PASADENA
Water&Power

2016
PUBLIC HEALTH GOALS REPORT

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Background

The California Health and Safety Code specifies that Community Water Systems with more than 10,000 service connections must prepare a report every three years identifying any constituents in the water system that exceed the Public Health Goals (PHGs) within the three preceding calendar years. PHGs are established by California Environmental Protection Agency's (Cal-EPA) Office of Environmental Health Hazard Assessment (OEHHA) and are used for health risk assessments. The law states that if no PHG is established by OEHHA, then water suppliers must use the Maximum Contaminant Level Goal (MCLG) adopted by the United States Environmental Protection Agency (USEPA) in their risk assessment. Lead and Copper do not have MCL's but rather have Action Levels (AL). If the AL for lead or copper is exceeded, then public water systems are required to take action to reduce corrosion and notify the general public. Constituents that have a California drinking water standard, and a PHG or MCLG are to be addressed in a report.

The purpose of this report is to inform the City of Pasadena's (City's) customers of any constituents that were detected in the City's water system between 2013 and 2015 at a level exceeding a PHG or MCLG. This report will provide the following information as required by law: numerical public health risk associated with the MCL and PHG or MCLGs, the category or type of risk to health that could be associated with each constituent, the Best Available Technology (BAT) available that could be used to reduce the constituent level and an estimate of the cost to install that treatment. Constituents that are routinely detected in the City's water system but have no PHG or MCLG, and have been adopted by OEHHA or USEPA will not be addressed in this report. Such constituents will be addressed in a future report once OEHHA or USEPA selects and adopts a PHG or MCLG.

What are PHGs?

PHGs are set by OEHHA and are non-enforceable goals that are based on public health risk consideration. PHGs are numerical contamination levels that are deemed little to no risk to the public while disregarding risk management factors. Risk-management factors include analytical detection capabilities, treatment technology available, benefits and costs. Instead, public water systems follow drinking water standards called maximum contaminant levels (MCLs). MCLs are set by the California State Water Resources Control Board (SWRCB) - Division of Drinking Water (DDW) that takes into account risk-management factors while protecting the public's health. DDW regulates public water systems, including the City's water system. Drinking water that meets these drinking water standards have little to no risk and are deemed safe for consumption. MCLGs are the federal equivalent to PHGs, are set by the USEPA, and unlike PHGs can be set to zero.

Water Quality Data Considered

Water quality data from the City's water system between 2013 and 2015 that was used to determine compliance with DDW requirements was used for this report. This report includes post treatment

constituents that were detected above the PHG. If no data after blending or treatment was available then pre-treatment data was used.

Report Guidelines

The Association of California Water Agencies (ACWA) provided guidelines for water utilities to be used in preparing newly required reports. The ACWA guidelines were used to prepare this report. No guidelines were available from the state regulatory agencies.

Best Available Technology (BAT)

USEPA and DDW adopted Best Available Technologies (BATs) which are best known methods of reducing contaminant levels. It is required by law in this report to produce cost estimates for BATS to lower constituents down to PHG or MCLG level. However, it is not always feasible to determine what treatment is needed to further reduce a constituent down to the PHG or MCLG. Many MCLGs and PHGs are set to a numerical value far below the Detection Limit for Reporting (DLR). This makes it difficult to verify if constituents were reduced to the PHG by any analytical means. In other cases, installing treatment to further reduce the constituent to PHG or MCLG levels could adversely affect other aspects of water quality.

BATs that could be used to reduce constituent levels are summarized in this report. BAT cost estimates are based on the maximum potential water capacity for each well that contains the constituents above the PHG and DLR, multiplied by the annualized capital cost and Operations and Maintenance (O&M) per 1,000 gallons of water. Many of the constituents that are above the PHG in the City's water system can be removed with multiple BATs. Only BATs that were able to address multiple water contaminants within the City's water system and are considered effective for large public water systems are provided in this report.

Water System Description and Water Quality

About 55% of the City's water supply comes from imported water purchased from Metropolitan Water District (MWD) of Southern California, while the rest is provided from local groundwater sources. The City maintains eighteen groundwater wells, of which three are considered "inactive" by the drinking water program and two are "standby" groundwater sources. The City also has five interconnections with MWD and several with other water retailers. Water quality issues have been found in several wells. Wells that are operational and impacted by a contaminant are either blended or treated to ensure water does not exceed the MCL. Common water quality constituents in the City's water sources are nitrate, perchlorate and volatile organic compounds (VOCs) contamination.

Sunset Reservoir Blending Plan

There are five groundwater wells that could be blended with MWD water at the Sunset Reservoir before water is delivered to the costumers. These wells are Bangham, Copelin, Garfield, Sunset and Villa, and are commonly known as the Sunset blending wells. Although Villa is an active well, it is non-operational.

Bangham, Sunset, and Copelin Wells are known to have nitrate levels above the MCL. Bangham, Sunset, Garfield and Villa wells have perchlorate levels above the MCL. Sunset and Copelin Wells have VOC levels above the MCL. When any of the Sunset blending wells are in use, they are mixed with MWD water. MWD water has low or undetectable levels of nitrate, perchlorate and VOC.

The City created the Sunset Reservoir Blending Plan to provide operational procedures and guidelines for blending Sunset Reservoir wells with MWD water. The objective of the plan is to ensure that the City maintains nitrate, perchlorate and VOCs concentrations below 80% of the MCL in Sunset Reservoir and the distribution system. The blending plan takes effect if any of the Sunset blending wells are in operation. Once the plan is in effect, regular water quality monitoring at the Sunset Reservoir is done to ensure that the water delivered meets the blending objective (80% or lower of the MCL).

Monk Hill Treatment and Windsor Reservoir Blending Plan

Groundwater in the Arroyo Seco area is known to have elevated levels of perchlorate and VOCs which has affected four of the City's wells. Arroyo Well was shut down from 1997 to 2011, while Ventura, and Well 52 were shut down from 2002 to 2011. Windsor Well was placed out of operation in 2007. In October of 2011, the City inaugurated the Monk Hill Treatment System (MHTS). MHTS was designed to remove perchlorate by ion-exchange technology and VOCs by Liquid Phase Granular Activated Carbon (LGAC) technology. The treated water is then disinfected and discharged to the Windsor Reservoir before it is delivered to customers. In Windsor Reservoir the water from different wells can be blended to control nitrate. As with Sunset Reservoir, a blending plan was created to manage nitrate concentrations with a blending objective of 80% or lower of the MCL. MHTS treatment objective is to have undetectable contaminants at the plant effluent and Windsor Reservoir. MHTS undergoes weekly monitoring to ensure compliance with the MHTS treatment goals. Due to low water levels and high nitrate concentrations in Ventura, Well 52, and Windsor Well, the vast majority of water produced and treated has come only from Arroyo Well which has low levels of nitrate.

Eastside Wells Collector Pipeline and Jones Reservoir Blending Plan

The City had seven local groundwater wells located in the eastside portion of Pasadena. Jourdan Well and Monte Vista Well exceeded the MCLs for perchlorate and nitrate and therefore were taken out of service and registered as inactive in 1997 and 2007, respectively.

The Eastside Well Collector Pipeline was placed in operation in 2015. The pipeline diverts water flows from Chapman, Twombly, and Wadsworth wells directly into the distributions system or Jones Reservoir where water can be blended with either MWD water or other Eastside wells. Woodbury Well has elevated concentrations of perchlorate and may be operated if it is blended with other wells or MWD water in Jones Reservoir. The Eastside Well Collector Pipeline was implemented to increase the City's groundwater pumping capacity by blending well water sources with lower contaminant levels with water sources containing higher contaminant levels.

The City created the Jones Reservoir Blending Plan to provide operational procedures and guidelines for blending Eastside Wells with MWD water or other Eastside Wells. Currently, the Jones Reservoir Blending plan takes in effect when Woodbury is blended with either MWD water or the remaining

Eastside Wells. The objective of the plan is to ensure that the City maintains nitrate and perchlorate concentrations below 80% of the MCL in Jones Reservoir and the distribution system. Regular water quality monitoring at the Jones Reservoir is done to ensure that the water delivered meets the City's blending objective (80% or lower of the MCL).

The Sunset Reservoir, the MHTS and the Jones Reservoir blending plans were reviewed by the DDW and approved for use.

Cost Estimates

The Guidelines for Preparation of Required Reports on Public Health Goals ACWA states that data used by the drinking water agency in determining compliance with DDW requirements is used for the PHG Report. The data used for PWP's PHG Report applies to any constituent that was detected above the PHG and DLR in the City's water system after treatment. If no data is available post-treatment, then pre-treatment data is used. Cost estimates for the BATs are based upon ACWA's guidelines for cost of BATs. The figures are set in units of $/1,000 gallons of treated water for each BAT for that constituents. ACWA's BAT estimates are annualized cost with O&M including unless otherwise stated. These estimated cost were used, then multiplied based on the maximum potential water capacity for each well or reservoir that contains the constituents above the PHG and DLR. The costs were determined on worst case basis assuming that there was no treatment currently available. Cost for BATs will be expressed in terms of annualized capital cost and O&M as well as cost per capita.

Constituents Detected That Exceed A PHG or A MCLG

The following information is in regards to constituents that were detected in one or more of the City's water sources at levels exceeding the PHG or MCLG when no PHG is adopted by OEHHA. As long as drinking water are below the MCL set by DDW, the drinking water is considered "safe" for consumption. Table 1 refers to constituents that were above the PHG that will be addressed in this report with their respective MCL, DLR and BATs.

Table 1: Constituents found in the City of Pasadena's water systems that were above the Public Health Goals (PHG) or MCLG when no PHG is adopted by OEHHA, and its respective Maximum Contaminant Limit (MCL) or Action Level (AL), Detection Limits for Reporting (DLR), and Best Available Technologies (BATs) to reduce constituents from the MCL to the PHG.

Constituent	MCL/(AL)	PHG/MCLG	DLR	BATs
Tetrachloroethylene (µg/L)	5	0.06	0.5	PAT, GAC
Hexavalent Chromium (µg/L)	10	0.02	1	RCF, IX-Weak base Anion
Lead (µg/L)	(15)	0.2	5	n/a
Copper (mg/L)	(1.3)	0.3	0.05	n/a
Arsenic (µg/L)	10	0.004	2	IX, Blending, RO CF, GFO
Fluoride (mg/L)	2	1	0.1	n/a
Coliform (%)	5	0	n/a5	n/a
Gross Alpha (pCi/L)	15	0	3	RO
Uranium (pCi/L))	20	0.43	1	RO

Note: PAT: Packed Aeration Tower, RCF: Reduction Coagulation Filtration, IX: Ion Exchange, GAC: Granular Activated Carbon, GFO: Granular Ferric Oxide Resin, CF: Coagulation Filtration. RO: Reverse Osmosis;mg/L = milligram per liter (parts per million or ppm), µg/L = microgram per liter (parts per billion or ppb), ng/L = nanogram per liter (parts per trillion or ppt), pCi/L = picocuries per liter

Tetrachloroethylene (PCE)

Tetrachloroethylene (PCE) is a VOC that is widely used as a dry cleaning product and is a common soil contaminant. PCE is a carcinogen: a compound that may increase risk of obtaining cancer if one drinks water above the MCL throughout their lifetime. The cancer risk for this compound at the California MCL is 8×10^{-5}, or eight surpluses of cancer cases per hundred thousand people drinking two liters of water a day for 70 years. However, according to California drinking water regulations, water that meets the MCLs drinking water standard is associated with little to no risk and is considered safe for consumption.

PCE was above the PHG for Sunset Reservoir#1 in 2014 with PCE levels ranging from 0.55 µg/L to 0.65 µg/L. PCE levels are above the PHG but well below the MCL for PCE. Sunset, Bangham, Garfield, and Copelin wells, when in operation, enter Sunset Reservoir #1 and #2 and are blended with MWD water before entering the distribution system. Traces of PCE entering Sunset Reservoir #1 and #2 come from Bangham Well and Copelin Well. They are blended with MWD water, which has undetected levels of PCE. Water from Sunset Reservoir#1 then enters the distribution system after disinfection.

The associated BATs to reduce PCE are packed tower aeration, advanced oxidation process, and granular activated carbon. The most feasible BAT is a LGAC system, much like the one installed in MHTS.

The estimated annual cost of a LGAC system for all wells containing PCE, including O&M cost is two million dollars. The estimated cost for the system per capita is twelve dollars per year.

Hexavalent Chromium (Cr (VI))

Hexavalent Chromium (Cr (VI)) is a naturally occurring metal that can also enter drinking water sources through leaks from manufacturers of textile dyes, wood preservation, leather tanning and anti-corrosion coatings. Cr(VI) is known to cause cancer if one drinks water above the MCL throughout their lifetime. The risk of cancer for Cr(VI) is 5 $x10^{-4}$, or five surpluses of cancer cases per ten thousand people drinking two liters of water a day. Due to Cr(VI) toxicity, a PHG and MCL have been adopted.

Hexavalent Chromium was detected in nine of the City's wells in 2015: Arroyo, Bangham, Chapman, Garfield, Sunset, Well 52, Twombly, Wadsworth, and Woodbury wells. All wells were above the PHG, but below the MCL for Cr(VI). The values detected ranged from 1.7 µg/L to 7.2 µg/L, with Chapman Well having the highest concentration of Cr(VI) at 7.2 µg/L. One year of data for Cr(VI) was available for all City wells. All of the Cr(VI) in City wells appear to be of natural origins.

Hexavalent Chromium for the City's well is already below the MCL and to lower Cr(VI) to the DLR (1 µg/L) would require a weak base ion resin or reduction coagulation filtration system. Weak base ion exchange system is the most feasible technology for the City's water system. The estimated annualized capital cost for an ion exchange system including O&M cost to treat all wells that contain Cr(VI) would be forty seven million or two hundred eighty three dollars per capita per year.

Lead and Copper

There are no MCLs for lead and copper; however lead and copper have an action level. Every three years homes are tested within the distribution system for lead and copper levels. The health risks associated with lead include adverse effects to the nervous system, high blood pressure and an increased risk of cancer. The cancer risk associated with drinking two liters of water a day above the action level is two surpluses of cancer cases per millions of people.

Customers' homes that are identified as high risk, such as new plumbing installed with lead solder, have their tap water tested for lead and copper. If the 90th percentile value exceeds the action level for lead or copper then the City must undergo additional actions to control corrosion. The PHG for lead and copper are 0.2 µg/L and 0.3 mg/L, respectively.

In 2014 the City conducted lead and copper testing under the Lead and Copper Rule (LCR). Samples were taken from customer's tap that were considered high risk for lead and copper contamination. The 90th percentile value of the samples taken was 1.7 µg/L for lead. This was above the PHG for lead but below the action level of 15 µg/L. Copper was found above the PHG for samples above the 90th percentile with copper concentration ranging from 0.4-0.95 mg/L. This was above the PHG for copper but below the action level of 1.3 µg/L set by the DDW.

The City already has water sources that naturally contain calcium carbonate: a compound used for corrosion control treatment. Additionally, the City's water system and water sources are in full compliance with the Federal and State LCR and under the DDW, the City's system has optimized

corrosion control. It is unclear if any additional steps could be considered without causing other potential water quality problems. Hence, no BAT assessment will be needed for lead and copper.

Arsenic

Arsenic is a semi-metal that enters drinking water via natural deposits or through industrial or agricultural uses. People who drink water containing arsenic above the MCL over many years may experience skin damage or circulatory problems. Arsenic is also categorized as a carcinogen: increases the risk of cancer when drinking water with arsenic above the MCL. The health risk associated with arsenic is 2.5×10^{-3}, or 2.5 surpluses of cancer cases per thousands of people drinking two liters of water a day for seventy years. Arsenic was detected above the PHG for two City wells.

In 2014, Arroyo Well and Ventura Well had arsenic above the PHG and DLR. Arroyo Well had an arsenic concentration value of 2.6 µg/L. Ventura Well had an arsenic concentration of 3 µg/L. Arsenic concentrations for both wells are below the MCL of 10 µg/L.

Further reduction of arsenic, below the MCL would require reverse osmosis, ion exchange, granular ferric oxide resin, or coagulation filtration. The applicable BAT for the City's water system would be an ion exchange system. The annualized capital cost including O&M cost for an ion exchange system to treat all wells impacted with arsenic would cost three million six hundred thousand or twenty two dollars per capita per year.

Fluoride

Fluoride is a naturally occurring element, deposited into drinking water via erosion of natural deposits. Fluoride is sometimes added into drinking water supplies as a public health measure to prevent tooth decay. Drinking fluoride above the federal MCL of 4 mg/L over many years may develop bone disease, including pain and tenderness of the bones. Children who drink water containing fluoride above the MCL of 2 mg/L may develop mottled teeth.

The City's groundwater wells have naturally occurring fluoride concentration ranging from 0.3-1.5 mg/L. Twombly and Wadsworth, which directly feed into the distribution system, had fluoride concentration above the PHG from 2013 to 2015, ranging from values of 1 mg/L to 1.5 mg/L. Jones Reservoir, which may have any of the east side collector wells entering the reservoir, had fluoride concentration ranging from 1.0 mg/L to 1.3 mg/L from 2014 to 2015. In 2007, MWD started fluoridating their water at an average concentration of 0.8 mg/l. Once MWD blends with the City's groundwater, the fluoride concentration ranged from 0.4 to 1.3 mg/L. Wells and reservoirs are monitored weekly to ensure that fluoride concentrations are below the MCL.

The City wells fluoride concentrations are below the MCL for fluoride and, in some cases, below the PHG. The BAT for fluoride is ion-exchange, reverse osmosis, activated alumina and blending. Ion-exchange is found to be the most cost effective method to remove fluoride within the City's system.

Total Coliform

Total Coliform bacteria are naturally present in the environment and are used as indicators of potentially harmful pathogens. Once a sample is total coliform positive, the water distribution system

must test for fecal coliform, which causes short-term effects such as diarrhea, cramps and/or headaches. The City's water distribution samples may not collectively exceed more than 5% positive for total coliform.

The City has a rigorous total coliform testing program, in which more than thirty distribution sites are tested each week to ensure the health of the City's distribution system. The City collects 130 to 168 samples each month to test for total coliforms within the City's distribution system. From 2013 to 2015, the monthly percentage of total coliform samples testing positive above the PHG ranged from 0.60% to 1.44%. All total coliform positive results were above the PHG but below the MCL.

The City works closely with their regional supplier MWD to ensure proper disinfection within the City's water system. The City takes all measures described by DDW as BAT for coliform bacteria in Section 64447, Title 22 of the California Code of Regulations. These measures include an effective cross-connection control program to protect the wells and the distribution systems from coliform contamination, maintaining a disinfectant residual throughout the systems, an effective monitoring and surveillance program, and maintaining positive pressures in the distribution system. Further disinfection may cause adverse effects within the City's water quality. Therefore, no estimate cost has been included to further reduce total coliform to the PHG.

Gross Alpha

Gross Alpha is a measure of several different radioactive substances that naturally occur in well water due to radioactive elements decaying or breaking down. These include radium 226, radium 228, and uranium. There is a health risk of obtaining cancer if one drinks water containing gross alpha above the MCL of 15 pCi/L. The cancer risk associated with gross alpha particles is one surplus of cancer cases per one thousand people who drink two liters of water a day for 70 years. The MCL associated with gross alpha excludes alpha particles emitted from uranium and radon. There is no PHG for gross alpha; however an MCLG of zero was adopted for Gross Alpha for this report.

From 2013 to 2015, gross alpha particle test were conducted for four of the City's wells. Arroyo Well, Well 52 and Chapman Well had detected levels of gross alpha. In 2013, Arroyo Well had gross alpha particle emission level of 4.7 pCi/L. In the same year, Well 52 had an average gross alpha emission level of 5.7 pCi/L. Chapman Well in 2015 had a gross alpha particle emission of 7.1 pCi/L. Each well had gross alpha particles above the PHG but not above the MCL. Gross Alpha was below the MCL for wells analyzed from 2013 to 2015, once the gross alpha value is adjusted by subtracting the uranium value. Further reduction of gross alpha would require a BAT for a large public water system. The BAT for a large public water system is reverse osmosis. The annual cost for reverse osmosis is approximately fifteen million to sixty and a half million dollars, or ninety two to three hundred sixty three dollars per capita per year.

Uranium

Uranium is a radioactive compound that naturally occurs in varying amounts in the earth's crust. Uranium has a health risk of developing cancer if one drinks water containing uranium above the MCL.

The cancer risk associated with uranium is five surpluses of cancer cases per hundred thousand people who drink two liters of water per day for seventy years.

Uranium was found above the PHG for eight of the City's wells. Uranium levels ranged from 4.3-13 pci/L between 2013 and 2015 for these wells. Even though eight wells were found to have uranium above the PHG, they were below the uranium MCL of 20 pCi/L.

Uranium was below the MCL for all wells analyzed between 2013 and 2015. Further reduction of uranium would require the BAT of reverse osmosis. The annualized cost for reverse osmosis is approximately fifteen to sixty million dollars, or ninety two to three hundred sixty three dollars per capita per year.

Recommendations for Further Action

The City's drinking water meets all California SWRCB's DDW and USEPA drinking water standards set to protect public health. All constituents identified in this report are below the MCL after treatment via the City's MHTS or other rigorous blending plans. To reduce the constituents further would be at an additional treatment process which would be costly to the City. There are also no analytical methods to measure if the constituents were reduced to or below the PHG/MCLG. Furthermore, reduction of the constituents to such levels may adversely affect other aspects of water quality. The health benefits in this hypothetical reduction of constituents are unquantifiable, therefore no further action is proposed.

Agency Hierarchical Chart