Section 3
Current and Future Water Demand

Understanding the magnitude and location of future water demands, and any potential changes from existing water demands, allows the County to develop recommendations that will meet or manage demands for water quantity and quality into the future. Butte County water demand includes agricultural, urban, and environmental water uses. The *Butte County Water Inventory and Analysis* (CDM 2001) identified County water supply and demand during average and dry water years. As part of this Plan, the County developed agricultural and urban water demand forecasts and an initial environmental water demand assessment. These analyses are necessary information for water resource planning. These demand projections provide context for water policy recommendations.

The following sections describe current and future water demands for agricultural, urban, and environmental water uses in the County. The methodologies for each sector are different because they are specialized to account for the various factors that affect demand in each sector. The findings show that future agricultural water demand will decline slightly, urban demand will increase, and additional monitoring is needed to project future environmental demand.

3.1 Agricultural Water Demand

3.1.1 Current Agricultural Demand

The Butte County Agricultural Commissioner's office estimated the County's agricultural production value in 2002 was over $300 million. Rice and almond crops contributed significantly to the total value. The *Butte County Water Inventory and Analysis* (2001) characterizes current agricultural demand in the County in average and dry water years. The report estimates water demand using DWR's 1997 land use data, Agricultural Commissioner Reports, and discussions with land owners and water purveyors regarding irrigated crop acreage and irrigation requirements.

Total agricultural demand in the County is about 1 million acre-feet in a normal water year and 1.1 million acre-feet in a drought year, or about 70 percent and 73 percent of total County water demand, respectively. Butte County has about 230,500 acres of irrigated crop land in a fully cropped, normal year. Rice accounts for about 110,000 acres, or 48 percent of total irrigated acreage. Rice requires approximately 5.5 acre-feet applied water per acre. Other major crops in the County include grain, orchards, and pasture. Orchard crops require an average of 3.6 acre-feet applied water per acre.

Butte County has an adequate supply of surface water and groundwater to meet current agricultural demands.

3.1.2 Future Agricultural Demand

Future agricultural water demand will vary from current demand because of changes in economic, land use, and hydrologic conditions. The Plan includes an agricultural demand forecast to estimate future demand based on potential, reasonable scenarios for future agricultural water use. Appendix B is the Agricultural Water Demand Forecast Report. The following sub-sections summarize the report.

3.1.2.1 Agricultural Demand Forecast Methodology

The analysis developed and evaluated five agricultural water demand scenarios using an economic model of agricultural production developed specifically for Butte County. A "Delphi" group of agricultural experts from Butte County was convened for several meetings to review and provide independent, unbiased evaluation of the approach, assumptions, data, and results. The analysis forecasted demand for five geographic regions within the County. The following paragraphs describe the future agricultural scenarios.

Agricultural Land Conversion

Recent trends show agricultural land conversion for urban and environmental uses, resulting in less irrigated crop land in production. Figure 3-1 shows the cities most likely to develop on agricultural land in the future. In addition to urban development, local governments and land trusts in Butte County are purchasing permanent agricultural conservation easements, which remove land from production to protect its conservation values.

Figure 3-1
Cities with Potential Agricultural Land Conversion

Increased Crop Prices

Crop prices frequently increase or decrease as a result of changing market demands, competition from other production regions, and government programs. Price changes would affect the amount of land in production and the demand for water. Price changes tend to be disproportionate, meaning that some commodity crop prices would increase or decrease relative to other crops.

Increased Crop Idling

Agricultural water has been identified as a potential water source to meet new and increasing water demand for environmental resource protection and water supply reliability. Urban water districts, including Metropolitan Water District, and government programs, including the CALFED Environmental Water Account, have initiated or proposed to initiate water purchases from agricultural water districts through idling of irrigated crop land. Crop idling would decrease the amount of applied surface water in the County.

Conservation
Water conservation is an important component of managing water demands and supplies in the future. Agricultural practices could achieve conservation at an on-farm level (e.g., by reduction of applied water) and at a district level (e.g., through such methods as canal lining, spill recovery, and automation). This scenario only considered savings from on-farm irrigation systems and management.

Combination Scenario
The combination scenario forecasts likely changes in agricultural water demand in Butte County taking into account a combination of the most probable land and water use changes. A combination scenario, for average and dry years, includes agricultural land conversion, crop idling, and conservation scenarios are all implemented.

Table 3-1 summarizes the forecast scenarios and indicates how the analysis represented them.

Table 3-1
Summary of Agricultural Demand Forecast Scenarios

Scenario	***Implementation Method***	***Analytical Representation***
Land Conversion	Decrease total land in production	Decrease irrigated land 3% in Vina and West Butte Decrease irrigated land 1% in East Butte
Crop Idling	Decrease surface water used for crop production	Decrease surface water delivery 10%
Crop Prices	Increase relative crop prices	Increase rice and orchards price 10%
Water Conservation	Increase crops irrigation efficiency	Set target irrigation efficiencies for each crop
Combination Scenario – Average and Dry Years	Combines land conversion, crop idling, and conservation scenarios	Decrease irrigated land 3% in Vina and West Butte Decrease irrigated land 1% in East Butte Decrease surface water delivery 10% Set target irrigation efficiencies for each crop

3.1.2.2 Agricultural Water Demand Forecast Results

Forecast results showed changes in crop acreage and applied water use under each scenario. Figure 3-2 is an example of forecast results. It summarizes changes to total applied water under the average year combination scenario in all regions. In the East Butte region, total applied water would decrease 55,020 acre-feet, or 8.75 percent. Total crop acreage would decrease 3,340 acres, or 2.77 percent (not shown). All other regions also would experience decreases in applied water and total acreage.

The agricultural water demand forecast generated several important conclusions for future water resource planning.

- In general, the analysis indicates that most of the reasonably foreseeable changes would not result in significant long-term changes in agricultural water demand in Butte County. Total applied water demand under the average year combination scenario would decrease a minimum of 0.6 percent (1,300 acre-feet) in the West Butte region and a maximum of 8.75 percent (55,020 acre-feet) in the East Butte region.

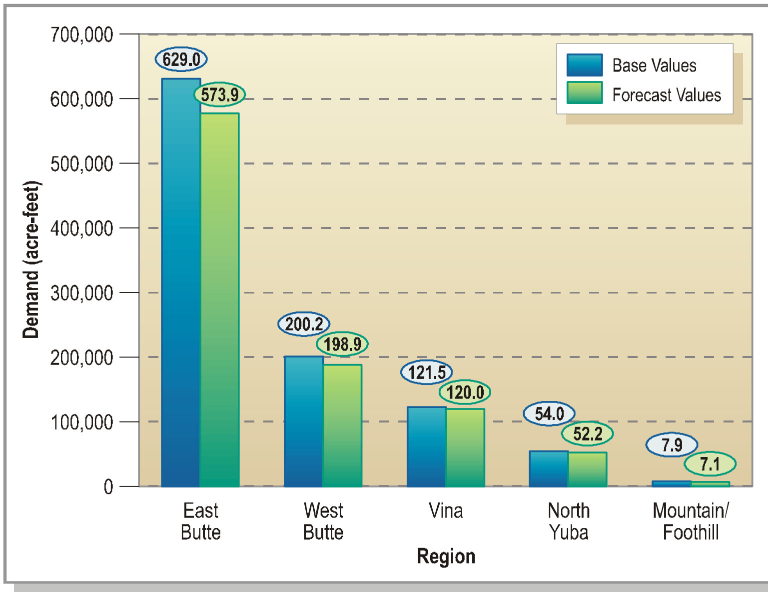

Figure 3-2
Comparison of Total Applied Water
Under Base and Combination (Average Year) Scenarios

- Crop idling results in the largest projected decreases to agricultural water demand and provides purveyors with surplus water that could be used by government programs or other water districts. Total water demand in the County under the crop idling scenario decreases 63,700 acre-feet (6.3 percent).

- Agricultural land conversion would result in a small reduction in irrigated cropland and agricultural water use in the County. Total water demand in the County under the agricultural land conversion scenario decreases 9,600 acre-feet (0.9 percent).

- Water conservation would reduce applied water and provide purveyors with surplus water that could be used by government programs or other water districts; however, conservation could be expensive. Total water demand in the County under the water conservation scenario decreases 51,800 acre-feet (5.1 percent).

- Relative changes in crop price can have an important effect on agricultural water demand. The analysis presented one plausible case that could increase water demand; however, price forecasting is inexact and has not been attempted in this study. Therefore, results of the price change scenario should be viewed as an example.

- A combination scenario, which would include the effects of three other scenarios, results in a reduction in agricultural water demand. Although the combination scenario is plausible, readers should consider it a cumulative analysis of potential future conditions.

- The combination scenario was evaluated for both an average year and a dry year condition. The dry year conditions start from the same base level of crop acreage and a higher base level of water use, but the incremental change resulting from the combination scenario is similar to the average conditions. Total water demand in the County decreases 60,500 acre-feet (6.0 percent) in an average year and 71,300 acre-feet (6.3 percent) in a dry year under the combination scenario.

3.2 Urban Water Demand

The Plan includes an urban water demand forecast that characterizes urban water use in Butte County in 2000, 2010, 2020, and 2030. The forecast estimated water demand in six study areas in Butte County: Biggs, Chico, Gridley, Oroville, Paradise, and the remaining unincorporated areas. The following sections summarize current and future urban water demands, as detailed in Appendix C, which includes the Urban Water Demand Forecast Report.

3.2.1 Current Urban Demand

The urban demand forecast reports urban water use in the year 2000. Table 3-2 lists Butte County water service purveyors and the areas they serve.

Table 3-2
Forecast Model Study Areas

Study Area	***Water Purveyor(s)***
Biggs	City of Biggs
Chico	California Water Service Company, Chico
Gridley	City of Gridley
Oroville	California Water Service Company, Oroville
	Oroville Wyandotte Irrigation District
	Thermalito Irrigation District
Paradise	Paradise Irrigation District
Unincorporated Areas	Several water purveyors (not listed)
	Private wells

Urban water use includes households uses, commercial and industrial uses, and landscape irrigation. Table 3-3 summarizes the urban water users' average daily demand during minimum and maximum water use months and total average annual demand.

Table 3-3
Urban Population and Water Demand, 2000

		Monthly Demand (million gallons)				
City	***2000 Census Population***	***Minimum***		***Maximum***		***Annual Demand (million gallons)***
		Demand	***Month***	***Demand***	***Month***	
Biggs	1,799	7.0	January	26.0	June	186.4
Chico	59,444	325.9	January	1,004.2	July	7,616.1
Gridley	5,450	18.3	February	69.5	June	494.4
Oroville	12,969	69.1	December	243.8	August	1,650.4
Paradise	26,451	84.4	March	358.2	September	2,431.3
Unincorporated Areas	97,058[1]	238.9	February	1,210.6	July	8,322.3

[1]Estimated as the incorporated areas' population subtracted from the entire county's population.

The *Butte County Water Inventory and Analysis Report* (2001) estimated total County urban water demand in 1997 to be 20,463 million gallons. The Urban Water Demand Forecast report estimates County demand in 2000 to be about 20,700 million gallons. Each study used different methods, but they used similar data sources produced similar results.

3.2.2 Future Urban Demand

Future urban water demand varies from current demands because of changes in development, population, economic and hydrologic conditions. The urban water demand forecast characterizes and assesses the urban water needs of Butte County through 2030. Appendix C includes the complete Urban Water Demand Forecast report.

3.2.2.1 Urban Demand Forecast Methodology

The urban demand forecast analysis used IWR-MAIN Water Demand Management Suite© to perform the urban water demand forecast with the *adjusted rate of use* forecasting method. The *adjusted rate of use* method calculates the quantity of water used in a given subsector for a specified forecast year, in this case, 2010, 2020, and 2030. The base year for the analysis was 2000, which was an above normal year; therefore, the analysis included adjustment factors so that the projections reflect water demands in an average year. The forecast estimated water demand in each subsector in six study areas in Butte County: Biggs, Chico, Gridley, Oroville, Paradise, and the remaining unincorporated areas. Table 3-4 defines the subsectors used in the forecast.

Table 3-4
Urban Water User Subsectors

Sector	***Subsector***	***Counting Unit***
Residential	Single-Family	Single-Family Housing Units
	Multifamily	Multifamily Housing Units
Nonresidential	Commercial	Commercial Jobs
	Industrial	Industrial Jobs
	Large Landscape	Population, in 1000s

To assess future urban water demand, the forecast model required current data and projections for the following water use variables:

- Demographics;
- Weather;
- Marginal price;[1]
- Elasticity;[2] and

[1] Marginal price is the price of water and sewer service per quantity of water in excess of a base volume at a flat cost. See Appendix C for more information.

- Unmetered/unaccounted.[3]

The analysis assumes that existing levels of water use efficiency continue into the future. Chico has plans to upgrade distribution piping in the near future to reduce losses. These plans were factored in to Chico's projections because they are firm plans to reduce water demand.

The following text discusses housing projections used in the analysis. Appendix C includes projections for all of the above variables and further demographic data, including employment, population, median income, persons per household, and housing density.

- Biggs - a 49 percent increase in single-family housing units from 2000 to 2030. During the same time, the multifamily units are projected to decrease by 11 percent. The CSU Chico Center of Economic Development (CED) attributed part of these large increases in housing units to people that work in Chico moving to Biggs.

- Chico - a 112 percent increase in single-family housing units from 2000 to 2030. During the same time, the multifamily units are projected to increase by 68 percent. The CED attributed part of these large increases in housing units to annexation of already-developed areas adjacent to the incorporated boundaries of Chico.

- Gridley - a 28 percent increase in single-family housing units from 2000 to 2030. During the same time, the multifamily units are projected to increase by 59 percent. The CED attributed part of these large increases in housing units to people that work in Chico moving to Gridley.

- Oroville - a 189 percent increase in single-family housing units from 2000 to 2030. During the same time, the multifamily units are projected to increase by 232 percent. The CED attributed part of these large increases in housing units to annexation of already developed areas adjacent to the incorporated boundaries of Oroville.

- Paradise - a 31 percent increase in single-family housing units from 2000 to 2030. During the same time, the multifamily units are projected to increase by 3 percent. The CED did not project much growth for Paradise because it is nearly built out to its general plan.

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[2] Elasticity is a measure of the sensitivity of the per unit water use rate to the change in the explanatory variable; it indicates the percent change in per unit water use given a percent change in the variable value. See Appendix C for more information.
[3] The unmetered/unaccounted water category in IWR-MAIN accounts for water losses in the water purveyors' conveyance systems, as well as unmetered use, system flushing, and fire fighting.

3.2.2.2 Urban Demand Forecast Results

Results indicate increases in urban demand, in millions of gallons, over the forecast period. Figure 3-3 shows the overall increases in water demand in study areas from 2000 to 2030.

The urban water demand forecast generated several conclusions important for future water resource planning.

- The largest urban water demand growth during the study period could occur in Chico (96 percent), primarily because of increases in household and commercial water use. Residential water demand could increase as a result of projected new housing growth and annexation of already developed land adjacent to the incorporated boundaries. Additionally, commercial jobs in the area are estimated to increase 87 percent, which cause an 82 percent growth in commercial water demand.

- Biggs and Gridley show 44 percent and 33 percent increases in urban demand, respectively. Increases in single or multi-family housing units result in most of the projected urban water demand growth. In Biggs, increases in median incomes could cause single-family water use to grow to 66 percent. In Gridley, increases in persons per household could cause multi-family water use to grow 115 percent.

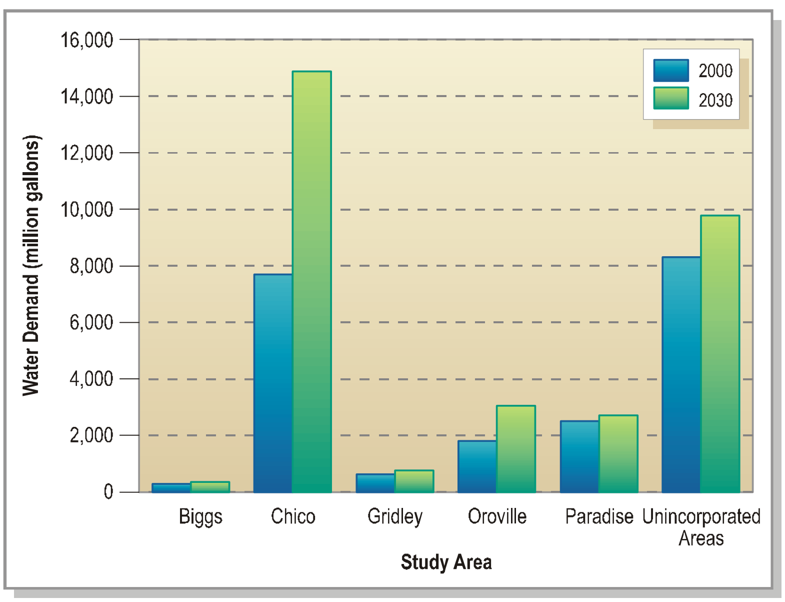

Figure 3-3
Urban Demand Forecast Results

- Urban water demand in Oroville is estimated to increase 77 percent between 2000 and 2030, mainly from increases in single and multi-family housing units. The per unit water use rate for both subsectors, however, is projected to decrease slightly between 2000 and 2030 because of decreases in persons per household.

- The analysis estimates an 11 percent increase in urban demand in Paradise from 2000 to 2030. The projected growth for housing is a 27 percent increase in single family units and a 10 percent increase in multi-family units. These growth rates are lower than other study areas because Paradise is nearly built out to its general plan.

- The demand in unincorporated areas would decline somewhat because of the urban annexation of existing housing developments that are currently in unincorporated areas. This decline, however, is overshadowed by the increase in development in the unincorporated areas that produces an overall increase in water demand.

- Urban demand in the entire County is estimated to increase 51 percent. The County's growth is primarily due to increases in residential and commercial uses in Chico. Commercial uses in the County show the largest increase because of the projected increase in commercial jobs between 2000 and 2030.

3.3 Environmental Demand

Calculating current environmental demand and projecting future demands requires knowledge of current habitats, demands by habitat type, instream flow requirements, and groundwater-surface water interactions for areas with shallow groundwater. Some of this information is not yet available; therefore, rigorous demand calculations are not currently possible. As an initial step, the DW&RC performed preliminary environmental demand calculations as a frame of reference for water resource planning. The next step will be additional environmental monitoring to obtain necessary data, and then more rigorous demand calculations.

3.3.1 Preliminary Current Environmental Demand Estimates

The *Butte County Water Inventory and Analysis* calculated environmental water demand for managed wetlands and rice decomposition in Butte County. Total environmental water demand is approximately 139,000 acre-feet in a normal year and 161,000 acre-feet in a dry year. The report also calculates conveyance losses, which can be considered in environmental water use. Conveyance losses were 230,100 acre-feet during a normal year and 185,100 acre-feet during a dry year. The *Water Inventory and Analysis* did not calculate environmental demand associated with riparian and terrestrial vegetation or instream demand.

As part of the Plan, the DW&RC applied the water balance approach to calculate preliminary environmental water demand and use in Butte County. Figure 3-4 shows surface water hydrology which could contribute to environmental water demands. In the water balance, the DW&RC calculates precipitation, environmental evapotranspiration, runoff, stream flow, and change to groundwater storage. Appendix D includes a description of methodology and preliminary investigation into environmental demand.

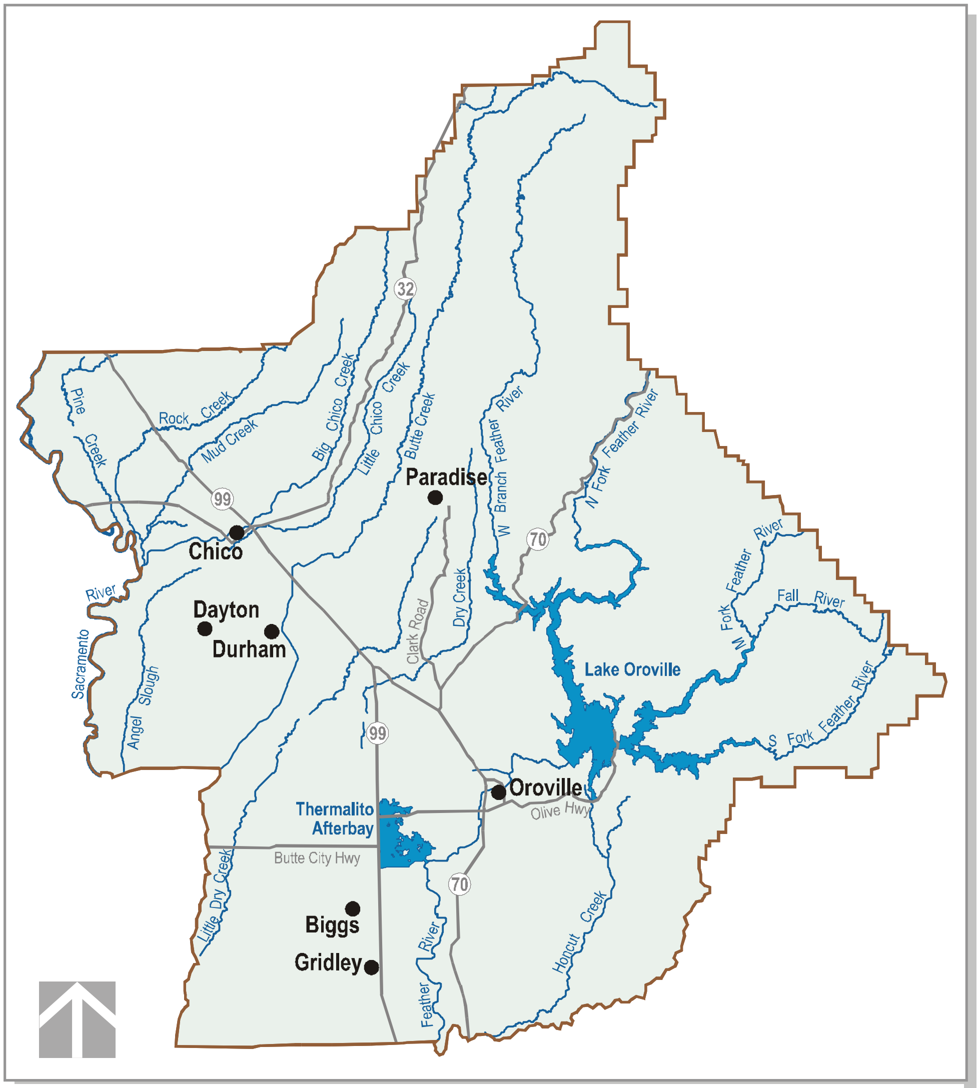

Figure 3-4
Butte County Hydrology Map

3.3.2 Refined Environmental Demand

Prior to this planning process, the DW&RC determined that increased understanding of environmental demand was necessary. The Board of Supervisors has already approved the completion of an Environmental Monitoring Plan (Appendix E), the purpose of which is to:

- Estimate the water demand of natural ecosystems in the County; and
- Monitor the health of terrestrial and aquatic habitats under changing water and land use conditions.

Environmental demand represents multiple habitats, including:

- Instream aquatic habitat in rivers, creeks, and sloughs;
- Riparian zones along rivers, creeks, and sloughs;
- Managed wetlands;
- Upland wetlands including vernal pools and springs;
- Lake and reservoir aquatic habitat; and
- Lacustrine (lake shore environment) habitat.

The Environmental Monitoring Plan focuses on several activities:

- Classifying habitat using the California Wildlife Habitat Relationships System protocol developed by the California State Department of Fish and Game and implemented by the Department of Forestry and Fire Protection.
- Ground-checking habitat classifications, because classification is often performed at a large scale and may not be accurate at smaller scales.
- Identifying instream flow requirements using an adaptive management approach, in which assumptions about flows will be revised periodically based on wildlife performance within the waterways.
- Using information from habitat classification and instream flow requirements to calculate environmental demands using the SLURP model (Semi-distributed Land Use-based Runoff Practices) and a groundwater-surface water model (the Integrated Groundwater-Surface Water Model).

A major unknown concerns the interactions between plants and shallow groundwater areas that may not be fully saturated. The models, and additional monitoring, will help determine these interactions. All of these activities will work together to identify environmental demands and better understand environmental mechanisms within the County.