Butte County Groundwater Quality

Trend Monitoring Program

(Updated September 2006 with input from the Technical Advisory Committee)

The Groundwater Management Ordinance, Codified as Chapter 33A in the Butte County Code, establishes Monitoring Frequency for Groundwater Quality (BCC 33A-9) as follows:

1. The frequency of groundwater quality monitoring shall be at a minimum of once a year during peak groundwater use (July or August). The following minimum groundwater quality measurements shall be taken:

   A. Groundwater temperature;
   B. Groundwater pH; and
   C. Groundwater electrical conductivity.

2. Within each sub-inventory unit, **increased frequency and location of groundwater quality monitoring and monitoring constituents may be determined and conducted by the local stakeholders**. All monitoring data collected by stakeholders shall be submitted to the Department within thirty (30) days of collection. (BCC 33-9)

MONITORING OBJECTIVES

Two important questions must be considered when designing the framework for a water quality monitoring program:

1. What are the priority objectives of the monitoring program?
2. How will data gathered be utilized to better understand and manage the resource?

By defining the desired monitoring framework outcomes, you can better determine the program process objectives. These objectives include:

- Establishing a baseline of information to reveal trends over time of Butte County groundwater quality. Measurements taken will serve as an initial indicator of changes in water quality that may warrant further investigation or testing.
- Ensure that groundwater resources are well managed by documenting the quality of local groundwater. Availability and distribution of this information will be a useful educational tool.
- Support and enhancement of the level monitoring program (and vice-versa) resulting in a more comprehensive Groundwater Monitoring Program.

PARAMETERS TO BE MONITORED

As stated in Chap 33A, the parameters to be monitored are temperature, pH and electrical conductivity. These three parameters do not fully characterize the quality of local groundwater nor do they provide enough information to ensure that water is safe to drink. Yet, they do encompass the basic characteristics to consider when evaluating water for evidence of saline intrusion. **This**

monitoring program is not designed to characterize or focus on sites where groundwater has become contaminated due to pollutants, nor can it identify specific sources of pollution. However, it does provide valuable information on baseline water quality conditions before groundwater resources are further developed and to characterize water quality trends basin-wide in Butte County.

All groundwater monitoring is not the same. **Compliance** monitoring is generally site specific and focuses on the impacts and influence specific activities have on groundwater quality. It can be used to support regulation and enforcement. This is not the nature of the Department's groundwater trend monitoring program. **Ambient** monitoring is focused on assessing the overall quality of groundwater resources and can quantitatively evaluate improvement or deterioration in groundwater quality.[1] The Department is working to expand a groundwater trend monitoring network to provide the necessary data to be used in assessing the resource and refine future monitoring activities. The County's groundwater monitoring program is a work in progress and requires expansion to adequately cover the entire basin geographically prior to including additional constituents.

Public health parameters are currently being addressed by federal, state and local agencies such as the Department of Health Service (DHS), the Department of Toxic Substances Control (DTSC) and Butte County Public Health. Therefore, the priority locally will be placed on increasing the number of wells monitored and cooperating closely to share data with other agencies such as DWR and USGS who are also conducting water quality monitoring within Butte County. In the meantime, the data collected annually for temperature, pH, EC, and TDS is building a foundation that serves to establish baseline levels of these parameters across the county so that any future changes in water quality can be detected and further investigation and monitoring can subsequently be developed.

DEFINITION OF PARAMETERS AND THEIR IMPORTANCE

Electrical Conductivity/Total Dissolved Solids

Degraded water quality is a predominant impact of over utilizing groundwater resources resulting in saline intrusion from among other sources, marine formations underlying freshwater aquifers. In Butte County, the primary freshwater bearing formations include the Tuscan formations, overlying Alluvium deposits, Basin deposits, and the Riverbank and Modesto Formations. A number of marine formations beneath the Tuscan formation make up the underlying saline aquifer system.[2] Increasing salinity in groundwater wells could indicate over utilization of groundwater resources. To ensure sustainable management of local groundwater resources, monitoring efforts need to provide baseline trends related to salinity.

What is salinity? Salinity is a measure of the amount of salts in the water. This is where measuring electrical conductivity becomes important. Because dissolved ions increase salinity as well as conductivity, the two measures are related. Saltwater primarily contains sodium chloride (NaCl), but saline waters can owe their high salinity to a combination of other dissolved ions. The major positively charged ions (cations) are calcium (Ca+2), potassium (K+) and magnesium (Mg+2). The major negatively charged ions (anions) are chloride (Cl-), sulfate (SO4-2), carbonate (CO3-2), and bicarbonate (HCO3-).[3] Conductivity then, is the ability of the water to conduct an electrical current which is made possible by the presence of charged ions. The more ions present in the water, the more conductive the solution and the higher the measured EC. A measure of electrical conductivity

[1] SWRCB. Report to the Governor: A Comprehensive Groundwater Quality Monitoring Program for California. Page 9. http://www.waterboards.ca.gov/gama/docs/final_ab_599_rpt_to_legis_7_31_03.pdf.
[2] Fulton, Allen. "Seeking an Understanding of he Groundwater Aquifer systems in the Northern Sacramento Valley: An Update". Article No. 1 – September 2005
[3] SWRCB EC/Salinity Fact Sheet. http://www.waterboards.ca.gov/nps/cwtguidance.html#30.

therefore indicates the combined effect and presence of all these constituents. This means if the overall EC of the water sample is “low,” then the concentration of the individual ions is likewise low.

The term, Total Dissolved Solids (TDS) is often used for the same thing as salinity when referring to fresh water. Electrical conductivity is used to approximate total dissolved solids by a mathematical conversion. The measurement of TDS has units of mg/L or parts per million (ppm) and experimentally can be determined in a lab by evaporating a sample of water and weighing the solids left behind.

What constitutes a “low” or acceptable measure of EC/TDS? Water quality standards have been established by the U.S. Environmental Protection Agency for over 200 pollutants. TDS and EC are among the parameters guided by Secondary Drinking Water Standards established to protect the odor, taste, and appearance of drinking water. The established maximum contaminant level (MCL) for TDS is 500 ppm and 1600 microSiemens (uS) for EC.

There are several water quality standards for irrigated agriculture, and they all recognize the total the total salt is an important criterion in determining the suitability of water for irrigation. Water’s salinity affects plant water availability and yield and is thus an important factor. Typical ranges for irrigation water for TDS are 0-2000 ppm and 0-3000 uS for EC.[4] The Department of Health Services however has established the following preferred agricultural water quality level: TDS < 450 ppm and EC < 700.

Conductivity is affected by the quantity and types of minerals present in the water. Since soil and rocks release ions into water flowing over or through them, the geology of the aquifer plays a role in determining the amount and type of ions in solution. Having several years of EC measurements is necessary to establish typical levels before trends can be observed.

Electrical conductivity is also greatly dependent on temperature, however most meters provide a reading for EC that has been temperature adjusted to a standard 25 ^{o}C (77 ^{o}F).

Alone, EC does not indicate whether or not the water is safe to drink. Yet, it can be used as an indicator of changing water quality conditions that may instigate further testing and investigation.

pH

pH, by definition, is dependent on the solution’s hydrogen ion concentration and is a measure of how acidic or basic the water is. The abundant presence of hydrogen ions in solution (as indicated by low pH) can change concentrations of other substances present in the water, sometimes to a more or less toxic form. For example, a decrease in pH (below 6) may increase the amount of mercury (or other metals) soluble in water. pH therefore is important because it affects the solubility of substances in solution. The U.S. EPA has identified a desirable pH range of 6.5-8.5 as part of its Secondary Drinking Water Standards.

pH is also an important parameter for irrigation water. The pH of the soil affects plant production and acceptable soil pHs vary by plant type. Irrigation water or precipitation can change the pH of the soil overtime. Variation in pH can affect plant growth, nutrition, and susceptibility to pests. Nutrients present in the soil may be unavailable to plants due to a pH that is either too high or too low.[5]

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[4] Artiola, Janick F., Ian L. Pepper, Mark Brusseau. Environmental Monitoring and Characterization. Table 9.4, pg 148.
[5] IPM Almanac online. *Using a pH meter can increase performance and yield.* http://www.ipmalmanac.com/tipsheets

Temperature

Temperature is a standard parameter measured when assessing water quality mostly to indicate the point at which water being sampled is representative of aquifer water and not water standing in the well casing. Data is recorded when the temperature, pH and EC from the well stabilizes, typically after purging a minimum of three well volumes.[6] Changes in temperature can also be an indication of other source waters migrating into the aquifer system such as stream seepage or flow from a different aquifer system.

OTHER RESOURCES AND MONITORING EFFORTS

This groundwater trend monitoring program provides initial data necessary for detecting potential degradation of groundwater from saline sources. A host of other state and federal agencies implement groundwater monitoring programs with different objectives and focuses. These agencies include the State Water Resources Control Board (SWRCB) and Regional Water Quality Control Boards (RWQCBs), Department of Water Resources (DWR), Department of Health Services (DHS), Department of Toxic and Substance Control (DTSC), Department of Pesticide Regulation (DPR), the US Environmental Protection Agency (EPA), Bureau of Reclamation, and United States Geological Survey (USGS). More locally, Butte County Department of Public Health as well as California Water Service Company (with offices in Chico, Oroville, and Willows) may also be helpful resources for obtaining information on water quality parameters. California Water Service Company's water quality data is available online at http://www.calwater.com/WaterQuality.html. Sub area stakeholders are encouraged and empowered by the groundwater management ordinance to supplement the Department's data with additional verifiable groundwater quality data that may create a more complete basis for assessing groundwater quality within their sub area.

[6] USGS Field Manual. http://water.usgs.gov/owq/FieldManual/index.html