From Yuck to Yes: What Drives Acceptance of Potable Water Reuse

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Abstract

Growing water scarcity and climate pressures are driving the exploration of alternative drinking-water sources, including potable reuse. Potable reuse offers a reliable and climate-resilient source of water, yet public acceptance presents a major obstacle to widespread adoption. This review synthesizes research on the sensory, physiological, and psychological factors that shape how people evaluate drinking water and relates these concepts to three case studies of reuse programs in Colorado, California, and Singapore. These findings reveal that outreach efforts should consider the presentation of potable reuse water, including its name, the platforms used, and the messengers delivering the information. Strategies should be specific to audiences and use engaging, memorable educational methods. Consistency across treatment plants and an interdisciplinary approach further strengthen public confidence and program success. This review provides a framework for integrating sensory science, psychology, and communication practices to support the development of safe, publicly accepted potable reuse systems.

Keywords: Potable water reuse, yuck factor, flavor perception, taste and odor, public perception, outreach strategies

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A human truth is the need for water, and a planetary truth is that all water is recycled. As cities confront growing water stress driven by population growth, urbanization, intensified weather events from climate change, and pressure on freshwater catchments, communities are increasingly turning to alternative water sources. An important component of this is potable reuse, which treats wastewater to drinking-water standards or better. Water reuse helps the environment by conserving and managing freshwater, saving energy, and reducing wastewater entering ecosystems (Kumar et al. 2021). This process has emerged as a strategy for resilient, climate-independent water supply (Tortajada & Ong, 2016; WHO, 2017).

Despite the technical reliability of reused water, its widespread adoption depends heavily on public acceptance (WHO, 2017). While drinking a glass of water may present itself as a universal experience, it is profoundly individual. Perceptions vary based on flavor, physiological, and psychological factors. Opposition to this water source arises from the bad flavor, yuck factor, risk perception, distrust, negative experiences, and differences in culture. When these factors causing resistance are turned into positive experiences and related to consumers' personal beliefs and lives, attitudes can begin to change. Understanding these factors is critical for developing potable reuse programs that are both safe and socially accepted.

This literature review synthesizes research across psychology, sensory science, and water communication to examine how these factors shape public perception of recycled drinking water, and then connects these ideas to three case studies that illustrate their relevance in practical scenarios. This review aims to examine how physiological and psychological perceptions of flavor can guide treatment approaches and public communication strategies for successful potable water reuse.

The review begins by introducing potable water reuse and the role of the yuck factor in shaping initial reactions to recycled water. It then examines the sensory and physiological aspects contributing to water perception, including flavor—encompassing taste, odor, and key chemical drivers—as well as individual physiological differences such as saliva composition, personal habits, and illness. Next, the review explores psychological influences on acceptance such as risk perception, user–provider distrust, bottled water preferences, past experiences, culture, and education. This review concludes by describing and dissecting case studies from Singapore, Colorado, and California to draw key lessons from these cases and highlight interesting areas where additional research could benefit the adoption of new reuse plans.

What is Potable Water Reuse

Water reuse is generally considered and proven to be safe with multi-barrier technology (Ong, 2015). These technologies include membranes, membrane bioreactors, biotreatments, and advanced oxidation processes (Tzanakakis et al., 2023). Using multiple treatment strategies ensures safety is not reliant on a singular treatment strategy. This is especially important when one treatment area needs maintenance or does not work properly. Reuse treatment is more complex than existing water treatment, resulting in water that is often considered better quality than typical drinking water in the area (Bai et al., 2020; Ong, 2015).

Membrane filters use a thin layer of polymers or ceramics and push water through the membrane using high pressure (Tzanakakis et al., 2023). Different membranes are classified based on pore size or molecular weight cutoff (Qin et al., 2021). A common type of membrane used in water reuse treatment is reverse osmosis, which is found to remove 95 to 99 percent of pollutants. Ultrafiltration and microfiltration, which differ based on particle sizes removed, are also common in water reuse treatment (Tzanakakis et al., 2023). Membrane filters remove sediment, algae, bacteria, viruses, and total dissolved solids (Gray, 2014). Membrane Bioreactors (MBR) are a combination of a biotreatment (microorganisms) and a membrane. This process deviates from traditional biological treatments, which require more space and produce more sludge (Rahman et al., 2023). This treatment is considered high-grade (Tzanakakis et al., 2023). Membrane filtration has a high initial cost, a limited life span, and requires regular maintenance (Ong, 2015).

Reuse schemes using membrane filtration methods demineralize water, which can have negative consequences for potable water. As discussed by Ong, demineralized water tends to have a lower pH. This can prove problematic because low pH is corrosive to the pipes and storage areas where water moves. Pipes can leach unsafe materials and contribute to an overall unpleasant flavor. On its own, demineralized water is described to have poor taste characteristics (2015). Globally, water drinkers are used to minerals in their water to some extent. Given that mineral content strongly shapes how water tastes, it’s important to also recognize naturally present or added minerals support human health (Ong, 2015). Reuse plans should address mineral additions to maintain taste and safety.

Membrane filtration processes are combined with an advanced oxidation process (AOP). These filtration methods include chlorination, ozonation, and ultraviolet light (Tzanakakis et al., 2023). In AOP, very reactive molecules are created in the water to break apart contaminants. (Hübner et al., 2024). Contaminants removed with AOP include organic matter, pharmaceuticals, carbon tetrachloride, and pharmacological waste (Kumari & Kumar, 2023).

While water reuse treatment methods are thorough and the need for reuse exists, public acceptance is one of the main obstacles preventing the advancement of these projects

(Tortajada& Ong, 2016). People are still hesitant to reuse water directly due to the yuck factor (Garcia-Cuerva et al., 2016). It is hard for people to separate water from its history, especially when terms like toilet to tap still propagate. Linking water with waste increases the risk and disgust people feel. To overcome consumer aversion to water reuse, it is important water providers develop an effective outreach strategy and guarantee consistent and safe water quality (Wester et al., 2016).

Yuck Factor

The yuck factor is one of the strongest factors impeding the adoption of reuse strategies across the world. A University of Pennsylvania bioethicist devised the term yuck factor to describe people's instinctive aversion to unfamiliar technologies (Schmidt, 2008). The yuck factor is influenced by disgust, fear, culture, trust, and the presentation of information.

Schmidt (2008) examines how these factors present and why they exert such a powerful influence on public acceptance. Disgust is a strong feeling of revulsion that is not necessarily based on fact. Disgust can be an emotion based on fear, uncertainty, and assumption. Emotional ties to fear and disgust make it difficult to overcome these gut instincts. These instincts vary based on cultural norms. How information is presented shapes stances and reactions to reuse. The language used can target both positive and negative reactions. Terms focusing on sewage and toilets draw emphasis to unclean water, appealing to disgust, which directly opposes the rigorous treatment reuse water goes through. Further, who is presenting this information can impact an audience's reaction to it. Generally, the government and scientists with no conflict of interest are believed to be reliable sources. People with existing relationships, such as people with shared cultural values, are more open to new opinions when they come from a source already sharing similar morals. Overcoming yuck is a complicated pursuit requiring a variety of strategies and considerations.

Sensory Interactions

Flavor

Flavor is multidimensional, created by a combination of taste, odor, and mouthfeel (Devesa & Dietrich, 2018). Different organic and inorganic inputs affect the flavor of water. Certain flavors lead to rejection, even when they are considered safe for human health (Crider et al., 2018). Further, flavor perception varies widely across individuals because of physiological differences. Changes in saliva, aging, and health conditions can heighten or dull the ability to detect certain tastes, meaning the same water can be perceived very differently from person to person. Flavor plays a major role in shaping people's perceptions of a water source (Doria et al., 2009).

Odor

One assessor consumers use to assess their water is odor (WHO, 2017). Odor in water makes the source seem unsafe, creating unease towards it. The most common aromas noticed in water are from disinfectant and organic matter, which produce chemical, earthy, musty, and swampy smells (Devesa & Dietrich, 2018). The intensity of odors is linked to changes in pH; the pH level affects chemical reactions, resulting in changes in mineral solubility and separation of chemicals (Adams et al., 2022). Intensities are also increased for water with warmer temperatures containing geosmin, MIB, and chlorine. Odor strength is not always correlated with higher concentrations; in some cases, lower concentrations of a compound produce a stronger smell (Whelton & Dietrich, 2004).

Odor in water does not automatically signify danger, such as chlorine being added to increase the safety of the water, but these complaints should be acknowledged. In the case of Flint, Michigan, residents voiced their complaints about the odoriferous nature of their water, but water providers dismissed these concerns, leading to a public health crisis (Pauli, 2020). Repudiation of the sensory experience as purely aesthetic minimizes public concerns, which can break trust and miss health risks (Spackman & Burlingame, 2018). It should be noted that in most cases with reports of aesthetic conditions, there is no significant association with water quality issues (Spackman & Burlingame, 2018; Wedgworth et al., 2014). This is not to say these reports should be deemed unworthy because aesthetic objections cause people to seek alternative water sources and raise civic discourse, which questions the source and supplier.

Geosmin and 2-methylisoborneol

Geosmin and 2-methylisoborneol (2-MIB) are some of the most frequently detected taste and odor compounds across the world (Devi et al., 2021). Both compounds are produced by algae, cyanobacteria, and actinomycetes (a taxonomic category of bacteria) (Whelton & Dietrich, 2004). Geosmin and 2-MIB cause earthly and musty smells affecting the taste of water. Warmer temperatures can increase the intensity of these odors (Whelton & Dietrich, 2004). The musty, earthy scent can signal danger to the consumer, even if the water is safe to use and drink (Spackman & Burlingame, 2018). Anthropogenic impacts of wastewater, runoff pollution, and climate change have increased associated blooms to concerning levels for water quality.

Conventional operations to treat water, such as coagulation, chlorination, and sedimentation, do not work for the removal of MIV and geosmin (Srinivasan & Sorial, 2011). For this reason, removing geosmin and MIV requires other strategies such as ozonation, biofiltration, or activated carbon (Whelton & Dietrich, 2004). These processes are not usually implemented by treatment plants due to budget, scale, and lack of health concerns associated with levels found in water sources. Utilizing different treatment processes can cause unintended effects, such as ozone creating a fruity scent (Dietrich, 2006). While new technologies are more effective than traditional methods in removing scent, there is still persistence throughout treatment, requiring refinement so treatment can be more productive (Srinivasan & Sorial, 2011).

Chlorine

Chlorine is a disinfectant added to waters around the world to help protect public health by preventing disease. While some people consider water unsafe without chlorine, others consider water unsafe because of chlorine additives. Chlorine represents one of the most distinguishable and frequently reported taste and odor issues in drinking water worldwide (Dietrich, 2006; Dietrich et al., 2015). It is characterized as having a chlorinous, bleach smell or taste (Water Quality Association, 2022).

Detection and acceptability of chlorine in water are variable, depending on components including, but not limited to, culture, biology, origin, concentration, temperature, pH, and other chemicals. Higher temperatures specifically cause chlorine odors to strengthen (Whelton & Dietrich, 2004). Distribution system conditions can also affect chlorine levels. Homes with low water pressure, for instance, are more vulnerable to pipe intrusion events, increasing total chlorine concentrations (Wedgworth et al., 2014). While chlorine can mask other odors such as fishy, earthy, or musty scents (Dietrich, 2006), its own chemical odor is often considered unappealing and remains a primary factor limiting tap water consumption (Ratelle et al., 2022). When dealing with chlorine, there is an important balance to maintain between safety and taste.

As the reduced form of chlorine, chloride affects the sensory and aesthetic qualities of drinking water when in the presence of other elements. Aesthetically, chloride can cause objectionable flavors when coupled with sodium, calcium, potassium, and magnesium. Salty tastes manifest when in the presence of sodium and bitter tastes when compounded with magnesium or calcium (Dietrich et al., 2015; Burlingame et al., 2007). The negative opinions of taste when these compounds are in drinking water indicate that water users do not prefer these ions when combined with chloride at certain levels. However, the inclusion of chloride should not be overlooked as it is an essential mineral that plays crucial roles in the body for functions including electrolyte balance, digestion, and muscle and nerve function (Harvard, 2024).

Further, chlorine in the water can react, triggering unappealing taste and odor issues. In a Ugandan settlement, chlorine detection increased with lower turbidity and electrical conductivity. This is due to chlorine reacting with these contaminants and creating compounds, resulting in taste and odor issues (Heylen et al., 2025). The material water transports through can also react in an unsavory way. In pipes, valves, and fittings, chloride reactions induced reports of rubber odors (Dietrich et al., 2015). In the presence of chlorine, pipes constructed with high-density polyethylene tended to leach a “chemical/plastic” odor into the water (Heim & Dietrich, 2007). Just as synthetic plumbing materials can alter the sensory qualities of water, new materials developed for other aspects of water treatment and transport can succumb to this same fate. This emphasizes the need for sensory testing of new materials in the presence of chemicals, such as chlorine, to assess how consumer perceptions of safety and quality are impacted.

One of the most common types of water treatment involves adding chlorine. Adding this element to water introduces the possibility of detection by consumers. While there are threshold levels regarding how much chlorine can be in water, people may still be able to detect chlorine under these levels. For example, in Dhaka, Bangladesh, the taste perception of chlorine is a proven barrier to water treatment acceptance; in this city, the free chlorine target dose is around 2.0 mg/L, but community members were detecting sodium hypochlorite (NaOCL) at the median level of 1.16 mg/L (Crider et al., 2018). Similar patterns are found in a Ugandan refugee settlement and in a peri-urban community in Cambodia. Ugandan settlements recorded chlorine taste detection and rejection thresholds that varied widely across water sources and individuals (Heylen et al., 2025). In Cambodia, taste test respondents reported a distaste for water surpassing 1.25 mg/L of free chlorine, a level that is 0.75 mg/L lower than suggested (Jeuland et al., 2015). This gap between technical targets— set by public agencies and treatment plants— and sensory acceptability underscores the importance of integrating public perception into water quality management. Water technically considered safe may be rejected if it tastes or smells off.

When the taste of water is seemingly off, people are inclined to turn to a different source. However, just because a source tastes more favorable does not mean it is safer. This situation is seen in Cambodia, where results of a blind tasting study found consumers were highly sensitive to chlorine taste, preferring untreated or naturally sourced water if chlorine taste was too strong (Jeuland et al., 2015). This same situation arose in the Northwest Territories and Yukon, Canada, where users who were concerned about chlorine preferred to drink untreated water from the land (Ratelle et al., 2022). For these cases, taste acceptability outweighs perceived health benefits in decision-making. Consideration for water users' preferences helps build trust in a source and increases source use.

Total Dissolved Solids

Total dissolved solids (TDS) refers to the dissolved inorganic and organic matter in water. As listed by the World Health Organization, the main ions encompassed in TDS include “calcium, magnesium, sodium, and potassium cations and carbonate, hydrogencarbonate, chloride, sulfate, and nitrate anions” (2003, p.1). TDS has the greatest impact on taste and a smaller effect on mouthfeel. In a study analyzing the taste of bottled and tap water, TDS was found to be the most influential factor impacting the taste panel's preferences (Platikanov et al.,2013). Reports of good-tasting water include bicarbonate, calcium, and magnesium (Dietrich & Burlingame, 2015; Platikanov et al.,2013). Sodium, potassium, and chloride are more discernible tastes and create negative opinions on the water source (Devesa & Dietrich, 2018; Platikanov et al.,2013).

Wastewater already has high salinity, and climate change intensifies this issue. High salinity in water means water utilities have to pursue treatment processes to remove salts. (Wei et al., 2021). Water membrane treatment processes, such as reverse osmosis, are very effective at removing minerals, including salt, from water. However, water with no minerals will not taste right, especially in places with high preferences for TDS. To maintain taste and stop corrosion in pipes (which also alters taste), water needs to be remineralized or blended (Devesa & Dietrich, 2018; Wei et al., 2021). Water providers' goal is to minimize changes (magnitude less than or equal to 200 mg/L.) in mineral levels to maintain what consumers are used to. (Devesa & Dietrich, 2018).

Increasing levels of TDS can create mineral and salty tastes. Causes of these increases include drought, potable reuse schemes, and agriculture (Dietrich & Burlingame, 2015). In a tasting panel with both trained professionals and untrained consumers, water samples with different TDS levels were rated. Results found after a threshold TDS amount, increasing levels correlated to decreasing preference for the water (Devesa & Dietrich, 2018). Water with low TDS levels can taste flat or, in some cases, bitter (Shuai et al., 2023). Generally, water is preferred if it falls below 500 mg TDS/L and above 30 mg TDS/L (Devesa & Dietrich, 2018; Platikanov et al., 2013).

Levels of TDS preference are highly variable due to human preference. Spain, France, and the Netherlands have reported preferences ranging from 200 to 400 mg/L, while California is much lower, around 80 mg/L(Devesa & Dietrich, 2018; Dietrich & Burlingame, 2015). Regional choices, such as drinking mineral water in Europe or regional characteristics such as geology, can affect preferences for TDS levels. People who are used to water with low TDS are more likely to reject the taste if TDS increases than the reverse scenario with TDS decreasing (Devesa & Dietrich, 2018).

Physiological Factors

Saliva is a critical mediator of taste perception, shaping how humans experience flavor. Spielman (1990) notes saliva contributes to tasting ability in three main ways: as a solvent, as a carrier of molecules, and through its composition. These variations in saliva composition—such as ionic concentration, buffering capacity, and pH—can alter sensitivity to tastes like saltiness, bitterness, and sourness. Bitter and sour tastes are detected more frequently than salty and sweet tastes. Individuals with higher salivary flow rates have higher concentrations of proteins, sodium, calcium, chloride, and bicarbonate in their mouths. In the context of taste, higher sodium in saliva, due to an increase in flow, makes people less susceptible to tasting it at low thresholds (Burlingame et al., 2007). Likewise, increased bicarbonate levels in high saliva flow may neutralize acidic components in water, altering how people assess its taste. Ergo, different saliva compositions play a role in taste function.

Diverse bacterial communities in the mouth reflect human characteristics, including health status, dietary choices, intrinsic factors, behavioral factors, and geographic location (Ruan et al., 2022). Various medical problems and medical treatments have direct effects on taste and odor function. For instance, chemotherapy damages taste buds, diabetes impairs mouth wound healing, Alzheimer's impairs motor function and sensory perception, and oral mucosal disease impairs the oral mucus membranes (Ship, 1999). These are a few out of the many medical treatments and conditions that can alter saliva composition, whether it is a direct effect of radiation in chemotherapy or an indirect effect of memory and motor function decline.

The habits people develop can modify how they taste and smell. In the case of heavy drinking, beneficial, mutualistic bacterial communities can be depleted, leaving bacteria that can cause disease (Fan et al., 2018). Pathogenic bacteria could be the cause of off-flavors described by people consuming substantial amounts of alcohol because their mouths are unable to salivate properly, and tissue in their mouths is damaged. In a similar vein, smokers alter their oral microbiome by promoting an environment that lacks oxygen and a bacterial community that is unable to break down foreign substances (Wu et al., 2016). These degradations of the oral microbiome can cause tastes and scents to shift. In particular, taste sensitivity decreases with higher levels of nicotine dependence (Chéruel et al., 2017). These habits degrade overall taste perception and can cause off-tastes as a result of personal choice rather than due to water properties.

Geographic location is an essential factor in the structure of saliva microbiomes. A study re-analysing rRNA data from 2,206 saliva samples across 47 studies found significant differences in the structure of salivary microbiota across different geographic locations, but in the same geographic location, across both Chinese and Western participants, the samples showed no differences (Ruan et al., 2022). This implies that where people are from can impact their taste perceptions. Regional differences in diet, molded by local culture and agriculture, can influence saliva content and volume, thereby affecting how individuals perceive taste (Burlingame et al., 2007). Two people may taste the same thing differently if they are from two unique locations due to differences in salivary microbiota.

Psychological Influences

Risk Perception

People do not want to drink water they perceive to be unhealthy and possibly dangerous. This risk perception, whether it is true or not, inhibits change and acceptance in the world of water. In the case of reuse, users who viewed the source as a health risk had a lower acceptance of it (Nkhoma et al., 2021). Perceived risk can push people towards bottled water or even untreated water from the land if the risk of municipal water seems too great (Ratelle et al., 2022). Risk perception isn't always shaped by fact; rather, it is often influenced by feeling. This emotional tie makes it important to validate and put effort toward addressing health risk concerns.

Aesthetic conditions, including taste, odor, and color, often dictate whether people deem water as safe. What one person considers safe aesthetics of water, another person may find unsafe and unappealing. This divergence is captured by a study that took place in the Black Belt of Alabama, where aesthetic conditions were self-reported and then compared to actual water quality. This study found no correlation between water quality and reported aesthetic issues (Wedgworth et al., 2014). Further, a Canadian study about the association between perceptions of water quality and actual quality found that in the presence of aesthetic issues, over 56 percent of respondents still reported being satisfied with their quality of water (Ochoo et al., 2017). This split in the sample population highlights, once again, that actual safety and perceived safety do not always match because people are partial to different aesthetics.

While water users believe their concerns are for their health, this reaction can really be a reflection of an emotional reaction: disgust (Wester et al., 2016). In relation to water, it can best be explained by core disgust. This type of disgust is based on the evolutionary defense against disease by keeping seemingly harmful objects out of the body. Core disgust is caused by the three cognitive appraisals explained by psychologist Michelle Yarwood (2022): oral incorporation into the self, offensiveness, and contamination.

Focusing on the latter two appraisals gives insight into possible reasons for human disgust toward certain water. Yarwood describes offensiveness manifesting as an aversion to consuming bodily products. This can explain the detriment of using terms such as toilet to tap. Toilets are receptors of human waste and therefore have an offensive connotation when related to a product being consumed. Contamination is the belief that something is impure due to contact with a polluting agent. Yarwood goes on to explain contamination responses using the law of contagion and the law of similarity. The law of contagion is rooted in the theory “once in contact, always in contact,” and the law of similarity assumes the same characteristics over two different products because they appear similar (Yarwood, 2022). Water faces many waste effluents. Based on the law of contagion, these pollutants still pollute the water even when they are treated for or diluted out. Under the law of similarity, all water would be expected to taste the same. In reality, this is not the case, and the deviance from expectation into unfamiliarity can cause disgust. Consuming a product is not required to elicit disgust. This makes disgust a psychological reaction that can vary person-to-person.

User–provider distrust

Just like any good relationship, building trust is a key step to success. This is no different for the water provider-consumer relationship. Building trust is associated with lower risk perceptions (Nkhoma et al., 2021). When a consumer trusts a provider, the provider has shown good communication, transparency, and product. Being the only food/beverage directly delivered into homes alters the relationship between consumer and producer because the product does not undergo inspection by the consumer before purchase (Spackman & Burlingame, 2018). This distinctive relationship can cause a focus on treatment based on industry and agency standards, producing a product that lacks the input of a human assessor. Customer-based evaluations should not be shunned in the world of water because positive assessments build confidence in public water suppliers (Burlingame et al., 2017). In situations where both sides can communicate and maintain a relationship, trust is built, instilling confidence in a source even when it may seem different.

Addressing concerns about a water source can make or break the user-provider relationship. The absence of aesthetic, safety, and supply issues denotes trustworthy water in the eyes of the consumer(Doria et al., 2009). In cases where water utilities are unable to correct a water contamination issue in a reasonable amount of time, consumers' perception of risk increases, leading to an overall distrust of the water source (Anadu & Harding, 2000). The acknowledgement of an issue, coupled with the absence of meaningful action, inhibits trust from forming. Alternatively, when issues are addressed and communicated with the public, trust can be built, resulting in a more positive perception of a municipal water source. A study based in Canada highlighted the importance of developing a mechanism to reach out to the users of a drinking water source because public perception is "often considered as a yardstick for public services, like drinking water supply" (Ochoo et al., 2017, p. 442). Strengthening these relationships with communication should move beyond merely uploading a report to a website, instead opting for an interface and writing style easily comprehended by the public audience.

Bottled Water Preferences

Stigma against a water source can also impact how likely a consumer is to choose it. In the case of French bottled water drinkers, despite the fact that tap water consumers were just as sensitive to chlorine flavor as bottled water consumers, these individuals were less willing to accept chlorinated tap water as their source of drinking water (Puget et al., 2010). Both of these tasting groups had a similar experience in terms of detection, but their opinions differed due to individual biases. An Iranian study examining tendencies towards bottled drinking water consumption found that 74% of study participants believed tap water may be contaminated and, therefore, not to be trusted. In reality, the study city (Tabriz) follows strict national and World Health Organization standards for tap water (Aslani et al., 2021). This reflects a broader mistrust of municipal water systems, manifesting as a perceived distaste for tap water and a corresponding preference for bottled sources.

In the United States, bottled water and municipal water are regulated by different entities. Bottled water is considered a food product and is accordingly controlled by the Food and Drug Administration. This compares to municipal water, which is regulated by the Environmental Protection Agency. Both of these agencies follow their own set of standards. Each time the EPA establishes a standard for a contaminant, the FDA will either adopt it for bottled water or declare the standard unnecessary for bottled water (FDA, 2022). The deviation in agency regulation results in maximum contaminant levels that occasionally bifurcate. Under FDA regulation, inorganic chemicals, including copper, are more stringent; the FDA regulates 1 mg/L compared to EPA 1.3 mg/L, likely due to municipal water having to move through pipes in homes and through the ground. These deviations could result in flavor differences, but in most cases, EPA and FDA mirror each other. While there are cases, such as Flint, Michigan, where tap water does not meet EPA standards, the argument that bottled water is safer is generally untrue in the United States, where both regulating agencies follow similar guidelines for water safety. This once again reveals water preference as a factor of social and psychological bias rather than measurable differences in water quality.

Despite tap water meeting all safety standards, public acceptance often depends more on perception than on measurable quality. Aslani et al. (2021) found that only 6.1% of highly educated bottled water users found municipal water acceptable, while 51.4% of low or no academic education users did. This contradicts what may be expected, as more knowledge of this source and the standards it adheres to would produce a higher level of trust in tap water. In some places, bottled water can be a symbol of wealth through packaging and claims of superior quality and source. In others, socioeconomic inequality drives the divide: wealthier communities often have municipal systems with stricter conditions to meet, funded by more money, while lower-income areas may face contamination risks that push them toward bottled alternatives. Together, these findings show that preferences for bottled or municipal water reflect social identity and trust as much as safety or taste. Understanding these dynamics is crucial when considering public acceptance of reclaimed or reused water, where psychological and cultural barriers may outweigh scientific assurances of safety.

Past Experiences

Lived experiences shape individuals, so it only makes sense these experiences also affect taste perception. As described by Ochoo et al. (2017), one of the factors affecting the public perception of drinking water is past experience. Both positive and negative opinions can arise from these experiences. Memorability of past illnesses associated with water contributed to increased estimation of risk of a drinking source, while an absence of health risk events increased trust (Doria et al., 2009). In the case of a Canadian indigenous community, frequent water contamination, taste and odor issues, and unreliable water delivery services have contributed to water insecurity and challenges within this community (Ratelle et al., 2022). Based on these experiences, this community has been given no reason to trust municipal water, incentivizing them to use water from the land – whether it be groundwater or surface water. These past experiences have broken trust and left a bad taste in the mouth of consumers, in the most literal sense. It is experiences like these pushing people away from municipal water.

Where people are from informs their preferences in water. In a cross-national study about perceptions of drinking water and risk, a pattern arose of people using characteristics they are accustomed to as their reference standard (Doria et al., 2009). People are used to their tap water, so anything unfamiliar seems unsafe and wrong. This explains the preference people have for and against hard versus soft water. In areas closer to the Rocky Mountains water is harder. People who grow up in these areas are used to the high quantities of dissolved minerals, so soft water may taste flat, slimy, and unsafe in comparison. Both kinds of water are safe, but people have aversions because they are not what they are used to. Nkhoma et al. (2021) emphasize considering local context because different populations have preferences dependent on where they grew up.

Cultural Influences

People's perception of taste is culturally situated. Taste can be a social construct informed by shared social knowledge and altered through interactions (Shapin, 2012). These social exchanges can be harmful when bad experiences are shared, cultivating a distrust of a water source, even if someone doesn't personally have any negative experiences. On the other hand, sharing positive experiences creates belief in the reliability of a water source and can even help shift opinions.

Where someone grew up can culturally condition people into liking or disliking certain aspects of water. People living in different areas hold different values related to local issues. Areas with water scarcity have a culture of water conservation, and can be more inclined to support water saving tactics than somewhere where water is abundant. This situation was observed in a national study about public perceptions of water reuse, which found that the most water-conscious respondents and reclaimed water supporters live in areas that had experienced a drought period within 13 months before taking this survey (Garcia-Cuerva et al., 2016).

To many indigenous communities, water is a living entity with a spirit. Chemically treating the water can be seen as killing the spirit of the water. Devoid of spirit, the water is lifeless and should not be drunk (Latchmore et al., 2018). In examining the taste threshold for chlorinated water among indigenous and non-indigenous rural Panamanians, indigenous participants were more likely to reject chlorinated samples than non-indigenous participants (Osler et al., 2024).

Introducing chemically treated water impacts how likely indigenous people are to choose the safe, but chemically altered option over familiar natural sources such as springs, rivers, lakes, and aquifers.

For the indigenous peoples in subarctic Canada, water is intertwined with identity and place. Water is more than a resource to this group of people; it has cultural and spiritual connections (Ratelle et al., 2022). Native people living in the arid western United States have also built identity, customs, and history connected to the water of their homes. Disrupting natural flows and altering ecosystems impacts the tribes and inflicts cultural wounds (McGreal et al., 2022). These communities of people have different relationships to water, which can impact how they view changes to water sources. Forcing indigenous people to adhere to a water source is another modern form of forcing Western ideals onto them without consideration for their opinions and customs. These groups were the original stewards of the lands, and thus their input should be considered and not ignored.

In some cultures, women are the main holders of water knowledge. This is seen in indigenous communities where both women and water are givers of life, creating a culture where women protect the resource (Latchmore et al., 2018; McGreal et al., 2022). The culture of gendered roles is also observed in Ghana, where women typically collect water for the home. While women are the primary people collecting water, they are not the primary people charged with managing and leading water topics. Colonization has forced male-dominated governance systems all over the world. This culture of cutting women out of leading roles has disconnected them from water stewardship and governance.

Education

Education about different water topics can help people understand the source better. This education takes many different forms, whether it consists of understanding treatment processes better, broadening knowledge of environmental issues, or targeting demographics based on local experiences.

More education can have both a positive and a negative effect on the perception of public water. In many cases, this confounding relationship can be explained by income. In one study exploring data from 141 countries, more education increased self-reported anticipated harm from drinking water in the next two years, with the exception of countries categorized as high-income (Miller et al., 2024). This compares to the high-income country of Canada, where, in the case of Newfoundland, even within the same community, people who had completed college/university reported being more satisfied with their water quality than those with less education (Ochoo et al., 2017). In some cases, more education means more knowledge of the contaminants that may be in water sources, creating a negative perception of the source, while in other cases, it may mean more trust in water sources due to the knowledge that water is treated for human health.

Educating the public about public water should be done with tact and consideration for the audience. In one case, educational brochures were able to lower anticipated disgust, but did not sway users' willingness to use recycled water (Wester et al., 2016). This suggests that while information alone can soften emotional reactions of disgust, it is not always enough to change behavior. In Ghana, a water public messaging strategy relied on radio broadcasts. However, this approach created a mismatch between the intended audience and who it actually reached: women are charged with water-related responsibilities in the home and would benefit from the show, yet men are the primary radio listeners (Nadal et al., 2025). This type of educational outreach did not consider its main audience, hindering the spread of information to women.

A town in Oregon sent quarterly notices informing its residents of water contamination. After distributing this information to citizens, there was an increase in risk perception because no measures were taken to fix the issue (Anadu et al., 2000). This type of education lends the ability to build trust in the supply source and utility, but only if actions are taken to remedy issues. Effective education pairs factual explanations with strategies addressing emotional and cultural dimensions of the water topic. For education to truly influence behavior, it must be supported by action—whether that means addressing disgust responses, tailoring messages to specific audiences, or resolving known contamination issues. Water interactions vary from place to place, making context-specific education strategies important.

In Ghana, men and women interact with water differently. Women have detailed and practical knowledge of water sources from being the primary person collecting water for the home. Despite this unique relationship, they are often absent from water management meetings and positions (Nadal et al., 2025). Good education should include people of all genders because everyone can bring a unique perspective.

Case Studies

Arid Inland Region: Colorado's Road to Potable Reuse

Arid areas naturally have smaller water budgets, but the expected low quantities of water are in a mismatch with water demand. Population growth, economic opportunities, inefficient irrigation strategies, and water management constraints put more pressure on water resources, creating consequences including ecosystem degradation and decline in quality of life (Chitsaz & Azarnivand, 2016). These issues are being exacerbated by climate change. In areas where temperatures are expected to rise, evapotranspiration will also increase, which will require more water to meet irrigation needs (El-Rawy et al., 2023). Irrigation is used not only for agriculture, but also for lawns. In areas with rising temperatures and lower precipitation, it will be hard to meet water requirements.

Arid areas are prone to salinity issues in both ground and surface waters. Naturally, salinity is higher in these areas due to evaporation, low precipitation, and weathering of rocks. However, human activity increases salinity through sewage effluents, recharge water, fertilizers, and road salts (Etikala et al., 2021). With climate change, these inputs will become even more powerful if there is less precipitation to dilute saline water, more people contributing effluents, and greater evaporation of water storage, leaving salts behind. Drinking saline water can have negative health consequences. Some reported health issues are cardiovascular disease, diarrhea, high blood pressure, hypertension, skin issues, and respiratory diseases (Etikala et al., 2021).

As outlined by the Colorado Water Conservation Board in the Colorado Water Plan Executive Summary (2023), Colorado is experiencing population growth, large and intense wildfires, warming/drying from climate change, and more frequent and prolonged droughts. These factors put an already limited and overallocated water source at risk. As a headwater state, the sustainability of state waters is important not just to Colorado, but also to all the other states that receive water traveling from Colorado. To address water risks, one specific solution Colorado is looking towards is water reuse.

Regulation Advances

First published in 2022 and updated in 2025, the Colorado Department of Public Health and Environment (CDPHE) passed a formal rule authorizing Direct Potable Reuse (DPR) in Section 11.14 of Regulation 11 (Colorado Water Quality Control Commission, 2025). This section details plans for communication, treatment, and monitoring, signaling the feasibility of using DPR in the near future for Colorado. According to Section 11.14(3), one aspect required by water utilities under this regulation is to develop a plan for community communication and outreach. More specifically, this communication is required to define DPR and give the reason behind a supplier's choice to use it. This information is to be distributed by different means, including mail, public repository, public meeting, and one other option tailored to the community, all of which are complete with accessible options for people who speak different languages.

Water treatment devices and monitoring are outlined under Regulation 11. Treatment techniques requirements are given for both pathogen and chemical reduction. For pathogen reduction, treatment is required to have UV or ozone to disinfect and a filtration method such as reverse osmosis, biofiltration, or ozone (11.14(7)b). To reduce chemicals, the supplier must utilize an advanced oxidation process with either reverse osmosis or an adsorption process (11.14(7)d). To ensure this water source meets Colorado and EPA standards, monitoring during the first 12 months is particularly stringent: some parameters must be measured every 15 minutes, whereas others are required only monthly. Some of these parameters include Ammonia, temperature, turbidity, nitrate, lead, disinfection byproducts, and organic chemicals (11.14(6)b) (Colorado Water Quality Control Commission, 2025). These requirements reduce uncertainty, which helps with communication and risk perception to the public.

PureWater

One Colorado reuse project being pursued is the PureWater Demonstration. This project is a mobile demonstration that filters recycled water for direct potable reuse, meeting all water standards. The mobile demonstration uses a 6-step advanced water purification process. Processes utilized include: ozonation, biofiltration, microfiltration, granular activated carbon, ultraviolet light/advanced oxidation, and chlorination. This project differs from other reuse schemes because it does not rely on reverse osmosis, and it does not produce salt waste, a hard waste product to get rid of in inland states (Adams, 2018; Colorado Springs Utilities, n.d.).

In a Denver Water article, Allegra da Silva, president of WateReuse Colorado, stated their goal for this project was to “bring together Colorado lawmakers, regulators, water providers and the public to raise awareness about water reuse," helping people realize direct potable reuse is a logical and quality water option (Adams, 2018). While places like Denver Water are not expecting to utilize this technology within the next few decades, places like Colorado Springs may need to due to their geographic location of being one of the largest Colorado cities not on a major water source (Adams, 2018; Colorado Springs Utilities, n.d.).

This project's emphasis on community engagement melds with the Colorado Water Conservation Board's value of an informed public willing to engage with new, inventive, sustainable solutions, creating a community that can adapt to water challenges (Colorado Water Conservation Board, 2023). This project goes a step further by involving a brewery business by sending purified water produced by the PureWater to brew beer with (Adams, 2018). This small-scale project lays the groundwork for normalizing this type of water treatment and helps build education and trust surrounding direct potable reuse.

Castle Rock

Castle Rock is a fast-growing community in Colorado, but it lacks a naturally renewable source of water to support its growth. This has led to a dependence on groundwater, a source that is not easily replenished. In anticipation of population growth, a decline in groundwater, and drought periods, Castle Rock has been exploring potable reuse at one of its treatment plants.

This treatment facility takes water from Plum Creek. This water could be raw or, more likely, it is a mix containing water that was treated from a water reclamation facility and put back into the creek before being pumped back to the reuse treatment facility. The treatment process begins with blending all source water, which could be a combination of raw and wastewater, before a flocculation compound is added to induce sedimentation. Next, water passes through biological activated carbon, microfiltration, ozonation, a granular activated carbon filter (GAC), and finally, it is subject to UV disinfection. Viruses, PFAS, pharmaceuticals, hormones, silt, sands, and protozoa were all contaminants filtered out through these steps (Castle Rock Water, n.d.).

On top of the treatment facility, Castle Rock has regular water conservation education and has water-conscious regulations. For example, on the Castle Rock government website, there are how-to videos with titles including “Summertime Watering Times,” “Cycle and Soak,” and “Do you have a water leak?” to name a few (Town of Castle Rock, n.d.). They also offer tours of their advanced treatment facility, where people can get an inside look at the treatment processes (Castle Rock Water, n.d.). Further, youth outreach consists of the Water Efficiency Supervisor providing presentations about water in Castle Rock. Rebates are offered for water-conscious actions such as removing turf and replacing it with ColoradoScape low-water-using plants (Town of Castle Rock, n.d.).

Castle Rock cultivates a culture of water-wise choices and rewards changes for making positive changes with rebates. This helps when trying to move to a water reuse scheme because the culture and concern for scarcity have already been built. People are less resistant to drinking reclaimed wastewater if they have the information that it is not only safe, but really the only good solution if they want to have water in the future. Additionally, water entering a natural water body before being reused could help with public acceptance because it is not a direct path from the wastewater treatment facility to the drinking water treatment facility.

Semi-arid Coastal Region: Orange County’s Groundwater Revival

Orange County is located in California and is known for its miles of coastline, arid climate, dense population, and tourist attractions (OC government, n.d.). North and central Orange County are on top of the Orange County Groundwater Basin, which “provides approximately 85% of the potable water supply for 2.5 million people" (Orange County Water District, n.d., p.1). This groundwater basin must balance withdrawals with recharge, or else it faces the risk of saltwater intrusion. To supplement supply, water is imported from the Sacramento-San Joaquin River Delta and the Colorado River, a process that is both expensive and energy-intensive (Orange County Water District, n.d.).

Groundwater Replenishment System

To offset the water demands of a growing population, recharge groundwater, and reduce the need for imported water, a joint project between the Orange County Sanitation District (OC San) and Orange County Water District (OCWD) was born, called the Groundwater Replenishment System (GWRS). As the Orange County Water District explains, this project is a water purification system designed for indirect potable reuse.

Before being sent to GWRS, water undergoes pre-purification, as described by the Orange County Sanitation District website (n.d.). During this step, water is treated in similar ways to typical treatment plants using bar screens, trickling filters, activated sludge, disinfection process, and settlement. Next, the GWRS receives this treated wastewater, where it then faces microfiltration, reverse osmosis (RO), and ultraviolet light with hydrogen peroxide. Microfiltration draws water through holes in polypropylene hollow fibers. This filters some bacteria and viruses, as well as suspended solids. Reverse osmosis membranes are made of a semipermeable plastic. Forcing water through this structure of membranes removes chemicals, viruses, and pharmaceuticals. UV light, coupled with hydrogen peroxide, disinfects and traces contaminants left in the water.

During reverse osmosis, minerals are filtered out, requiring treatment for minerals to be added back into the water to stabilize and buffer it. Further, at the end of the process, pH may need stabilization, done through air stripping, to remove excess carbon dioxide. This helps keep the pH stable, preventing bad reactions that can cause unpleasant water.

After facing these intense treatment processes, water is either sent to injection wells or to a surface basin. Injection wells help recharge groundwater, preventing saltwater from infiltrating into freshwater resources. At these injection sites, 100% GWRS water is allowed to be used due to its high quality. The basins let water naturally filter back into groundwater and also act as a source of local drinking water. These basins require blending of GWRS water with another source. Utilizing water for GWRS decreases the quantity of wastewater that would otherwise enter the ocean. Utilizing wastewater is far more efficient than pursuing desalinated seawater, which would use three times the amount of energy and require brine disposal. Further, utilizing water in Orange County has already decreased the dependency on water imports, which is also energy-intensive and expensive.

The GWRS shows how successful and important partnerships can be. This project partnered with Orange County Water (OCWD) and Sanitation District (OC San). Even within OC San, there is a collaboration between a board of members representing cities, special districts, and the county. While both districts faced different issues, they found the same solution. Sharing the cost and reaching agreements on management and funding for this project made the project attainable.

Another essential relationship this project cultivated was between the OCWD/OC San, the public, and relevant community stakeholders. This project put in work early, reaching out to the community, which paid off long-term. Outreach included over 2,000 presentations, surveys, education outreach to the general public, and relevant application of this education in the context of Orange County (Orange County Water District, 2023). These efforts, coupled with a history of transparency and quality water, helped with the transition to implement GWRS.

This project continues pursuing a relationship with the public through presentations, facility tours, brochures, videos on their website, a newsletter, and an online collection of statements from the community, government officials, and health/science professionals (Orange County Water District, n.d.). Within these statements, five out of 8 health/science professionals mentioned the “high quality” of this water source, and over 16 government officials commented positively on this source (Orange County Water District, 2023).

In 2017, GWRS water was bottled for a water tour to educate the public about the safety and taste of reused water. This tour was accompanied by a media campaign coined #GetOverIt!. This campaign won the 2018 Environmental Communications Awards Competition (American Academy of Environmental Engineers and Scientists, 2018). Additionally, bottling water for this tour set a new Guinness World Record for most recycled wastewater to drinking water in 2018 (Guinness World Records,2018). Setting a world record generated media buzz and called attention to reusing wastewater. On this tour, bottled water was especially targeted toward millennials who had the best social media engagement. In total,13,000 GWRS bottles were given out throughout this tour (American Academy of Environmental Engineers and Scientists, 2018). This campaign took into account the culture surrounding social media and recognized it as a legitimate source to spread information. Face-to-face interactions gave the public opportunities to speak with water professionals and formulate their own opinions on reuse water.

Tropical City-State: Singapore’s NEWater Success Story

Singapore is uniquely situated as a densely populated island country with little natural water storage, no mountains, and a lack of fast-flowing rivers. These characteristics prove challenging because there are few water resources, an increasing demand for water, and a need for sustainable development. As a solution to these factors, Singapore has diversified its portfolio of water supplies. These sources include local catchments, imported water, NEWater, and desalinated water (International Water Association, n.d.). Desalination is energy-intensive, expensive, and produces a waste product of brine. Imported water comes from Malaysia due to agreements signed in 1961 and 1962, the former lasting until 2011 and the latter in effect until 2061 (Ministry of Foreign Affairs, Singapore, 2025). Periods of drought in Malaysia, coupled with previous water disagreements, have influenced Singapore to take the initiative to secure its water independence and reliability, so as not to be dependent on a single source.

Singapore’s Public Utilities Board (PUB) has adopted a holistic approach to water management and strategy prioritizing effective rain catchment, endless water reuse, and desalination of more ocean water. These steps support Singapore’s progress towards becoming a sustainable water-wise city, a plan that emphasizes “creating a strong governance, building knowledge and capacity, utilizing planning tools, and implementation tools” (International Water Association, n.d.). These governing principles are embedded in the water choices Singapore makes and plans for in the future.

NEWater

NEWater is one of Singapore's national taps, which treats wastewater into clean reclaimed water. This reclamation process puts water through microfiltration/ultrafiltration, reverse osmosis, and ultraviolet disinfection. In the first step, microscopic particles and bacteria are filtered out. In the next step of reverse osmosis, a semi-permeable membrane filters out contaminants such as heavy metals, bacteria, viruses, aromatic hydrocarbons, and chlorides.

Finally, UV light inactivates any remaining bacteria/viruses in the water. Then, to balance pH, alkaline chemicals are added back into the water (Singapore's Public Utilities Board, 2024).

The quality of NEWater has been subject to over 150,000 scientific tests and meets safety requirements set by the World Health Organization (WHO) and the United States Environmental Protection Agency (International Water Association, n.d.; Singapore's Public Utilities Board, 2024). The filtration ability of these plants results in NEWater quality better than drinking-water standards set by Singapore and the WHO (Bai et al., 2020). These standards are continuously monitored; twice a year, an interdisciplinary panel of engineers, chemists, toxicologists, and microbiologists audits NEWater (International Water Association, n.d.). Despite the assurance of quality, this water is used mostly for non-potable use. The portion of NEWater used for indirect potable use has to be blended with other water in basins before it can be drawn out, treated, and then used for drinking water (Singapore's Public Utilities Board, 2024).

Despite its name, NEWater is not a new idea for Singapore. They first started exploring this idea in the 1970s and again in the 1990s when technology became more accessible and efficient (Singapore's Public Utilities Board, 2024). Implementing this source took more than just building infrastructure and technology; it took building a public relations campaign.

The Minister for Sustainability and the Environment and Minister-in-Charge of Trade Relations, Grace Fu, captured this when she stated, "Our achievements would not have been possible without public acceptance." It took substantial educational and engagement work to combat a "psychological resistance" that is common in most parts of the world (Ministry of Sustainability and the Environment Singapore, 2024).

A core part of winning public support is branding; making the name NEWater was a conscious choice in 2002 to direct away from associating recycled water with sewage and waste

(Qian & Leong, 2016; Tan, 2019). The word new makes the reused water feel innovative and attracts the public's attention. With this attention, PUB did not waste it; instead, they pulled off an intentional public education campaign. Part of this plan invested in a NEWater Visitor Centre where visitors acted as a water molecule traveling through the treatment process and looked over daily operations happening in the NEWater factory (Singapore's Public Utilities Board, 2024). While the Centre closed in 2024 (due to the reuse plant shutting down), in the years it was open, over "1.7 million visitors" came into the Centre (Ministry of Sustainability and the Environment Singapore, 2024). This type of interactive learning pedagogy helps learners think critically about this process and is a memorable experience.

Another dimension of trust-building emerged through the use of media and public communication. From a period of 1997 to 2008 Singapore press had 171 out of 223 reports with positive story lines about water reuse. The peak of this media coverage occurred in 2002, the year NEWater was brought to the public (Yu, D. J., & Leong, C., 2010). Language that was positive and clear, coupled with consistent messaging, reduced uncertainty and increased audience retention of information related to NEWater due to the frequency of seeing key messages (Qian & Leong, 2016). Staged photos with the Prime Minister Goh Chok Tong drinking NEWater helped build public confidence; if the head of government felt confident drinking it, why should the public not (Tan, 2019).

What makes Singapore a unique city-state also makes it vulnerable to climate change. When given the chance between a future of scarcity and dependence on other countries or adapting to a new water framework that ensures sustainability and security, most people would choose to overcome their aversion. Instead of trying to change people's psychological revulsion, Singapore focused on pitting "science against scarcity" (Qian & Leong, 2016, p.5). This framing is seen through stories in the media focusing more on technical and strategic aspects of reclaimed water rather than social and health topics. (Yu, D. J., & Leong, C., 2010). When providing a broader context of global scarcity of fresh water, the weight of the issue increases (Qian & Leong, 2016). This makes water reuse seem inevitable and strategically helps minimize resistance.

An interesting public engagement initiative NEWater explores is NEWbrew, a beer marketing campaign aimed at destigmatizing potable reuse (Brewerkz, 2024). This beer was publicly launched at events like Singapore International Water Week, which is explicitly about public and international outreach. At this event, two batches were brewed with NEWater and regular water. In a blind test, these beers were reported as tasting “almost the same”(Brewerkz, 2024). The beer generated media coverage, social media buzz, and public discussion. The media posts surrounding NEWbrew contained many mentions of the word “sewage” and related puns (Asian News International, 2022; Zilber, 2022). This compares to the official NEWbrew website, which refrains from mentioning any words related to sewage. Instead, the website opts for words and phrases with positive connotations, such as “premier ultra-pure recycled water,” “weather-resilient and endlessly recyclable water source,” and “ultra-clean, high-grade” (Brewerkz, 2024). Using NEWater for brewing creates a separation between reuse water and the consumer. Mentally, this could be helping the reaction to this water because, in a way, it is going into a reservoir and being transformed before being available for drinking. This is a similar process to putting NEWater in a reservoir before it is pumped to a treatment facility for drinking water.

Lessons Learned and Recommendations

Reuse projects in Colorado, Orange County, and Singapore have all found success due to their pursuit of community outreach. Taken together, these case studies reveal a shared set of strategies supporting public acceptance of reuse. These strategies include the presentation of reuse through its name, the source of information, and the platform it is shared over. On top of marketing potable water reuse, tailoring to people's lived experiences and introducing interactive education helps engage people. Building trust in water reuse is accomplished through interdisciplinary work and consistency of methods in treatment plants.

Public Outreach: From Messaging to Experience

The names of these projects are tactfully developed to separate water from the waste products it once contained. The name Groundwater Replenishment System contains information on the practical application of this water. This appeals to Californians who are aware of scarcity and saltwater intrusion issues. Further, the word replenish evokes feelings of restoration and balance. In Singapore, calling reuse water NEWater makes the water seem exciting and fresh, while PureWater in Colorado highlights the refined and clarified water quality. Focusing on these positive attributes helps water seem safer to the consumer. Just as bottled waters sell a certain image, potable reuse should also consider how water is being marketed through name and image.

The source where information is coming can be a determinant in acceptance. People can be apprehensive when information is from a source that has stakes in a project or a source that has proven to be unreliable in the past. Both Singapore and Orange County used government employees, past and present, as a reliable source of information. Singapore staged photos with government officials drinking labeled bottles of NEWater, showing the public that this is a safe form of drinking water. Orange County's website features positive comments from various government positions showing support. This website also highlights favorable comments from scientists and health professionals. Water utilities can also be seen as a reliable source if they have established a pattern of reliable and safe water. A combination of sources representing different disciplines and backgrounds helps appeal to a wide demographic of people. For this reason, it is important for a diverse array of people to deliver water reuse information.

Media platforms help reach consumers in the spaces and formats most familiar to them. Preferred media platforms vary based on certain demographics, such as age, but all people are important for the adoption of reuse. For this reason, outreach campaigns should purposefully target different groups of people across different platforms. Orange County Sanitation District has taken unique approaches to spread awareness and acceptance of GWRS. Some of these approaches include using the hashtag #GetOverIt! on social media and breaking a world record for converting recycled water to drinking water in 24 hours. In Singapore, the media helped shape positive narratives with consistent messaging and emphasis on the quality of the water. Social media is now one of the main ways people get information. These campaigns demonstrate how the media does more than share information; it shapes the tone, emotion, and public narrative around recycled water.

Tailoring outreach information and approaches to specific communities makes the information more personal and places the consumer at the center of this water issue. All three of these locations have a culture that cultivates concern for water resources. Singapore overcomes risk perception by providing an alternate scenario centered on water scarcity. Colorado already offers rebates for water conservation, and adoption of water reuse builds on this existing culture. Water scarcity is something personal and relevant to these areas, which makes the need for water reuse easier to understand when put in context. Using this personal connection is more meaningful than technical data about safety, which can be meaningless without context. By grounding communication in people's lived experiences, outreach efforts help bridge the gap between information and genuine understanding.

Education strategies involving interactive elements help demystify potable reuse. Allowing people to see, touch, and even drink recycled water allows them to validate safety and taste for themselves. Facility tours of GWRS water, mobile demonstration of PureWater filtration, beer brewed from NEWater and PureWater, and bottled reuse water handed out at events provide memorable education experiences. These experiences are more effective than hearing facts and information because they actively engage and let people experiment. Cultivating an interactive, engaged, experimental learning pedagogy helps increase the effectiveness of education, an essential aspect of adopting water reuse schemes.

Program Design and Implementation

Beyond public outreach, successful potable reuse projects rely on strong program design and implementation. Developing consistency across treatment and utilizing an interdisciplinary approach helps the efficiency and reliability of potable water reuse.

Maintaining treatment components across different countries and treatment plants helps build confidence and strengthen the literature supporting potable reuse. While the specific filters varied, all three case studies used some variation of membrane filtration combined with an advanced oxidation process. Repeated use of these technologies adds to growing global evidence showing multi-barrier treatment methods can consistently produce high-quality water.

Success in these programs was largely due to interdisciplinary approaches to developing, building, testing, and executing potable reuse. The creation of an effective water reuse treatment strategy requires chemists, engineers, biologists, public health officials, water treatment plant workers, government officials, and many more to work together. Without the combined effort of a sanitary and water district, GWRS would not be where it is today. Collaboration between these agencies created a space to share ideas, costs, and now they share the benefits. PureWater brings together lawmakers, regulators, water providers, and the public to develop and test this water. Ongoing assessment of NEWater is led by an independent, interdisciplinary expert panel that provides external scientific review and brings diverse perspectives to water quality and safety. Creating a space for collaboration between different disciplines helps increase mutual learning, innovation, and problem-solving.

Areas for More Research

While there are many positive lessons learned from these case studies, there is also room for improvement. One area to pursue is bridging social media trends with practical information because this form of media is one of the main ways people get information now. For this reason, there should be more consideration for the implementation of modern social media strategies.

Utilities should consider more studies on the taste of potable water reuse using professional panels, but also everyday consumers. Currently, recycled water tasting events are very informal and are used as an educational tool more than a structured assessment of consumer taste perceptions. Even though this water is scientifically safe, the flavor may seem off, which can affect acceptability. Going even further, separating studies into regions could help determine the extent to which where someone is from affects taste preference.

Finally, water utilities should look more specifically at what pedagogies are most effective in not just education, but also acceptance of potable water reuse. Preferences could vary based on local culture, but understanding what yields the best educational progress towards acceptance helps utilities beginning their potable reuse journey.

Conclusion

This literature review examined how physiological and psychological factors interact to affect how people perceive water. These factors were then applied to three case studies of potable water reuse in Colorado, California, and Singapore to understand what factors affect public acceptance. A common pattern throughout literature is how subjective flavor perception can be. This means mental barriers affect taste as much as the actual chemistry of the water. Through the connection to case studies, it is revealed that community-tailored outreach, consistent messaging, interactive education, and careful framing of reuse water are critical to building acceptance. These are important findings to consider as climate change prevails and populations increase, forcing the need for alternative water sources. While potable reuse seems like an obvious solution, it requires a combination of robust treatment processes, strategic communication, and engagement with the sensory and emotional experiences of consumers.

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