# A Comparison of the Water Quality Between Chinatown and Bayside: Two Demographically Different Regions in NYC

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## ABSTRACT

In this research paper, we will be comparing the water quality in Chinatown –an area with a majority poor Asian population– and Bayside –a more affluent and well-funded region in New York City. Our hypothesis was that Bayside's water will be safer to drink than Chinatown's for the following reasons: (a) Bayside received a 62.5 million dollar grant to renew its piping system and (b) drinking water injustices have plagued communities with high rates of racial and economic minorities, as seen in the Flint Michigan water crisis. Researching if the accessibility of clean drinking water is dependent on the region is important to ensure no environmental injustices in water quality are occurring in an area of a specific racial and economic demographic. We selected 15 restaurants from both regions and tested for the pH and TDS in collected water samples. We then used DataClassroom to conduct t-tests and linear regression tests to analyze our data. In conclusion, we failed to reject our null hypothesis, as the water from Chinatown and Bayside had no significant difference. Our study raises several important future research questions such as how the year a building is built correlates to the pH level, as a negative correlation was observed based on our study.

## INTRODUCTION

Accessibility to safe-drinking water is recognized as a human right as we need it for survival and adequate health (1). However, many low-income regions still rely on unsafe drinking water (2). Since bottled water is more expensive (3), people living in low-income regions are forced to consume unsafe tap water, bringing many risks to their health. The Safe Drinking Water Act of 1974 allowed the Environmental Protection Agency (EPA) to pass standards for sources of tap water designed for drinking usage (4), and the purpose of this paper is to ensure two of these standards are followed in two demographically different regions of New York City. pH is a parameter indicating how acidic or alkaline a sample is. Water with a pH of 7 is neutral, while water with more free hydrogen ions is acidic (pH < 7), and water with more free hydroxyl ions is alkaline/basic (pH > 7) (5). Total dissolved solids (TDS) are the concentration of inorganic salts and organic matter that are dissolved in a sample of water such as zinc, iron, lead, and pollutants (6). The EPA states that safe drinking water should have a pH range of 6.5 to 8.5 and should not exceed 500 parts per million (PPM) for TDS values (7). Unlike national primary drinking water regulations, these two variables are secondary regulations, meaning they're not enforced by the EPA but only recommended (7). This increases the likelihood of these standards not being met, and frequently drinking water that's not meeting the standards proposed can lead to negative health impacts such as organ damage and lead exposure (6, 8), emphasizing why these are important metrics to test for when determining the water quality of a sample.

10% of New York City's water comes from the Croton watershed, while the rest comes from the Catskill/Delaware watershed (9). Although all of New York City's water comes from these two watersheds –which are often considered extremely clean–, local distribution of the water may degrade its quality depending on the piping conditions of the region (9). While Chinatown is located in lower Manhattan, Bayside lies in northeast Queens. The regions are around 14 miles apart, meaning their pipelines are likely to be different compared to each other. In order to deliver safe water supplies to consumers, old water pipes must be replaced or upgraded, but renewing them usually costs a substantial amount (10). In 2018, Bayside received 62.5 million dollars to replace the old cast iron pipes with new ductile iron water mains. These funds improved water distribution greatly, allowing for increased accessibility of high-quality drinking water

(11). However, there's a lack of information concerning funding for Chinatown's drinking water.

Nearly three-fourths of Chinatown's residents are Asian and the median annual household income is $65,410 (12). Although Chinatown's median annual household income isn't considered low (as it's above the national median annual household income of $64,994), this is possibly due to Chinatown experiencing dramatic gentrification over the past several years. Landlords are raising their rent, which consequently displaces poorer residents for wealthier ones, therefore increasing the median household income in Chinatown (13). However, most Chinatown residents are actually making less than $25,000 a year (12). On the other hand, Bayside has Asian residents making up slightly less than half the racial profile and white residents making up over a third. Bayside's median annual household income is $88,852, with the majority making $75,000 to $149,000 (14). Additionally, Bayside is not experiencing any form of gentrification, meaning economic minorities in this area aren't being displaced, which validates the median household income data of Bayside (15). During the Flint Michigan water crisis, it was mainly residents living in economically depressed areas with high percentages of racial minorities that were affected by the lead infiltrated water (16). Chinatown's demographic profile matches those affected by the Flint Michigan water crisis, which stresses the need to conduct this study to ensure that environmental injustices aren't occurring in this region as well.

This raised the question of how the accessibility of clean drinking water is different in Chinatown compared to Bayside, a more affluent and well-funded region in New York City. Although all of New York City's tap water comes from the Catskill/Delaware and Croton watershed, a potential lack of funding to renovate old pipes along with potential demographic preferences can result in Chinatown's drinking water having a greater TDS than Bayside's and an average pH value that's not between 6.5 to 8.5. Contrastingly, since Bayside's drinking water comes from renewed and well-funded water pipes, we expected it to have a lower TDS value compared to Chinatown's and an average pH value within the 6.5 to 8.5 range.

## METHODS

First, Google Maps was utilized to locate 15 restaurants in both Chinatown and Bayside. The website PropertyShark was then used to determine the date of building construction by inputting the address. Next, tap water samples from these 30 restaurants were collected and tested for pH and TDS (PPM). The data collected was then compared to the EPA safe drinking water standards to determine if all water samples fell within a pH range between 6.5 to 8.5 and a TDS value between 0 and 500 PPM (7). Finally, DataClassroom was used to create data visualizations and conduct statistical tests. T-tests were used to determine significant differences between Chinatown and Bayside for pH, TDS, and the year built of the building, while linear regression was used to explore relationships between the year built and the water quality variables.

## RESULTS

There was a significant difference when exploring the contrast in building age between Chinatown and Bayside, p-value $<0.01$. The locations sampled from Chinatown are ~55 years older on average compared to Bayside, with the mean year built in Chinatown and Bayside being 1900.02 and 1955.2, respectively (Figure 1). Although Chinatown's buildings tend to be older, the median and mean pH and TDS values of water samples in those restaurants only remain slighter higher than the water sampled in Bayside restaurants. After comparing the pH and TDS values between Chinatown and Bayside, no significant differences were observed as all the p-values are greater than 0.05 (Figure 2, 3).

When exploring the potential relationship between the year built and TDS, no relationship was present, p-value = 0.56 (Figure 4). However, there was a significant relationship between the year built and pH value, p-value = 0.03. A negative correlation between the year built and the pH was observed, r value = -0.42. As the year built of the restaurant increases, the pH decreases, with 16.3% of the variation in pH being explained by the building age, $r^2 = 0.163$ (Figure 5).

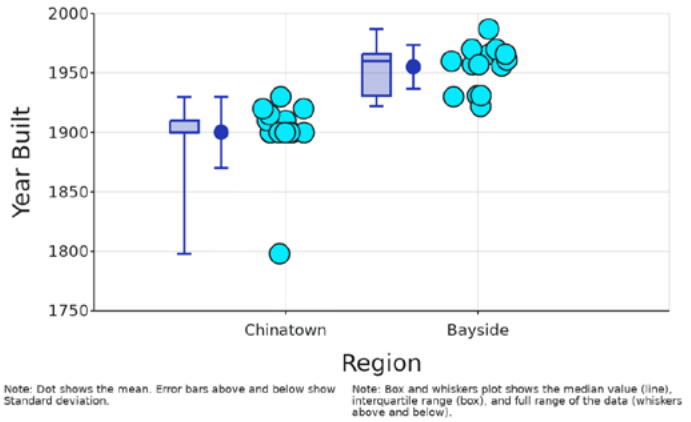


**Figure 1:** N=15. This figure depicts the differences in the year of which Chinatown and Bayside buildings were built. The average year Chinatown's building is built is 1900.2, while Bayside's is 1955.2. A significant difference, p-value = <0.01

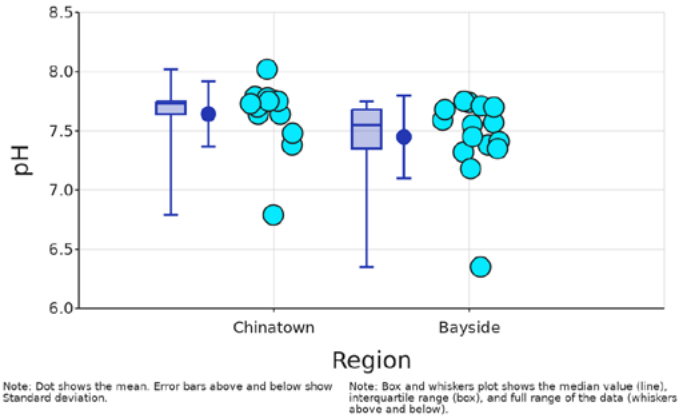


**Figure 2:** This figure shows a comparison of the pH values between Chinatown and Bayside. No significant differences, p-value = 0.10

From all of the water samples, one of Bayside's has a pH of 6.35, which is below the EPA recommended pH range. No water samples exceeded the TDS recommended value. In conclusion, Chinatown's restaurants are observed to be older than Bayside's, yet there's no significant difference in the pH and TDS values between the two regions. There's a negative correlation between the year built by the restaurant and the pH, but no relationship between the year built with the TDS.

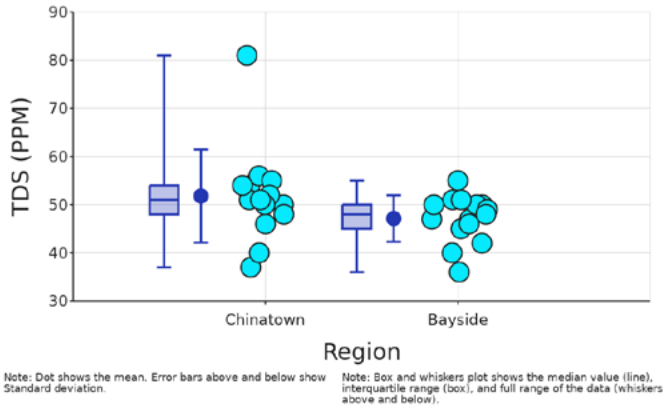


**Figure 3:** This figure shows a comparison of the TDS values between Chinatown and Bayside. No significant difference, p-value = 0.11

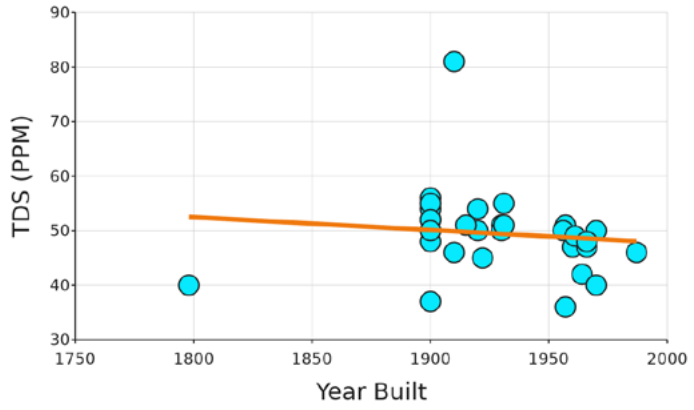


**Figure 4:** No significant relationship between the year built and TDS values, p-value = 0.56

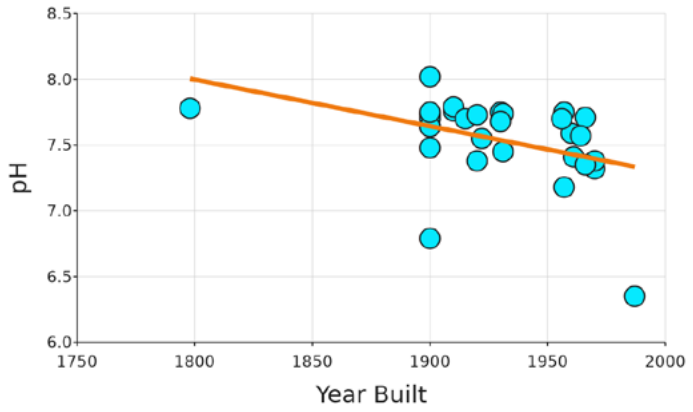


**Figure 5:** There is a significant relationship between the year built and pH values, p-value = 0.03. R = -0.42. R^2 = 0.163

## DISCUSSION

The average pH of New York City's drinking water is 7.3 (17), but both regions' pH average is greater than the city's average. Contrastingly, the average TDS of New York City's drinking water is 101 (17), but both regions' TDS average is less than the city's average. Using the EPA standards, it's observed that the overall drinking water from both regions is still considered safe despite these values being different from the city's average. And although Bayside received 62.5 million dollars to renew their water distribution pipes (11), it's observed from figures 2 and 3 that there are no significant differences in the pH or TDS between Chinatown and Bayside, meaning we failed to reject the null hypothesis. In fact, one of Bayside's water samples is unsafe to drink with a pH of 6.35, which is below the EDA-approved drinking water standards of 6.5 to 8.5. As a result, the drinking water from this restaurant has a bitter metallic taste (7), and if consumers are frequently exposed to this acidic water, it can result in diarrhea, shortness of breath, and organ damage (8). Drinking water samples above the recommended TDS value of 500 PPM may have a salty or bitter metallic taste, an unpleasant odor, or be discolored (6, 7). When consumers frequently drink this kind of water, it can lead to lead exposure, laxative effects, and constipation effects (1, 6). However, the TDS in all 30 locations sampled is within the EPA recommended range and is thus of least concern.

Since Bayside received substantial funding for the renewal of its pipelines, it raised the question of why its drinking water quality wasn't significantly different than Chinatown's, and in one instance, worse. Our hypothesis is that Bayside's water quality could've been worse prior to when the infrastructure project began in 2018. Therefore, the pipeline upgrade only improved it to match the water quality of other regions in New York City such as Chinatown. However, there's a lack of information on the internet regarding water quality tests in Bayside before 2018, so this hypothesis can't be tested. One possible explanation for the 6.35 pH value in a water sample could be that the infrastructure project mainly upgraded pipelines in residential areas, but we tested the water quality of restaurants. Therefore, the pipelines beneath the restaurants may not have been renewed. However, this hypothesis would be contradicted by State Senator Tony Avella's statement, "This work will greatly improve the water distribution system in Flushing and Bayside" and Ana Barrio's statement, "This project will improve the neighborhood's water" (11). These promises imply how the project will benefit the entire area, not just selected residential streets. This proposes a future case study comparing the water quality of houses in Bayside that are directly above where pipelines were replaced to houses that aren't directly above the mapped areas of pipeline renovation. The importance of this research is to see whether the pipelines are beneficial to the rest of Bayside or only selected streets.

On average, Chinatown restaurants are observed to be 55 years older than Bayside restaurants (Figure 1). This can be explained by Chinatown's development forming in the mid-1800s (18), while Bayside's development formed later, in the mid-1900s (19). Despite this disparity in building age, it's observed to have no impact in a region having poorer water quality. However, there is a negative correlation between the year built and pH values (Figure 5). Since the reasoning for this is unknown, a future study can be done to determine how the year a building is built can influence the pH of its water. Does the pH continuously decline past 7? Does it not correlate at all once a larger sample size is used?

The pH of a water sample is inversely proportional to the temperature (20). Since we collected our data

samples in bottles and waited 6 hours before we tested for the pH and TDS, temperatures could've risen or declined within those 6 hours which then altered the pH value. Therefore, a potential flaw in our study could be the inaccurate data reporting in the pH values.

A water quality study was conducted in a region of a developing country: Wondo Genet Campus, Ethiopia. Results showed that all sampling sites met the WHO standards (1), showing how developing countries aren't always aligned with poor-quality drinking water. Additionally, our research showed that both Chinatown and Bayside are observed to have safe drinking water and no significant differences in quality. Ultimately, this ensures that racial and economic preferences aren't always present in the accessibility of clean drinking water, whether on a local or global scale.

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