Dark Waters Project: The Assessment of the Presence of Heavy Metal Contaminants in the Tap Water of Watts Residences, and Public Perceptions of Water Infrastructure in Los Angeles

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A special thanks to Timothy Watkins

Table of Contents

Neighborhood block	Number of samples	Lead under 15ppb	Lead above 15ppb
Purple: Between E 97th st (s) and E 92nd St (n), S Alameda St (e) and Grape St (w)	22	0	0
Dark Purple: **Jordan Downs**: E 97th St (n) and E 103rd St (s), S Alameda St (e) and Grape St (w)	30	2	0
Brown: E 92nd St (n) and E 103rd St (s), Grape Ste (e) and Graham Ave (w)	98	3	1
Orange: **Nickerson Gardens**: E 111th St (n) and Imperial Hwy (s), S Central Ave (w) and Compton Ave (e)	122	3	2
Green: E 103rd St (n) and E 108th St (s), Graham Ave (w) and Croesus Ave (e)	76	4	0
Blue: **Imperial Courts**: Santa Ana Blvd (n) and E 117th St (s), Croesus Ave(w) and Mona Blvd (e)	42	1	0

Teal: E 92nd St (n) and E 102nd St (s), Success Ave (w) and Grandee Ave (e)	78	2	0
Gray: E 108th St (n) and E 111th St (s), Avalon blvd (w) and McKinley Ave (e)	41	1	2

TOTAL samples with verified addresses: 530

Background and Aims

As a result of water infrastructure neglect, Watts faces plumbing issues that contribute to heavy metals in drinking water from lead service lines (LSL) in homes built before the Safe Drinking Water Act of 1985. This can lead to the corrosion of lead solder, pipes, faucets, and fixtures that homeowners, landlords, and tenants can not afford to replace or test. California banned lead plumbing and pipes in 1985 and the U.S. Congressional ban went into effect in 1986 (Hoague, D., et al.). The Better Watts Initiative, the environmental justice wing of the Watts Labor Community Action Committee, has continuously advocated for the investigation of the city's water infrastructure, which is part of a wider mission to address community-wide pollution and environmental injustice. BWI has joined efforts with 501CTHREE and the Watts Labor Community Action Committee (WLCAC) to collect residential tap water. In 2020, 501CTHREE donated a water treatment system to WCLAC and placed another under its supervision at Watts' Mafundi Building. In 2022, BWI and 501CTHREE were awarded a grant from the Robert Woods Johnson Foundation to test the tap water of residences in Watts for lead contamination. Alongside this grant, BWI collaborated with 501CTHREE to develop and field a survey to research trusted sources of information on water quality. The Better Watts Initiative coordinated the water sample and data collection phase. The WLCAC, Timothy Watkins, and trusted community leaders were crucial in gaining community support and recruiting Watts residents. Among the water sampling team included Watts residents, people who live/have lived in the public housing developments, and students from local universities. Over 500 tap water samples from homes in the neighborhood of Watts, Los Angeles were collected and tested to assess community-wide exposure to lead and other heavy metals through tap water.

According to CalEnviroScreen 4.0, Watts, a neighborhood spanning two square miles in South Los Angeles, is among the most polluted neighborhoods in California with an overall score in the 100th percentile and a cumulative lead pollution score of 91 coming from water, air pollution, soil, and paint (CalEnviroScreen 4.0). Many injustices in Watts are a result of malign neglect on behalf of elected leaders. Lead contamination is an expected contributing factor to many of the preventable health disparities observed in the community including a 14-year shorter average life expectancy than surrounding neighborhoods and a nearly 50% dropout rate of adolescents before eighth grade. The compounding cognitive impairments associated with youth lead exposure undermine children's academic performance (Hoague, D et al.). Children exposed to environmental lead have long-term adverse health consequences showcased by a volume reduction in certain areas of brain matter, leading to lowered IQ test scores and deficiencies in academic skills (Eid 2016). The purpose of this study is to locate the distribution of heavy metal-contaminated water across residencies of Watts, California. Subsequently, this data can be used to inform policy recommendations that can address water infrastructure redevelopment, such as the retrofitting of pipes.

Methodology

Sampling Procedure

This study deployed teams of community volunteers from the Watts neighborhood to inform residents about the study, collect contact information, and schedule water sample collection from the residents' homes. Participants were asked to complete a survey and provide a water sample, however, the survey was not required for participation. The sampling team collected a total of 590 water sample bottles. Throughout the sample collection there were a number of logistical errors that resulted in faulty water samples. For these reasons, we sorted and removed faulty samples that were collected, changing the total number of samples to 564. Of the 564 samples collected, 530 had verified addresses. Additionally, 184 participants chose to respond to the survey. The neighborhood was divided into the following eight geographical sections to obtain a representative sample of the community: Between E 97th st (s) and E 92nd St (n), S Alameda St (e) and Grape St (w); Jordan Downs community, E 97th St (n) and E 103rd St (s), S Alameda St (e) and Grape St (w); Between E 92nd St (n) and E 103rd St (s), Grape Ste (e) and Graham Ave (w); Nickerson Gardens community, E 111th St (n) and Imperial Hwy (s), S Central Ave (w) and Compton Ave (e); Between E 103rd St (n) and E 108th St (s), Graham Ave (w) and Croesus Ave (e); Imperial Courts community, Santa Ana Blvd (n) and E 117th St (s), Croesus Ave (w) and Mona Blvd (e); Between E 92nd St (n) and E 102nd St (s), Success Ave (w) and Grandee Ave (e); Between E 108th St (n) and E 111th St (s), Avalon blvd (w) and McKinley Ave (e).

Samples for this study were collected following random daytime (RDT) protocol, without prior flushing of taps. Samples were predominantly collected from kitchen taps, but eligible taps also included taps designated for drinking or cooking purposes. 564 samples were collected in 250 mL pre-washed high-density polyethylene (HDPE) bottles. Following collection, samples were stored in iced cooler packs and transported to the lab for preservation and refrigerated storage. The study duration spanned four months from May through August.

Institutional review board (IRB) was obtained, and all participants provided informed, written consent for sample and survey data collection.

Laboratory Analysis

Lead Testing

To assess the Lead (Pb) content of the water samples, the eXact LEADQuick handheld meter was utilized. This portable device offers convenient and reliable measurements down to 3 parts per billion (ppb) of Pb. Lead measurements that exceed 15 ppb are considered violations of the detectable safety limit set by the EPA. Lead measurements lower than 5 ppb (a “lo” result) are considered below the detectable lead level.

Inductively coupled plasma optical emission spectroscopy (ICP-OES)

Copper (Cu), Iron (Fe), and Zinc (Zn) were analyzed utilizing inductively coupled plasma optical emission spectroscopy (ICP-OES) using the Perkin-Elmer Avio 200 instrument. Calibration of the instrument was conducted using the Inorganic Ventures trace metals calibration standard.

ICP Data

In this study, the concentration of heavy metals including Copper (Cu), Iron (Fe), and Zinc (Zn) was quantified and compared to the standard set by the United States Environmental Protection Agency (USEPA). Measurements of these heavy metals are categorized as either Primary or Secondary “maximum contaminant levels (MCLs).” A primary MCL is an enforceable standard set to protect public health by limiting the levels of contaminants in drinking water. A secondary MCL is a contaminant which is not health threatening but may cause your water to appear cloudy, colored or taste or smell bad above a certain level.

Sensor Data

The main goal of this study was to determine if measuring a combination of water quality indicators with low-cost sensors could classify whether a water sample is contaminated with heavy metals.

A wireless sensor network comprised of a pH, electrical conductivity (EC), dissolved oxygen (DO), oxidation-reduction potential (ORP), and temperature probes were used to test the additional water quality parameters.

Results

Summary Stats for Each Metal

Sample data:

Number of collected samples: 564

TOTAL samples with verified addresses: 530

Total samples with lead detection: 21

- Number of samples with detection over 5ppb under 15ppb: 16
- Number of samples with detection above 15ppb: 5

Number of samples with lead detection found in the public housing developments: 8

- Number of samples with detection over 5ppb under 15ppb in the public housing developments : 6
- Number of samples with detection above 15ppb in the Nickerson Gardens: 2

Percentage of samples with lead detection found in the public housing developments: 4.1%
Iron:

- 5 secondary MCLs (not health threatening)

Copper:

- 1 secondary MCL (not health threatening)
- 1 primary MCL (void sample- missing address)

Other Measures

pH, an indicator of the acidity or basicity of water fell mostly within the neutral range of 6.5-8.5 with 96% of samples being neutral. A minimum pH of 5.8 was measured, while the maximum was 9.5. The cells outside of the neutral range were mostly skewed on the more basic side of the pH scale with 4% of samples above 8.5 while only 0.36% were on the acidic side.

ORP is a measurement representing the oxidative or reductive capability of water. The average value for ORP was 290.8 mV with 95% of samples indicating normal ORP values for safe drinking water. There were very few outliers amongst the ORP data with only 4% of samples being more reductive and 0.54% being highly oxidative.

EC, a measure of water's ability to conduct electrical current, acts as an indicator of dissolved mineral content and overall water salinity. Analysis of the conductivity values revealed an average value of 115.9 uS/cm, some households had elevated EC levels up to 720.95 uS/cm which is still well below the 1,000 uS/cm maximum advisory from the EPA.

DO is the amount of dissolved oxygen in drinking water. Drinking water should generally fall between 6.5-8 mg/L. Many of the samples (70%) contained levels lower than recommended of dissolved oxygen, but only 12% were so low to be considered in the hypoxic zone. Higher levels of dissolved oxygen are usually associated with better taste, only 16% of samples were found to be in the recommended range.

Water Quality Distribution in the Surveyed Areas of Watts

Among the metals studied in the selected tap water, Cu was detectable in 95% of samples, Fe was detectable in 68% of samples, and Zn was detectable in 97% of samples. **16 Pb samples were detected between 5ppb and 15ppb (primary MCLs), which is less than 5% of the samples**. Of the samples tested **2 Cu samples (0.37%), one secondary MCL, and one primary MCL**, which violated the EPA guidelines, **5 Fe samples (0.92%), secondary MCLs,** violated the EPA guidelines, **0 Zn samples** violated the EPA guidelines and **5 Pb samples (0.87%), primary MCLs,** violated the EPA guidelines. The overall ranking order of the average value of heavy metal content in the sampled tap water is 0.104 mg/L Zn > 0.095 mg/L Cu > 0.023 mg/L Fe > 0.00051 mg/L Pb. Of the samples tested 21%, 72%, and 16% samples were below the detection limit for Cu, Fe, and Zn, respectively.

The distribution of the sample data can be divided into eight geographical sections (see map on next page):

Between E 97th st (s) and E 92nd St (n), S Alameda St (e) and Grape St (w), 22 samples were collected. No samples indicated heavy metal violations.

In the Jordan Downs community, E 97th St (n) and E 103rd St (s), S Alameda St (e) and Grape St (w), 30 samples were collected. Two of these samples had detectable levels of lead above 5 ppb, but under the safety violation limit of 15 ppb. No samples violated the limit, 15 ppb.

Between E 92nd St (n) and E 103rd St (s), Grape St (e) and Graham Ave (w), 98 samples were collected. Three of these samples had detectable lead levels above 5 ppb, but under the safety violation limit of 15 ppb. One sample had a lead violation above the 15 ppb standard.

In the Nickerson Gardens community, E 111th St (n) and Imperial Hwy (s), S Central Ave (w) and Compton Ave (e), 122 samples were collected. Three samples indicated detectable lead levels above 5 ppb but under the violation limit. Two samples were above the lead action limit, 15 ppb.

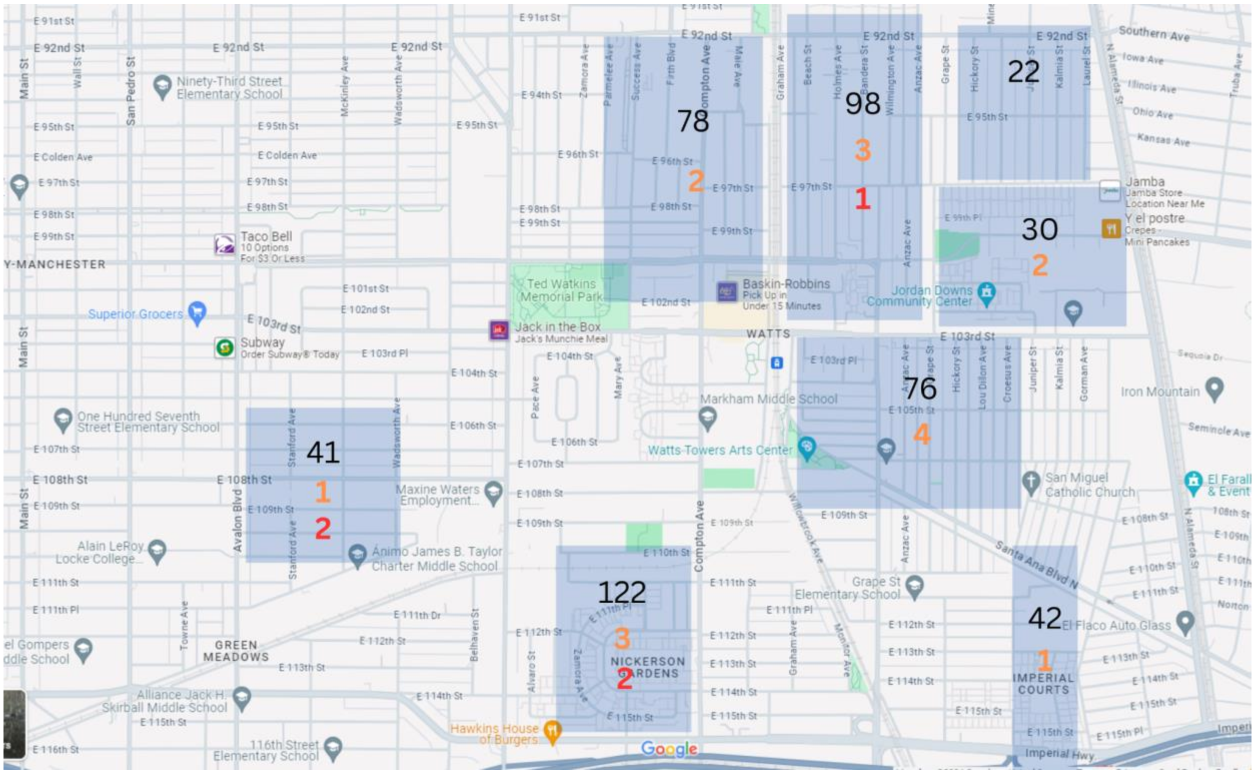
Between E 103rd St (n) and E 108th St (s), Graham Ave (w) and Croesus Ave (e), 76 samples were collected, four of which had detectable lead levels over 5 ppb. However, there were no lead standard violations.

In the Imperial Courts community, Santa Ana Blvd (n) and E 117th St (s), Croesus Ave (w) and Mona Blvd (e), 42 samples were collected, one of which held a detectable lead level above 5 ppb but under 15 ppb.

Between E 92nd St (n) and E 102nd St (s), Success Ave (w) and Grandee Ave (e), 78 samples were collected, 2 of which held detectable lead levels above 5 ppb but under the action limit of 15 ppb.

Between E 108th St (n) and E 111th St (s), Avalon blvd (w) and McKinley Ave (e), 41 samples were collected. One sample held a detectable lead level above 5 ppb but under 15 ppb, and 2 samples indicated lead violations at or above 15 ppb.

In regard to results for iron, there were 5 secondary MCL measures, and for copper there was 1 secondary MCL; these are not regarded as health threatening, but instead affect the appearance of water. There was 1 copper primary MCL violation, however the sample was missing a corresponding address, making the sample void. Over 95% of the water samples (500) tested below the lead detectable level.



Legend:

Total number of samples

Lead detections between 5ppb and 15ppb

Lead violations above 15ppb

Lead Results Dissemination

In February of 2024, our team started the process of communicating water test results. Three different letters were written to communicate three potential test results: lead test below the 5 ppb detectable level, between 5 ppb and 15 ppb, and above 15 ppb. The letters were uploaded onto an online, shareable link, then they were sent to residents via text and email. 306 letters were sent to residents whose water samples tested below the 5 ppb detectable lead level. 55 letters were sent via email to residents with lo water tests. 10 letters via text were sent to residents whose water samples tested between 5 ppb and 15 ppb. One letter was emailed to a resident whose sample also tested between 5 ppb and 15 ppb. 4 letters were sent via text to residents whose water samples exceeded 15 ppb. 16 PUR Water pitchers were sent to residents in properties that were found to have any measure of lead detected in the tap water. Efforts to communicate results for other heavy metals like copper and iron are currently being undertaken.

Survey Results and Chart Visualizations

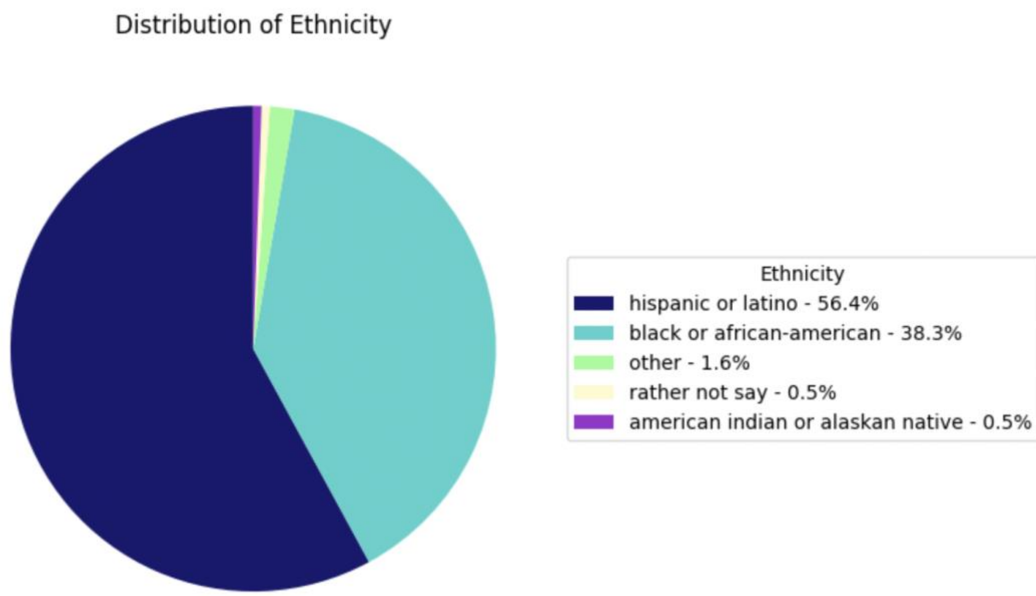
Demographic Analysis

To understand the community and gather possible indicator variables on water quality demographic data was collected in the survey regarding ethnicity and housing situations including housing type, the number of people in the home (including children), rates of ownership vs. tenancy, and home ages.

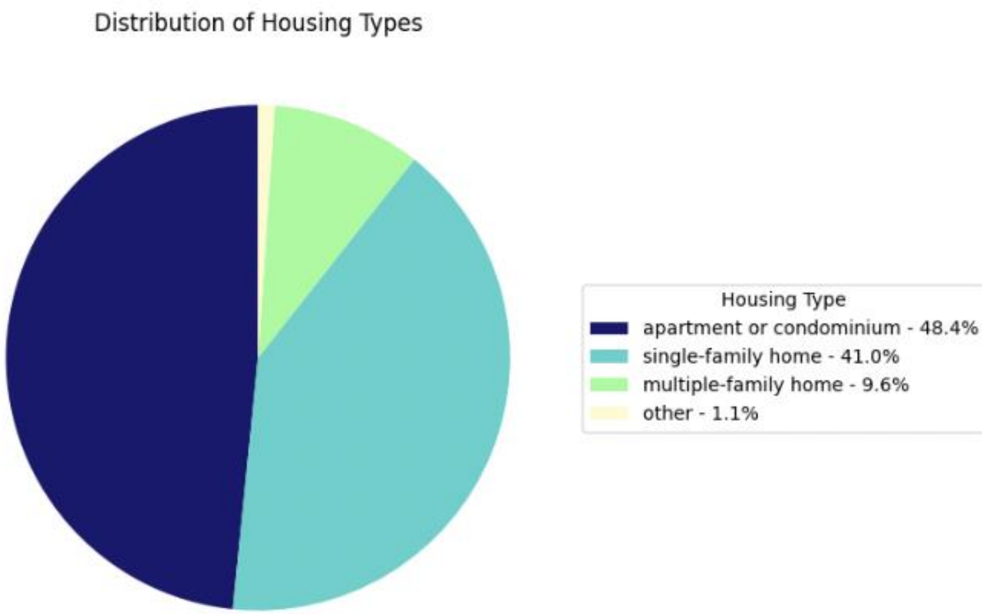
The survey found that the majority of respondents were either Hispanic or Latino with 58% of respondents identifying as such. Black or African-American was the second highest percentage of people surveyed at 39%

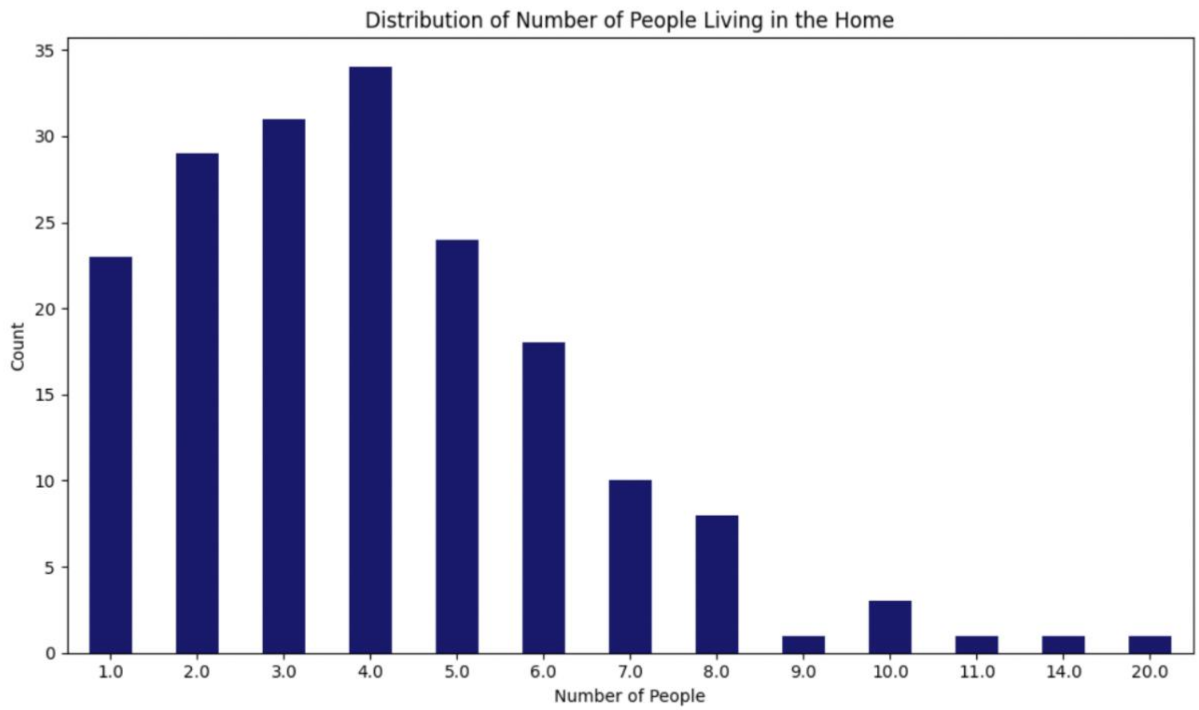
Hispanic or Latino	106
Black or African-American	72
Other	3
Rather not say	1
American Indian or Alaskan native	1

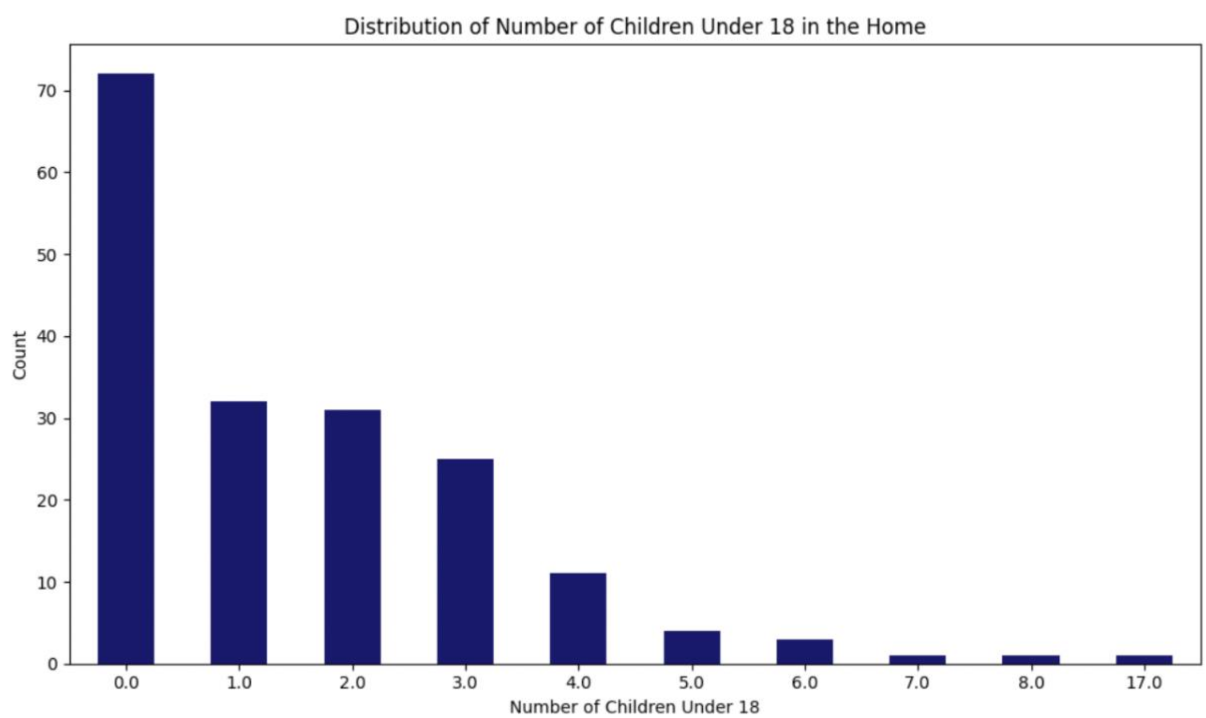
Analysis of the survey data helped identify the housing trends among residents in Watts. Of the homes with survey responses most lived in rented apartments or condominiums (49%) followed closely by single-family homes (41%). Only 23% of people owned their homes in the areas surveyed and most homes were built between 1950-1960. The oldest home reported was over 100 years old with a con

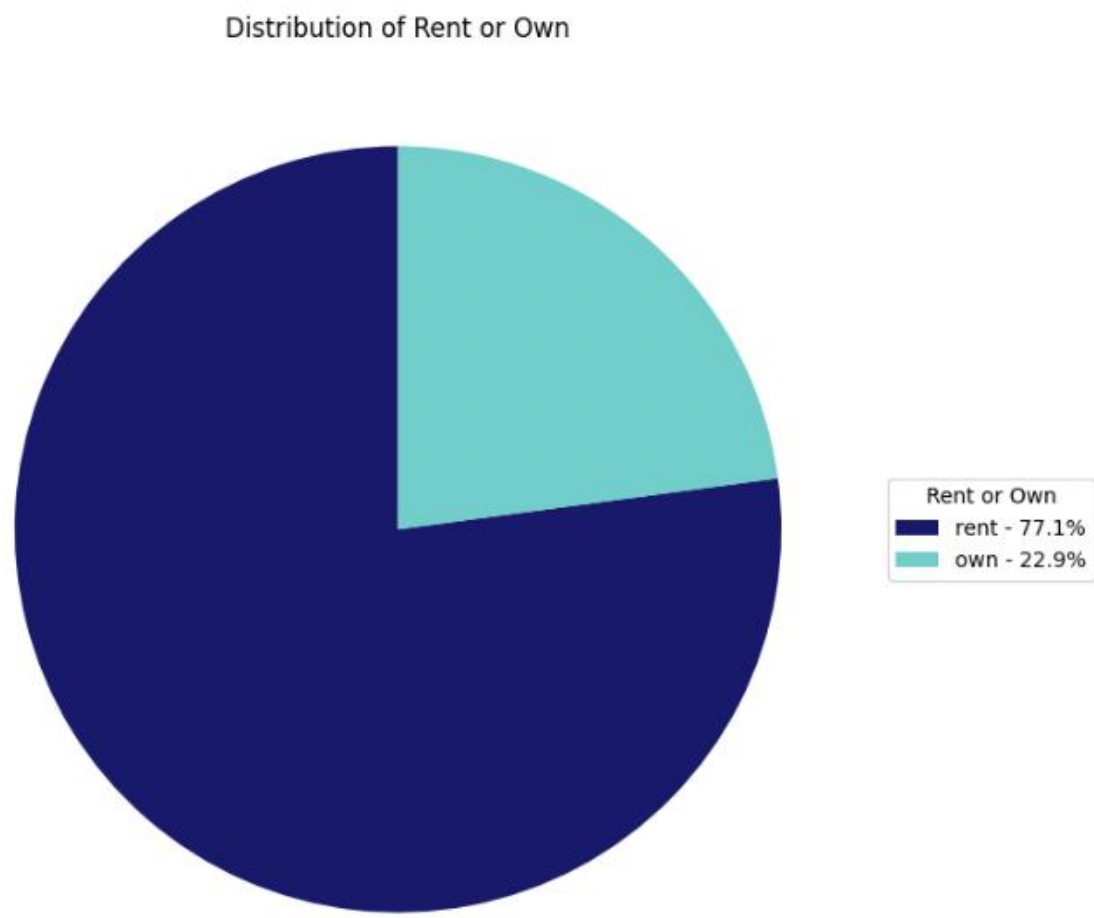


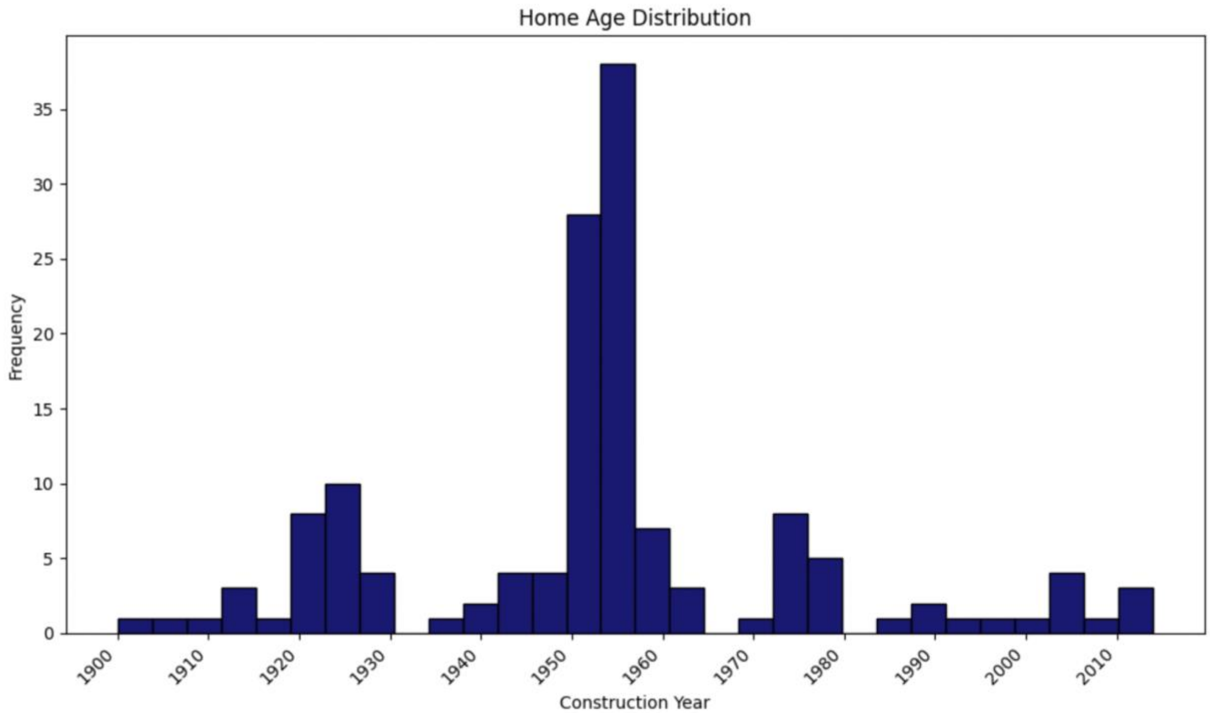
struction date of 1900, with the latest builds being in 2016. Upon examination of the distribution of people and their ages in the home, it is clear that the majority of homes had 3-5 members living in the home, with about 60% of homes having one or more children under the age of 18 living in the home.




Distribution of Number of People Living in the Home
Count
35
30
25
20
15
10
5
0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
14.0
20.0
Number of People


Distribution of Number of Children Under 18 in the Home
Count
70
60
50
40
30
20
10
0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
17.0
Number of Children Under 18


Distribution of Rent or Own
Rent or Own
rent - 77.1%
own - 22.9%



Behavioral Analysis

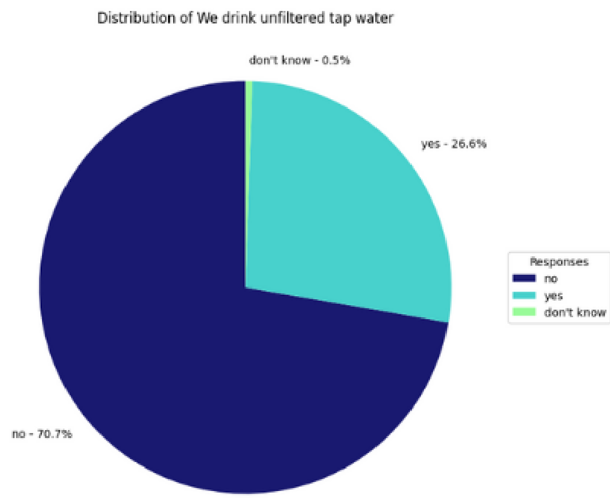
Residents were asked various questions regarding their behavior surrounding drinking tap water in their homes. Residents were asked if the following statements described their household:

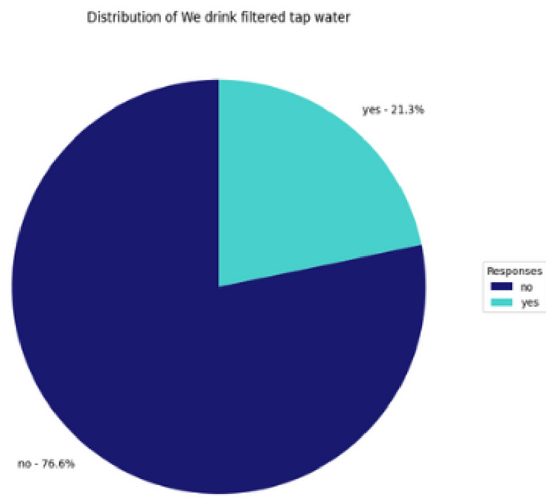
1. We drink unfiltered tap water
2. We drink filtered tap water
3. We boil our tap water before drinking it
4. We drink bottled water

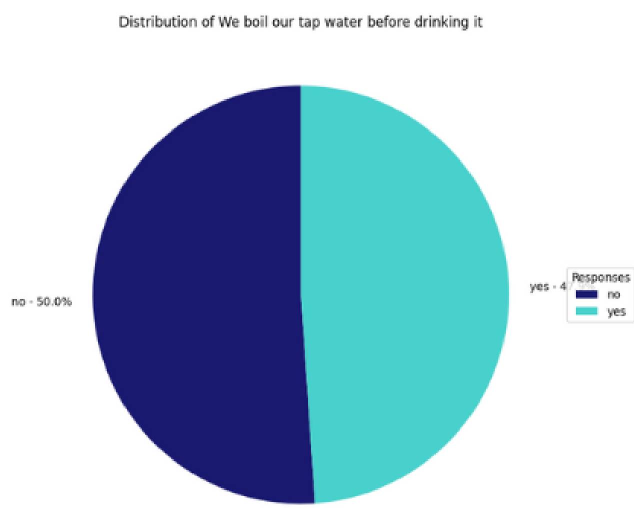
The overwhelming majority of respondents, 96%, drink bottled water as their main source of hydration with a little under half of the surveyees also reportedly boil their tap water before consumption.

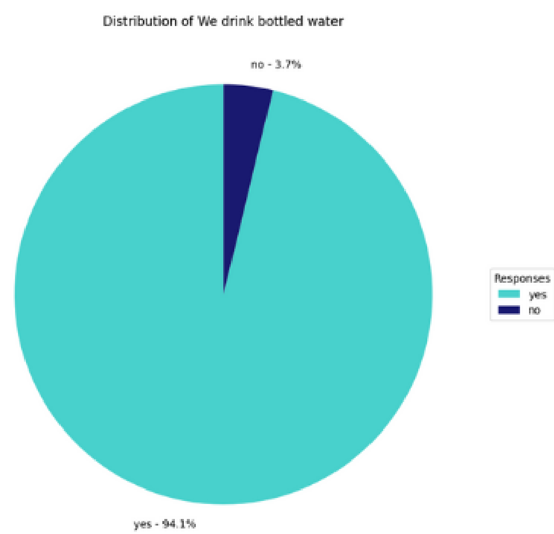
	Yes	No	I don't know
We drink unfiltered tap water	50	133	1
We drink filtered tap water	40	144	

We boil our tap water before drinking it	90	94	
We drink bottled water	177	7	







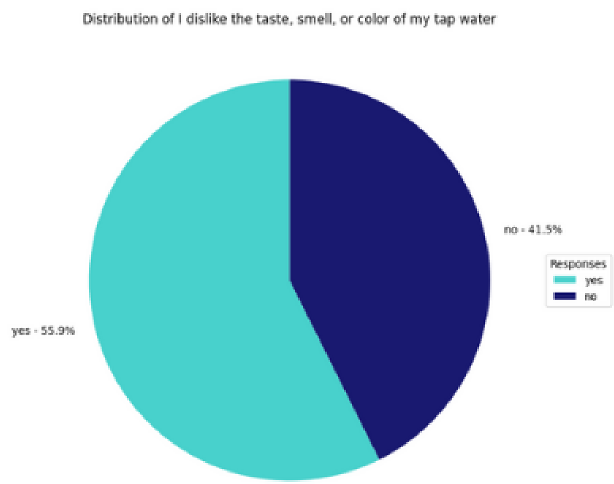


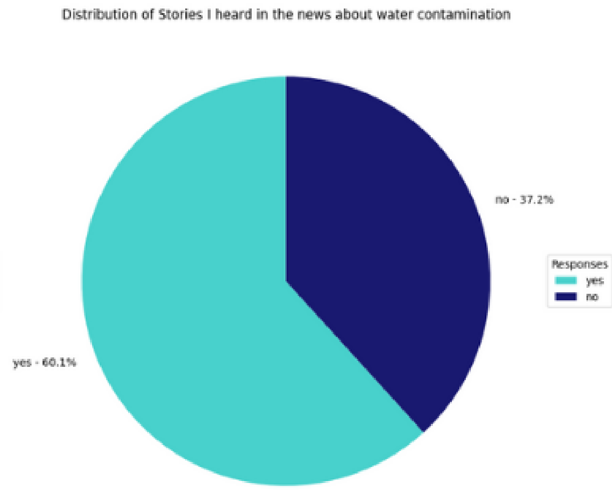
It was also ascertained why a household prefers not to drink unfiltered tap water through the following statements:

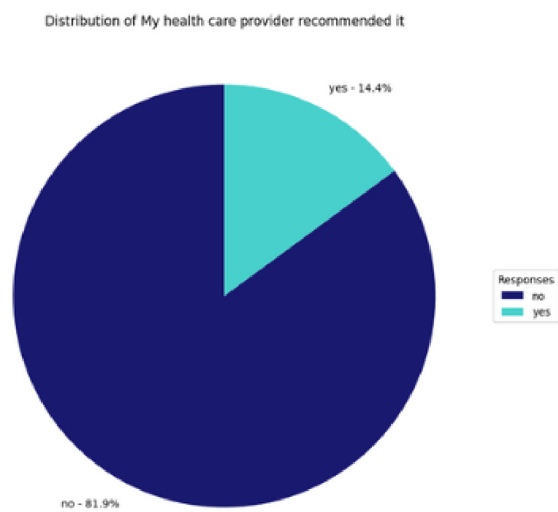
1. I dislike the taste, smell, or color of my tap water
2. Stories I heard in the news about water contamination
3. My healthcare provider recommended it
4. I don't trust the water company
5. I was told by friends or family not to drink tap water

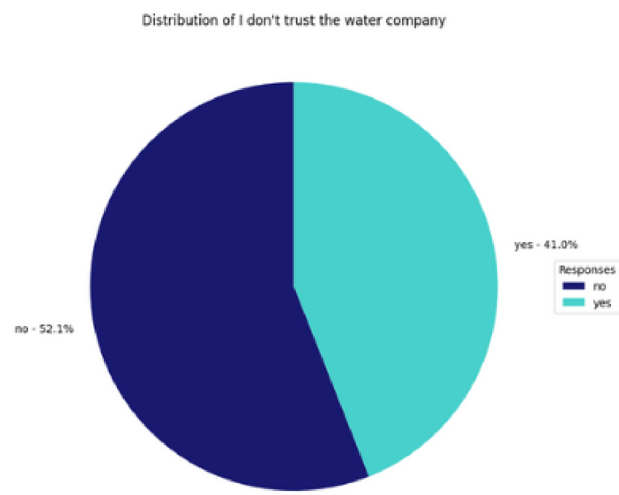
	Yes	No
I dislike the taste, smell, or color of my tap water	105	78
Stories I heard in the news about water contamination	113	70
My healthcare provider recommended it	27	154
I don't trust the water company	77	98
I was told by friends or family not to drink tap water	76	106

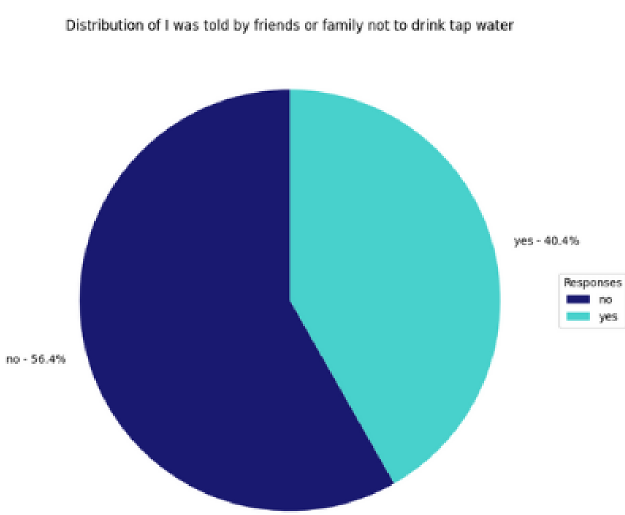
Furthermore, the survey indicates that when it comes to their drinking water habits, they largely do not drink unfiltered tap water because of perceived water quality issues, or stories they have heard about water contamination. Additionally, word of mouth in the community and lack of trust in the water utilities contribute to behaviors associated with not drinking tap water.


Distribution of I dislike the taste, smell, or color of my tap water
no - 41.5%
yes - 55.9%
Responses
yes
no


Distribution of Stories I heard in the news about water contamination
no - 37.2%
yes - 60.1%
Responses
yes
no


Distribution of My health care provider recommended it
yes - 14.4%
no - 81.9%
Responses
no
yes


Distribution of I don't trust the water company
yes - 41.0%
no - 52.1%
Responses
no
yes


Distribution of I was told by friends or family not to drink tap water
yes - 40.4%
no - 56.4%
Responses
no
yes

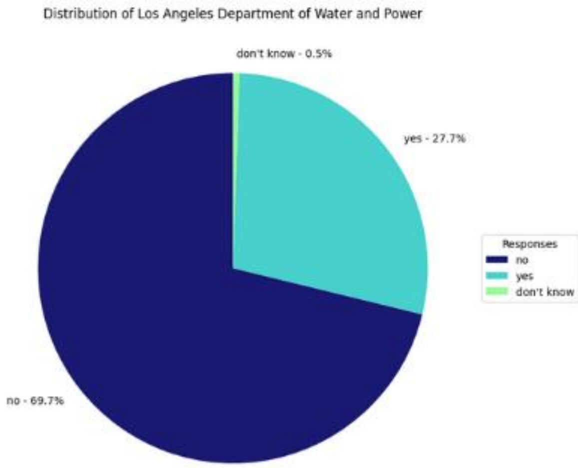
Trust Analysis

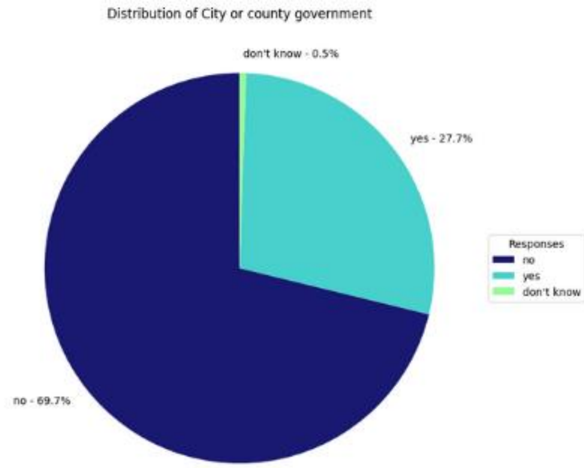
Understanding who consumers trust to inform them about the safety of their drinking was also important in interpreting the reason behind the behaviors demonstrated. The survey asked if consumers trusted the following groups:

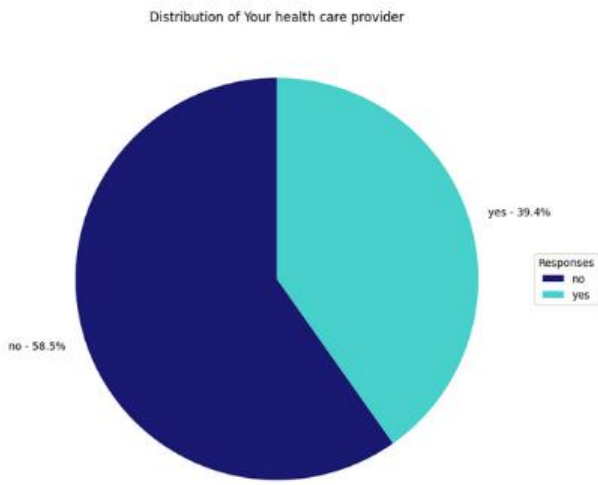
1. Los Angeles Department of Water and Power
2. City or county government
3. Your healthcare provider
4. Your place of worship
5. Friends and neighbors
6. Community organizations & activists

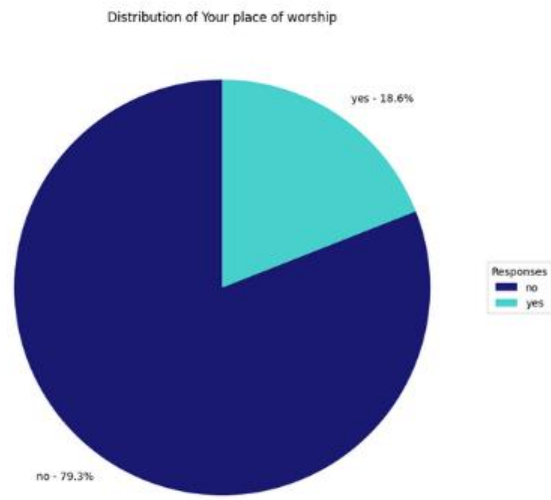
	Yes	No	I don't know
Los Angeles Department of Water and Power	52	131	1
City or county government	52	131	1
Your healthcare provider	74	110	
Your place of worship	35	149	
Friends and neighbors	55	129	
Community organizations & activists	78	105	1

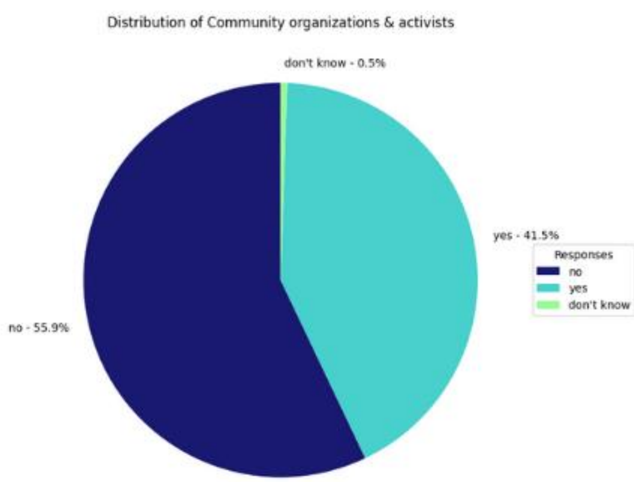
When ranking the sources that respondents trusted, community organizations placed the highest followed by healthcare providers. City and country governments had the same trust score as the local water utility. On the other hand, friends and neighbors and places of worship fell last in the hierarchy.

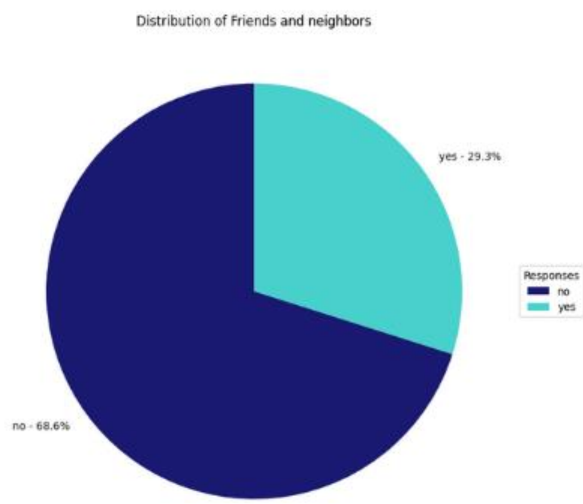

Distribution of Los Angeles Department of Water and Power
don't know - 0.5%
yes - 27.7%
no - 69.7%
Responses
no
yes
don't know


Distribution of City or county government
don't know - 0.5%
yes - 27.7%
no - 69.7%
Responses
no
yes
don't know


Distribution of Your health care provider
yes - 39.4%
no - 58.5%
Responses
no
yes


Distribution of Your place of worship
yes - 18.6%
no - 79.3%
Responses
no
yes


Distribution of Community organizations & activists
don't know - 0.5%
yes - 41.5%
no - 55.9%
Responses
no
yes
don't know


Distribution of Friends and neighbors
yes - 29.3%
no - 68.6%
Responses
no
yes

Health and Quality

Lastly, surveyees responded on their water quality regarding health effects they have experienced and the taste, odor, and color of their water. Reported health effects include headaches, stomach issues, diarrhea, allergic reactions, dry skin, lightheadedness, face blotches, rashes, itching, enlarged veins, bad hair, and skin tone changes.

The majority of respondents (63%) do not experience a foul smell in their water, similarly, 59% of respondents have never encountered a foul taste in their water. Regarding water discoloration, a notable portion (30%) of the respondents have indicated occasional instances of water quality discoloration.

References

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