GROUNDWATER

Fulton, Allen et al. Seeking an Understanding of the Groundwater Aquifer Systems in the Northern Sacramento Valley. Pamphlet. Cooperative Extension and California Department of Water Resources. N.d.[1]

This pamphlet summarizes information regarding freshwater aquifer systems in the northern Sacramento Valley and provides information about six geologic cross-sections that have been and are currently being developed and studied to help understand the sub-surface hydrogeology of the area. The pamphlet identifies marine groundwater formations such as the Great Valley Sequence and the Lower Princeton Submarine Valley Fill as the primary saline water aquifer systems in the area. It also identifies transitional aquifer systems including the Neroly Formation, the Ione Formation, and the Upper Princeton Valley Fill that contain a mixture of freshwater and saline water.

It describes the freshwater aquifer systems as including (1) the Alluvial aquifer system (the uppermost groundwater bearing unit) reaching from ground surface to a maximum depth of about 200 feet; (2) the Upper Tuscan system, exposed on the east side of the valley along the foothills and found at a depth of about 800 feet in the central portion of the valley; (3) the Lower Tuscan system, also exposed on the east side of the valley and underlying the Upper Tuscan system, and extending westward across the valley approaching Interstate 5; and (4) the Tehama Formation , exposed on the west side of the Sacramento Valley at a depth from the ground surface to about 1,000 feet.

The pamphlet provides information postulating the location of groundwater recharge areas and suggests that understanding the extent of the aquifer system is important to managing a balance between preservation and utilization.

Giller, Joseph Anthony. Hydrogeochemistry of the Cherokee Creek Watershed. Thesis, California State University-Chico: Summer, 1998.[2]

The Tuscan Formation allows easy transport of groundwater into the valley. Nearly all of the groundwater contained in the Tuscan is under pressure or confined.

The Chico Formation underlies most of the valley at depths greater than 1500 feet. It is exposed in the southwestern portion of the watershed along the banks of Dry Creek.

The Ione Formation, north of the town of Pentz, crops out along the banks of Dry Creek.

Camp Dresser & McKee, Inc. Butte County Department of Water and Resource Conservation. Butte County Water Inventory and Analysis. Butte County: 2001.[3]

The analysis provides a summary of Butte County's water resources through a collaborative effort between the Camp Dresser & McKee, Inc. team, Butte County Department of Water and Resource Conservation staff, and the California Department of Water Resource's Northern District staff. The California Department of Water Resource's Northern District staff prepared a report, Butte County Water Inventory and Analysis, to support data needs for the overall inventory project. The results are used extensively in this report.

This report presents an inventory of Butte County's current water resources; water resource-related programs; urban, agricultural, and environmental needs; available water supplies to meet needs in normal and drought hydrologic conditions; and an assessment of potential imbalances between needs and corresponding water supplies.

The approximate depth at the deepest portion of the aquifer to the base of fresh water within each of the inventory units in the Sacramento Valley are as follows: Vina Inventory Unit – 1,600 feet; West Butte inventory Unit – 1,500 feet; East Butte Inventory Unit – 1,400 feet; and North Yuba Inventory Unit – 600 feet. The majority of domestic wells in the county have been completed in the upper 200 feet of the aquifer, while 90% of the agricultural and municipal wells are completed in the upper 600 feet and 750 feet of the aquifer, respectively. Butte County's fresh groundwater-bearing units in the Sacrament Valley include the Tuscan, Laguna, Riverbank, and Modesto Formations.

The Tuscan Formation is exposed in the foothill regions and serves as a recharge area for the Sacramento Valley's aquifer system. Groundwater recharge occurs through precipitation and deep percolation of runoff from nearby creeks, streams, and reservoirs. Groundwater levels reflect rainfall patterns, however, aquifer specific yield are much lower in the foothill region than those in the Sacramento Valley.

The Tuscan formation is described as four separate but lithologically similar units, Units A through D. Unit A consists of the oldest deposits of the Tuscan formation and is about 250 feet thick. Units B and C are about 6-00 feet thick each and overly Unit A in most locations in Butte County. Unit D is the youngest unit and is not exposed in Butte County. The total thickness of the Tuscan formation is approximately 1,450 feet in Butte County. Tuscan formation groundwater in the Sacramento Valley Region is contained primarily within the pore spaces of the reworked sand and gravel layers. Much of the groundwater in the Tuscan formation is confined under pressure by layers of impermeable clays, lahars or tuff breccias. The permeable layers of the Unit B sediments compose the main aquifer material for groundwater storage in the valley. The fine-grained, consolidated lahars of Unit C form thick, low permeability confining layers for groundwater contained in the more permeable sediments of Unit B.

The Cherokee Inventory Sub-Unit is approximately 45.9 square miles and has an approximate population of 1,000 people. The Cherokee area is supported mainly by groundwater, and many residents are concerned that surface water transfers that include groundwater substitution will have a negative impact on their groundwater sources.

Butte County Resource Conservation District. <u>Long Range Plan.</u> Butte County: July 2003.[4]

This document outlines the plan priority objectives, for water quality and water quantity development:
To insure the economic and environmental future of Butte County's citizens the plan includes working for the protection of the quality, supply and availability of groundwater.
Coordination with Butte County and other agencies to improve watersheds and recharge areas for underground aquifers is recommended.

Fulton, Allen et al. Groundwater Level Monitoring: What Is It? How Is It Done? Why Do It? Pamphlet. UC Cooperative Extension and California Department of Water Resources. n.d.[5]

This pamphlet describes three essential components of effective groundwater management to include: (1) monitoring groundwater levels; (2) monitoring groundwater quality, and (3) monitoring land subsidence. Due to the limits of financial resources and the fact that groundwater monitoring is in the early stages, the authors indicate that groundwater level monitoring usually takes priority over monitoring groundwater quality and land subsidence. The pamphlet further describes the technical aspects of monitoring groundwater levels, establishing ground surface elevations, using production or observation wells to measure groundwater levels, the types of devices available to measure groundwater levels, the factors that determine where to monitor groundwater levels, deciding when to monitor groundwater levels, record keeping, and applying groundwater level monitoring results.

Peterson, Jeffrey Loren. Hydogeologic Investigations for Ground Water Resources in Complex Metamorphic Terrane Thesis, California State University-Chico: Fall, 1984.[6]

Groundwater resources in the upturned low-grade metamorphic tuffaceous rocks (greenstone) in a portion of the Middle Jurassic Oregon City Formation near Cherokee, California are considered limited. Ground water flow in this complex lithology is solely dependent on secondary porosity and permeability and varies with depth as well as lithology.

All existing wells in the study area have low yields with the greatest recharge apparently accumulating in topographic low areas. Based on the well recovery test performed on Linam Well No. 4, true well yields may be less than 1 gal. /min. In order to supplement domestic and light irrigation needs, surface storage tanks or cisterns are recommended.

California Department of Water Resources, Northern District. Drought Contingency Plans for Selected Small Communities. Memorandum Report. Butte County: November 1987.[7]

A 1986-87 study focused on 13 small communities in the northern part of California that had severe water shortage problems. The community of Cherokee (population 180) was one of the five areas in Butte County selected for study. This report gives a brief history, the local geology and occurrence of ground water for the selected communities.

The ground water flow is generally northward for the southern portion of the Cherokee area and southward for the northern portion. Where the valley's surface drainage converges the flow turns east along Spring Valley Gulch. The fault along the gulch may form a ground water barrier retaining ground water on the west side.

The wells of the Cherokee area are developed in the weathered and fractured metavolcanic rocks. Considerable variances in depth to water and well yields were found through out the area.

Camp Dresser & McKee, Inc. Butte County Department of Water and Resource Conservation. Urban Water Demand Forecast. Technical Memorandum. Butte County: October 2003.[8]

This document was developed to provide a method to forecast future demand for water in the urban areas of Butte County. Forecasting models, methods, and data input sources for Biggs, Chico, Gridley, Oroville, Paradise and unincorporated areas are discussed. Other factors addressed in forecasting are housing, employment, population, income, persons per household, and housing density projections. In addition, weather data, marginal price for water and un-metered water losses are utilized in forecasting.

According to the Urban Water Demand Forecast, the water demand projection for Paradise will grow from 2,431.3 million gallons in 2000 to 2,701.2 million gallons in 2030, an increase of 11%. The unincorporated areas of the county are projected to grow from 8,322.3 million gallons in 2000 to 9.736.4 million gallons in 2030, and increase of 17%. Countywide, a water demand increase of 51% is predicted from 2000 to 2030.

Department of Water Resources, Northern District. Sacramento Valley Basin Ground Water Levels, Butte County. Department of Water Resources: February 1993.[9]

This report summarizes ground water level data collected by the Department through April 1992. The report presents locations of wells, information related to the monitoring program, and hydrographs depicting ground water levels over time.

Camp Dresser & McKee, Inc. County Department of Water and Resource Conservation. Integrated Water Resources Plan, Volumes I, II and Executive Summary. Report. Butte County: June 2004.[10]

This document describes the Integrated Water Resources Program Coordinator, the Groundwater Management Plan, Drought Management Plan, and Groundwater Basin Management Plan. It specified the planning process to include public involvement, the creation of a steering committee and definition of the objective of the plan.

Current and future water demands are described for agricultural water. Year 2000 urban water demand for Paradise and unincorporated areas of Butte County were 2,431.3 million gallons and 8,322.3 million gallons respectively. Future population was forecast for Paradise as a 27% increase in single-family housing units from 2000 to 2030. During the same time, the multi-family units are projected to increase by 10%. This development translates to an 11% increase in urban water demand by 2030. Demand in the unincorporated area is forecasted to increase due to new development despite the urban annexation of existing housing developments in unincorporated areas. Environmental demand is also discussed in detail.

Measures to protect recharge areas from land use practices that can affect the quality and quantity of recharge into the aquifer are discussed. Zoning changes to protect habitat areas and limiting activities that could degrade water quality would reduce the potential for these effects.

Butte County Department of Water and Resource Conservation. Paradise Ridge Memorandum of Understanding Summary Status Report. Butte County: May 31, 2001.[11]

Substantial work on water quality has been done on Lake Oroville, Thermalito Forebay and Thermalito Afterbay. The State Water Project (SWP) assessment of 1998-1999 found that all data were below the Article 19 objectives for drinking water. The cationic composition included calcium, magnesium, and sodium, which were less than 10 mg/l at all stations. Furthermore, bicarbonate dominated the anionic composition while chloride; nitrate and sulfate were near or below their respective reporting limits. In addition, all minor elements were below detection limits, except for iron, and manganese collected in August 1998 and July 1999 from Lake Davis. Recently, MTBE (*Methyl tertiary-butyl ether)*, a fuel oxygenate added to gasoline to reduce air pollution and increase octane rating, has become a widespread concern in surface, and groundwater quality in California. Conditions prompting concern are increased water recreational activities at Lime Saddle Marina, among others.

Lime Saddle water quality is being studied by the Department of Water Resources (DWR) due to rapid population growth, demand for more water, the use of recreational watercraft and complaints about water quality. The anticipated duration of the study is from February 2001 through November 2001.

The water quality of the Spring Valley Water supply is also thoroughly discussed in this document. The Spring Valley School, which lies within the Cherokee Watershed, is served by three wells on the school property, all of which provide limited flows that contain fecal coliform organisms and is therefore chlorinated. The water also has a high iron and manganese content. In 1989, the Butte County Department of Public Health warned the school that the water was unsuitable for potable use, except with filtration as well as chlorination. In 1992, the Department of Public Health warned the school that the filters that had by then been installed, and also the available flow were inadequate. Several attempts have been made to drill deeper and better wells near the school but without success. In June 2000, the Department of Public Health advised the school that the water from one well had high fluoride content and should be continuously blended with water from the other two wells. Since January 2000, the school has been providing water in five or six gallon bottles for potable use and using the well water only for gardening, cleaning and general kitchen purposes. Total water use at the school has been limited to about 2,000 gpd from the wells, about 1,222 gal/year of bottled water for drinking, and firefighting water held in a 3,000-gallon tank.

In addition to water quality issues from its wells, according to information provided by technical staff at the Spring Valley School, the number of pupils is expected to double in the next ten years. Thus, implying a planning total of approximately 240 persons with an average demand of about 4,800 gpd. In addition, the four residences near the school would add about 2,000 gpd of average demand. With the availability of adequate water supply, the school plans to expand grassed and landscaped portions of the property to at total of about 2.25 acres. On the basis of an estimated typical application of about 7.5 inches per acre per month, the estimated water demand for this purpose is about 1.4 acre-feet per month (AF/m) in the irrigation season.
The Butte County Fire Department advised Spring Valley School in May 2000 that the minimum firefighting requirements would be a minimum fire flow of 1,500 gpm for at least two hours with a system normal operating design pressure of at least 20 psi and distribution mains of at least 6 inches in diameter. Combining these demands, and providing for replenishment of firefighting storage, yields an average demand at the school of approximately 22,300 gpd, or about 2.08 AF/m, and a peak day demand of about 133 gpm.

Butte County Division of Environmental Health. <u>Drink Water Source Assessment and Program Evaluation of the Domestic Water Well Serving Spring Valley School Water System.</u> Butte County: June 2001.[12]

The initial summary of findings for the three wells serving the Spring Valley School in May 2000 identified potential contaminant activities (PCAs). Visual inspection on the site and input by Spring Valley School water system's representative found that the most significant PCAs are those associated with the onsite sewage evaporation pond and related collection system, animal grazing activities and septic systems on neighboring properties.

PCAs of lesser concern include activities associated with the maintenance of highway, roads, and railroad right-of-ways. The wells may be influenced by activities that occurred in the past including discharges to a drainage ditch/creek from the old Cherokee Mine and two old highway maintenance repair shops.

Camp Dresser & McKee, Inc. <u>Basin Management Objective Development Packet, Cherokee</u>. Technical Memorandum. Butte County: May 2004 [13]

This document was developed to provide guidance and information for use by Cherokee Area representatives to develop Basin Management Objectives which are locally developed guidelines for groundwater management that describe actions to be taken by well owners in response to well-monitoring data. The packet describes the Cherokee Sub-inventory Unit physical setting including surface water features, geology, and groundwater setting; local infrastructure setting including groundwater use and existing infrastructure; and local monitoring setting to include water well terminology overview, water quality monitoring, water level monitoring, subsidence monitoring

Fresh water-bearing units in Butte County are described in this document and include the Modesto Formation, the Riverbank Formation, the Laguna Formation, the Tehama Formation, and the Tuscan Formation with four separate but lithologically similar units: Unit A, Unit B, Unit C, and Unit D.

Ground water movement and extraction is illustrated for normal, non-drought years, and seasonal groundwater decline is noted for the summer months when agricultural and/or municipal demands are highest. The document notes that decreases in water level are seasonal and that the basin groundwater typically recharges during the winter months through rainfall and associated runoff. It provides an estimate of groundwater extraction by local areas in 1997 to include the Cherokee area and suggests that that there is no evidence of land subsidence in Butte County from overdrafting of aquifers.

The primary uses for groundwater in the Cherokee Sub-inventory Unit are listed as domestic and irrigation with most of the domestic wells occurring east of the Cherokee Strip and most of the irrigation wells occurring within the Cherokee Strip. The draw down of groundwater levels during the seasonal withdrawals for irrigation is illustrated and the source of the area's water supply is broken down by source (i.e., groundwater, surface water, and reused surface water). Depth figures for the area's approximately 183 wells are provided, and the document indicates that approximately 50 percent of the area's wells are installed to a depth of about 165 feet or less. The 1997 estimate for groundwater extraction in the Cherokee Sub-inventory Unit was 24,000 acre-feet.

The location, depth, and water levels for seven wells within the Cherokee Sub-inventory Unit that the Department of Water Resources and the Butte County Department of Water and Resource Conservation monitor periodically for groundwater levels are described.

Information on water quality samples collected annually from two well sites in the Cherokee Sub-inventory Unit is included. Butte County Water and Resource Conservation Department collects the water quality samples and reports that water quality attributes (including temperature, total dissolved solids, electrical conductivity, and pH) are within the preferable range for drinking water and agricultural water.

Camp Dresser & McKee, Inc. Basin Management Objective Development Packet, Pentz. Technical Memorandum. Butte County: May 2004.[14]

To provide guidance and information for use by Pentz area representatives to develop Basin Management Objectives is the focus of this memorandum. Locally developed guidelines for groundwater management that describes actions to be taken by well owners in response to well-monitoring data is described.

The Pentz area physical setting includes surface water features, geology, and groundwater setting. The local infrastructure setting includes groundwater use and existing infrastructure with local monitoring setting to include water well terminology overview, water quality monitoring, water level monitoring, and subsidence monitoring.

Fresh water-bearing units in Butte County are described in this document and include the Modesto Formation, the Riverbank Formation, the Laguna Formation, the Tehama Formation, and the Tuscan Formation with four separate but lithologically similar units: Unit A, Unit B, Unit C, and Unit D.

The Pentz area has approximately 243 wells with most (71%) used for year-round domestic purposes. A smaller number (16%) of wells are used for irrigation during the summer months. The source for water supply in the Pentz area is entirely groundwater. In 1997, the estimated groundwater extraction amount for the Pentz area was 100 acre-feet.

This document suggests that there is insufficient data to estimate seasonal groundwater level fluctuation or the location direction of groundwater movement in the Pentz area. The Department of Water Resources and the Butte County Department of Water and Resource Conservation do not currently monitor groundwater levels in the Pentz area.

Camp Dresser & McKee, Inc. Basin Management Objective Development Packet Western Canal. Technical Memorandum. Butte County: May 2004.[15]

The memorandum describes the Western Canal area physical setting including surface water features, geology, and groundwater setting; local infrastructure setting including groundwater use and existing infrastructure; and local monitoring setting to include water well terminology overview, water quality monitoring, water level monitoring, subsidence monitoring.

The Western Canal area has approximately 200 wells with most (56%) used for seasonal irrigation purposes, while 24% are used for domestic purposes year-round. The source for water supply in the

Western Canal area is approximately 71% surface water, 7% groundwater, and 22% re-used surface water.

The California Department of Water Resources and Butte County Department of Water and Resource Conservation currently monitor ten wells in the Western Canal area. From 1997 to the present time, these wells have been monitored four times a year for water level. In addition, two wells in the Western Canal area are monitored for water quality. All water quality attributes measured in these wells are within preferable ranges.

Camp Dresser & McKee, Inc. Butte County Department of Water and Resource Conservation. Groundwater Management Plan. Public Review Draft. Butte County: April 2004.[16]

This plan was developed to support the long-term maintenance of high quality groundwater resources for agricultural, environmental, rural domestic and urban needs. Areas not managed under existing AB 3030 Groundwater Management Plans are covered and thereby excludes the Richvale Irrigation and Western Canal Water Districts.

The packet describes the Butte County topography, climate, surface water hydrology, hydrogeology, ground water levels, groundwater movement, groundwater storage, groundwater quality, land subsidence, groundwater well infrastructure, well depths, yields, supply, demand and demand forecast.

Rainfall and winter snow pack in the Sierra Nevada provide Butte County with significant surface water flows and associated groundwater recharges as surface water traverses the county. Surface water bodies are believed to contribute to groundwater recharge as the water bodies traverse the outcrop locations of the county's freshwater-bearing geologic formations. Additionally, surface water managed for agricultural use contributes to groundwater recharge.

This document describes groundwater quality in the Sacramento Valley portion of Butte County as typically of good quality, as evidenced by its low total dissolved solids (TDS) concentrations, ranging from 67 parts per million (PPM) to 232 ppm. The preferred temperature for drinking water is less than 50 degrees Celsius, above which there can be plant and/or algae growth. Groundwater temperatures range from 17.6 degrees Celsius to 27 degrees Celsius. Recent monitoring indicates that the basin is a high-quality fresh water basin that is free of saline intrusion.

Inelastic land subsidence, for the purpose of the Groundwater Management Plan, is the permanent lowering of the ground surface resulting from compaction of geologic materials caused by groundwater extraction. No land subsidence has been observed in the Butte County portion of the Sacramento Valley.

The Sacramento Valley portion of Butte County has approximately 9,400 wells serving domestic, irrigation, municipal, monitoring and other uses. Well depths for different uses are discussed. The East Butte region has wells that yield an average of 980 gallons per minute.

Water supply and demand are discussed. The greatest demand (64%) is in the East Butte region, which primarily uses surface water, as does the Foothill region. The rest of the county primarily uses groundwater. Under normal conditions, Butte County has an adequate supply to meet current demands. Drought adjustments and forecasted water demands for agricultural and urban needs are also discussed.

In addition to describing monitoring systems for water quality and subsidence, the document provides information regarding the Groundwater Basin Management Ordinance (BMO) and its aim to protect groundwater, prevent subsidence, and future plans for wellhead or recharge area protection.

Drought is defined as a normal, recurrent, and insidious climatic event. Historically, Butte County has experienced 9 drought periods since 1900, ranging from 1-5 years in duration, with droughts twice exceeding 3 years. Drought impacts in Butte County are usually delayed due to an abundance of stored surface and groundwater, and the economic impacts are difficult to assess due to lack of studies. The Plan designates increased monitoring by the Drought Task Force during drought years 1-3, the establishment of the Drought Interagency Coordination Group in years 4-6, and the activation of Working Groups in years 6 and beyond.

The establishment of a continuous monitoring system was described. Drought response and mitigation are specified for agricultural, urban, environmental and rural communities. Specific drought issues regarding groundwater supplies have been identified for the communities of Berry Creek, Cherokee, Cohasset, and the Lime Saddle area. Specifically, Cherokee has 60 groundwater wells and by 1987 they had already stressed the sustainable supply. There have been instances of water hauling during periods of drought conditions. In addition, there are landowners in the Lime Saddle area existing on marginal groundwater supplies.

Regional Water Quality Control Board Central Valley Region. Order No. R5-2003-0096, Monitoring and Reporting Program No. R5-2003-0096 for Mineral Resources LLC, and Goodall Estate Company, Morris Ravine Quarry, Butte County. Regional Water Quality Control Board: June 6, 2003.[17]

Mineral Resources, LLC began mining and processing silica sand and recycling processed water through three settling ponds located in a saddle on the north side of the Morris Ravine Quarry site. Process water discharged to the ponds is high in suspended solids. Once the solids have settled, the clarified process water is conveyed from the settling ponds to the processing plant for re-use. On March 18, 2003 and again on March 19, 2003, Mineral Resources was found to be discharging to the settling ponds even though the report of waste discharge was incomplete and waste discharge requirements had not been adopted. Regional Board staff issued a Notice of Violation for breach of Water Code Section 13264, discharging without waste discharge permit.

This order requires that Mineral Resources, LLC and Goodall Estate Company, their agents, successors, and assigned comply with discharge prohibitions, discharge specifications, groundwater limitations, and provisions as described in the order.

Regional Water Quality Control Board Central Valley Region. Order No. R5-2003-0143, Waste Discharge Requirements for Butte-Glenn Community College District, Butte College Wastewater Treatment Plan, Butte County, California. Regional Water Quality Control Board: September 5, 2003.[18]

Butte College, in the Butte-Glenn Community College District, owns and operates a wastewater treatment and disposal system for its main campus, which is located between Chico and Oroville along Durham-Pentz Rd. The total campus population, including students, faculty, and staff, is approximately 7,700. Influent flow to its wastewater treatment plant is approximately 40,000 gallons per day.

This order describes a change in the location of wastewater discharge to two new disposal ponds constructed on Butte College land in addition to three existing shallow marsh disposal ponds. The property surrounding the new ponds has been signed and fenced to discourage public access. The existing marsh disposal ponds, in a lightly trafficked area of the campus, are posted, and the stabilizations ponds and treatment plant are fenced. The Regional Board considered the mitigated negative declaration and concurred that impacts on water quality would not be significant, if the following mitigation measures identified in the mitigated negative declaration were implemented: (a) maintain a minimum 500-foot buffer between new ponds and nearby 5-acre residential lots; (b) install at least four groundwater monitoring wells; and (3) periodically test groundwater monitoring wells for pathogenic organisms, salts, and nitrates.