PASADENA
Water&Power

2019
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) levels within the three preceding calendar years. PHGs are established by the 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 if one exists.

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 2016 and 2018 at a level exceeding a PHG or MCLG. This report will provide the following information as required by law: the category or type of risk to health that could be associated with each constituent, the numerical public health risk associated with the MCL and the PHG or MCLG, the Best Available Technology (BAT), if available, that could be used to reduce the constituent level and an estimate cost to install that treatment. Constituents, including naturally occurring minerals, that are routinely detected in the City's water system but have no PHG or MCLG and have not been adopted by OEHHA or USEPA, will not be addressed in this report.

What are PHGs?

PHGs are set by OEHHA and are non-enforceable goals that are based solely on public health risk consideration. PHGs are numerical contamination levels that are deemed minimal to no risk to the public while disregarding risk management factors. Risk management factors include analytical detection capabilities, available treatment technology, benefits and costs. MCLGs are the federal equivalent to PHGs, are set by the USEPA, and unlike PHGs, can be set to zero. Instead of PHGs or MCLGs, 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) and take 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 MCL drinking water standards has little to no risk and is regarded as safe for consumption.

Water Quality Data Considered and Report Guidelines

Water quality data from the City's water system used to determine compliance with DDW requirements between 2016 and 2018 was used for this report. In some cases, compliance is based on levels after treatment. For other parameters, compliance is based directly on well water results. This report discusses parameters that were found above the Detection Limit for Reporting (DLR) for that parameter and also above the associated PHG/MCLG. The DLR is a designated minimum level at or above which any analytical finding shall be reported to DDW.

The Association of California Water Agencies (ACWA) provided guidelines for water utilities to use in preparing these required reports. The 2019 ACWA guidelines were used to prepare this report. No guidelines were available from the state regulatory agencies.

Best Available Technology (BAT) and Cost Estimates

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 the 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 PHGs and MCLGs are set to a numerical value far below the DLR. This makes it challenging, and at times impossible to verify if constituents were reduced to the PHG by existing analytical means. In other cases, installing treatment to further reduce a constituent to PHG or MCLG levels could adversely affect other aspects of water quality.

Many of the constituents that are above the PHG in the City's water system can be removed with multiple BATs. Only BATs that are able to address multiple water contaminants within the City's water system and considered effective for large public water systems are provided in this report. Note that the BATs described in this report may still not achieve the PHG or MCLG levels and the costs may be significantly higher to do so.

These rough cost estimates for the BATs are based upon:

- ACWA's guidelines for the cost of BATs
- A worst-case basis assuming that there is no treatment currently in place
- The designed 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. This value is divided by the number of customers the City serves to calculate the cost per capita.

Pasadena Water System Description and Water Quality

More than 60% of the City's water supply comes from imported water purchased from the Metropolitan Water District (MWD) of Southern California, while the rest is provided from local groundwater sources. The City maintains eighteen groundwater wells, eight of which are considered "inactive" by DDW. The City also has five interconnections with MWD and several more 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 that the water does not exceed the MCL. Common water quality constituents in the City's water sources are nitrate, perchlorate, 1,2,3-Trichloropropane (1,2,3-TCP) and volatile organic compounds (VOCs) contamination. The Sunset Reservoir, the Monk Hill Treatment System (MHTS) and the Jones Reservoir blending plans discussed below were reviewed by DDW and approved for use.

Sunset Reservoir Blending Plan

Two groundwater wells can be blended with MWD water at Sunset Reservoir before water is delivered to the customers. These wells are Bangham and Sunset, and are commonly known as the Sunset blending wells. Sunset Well is known to have nitrate levels above the MCL while Bingham Well's nitrate levels are near the MCL. Bangham and Sunset Wells have perchlorate, 1,2,3-TCP and 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, 1,2,3-TCP and VOCs.

The City created the Sunset Reservoir Blending Plan to provide operational procedures and guidelines for mixing Sunset blending wells with MWD water. The objective of the plan is to ensure that the City maintains nitrate, perchlorate, 1,2,3-TCP and VOC concentrations below 80% of the respective MCLs in Sunset Reservoir and the distribution system. The blending plan takes effect if either of the Sunset blending wells are in operation. Once the plan is in effect, regular water quality monitoring at the Sunset Reservoir is performed to ensure that the water delivered meets the blending objective (80% or lower of the respective MCL).

Monk Hill Treatment and Windsor Reservoir Blending Plan

Groundwater in the Arroyo Seco area is known to have elevated levels of perchlorate, nitrate and VOCs, which have affected four of the City's wells, which necessitated limiting their use from the late 90s until 2011. 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 MHTS treatment objective is to have undetectable amounts of perchlorate and VOCs at the plant effluent. The treated water is then disinfected and discharged into Windsor Reservoir before it is delivered to customers. The water from different wells can be blended to control nitrate levels in Windsor Reservoir.

Similar to Sunset Reservoir, a blending plan was created to manage nitrate concentrations with a blending objective of less than 80% of the MCL. 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 Wells, the vast majority of water produced and treated has come only from Arroyo Well, which has lower levels of nitrate.

Eastside Wells Collector Pipeline and Jones Reservoir Blending Plan

The City has four active local groundwater wells located in the eastside portion of Pasadena. The Eastside Well Collector Pipeline, which was placed in operation in 2015, can either divert water flows from Chapman, Twombly, and Wadsworth Wells directly into the distribution system or into Jones Reservoir where water can be blended with either Woodbury Well and/or MWD water. Woodbury Well has elevated concentrations of perchlorate and 1,2,3-TCP and may only be operated if it is blended with other wells or MWD water. The Eastside Well Collector Pipeline was implemented to increase the City's groundwater pumping capacity by blending well water sources containing 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 Woodbury Well with MWD water or other Eastside wells. The objective of the plan is to ensure that the City maintains nitrate, perchlorate and 1,2,3-TCP concentrations below 80% of the respective MCLs in Jones Reservoir and the distribution system.

Constituents Detected That Exceed a PHG or a MCLG

Water quality data from the City's water system used to determine compliance with DDW requirements between 2016 and 2018 were used for this report. The following information is in regards to constituents that were detected in one or more compliance locations of the City's water system or in supplemental water purchased from MWD at levels exceeding the DLR and PHG or MCLG (when no PHG is adopted by OEHHA). As long as the drinking water measurement levels 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, PHG or MCLG, DLR and BATs.

Table 1: Constituents found in the City of Pasadena's water systems that were above the Public Health Goals (PHG) or Maximum Contaminant Level Goal (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	PWP Levels	MCL/(AL)	PHG/MCLG	DLR	BATs	Total Cost/Year (in $ millions)	Cost per Capita/Year
Fluoride (mg/L)	0.4-1.4	2	1	0.1	IX, RO, AA, B	$1.4 to $3	$8 to $18
Bromate (µg/L)	ND – 10 (Highest Running Annual Average: 5.0)	10	0.1	1.0	control of ozonation	n/a	n/a
Copper (mg/L)	ND – 0.53	(1.3)	0.3	0.05	n/a	n/a	n/a
Perchlorate (µg/L)	ND – 4.9	6	1	4	IX	$0.9 to $2	$5 to $12
Hexavalent Chromium (µg/L)	1.7 – 8.9	n/a	0.02	1.0	RCF, IX-Weak base Anion	$14 to $56	$80 to $350
Coliform (%)	0.0 – 0.8	5	0	n/a	n/a	n/a	n/a
Uranium (pCi/L)	2.3 – 15	20	0.43	1	RO	$6 to $55	$40 to $350
Gross Alpha (pCi/L)	3.9 – 10.6	15	0	3	RO	$6 to $55	$40 to $350
Radium 228 (pCi/L)	1.0 – 1.4	n/a	0.019	1	RO	$6 to $55	$40 to $350
Tetrachloroethylene (µg/L)	ND – 1.2	5	0.06	0.5	PAT, GAC	$0.5 to $4	$3 to $25
1,2,3-Trichloropropane (ng/L)	ND – 12 (not served directly to customers)	5	0.7	5	GAC	$0.8 to $7	$5 to $40

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

Fluoride

Fluoride is a naturally occurring element, dissolved into drinking water via erosion of natural deposits. Fluoride is sometimes added to drinking water supplies as a public health measure to prevent tooth decay. Drinking water with fluoride above the federal MCL of 4 mg/L over many years may cause fluorosis, which impacts one's teeth and bones. Children who drink water containing fluoride above the state MCL of 2 mg/L may develop mottled teeth. For fluoride, there is no cancer risk associated with drinking water above the PHG, or the MCL.

The City's groundwater wells have naturally occurring fluoride concentration ranging from 0.4 to 1.4 mg/L. In 2007, MWD started fluoridating their water at an average concentration of 0.7 mg/L, which is also the average concentration at the City's wells. The fluoride concentrations of the City's wells are below the state and federal MCL and, in some cases, below the PHG. Wells and reservoirs are monitored weekly to ensure that fluoride concentrations are below the MCL.

The BATs to reduce fluoride levels at the few City wells that exceed the PHG of 1 mg/L are 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. The annualized capital cost including O&M cost for an ion exchange system to treat all wells over the PHG for fluoride would cost between one million four hundred thousand to three million or eight to eighteen dollars per capita per year.

Bromate

Bromate is a byproduct of drinking water disinfection operations formed when water containing naturally occurring bromide ion is ozonated. The cancer risk associated with drinking water with bromate greater than the MCL of 10 µg/L is $1x10^{-4}$, or 1 surplus cancer case per ten thousand people who drink water in excess of the MCL over a lifetime. The cancer risk for bromate at the PHG of 0.1 µg/L is $1x10^{-6}$, or one surplus cancer case per million people drinking water in excess of the PHG over a lifetime.

Bromate is formed only during ozonation and the MCL applies only to water treatment plants that use ozone. Therefore, this MCL does not apply to the City's groundwater sources. However, the supplemental water the City receives from MWD's Weymouth Treatment Plant has been ozonated since late 2017. The water the City received from MWD met the MCL for bromate at all times, but exceeded the PHG for bromate since ozonation was implemented. The bromate in the water the City received from MWD ranged from ND (Not Detected) to 10 µg/L and the highest Running Annual Average was 5.0 µg/L.

The BAT to reduce bromate is managing the ozone treatment process to reduce production of this byproduct. As such, this process is under the control and jurisdiction of MWD. MWD already applies BAT control of the ozonation process at Weymouth treatment plant and no further consideration will be addressed in this report.

Lead and Copper

Lead and copper are both metals that can originate from the internal corrosion of household water plumbing systems. Lead can also potentially come from industrial manufacturer discharges and copper may be from leached wood preservatives. There are no MCLs for lead and copper. Rather, both lead and copper have an action level (AL) of 15 µg/L and 1.3 mg/L respectively. This establishes that if the 90th percentile level exceeds the action level(s), the water system could be triggered into heightened monitoring, corrosion control treatment, public education and lead service line replacement.

Infants and children who drink water containing lead in excess of the action level may experience delays in their physical or mental development. Adults who drink this water over many years may endure adverse effects to the nervous system, an increased risk of cancer, kidney problems and high blood pressure. The cancer risk associated with drinking water above the lead action level over a lifetime is $2x10^{-6}$, or two surplus cases of cancer per million people. The cancer risk for lead at the PHG level of 0.2 µg/L is $1x10^{-6}$, or one surplus cancer case per million people drinking water over a lifetime. The health risk associated with drinking water with copper above the AL is digestive system toxicity (nausea, vomiting, and diarrhea). For copper, there is no cancer risk associated with drinking water above the AL or PHG.

Every three years a targeted pool of higher risk homes are tested for lead and copper levels under the Lead and Copper Rule (LCR). Customers' homes that are identified as higher risk, such as those that had new plumbing installed before the ban of lead in solder took place, can have their tap water tested for lead and copper. This testing took place in the City most recently in 2017. As described above, if the 90th percentile value at tested homes exceeds the action level for lead and/or copper then the City must undergo additional actions to control corrosion. In 2017, none of the homes had detectible levels for lead and so the 90th percentile value of the samples taken was ND. Therefore, the PHG was not exceeded for lead. However, the 90th percentile value of the samples taken for copper was 0.35 mg/L. This was above the PHG of 0.3 mg/L for copper, but below the action level of 1.3 mg/L. The level of copper in the samples of the homes ranged from ND to 0.53 mg/L.

The City already has water sources that naturally contain calcium carbonate that is a compound used for corrosion control treatment. Thus, the City's water system already has optimized corrosion control and is in full compliance with the Federal and State LCR. It is unclear if any additional steps should be considered without causing other potential water quality problems. Hence, no BAT assessment is needed for lead and copper.

Perchlorate

Perchlorate is an inorganic chemical used in solid rocket propellant, fireworks, explosives, flares, matches and a variety of industries. Perchlorate has been shown to interfere with the uptake of iodide by the thyroid gland and therefore reducing the production of thyroid hormones, leading to adverse effects associated with inadequate hormone levels. Thyroid hormones are needed for normal prenatal growth and development of the fetus, as well as for normal growth and development in the infant and child. In adults, thyroid hormones are needed for normal metabolism and mental function. For perchlorate, there is no cancer risk associated with drinking water above the PHG or the MCL.

The City manages perchlorate in several ground water wells by adhering to blending plans at Sunset and Jones Reservoirs and by means of the Monk Hill Treatment System previously described. Perchlorate was not detected at MHTS or at Jones Reservoir between 2016 and 2018. However, perchlorate was detected in Sunset Reservoir at levels ranging from ND to 4.9 µg/L with an average of ND. These levels were below the MCL of 6 µg/L and met the blending objective of 80% of the MCL, but were at times, above the PHG of 1 µg/L.

The BAT to further reduce perchlorate levels in Sunset Reservoir beyond blending is ion exchange. The additional annualized cost for IX ranges from nine hundred thousand to two million dollars or five to twelve dollars per capita per year.

Hexavalent Chromium (Cr(VI))

Hexavalent Chromium [Cr(VI)] is a heavy metal and can be naturally occurring or produced by industrial processes such as manufacturers of textile dyes, wood preservation, leather tanning and anti-corrosion coatings. Due to Cr(VI) toxicity, a PHG of 0.02 µg/L has been adopted. The cancer risk for this compound at the PHG of 0.02 µg/L is $1x10^{-6}$, or one surplus cancer case per million people drinking water in excess of the PHG over a lifetime. The previous MCL of 10 µg/L was withdrawn on September 11, 2017 and no MCL has been reinstated therefore there is no numerical public health risk associated with an MCL.

Hexavalent Chromium was detected above the PHG in nine of the City's wells between 2016 and 2018: Bangham, Sunset, Arroyo, Ventura, Well 52, Twombly, Wadsworth, Woodbury, and Chapman Wells. The values detected ranged from 1.7 µg/L to 8.9 µg/L, with Chapman Well having the highest concentration of Cr(VI) at 8.9 µg/L. The Cr(VI) in City wells appear to be of natural origins.

To decrease the hexavalent chromium levels to below the PHG would require a weak base ion exchange or reduction coagulation filtration system. A 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) ranges from fourteen million to fifty-six million dollars or eighty to three hundred and fifty dollars per capita per year.

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 City must test for E.coli, which causes short-term effects such as diarrhea and cramps. The City's water distribution samples may not collectively exceed more than 5% positive for total coliform in any given month. There is no PHG for Total Coliform, but an MCLG of zero set by the USEPA was in effect until April 2016 after which the MCLG was removed and replaced with a system assessment requirement under the Revised Total Coliform Rule.

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 133 to 163 samples each month to test for total coliform within the City's distribution system.

From 2016 to 2018, the monthly percentage of total coliform samples testing positive above the MCLG ranged from 0.0% to 0.8%. The total coliform positive results were above the MCLG of zero, but well below the MCL. None of the samples were found to be positive for E. Coli.

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 system, an effective monitoring and surveillance program, and maintaining positive pressures in the distribution system. Further disinfection may cause adverse water quality effects within the City's distribution system. Therefore, no estimate cost has been included to further reduce total coliform.

Uranium

Uranium is a radioactive compound that naturally occurs in varying amounts in the earth's crust. People who drink water containing uranium in excess of the MCL over many years may have kidney problems or an increased risk of getting cancer. The cancer risk associated with drinking water with uranium greater than the MCL of 20 pCi/L is $5x10^{-5}$, or five surplus cancer cases per hundred thousand people who drink water in excess of the MCL over a lifetime. The cancer risk for uranium at the PHG of 0.43 pCi/L is $1x10^{-6}$, or one surplus cancer case per million people drinking water in excess of the PHG over a lifetime.

From 2016 to 2018, uranium analyses were conducted for eight of the City's wells: Bangham, Sunset, Arroyo, Well 52, Twombly, Wadsworth, Woodbury, and Chapman Wells. Uranium was found above the PHG for all of these wells, but below the MCL of 20 pCi/L. Uranium levels ranged from 2.3 to 15 pCi/L between 2016 and 2018 for these wells.

Further reduction of uranium to the level at or below the PHG would require the BAT of reverse osmosis. The annualized cost for reverse osmosis ranges from six to fifty-five million dollars or forty to three hundred and fifty dollars per capita per year.

Gross Alpha and Radium 228

Gross Alpha is a measure of several different radioactive substances that naturally occur in well water due to the erosion of natural deposits. 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 for many years. The cancer risk associated with gross alpha particles is $1x10^{-3}$, or one surplus cancer cases per one thousand people who drink water above the MCL over a lifetime. There is no PHG for gross alpha; however, an MCLG of zero was adopted for Gross Alpha.

Radium 228 is radioactive compound that naturally occurs in well water due to the erosion of natural deposits. The cancer risk associated with radium 228 is $1x10^{-6}$, or one surplus cancer cases per million people who drink water over the PHG of 0.019 pCi/L during a lifetime. There is no specific MCL for Radium 228, however there is an MCL of 5 pCi/L for Radium 226 and Radium 228 combined and an

MCLG of zero. The cancer risk associated with drinking water greater than the MCL over a lifetime is $3x10^{-4}$, or three surplus cancer cases per ten thousand people.

From 2016 to 2018, gross alpha and radium particle tests were conducted for eight of the City's wells: Bangham, Sunset, Arroyo, Well 52, Twombly, Wadsworth, Woodbury, and Chapman Wells. Gross alpha was detected above the MCLG but below the MCL on all eight wells with a range of 3.9 to 10.6 pCi/L. Gross Alpha was far below the MCL for wells once the gross alpha value was adjusted by subtracting the uranium value. Radium 228 was detected above the PHG on three wells (Sunset, Well 52 and Chapman) with a range of 1.0 to 1.4 pCi/L

For gross alpha and radium 228, there may not be commercially available technology to reach a MCLG of zero. However, a further reduction of radium 228 along with gross alpha would require reverse osmosis as the BAT for a large public water system. The annual cost for reverse osmosis ranges from six to fifty-five million dollars or forty to three hundred and fifty dollars per capita per year.

Tetrachloroethylene (PCE)

Tetrachloroethylene (PCE) is a VOC and is a common soil contaminant. It is prevalent in discharge from factories, dry cleaners and auto shops. PCE has an MCL of 5 µg/L and there is a health risk of obtaining cancer if one drinks water above the MCL throughout their lifetime. The cancer risk for this compound at the MCL is $8x10^{-5}$, or eight surplus cancer cases per hundred thousand people. The cancer risk for this compound at the PHG level of 0.06 µg/L is $1x10^{-6}$, or one surplus cancer case per million people drinking water in excess of the PHG over a lifetime.

PCE was above the PHG of 0.06 µg/L for Sunset Reservoir between 2016 and 2018 with levels ranging from ND to 1.2 µg/L with an average of 0.6 µg/L. PCE levels were above the PHG but well below the MCL of 5 µg/L. Traces of PCE entering Sunset Reservoir come from Bangham and Sunset Wells. As described in the "Sunset Reservoir Blending Plan" section above, these two wells are blended with MWD water, which has undetected levels of PCE. Water from Sunset Reservoir enters the distribution system after disinfection. PCE was not detected in Jones Reservoir or in the Monk Hill Treatment System.

The associated BATs to reduce PCE at Sunset Reservoir beyond blending to a level at or below the public health goal are packed aeration tower and granular activated carbon. The most feasible BAT is a Liquid Phase GAC system, similar to the one installed in MHTS. The estimated annual cost of a Liquid Phase GAC system for all wells containing PCE, including O&M cost ranges from five hundred thousand to four million dollars. The estimated cost for the system per capita is three to twenty-five dollars per year.

1,2,3-Trichloropropane (1,2,3-TCP)

1,2,3-Trichloropropane (1,2,3-TCP) is a chemical compound that is commonly discharged from industrial and agricultural chemical factories, used as cleaning and maintenance solvent, paint and varnish remover and a cleaning and degreasing agent. There is a health risk of obtaining cancer if one drinks water containing 1,2,3-TCP above the MCL of 5 ng/L which became effective starting December 14, 2017. This numerical risk is $7x10^{-6}$, or 7 surplus cancer cases per million people who drink water in

excess of the MCL over a lifetime. The cancer risk for 1,2,3-TPC at the PHG of 0.7 ng/L is $1x10^{-6}$, or one surplus cancer case per million people drinking water in excess of the PHG over a lifetime.

During 2016 and most of 2017, 1,2,3-TCP was not a regulated compound and there was no MCL in place. However, in anticipation of the upcoming regulation, the City was already testing well water sources for 1,2,3-TCP. During this time, the three wells that had measurements above the PHG are Bangham, Sunset and Woodbury Wells. The values ranged from ND to 12 ng/L with an average of 5.7 ng/L. Of notable emphasis is that under no circumstance were any of these well waters served to the public directly in 2016 or 2017. Blending plans were already in effect at this time due to other constituents discussed above (i.e., nitrate, perchlorate, PCE), so these measurements do not reflect what was distributed into the system. As of March 2018 however, DDW issued instructions to the City to include 1,2,3-TCP in the routine testing of Sunset and Jones Reservoirs to demonstrate compliance with the new MCL and associated blending objective. 1,2,3-TCP has been ND (Not Detected) since testing in the reservoirs was instituted and was likely below the level of detection at these reservoirs had testing been conducted before the MCL regulation was enacted December 2017.

An additional reduction of 1,2,3-TCP beyond blending to a level at or below the PHG would require GAC. The annualized cost for GAC ranges from eight hundred thousand to seven million dollars or five to forty 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. For some constituents, there are also no analytical methods to measure if it has been 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