THE Bulletin

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SPECIAL ISSUE

WATER AND HEALTH: THE COMING WATER CRISIS AND WHAT WE CAN DO ABOUT IT

Foreword to this Special Issue of the SCCMA Bulletin by the SCCMA Environmental Health Committee

The Santa Clara County Medical Association's Environmental Health Committee is committed to preserving the health of our community by educating physicians and the public about the important links between issues of environmental and public health. As guardians of public health, we acknowledge the critical need for a continuous access to a clean and safe supply of water, and also the importance of investing in a reliable and safe supply of water.

Water recycling is not new to our region: it has been practiced in California for over half a century for both potable (drinking) and non-potable purposes. Locally we have used recycled water since the early 1990s for manufacturing and cooling and to irrigate our parks and schoolgrounds. Therefore, further purification of recycled water to increase our drinking water sources is an appropriate and sustainable approach to our current water challenges. For these reasons, following a series of presentations and discussions with representatives of Valley Water, in December 2021 the SCCMA endorsed Valley Water's Purified Water Project to augment groundwater with highly treated recycled water.

We understand that our patients and many others in the community value our opinion about all health-related issues, including water reuse. For this reason, we have prepared this Special Issue of the Bulletin focusing on water and health with details about the Purified Water Project and our need to protect our water supplies. In so doing, we honor the ethical practice of informed consent. By deepening our understanding of the threats to our current water supply and the appropriate application of advanced water treatment, we can help our patients – and the public – make informed decisions about the use of recycled water in our community.

The SCCMA Environmental Health Committee will continue to follow this project closely to ensure that our members remain informed and, in turn, can inform others.

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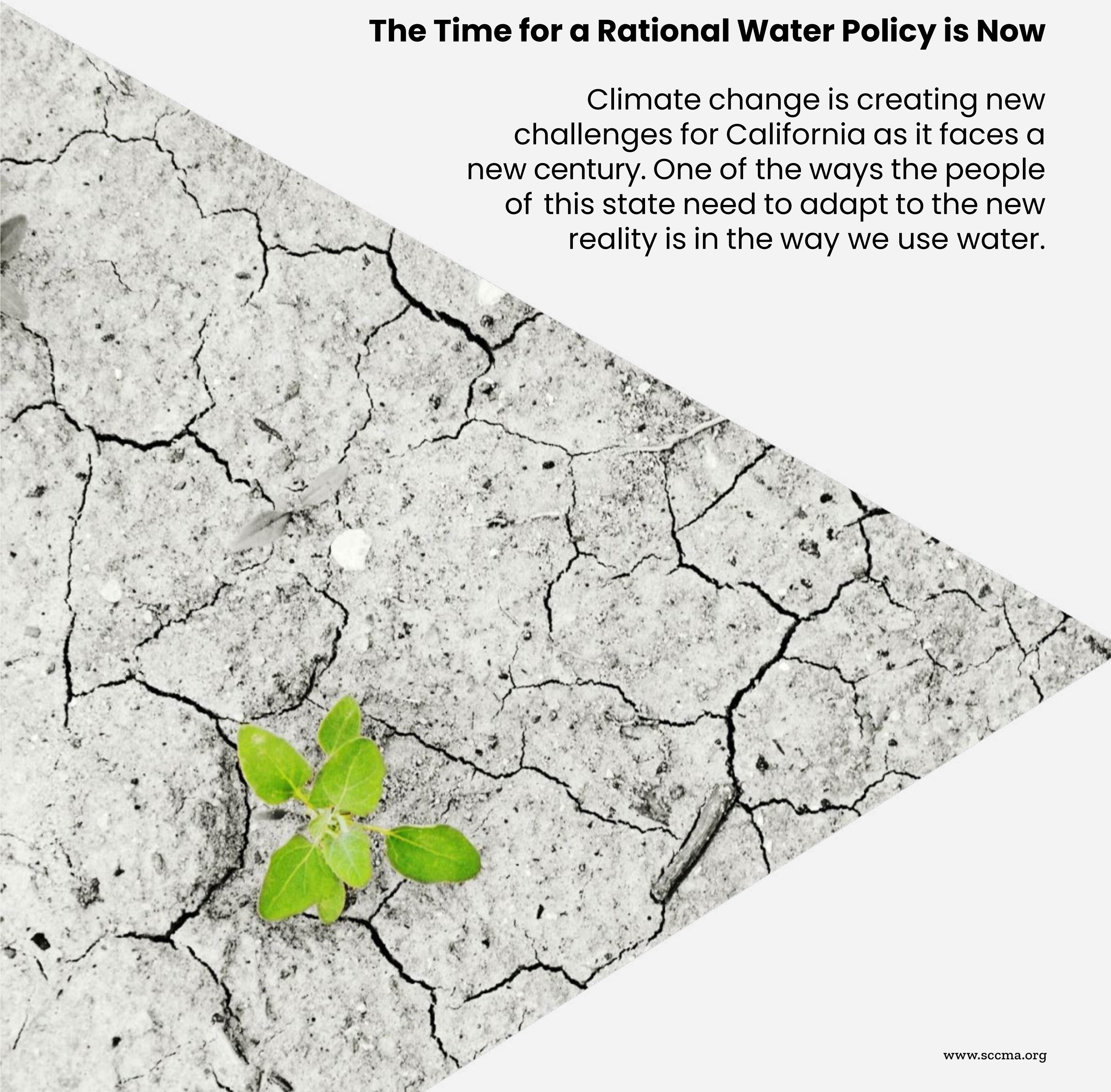
Climate Change, Drought, and the Lessons of Flint

The Time for a Rational Water Policy is Now

Climate change is creating new challenges for California as it faces a new century. One of the ways the people of this state need to adapt to the new reality is in the way we use water.



Our state is particularly impacted by droughts, which are increasing in frequency, length and intensity. The last historic drought was from 2012-2016, and only a few years later California is once again facing drought conditions. February this year was the second driest since we began keeping records (1895), and 2022 is on track to be the driest year ever.[1] The United States Department of Agriculture has designated all of California's 58 counties as "drought disaster areas," and the National Oceanic and Atmospheric Administration Drought Monitor shows almost 60 percent of the state in "extreme drought," defined as water "inadequate for agriculture, wildlife and urban needs. Reservoirs are extremely low. Hydropower is restricted."

- National Integrated Drought Information System

Climate change will only increase demand for water while simultaneously reducing supply (U.S. EPA, 2016). At higher temperatures, water evaporates from reservoirs more quickly. Plants must transpire more water to keep cool, so irrigated crops will need more water. Declining rainfall has already reduced inflows into the Colorado River, a key irrigation source for Southern California. The Sierra snowpack has also declined to historically low levels as snow melts earlier in the year. Decreases in these natural reservoirs will lead to further restrictions on California's water supplies.

This special issue of the Bulletin has been prepared to provide SCCMA members with information about how our local community is responding to these challenges. In particular, we have investigated how Valley Water—Santa Clara County's regional water supplier—plans to augment our drinking water supply with recycled water. Following the example of cities in Southern California, Valley Water will purify already treated wastewater through additional processes that produce clean, safe drinking water as a hedge against future shortages to increase our resilience to climate change.

We as physicians must help ensure that our water supplies are clean, safe, and affordable for all residents. Over the past ten months, the SCCMA Environmental Health Committee has studied the supply, regulation, and treatment of drinking water, and in consultation with local water professionals, we prepared the articles in this issue. By way of introduction, we offer the cautionary tale of Flint, Michigan, which highlights how physicians in one city were able to advocate for clean water and protect public health.

Quality as Well as Quantity

Water is a basic human need that is sometimes taken for granted. Even where it is abundant people may lack high quality, clean water for human consumption. In Latin America, home to some of the world's largest rivers and lakes, poor water management that prioritizes industry and industrial agriculture have left many without access to safe drinking water. More than 130 million people in the region have no safe drinking water in their homes, and only one in six enjoys adequate sanitation service (Barlow & Clarke, 2016).

The United States is not immune to these problems. In Flint, Michigan a disastrous decision to save costs by switching the city's water source left thousands exposed to toxins, including young children. These exposures will cause life-long health effects. The story of Flint is a cautionary tale about the need to implement a rational water management program that provides enough water for everyone while also ensuring its safety and quality.

The Story of Flint

Flint, Michigan, the birthplace of General Motors, is a hard-bitten former industrial city about 70 miles north of Detroit. A classic Rust Belt casualty, by the 1980s the cumulative effects of oil shocks and overseas competition shuttered Flint's auto plants. Roughly 1 in 6 homes in Flint were abandoned as the city's population dwindled to just 100,000, of whom 45% live below the poverty line (Denchak, 2018).

For over a century the Flint River that flows through the heart of the city served as an unofficial waste dump. Runoff from farms, factories, meatpackers, and lumber and paper mills were dumped into the river. Landfill leachate and raw sewage from overloaded waste treatment plants also flowed into it; the river itself caught fire twice. While it originally served as the city's water supply, in 1967 Flint began to purchase Lake Huron water from Detroit to meet its drinking water needs.

In 2011, as Flint faced a $25 million dollar budget shortfall, Michigan Governor Rick Snyder appointed an "emergency manager" to run the city with the sole mandate to cut costs and keep the city solvent. Flint had made plans to join a new water authority building its own pipeline to Lake Huron, with the intention of continuing to take water from Detroit in the interim. To save money, however, the emergency manager decided in 2013 to switch the city's water supply back to the Flint River. The failure to properly treat the water from the river resulted in higher levels of microbial pathogens and caused the highly corrosive river water to leach lead from old pipes into people's homes.|

On April 25,2014 the city began distributing Flint River water to their community. Flint residents noticed the change immediately, complaining of discolored, foul smelling and tasting water. They noted skin rashes and loss of hair. The most serious problem, however, was with the children of Flint.

Dr. Mona Hanna-Attisha, a Flint pediatrician, was alarmed to read a Virginia Tech study that found 40 percent of sampled households in Flint had lead in their water above 5 parts per billion (mcg/L), and 17 percent had lead in their water above the 15 mcg/L, the federal "action level," which researchers termed a "very serious" problem (Virginia Tech, 2015). When Dr. Hanna-Attisha sampled her patients' blood lead levels she discovered that they had nearly doubled since 2014 when the source water was changed; in some neighborhoods the rates tripled. Overall, nearly 9000 children were exposed to dangerous lead levels for 18 months (Hanna-Attisha, et al., 2016). Lead toxicity in children affects multiple organ systems and can have long-lasting impacts. There is no level shown to be safe in children, and any lead detected in the blood is considered abnormal. Blood lead levels greater than 10 mcg/dl consistently cause cognitive and neurobehavioral deficits, and even lower levels can have adverse neurocognitive effects. Even at levels below 10 mcg/dl lead can cause renal toxicity, usually a chronic insterstitial nephritis, as well as subtle abnormalities in renal tubular function that can lead to aminoaciduria, glycosuria, and low-molecular weight proteinuria. (Lead nephrotoxicity is usually described as a chronic interstitial nephritis.) Lead toxicity can also cause anemia from inhibited erythropoiesis as well as hemolysis.

The adverse neurobehavioral effects of lead toxicity appear to persist into adolescence and adulthood, despite a decrease in blood levels over time. A longitudinal study of over 1000 children showed that lead toxicity in childhood, based on blood lead levels at age 11, was associated with lower IQ scores and lower socioeconomic status at age 38, even corrected for maternal IQ , child IQ , and childhood socioeconomic status (Reuben, et al., 2017).

In addition to lead poisoning, poor disinfection of the treated water led to an outbreak of Legionnaire's disease. Ironically, the state's attempt to correct the disinfection problems by adding more chlorine to the water resulted in the formation of carcinogenic trihalomethanes, creating further serious contamination. In short, the lack of a deliberate, programmed approach to treating the water in Flint led to a public health disaster of historic proportions that was only curtailed by the astute action of a local physician (Masten, et al., 2016).

In November 2016, a federal judge ordered the state of Michigan to provide door to door bottled water delivery for residents until enough faucet filters could be distributed and the city, with the help of state funding, could replace thousands of lead pipes. The residents of Flint continue to struggle with the health impacts of the water crisis.

The Way Forward

The story of Flint demonstrates the importance of a well thought out, proactive plan to supply safe, clean water to all our communities. The state of Michigan enacted a poorly conceived plan that failed to anticipate foreseeable problems, with predictably poor results. But it also highlights the part physicians can play in ensuring that good plans are adopted. The efforts of a single pediatrician helped bring the issue of Flint's water crisis to the forefront. Her example demonstrates the importance of physicians taking part in the discussion around environmental health.

Our own community has been impacted by water contamination in the past. The San Francisco Bay is improving after historical pollution with heavy metals. Legacy mercury mining in Almaden Valley, along with stormwater runoff and wastewater, has contributed to pollution of the Guadalupe River watershed and the Bay, resulting in fish consumption advisories and guidelines. More recently, dentists removing dental amalgam containing mercury must now control this pollution at the source. Other heavy metal contamination from the high-tech industry, such as copper, nickel, and silver, has been addressed by wastewater treatment upgrades and source control efforts. Leaking underground tanks, industrial spills, septic systems, inefficient agriculture, and other sources can pollute groundwater which may require treatment or make it unusable. These cases illustrate how controlling the source of industrial and agricultural pollution is the best approach to preventing chemical and biological contamination. This is the approach Valley Water has adopted in managing water destined for its water purification facilities. According to Kirsten Struve, Assistant Officer of Valley Water's Water Supply Division, *"All wastewater treatment facilities in Santa Clara County have pretreatment programs that limit the pollutants discharged by industry, monitor the municipal sewer system, and encourage pollution prevention. As we prepare to add purified water to our drinking water supplies, Valley Water will continue to work with our wastewater agency partners to develop source control strategies to enhance these existing programs."*

Our water future will be impacted by climate change in unprecedented ways, and the time to plan for that future is right now. This issue of the SCCMA Bulletin includes articles describing the many ways Valley Water intends to provide clean and safe drinking water for the years ahead, including construction of a project to supply high-quality, purified recycled water, similar to those in place for the past 60 years in Southern California.

The following articles were written by the members of the Environmental Health Committee with assistance from Valley Water staff:

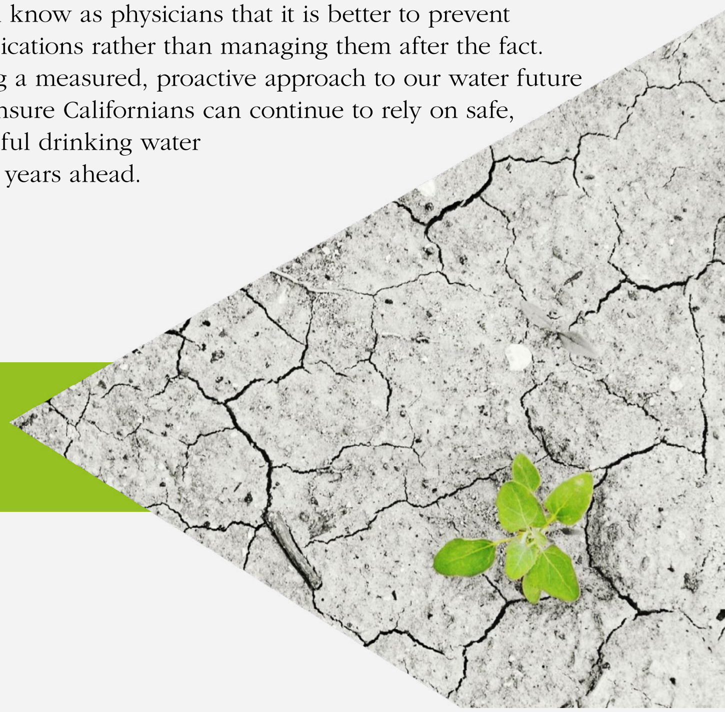
- **"Water Supply"** by Stephen Jackson, MD, Samantha Greene, PhD, and Rachel Hernandez describes the various water sources supplying our valley and the need to supplement them with new sources.
- **"Making Water Safe for Use and Reuse"** by Santosh Pandipati, MD, Medi Sinaki, PE and Eric Rosenblum, PE goes into the technical aspects of water treatment, outlining the multiple layers of filtering and decontamination used to produce high quality drinking water.

"As physicians, we are charged with doing our part to protect the public's health. The people of our community need to consider what to do about our water future."

- **"The Purified Water Project: Securing the Future of Santa Clara County"** by Valley Water Staff, in a question and answer format, provides details about the local groundwater augmentation project, including regulations and monitoring procedures to ensure safe drinking water.
- **"The Challenge of Water Pollution Prevention: A Call to Action for Toxics Reduction"** by Cindy Russell, MD discusses the need for more comprehensive source control efforts and the importance for physicians to become aware of emerging issues related to regulation of water pollution.

As physicians, we are charged with doing our part to protect the public's health. The people of our community need to consider what to do about our water future. When we obtain informed consent from our patients, we list all the risks, benefits and alternatives to a proposed course of action. Often, there is a risk in doing nothing. With climate change rapidly impacting our supply of vital water resources, we must either adapt or suffer the consequences. There will be risks and challenges going forward. But trying to maintain the status quo will be increasingly expensive and add health risks if we are forced into a reactive policy rather than a proactive one.

We all know as physicians that it is better to prevent complications rather than managing them after the fact. Taking a measured, proactive approach to our water future will ensure Californians can continue to rely on safe, healthful drinking water in the years ahead.



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WATER SUPPLY

If water is the essential ingredient of life, then water supply is the essential ingredient of civilization

*- **David Sedlak,***
"Water 4.0: The Past, Present, and Future of the World's Most Vital Resource"

By:
Stephen Jackson, MD, Samantha Greene, PhD, and Rachel Hernandez

Introduction

Traditionally, physicians have had an ethical responsibility for maintaining the health of their communities. Indeed, physicians are aware of the necessity of clean water for human health, and that safe water is a vital public health resource. Historically, water-borne illnesses transmitted through contaminated water have devastated populations. Even today, every year over 800,000 people in low- and middle-income countries die as a result of contaminated water and inadequate sanitation, and these water-borne diseases remain a major cause of mortality in children under five years of age (WHO, 2022). Societal health – proper social and economic function and environmental well-being – depends upon access to a reliable and sustainable source of clean and safe drinking (potable) water.

But reliable water supplies have become increasingly limited. The western part of the United States is undergoing extended arid conditions, and in California, the impact of a warming climate is leaving less water available for our use. A general lack of public awareness and concern – bordering on irresponsibility – underplays the challenges that we as a community face in managing this scarce, life-sustaining resource.

This article focuses on the supply of water that we use in Santa Clara County, including how much we need, where it comes from, and what the future holds for its continued availability. We also discuss the options that we currently have for both reducing our demand and also increasing our supply by developing new sources—particularly recycled water—to meet future needs.

Water Supply and Demand

The average yearly water use in Santa Clara County is approximately 315,000 acre-feet per year (AFY). [Note: one acre foot equals 325,851 gallons, enough to cover an area about the size of a football field with water one foot deep.] Most of this water is supplied by our county water provider, Valley Water. Reflecting the urban character of Silicon Valley, nearly 90% of the water Valley Water supplies is for municipal use. As shown in Figure 1-1, more than half is for residential purposes, the rest for commercial, institutional and industrial use (National residential indoor uses are highlighted in Figure 1-2). Only about 25,000 AFY is used for agricultural irrigation, mostly in the southern part of the county.

It is worth noting that our water use would be significantly higher if not for savings due to water conservation. This reduction in water use is due to the efforts of thousands of individuals and business in our community responding to the increasingly frequent "drought emergencies" declared over the past thirty years. (See "Conservation" below.) Nevertheless, as population and jobs in the county continue to grow, the annual demand for water is also projected to increase, reaching 335,000 AFY by 2040.

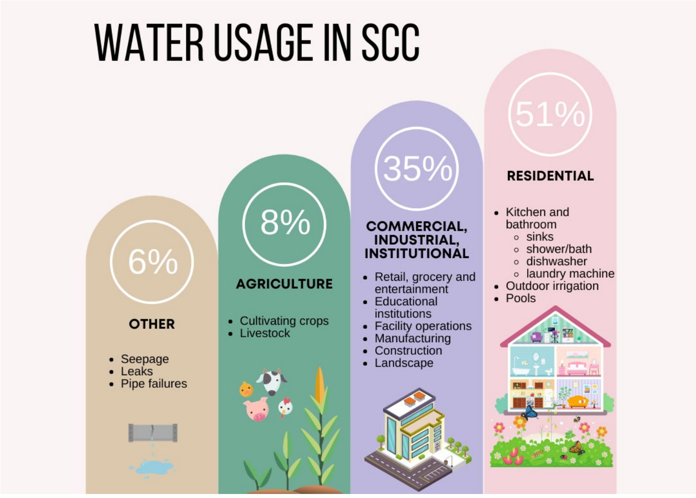

Figure 1-1. Water use in Santa Clara County

Local Water

We depend upon two primary sources for our water: local water and imported water. As the name implies, local water refers to water available within the county. Rain falling on our watersheds drains into creeks, streams and rivers. Reservoirs capture a portion of this rainfall runoff, and some percolates into the ground, recharging local groundwater aquifers. Because it depends on rainfall, the amount of local water available varies year to year. On average, our region receives 14 inches of rainfall annually.

During wet years, above average rainfall fills our local reservoirs and helps replenish groundwater basins. In dry years, such as the past three years, below-average rainfall may not be sufficient to fill reservoirs. This causes us to increase reliance on groundwater supplies and draw down local aquifers.

When demand for water continually outstrips the ability of rainfall and local rivers to recharge the groundwater basins, even deeper wells must be drilled to reach falling water levels. Over time, this can result in subsidence, as the land surface sinks over empty aquifers. This is precisely what happened in Santa Clara County during the last century.

Historical Challenges

In addition to corralling surface water, farmers, ranchers and dairymen of the 1800's drilled hundreds of wells to supply water for irrigating orchards and crops and feeding dairy cattle. As pumping continued unchecked into the 20th century, groundwater levels in some places dropped by as much as 100 feet. In 1929 the community formed the Santa Clara Valley Water Conservation District (SCVWCD)—the forerunner to today's Valley Water—to build reservoirs to capture more rainfall that could then be released to streams and percolation ponds to recharge the aquifers. In response, groundwater levels began to rebound, as shown in Figure 1-3.

Between 1940 and 1960, however, Santa Clara County's population grew twenty-fold to over 600,000. The character of the valley changed from agricultural to urban-industrial, and demand for water once more exceeded the local supply. Groundwater levels started falling again, and with it the land: in 50 years the surface of the Valley floor sank by as much as 13 feet due to subsidence. Community leaders began looking outside the county, prepared to import water to meet local needs.

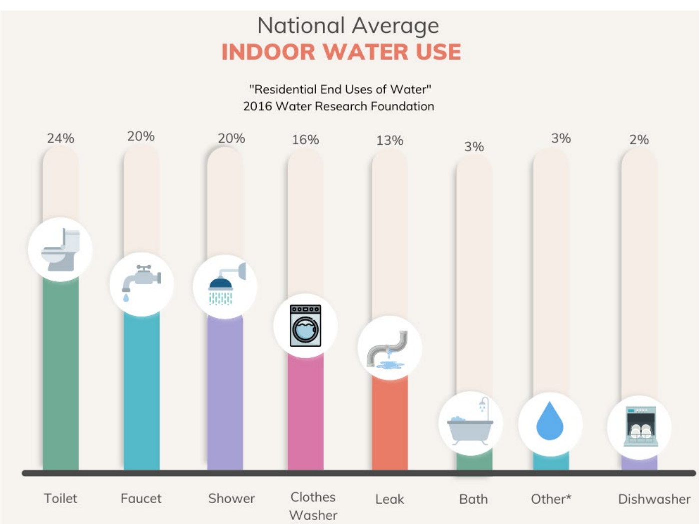

Figure 1-2 National Average Indoor Water Use

Imported Water

As early as 1939 some cities in Santa Clara County had begun to purchase water from San Francisco, piped to the Bay Area from the Hetch-Hetchy reservoir. To make up for the county-wide shortfall, SCVWCD joined the State Water Project (SWP) and began importing water from the Sacramento River-San Joaquin River Delta. Augmented with imported water, county water supplies once more were sufficient both to meet local needs and to recharge the county's groundwater basins. SWP water was also sent directly to newly constructed drinking water treatment plants, which were built to serve the growing residential population. By augmenting local water with imported supplies, Valley Water was able to halt subsidence and continue to meet the county's growing needs.

Soon, however, even this augmented supply proved insufficient. When a severe drought hit in the mid-1970s, water allocations from the SWP were cut back and more water was needed. By then, SCVWCD had merged with the county flood control agency to form the Santa Clara Valley Water District (now called Valley Water). Valley Water contracted with the federal government to receive additional water from the Central Valley Project. This period also witnessed the construction of the county's first recycled water treatment plants and the initiation of widespread conservation efforts.

Imported water now accounts for 50% of our total water supply (Figure 1-4). On a countywide basis, about 40% of our imported water comes from the state and federal projects, while San Francisco continues to sell water to local cities, comprising about 10% of county supplies.

Keeping the Water Flowing

Today, Valley Water treats and delivers water to users through a complex system of facilities that include 10 dams and surface water reservoirs; groundwater recharge basins; three pump stations and 142 miles of pipelines; and three major water treatment plants.

The treatment plants are specifically designed to filter and disinfect surface water from both local and imported sources (see next article "Making Water Safe for Use—and Reuse"). The Penitencia Water Treatment Plant serves Milpitas and parts of San Jose, processing up to 40 million gallons per day (mgd) of mostly imported water (a million gallons represents a little more than 3 acre feet of water.) The Santa Teresa Water Treatment Plant serves most of South San Jose and treats up to 100 mgd, while the Rinconada Water Treatment Plant serves western Santa Clara County as far north as Los Altos with just under 100 mgd; both plants treat a mix of imported and local supplies.

Valley Water's 10 dams and surface water reservoirs also help replenish groundwater by releasing water to streams for in-channel percolation and by diverting water directly to percolation ponds to where it is allowed more time to seep into groundwater basins, which in turn serve as underground storage reservoirs. To minimize the impacts of Valley Water's reservoir operations on downstream habitat and aquatic life, Valley Water slowly releases the stored surface water throughout the year. Currently, 5 out of 10 dams have seismic restrictions and are operating under state-mandated capacity restrictions which decrease available storage to 38% of total capacity. Anderson Reservoir is currently undergoing a seismic retrofit project that, once completed, will restore Valley Water's

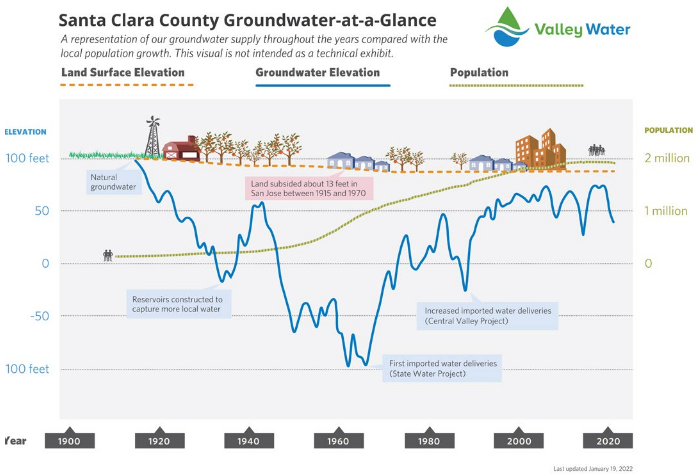

Figure 1-3. Groundwater and land surface levels in Santa Clara County

available storage to 90% of total capacity.

Because groundwater-pumping demands exceed natural recharge, Valley Water also manages groundwater recharge operations, filling 277 acres of recharge ponds with local and imported water. The aquifers are also recharged through seepage from 90 miles of local creeks. For comparison's sake, county aquifers hold more than all 10 of Valley Water reservoirs combined.

Addressing Challenges Today

With each drought, our local and imported water supplies are reduced. In 2022 we've had three consecutive years of less than average rainfall (with less than 8 inches in winter 2021-22). Except for water allocated under an emergency provision to protect human health, our annual allocation from state and federal imported water supplies have drastically decreased in the last 3 years.

The optimistic view that wet years will continue to compensate for extended dry spells is no longer justified, as extended droughts and mega-droughts have become the new normal. The last time our region was as dry as it has been for the past 22 years was around 800 A.D., when the Mayans built their temples and Viking ships sailed the North Atlantic. As the agency responsible for meeting the county's water needs, Valley Water has developed a range of options to meet this challenge, including water conservation, and water reuse.

Conservation

Conservation (in essence, another type of "local water") is a key water resource strategy. Conservation currently accounts for 15% of our county's total water supply, and it has become a routine way of life. As shown in Figure 1-5, since 1992 total water use in the county has declined while its population has increased by 25% to nearly two million. Valley Water's programs encourage conservation primarily through rebates that reimburse water customers who switch to water efficient fixtures, irrigation systems, and landscapes. Valley Water offers residents free water saving devices (including shower heads and hose nozzles) and operates a program to help identify leaks and water waste. To promote water conservation in the next generation, Valley Water also provides a range of educational programs for students ranging from pre-kindergarten to 12th grade, as well as adults (see "Learning Center" on www.valleywater.org). Nonetheless, a communal response of even greater conservation will require more education and incentives, and even mandates when necessary.

Water Reuse

Water reuse is not a new concept because all water on the planet has been used countless times as part of the natural water cycle. Importantly, another key element of Valley Water's long-term water supply strategy is the reuse of effluent from local wastewater treatment plants. This purified recycled water constitutes a new local supply that is not dependent on rainfall. Sometimes called "reclaimed" water, recycled water is produced by further treating wastewater, using advanced processes to purify wastewater plant effluent.

Presently, recycled water produced in Santa Clara County is used only for non-potable purposes such as construction, commercial cooling, industrial manufacturing, and agricultural and landscape irrigation. It accounts for only about 5% of local water. But non-potable recycled water can be further purified so that it is safe for use as drinking water. Presently, potable quality recycled water is being produced at the Silicon Valley Advanced Water Purification Center (SVAWPC) in San Jose. However, currently this drinking quality water is blended with other recycled wastewater to improve the latter's quality and expand use for non-potable applications. Valley Water has plans to construct more facilities to increase non-potable and potable reuse for our local supply (Valley Water, 2021).

The SVAWPC produces water that rivals distilled water in its purity. Critically important for public health, this water is continually tested and monitored for its content and purity in a tightly regulated manner. In fact, the SVAWPC's treatment processes consistently produce water that meets or exceeds state and federal drinking water standards. (To learn more about advanced water treatment methods and regulation of recycled water, see "Making Water Safe for Use—and Reuse") Advanced purification of recycled wastewater is a locally controlled, drought-resistant, reliable, resilient, safe and expandable source for drinking water. Successful similar projects exist statewide, such as the Orange County Groundwater Replenishment System that has been operating for well over a decade. Monterey County recently completed a

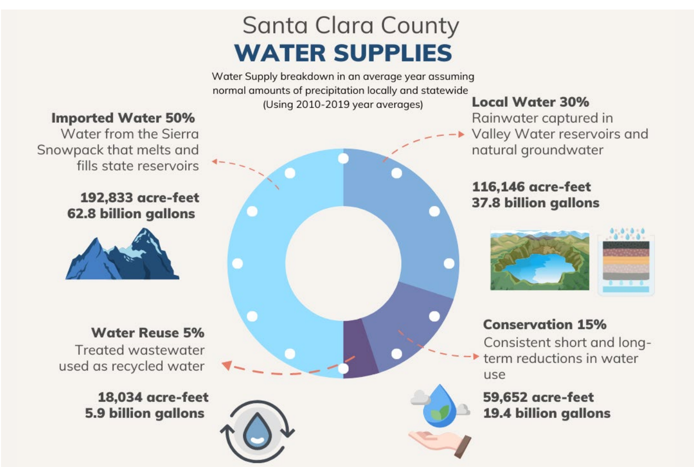

Figure 1-4. Santa Clara County water supplies (using 2010–2019 year averages)

The last time our region was as dry as it has been for the past 22 years was around 800 A.D., when the Mayans built their temples and Viking ships sailed the North Atlantic

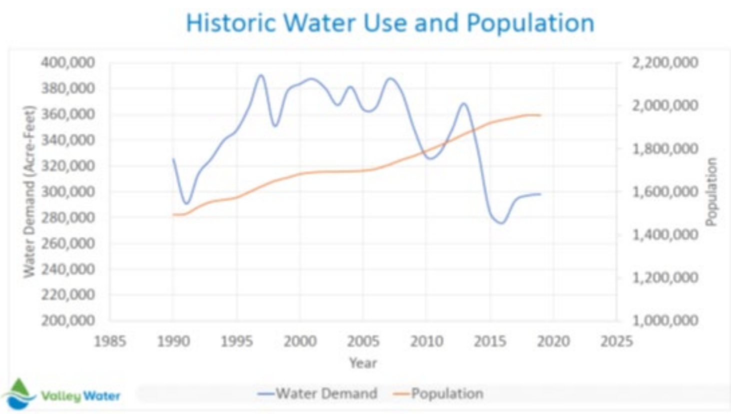

Figure 1-5. Historic water use indicates declining per capita water use.

similar project in 2020, and Los Angeles has planned a massive project of this nature.

Other Sources

One novel approach to mitigate the increasingly common reductions in allocations from the state and federal water projects is to store groundwater outside the county in Central California ("water banking"). In wet years, Valley Water delivers surplus water to the Semitropic Groundwater Storage Bank in Kern County, and in drought years it can receive water from it. The Semitropic Bank can store 1.65 million AF; Valley Water's contract allows storage of up to 350,000 AF, equal to about one year's water demand.

Valley Water is also developing other water sources as a hedge against future water shortages, like graywater use and rainwater capture. Graywater is household wastewater from sinks, showers, bathtubs, washing machines, and dishwashers, that when filtered properly can be used to refill toilet tanks and irrigate home gardens. Valley Water has a rebate program that reimburses homeowners who invest in laundry-to-landscape graywater systems. Another rebate opportunity for residents is through the rainwater capture program. Residents can collect rainwater through barrels or cisterns for reuse outside the home.

Desalination of seawater, which currently provides the majority of water used in Israel and the United Arab Emirates, could also produce another source of water to augment Santa Clara County's water supply. Although desalination uses the same purification technology as potable reuse, it takes significantly more energy to remove salt from ocean water. It also imposes harm on the sensitive bay ecosystem. Valley Water is currently participating with seven other Bay Area water agencies in the Bay Area Regional Reliability (BARR) program, which includes a long-term study of the feasibility of desalination (https://www.bayareareliability.com/).

Conclusion

Physicians are among the frontline guardians of public health. By becoming informed about the process of purifying recycled water, we can educate our patients and reassure the public about the safety of this form of water reuse. Indeed, physician advocacy will be a key element for gaining the public's acceptance and consent.

Authors

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Chair of the Environmental Committee, is a retired anesthesiologist and critical care physician and a practicing medical ethicist.

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Rachel Hernandez
is a sophomore high school student interested in water resources management to address challenges of water supply and demand.

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A Human Right to Water

In 2012, California became the first state in the nation to legislatively recognize the human right to water. With that law, the California Water Code (Sec. 106.3) was amended to clarify that all Californians deserve "safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes." This right, in turn, depends upon the three core components of drinking water: quality, accessibility and affordability. But throughout California, nearly two-thirds of those who live below the poverty level must pay a higher percentage of their income for water than is considered "affordable," and across the state, contaminated water sources disproportionately burden low-income communities and communities of color (OEHHA, 2021).

As a nonprofit committed to health equity, we understand the importance of maintaining an affordable supply of clean, safe water for all in our community. Currently, the reliability of our water supply has become increasingly threatened by earthquakes and other hazards, more frequent droughts, and loss of snowpack due to a warming climate. Unless we act now, more and more median-income and low-income residents will be unable to access the water they need. Along with their efforts to promote water conservation, The Health Trust supports Valley Water's plans to develop high-quality, purified recycled water to augment our groundwater aquifer. The proposed Purified Water Project will produce a resilient, reliable, and locally-controlled water supply, ensuring the availability of affordable water in our community for years to come.

Michele Lew, CEO
The Health Trust

MAKING WATER SAFE FOR USE— AND REUSE

By:
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Introduction

As human-induced climate change continues to alter the Earth's weather globally, local effects vary from region to region. Here in California we have seen record-breaking droughts and wildfires that have reduced the availability of our water for human, agricultural, and industrial use. Water scarcity and deterioration of water quality threaten the well-being of millions of Californians, as well as many billions around the world. We will need to not only to conserve water, but also to reuse it to achieve our needs.

At least half of the water used in Santa Clara County falls as rain and snow hundreds of miles away. The water is pumped and piped here, and stored in local reservoirs and aquifers. Most of this water is used once, collected, treated at wastewater facilities, and then discharged[1]. However, as these remote supplies have become less reliable, a growing percentage of wastewater has been returned to our community as recycled water, currently used for irrigation and industrial use.

Major advances in water treatment technology now allow us to recycle wastewater and purify it so that it is safe for human consumption. Our county water agency, Valley Water, is implementing just such a program to augment our diminishing water supplies. As California healthcare providers, our patients will ask us to attest to the safety of locally produced recycled water. This article has been prepared to help address some of

1. Three of the four regional treatment plants in Santa Clara County discharge the treated water ("effluent") into San Francisco Bay; the South County Regional Wastewater Authority in Gilroy stores effluent in ponds where it evaporates and is absorbed into the soil.

Without treatment, virtually all water supplies would pose some risk to public health.

these concerns by providing the technical background behind the regulations and treatment methods that make recycled water safe to drink.

Health Risks Associated with Drinking Water

Health risks associated with drinking water include illnesses caused by microbiological pathogens such as bacteria (e.g., cholera, typhus, salmonella, campylobacter), viruses (e.g., enterovirus, adenovirus, norovirus), protozoa (e.g., Giardia, cryptosporidium) and helminths (e.g., tapeworms). Potential health risks associated with toxic chemicals (heavy metals, synthetic organics) range from acute and chronic illnesses to carcinogenic and mutagenic effects. These chemicals include trace levels of pesticides and herbicides, petrochemical pollutants, fluorinated and chlorinated hydrocarbons (e.g., per- and polyfluoroalkyl substances, or PFAS), as well as residual pharmaceutical and personal care products.

Without treatment, virtually all water supplies would pose some risk to public health. The risks posed by these potential contaminants in drinking water vary widely, as does our knowledge of them. For example, the link between gastrointestinal illnesses and infection by waterborne microbial pathogens was recognized more than a century ago. The health risk from exposure to some heavy metals (e.g., lead) was detected even earlier. The carcinogenic effects of many organic chemicals, by contrast (e.g. dioxane, and polychlorinated biphenyls, or PCBs) were detected only within the last several decades, while the connection between illness and trace amounts of other substances in drinking water (including nanoparticles and microplastics) is a subject for ongoing research with respect to both potential illness and pathophysiologic pathways. Despite their differences, the risk from all these substances must be managed by the utilities that produce drinking water as well as the agencies that regulate them.

Water Treatment to Mitigate Health Risks

Water treatment plants are designed to remove contaminants that pose a risk to human health. Once water has been used indoors at homes or business facilities, wastewater treatment plants are responsible for removing sanitary and industrial waste from sewage so that the treated effluent is safe to discharge into the environment. Recycled water plants, or in some cases advanced water purification facilities, further process treated wastewater for either non-potable or potable reuse. Water, wastewater, and water recycling facilities all employ three basic types of processes to treat water:

- ***Physical methods*** separate pollutants by physical characteristics like weight (sedimentation) or size (filtration), including advanced membrane filtration processes (microfiltration, reverse osmosis).
- ***Biological methods*** allow microorganisms to metabolize pollutants and convert them into a biomass that can be physically removed by settling and filtration. Biological methods can also metabolize the settled biomass through anaerobic digestion.
- ***Chemical methods*** purify the water through addition of specific substances, as when coagulants are added to help filter small particles, or chlorine or ozone are added to inactivate pathogens. Chlorine and ozone are particularly effective disinfectants that oxidize cell membranes and kill pathogens by dispersing their genetic material. Ultraviolet disinfection, which introduces specific frequencies of light to disrupt cellular material, may be included in this category.

Water, wastewater, and recycled water are all treated by some combination of these methods. Some methods (filtration, chlorination) are commonly used by both water and wastewater treatment plants. In Santa Clara County, for instance, Valley Water's surface water treatment plants include

1) coagulation and sedimentation, 2) filtration through sand and carbon, and 3) disinfection with chlorine and ozone (see treatment train displayed in figure 2-1). Local wastewater treatment plants also filter and disinfect water after biological treatment. Advanced purification facilities providing water for human consumption utilize membrane filtration (e.g., reverse osmosis), to produce "ultrapure" water.

Treatment to remove pathogens

All three treatment types are used in various combinations to eliminate pathogens from water. The design of treatment facilities depends upon the quality of the source water being treated, as well as the quality of the water required.

In water from rivers and reservoirs, pathogens are often attached to small particles suspended in the water. At drinking water treatment plants these are addressed through coagulation and filtration (chemical and physical treatment), removing both the particles and pathogens. Valley Water adds ozone to the water before filtering and chlorine after filtration to kill any remaining pathogens. A small amount of ammonia is also added to chlorine to form a residual disinfectant (chloramine) that prevents regrowth of any surviving microorganisms. Bacteria which are resistant to disinfection (e.g. cryptosporidium) can be effectively removed by coagulation and filtration (Yates & Gerba, 1998).

Removal of pathogens from municipal wastewater is more complicated because sewage is much more heavily polluted than surface water and carries a much greater microbial burden. As a result, the first steps in wastewater treatment involve removing trash, sand and gravel, and settleable organic matter through screening and primary settling (physical treatment). Effluent from those methods is then subjected to some form of biological treatment, either with biomass suspended in aerated tanks or by passing the water over biologically active media, and then settled again before final filtration. While many pathogens are eliminated by biodegradation, a final disinfection step with a chemical oxidant or ultraviolet light is implemented before the water is released to the environment or reused.

The quality of filtered and disinfected effluent from wastewater treatment plants is typically as clean as the river water that is treated by surface water treatment plants. In order to recycle water for human consumption, however, it must be further purified to ensure the removal of microbial pathogens and toxic chemicals. Reverse osmosis (RO) treatment is often utilized to provide further treatment in this case. In RO treatment, water is forced through a porous membrane with openings as small as 0.4-0.8 nanometers in diameter (Kosutic, et al., 2006). While water molecules pass readily through these pores, virus particles are effectively filtered out, as are bacteria and protozoa. Even membranes with slightly larger pore sizes (ultrafiltration, nanofiltration) can successfully remove pathogens at lower pressures and with reduced energy costs. Using RO treatment for groundwater injection and surface water augmentation exceeds requirements and is consistent with the California State Water Resources Control Board (SWRCB) regulatory preference for multiple barriers to the presence of pathogens and contaminants of concern.

Biologically active carbon filtration is another advanced treatment method that can remove both pathogens and organic chemicals. A biomass cultivated on a base of activated carbon metabolizes residual organic material while the carbon adsorbs chemical contaminants. Following filtration, advanced disinfection techniques include ultraviolet disinfection, and oxidation with ozone and hydrogen peroxide, alone or in combination.

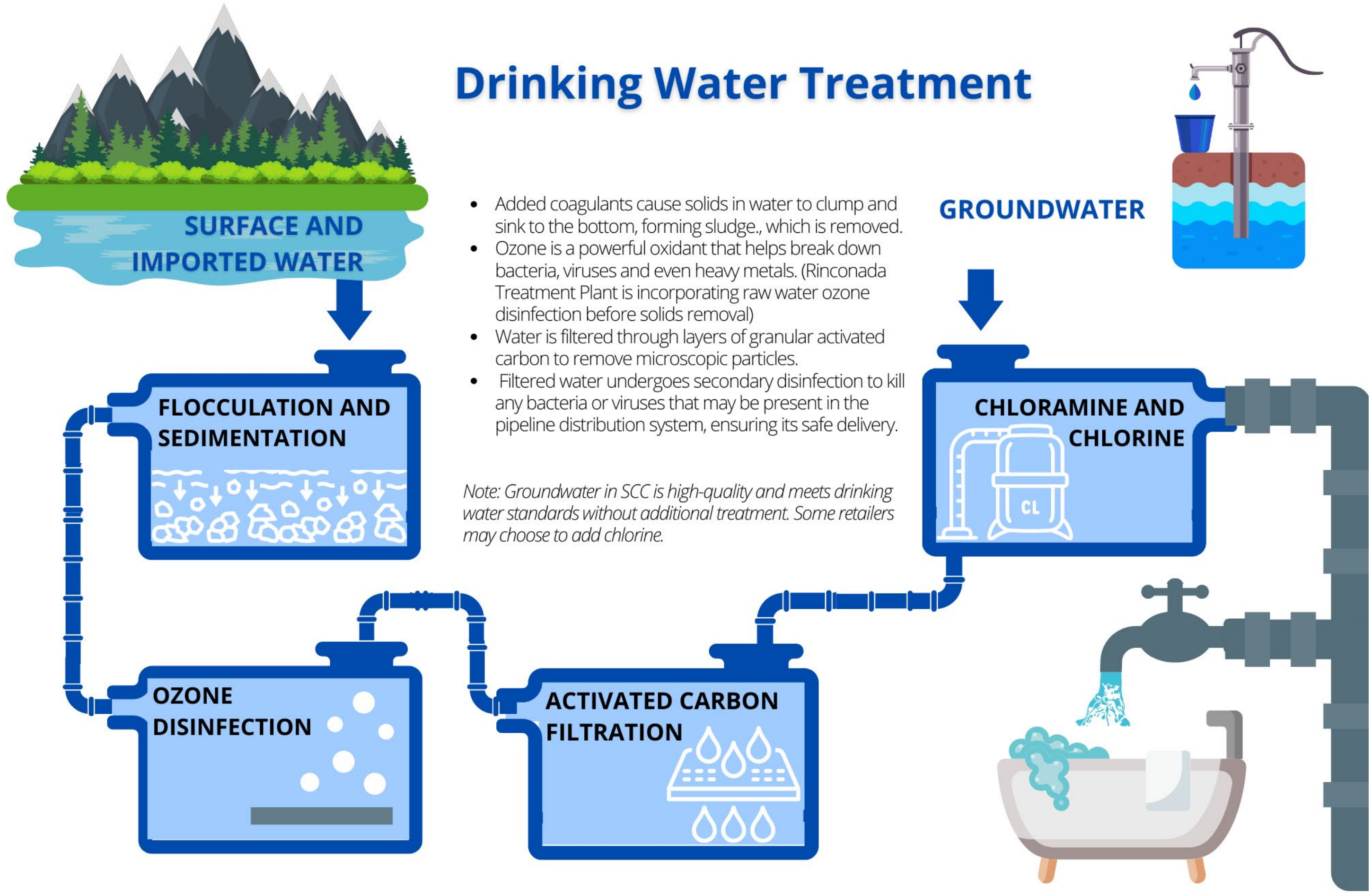

Figure 2-1 Drinking Water Treatment Process, Valley Water

Treatment to remove chemical pollutants

Unlike the pathogens that can be removed by coagulation and filtration or inactivated by disinfection, chemicals that are dissolved in water may require further physical and chemical treatment. Metals like iron and manganese can be removed from water through chemical precipitation, and some water treatment plants have added filtration with activated carbon to remove many toxic organic chemicals. If surface water has a sufficiently high concentration of toxic material, however, advanced treatment may be required. By forcing water through a "molecular sieve" with 0.0001 micron pores, RO removes most chemicals with a molecular weight of 100 or more.

Many toxic organic chemicals are broken down into nontoxic metabolites by bacteria during the biological treatment step in wastewater plants, which also can remove some metals like copper and nickel as co-precipitates in settled biomass. Nitrates and perchlorates can also be removed by biological treatment. Aside from advanced membrane treatment, the most effective way to eliminate many potentially toxic chemicals from drinking water is by eliminating them from the waste stream while regularly monitoring source waters and protecting them from contamination.

Regulating Drinking Water and Recycled Water

Regulating Drinking Water

Drinking water in California is regulated by the Division of Drinking Water in the SWRCB (SWRCB, 2021). Water quality requirements are based on federal standards in the Safe Drinking Water Act, which establishes legal limits for over 90 contaminants in drinking water, including microbial pathogens[2], disinfectants and disinfectant byproducts[3], inorganic[4] and organic chemicals[5], and radionuclides[6]. These are known as Maximum Contaminant Levels (MCLS) (EPA, 2009). Maximum Contaminant Levels established for chemical carcinogens are designed to ensure that no more than 1 in ten thousand (or in some cases 1 in one million) consumers will experience an increased risk of cancer, based on the best available dosage and response information. This compares favorably with the current lifetime risk of a person being diagnosed with cancer, which is on the order of 300,000 to 400,000 per million, or an individual lifetime risk of 30%-40% (Sinclair, et al., 2015).

There are no specific numerical lower limits for microbial pathogens—the Public Health Goal for viruses in water is "zero"—but drinking water plants must remove or inactivate a minimum of 99% of Cryptosporidium, 99.9% of Giardia, and 99.9% of all viruses in their source water. Monitoring bacterial pathogens is accomplished by culturing coliform bacteria: any test that confirms the presence of fecal coliform bacteria (e.g., E. coli) is considered a violation resulting in additional controls. EPA standards also specify treatment techniques (filtration, disinfection) that water plants are required to use to reduce contaminant levels in drinking water (EPA, 2009).
In addition to MCLs for known health risks like microbial pathogens, the EPA also sets non-enforceable Maximum

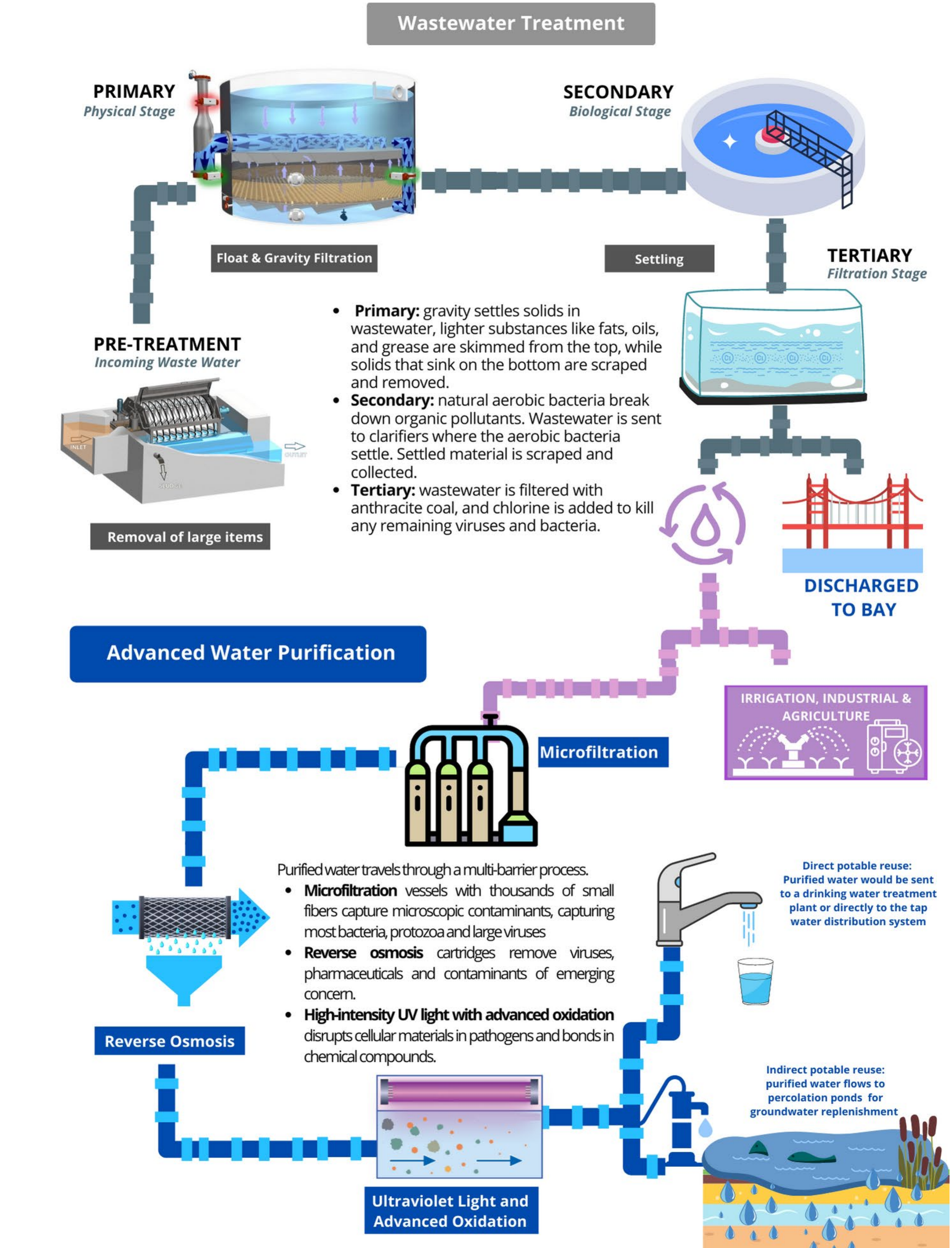

Figure 2-2 Wastewater Treatment and Purification Process, Valley Water

2. https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations#Microorganisms
3. https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations#Disinfectants and https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations#Byproducts
4. https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations#Inorganic
5. https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations#Organic
6. https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations#Radionuclides

Based on its extensive regulation and treatment, recycled water is safe for human consumption and is a reasonable alternative to augment our existing supplies.

Contaminant Level Goals (MCLG) for contaminants whose impact on health has not been clearly established. The goals represent the level below which there is no known health risk for a given substance. Both the EPA and the SWRCB continually refine their regulations to protect public health based on EPA's Candidate Contaminant List (CCL) that identifies constituents for further evaluation. For example, in 2018 the CCL listed PFAS, and in 2021 EPA announced plans to regulate perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) in drinking water. Valley Water has conducted countywide sampling indicating that PFOA and PFOS are not widely present above advisory levels. (A perspective on regulation of water quality, including the need to regulate emerging contaminants of concern, is provided in the article "The Challenge of Water Pollution Prevention: A Call to Action for Toxins Reduction."

Regulating Recycled Water

The SWRCB is also responsible for developing and enforcing rules to regulate the quality and use of recycled water, including its use as drinking water. MCL standards are the same for all drinking water, regardless of the source, including recycled water. Facilities treating wastewater for potable use, however, must also meet stringent requirements on the types of treatment processes they employ. These requirements are designed to ensure that all the contaminants potentially found in sewage are removed so the water produced will always be as safe or safer than water from conventional sources.

Regulation of recycled water begins with wastewater discharge limits. Rules requiring the removal of pathogens, metals and organic chemicals from sewage are designed not only to safeguard downstream users, but also to protect aquatic biota. Because organisms that live in water are more sensitive to certain chemicals than humans (e.g. copper), these limits may even be lower than for drinking water standards.

The treated effluent from wastewater plants is piped directly to advanced water purification facilities that produce potable water. To compensate for the lack of dilution by rivers, regulations require advanced water purification facilities to substitute additional treatment processes. The SWRCB has adopted a "multiple barrier" approach to ensure that if any one process fails, the product will still meet drinking water standards at the end of the treatment train. With respect to pathogens, each treatment unit is credited with removing a certain percentage of viruses, bacteria, and protozoa based on operational research. These credits are measured in decades or logs, so treatment that removes 90% of a contaminant, leaving only 10% (10-1), is credited with 1-log removal. While drinking water regulation mandates a minimum of 99.9% removal of virus (a 3-log removal requirement), recycled water must undergo a treatment train that "achieves at least 12-log enteric virus reduction, 10-log Giardia cyst reduction, and 10-log Cryptosporidium oocyst reduction" before it is allowed to percolate into the drinking water aquifer (SWRCB, 2016).

To ensure that advanced treatment of recycled water for potable reuse achieves this level of risk reduction, each unit process is tested to validate removal of each constituent of concern. The verified log removal credits allocated to each individual process are then added and compared to the minimum log reduction requirement. For example, wastewater treatment followed by ultrafiltration and reverse osmosis can achieve 1.5-log credits for virus removal, Ultraviolet disinfection and advanced oxidation together can be credited with 6-log removal, and chlorine disinfection can receive 6-log credits, resulting in a total of 13.5-log credits (Salveson, et al., 2018). In addition, recycled water that percolates into the ground after treatment is credited 1-log reduction for each month retained underground. A diagram tracing the flow of water through a similar treatment train is presented in Figure 2-2.

Summary

For nearly 30 years, Santa Clara County cities have been reusing a portion of their wastewater effluent for landscape irrigation, commercial cooling, and a variety of other applications. Recycled water produced from wastewater effluent can be used for a variety of purposes, depending on the level of additional treatment provided. Now, with the completion of the planned Purified Water Project (see "The Purified Water Project"), agencies in Santa Clara County will have the option to operate both non-potable and potable water reuse systems.

Based on its extensive regulation and treatment, recycled water is safe for human consumption and is a reasonable alternative to augment our existing supplies. While we might wish we could continue to obtain all of our water from naturally pristine sources, climate change has made water scarcity a pernicious reality. We will no longer have the luxury of avoiding water conservation, recycling and reuse moving forward. Recognizing this fact, in its 2012 resolution, the California Medical Association endorsed expanded potable and non-potable water reuse. A decade later, and in view of the extensive regulatory structure and the high reliability of the technological capacity of existing and new treatment processes, developing recycled water to augment our drinking water is a safe, effective and appropriate approach to ensuring a reliable water supply in the years ahead.

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THE *PURIFIED WATER* PROJECT

Foreword by the Environmental Health Committee

In addition to the detailed background information provided in this special issue of the SCCMA Bulletin, the Environmental Health Committee invited Valley Water staff to provide summary answers to what commonly might be referred to as "Frequently Asked Questions," or questions spurred by reading this series and likely to be raised not only by medical professionals but also by the communities we serve. Of course, we welcome any further questions, which can be sent to us by contacting SCCMA's Angelica Cereno at angelica@sccma.org or 408-998-8850; or Gina Adriano at GAdriano@valleywater.org.

Additional details about the Purified Water Project can also be found on the Valley Water website at https://beheard.valleywater.org/purifiedwaterproject/widgets/34076/faqs#question6099.

SCCMA will continue to follow this project closely as it develops to ensure that our members can remain informed and inform others. And, as mentioned, SCCMA shall offer a weekend morning for SCCMA members to take a guided tour through the Advanced Water Purification Plant later this year.

1. We need an additional reliable water supply for Santa Clara County. Why recycle drinking water? Aren't there other alternatives?

Once local water supplies from rainfall and groundwater are no longer sufficient to supply water for the community, alternatives include importing water from other areas, conserving, recycling water used locally, capturing stormwater, and desalinating seawater. Currently, Santa Clara County imports half its water from outside the county. All this water comes at a price—an economic cost as well as an energy cost—so deciding which sources to use involves consideration of both social and environmental impact. About a fifth of the energy consumed in California is used in the water supply chain, and therefore, whether it's imported water, local recycled water, or desalination, there is a carbon footprint for all alternatives to treating and delivering clean, safe water (Public Policy Institute of California, 2018).

Since 1961 Valley Water has supplemented our local water supplies with water imported from central California. When it's available, imported water costs on average between $400-500 per acre-foot, but supplies are increasingly vulnerable. During the most recent drought, for instance, allocations of state and federal supplies have been cut to 5% of normal or eliminated

entirely, and imported water costs can readily double during droughts. Imported water will always be a critical source for Santa Clara County. But to secure water reliability for our region, we need to diversify sources. Expanding conservation and water recycling reinforce our water supply in dry periods. Santa Clara County has been recycling wastewater for non-potable use for over 60 years, and today recycled water is distributed to hundreds of irrigation and industrial sites. Because utilities must treat wastewater to discharge it into San Francisco Bay, most of the cost for recycled water is for construction and operation of separate pipelines required to distribute it to customers. Major recycled water users have been connected to the system in the last few decades. It is becoming more costly – and with less benefit – to further expand these pipelines to sites with lesser demand. Expanding recycled water for drinking purposes bears greater benefits to our overall water supply.

Both potable water reuse and desalination involve purifying alternative sources (treated effluent and seawater) for use as drinking water. During a year with average precipitation and abundant water, imported water is much less expensive—a

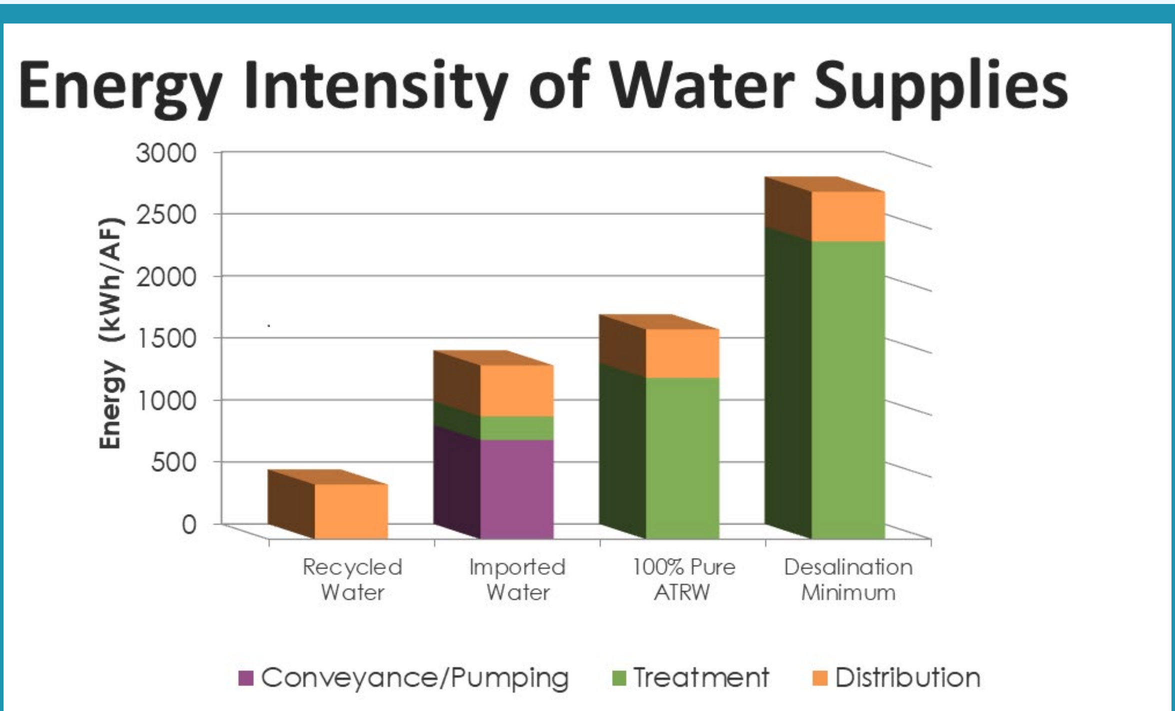

Figure 3-1. Energy Intensity of Water Supplies, Valley Water

fraction of the cost of purified water—but those supplies have become increasingly unreliable. Valley Water is continuing to explore regional desalination opportunities with other bay area water agencies (https://www.regionaldesal.org/), but has found potable water reuse to be the best alternative to meet our county's water needs at this time.

Both purified recycled water and seawater desalination utilize reverse osmosis, an energy-intensive process that forces water through a semi-permeable membrane to remove a wide range of chemicals, including salts. However, seawater is saltier than treated effluent by as much as 43 times (35,000 mg/L compared to 800 mg/L), requiring much more energy to make it potable and can cost up to 10 times as much. Additionally, the concentrated brine from seawater desalination is more harmful to our sensitive South Bay ecosystem.

Conservation is an essential part of any water supply strategy. It's the quickest, most cost-effective way to make water available – by using less. Residents in Santa Clara County have been somewhat successful in adopting long-term conservation measures. Valley Water continues incentivizing water savings through a variety of rebate programs and educational resources. However, even ramped up conservation efforts could not compensate for the dependency on imported water sources, which constitute half of the region's water supply. (For a more detailed discussion of water supply issues and alternatives see "Water Supply").

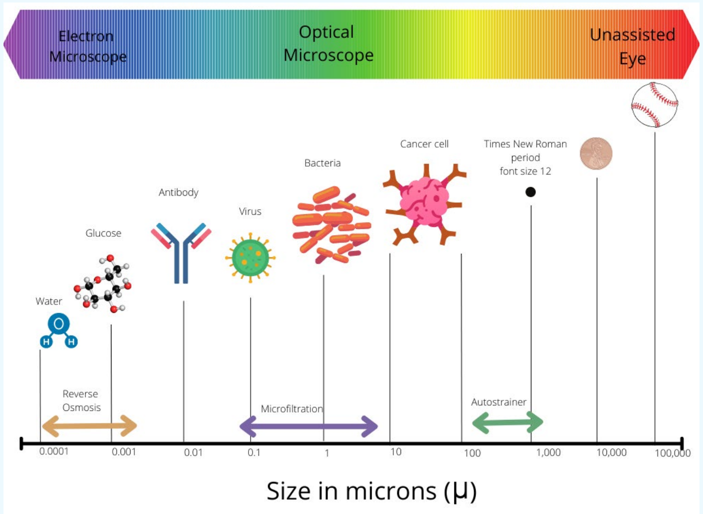

Figure 3-2. A multiple barrier approach, Valley Water

2. Do we have any experience locally with recycled water?

Currently, recycled water is used in Santa Clara County only for non-potable purposes. On average, four regional wastewater treatment facilities (located in Gilroy, San Jose, Sunnyvale and Palo Alto) annually process about 140,000 acre-feet of wastewater (45.6 billion gallons), but only about 11% of this treated wastewater is reused as recycled water. Nevertheless, recycled water use accounts for approximately 5 percent of our county's total water supply.

In the past decade, Valley Water has been planning to increase production of recycled water, to include water reuse for drinking. The Countywide Water Reuse Master Plan (Valley Water, 2021) outlines Valley Water's approach to expand water reuse in the county so that it will account for 10 percent of the total water supply by 2028.

3. Is recycled water used for drinking anywhere else?

Yes, potable water reuse projects exist statewide, such as the Orange County Groundwater Replenishment System which has been operating for nearly 15 years. On an annual basis, the Orange County Groundwater Basin supplies 77% of the potable water supply for 2.5 million people. But it must be recharged each year primarily with imported water, which fluctuates in availability. To protect the basin and reduce dependency on imported water, the Groundwater Replenishment System provides a new source of water for nearly 850,000 residents. (Orange County Water District, 2021). The Orange County Water District and its partners have expanded the facility twice to increase production from its original capacity, providing water security for the people of Orange County.

Potable reuse has been adopted across the country and world to augment drinking supplies, including Fairfax, VA; El Paso, TX; Scottsdale, AZ, Singapore, Australia and South Africa (CDM Smith, 2017). A more detailed list of facilities is available in the 2017 EPA Potable Reuse Compendium.

4. What assurance do we have that purified recycled water using for drinking will be produced safely here in Santa Clara County?

The possibility of reusing water for drinking in our region was ushered in by the Silicon Valley Advanced Water Purification Center (SVAWPC) which opened in 2014. The facility processes secondary treated wastewater from the San Jose-Santa Clara Regional Waste Water Facility with a multi-barrier advanced purification process that removes microscopic contaminants, inactivates microorganisms and destroys trace organic compounds to meet California's strict drinking water standards.

The advanced purification process at SVWAPC uses physical methods in three different stages to remove contaminants:

- autostrainers in the pre-treatment phase remove particles 300 microns in size or larger
- microfiltration vessels with thousands of small fibers capture microscopic contaminants, capturing most bacteria, protozoa and large viruses
- reverse osmosis cartridges with pore openings as small as 1 nanometer (or 0.001 micron) removes viruses, pharmaceuticals and contaminants of emerging concern.

The facility also uses high intensity ultraviolet light disinfection, which, together with a pilot advanced oxidation system, has proven to inactivate and disrupt both cellular materials in pathogens and bonds in chemical compounds, rendering them harmless. Together with membrane filtration, these steps will produce purified water that meets or exceeds all state and federal drinking water standards. This higher level of treatment, and natural soil aquifer treatment, provide a robust and reliable safeguard against microscopic pathogens and other potential contaminants. This "multiple barrier approach" is illustrated in Figure 3-2.

During the first 15 months of operation, Valley Water staff performed challenge testing at SVAWPC to evaluate the effectiveness of its methodology and equipment. The tests purposefully stressed systems through use of "spiked" water with intentionally high levels of contaminants to assess how well these were removed. Additionally, small equipment components in the treatment process were temporarily altered to simulate equipment failures and ensure the technology could detect errors in the system.

Regular monitoring and testing of more than 4,000 water samples over 15 months revealed excellent removal of pathogens and contaminants of emerging concern through the advanced purification process, producing high-quality water that is safe to drink. Currently this purified water is blended with existing recycled water to improve its quality and allow for expanded use. With the security provided by the test plan and eight years of operation, Valley Water is pursuing potable reuse with the Purified Water Project.
(For a more detailed discussion of recycled water purification see "Making Water Safe for Use—and Reuse").

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5. What happens to the recycled water once it is produced?

The Purified Water Project will increase local drinking water supplies by replenishing groundwater basins. This is known as indirect potable reuse because the water goes through an environmental buffer before mixing directly with drinking water.

A new advanced purification facility, to be constructed in Palo Alto, will produce up to 10 million gallons of purified water a day. The water will travel through approximately 20 miles of pipeline to the Los Gatos Recharge Ponds located in Campbell. At these ponds, purified water will naturally filter through layers of soil, gravel and rock as it travels to the groundwater basins. Here, it will blend with water already in the basin over several months and years before reaching wells for drinking or home use. Currently, the ponds are supplied with local and imported water. A similar groundwater replenishment project has recently been completed in Monterey County.

6. Why are we putting the purified water into the ground instead of sending it directly to peoples tab?

California state regulations are not yet finalized for direct potable reuse projects (DPR) which introduce recycled water directly to a public drinking water system or upstream of a drinking treatment plant. The State Water Board's Division of Drinking Water is developing criteria on operations related to treatment, monitoring, testing and quality assurance to ensure the protection of public health (see "Making Water Safe for Use – and Reuse"). The Purified Water Project exceeds requirements for an indirect potable reuse project (IPR) as mentioned above. Achieving a higher log reduction than required for an IPR project, allows potential expansion for DPR use once regulations are determined and it ensures protection of the quality of our groundwater. Managing our groundwater is critical because it is our largest storage and also protects from land subsidence. The Countywide Reuse Master Plan does evaluate potential direct potable reuse opportunities pending finalized regulations.

The percolation of purified recycled water through the ground provides an additional layer of treatment via natural biological processes and physical processes like sorption as the water moves through the soil. This is called soil aquifer treatment (see "Making Water Safe for Use – and Reuse"). Groundwater replenishment with purified water will occur at locations where the geology and soil conditions have been studied extensively. Valley Water conducted soil-column studies for the Purified Water Project by introducing purified water to soil samples collected at and nearby the percolation ponds. This testing, along with geochemical modeling, helps determine the best purified water conditions, such as pH and alkalinity, to minimize the potential leaching of metals like arsenic and chromium into groundwater. Valley Water has conducted groundwater replenishment at the Los Gatos Recharge Complex since the 1930s and will continue our efforts to aggressively protect groundwater quality as we introduce purified water as a new recharge source.

7. How much will the project cost? Will Santa Clara County water remain affordable?

The anticipated project cost is more than $700 million. Valley Water is using a public-private-partnership model (often referred to as P3) to take advantage of private sector innovation and efficiencies.

Under the P3 model, a private partner will design, build, finance, operate and maintain the new purification facility and the pipeline infrastructure. Valley Water will own the facility, corresponding infrastructure, and the purified water produced. In the services contract, payment for the purified water will be negotiated at a fixed price. The contract structure will allow payments at project milestones if grant funding is available. This type of agreement incentivizes the private partner to complete the project efficiently with minimal delays and cost overruns. Since the private partner finances the project cost upfront, the P3 model also helps lessen the impacts of a costly

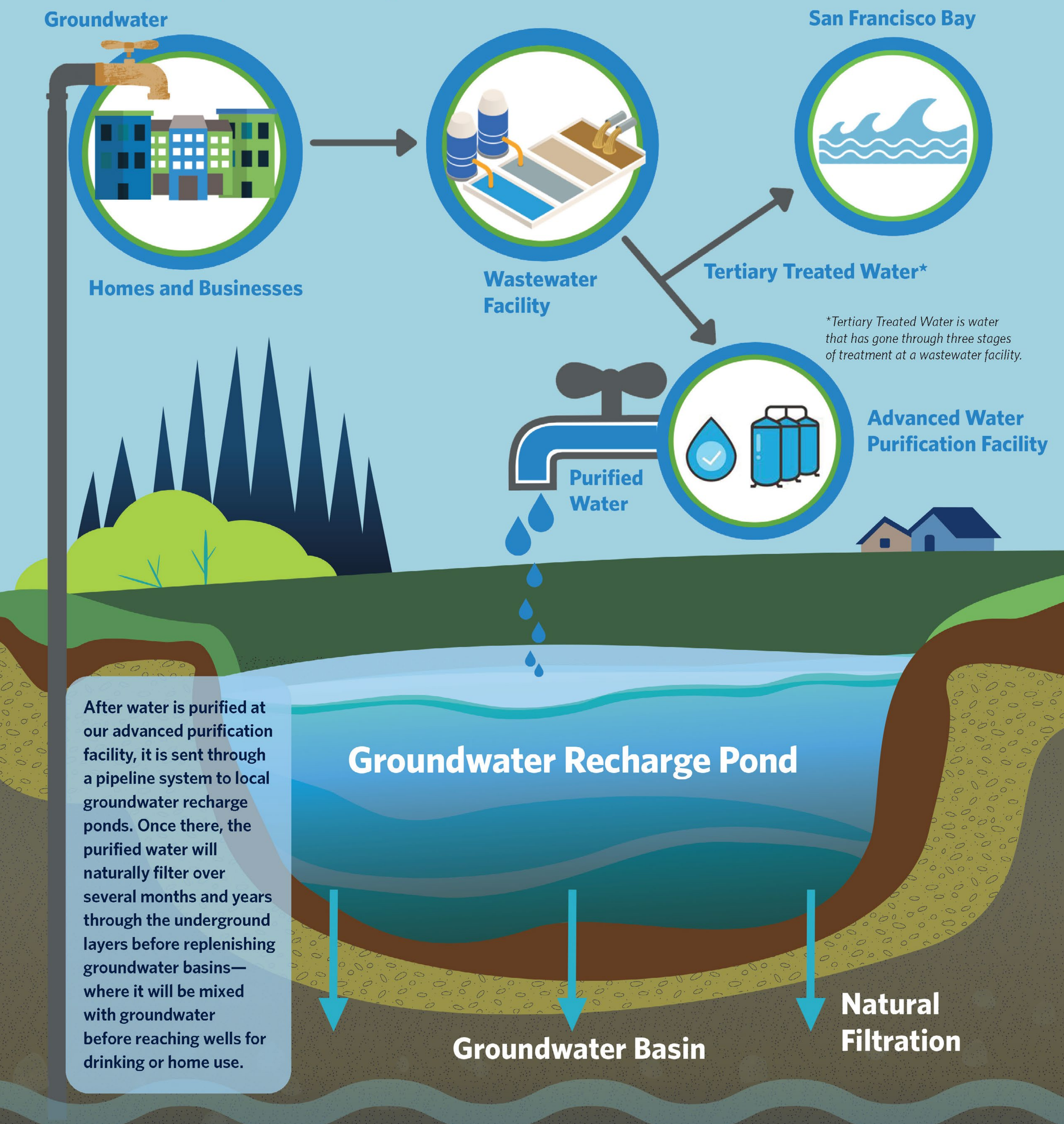

Figure 3-3. A groundwater replenishment project, Valley Water

The greatest threat to our water supply isn't extreme weather patterns, it's inaction (...) we will not have sufficient water for our region

infrastructure project on rate payers. A request for proposals to select the private partner is anticipated for release in summer 2022. Valley Water seeks to break ground in 2024 and have water flowing to the ponds by 2028.

8. What happens if we don't build the Purified Water Project?

The greatest threat to our water supply isn't extreme weather patterns, it's inaction. If we do not pursue new water sources, we will face increased scarcity with economic, social and environmental impacts. The short answer is we will not have sufficient water for our region without action now. To ensure a continued and reliable source, we need to implement the strategies in our water supply master plan of protecting current infrastructure, increasing conservation and water reuse (Valley Water, 2020). We cannot continue straining existing sources (groundwater) and depending on vulnerable sources (imported water). Potable water reuse balances an energy-intensive and costly process with the valuable benefits of a sustainable and renewable, drought-proof water supply.

Making our water supply resilient to climate change will require community support. This includes not only elected officials and community leaders, but also all residents of Santa Clara County. Local health professionals in particular are invited to visit the Silicon Valley Advanced Water Purification Center to observe first-hand the water reuse technology that will be utilized in the Purified Water Project.

In acknowledgement of the role of physicians as public health envoys, Valley Water will be hosting a special tour and lecture at the purification center later this year for members of the Santa Clara County Medical Association to raise awareness about this important project. Contact SCCMA (Angelica Cereno angelica@sccma.org) or Valley Water (Gina Adriano gadriano@valleywater.org) for more information.

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Cindy Russell, MD
SCCMA Immediate Past President

The Challenge of Water Pollution Prevention:
A call to action for toxic reduction

"Everything that man himself injects into the biosphere - chemical, biological or physical - can ultimately find its way into the earth's water. And these contaminants must be removed, by nature or by man, before that water is again potable." (USEPA, 1972)

-- Charles C. Johnson, Jr. MD, Assistant Surgeon General of the United States

First Administrator of the Consumer Protection and Environmental Health Service (1968-1971)

Introduction

Throughout time all water has been recycled. From rain to rivers to wells we are still drinking the same water our ancient ancestors did. Maintaining water quality, however, has become more challenging. Pollution has become an escalating unsolved problem in the modern world, with increased population growth, industrialization and the introduction of manmade novel manufacturing goods and processes. There are over 80,000 chemicals in commerce, 2,500 of which are high production chemicals at over a million pounds per year. About 2,000 new chemicals are introduced annually according to the Agency for Toxic Substances and Disease Registry (ATSDR). Only 14 chemicals have been restricted in the U.S. so far by the ATSDR, although several hundred are on a Substance Priority List.

These chemicals meander into soil, water, air and living systems. Some are safe, many are known toxins, and most have never been studied to determine their effects on human or environmental health. Impacts on human health from chemicals include cancer, reproductive harm, multiple chemical sensitivities, developmental abnormalities, immune toxicity and neurologic harm. Children are especially vulnerable (AAP, 2018).

As explained in the previous articles of this Special Issue of the Bulletin, our water utilities can now employ sophisticated technology (reverse osmosis, ultraviolet disinfection, advanced oxidation) to purify wastewater so it can be safely added to existing drinking water supplies. This is a remarkable and necessary accomplishment that is embraced by many communities in California and elsewhere. It has also been endorsed by both the Santa Clara County Medical Association and the California Medical Association. (CMA, 2012).

CMA Resolution 118a-12
WATER RECYCLING

RESOLVED: That CMA encourage efforts to expand potable and non-potable water reuse; and be it further

RESOLVED: That CMA encourage efforts to conserve water, monitor recycled water quality, and encourage source reduction of contaminants; and be it further

RESOLVED: That CMA encourage private and public cooperation to further develop technologies and programs to increase water reuse while ensuring water quality.

Adopted by California Medical Association House of Delegates, October 2012

Advanced water treatment is a wonderful process; however it is expensive, uses large amounts of energy, and produces residual waste. Preventing pollution, on the other hand, if taken seriously could reduce costs, decrease waste and improve human and environmental health. These advantages will apply not just to water quality but also to improve the quality of our soil and air, where exposure to pollution can be even more harmful (Grandjean & Bellanger, 2017). Investing in water purification infrastructure while at the same time practicing pollution prevention is a sensible recipe for health. We continue to add pollutants to our rivers and streams despite the oversight of dedicated federal and state agencies. The US Geological Survey (USGS) monitors water quality in rivers, streams, and wetlands. The Environmental Protection Agency (EPA), along with state water boards, regulates discharges into these water bodies and sets standards for drinking water systems. (Bottled drinking water, however, is monitored by the Food and Drug Administration.) But as soon as these agencies begin to understand and address one pollutant, more hazardous chemicals are added to the list of "contaminants of emerging concern."

In short, it is virtually impossible for the science to keep up with unregulated commerce that designs products for convenience and efficiency rather than ecological systems. Policies, politics and personal choices have room for improvement in preventing pollution. Everyone has a role to play in protecting water.

This article explains how we currently attempt to manage pollution in our water, both by regulating water quality itself, and—to a lesser extent—by regulating the chemicals that we allow to enter our environment. It surveys some of the more toxic pollutants, including regulated chemicals and those "constituents of emerging concern" for which limits have not yet been set. More progressive policies for regulating chemicals in the European Union are also examined, with the goal of understanding how physicians here can support efforts to minimize risks to their patients and public health.

Regulating Water Pollution in the United States

In the early 1900's cities polluted their own drinking water, discharging sewage upstream of drinking water intakes. This spread waterborne diseases such as typhoid, cholera, giardia and hepatitis A. Water filtration and chlorination were introduced to reduce the rates of disease, but it wasn't until 1948 that Congress passed the Federal Water Pollution Control Act, the first federal legislation to address water pollution in the US. It was a good start, but the legislation was weak and failed to check waterborne disease and reduce industrial pollution or degradation of recreational areas.

In 1972, two years after formation of the EPA, Congress passed the Clean Water Act (CWA) regulating industrial and municipal pollutant discharges. Now celebrating its 50th anniversary, the CWA required dischargers to obtain permits and set water quality standards nationwide, including a goal that all waters in the United States would be "fishable and swimmable" by 1983. The CWA also funded construction of more efficient sewage plants in communities across the country.

While the CWA was a big step towards cleaning up surface waters, drinking water needed its own set of regulations. In 1974, the Safe Drinking Water Act (SDWA) directed the EPA to develop drinking water standards, which now include microorganisms, disinfectants, disinfection byproducts, organic chemicals, and radionuclides. Regulatory limits—referred to as "maximum contaminant levels" or MCLs—have now been assigned to over 90 chemicals, viruses, and bacteria.
These laws are hampered, however, both by the exemption of many activities from regulation as well as by the sheer number of potential toxins. For instance, there are still thousands of unregulated chemicals, many of which have been identified as "contaminants of emerging concern" (CEC) suspected to cause harm. Chemicals are known to create multiple "byproducts" in their manufacture or degradation that add to the toxic load. These chemicals, which can be carcinogenic or disrupt the human endocrine system, include pharmaceuticals, cosmetics, and personal care products, as well as nanoparticles and "forever chemicals"— the Teflon-like compounds classified as per- and polyfluoroalkyl substances (PFAS). Some of these contaminants are also included on EPA's Drinking Water Contaminant Candidate List (CCL). As noted in the article "Making Water Safe for Use—and Reuse) the CCL is EPA's priority list of chemicals identified for further evaluation, which as of 2021 listed 66 chemicals including PFAS, disinfection byproducts and bisphenol A. While advanced water treatment removes these contaminants, their overall presence in water supplies remains a concern.

As explained below, the problem is that many chemicals are considered "innocent until proven guilty," so before agencies can restrict production or regulate disposal, they must generate enough solid science to withstand political (and corporate) scrutiny. As a result, testing has historically occurred only after the suspected toxins have been commercialized and released.

REGULATING CHEMICALS IN THE UNITED STATES

Toxics Substances Control Act of 1976

The 1976 Toxics Substances Control Act (TSCA) gave the EPA the authority to require reporting of chemicals that pose an unreasonable risk of injury to human health or the environment. These included substances found in a broad range of consumer products such as furniture, cleaning agents, paint, carpeting, and clothing. Its weaknesses were apparent, however, in that it not only excluded chemicals in food, drugs, cosmetics and pesticides, but it "grandfathered" some 62,000 chemicals that the EPA could regulate only if the cost to industry was the "least burdensome" of all possible options to address potential issues. In addition, new chemicals were given only a 90-day window to prove they were not risky enough to require pre-market safety testing.

TSCA Reform Bill: Frank R. Lautenberg Chemical Safety in the 21st Century Act

Since passage of the original TSCA in 1976 some 22,000 chemicals have been added to the environment (Denison, 2017). To respond to this growing challenge, the 2016 TSCA Reform Bill added significant improvements. It allowed the EPA to assess the safety of chemicals used in commerce during the previous ten years without regard to the cost to industry, and considered their impact on the most vulnerable populations— pregnant women, infants, children, and the elderly.

While it requires new chemicals to obtain a "finding of safety" before entering the market, the great number of grandfathered chemicals will still take time to study and regulate. (Some critics say, "close to geologic time.") Since the law's passage, EPA has completed determinations on 3,607 new chemical cases, but has restricted only 14 chemicals out of tens of thousands. A backlog of chemical evaluation has occurred in the last 4 years that is being addressed presently.

"At present, the outcomes and exposures covered by the literature represent only a small part of the chemical universe and their full spectrum of effects on human health. The total environmental burden of disease costs likely exceed 10% of the global GDP."
(Grandjean and Bellanger 2017)

The Endocrine Society Provides Critical Comments

Critics of the TSCA Reform bill include the Endocrine Society, who highlight among its weaknesses the provisions that still force the EPA to consider economic costs of regulation "to the extent practicable." They note that "typical cost-benefit analyses focus on the costs of regulation to manufacturers but often fail to account for the costs associated with harms to human health." They also point out that the reform bill severely limits the ability of states to make their own regulatory policies (specifically in children's products), and that there is no requirement to test new chemicals for endocrine disruption or other toxicologic properties (Vandenberg, 2016).

Regrettable Substitutions

Even when regulations phased out some chemicals, chemical companies have substituted untested chemicals from the same family with similar effectiveness, but even greater risks to health and the environment. An example of this "regrettable substitution" is the now-banned fire retardant DecaBDE used in clothing, curtains, carpeting and electronics. One substitute replacing DecaBDE is TCDPP (tris(1,3-dichloro-2-propyl) phosphate), which is now so widespread in the environment it is found in human plasma, breast milk and urine. This substitute chemical has been shown to be an endocrine disruptor and a developmental neurotoxin in animal studies. (Wang 2020). Another useful chemical bisphenol A (BPA), used in baby bottles, water bottles and cash register paper, is a well-known endocrine disruptor found in the linings of cans and almost everyone tested. BPA has been substituted with compounds in the same family such as bisphenol S (BPS) and bisphenol F that have similar toxicologic profile. BPS is now found in consumer products, household dust, water and in humans through biomonitoring studies (CHEMTrust, 2018).

The Challenge Before Us

Given the challenges presented by this patchwork approach to regulation, how well has our water been protected from pollution? While our rivers do not catch fire and lakes are not choked with sewage, the CWA has fallen short of its original goal of rendering all US waters "fishable and swimmable." In fact, a 2018 EPA report showed that nearly half the rivers and streams and more than one third of lakes in the United State were unfit for swimming, fishing or drinking (EIP, 2022). To appreciate the extent of the problem we need to consider both point source and non-point source pollution, the categories by which EPA implements its rules.

Point Sources: Some Regulated, Some Not

Point sources are sources of pollution you can, well, point to—like a pipe that discharges waste into a river or lake.

These point sources include factories, oil refineries, paper mills, chemical plants, electronics manufacturers, farms, feedlots and municipal wastewater treatment plants. All of these are regulated under the National Pollutant Discharge Elimination System of the Clean Water Act, which sets limits on the pollutants dischargers are permitted to release. But not all point source dischargers are regulated equally, and many are exempted from regulation. The following are a few examples of the types of discharges yet to be adequately controlled.

Pollution from exempted agricultural operations and "factory farms"

While agriculture is a major source of water pollution from pesticides, nitrogen fertilizers and manure with antibiotic resistant bacteria, in 1977 the CWA was amended to "provide that discharges that are part of normal farming, ranching, and forestry activities …generally do not require a [permit]." As a result, a 2020 study of 72 streams by the USGS showed that 88% of the water bodies contained 5 or more pesticides that impact environmental and human health. Concentrated animal feed operations create over 300 million tons of manure annually and pollute water bodies with nitrates, phosphates, antibiotics, antibiotic resistant organisms and over 150 pathogens as well as odorous toxic fumes.

Pollution from Oil and Gas Exploration and Production

Oil and gas operations enjoy several exemptions from the CWA, including storm water runoff and underground injections (unless diesel is used). Freshwater is used throughout oil and gas exploration, drilling and production. Water produced from fracking is contaminated with proprietary toxic chemicals, heavy metals and radioactive waste, and can be legally dumped in unlined pits where it percolates into groundwater and has polluted wells, drinking water and irrigation water.

Pollution from Pharmaceuticals and Personal Care Products

Chemicals found in pharmaceuticals and personal care products are routinely identified in wastewater, storm water runoff and water bodies, posing a threat to aquatic organisms. While the World Health Organization (WHO) concluded that it is unlikely that trace amounts of pharmaceuticals in water pose a serious threat to public health, there remain concerns about consuming endocrine disruptors and antibiotic resistant organisms even in low doses. (Caban & Stepnowski, 2021) Prescription medications, incompletely metabolized by our complex biology, flow out of wastewater treatment plants and affect the complex biology of many aquatic species (Ebele, et al., 2017). While these substances may eventually be regulated, many may be affecting our health now.

Nonpoint Sources: Everything Else

Unlike point sources, "nonpoint source" pollution is more difficult to pinpoint. Inadequately regulated, nonpoint source pollution is the biggest source of water pollution today. Illegal dumping and chemical spills are two forms of nonpoint sources, but there are many other ways toxins can enter the water from innumerable diffuse sources. Even rainwater in some parts of the United States has been tested and found to contain 17 different kinds of PFAS absorbed from the atmosphere. (Bourzac, 2021)

Storm water is one of the major nonpoint sources of pollution. Runoff from construction sites can send petroleum pollutants into neighboring streams, along with silt and debris. Runoff from streets and highways can be filled with the residue of traffic (hydrocarbons, heavy metals), and chemicals applied to residential lawns and gardens also make their way into local water bodies. Other nonpoint sources include agricultural runoff (especially pesticides and nitrogen fertilizers), leaking septic systems, and oil pollution from boating. A myriad of pollutants, including both regulated and unregulated chemicals, have been found to enter US waterways through nonpoint sources. The following list should serve to suggest the magnitude of the problem.

Sunscreens and Nanoparticles

We would all advise our patients to wear sunscreen when swimming to protect their skin, but sunscreen can also be a significant source of nonpoint source water pollution. Common sunscreen ingredients can disrupt freshwater ecosystems, harming aquatic organisms at the bottom of the food chain that bioaccumulate at the top of the food chain. For this reason, the use of chemical sunscreens are beginning to be regulated in Hawaii, but the mineral sunblocks that replace them (e.g. engineered zinc oxide and titanium dioxide nanoparticles) may be even more hazardous to the environment. When these tiny particles are created to make the minerals less visible on the skin, they unfortunately become very bioactive and do not degrade. While larger nanoparticles in sunscreen do not appear to be absorbed

through the skin, they can be ingested and bioaccumulate in intestinal tissue (Larese Filon, et al., 2015). Nanoparticles in spray sunscreens can even be inhaled and enter the circulation through the lungs. Research has shown broad adverse effects of nanoparticles on aquatic organisms as well as human mitochondria with the mechanism of toxicity being lysosomal dysfunction and oxidative stress (Chen, et al., 2018).

Topical Pet Flea Control Products

Topical flea control products, both liquid and solid (collars), accumulate on pet's fur and are washed down the drain. These products contain the pesticides fipronil and neonicotiamide that endanger invertebrates in water and pose a risk to children exposed to them on a long-term basis. A recent and disturbing study found urinary metabolites of common topical flea pesticides in both owners as well as their pets (Wise, et al., 2022).

"Forever" Chemicals: PFAS in Air, Water, Soil, Fish... and Us

Per- and poly-fluoroalkyl substances (PFAS) are a family of more than 3,000 synthetic compounds that have been in production for over sixty years but have only recently emerged as "forever chemicals" of concern. These chemicals have a common chain of fluorine-carbon bonds that are incredibly stable and resistant to breakdown in humans, animals and the environment. They are used in many different products, including: water, soil, and stain-resistant coatings for clothing, furniture, carpets, cookware; firefighting foams; as well as in food packaging and liquid resistant linings of coffee cups and pizza boxes. Although the majority of human exposure to PFAS is in food, packaging and indoor air, PFAS have also been found in surface water, groundwater and drinking water. These particles bioaccumulate and can be passed down to offspring. There is no disclosure required for consumer products.

While only a few PFAS have been thoroughly studied (PFOA, PFOS), these chemicals, at extremely low levels, have been linked to cancer (kidney and testicular), thyroid disease, and immunotoxicity, and are suspected of reducing the effectiveness of vaccines (Grandjean, et al., 2017). PFOS and PFOA are both now on the 2021 CCL and are scheduled to be evaluated for formal regulation under the SDWA, but industry is still lobbying to carve out an exemption (NLR, 2022).

Our Plastic Planet: Nurdles in Turtles

Can you go a day without plastic? It isn't easy. The amount of plastic in the world continues to rise every year. In 1950 two million tons of plastic was produced, increasing to 368 million tons in 2019, over 40% for single-uses, the worst offender (PSF, 2021). Water, food, vegetables, batteries, laundry soap, and (since COVID) even bagels all come in tidy plastic wraps. Plastic is also used in 3D printing, microfiber clothing and in beauty products such as lip gloss.

When ultraviolet light breaks down plastic bags and bottles, these tiny pieces—"microplastics"-- can leach some 300 toxic chemicals into water, including polychlorinated biphenyls (PCB's), pesticides and flame retardants. Heavy metals can also be attracted to the plastic which, when coated with algae, looks like food to marine animals. And small plastic pellets used in the manufacture of larger plastics ("nurdles") can escape into the ocean: a 2002 study found nurdles to be the most common contaminant on Orange County beaches (Moore, et al., 2001). Nurdles have also been found in all species of marine turtles (including juveniles), dolphins and whales (Duncan, et al., 2021). A group of researchers in the Netherlands even detected plastic polymers in the blood from 17 of 22 healthy volunteers (Leslie, et al., 2022).

Plastic fibers and microbeads (used in facial scrubs) have also worked their way into drinking water. A 2014 peer reviewed study showed a variable number of microplastic fibers in all 24 German beers examined (Liebezeit & Liebezeit, 2014). Plastic bits have been found in 83% of water samples worldwide and in 94% of water samples in the U.S. Although the health risk of microplastics is not known, the fact that they may attract persistent organic pollutants and toxic heavy metals is of concern. It appears these microplastic can also clog up the digestive tracts of aquatic species, interfering with marine ecosystems.

While microplastics are not on the CCL list and have not yet been recognized as a CEC, Congress nevertheless banned plastic microbeads from rinse-off personal care products in the 2015 Microbead Free Waters Act (HR1321), and a 2018 California law (SB 1422) requires measurement of microplastics in drinking water and development of safety guidelines within four years.

> **"The worst fertility disrupters are organochlorine compounds (chlorinated pesticides, polychlorinated biphenyls, and dioxins), bisphenol A (BPA), and organophosphate pesticides and herbicides"**
> Pizzorno (2018)

Getting to the Point: The Impact of Chemicals on Human Health

A first step in learning about the impact of these substances is to determine the burden of chemicals we already carry in us (Pellizzari, et al., 2019). The CDC's National Biomonitoring Program has catalogued numerous substances (heavy metals, flame retardants, pesticides, plasticizers etc.) found in all of us at the parts per billion (ppb) or parts per trillion (ppt) level. Even newborns are victims of chemical pollution. Contradicting the notion that the placenta is a trusted barrier protecting the fragile developing human, the Environmental Working Group (2005) discovered an average of over 200 man-made chemicals in cord blood, out of 413 measured, including PFAS and pesticides. While we don't know how these small amounts of chemicals affect newborn health or growth, 180 of them have been linked to cancer in humans or animals.

The Dose Does Not Always Equal the Poison

Applying the traditional dogma of "the dose makes the poison," small amounts of some chemicals may be safe. Endocrine disrupting chemicals (EDCs) on the other hand can activate biological responses at the ppt level, just like the hormones they mimic. In fact, these chemicals can have more substantial effects at lower doses than high doses in a nonlinear fashion called a nonmonotonic dose response (Vandenberg, et al., 2012). Health effects are now established as epidemiological studies show that environmentally relevant exposures to EDCs are associated with human diseases and disabilities. Special consideration needs to be made for developmental toxins to which pregnant women and children are exposed (Grandjean & Landrigan, 2014). Furthermore, when we are exposed to many toxic chemicals simultaneously, they can act synergistically to challenge our DNA repair mechanisms, affect our immune systems, and disrupt natural endocrine signaling.

There is abundant scientific research, including epidemiologic studies on how exposure to chemicals—from carcinogens to neurotoxins to immune toxins to obesogens—contribute to our modern epidemics (Pizzorno, 2018). The WHO reviewed data in 2019 and concluded, "The 2021 data addendum estimates that 2 million lives and 53 million disability-adjusted life-years were lost in 2019 due to exposures to selected chemicals" (WHO, 2016).

Grandjean and Bellanger (2017) calculated that direct and indirect costs of chemical toxicity to society due to illness, reduced brain function and health care spending equaled 10% of the 2016 GDP." The study deemed the illnesses caused by these exposures—mostly from air pollution--and the costs they incurred to be all "preventable."

REACHing for a Better Chemical Policy: "No data, no market"

Clearly we need a more effective approach to keeping pollutants out of our water supply. In search of alternative regulatory models, we might look to the European Union, whose innovative REACH program has already brought measurable results.

In 2007, the two dozen member countries in the European Union adopted the ***Registration, Evaluation, Authorization and Restriction of Chemicals program (REACH)*** to regulate the production, disposal, and use of chemical substances and mixtures manufactured or imported into the EU at volumes exceeding 1 metric ton per year (ITA, 2022). Within this high-volume list, chemicals that are carcinogenic, mutagenic or toxic for reproduction, as well as those that are persistent, bioaccumulative and toxic (PBT), can be identified by the European Chemicals Agency as "Substances of Very High Concern" (SVHC). These are placed on the "Candidate List" and may ultimately be banned from entering the European market unless given special authorization. (ECHA, 2022)

More importantly, REACH places the burden of proof on companies to provide safety data for new chemicals. Their motto is "No data, no market." To date the EU has restricted the use of about 1300 chemicals and plans to look at 30 additional high-risk substances per year. There are however more than 80,000 chemicals already used in consumer products and REACH exempts pesticides, medicine and food products, chemicals used in research and development, polymers, waste and some industrial processes if not chemically altered.

The Great European Detox of 2022: Banning Chemical "Families"

As part of the European Green Deal, on April 25, 2022 the European Commission announced the largest ban of toxic chemicals to date. Their commitment to a "restrictions roadmap" could rapidly address up to 12,000 substances that have "unacceptable" health and environmental concerns by banning not just individual chemicals but "families" of chemicals with similar structure and toxic profiles where the most harmful member defines legal restrictions for the whole family.

These could include CMR's (Carcinogenic, Mutagenic, Reprotoxic), endocrine disruptors (ED), immunotoxicants, neurotoxicants, respiratory sensitizers and STOT substances (Specific target organ toxicity). Included in the proposed ban are all bisphenols, all forms of PVC, restrictions on all forms of PFAS, restrictions on many flame retardants, skin sensitizers in consumer products and nickel in consumer products.

This effort is aided by an independent network of reference laboratories, research centers, and related organizations (the NORMAN network) monitoring contaminants of emerging concern. (Dulio, et al., 2018) Created in 2005, the NORMAN network:

- Provides transparent information and monitoring of CEC
- Facilitates rapid exchange of data from different sources on CEC
- Harmonizes common sampling and measurement methods
- Establishes an independent open forum for technical scientific debate
- Is a bridge between science and policy-making

> **"This 'great detox' promises to improve the safety of almost all manufactured products and rapidly lower the chemical intensity of our schools, homes, and workplaces"**
> Tatiana Santos, Chemicals Policy Manager, European Environmental Bureau

Pollution Solutions: Breaking the Cycle

As described in detail in this issue, we are fortunate to have advanced water treatment methods like those planned by Valley Water that can produce recycled water purified to exceed drinking water standards. The vast majority of chemicals known or unknown are removed in this process. The medical community should whole-heartedly support these efforts.

It is equally important, however, for the medical community to support common sense pollution prevention efforts. Not only do these measures protect our drinking water supplies—the majority of which do not receive advanced treatment—they also remove these contaminants from the air and soil, cleaning up the environment as a whole, and not just shifting the burden of pollution from one phase to another. A critical step is to support strong chemical policy for the U.S. that stresses pollution prevention as the primary means of keeping our water clean in the first place.

If we are to take pollution prevention seriously, we need a robust, multifaceted, transparent, and accountable process that prioritizes public health over industry influence. Such a process will require more efficient and more extensive toxicity testing of novel substances, more rapid implementation of restrictions, and a shift to "green" products designed for safety first. TSCA reform has helped move us in the right direction, and the EU may have given us a roadmap to further progress, providing inspiration for a new industrial revolution.

Architect William McDonough points out in his book **"Cradle to Cradle, "**Human industry has been in full swing for little over a century, yet it has brought about a decline in almost every ecosystem on the planet. Nature does not have a design problem. People do" (McDonough & Braungart, 2002). Paul Hawken (1993) echoes that sentiment in his classic book, **The Ecology of Commerce:** *"To create an enduring society, we will need a system of commerce and production where each and every act is inherently sustainable and restorative"* . A healthy and sustainable planetary future involves clean water for all life forms. It is an imperative for biodiversity, ecosystem protection, as well as human health. We physicians can educate ourselves and our patients about the importance of reducing synthetic chemicals and plastics in the household, reducing consumption in general (reduce, reuse, recycle), and supporting initiatives to reduce medical waste in healthcare systems. We must also communicate our concerns to our elected representatives. Our children and their children will be grateful we made the effort.

> **"To create an enduring society, we will need a system of commerce and production where each and every act is inherently sustainable and restorative."**
> Paul Hawkins, The Ecology of Commerce

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Additional Resources

1. EWG Skin Deep-An updated database of over 69,000 products in ingredients in our cosmetics and skincare products alomg with product safety information. https://www.ewg.org/skindeep/
2. The Campaign for Safe Cosmetics. https://www.safecosmetics.org
3. Our Water Our World. Solve Pest Problems with Less Toxic Products. https://ourwaterourworld.org
4. Toxic Matters. UCSF Program on Reproductive Health and the Environment. https://prhe.ucsf.edu/resources/toxic-matters
5. UC Davis IPM Program. http://ipm.ucanr.edu
6. Beyond Pesticides. Northwest Center for Alternatives to Pesticides. https://www.pesticide.org
7. Drinking water Safety: What broke the Safe Drinking Water Act? 5/10/17 https://www.politico.com/agenda/story/2017/05/10/safe-drinking-water-perchlorate-000434/
8. Practice Greenhealth: Sustainable Solutions for Health Care. https://practicegreenhealth.org
9. Green Science Policy. https://greensciencepolicy.org