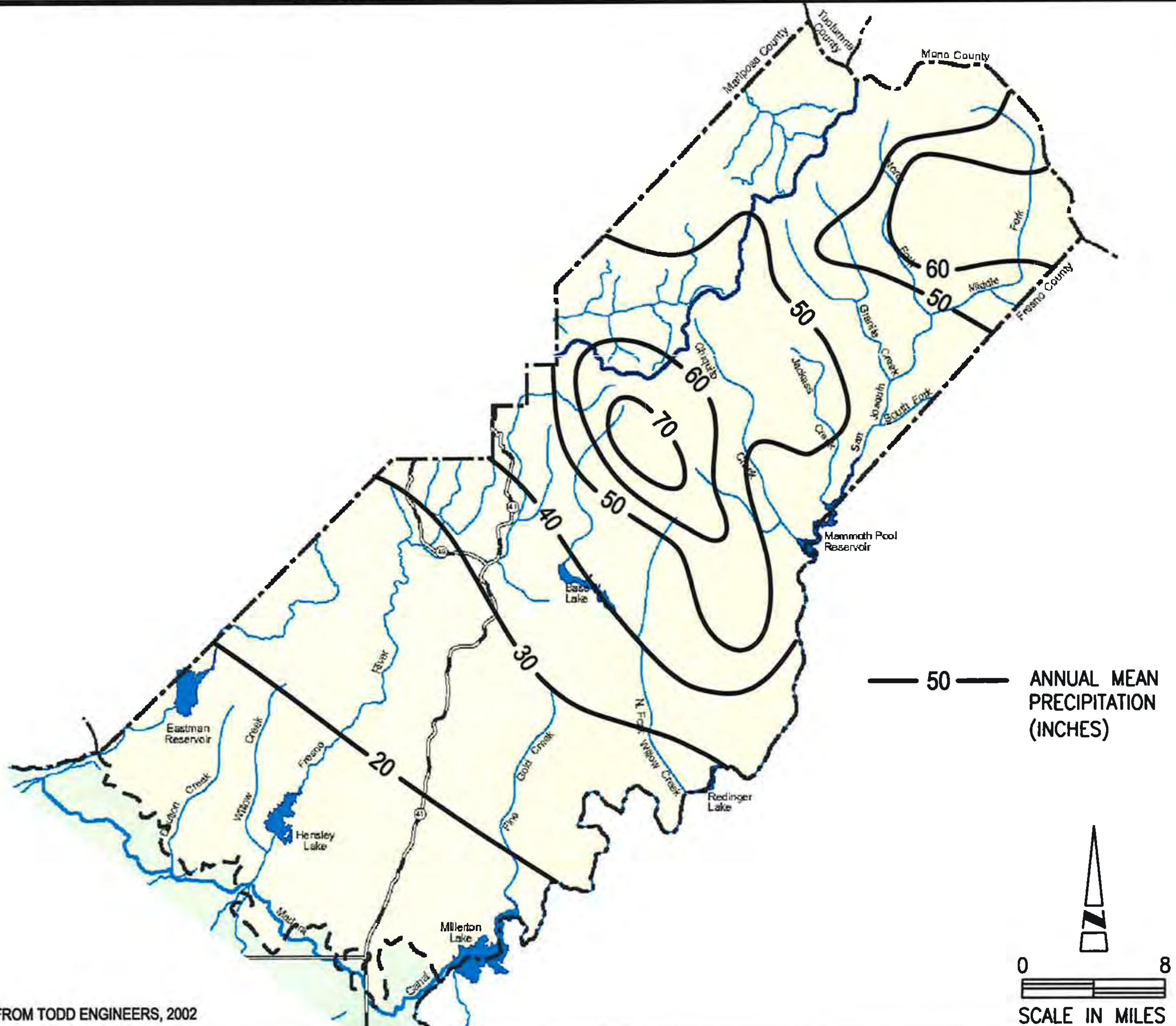
| COUNTY OF MADERA INTEGRATED REGIONAL WATER MANAGEMENT PLAN | BEC PROJECT NO. | FIGURE |
|---|---|---|
| **MAJOR ROCK TYPES IN THE FOOTHILLS AND MOUNTAINS** | 22203.00 | 5-8 |

DWG: V:\Madera, County of\22203.00 IRWMP\CAD\FIGURES\Chapter 5\FIG 5-9.dwg USER: drodriguez
DATE: Apr 02, 2008 11:05am XREFS: G-BD8x11 IMAGES: Co-Region.tif

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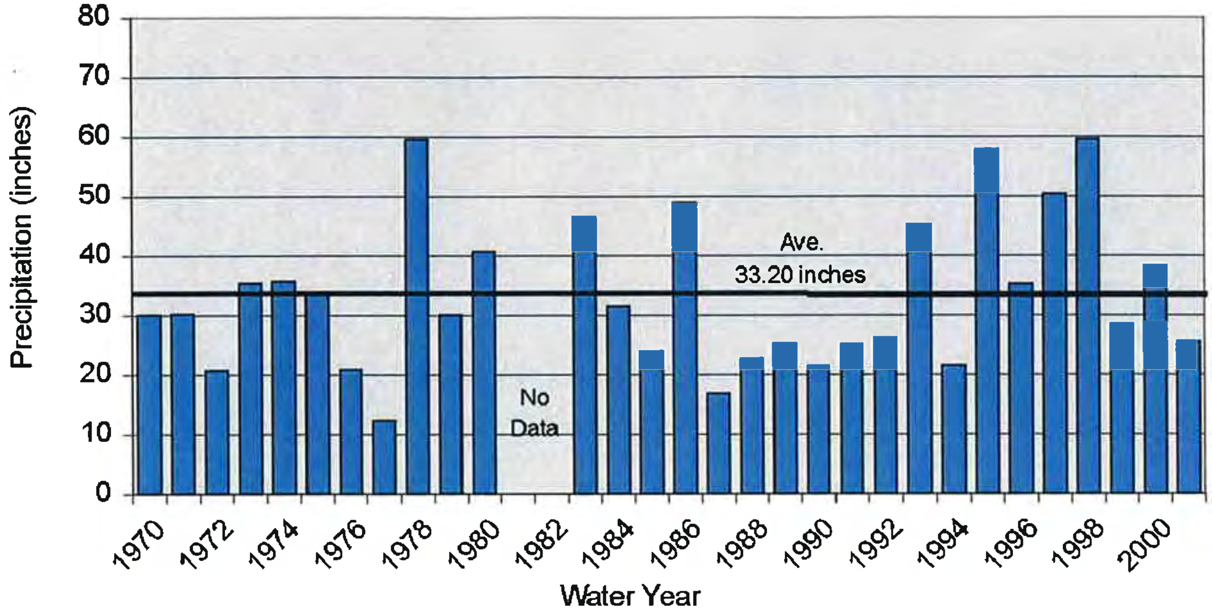
COUNTY OF MADERA
INTEGRATED REGIONAL WATER
MANAGEMENT PLAN

**ANNUAL MEAN PRECIPITATION**

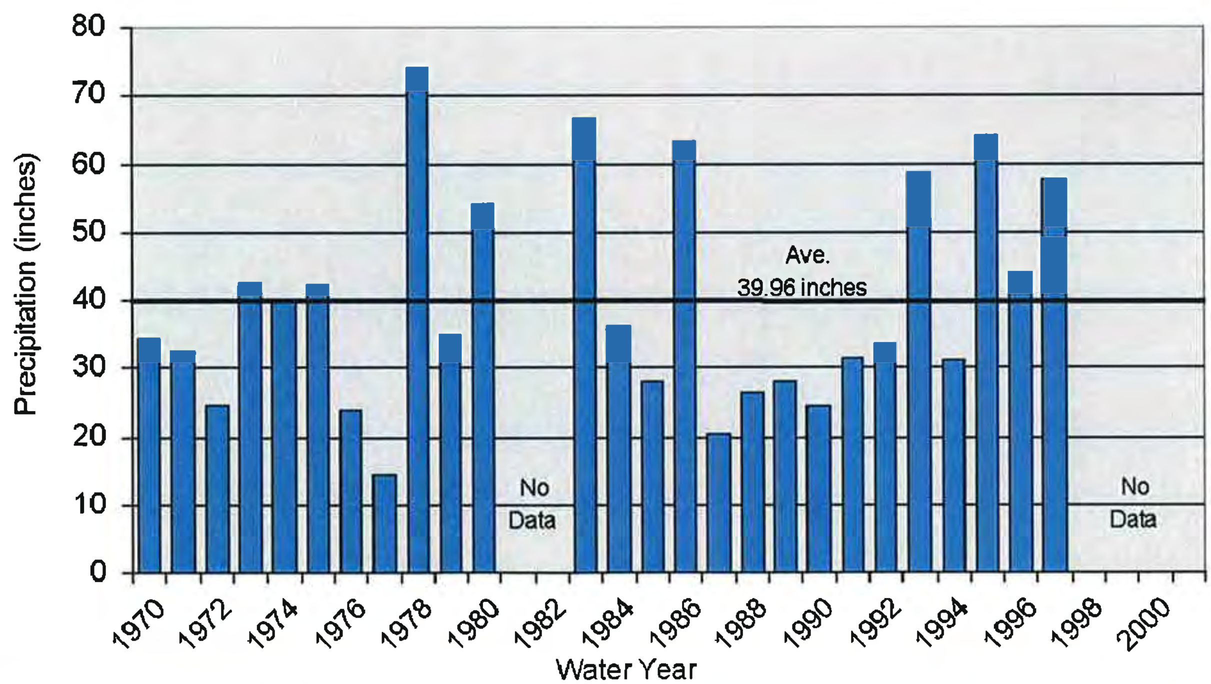
BEC PROJECT NO. 22203.00

FIGURE 5-9

## Annual Precipitation at North Fork Station
(Elevation 2,630 feet msl)




## Annual Precipitation at Crane Valley Station
(Elevation 3,400 feet msl)




SOURCE: TODD ENGINEERS, 2002

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|---|---|---|---|

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DATE: Apr 02, 2008 9:44am XREFS: G-BD8x11 IMAGES: Annual Ppt.jpg

streamflow is highly important to operation of the open-space-preserving institution of cattle ranching and the ecology of the Foothills and Mountains.

#### 5.1.2.5 Water Levels

As part of this Plan and the previous evaluation for the Oakhurst area, water-level monitoring networks for wells were developed in all of the areas studied. Measuring points were located using GPS, and this allowed water-level elevation maps to be prepared for the first time. Stream channel elevations were also established using GPS so that groundwater level elevations could be compared to stream channel elevations. In the areas evaluated, groundwater was moving from topographically high areas toward topographically low areas (stream channels). Groundwater was either discharging to the streams or was consumed by pumpage or plant evapotranspiration near the streams. In general, groundwater elevations were above those of the adjacent stream channels. This indicated that there was little or no recharge from stream channels in low topographic areas (i.e., the Fresno River in Oakhurst).

Frequent groundwater-level measurements indicated that groundwater levels responded rather rapidly to precipitation (after the initial several inches of precipitation falls in the winter). Water levels then generally rose until precipitation ceased in the spring, when they began to decline. In the winter, water levels in wells in the areas evaluated were shallow (commonly less than 50 feet deep) except in topographically high areas. Water levels are generally deeper in deep wells and in wells in the higher topographic areas.

Groundwater development in the Foothills and Mountains is normally dependent on recharge each winter because of the relatively small storage space available in the fractured hardrock. Continuous water-level measurements are available for several wells at the Chukchansi Casino, and these have proved useful in managing the wells being used. That is, the seasonal high and low water levels each year can be compared to those for previous years, and this information can be used as a guide to managing the pumpage during the next summer.

## 5.2 Existing Surface Water Supply

### 5.2.1 Water Entitlements

The major river systems in Madera County are the Chowchilla River to the north and the Fresno River to the south. These river systems are tributary to the San Joaquin River, which coincides with the south and the west boundaries of the County. CWD, MID, and USBR are the major water rights holders on the Chowchilla, Fresno, and San Joaquin River systems, which are both riparian and appropriative in nature. In addition to these sources of supply, CWD, MID, GFWD, and the County are CVP water service contractors holding contracts for CVP water. CWD and MID divert their CVP supply from the Madera Canal, which takes its supply from the San Joaquin River at Friant Dam. GFWD diverts its CVP supply directly from the San Joaquin River downstream of the dam. The County takes its CVP supply from Millerton Lake for use in MD-1 Hidden Lakes. CCC is a

San Joaquin River Exchange Contractor and receives surface water from the Delta-Mendota Canal under the exchange contract with USBR.

The following paragraphs summarize the water rights held by these agencies and others which are considered significant such as:

- Central Valley Project Water Rights
- San Joaquin River Exchange Contract
- Other Water Rights

#### 5.2.1.1 Central Valley Project Water Rights

Madera County and the various water district CVP water contracts are summarized as follows:

**Chowchilla Water District**

- CVP Water, Contract No. 175r-2358-LTR1. The Class 1 contract amount is 55,000 AFY with an average yield of 48,000 AFY, and the Class 2 contract amount is 160,000 AFY with an average yield of 42,000 AFY.

- Chowchilla River Buchanan Dam/Eastman Reservoir, Contract No. 14-06-200-3844A-LTR1-2. The CVP total average yield is 48,000 AFY. Water delivered under this contract to CWD by USBR is pursuant to Water Right Permit No. 16301 issued to USBR, which authorizes storage of 143,000 AF of water behind Buchanan Dam. The underlying water rights consist of an appropriative rights License No. 8572, which allows CWD to divert 50,000 AFY for underground storage at a maximum rate of 600 cfs and 90 cfs diverted directly for irrigation. This appropriative water right, and three much smaller appropriative rights, were allowed to be stored in Eastman Reservoir behind Buchanan Dam together with any additional water which would become available due to owners of lands within the CWD not exercising their riparian rights and waters which would otherwise be lost in conveyance. The sum of the yields of these other rights is small and is not considered significant in quantification of the surface water rights in Madera County for purposes of this study.

**Madera Irrigation District**

- CVP Water, Contract No. 175r-289-LTR1. The Class 1 contract amount is 85,000 AFY with an average yield of 78,200 AFY, and the Class 2 contract amount is 186,000 AFY with an average yield of 65,100 AFY.

- Fresno River Hidden Dam/Hensley Lake, Contract No. 14-06-250-4020A-LTR1-2. The CVP total average yield is 24,000 AFY. Water is delivered under Contract No. 14-06-250-4020A-LTR1-2 to MID by USBR per Water Right Permit No. 16584, which authorizes storage of 74,000 AF of water behind Hidden Dam. The underlying water rights are the Big Creek and Soquel pre-1914 water rights and the Franchi Weir adjudicated water rights. These water rights, and other much smaller appropriative rights, are allowed to be stored in Hensley Lake. Riparian and appropriative water rights can reach several thousand AF in some years. Also, riparian rights quantities can increase with a change in diversion capabilities and cropping patterns and could become more significant even in below-normal water years.

**Gravelly Ford Water District**. CVP Water, Contract No. 1-07-2-W0242-LTR1. The Class 2 contract amount is 14,000 AFY with an average yield of 4,000 AFY.

**County of Madera**. CVP Water, Contract No. 14-06-200-2406A-LTR1. Class 1 contract amount is 200 AFY with an average yield of 200 AFY.

**Total CVP Water Rights in Madera County**. The total CVP water rights in Madera County can be summarized as follows:

- Class 1 contract amount is 140,200 AFY with an average yield of 126,400 AFY (90%).
- Class 2 contract amount is 360,000 AFY with an average yield of 111,100 AFY (30%).
- Total contract amount is 500,200 AFY with an average yield of 237,500 AFY (47%).

Average CVP yields depend on the time period evaluated due to highly variable allocations associated with changing hydrologic conditions.

#### 5.2.1.2 San Joaquin River Exchange Contract

CCC is the only San Joaquin River exchange contractor in the County and has a very reliable source of water. The CVP contract amount is 59,000 AFY with a minimum yield of 45,000 AFY.

#### 5.2.1.3 Other Water Rights

In addition to the CVP and the San Joaquin River exchange contract, there are other surface water rights in the County. These are summarized below and include MID Big Creek, Soquel, and Franchi weir water rights, which are underlying rights to the water stored in Hensley Lake

- LeGrand-Athelone WD. Water is available through annual transfer with an average yield of 400 AFY.

- MID Big Creek Diversion to Fresno River. A pre-1914 water right exists for the first 50 cfs (December 1 to July 15) with an average yield of 9,400 AFY with April diversions limited to 20 cfs.

- MID Soquel Diversion from Willow Creek to Fresno River. A pre-1914 water right exists for the first 50 cfs between October 1 and July 31 less 1 cfs to remain in Willow Creek. Since 1978, water has remained in Willow Creek and is stored in Bass Lake until the fall of each year. It is then released and delivered to MID through the San Joaquin River CVP system. The average yield is 9,700 AFY.

- MID adjudicated water right Fresno River at Franchi Weir. The first 200 cfs includes Big Creek and Soquel Diversions with an average yield of 20,000 AFY.

- MID Lake Madera appropriative right, License No. 009229. This use is limited to stock water and recreation and has an average yield of 2,050 AFY.

- GFWD appropriative water right on Cottonwood Creek. The average yield is 1,800 AFY. The October 1 to June 1 yield is 5,000 AFY. The approximate annual yield of the “other water rights” is 4,000 AFY.

- Section 215 water. The average yield (as available) is 114,000 AFY. This water is defined under Section 215 of the Reclamation Reform Act of 1982 RRA as unstorable irrigation water that is released to comply with flood control criteria or unmanaged flood flows. These flows occur at Friant Dam, Buchanan Dam, and Hidden Dam. Water is made available under 1-year contracts and varies substantially from year to year. This water is made available to the CVP contractors from time to time. With the construction of Temperance Flat, the availability of Section 215 water could be drastically reduced. Section 215 water is not available every year and, when available, often Class 1 and 2 water use is reduced because of the lower cost of Section 215 water.

- In addition to the abovementioned water rights, there are other rights to water from the San Joaquin River, as well as benefits from percolation, that are very important to the water supply of Madera County that must be protected.

### 5.2.2 Summary of Surface Water Supply

The average annual amount of surface water delivered in the County is estimated to be approximately 300,000 AFY as shown in Table 5-1.

**Table 5-1. Average Surface Water Deliveries,[a] AFY (1996-2006)**

| District or Water Right | Water Delivered | Remarks |
|---|---|---|
| MID | 120,000 | Includes water from all sources and deliveries to subordinate land including MWD. |
| CWD | 105,000 | Includes water from all sources and riparian water deliveries. |
| GFWD | 8,700 | Includes water rights, CVP, and purchased water. |
| CCC | 59,000 | Minimum allocation is 45,000 AF in critical years. |
| LeGrand-Athelone WD | 400 | |
| MID Lake Madera Appropriation Right: License No. 009229 | 2,050 | Use limited to stock water and recreation. |
| Fresno River riparian water | 2,500 | Riparian water use on the Fresno River ranges from several hundred AF in dry years to as much as 5,000 AF or more in wet years. |
| Total | 297,650 | |
| Use | 300,000 | |

[a] Water delivery data does not include minor water rights holders and diversions or all riparian water use in the County including water diverted under holding contracts with the USBR.

This estimate includes CVP, water rights, riparian, and transfer water from all sources based on the 1996-2006 data. As stated earlier, not all water diverted from the San Joaquin River downstream of Friant Dam is accounted for, including riparian water and water pumped under holding contracts with USBR. An accounting or estimate of this water could not or would not be provided by USBR.

## 5.3 Comparison of Water Demand and Supply

Table 5-2 compares the existing and projected 2030 water demand and average surface water supply. As can be seen, there is an existing deficit of approximately 900,000, which currently is satisfied by groundwater pumping. If no additional water supplies are brought into or developed in the County, this deficit will likely increase to approximately 1 MAFY by 2030 with severe consequences to the groundwater resources of the County.

**Table 5-2. Comparison of Madera County Water Demand and Supply, AFY**

| Year | Water Demand | Average Surface Water Supply | Supply Deficit (satisfied w/ groundwater | Percent Reliance of Groundwater |
|---|---|---|---|---|
| 2006 (Existing) | 1,200,000 | 300,000 | 900,000 | 75 |
| 2030 | 1,300,000 | 300,000 | 1,000,000 | 77 |

Based on projected population growth patterns, all but approximately 7,000 AF of the additional 100,000 AF of water required to meet demands in 2030 would be pumped in the Valley Floor, which would increase overdraft of the groundwater basin to an average of 155,000 AFY if no mitigation measures are implemented. The surface water supply estimates for 2030 assume the current average CVP deliveries are unchanged. This assumption may change if CVP water is dedicated to San Joaquin River restoration efforts or if an additional storage facility (Temperance Flat Dam) is constructed on the San Joaquin River. It is estimated that CVP contractors could lose as much as 15 to 20 percent of their CVP water supply due to potential increased releases to the San Joaquin River for restoration efforts. Any loss of CVP water will have to be replaced with additional groundwater pumping, increased capture and storage of existing surface water supplies, or through transfer of water into the County or reduced irrigation.

## 5.4 Water Resource Impacts of Continued Groundwater Use

The following section concludes the chapter on water supply by describing the effect of increasing groundwater use in the County. This conclusion has been divided into two parts to reflect the hydrogeologic differences between the two study regions.

### 5.4.1 Valley Floor Impacts

As previously stated, the majority of the Valley Floor has been defined as critically overdrafted by DWR. The current estimated total amount of groundwater overdraft, based on historical water level declines from 1970 to 2006, is about 100,000 AFY. Based on the water demand analysis for 2030, it is anticipated that the overdraft in the Valley Floor area will grow to approximately 155,000 AFY without mitigation measures being taken. The overdraft continues to increase with development of previously undeveloped land, including development of new irrigated land and additional urban and rural residential development unless surface water is developed or brought in from outside the County. The overdraft will result in higher pumping costs and require deepening of wells to sustain required pumping rates. This is not sustainable over the long term. Land subsidence resulting from groundwater overdraft has also occurred in the western part of the area, where the Corcoran Clay is present. This condition will worsen as groundwater overdraft continues. In addition, pumping of deeper groundwater from zones of the aquifer with poorer quality water will likely lead to required treatment to meet drinking water standards. An example would be the Madera Ranchos area, where poorer quality groundwater (elevated levels of iron and manganese) is present below a depth of about 600 feet. Ultimately, if Madera County and other counties in the San Joaquin Valley do not implement measures to address overdraft, it could lead to State-imposed regulations and possibly adjudication of the groundwater basins in Madera County and/or the entire San Joaquin Valley.

### 5.4.2 Foothills and Mountains Impacts

In areas of higher precipitation (Oakhurst, North Fork, and the topographically higher part of the Coarsegold area), as shown in Figure 5-9, the groundwater recharge is indicated to be adequate for the existing development. However, some problems have been encountered in parts of these areas due to well interference and groundwater quality (i.e., high uranium and arsenic concentrations in parts of the Oakhurst and North Fork areas). Well interference problems have usually resulted from larger-capacity water system wells that are in close proximity to other wells. These larger-capacity wells are pumped at relatively high rates for prolonged periods.

In areas of lower precipitation (Raymond-Hensley Lake and the lower part of the Coarsegold area), groundwater recharge is more limited and further large-scale dense development in these areas may require a supplemental water supply to augment the available groundwater. It is recommended that feasibility studies of developing surface water supplies for treatment and delivery for domestic use in these areas be conducted. The reports should evaluate the alternatives for acquiring surface water, including acquisition of water rights through State application or purchase. Possible storage facilities that could be used in conjunction with these projects include Eastman Reservoir and Black Hawk Reservoir. Except for iron and manganese, groundwater quality does not appear to be a problem in these areas. Deep wells have been drilled in some parts of these areas, and well interference needs to be investigated. Water quality protection and improved monitoring are needed to protect the water resources in the Foothills and Mountains.

# Chapter 6
# Water Quality

## 6.1 Groundwater Quality

Groundwater is usually clear, colorless, and has lower concentrations of organic matter and microorganisms than surface water due to the effects of natural filtration as the water percolates through the soil. The mineral content, however, is usually higher in groundwater than in fresh surface water. Groundwater commonly has calcium and magnesium ions, which contribute to the hardness of the water. Over time, the quality of groundwater changes more slowly than that of surface water. However, once contaminated, a groundwater aquifer may take decades or longer to return to its natural quality. Water pumped from a contaminated aquifer may require treatment to meet drinking water standards. Groundwater may also contain concentrations of natural constituents that are unhealthy when consumed by humans. Examples are arsenic and uranium.

Some of the chemical contamination of Madera County's Valley Floor groundwater has resulted from the inappropriate use and disposal of chemicals. Some sources of chemicals have been associated with agricultural and industrial uses, such as dry cleaners and even the natural environment. Soil fumigants DBCP and EDB have been a major class of agricultural contaminants because of their mobility in the soil-aquifer system. Steps have been taken to address the impacts, such as sealing new wells deeper below contaminated aquifers or treating pumped water. In addition, DBCP was banned in California in 1977. In some cases, high nitrate concentrations have resulted from fertilizer applications and other sources.

Groundwater is contaminated by industrial and agricultural chemicals that leach through the soil from a point source discharge, such as an underground tank leak, or from nonpoint sources when a chemical is widely used over a large area, such as by extensive fertilizer or pesticide application.

### 6.1.1 Valley Floor Groundwater Quality

Moore (1995) evaluated DBCP in groundwater in the Valley Floor of Madera County. Todd Engineers (2002) discussed groundwater quality problems in Madera County. The Root Creek Water District (Provost & Pritchard, 2005) conducted an extensive groundwater quality sampling program as part of a DWR grant program. KDSA (2007) conducted studies of high salinity groundwater near the San Joaquin River in the upper aquifer in the west part of the study area for the San Joaquin River Exchange Contractors. The results of various studies have been combined to produce a groundwater quality map for the Valley Floor of Madera County as shown in Figure 6-1. It should be noted that most of the water pumped from Valley Floor public water systems is of good quality.

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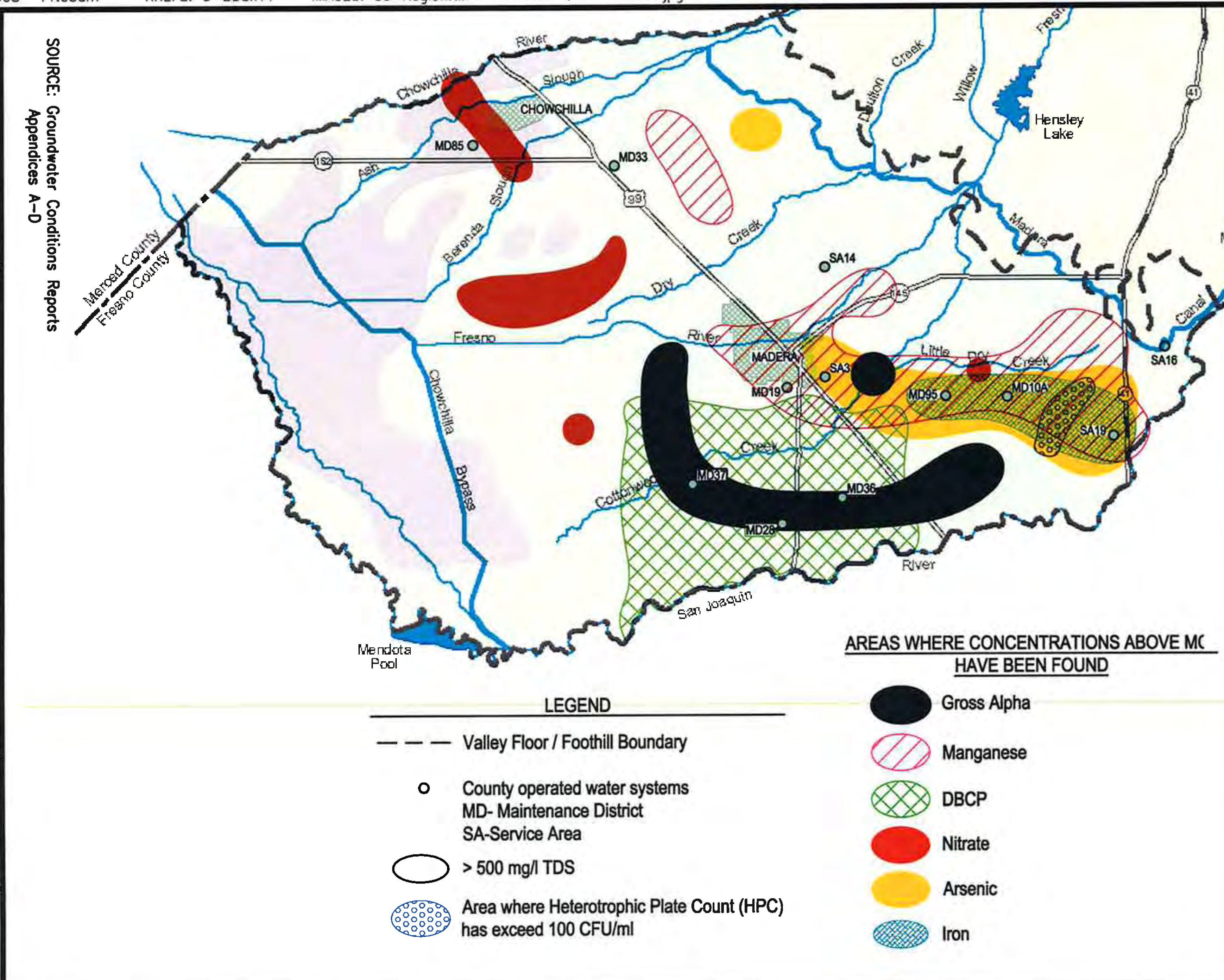
DATE: Apr 02, 2008 11:05am XREFS: G-BD8x11 IMAGES: Co-Region.tif Water-Qual-Concern.jpg




SOURCE: Groundwater Conditions Reports
Appendices A-D

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COUNTY OF MADERA
INTEGRATED REGIONAL WATER
MANAGEMENT PLAN

VALLEY FLOOR
AREAS OF WATER QUALITY CONCERN

BEC PROJECT NO. 22203.00

FIGURE 6-1

Groundwater quality data were obtained by Boyle from CDPH for all public water systems within Madera County for the years 2002 through 2007. These data were compiled for selected constituents and are summarized in Tables 6-1 and 6-2 for County-owned systems[1] and large public water systems (200 connections or more), respectively, in the Valley Floor. These water systems are shown in Figure 3-2 along with the service areas of the irrigation and water districts.

Todd Engineers plotted TDS concentrations in well water as of about 1970 and evaluated more recent data for water system wells as shown in Figure 6-1. TDS concentrations were generally less than 500 mg/L (the recommended drinking water limit) in water from most wells in the area east of the Eastside Bypass and southeast of the Berenda Slough. In the area west of the Bypass and northwest of the Berenda Slough, many wells had TDS concentrations exceeding 500 mg/L. The highest TDS well water (concentrations exceeding 2,000 mg/L) has been in the area near the San Joaquin River, particularly between Firebaugh and the Fresno County-Merced County line. High-salinity groundwater has been present in the upper aquifer west of the river for many decades. Due to altered directions of groundwater flow partly associated with pumping in western Madera County, this poor-quality groundwater is now moving to the northeast into Madera County. There is a localized brine plume southwest of Madera, where the former Oberti Olive Company disposal ponds were located.

Known areas where nitrate concentrations in water from wells exceeded 45 mg/L MCL are also shown in Figure 6-1 based on the study by Todd Engineers (2002a) and supplemented by data analyzed for this study. Two wells were located in the southeast area and seven others west of Highway 99. High nitrate concentrations can be derived from a number of sources, the largest source in irrigated areas being nitrogen fertilizer. Areas with sandy topsoils and shallow alluvium are particularly vulnerable to high nitrate concentrations. Another source is sewage effluent, and high nitrate concentrations have been found in shallow monitoring wells at the City of Madera WWTP. Natural sources of nitrate are generally not important in the Valley Floor area. Studies in the Fresno-Madera area have indicated that most of the high-nitrate groundwater is within the uppermost 200 feet of the aquifer. Deeper groundwater, commonly below a depth of about 300 feet in much of the Valley Floor subarea, normally has low nitrate concentrations.

There is an area of detectable DBCP concentrations in groundwater south of Madera, primarily south of Avenue 12 and between about Road 19 and Highway 99 (Moore, 1995) as shown in Figure 6-1. Extensive vineyards have existed in this area and it is where the heaviest DBCP applications were made. Samples from 48 wells sampled during 1979 to 1984 had DBCP concentrations exceeding 0.2 µg/L (the present MCL). Resampling in 1993 generally indicated lower DBCP concentrations, consistent with evidence in other parts of the valley. The reduction in concentrations is primarily due to pumping of the shallow groundwater and reapplying it to irrigated lands, which degrades the DBCP. Experience indicates that DBCP concentrations in groundwater have decreased to an average of about half of the previous concentrations over a 10-year period. Numerous test wells have been installed to identify and develop better quality groundwater in and near Madera County. DBCP concentrations have also been shown to be present only in the shallow groundwater, similar to the distribution of nitrate. DBCP concentrations are normally not present in detectable concentrations in the groundwater below a depth of about 300 to 350 feet.

---

[1] Some data were obtained from the 2005 Consumer Confidence Reports for County-owned systems.

## Table 6-1. Groundwater Chemistry Data (2005 CCR)
## County-Owned Small Water Systems - Valley Floor

| System Name | Well Screen (ft bgs)[1] | No. | Chloride | Hardness | Na | EC | SO4 | TDS | Fe | Mn | NO3 | Arsenic | Fluoride | Gross Alpha | Vanadium | DBCP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Drinking Water Standards - primary MCLs (secondary MCLs) [notification level] | | | | | | | | | | | | | |
| | | | (250) mg/L | None mg/L | None mg/L | (900) µmhos/cm | (250) mg/L | (500) mg/L | 300 µg/L | 50 [500] µg/L | 45 mg/L | 10 µg/L | 2 mg/L | 15 pci/L | [50] µg/L | 0.2 µg/L |
| MD 28 - Ripperdan Self Help | 450-500 | 1 | 40.3-44 | 149-159 | 26-29 | 370-390 | 11.1-12.4 | 282-270 | | | 17.6-19.5 | 2.2 | <.1-.1 | <1-7 | 38 | 0.080 |
| MD 33 - Fairmead | 240-552 | 2 | 26.5 | 71-82 | 26-27 | | 3-3.1 | 185-199 | | | 13.3-13.4 | | | | 21 | |
| MD 36 - Eastin Arcola | 280-360 | 2 | 25.3 | 84 | 25 | | 9.1 | 215 | | | 9.3 | | | | 32 | |
| MD 37 - La Vina | 297-393 | 2 | | 48-138 | 18-21 | | 2.8-3.6 | 150-160 | <100-270 | | 3.8-5.3 | 2.2-2.4 | | | 34 | |
| MD 85 - Valeta MWC | to 205? | 1 | 64.7-81.9 | 314-329 | 31-43 | 260-890 | 14.5-15.6 | 470-560 | | | 11.6-46.1 | 2.4 | | <1-5 | 17.15 | |
| MD 95 - Ranchos West | to 550? | 3 | 40-43.1 | 83-87 | 30-34 | | 6-6.1 | 260-264 | <100-4800 | <20-59 | 16.2-16.5 | <.05-.11 | | | 19.75 | |
| SA 14 - Chukchansi Subdiv. | to 389? | 1 | 19.2-20.1 | 59 | 21 | 200-203 | 3.5-3.6 | 190-199 | | | 9.1-10.6 | 2.1 | | | 22 | |
| SA 16 - Sumner Hill | Surface Water | 2 | 5.5 | <20 | 6 | 40 | 0.9 | 51 | | | | | | | | |

# Table 6-2. Groundwater Quality Data (2002-2007)
## Large Water Systems - Valley Floor

| System Name | Well No. | Well Name | Perf. Interval (ft bgs) | Alkalinity | Chloride | Hard-ness | pH | Na | EC | SO4 | TDS | Fe | Mn | NO3 | Arsenic | Fluoride | Gross Alpha | Uranium | Vanadium | DBCP | 1,2,3-TCP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Drinking Water Standards - primary MCLs (secondary MCLs) [notification level] | | | | | | | | | | | | | | | | | |
| | | | | None | (250) | None | 6-8 | None | (900) | (250) | (500) | 300 | 50 | 45 | 10 | 2 | 15 | 20 | [50] | 0.2 | [0.005] |
| | | | | mg/L | mg/L | mg/L | | mg/L | µmhos/cm | mg/L | mg/L | µg/L | µg/L | mg/L | µg/L | mg/L | pci/L | pCi/L | µg/L | µg/L | µg/L |
| **CHOWCHILLA CITY WATER DEPT** | | | | | | | | | | | | | | | | | | | | | |
| | 2010001-001 | Well 01 | | 63 | 16 | 50 | 6.6 | 27 | 190 | 3 | 186 | <100 | 65 | <2-3 | 4.3 | <0.1 | <1-1 | | 9.5 | <0.5 | <0.5 |
| | 2010001-003 | Well 03 | | 67 | 19 | 53 | 7.1-7.3 | 19-20 | 170-189 | 3 | 170-200 | <100 | <20 | <2-3.2 | 2.2 | <0.1 | <1-3 | | | <0.01 | <0.5 |
| | 2010001-004 | Well 04 | | 73-84 | 19-20 | 63-65 | 7.2-7.6 | 15-20 | 180-210 | 3 | 174-200 | <100-150 | <20 | 3.2-4.5 | 2.4-2.7 | <0.1 | <1-2 | | | <0.01 | <0.5 |
| | 2010001-008 | Well 08 | 242-402 | 71-80 | 19 | 63-67 | 7.1-7.6 | 17-18 | 180-205 | 3-4 | 165-190 | <100 | <20 | 4.8-8.2 | 2 | <0.1 | <1 | | | <0.01 | <0.5 |
| | 2010001-010 | Well 10 | 358-474 | 154-165 | 45-63 | 184-188 | 7.7-8.1 | 22-30 | 420-600 | 8-13 | 310-423 | <100 | <20 | 18-30 | <2-2 | <0.1-0.2 | 2-7 | | | <0.01 | <0.5 |
| | 2010001-011 | Well 11 | | 67-70 | 16-18 | 59 | 7 | 16-21 | 210-220 | 2-3 | 170-172 | <100-200 | <20 | 3-8 | <2 | <0.1-0.1 | <1 | | 13.1 | <0.01 | <0.5 |
| **MADERA-CITY** | | | | | | | | | | | | | | | | | | | | | |
| | 2010002-011 | Well 15 | 195-465 | 200-220 | 42-47 | 190-210 | 6.5-7.4 | 46-48 | 590-600 | 17-18 | 400-410 | ND | ND | 27-30 | ND | ND | 8-12 | 8-10 | 9-10 | ND | ND-0.006 |
| | 2010002-012 | Well 16 | 190-520 | 81-84 | 17-19 | 56-72 | 7.1-7.9 | 22-25 | 220-250 | 4-7 | 180-200 | ND | ND | 3-12 | ND-4 | ND | | | 16-17 | ND | ND |
| | 2010002-013 | Well 17 | 260-620 | 100-120 | 26 | 110 | 6-7.6 | 27-28 | 280-350 | 12 | 230-250 | ND | ND | 4-13 | ND | ND | ND-1.45 | | 15-16 | ND | ND |
| | 2010002-014 | Well 18 | 280-610 | 72-86 | 18-19 | 67-70 | 6.7-7.8 | 22 | 230-240 | 5-6 | 160-180 | ND | ND | 5-14 | ND | ND-0.1 | ND-0.93 | | 17-18 | ND | ND |
| | 2010002-016 | Well 20 | to 600? | 84-94 | 19-20 | 11-88 | 6.5-7.8 | 22 | 260-280 | 6-7 | 190-200 | ND | ND | 4-8 | ND | ND | 0-2.32 | | 16 | ND-0.01** | ND |
| | 2010002-017 | Well 21 | 230-600 | 85-120 | 26-30 | 82-130 | 6.2-7.9 | 23-31 | 300-360 | 14-22 | 220-270 | ND | ND | 6-9 | ND | ND | ND-2.76 | | 16-17 | 0.09-0.1 | ND |
| | 2010002-018 | Well 22 | 240-520 | 62-79 | 17-18 | 56-64 | 5.9-7.9 | 19-21 | 210-220 | 4 | 160-170 | ND | ND | 3-4 | ND | ND | ND-1.15 | | 19 | ND | ND |
| | 2010002-019 | Well 23 | 210-770 | 64-95 | 19-20 | 46-60 | 6.3-8.0 | 22-36 | 210-250 | 3.-4 | 150-200 | ND | ND | 4-5.2 | 4-5.3 | ND-0.1 | ND-.32 | | 21 | ND | ND |
| | 2010002-020 | Well 24 | 210-520 | 76-86 | 14-16 | 59-66 | 5.9-7.8 | 22-23 | 210-220 | 5 | 150-180 | ND | ND | 4-5 | 2-3 | ND | ND-0.63 | | 14-15 | ND | ND |
| | 2010002-021 | Well 25 | 275-505 | 70-86 | 17-20 | 50-82 | 5.9-7.9 | 21-24 | 200-260 | 3-4 | 180 | ND | ND | 6-7 | ND-2 | ND-0.11 | ND-1.44 | | 27-28 | ND | ND |
| | 2010002-001 | Well 26 | 240-600 | 46-63 | 17-18 | 49-53 | 7-8 | 18-19 | 190-200 | 3 | 140-180 | ND | ND | 9-11 | ND | ND-0.1 | | | 25-26 | ND | ND |
| | 2010002-022 | Well 27 | 270-510 | 140-180 | 17-35 | 160-180 | 6.7-7.8 | 28-30 | 460-480 | 4-7 | 300-320 | ND | ND | 12-29.6 | ND | ND | | | 15 | ND-0.45 | ND-.15 |
| | 2010002-023 | Well 28 | 270-540 | 69-81 | 17-26 | 55-63 | 6.3-7.9 | 21-23 | 220-240 | 5-6 | 160-180 | ND-350 | ND-220 | 2-5 | ND-2.5 | ND | .06-.79 | | 15-16 | ND | ND |
| | 2010002-024 | Well 29 | 370-590 | 52-76 | 19-21 | 54-57 | 6.3-8 | 22-23 | 200-220 | 4 | 160-180 | ND-400 | ND | 3-5 | ND-2.7 | 0.1-0.2 | | | 25-26 | ND | ND |
| | 2010002-025 | Well 30 | 430-720 | 81-89 | 21-22 | 61-72 | 7.8-7.9 | 21-27 | 230-250 | 4-4.1 | 180-190 | ND | ND | 4-6.4 | ND | ND-0.1 | .79 | | 23-24 | ND | ND |
| | 2010002-030 | Well 31 | | 75-100 | 19-20 | 71-85 | 7.8-7.9 | 24-25 | 260-280 | 8.6-8.7 | 200-210 | ND | ND | 3.9-6 | ND | ND | ND-1.54 | | 14 | ND | ND |
| | 2010002-031 | Well 32 - Pending | | 82 | 14 | 66 | 7.8 | 19 | 210 | 4 | 180 | ND | ND | 5 | ND | ND | .58 | .39 | 20 | ND | ND |
| | 2010002-032 | Well 33 | | 75 | 20 | 63 | 7.9-8.0 | 20 | 220 | 5 | 200 | ND | ND | 8 | ND | ND | ND-.73 | | | .018-.067 | ND |
| **MADERA CO MD 10A - MADERA RANCHOS** | | | | | | | | | | | | | | | | | | | | | |
| | 2010008-001 | Fender | 275-660 | 80-85 | 37-45.7 | 95-100 | 7.1-7.6 | 24-27 | 280-320 | 5.0-5.7 | 260-270 | ND | ND | 7.62-19.4 | 2.9 | ND-0.1 | ND-2.8 | | 24 | ND | ND |
| | 2010008-002 | Fernwood | 284-436 | 61-62 | 10-11.5 | 53-55 | 6.7-6.8 | 16-19 | 190-210 | 3.0-3.8 | 180-200 | 100-1380 | ND-41.9 | 15.5-25.7 | 2.9 | ND | ND-2.3 | | 24-30 | ND | ND |
| | 2010008-003 | Sparta - Inactive | 150-500 | 87-89 | 42-46 | 139-143 | 7.0-7.1 | 21-25 | 361-420 | 14.5-15.9 | 310-360 | 400-1380 | ND | 46.2-55.3 | ND | ND-0.25 | ND-1.7 | | 17-21 | ND | ND |
| | 2010008-004 | Well 96-1 (Charlton) | 306-555 | 67-76 | 45-52 | 87-90 | 6.6-6.9 | 23-25 | 280-320 | 3.0-3.7 | 270-300 | ND | ND | 13.2-16.8 | 2.6 | ND | ND-1.4 | | 22-23 | ND | ND |
| | 2010008-005 | Well 96-2 (New Fender) | 250-600 | 80-104 | 48.0-59.5 | 95-127 | 6.8-6.9 | 28-39 | 350-392 | 4.5-4.7 | 280-360 | ND | ND | 11.1-16.7 | 2.2 | ND-0.3 | ND-2.6 | | 22 | ND | ND |

# Table 6-2. Groundwater Quality Data (2002-2007)
## Large Water Systems - Valley Floor

| System Name | Well No. | Well Name | Perf. Interval (ft bgs) | Alkalinity | Chloride | Hard-ness | pH | Na | EC | SO4 | TDS | Fe | Mn | NO3 | Arsenic | Fluoride | Gross Alpha | Uranium | Vanadium | DBCP | 1,2,3-TCP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Drinking Water Standards - primary MCLs (secondary MCLs) [notification level] | | | | | | | | | | | | | | | | | |
| | | | | None | (250) | None | 6-8 | None | (900) | (250) | (500) | 300 | 50 | 45 | 10 | 2 | 15 | 20 | [50] | 0.2 | [0.005] |
| | | | | mg/L | mg/L | mg/L | | mg/L | µmhos/cm | mg/L | mg/L | µg/L | µg/L | mg/L | µg/L | mg/L | pci/L | pCi/L | µg/L | µg/L | µg/L |
| **MADERA CO MD 19 - PARKWOOD** | | | | | | | | | | | | | | | | | | | | | |
| | 2010004-002 | Well 02 | | 91-129 | 25.1-38.3 | 84-115 | 6.8-7.1 | 23-39 | 240-340 | 9-18.5 | 212-270 | ND | ND | 9.2-19 | 2.1-2.6 | ND | ND-3 | ND | 18-20 | ND-0.02** | ND |
| | 2010004-003 | Well 03 | | 98 | 25.9 | 82 | 7.4 | 23 | 250 | 10.3 | 216 | ND | ND | 9-17.1 | ND | ND | ND-3 | ND-1.2 | 23-24 | ND-0.02 | ND |
| | 2010004-004 | Well 04 | | 109-135 | 31.2-36.4 | 95-135 | 7.2-7.6 | 29-30 | 270-350 | 13.1-18 | 230-287 | ND | ND | 10.2-19 | ND-2.3 | ND-0.1 | ND-3 | ND-2 | 18-20 | ND-0.02 | ND |
| **MADERA CO SA 3 - PARKSDALE** | | | | | | | | | | | | | | | | | | | | | |
| | 2010006-001 | Well 01 | 216-480 | 81 | 18.3 | 63 | 7.2 | 23 | 190 | 4.6 | 181 | ND | ND | 5.9-12.2 | ND | ND | ND-2.5 | | 20-21 | ND-0.03** | ND |
| | 2010006-002 | Well 02 | 216-456 | 75-80 | 18.6 | 49-52 | 7.1-7.3 | 22 | 170-180 | 3.6-5.35 | 160-176 | ND | ND | 6.0-10.6 | ND | ND | ND-2.0 | | 22-23 | ND-0.02** | ND |
| | 2010006-003 | Well 03 (Chavez School) | | 70 | 20 | 53.9 | 7.3 | 23 | 227 | 3 | 180 | ND | ND | 1.6-8.9 | ND | 0.1 | 1.12-1.5 | | 20 | ND | ND |
| **MADERA CO SA 19 - ROLLING HILLS** | | | | | | | | | | | | | | | | | | | | | |
| | 2010009-002 | S&J Ranch Well | | 70-72 | 7.3-9.1 | 49 | 7.0-7.2 | 16-18 | 140-180 | 3.2-3.5 | 139 | ND-670 | ND-33 | 4.7-7.2 | 4.5-4.9 | 0.1 | ND-6.3 | | 6.0-9.5 | ND | ND |
| | 2010009-003 | Well 02 - New Highway 41 | | 85 | 8.9-11.3 | 60-67 | 6.9-7.1 | 17-19 | 160 | 4.4-6.5 | 140-150 | ND | ND-85 | 3.6-6.4 | ND-4.6 | ND-0.1 | ND-2.6 | | 6 | ND | ND |
| **MADERA VALLEY WATER COMPANY** | | | | | | | | | | | | | | | | | | | | | |
| | 2010010-001 | Well 01 | 238-568 | 76-78 | 18.6-20.2 | 57.0-59.4 | 6.7-6.9 | 20 | 203-210 | 3.2-3.4 | 190-195 | ND | ND | 4.1-12.6 | 3-5 | ND-0.1 | ND-1 | ND | | ND | ND |
| | 2010010-002 | Well 02A | 294-494 | 76.0-77.5 | 18.4-20.2 | 57.0-59.4 | 6.7-7.1 | 19-22 | 204-220 | 3.2 | 181-190 | ND | ND | 6.5-12.3 | 2.7-3.6 | ND-0.1 | ND-2 | ND-1.5 | | ND | ND |
| | 2010010-003 | Well 03 | 250-450 | 75.5-78.0 | 19.3-20.0 | 55.0-59.4 | 6.9-7.2 | 19-21 | 204-220 | 3.2-3.3 | 188-190 | ND | ND | 6.8-12.5 | 2.8-4.0 | ND-0.1 | ND-1 | ND | | ND | ND |
| | 2010010-006 | Well 04 | | 76-78 | 18.8-24.4 | 57-62 | 7.0-7.3 | 18-22 | 208-210 | 3.2-5.4 | 190-195 | ND | ND | 3.37-12.2 | 2.1-4.1 | ND-0.1 | ND-1.4 | | | ND | ND |
| | 2010010-007 | Well 05 - New Well | | 75.5-84.0 | 18.8-22.0 | 57.0-57.4 | 6.7-6.8 | 20-23 | 200-210 | 3.2-3.4 | 190-200 | ND | ND | 3.5-12.2 | ND-3.2 | ND-0.1 | ND | | | ND | ND |
| | 2010010-004 | Well 06 | | 76.0-77.5 | 18.8-19.9 | 57.0-59.4 | 7.2-7.25 | 18-22 | 206-220 | 3.2-3.3 | 190-194 | ND | ND | 4.38-12.2 | 3-9 | 0.1-0.2 | ND-1 | ND | | ND | ND |
| | 2010010-005 | Well 10 | 284-564 | 78.0-79.6 | 18.8-19.8 | 57.0-57.4 | 7.1-7.4 | 19-22 | 206-210 | 3.2-3.3 | 189-200 | ND | ND | 4.33-21.0 | 2.3-6.0 | 0.1 | ND-3 | ND-2 | | ND | ND |
| **CENTRAL CA WOMENS FACILITY** | | | | | | | | | | | | | | | | | | | | | |
| | 2010800-001 | Well 401 | | 84 | 38 | 81.2 | 6.8 | 24 | 272 | 7 | 198 | 65 | ND | 9.1-12.9 | 4.8 | .17 | .47-1.05 | | | ND | ND |
| | 2010800-002 | Well 402 | | 88 | 40 | 87.2 | 7.02 | 25 | 286 | 10 | 210 | 64 | 39 | 5.4-30 | 10 | .14 | .99-2.08 | | 5.8 | ND | ND |
| | 2010800-003 | Well 403 | | 86 | 36 | 76.4 | 6.9 | 24 | 260 | 8 | 192 | 41 | ND | 11-21.8 | 6 | .22 | 1.12 | | 14 | ND | ND |
| **VALLEY STATE PRISON FOR WOMEN** | | | | | | | | | | | | | | | | | | | | | |
| | 2010801-001 | Well 01 | | 100 | 36-39 | 70-100 | 7.0-7.1 | 24-26 | 320-340 | 7.6-8.3 | 220-240 | ND-210 | 44-47 | ND-2.3 | 7.2-13 | ND-.19 | .38-2.36 | 2.25 | | ND | ND |
| | 2010801-002 | Well 02 | | 110 | 37 | 70 | 7 | 25 | 330 | 9.8 | | 320 | 36-89 | ND-2.3 | 3.9-12.0 | .18-18. | 1.0-4.95 | | | ND | ND |

**Unconfirmed single detection

Elevated uranium concentrations (indicated by gross alpha activities) have been found in shallow groundwater in an area that includes Howard School, the City of Madera WWTP, the LaVina School, and along Highway 99 north of the San Joaquin River. South of the San Joaquin River in Fresno County, high uranium concentrations have been found in groundwater beneath the city of Kerman and to the north and northeast in the area west of Biola. The uranium is indicated to be from a natural source and is generally present at high concentrations only in the shallow groundwater (following the vertical patterns for nitrate and DBCP). The full extent of the area of high uranium concentrations in Madera County has not been delineated, primarily due to the lack of public water systems in the area (i.e., sampling of private domestic wells has not been required in the County). On the other hand, uranium concentrations have generally been low in well water in the Madera, Chowchilla, Madera Ranchos, S&J Ranch, Rolling Hills, and the Children's Hospital area.

Slime-producing organisms are present in some groundwater beneath the east part of the Valley Floor, primarily in the area northeast of the Santa Fe Railroad tracks. Included are Rolling Hills, Madera Ranchos, part of RCWD, and an area east of Berenda. The bacterial test for HPC has generally been correlated with the occurrence of slime-producing organisms. An association between slime-producing organisms and subsurface geologic conditions is that higher HPCs are often associated with groundwater produced from blue or green deposits, which are indicative of reduced conditions in the groundwater.

Methane gas has been found in groundwater in several areas, including east of Berenda and the Red Top area. The methane gas appears to be associated with deeper groundwater beneath a significant confining bed or beds. The Red Top area has an active gas field, and significant deep exploration drilling for natural gas was conducted in the area west and east of Berenda.

Elevated iron and manganese concentrations have been found in well water in some areas, including in part of RCWD, Rolling Hills, and Madera Ranchos. Some deeper wells in the City of Madera, particularly beneath the eastern part, have encountered high iron and manganese concentrations at depth. These occurrences are also usually related to the blue or green deposits at depth, where reducing conditions are indicated.

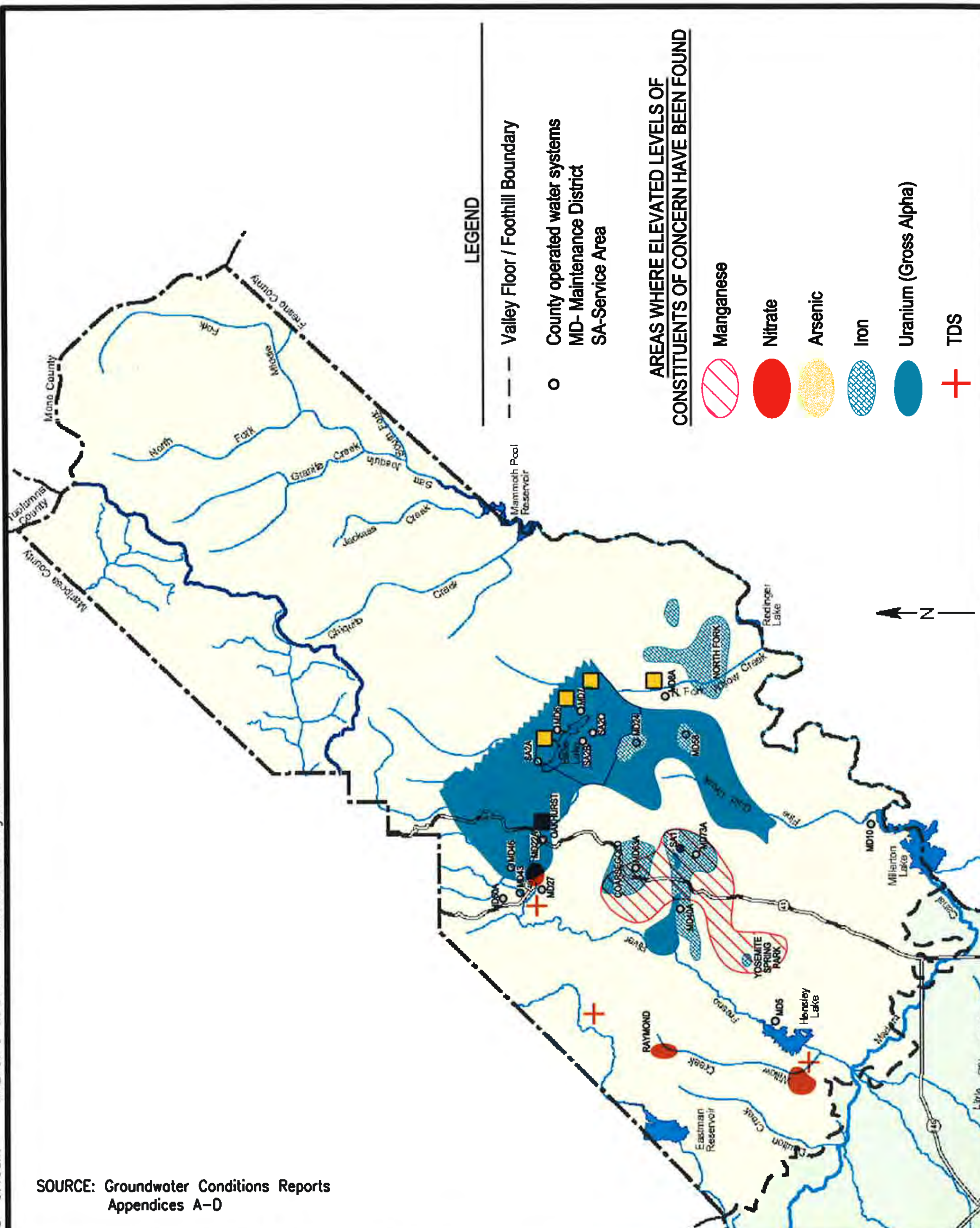
With the lowering of the arsenic MCL to 10 mg/L, some groundwater (generally deeper such as in parts of RCWD and Madera Ranchos) exceeds the new MCL. This constituent also appears to be associated with the blue-green deposits.

There are some other localized areas of groundwater degradation in the Valley Floor of Madera County, including the Madera landfill as discussed by Todd Engineers (2002a).

Despite the problems noted, most of the groundwater in the Valley Floor is of suitable quality for irrigation. In addition, groundwater of suitable quality for public supply has been demonstrated to be present in most of the area at specific depth intervals.

### 6.1.2 Foothills and Mountains Groundwater Quality

The areas of water quality concern in the Foothills and Mountains are shown in Figure 6-2. These are based on groundwater quality data obtained from the CDPH Water Quality Inquiry database for




SOURCE: Groundwater Conditions Reports
Appendices A–D

DWG: V:\Madera, County of\22203.00 IRWMP\CAD\FIGURES\Chapter 6\FIG 6-2.dwg USER: mthorne
DATE: Apr 02, 2008 9:46am XREFS: G-BD8x11 IMAGES: Co-Region.tif

| | | | |
|---|---|---|---|
| BOYLE ENGINEERING CORPORATION<br>1360 E. Spruce Avenue Suite 101<br>Fresno, California 93720 559-448-8222<br>WWW.BOYLEENGINEERING.COM | COUNTY OF MADERA<br>INTEGRATED REGIONAL WATER<br>MANAGEMENT PLAN<br><br>**FOOTHILLS AND MOUNTAINS<br>AREAS OF WATER QUALITY CONCERN** | BEC<br>PROJECT NO.<br><br>22203.00 | FIGURE<br><br>6-2 |

all public water systems in Foothills and Mountains of Madera County for 2002 through 2007. These data are summarized in Tables 6-3 and 6-4 for County-owned systems[1] and large public water systems, respectively. These water systems are shown in Figure 3-3 along with the service areas of other private water systems in the Foothills and Mountains. Additional data has been taken from Todd Engineers (2002b), KDSA (2007), and other sources.

High iron and manganese concentrations are common in water from hardrock wells, particularly along Highway 41. These problems are common in the Coarsegold and Oakhurst areas, where treatment to remove these constituents has been common in water systems for many decades. High-salinity groundwater has been recognized in parts of the Oakhurst Basin for more than three decades. Additional well sampling for this Plan has found additional areas with this saltwater influence, including northeast of Raymond and near Hensley Lake.

Hydrogen sulfide gas, or rotten egg odor, has been found in water from wells in parts of the Foothills and Mountains. High uranium concentrations have been recognized in the Oakhurst and Bass Lake areas for some time. As part of this evaluation, new sampling indicated a widespread area of high uranium concentrations in the North Fork area and another, less extensive, area north of Yosemite Lakes Park in the Coarsegold area. Some low-pH groundwater (pH less than 6) has been found in water from some wells in the Foothills and Mountains due to natural factors. With the lowering of the arsenic limit, exceedances of the new MCL have been found in parts of the Oakhurst area (sometimes associated with high uranium concentrations) and in a localized area at and near North Fork. High nitrate concentrations have been found in water from wells in several areas, primarily in the Ahwahnee area and near Hensley Lake. Except for the nitrate concentrations, these exceedances of MCLs are due to natural factors.

There are some significant instances of groundwater contamination in localized areas, including MTBE exceedances in Yosemite Lakes Park, gasoline contamination at several sites in Oakhurst, and solvents apparently associated with dry cleaners in Oakhurst.

Morin (1977) evaluated high-TDS groundwater in the Oakhurst Basin and correlated the geographic distribution with linear features (large fracture zones or faults) determined from interpretation of aerial photographs. This high-TDS groundwater is believed to be ancient connate groundwater and occurs primarily in low topographic areas. High-TDS areas northeast of Raymond and near Hensley Lake also appear to be associated with lineaments mapped by the U.S. Geological Survey. Shanks (1990) evaluated uranium in groundwater of the western Sierra Nevada, including areas in Madera County. About 130 private domestic wells have been sampled since 2004 in the Oakhurst, North Fork, Coarsegold, and Raymond areas, and this has allowed much better definition of the extent of uranium in the groundwater. The wells with uranium or alpha activity MCL exceedances are primarily in the Oakhurst Basin, the northwest part of the North Fork area, near Bass Lake, in the north part of Yosemite Lakes Park, and to the north. The reason for the geographic distribution of the high uranium concentrations has not been determined. However, the uranium occurrence in the Oakhurst Basin appears to be associated with lineaments. This groundwater may also be ancient groundwater. When wells in the uranium problem areas are drilled deeper, even higher concentrations are generally found. Wells with arsenic exceedances are fairly localized but include

[1] Some data were obtained from the 2005 Consumer Confidence Reports for County-owned systems.

# Table 6-3. Groundwater Quality Data (2005 CCR)
# County-Owned Small Water Systems - Foothills/Mountains

| System Name | Perf. Interval (ft bgs) | No. Sources | Chloride | Fluoride | Hardness | Na | EC | SO4 | TDS | Fe | Mn | NO3 | Arsenic | Gross Alpha | Uranium | Vanadium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Drinking Water Standards - primary MCLs (secondary MCLs) [notification level] | | | | | | | | | | | | | |
| | | | (250) mg/L | 2 mg/L | None mg/L | None mg/L | (900) µmhos/cm | (250) mg/L | (500) mg/L | 300 µg/L | 50 [500] µg/L | 45 mg/L | 10 µg/L | 15 pci/L | 20 pCi/L | [50] µg/L |
| MD 01 - Hidden Lake Estates | Surface Water | 1 | 5.4 | | <20 | 7 | 40 | .9 | 45 | | | | | | | |
| MD 05 - Mountain Ranches | 600-1000 | 2 | 20.7-27.6 | .7-2.2 | 117-129 | 38-44 | 370-380 | 27.7-29.8 | 255-259 | | | <2-3.9 | 4.2-8.8 | <1-3 | | 21.5 |
| MD 06 - Lake Shore Park | 450 | 3 | 2.7-49.5 | 05-07 | 28-159 | 13-56 | 106-460 | .6-9.4 | 108-368 | <100-440 | 120-250 | | 2-76 | <1-164 | <1-166 | |
| MD 07 - Marina View Heights | 200-550 | 2 | 5.9-17.7 | <.1-.2 | 39-112 | 20-37 | | 1.8-3.3 | 152-233 | <100-270 | <20-37 | | <2-15.7 | 27-180 | 30-182 | |
| MD 08 - Northfork | 520 | 2 | 29.4 | 1.0 | 35 | 39 | 200 | 6.5 | 150 | | | | 13-14.3 | | 1.38 | |
| MD 24 - Teaford Meadow Lakes | 240-640 | 3 | 2.6-8.3 | | 41-100 | 8-13 | 110-200 | 1.3-3.4 | 100-177 | <100-250 | <20-110 | <2-2.9 | <2-9.2 | <1-6 | <1-7.6 | |
| MD 40 - Sunset Ridge Estates | 550 | 3 | 4.7-8.5 | .2-.3 | 88-100 | 21-24 | 230-250 | 6.9-26.8 | 185-198 | 310-1300 | 140-198 | | | | | |
| MD 42 - Still Meadow | 400, 430 | 2 | 24-28.4 | .2-.4 | 87-139 | 27-37 | 280-330 | 20.6-28.1 | 212-242 | <100-570 | <20-112 | | 24-28.4 | 10-12.3 | | |
| MD 43 - Miami Creek Knolls | 200-400 | 4 | 21.5-121 | <.1-.2 | 79-158 | 12-88 | 200-600 | 3.7-18.9 | 159-392 | <100-2000 | <20-24 | 7.2-74.8 | <2-7 | 6-10 | | .44 |
| MD 46 - Ahwahnee Resorts (ACC) | 900-1160 | 3 | | <.1-.3 | 61-135 | 40-110 | 290-750 | 7-9.9 | 207-500 | | | 2-8.2 | 3.2-10 | 2-17 | 2.6-32 | <3 |
| MD 46 - Ahwahnee Resorts (MCE) | 900-1160 | 3 | | <.1 | 43-65 | 13-17 | 130-170 | .5-.7 | 121-142 | | | 2-6 | <2-2 | 3-18 | 8-20.6 | 7.23 |
| MD 58 - Sierra Highlands | 380 | 1 | 30.3 | .9 | 35 | 38 | 200 | 6.5 | 144 | | | | | | 2 | |
| MD 60 - Dillon Estates | 140, 900 | 2 | 33.8-121 | <.1-.2 | 79-110 | 31-88 | 390-600 | 4.6-5.2 | 237-315 | | | 5.5-19.6 | <2-7 | 8.6-11 | | 6 |
| MD 63 - Meadow Springs Ranch | | 2 | 3.4-3.5 | .2 | 114-139 | 12-15 | | 15-37.8 | 185-234 | <100-550 | <20 | | <2-4.3 | | | |
| MD 73 - Quartz Mountain | 400-875 | 4 | 5.2-8.3 | <.1-.2 | 143-154 | 18-19 | 298-328 | 23.2-33.5 | 240-270 | 1020-6050 | 180-285 | | | 2-4.9 | | |
| SA02W - Wishon Cove | Surface Water | 1 | | | | | 25 | | 42 | | | | | | | |

# Table 6-4. Groundwater Chemistry Data (2002-2007)

## Large Water Systems - Foothills/Mountains

| Well No. | Well Name | Alka-linity | Chloride | Hardness | pH | Na | EC | SO4 | TDS | Fe | Mn | NO3 | Arsenic | Fluoride | Gross Alpha | Uranium | Van-adium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Drinking Water Standards - primary MCLs (secondary MCLs) [notification level] | | | | | | | | | | | | | | | |
| | | None | (250) | None | 6-8 | None | (900) | (250) | (500) | 300 | 50 [500] | 45 | 10 | 2 | 15 | 20 | [50] |
| | | mg/L | mg/L | mg/L | | mg/L | umhos/cm | mg/L | mg/L | µg/L | µg/L | mg/L | µg/L | mg/L | pci/L | pCi/L | µg/L |
| **BASS LAKE WATER COMPANY** | | | | | | | | | | | | | | | | | |
| 2010003-001 | School Road (Govt Center) | 13-130 | 2.6-3.3 | 12-94 | 6.7-7.4 | 2.9-21.0 | 38-270 | ND-4.8 | ND-170 | ND | ND-26 | ND | ND-5.1 | .13-.31 | 41.89-166 | 43.3-164 | |
| 2010003-002 | No. Shore (Airpt) Well 01 - Stby) | 150-200 | 4.1-6 | 140-170 | 6.9-7.1 | 15-17 | 330-400 | 3.1-3.9 | 200-250 | ND-160 | ND-18 | ND-2.3 | 2.5-3.2 | ND-0.11 | 23.1-34.7 | 9.34-40.2 | |
| 2010003-004 | No. Shore (Airpt) Well 04 | 10-110 | 3.1-5.2 | 12-84 | 6.2-6.5 | 3.1-14.0 | 41-250 | ND-3 | 33-180 | ND-150 | ND-6.3 | ND-2.6 | ND | ND-0.11 | 0.67-15.8 | 4.16-14.3 | |
| 2010003-005 | Willow Creek | ND-20 | ND-3.5 | 9.3-11 | 5.9-6.8 | 2.1-3.2 | 30-43 | ND | 24-75 | ND | ND | ND | ND | ND | 0.02-3.16 | 0.06-0.59 | |
| 2010003-006 | Pines Well 01 | 22-36 | ND-2.6 | 20-21 | 5.4-5.9 | 7.3-7.6 | 75-88 | ND | 58-110 | ND | ND | ND | ND | ND-0.1 | .57-6.07 | 1.03-1.05 | ND |
| **YOSEMITE SPRING PARK UTIL CO** | | | | | | | | | | | | | | | | | |
| 2010005-002 | Well 01A | 140 | 10-13 | 130-140 | 7.2-8 | 30 | 380-410 | 27-35 | 230-290 | ND | 90-110 | ND | 2.2-3 | 0.2-0.26 | 4.29-5.9 | | |
| 2010005-003 | Well 01E | 130 | 5.2 | 84 | 8.1 | 29 | 270 | 6.6 | 180 | 150 | 86 | ND | ND | .53 | | ND | |
| 2010005-008 | Well 11A - inactive (MTBE threat - RWQCB) | 130 | 16 | 140 | 6.7 | 26 | 400 | 38 | 260 | 14000 | 330 | ND | 9.7 | 0.3 | | | |
| 2010005-010 | Well 18A - inactive (MTBE threat - RWQCB) | 100 | 7.9 | 94 | 6.3 | 21 | 290 | 25 | 210 | 1000 | 180 | ND-6 | 8.6 | | | | |
| 2010005-013 | Well 31A | 110-120 | 14-17 | 160-170 | 6.7-7.7 | 20 | 420-450 | 59-77 | 270-310 | 350-430 | 170-190 | ND-5 | ND | 0.2-0.32 | 3.34-5.82 | 3.73 | |
| 2010005-016 | Well 35A | 120-150 | 24-61 | 200-220 | 6.6-7.7 | 22-24 | 520-540 | 72-98 | 340-380 | 730-830 | 170-200 | ND-3.1 | 3-4 | 0.23-0.4 | 6.88-7.52 | 4.21 | |
| 2010005-017 | Well 36A | 150 | 14 | 63 | 8.3 | 42 | 270 | 4 | 190 | ND | ND | ND | 8 | 2.3 | 7.88-10.3 | 6.11-11.4 | |
| 2010005-018 | Well 37A | 170 | 21 | 190 | 6.7 | 32 | 460 | 39 | 290 | 750 | 580 | ND-2.9 | 8.4 | 0.11 | 14.7 | 16.2 | |
| 2010005-019 | Well 38A - inactive | 140 | 12 | 140 | 6.8 | 23 | 370 | 37 | 230 | ND | 68 | ND-6.1 | 3.2 | | 47.5 | 46 | |
| 2010005-020 | Well 39A | 130-140 | 4-5.5 | 85-93 | 7.4-8.1 | 22-26 | 280-290 | 6-10 | 200-240 | ND | 75-130 | ND | ND-2.3 | 0.4-0.48 | 0.59-3.17 | | |
| 2010005-021 | Well 40A | 170 | 14 | 140 | 7.9 | 29 | 400 | 26 | 260 | ND | 220 | ND | 4 | 0.2 | | | |
| 2010005-022 | Well 41A - inactive (April 2007) | 96 | 17 | 89 | 6.5 | 22 | 230 | 9.3 | 180 | ND | ND | ND-7.2 | 3.6 | | 5.25-8.14 | 5.08-6.53 | |
| 2010005-023 | Well 42A - raw | 110-130 | 4-5.1 | 88 | 7.6-7.9 | 24-25 | 280 | 7.7-9.0 | 200-240 | ND | 140 | ND | ND | 0.4-0.44 | 0.1-2.03 | | |
| 2010005-024 | Well 44A | 110 | 7 | 81 | 7.7 | 20 | 230 | 6 | 170 | 100 | 160 | ND-6.0 | 5 | 0.2 | 4.43-9.51 | 6.7-8.49 | |
| 2010005-025 | Well 45A | 110 | 4 | 98 | 8 | 22 | 250 | 19 | 210 | 1200 | 210 | ND | ND | 0.3 | .32-1.13 | 0.9 | |
| 2010005-026 | Well 46A - standby (uranium concern) | 150 | 10 | 120 | 7.2 | 23 | 350 | 13 | 220 | ND | 38 | ND | 6.3 | | 28.9-46.2 | 17-40 | |
| 2010005-027 | Well 47A (new well) | 130 | 5.5 | 83 | 7 | 26 | 280 | 6.7 | 180 | ND | 67 | ND | ND | .36 | .28-1.01 | | |
| 2010005-043 | Well 048A | | | | | | | | | | | ND | | | | | |
| **HILLVIEW WC-OAKHURST/SIERRA LAKES** | | | | | | | | | | | | | | | | | |
| 2010007-001 | Ditton Well 01 (Forest Ridge) | 117 | 87 | 147 | 6.7 | 81 | 460 | 14.6 | 320 | 4300 | 97 | ND | 13 | 0.1-0.18 | 2.5 | 3.5 | |
| 2010007-002 | Ditton Well 02 (Forest Ridge) | 74-91 | 617-840 | 602-745 | 7.3-7.7 | 21-158 | 1900-2800 | 31.6-35.2 | 510-1410 | ND-180 | 290-420 | ND | 4.4-7 | ND-0.11 | 4.4 | 3.1 | |
| 2010007-003 | Ditton Well 03 (Forest Ridge) | 139-150 | 27.9-33.3 | 147-151 | 7.1-7.8 | 26-29 | 340-400 | 15.6-17.3 | 248-250 | 120-250 | 89-130 | ND | 3.8-5.9 | 0.2-0.22 | 7.2 | 6.6-250 | |
| 2010007-004 | Highland View 01 - standby | | | | | | | | | | | | | | | 107-1224 | |
| 2010007-005 | Highland View 02 - inactive | 122-130 | 6.4-6.8 | ND | 7.5-8.4 | 54-59 | 220-250 | 6.4-6.48 | 157-160 | ND-200 | ND | ND | 42-43 | 0.5-0.57 | 306-1029 | 181-1752 | |
| 2010007-006 | Pierce Lake Well 01 - inactive | 53-98 | 246-490 | 102-457 | 7.2-8.0 | ND-210 | 910-1900 | 28.4-59.3 | 538-1200 | ND-850 | ND-300 | ND-3 | 9.2-27.5 | 0.8-0.82 | | 15.5-283 | |
| 2010007-007 | Sierra Lakes Well 01A | 129-158 | 14.4-15.0 | 88-100 | 7.2-7.4 | 35-45 | 280-310 | 14-21.7 | 190-208 | 180-260 | 40-41 | ND | 16-21.9 | 0.3-0.37 | 6.3 | 5.1-185 | |
| 2010007-009 | Sierra Lakes Well 03 | 126-135 | 13.3-16.1 | 86-96 | 7.3-7.5 | 35-37 | 270-310 | 12.5-16.3 | 192-200 | ND-120 | 35 | ND | 15.9-25 | .37-.40 | 6 | 8 | |
| 2010007-010 | Sierra Lakes Well 04 | 95-116 | 10.9-11.6 | 86-92 | 7.1-7.4 | 27-28 | 280 | 14.9-49.8 | 190-206 | 310-1300 | 45-102 | ND | 32.8-149 | 0.4-0.44 | 47.5 | 22-201 | |
| 2010007-011 | Yosemite High School 02 | 86-100 | 5.8-8.8 | 59-65 | 7.4 | 16-19 | 190 | 3.8-5.7 | 140-148 | ND | ND | ND-4.3 | 5.8-6.5 | ND-0.11 | 17.3 | 18.8 | |

# Table 6-4. Groundwater Chemistry Data (2002-2007)

## Large Water Systems - Foothills/Mountains

| Well No. | Well Name | Alka-linity | Chloride | Hardness | pH | Na | EC | SO4 | TDS | Fe | Mn | NO3 | Arsenic | Fluoride | Gross Alpha | Uranium | Van-adium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Drinking Water Standards - primary MCLs (secondary MCLs) [notification level] | | | | | | | | | | | | | | | |
| | | None | (250) | None | 6-8 | None | (900) | (250) | (500) | 300 | 50 [500] | 45 | 10 | 2 | 15 | 20 | [50] |
| | | mg/L | mg/L | mg/L | | mg/L | umhos/cm | mg/L | mg/L | µg/L | µg/L | mg/L | µg/L | mg/L | pci/L | pCi/L | µg/L |
| 2010007-012 | Yosemite High School 03 | 89-90 | 36.7-43.9 | 45-61 | 7.2-7.4 | 46-50 | 300-310 | 10.8-11.8 | 200-208 | ND | ND | 4.45-10.2 | 17-26 | .66-.80 | 29 | 35.1 | |
| 2010007-017 | Junction Well 01 | 96-100 | 13.9-79.5 | 74-155 | 7.0-7.7 | 28 | 250-420 | 3.2-3.4 | 180-320 | ND | ND | 11.9-13.4 | ND | ND-.12 | 5.1 | 6.7 | |
| 2010007-024 | Ditton Well 04 (Forest Ridge) | 53-87 | 944-1200 | 245-765 | 6.8-7.7 | 155-262 | 2800-3300 | 39.0-39.8 | 1870-2520 | 200-490 | 300-415 | ND | 7.0-10.1 | ND-2.95 | 3.0-4.6 | 3.3 | |
| 2010007-028 | Junction Well 02 | 75-89 | 5.87-12.2 | 65-67 | 6.1-7.5 | 18-22 | 200 | 0.9-3.06 | 160 | ND | ND | ND-16.7 | ND | ND | 2-6 | 3.5 | |
| 2010007-030 | Sierra Lakes Well 05 - pending | 127 | 8 | 77.5 | 7.56 | 26 | 226 | 7.2 | 160 | ND | 29 | ND | 11.4 | 0.4 | 10 | | |
| 2010007-031 | Sierra Lakes Well 06 | 129 | 9 | 67.3 | 7.42 | 29 | 223 | 8 | 170 | ND | ND | ND | 10 | 0.6 | 4 | | |
| 2010007-032 | Sierra Lakes Well 07 | 121 | 8.7 | 81.6 | 6.83 | 26 | 224 | 10.4 | 170 | ND | 27 | ND | 15.6 | 0.5 | 48 | | |
| 2010007-033 | Sierra Lakes Well 08 | 127 | 10.9 | 83.6 | 7.15 | 29 | 242 | 5.7 | 180 | ND | 33 | ND | 19.2 | 0.6 | 18 | | |
| **MADERA COUNTY SA #1-INDIAN LAKES** | | | | | | | | | | | | | | | | | |
| 2010011-001 | Well 01 - inactive | 169 | 25.5 | 167 | 7.2 | 23 | 360 | 33 | 270 | 300 | 210 | ND-7.4 | ND | .17 | | | ND |
| 2010011-002 | Well 03 - inactive | 132 | 15.3 | 154 | 6.7 | 22 | 390 | 62.9 | 270 | 2700 | 83 | ND-7.4 | ND | ND-0.1 | | | |
| 2010011-003 | Well 04 | 156-169 | 12.1-26.3 | 159-161 | 7.4-7.6 | 24-27 | 350 | 29.7-51.4 | 246-250 | ND-700 | 130-180 | ND-7.4 | ND | 0.1-0.14 | 9.7 | | ND |
| 2010011-004 | Well 05 | 156-161 | 8.7-11.5 | 145-169 | 7.2-7.4 | 19-20 | 310-360 | 29-54 | 240-271 | 600-700 | 143-150 | ND-7.4 | ND | ND-0.1 | 4 | | ND |
| 2010011-005 | Well 06 | 167-169 | 9.80-9.95 | 155-182 | 7.2 | 21 | 310-380 | 32.0-62.3 | 270-290 | 800-1400 | 183-190 | ND-2 | ND | 0.1 | 4.4 | | ND |
| 2010011-008 | Well 07 | 180 | 9.7 | 139 | 7.9 | 25 | 340 | 16.9 | 239 | 470 | 129 | ND | ND | 0.2 | 1.0-3.5 | 1.3 | ND |
| 2010011-009 | Well 08 - PENDING | 151 | 7.7 | 129 | 7.6 | 24 | 290 | 23.9 | 236 | 470 | 141 | ND | ND | 0.2 | 2.7 | 3.4 | ND |
| **HILLVIEW WATER CO-RAYMOND** | | | | | | | | | | | | | | | | | |
| 2010012-002 | RAYMOND Well 07 | 192-196 | 15.5-15.7 | 153-156 | 7.3-7.7 | 32-60 | 380-430 | 12.0-14.2 | 270-272 | ND | ND-40 | ND-12.2 | 12 | 0.10-0.11 | 9.5 | 8.7 | |
| 2010012-004 | Well 02 | 148-157 | 11.5-11.7 | 117-127 | 6.9-7.2 | 22-24 | 290-340 | 5.7-7.4 | 220-223 | ND-100 | ND-27 | 4.7-12.2 | 2.2-5.1 | ND-0.1 | 7.1 | 6.4 | |
| 2010012-006 | Well 08 | 171-191 | 23.4-26.1 | 180-186 | 7.7-8.3 | 27-29 | 440-470 | 12.9-13.8 | 280-323 | ND | ND | 26.3-63.3 | 2.1-2.2 | ND-0.1 | 1.8 | 2.6 | |
| 2010012-007 | Well 05 | 112-122 | 12.5-12.6 | 282-386 | 7.0-7.4 | 27-40 | 710-740 | 222-305 | 480-674 | ND-2100 | ND | 14.9-29.1 | 14.0-14.4 | .24-.30 | 7.5 | 6.7 | |
| 2010012-009 | Well 09 - STANDBY | 130 | 21.2 | 145 | 7 | 27 | 400 | 13.1 | 279 | 380 | ND | 2.0-72.3 | 12.9 | 0.1 | 7.4 | 8.2 | |
| 2010012-010 | Well 10 | 145-148 | 10.7-11.3 | 97-98 | 7.7-8.1 | 32-42 | 290-330 | 9.88-10.3 | 200-224 | ND-200 | ND-41 | ND-10.1 | 8.6-9.5 | .10-.11 | 40.3 | 45 | |
| **HILLVIEW WATER CO-COARSEGOLD** | | | | | | | | | | | | | | | | | |
| 2010013-001 | Well 01 - inactive | 108 | 22.9 | 122 | 7.1 | 20 | 340 | 28.8 | 220 | 180 | 190 | ND | ND | 0.1 | | | |
| 2010013-002 | Well 02 | 129 | 23.7 | 141 | 6.8 | 21 | 330 | 40.4 | 254 | 1600 | 210 | ND | ND | 0.1 | 1.9-5.0 | 1 | |
| **HILLVIEW WATER CO-GOLDSIDE** | | | | | | | | | | | | | | | | | |
| 2010014-002 | Goldside Well 02 | 68 | 5.5 | 57 | 5.9 | 12 | 140 | 8.9 | 121 | ND | ND | ND-3.4 | ND | ND | 1.1 | 1 | |
| 2010014-004 | Goldside Well 04 | 86-94 | 373-480 | 291-374 | 7.5 | 155-190 | 1200-1800 | 25.2-26.1 | 1020-1230 | ND | 61-100 | ND | 3.5-5.0 | .19-.40 | 6.2 | 6.6 | |
| 2010014-005 | Hillview Well 01 | 80-92 | 119-144 | 204-242 | 6.2-6.8 | 23-24 | 570-580 | 6.0-7.4 | 410-566 | ND | ND | 14.7-24.7 | ND | ND | 4.8 | 5.5 | |
| 2010014-006 | River Creek Well 01 | 57-64 | 44.7-61.1 | 98-117 | 6.4-6.6 | 18-20 | 310-320 | 2.8-4.3 | 210-274 | ND | ND | 16.7-20.6 | ND | ND | 2.2 | 1.9 | |
| 2010014-007 | River Creek Well 02 | 79 | 7.6 | 61 | 6.6 | 14 | 180 | 1.1 | 158 | ND | ND | 10.7-12.4 | ND | ND | 2.6 | 3.5 | |
| 2010014-009GLSD | Goldside Well 06 | 100-124 | 175-370 | 190-319 | 7.5-7.6 | 84-158 | 722-1300 | 20.5-24.3 | 510-1020 | ND | 50-82 | ND | 2.6-3.6 | .20-.72 | 8.7 | | |
| 2010014-010 | Miami Creek Well 01 | 87 | 554 | 259 | 7.6 | 297 | 1700 | 26.5 | 1230 | ND | ND | ND-6.8 | 7.6 | ND | 13.0-30.5 | 11.9 | |
| **MILLERTON SRA - MEADOW TANK HILL** | | | | | | | | | | | | | | | | | |
| 2010300-002 | Millerton Lake | ND | | 8.4-9.2 | 6.5-6.7 | 2.2-2.7 | | | | 120-330 | 10-24 | ND | | ND | | | |
| **MILLERTON SRA - ROCKY POINT** | | | | | | | | | | | | | | | | | |
| 2010301-003 | Millerton Lake | ND | | 6.3-7.3 | 6.3-6.5 | 1.2-2.1 | | | | ND-220 | 10-27 | ND | | ND | | | |

the Hillview Sierra Lakes water system and several water systems at or near North Fork. The exceedances are not great in the North Fork area, and new wells can probably be drilled to tap low-arsenic groundwater.

The occurrence of hydrogen sulfide has not been mapped in detail but partly coincides with high-TDS areas. That is, some of the high-TDS groundwater also contains hydrogen sulfide. Besides the objectionable odor, this water can be corrosive when oxidized.

High nitrate concentrations in several localized areas may be due to several sources, including septic tanks in unsewered areas. In the low foothills near Hensley Lake, the source is not apparent, as relatively large lots are present. Natural sources of nitrate are normally not present in granitic or metamorphic rocks in the Sierra Nevada. For the MTBE problem in Yosemite Lakes Park, water from two deep supply wells is being pumped and treated, and this helps to control migration of this constituent toward other wells.

Despite these problems, there are substantial amounts of good-quality groundwater in each of the areas evaluated in the Foothills and Mountains. Iron and manganese are commonly removed by treatment. Pilot studies of uranium treatment have been completed on the School Road well in BLWC, and the uranium treatment is currently operating under permit by CDPH. Appendix E presents a case study of arsenic and uranium treatment for the Hillview Water Company. If uranium treatment is shown to be infeasible or not cost effective, the need for an alternative water source may be more pressing in parts of the Bass Lake-Oakhurst area.

## 6.2 Surface Water Quality

The quality of surface water can vary over time. Surface water may contain microorganisms such as bacteria, viruses, protozoa such as *Giardia* and *Cryptosporidium*, and organic and inorganic particulate matter as well as dissolved solids such as asbestos and bromide. The presence of organic matter is of great concern due to the reaction of these constituents with disinfectants, resulting in the formation of disinfection byproducts (DBP) of significant health concern. Surface water is subject to contamination by municipal wastewater discharges, animal and human activities in the watershed, industrial wastes, and agricultural runoff, which may contain microbial agents, pesticides, nitrates, and DBP precursors. In addition, storm runoff from roads and highways, such as Freeway 41 at the San Joaquin River, contributes to water quality problems in surface watercourses. Watershed protection is an important step in minimizing sources of pollution to protect public health and the environment. All surface waters that are used as sources of drinking water are required to undergo treatment as specified in the Surface Water Treatment Regulations implemented by the USEPA and CDPH.

Although there are several rivers providing major drainage to the mountain areas in and around Madera County, only the San Joaquin River and Willow Creek are currently used for domestic water supply. An evaluation of the watershed, water quality, and potential contaminating activities within the watershed were conducted by Boyle as part of the *Sanitary Survey of Upper San Joaquin River Watershed*, completed in December 1998. An update of this sanitary survey is to begin in late 2007 as required by CDPH. Water from the upper San Joaquin River held in Millerton Lake is delivered into the CVP, which includes the lower San Joaquin River, the Madera Canal, and the Friant-Kern Canal. Major components of the San Joaquin River system in eastern Madera County include Willow Creek, Bass Lake, Mammoth Pool Reservoir, Redinger Lake, Kerckhoff Reservoir, and Millerton Lake.

### 6.2.1 Surface Water Supply Systems

The upper San Joaquin River watershed, Millerton Lake, and the lower San Joaquin River to 7,500 feet downstream of Friant Dam have provided supply for seven domestic water systems in Madera County as shown in Table 6-5.

**Table 6-5. Domestic Water Systems Using Surface Water**

| Water System | Surface Water Source of Supply |
|---|---|
| Bass Lake Water Company | Upper Willow Creek |
| Millerton Lake State Parks & Recreation | |
| Meadow Tank Hill Water System | Millerton Lake (north shore) |
| Rocky Point Water System | Millerton Lake (north shore) |
| Madera County Resource Management Agency | |
| Service Area 2B - Wishon Cove | Bass Lake |
| Service Area 2C - Molly Cabin | Bass Lake |
| Maintenance District 1 - Hidden Lake Estates | Millerton Lake (north shore) |
| Service Area 16 - Sumner Hill | San Joaquin River (below Friant Dam) |

Water quality data has been compiled for three systems using surface water, including Bass Lake Water Company (BLWC), SA16-Sumner Hill (SA16) and MD1-Hidden Lake Estates (MD1), which use Willow Creek, the San Joaquin River, and Millerton Lake, respectively, as source water. As such, these water systems are representative of the source water used by all surface water systems in Madera County. The general mineral, physical, and inorganic chemical quality of the raw surface water used by the BLWC, MD1 and SA16 is presented in Table 6-6.

The water quality of the surface water source is monitored by each public water system as well as by USBR as part of the operations of the CVP. The precipitation and runoff patterns within the Upper San Joaquin River watershed and the streamflow release patterns from the reservoirs can be highly variable from year to year, resulting in varying water quality within reservoirs and for in-stream intakes. A summary of general chemical monitoring conducted quarterly by USBR for the raw water at Friant Dam for years 2004 through 2006 (collected quarterly) is presented in Table 6-7 for comparison purposes. The raw water turbidity of the Willow Creek at the BLWC intake is usually quite low, ranging from 0.1 to 0.5 NTU in the summer and 20 to 30 NTU during heavy rain and runoff periods. The total dissolved solids are also low, the water is very soft with a hardness typically less than 20 mg/L, and both color and odor of the raw water generally meet the secondary MCLs. There have been no detections of volatile organic chemicals or synthetic organic chemicals in the water. The water pH varies between 5.6 and 7.3, which aids in disinfection but poses potential corrosion problems. The raw Willow Creek water is aggressive, with the Langelier Saturation Index (LSI) as low as -4.9 but averages approximately -3.4. The Langelier Saturation Index is a commonly accepted index for corrosivity. A noncorrosive water would have an LSI above zero.

## Table 6-6. Foothills and Mountains Surface Water General Mineral, Physical & Inorganic Chemical Analyses

| | Units | MCL | Bass Lake WC | SA16 | MD1 |
|---|---|---|---|---|---|
| **Chemical** | | Primary (Secondary) | | | |
| **Source** | | | **Willow Creek** | **San Joaquin River** | **Millerton Lake** |
| **Sample Dates (range)** | | | **(1994-2004)** | **(2001-2005)** | **(2003-2006)** |
| **No. Samples in Period** | | | **10** | **4** | **4** |
| Alkalinity, (Total) as CaCO3 | mg/L | --- | 3-33 | <20-23 | <20 |
| Aluminum | µg/L | 1,000 (200) | | <50-65 | <50 |
| Antimony | µg/L | 6 | | <6 | <6 |
| Arsenic | µg/L | 10 | | <2 | <2 |
| Barium | µg/L | 1,000 | | <100 | <100 |
| Beryllium | µg/L | 4 | | <1 | <1 |
| Bicarbonate | mg/L | --- | 5-23 | <2-17 | 5 |
| Cadmium | µg/L | 5 | | <1 | <1 |
| Calcium | mg/L | --- | | 2-4.66 | 2-3 |
| Carbonate | mg/L | --- | ND | <2 | <2 |
| Chloride | mg/L | (250)[1] | ND-3.3 | 3.2-6.73 | 4.4-6.3 |
| Chromium Total | µg/L | 50 | | <1-2.75 | <1-2.5 |
| Color, Apparent (Unfiltered) | units | (15) | ND-20 | <5 | <5 |
| Copper | µg/L | 1,300 (1,000) | | <50 | <50 |
| Corrosivity | - | --- | LSI=(-4.9)-(-1.7) | Highly Aggressive | Highly Aggressive |
| EC | µmho/cm | (900)[1] | 25-80 | 10-40 | 35-40 |
| Fluoride (F) Temp. Depend. | mg/L | 2.0 | | <0.1 | <0.1 |
| Hardness, (total) as CaCO3 | mg/L | --- | | 14-21 | 16-<20 |
| Hydroxide | mg/L | --- | ND | <0.5 | <0.5 |
| Iron | µg/L | (300) | | <100 | <100 |
| Lead | µg/L | 15 | | <5 | <5 |
| Magnesium | mg/L | --- | 0.4-0.7 | <2 | <2 |
| Manganese | µg/L | (50) | | <20 | <20 |
| MBAS | mg/L | (0.5) | | <0.025 | <0.025 |
| Mercury | µg/L | 2 | | <0.5 | <0.5 |
| Nickel | µg/L | 100 | | <10 | <10 |
| Nitrate (N03) | mg/L | 45 | ND | <2-3.54 | <2 |
| Nitrite (as N) | µg/L | 1000 | | <100-<400 | <400 |
| Odor Threshold @ 60 $^{o}$C | TON | (3) | ND-4 | ND-1 | ND |
| pH, Laboratory | units | --- | | 5.3-7.2 | 5.5-6.4 |
| Potassium | mg/L | --- | ND | <1 | <1 |
| Selenium | µg/L | 50 | | <1-<5 | <5 |
| Silver | µg/L | (100) | | <1-<10 | <10 |
| Sodium | mg/L | --- | 1.1-3 | 3.1-7 | 7 |
| Sulfate | mg/L | (250)[1] | ND-12 | 0.9-3.83 | 0.5-1.0 |
| TDS | mg/L | (500)[1] | ND-53 | 35-51 | 46 |
| Thallium | µg/L | 2 | | <1 | <1 |
| Turbidity, Laboratory | NTU | SWTR-0.3 | 0.08-4.7 | 0.05-0.3 | 0.1-0.2 |
| Zinc | µg/L | (5,000) | ND | <50 | <50 |

[1]Recommended Level ND = Nondetect

The San Joaquin River water treated at MD1 and SA16 is generally of good mineral quality for domestic use, although it is highly aggressive (which may be impacting the distribution system and customer internal piping) and very soft, with a hardness generally below 20 mg/L. The raw water turbidity is usually low (less than 3 NTU) for most of the year. The highest turbidity recorded by MD1 in 2005-2006 was 28.1 NTU, occurring in January 2006. As can be seen from Tables 6-6 and 6-7, the alkalinity, hardness, and total dissolved solids in the San Joaquin River water are extremely low, as are both color and odor. The treated water pH varied between 5.5 to 6.4 above Friant Dam and 5.3 and 7.2 below Friant Dam. The LSI was -3.83 at MD1 in 2006. In addition, the water's extremely low alkalinity provides no buffering capacity to prevent pH swings in the distribution system. This shows the water to be very corrosive if not corrected in the treatment process.

The source water total organic carbon (TOC) and alkalinity monitoring shows that the water has relatively low alkalinity, reflective of the snowmelt coming from the San Joaquin River watershed, and moderate to low TOC levels.

### 6.2.2 Surface Water Contaminants of Concern

#### 6.2.2.1 Microbiological Contaminants

Microbial agents are found in all surface waters of California and pose a continuing threat to human health. It has been clearly shown that without adequate treatment of surface water for drinking water purposes, there is a definite potential for disease outbreak. Compliance with surface water treatment regulations, which were established to remove and inactivate bacteria, virus, *Giardia*, *Cryptosporidium* and *Legionella*, is required in all public water systems using surface water or groundwater under the influence of surface water. Adequacy of treatment is demonstrated through performance standards for turbidity removal and disinfection.

Surface water systems are required to monitor their raw (untreated) surface water supply for total coliform and fecal coliform or *E. coli* bacteria on a routine basis to demonstrate the degree of contamination of the source water. This data for BLWC, MD1 and SA16 is provided in Table 6-8. USBR has also conducted monitoring for pathogenic organisms from 2004 through 2006 (collected quarterly), including coliform, *E. coli*, *Giardia*, and *Cryptosporidium*, at the Friant Dam, as summarized in Table 6-9.

The bacteriological sampling results for the BLWC Willow Creek intake are quite good for stream water. The maximum total coliform measurement of 500 MPN/100 mL is half the 1,000 MPN/100 mL level generally used by CDPH to require higher levels of pathogen removal in the treatment process. The data also show no discernible increase in bacteriological levels during the summer months when recreational activities in the creek are at their highest.

The microbiological sampling results of the San Joaquin River by MD1, SA16, and USBR show low levels of microorganisms, including coliform bacteria, *Giardia*, and *Cryptosporidium*. The microbiological water quality at the MD1 intake is somewhat better than that of the SA16 intake below Friant Dam.

# Table 6-7. USBR - Raw Water Quality at Friant Dam
# General Mineral, Physical & Inorganic Chemical Analyses

| Parameter | Units | MCL Primary (Secondary) | Sample Date 2/23/04 | 5/25/04 | 8/31/04 | 11/16/04 | 2/8/05 | 5/10/05 | 8/9/05 | 11/15/05 | 2/14/06 | 5/9/06 | 8/22/06 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **General Mineral, Physical & Inorganic Chemical Analyses** | | | | | | | | | | | | | |
| Alkalinity, (Total) as CaC0$_3$ | mg/L | --- | 14 | 11 | 12 | 15 | 16 | 15 | 8 | 11 | 13 | 16 | 5.1 |
| Aluminum | µg/L | 1000 (200) | --- | <25 | 4.2 | 120 | 32 | 20 | 15 | <25 | 64 | <45 | --- |
| Ammonia (as N) | µg/L | --- | 60 | <50 | 70 | 50 | 70 | 50 | 70 | <50 | <50 | <50 | <50 |
| Antimony | µg/L | 6 | --- | <1 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <1.0 | <1.0 | <2.5 | --- |
| Arsenic | µg/L | 10 | --- | 1.6 | 1.2 | 1.3 | 1.4 | 1.3 | 1.0 | 1.90 | 2 | <5.0 | --- |
| Barium | µg/L | 1000 | --- | 5.7 | 5.8 | 14 | 7.0 | 7.4 | 4.2 | --- | 8.70 | <10 | --- |
| Beryllium | µg/L | 4 | --- | <1 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <1.0 | <1.0 | <1.0 | <1.0 |
| Bicarbonate Alkalinity (as $CaCO_3$) | mg/L | --- | 17 | --- | 15 | 18 | 20 | 18 | 10 | --- | --- | --- | --- |
| Boron | µg/L | --- | --- | <50 | 17 | <25 | <25 | 83 | <25 | --- | <50 | <50 | --- |
| Cadmium | µg/L | 5 | --- | <50 | <25 | <50 | <50 | <50 | <50 | <0.50 | <0.50 | <1.0 | --- |
| Calcium | mg/L | --- | 4.0 | 3.2 | 2.0 | 3.0 | 3.0 | 3.0 | 2.0 | --- | 3 | 3 | --- |
| Carbonate Alkalinity (as $CaCO_3$) | mg/L | --- | <5 | --- | <5 | <5 | <5 | <5 | <5 | --- | --- | --- | --- |
| Chloride | mg/L | (250)[1] | 3.0 | 1.5 | 1.9 | 1.6 | 2.7 | 1.7 | 0.56 | 1.6 | 1.6 | 1.4 | <1.0 |
| Chromium Total | µg/L | 50 | | <2.0 | <0.5 | <0.5 | 0.6 | 0.7 | <0.5 | <1.0 | <1.0 | <5.0 | --- |
| Copper | µg/L | 1300 (1000) | | <2.0 | <0.5 | 3.7 | <0.5 | <0.5 | <0.5 | <2.0 | <2.0 | <50 | --- |
| Cyanide | µg/L | | | <5 | <5 | <5 | <5 | <3 | <5 | <3.0 | <3.0 | --- | <3.0 |
| Fluoride (F) Temp. Depend. | mg/L | 2.0 | <0.2 | 0.05 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.05 | <0.5 | <0.10 | <0.5 |
| Hydroxide Alkalinity (as $CaCO_3$) | mg/L | | | | | | | | <5 | | | | |
| Iron | µg/L | (300) | | <20 | <10 | 190 | <100 | <100 | <100 | --- | 41 | <50 | --- |
| Lead | µg/L | 15 | | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <2.5 | --- |
| Magnesium | mg/L | --- | 1.0 | 0.81 | <1 | 1.0 | <1 | <1 | <1 | --- | 0.61 | 0.75 | --- |
| Manganese | µg/L | (50) | | <2.0 | 3.1 | 5.0 | <5.0 | 2.3 | 1.5 | --- | 3.40 | <5.0 | --- |
| Mercury | µg/L | 2 | 0.0012 | 0.004 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| Molybdenum | µg/L | --- | | <2.0 | 1.3 | 1.0 | 1.4 | 1.1 | 0.06 | --- | <2.0 | <10 | --- |
| Nickel | µg/L | 100 | | <5 | <1 | <5 | <5 | <1 | <1 | <5.0 | <5.0 | <5.0 | --- |
| Nitrate + Nitrite as N | mg/L | 1.0 | <0.16 | <0.1 | <0.05 | 0.07 | 0.05 | <0.05 | <0.05 | <0.05 | <0.1 | <0.1 | <0.1 |
| Phosphorus, Total as P | mg/L | --- | <0.05 | <0.01 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.01 | 0.05 | 0.012 | <0.01 |
| Potassium | mg/L | --- | 1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | --- | <1.0 | 0.71 | --- |
| Selenium | µg/L | 50 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 |
| Silver | µg/L | (100) | | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | --- | <0.50 | <5.0 | --- |
| Sodium | mg/L | --- | 4 | 3.5 | 2 | 3 | 3 | 3 | 1 | --- | 3.0 | 2.8 | --- |
| Sulfate | mg/L | (250)[1] | 1.4 | <2 | 0.78 | 1.2 | 1.3 | 0.87 | 0.44 | 0.8 | <0.50 | <5.0 | <0.50 |
| TDS | mg/L | (500)[1] | 14 | 31 | 21 | 23 | 34 | 24 | 24 | 37 | --- | <10 | 16 |
| Thallium | µg/L | 2 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | --- |
| TOC | mg/L | TT | 2.5 | 2.4 | 1.6 | 2.7 | 1.8 | 2.3 | 2.0 | 1.90 | 2.90 | 2.60 | 1.90 |
| Zinc | µg/L | (5000) | <5 | <2 | <10 | 2.7 | <2 | <2 | 17 | <5.0 | 6.20 | <10 | --- |
| **Radiological** | | | | | | | | | | | | | |
| Gross Alpha | pCi/L | 15 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 |
| Uranium | pCi/L | 20 | | <1.0 | 0.22 | 0.20 | 0.30 | 0.85 | 0.47 | --- | <1.0 | <10 | --- |

[1]Recommended Level

## Table 6-8. Foothills/Mountains Surface Water Bacteriological Sampling - Raw Surface Water

| Sample Date | Total Coliform (MPN/100 mL) | Fecal Coliform (MPN/100 mL) | Sample Date | Total Coliform (MPN/100 mL) | Fecal Coliform (MPN/100 mL) |
|---|---|---|---|---|---|
| **BLWC (Willow Creek Intake)** | | | | | |
| 07/29/04 | 30 | 13 | 08/07/02 | 26 | No data |
| 07/06/04 | <2 | No data | 07/24/02 | 130 | No data |
| 05/25/04 | 30 | 4 | 07/10/02 | <2 | No data |
| 04/05/04 | 80 | <2 | 06/26/02 | 30 | No data |
| 03/15/04 | 300 | 4 | 06/12/02 | 30 | No data |
| 02/17/04 | 300 | 23 | 05/15/02 | 7 | No data |
| 01/19/04 | 170 | <2 | 05/01/02 | 4 | No data |
| 11/17/03 | 80 | 8 | 04/17/02 | 500 | No data |
| 10/27/03 | 70 | 4 | 03/20/02 | 2 | No data |
| 09/15/03 | 26 | 11 | 03/06/02 | <2 | No data |
| 08/06/03 | 110 | 8 | 02/06/02 | 13 | No data |
| 07/09/03 | 30 | 17 | 01/23/02 | 17 | No data |
| 06/18/03 | 30 | 23 | 01/09/02 | 22 | No data |
| 05/28/03 | 110 | 4 | 12/26/01 | >23 | 1.1 |
| 05/14/03 | 9 | 2 | 12/21/01 | 27 | No data |
| 04/23/03 | 50 | 50 | 11/28/01 | 80 | No data |
| 03/12/03 | 8 | 2 | 10/17/01 | 170 | No data |
| 03/05/03 | 2 | <2 | 09/19/01 | 23 | No data |
| 02/19/03 | 23 | 13 | 08/08/01 | 50 | No data |
| 01/09/03 | 4 | 2 | 07/10/01 | 280 | No data |
| 01/02/03 | 17 | 17 | 06/28/01 | 8 | No data |
| 12/26/02 | 17 | 17 | 05/30/01 | 80 | No data |
| 12/11/02 | 12 | No data | 05/15/01 | <2 | No data |
| 11/27/02 | 23 | No data | 04/18/01 | 14 | No data |
| 11/13/02 | 500 | No data | 04/01/01 | 3.6 | No data |
| 10/16/02 | 110 | No data | 03/21/01 | 22 | No data |
| 10/02/02 | 80 | No data | 03/07/01 | 14 | No data |
| 09/18/02 | 50 | No data | 02/21/01 | 4 | No data |
| 09/04/02 | 23 | No data | 02/07/01 | 4 | No data |
| 08/21/02 | 7 | No data | 01/24/01 | 140 | No data |

| Sample Date | Total Coliform (MPN/100 mL) | Fecal Coliform (MPN/100 mL) | Sample Date | Total Coliform (MPN/100 mL) | Fecal Coliform (MPN/100 mL) |
|---|---|---|---|---|---|
| **SA16 (San Joaquin River Intake)** | | | **MD1 (Millerton Lake Intake)** | | |
| 02/04/05 | 4 | <2 | 01/10/06 | 900 | 80 |
| 03/07/05 | 110 | 30 | 02/10/06 | 4 | <2 |
| 04/05/05 | 130 | 50 | 03/07/06 | 60 | 17 |
| 05/02/05 | 50 | 8 | 04/17/06 | 20 | 4 |
| 06/06/05 | 80 | 2 | 05/15/06 | 11 | 4 |
| 07/12/05 | 130 | 4 | 06/19/06 | 27 | <2 |
| 08/09/05 | 500 | 30 | 07/10/06 | 30 | <2 |
| 09/07/05 | 1600 | 4 | 08/08/06 | 140 | <2 |
| 10/05/05 | 300 | 8 | 09/12/06 | 13 | <2 |
| 11/09/05 | 30 | 17 | 10/16/06 | 23 | 2 |
| 12/13/05 | 130 | 8 | 11/08/06 | 23 | <2 |
| 01/10/06 | 300 | 110 | 12/05/06 | 17 | <2 |
| 02/07/06 | 80 | 2 | | | |
| 03/07/06 | 110 | 70 | | | |
| 04/17/06 | 80 | 23 | | | |
| 05/15/06 | 130 | 2 | | | |

**Table 6-9. Pathogen Monitoring Data – USBR at Friant Dam**

| **US Bureau of Reclamation, FKC @ Friant Dam** | | | | | |
|---|---|---|---|---|---|
| **Date** | **Total Coliform (MPN/100 mL)** | **Fecal Coliform (MPN/100 mL)** | ***E. coli* (MPN/100 mL)** | ***Giardia* (Count/L)** | ***Crypto-sporidium* (Count/L)** |
| 02/23/2004 | 30 | 13 | 13 | <0.1 | <0.1 |
| 05/25/2004 | 8 | <2 | <2 | --- | --- |
| 08/31/2004 | 2 | <2 | <2 | --- | --- |
| 11/16/2004 | --- | --- | --- | 0.2 | <0.2 |
| 02/08/2005 | 22 | 22 | 17 | --- | --- |
| 05/10/2005 | <2 | <2 | <2 | --- | --- |
| 08/09/2005 | 17 | <2 | <2 | --- | --- |
| 11/15/2005 | 11 | 11 | 11 | <0.1 | <0.1 |
| 02/14/2006 | 2 | 2 | 2 | --- | --- |
| 05/09/2006 | 11 | 8 | 8 | <0.1 | <0.1 |
| 08/22/2006 | 17 | <2 | <2 | <0.1 | <0.1 |

#### 6.2.2.2 DBP Precursors

The use of chlorine (and other disinfectants) has come under scrutiny in recent years as research has revealed that these disinfectants react with natural organic matter and some inorganic constituents in water to form various DBPs. Some of these DBPs are suspected carcinogens. Currently, two groups of DBPs are regulated by the USEPA with MCLs (total trihalomethanes and five haloacetic acids) as well as two individual DBPs (bromate and chlorite). The MCLs for these DBPs are applied to locations sampled in the distribution system under the USEPA Stage 1 and Stage 2 Disinfectants/Disinfection Byproducts Rules. The MCLs for total trihalomethanes (TTHM) and five haloacetic acids (HAA5) are 80 and 60 µg/L, respectively.

The rate of DBP formation and the resulting peak DBP levels are a complex function of disinfectant type, disinfectant concentration, raw water natural organic matter composition, and concentration. Constituents typically monitored include TOC, disinfectant contact time, and water pH and temperature. All of the surface water systems in Madera County currently use free chlorine for primary disinfection (pathogen inactivation) and secondary disinfection (distribution system residual). The use of free chlorine, in conjunction with long contact times in some of these systems, can result in elevated DBP levels in the distribution system. Table 6-10 summarizes TOC data for BLWC, MD1 and SA16. Table 6-11 shows the TTHM and HAA5 monitoring averages for these systems between 2004 and 2006.

The TOC content of the Willow Creek water has ranged from nondetect to 1.4 mg/L, which is very low. This reflects low organic content of the water and should correlate to lower DBP levels. Prior to 2000, BLWC chlorinated the water prior to filtration. During this time period, TTHM levels in the distribution system ranged from 9 to 43 µg/L, and HAA5 levels ranged from 11 to 80 µg/L. In early 2000, BLWC relocated the chlorine injection point downstream of the filter. The disinfection byproduct data available since that change was made are very limited; however, there appears to have been a reduction in TTHM and HAA5 levels. Samples collected in August 2002 and January, April, and July 2004 indicate TTHM levels in the distribution system now range from nondetect to 14.2 µg/L. HAA5 levels in the distribution system now range from 15 to 33 µg/L. Other systems using water from Bass Lake should have similarly low DBP levels.

The TOC and alkalinity for the San Joaquin River at locations at the intakes for MD1 and SA16 reflect higher TOC than Willow Creek, but still relatively low levels. SA16, which is downstream of Friant Dam and the recreational activity of Millerton Lake, has higher TOC content in their source water than does MD1. The DBP data in Table 6-11 shows that the MD1 water system complied with the TTHM MCL for 2006, with a first-year running annual average TTHM value of 54 mg/L. Measured TTHM levels ranged from 20 to 117 µg/L. (Note that the highest concentration also correlates to a period with higher TOC per Table 6-10.) The quarterly sample collected in February 2007 resulted in a running annual average of 41 µg/L.

**Table 6-10. Foothills/Mountains Surface Water Total Organic Carbon & Alkalinity Monitoring**

| Date | Source Water Alkalinity (mg/L) | Source Water TOC (mg/L) | Treated Water TOC (mg/L) |
|---|---|---|---|
| **BLWC** | | | |
| 10/10/02 | 20 | --- | --- |
| 01/15/03 | 18 | --- | --- |
| 01/26/04 | --- | 1.1 | --- |
| 04/05/04 | --- | <1.0 | --- |
| 07/23/04 | --- | 1.4 | --- |
| 02/03/05 | 12 | --- | --- |
| 01/25/06 | 0 | --- | --- |
| **SA16** | | | |
| 01/18/05 | 67.0 | 2.9 | 0.8 |
| 02/01/05 | 64.0 | 0.9 | 1.5 |
| 03/10/05 | 26.0 | 4.4 | 3.8 |
| 04/05/05 | <20 | 3.1 | 2.5 |
| 05/02/05 | <20 | 2.9 | 2.3 |
| 06/08/05 | <20 | 3.1 | 2.1 |
| 07/14/05 | <20 | 2.7 | 2.8 |
| 08/09/05 | <20 | 2.5 | 1.7 |
| 09/21/05 | <20 | 2.3 | 1.5 |
| 10/03/05 | <20 | 2.1 | 1.4 |
| 11/09/05 | <20 | 2.2 | 1.6 |
| 12/13/05 | <20 | 2.4 | 1.5 |
| 02/07/06 | - | 2.9 | 2.4 |
| **MD1** | | | |
| 01/10/06 | <20 | 2.5 | 1.3 |
| 02/07/06 | <20 | 2.8 | 2.1 |
| 03/07/06 | <20 | --- | --- |
| 04/17/06 | <20 | 3.3 | 1.6 |
| 05/15/06 | <20 | 2.2 | 1.6 |
| 06/19/06 | <20 | 1.8 | 1.0 |
| 07/10/06 | <20 | 1.6 | 1.2 |
| 08/08/06 | <20 | 1.1 | 0.7 |
| 09/12/06 | <20 | 0.4 | 1.0 |
| 10/16/06 | <20 | 1.1 | 1.0 |
| 11/08/06 | <20 | 1.2 | 1.0 |
| 12/05/06 | <20 | 1.1 | 0.9 |

## Table 6-11. Foothills/Mountains Surface Water Disinfection Byproduct Monitoring

| Sample Date | TTHM (µg/L) | | | Quarterly Running Annual Avg (µg/L) | MCL Compliance |
|---|---|---|---|---|---|
| | Site 1 | Site 2 | System Average | | |
| **BLWC** | | | | | |
| 01/26/04 | 8.7 | | 8.7 | | |
| 04/05/04 | <0.5 | | 0.0 | | |
| 07/23/04 | 12.0 | 12.0 | 12.0 | 7 | Yes |
| **SA16** | | | | | |
| 08/12/04 | 40.8 | | 40.8 | | |
| 01/26/05 | 45.3 | | 45.3 | | |
| 05/12/05 | 75.8 | | 75.8 | | |
| 08/22/05 | 69.7 | | 69.7 | 58 | Yes |
| 11/22/05 | 75.3 | | 75.3 | 67 | Yes |
| 02/07/06 | 169.4 | | 169.4 | 98 | No |
| 05/12/06 | 32.0 | | 32.0 | 87 | No |
| **MD1** | | | | | |
| 02/07/06 | 117.0 | | 117.0 | | |
| 05/15/06 | 31.0 | | 31.0 | | |
| 08/08/06 | 20.0 | | 20.0 | | |
| 11/13/06 | 47.0 | | 47.0 | 54 | Yes |
| 02/12/07 | 66.0 | | 66.0 | 41 | Yes |
| **Sample Date** | **HAA5 (µg/L)** | | | **Quarterly Running Annual Avg (µg/L)** | **MCL Compliance** |
| | **Site 1** | **Site 2** | **System Average** | | |
| **BLWC** | | | | | |
| 01/26/04 | 21 | | 21 | | |
| 04/05/04 | 33 | | 33 | | |
| 07/23/04 | 20 | 22 | 21 | 25 | Yes |
| **SA16** | | | | | |
| 08/12/04 | 79 | | 79 | | |
| 01/26/05 | 220 | | 220 | | |
| 05/12/05 | 170 | | 170 | | |
| 08/22/05 | 120 | | 120 | 147 | No |
| 02/07/06 | 131 | | 131 | 160 | No |
| **MD1** | | | | | |
| 02/07/06 | 660 | | 660 | | |
| 05/15/06 | 130 | | 130 | | |
| 08/08/06 | 67 | | 67 | | |
| 11/13/06 | 67 | | 67 | 231 | No |
| 02/12/07 | 54 | | 54 | 80 | No |

The first year running annual average HAA5 value of 231 µg/L exceeds the HAA5 MCL of 60 µg/L. Measured HAA5 levels ranged from 67 to 660 µg/L, which is at least ten times the MCL of 60 µg/L. Again, the very high level of HAA5 was found during the first quarter 2006 when TOC levels were at their highest. A sample collected in February 2007 showed HAA5 levels at 54 µg/L, reducing the running annual average to 79 µg/L. This level is still above the HAA5 MCL of 60 µg/L.

Even with MD1 having low TOC levels (during the second half of 2006, TOC levels were below 2 mg/L), the water system failed the HAA5 MCL for the last quarter of 2006. This shows that achieving low TOC levels in the treated water will not ensure compliance with the HAA5 MCL for the San Joaquin River water at lower elevations. Other factors, such as the type of organic material in the water, predisinfection, and long detention times (age of water) or stagnation in storage tanks, may have significant impact on the formation of DBPs.

Similar to the MD1 system, SA16 has had violations of the DBP MCLs. The monitoring summary for TTHM and HAA5 at SA16 presented in Table 6-11 shows distribution system TTHM levels ranging from 45 to 169 µg/L. The 169 µg/L measurement, from the first quarter of 2006, resulted in the running annual average TTHM value exceeding the MCL of 80 µg/L. Measured HAA5 levels ranged from 120 to 220 µg/L, which is at least twice the MCL of 60 µg/L.

In summary, the San Joaquin River water at lower elevations has sufficient organic matter, whether measurable as TOC or as other organics, and results in elevated DBPs that have caused individual water systems to violate MCLs. Further study is needed as to the type of organic material that is the cause, whether any watershed control is feasible, and whether alternative disinfection and filtration treatment processes can correct the problem at a reasonable cost.

#### 6.2.2.3 Fresno River Nutrient Reduction Plan

The Upper Fresno River drainage area above Hidden Dam and Hensley Lake consists of 234 square miles of mountain and foothill terrain. The dam was constructed in the mid-1970s by the US Army Corp of Engineers (USACE) for flood control, irrigation, resource management, and recreation.

During the months of March through September, and particularly in the late summer, Hensley Lake experiences massive algal blooms. The algae develops as a layer on the surface of the lake that is more pronounced in shallow water and along the shore, often in areas where a high level of water contact with the shore takes place. A hydrogen sulfide odor has been associated with the eutrophic conditions experienced, characterized by an abundant accumulation of nutrients that support a dense growth of algae and other organisms. The algae is of concern due both to the nuisance associated with the blooms (reducing the desirability of water-related activities at Hensley Lake) to a potentially lethal effect on aquatic life due to the depletion of dissolved oxygen content with the heaviest algae growths.

A project report prepared by Madera County in December 2004, *Fresno River Nutrient Reduction Plan*, describes a study that was undertaken to collect historical and new data, identify nutrient sources, model nutrient loading, and develop an implementation plan to reduce nutrient loading and algal problems experienced in Hensley Lake to acceptable levels. The technical and analytical portions of the project were conducted by the California Water Institute, California State University, Fresno.

As part of this project, the hydrology of the Fresno River was characterized using models and existing river flow information. A predictive nutrient model could not be developed due to lack of data. The report concluded that there was no clear indication that nutrients in the Fresno River account for the eutrophic conditions in Hensley Lake. It was determined that internal loading (the recycling of nutrients already in the lake), coupled with physical processes within the lake itself, was a more likely explanation.

Six water quality sampling events were conducted on the Fresno River between June 2003 and March 2004 (three during the wet season and three during the dry season). Samples were analyzed for temperature, dissolved oxygen, electrical conductivity, pH, turbidity, clarity and chlorophyll, total coliform, and *E. coli*. Samples were also analyzed for nutrients including total nitrogen and phosphorus. Dissolved oxygen levels were greater than 5 mg/L (the target level established by the Regional Water Quality Control Board) in all samples, with the lowest level of dissolved oxygen just below the Oakhurst wastewater treatment facility. The pH ranged from 6.5 to 8.5, while the EC was less than 200 µmho/cm in all samples, meeting the Regional Water Quality Control Board's criteria to make the water suitable for agricultural uses. Total coliform and *E. coli* bacteria were found at levels of some concern at some locations.

## 6.3 Impacts of Failing Septic Systems

Septic tank/leachfield systems in Madera County are regulated by the Madera County Environmental Health Department by County ordinance. The Madera County code (Section 13.87.020) identifies the following required setbacks:

*Madera County Code, Title 13, Section 13.87.020*

A. *No septic tank, drainage field or leaching system shall be located within 100 feet of any well, within 100 feet of a stream, or within 100 feet of any body of water, measured from high water mark.*

B. *No cesspool, pit privy or seepage pit shall be located within 100 feet of any well, within 100 feet of a stream, or within 100 feet of any body of water, measured from high water mark.*

Houses constructed before these ordinances were enacted may have septic systems located much closer to creeks and lakes than the currently enforced setbacks. Within the upper San Joaquin River watershed, the unsewered developments using individual septic systems have the greatest potential impacts on Bass Lake, Kerckhoff Reservoir, and Millerton Lake[1].

[1] Sanitary Survey of the Upper San Joaquin River Watershed, Boyle, 1998.

The greatest impact of failing septic systems is due to overland flow to surface water bodies. However, failing septic systems can also degrade local shallow groundwater. Septic systems that are not properly maintained may result in excessive solids reaching the leachfields. Failures resulting from clogging of the leachfield due to these solids may cause either a sewage backflow into the home or result in sewage surfacing in the vicinity of the septic system. Failing septic tank/leachfield systems installed closer than the recommended setbacks have a higher likelihood of impacting the water body with raw sewage that has surfaced.

Untreated wastewater contains excessive nutrients (nitrogen and phosphorus) that can harm native plant and fish populations. Wastewater's excessive organic matter can also use up the oxygen supply in streams and rivers. Increased levels of microbial populations (bacteria, viruses, and other pathogens) may result from septic system failures. The soils are a good mechanism for filtering and removing these pathogens as the water passes through. Generally, at least 30 to 50 feet of soil is needed to provide adequate filtration for viruses and bacteria, depending on soil conditions.

These are acute pathogens, potentially causing illness due to a single exposure of an infective dose. Although most people would experience only mild illness from waterborne microbes, pathogenic organisms, such as *Cryptosporidium* and *E. coli*, can cause serious illness and even death.

## 6.4 Existing County Ordinances

Existing County ordinances related to water and wastewater are incorporated into the Madera County Code. These are summarized below.

### 6.4.1 Water Related Ordinances

Water-related requirements incorporated into the Madera County Code can be found in *Title 13-Water and Sewers* and *Title 17-Subdivisions*. Pertinent code sections are summarized in Table 6-12.

**Table 6-12. Water-Related County Ordinances**

| | Section | Description | Ordinance No. |
|---|---|---|---|
| **Title 13 Water and Sewers** | | | |
| | ***13.12 Service Design Requirements*** | | |
| | **13.12.040** | **Total Requirements for Water Flow** | 383B, 1978 |
| | | A. Total water flow, except for small systems, shall be sum of min fire flow plus the max daily domestic water flow requirements: | 383 §140, 1974 |
| | | OT = OF + 2 x OD for UNMETERED service | |
| | | OT = OF + 2.5 x OD for METERED service without yard irrigation | |
| | | OT = OF + 3.5 x OD for METERED service with yard irrigation | |
| | | Where OT = Total Required Water Flow | |
| | | OD = Average Daily Required Domestic Water Flow | |
| | | OF = Minimum Required Fire Flow | |

| | Section | Description | Ordinance No. |
|---|---|---|---|
| | **13.12.040** | B. For small systems (serving 4 or less residential units) | 383B, 1978 |
| | | OT = 2.2 gpm per residential unit if Co pump test used | 383 §140, 1974 |
| | | OT = 3.3 gpm per residential unit if Well drillers yield test used | |
| | **13.12.050** | **Average Required Daily Water Flow, OD** | 383 §141, 1974 |
| | | OD = 2.5 x SU x DF (in gpm) | |
| | | Where OD = Average Daily Required Domestic Water Flow | |
| | | SU = # service units (water service) [SFR = 0.35 SU x 3 per res min] | |
| | | DF = Density Factor [DF = 0.45 to 2.0 for >200 down to 5 connections] | |
| | **13.12.060** | **Duration of Average Daily Required Domestic Water Flow** | 383 §142, 1974 |
| | | Systems shall be capable of providing OD for a minimum duration of 2 hours | |
| | **13.12.070** | **Required Fire Flow and Duration** | 598 §2, 2004 |
| | | As set forth in Appendix III-A of the California Fire Code for areas served by a public water system *(NOTE: minimum fireflow specified in CFC is 1500 gpm for 2 hours)* | 542 §2, 1991<br>383A §1, 1978<br>383 §143, 1974 |
| | | As set forth in Section 1142 of the National Fire Codes of the National Fire Protection Association for areas not served by a public water system | |
| | **13.12.090** | **Pressure** | 383 §160, 1974 |
| | | Normal operating pressures of not less than 30 psi and not more than 100 psi. During maximum hour demand the pressure shall not be less than 25 psi. | |
| | **13.12.100** | **Storage** | 383 §161, 1974 |
| | | Storage capacity with gravity flow or power source shall be provided in new subdivisions for fire protection or major disruption of the distribution system. | |
| | | Capacity required based on power source reliability and source reliability (i.e., more than one), rated from 50% to 0% of OF+OD | |
| | ***13.52 Well Standards*** | | |
| | **13.52.050** | **Well Standards** | 492 (part), 1985 |
| | | A. Standards adopted. Excepted as otherwise specified, the standards for the construction, repair, reconstruction, or abandonment of wells published in the Department of Water Resources Bulletins 74-81 and 74-90, "Water Well Standards, State of California" and subsequent revisions and addendums are incorporated and made a part of this chapter. Standards for monitoring wells shall be those adopted by the director in conformance with requirements of the Department of Water Resources. | |
| | | B. Min horizontal distances specified between sewage disposal facilities/Ag wells and other agricultural, domestic and public wells | |

| | Section | Description | Ordinance No. |
|---|---|---|---|
| | *13.53 Maintenance District No. 22F Regulations* | | |
| | **13.53.030** | **Assessment and adjustments** | 608 §2 (part), 2005 |
| | | Establishes an assessment for parcels receiving water from the MD22F water system and for those within 500 feet of a fire hydrant. | |
| | *13.55 Water Conservation* | | |
| | **13.55.020** | **Rules and Regulations** | 532 §1, 1990 |
| | | Conservation program adopted for areas served by County Service Areas or County Maintenance District-operated community water systems as follows: | |
| | | A. No outdoor water use between 12 pm and 5 pm on any day | |
| | | B. Even number street addresses: water on Mon, Wed, Fri only | |
| | | C. Odd number street addresses: water on Tue, Thurs, Sat | |
| | | D. Anyone may water on Sun | |
| | | E. Hosing paved driveway, sidewalks or parking lots in prohibited. | |
| | | F. Restaurants to serve water only on request | |
| | **13.55.025** | **Additional Rules & Regulations During Periods of Water Shortage** | 532A §1, 1995 |
| | | The Co Engineer may adopt additional temporary measures as set forth in this section to protect the health and safety of persons if it is determined that the above conservation measures are inadequate to prevent water shortages in a particular SA or MD. | |
| | ***13.100 Rules & Regulations Pertaining to Groundwater Banking--Importation of foreign water, for the purpose of groundwater banking, to areas of Madera County which are outside of local water agencies that deliver water to lands within their boundaries--Exportation of groundwater outside the County.*** | | |
| | | To address severe groundwater overdraft in the Madera, Chowchilla and Delta-Mendota Groundwater Basins, this Section delineates rules and regulations for groundwater banking, importation of foreign water, and exportation of groundwater outside the County. | 573B §1(part), 2001 |
| **Title 17 Subdivisions** | | | |
| | *17.48 Improvement Standards & Procedures- Minimum Requirements* | | |
| | **17.48.010** | **Water Systems** | 278N §10(part), 2004 |
| | | Establishes that a water system shall be installed with service to each parcel in each new subdivision below the 500 foot elevation. For subdivisions above the 500 foot elevation, a water system shall be installed in all land divisions with lots less than 3 acres in size. | |
| | | Establishes that water systems in subdivisions shall be operated by a PUC-regulated utility or be served by a district or public agency under the direction of the Board of Supervisors | |
| | | Requires water supply information acceptable to a hydrogeologist for land divisions with parcel sizes of 3 acres or larger. If supply information is not available, well drilling and testing may be required | |

#### 6.4.1.1 Water Quality Monitoring for Private Wells

Section 13.52.090 Well Standards currently requires that a new well be tested for chemical and bacteriological analysis (one-time testing). County staff indicated that this section is being updated to include a specific panel of constituents to be monitored, based on well location in either the mountain area above the 500-foot elevation or in the valley area below 500 feet. The County will use this information to ensure the protection of high-quality water aquifers and as a means of keeping the well owners informed of any water quality concerns with their domestic supply. The anslyses required for one-time testing are shown in Table 6-13. The only difference between testing in the mountain and valley areas would be the requirement for testing for DBCP from new wells drilled in the valley area below the 500-foot elevation.

**Table 6-13. Private Well Testing Analyses**

| Mountain Area (Above 500' Elevation) | Valley Area (Below 500' Elevation) |
|---|---|
| Aluminum | Aluminum |
| Arsenic | Arsenic |
| Coliform bacteria | Coliform bacteria |
| Copper | Copper |
| Fluoride | Fluoride |
| Iron | Iron |
| Gross alpha | Gross alpha |
| Lead | Lead |
| Manganese | Manganese |
| Nitrate | Nitrate |
| pH | pH |
| Specific electrical conductance | Specific electrical conductance |
| | DBCP |

### 6.4.2 Wastewater Related Ordinances

Wastewater-related requirements incorporated into the Madera County Code can be found in *Title 13-Water and Sewers, Title 14-Building and Construction*, and *Title 17-Subdivisions*. Pertinent code sections are summarized in Table 6-14. The County has also adopted specific ordinances under Title 13 establishing the rules and regulations for each County sewer district, including SA2-Bass Lake, SA3-Parksdale, MD22-Oakhurst, MD8-North Fork, and MD37-LaVina.

**Table 6-14. Wastewater-Related County Ordinances**

| | Section | Description | Ordinance No. |
|---|---|---|---|
| **Title 13 Water and Sewers** | | | |
| | ***13.54 General Provisions [Sewage Disposal Ordinance]*** | | |
| | | Makes it unlawful to maintain a residence, business, or other building for human occupancy without sewage disposal meeting standards. Makes it unlawful to discharge sewage effluent onto the land or into any stream/water body unless it meets the requirements of the California Regional Water Quality Control Board. | 262A §1982; 363(part), 1972<br>279 §43, 1963 |
| | ***13.57 Requirements and Limitations [Sewer Systems]*** | | |
| | **13.57.10** | **Individual Sites** | 279 §40, 1963 |
| | | On-site sewer systems not allowed for lots less than 1 acre except with the approval of the director | |
| | **13.57.020** | **Use of Community Sewer Systems** | 279 §41, 1963 |
| | | Owners of buildings with sewage may be required to connect to a public sanitary sewer if one is located within 200 feet, when there is an existing violation of any provision of this article. | |
| | ***13.60 Registration and Authorization [Sewer Systems]*** | | |
| | **13.60.030** | **Permits** | 279 §47, 1963 |
| | | A permit from the County Health Department must be obtained prior to construction of any type of sewage facility. | |
| | **13.60.040** | **Additional Conditions for Permits - Aerobic Systems** | 279C/232A §§1,2, 1987 |
| | | Where aerobic wastewater treatment systems are required, they shall meet NSF Standard 40 or its equivalent. | |
| | ***13.66 Community Sewer Systems – General*** | | |
| | | The community sewer system chapters are to promote good community sewer system practices, encourage economic and efficient development and to establish minimum standards of design, construction, and operation of community sewer system facilities constructed, replaced, extended or rehabilitated to serve new subdivisions and residential, commercial, and industrial developments within the unincorporated area of the county. The standards prescribed in the community sewer system chapters are intended as minimum standards. | 279 §100-103, 1963<br>279-C §2(part), 1994 |
| **Title 14 Building and Construction** | | | |
| | ***14.20 California Plumbing Code*** | | |
| | **14.20.110** | **Private Sewage Disposal Systems** | 598 §7(part), 2004 |
| | | Requires only aerobic systems to be used in Yosemite Lakes Park. Other areas may use aerobic, alternative design, or standard on-site wastewater treatment systems, as appropriate. | |

| | Section | Description | Ordinance No. |
|---|---|---|---|
| | **14.20.111** | **Disposal Systems Sections K-4, K-13 and K-14** | 598 §7(part), 2004 |
| | | K-4 Percolation test criteria identified. | |
| | | K-13 Location where sewage disposal systems are prohibited are identified. | |
| | | K-14 Minimum separation between wastewater disposal systems and water systems are identified. | |
| **Title 17 Subdivisions** | | | |
| | ***17.48 Improvement Standards & Procedures- Minimum Requirements*** | | |
| | **17.48.020** | **Sewage Systems** | 278N §10(part), 2004 |
| | | Establishes that all lots in a proposed subdivision shall be connected to an installed community sewer disposal system or connected to an adjoining community sewer system for each new subdivision west of the 500-foot elevation. For subdivisions east of the 500-foot elevation, a community sewer system is recommended, but installation of septic tanks for each lot would be allowed in accordance with the County sewer ordinance. | |

# Chapter 7
# Flood Control Planning

This chapter addresses flood control planning in Madera County. Current federal, state, and county flood control programs are described, and a historical perspective on flooding is presented. This chapter also identifies problem areas and recommends remedial actions to address flooding in the County. Chapter 3 reviewed individual storm drainage and recharge systems. This chapter takes a more integrated approach to flood control planning in the County.

## 7.1 Current Flood Control Programs

### 7.1.1 Federal Flood Control Program

The Federal Emergency Management Agency (FEMA) is the federal agency responsible for flood control planning, while the USACE provides engineering services for flood control projects. FEMA's primary mission is to reduce the loss of life and property and protect the nation from all hazards, including natural disasters (such as floods), acts of terrorism, and other manmade disasters, by leading and supporting the nation in a risk-based, comprehensive emergency management system of preparedness, protection, response, recovery, and mitigation. FEMA often works in partnership with other organizations that are part of the nation's emergency management system. These partners include state and local emergency management agencies, 27 federal agencies, and the American Red Cross.

The USACE offers engineering services to federal agencies by planning, designing, building, and operating water resources and other civil works projects (navigation, flood control, environmental protection, disaster response). The USACE generally works on specific flood management projects such as the floodplain management study completed for Madera County in 1973.

### 7.1.2 State Flood Control Program

DWR (the agency responsible for flood control planning and management in California) acknowledged in a white paper that California's Central Valley flood control system is deteriorating (DWR, 2005 – Responding to California's Flood Crisis). This problem is exacerbated by the Central Valley's growing population, which is pushing new housing developments and job centers into areas that are particularly vulnerable to flooding. Yet funding to maintain and upgrade the flood protection infrastructure has sharply declined. A recent court ruling (Paterno versus State of California) held the State liable for flood-related damages caused by levee failure. DWR's resources are therefore strained. However, it plans to reduce flood risks through an integrated approach for better planning, new investments, improved management of existing infrastructure, and closer collaboration between water agencies and users (DWR, 2005).

California's flood control system in the Central Valley includes reservoirs with flood detention space, approximately 1,600 miles of project levees, overflow weirs, and bypass channels. These facilities were originally constructed by or incorporated into a federally designated flood control project as shown in Figure 7-1 (DWR, 2005). The State's flood control system discharges through the Sacramento-San Joaquin Delta. DWR is responsible for inspection and evaluation of the State's federally-designated project levees and channels. Most project levees are maintained by local agencies such as reclamation and levee districts and the Madera County FCWCA. Where the levees provide broad system of benefits and local interests are unable to perform satisfactory maintenance, DWR may perform the levee maintenance. These maintenance activities are funded through assessments of benefiting landowners.

### 7.1.3 Madera County Flood Control Program

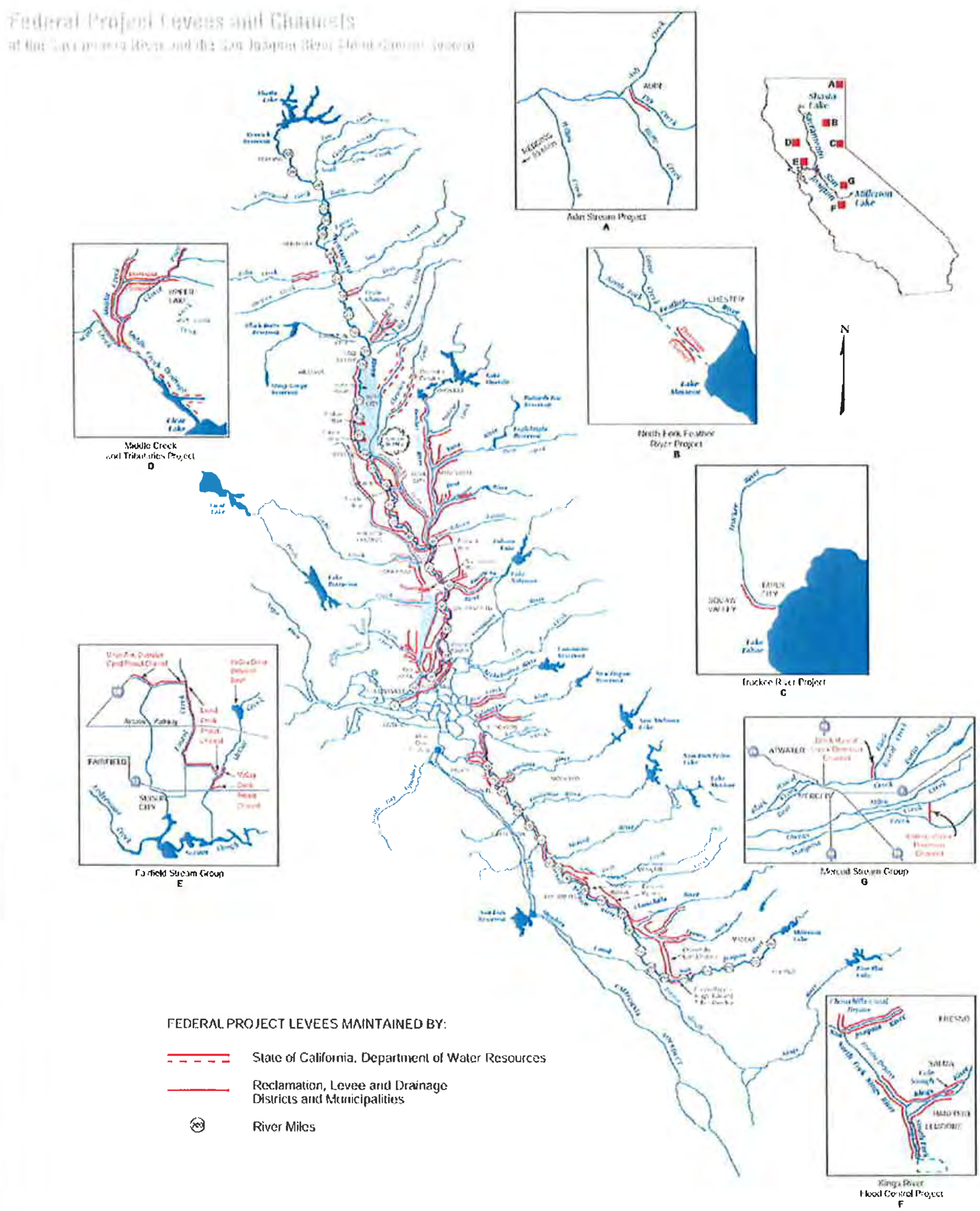
#### 7.1.3.1 Madera County Flood Control and Water Conservation Agency

The Madera County FCWCA was formed in 1969 by Madera County Flood Control Act 4525. This was enacted because the water and drainage problems in Madera County require countywide water conservation, development of water resources, and control of drainage, storm, flood, and other waters.

Act 4525 has the following components:

- Provides for the general authority of FCWCA.
- Designates its board of directors and officers.
- Defines its powers, duties, and obligations.
- Provides for zones of benefit and works of construction.
- Establishes a tax structure for the agency and provides for the issuing of certain bonds.
- Grants the right of eminent domain.
- Provides for the enforcement of rules and regulations.
- Grants the right of dissolution protecting the rights of holders of bonds and other obligations.

FCWCA is responsible for regular maintenance of certain natural water courses in the County. These responsibilities are delegated through contracts with the State and the Army Corps of Engineers to provide adequate carrying capacity for portions of the Fresno and Chowchilla Rivers and Ash and Berenda Sloughs. Additional channel-clearing activities are performed in partnership with the irrigation and water districts. FCWCA also makes recommendations to the Board for




SOURCE: DWR, 2005

| | | | |
|---|---|---|---|
| BOYLE ENGINEERING CORPORATION<br>1360 E. Spruce Avenue Suite 101<br>Fresno, California 93720 559-448-8222<br>WWW.BOYLEENGINEERING.COM | COUNTY OF MADERA<br>INTEGRATED REGIONAL WATER<br>MANAGEMENT PLAN | BEC<br>PROJECT NO. | FIGURE |
| | **FEDERAL PROJECT LEVEES AND CHANNELS** | 22203.00 | 7-1 |

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various public works to prevent or minimize flooding. FCWCA also administers water conservation and development of water recharge projects. The National Flood Insurance Program, which is a branch of FEMA, is administered locally by FCWCA for new construction and remodels of structures located in special flood hazard areas.

#### 7.1.3.2 Current Flood Control and Damage Program

The State of California legislation and Government Code Section 65302, 65560, and 65800, confer upon local government authority to adopt regulations designed to promote public health, safety, and general welfare of its citizenry. FCWCA therefore adopted floodplain management regulations based on the following:

- The flood hazard areas of the County are subject to periodic inundation, which results in loss of life and property, health and safety hazards, disruption of commerce and governmental services, extraordinary public expenditures for flood protection and relief, and impairment of the tax base, all of which adversely affect the public health, safety, and general welfare.
- These flood losses are caused by uses that are inadequately elevated, flood-proofed, or protected from flood damage. The cumulative effect of obstruction in areas of special flood hazards that increase flood height and velocities also contribute to flood loss.

The County's flood control and damage program is designed to:

- Protect human life and health.
- Minimize expenditure of public money for costly flood control projects.
- Minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public.
- Minimize prolonged business interruptions.
- Minimize damage to public facilities and utilities such as water and gas mains; electric, telephone and sewer lines; and street and bridges located in areas of special flood hazard.
- Help maintain a stable tax base by providing for the sound development of areas of special flood hazard so as to minimize future blighted areas caused by flood damage.
- Ensure that potential buyers are notified that the property is in an area of special flood hazard.
- Ensure that those who occupy the area of special flood hazard assume responsibility for their actions.

#### 7.1.3.3 Current Methods of Reducing Flood Losses

In order to accomplish its purposes, the County's ordinance includes methods and provisions to:

- Restrict or prohibit land uses that are dangerous to health, safety, and property due to water or erosion hazards or that result in increases in erosion or flood height or velocities.
- Require that land uses vulnerable to floods, including facilities that serve such uses, be protected against flood damage at the time of initial construction.
- Control the alteration of natural floodplains, streams channels, and natural protective barriers that help accommodate or channel flood waters.
- Control filling, grading, dredging, and maintenance of levees and other development that may increase flood damage.
- Prevent or regulate the construction of flood barriers that will unnaturally divert flood waters or increase flood hazards in other areas.

#### 7.1.3.4 Current Programs and Staffing

In addition to the above general regulations and policies, FCWCA has the responsibility to maintain approximately 75 miles of levees on the Fresno and Chowchilla River systems. However, it does not have sufficient funding and staff to adequately address flood control planning and maintenance requirements. Further discussion of flood control projects, programs, and funding is included in Section 8.1.3.

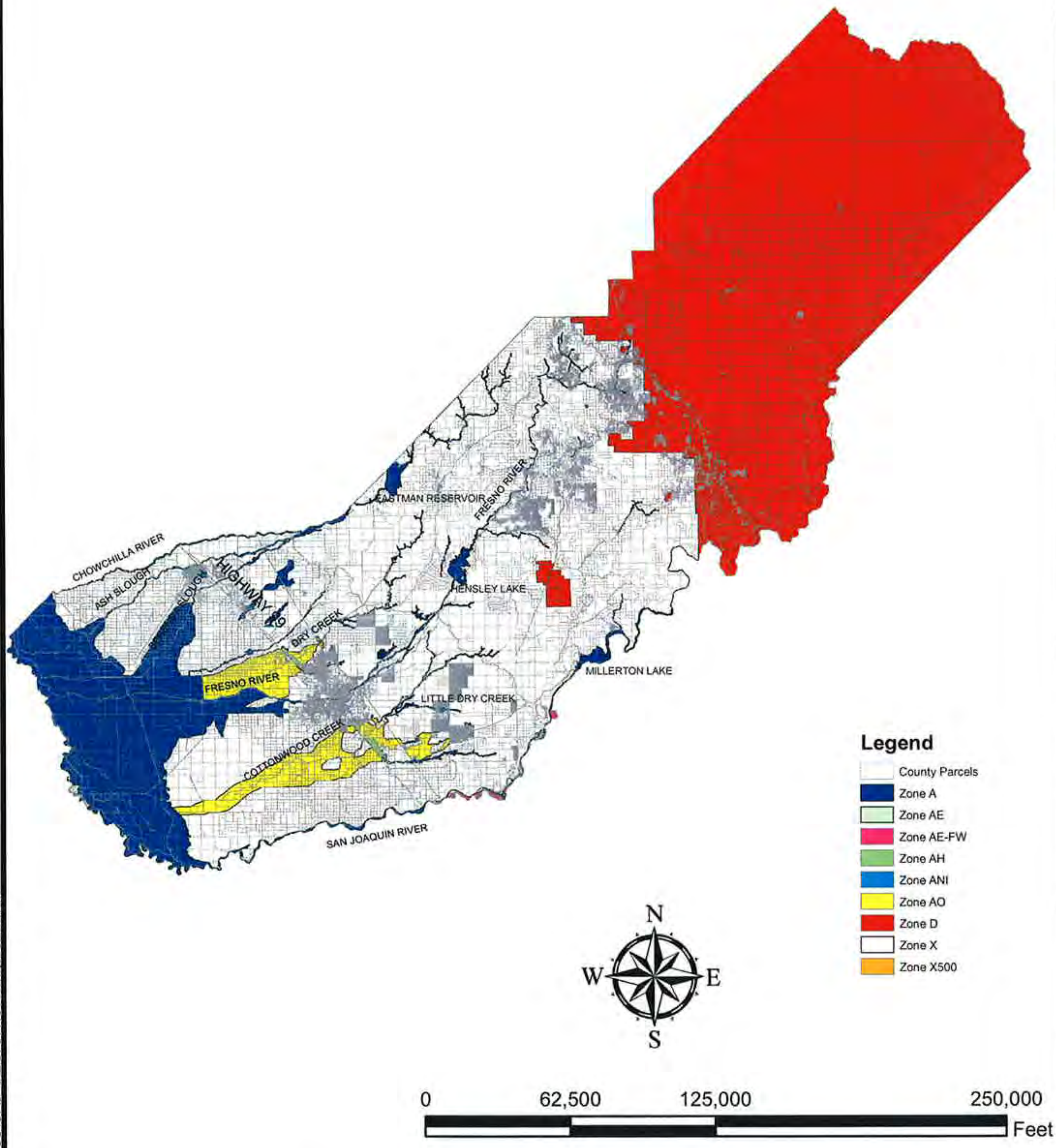
## 7.2 Flooding Problems

### 7.2.1 Madera County Flood Zones

Figure 7-2 shows the flood zones in the County as designated by FEMA. The following is a brief description of these flood zones:

#### 7.2.1.1 Zone A

These are areas with a 1 percent annual chance of flooding (100-year flood event) and a 26 percent chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these areas. This is a high-risk zone and encompasses mainly the immediate vicinity of Eastman Reservoir, Hensley Lake, and Millerton Lake. It also includes the southernmost portions of the Chowchilla River, Ash Slough, Berenda Slough, Fresno River, Chowchilla Bypass, and San Joaquin River.

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| BOYLE ENGINEERING CORPORATION<br>1360 E. Spruce Avenue Suite 101<br>Fresno, CA 93720 559-448-8222<br>WWW.BOYLEENGINEERING.COM | COUNTY OF MADERA<br>INTEGRATED REGIONAL WATER MANAGEMENT PLAN | BEC PROJECT NO. | FIGURE |
|---|---|---|---|
| | FLOOD ZONES | 22203.00 | 7-2 |

#### 7.2.1.2 Zone AE

Zone AE is similar Zone A and has a 1 percent annual chance of flooding and a 26 percent chance of flooding over the life of a 30-year mortgage. In most instances, base flood elevations derived from detailed analyses are shown at selected intervals within these zones. This is a high-risk flood area and generally consists of specific areas along the northern banks of the San Joaquin River between Highway 99 and Millerton Lake.

#### 7.2.1.3 Zone AE-FW

This zone is a 100-year delineated floodway. It covers specific areas along the southern banks of the San Joaquin River between Highway 99 and Millerton Lake.

#### 7.2.1.4 Zone AH

Zone AH has a 1 percent annual chance of shallow flooding, usually in the form of a pond, with an average depth ranging from 1 to 3 feet. These areas have a 26 percent chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones. This is also a high-risk flood area and located along portions of Highway 99 east and west of the City of Madera.

#### 7.2.1.5 Zone ANI

This area is located in the City of Chowchilla but not included in any flood zone.

#### 7.2.1.6 Zone AO

These are river or stream flood hazard areas and areas with a 1 percent or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet. These areas have a 26 percent chance of flooding over the life of a 30-year mortgage. Average flood depths derived from detailed analyses are shown within these zones. This is a high-risk flood zone and is located adjacent to Fresno River, Dry Creek, and Cottonwood Creek.

#### 7.2.1.7 Zone D

Zone D covers areas with possible but undetermined flood hazards. No flood hazard analysis has been conducted and areas are not mapped. Flood insurance rates are commensurate with the uncertainty of the flood risk. These areas are located in the Foothills and Mountains.

#### 7.2.1.8 Zone X

Zone X encompasses areas outside the 1 percent annual chance floodplain, areas of 1 percent annual chance sheet flow flooding where average depths are less than 1 foot, areas of 1 percent annual chance stream flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1 percent annual chance flood by levees. No base flood elevations or depths are shown within this zone. Insurance purchase is not required in these zones. These areas have low to moderate flood risk.

#### 7.2.1.9 Zone X500

This zone has the same description as Zone X; however, this area falls between the 100 and 500-year flood zone. This zone has low to moderate risk and is located adjacent to the Atchison, Topeka & Santa Fe Railroad (AT&SF) railroad north of the City of Madera.

### 7.2.2 Flooding Situation

As shown in Figure 7-2, the high-risk flood zones are located in the Valley Floor. The Valley Floor has a long history of flooding, mainly associated with the Fresno and Chowchilla Rivers and their tributaries, all of which are tributary to the San Joaquin River. Damaging floods have occurred about once every 3 years on average. This section describes the flooding situation and is based on reports prepared by the USACE, work being done by the County's Levee Task Force and eyewitness accounts.

#### 7.2.2.1 Flood Season and Flood Characteristics

Generally, rain floods can occur in the County anytime during November through April. This type of flood results from prolonged heavy rainfall over the river tributary areas and is characterized by high peak flows of moderate duration. Flooding is more severe when antecedent rainfall has caused saturated ground conditions and infiltration is minimal.

Cloudburst storms, sometimes lasting as long as 3 hours, can occur over the drainage basins in the County anytime from late spring to early fall and may occur as an extremely severe sequence within a general winter rainstorm. The intensity of cloudburst storms is quite high, and they can produce enough precipitation to result in peak flows greater than those of general flood-producing rainstorms over the drainage basins in the County. Flooding from cloudbursts is characterized by high peak flows, short-duration flood flows, and small-volume runoff.

#### 7.2.2.2 Factors Causing Flooding

Floodway obstructions, limited channel capacity, and poor levee maintenance are the main factors causing flooding in Madera County. Natural obstructions to flood flow include brush, reeds, and other vegetation growing along stream banks in floodway areas. During floods and flood releases from Buchanan Dam on the Chowchilla River, Hidden Dam on the Fresno River, and Friant Dam on the San Joaquin River, such vegetation impedes flood flows and causes conditions that increase flood heights. Vegetation washed out and carried downstream during floods often collect on bridges or plug culverts, thus creating a damming effect and overtopping of the flood control levees. As flood flows increase, masses of debris may break loose, and a wall of water and debris surges downstream until another obstruction is encountered. These obstructions cause unpredictable areas of flooding; possible destruction of or damage to bridges, culverts, and levees; and increased velocities of flow immediately downstream.

Flooding can be severe on the Valley Floor because slopes are gentle and there are railroad bridges, railroad culverts, highways, roads, street bridges, road culverts, low water crossings, and irrigation diversion weirs located on the various streams, some of which were considered by the USACE to be obstructive to flood flows.

A program to replace undersized culverts should be a part of a countywide flood control program. Undersized culverts can create extremely high water velocities and cause downstream erosion problems and overtopping of roadways in major storm events. Also, there is increasingly more trash being dumped along County roads due to limited access to and the high cost of dumping at County landfills. This only exacerbates the problem of culverts plugging and causing flood damage.

The AT&SF railroad bridge across the Fresno River is also considered a serious obstruction to river flows. Although river flows do not reach the top of the underclearance, the many closely-spaced timber piers of the bridge catch debris, which creates a damming effect and results in materially increased water surface elevations upstream.

The paved low water crossing of Cottonwood Creek at Avenue 13 forms a low barrier that reduces channel capacity and increases overbank flooding upstream. On Root Creek, the fill and small-diameter culvert at the AT&SF railroad crossing create a dam to creek flows that results in ponding for more than 2 miles upstream. However, by acting as a dam, the obstruction reduces the potential for flooding downstream. The fill retards floodwater, and the small culvert opening limits the amount of flow so that only minor areas along the lower stream course are inundated under most flow conditions. In effect, the obstruction protects agricultural areas and roadways in the floodplain downstream.

The flood risk along the Chowchilla River, Berenda Slough, and Ash Slough is exacerbated by the limited capacity of the Chowchilla River channel system and the poor state of the levee system. A major cause of the limited channel capacity is the plant *Arundo donax*, which is choking off the channel and increases fire risk to nearby structures. In addition, the plant consumes tremendous quantities of water. The plant is not native to the area and was originally introduced to help prevent erosion problems. In addition, permitting requirements of the California Department of Fish and Game for removal of vegetation from the channels make it difficult to maintain the carrying capacity of the channels. Loss of historical overflow areas has also increased flooding problems.

### 7.2.3 Historical Floods

The Valley Floor has experienced many floods in the past. Historical data available indicate that floods occurred in 1861-62, 1867-68, 1911, and 1914. Records and eyewitness accounts also indicate that floods have occurred in 1938, 1943, 1945, 1950, 1952, 1955, 1956, 1958, 1963, 1969, 1983, 1995, 1997, 1998 and 2006. Three peak flood flows occurred in 1938, and two occurred in each of 1950, 1958, and 1969. The floods that occurred in December 1955 and February 1969 were of about equal magnitude and the most severe known in the Valley Floor. The floods that occurred in February and March 1938, November 1950, and April 1958 also were serious floods. Comparative recorded or estimated peak flood flows on the Fresno River have been as high as 17,500 cfs (USACE, 1973).

Peak flows on the Fresno River during other major floods from 1938 to the present have ranged from 5,000 to 8,500 cfs. Peak flows on other streams in the Valley Floor are not available. Hidden Dam, a multipurpose storage project on the Fresno River completed in 1975, provides flood protection to the City of Madera and agricultural areas in the Fresno River floodplain. The levees that transport the stored water from Hensley Lake are relatively well maintained. Flood control improvements on Cottonwood, Little Dry, and Root Creeks have not been implemented; therefore, flooding and flood damage still occur in these areas relatively frequently.

The maximum controlled flood release from Buchanan Dam is 7,000 cfs. The design capacity of Ash Slough and Berenda Slough downstream of Highway 99 is 5,000 cfs and 2,000 cfs, respectively. The capacity of the Chowchilla River downstream of Highway 99 is less than 50 cfs. No flood releases from Buchanan Dam are diverted into the Chowchilla River downstream of Highway 99. The capacity of Berenda Slough near Avenue 22 has been reduced to less than 500 cfs due to vegetative growth in the channel. The flood risk is exacerbated by the limited capacity of the Chowchilla River channel system caused by *Arundo donax* and the poor condition of the levee system in many areas. Flooding on the Chowchilla River system is more severe compared to the Fresno River system. The County was put on notice by the Central Valley Flood Protection Board (formerly the Reclamation Board) that deficiencies exist on the Chowchilla River and Ash and Berenda Sloughs. The County was recently notified by the Board that the County's submitted corrective action plan was acceptable. In addition, the County has requested an extension of time to complete the corrective actions but have not received an answer to the request. If corrections are not made and a reinspection scheduled by the deadline, the project will be considered inactive and will not be eligible for PL84-99 rehabilitation assistance.

### 7.2.4 Future Floods

Investigations made by the USACE in the 1970s showed that flood-producing storms larger than those of the past could occur over the watersheds in the Valley Floor. The USACE designated future flood conditions as "intermediate regional" and "standard project." The standard project flood would be larger than the intermediate regional flood and would occur less frequently. Selection of these flood conditions was based on hydrologic computations by the USACE, which included analysis of available past floods and consideration of pertinent meteorological and physiographic conditions (USACE, 1973).

The intermediate regional flood is one that could occur once in 100 years on average, although it may occur in any year. Peak flows were estimated to be as high as 5,000 cfs (USACE, 1973). Standard project floods on streams are those that can be expected from the most severe combination of meteorological conditions reasonably characteristic of the geographical region, excluding extremely rare combinations. Peaks can be expected to be as high as 21,000 cfs (USACE, 1973).

## 7.3 Potential Programs and Projects

The County has established a Levee Task Force to work on flood control planning issues. If the levee system and channels are not maintained, the levees would be decertified by the USACE. This would make it more difficult for the County to obtain funding to implement flood control planning projects and would make the County ineligible for FEMA rehabilitation assistance under Public Law 84-99. In addition to the current maintenance, the County must demonstrate the future ability to maintain the levee system by having a maintenance program. The following are the potential flood control programs and projects discussed and deemed potentially viable by the IRWMP consulting team and the Levee Task Force:

- *Arundo donax* mapping and eradication
- Channel restoration
- Levee restoration and maintenance
- Construction of storm water retention basins
- Flood warning and forecasting
- Flood fighting and emergency evacuation plans

### 7.3.1 Arundo Mapping and Eradication

Clearing *Arundo donax* from the water channels in the County may not stop flooding entirely. However, at a minimum, the water channels should be restored to their intended capacity. According to the Levee Task Force, the eradication of *Arundo donax* from the water channels in the County is considered by the State to be a maintenance activity. It was recommended at one of the Levee Task Force meetings that the maintenance of the channels and levees could be done by the irrigation and water districts. They should, however, be helped with funding. The following are the steps involved in the mapping and eradication of *Arundo donax*:

- Because the plant is so invasive and covers wide areas, the first step in effectively eradicating it is mapping its locations. This mapping can be done by employing GPS and geographic information systems (GIS). The mapping will quantify the extent of the problem and help in estimating the cost to eradicate this invasive plant.

- Eradication of *Arundo donax* by spraying and cutting followed by another round of spraying and cutting is the recommended method to be employed. According to the Levee Task Force, *Arundo donax* needs to be sprayed in September to be most effective. The first round is expected to clear 95 percent of the plant and the second round is expected to clear the remaining plants. This is expected to take 2 to 3 years.

### 7.3.2 Channel Restoration

In conjunction with the eradication of *Arundo donax*, the County has received a countywide permit from the California Department of Fish and Game for streambed alteration and routine maintenance. This will allow the County to alter the size and shape of the channels and restore them back to their original design capacity. It is important that the channels be cleared and maintained to handle the 100-year design flood flows such that the system can function as designed by the USACE.

### 7.3.3 Levee Restoration and Maintenance

The County is working to restore the levees identified by the Central Valley Flood Protection Board as being deficient. This will prevent the levees from being decertified and the potential loss of future funding.

Prior to the USACE's construction of Hidden Dam, there were no existing flood control structures that would have an effect along the Fresno River. This is because flood protection was provided by individual landowners adjacent to the river through the construction of low, discontinuous levees along both the Fresno River and Cottonwood Creek west of Madera. These levees were uncompacted fill and were frequently tunneled by rodents so that failures occurred even during minor flow conditions. A small levee at the head of Cottonwood Creek restricts flood overflow to that stream. A culvert and roadfill across Cottonwood Creek at Road 400 restrict creek flow to the amount that will pass through the culvert and divert remaining flow to China Slough and ultimately to the main stream channel downstream. Thus, high flows that would have flooded agricultural areas in the Cottonwood Creek floodplain are instead directed along the Fresno River.

The Fresno River has been included in the designated floodway program of the State of California. Under this program, the Central Valley Flood Protection Board has statutory authority to regulate the uses of and construction in designated floodways so as not to impair capacity. The Fresno River was brought into the program in two stages:

- A designated floodway for the river reach from the upper limit of the channel improvement work that included the Hidden Dam project upstream to the AT&SF bridge was adopted on May 8, 1970.

- A floodway for the reach from the railroad bridge upstream to Hidden Dam was adopted on April 2, 1972.

The floodway designation was based on a USACE estimate of 1959 flood flows and a U.S. Geological Survey backwater analysis of these flows to determine the areas inundated. The floodway reflects the flows shown in Table 7-1.

**Table 7-1. Fresno River Channel Designated Flows**

| Reach | Flow (cfs) |
|---|---|
| Hidden Dam downstream to the MID weir | 10,000 |
| MID weir downstream to the Southern Pacific Railroad bridge in Madera | 8,000 |
| Downstream from the Southern Pacific Railroad bridge in Madera | 5,000 |

Madera County has a general zoning ordinance applicable to stream channel and river bottom areas. It provides that these areas be reserved as “open spaces” but does not cover riparian flood-prone areas.

### 7.3.4 Storm Water Retention Basins

It is recommended that a local storm water drainage system consisting of storm drains, retention basins, and pump stations be used to control flooding in the County. The system should be designed to retain and infiltrate as much storm water runoff as possible. The City of Madera’s 1997 Storm Drainage Master Plan includes proposals for drainage areas, each providing service to substantial acreage. These drainage areas are planned to be served by a retention basin.

This system would work by storm water flowing into storm drain inlets and through a network of pipes to a nearby retention basin. Here the water is stored to protect flooding downstream and to replenish the groundwater aquifer, which is in overdraft and the primary source of the County’s drinking water.

Funding for local drainage services comes from fees paid by new development or from grant funding. Each year drainage impact fees should be updated to keep pace with cost changes in construction and land acquisition.

### 7.3.5 Flood Warning and Forecasting

The National Oceanic and Atmospheric Administration (NOAA), through its National Weather Service (NWS), maintains year-round surveillance of weather conditions. NOAA storm forecasts are furnished to the NWS office in Fresno for distribution directly to agencies responsible for flood protection and, by way of the local news media, to the general public.

Personnel from the NWS office in Sacramento and from DWR are assigned to the Joint Federal-State River Forecast Center, which monitors weather conditions and river stages on a year-round basis. If floods on major streams become imminent, the Federal-State Flood Operations Center is activated. This center operates on a 24-hour basis and, among other flood emergency activities, advises all interested parties of flood emergency activities and of flood situations as they develop. The center furnishes flood warnings and forecasts of river stages to the local news media, law enforcement agencies, and other responsible agencies for their use and for dissemination to the public.

Although specific flood forecasts are not prepared for streams in the County, applicable daily weather forecasts are issued by the NWS office in Fresno. When weather conditions warrant, storm and probable flood warnings for local streams are issued by that office. The local news media and law enforcement agencies disseminate these warnings to the public.

### 7.3.6 Flood Fighting and Emergency Evacuation Plans

There are no specific formalized plans for flood fighting or emergency evacuation of people and personal property from floodplain areas in the County. Madera County and the City of Madera have adopted a community action plan for the County area and the major communities. The plan was prepared by the State Office of Emergency Services to cover a variety of natural and manmade disaster situations. For flood emergencies, the plan describes individual actions for before, during, and after flood events. It does not cover specific activities or assign responsibilities for emergency communications, safeguarding people and property, rescue and relief, or flood fighting. If the need arises, state and local law enforcement agencies and street and highway maintenance crews assist in the rescue of stranded persons and perform other flood-fighting activities. DWR, through the Flood Operations Center, coordinates flood-fighting activities throughout California and is authorized to receive requests for assistance from local public agencies during floods. The USACE responds to requests for flood-fighting and rescue work from the State Disaster Office when the emergency is beyond the capabilities of state and local governmental agencies. It is therefore recommended that an emergency response and recovery plan be developed for the County, consistent with the National Incident Management System.

# Chapter 8
# Water Resources Management Opportunities

The preceding chapters of this Plan described in detail the existing water resources conditions and problems of the County of Madera. In cooperation with the various stakeholders to this Plan, potential projects, programs, and policies have been identified to address water resources problems in the County. These include measures to increase water supply, reduce demand, improve water quality, and manage flooding in the County. Many of the identified projects, programs and policies are described by subarea because of the hydrogeologic differences between the two major regions of the County. However, to optimize the use of the available water resources and seek additional water supplies, water resource management should be integrated countywide.

## 8.1 Valley Floor Water Management Opportunities

As identified by previous sections of this Plan, the Valley Floor's most critical water resources issues include overdrafted groundwater basins and storm water flooding. As presented in Chapter 2, over 30 proposals for new developments have been received by the County Planning Department which will place additional water demands on already overdrafted groundwater basins. Also, the overdraft condition will worsen if additional undeveloped land is brought into agricultural production.

A list of projects, programs, and policies have been identified by stakeholders and the consulting team to help address the water resources challenges in the Valley Floor. These projects are summarized in Table 8-1. The level of detail of the projects differs as some are mere concepts to be developed further and some are in the implementation stage. The following sections describe the projects, programs, and policies that the County may consider implementing, supporting, or participating in through partnerships or agreements with other agencies in the County.

### 8.1.1 Water Supply Augmentation Measures

The following projects have the potential to increase water availability in the Valley Floor. These projects have the potential to reduce groundwater overdraft in the Valley Floor. The level of detail of each project is based on the available information at the time of this report.

#### 8.1.1.1 Chowchilla Water District-Merced Irrigation District Intertie

In 2000, a study was performed to evaluate the feasibility and estimate the cost for a water conveyance system to deliver irrigation water from the Merced Irrigation District to CWD. The study evaluated both a 15,000 AF (100 cfs) and a 7,500 AF (50 cfs) delivery of water between

**Table 8-1. Potential Water Supply Augmentation & Overdraft Reduction Projects on the Valley Floor**

| Project Name | Implementation Agency(ies) | Potential Overdraft Reduction (AFY) | Project Status | Projected Completion Date | Lead Agencies for Environmental Compliance: CEQA | Lead Agencies for Environmental Compliance: NEPA | Estimated Costs: Project Cost ($Million) | Estimated Costs: Annual O&M Costs ($) | Estimated Costs: Basis Year | Existing or Potential Funding Sources | Other Benefits | Implementation Issues/Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Water Enhancement Project (Madera Water Bank) | MID | 20,000 | Pilot testing project | 2013 (earliest) | MID | USBR | 91.156 | 3.5 M | 2005 | MID, USBR | | Developing funding sources and continuing pilot testing. |
| 2. Madera Canal/Hidden Dam Pump Storage Project | MID | 7,000 | Feasibility study and predesign reports complete | 2010 (earliest) | MID | USACE | 16.543 | 143,490 | 2005 | MID | | MID pursuing USACE authorization. |
| 3. Madera Lake Regulating and Recharge Project | MID | up to 10,000 | Feasibility study complete | Sep 2006 | MID | | 0.155 | 5,000 | 2004 | MID, DWR, USBR | | MID may pursue installation of a permanent water elevation control structure in the Fresno River and additional recharge basins on the south side of the Fresno River. Also, the feasibility of increasing the inlet canal capacity needs investigation. |
| 4. Lateral 32.2 Regulating and Recharge Reservoir | MID | 580 | Not currently funded | | MID | | 0.310 | 5,500 | 2004 | MID, DWR, USBR | | 2004 USBR Challenge Grant application denied. MID researching opportunities to have basin excavated by others. |
| 5. Merced Irrigation District to CWD Water Transfer | CWD / Merced ID | 7,500 - 15,000 | Feasibility study complete | | CWD | | 3.423 - 4.584 | | 2000 | | | Further evaluation of alternatives required. Awaiting funding. |
| 6. District-Wide SCADA Improvement Project | CWD / Merced ID | 7,000 - 14,000 | Design phase | | CWD | | 0.730 | | 2006 | CWD, DWR, USBR | Reduced O&M | $300,000 USBR Challenge Grant received. |
| 7. Root Creek Surface Water Project | RCWD | 4,190 | Agreements in place | | RCWD | | 5.810 | 272,000 | 2003 | RCWD, DWR | | Permitting and construction of facilities required for implementation of project. |
| 8. WWTP Effluent Reuse (Agricultural Reclamation) | City of Madera / MID | up to 9,600 | WWTP expansion underway | mid 2008 | City of Madera | | | | | City of Madera and MID | | Deliveries of groundwater pumped from under the WWTP percolation ponds to MID may begin in 2008 and increase to a maximum of 9,600 AFY by 2030. |
| 9. WWTP Effluent Reuse (Agricultural Reclamation) | Chowchilla/CWD | up to 2,000 | City planning new WWTP | | City of Chowchilla | | | | | City of Chowchilla | | Current 1.8 MGD WWTP to be used for industrial. wastewater when new plant online. |
| 10. Residential Water Metering | City of Madera | 3,500 to 6,600 | Currently no program | Assumed 2015 in UWMP | City of Madera | | 6.0 - 9.5 | | 2007 | City of Madera | | All new single-family residences (SFR) have had meters installed since 1992. Currently all SFR are billed on a flat rate. |
| 11. Residential Water Metering | City of Chowchilla | 1,300 to 1,600 | Currently no program | Assumed implemented by 2015 | City of Chowchilla | | 0.7 - 1.1 | | 2007 | City of Chowchilla | | All SFR have had meters installed since 1992. Currently 950 unmetered. Currently all SFR are billed on a flat rate. |
| 12. Ultra-Low Flush Toilet Replacement Program | City of Madera | 375 | Currently no program | Assumed implemented by 2015 | City of Madera | | 7 - 8 | | 2006 | City of Madera | | Water savings based on AWWARF study and costs based on City of Fresno contracts for installing meters. |
| 13. Ultra-Low Flush Toilet Replacement Program | City of Chowchilla | 75-100 | Currently no program | Assumed implemented by 2015 | City of Chowchilla | | 1.2 - 1.8 | | 2006 | City of Chowchilla | | Water savings based on AWWARF study and costs based on City of Fresno contracts for installing meters. |
| 14. San Joaquin River Storage - Temperance Flat | USBR | 200,000 [1] | Requires State legislation | | | USBR | | | | | Flood Control | County needs to support authorization legislation and obtain its share of the project yield. |
| 15. Expansion of CWD Service Area | CWD/USBR | | | | CWD | USBR | | | | | | USBR processing application to add 10,000 acres. |

## Table 8-1. Potential Water Supply Augmentation & Overdraft Reduction Projects on the Valley Floor

| Project Name | Implementation Agency(ies) | Potential Overdraft Reduction (AFY) | Project Status | Projected Completion Date | Lead Agencies for Environmental Compliance | | Estimated Costs | | | Existing or Potential Funding Sources | Other Benefits | Implementation Issues/Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | CEQA | NEPA | Project Cost ($Million) | Annual O&M Costs ($) | Basis Year | | | |
| 16. Expansion of MID Service Area | MID/USBR | | | | MID | USBR | | | | | | Feasibility study required. |
| 17. Regulating / Recharge Basins in CWD | CWD | | | | CWD | | | | | | | |
| a. Road 16 and Avenue 20 Basin | CWD | | | | CWD | | | | | | | Basin constructed. Pumpback facility required. |
| b. Berenda Canal/Greenhills Basin Connection | CWD | | | | CWD | | | | | | | Feasibility study required. |
| c. Joint Use of City of Chowchilla Basins | CWD/City of Chowchilla | | | | CWD | | | | | | | Feasibility study required. |
| d. Water Supply Development Study | CWD | 4,000 to 10,000 | Awaiting authorization | | | | | | | | | Study to evaluate the potential of developing new supply for future farming and development. |
| 18. Improved Water Level Control Structures in CWD | CWD | | | | CWD | | | | | | | Feasibility study required. |
| 19. Improved Water Measurement Structures in CWD | CWD | | | | CWD | | | | | | | Feasibility study required. |
| 20. Surface Water Storage Reservoirs in CWD | CWD/USBR | | | | CWD | USBR | | | | | | Feasibility study of sites near the Madera Canal required. |
| 21. Replacement of Cast-In-Place Pipe | CWD | | | | CWD | | | | | | Reduced O&M | CWD currently replacing 1/2 mile per year. |
| 22. Replacement of Discharge Valve at Friant Dam | USBR | | | | FWA | USBR | | | | | | Feasibility study required. |
| 23. Madera Lake/Fresno River Diversion Structure | MID | | | | MID | | | | | | | Feasibility study required. |
| 24. City of Madera/MID Storm water Recharge Project | City of Madera/MID | | | | MID/City | | | | | | | City and MID need to work cooperatively to implement existing agreement. |
| 25. City of Madera Stormwater Retention Basin Project | City of Madera | | | | City | | | | | | | Further development of project description required. |
| 26. Replacement of Low Flow Gate at Hidden Dam | USACE/MID | | | | MID | USACE | | | | | | May be done as part of Pump/Storage Project. |
| 27. Fresno River to Madera Canal Diversion Structure | MID | | | | MID | USBR | | | | | | Feasibility study required. |
| 28. City of Madera Airport Recharge Project | City of Madera/MID | | | | MID | | | | | | | Feasibility study required. |
| 29. Arundo Removal Project | County/CWD/MID | | Developing project details | | County | | | | | | Flood Control | Limited work to begin in 2007. Funding required. |
| 30. Retirement of Irrigated Agricultural Lands | | | Conceptual | | | | | | | | | Concept stage. Further development of potential program required. |
| 31. Root Creek Flood Control and Water Supply | County/MID/RCWD | | Conceptual | | | | | | | | Flood Control | Feasibility study required. |
| 32. Downtown Fresno River Project | County/MID/City of Madera | | Conceptual | | | | | | | | | County and City of Madera seeking grant funds for feasibility study. |

[1] Estimated yield of project. Valley-wide overdraft benefits. Benefit to Madera County depends on allocation of new yield.

June 1 and August 31 each year. The additional water supply to CWD would help alleviate groundwater overdraft conditions in western Madera County and free up CWD's CVP water supply for other purposes. Several project alternatives were considered. The recommended alternative was chosen because of its economic value, flexible flows, fewer mechanical improvements required, and reduced impact to existing facilities. The work required includes both improvements to existing water conveyance systems and construction of new facilities.

The preferred route starts upstream of Lake Yosemite with construction of a new inverted siphon in the Merced Irrigation District Main Canal and ends with a section of new canal connecting to the Ash Main Canal and the Bethel Canal. These two canals would receive the water, which gives CWD the ability to manage these flows to meet system demand in the western portion of the district.

Estimated costs for the recommended project improvements at flows of 15,000 AF and 7,500 AF in 2007 dollars are $5,940,000 and $4,423,000, respectively, equating to a capital cost for water delivered of $396/AF or $590/AF, depending on the final project capacity. These costs include engineering design, development of construction documents for bidding and construction, legal services, easement purchases, regulatory fees, environmental documentation, etc. Assuming a cost of water from Merced Irrigation District at $80/AF, a 30-year project life and an interest rate of 5 percent, the annual cost of the water supply (in 2007 dollars) is expected to be approximately $118/AF for a 15,000-AF project and $132/AF for the 7,500-AF project. The next steps in developing the project would include a predesign report and CEQA compliance, followed by project design and construction.

#### 8.1.1.2 Temperance Flat Dam

The USBR performed an investigation of the storage opportunities on the San Joaquin River to develop water supplies to assist in the restoration of the river, improve river water quality, and increase water supply for urban areas. USBR and DWR are coordinating the effort with the California Bay-Delta Public Advisory Committee and the California Bay Delta Authority. The objectives sought with the newly developed water supply are as follows:

- River restoration.
- River water quality improvement.
- Conjunctive use of the surface water supply to reduce overdraft and support exchanges that improve the quality of water delivered to urban areas.

The study developed and evaluated numerous project alternatives. As a result of this comprehensive study, Temperance Flat Reservoir with two potential locations and an off-stream alternative adjacent to Millerton Lake, are being considered. The new Temperance Flat Reservoir could hold up to 1,300,000 AF of water and supply up to 200,000 AF of water (new yield) per year. Construction could begin by 2012 with facilities in operation by 2017 to 2019.

On September 18, 2007 the governor announced a $9 billion water infrastructure proposal. The proposal targets $5.1 billion for surface storage and identifies Temperance Flat as one of the reservoir sites. The need for increased surface water storage is gaining acceptance in California, and Temperance Flat is high on the priority list.

Madera County, as an “area of origin,” must evaluate the benefits and costs of water supply from this facility, determine how this water source will integrate with the other surface and groundwater sources available to the County, and develop a well-founded plan to acquire a portion of this new water supply to relieve overdraft and provide high-quality water for use within the County. Precipitation that falls in Madera County contributes nearly one-half of the mean annual runoff of the San Joaquin River at Friant. There is no agreement to date on how the new water supply will be distributed among the various users. A significant portion of the project costs will need to be paid by the water users. Therefore, the cost of the Temperance Flat water will likely be melded with other water costs to determine the economic attractiveness for those seeking a portion of the supply.

#### 8.1.1.3 Madera Irrigation District Groundwater Bank

The MID Water Supply Enhancement Project is a water bank with a total storage capacity of 250,000 AF that will recharge, bank, and recover up to 55,000 AFY of existing San Joaquin River and Fresno River water entitlements. Water will be banked in an overdrafted aquifer, and 10 percent of the water will be left behind to reduce overdraft. The project will be on a 13,646-acre property known as Madera Ranch.

##### 8.1.1.3.1 Project Benefits

MID, CWD, and GFWD supply water to a combined 350-square mile service area, representing 100 percent of the capacity of the Buchanan Unit (Eastman Reservoir), 100 percent of the Hidden Unit (Hensley Lake) and 23 percent of the Friant Unit (Millerton Lake) of the CVP (based on 100% Class I and II supplies, which are not available every year). These districts face significant water shortage in dry years. During dry years, farmers dramatically increase groundwater pumping, exacerbating overdraft of an aquifer that also supports increasing urban water demands from the City of Madera, City of Chowchilla, Madera Ranchos, and various housing developments. Overdraft is currently estimated to average 100,000 AFY in the Valley Floor. In addition, USBR is considering reallocation of a portion of the CVP system flows to meet the environmental needs of the San Joaquin River in compliance with a settlement agreement that resolves the 1988 lawsuit, “Natural Resources Defense Council (NRDC, and others) v. Rogers, Civ. No. S-88-1658 LKK (E.D. Cal.).”

Finally, Millerton Lake, Hensley Lake, and Eastman Reservoir are multiuse reservoirs providing flood control and water supply in addition to other benefits. These reservoirs must frequently release water to maintain sufficient storage for flood control downstream. This condition has been the impetus for Upper San Joaquin River Basin storage investigations conducted by USBR. The lack of sufficient storage, droughts that limit the availability of surface water, and anticipated permanent transfers of surface water to meet in-stream beneficial uses increase the need to store water when it is available outside of the water demand curve. Key benefits of the project are as follows:

- Water supply reliability to farmers over an area of 350 square miles will be increased.

- Seasonal operations of the districts will be improved by increasing the ability to meet peak irrigation demands in July and August even in dry years.

- Farmers in western Madera County are finding it increasingly difficult to afford the greater lift costs caused by declining groundwater levels. This project will reduce the groundwater overdraft due to the increased water supply it provides to the County, in addition to the recharge provided by the fact that only 90 percent of the banked water will be withdrawn.

- The project's water supply yield will reduce the competition for water supplies between farming, urban, and environmental interests in a county with increasing water demands and otherwise declining water supplies.

- The project will assist in meeting Delta water quality objectives by reducing stresses on the San Joaquin River system and improving dry- and critical-year water supplies.

- CALFED objectives will be met for increasing water supply for the region and reducing the mismatch between the water demands and supply while protecting the environment.

- Groundwater quality, which is deteriorating under the current condition of overdraft and urban encroachment onto farmlands, will begin to improve.

- In the past dry years (including 2007), MID has participated in dozens of water supply transactions to import surface water from other areas to improve water supply. The Water Supply Enhancement Project will help reduce the need for MID to import water during dry years, thus possibly making those foregone imports available for other agencies, including Madera County, which has statewide benefit.

- Subject to agreements with MID, Madera County could use the project (subject to CEQA and NEPA compliance) as a means to regulate and increase availability of water supplies to support the proposed new developments in the County. Participation in the project by the cities of Madera and Chowchilla could also improve groundwater conditions in and near the cities if exchange water could be made available to the cities for local recharge or for use in supplementing the cities' water supplies with treated surface water.

- The project could be used by USBR, the Department of Fish & Game (DFG) or DWR to aide San Joaquin River restoration efforts, contingent on compliance with NEPA and CEQA and subject to MID agreements.

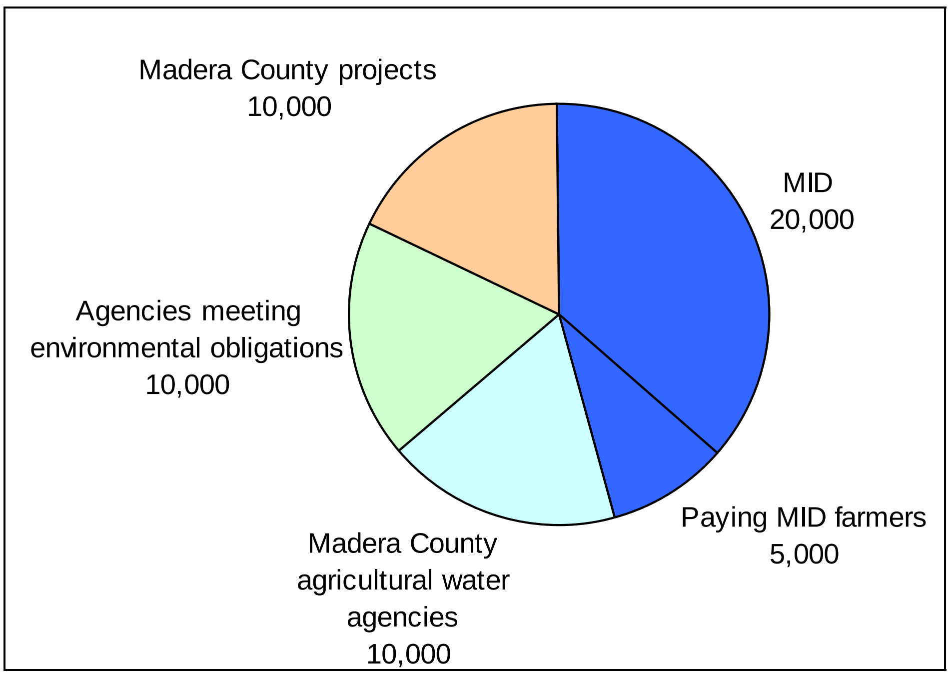
- The largest remaining tract of undisturbed upland grassland habitat in the Central Valley (10,878 acres) will be preserved, which is a key component of the US Fish & Wildlife Service Recovery Plan for Upland Species of the San Joaquin Valley (1998), which states, "A central component of species recovery is to establish a network of conservation areas and reserves that represent all of the pertinent terrestrial and riparian natural communities in the San Joaquin Valley. The recommended approach is to protect land in large blocks whenever possible." The plan specifies an area in Madera County with at least 6,000 acres of contiguous, occupied habitat. Absent this project, others have filed applications to develop four dairies on the Madera Ranch grasslands.

#### 8.1.1.3.2 Project Shares Allocation

MID has sized the Water Supply Enhancement Project to not only meet their needs but to also serve the needs of others in the County and the region. The MID board has approved, and staff is implementing a plan, that makes capacity available to others. The project capacity is defined by 55,000 "shares," with one share equaling 1 AFY of recharge, 1 AFY of recovery, 3 AF of storage space, and a 10 percent leave-behind requirement. Figure 8-1 shows MID's current proposed allocation of project shares.

MID has certified the project's CEQA Environmental Impact Report (EIR) and purchased the ranch for $37.5 million (September 2005), obtained over $8.6 million in previous studies and pilot tests, performed over 2 years of additional testing, received USBR approval for an 11,000-AFY pilot test, and was awarded a USBR Water 2025 grant of $297,600 for initial operations. USBR is preparing a NEPA Environmental Impact Statement (EIS) for the full-scale project. MID anticipates finalization of the NEPA process by mid-2008.

**Figure 8-1. Allocation of Project Shares**




MID included potential participation of GFWD and CWD in the EIR in recognition of the conveyances and water sources that are shared by these agencies. Participation by the County and others is subject to additional CEQA and NEPA compliance.

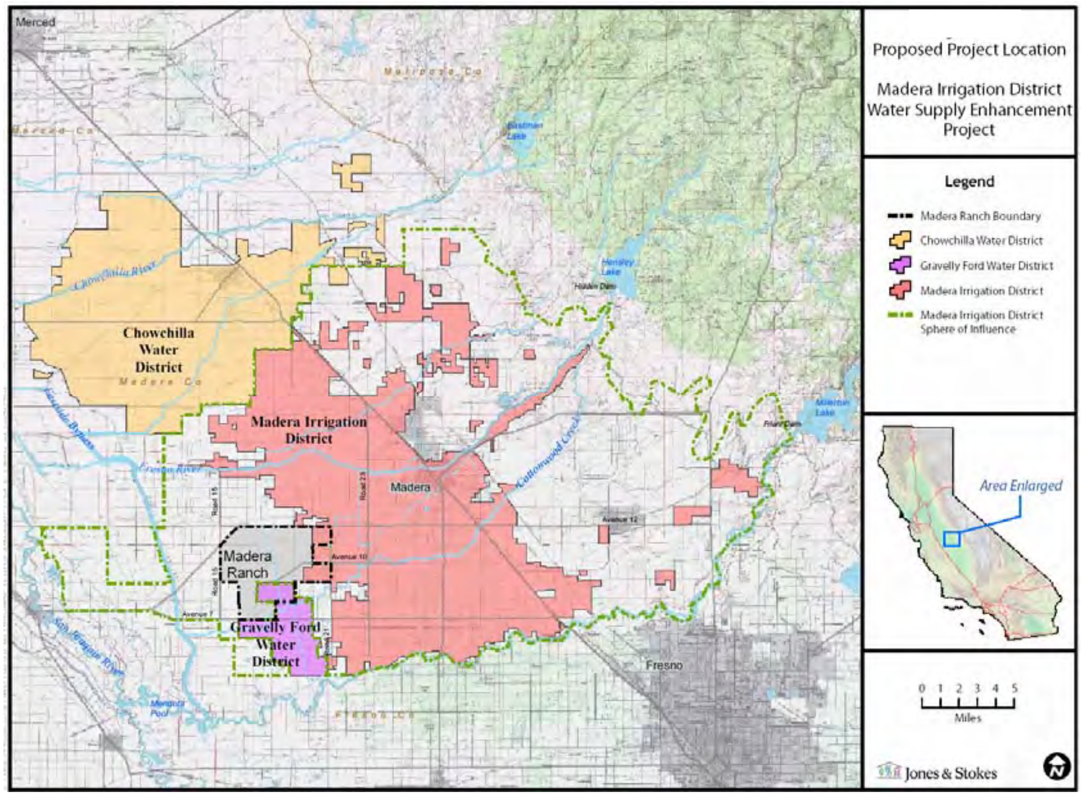
MID has formed a 10-member Madera Ranch Oversight Committee to protect adjacent lands and coordinate with the County. The committee includes the following representation:

- Five MID board members.
- One elected board member from GFWD.
- Three independent members representing the interests of surrounding landowners.
- One elected Madera County Supervisor.

#### 8.1.1.3.3 Project Description

The Water Supply Enhancement Project is located at Madera Ranch (Figure 8-2), which is a 13,646-acre (21.5-square mile) ranch located at the western end of the MID distribution system, south of the Fresno River, north of the San Joaquin River, and approximately 5 miles southwest of the City of Madera.

**Figure 8-2. Location Map**




MID's existing water system includes conveyances to the eastern portion of Madera Ranch, enabling immediate delivery of water for recharge through natural swales, basins, and in-lieu means. The project will enlarge these conveyances and add recovery wells and lift stations to enable recharge and recovery of greater volumes of water as detailed in Table 8-2.

**Table 8-2. Full-Scale Project Summary**

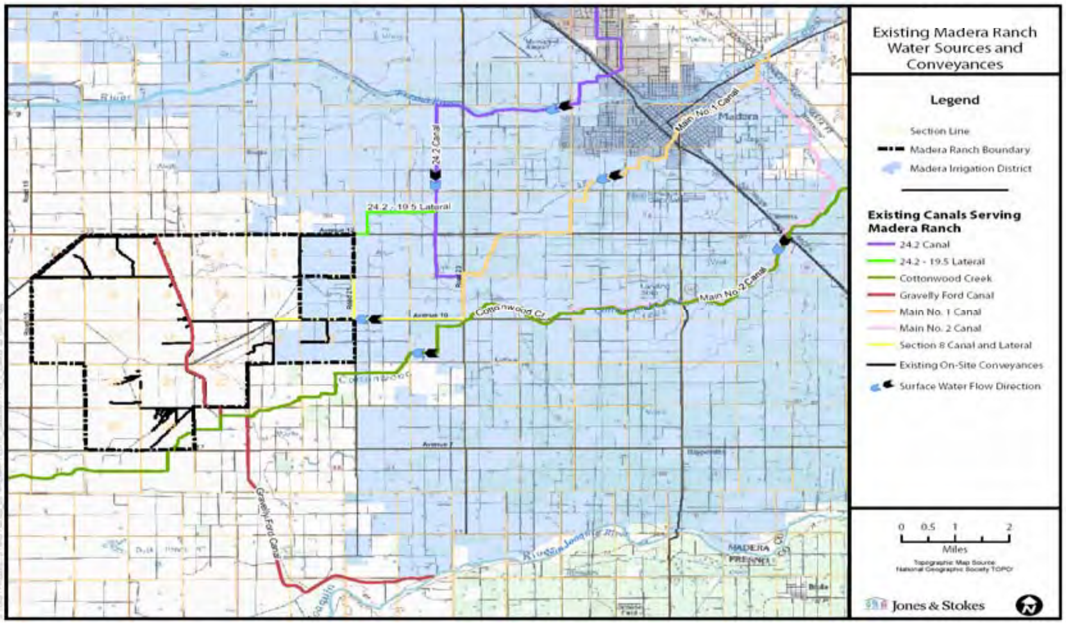
| | |
|---|---|
| Owner/operator | MID |
| Objective | Increase storage capacity and supply reliability |
| Source of recharge water | San Joaquin River and Fresno River surface water entitlements |
| Water conveyance | Gravity delivered through existing MID canals |
| Total capacity | Up to 250,000 AF |
| Annual capacity | Up to 55,000 AFY |
| Instantaneous capacity | Approximately 200 cfs |
| Percentage of water left behind for overdraft recovery | 10% |
| Recharge basin area | Up to 1,000 acres (less than 8% of ranch) |
| Swale recharge areas | Approximately 700 acres |
| In-lieu surface water delivery recharge areas | Approximately 2,600 acres |
| Percentage of Madera Ranch remaining as is | Approximately 85% |
| Wells for recovery of stored surface water | Up to 49 new wells |
| Recovery and stored water use | Pumped back into MID and surrounding areas for agricultural use |

Banked water would be recovered through an exchange in which the recovered water would be pumped back to MID farmers in lieu of the normal surface water deliveries from Millerton and Hensley Lakes, thus making an equal volume of water available in those facilities for delivery to others, including exchanges that can make surface water available to the Foothill and Mountain communities. MID plans to construct the project in two phases. Phase 1 will involve recharge-related facilities only. Phase 2 will involve supplemental recharge facilities and facilities for water recovery.

**Phase 1 Facilities**. Phase 1 will increase the capacities of existing MID conveyances to Madera Ranch. This work will include reconditioning and extending existing canals to provide at least 200 cfs of conveyance capacity into Madera Ranch; constructing 55 acres of recharge basins on agricultural land to regulate flow, remove sediment, and provide some recharge; enabling recharge to approximately 700 acres of natural swales; integrating approximately 2,600 acres of Madera Ranch farmland into an in-lieu recharge program in which surface water will be served in lieu of groundwater pumpage; and direct recharge onto farmlands when fields are fallow.

**Phase 2 Facilities**. Phase 2 will expand recharge areas, develop wells and piping to recover banked water, and install pumps to deliver the recovered water. Phase 2 facilities will include constructing up to 1,000 acres of new on-site recharge basins and canals as required to supplement Phase 1 facilities; using up to 15 existing wells for recovery; installing up to 49 new wells and recovery pipelines; and installing up to 13 lift stations on canals to provide 200 cfs of pumpback capacity into the MID service area. Figures 8-3 through 8-8 show the existing conveyances and the Phase 1 and Phase 2 improvements.

## Figure 8-3. Existing Conveyances




## Figure 8-4. Phase 1 Conveyance Upgrades

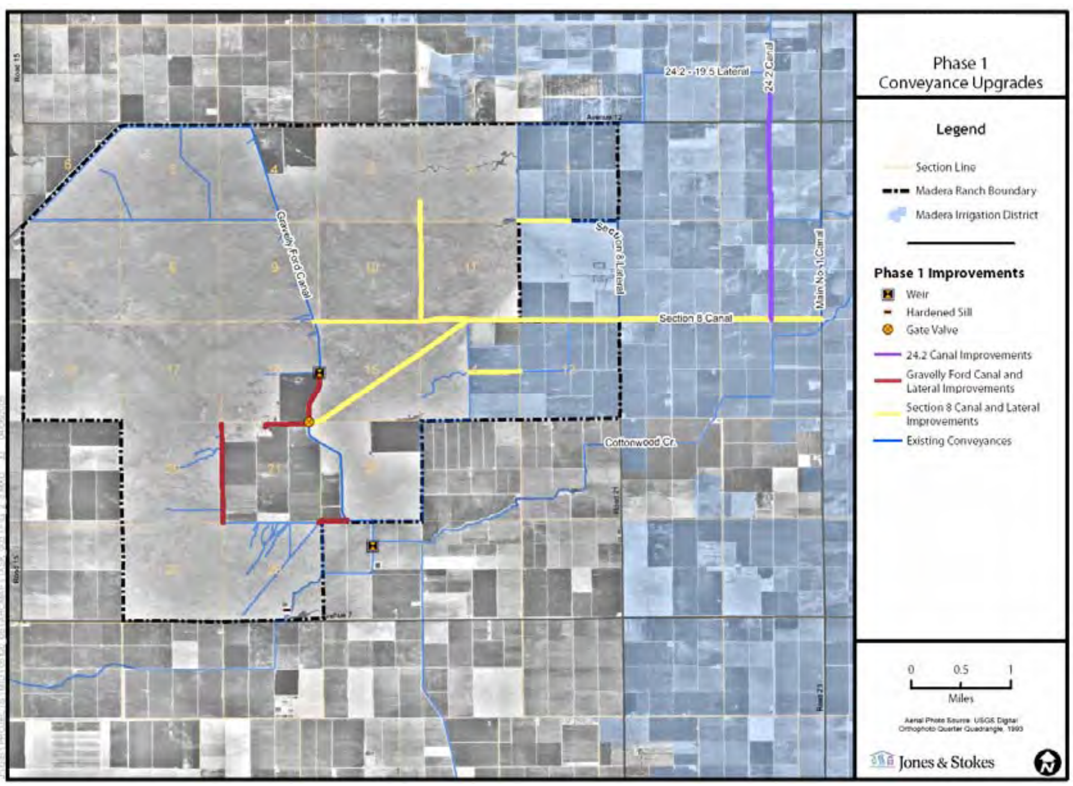


**Figure 8-5. Phase 1 Recharge Areas**

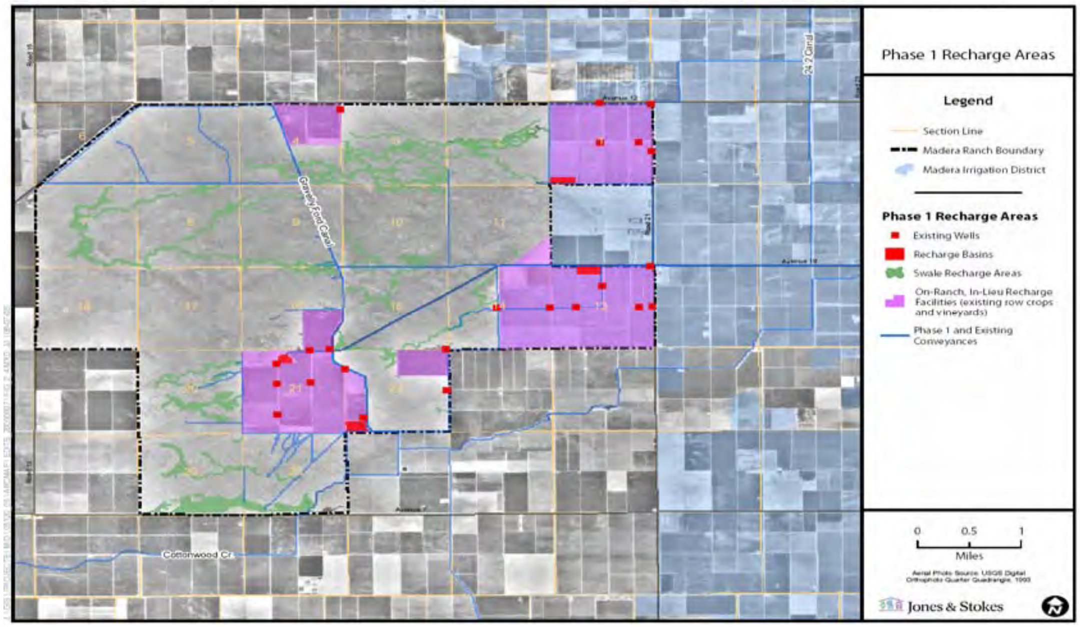
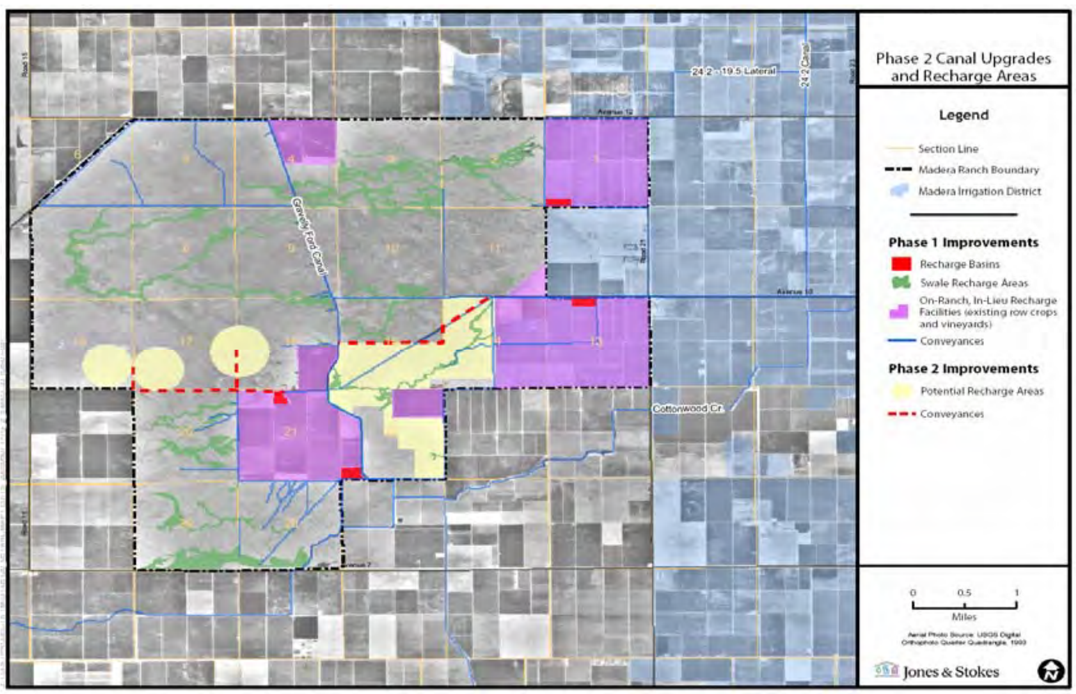
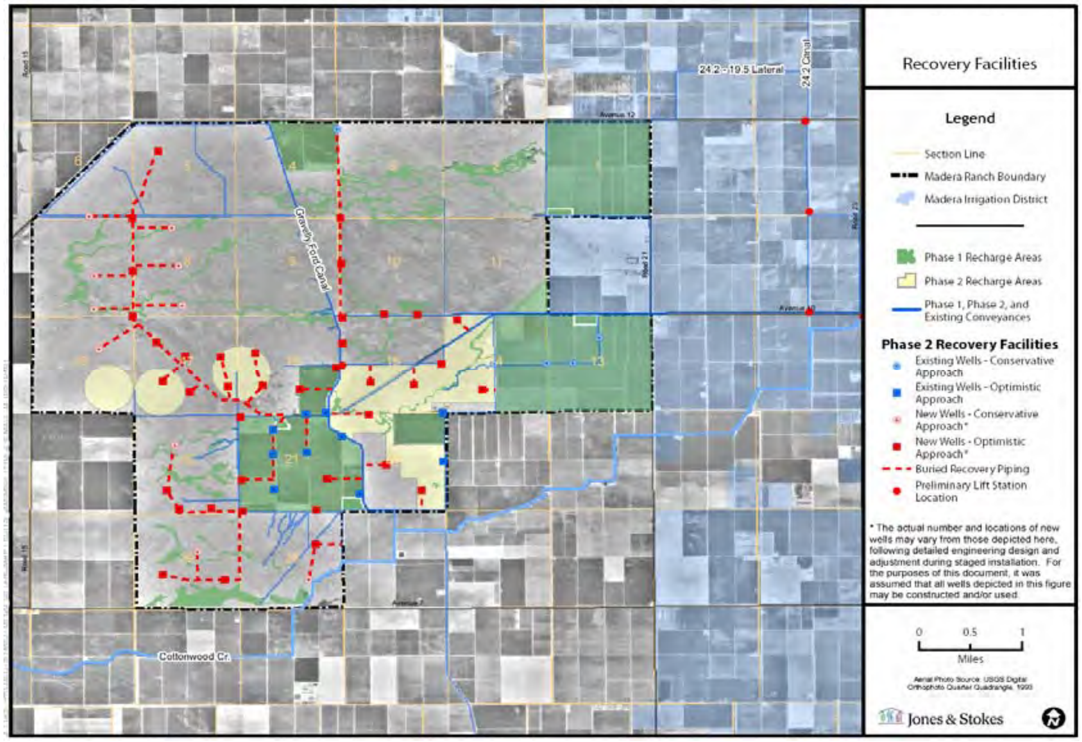


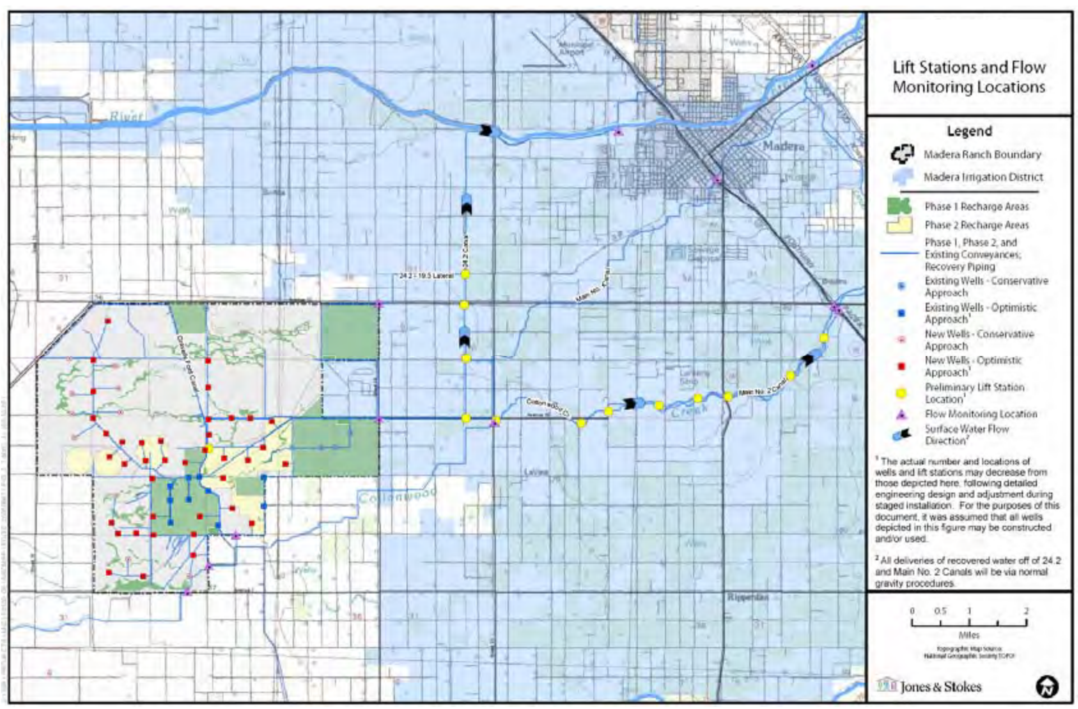

**Figure 8-6. Phase 2 Recharge Areas**



## Figure 8-7. Phase 2 Recovery Facilities




## Figure 8-8. Phase 2 Lift Stations



#### 8.1.1.3.4 Estimated Project Costs and Schedule

The estimated capital costs for the Water Supply Enhancement Project are as follows:

- Purchase of Madera Ranch: $37.5 million (completed).
- Final design and construction of Phase 1: $15.6 million.
- Final design and construction of Phase 2: $26.9 million.
- Total: $80 million.

In addition, MID anticipates expending approximately $10 million (over $2.5 million to date) on permitting, monitoring, debt service, reporting and management of the project over the next few years, with development proceeding according to the following schedule:

- By January 2008: 20 percent of recharge system online (USBR pilot).
- By late-2008: NEPA compliance complete for full scale project.
- By Jan 2009: 100 percent of recharge system on-line (Phase 1).
- By May 2009: 33 percent of recovery system on-line (Phase 2).
- Remainder of recovery system brought on-line as required.

### 8.1.1.4 Joint Cities and Water Agency Recharge and Regulating Reservoirs

Topsoils in parts of Madera County are relatively permeable and infiltrate water at moderate to high rates. The cities of Chowchilla and Madera have found that retention and infiltration of storm water by percolation is an economical means to manage storm water, the water then becoming a component of recharge to a groundwater basin currently in overdraft. However, the amount of this recharge is only a small part of City pumpage. These basins can also be used for active recharge programs where excess water in wet years is diverted into the basins for recharge. The basins can also be used for the regulation of canal flows to reduce operational spill and tailwater discharge.

The City of Chowchilla has plans to install regional storm drainage basins in cooperation with CWD for multiuse benefits. Currently, the City has seven storm drainage basins in operation. There is a need to prepare a comprehensive plan to size and locate basins to optimize their water conservation and recharge benefits.

CWD currently operates 10 regulating/recharge basins but is in need of additional facilities. A greater volume of spill from the CWD occurs in the wetter years compared to the dryer years, fluctuating between 3,000 and 28,000 AFY and averaging 13,200 AFY over the 1995 to 2005 period. New, properly-placed and -operated percolation basins will assist in reducing spills and possibly the groundwater overdraft.

The City of Madera, the County of Madera, and MID are planning to install additional basins to capture operational spill and storm water runoff for groundwater recharge. MID currently operates six percolation ponds and recharges an average of approximately 3,000 AFY. MID also reports spill water during the irrigation season averaging approximately 1,000 AFY. During wet years a much larger amount of spill occurs. The City and MID have entered into a

Memorandum of Understanding regarding joint use of percolation basins. Capture and control of runoff from Root Creek and Cottonwood Creek have been identified as good water supply sources for groundwater recharge. As is the case in Chowchilla, new, properly placed and operated percolation basins will assist in reducing the current groundwater overdraft, and there is a need to prepare a comprehensive plan to size and locate basins to optimize their water conservation and recharge benefits.

#### 8.1.1.5 Madera Lake Area Groundwater Storage

As stated in its Groundwater Management Plan, MID will actively pursue additional groundwater recharge facilities and work cooperatively with other agencies to facilitate conjunctive use programs. The pursuit included the "Madera Lake Area Groundwater Storage Feasibility Study" conducted in 2006 for MID, which evaluated the potential for increased groundwater recharge through use of Madera Lake and the potential for construction of additional recharge basins, especially on the south side of the Fresno River.

Madera Lake, approximately 500 acres in size, is currently operated intermittently as a groundwater recharge facility and is designated by Madera County as a wildlife sanctuary. More frequent or regular use of the facility as a groundwater recharge or regulating facility will increase the wildlife benefits at Madera Lake. However, it is becoming increasingly difficult to gravity flow water from the Fresno River into Madera Lake through the Inlet Canal because the elevation of the Fresno River channel at the diversion point continues to decline. The use of temporary barriers in the river channel to raise the water level to enable diversion into Madera Lake is currently required.

Also, the Inlet Canal control structure invert is now too high to allow diversion of the low flows from the river. The structure is also in need of major repair and modifications to be used on a regular basis. Prior to the project, there was no means to measure the amount of water diverted from the river into the lake. In an effort to improve the groundwater recharge capabilities of Madera Lake, improve the wildlife habitat benefits, and improve the efficiency of its operations, MID requested Boyle to study the above-mentioned problems and provide a proposal to remedy the problems, including evaluation of a permanent water elevation control structure in the Fresno River.

After investigation of the site and current facilities, Boyle recommended construction of a permanent water elevation control structure in the Fresno River to divert and measure water flow to Madera Lake. In addition, a groundwater-monitoring program was recommended that included construction of monitoring wells and a new lake water level measuring facility (gauging station). Recorders would be designed to read groundwater and lake water levels as well as inflow and outflow rates from the lake. This would eliminate the need for daily visits to the site. To improve operations and flexibility in moving water in and out of the lake, it was recommended that the lake outlet structure be modified and repaired. This would allow the lake to be used once again as a regulating reservoir in addition to providing improved groundwater recharge benefits. The use of the lake for regulating flows allows capture and storage of flows above the required amount needed downstream for delivery at a later date or left in the lake for recharge instead of being lost at the end of MID's delivery system.

Boyle also recommended that a groundwater-monitoring plan be developed to monitor the response of groundwater levels in the Madera Lake area to the proposed recharge program. The data collected would determine the recharge capabilities of the lake and the direction the recharged water traveled. It was recommended that a series of monitoring wells be installed around the lake with an emphasis on the area southwest of the lake, which is the general direction of groundwater flow in the area. Land south of Madera Lake and the Fresno River is within MID's boundaries and has been identified as a very favorable area for recharge based on the City of Madera's 1999 Water Master Plan and Storm Drainage Master Plan.

The improvements to the Madera Lake infrastructure have been completed and the groundwater recharge test was successful. The use of State grant funds enabled evaluation of the recharge potential of the lake area and to reestablish the lake as an important regulating reservoir for MID's water operations.

The recharge test indicated that the recharge potential of Madera Lake is approximately 10,000 AFY. The test also indicates that the primary flow of groundwater in the area and the recharged water is to the southwest. This is important in that the lake lays upgradient (northeast) of MID and the City of Madera, and the recharged water will help alleviate the overdraft within the district and the basin. The use of Madera Lake as a groundwater recharge facility and regulating reservoir will improve MID's water supply and water delivery efficiency. The ability to use Madera Lake as a regulating reservoir will conserve Fresno River water that would have otherwise be lost as operational spill.

The groundwater recharge feasibility study was widely supported by the other water users in the County including neighboring water districts and the Madera County Farm Bureau. The increased use of Madera Lake for recharge and regulating operations will increase lake water levels and will also improve the habitat available for the large number of waterfowl and wildlife that inhabit the lake area that is designated a wildlife sanctuary by Madera County.

The following project implementation steps were recommended in the feasibility study:

- Increase use of Madera Lake as a groundwater recharge facility and regulating reservoir.
- Continue the monitoring program, including reading the water levels in the monitoring wells even when the lake is not being used for recharge or regulating purposes. The data gathered will assist in evaluating the long-term potential and benefits of a groundwater recharge program at the lake.
- Initiate discussions with USACE and DFG regarding permitting and construction of a permanent water elevation control structure in the Fresno River. Permits required will include a Lake and Streambed Alteration Permit (Section 1601 of the Fish and Game Code) and possibly a USACE Section 404 permit.
- Develop and initiate a program to investigate the potential for additional recharge basins south of Madera Lake and the Fresno River.

- Investigate the potential for constructing extraction wells in the area to recover recharged water during water short years.
- Pursue funding opportunities for construction of a permanent water elevation control structure in the Fresno River, including additional grant funds available for construction projects under the DWR Groundwater Storage Program.
- Based on the outcome of the previous recommendations, initiate CEQA review of the construction of a permanent water elevation control structure in the Fresno River.
- Design and construct a permanent water elevation control structure in the Fresno River to serve both Madera Lake and any additional recharge basins constructed in the area.

#### 8.1.1.6 Madera Canal/Hidden Dam Pump Storage Project

MID is evaluating a potential pump storage project connecting the Madera Equalization Reservoir on the Madera Canal and Hensley Lake (Hidden Dam) on the Fresno River. The project will allow MID to pump San Joaquin River water from the Friant system of the CVP into Hensley Lake when storage space is available for use later in the year. The ability to store San Joaquin River water in Hensley Lake will assist MID in its efforts to increase available surface water supplies and decrease groundwater pumping (and therefore overdraft) in the district.

As part of MID's investigation, a feasibility study was completed in August 2003 that evaluated the feasibility of the project from operational, technical, and economic perspectives. The feasibility study evaluated the potential availability of water from the Friant system that could be pumped and stored in Hensley Lake. The study assumed a 100-cfs pumping plant and power generation facilities located only at the Madera Equalization Reservoir to evaluate the economic feasibility of the project. Based on this preliminary assessment, it was concluded that the project was operationally, technically, and economically feasible, and it was recommended that MID proceed with further studies to evaluate the project. Therefore, MID authorized preparation of a predesign report to further investigate and evaluate the project.

Based on the findings of the feasibility study, the proposed Madera Canal/Hidden Dam Pump Storage Project is technically, legally, and institutionally feasible. The operations study and the economic analysis of the stored water costs indicate that a pumping plant with a capacity of 140 to 180 cfs is the most beneficial when considering the amount of water available for pumping, storage available, evaluation of the risk of spilling stored water, and the cost per acre-foot for the stored water. The average annual amount of storable water is about 5,800 to 6,500 AFY, depending on the size of the pumping plant. The average annual cost of stored water is approximately $100/AF (2005 costs) and will range from $90/AF to $130/AF in average years, depending on the amount of water released from Hidden Dam and diverted through the project's power generation facilities. These costs are generally less than other outside sources of water available to MID, especially in lean water years.

The study confirms the preliminary findings of the earlier feasibility study that it is cost effective to have power generation facilities in addition to the pumping facilities. Power generation facilities at both the Madera Equalization Reservoir and at the Fresno River turnout are beneficial. Power generation revenues reduce the annual average cost of stored water by $60/AF to $80/AF.

Based on consultation with the involved agencies conducted as part of this study, there is tremendous support for the project. Agencies consulted include USACE, USBR, and DFG. The project has many positive aspects such as:

- Although not a firm source, the project does create a new source of developed water. If the project were operated in conjunction with another project, such as a groundwater bank, the project could potentially create a firm source of water for MID and/or its partners.

- The project produces a clean source of renewable energy.

- The water developed will reduce groundwater pumping.

- The project will provide increased flexibility in operations by allowing Fresno River water to be delivered to a larger portion of the district.

- The project offers the potential for improved recreational opportunities at Hensley Lake.

- The project will provide additional operational flexibility, which will improve water management and will improve utilization of supplies from other sources.

- Design of project facilities will improve the ability to release low flows from the dam and improve water measurement that will benefit MID and may assist in maintaining higher water levels in Hensley Lake.

There has not been any major environmental, legal, or institutional issues identified that would prevent the project from moving forward. Therefore, it is recommended that there be further discussion and studies with USACE regarding the modifications of Hidden Dam outlet facilities and preliminary approval be obtained before project initiation takes place. In addition, further discussions with USACE, USBR, and DFG should take place regarding storage issues, timing of releases, and release rates from Hidden Dam, and diversion of releases to the Madera Equalization Reservoir. An operational model of project facilities should be developed to assist in these discussions. The model would be used by MID for planning and operational decision making once the project is constructed. Finally, it is recommended that further research into potential power purchasers and power generation issues be initiated along with pursuing potential funding sources, including private sources, as discussed in the report.

In summary, the Madera Canal/Hidden Dam pump storage project is technically, legally, institutionally, and economically feasible, and the potential benefits warrant continued development of the project.

### 8.1.1.7 Additional CWD and MID Projects

CWD and MID have identified additional potential projects that are aimed at water supply augmentation and groundwater recharge. They are described as follows.

- River Channel Seepage Enhancement Feasibility Study. Perform a study to determine the feasibility for increasing seepage in the Ash Slough, Berenda Slough, and Chowchilla River by constructing check structures in the river channels to raise the level of the water and thereby increase the seepage in the affected section of the river channel.

- Madera Canal Surface Storage Reservoir Feasibility Study. Perform a study to determine the feasibility for constructing a 1,000- to 20,000-AF capacity offstream surface storage reservoir adjacent to the Madera Canal.

- Buchanan Dam Enlargement Feasibility Study. Perform a study to determine the feasibility for enlarging the capacity of Buchanan Dam by 10,000 to 50,000 AF.

- Chowchilla River Surface Storage Feasibility Study. Perform a study to determine the feasibility for constructing a 10,000- to 100,000-AF surface storage reservoir on the Chowchilla River or one of its tributaries.

- Groundwater Recharge Pond and Recovery Well Feasibility Study. Perform a study to determine the feasibility of constructing 10 to 20 groundwater recharge ponds and 20 to 40 groundwater recovery wells in CWD. DWR well logs would first be analyzed to determine potential groundwater recharge sites and recovery well sites.

- Expansion of CWD and MID Water Service Areas. Significant groundwater overdraft is taking place in nondistricted areas outside of CWD and MID. To have better control over the management of the water resources, the service areas of the two largest irrigation and water districts (CWD and MID) could be expanded. This could be done through annexation of adjacent areas currently farmed using groundwater. Recognizing this opportunity to reduce overdraft, CWD, in cooperation with the City of Chowchilla and Chowchilla-Red Top Resources Conservation District, commissioned a study to identify potential additions to its service area (Wrime, 2002). Extension of surface water service areas and the water resource benefits should be pursued since the water resource benefits to the Madera groundwater basin are expected to be significant and more so if coordinated with additional surface water storage projects.

### 8.1.1.8 Madera Canal Capacity Increase

The Madera Canal is the major facility that conveys water from the San Joaquin River at Friant Dam to the CVP contractors (Madera Irrigation District and CWD) in Madera County. The canal is also used by USBR to convey flood water to river and creek channels in Madera County when necessary to control flooding. The capacity of the canal ranges from 1,275 cfs at the dam to 750 cfs at the end of the canal. Madera Irrigation District is entitled to 60 percent of the canal capacity and CWD is entitled to 40 percent. During much of the irrigation season, the canal is operated at or near capacity, which is problematic in that many of the previously discussed water augmentation projects would or could use the Madera Canal to convey water into the County and to project facilities. This includes potential water obtained from additional storage on the San Joaquin River (Temperance Flat Dam), the Madera Water Bank, the Madera Lake groundwater storage project, and Madera Canal/Hidden Dam pump storage project. In addition, the expansion of CWD and Madera Irrigation District may require additional conveyance capacity in the canal. Development of additional recharge and storage sites in the County may also require the increased capacity of the canal to enable conveyance of San Joaquin River water, which will likely be the major source of water for these facilities.

If in the future the cities of Madera and Chowchilla can obtain surface water supplies for treatment and delivery to their customers, it is likely that the water will be conveyed through the Madera Canal. The operation of water treatment facilities would require a year-round source of water. The canal is also the key facility that allows water purchased outside the County to be conveyed into the County through transfers and exchanges. This is important in that water supplies obtained for use in the Foothills and Mountains may also require use of the Madera Canal as part of the transfer and exchange process to allow delivery of surface water to communities in the Foothills and Mountains. Increasing the capacity of the Madera Canal would have countywide benefits. Therefore, a feasibility study for increasing the capacity of the Madera Canal needs to be conducted.

### 8.1.2 Water Demand Reduction Measures

The following are water demand reduction measures that could be considered in the Valley Floor area. Many of the potential water demand reduction measures are applicable to the Foothills/Mountains area also.

#### 8.1.2.1 Irrigation Water Conservation Opportunities

The following water conservation measures are recommended for consideration for agricultural lands in the County:

- Additional projects for tailwater/spill recapture should be identified. Opportunities to construct recharge basins and/or regulating reservoirs along major conveyance facilities should be studied in an effort to reduce the amount of surface water that leaves a district.

- Incentive pricing to influence water use decisions should be reviewed. A study of water rates could identify rate-setting policies that could encourage the use of surface water instead of groundwater. In some cases, groundwater is less expensive than purchasing surface water.

- Water measurement (meters) for better water accounting and assessment of water conveyance and use efficiencies. Most agricultural deliveries in the County are metered, but there is a need for improved measurement and control of major conveyance facilities. A study of needed improvements may identify opportunities for improvement and potential funding sources.

- Distribution system and on-farm irrigation water delivery improvements can be made at both district and farm levels. Examples include construction and automation of modern canal water level structures at the District level and conversion to drip or microsprinklers at the farm level. A comprehensive evaluation of district delivery efficiencies and on-farm irrigation efficiencies would identify areas where improved facilities and practices would conserve water. Funding sources should also be evaluated.

It should be noted that agricultural water use efficiency has made tremendous progress in the last 20 years and continues to evolve and improve out of necessity to deal with reductions in water supplies and economic conditions. The irrigation and water districts in the County with CVP water service contracts, including MID, CWD, and GFWD, are required to submit annual Water Management Plans to USBR that include measures to ensure efficient water use.

#### 8.1.2.2 Municipal and Industrial Water Conservation

Most of the municipal water delivered for residential use in the Valley Floor area is unmetered and billed at a flat rate. Data shows that when meters are installed and water is billed on a volumetric use rate, the amount of water used by a typical residence is reduced by 15 to 25 percent. Since 1992, all new construction has required the installation of water meters. However, in the case of the two largest urban areas of the Valley Floor, the meters are not read, and billing for water use is at a flat rate. Installation of meters and billing of water use on a volumetric basis will cost the cities of Madera and Chowchilla approximately $6M to $9.5M and $700,000 to $1.1 million,[1] respectively, and water savings would be approximately 3,500 to 6,600 AFY and 1,300 to 1,600 AFY, respectively. Installation of meters and billing on a volumetric use basis would have an immediate impact on the volume of groundwater pumped for residential use and a direct impact on overdraft.

All large commercial, industrial, and institutional water customers served by municipal water systems are metered and billed monthly. It is recommended that water surveys (audits) be conducted for these customers, including review of all interior and exterior water use. Recommendations where improvements should be made and follow up visits should be conducted.

Water conservation patrols in communities should have the responsibility to educate water users that overuse water for irrigation purposes. The patrol should provide a variety of resources to help consumers conserve including staff expertise, written water conservation materials, and hands-on landscape irrigation water management training.

All municipal-maintained median strips and traffic islands that require plantings should be landscaped with drought-tolerant plants and irrigated using low-flow, water-efficient irrigation systems. The Building Department of the municipalities should maintain lists of approved plantings for public rights-of-way. Criteria for inclusion on the list include low water consumption and drought tolerance.

[1] Based on projected City of Fresno costs.

There is ever-increasing use of artificial lawn for landscaping purposes. The County and cities in Madera County may want to investigate potential funding sources to implement a rebate or cost share program for both residential and commercial water users that convert existing irrigated lawn areas to artificial lawn.

#### 8.1.2.3 Wastewater Reclamation Opportunities

As stated in Chapter 3 of this Plan, only the two incorporated cities in the County (Chowchilla and Madera) have significant wastewater treatment plants. The community of Oakhurst also has a wastewater treatment plant. None of these three entities operates a recycled water facility. As a water demand reduction measure, it is recommended that the three entities investigate the potential for development of recycled water facilities. Some of the potential uses for recycled water include large landscape irrigation such as golf courses, residential lawn irrigation, flushing water in large commercial and institutional establishments, and area-specific groundwater recharge projects. These and other water recycling issues should be explored in greater depth in a feasibility study.

Further, industrial and commercial customers should be encouraged and assisted to establish treatment and reuse of wastewater.

### 8.1.3 Flood Control Projects and Programs

#### 8.1.3.1 Joint Powers Agreement

Because storm water management in the County encompasses different jurisdictions, it is recommended that a joint powers agreement (JPA) be established between the agencies for flood control. Strong interest is currently shown by Madera County, the City of Madera, and MID for such collaboration. Meetings have been held on flood control planning and recharge projects. An existing JPA between the Chowchilla Red Top Resource Conservation District, City of Chowchilla, and Chowchilla Water District could possibly be expanded to include other agencies for this purpose.

#### 8.1.3.2 Potential Projects and Programs

The following are some of the potential flood control projects and programs identified during discussions in Chapter 7.

##### 8.1.3.2.1 Storm Water Master Plan Update

The most recent Storm Water Master Plan in the County was developed for the City of Madera in 1998. Even though, this storm water master plan contains useful information, an updated storm water master plan encompassing the entire Valley Floor will be extremely useful in reducing flooding while using the flood water for groundwater recharge. For example, the City of Madera and MID have discussed the possibility of putting more storm water into MID canals after filtration to move the water to the Water Bank or other local recharge basins. It is therefore recommended that a joint storm water master plan be developed for the Valley Floor agencies, including the cities of Madera and Chowchilla, County of Madera, MID, CWD, and Root Creek Water District among others.

#### 8.1.3.2.2 City of Madera Downtown River Project

The County and City of Madera are currently planning a feasibility study of a downtown river project. The purpose of this project is to supply a portion of the Fresno River with year-round water. In addition to providing flood control and possible groundwater recharge, the project would be aesthetically pleasing, offer opportunities for recreation, and create economic development incentive. Representatives from Madera County, City of Madera, and MID (who would be essential partners) have shown a positive response to the concept. A feasibility study should be undertaken to explore the benefits and costs of this popular project. The above-mentioned agencies are currently seeking State grant funds to conduct the study.

#### 8.1.3.2.3 Comprehensive Flood Control Program

A comprehensive flood control program should be implemented by the County through the Madera County FCWCA. The program would provide for the collection and safe disposal of storm water runoff generated within the urban and rural watersheds or “drainage areas” with emphasis on groundwater recharge. The cities within the County have selected retention and percolation as the preferred storm water management option. This should be extended countywide. All agencies within the County should be closely integrated and coordinated to provide efficient, comprehensive services. Collectively, these facilities should comprise a “Storm Drainage and Flood Control Master Plan.” This should be a follow-up to the Valley Floor Storm Water Master Plan.

The economic vitality of the County requires positive flood control, including planned local drainage facilities similar to Fresno Metropolitan Flood Control District.

It is proposed that the flood control program provide water supply and water quality benefits by capturing an average of 90 percent of all urban runoff. It should also provide for a cooperative groundwater recharge program done in partnership with other local water agencies. As in the cities, water conservation benefits should be a design objective of the flood control and urban drainage systems in the County.

#### 8.1.3.2.4 Countywide Emergency Response and Recovery Plan

It is recommended that a more formalized emergency response and recovery plan be developed for the County. This plan must be well coordinated with all the various departments of the County. It should be in compliance with the National Incident Management System and cover not only flooding but all the other significant hazards faced by the County. It should have the following components:

- Emergency management organization
- Disaster scenarios definition
- Response/recovery/restoration activities
- Plan activation and deactivation
- Plan documentation
- Awareness and training activities
- Plan distribution
- Plan testing
- Plan maintenance

#### 8.1.3.3 Funding Sources

Funding for flood control planning in Madera County could come from grant funding and the benefiting landowners through impact fees paid to the County and cities. Grant funding could come from the DWR and be matched by the local agencies. Private funds acquired by the agencies to avoid flood impacts should be relied upon to control urban runoff.

On occasion, the system construction funding produced by the development of the lands needing such facilities is insufficient to secure timely construction and to avoid the need for temporary facilities. The creation of a County Economic Development Reserve similar to Fresno Metropolitan Flood Control District would provide resources necessary to secure construction of permanent planned local drainage facilities for high priority economic/jobs development.

The County should consider establishing a policy to budget and implement the use of an annual Economic Development Reserve, based on the following:

- Up to 50 percent of the existing Madera County FCWCA annual budget reserve may be allocated to the support of construction of Master Plan storm drainage facilities to service-designated, high-priority, economic/jobs development projects during the budget year.

- Projects should be considered on a first-come/first-served basis unless multiple projects are competing, and then a merit-based prioritization should be developed and implemented to choose projects for funding.

- The commitment of FCWCA general funds to such a project must create additional financial leverage toward construction of master plan facilities by (a) drawing in additional public or private monies, (b) effecting construction of critical elements of the drainage system, and (c) serving an economically targeted industry or area.

- Projects meeting the definition for eligible projects (to be developed as part of the program) may be submitted for reserve appropriation consideration by private parties, other public agencies or FCWCA itself. All projects proposing use of the economic development reserve should be reviewed by the appropriate committee (i.e., Water Advisory Commission) for a determination of priority and consistency with this policy.

The committee should submit its recommendation to the full Board of Supervisors for action.

- All project proposals should, whenever possible, be considered at the time of budget adoption. However, projects may be considered throughout the fiscal year as may be necessary due to critical project timing considerations.

## 8.2 Foothills and Mountains Water Management Opportunities

### 8.2.1 Surface Water Supply Requirements

The major communities in the Foothills and Mountains include the Oakhurst and Ahwahnee area, Coarsegold, North Fork and South Fork area, and the Raymond Daulton Ranch-Hensley Lake area. Groundwater investigations have been prepared for each of these areas by KDSA as part of this Plan, including examining the availability and quality of the groundwater. Groundwater sources in these communities are replenished from precipitation (primarily rainfall). A portion of the rainfall is consumed by evapotranspiration by the native forest and brushlands; the remainder of precipitation is runoff that flows over land, in creeks and streams, and also in the fractures of the hard rock. It is these fractures that are the sources of the groundwater captured by both the private and community wells in the Foothills and Mountains.

Precipitation varies linearly with elevation, as shown in Figure 5-9. The average annual rainfall for the specific areas, developed from DWR data compilation depicted on Plate 2 of their report (DWR 1966), is presented in Table 8-3. It is the amount of rainfall in excess of the evapotranspiration that produces the water source for wells in the Foothills and Mountains and streamflow.

The native evapotranspiration varies depending upon the vegetative type and the density of growth. For areas between elevations 900 and 2,500 feet, the approximate average native evapotranspiration

**Table 8-3. Community Average Annual Precipitation**

| Community | Average Annual Precipitation (inches) |
|---|---|
| Oakhurst | 33 |
| Ahwahnee | 28 |
| Coarsegold | 27 |
| North Fork/South Fork | 32 |
| Raymond | 16 |
| Daulton | 13 |

is about 13 inches per year in the Daulton area, 18 inches in the Raymond area, 16 to 24 inches in the Coarsegold area, 15 to 20 inches in the Ahwahnee area, and 20 to 25 inches in the Oakhurst area.

By comparing the average annual rainfall to the approximate average annual native evapo-transpiration, some general inferences can be drawn regarding the availability of groundwater. In the Oakhurst, Ahwahnee, upper Coarsegold, and North Fork/South Fork areas, average annual rainfall substantially exceeds the average annual native evapotranspiration. With the additional potential recharge that could occur from runoff of tributary watersheds, these communities' current water demands are expected to be met by pumping groundwater in all water year types.

The existing developments in the Oakhurst area served by the Broadview Terrace Mutual Water Company (Broadview) and the Hillview Water Company (Hillview) experience groundwater level declines and reduction in well production in the summer months. Of equal concern are the high levels of uranium found in many of the wells operated by the two water companies. The well production issue could be solved by properly spacing wells adequate distances apart. If treatment for uranium removal is proven to be infeasible, then there would be a need for a supplemental surface water supply source to meet the demand in months of high water use and improve the delivered water quality such that it meets the Domestic Water Quality Standards.

It appears that in the lower Coarsegold area (average annual rainfall approximately 20 inches) and in parts of the Raymond and the Daulton areas (average rainfall less than 20 inches), supplemental supplies of surface water may be needed to support large-scale development unless the groundwater supplies are identified and adequately tested prior to project approval. The amount of surface water required will depend on the amount of area developed, land use, and density of the development. Careful monitoring of the groundwater levels should be continued as the communities grow as recommended in the hydrogeologic studies by KDSA (2007).

As discussed in Section 8.2.3, research and anecdotal evidence indicate that the native evapotranspiration can be significantly reduced through various methods of vegetative treatment. Reduction in the native evapotranspiration may result in additional runoff in the higher mountain communities and potentially increase surface water supplies, but additional research and study are needed to document the water supply benefits of vegetative management. Parallel activities should include updating the feasibility studies of development of supplemental surface water supplies. Past studies of potential surface water projects have been performed anticipating the need for the additional water supply which are summarized below.

### 8.2.2 Water Supply Augmentation Opportunities

In 1966, a study was performed to determine the best method of supplying water for municipal and industrial purposes to the areas of Oakhurst, Ahwahnee, Coarsegold, North Fork, and South Fork. This project was termed the "Oakhurst-Soquel Project." In 2003, another study to supply water to the mountain communities (Redinger Project) was made to determine the most appropriate way to provide surface water to the growing communities in eastern Madera County (Kretzinger, 2003). The plan called for diverting water from the San Joaquin River at Redinger Lake on the San Joaquin River at elevation 1,400 feet.

The Redinger Project proposed to serve Raymond, O'Neals, and Yosemite Lakes Park as an additional phase, with the Oakhurst, Ahwahnee, Coarsegold, North Fork, and South Fork areas being served by the Oakhurst-Soquel Project. The recent evaluations of the groundwater supply availability indicate that the groundwater conditions are not as dire as predicted when these previous surface water studies were preformed, but limited surface water supply investigations are recommended to determine the best manner to augment the groundwater in the areas noted above if future developments are undertaken. These include the three projects listed below. The project concepts are discussed in the following sections.

- Broadview and Hillview surface water supply from Lewis Creek, Willow Creek, or Bass Lake.
- Lower Coarsegold area surface water supply.
- Raymond/Daulton area surface water supply.

#### 8.2.2.1 Broadview and Hillview Surface Water Supply

To date there has not been a study to quantify the surface water requirements or detailed evaluation of facilities needs of this portion of Oakhurst. Based on water use data for these areas, it is estimated that a surface supply of approximately 500 AFY (310 gpm, 450,000 gpd, or 0.69 cfs) would be sufficient to mitigate current water supply problems in these areas. There are several potential points of diversion along Lewis Creek downstream from the confluence of Nelder Creek that warrant investigation. Other sources of water supply to be considered are Willow Creek and Bass Lake, which is operated by Pacific Gas and Electric Company. A water supply investigation is needed to determine the best option to alleviate water supply and quality problems that affect the health and safety of this portion of the Oakhurst area. It should be noted that MID's Big Creek water flows into Lewis Creek and is not available for use without a contract agreement. Also, MID's Soquel water either flows into Nelder Creek or stays in Willow Creek to Bass Lake, depending on conditions. This water is also not available for use without a contract agreement.

The water supply investigation should consider the following factors:

- Quantification of water needs
- Availability of water (water rights and water source investigation)
- Raw (untreated) water quality
- Diversion structure cost
- Water transmission costs
- Water treatment storage costs
- Treated water distribution costs
- Water procurement costs (water rights)
- Environmental impact
- Cost to water users

#### 8.2.2.2 Lower Coarsegold Surface Water Supply

Surface water supply for the lower Coarsegold area was evaluated as a supplemental supply to groundwater for the Yosemite Lakes Park development in 1973. The study resulted in an agreement with MID to allow storage of Coarsegold Creek water in Black Hawk Reservoir, with a capacity of 650 AF and diversion of up to 2,000 AFY for use in the Yosemite Lakes Park development. However, the agreement was terminated in the early 1990s. Any study to evaluate surface water alternatives for the lower Coarsegold area should include evaluation of the potential of negotiating a new agreement with MID for storage and diversion of water from Black Hawk Reservoir. This potential project is well located, and a 2,000-AFY yield is in the anticipated range of the supplemental water supply need of lower Coarsegold. After storage, the raw water would need to be treated, stored, and pumped through new distribution mains to the consumers. A water supply investigation is needed to determine if this project is a cost-effective means to supplement the available groundwater supply in the lower part of the Coarsegold area. The water supply investigation should consider the same factors identified Section 8.2.2.1.

#### 8.2.2.3 Raymond/Daulton Surface Water Supply

The 2030 population projection for the Raymond/Daulton area indicates that an additional water supply of approximately 500 AFY will be needed. It is uncertain how much of this water could be supplied by wells.

A preliminary appraisal of the water resource features in the area indicates that Eastman Reservoir is the nearest supply source to Raymond and could provide a good-quality firm water supply of 500 AFY if the water could be acquired or purchased. The storage capacity of Eastman Reservoir is 150,000 AF. The evaluation of Buchanan Dam is 450 feet above mean sea level. Water could be withdrawn from the lake and piped 4 to 5 miles to a water treatment plant and storage site located west of the community of Raymond at an elevation of approximately 1,000 feet. After treatment and storage, water could be delivered to the consumers by gravity, eliminating the need for finished water pumping and large standby generators.

A new water distribution system would be constructed to deliver the treated surface water from storage to the consumers. An agreement with CWD to secure the water supply, a license with USACE to allow installation of facilities at the reservoir, and rights-of-way will need to be acquired for facility installation. A water supply investigation is needed to determine if this project is a cost-effective means to supply potable water to the Raymond area.

The water supply investigation should consider the same factors identified in Section 8.2.2.1.

### 8.2.3 Watershed Management

Madera County has a very active and historical program for fire protection, resource management, and environmental enhancement. Typical practices of fuel management include thinning of conifers; mastication of small trees, brush, and shrubs; prescribed burning and vegetation replacement. Although the main objective of the past and current programs has been fire protection, it has been observed that in areas where vegetation management has been conducted, storm runoff increases and increased groundwater recharge enhances springs, which tend to run for greater durations. A literature review supports the potential to increase water supply through vegetation management.

#### 8.2.3.1 Past and Current Projects in Madera County

The following are specific watershed management projects that have been, or are currently being, conducted in the Foothills and Mountains.

- **Fuel Break Program**: The fuel break program stretched 72 miles and covered 13,342 acres of fuel modification, plantations, and watershed enhancement. Cooperators were the California Department of Forestry and Fire Protection (CDF), Farm Service Area (FSA), Natural Resource Conservation Service (NRCS), Coarsegold Resource Conservation District (CRCD), and private landowners. CRCD reported that the program increased the water yields to the beneficial downstream uses by well over 6,000 AF of water (CRCD, 2007).

- **Willow Creek Watershed Restoration Project**: CRCD, in partnership with Madera County and the Central Sierra Watershed Management Committee, was responsible for this project. The project area included 6,400 acres in the Willow Creek watershed, of which 705 acres near North Fork were targeted for intensive management (California Association of Resource Conservation Districts, 2007). The objectives were to reduce the occurrence of wildfires, which threaten the lives of residents, properties, and wildlife, and to increase water yield. The project consisted of extensive vegetation restoration in the watershed, erosion control measurements, and construction and extension of existing shaded fuel breaks. The results were not only a reduction of fire fuels but also an increase of water production (about 1 AF/acre cleared) and harvest of hardwood products (CRCD, 2007).

- **Crooks Mountain Fuel Break**: This project began in 2005 and consists of constructing and maintaining a fuel break 11.9 miles long and 300 feet wide to protect the towns of Ahwahnee, Nipinnawasee, and Oakhurst. The project has been developed in conjunction with the U.S. Forest Service (USFS), CDF, CRCD, Chowchilla/Red Top RCD, and Eastern Madera County Fire Safe Council (EMCFSC). The cleared fuel was chipped and the chips left in place. The cleared areas were sprayed with herbicides during the spring growing season after the clearing. Bob Buckles from EMCFSC indicated that the firebreak not only benefits the public in general but also improves wildlife habitat and the watershed by adding forage for ranchers and increasing water yields by 30 percent (CRCD, 2007).

- **Upper Finegold Creek Watershed Planning**. This Sierra Foothill Conservancy project consists of developing a watershed assessment and management plan to identify priority projects that will improve water quality and quantity and protect habitat in the Finegold Creek watershed, a major source of water for the San Joaquin River.

- **Forest Stewardship Landowner Plans**. There are plans for 246 ranches in eastern Madera County that are site specific for treatment, soil, erosion, water, and increased water yields. These plans were peer reviewed, approved by multiple agencies, prepared by a California State licensed wildland manager, funded, and completed with follow-up evaluation (on file with CDF, FSA, NRCS, Ballew personal records). Increased water yields of over 50 percent of precipitation were noted in many cases and plans (Ballew, 2007).

There are several other projects within Madera County; however, water yield increases resulting from management were not identified. Some of those projects are as follows:

- **601 Community Fuel Break**: The teams involved in this project are CDF, Madera County Fire, Ahwahnee Volunteer Fire Department, USFS, NRCS, Ahwahnee Community Council, Madera County Road and Planning Departments, Mariposa Fire Safe Council, EMCFSC, Mono Indian Rancheria, Pacific Gas and Electric Company, CRCD, California Reforestation, Inc., and local landowners. Over 200 miles of fuel break has been constructed and 20,000 acres of fuel modification performed (CRCD, 2007).

- **Bureau of Land Management Neighborhood Fuel Reduction and Chipping Program**: Under National Fire Plan grants, EMCFSC is implementing a comprehensive program to reduce fire fuel in neighborhoods in national forests and other open spaces in eastern Madera County. Individual property owners are encouraged to thin their property. EMCFSC sends out a chipper for waste disposal. This discourages open-air burning, which impacts air quality.

- **Air Quality Improvement and Fuel Reduction (Aquifer) Project:** The Aquifer Project consisted of 3 miles of fuel break across private property. The project involved EMCFSC employees, the North Fork Mono Rancheria, Hughes Tree Service, CRCD, and County at-risk youth programs. Chippers were used to create the break.

- **Vegetation Management Program**. This CDF project, which has been in existence since 1982, is a cost-sharing program that focuses on prescribed fires and mechanical means for addressing wildland fire fuel hazards and other resource management on State Responsibility Area lands.

- **Sugar Pine Adaptive Management Project.** The focus of this USFS project, located in the Sierra National Forest, is centered on forest health and fuel reduction. The plan proposes to treat surface and ladder fuels to interrupt fire spread and fire intensity levels by thinning, mastication, and prescribed fires. The project also considers using prescribed burning and manual methods in order to eradicate and prevent noxious weeds invading treated areas.

#### 8.2.3.2 Potential to Reduce Evapotranspiration and Increase Water Yield – Literature Review

Managing wildland vegetation is a time-tested practice in California. Since the 1940s, an average of 300,000 to 400,000 acres have been in some stage of the process each year, with prescribed burns being the most common management practice (Adams and Coppock, 1986). One of the purposes of this management was to create better grazing for livestock, but management also protected against wildfires, improved wildlife habitat, and increased water yields.

Good management practices generally favor infiltration and on-site retention of precipitation to produce forage and reduce erosion. However, when water is more valuable than forage, increased water yields may preempt forage as a management objective. In some areas, there are deliberate efforts to increase surface runoff by reducing infiltration. This is known as "water harvesting." In other areas, it is possible to increase water yield by vegetation management. Assuming favorable soil and geological conditions for infiltration and subsurface movement of water, it follows that water savings, due to conversion of species and reduction of evapotranspiration, results in more water percolating through the soil to feed base flows to streams and groundwater (Hibbert, 1983).

Because evaporation and transpiration occur concurrently and are hard to distinguish from one another in most environments, the sum of both effects together is known as evapotranspiration. Apart from the availability of water in the soil, the evaporation from a soil is mainly determined by the fraction of the solar radiation that reaches the soil surface. This fraction diminished over the growing period as the plants develop and the vegetative canopy shades more and more the ground area. When the canopy is small, water is lost mainly by evaporation, but once the soil is completely covered, transpiration is the main process. Evapotranspiration is affected by several factors such as weather parameters, vegetation factors, and management and environmental conditions. The primary weather parameters that affect evapotranspiration are radiation, air temperature, humidity, and wind speed. Differences in resistance to transpiration, vegetation height, vegetation roughness, reflection, ground cover, and vegetation rooting system result in different evapotranspiration levels. Factors, such as soil salinity, poor land fertility, presence of hard or impenetrable soil horizons, and poor soil managements, may limit the vegetation development and reduce the evapotranspiration (Allen et al., 1998).

In order to study vegetation management for water production, two major types of watershed must be considered separately: forestland and brushland.

Forestland in Sierra Nevada watersheds can be divided into a Lodgepole Pine-Red Fir zone and a Mixed Conifer Zone, both of which lie predominantly within federal lands or areas administratively reserved from management. Treatments are similar for both zones. Streamflow can be altered either by increasing or by delaying it. Water yield from forested areas may be increased by prescribed burning, mastication, or by patch cutting of small areas during timber harvest.

#### 8.2.3.2.1 Water Supply Benefits through Timber Harvest

The following benefits can be realized through timber harvest:

- Reduction of the interception loss, allowing more precipitation to reach the soil surface.
- Reduction of deep-rooted shrubs in the understory, providing more space for plants that absorb less moisture from the soil.
- Growth of younger-age stands of trees where the evapotranspiration is less than in mature forest.

- Maintenance of high infiltration capacity so there will be less loss of precipitation through sudden runoff.

- Maintenance of small quantities of leaves and debris on the ground surface to reduce erosion and ensure high infiltration capacity.

Where the forest has a canopy density greater than 40 percent, a practice called "snow management" can be applied. This involves harvesting the forest into a network of small openings. The result is delaying snowmelt and therefore delaying runoff (Adams and Coppock, 1986; Hibbert, 1983). This practice will probably reduce total yield, but more water will be available for storage and use because the reservoir storage is not expected to be overwhelmed by a concentrated snowmelt runoff as the runoff period is extended later into summer. Given the state of reservoir capacity in California, delaying streamflow is perhaps the greatest contribution watershed management can make to meeting future demands (Kattelmann et al., 1983).

USFS studied the results of vegetation management in watersheds from the National Forest land in the Sierra Nevada (Kattelmann et al., 1983; Adams and Coppock, 1986). Many of these studies were conducted within Madera County (Ballew, 2007). When physical, legal, and administrative constraints and sustained yield guidelines are considered, the current streamflow could increase by about 1 percent (0.6 cm), although the added yield could be greater in particular watersheds. This estimation considered intensive forest watershed management. If the level of active management drops off, streamflow can be expected to decline due to increased transpiration losses.

Vegetation management in brushland is easier and more economical at lower elevations. Brushland has been managed historically in two ways: 1) "rotation treatment," where part of the area is cleared and native plants are allowed to grow again, and 2) "type conversion," where the plant cover is changed from one type (usually trees or shrub), to another (grass or herbs).

In the rotation treatment, parts of the brush land are periodically cleared (usually by prescribed burning) and native plants are allowed to grow again. This creates patches of different-aged brush, allowing the cleared and young-growth areas to serve as fuel breaks during later burns. Prescribed burning is mainly used for reduction of fuel accumulation, but it also creates more forage for cattle and additional water yield. Biswell (1989) mentioned that several hydrologic principles are involved in the increase of the water yield through prescribed burning.

#### 8.2.3.2.2 Water Supply Benefits from Prescribed Burning

The following benefits can be realized through prescribed burning:

- Reduction of interception losses by removal of fuels.

- Reduction of soil water losses by removal of deep-rooted plants that consume much water in favor of shallow-rooted plants.

- Reduction of evapotranspiration losses in chaparral by growing younger stands through rotational burning.

Usually, the hydrologic effects of prescribed burnings are small as the severity of the fire is low (Schumann, 2005 and Troendle et al., in press). On the contrary, when the severity of the fire is high (wildfires) and the ground cover is reduced by the fire, the soil is exposed to raindrop impact, and the infiltration rate decreases. In addition, the burning results in soil hydrophorbicity, or water repellency. These processes result not only in increase of surface runoff but also sediment yield.

In the type conversion treatment, the amount of potential increase of water yield resulting from the conversion to grass and managed grass/oak woodlands depends on the comparative amount of water used by the original community and the new vegetation. The greater the difference, the more water gained. Deep-rooted trees and brush withdraw water from the entire soil profile the year-round versus annual grasses, which withdraw water near the soil surface for only a few months. Furthermore, brush intercepts more precipitation than grass. Consequently, brush-to-grass conversion results in a reduction of water losses. Adams (1986) mentioned that in the 20- to 45-inch annual precipitation zone in California, the 400,000 acres converted from brushland to grassland between 1946 and 1982 would yield about 150,000 AF of additional runoff. However, some of this runoff is probably intercepted and transpired by brushy and riparian areas. The rest might be captured in on-site ranch use, reservoirs, or as groundwater recharge.

Water yield increases are related to annual precipitation. Increases in water yield would be larger in wet years (Ponce and Meiman, 1983). Burgy and Papazafiriou (1971), evaluating the responses to vegetation management in Madera County, present a figure that clearly shows the relationship between water yield increase and rainfall when rainfall is greater than 15 inches and less than 35 inches for fully converted grasslands .

Ziemer (1986), citing studies from Hibbert and Clary, states that there is no potential for increasing water yields in areas with less than 15 inches of annual precipitation, and marginal potential when precipitation is between 15 and 20 inches. Similarly, UC research indicates that at least a 20-inch average rainfall is needed in a watershed before significant long-run gains in runoff can be expected from vegetation management. Evidence shows that vegetation management ceases to provide significant increases in runoff at about 48 inches (Adams and Coppock, 1986). According to those authors, the theoretical gains expected for type conversion treatment, are:

- For areas with 20 inches of annual precipitation, the annual water yield can be increased from 1.7 to 4.8 acre-inches per acre of treated watershed.

- For areas with 30 inches of annual precipitation, the water yield can be increased from 4.5 to 11.6 acre-inches per acre of treated area.

The gains for rotational burning are similar, but they would disappear after the brushy ground cover is reestablished.

With periodic maintenance to prevent shrub regeneration, the long-term water yield increase from chaparral conversion is expected to average 2.4 inches per year over areas actually converted. For mountain brush, it is about 2 inches per year. Only 0.4 inches can be expected by eradicating sagebrush, piñon and juniper trees on the most favorable sites. It is a generalized conclusion that the areas must be maintained in grass or prescribed vegetation community to assure continued water yield response (Hibbert, 1983).

Other studies in the foothills of Madera, Tulare, and Tehama counties showed increases in runoff resulted from the conversion from brush to grass. Water yield increases of as much as 10 inches were measured without serious soil erosion acceleration on the brush-converted sites (Burgy, 1958). In northern California experiments, Kattelmann et al. (1983) found that the total conversion of brushland to grass increased the annual streamflow by 50 percent or more for years of average and high precipitation. However, contrary to the findings of Burgy, this conversion resulted in a severe increase in mass movement and subsequent sedimentation.

Only a percentage of the original area is treatable because of constraints to the vegetation management: 1) only part of any vegetation type can be treated economically for water yield improvement; and 2) consideration of other resources values, social and political constraints, and physical limitations tend to reduce further the area that can be treated.

The vegetation must be replaceable with a type that uses less water, which should be low in biomass, deciduous or dormant most of the time, and shallow rooted, which has less access to water stored in the regolith.

Physical limitations, such as rough terrain, steep, unstable soils, and poor access, reduce the treatable area. Vegetation management tends to be ineffective on shallow soils (Kattelmann et al., 1983). Steep slopes may be too unstable to work on. The erosion potential on steep slopes is related to the contribution of roots to soil strength. Removing vegetation or conversion from brush to grass reduces the frequency of deep, woody roots and increases the probability of accelerated mass erosion (Ziemer, 1986). Ponce and Meiman (1983) concluded that the risk of mass wasting is high in areas of steep slopes. According to Hibbert (1983), there could be little opportunity to increase flows from brushlands in the Sierra Nevada watersheds because of erosion hazards associated with brush conversion and other constraints of management. If erosion occurs, there will be an increase of sediments, which could affect water quality. Furthermore, some limited areas not in timber production may be precluded from treatment, as the cost of providing access to them could exceed the water yields benefits.

In addition, the results of vegetation management potentially could affect the downstream channel morphology. Flow increases may change the energy regimen of the channel system, which may change the sediment transport characteristics and adversely affect the aquatic ecosystem.

There are also timing issues. The increase of water yield is produced during the winter, while the demand for additional water generally occurs during the summer, requiring storage facilities. This not only requires land and money but also needs to meet the current state and federal regulations.

#### 8.2.3.2.3 Advantages and Disadvantages of Vegetative Management

A summary of the identified advantages and disadvantages associated with the use of vegetation management to increase water supplies are presented below.

**Advantages**

- Where the soils are stable, there could be an improvement of water quality as grassland reduces the impact of raindrops on the ground, reducing surface erosion and sediments in streams.
- Reduction of fire loads reduces the cost of fighting wildfires, loss of life, improvements and resource damage, and potential atmospheric impacts.
- Reduction of water losses by reduction of evapotranspiration and interception.
- Improvement of grazing patterns, increasing the animal-unit-month.
- Potential wildlife benefits.

**Disadvantages**

- Need for reservoirs to store runoff, possible legal issues, and need for permits.
- Mass erosion on steep slopes and unstable soils, and, consequently, increase of sediment load and other impacts to water quality.
- Need for maintenance. Brushland regeneration will cause the elimination of the increase of water yield.
- Land ownership patterns in the watershed, which may not be suitable for integrated management such as areas with small parcels with multiple owners. Areas such as these may make it difficult to implement a project at a scale that is economically feasible. Cooperation of landowners will be an important factor in the design and implementation of a vegetative management program designed to improve water supply.
- The increase of peak flows modifying the channel morphology and affecting the aquatic ecosystem.
- Habitat and other potential environmental impact from loss of brushland.
- Cost.

#### 8.2.3.3 Potential Water Supply

Based on the literature review, it is clear that at least 20 inches of annual precipitation are needed before significant gains in water yield can be expected from vegetation management. For the areas that exceed that minimum precipitation, potential increase in water yield of 0.26 to 0.60 AF/acre of treatable area due to vegetation management may be expected. Because of topography, density of vegetation, access, legal, and other constraints, not all of the area is treatable. Numerous references indicate that the treatable area would be about 20 to 30 percent of the total area.

#### 8.2.3.4 Approximation of Additional Water Yield and Cost

About 704,000 acres of Madera County receives more than 20 inches of precipitation. A large portion of this land is under federal jurisdiction and management and is unavailable without special agreements. This reduces the private land area applicable for vegetation management to approximately 192,000 acres. Therefore, the minimum annual increase of water yield resulting from vegetation management on private lands is expected to be approximately 10,000 AF, and the maximum increase of water yield is expected to be approximately 34,500 AF.

The estimated average cost of treatment is approximately $1,000 per acre and includes an herbicide application in the second year on brush regrowth. It is assumed that a follow-up herbicide treatment will be repeated in the fifth year at $150/acre. A 30-year period and an interest rate of 5 percent results in an average cost of $180/AF.

The cost and efficiency of capture, conveyance, treatment, and distribution of the additional water generated through the implementation of vegetation management treatments is not considered in this estimation. In many cases the flow will be into rivers and streams which already have conveyance infrastructure associated with them, so costs may not be an issue or may only involve expansion of existing infrastructure. These cost components must be developed on a case-by-case basis.

#### 8.2.3.5 Watershed Management Study Conclusions

- Water yield improvements are economically feasible on favorable sites where other resource values, such as increased forage production and reduced cost of fighting wildfires or loss of life and property, help defray conversion costs. Water yield augmentation can be important to the mountain communities, private landowners, and small hydroelectric facilities in the Sierra Nevada.

- Due to many physical and legal constraints, the potential to increase water yield on a large-scale program may not be as great as has been demonstrated on small experimental watersheds. However, those small percentages of yield increment represent very large volumes of water.

- Based on the previous research regarding vegetation management, it can be concluded that the increase of water yield through vegetation management is viable in Madera County.

Average increases of water yield in the order of 22,000 AF may be expected, with an average cost of the increase in water yield of $180/AF. If required, infrastructure to capture the water and put it to beneficial use will have to be planned, designed, financed, and constructed.

#### 8.2.3.6 Recommendations for Development of Effective Vegetation Management Plan for Water Supply Development

Prior to implementation of specific vegetation management projects within Madera County, feasibility studies, including pilot tests, are needed and should include the following tasks:

- The project area must be defined.
- Soils maps need to be prepared and analyzed in order to evaluate the potential results of a vegetation management program in the area. Existing soil maps of the County should be reviewed and verified. Among other characteristics, permeability, water-holding capacity, and slopes should be included.
- Vegetation coverage maps have to be prepared and analyzed. Existing vegetation maps of the County should be reviewed and verified.
- The most favorable areas for vegetation management treatment should be identified based on soil and vegetation information.
- Management recommendations to minimize fire danger and maximize water availability and biodiversity should be developed for those specific areas considering the constraints and opportunities that each one has.
- Selected operational projects must be able to quantify costs and benefits, especially the water supply increase in oak woodland, brushland, and forest areas. Those projects must address:
    - Methodology to verify additional water produced (i.e., streamflow measurements) and the rights to the additional water.
    - Facilities needed to capture and distribute the water for beneficial use.
    - Project costs and benefit/cost ratios.
    - Environmental compliance.
    - Procedures for vegetation management in brushland and forest areas based on current and historical project results.

## 8.3 Water Quality Improvement Opportunities

This section summarizes potential projects, programs, and policies that could be implemented by the County for the protection and improvement of water quality. They include:

- Implementation of the existing groundwater management plans water quality protection elements. The existing groundwater management plans in the County include groundwater quality protection measures being implemented by the irrigation and water districts. In addition, the agricultural lands in the County participate in the East San Joaquin Water Quality Coalition, which conducts the water quality monitoring program required by the Regional Water Quality Control Board.

- Enforcing existing policies and ordinances and enacting new ones as necessary. Code enforcement requires proper staffing levels and effort that can pay for itself through water savings and avoidance of water quality problems requiring costly cleanup or solutions.

- Sewering unsewered areas.

- Groundwater wellhead treatment.

#### 8.3.1.1 Recommended County Policies and Ordinances

In addition to enforcing the existing County policies and ordinances described in Chapter 6, the County should consider adopting ordinances which set forth the following requirements:

- Testing of private wells upon sale of any property served by a private drinking water well for the constituents noted in Table 6-13 in addition to new private wells at the time of drilling.

- Well standards (Title 13, Section 13.52) including the requirement for full destruction of abandoned wells in the Valley Floor to prevent cross-contamination of aquifers. A program to identify and properly abandon wells no longer in use should be developed.

- Consolidation of small water systems, where feasible, to enhance the viability of the joined water systems through a larger rate base and economy of scales. This will become increasingly important as regulators tighten drinking water standards and the ability to find potable wells that do not require treatment becomes more difficult.

#### 8.3.1.2 Potential Sewer Collection Areas

There are several unsewered areas in the County. To limit the impact of failing septic systems, it is recommended that a feasibility study be conducted for sewering these areas. The study should identify the high density areas and environmentally sensitive areas (i.e., near watercourses and water bodies) that would be the highest priority areas for sewering. It is also recommended that new developments install centralized treatment and disposal systems instead of private septic tanks when technically and economically feasible.

#### 8.3.1.3 Groundwater Wellhead Treatment

The Scope of Services for the IRWMP, Study Topic 3: *Water Quality Protection and Improvement*, included a task to provide an analysis of infrastructure or other technologies to improve water quality. After working with the Madera County staff and the various Advisory Committees, it was determined that an evaluation should be conducted of treatment alternatives to remove uranium and arsenic from drinking water, evaluate alternatives for private wells, and demonstrate one wellhead treatment application in the Hillview Water Company water system, which serves a portion of the community of Oakhurst. The full case study can found in Appendix E. A groundwater monitoring program is also recommended as shown in Appendix F.

Evaluation of water quality issues in Madera County has identified several contaminants of concern. Two of the more significant are arsenic and uranium. The USEPA has established a lower standard for arsenic of 10 µg/L in drinking water, effective as of January 2006 for all public water systems (those serving 15 or more connections or more than 25 people). The USEPA has also adopted a standard for uranium of 30 µg/L, which is equivalent to the California standard of 20 pCi/L, which is applicable to public water systems. Although these drinking water standards do not apply to individuals using private wells, the standards are a gauge by which to determine the potability of water produced by privately-owned wells.

For a public water system, removal of a contaminated well or surface source from the public water system may be the easiest means of compliance with the water quality standards. However, this is not always feasible in water-short areas. A suitable location for a replacement well may not be available, and construction of a replacement well may not produce a sufficient quantity of potable water. Hydrogeologic studies should improve the probability of situating a well in an area that will produce a sufficient quantity of water meeting drinking water standards.

Appendix E provides information on water treatment alternatives for a public water system, using Hillview Water Company's Sierra Lakes well field as an example. The Task Memorandum (Appendix E) provides a description of treatment alternatives for removing arsenic and uranium from the water, and an opinion of probable costs for construction, operation, and maintenance of one treatment alternative. Possible actions to bring a water system into compliance with the arsenic and uranium water quality standards are presented. These actions can be applied to any public water system facing similar drinking water standard violations.

Homeowners with private wells in areas affected by arsenic and/or uranium also will be faced with decisions to ensure a healthy and potable water supply. It is important for Madera County to notify these homeowners that have private wells in such areas of their water supply alternatives. The use of bottled water for drinking and cooking is one common alternative. Appendix E identifies point-of-use treatment alternatives that could be implemented by a homeowner or a small public water system.

## 8.4 Other Water Management Measures

In addition to the specific water management opportunities discussed in this chapter, there are other water management measures that could be implemented throughout the County. These include:

- Measurement of well pumpages in the valley.
- Implementation of land use policies regarding water availability.
- Demonstration of sustainable water supply for new development.
- Controls on groundwater pumping.
- Implementation of additional water management measures to improve water use efficiency.
- County water and wastewater system infrastructure improvements.

Many of these management measures will require legal analysis as to their implementability.

### 8.4.1 Land Use Policies

The County should consider enacting policies for the following, where it is legally feasible:

- Limitations on new development (agricultural and urban) if water supply is not sufficient to meet demand without measures to mitigate the increase in overdraft or impact on existing users. Limits could include a limit on groundwater pumping on a per-acre basis and could be applied to only areas defined as being in a state of severe overdraft as defined in the policy or ordinance.

- Minimum lot sizes for division of land in the Foothills and Mountains subarea with limited water supplies.

- Water or irrigation district annexation as a prerequisite for development of agricultural lands.

### 8.4.2 Water Supply for New Development

The following are actions that the County could consider regarding water supply for new development. These measures will ensure adequacy of water supply for new developments while not negatively impacting existing water users in the County. These measures include:

- Proof of water supply for new development (SB 610 and SB221 processes), which is currently required by State law for large developments (500 dwelling units or 500,000 square feet or more of commercial floor space). The County could consider adopting similar requirements for developments that do not meet the State threshold. The approving agency would require the applicant to detail a plan for balancing a new development’s water supply and not rely on mining or overdrafting the groundwater to meet its demands. The plan would include development of new surface water supply or mitigation for groundwater pumping for new development. This type of requirement may be burdensome for small developments. The County should consider development of a water impact fee program for developments not meeting the threshold requiring a detailed water balance plan.

- Reclamation requirement/reuse of wastewater.
- Dual plumbing (nonpotable/recycled and potable water).
- Incentive pricing requirements for community systems.

### 8.4.3 Mitigation Water Credit Program

The County has had preliminary discussions regarding the development of a mitigation water credit program that would function similar to existing air quality credit programs. These types of programs focus on reducing or eliminating the impacts on natural resources, such as air quality, or in this case water, from new development. It is anticipated that such a program would apply to new development that would increase the water demand in areas of the County subject to overdraft or water shortage. Development may include residential, commercial, industrial and agricultural. It is envisioned that a program could be developed that would allow for the acquisition of “water credits” through the reduction or elimination of existing water use in the County or through the increase in developed water supply for use in the County.

Water use reductions could be achieved and credit gained through the implementation of a project or program designed to reduce existing water use through the replacement of existing water use facilities with new water conserving facilities, such as a program to replace older toilets with ultra-low flow toilets, installation of water recirculation systems at commercial or industrial facilities, or the conversion of existing irrigation systems to higher efficiency systems such as drip or microsprinklers. Credits could also be achieved through the complete elimination of an existing water use such as the permanent retirement of irrigated agricultural land, by transfer of water into the County, or by reduction of evapotranspiration through vegetative management, as discussed in Section 8.2.3. The credits earned would be used to offset the water demand of the proposed project or development.

There are many issues involved with development and implementation of a mitigation water credit program such as quantifying the existing water use and accounting for the actual water savings, ensuring that the water savings project or program is maintained and not modified or eliminated, and monitoring land use changes and any other changes that would increase the water use of the land or facility used to earn the credits. In addition, there are many legal issues regarding development and implementation of such a program, especially in a basin that is not adjudicated, such as ownership of the water that is saved and the overlying right of a landowner to pump groundwater for beneficial use. The first step in the development of such a program would be to identify and evaluate existing programs being implemented in other regions of the state or country. It is recommended that the County continue researching the potential development of a program.

### 8.4.4 Agricultural Water Management Measures

The following are other water management actions that the County could consider for discussion with stakeholders to better address the serious overdraft problem on the Valley Floor. These are aimed at reducing groundwater overdraft and include:

- Formation of new districts in unincorporated/nondistricted land.
- Measurement of pumpage from irrigation wells.
- Groundwater pump tax or land-based assessment to fund water supply projects (subject to the constraints of Propositions 13 and 218). Funds raised through these mechanisms should not go into the General Fund and should be reserved for implementation of engineered projects and not further studies.
- Development of comprehensive countywide groundwater monitoring program.

### 8.4.5 County Systems Infrastructure Improvements

Many of the County-operated water and sewer systems identified in Chapter 3 are in a state of disrepair. The County recently began assessing the condition of some of these systems. A technical evaluation and rate studies are currently under way for the Madera Ranchos water, Hidden Lake Estates water, and Bass Lake water and sewer systems. Further, sanitary sewer management plans (SSMPs) are planned to be developed in the near future for the sewer systems. The County is currently applying to the State Revolving Fund for grants to make improvements to some of the water and sewer systems. It was estimated by County staff that it would cost approximately $90 million to complete repairs and make the necessary improvements to all County-operated water and sewer systems. It is recommended that funds be sought from all available sources to repair these systems to improve water supply reliability and quality for the special district customers.

# Chapter 9
# Conclusions and Recommendations

This chapter summarizes the major conclusions and recommendations of the previous chapters of this IRWMP, including the groundwater conditions reports of the four Foothills and Mountains study areas and the proposed groundwater monitoring program for Madera County prepared by KDSA, which are included in the Appendices (Volume 2) of this IRWMP.

## 9.1 Conclusions

### 9.1.1 Water Demand

- The County's population is anticipated to grow from the estimated 2007 population of 148,700 to approximately 355,000 by 2030 based on Madera County Planning Department estimates.

- Agriculture accounts for over 53 percent of the land use in the County, while open space accounts for over 38 percent of the land use. Urban and residential uses account for the remaining 8 plus percent of land use in the County.

- Current water use in the County averages about 191 gpcd. Water use in the incorporated cities of Madera and Chowchilla averages 230 and 311 gpcd, respectively, and averages 168 gpcd in the unincorporated areas of the County.

- The estimated agricultural water demand for the entire County was 1.17 MAF in 2006. The estimated urban and rural water demand for 2006 was approximately 29,500 AF, or 2.5 percent of the total approximate water demand in the County of 1.2 MAF.

- Because of agriculture's heavy reliance on groundwater and the continued overdraft of the basins in the County, the potential reductions in available surface water supplies due to reallocation of water for environmental uses and conversion of agricultural land to urban uses, it is estimated that average annual agricultural water use in Madera County will level off and be approximately 1.2 MAFY by 2030.

- The projected water demand for the entire County in 2030 is estimated to be 1.3 MAF, which is approximately 8 percent greater than the current demand. Agriculture will account for about 1.2 MAF, or 92 percent of the total demand. Urban and rural water demand by 2030 will be triple the 2006 demand and will account for the remaining 8 percent, or about 100,000 AF.

### 9.1.2 Water Supply

- A combination of groundwater and surface water is used to meet water demand in Madera County. Groundwater for the Valley Floor is pumped from the Madera, Chowchilla, and Delta-Mendota groundwater subbasins, which are hydraulically connected and are part of the greater San Joaquin Valley Groundwater Basin. In the Foothills and Mountains, groundwater is drawn from wells and springs in weathered materials and fractures in the hard rock.

- The San Joaquin River forms most of the southern and western boundaries of Madera County and ultimately serves as the discharge point for surface water runoff from more than 90 percent of the County (including the Fresno River and Chowchilla River basins). Less than 10 percent of precipitation and stream flow originating in Madera County drains out of the County to another river system (Merced River).

#### 9.1.2.1 Groundwater

- Recharge to groundwater in the Foothills and Mountains is derived from precipitation on the local watershed. Average precipitation is generally about 14 inches per year in the lowest foothill areas to more than 50 inches per year in the higher parts of the watersheds. Groundwater development in the Foothills and Mountains is normally dependent on recharge each winter because of the relatively small storage space available in the fractured hard rock. Groundwater in the Foothills and Mountains is normally developed from wells or springs tapping shallow weathered rock or underlying fractured hard rock. However, substantial water production has been found at depths exceeding 700 feet at some locations in the Coarsegold, Raymond, North Fork, and Oakhurst areas.

- In areas of higher precipitation (Oakhurst, North Fork, and the topographically higher part of the Coarsegold area), groundwater recharge is adequate for existing development. However, some problems have been encountered in parts of these areas due to well interference and groundwater quality issues. In areas of lower precipitation (Raymond-Hensley Lake and the lower part of the Coarsegold area), groundwater recharge is more limited.

- Recharge in the Valley Floor is through precipitation and surface water flows from the Foothills and Mountain areas. Average annual rainfall in the Valley Floor is about 11 inches. Surface water flows recharge the Valley Floor groundwater basins through natural and intentional percolation along with agricultural irrigation with surface water in lieu of pumping groundwater.

- Historically, the direction of groundwater flow in much of the Valley Floor area was to the southwest, toward the valley trough (San Joaquin River downstream of Mendota). However, as groundwater pumping has increased, several large cones of depression have developed in the following areas primarily due to the lack of surface water deliveries in the area: (1) south of Highway 145 and northeast of the Santa Fe Railroad tracks,

(2) near and east of Fairmead, (3) west of CWD and MID, and (4) north of CCC, AWD, and GFWD.

- Average groundwater levels in the Valley Floor have declined up to 5 feet per year during the period of 1970 to 2006. There has been virtually no water-level decline in recent decades near the San Joaquin River downstream of Mendota, near the west edge of the Valley Floor area in Madera County. Water-level declines have averaged about 1 foot per year farther east, primarily in the area between the Eastside Bypass and the San Joaquin River and near the San Joaquin River upstream of Mendota. Rates of water-level decline generally increase with increasing distance from the Chowchilla River, Fresno, and San Joaquin Rivers. For example, near the Fresno River east of the City of Madera, the average rate of water-level decline has been less than 1 foot per year. In contrast, the greatest average water-level declines in the Madera area have exceeded 5 feet per year. These include areas east of the Santa Fe Railroad, such as Madera Ranchos, Rolling Hills, and nearby irrigated lands, that rely solely on groundwater. Another area with large water-level declines is in the eastern part of CWD and to the east, where irrigated lands and the City of Chowchilla rely solely on groundwater.

- The total amount of groundwater overdraft in the Valley Floor, based on historical water-level declines for the past 30 years, is estimated to be about 100,000 AFY. The overdraft is continuing to increase with development of previously undeveloped land in the Valley Floor, including development of new irrigated land and additional urban and rural residential development relying solely on groundwater.

#### 9.1.2.2 Surface Water

- The major river systems in Madera County are the Chowchilla River to the north and the Fresno River to the south. CWD, MID, and USBR are the major water rights holders on the Chowchilla and Fresno River systems. CWD, MID, GFWD and the County are CVP water service contractors holding contracts for CVP water. CCC is a San Joaquin River Exchange Contractor and receives surface water from the Delta-Mendota Canal via the Mendota Pool under the Exchange Contract with the USBR.

- The average annual amount of surface water delivered in the County is approximately 300,000 AFY (1996-2006). The availability of surface water can vary tremendously from year to year and is dependent on hydrologic conditions. In addition, increased pressure to allocate additional water to San Joaquin River restoration plans may reduce supplies available to the CVP contractors which would cause increased groundwater pumping to make up for lost surface water supplies. This will only exacerbate the existing groundwater overdraft condition in the County. It is estimated that CVP water service contractors could lose as much as 15 to 20 percent of their water supply due to river restoration efforts.

#### 9.1.2.3 Impacts of Continued Groundwater Use

- Assuming the average annual surface water supply remains unchanged, almost 100,000 AF of additional groundwater pumping will be required to meet 2030 demands as compared to current demands. All but approximately 7,000 AF of the additional 100,000 AF of groundwater required to meet demands in 2030 would likely be pumped in the Valley Floor, which would increase the estimated average overdraft from 100,000 AFY to 155,000 AFY.

- Sustained overdraft of the groundwater basins will result in higher pumping costs and require deepening of wells to sustain required pumping rates. This is not sustainable over the long term. Land subsidence resulting from groundwater overdraft has also occurred in the western part of the area, where the Corcoran Clay is present. This condition will worsen as groundwater overdraft continues. In addition, pumping of deeper groundwater from zones of the aquifer with poor-quality water may lead to required treatment to meet drinking water standards. An example would be the Madera Ranchos area, where poor-quality groundwater is present below a depth of about 600 feet. Failure to address the overdraft issue and its impacts may lead to additional State-imposed regulations on groundwater pumping and potential adjudication of the basin.

- In areas of higher precipitation (Oakhurst, North Fork, and the topographically higher part of the Coarsegold area) KDSA studies indicate that groundwater recharge is adequate for the existing development. However, some problems have been encountered in parts of these areas due to well interference and groundwater quality (i.e., high uranium and arsenic concentrations in parts of the Oakhurst and North Fork areas). Well interference problems have usually resulted from larger-capacity water system wells that are in close proximity to other wells. These larger-capacity wells are pumped at relatively high rates for prolonged periods.

- In areas of lower precipitation (Raymond-Hensley Lake and the lower part of the Coarsegold area), groundwater recharge is more limited. Except for iron and manganese, groundwater quality does not appear to be a problem in these areas. Some deep wells have been successfully drilled in parts of these areas. Water quality protection and improved monitoring are needed to protect the water resources in the Foothills and Mountains. Large-scale dense development in these areas may require acquisition and treatment of surface water supplies to meet future water demands.

### 9.1.3 Water Quality

- Groundwater quality contaminants of concern in the Valley Floor include high salinity (TDS), arsenic, nitrate, uranium, methane gas, iron, manganese, slime production, and DBCP with the MCL exceeded in some areas. However, most of the groundwater in the Valley Floor is of suitable quality for irrigation. In addition, groundwater of suitable quality for public supply has been demonstrated to be present in most of the area at specific depths.

- Groundwater quality contaminants of concern in the Foothills and Mountains include manganese, iron, high salinity, hydrogen sulfide gas, uranium, nitrate, arsenic, and MTBE, with the MCL being exceeded in some areas. Despite these problems, there are substantial amounts of good-quality groundwater in each of the areas evaluated in the Foothills and Mountains. Iron and manganese are commonly removed by treatment. The Bass Lake Water Company has recently begun operation of a uranium treatment plant on one of its wells. If uranium treatment is shown to be infeasible or not cost effective, surface water systems may be required in parts of the Bass Lake-Oakhurst area.

- Water produced from wells in several areas of the County, including some of the wells of the Hillview Water Company in Oakhurst, have elevated levels of uranium and arsenic. A Task Memorandum Report (Appendix E) evaluating treatment alternatives to remove uranium and arsenic from Hillview's Sierra Lake wells and alternatives for private wells was prepared. The report concluded that the technology exists and it is feasible to operate both centralized and point-of-use (private well) treatment systems. Total 20-year cost for a centralized treatment system for the Hillview Sierra Lake wells is approximately $10 million. Annual operation and maintenance costs are approximately $3 per 1,000 gallons. Homeowners with individual wells that produce water with arsenic and/or uranium should seek the guidance of CDPH in identifying devices certified for specific contaminant removal, or the USEPA Environmental Technology Verification Program. This report can be used as a basis for investigation of the use of this technology in other areas of the County with similar water quality problems.

- Only the San Joaquin River system is currently used for domestic water supply in the County. The water quality in the river is very good in most reaches. However, at lower elevations the river water contains sufficient organic matter, resulting in elevated DBPs, which have caused individual water systems to exceed MCLs.

- The greatest impact of failing septic systems is due to overland flow to surface water bodies. However, failing septic systems can also degrade local shallow groundwater. Untreated wastewater contains excessive nutrients (nitrogen and phosphorus) that can harm native plant and fish populations. Wastewater's excessive organic matter can also use up the oxygen supply in steams and rivers. Increased levels of microbial populations (bacteria, viruses, and other pathogens) may result from septic system failures.

### 9.1.4 Flood Control

- Madera County has a long history of flooding, mainly associated with the Fresno and Chowchilla Rivers and their tributaries, all of which are tributary to the San Joaquin River. Floodway obstructions, limited channel capacity, and poor levee maintenance are the main factors causing flooding in Madera County. Natural obstructions to flood flow include native and nonnative vegetation growing in floodway channels. The plant "*Arundo donax*" is a major problem in that its rapid growth and spreading is reducing channel capacities. In addition, *Arundo donax* consumes large volumes of water and is a fire hazard to nearby structures.

- DWR acknowledged in a white paper that California's Central Valley flood control system is deteriorating. Yet State funding to maintain and upgrade flood protection infrastructure has sharply declined.

- The Madera County FCWCA was formed in 1969 by Madera County Flood Control Act 4525 to be responsible for flood control planning in the County. In addition to some general regulations and policies, FCWCA has responsibility for maintenance of approximately 75 miles of levees on the Fresno and Chowchilla River systems. FCWCA currently does not have sufficient staff and funding to adequately address flood control problems and required maintenance activities in the County.

- The USACE has indicated that the levee system on the Chowchilla River may be decertified if certain actions are not taken. The County has established a Levee Task Force to work on this issue as well as other flood control issues and problems. The Levee Task Force is developing plans to address the levee decertification issue including the eradication of *Arundo donax* and the flood channel and levee improvements required to prevent decertification of the levee system.

### 9.1.5 Water Resources Management Opportunities

- Many potential projects, programs, and policies to increase water supply, reduce demand, improve water quality, and manage flooding in the County are identified in the Plan. Many of the identified projects, programs, and policies are described by subarea because of the hydrogeologic differences between the two major subareas of the County. However, to optimize the use of the available water resources and seek additional water supplies, water resource management must be implemented and coordinated throughout the County.

- The majority of the major projects have been identified by the agencies or cities in the County that are water purveyors, and they would likely take the lead in developing and implementing the projects. The identified projects are in various stages of development and implementation and include water supply augmentation projects as well as demand reduction projects. Some of the projects are only at the concept level while others are in various stages of implementation. Many of these projects will move forward with or without funding support of the County. However, there are several major projects in which the County has the opportunity to participate in or partner with the lead agency in funding, developing and implementing the project in exchange for a share of the potential benefits. Projects that are being developed by other agencies may benefit from cooperation with the County, especially in seeking State funding for the projects. These projects are identified throughout the report and in the recommendations section later in this chapter.

- The County operates and maintains 34 County Service Areas and Maintenance Districts that include sewer and water systems. Fourteen of these special districts are located in the Valley Floor. Water supply for all these systems comes from groundwater wells, with the exception of MD-1 Hidden Lakes Estates, SA-2B Bass Lake-Wishon Cove, SA-2C Bass Lake – Molly Cabin, and SA-16 Sumner Hill, which treat surface water. Many of these water and sewer systems are in need of repairs and improvements. Several studies are under way to identify the required improvements and their cost. County staff has recently estimated that it would cost approximately $90 million to complete repairs and improvements on all County-operated water and sewer systems.

- Wastewater reclamation opportunities exist and can be developed to reduce water demands throughout the County. The primary opportunities to implement reclamation projects are at the cities of Madera and Chowchilla and the community of Oakhurst wastewater treatment plants. Use of treated or percolated effluent to meet agricultural water demands or urban water demands exist, such as golf courses, landscaped areas, etc., and can reduce the amount of groundwater pumped and help maintain and improve the groundwater quality of the basin.

### 9.1.6 Watershed Management

- Madera County has a historical and very active watershed management program for fire protection, resource management, and environmental enhancement. Typical practices of fuel management include thinning of conifers; mastication of small trees, brush, and shrubs; prescribed burning, and vegetation replacement. Although the main objective of the past and current programs has been fire protection, it has been observed that in areas where vegetation management has been conducted, storm runoff increases and increased groundwater recharge enhances springs, which tend to run for greater durations.

- Water yield improvements from watershed management practices are economically feasible on favorable sites where other resource values, such as increased forage production and reduced cost of fighting wildfires or loss of life and property, help defray conversion costs. Water yield augmentation can be important to the mountain communities, private landowners, and small hydroelectric facilities in the Sierra Nevada.

- Due to many physical and legal constraints, the potential to increase water yield on a large scale may not be as great as has been demonstrated on small experimental watersheds. However, those small percentages of yield increment represent very large volumes of water.

- Based on the previous research regarding vegetation management, it can be concluded that the increase of water yield through vegetation management is viable in Madera County. Average increases of water yield in the order of 22,000 AF may be expected, with an average cost of the increase in water yield of $180/AF. Infrastructure will have to be planned, designed, financed, and constructed to capture the water and put it to beneficial use.

## 9.2 Recommendations

The following recommendations are a summary of the major recommendations found throughout the Plan including the KDSA groundwater condition reports and proposed groundwater monitoring program contained in the Appendices (Volume 2) of this IRWMP. Many of the recommendations will require further investigation and funding and many will require approval of the responsible agency prior to implementation. In addition, many of the projects will require compliance with

CEQA and/or NEPA.  These recommendations are for consideration by the County and other agencies in the County.  **The acceptance of this Plan by the County does not commit or require the County to implement any of the recommendations.  Plans to develop and implement recommendations in this Plan will be brought to the appropriate County decision makers for approval prior to development or implementation of the particular recommendation and all legal requirements and procedures regarding adoption and implementation of policies, programs, and projects will be followed.**

Although some of the recommendations are identified by study area, it should be noted that many of these recommendations may apply to other study areas and may have countywide benefits as noted in the recommendation.

### 9.2.1 Foothills and Mountains

#### 9.2.1.1 New Wells

The following recommendations for new well requirements are included in the KDSA "Groundwater Conditions in the Oakhurst Basin" (Appendix A) and are also referenced and recommended in the groundwater conditions reports for the North Fork, Coarsegold, and the Raymond-Hensley Lake areas (Appendices B, C and D).

- Requirements for enhanced water supply evaluations and pump testing of new public supply wells should be developed as detailed in Appendix A.  This does not include individual or shared private wells.

- A complete hydrogeologic evaluation should be made by a certified hydrogeologist, where it is proposed to use groundwater to meet the water demand of new large subdivisions.  The recommended details of the Subdivision Study are presented in Appendix A.  The study should include conclusions regarding: 1) the amount of groundwater available for the entire development during a series of dry years, 2) the expected availability of water under full development, 3) the feasibility of the proposed method of obtaining the water (i.e., individual wells or community wells), 4) the anticipated depths and yields of recommended wells, 5) the chemical and radiological quality of the water, and 6) the type of well to be used.  The examination should include the tentative subdivision area and should extend peripherally to include an evaluation of the effect of the pumpage for the proposed project on existing water supply wells in the area.  If individual wells are proposed for the subdivision, specific recommendations regarding the number of test wells and pump test procedures are also detailed in Appendix A.  Any program or regulation adopted by the County that would implement this recommendation would have to define the size of subdivision to which the regulation applies.

- Certified hydrogeologists should recommend where new public water system wells would be drilled after fully considering well interference, locations of groundwater recharge, and other factors. This recommendation does not apply to individual or shared private wells.

- The County should develop a program to notify landowners of areas where the uranium activity is expected to exceed the MCL to assist landowners in the decision-making process for locating new wells. Also, the program should provide landowners with existing wells in these areas the required information to assist the landowners with the testing of their well water and should provide them with access to the proper resources to help them determine whether the water should be used for drinking purposes. A Task Memorandum Report (Appendix E) evaluating treatment alternatives to remove uranium and arsenic from Hillview Water Company's Sierra Lake wells and alternative treatment systems for private wells was prepared. Information from the report regarding point-of-use (private well) treatment systems should also be provided to the landowners.

- Well spacing criteria should be developed to govern the distance between new public supply wells and existing wells in densely populated areas to help prevent well interference problems. Spacing criteria should also consider spacing from septic systems and property lines. In addition, further study is required to identify how groundwater travels in the Foothills and Mountains area.

#### 9.2.1.2 Land Development

- The County should develop a program to identify and protect the groundwater recharge areas in the Foothills and Mountains area, including zoning regulations to prevent building in these areas. At a minimum, this would include areas within 50 feet of streams, meadows, and other recharge areas identified during hydrogeological investigations.

- The County should develop requirements for new large subdivisions with a defined number of lots to construct on-site storm water detention/retention basins to capture storm water runoff. Properly designed basins will improve storm water quality before it enters the nearby watercourse and will contribute to local recharge. Definition of the size of subdivision to which the requirements would apply would be established during the County ordinance creation process. In addition, the County should encourage the legal construction of retention/detention basins on private properties in the Foothills/Mountains area with the same goal of improving water quality and recharge.

#### 9.2.1.3 Water Conservation and Wastewater Recycling

- It is recommended that the County evaluate the feasibility of installing meters on all its water service connections within its County Service Areas and Maintenance Districts and developing water rate schedules that will encourage water conservation. Data shows that typical residential water use is reduced by 15 to 25 percent when meters are installed and water is billed on a volumetric use rate.

- The WWTP for the Oakhurst area disposes of treated effluent through the use of sprayfields. It is recommended that the County proceed with plans to construct a pipeline crossing of the Fresno River to enable the development of additional sprayfields on the north side of the river and to eventually take water to the Sierra Meadows golf course area for irrigation use on the golf course and surrounding landscaped areas. This will free up Miami Creek water for other uses and should improve water quality in the Fresno River by minimizing or eliminating disposal of effluent on the sprayfields adjacent to the river.

- The Bass Lake WWTP also disposes of treated effluent through the use of sprayfields. The County is currently evaluating the WWTP capacity to determine its ability to handle additional flow anticipated from future development. It is recommended that an evaluation of alternative disposal options be conducted with the goal of reducing the amount of groundwater pumped or surface water required to be treated in the Bass Lake area to meet water demands.

#### 9.2.1.4 Water Quality

- County Ordinance 17.48.020 allows for individual septic tanks on each lot of a subdivision on land above the 500-foot elevation. It is recommended that the County review this ordinance and specifically the size and number of lots allowed to have individual septic systems in large subdivisions with the goal of protecting groundwater quality. Any modification of the existing ordinance must include clear definition of the subdivisions subject to the ordinance.

- County Maintenance District 22F (MD 22F) covers the service areas of the four Hillview Water Company water systems. It is recommended that the MD 22F committee move forward with the feasibility study of the possible acquisition of the four water systems by the County.

- Broadview Terrace Mutual Water Company continues to have water quality problems, especially uranium concentrations that exceed the MCL. Customers of Broadview are on a year-round notice to not drink the water. The County should consider including the alternative of acquiring Broadview and consolidating it with the Hillview Water Company as part of the Hillview acquisition study mentioned above. Consolidation of water systems enhances the viability of the joined water systems through a larger rate base and economy of scales. This will become increasingly important as regulators tighten drinking water standards and the ability to find potable wells that do not require treatment becomes more difficult.

- There are several unsewered areas in the County. To limit the impact of failing septic systems, it is recommended that a feasibility study be conducted for sewering these areas. It is also recommended that new developments install centralized treatment and disposal systems instead of private septic tanks where technically and economically feasible.

#### 9.2.1.5 Water Supply

- The hydrogeologic investigations of the lower Coarsegold and Raymond-Hensley Lake areas conclude that the recharge in these areas is very limited and that further large-scale dense development in these areas may require a supplemental water supply to augment the available groundwater. It is recommended that feasibility studies of developing surface water supplies for treatment and delivery for domestic use be conducted. The studies should evaluate the alternatives for acquiring surface water, including acquisition of water rights through State application or purchase. Possible storage facilities that could be used in conjunction with these projects include Eastman Reservoir and Black Hawk Reservoir. The studies should also evaluate the potential of importing groundwater pumped from other regions of the County. The study should evaluate the number of dwelling units that are sustainable with each of the identified water sources.

- The lateral extent of the cones of depression associated with deep wells in the Coarsegold area has not been determined. This is important because pumping of deep wells could draw groundwater from beneath adjoining lands and limit future pumping of deep groundwater beneath other lands. Further studies should be done on the cone of depression due to deep well pumping in systems such as Yosemite Lakes.

#### 9.2.1.6 Watershed Management

Prior to implementation of specific vegetation management projects designed to increase water supply within Madera County it is recommended that the legal issues, such as the right to any verified increase in water supply due to the project, be evaluated. If it is determined that there is a legal mechanism for acquiring the right to the water produced by the project, feasibility studies, including pilot tests, are needed and should include the following tasks:

- The project area must be defined.

- Soils maps need to be prepared and analyzed in order to evaluate the potential results of a vegetation management program in the area. Existing soil maps of the County should be reviewed and verified. Among other characteristics, permeability, water-holding capacity, and slopes should be included.

- Vegetation coverage maps have to be prepared and analyzed. Existing vegetation maps of the County should be reviewed and verified.

- The most favorable areas for vegetation management treatment should be identified based on soil and vegetation information.

- Management recommendations to minimize fire danger and maximize water availability and biodiversity should be developed for those specific areas considering the constraints and opportunities that each one has.

- Selected operational projects must be able to quantify costs and benefits, especially the water supply increase in oak woodland, brushland, and forest areas. Those projects must address:

  - Methodology to verify additional water produced (i.e., streamflow measurements).

  - Facilities needed to capture and distribute the water for beneficial use.

  - Project costs and benefit/cost ratios.

  - Environmental compliance.

  - Procedures for vegetation management in brushland and forest areas based on current and historical project results.

### 9.2.2 Valley Floor

#### 9.2.2.1 Water Supply

The major water supply issue in the Valley Floor is the continuing overdraft of the groundwater basins. The following recommendations are intended to help alleviate this problem through the reduction of groundwater pumping or by increasing available water supplies. Many of the recommended projects and programs are applicable to the Foothills and Mountains and may provide additional water supply to the Foothills and Mountains through transfer and exchange programs.

The following recommendations describe projects, programs, and policies that the County may consider implementing or participating in through partnerships or agreements with other agencies in the County. Many of the identified projects will be developed and operated by other agencies in the County but will require County support for implementation. The level of detail of the projects differs as some are mere concepts to be developed further and some are in the implementation stage. The following list of recommendations addresses only the major projects identified that are in some stage of development or have the potential to significantly contribute to overdraft reduction in the near term. A complete list and further description of all identified projects, programs and policies is presented in Chapter 8.

- As a CVP contractor, the County must engage in the process and support the other CVP contractors' efforts to protect CVP allocations from further reduction due to San Joaquin River restoration efforts. Provisions to make up for any water lost to river restoration efforts must be a part of any plan. It is critical that the County be actively engaged to protect this vital portion of the County's water supply.

- The County should evaluate participation in water banking as a potential means of augmenting water supply within the County. A number of water bank projects may be presented following acceptance of this Plan.

- As a CVP contractor, the County is eligible to receive Section 215 water (water released from Friant Dam for flood control purposes). The County should pursue acquisition of this water when available and should develop agreements with MID, CWD and the USBR to use the Madera Canal to convey Section 215 water to County facilities or joint use facilities that may be developed as part of a multiagency project. Through transfers and exchanges with MID, CWD and others it may be possible for the County to receive surface water in other areas of the County where surface water supplies are needed. Currently, MID and CWD have "agricultural use" contracts with USBR that may limit opportunities in this area.

- CWD performed a study to evaluate the feasibility and estimate the cost for a water conveyance system to deliver up to 15,000 AFY of irrigation water from the Merced Irrigation District to CWD. The study determined that the project is technically and economically feasible. It is recommended that CWD pursue development and implementation of the project and that the County cooperate with and assist CWD in expediting the project.

- USBR performed an investigation of the storage opportunities on the San Joaquin River to develop water supplies to assist in the restoration of the river, improve river water quality, and increase water supply. The study developed and evaluated numerous project alternatives. As a result of this comprehensive study, Temperance Flat Dam and Reservoir, with two potential locations and an off-stream alternative adjacent to Millerton Lake, are being considered. The new Temperance Flat Reservoir could hold up to 1,300,000 AF of water and supply up to 200,000 AF of water (new yield) per year.

  Madera County, as an "area of origin," and a CVP contractor must evaluate the benefits and costs of water supply from this facility, determine how this water source will integrate with the other surface and groundwater sources available to the County, and develop a well-founded plan to acquire a portion of this new water supply to help alleviate overdraft and provide high-quality water for use within the County. There is no agreement to date on how the new water supply will be distributed among the various users. A significant portion of the project costs will need to be paid by the water users. Therefore, the cost of the Temperance Flat water will likely be melded with other water costs to determine the economic attractiveness for those seeking a portion of the supply. Water from this project could be stored in the County's share of the Madera Water Bank and/or through transfers and exchanges to be used in most parts of the County, including the Foothills and Mountains area. The County should identify a standing committee, such as the Water Advisory Commission, that will monitor the progress of the project and develop a plan for Madera County to acquire a fair share of the developed water.

- MID has determined that the Madera Canal/Hidden Dam Pump Storage Project is feasible and the potential benefits warrant continued development of the project. The project has the potential to provide approximately 6,000 AFY (average) of additional water supply for use by MID as a redirection of an existing water supply. MID is currently seeking authorization from USACE and will have to seek funding for the project. There are potential partnering opportunities for the County and/or other water agencies in the County that should be pursued.

- The Madera Lake Area Groundwater Storage Study indicated that the recharge potential of Madera Lake is approximately 10,000 AFY. The test also indicates that the primary flow of groundwater in the area and the recharged water is to the southwest. This is important in that the lake is upgradient (northeast) of MID and the City of Madera, and the recharged water will help alleviate the overdraft within the district and the basin. The use of Madera Lake as a groundwater recharge facility and regulating reservoir will improve MID's water supply and water delivery efficiency. The ability to use Madera Lake as a regulating reservoir will also conserve Fresno River water that would have otherwise been lost as operational spill. The study also indicated that the area south of the Fresno River adjacent to Madera Lake is favorable for the construction of additional recharge basins. This project, in conjunction with the acquisition of surface water supplies by the County and the development of the Madera Water Bank, may create opportunities to store, transfer, and exchange water with MID that would allow for delivery of other surface waters in the County at locations were it is needed for future development. The County and City of Madera should discuss with MID the possibilities of participating in the development of the project.

- As discussed in Section 8.1.1.8, the Madera Canal is the key facility for conveying San Joaquin River water into the County for current use. Its use would be required for many of the water augmentation projects identified. It is also the primary facility that allows water purchased or brought in from outside the County to be conveyed into the County through transfers and exchanges. Increasing the canal capacity may be required in the future and would have countywide benefits, including the Foothills and Mountains. It is recommended that a feasibility study for increasing the capacity of the canal be conducted and that funding for the study be obtained from all future beneficiaries.

- As part of the City of Madera WWTP expansion project, it is proposed that a system of extraction wells be constructed in the area of the percolation ponds to pump groundwater from under the ponds to prevent mounding and elevated concentrations of nitrates and other contaminants in the underlying groundwater. The City has entered into an agreement with MID to pump up to 9,600 AFY of the groundwater into the MID distribution system for irrigation use. The City may discuss with MID the possibility of exchanging this groundwater for surface water delivered upgradient of the City for use in recharging the groundwater basin. This type of project presents the opportunity for the City of Madera, MID, and possibly the County to participate in developing joint use recharge facilities. This and other opportunities should be pursued by the County and other water agencies in the County. The County should take the lead in initiating a feasibility study for potential joint use recharge facilities throughout the County. In addition, the study would evaluate the opportunities for these basins to also serve as flood control basins.

- The major water systems in the Valley Floor do not meter and charge for water on a volumetric basis. These systems include the cities of Madera and Chowchilla and the County Service Areas and Maintenance Districts. Data shows that water use is reduced by 15 to 25 percent when meters are installed and water is billed on a volumetric basis. Potential water savings and reduction in groundwater pumping could range from 6,000 to 9,000 AFY. It is recommended that a jointly funded study be initiated that would determine the cost, recommend a process for meter installation, evaluate alternative water rate schedules, and identify potential funding sources.

#### 9.2.2.2 Water Quality

- The San Joaquin River water has sufficient organic matter, whether measurable as TOC or as other organics, that, when disinfected with free chlorine, results in elevated DBPs that have caused several County-operated water systems to violate MCLs. Further study is needed to determine the type of organic material that is the cause, whether any watershed control is feasible, and whether alternative disinfection and filtration treatment processes can correct the problem at a reasonable cost.

- The County should develop a program to identify and properly abandon wells no longer in use to prevent the cross-contamination of aquifers. The County's well standards (Title 13, Section 13.52) should outline the criteria for determining whether a well should be abandoned and the process for abandonment.

#### 9.2.2.3 Land Use and Development

The County should investigate the following policies for legal and institutional feasibility and for potential adoption. The size of the development to which any new policy would apply would be established during the development and adoption process for the policy.

- Limiting new agricultural development if water supply is not sufficient to meet demands and/or requiring annexation into a water or irrigation district as a prerequisite. Limits could include a limit on groundwater pumping on a per-acre basis and could be applied to only areas defined as being in a state of severe overdraft as defined in the policy or ordinance.

- Metering of water produced by groundwater wells.

- Groundwater pump tax or land-based assessment to fund water supply projects. Funds raised through these mechanisms should not go into the General Fund and should be reserved for implementation of engineered projects and not for further studies. A tax or assessment may be subject to the constraints of Propositions 13 and 218.

- Requiring all new large development to provide the approving agency a detailed plan to balance the development's water supply and not rely on mining or overdraft of the basin to meet its demands (similar to the Root Creek Water District plan to mitigate water use for the proposed Gateway Village development). The plans should include development of new surface water supply or mitigation for groundwater pumping. This requirement may be burdensome for small developments. The County should consider development of a water impact fee program for small development projects. This revenue source would assist the County in developing and implementing some of the larger cost-effective projects that will provide significant water benefits. This program should be considered for countywide implementation.

- Requiring new large development to include facilities for the reuse of wastewater, including dual plumbing (nonpotable/recycled and potable water).

#### 9.2.2.4 County Service Areas and Maintenance Districts

Many of the County-operated water and sewer systems are in need of repair and improvement. The County recently began assessing the condition of some of these systems. The County is currently applying to the State Revolving Fund for grants to make improvements to some of the water and sewer systems. It was estimated by County staff that it would cost approximately $90 million to complete repairs on all County-operated water and sewer systems. It is recommended that funds be sought from all available sources to repair these systems to improve water supply reliability and quality for the special district customers. It is also recommended that rate structures be implemented in order to collect adequate funds to make the districts self sufficient. The County should also look at combining districts where possible as discussed earlier.

#### 9.2.2.5 Flood Control

The County was put on notice by the Central Valley Flood Protection Board (formerly the Reclamation Board) that deficiencies exist on the Chowchilla River and Ash and Berenda Sloughs. The County was recently notified by the Board that the County's submitted corrective action plan was acceptable. In addition, the County has requested an extension of time to complete the corrective actions but have not received an answer to the request. If corrections are not made and a reinspection scheduled by the deadline, the project will be considered inactive and will not be eligible for PL84-99 rehabilitation assistance.

- The County should proceed immediately with all corrective actions as outlined in the action plan, including plans for *Arundo donax* mapping and eradication plans, channel restoration, and levee restoration and maintenance.

- It is also recommended that the County initiate formation of a group of representatives from the County, cities of Madera and Chowchilla, MID, and CWD to discuss development of a multiagency project to construct and operate storm water detention/ groundwater recharge basins throughout the Valley Floor with the objectives of reducing flooding problems and recharging the groundwater basin. Locations, such as upgradient of the cities of Madera and Chowchilla and the Root Creek and Madera Ranchos areas, will help reduce groundwater overdraft in these critical areas. Plans for joint use of storm water basins in the cities of Madera and Chowchilla and County Road Department storm water ponds should also be developed so that when the basins are not needed for storm water detention, they can be used for recharge purposes through agreements with MID and CWD.

- Madera County and the City of Madera have adopted a community action plan for the County area and the major communities. The plan was prepared by the State Office of Emergency Services to cover a variety of natural and manmade disaster situations. For flood emergencies, the plan describes individual actions for before, during, and after flood events. It does not cover specific activities or assign responsibilities for emergency communications, safeguarding people and property, rescue and relief, or flood fighting. It is therefore recommended that an Emergency Response and Recovery Plan be developed for the County consistent with the National Incident Management System.

- The Madera County FCWCA was formed in 1969 by Madera County Flood Control Act 4525. This was enacted because the water and drainage problems in Madera County require countywide water conservation, development of water resources, and control of drainage, storm, flood, and other waters. FCWCA has many authorized functions and authorities, including the ability to tax (subject to Propositions 13 and 218) and issue certain bonds for project work as well as enforcement powers. However, FCWCA has no assigned staff and a very limited budget even though it has responsibility for maintenance of approximately 75 miles of levees on the Fresno and Chowchilla River systems. The County Board of Supervisors sits as the Board for FCWCA. It is recommended that the County provide adequate staff and funding to develop and implement a well-coordinated flood control program for the entire County. To accomplish this, a detailed study is needed of the functions, programs, and projects for which FCWCA would be responsible, along with a determination of the required staffing and funding levels.

### 9.2.3 Groundwater Monitoring Program

It is recommended that the County implement the proposed countywide groundwater monitoring program as presented in Appendix F. The program is designed to continue the data collection started as part of this project and to fill in the gaps where sufficient data is not currently collected. The program includes the installation of additional stream gauges, expansion of the water-level reading network, and continued collection of water samples for water quality testing in both the Valley Floor and Foothills and Mountains areas. The program also includes the evaluation of the data and the preparation of hydrographs and water level and water quality maps. Estimates of groundwater pumpage and consumptive use of crops in the Valley Floor will be compared to surface water use and groundwater trends to identify problem areas where increased mitigation measures can be focused. This program is vital to monitoring groundwater conditions throughout the County and to provide up-to-date data for future decisions regarding development and protection of the County's water resources.

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