TODD ENGINEERS

GROUNDWATER WATER RESOURCES HYDROGEOLOGY • ENVIRONMENTAL ENGINEERING

October 27, 2004

TECHNICAL MEMORANDUM

To: Frank Honeycutt
Department of Public Works
County of San Luis Obispo

From: David W. Abbott, R.G. 4310

Re: Groundwater Resources of CSA 23 - Santa Margarita

County Service Area No. 23 (CSA 23) is owned and governed by the County of San Luis Obispo (SLO); operated and managed by Department of Public Works (DPW). Since the late 1940s, CSA 23 (and its predecessor, County Waterworks District No. 6) has supplied potable water to the town of Santa Margarita (Carollo Engineers, 1964; SLO DPW, 2004). The current estimated population of Santa Margarita is 1,340. The average annual (calendar year) water usage is about 202 acre feet per year (AFY); July is the peak demand month requiring 25 to 30 acre feet (AF).

It should be noted that water use and water balance computations throughout this report are reported to the nearest acre-foot. This level of reporting is not intended to claim accuracy to the nearest acre-foot. Estimated water use and balance values probably are significant only to one or two digits. The reporting is maintained to retain accuracy throughout subsequent computations and to allow the reader to replicate the computations.

CSA 23 currently operates two wells. Well 4 is the primary water supply for the system, providing about 85 percent of the water supply. All wells are located within the town of Santa Margarita. Installed in 1996, Well 4, located on the downstream side of the town and a major transportation corridor, taps a relatively shallow (50 feet) and thin (13 feet) yet prolific alluvial aquifer. Well 3, installed in 1991, provides the remaining water supply. Well 3, located on the upstream side of town, taps a relatively thick, but low-yielding sandstone (Santa Margarita Formation). Wells 1 and 2, installed in the early 1950s and located near Well 4, are now used only for emergency back-up supply. Domestic wastewater disposal for the town is by means of onsite individual residential septic systems.

Purpose

CSA 23 is responsible for the provision of a long-term, reliable and high quality drinking water supply to the town of Santa Margarita. Recognizing eventual growth toward build-out of the town, cumulative effects of regional development, and the inevitability of drought, several issues have been identified that affect the future quantity and quality of the water supply for the town of Santa Margarita:

1. The alluvial aquifer has been and is the primary source of water for CSA 23. However, the alluvial aquifer is relatively thin and is subject to significant seasonal fluctuations in groundwater levels of about 15 to 20 feet. Considering that the bottom of the aquifer is at 50 feet depth, these water level fluctuations significantly reduce well yields in the dry season; extended drought has resulted in larger fluctuations with greater impacts on well yield. Accordingly, the wells and the shallow aquifer are sensitive to operational procedures, particularly in drought.

2. CSA 23 anticipates increased water demands on the system with build-out of the town of Santa. Margarita. The maximum annual demand between water years 1999 and 2003 is 216 AFY; here, the water year is defined as July 1 to June 30. CSA 23 (SLO PWD, 2004) estimates that an additional 54 AFY of water will be needed, representing a twenty-five percent increase over current maximum annual usage (216 AFY). Note that this maximum annual usage (216 AFY) is about seven percent greater than the average annual usage (202 AFY).

3. The current back-up and supplemental source, Well 3, is not capable of fully replacing Well 4, which serves as the primary source of water.

4. In addition, agricultural and/or residential development of the surrounding Santa Margarita Ranch based on groundwater may further reduce the reliability of the alluvial aquifer and a groundwater supply to the town of Santa Margarita.

5. Well 4 is located in close proximity to an active transportation corridor and commercial land uses, and is downstream from numerous individual septic systems. The shallow alluvial aquifer tapped by Well 4 is susceptible to potential water quality impairment (Boyle, September 2001).

Accordingly, CSA 23 is evaluating alternative and supplemental water sources to provide a reliable and high quality water supply. Additional water can be obtained through development of additional strategically located and installed wells (local groundwater) or through purchase of supplemental water. Sources of water that could be purchased for CSA 23 include: (1) the State Water Project's Coastal Branch Aqueduct located within 50 feet of Santa Margarita; and (2) water from the planned Nacimiento Project (not yet constructed). The Nacimiento Project would provide water to several North County communities and to the City of San Luis Obispo with a pipeline going through Santa Margarita.

The purpose of this study is to evaluate the feasibility of developing additional groundwater supply. Specific objectives include:

- Evaluate the long-term and sustainable groundwater supply from wells located within the town of Santa Margarita, and

- Generally address the cumulative impacts on the local groundwater supply of increased use of groundwater by CSA 23 and other existing and foreseeable (i.e., Santa Margarita Ranch) groundwater uses. The Santa Margarita Ranch is in the initial stages of preparing an Environmental Impact Report (EIR) to comply with the California Environmental Quality Act (CEQA) and, as such, the project has not been well-defined by the Ranch.

Setting

Santa Margarita, an inland community, is located in northern San Luis Obispo County, ten miles south of Atascadero and less than one mile east of Highway 101. The town is divided by active railroad tracks (Union Pacific), including a large switching yard, and the adjacent El Camino Real (Highway 58). The town's layout is generally rectangular with an area of about 0.50 square miles (mil or 320 acres. The 14,000-acre privately-owned Santa Margarita Ranch surrounds the town.

Santa Margarita is located in the upper watersheds of two small tributaries to the Salinas River. Santa Margarita Creek (the larger of the two streams) drains the extreme western portion of the town while Yerba Buena Creek drains the eastern portion. Both intermittent creeks flow from south to north. Yerba Buena Creek flows into Santa Margarita Creek near the southern boundary of Garden Farms. Another much larger nearby watershed, Trout Creek, is east of the Yerba Buena watershed and outside of the town limits. Santa Margarita and Trout creeks join near the confluence with the Salinas River about three miles north of town. Both Santa Margarita and Yerba Buena creeks have been gauged for stream flow near the town. Twenty-one years of record are available for each gauge station, and discharge records for the creeks overlap between 1979 and 1985 providing a comparison between the two stations.

The local topography in Santa Margarita is relatively flat with land surface elevations ranging from 1,000 to 1,020 feet above mean sea level (msl). Miller Flat, located upstream and southeast of town and drained by Yerba Buena Creek, has a relatively low and gentle topography, rising to 1,120 feet msl. The Yerba Buena Creek watershed attains elevations of 2,228 feet msl near the headwaters of Sycamore Canyon, while the Santa Margarita Creek watershed reaches elevations of 2,761 feet msl at Tassajera Peak. Average annual rainfall is between 25 and 30 inches (Rantz, 1969).

Water Demand and Drought

The current (2004) estimated population of Santa Margarita is 1,340. The average water usage between calendar years 1998 and 2004 is about 202 AFY (65.82 million gallons [MG]), representing a water duty of 135 gallons per day per capita (gpd/c), which is relatively low in comparison to similarly sized and geographically located communities (about 165 gpd/c). The annual average water usage is equivalent to pumping 24 hours/day at 125 gallons per minute [gpm]; 12 hours/day for 250 gpm; or about 167 gpm for 18 hours/day (recommended). July is the peak water demand month with use between 25 and 30 AF or about 235 gpd/c in summer. Pumping 18 hours/day would result in a required peak month well discharge between 243 and

292 gpm. September peak water demand uses range between 19 and 22 AF or about 178 d/c. Pumping 18 hours/day to meet this demand would result in a required well discharge between 185 and 221 gpm.

SLO DPW (2004) has estimated the build-out potential for Santa Margarita by identifying 123 residential lots and 15 commercial lots that remain available for development. Annual maximum water usage was estimated for the residential lots (16.117 MG) and commercial lots (1.440 MG), resulting in an estimated additional 54 AFY needed for build-out. SLO DPW (2004) estimated total current maximum demand as 216 AFY (based on the July 1 to June 30 water year). Total future water demand (270 AFY) requires a twenty-five percent increase from the maximum annual water usage.

Hydrogeologic Analysis

Hart (1976) provides detailed mapping of the regional geology of the Santa Margarita area. The town of Santa Margarita is located in the Nacimiento Fault Zone, which is a northwest trending thrust fault paralleling the San Andreas Fault. The northwest-trending strike-slip Rinconada Fault and the axis of the Santa Margarita Syncline are located east of the town. The area has been divided into eight geologic units. The geologic units, from oldest to youngest, are:

Permeability	Geologic Unit	Specific Capacity
Very Low:	Franciscan mélange Toro Formation/Vaqueros Sandstone	negligible
Low:	Atascadero Formation Monterey Formation Santa Margarita Formation Paso Robles Formation	0.01 to 5 gpm/ft of dd
High:	Older Alluvium Younger Alluvium	0.68 to 80gpm/ft of dd

As shown above, these units have been organized for this study into three hydrogeologic units based on permeability, with a continuum from very low to high permeability. The relative permeability of the geologic units was based on hydraulic data summarized from consultant reports (Mann, 1987; Luhdorff and Scalmanini, 1992; McRae, 1994) and Department of Water Resources (DWR) Water Well Drillers Reports for the area.

The analysis of the relative permeability of local geologic units focused on specific capacity data. Specific capacity is the yield of the well divided by the drawdown in the pumping well at a specified time and is directly proportional to the permeability of the aquifer materials or productivity of the aquifer. High specific capacities indicate good aquifers while low specific capacities indicate poor aquifers or inefficient wells. The specific capacity of the alluvium ranges from 0.68 to 80 gallons per minute per foot (gpm/ft) of drawdown and is significantly greater than the specific capacity of the low permeability units which ranges from 0.01 to 5 gpm/ft of drawdown.

As a matter of reference, Well 3 taps the low-permeability Santa Margarita Formation and provides a discharge of about 100 gpm with 300 feet of drawdown. Wells 1, 2, and 4 tap the high-permeability younger alluvium and have discharges of about 250 gpm with less than 6 feet of drawdown. It is noteworthy that Wells 1, 2, and 4 operate at relatively large yields with about 20 feet of perforations/screen, while Well 3 operates at lower yields (100 gpm) with 405 feet of screen. The recommended operating discharge for Well 3 is about 35 gpm; for Well 4 it is estimated to be greater than 200 gpm depending on the magnitude of water level fluctuations.

In summary, the alluvial aquifer is characterized by significantly higher permeability than bedrock formations, including the Santa Margarita Formation that is tapped by Well 3. Because of the low permeability of bedrock formations, well yields are relatively low and achieved only with significant drawdown. As a result, Well 3 can provide only partial back-up and cannot replace the primary alluvial sources of water to CSA 23. Provision of adequate back-up supply or additional water supply for future build-out using bedrock can only be achieved with multiple bedrock wells and considerable capital and operation and maintenance costs. Approximately six bedrock wells with capacities less than 35 gpm would be needed to replace the yield of one alluvium well (200 gpm).

The alluvial aquifer is shallow (about 50 feet depth) and relatively thin (13 feet thick; ranging from 37 to 50 feet). In winter, the non-pumping or static water level is near ground surface. During an average rainfall year the water levels fluctuate by about 20 feet. The lower water level results in reduced well yields, particularly in late summer and early fall. However, fall/winter rains typically recharge the aquifer fully by early January, producing artesian conditions. In other words, water levels rise above the top of the aquifer in the overlying clay. During extended droughts, the depth to water may reach to 30 feet below ground surface, severely reducing the available drawdown and yield of the well.

Water Budget Analysis

A water budget analysis was conducted to estimate available groundwater supply under existing conditions and provide the basis for evaluation of potential cumulative impacts of future water demands. A water budget analysis accounts for all water inflows, outflows, and change in storage of a watershed. The water budget equation is simply a statement of the conservation of mass in the hydrologic system (Heath and Trainer, 1968) and can be expressed in the following equation:

$$\text{Inflow} = \text{Outflow} \pm \text{Change in Storage}$$

Water Inflow to the system can be rainfall, surface water and groundwater inflow, irrigation return flows, septic system return flows, and water import. Water Outflow to the system is usually more difficult to estimate but includes evapotranspiration, stream flow (both baseflow and storm runoff), groundwater outflow, groundwater pumpage and consumption, and water exports. Groundwater pumpage is partially offset by irrigation or septic system return flows. Change in Storage refers to changes in surface water and groundwater elevations from the beginning of the selected study period to the end. The study period represents an average rainfall period and includes both above and below average rainfall years. All hydrologic data are summarized on an annual basis; this study uses the water year, which extends from October 1 to September 31 (i.e., Water Year 1979 coincides with October 1, 1978 to September 31, 1979).

Watershed: The watersheds for this analysis include Santa Margarita Creek and Yerba Buena Creek above their respective gauges in the town. Surface water drainage divides define the watershed. All precipitation that falls on the watershed drains toward their respective gauge stations or lower elevations of the watershed. Similarly, groundwater divides are assumed to coincide with surface water divides; groundwater flows toward the lower elevations in the watershed. Precipitation that falls on adjacent watersheds drains toward their respective lower elevations. Therefore, surface water and groundwater inflows into the Santa Margarita and Yerba Buena Creek watersheds from other watersheds are zero. In addition, imported water to the watersheds above their stream flow gauges is zero. The area above the stream flow gauges of Yerba Buena Creek (4.38 mil or 2,803 acres) is 38 percent of the area of Santa Margarita Creek (11.44 mil or 7,322 acres).

Precipitation: The principal water inflow to the watershed is rainfall. Two rainfall gauge stations were reviewed for these analyses: the Santa Margarita Booster Station and the National Oceanic and Atmospheric Administration (NOAA) Santa Margarita station. The Santa Margarita Booster Station has a long record extending from 1948 to 1999. The average annual rainfall from the 52-year record is 31.72 inches. Annual rainfall varies from a minimum of 13.09 inches in 1989 to 58.28 inches in 1983. The Santa Margarita station has a record extending from 1946 to 1975. The average annual rainfall from the 30-year record is 29.17 inches. Annual rainfall varies from a minimum of 9.94 in 1947 to 49.55 inches in 1969. Based on the rainfall records, precipitation can fluctuate between 34 percent and 184 percent of the average annual rainfall.

Precipitation was also assessed using an average annual rainfall or isohyetal map (CDWR, 1958). The areas between isohyets (equal precipitation contour lines) were measured with a self- compensating polar planimeter. The computed average annual rainfall for the Santa Margarita and Yerba Buena watersheds were 29.48 inches and 29.82 inches, respectively, which is comparable to the long-term record averages (31.72 and 29.17 inches). Using these values, the total water inflow to the Santa Margarita and Yerba Buena watersheds is about 17,988 AFY and 6,965 AFY, respectively.

Evapotranspiration: Evapotranspiration (ET) includes both direct evaporation (caused by solar/wind energy) and transpiration from vegetation. This component of the water budget is probably the most difficult to estimate. In general, ET is the primary outflow and can account for about 70 percent of the total rainfall on the watershed.

Stream Flow: Two stream flow gauge stations were reviewed for this study for each respective watershed. The Santa Margarita Creek station, located near the intersection of State Highways 101 and 58, has a record from 1979 to 2000. The geometric average annual stream flow from the 22-year record is 4,862 AFY (arithmetic average: 9,567 AFY). The geometric average is used when the data have a non-gaussian distribution (i.e., several orders of magnitude between values); and is the n^{th} root of the product of the values of *n* positive numbers or the antilogarithm of the average of the logarithms of individual values (AGI, 1977). The arithmetic average is used when the data are represented by gaussian distributions, and is the sum of the values of *n* numbers divided by *n* (AGI, 1977). The geometric average is a better estimator of the central tendency of any data set than the arithmetic average. Annual stream flow varies from a minimum of 275 AFY in 1990 to 32,347 AFY in 1995. The Yerba Buena Creek gauge station, located near the intersection of State Highway 58 and the active railroad tracks, has a record from 1965 to 1985. The geometric average annual stream flow from the 21-year record is 1,861 AFY (arithmetic average is 1,794 AFY). Annual stream flow varies from a minimum of 39 AFY in 1977 to 6,530 AFY in 1969.

The stream flow records overlap between 1979 and 1985, indicating a good correlation between the two stations. In comparison, Yerba Buena Creek has approximately 18 percent of the stream flow of Santa Margarita Creek. Note that the town of Santa Margarita mostly overlies Yerba Buena Creek - the low flow creek.

Groundwater Outflow: McRae (1994) constructed water table maps for the Santa Margarita area. Using these maps, groundwater outflow can be estimated by applying Darcy's Law, which states that the discharge is directly proportional to the transmissivity (T-value) in gallons per day per foot (gpd/ft), the hydraulic gradient (i) in ft/ft, and the width (w) in feet of the aquifer.

$$Q = T \times i \times w$$

Review of pumping test data indicates the transmissivity of the alluvium in the vicinity of Santa Margarita ranges from about 10,000 to 90,000 gpd/ft (McRae, 1994). The T-value in the vicinity of the gauge stations is about 10,000 gpd/ft. The water table map (McRae, 1994) provides: (1) the width of the aquifer, which ranges from 1,509 feet at the Yerba Buena gauge to 1,735 feet at Santa Margarita gauge, and (2) the hydraulic gradient, which ranges from 0.011 ft/ft at Yerba Buena to 0.0121 ft/ft at Santa Margarita. Calculations show that groundwater outflow ranges between 203 and 233 AFY beneath the gauges, respectively. The average stream flow for Santa Margarita Creek and Yerba Buena Creek is 4,892 AFY and 1,861 AFY, respectively. Groundwater underflow represents between 4 percent (Santa Margarita Creek) and 13 percent (Yerba Buena Creek) of the stream flow discharge. In other words, between 87 and 96 percent of the water conveyed naturally through the town of Santa Margarita is surface water.

Pumpage: Groundwater pumpage has been recorded monthly for Wells 1, 2, 3 and 4 by CSA 23. Recent records indicate that total annual average pumpage between 1998 and 2003 is 205 AFY comparable to the estimates (216 AFY) provided by CSA 23. Other groundwater pumping exists (e.g., the high school well) but is assumed to be respectively small compared to the overall community demand. Well 4 supplies 85 percent of the water to the system from the Santa Margarita watershed (174 AFY) while Well 3 pumps the remaining 31 AFY from the Yerba Buena watershed. Approximately 50 percent of the water pumped to consumers is assumed lost to evapotranspiration, while the remaining 50 percent is assumed to return to the groundwater basin by way of septic tanks and deep percolation of irrigation water for landscaping. Therefore, the gross pumpage (205 AFY) is offset partially by return flows (103

AFY) from irrigation and septic systems. While most of the pumping is assigned to the Santa Margarita watershed, most of the town's homes and businesses are in the Yerba Buena watershed. Accordingly, most of the return flows occur in the Yerba Buena watershed. For this study, it is assumed that 80 percent of the return flows (82 AFY) occur to the Yerba Buena watershed and 20 percent (21 AFY) occur to the Santa Margarita watershed.

Storage: McRae (1994) estimated groundwater storage for the Santa Margarita Creek alluvial aquifer system from the Salinas River to the headwaters of Santa Margarita and Yerba Buena Creeks. Review of the data indicated that groundwater storage beneath and upstream from the town is about 410 AF. This indicates a relatively small storage capacity in comparison to both the subsurface outflow at the gauge stations (203 + 233 AFY = 434 AFY) and groundwater pumpage (205 AFY).

For the water budget, no significant surface water reservoirs exist in the watershed. Since the aquifer refills nearly every winter due to precipitation then the change in groundwater storage is zero. If both surface water and groundwater storage change is zero, then the residual of the equation represents net error.

In summary, the inflows and outflows on a watershed basis are tabulated as follows:

<u>Santa Margarita Watershed</u>

Inflow = Rainfall (17,988 AFY) + Return flows (21 AFY)	=18,009 AFY
Outflow = ET (12,592 AFY) + Surface Water Outflow (4,862 AFY) + Groundwater Outflow (233 AFY) + Pumpage (174 AFY)	=17,861 AFY
Groundwater Storage Change	= 0 AFY
Balance (net error = 0.82 percent)	= 148 AFY

<u>Yerba Buena Watershed</u>

Inflow = Rainfall (6,965 AFY) + Return flows (82 AFY)	= 7,047 AFY
Outflow = ET (4,876 AFY) + Surface Water Outflow (1,861 AFY) + Groundwater Outflow (203 AFY) + Pumpage (31 AFY)	= 6,971 AFY
Groundwater Storage Change	= 0 AFY
Balance (net error = 1.08 percent)	= 76 AFY

The balances result in small positive residuals that represent the net error in the calculations. These values do not represent "surplus" water that might be available for future development. If additional groundwater is developed by CSA 23 or other pumpers in the watersheds, the water balance would change. Over the long term, increases in groundwater pumping would most likely be accompanied by decreases in other outflows, namely, ET, stream flow and particularly, subsurface outflow.

The actual impact on these outflows would depend on the amount, location, and timing of pumping. Outflow to ET could decrease if the water table is drawn down and becomes less accessible to vegetation. With regard to stream flow, local stream flow is intermittent and largely represents winter-time runoff; some of this flow might be induced to percolate and flow into a well. An increase in groundwater pumping would likely affect subsurface outflow.

As shown in the summary above, groundwater outflow is estimated at 233 AFY for the Santa Margarita watershed and 203 AFY for the Yerba Buena watershed, for a total of 436 AFY. Groundwater pumping by CSA 23 amounts to 205 AFY, with a net consumption of 102 AFY and return flows of 103 AFY. Assuming that all other inflows and outflows are negligible, then the total amount of subsurface flow entering the town of Santa Margarita from the south is about 539 AFY (436 AFY + 103 AFY). Pumping by CSA 23 intercepts about 38 percent of this flow (205 AFY/539 AFY) and consumes about 19 percent. The subsurface outflow from the areas upstream from the gauge stations contributes to groundwater supplies downstream, including the Garden Farms area, Atascadero Sub-basin, and Paso Robles Basin as a whole; other tributaries, such as Trout Creek, contribute water to the water balance for these downstream areas.

These water budget analyses indicate that that the Santa Margarita watershed has a greater rainfall inflow (17,988 AFY) than the Yerba Buena watershed while having similar groundwater outflows. This indicates that a greater quantity of groundwater may be developed from the Santa Margarita watershed. Groundwater development in the Yerba Buena Creek watershed would be less favorable than in the Santa Margarita watershed for the following reasons:

1. The average rainfall on the Yerba Buena Creek watershed (6,965 AFY) is significantly less than for the Santa Margarita Creek watershed (17,988 AFY);

2. The alluvial aquifers in the Yerba Buena Creek watershed are thinner and not as extensive as those in the Santa Margarita Creek watershed; and

3. The water quality issues are more significant due to the greater number of septic systems in the Yerba Buena watershed.

Cumulative Water Demands

A key issue regarding the long-term reliability of groundwater supply for CSA 23 is the cumulative effect on the local groundwater supply of groundwater use not only by CSA 23, but also other existing and foreseeable groundwater uses. The privately-owned Santa Margarita Ranch, which surrounds the town of Santa Margarita, is the focus of this discussion.
Santa Margarita Ranch extends over 14,000 acres of the Santa Margarita, Yerba Buena, and Trout creek watersheds. Currently, the ranch is used primarily for grazing, with about 974 acres in vineyards. A recent (July 7, 2004) planning session for future development of the ranch identified potential new land uses. Specifically, Tentative Tract 2586 encompasses 6,195 acres southwest of the town of Santa Margarita. The proposed development of this area, which is well-defined, would include 112 residential units, with water provided by an onsite mutual water company and wells. Wastewater treatment and disposal would be provided by means of onsite septic tank systems. Remaining areas would be dedicated to agriculture with agricultural conservation easements or would remain undeveloped. Additional development for agriculture would include possibly two ranch headquarters and two wineries.

In addition to the above, Santa Margarita Ranch has identified other development scenarios including more than 400 residential units, a golf course, guest ranch, bed and breakfast, wineries, parks, churches, ranch headquarters, livestock facilities, and other facilities. Because these other scenarios are not well-defined by Santa Margarita Ranch, future water use estimates remain unresolved.

The proposed Santa Margarita Ranch project is in planning stages including environmental review. At this time of writing, the estimated water demands for the proposed project are not known. To provide an order-of-magnitude estimate of residential demands on groundwater, it is assumed that each of the 112 residential units would have a water demand of 0.5 AFY, amounting to total water demand of 56 AFY. Of this amount, it is assumed that one-half (28 AFY) would be returned to groundwater by way of septic tanks and landscape return flows and the remaining 28 AFY would be consumed. Water demands for the ranch headquarters and wineries are not known and depend on the size of the facilities, but can be estimated tentatively at a total of 5 AFY, for a grand total of 33 AFY.

The specific sources of water supply (i.e., well sites) for these water demands are not known, but could be located not only in the Yerba Buena watershed with a potential impact on CSA 23, but also in the Trout Creek watershed to the east. Groundwater pumping in the Trout Creek watershed would not affect the town of Santa Margarita.

Impacts on CSA 23 of additional groundwater consumption of 33 AFY for proposed Santa Margarita Ranch development are dependent largely on where the groundwater would be pumped. Pumpage from the Trout Creek watershed would have no impact, while pumpage from the Yerba Buena watershed may reduce inflow to CSA 23. The reasonable development of other scenarios identified by the Santa Margarita Ranch (e.g., a total of 550 residential units and a golf course) could have greater impacts, again depending on the location and characteristics of planned development. Recognizing potential cumulative impacts of development, CSA 23 should look for opportunities to retain and recharge local surface water runoff; this would help to increase the reliability of groundwater supply and also may reduce potential problems with drainage and flooding.

Current Water Supply

CSA 23 and its predecessor, County Water Works District No. 6, have installed four wells for the town of Santa Margarita. CSA 23 currently operates two wells (Wells 3 and 4).

Wells 1 and 2 were drilled in 1947 and 1952 and were replaced in 1997 by Well 4. Wells 1 and 2 now serve as designated standby emergency wells. Charles A. Shaw drilled the 16-inch diameter steel cased wells to depths of 49 feet, probably with cable tool drilling methods. The wells are both located on El Camino Real (Highway 58) near Maria Avenue and are about 10 feet apart. Blue hard shale was encountered at 48 feet. A 13-foot thick coarse-grained sand and gravel aquifer was encountered overlying the shale. Well 1 is perforated from 30 to 48 feet while Well 2 is perforated from 29 to 49 feet. Pumping tests conducted on the wells and historical water level data indicate relatively high well yields with specific capacities in the range of 40 gpm/ft of drawdown for Well 2 to 60 gpm/ft of drawdown for Well 1. These values indicate a very permeable alluvial aquifer.

In 1991, **Well 3** was installed by CSA 23. Well 3 is situated near the southwest portion of the town of Santa Margarita near the intersection of Estrada Avenue and "K" Street. Cache Creek Drilling, Inc. drilled the well to a total depth of 783 feet using direct mud rotary drilling technique and subsequently logged the boring with geophysical downhole tools (electric and natural gamma radiation logging). Santa Margarita sandstone was encountered from ground surface to total depth. The 7.875-inch diameter exploration boring was reamed to a 26-inch diameter hole to accommodate 12-inch diameter steel casing and an annular filter pack. The well was completed with steel continuous wirewrap screened intervals that range from 290 to 720 feet in depth. Total length of the screen was 405 feet. The screen aperture size was 0.050-inch (50 slot). The static water level was near ground surface. Pumping tests conducted on the well and historical water level data indicate a specific capacity of 0.35 gpm/ft of drawdown.

Well 4, installed in 1996, is approximately 40 feet from Wells 1 and 2. Miller Drilling Company drilled the 14-inch diameter steel cased well to a depth of 70 feet with mud rotary. Similar to Wells 1 and 2, blue sandstone and shale was encountered at 49 feet. A coarse-grained sand and gravel aquifer was encountered overlying the shale. Well 4 is constructed with 20 feet of stainless steel wirewrap screen from 29 to 49 feet. The screen aperture size is 0.120-inch (120 slot). The drillers log indicates the aquifer depths range from 9 to 49 feet in contrast to Wells 1 and 2, which indicate the aquifer is between 35 and 48 feet. This discrepancy is probably due to the less reliable geologic logging of mud rotary drilling in Well 4; assumed cable tool techniques used for Wells 1 and 2 provide more accurate subsurface soil descriptions. Note that Wells 1, 2, and 4 are screened opposite the same interval even though Well 4 indicates a thicker aquifer.

An eight-foot long tailpipe or sump was attached to the bottom of the screen to a depth of 57 feet. The tailpipe allows the pump (with a special cooling shroud) to be set beneath the well screen and to provide use of additional available drawdown. Typically, well pumps are installed above the well screen to prevent water levels from being lowered below the top of the screen or perforations. Water levels that encroach upon the screened interval can cause cascading water, which can reduce the life span of a well and create temporary impairments to water quality (i.e., turbidity). Pumping tests conducted on the well and historical water level data indicate relatively high well yields (comparable to Wells 1 and 2) with a specific capacity of 80gpm/ft of drawdown.

Reliability of Groundwater Quantity

Recommended well yields are based on the specific capacity of the well and the available drawdown. The specific capacities for Well 3 and Well 4 are 0.35 and 80 gpm/ft of drawdown, respectively. The available drawdown is measured as the vertical distance between the static water level and the top of the well screen. Utilizing two-thirds of the available drawdown or 100 feet -- whichever is less -- allows efficient operational use of the well and management of the aquifer, while accounting for seasonal water level fluctuations and any decrease in well and pump efficiency due to aging.

Well 3. The static water level for Well 3 is ground surface (0 feet) while the top of the screen is 230 feet; the available drawdown is 230 feet. The recommended drawdown is 100 feet because the 2/3-available drawdown (153 feet) exceeds 100 feet. The specific capacity is about 0.35 gpm/ft of drawdown. Therefore, the recommended long-term discharge of Well 3 is about 35 gpm (100 feet x 0.35 gpm/ft of drawdown). Current pumping rates for Well 3 are 100 gpm or about three times the suggested discharge. Water level data for Well 3 indicates that non-pumping water levels are about 75 feet below ground surface and rarely recover to the original static water levels. This implies that over pumping the well has caused the water levels near Well 3 to decline by 75 feet. Reducing the long-term pumping rate to 35 gpm may allow the water levels to recover to ground surface. Lower pumping rates will reduce operating costs by saving energy, prolong the life of the well, and more efficiently manage the local groundwater. Operating Well 3 at three times the recommended capacity will reduce to life of the well and reduce water quality.

Well 4. Annually, the static water level for Well 4 ranges between 2 feet below ground surface in winter to about 20 feet below ground surface during average rainfall years, and the depth to the top of the screen is 29 feet. During winter, the recommended drawdown is 18 feet [2/3 x (29 feet — 2 feet)]; during late summer, the recommended drawdown is 6 feet [2/3 X (29 feet — 20 feet)]. The specific capacity of Well 4 is 80 gpm/ft of drawdown. Therefore, the suggested discharge of Well 4 could range from about 1,440 gpm in winter to 480 gpm in late summer.

Records during extended droughts indicate that the static water level reached depths ranging from 28 feet in December 1991 (Wells 1 and 2) to 36 feet in March 1991 (Well 1). These lower static water levels reduce the available drawdown, reduce the capacity of the aquifer (i.e., transmissivity) and, consequently, the yield of the well. The alluvial aquifer is 13 feet thick ranging from 35 to 48 feet below ground surface. The aquifer was fully saturated in December 1991. However, the water level was one foot above the top of the screen (29 feet), while in March 1991 the water level was 7 feet below the top of the screen.

Pumping to the bottom of an aquifer is not recommended. It is recommended that 50 percent of the aquifer can be used for drawdown. Therefore the maximum pumping water level will be to a depth of 41 feet [48 feet - (13 feet x 0.5)]. In addition, the specific capacity is directly proportional to the aquifer thickness. The specific capacity is also reduced by 50 percent (40 gpm/ft of drawdown) and the 2/3-rule applies; accordingly, calculations show that under these circumstances Well 4 could be operated between 347 gpm (565 AFY; December 1991) and 133 gpm (215 AFY; March 1991) during moderate to severe droughts, respectively. Current pumping rates for Well 4 are about 350 gpm, or near the maximum amount. Drought conditions would result in reduced operating rates or over pumping the well. Note that the peak monthly water demand ranges between 243 to 292 gpm. A strategically located second well, tapping the alluvium, would protect the system from a shortfall in quantity.

Reliability of Groundwater Quality

The town of Santa Margarita relies on local groundwater for both potable water supply and wastewater disposal. This raises concern about potential water quality impairment. It is noteworthy that approximately eighty percent of the town (and wastewater discharge) is located in the Yerba Buena drainage, while Wells 1, 2, and 4 are located in the Santa Margarita drainage.

Inorganic, biological, and organic water quality data have been collected for the CSA 23 wells since 1982. Inorganic water quality includes the following: major cations (calcium, magnesium, and sodium), major anions (bicarbonate, sulfate, and chloride), minor ions (iron, manganese, fluoride, and nitrates), general physical properties (hardness, alkalinity, pH, electrical conductivity [EC], total dissolved solids [TDS], and MBAS), biological properties (coliform and e-coli), and trace ions (aluminum, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, selenium, silver, and zinc). Other analytes and physical properties were measured but have remained below the detection limit (i.e., MTBE was analyzed eleven times -- not detected; or antimony was analyzed five times -- not detected).

Inorganic Water Quality: Wells 1, 2, and 4 (alluvium) exhibit similar water quality, while Well 3 (Santa Margarita Formation) indicates a different water quality than the alluvium. The average total dissolved solids (TDS) concentration from the alluvial wells is about 400 mg/L and for Well 3 is 490 mg/L. Iron and manganese concentrations tend to be elevated in Well 3 and are currently treated to reduce these concentrations before discharging the water to CSA 23 system. There appear to be no apparent water quality trends (decreasing or increasing) through time on any of the wells.

MBAS: Methylene blue active substances (MBAS) is an indicator of soaps and detergents, which could indicate any impacts from onsite wastewater disposal practices to local groundwater. MBAS was analyzed for 56 samples and detected 6 times (11 percent) ranging between 0.02 to 0.30 mg/L. Wells 1 and 2 each detected MBAS three times; Wells 3 and 4 did not detect MBAS. This suggests a minor component of septic effluent impact.

Nitrogen: Between 1985 and 2004, both nitrates as NO3 and nitrites as nitrogen were analyzed for the four CSA 23 wells. The total number of samples collected for nitrate as NO3 and nitrite as nitrogen were 72 and 17, respectively. All of the samples analyzed for nitrite as nitrogen were below the detection limit. In contrast, concentrations for nitrate as NO3 ranged from 1.1 to 27.0 mg/L, all below the maximum contaminant level of 45 mg/L for Wells 1, 2, and 4. Only a single detection (0.6 mg/L) out of 16 analyses for nitrate as NO3 was found for Well 3, which taps the Santa Margarita Formation. Nitrate as NO3 concentrations for Wells 1, 2, and 4 has varied but no distinctive time-related pattern has been observed; since January 2000 the concentrations have been below 5 mg/L for all wells. This suggests some effect of local wastewater disposal; however, nitrate concentrations are within drinking water standards.

Coliform: Total coliform, fecal coliform, and Escherichia coli (E-coli) data were collected in 1997 (Wells 1 and 2; short set of data) and between 1997 and 2004 (Wells 3 and 4). Review of these data is suggestive, but not conclusive, that there could be small impacts on all wells from nearby waste disposal practices.

Total coliform was analyzed 400 times using the present/absent test method and 64 times using the most probable number (mpn/100 ml) test. The results indicate that 11.75 percent of the samples collected indicated a presence of coliform. However, nine of these samples were collected between 0.5 and 30 minutes from initiation of pump start-up (Wells 3 and 4) in an effort to determine the source of the contamination. Removing those nine samples from the data set indicates that coliform was present in 6.75 percent of the samples. Total coliform was detected in 7.81 percent of the mpn/100 mL test with an average concentration of 1.0 mpn/100 mL in Well 3 and 2.4 mpn/100 mL in Well 4. In addition, E-coli was detected only twice in Well 4 from a total sampling set of 216 tests (0.51 percent). No fecal coliform was observed in five present/absence tests and fifteen mpn/100 mL tests.

Review of the inorganic water quality, nitrogen, and bacterial testing for Wells 1, 2, 3, and 4 are only suggestive of a small impact from nearby waste disposal practices. It should be noted that Well 3 is generally upstream from the community and should not be impacted significantly from waste disposal practices.

Findings

1. Review of hydrogeologic information for the Santa Margarita and Yerba Buena drainage basins (and corresponding aquifers) both beneath and upstream from the town of Santa Margarita indicate that the thin and shallow alluvial aquifer can potentially support the future water needs of the town. Not much is known about the alluvial aquifer in the Yerba Buena drainage; however, it is probably thinner and more susceptible to onsite wastewater disposal impacts. In addition, less potential recharge is available in the Yerba Buena watershed, which may be affected by Santa Margarita Ranch future development. Therefore, development of groundwater resources should focus on the Santa Margarita drainage. Strategically placed wells in the Santa Margarita drainage area can be installed to more fully manage the small groundwater basin and provide a reliable back-up system for CSA 23. Potential well yields (200 to 400 gpm) and water quality would be expected to be similar to Wells 1, 2, and 4.

2. The alluvial aquifer has been and is the primary source of water for CSA 23. However, the alluvial aquifer is relatively thin and is subject to significant seasonal fluctuations in groundwater levels of about 15 to 20 feet. Considering that the aquifer is only 50 feet deep, these water level fluctuations significantly reduce well yields in the dry season; extended drought has resulted in larger fluctuations with greater impacts on well yield. Accordingly, the wells and the shallow aquifer are sensitive to operational procedures, particularly in drought. Additional production wells located in the Santa Margarita watershed would provide operational flexibility to the system.

3. CSA 23 anticipates increased water demands on the system with build-out of Santa Margarita. CSA 23 estimates that an additional 54 AFY of water will be needed, representing a twenty-five percent increase over maximum usage (216 AFY). Additional wells in the alluvial aquifer will help alleviate the potential water shortfall due to increased system demands.

4. Because of the low permeability of bedrock formations (including the Santa Margarita Formation), well yields are relatively low (20 to 40 gpm) and achieved only with significant drawdown. Adequate back-up supply or additional water supply for future build-out using bedrock can only be achieved with multiple bedrock wells and considerable capital and operation and maintenance costs. Bedrock wells (i.e., Well 3) are

less reliable with regard to water quantity and have poorer water quality than the local alluvial aquifers.

5. Additional agricultural and/or residential development of the surrounding Santa Margarita Ranch based on groundwater is uncertain and additional demands will reduce the reliability of the alluvial aquifer as a source of groundwater.

6. Well 4 is located in close proximity to transportation and commercial land uses and downstream from numerous individual septic systems. The shallow alluvial aquifer tapped by Well 4 is susceptible to potential water quality impairment from these sources. The installation of a strategically placed production well, sited at the upstream side of the town of Santa Margarita along the southerly boundary in the Santa Margarita watershed, can reduce these potential impacts. A test well should be installed to assess the water quantity and quality issues at this strategic site

Recommendations

1. CSA 23 should develop a program to methodically assess the local alluvial groundwater resources in the Santa Margarita watershed. The exploration should focus on areas within the town and near the creek (as a source of recharge), but upstream from the developed areas. CSA 23 also should look for opportunities to retain and recharge local surface water runoff; this will help to increase the reliability of groundwater supply and also reduce potential problems with drainage and flooding.

2. CSA 23 should install test wells and one or more production wells utilizing drilling techniques (i.e., cable tool) that allow clear and unambiguous identification of subsurface materials and aquifer depths. The test wells can be designed for conversion to production wells. These subsurface materials should be mechanically analyzed with a stack of graduated sieves. A customized stainless steel wirewrap screen should be designed to match the sieve analyses. The production wells can be designed without (preferred) or with annular filter packs. The wells should be drilled to bedrock to identify the thickness of the alluvial aquifer. The well should be constructed with a tailpipe or sump to allow installation of the pump below the screened interval, similar to Well 4.

3. CSA 23 collects excellent operational records on their wells. These records should continue to be collected and include (a) non-pumping (or static) water level, (b) pumping water level, (c) instantaneous discharge, (d) quantity of monthly water pumped, and (e) monthly hours of pumping.

4. Required water quality sampling should continue to be collected for the California Department of Health Services (DHS). However, Title 22 analytes should be supplemented with MBAS and turbidity. Currently, CSA 23 collects water samples for major cations and anions and physical properties one year, while the trace ions are analyzed the following year. The complete suite of analytes and physical properties should be collected on the same day to provide a complete understanding of water

quality. Quarterly sampling for Nitrate as NO3 should be conducted on the pumping wells.

<u>Operating Recommendations</u>

5. Wells 1 and 2 should continue to be designated as emergency back-up wells. However, the wells should be pumped to waste for three hours each month. Samples should be collected near the end of the test and analyzed for pH, Nitrate as NO3, and MBAS. Although the wells are not used, monthly static water levels for both wells should be collected to assess potential well interference from Well 4. The wells should be properly protected from surface water from entering the top of the casing; this protects the wells from contamination.

6. CSA 23 should conduct an 8-hour aquifer test on Well 4, while measuring water levels at Wells 1 and 2 and a nearby existing monitoring well. This testing will identify aquifer properties (transmissivity and storativity) and any potential recharge (i.e., Santa Margarita Creek) or barrier boundaries in the vicinity of Well 4.

7. It would also be prudent to continue to negotiate with imported water agencies to supplement existing as well as potential resources, particularly during extreme drought (i.e., Water years 1991 and 1992) or during maximum month demands.

References

American Geological Institute (AGI), 1977, Glossary of Geology, Editors: Margaret Gary, Robert McAfee Jr., and Carol Wolf, American Geological Institute, Washington, D.C.

Boyle Engineering Corporation, September 2001, County of SLO Drinking Water Source Assessment Santa Margarita Well No. 1, 2, and 4.

Boyle Engineering Corporation, October 2001, Santa Margarita Wells Watershed Survey prepared for County of SLO.

Boyle Engineering Corporation, April 2002, County of SLO Drinking Water Source Assessment Santa Margarita Well No. 3.

California Department of Health Services, February 10, 1998, SLO Waterworks District No. 6, Santa Margarita, SLO 4010024 (Water Permit No. 04-06-98P-006).

California Department of Health Services, December 18, 1986, Letter to SLO Health Agency Director: Water Supply Facilities at CWWD No. 6.

California Department of Water Resources, May 1958, San Luis Obispo County Investigation, Bulletin No. 18, Volume I: Text and Plates, Volume II Appendices.

Cannon Associates, January 2000, County Service Area No. 23 — Santa Margarita: Preliminary Review of Supplemental Water Supply Alternatives, prepared for County of SLO.

John Carollo Engineers, 1964, Waterworks Survey for SLO County Waterworks District No. 6, Santa Margarita, California.

Hart, Earl W., 1976, Basic Geology of the Santa Margarita Area, San Luis Obispo County, California, California Division of Mines and Geology, Bulletin 199.

Harry R. Feder, Consulting Geologist, September 19, 1985, Letter to Mr. Wallace H. Campbell: Santa Margarita Ranch Wells 8G-1, 9R-1 Recommendations.

Harry R. Feder, Consulting Geologist, November 18, 1981, Letter to Nahama & Weagrant Energy Company: Ranch Ground Water.

Heath, Ralph C. and Frank W. Trainer, 1968, Introduction to Ground-Water Hydrology, published by John Wiley and Sons, NY.

Luhdorff and Scalmanini, May 1992, Well Records for CSA 23 - Well 3.

Mann, John F., September 16, 1987, Ground Water Resources of the Santa Margarita Ranch, San Luis Obispo County, California

McRae, Brian E., August 1994, A Hydrologic Inventory of Santa Margarita's Groundwater Basin, a Thesis in partial fulfillment of B.S. in Civil Engineering, California Polytechnic, San Luis Obispo, CA.

James M. Montgomery, Consulting Engineers. Inc. (Robert C. Scott), June 1979, Ground-Water Reconnaissance on the Santa Margarita Ranch West of Highway 101.

Rantz, S.E., 1969, Mean Annual Precipitation in the California Region, U.S Geological Survey, Basic-Data Compilation, South Half.

San Luis Obispo County Department of Planning and Building, "Santa Margarita Ranch Environmental Impact Report (EIR) Scoping Meeting," Handout, July 7, 2004.

SLO Health Agency, December 12, 1985, Letter: Approval of test hole drilling on the Santa Margarita Ranch.

SLO Public Works Department, January 29, 2004, County Service Area 23, Santa Margarita, California, Water System Master Plan 2003.

SLO Public Works Department, October 25, 2004, Technical Memorandum to Paavo Ogren, Deputy Public Works Director: Comparison of water demand for CSA 23.

United States Department of Agriculture, Soil Conservation Service, 1977, Soil Survey of San Luis Obispo County, California, Paso Robles Area.

Wiese, John H., March 16, 1986, Letter to SLO County Engineering Department (Mr. Hal Wilkinson): Sources of groundwater in Santa Margarita area.