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Groundwater Quality in the Central and West Coast Basins

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Groundwater producers regularly operate and sample nearly 400 production wells and WRD monitors and samples over 250 observation wells to measure the quality of the groundwater in the Central and West Coast Basins (CWCB). The good news is that the vast majority of groundwater is of high quality and requires little to no treatment before being pumped out of wells and served to the public. The slow movement of groundwater through the underlying gravel, sand, silt, and clay formations improves groundwater quality through a process known as geopurification. Occasionally, though, there are a few compounds that exceed their regulatory Maximum Contaminant Levels (MCLs) from natural causes or human activities. As a result, the impacted groundwater requires treatment before being served to the public or requires the wells to be shut off. The purpose of this Technical Bulletin is to answer the question "What are the most prevalent compounds that exceed their MCLs in the CWCB?"

WRD Hydrogeologist Tony Kirk Collects a Groundwater Sample

To answer this question, WRD queried its water quality database of nearly 750,000 records of groundwater test results for monitoring and production wells. The query identified wells that had samples exceeding either their Primary MCL (PMCL) or Secondary MCL (SMCL), and totaled the number to determine the prevalence of the compounds in the basins. PMCLs are regulatory limits established for compounds that pose a health risk to consumers and SMCLs are established for compounds that are not a health risk but are an aesthetic nuisance such as taste, odor, or discoloration of the water or plumbing fixtures. Both PMCLs and SMCLs are established by the United States Environmental Protection Agency (USEPA) and the California Department of Public Health (CDPH) after a considerable amount of research is performed on the compound.

The results confirmed that the vast majority of groundwater samples do not exceed their MCLs, indicating good water quality. Less than 0.5% of the samples exceeded their PMCLs and only 2% exceeded their SMCLs. Of the compounds that were found to exceed their MCLs, the most commonly detected ones are listed below:

Primary MCL (PMCL) Exceedances:

#1. Arsenic was found above its PMCL in more wells than any other constituent. Arsenic is an inorganic compound that occurs naturally in soils, rocks and minerals. It dissolves in the groundwater at low or high concentrations depending on the prevalence of the arsenic-bearing rock and the geochemical conditions of the soil/groundwater interactions. Arsenic can also enter the groundwater through human activities such as agricultural or industrial practices. The PMCL for arsenic was recently lowered by the USEPA from 50 parts per billion (ppb) to 10 ppb. The CDPH has proposed 10 ppb for the State PMCL. The highest concentration found in the database query was 205 ppb. Treatment technologies are varied for Arsenic and include precipitation, adsorption, ion exchange, membranes, and some alternative technologies.

#2. Perchloroethylene (PCE or Tetrachloroethylene) was the second-most detected compound above its PMCL. It is a volatile organic compound (VOC) that is a colorless liquid with a mild chloroform-like odor. PCE is most commonly used in the textile industry (businesses concerned with the design or manufacture of clothing) and also as a component in dry-cleaning products. PCE released to soil will readily evaporate or leach into groundwater where it can travel considerable distances. The PMCL for PCE has been set at 5 ppb by both the USEPA and CDPH. The highest concentration found was 27 ppb. The USEPA has approved Granular Activated Carbon in combination with Packed Tower Aeration as a PCE treatment technology.

#3. Trichloroethylene (TCE) was the third-most detected compound above its PMCL. It is a VOC with its greatest use to remove grease from fabricated metal parts. If released to soil it can leach into groundwater and can travel considerable distances. The PMCL for TCE has been set at 5 ppb by both the USEPA and CDPH. The highest concentration found during the database query was 850 ppb. The USEPA has approved Granular Activated Carbon in combination with Packed Tower Aeration as a treatment technology for TCE.

The next five most commonly detected compounds above their PMCLs included di (2-ethylhexyl) phthalate, nitrate, aluminum, gross alpha radiation, and perchlorate.

Secondary MCL (SMCL) Exceedances:

#1. Total Dissolved Solids (TDS) was found above its SMCL in more wells than any other constituent. TDS is the sum of all dissolved organic and inorganic substances in the water, such as sodium, chloride, calcium, potassium, magnesium, bicarbonates, nitrates, and phosphates, but also many others. TDS is often referred to as "salt" to represent the mineralization of water and is commonly present in all groundwater, but at varying concentrations. It enters groundwater naturally such as dissolving aquifer minerals or from seawater intrusion. It also can be added to groundwater from human activities such as fertilizer applications, oil field brines, industrial discharges, and sewage effluents. TDS can also be brought into groundwater basins in replenishment water if the imported sources are more mineralized than the local water. TDS is persistent in environment and can build up in concentrations over time in a process known as "salt loading". The USEPA has a SMCL of 500 parts per million (ppm) for TDS and the CDPH has a recommended SMCL of 500 ppm and an upper value of 1,000 ppm. Water with TDS greater than 3,000 ppm is typically considered too salty to drink. The highest concentration found in this analysis was 34,100 ppm, which is close to the salinity of pure seawater (about 35,000 ppm). Excessive TDS is generally found in the CWCB near the coast where seawater intrusion has occurred, but can also be found in other areas. Membrane treatment with reverse osmosis is often used to significantly reduce TDS concentrations.

Total Dissolved Solids (TDS) can enter groundwater from seawater intrusion or other sources. The Recommended SMCL is 500 ppm.

#2. Manganese was the second-most detected compound above its SMCL. It is a beneficial human nutrient at low concentrations, a nuisance compound at moderate concentrations (causing black to brown water color, black staining of fixtures, and a bitter metallic taste), and at very high concentrations may cause neurological damage. Manganese is a natural metallic element commonly present in groundwater due to the weathering and leaching of manganese-bearing minerals and rocks into the aquifers. It can also be introduced through human activities such as industrial, sewage, and landfill discharges. The USEPA and CDPH SMCL for manganese is 50 ppb. The CDPH also has a notification level (NL) for it at 500 ppb to guard against extremely high levels. The highest concentration found in the database analysis was 3,600 ppb. Technological treatment for manganese removal includes sequestration, ion exchange, and oxidation/filtration.

#3. Odor was the third-most detected compound above its SMCL. It is not necessarily representative of any one compound but instead an indicator of how aesthetically unpleasing the water is to humans. The root cause for odor problems can be organic, carbon-rich, deep aquifers with elevated hydrogen sulfide gas concentrations, modern chemicals such as MTBE, or numerous other sources. The water often has a "rotten egg", musty, or chemical smell at high concentrations and although the water may be suitable to drink, consumers do not like it because of the odor. The SMCL for odor is 3 TON (Threshold Odor Number) as established both by the USEPA and CDPH. The highest concentration found in the database query was 4,000 TON. Treatment technologies for odor depend on the concentrations, but common methods are granular activated carbon, aeration, or oxidation (chlorine, ozone, or UV/hydrogen peroxide).

The next five most detected compounds above their SMCLs included iron, color, chloride, sulfate and aluminum.

More detailed information on the quality of groundwater in the CWCB can be found in WRD's annual Regional Groundwater Monitoring Report available on our web site or at our office. WRD also has its Safe Drinking Water Program to assist pumpers with wellhead treatment planning and funding if their wells have MCL exceedances. Please contact the author if you have any questions or comments about this program or on the quality of groundwater in the CWCB.

Internet References used in this Technical Bulletin:

CDPH: www.cdph.ca.gov/certlic/drinkingwater/Pages/Chemicalcontaminants.aspx

USEPA: www.epa.gov/ogwdw/hfacts.html

USGS: pubs.usgs.gov/fs/fs075-03/

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