



# Stopping the Drain on Household Budgets

Addressing Tap Water Mistrust through Affordable Premise Plumbing Investments

**Peter Roquemore**

**Disclaimer:** This report was prepared in partial fulfillment of the requirements for the Master in Urban and Regional Planning Degree in the Department of Urban Planning at the University of California, Los Angeles (UCLA). It was prepared at the direction of the Department and of California Municipal Utilities Association as a planning client. The views expressed herein are those of the authors and not necessarily those of the Department, the UCLA Luskin School of Public Affairs, UCLA as a whole, or the client.



## **Acknowledgements:**

First, I extend gratitude to Jonathan Young and Danielle Blacet at the California Municipal Utilities Association for not only taking me and this project on, but also for their support and enthusiasm during the process.

Thank you to the Luskin Center for Innovation for supporting research into premise plumbing and water quality at the tap. Progress in research on this topic will inform policy that can benefit the lives of Californians.

An enormous thank you to my faculty advisor Greg Pierce for trusting me with this project and supporting me in the journey to move the conversation on this important issue forward. Your mentorship in water policy and planning has been invaluable to my personal growth as well as this project.

Silvia Gonzalez, for your help in reviewing my work and organizing the Premise Plumbing Working Group, thank you.

To Jonathan Leung, everyone at the Los Angeles Department of Water & Power Water Quality Team, and all of the participants in the Premise Plumbing Working Group who engaged in this project, provided feedback, and shared your data, thank you.

This project would not have been possible without the love and friendship of my fellow classmates who provided equal parts motivation to grind out long nights and to take much needed breaks.

Finally, my overwhelming appreciation and love to my Fiancé, Erin, who through the iterations of this project has become a fierce advocate for tap water – taking any bottled water drinking/tap water myth spreading coworkers to task – and giving me the space and support this project required. Thank you.

## Table of Contents

Executive Summary .....	1
Introduction .....	3
Literature Review .....	4
Background .....	4
Tap Water: Responsibility and Quality .....	4
Premise Plumbing Corrosion and Contamination .....	5
<i>Attributes and Impacts</i> .....	6
Mistrust in Tap Water .....	8
The Cost of Premise Plumbing Repair Solutions .....	9
Data and Methods.....	10
Expert Interviews and the Premise Plumbing Working Group .....	10
LADWP Case Study .....	11
<i>LADWP Overview</i> .....	11
<i>LADWP Customer Complaint Data</i> .....	11
<i>Water Filters</i> .....	12
Limitations.....	13
LADWP Customer Complaint Analysis .....	14
Customer Perception .....	14
Customer Responsibility.....	14
Premise Plumbing Issues.....	15
<i>LADWP Case Study Findings</i> .....	15
Cost of Restoring Tap Water Quality.....	16
<i>Comparing Costs of Bottled and Tap Water</i> .....	16
<i>Home Filtration Costs</i> .....	19
<i>Premise Plumbing Repair Costs</i> .....	22
Discussion.....	27
Financial and Social Barriers to Addressing Premise Plumbing .....	27
Recommendations .....	29
Gather More Premise Plumbing Data .....	29
<i>Expand Utility Customer Service</i> .....	29

<i>Public Health Department Inspections .....</i>	29
<i>Premise Plumbing Benchmarking .....</i>	30
<i>Targeting Tests in Low-Income Housing.....</i>	30
Further Engage Households on Residential Water Quality .....	30
Financing Premise Plumbing Upgrades.....	31
<i>Offer On-Bill Financing .....</i>	31
<i>Special Assessment Districts.....</i>	32
<i>State Financing.....</i>	32
Conclusion .....	34

## Executive Summary

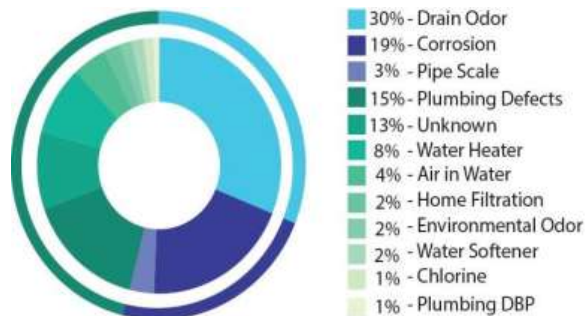
This report focuses on the issue of tap water mistrust in the City of Los Angeles. While recent research into water quality of Los Angeles Department of Water and Power (LADWP) indicates that water at the tap for their customers is safe to drink, the Los Angeles metropolitan region has one of the highest rates of household mistrust in tap water in the nation.

Mistrust in tap water is not unique to Southern California, in fact it is common across the United States. Only about a third of Americans say they usually drink straight from the tap. Many factors contribute to mistrust in tap water including socio-economic status, skepticism fueled by high profile stories like the environmental justice disaster in Flint, Michigan, individual perception of water quality based on aesthetics, and misunderstanding of responsibility for remedying tap water when an issue arises.

The trend to question tap water is not benign as there are costs associated with the mistrust. When households do not trust their tap water they rely on bottled or filtered water. Filtering tap water may remove aesthetic issues and restore trust in tap water; saving a household money. However, households should be aware that costs can vary based on filter capacity with some filters outpacing bottled water in expense. Households that do not trust tap water are more likely to consume sugary beverages and bottled water. The latter raises public health concerns and both are more expensive than the cost of tap water. In fact, this report found that in Los Angeles households purchasing bottled water pay 25 to 125 times the cost of tap water and can add thousands of dollars to household expenses each year. However, if mistrust is motivated by an aesthetic issue caused by premise plumbing, or the plumbing in the house, which is the responsibility of the property owner, repairs to remedy the problem can be costly – and in many cases out of reach for households.

By analyzing LADWP customer complaint data this report identified that over 70% of customer complaints of aesthetic tap water issues are the responsibility of the homeowner. This means financial responsibility for restoring tap water quality falls on the household, not LADWP. By identifying the cause of these aesthetic issues in premise plumbing this report found that:

- The majority of complaints have low-cost solutions and can be avoided in the future with proper plumbing maintenance.
- Water aesthetics indicate corrosion is present in 19% of complaints which could lead to repairs in the thousands of dollars.



- Switching from bottled water to tap water can create savings substantial enough to offset costs of investing in premise plumbing repair or purchasing filters.

While tap water savings are substantial, the upfront cost of a plumbing repair is great enough that households on a budget may opt to purchase bottled water. Monthly bottled water costs can be less expensive than an investment in a repair but quickly become financially burdensome over time. To ensure that households are not kept from the cost savings and health benefits of trusting and consuming tap water, utilities can create on-bill financing programs where the utility covers and upfront costs of repair and is paid back over time on a regular utility bill. More broad reaching strategies for addressing premise plumbing repair costs across localities like special assessment districts are likely not feasible without increased data on the presence of premise plumbing issues. Utilities and local governments should begin integrating premise plumbing quality in regular building inspections and conduct public outreach with water quality tests. Furthermore, engaging customers with information on how to maintain their household plumbing offers a utility the opportunity to connect to hard-to-reach households and do necessary trust building with customers.

## Introduction

Imagine turning on the faucet to fill up a glass of water first thing in the morning only to have brown or sediment-filled water pour out. The image is unsettling and the experience understandably can cause households to question the safety of their tap water.

Trust in tap water is low across the nation and particularly in Southern California. This report focuses on the issue of tap water mistrust in the City of Los Angeles. While recent research into water quality of Los Angeles Department of Water and Power (LADWP) indicates that water at the tap for LADWP customers is safe to drink,<sup>1</sup> the Los Angeles metropolitan region has one of the highest rates of household mistrust in tap water in the nation.<sup>2</sup>

Some of this mistrust is due to the misperception of risk and the crisis in Flint, Michigan has rationally sparked national anxiety around the quality of tap water. In Los Angeles, there are communities that have faced different types of systemic problems with water service and neglected quality resulting in discolored water or otherwise unclean water. While system issues have been highlighted in the media there is a lesser studied cause for unclean water coming from the tap. Plumbing in the residence, or premise plumbing, can alter the taste, color, and smell of tap water. Unclean or unsafe water drawn from the tap fuels household mistrust in tap water. This mistrust can drive families to choose bottled water and sugary bottled beverages over tap water. This decision stresses household budgets and increased intake of sugary beverages has negative public health implications.<sup>3</sup> Mistrust also undermines many of the good-faith efforts of water systems to serve their customers well.

Addressing mistrust caused by premise plumbing is complicated by social and financial barriers. Federal policy ends water utility responsibility for water quality at the property line where responsibility transfers to the property owner. Addressing gaps in carrying out this responsibility can be made more difficult in urban environments by tenant/landlord relationships, perceptions of aesthetic water quality, and the financial barriers to fixing a premise plumbing problem.

This report assesses both the prevalence of premise plumbing issues in Los Angeles and the financial options households have to obtain clean water that they trust for drinking and cooking. We analyze customer complaints, and compile costs of plumbing work, water filters, and bottled water to compare to the cost of tap water to

---

<sup>1</sup> Auger-Velez, V., LaCoe, R., Rabinowitz, C., & Zhao, B. LA TAP (Tap Water Action Plan): Evaluating the Customer Experience of Tap Water in Los Angeles

<sup>2</sup> American Housing Survey 2015

<sup>3</sup> Ariana Javidi and Gregory Pierce, "U.S. Households Perception of Drinking Water as Unsafe and Its Consequences: Examining Alternative Choices to the Tap," *Water Resources Research* 54, no. 9 (2018): , doi:10.1029/2017wr022186.



inform recommendations that stakeholders can use to build trust and reduce financial barriers to safe, clean, and affordable tap water.

## Literature Review

### Background

In the late twentieth century, a combination of new technology and policy improved delivered water in regulated community water systems. The use of advanced filtration, chemical treatment, and protected water ways have led to the virtual elimination of deadly waterborne disease in the United States.<sup>4</sup> The Lead and Copper Rule passed in 1991 was successful in reducing household exposure to toxic levels of lead and copper in tap water, although gaps especially post-Flint have become apparent.<sup>5</sup> Despite these improvements the United States Environmental Protection Agency (EPA) estimates the cost to update and maintain the nation's water delivery infrastructure to federal standards in the tens to hundreds of billions of dollars.<sup>6</sup>

Drinking water quality in the United States has been the subject of national attention in recent years following the environmental justice crisis in Flint, Michigan where residents were exposed to *Legionella* and lead poisoning. There have also been water quality issues in the San Joaquin Valley of California. Images in the media of brown, red, and orange water coming from kitchen sinks and bathtubs and stories of poisoned children threw the spotlight on mismanagement by some water utilities. In Los Angeles County, there are few cases of overt water system failure which suggest tap water is unsafe. At the same time, there are an increasing number of well-documented accounts in the media of discolored, foul-smelling, and poor-tasting water in largely disadvantaged communities served by publically-regulated drinking water systems.<sup>7</sup>

High profile water contamination stories in the media fuel mistrust of tap water quality, build the perception that tap water is not safe and that any aesthetic irregularity is cause for alarm. One of the lesser studied sources of aesthetic irregularity and mistrust in tap water are the non-lead impacts of residential premise plumbing.

### Tap Water: Responsibility and Quality

The Safe Drinking Water Act (SDWA) passed in 1974 (amended in 1986 and 1996) protects public health by regulating the nation's public drinking water supply. The rules apply to every public drinking water system in the nation defined as a having at least 15 service connections and 25 people for 60 days of the year. The EPA sets national standards for drinking water and public water systems are responsible for

---

<sup>4</sup> Ronnie B. Levin et al., "U.S. Drinking Water Challenges in the Twenty-first Century.," *Environmental Health Perspectives* 110, no. Suppl 1 (2002): , doi:10.1289/ehp.02110s143.

<sup>5</sup> <https://www.epa.gov/sdwa>

<sup>6</sup> *ibid.*

<sup>7</sup> Jennings, A. (2019, February 13). Compton district that served 'disgusting' drinking water will cease to exist. Los Angeles Times. Retrieved April 9, 2019, from <https://www.latimes.com/local/lanow/la-me-sativa-water-district-compton-20190213-story.html>

ensuring the tap water delivered to the public does not exceed contaminant levels in those standards.<sup>8</sup>

The infrastructure that falls under EPA authority in the SDWA totals approximately one million miles in pipe length. However, there exists an additional piped infrastructure of over six million miles of private pipeline that falls outside of the protections established in the SDWA. The Nation Research Council defines premise plumbing as, “the portion of potable water distribution system associated with schools, hospitals, public and private housing, and other buildings.” It is connected to the main distribution system via the service line. A key factor in premise plumbing is the lack of clarity among the public over where responsibility lies in premise plumbing and water quality at the tap. Aside from the Lead and Copper Rule, EPA regulation stops at the property line, demarcating public and private infrastructure. It is common to find that customers believe the EPA regulations extend to their tap water which can leave customers who are faced with repairs due to premise plumbing leaks or contamination feeling lost. One survey revealed respondents felt they had inadequate information about their premise plumbing and felt “frustrated” by water utilities, contractors, and insurance companies.<sup>9</sup>

Public pipe infrastructure and the water quality it aims to deliver is monitored and maintained by the public drinking water systems that are held accountable by the EPA, state, and customers. However, as water crosses into the private property it faces a number of variables of material and care that impact the quality of water that a household experiences when they turn on the tap. Stagnant water, high surface area to volume ratios, different pipe materials, extreme temperatures, reduced disinfectant residuals, potential regrowth of bacteria, variable velocities, vapor and bioaerosol exposure, frequent cross connections, and leaching and permeation are all factors in premise plumbing which can contribute to degraded water quality and exposure at the tap.<sup>10</sup>

### Premise Plumbing Corrosion and Contamination

The California Human Right to Water, Assembly Bill (AB) 685 passed in 2012, ensures safe, clean, affordable access to drinking water for every human.<sup>11</sup> While public water systems are held to standards to ensure delivery of safe water to residences, conditions in private premise plumbing can result in unclear or even unsafe water at the tap. Issues range from life threatening issues like Legionella, lead, and copper poisoning to less harmful but still off-putting contamination like color, taste, and odor changes. These aesthetic irregularities can discourage tap water use and fuel skepticism of tap

---

<sup>8</sup> <https://www.epa.gov/sites/production/files/2015-04/documents/epa816f04030.pdf>

<sup>9</sup> Ewa J. Kleczyk and Darrell J. Bosch, "Incidence and Costs of Home Plumbing Corrosion," *Journal - American Water Works Association* 100, no. 12 (2008): , doi:10.1002/j.1551-8833.2008.tb09804.x.

<sup>10</sup> *Drinking Water Distribution Systems: Assessing and Reducing Risks* (Washington, DC: National Academies Press, 2006).

<sup>11</sup> [https://www.waterboards.ca.gov/water\\_issues/programs/hr2w/](https://www.waterboards.ca.gov/water_issues/programs/hr2w/)

water safety. Conditions in premise plumbing can encourage the deterioration of water quality through the release of contaminants, defined by the EPA as “any physical, chemical, biological, or radiological substance in water”, or through opportunistic premise plumbing pathogens like *Legionella pneumonia*, *Mycobacterium avium*, and *Pseudomonas aeruginosa* that exist naturally in drinking water sources but whose growth may accelerate under certain conditions.<sup>12,13</sup>

While lead and *Legionella* contamination are more serious public health issues, the focus of this report are premise plumbing events that are more likely to impact customer perception of tap water like taste, odor, and color. For instance, the “tap water aesthetics related to premise plumbing material” were a top factor in influencing homeowner decisions on plumbing investment.<sup>14,15</sup> Individual customer perceptions vary widely making it difficult to set and use quantifiable standards for aesthetic water qualities. For instance, the actionable level for copper in tap water is 1.3 mg/L. The EPA sets a taste threshold for copper in water at 1 mg/L but multiple studies on individual taste thresholds have resulted in a range of 0.2 mg/L up to 13 mg/L.<sup>16</sup> Additionally, chlorine is a chemical used in treatment of tap water. While many customers complain about slight chlorine tastes, others associate the taste with safety of their water. Individual perceptions vary but consistency in how water looks and tastes is important for building trust. Customers often acclimate to a consistent product and in the case of tap water, a signal that it is safe. When inconsistencies arise in the quality or quantity it is a signal that something has changed which could mean that the change could be unsafe.<sup>17</sup>

#### *Attributes and Impacts*

Critical to understanding tap water perception and determining responsibility is understanding the root cause of different aesthetic impacts. Tap water taste, color, and odor is influenced by naturally occurring minerals in the water source, treatment chemicals, pH levels, and leaching of pipe materials into water. Tables 1 and 2 (below) separate the aesthetic perception impacts described below into attributes found in water and those caused by premise plumbing materials. Metallic tastes in water are most commonly caused by leaching of copper or steel from premise plumbing pipe material.

---

<sup>12</sup> <https://www.epa.gov/ccl/definition-contaminant>

<sup>13</sup> Joseph Falkinham, "Common Features of Opportunistic Premise Plumbing Pathogens," *International Journal of Environmental Research and Public Health* 12, no. 5 (2015): , doi:10.3390/ijerph120504533.

<sup>14</sup> I.h. Mel Suffet et al., "AWWA Taste and Odor Survey," *Journal - American Water Works Association* 88, no. 4 (1996): , doi:10.1002/j.1551-8833.1996.tb06542.x.

<sup>15</sup> Juneseok Lee et al., "Homeowners Decision-making in a Premise Plumbing Failure-prone Area," *Journal - American Water Works Association* 105, no. 5 (2013): , doi:10.5942/jawwa.2013.105.0071.

<sup>16</sup> Ignacio Vargas et al., "Copper Corrosion and Biocorrosion Events in Premise Plumbing," *Materials* 10, no. 9 (2017): , doi:10.3390/ma10091036.

<sup>17</sup> Andrea M. Dietrich, "Aesthetic Issues for Drinking Water," *Journal of Water and Health* 4, no. S1 (2006): , doi:10.2166/wh.2006.0038.

High pH can also result in a metallic taste and low pH leaving a bitter taste.<sup>18</sup> Iron concentrations in water as low as 0.3 mg/L result in yellow or rust colored stains on clothes and fixtures while ferric iron deposits from corroded pipes result in rust colored water.<sup>19</sup> Copper concentrations in water can also result in blue and green stains on fixtures in pipes.<sup>20</sup> Further, it has been documented that high concentrations of copper in water have turned the hair of consumers green after showering.<sup>21</sup>

*Table 1. Top Aesthetic Water Indicators*

<b>Water Attributes</b>	<b>Perception Impact</b>
<b>pH</b>	Low pH – Bitter Metallic Taste, High pH – Slippery feel/Soda taste
<b>Total Dissolved Solids</b>	Salty Taste
<b>Chloride</b>	Salty Taste
<b>Zinc</b>	Metallic Taste
<b>Manganese</b>	Bitter or Metallic Taste
<b>Iron</b>	Yellow or Rust Colored Water or Stains.

*Table 2. Common Aesthetic Water Indicators from Premise Plumbing Materials*

<b>Pipe Material</b>	<b>Perception Impact</b>
<b>PvC</b>	Gasoline like odor
<b>HDPE</b>	Sweet, solvent, phenol like odor
<b>PEX</b>	Chemical or solvent like odor
<b>Copper</b>	Metallic taste, brown/yellow color, blue/green stains, pinhole leaks
<b>Steel</b>	Metallic taste, sediment, rust colored water

High density polyethylene pipe (HDPE) is a common plastic recognized by the “2” symbol on the product, is used in premise plumbing, and has been shown to result in an oily/plastic/citrus odor in tap water. Polyvinyl chloride (PvC) pipe is associated with gasoline like odor. Another common plastic used in premise plumbing, cross-linked

<sup>18</sup> Gary A. Burlingame, Andrea M. Dietrich, and Andrew J. Whelton, "Understanding the Basics of Tap Water Taste," *Journal - American Water Works Association* 99, no. 5 (2007): , doi:10.1002/j.1551-8833.2007.tb07930.x.

<sup>19</sup> Alex Colter and R.L. Mahler, *Iron In Drinking Water*, report, College of Agriculture and Life Science., University of Idaho

<sup>20</sup> Mark L. McFarland, Tony L. Provin, and Diane E. Boellstorff, *Drinking Water Problems: Corrosion*, report, AgriLife Extension, Texas A&M.

<sup>21</sup> J. J. Nordlund, "On the Cause of Green Hair," *Archives of Dermatology* 113, no. 12 (1977): , doi:10.1001/archderm.113.12.1700.

polyethylene (PEX), has been found to produce odors described as “chemical or solvent” like.<sup>22</sup>

An additional concern in copper piping is the development of pinhole leaks. Copper corrosion can form in two ways, by forming scales and leaching into the water or in concentrated hot spots that create holes perpendicular to the flow of water. Leaks in copper piping introduce the potential for additional contaminants to enter the water stream, can encourage mold growth, and damage floors, walls, and ceilings causing the cost of premise pipe repair to grow beyond the cost of filtration or pipe replacement. Not only do additional costs from pinhole leaks increase the unaffordability of these projects, they also place stress on households who may have to relocate during repairs or lose access to their household plumbing for drinking, cooking, bathing, and washing clothes during the course of the repair.<sup>23</sup>

### Mistrust in Tap Water

Mistrust in tap water is common across the United States. Only about a third of Americans say they usually drink straight from the tap.<sup>24</sup> Another third drink filtered tap water and another third rely on bottled water. Literature suggests that income and race play a role in trust in tap water and reliance on bottled water. Sixty percent of Households with annual incomes under \$50,000 cite concerns about contamination as reasons for not drinking tap water while only forty percent of households with annual incomes over \$100,000 share those concerns.<sup>25</sup> Pierce and Gonzalez (2016) find that factors in American households’ strongly influencing perception of drinking water are education level, income, racial or ethnic minority status, and most importantly foreign-born nativity.<sup>26</sup> In their study on mistrust of tap water, they found lower income households of Latino descent tended to mistrust tap water at higher rates than foreign-born households of other world regions.

Onufrak et al (2012) studied perception of tap water and favorability of bottled water and found that over 24.6% of respondents believe bottled water to be safer than tap water and that mistrust in tap water was closely related to minority status, in particular, among non-whites who mistrust their tap water, there is a higher likelihood of

---

<sup>22</sup> M.I. Durand and A.m. Dietrich, "Contributions of Silane Cross-linked PEX Pipe to Chemical/solvent Odours in Drinking Water," *Water Science and Technology* 55, no. 5 (2007): , doi:10.2166/wst.2007.174.

<sup>23</sup> Ibid

<sup>24</sup> Tobin, M. (2017, June 27). AP-GfK water poll finds many Americans avoid tap water. Retrieved May 14, 2019, from <https://waterpolls.org/ap-gfk-flint-water-poll-2016/>

<sup>25</sup> <https://www.csmonitor.com/Environment/2016/0305/Most-Americans-don-t-drink-or-trust-tap-water-Should-they>

<sup>26</sup> Gregory Pierce and Silvia Gonzalez, "Mistrust at the Tap? Factors Contributing to Public Drinking Water (mis)perception across US Households'," *Water Policy* 19, no. 1 (2016): , doi:10.2166/wp.2016.143



relying on bottled water.<sup>27</sup> Mistrust in tap water that results in increased bottled water or sugary bottled beverage intake not only has public health consequences, but also can create a financial burden for households. Research shows that a household relying on bottled water for drinking and cooking can see annual costs range from \$983-\$1499 for bottled water alone.<sup>28</sup> Considering that low-income communities of color are more likely to mistrust tap water and rely on bottled water this increase in spending can be especially burdensome.

### The Cost of Premise Plumbing Repair Solutions

The financial cost to a household to repair premise plumbing or address aesthetic issues of water varies depending on the issue, the size of the residence, materials used in plumbing, and personal preference. When compared to the average monthly water bill or average monthly bottled water cost, the upfront cost of premise plumbing repairs can be daunting. Point-of-use (POU) filter devices can address certain aesthetic qualities in tap water and may satisfy the perception issues of households. POU costs to consider include not only upfront purchase price and potential installation fees, but also the cost of replacing filters periodically. Household expenditure on POU devices is difficult to assess because device costs range from under \$100 to several hundred of dollars and filter replacement schedules vary based on perception and water quality.

In contrast, infrastructure repair or replacement is more costly upfront but less expensive to maintain. Households suffering from pinhole leaks report repair costs ranging from a few hundred dollars with the highest reported repair due to corrosion costing \$25,000.<sup>29</sup> The cost to treat residential pipes or re-pipe with copper or plastic can range from \$6,500 - \$9,000 depending on the material and size of home.<sup>30</sup> These costs are far beyond the annual median household expenditures on plumbing or plumbing fixture repairs at \$1500 and \$660, respectively.<sup>31</sup> This research contributes to current literature by exploring the costs of premise plumbing repair if structured so that the upfront burden does not deter property owner investment through a cost comparison model.

---

<sup>27</sup> Stephen J. Onufrak et al., "The Relationship of Perceptions of Tap Water Safety with Intake of Sugar-sweetened Beverages and Plain Water among US Adults," *Public Health Nutrition* 17, no. 01 (2012): , doi:10.1017/s1368980012004600.

<sup>28</sup> Ibid

<sup>29</sup> Ibid

<sup>30</sup> Ibid

<sup>31</sup> American Housing Survey 2017

## Data and Methods

This research presents an opportunity to look further into the causes of mistrust and how aesthetic qualities may reinforce the poor perception of City of Los Angeles tap water. Household choice of drinking water typically falls into drinking tap water, filtering tap water, or purchasing bottled water. This report first compares the costs of each of those options. This report further uses Los Angeles Department of Water and Power (LADWP) customer complaint data to determine how many complaints are due to pure misperception, system distribution network issues or premise plumbing issues. It further identifies which premise plumbing issues are present in the city of Los Angeles and how frequently they occur. Interviews with industry experts provide the costs of repair to those issues. Comparing those costs can inform policy makers about financial mechanisms to enable affordable plumbing upgrades and provide insight into how differences in the time horizon of costs could influence drinking water investment decisions.

### Expert Interviews and the Premise Plumbing Working Group

The Premise Plumbing Working Group (PPWG) is an informal working group organized by the University of California, Los Angeles (UCLA) Luskin Center for Innovation that brings together experts from the public and private sectors to discuss solutions to premise plumbing issues in California. Progress on this report and its findings were shared with the PPWG on a quarterly basis to solicit feedback.

To gain insight into the perspective of water utility staff on the current state of premise plumbing issues interviews were conducted with staff from three members of the California Municipal Utilities Association utilities listed below:

- Operations Manager for Pasadena Power and Water
- Water Conservation Manager for East Bay Municipal Utility District
- Assistant Director and Staff Team from Water Quality Division at LADWP

The existing literature on premise plumbing lacks information on the cost of addressing premise plumbing issues in California. To obtain relevant and current costs for plumbing work, outreach was conducted to a range of relevant plumbing industry and plumbing industry adjacent associations and experts listed below:

- Apartment Owners Association of California Inc.
- Building Owners and Managers Association International
- California Apartment Association
- California Rental Housing Association
- International Association of Plumbing and Mechanical Officials
- Local Union Plumbers 78
- National Association of Residential Property Managers
- Plumbers and Steamfitters Local Union 342
- Trimble, Inc. – publisher of the Plumbers Pricing Manual
- Ten local Los Angeles Plumbers

Outreach to landlord and property management groups did not result in cost findings. Responses from these sources indicated that per-unit spending decisions are privately held by each landlord. Plumbers were generally reluctant to provide specific cost estimates for hypothetical projects in order to avoid being cited for certain prices. Neither IAPMO nor Trimble, Inc. could provide cost estimates. The most fruitful interview was conducted with the assistant business manager from Plumbers & Steamfitters Local Union 342 based in Concord, CA who provided a list of costs estimates, labor, and materials for common premise plumbing projects.

## LADWP Case Study

To measure water quality perception and the need for premise plumbing upgrades this study focuses on a single water provider's customer complaint data. Focusing on a single water provider allows this study to control for potential variation in utility response protocols, system water quality, water system supply, and regional policy that impacts the residential tap water experience.

### *LADWP Overview*

LADWP serves all four million people within the City of Los Angeles. LADWP is a member organization of the report client, California Municipal Utilities Association. LADWP's 4,900 employees provide 310 million gallons-per-day to 609,694 residential connections in Los Angeles across 473 square miles.<sup>32,33</sup> LADWP Water Quality Reports indicate delivered water is within federal and state standards.<sup>34</sup> For instance, a recent study of water quality at the tap based on the same data set used in this report indicates that in 99.4% of tap water in homes of customer complaints fell within Federal safety standards.<sup>35</sup>

### *LADWP Customer Complaint Data*

The LADWP Water Quality Team provided residential customer complaint data it compiled for the years, 2016-2018. The 2016-2017 set of data required cleaning to remove duplicate complaint lines. LADWP customer care protocols require each customer complaint and accompanying water quality tests and results to be logged. This protocol provides a customer complaint data set that allows analysis of customer perception, water quality, and whether responsibility lies with LADWP or the customer. Responsibility is determined by comparing water quality tests and aesthetic observations at the supply line to a property and at one or more taps within the residence. Any elevated chemical presence from indoor samples or aesthetic difference in supply and indoor observations tells us the issue is originating in the premise plumbing and therefor is an issue of customer responsibility. Responsibility on the customer side of the

---

<sup>32</sup> <https://www.ladwp.com/ladwp/faces/ladwp/aboutus/a-water/a-w-factandfigures>

<sup>33</sup> [https://sdwis.waterboards.ca.gov/PDWW/JSP/WaterSystemDetail.jsp?tinwsys\\_is\\_number=2544&tinwsys\\_st\\_code=CA&wsnumber=CA1910067](https://sdwis.waterboards.ca.gov/PDWW/JSP/WaterSystemDetail.jsp?tinwsys_is_number=2544&tinwsys_st_code=CA&wsnumber=CA1910067)

<sup>34</sup> Los Angeles Department of Water & Power Drinking Water Quality Report 2017

<sup>35</sup> Ibid

property line comes with the financial responsibility to fund any upgrades or improvements to premise plumbing to address the aesthetic issue. To determine the likely premise plumbing issue(s) present, the aesthetic issues described in the complaint notes were paired by the author with known premise plumbing material indicators. This analysis provided the frequency that premise plumbing issues present themselves in customer complaints in the LADWP service area.

### *Water Filters*

Tap water filters come in a variety of styles with some attaching to faucets, integrating into plumbing, or standing on counter tops. Each style has further variation in filter capacity, design. To choose among filter types to analyze, this study consulted the Centers for Disease Control water filtration recommendations and National Sanitation Foundation ratings.

A filter's capacity is determined by the quality and volume of water running through a filter and the type contaminant that a device must filter. The varied nature of perception and premise plumbing issue may allow some households using filtration devices to use filters that address fewer aesthetic issues. Other households may need more advanced filters that essentially "work harder" and may need to be replaced more frequently making it difficult to assign a realistic monthly cost estimate for filter replacement. There is a dearth of literature on household filter management and it is out of the scope of this report to fully explore these trends. However, comparing the capacity of filters can provide maximum costs of replacing filters.

Online retail markets were also researched to collect a range of costs at check-out for home filtration devices. We then select popular retail models and calculate estimated monthly cost for filter replacement and cumulative costs over one and five years for filter replacement based on the filtration demands required to filter 3.96 gallons of tap water per person per day in the average household size in Los Angeles.

## Limitations

The data provided by LADWP for the analysis in this report only includes water quality issues that have been volunteered by customers filing an official complaint with LADWP. We recognize that roughly 65% of households pay their own water utility bill in California; this number is likely even lower in LADWP territory due to the high prevalence of master-metered apartment rentals in the city.<sup>36</sup> The remaining households may lack information necessary to raise a water quality issue with LADWP given they do not hold direct water accounts. It is recognized that tenant/landlord relationships, especially among undocumented or low-income populations, may deter tenants from filing formal complaints with LADWP or approaching their landlord for assistance. For these reasons the data used in this report does not fully capture the scale of tap water complaints in Los Angeles is likely not representative of all concerns.

The data provided by the LADWP Water Quality Team also required interpretation. The 2016-2017 data set included qualitative notes from LADWP staff that this report analyzed and coded. The 2018 data did not include qualitative notes from LADWP staff on-site inspections or phone call logs. Therefore, 2018 data was not used to analyze perception but is included in analysis of plumbing issues present in complaints.

---

<sup>36</sup> American Housing Survey 2017



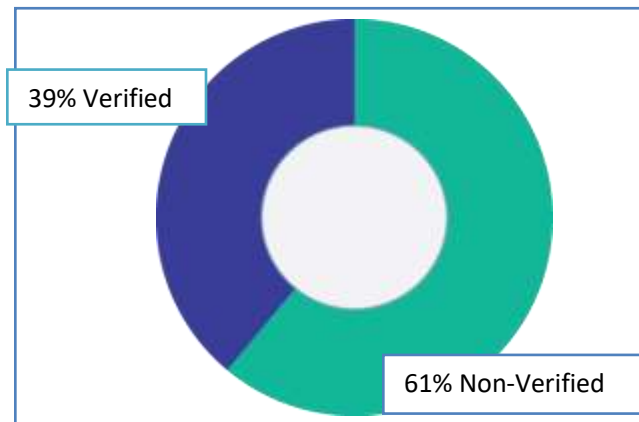
## LADWP Customer Complaint Analysis

### Customer Perception

When LADWP receives a customer water quality complaint it is logged and an appointment for an at home inspection is scheduled, if requested. LADWP includes notes from the inspection and water quality test results in the customer complaint file. Using the text of the initial complaint each customer complaint is categorized as aesthetic or not. If it is aesthetic, the initial complaint was compared to notes from the inspection

and water quality tests to determine if LADWP staff agreed with the customer that an aesthetic issue is present in the tap water. This report categorizes complaints as “Verified” if LADWP observations confirm the aesthetic issue present in the customer complaint and “Non-Verified” when LADWP observations do not indicate an aesthetic issue on site. Figure 1 (above) depicts the 1448 complaints categorized as aesthetic from years 2016 and 2017; 61% were non-verified in the course of on-site inspections by LADWP employees or in water quality tests. In short, unsurprisingly in light of the literature, the results of this analysis suggest there is a large misperception issue taking place with customers who file water quality complaints with LADWP.

Figure 1: LADWP Aesthetic Water Complaints



### Customer Responsibility

Verified complaints were then subsequently classified by LADWP as either its responsibility or the customer's. A minority of the complaints categorized as LADWP responsibility were tied to temporary and focused disturbances in water quality including construction on a local water main, algal blooms during a nearby wildfire, or a broken fire hydrant. Figure 2 (below) shows that the majority of aesthetic complaints verified by LADWP were the responsibility of the customer to address. Seventy-three percent of aesthetic complaints are due to water quality issues that originate on the customer side of the property line in the premise plumbing. The high rate of complaints that are customer responsibility is consistent with previous research confirming the quality of LADWP delivered water.

Figure 2: Responsibility of LADWP Customer Complaints



Image Sources, Alturas Homes & Ron Gilbert

### Premise Plumbing Issues

Further analysis was conducted to classify each premise plumbing issue with respect to the source cause of the problem. Shown in Figure 3 this assessment indicates that the majority of complaints are due to minor plumbing and routine maintenance issues in household

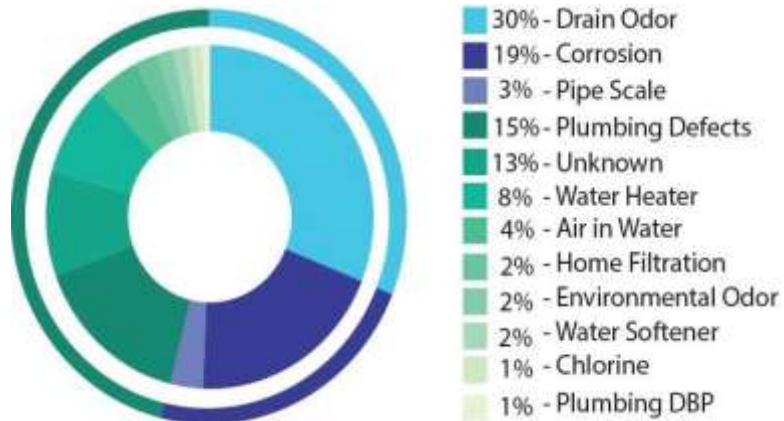


Figure 3: Premise Plumbing Issues

plumbing and appliances. Drain odor is the most common reason for a confirmed customer complaint (30%). These issues can be easily and cheaply addressed by disinfecting the problem drain with bleach, but may require a plumber if issues persist. Roughly one fourth of all complaints relate to the presence of copper or galvanized steel corrosion. Corrosion is a serious premise plumbing issue that can lead to unsafe levels of copper in water, pinhole leaks, water damage, and mold issues in areas near leaks.<sup>37</sup> Solving a corrosion related premise plumbing issues is often more costly and invasive for a household if sections of walls, floors, or ceiling must be removed to access pipes.<sup>38</sup> This analysis provides insight into the aesthetic water issues households in Los Angeles face that may drive mistrust in tap water quality as well as the costs for household to restore water quality.

### LADWP Case Study Findings

1. Tap water perception in Los Angeles is present and an obstacle to building trust in tap water quality:
  - a. Data from 2016-2017 shows 61% of complaints were not verified by LADWP staff conducting inspections. In these cases, households perceived an aesthetic issue in their tap water that LADWP staff did not perceive.

<sup>37</sup> Ibid

<sup>38</sup> Ibid

- b. Drain odor complaints illustrate a classic case of misperception as customers blamed odor on water when the origin was the drain itself.
- 2. Customer Responsibility: 73% of verified complaints are responsibility of the customer. There is a need for accessible materials and information on understanding responsibility changes at the property line and how to address premise plumbing issues for customers.
- 3. Low Hanging Fruit: 80% of complaints are related to routine maintenance or perceived water odor. Resolving these issues comes at relatively low cost or no cost if avoided with regular maintenance of premise plumbing.
- 4. Corrosion Risk: Nearly one fourth of all aesthetic complaints indicate potential corrosion in pipes.

### Cost of Restoring Tap Water Quality

The frequency of issues identified above advances our understanding of household encounters with premise plumbing defects. However, in order to design policy to effectively prevent or remedy the occurrences we need to map the costs a household or landlord faces to address a defect and compare those to the costs of bottled and filtered water. To understand the affordability of premise plumbing solutions, this report compares the costs of three major responses to mistrust at the tap: bottled water reliance, filtration, and infrastructure repair or replacement. First, we calculate the expected ongoing cost of a household to rely on bottled water for cooking and drinking needs compared with the cost of that household using the same quantity of water from the tap and paying current LADWP rates. Next, we look at the cost over time of maintaining a home water filtration device. Finally, we examine the one-time costs for repairing the premise plumbing issues present in the LADWP customer complaint data.

This analysis provides two cost analysis perspectives, a short-term month-to-month cost and a long-term cost analysis over multiple years. We recognize that the incentive of long-term financial benefits are difficult for households living pay check to pay check to realize and that monthly expenses may drive their decision making. Moreover, we consider the split incentives present in the tenant-landlord relationship, and limited ability of the tenant to make major investments in their residence. In a renter household, the tenant receives the immediate benefits of affordable and clean tap water while the cost falls on the landlord. Through the expertise on the Premise Plumbing Working Group potential legal avenues for tenants to compel premise plumbing repair were explored. No legal precedent was identified and this strategy was not further considered. Lacking a tangible financial benefit or legal pressure, the landlord is less motivated to make a repair unless a present health hazard mandates the investment.

### *Comparing Costs of Bottled and Tap Water*

In Los Angeles, households who mistrust the quality of their tap water and choose to rely on bottled water for drinking and cooking needs can face annual costs of water increase by nearly \$1000 a year on the low end and \$4,900 per year at the high end. To compare the costs of bottled and tap water this report uses the average household size in Los Angeles of 2.83 people and average daily consumption for

drinking and cooking purposes per person of 3.96 gallons-per-day.<sup>39,40</sup> Annually, this rate of daily consumption equals 5.4 CCF, or 4,035 gallons. LADWP charges residential consumers in a single-family home \$6.40 per CCF.<sup>41</sup> This analysis rounded up to 6 CCF to account for LADWP water metering practices. When metering LADWP charges customers at the last whole number, dropping off decimal readings or mid-dial readings.<sup>42</sup> This rounding may result in a slightly higher cost for tap water in the analysis but avoids under estimating tap water costs by rounding down below average consumption. When comparing costs over time this analysis assumes an annual increase of 4% in the price of tap water. This is consistent with recent cost increases and similar analysis that incorporates tap water costs.<sup>43</sup>

Bottled water costs vary depending on the quantity purchased and the location purchased. Common packing are larger 5-gallon containers or packages of 24 16.9oz bottles. The International Bottled Water Association indicates that consumers purchase bottled water from a variety of sources and that convenience stores likely offer higher costs but that only 4.7% of bottled water is purchased at a convenience store while 33.6% of bottled water is purchased in bulk from club stores, dollar stores, or online.<sup>44</sup> Javidi & Pierce (2018) found that the average cost of non-sparking bottled water was

---

<sup>39</sup> US Census Quick Facts 2018: Los Angeles city, California

<sup>40</sup> Javidi, A., & Pierce, G. (2018). U.S. Households Perception of Drinking Water as Unsafe and its Consequences: Examining Alternative Choices to the Tap. *Water Resources Research*, 54(9), 6100-6113. doi:10.1029/2017wr022186

<sup>41</sup> Retrieved from [https://www.ladwp.com/ladwp/faces/ladwp/aboutus/a-financesandreports/a-fr-waterrares/a-fr-wr-schedulearesidential?\\_adf.ctrl-state=3ywtb4b1\\_4&\\_afLoop=742700384724579](https://www.ladwp.com/ladwp/faces/ladwp/aboutus/a-financesandreports/a-fr-waterrares/a-fr-wr-schedulearesidential?_adf.ctrl-state=3ywtb4b1_4&_afLoop=742700384724579)

<sup>42</sup> Retrieved from [https://www.ladwp.com/ladwp/faces/wcnav\\_externalId/r-cs-how-read-watr-metr?\\_adf.ctrl-state=12ujt11rja\\_4&\\_afLoop=1211315454141329](https://www.ladwp.com/ladwp/faces/wcnav_externalId/r-cs-how-read-watr-metr?_adf.ctrl-state=12ujt11rja_4&_afLoop=1211315454141329)

<sup>43</sup> Jessup, K., DeShazo, J. R., & Panjwani, A. (2016). Turf replacement program impacts on households and ratepayers: An analysis for the city of Los Angeles. Los Angeles: Luskin Center for Innovation.

<sup>44</sup> Retrieved from <https://bottledwater.org/economics/real-cost-of-bottled-water>

\$1.21 per gallon and the cost of purchasing bottled water in larger quantity 5-gallon dispensers at \$0.25 per gallon.<sup>45</sup>

As shown in Figure 4, monthly cost of bottled water per household may vary greatly. The average monthly cost of purchasing bottled water in 5-gallon quantities is \$85.21 and \$406.80 for households relying on packages of 16.9 oz bottles. These costs dwarf the estimated \$3.20 monthly cost of tap water for cooking and drinking needs resulting in a monthly household savings range of \$82.01 - \$403.60 for households using tap water.

*Figure 4: Cost of Water*



Considering that households of lower income tend to mistrust their tap water at higher rates this presents both household health and affordability concerns.<sup>46</sup>

This analysis compares the marginal cost of water for drinking and cooking and does not include any fixed service fees households may pay, because in the case of LADWP, it does not charge any such fees.

<sup>45</sup> Ibid

<sup>46</sup> Ibid



## Home Filtration Costs

One-third of surveyed households indicated preference for filtered tap water.<sup>47</sup> Filters can restore confidence in tap water quality by removing perceived aesthetic qualities and bringing tap water into household preference. For households that choose bottled water due to an aesthetic tap water issue this analysis finds that home filtration is a more cost-effective method to providing trusted and satisfactory water than purchasing bottled water.

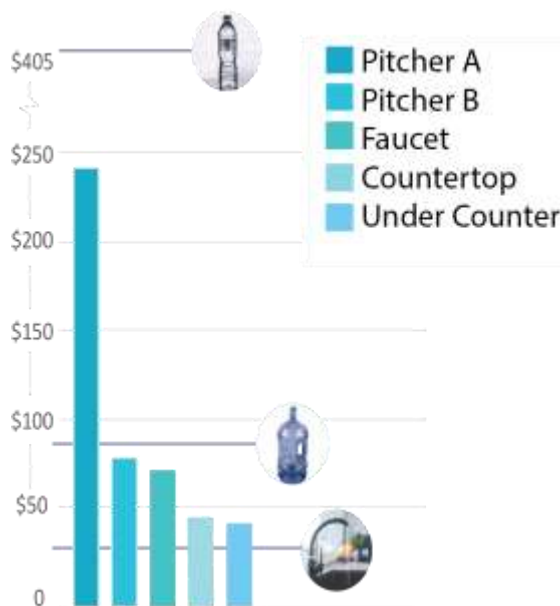
However, if an aesthetic issue is present that indicates corrosion or degradation of premise plumbing materials a water filtration device may only mask the underlying cause which could grow and create larger problems for the household.

The costs of repairing premise plumbing defects are addressed further in later sections of this report.

A wide range of water filter types are available in retail for households to choose. Products vary in the type of contaminant they filter, the filtration capacity, the size of the device, and whether they are free standing or installed directly into plumbing. Households should consult the National Sanitation Foundation ratings for retail filters to ensure the filter is rated for adequate aesthetic or contaminant filtration.

Households should consider in their choice that filtration devices require periodic filter replacements that add to the lifetime cost of relying on such a device for drinking or cooking water in addition to paying regular water bills. To understand the household cost of relying on a filtration device this report collected a range retail of prices for home filter devices and calculated the estimated expenditure for filters over time.

Figure 5: Monthly Cost Comparison



<sup>47</sup> Ibid

Table 3 (below) compares the costs and filter capacity of different types of filtration devices available online at Amazon.com. Filtration devices are available at a range of costs that may fit different household budgets. Two pitcher types are included in this analysis to highlight how filter capacity can impact costs even in similar devices.

*Table 3: Filter Type Comparison*

<b>Filter Type</b>	<b>Cost Range</b>	<b>Product</b>	<b>Filter Action</b>	<b>Filter Capacity</b>
<b>Pitcher A</b>	\$20-300	Brita Large 10 Cup Water Filter Pitcher	Carbon filter, NSF 42 – taste and odor	40 Gallons
<b>Pitcher B</b>	\$20-300	ZeroWater 23 Cup Pitcher	Carbon filter, NSF 42 – taste and odor	25 Gallons
<b>Faucet</b>	\$15-50	PUR Advanced Faucet Water Filter	Carbon filter, NSF 42 – taste and odor	100 Gallons
<b>Counter Top</b>	\$50-\$300	Lake Industries Stainless Steel Countertop Water Purifier Filter	Carbon filter, NSF 42 – taste and odor	1000 Gallons
<b>Under Counter</b>	\$800*	iSpring 5-Stage Prestige Top Purity Under Sink Reverse Osmosis	RO filter + farbon filter , NSF 58 – EPA regulated contaminants	Yearly replacement packages sold

\* Cost includes professional installation

To understand the long-term costs of maintaining each type of filtration device, and to compare against cumulative bottled water costs, a popular model for each filter type was selected based on Amazon user ratings. For each model the cost of filter replacements was calculated using the average household size of 2.83 and daily drinking and cooking consumption of 3.96 gallons-per-day. Table 4 (below) shows cumulative costs, adjusted for inflation, of buying and maintaining a filter replacement schedule over one, five, and 10 years. Household behavior with water filters is likely to vary based on sensitivity to aesthetic perception of water. This analysis displays cost estimates in a scenario where all drinking and cooking water is filtered and filters are replaced as they reach capacity.

Variety in filter capacity for different models of filtration devices is due to some filters requiring frequent replacement because they “work harder” by filtering out more water attributes. Figure 5 (below) compares monthly costs of tap, filtered, and bottled water. Incorporated into each filter cost is the cost of tap water to provide a comparison of the cost of water consumption using each method.

*Table 4: Cumulative Filter Replacement Cost*

<b>Filter Type</b>	<b>Initial Cost</b>	<b>Product</b>	<b>Year 1</b>	<b>Year 5</b>	<b>Year 10</b>
<b>Pitcher A</b>	\$28	Brita Large 10 Cup Water Filter Pitcher	\$527	\$2623	\$5488
<b>Pitcher B</b>	\$28	ZeroWater 23 Cup Pitcher	\$2422	\$12592	\$26463
<b>Faucet</b>	\$41	PUR Advanced Faucet Water Filter	\$418	\$2002	\$4167
<b>Counter Top</b>	\$80	Lake Industries Stainless Steel Countertop Water Purifier Filter	\$174	\$564	\$1098
<b>Under Counter</b>	\$800*	iSpring 5-Stage Prestige Top Purity Under Sink Reverse Osmosis	\$800*	\$1115	\$1546

\*Cost includes professional installation

Filtration replacement is likely to vary as most observed manufacturer suggested filter replacement schedules base replacement on lower average daily consumption than in this analysis. Filter replacement behavior would make for an interesting and necessary topic of future research.

Our analysis shows that many tap water filters with low upfront cost are more costly over time, and sometimes more costly than bottled water, as standard filters must be changed more frequently. While the under-counter filter has the lowest monthly cost of maintenance the upfront investment for installation makes it more costly than retail counter-top models like the Lake Industries model shown in Table 3 (above) that require no installation and have filters with larger capacity.

### *Premise Plumbing Repair Costs*

Both bottled water and water filters place sustained expense on households. If premise plumbing repair can achieve aesthetically pleasing water and restore tap water trust the benefits can be meaningful. Most of the premise plumbing issues present in the LADWP customer complaint data suggest solutions that may require the assistance of a professional plumber. While the internet has many step-by-step guides for do-it-yourself (DIY) plumbing projects it is more prudent to hire a professional plumber. Improper maintenance or DIY plumbing work can introduce new premise plumbing issues that perpetuate the residential water quality issues or cause additional financial stress down the road. A professional plumber can verify the cause, pinpoint problem, and repair the problem.

Based on findings of frequency of premise plumbing issues the cost analysis is broken into three categories; cost to remedy drain odor, costs of hiring a plumber to perform repairs or maintenance, and the costs of pipe repair or replacement.

*Figure 6: Drain Odor Complaints*



Drain odor (30% of complaints) may be resolved by disinfecting the problem drain with bleach. Bleach commonly retails for around \$4.00 a bottle making this an extremely low-cost solution to a common complaint and cause of misperception. However, if the problem persists, a professional plumber may need to inspect the drain plumbing and recommend further steps. Hourly plumber rate provided by Plumbers & Steamfitters Local Union 342 is \$140-\$155 per hour.



Nearly half of all complaints are related to routine maintenance or require a plumber to assess the problem. Households should expect to pay the rate of \$140-\$155 per hour for work necessary to remedy the problem. It is difficult to estimate total cost for repair as the severity of the problem and time needed to work around household infrastructure like walls, cabinets, appliances, etc. influence the cost of materials and time of labor needed.

*Figure 7: Plumbing Maintenance*



The most costly premise plumbing intervention is pipe replacement for corroding or leaking copper or galvanized steel pipes. Depending on the severity of the corrosion or frequency of leaks the issue may be resolved by removing only a section of a pipe for a few hundred dollars. If corrosion is present across the residence and full pipe replacement is recommended the household can face costs in the multiple thousands of dollars not including the cost of replacing and repairing walls, ceilings, and floors. Plastic pipe options like PEX are growing in popularity due to their cheaper cost and ease of installation compared to copper pipes. A full PEX re-pipe ranges from \$3300-\$5000 for materials and labor compared to \$3800-\$6000 for a copper re-pipe. Additionally, a property owner faces the costs of replacing and repairing walls, ceilings, and floors as part of the re-pipe. These costs vary based on house composition but surveyed households indicate paying up to \$13,000 for PEX re-pipe and \$16,000 for copper re-pipe with one respondent paying as high as \$25,000 in total re-pipe and repair costs.

*Figure 8: Plumbing Corrosion*

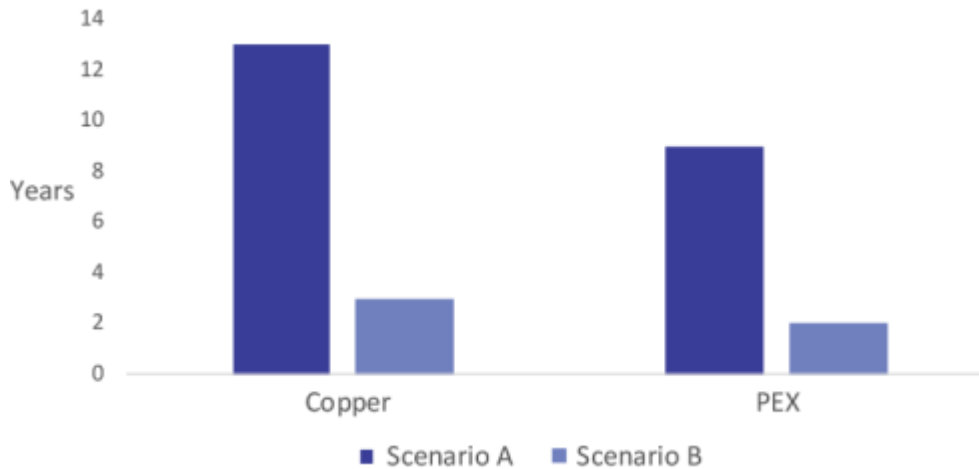
Tap water is more affordable than bottled water and filtered water therefore, premise plumbing that delivers aesthetically satisfactory drinking and cooking water delivers financial benefit. However, as described above, repairing premise plumbing comes at a cost and in some cases may require large upfront investment in which a household's financial benefit would be achieved over time.

The payback period for a copper re-pipe, a PEX re-pipe, and a visit from a plumber was calculated using the savings of switching from bottled water to tap water. This analysis sets the initial investment of a copper re-pipe at \$10,960.00 and a PEX re-pipe at \$7480.00 which are consistent with cost of materials, labor, and surveyed costs cited above. The plumber visit was set at \$500 which equals the cost of a pipe-leak repair or a plumber visit of three to four hours. The benefit to the household is the savings generated from relying on tap water in place of the bottled water costs established above. Scenario A represents savings of switching from 5-gallon water and Scenario B represents savings of switching from 16.9 oz bottles to tap water annually. Annually, the cost of bottled water was adjusted for 2% inflation, consistent with both nationwide and Los Angeles metropolitan area. An increase of 4% was applied to the cost of tap water annually. Using this benefit the net-present value for each investment was calculated to find the payback period. Figure 6 (below) shows payback periods for copper and PEX re-pipes. Based on household bottled water purchasing the savings



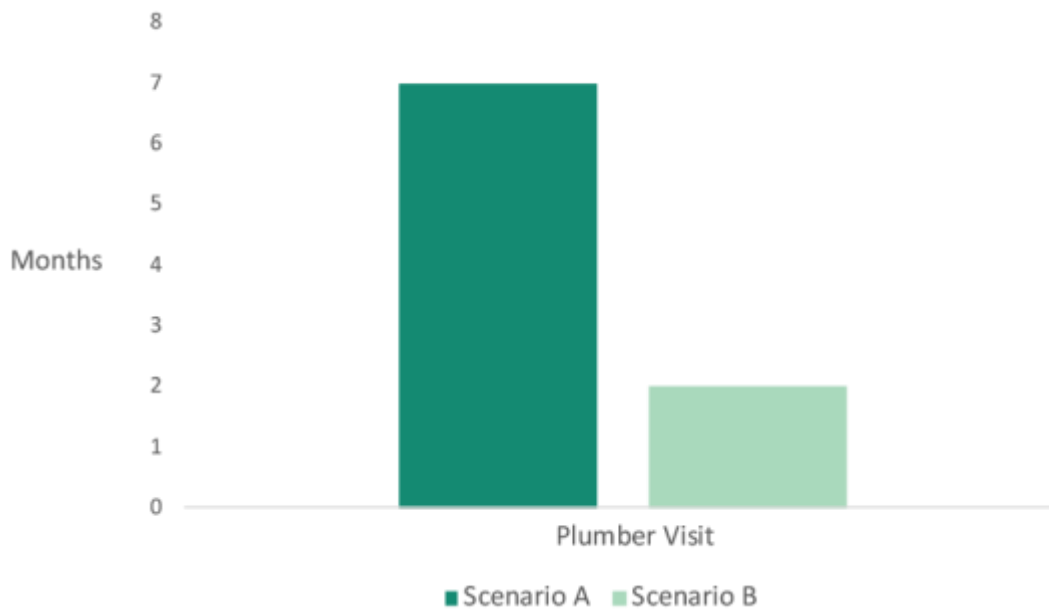
generated by switching to tap water pay back the investment cost in as few as two years but could take 10 or more years.

Figure 6: Re-pipe Payback Period



The savings generated from switching to tap water in both scenarios pay back the upfront cost of paying a plumber \$500 in under a year. As Figure 7 (below) shows a household may be fully paid back by the benefit in as little as two months.

Figure 7: Plumber Visit Payback Period



The household that invests in premise plumbing repair can use their newly unlocked savings to pay back their investment over time. In addition to these savings the household avoids paying higher costs in the long term for bottled water. Figures 8-10 (below) show the point at which the cumulative costs of purchasing bottled water exceed the investment cost to repair premise plumbing.

Figure 8: Copper Re-pipe

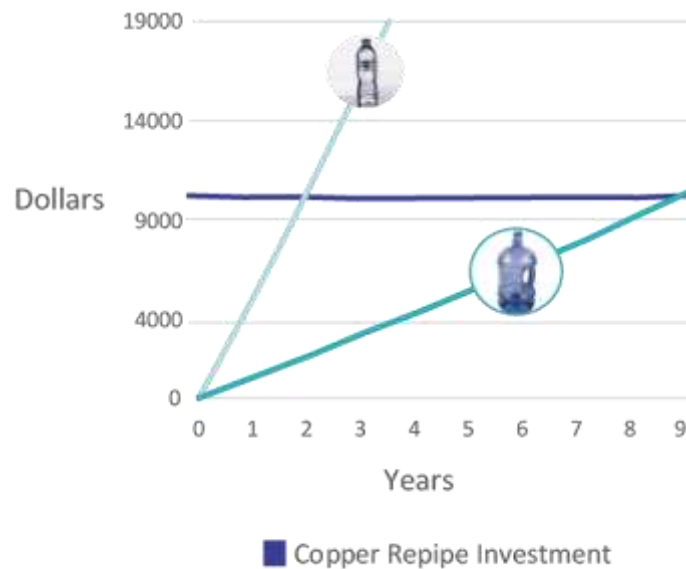


Figure 9: PEX Re-pipe

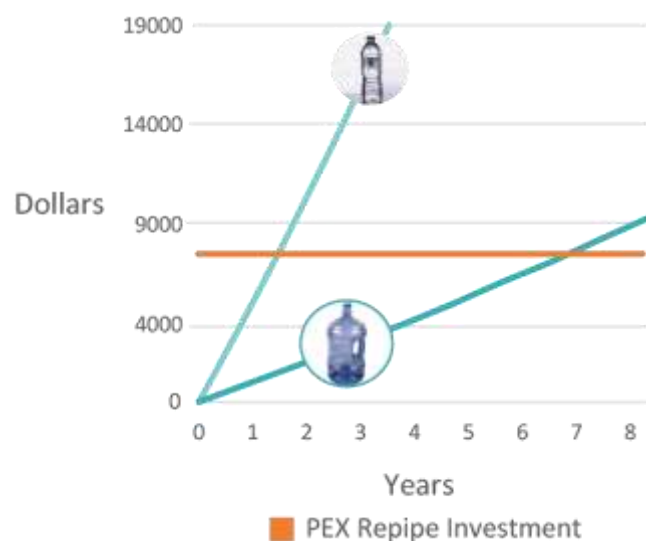
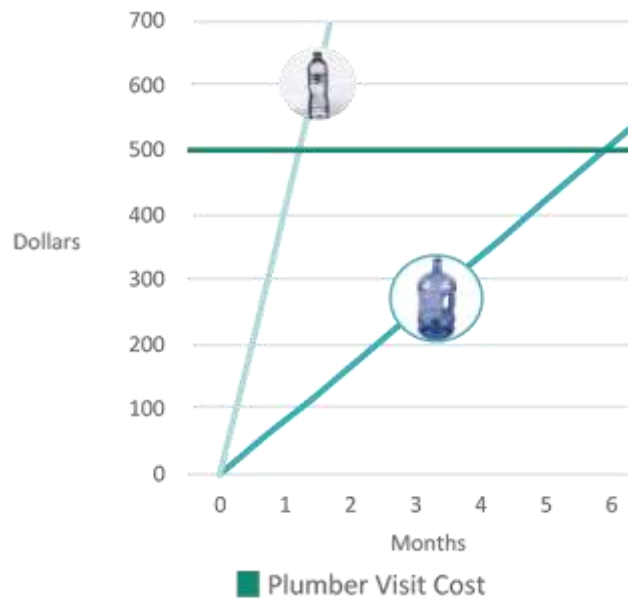


Figure 10: Plumber Cost



We find that the cost of bottled water greatly influences how quickly the cumulative cost becomes greater than an investment in premise plumbing repair. Both scenarios indicate that a household relying on bottled water would exceed the cost of a major re-pipe in under 10 years and exceed the cost of a plumber visit in a matter of months. Considering that 46% of customer complaints in this analysis may be solved with a plumbing visit there is the potential for a large percentage of households to feel a benefit in the short term.

The typical household can save anywhere from \$1000–\$4,800 a year and from \$80–\$400 a month by relying on tap water over bottled water. In many cases these savings justify an investment in premise plumbing repair or water filtration as they would more than recover the cost to a household in under a year. However, for households that cannot afford the upfront investment or cost of a plumber visit there are short-term financial barriers to households realizing the long-term financial benefits of upgrading their premise plumbing.

## Discussion

### Financial and Social Barriers to Addressing Premise Plumbing

Identifying a premise plumbing issue in a residence means the responsibility is on the property owner. While our analysis shows that the most cost-effective decision for a household is to invest in the upfront cost of hiring a plumber and making the proper plumbing repairs or replacements we recognize that upfront cost is a serious barrier for many households. On an annual basis, purchasing bottled water is the most expensive of all options. Depending on the price a household pays for bottled water if an investment in premise plumbing repair restores trust in tap water the savings achieved could payback the initial investment in under two years. However, payback periods will be longer for households that relied on bottled water purchased in larger 5-gallon containers.

Households on a month-to-month or week-to-week budget may still find the incremental cost of bottled water easier to manage than making the investment in repair. Though, for the cost of a month's worth of bottled water a household can purchase a counter top water filter and achieve savings both immediately and substantially over time.

When devising solutions, we must recognize that the reality for homeowners facing a serious premise plumbing issue is the necessity to have upfront financial capital to invest in upgrades. This presents barriers for many households to fully benefit from any type of rebate structured program. We must also recognize the political ecologies of urban life of a tenant are different from that of a homeowner. Tenant relationships to their physical environment and resources like energy, water, and green space are regulated by leases, legislation, and relationships with landlords.<sup>48</sup>

Tenant households in need of premise plumbing repair may face increases in monthly rent if the landlord chooses to recover the costs directly. The Housing + Community Investment Department of Los Angeles Renovation Cost Recovery Program allows for a landlord to recover the costs of a renovation requiring a permit through permanent and temporary rent increases.<sup>49</sup> The provisions cap any low-income tenant's lifetime rent increase to 10%<sup>50</sup> and other tenant households to 10% of the maximum allowable rent at the time of the cost recovery application, divided in equal parts over two years.

---

<sup>48</sup> Mee, K. J., Instone, L., Williams, M., Palmer, J., & Vaughan, N. (2014). Renting Over Troubled Waters: An Urban Political Ecology of Rental Housing. *Geographical Research*, 52(4), 365-376. doi:10.1111/1745-5871.12058

<sup>49</sup> Primary Renovation Cost Recovery Regulations. Section 220.00, Adopted June 2, 2005. Amended September 19, 2013.

<sup>50</sup> If a landlord increased rent for a low-income tenant by 7% to recover costs for foundation repair and five years later sought a rent increase of 6% to recover premise plumbing replacement costs the only allowable increase now would be 3% for the low-income tenant.

Of Los Angeles' 1.4 million households, 64% are renters.<sup>51,52</sup> Of those tenant households, 62% are "rent-burdened" and spend more than 30% of their household income on rent each month.<sup>53</sup> Additionally, many low-income households pay over 50% of their income on housing.<sup>54</sup> Any increase in housing cost can cause households to prioritize housing payments to avoid eviction and delay payments on other household expenses like heating or cooling, medical payments, food budgets, education, or credit card bills.<sup>55</sup> However, as our analysis above demonstrates, a low-income household relying on bottled water for drinking and cooking purposes may experience considerable savings, even with a temporary rent increase, if they are able to eliminate the annual bottled water expense from their household budgets.

However, with no legally compelling statute to address aesthetic water quality issues a landlord may be likely to put off the cost of an improvement. This is a classic example of the "split-incentive" where the landlord would be required to make a larger upfront payment that benefits a current tenant more than the landlord. In a competitive housing market, there is less incentive for a landlord to spend money on a problem like aesthetic water quality as there is little risk of a potential tenant turning down a lease agreement for an aesthetic issue.

Landlords and property managers should, however, be responsive to aesthetic issues that signal corrosion which could develop into a larger issue in the plumbing of a house or unit. These issues can deteriorate resulting in dangerous levels of copper, iron, or pathogen growth in water legally compelling action or causing necessary and possibly widespread repair to entire building piping. Water leaks from neglected, corroded pipes can result in further expenses due to mold growth and water damage to wooden joists and beams, drywall, and floors.

---

<sup>51</sup> Chiland, E. (2018, August 09). LA's rate of homeownership is one of the lowest in the nation, new study finds. Retrieved from <https://la.curbed.com/2018/8/9/17665124/los-angeles-homeowner-rate-renter-population>

<sup>52</sup> 2013-2017 American Community Survey 5-year estimate

<sup>53</sup> Rising Rent Burden in Los Angeles. (n.d.). Retrieved from <https://usc.data.socrata.com/stories/s/Rising-Rent-Burden-in-Los-Angeles/4wjy-s7d9/>

<sup>54</sup> Ibid

<sup>55</sup> Finnigan, R., & Meagher, K. D. (2018). Past Due: Combinations of Utility and Housing Hardship in the United States. doi:10.31235/osf.io/gdft6

## Recommendations

Recommendations for addressing premise plumbing problems are rooted in equity and feasibility. This report supports a “No Regrets” policy approach that ensures an increase of housing insecurity is not an unintended consequence of policy to remedy premise plumbing or build trust in tap water. Recommendations cover the need to gather data to understand the scale and costs of remediating premise plumbing issues, engage hard-to-reach households and share vital water service and tap water quality information with them, and finally, create equitable economic avenues for financing premise plumbing repair.

### Gather More Premise Plumbing Data

There is a need for comprehensive data collection on the condition of premise plumbing in cities across California. A strong profile of premise plumbing conditions can help households, utilities, and local governments. Households and landlords will understand aesthetic water issues and anticipate costs. Utilities can better manage household expectations of water quality and support households in ensuring water quality at the tap. Local governments will understand who is most vulnerable to unclean water due to premise plumbing and can develop policy and publically financed solutions to support households.

#### *Expand Utility Customer Service*

The easiest way to improve premise plumbing data collection is to standardize a water service provider customer service protocol across the state. As customers contacting a water service provider with water quality inquiries or complaints are making contact already they are a source of data that may be under-utilized. By creating customer service protocols that intentionally collect information from customers on their water aesthetics, premise plumbing, housing type, and tenant or ownership status individual water service providers can better identify trends across the customer base. Moreover, a standardized set of questions and data collection terminology across the state would advance understanding of premise plumbing issues significantly as researchers and decision makers could easily compare trends across populations.

#### *Public Health Department Inspections*

City and county public health departments can collect and/or report more data aesthetic water quality and the premise plumbing issues causing the issue in their routine housing inspections. Currently, the Environmental Health Division of the Los Angeles County Public Health Department routinely inspects rental units of five units of more and responds to requests for inspections at all other types of housing. Included in this inspection are checks on hot/cold water service and plumbing inspection cataloging and clogged or inoperable plumbing. Including tests for aesthetic water qualities and



potential causes in premise plumbing align with current practice and could advance data collection on this issue significantly.<sup>56</sup>

#### *Premise Plumbing Benchmarking*

Including premise plumbing characteristics in current building inventory practices can add to the understanding of premise plumbing needs in large multi-unit residential buildings at low cost. For instance, California requires buildings with 17 or more residential utility accounts to report building characteristics and energy use data to the state Energy Commission via an online ENERGY STAR Portfolio Manager. This reporting allows for benchmarking, a process of comparing a single buildings performance over time to similar buildings and established norms.<sup>57</sup> Premise plumbing characteristics should be included in the survey of building characteristics in order to set standard benchmarks for premise plumbing performance. Large metropolitan areas across California including Los Angeles, San Francisco, Berkeley, San Jose, and San Diego all have local benchmarking requirements. Los Angeles' benchmarking program boasts a success rate of 82% of buildings in compliance with reporting requirements, of those 22% are multifamily housing units.<sup>58</sup> The Los Angeles benchmarking ordinance requires a water audit evaluating system efficiency opportunities.<sup>59</sup> The audit should be amended to include evaluation of premise plumbing and water quality at the tap.

#### *Targeting Tests in Low-Income Housing*

As low-income households are particularly vulnerable to the costs of mistrusting tap water and are more likely to be hard-to-reach households, they should be a priority in data collection. Water service providers can provide testing to public housing and low-income verified accounts and work with local non-profits and established community organizations to sign-up households for water quality and premise plumbing inspections.

### **Further Engage Households on Residential Water Quality**

Public engagement is a popular strategy for water service providers that wish to promote water quality and water conservation programs. Expanding on this with materials framed specifically to highlight premise plumbing issues and water quality at the tap is beneficial to the water service provider and customer alike. The engagement campaign provides an additional touch point for a water service provider in relationship

---

<sup>56</sup> <http://www.publichealth.lacounty.gov/eh/AreasofInterest/housing.htm>

<sup>57</sup> Building Energy Use Benchmarking. (n.d.). Retrieved from <https://www.energy.gov/eere/slsc/building-energy-use-benchmarking>

<sup>58</sup> United States, City of Los Angeles Department of Building and Safety, Green Building & Sustainability. (2018, June 12). 2016 EBEWE Annual Report. Retrieved May 16, 2019, from <https://www.ladbs.org/services/green-building-sustainability/existing-buildings-energy-water-efficiency-program/2016-ebewe-annual-report>

<sup>59</sup> United States, Los Angeles Municipal Code. (n.d.). Ordinance 184674. Retrieved May 16, 2019, from [www.ladbs.org/docs/default-source/publications/misc-publications/ord\\_184674\\_12-15-16.pdf](http://www.ladbs.org/docs/default-source/publications/misc-publications/ord_184674_12-15-16.pdf)

building between themselves and their customers, especially households that do not pay their own water bill. Premise plumbing educational materials could be included in regularly distributed utility materials like water quality reports and consumer confidence reports as well as supplement pre-existing public engagement on water efficiency. The customer receives valuable information about their water, water service provider, and feels empowered to make decisions regarding premise plumbing.

An introduction to premise plumbing is needed in public education on this topic, as is further awareness of the responsibility issue, common aesthetic indicators of premise plumbing issues, suggested premise plumbing maintenance schedules, and finally the cost comparison of addressing premise plumbing or relying on bottled water.

Public education on premise plumbing should include materials framed for landlords, tenants, and home owner households. Each benefit from the same knowledge but due to social and financial limitations described above each use and benefit from the information differently. The household can benefit from the point of contact with the water service provider. The knowledge can assist households and landlords in planning for plumbing maintenance costs to avoid larger costs associated with corrosion. These materials can also aid the tenant in approaching a landlord regarding plumbing repairs.

It is important that premise plumbing educational materials are included in existing resources for landlords and tenants including the state issued California Tenants Guide, county or city wide tenant rights handbooks, and published online in collaboration with local housing authorities and public health departments.

## Financing Premise Plumbing Upgrades

### *Offer On-Bill Financing*

Water service providers can alleviate the short-term financial and social barriers to premise plumbing caused water quality issues by offering on-bill financing to customers. On-bill financing is a popular strategy deployed by utilities across California to encourage investment in conservation and efficiency upgrades. An on-bill financing program works by removing the upfront cost barrier for a customer by having a utility provide an appliance, upgrade, or repair at no initial cost to be paid back over time in the form of a surcharge on a regular customer bill.

Data in this report indicates the majority of premise plumbing issues are repaired at relatively low cost, therefore a repayment period on regular monthly or bi-monthly water bills should not be lengthy. Often these programs are supported by federal, state, or regional grants reducing the capital investment for a utility.<sup>60</sup> This model can address household worry of high up-front costs required for plumbing repairs and reduces social

---

<sup>60</sup> Henderson, P. (2013, July). On-Bill Financing Overview and Key Considerations for Program Design. Retrieved May 16, 2019, from <https://www.nrdc.org/sites/default/files/on-bill-financing-IB.pdf>

tension between tenants and landlords. Moreover, administrative costs could be low as water service providers can integrate repayment into current billing structures.

A water service provider can reduce the risk of non-payment by tying repayment to the address and to water service. Associating the repayment with the address removes the risk of a tenant moving out of service area before repayment is complete and reduces administrative obstacles of tracking tenants to new residences. Further, tying repayment to water service reduces risk to the water service provider by coupling the loan repayment to the risk of water service disconnection for the household. To promote equity and reduce risk of non-payment in structuring on-bill financing Housing and Community Investment Department of Los Angeles rent increase guidelines can serve as a template for repayment.

By shifting the repayment interaction from a landlord to the water utility we remove from the social equation the complicated dynamics of tenant and landlord relationships. Specifically, we remove landlords reluctant to pay upfront costs and worries from tenants about the riskier increase in rent and threat of eviction.

#### *Special Assessment Districts*

An option for financing costly upgrades are special assessment or special deferred assessments districts. These districts allow local governments to finance improvements with residents paying back the bond amount on property tax over time or at the point-of-sale of the residence. Formation of a district requires a public approval process including a petition signed by homeowners in support and a public comment period for dissenting homeowners to voice their concern.<sup>61</sup> Due to the geographic nature of the assessment districts this could become a feasible option where clusters of households with documented premise plumbing are located. Due to the lack of data on experiencing premise plumbing problems, additional research must be conducted to identify communities best suited for district formation. Special assessment districts may be a feasible long-term solution to premise plumbing upgrades but would require broad data collection and cooperation from local government offices.

#### *State Financing*

State governments should offer financing in the form of grants or loans to water utilities to support efforts to fix premise plumbing problems in customer households. The majority of customer premise plumbing issues are too low cost to warrant the creation of a grant program directly to households. However, water service providers, especially smaller systems with less economies of scale or administrative framework in place, can benefit from the funds to increase customer engagement and offer on-bill financing programs.

---

<sup>61</sup> <http://www.californiataxdata.com/pdf/assessmentdistrict.pdf>



## Conclusion

Addressing perceptions of tap water quality is a complex problem without a single solution. Current research provides ample evidence of elevated levels of mistrust among different populations and explores individual motivation for that mistrust. This report, however, advances our understanding of the tap water trust problem by identifying probable premise plumbing causes to aesthetic tap water issues that drive mistrust and the costs to resolve them.

Analyzing LADWP customer complaint data reveals that premise plumbing is the cause of aesthetic water issues in the majority of complaints. Nearly 80% of premise plumbing issues represented are solvable with investment of a few hundred dollars or could be avoided altogether with regular plumbing maintenance.

For households paying over 25 times the rate of tap water for bottled water each year, the financial case for investing in premise plumbing repair is sound. However, many households likely face month-to-month affordability concerns making the financial decision more complicated and stopping them from benefiting from long-term investments. Accordingly, there exists a need to further understand the pervasiveness of premise plumbing issues to match appropriate policy solutions to the problems. In particular, programs to finance premise plumbing upgrades can overcome short-term hurdles and provide accessible solutions to households which can enhance their long-term health and welfare.