Investigating the Condition and Investment Needs of Michigan's Drinking Water Infrastructure: Policy and Financing Ramifications

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Executive Summary

The aim of this project is to compile water infrastructure finance data for Flint and 249 other cities across Michigan. The research team used data scraping methods to extract fiscal data from city financial reports on water infrastructure operations, assets, and liabilities. The team compiled data for years 2008, 2015, and 2022. This report presents a summary of this information to learn more about the status of water infrastructure, water infrastructure investment, and water infrastructure finances over time. To our knowledge, this is the first effort to compile information of this nature for many cities over time.

The report articulates the key goals of the data collection effort, data collection methods, and a summary of what fiscal measures were compiled. We provide an explanation of the process used to select municipalities, a detailed assessment of the data collected, including summary statistics, case studies, and explanations of what can be learned from the examination. This discussion includes a map of shrinking, stable, and growing cities across Michigan. The report includes an in-depth evaluation of Flint, which includes comparisons with other cities in Genesee County, Michigan as well as comparison with Newark, New Jersey and Jackson, Mississippi, which are also addressing water quality challenges.

Key Findings:

- Water charges vary substantially from community to community, where cities with declining populations charge the most for water services on a per capita basis. Overall, water charges increased by about 25% between 2008 and 2022. The analysis highlights the critical issue of affordability, where the highest fees are often charged in relatively high poverty communities experiencing population decline.
- On average, the per capita value of water infrastructure assets and liabilities fell from $2,131 to $1,781 between 2008 and 2022, but there is considerable variation in experiences across communities
- Overall net position (assets minus liabilities) was stable over the period.
- With per capita water charges of more than $800 per person in 2022, Flint is among the most expensive cities in Michigan for water services.
- Flint experienced a major water infrastructure investment between 2015 and 2022, with per capita assets increasing from $2,000 to more than $6,500. Liabilities also increased from $1,600 to $3,600 over the 2015-2022 period. Overall, net position improved substantially over the period

Report Outline

Introduction

The Flint water crisis, which occurred over the 2014-2016 period, highlighted both the challenges and importance of maintaining critical public infrastructure. The once thriving manufacturing community has faced ongoing challenges since the 1970s and early 1980s. Flint's population peaked in 1960 at about 200,000 and has been in decline since, with its current population at about 80,000. (BiggestUSCities) The steep decline in population during the 1980s and 1990s was precipitated by recession and high gas prices, which hurt United States (US) automakers. More fuel-efficient Japanese automobile companies made inroads to the US market. At the same time, GM closed plants in Flint, laying off tens of thousands of workers as operations were relocated to Mexico. (Smith, 2011)

Over this period of economic and population decline, the city of Flint struggled to manage excess housing, housing dilapidation, and an eroding property tax base. Currently, the poverty rate in Flint is 33.3% (Welfare Info) with a per capita income of $19,914 as compared to $38,151 for Michigan as a whole (City-Data). In such an environment, city authorities have sought to adequately fund critical public services, and public infrastructure investment decisions have been deferred.

In 2002, a financial emergency was declared for Flint by Michigan Governor John Engler who subsequently appointed an emergency manager (Flint Water Crisis). Fiscal challenges were further exacerbated by the Great Financial Crisis of 2007-2008. In the wake of the financial crisis, fiscal conditions in Flint worsened; in 2011 Governor Rick Snyder appointed the first of several emergency managers who reported directly to the Michigan Department of Treasury. The Flint water crisis was the result of a cost saving decision by the emergency manager to switch the city's water supply from the Detroit Water and Sewerage Department to the Flint River. As result, dangerous levels of lead as well as other contaminants were found in Flint drinking water. Corrosive and insufficiently treated Flint River water resulted in the leaching of lead from aging pipes, causing significant harm to the citizens of Flint.

While the Flint water crisis brought to the forefront the challenges associated with chronic fiscal decline and problems associated with aging water infrastructure, Flint is by no means alone in fiscal problems and depreciating infrastructure. Other cities in the rust belt and beyond are also struggling with water infrastructure, water quality, and the associated negative impacts on human well-being.

Other communities in Michigan are experiencing fiscal challenges, which has led to the deferral of critical infrastructure reinvestment. According to the American Society of Civil Engineers (ASCE), Michigan's basic infrastructure has an overall grade of C minus with drinking water systems, bridges, energy, roads and stormwater systems graded at a D level.

Nationwide, concerns about aging public infrastructure date back to the 1980s. In 1984, economists Charles Hulten and George Peterson (1984) wrote that, "deterioration of this "public infrastructure capital has reached alarming proportions, and that a significant fraction of future national savings will be needed to reverse the damage of past neglect" (Hulton and Peterson, 1984). Today, engineers agree that the US has underinvested in key public infrastructure; the ASCE rated America's infrastructure at a C minus level for 2022 (American Society of Civil Engineers). However, the challenges are not uniform across all states and communities. Those communities that have struggled with structural economic changes in economic conditions and population decline are much more likely to have subpar water systems and other public infrastructure problems. This puts marginalized groups at the greatest risk of being exposed to environmental hazards.

Challenges associated with population decline affect many countries across the globe. Global population is expected to peak between 2050 and 2080 (Population Connection), and countries such as China, Japan, and several European countries are already experiencing population decline. In each of these countries, many cities are experiencing population shrinkage (Li, et al., 2020). The experiences of Flint and other Michigan cities can offer guidance to city leaders here in Michigan, across the US, and the globe.

The aim of this project is to compile fiscal data for Flint and hundreds of other cities across Michigan. To collect this information, we used data scraping methods to extract fiscal data on water infrastructure operations, assets, and liabilities. We compiled data for the years 2008, 2015, and 2022. In this report, we present a summary of this information to learn more about the status of water infrastructure, water infrastructure investment, and water infrastructure finances over time. To our knowledge, this is the first effort to compile information of this nature for many cities over time.

In the next section of this report, we provide descriptions of our key goals for data collection, data collection methods, and a summary analysis of these data. We provide a detailed explanation of the process used to select municipalities for our examination. We offer a detailed discussion of data collected, summary statistics, and explanations of what can be learned from the examination. This discussion includes a map of shrinking, stable, and growing cities across Michigan. The report also includes a more detailed evaluation of Flint, which includes comparisons with other cities in Genesee County, Michigan as well as Newark, New Jersey and Jackson, Mississippi, which are also addressing water quality and infrastructure challenges. The final section offers a summary of what was learned with concluding remarks.

Background and Methodology

In this project, we collected and analyzed data required by the state of Michigan via fiscal regulations to improve our understanding of what can be learned regarding the condition and needs of the state's drinking water infrastructure systems.[1] Fiscal regulations require the reporting of financial data that are quantitative in nature, consisting of both codifiable narrative and numbers. We begin this section with a discussion of core accounting principles and water asset management issues.

Principles of Accounting and Water Asset Management

Accounting Standards

The Government Accounting Standards Board (GASB) Statement No. 34 (GASB 34), issued in 1999, standardized government accounting practices and significantly improved the quality of financial reporting for state and local governments in the U.S. By making financial statements more detailed and easier to understand, GASB 34 helped promote greater accountability and transparency in how public resources were managed. It also allowed for better comparisons

[1] This study does not examine the situation of those households who access drinking water via wells or use a septic type of system for clean water. These are important issues but beyond the scope of this study.

between different government entities, facilitating more informed decision-making by officials, taxpayers, and investors. The introduction of this standardized approach to government accounting has had a lasting impact on public financial management, making it easier to assess the fiscal health and sustainability of government operations.

One major feature of GASB 34 was how it treated asset depreciation in government accounting. Before, most governments didn't regularly record or report the decrease in value of long-term fixed assets. With GASB 34, depreciation became a key part of financial reports. Governments now had to calculate and show how their assets, like infrastructure, buildings, and equipment, lost value over time, using methods like straight-line or accelerated depreciation. Including depreciation in financial statements gave a more accurate fiscal picture of government provided services and the long-term sustainability of public assets.

Depreciation expense plays an important role in decisions about investing in expensive long-term assets like drinking water infrastructure. For communities and water utilities, infrastructure such as water treatment plants, pipelines, and reservoirs are big, long-term investments that are crucial for providing safe and reliable drinking water. Over time these assets wear out, which leads to a loss in asset value or depreciation. Recording depreciation expenses in financial statements shows this gradual loss in value, helping leaders realize when assets need to be repaired, upgraded and replaced to keep services running efficiently and effectively.

A significant amount of a drinking water system's infrastructure is out of sight, making it difficult to determine where to direct reinvestment. Tracking depreciation expense of water system assets can affect how water revenues are budgeted and prioritized. When water revenues are spent wisely, fixing aging infrastructure and preventing problems like water losses due to distribution system leakages or service outages due to pipe bursts, the system's drinking water quality is better preserved.

Depreciation expense also affects how affordable it is to invest in water infrastructure. As infrastructure wears out, replacing or repairing it is expensive. Publicly owned water utilities typically issue debt to finance large infrastructure asset replacement. Water utilities have fixed operating and maintenance (O&M) costs as well. Water rates are set to generate water revenues paid by water customers that are used to pay debt and O&M expenses. There exists a tension between providing customers affordable water and adequately maintaining water system infrastructure. Managing depreciation helps with planning and future investment decisions. By understanding depreciation and its impact on the overall financial health of the water utility, authorities can make smart investment choices that keep water infrastructure working for longer while also making sure costs stay affordable.

In the U.S., local governments' decisions about investing in capital assets, like roads, bridges, utilities, and public buildings, are influenced by regulatory rules, financial practices, and budget limits. They usually follow Generally Accepted Accounting Principles (GAAP), which are set by the Government Accounting Standards Board (GASB), to make sure their financial reporting is clear and accountable. These rules require local governments to carefully record and report on their investments in these assets, including details about their purchase, construction, and maintenance. This process involves not only tracking the initial costs but also ongoing expenses, like depreciation, repairs, and upgrades throughout the asset's useful life.

Decisions about investing in capital assets are best guided by strategic planning, budgeting, and a community's needs. Local governments often try to balance between attending to current public service needs and planning for the future to manage long-term financial sustainability. Accounting policies are essential in this process because they offer a framework for understanding the costs and benefits of capital projects. These policies help local governments make choices that align with both their current budget and the community's future goals.

Transparent accounting practices are also important for keeping the community and other stakeholders informed. They help local governments explain to taxpayers, bond investors, and regulatory agencies why certain investment decisions are made. By following clear accounting rules, local governments can build trust with residents, showing planned uses of public funds.

Accounting policies play a big role in how local units decide to invest in long-term assets, such as buildings, equipment, or infrastructure. The way depreciation is calculated, or capital expenses are recorded affects financial reporting. For instance, using conservative accounting methods might mean that greater expenses are recorded early on, which could make planned investments seem more expensive in the short term and negatively impact investment decisions. On the other hand, more flexible accounting methods might defer some project expenses, improving the balance sheet in the short term and obscuring project liabilities and debt over time. The accounting policies chosen can influence perceived investment risks and ultimately affect investment decisions.

The choice of accounting policies can also affect financing terms of investments. Lenders and investors look at financial reports to decide if an organization is financially stable enough for them to lend money to or invest in. If an organization uses conservative accounting policies that prioritize accuracy and transparency, it may build trust with these lenders and potentially receive better loan terms. However, if an organization uses aggressive accounting practices that hide true financial conditions or inflate revenues, it might lose investor trust and face higher borrowing costs.

Furthermore, accounting policies can also influence how a local unit handles and plans for future financial commitments. For example, if a local government's practice is to recognize most of its expenses upfront, this cautious approach might slow down new investment decisions but ensure that it is prepared to manage future costs. On the other hand, deferring expenses might encourage more immediate investment but could lead to financial strain if obscured costs become due earlier than projected. By choosing the right accounting approach, organizations can better manage their finances, gain trust from lenders and investors, and make well-informed decisions that support infrastructure development and contribute to the community's well-being.

Conservative accounting policies set high capitalization thresholds which require major expenditures be depreciated or capitalized rather than expensed immediately. The purpose of capitalizing long-term asset costs is to better align its cost with its expected useful life. The capitalization criteria of a project can make it appear financially strained in the short term, which may lead decision-makers to limit the timing and scale of financially sound capital investments.

With this background in place, we now turn to a discussion of the approach we used to compile detailed information on drinking water finances and infrastructure from 270 Michigan municipalities.

Methods

As discussed in greater detail in the Data Overview section, we compiled detailed information from 270 Michigan municipalities on drinking water finances and infrastructure. The following fiscal measures were taken from the comprehensive annual financial reports (CAFR) that are collected by the Michigan Department of Treasury for every local government in Michigan going back to 2001. The dataset includes municipal population and the following fiscal measures for fiscal years 2008, 2015, and 2022:

Fiscal Measure	**Definition**
Total Assets	Value of depreciated drinking water assets
Total Current Assets	Value of current drinking water assets
Total Noncurrent Assets	Value of Noncurrent drinking water assets
Total Liabilities	Total drinking water-related liabilities
Total Current Liabilities	Current drinking water-related liabilities
Total Noncurrent Liabilities	Noncurrent drinking water-related liabilities
Total Net Position	Total drinking water assets minus total liabilities
Operating Income (Loss)	Total drinking water operating income
Pooled Cash Investments	Pooled cash investments for drinking water
Cash and Cash Equivalents	Cash and cash equivalents for drinking water
Operating Expenses	Operating expenses for drinking water
Charges for Service	Charges for drinking water related services
Nonoperating Revenue (ALL POSITIVE)	Nonoperating revenue for drinking water
Nonoperating Revenue (ALL NEGATIVE)	Nonoperating revenue for drinking water

We present a detailed discussion of the financial data in the next section. However, before presenting the data, we first describe the process of data collection and cleaning.

Data Overview

Sample Design and Number of Municipalities

Data were collected from a large sample of Michigan local governments who own and maintain community/public drinking water systems. According to the Michigan Department of Environment and Great Lakes (EGLE), there are an estimated 1,383 community water supply systems in the state. The state of Michigan tracks the existence of these systems and the populations they serve but does not collect any financial or physical investment information other than that collected on an ad hoc basis for the revolving fund applications.

Of these 1,383 drinking water supply systems, the largest is the city of Detroit with over 700,000 retail population and the smallest systems have only one person. To obtain a sample of municipalities, we restricted potential selection to include local governments that have a drinking water supply retail population of more than 1,000, which includes a total of 495 community water supply systems in 70 of the 83 Michigan counties. Given the data limitations as described below, we collected usable data from 250 municipalities.[2] Below, we provide a description of the processes used to compile and organize the data.

Step 1: Data Import and Exploration

- Load data files: The process begins with loading various files based on the Public Water Supply ID, including any pre-existing water quality reports or metadata that might be available.

- Explore the dataset. This step involves checking the structure of the data, such as columns, file paths, or locations associated within the water reports files.

Step 2: Categorization and Sampling

The goal of data categorization is to organize financial information to ensure all relevant subsets are included for analysis. This categorization allows for a structured approach to data sampling and later analysis.

Categorization Process

Criteria Used for Categorization:

[2] There are an additional 20 communities where data require further cleaning, after which this financial information will be reincorporated into the database.

- Geography: The data is first organized based on geographic divisions, such as counties and communities. This helps in managing data regionally, allowing for targeted analysis of water quality in different areas.

- Population Distribution: Population data is used to categorize areas into different strata based on size, growth rate, or density. This ensures that communities and regions with varying population sizes are represented.

- Time Period: Reports are also categorized by year (2008, 2015, and 2022). This allows for temporal comparisons and trend analysis.

Handling Missing Data and Duplicates

During categorization, instances of missing data or unavailable reports are identified. The code flags missing files and logs these occurrences for documentation. Checks for duplicate files are also conducted, with duplicates being reviewed and resolved to ensure consistency in the analysis.

Step 3: Download Process

- The download process involved iterating over the specified counties, communities, and years. The scripts attempted to find and download corresponding files based on the criteria.

- Mechanisms were put in place to account for missing files by identifying instances where no document was found. Specific naming conventions were used to organize the files, making it easier to track and avoid duplicates.

Step 4: Checking Data

Loaded data are not always of uniform data type and may also have some inconsistencies that require examination.

- All the data collected is cross-verified and missing data from the documents has been updated and corrected.

- Initially, data were collected for 430 communities, but after eliminating communities that report sewage and water together in their financial reports, the number was reduced to 360.

- Later the verification of consistency of the location in 2008, 2015, and 2022 reduced the number to 300 communities.

Step 5: Data and Analysis

The goal here is to clean the data and make it consistent to perform analyses and generate visualizations.

Data Cleaning

- The datatypes are formatted make the data consistent throughout the tables.

- Null values were analyzed; in some cases, columns were combined into one.

- Combine Non_Operating_Revenue (ALL_POSITIVE) and Non_Operating_Revenue (ALL_NEGATIVE) to one column.

- Identify structurally missing data. (columns with logical reasons for missing data can be identified from domain knowledge)

- Remove columns with more than 50% missing values.

Handling Missing Values

Fill missing values for numeric columns were filled in with mean values to generate overall summary statistics for all periods.

Processing the Data

- Real Values: Adjustment of the consumer price index (CPI) to calculate real (inflation-adjusted) values where the CPI = 2008: 75.1, 2015: 83.1, 2022: 100.0,

- Per Capita Real Values: Normalize data by population. All financial data are normalized by population to make data comparable across different sized cities.

- Location: Normalizes the "Location" column by converting all text to lowercase, removing any leading or trailing spaces, and stripping out ".pdf" from the filenames. This step ensures consistency in the "Location" column for accurate data merging.

- Time Periods: Combine 2008, 2015 and 2022 data based on location and create merged data.

Population (Growing, Shrinking, Stable)

We calculate the percentage change for metrics like population or financial data between 2008 and 2022, 2008-2015, and 2015 and 2022. The percentage change metrics identify growth or decline over time.

- After calculating the percentage change, we classify by grouping changes into "Increase," "Decrease," or "No Change."

The information presented in the tables of this report is extracted from the finalized database.

Summary of All Communities in the Sample

In this subsection we present financial data in three formats as shown in Tables 1, 2, and 3. Table 1 presents nominal data that has not been adjusted for inflation. In Table 2, we present real inflation-adjusted financial data. The inflation-adjusted data are expressed in 2022 dollars Table 3 presents financial data expressed in real per capita terms. Each table presents the mean and standard deviation for each fiscal measure. Table 1 is presented for reference, but the more meaningful tables are Tables 2 and 3.

The information provided in Table 2 suggests that on average the population has been stable over the period with a slight upward trend. Correspondingly, drinking water assets, liabilities, net position, operating expenses, and charges for services also exhibit a slight upward trend. Table 2 is presented to provide an overall perspective, but the per capita measures presented in Table 3 are more informative, enabling comparisons of different sized communities. Here, real per capita total assets decreased from $2,131 to $1,778 between 2008 and 2022. While liabilities also decreased modestly, overall net position was stable. However, real per capita charges for services increased from $197 to $249 between 2008 and 2022, underscoring concerns about increasing costs of drinking water provision.

The affordability of drinking water has become a pressing issue for many communities across the US, particularly as the costs of maintaining and upgrading aging infrastructure continue to rise. According to data from the US Environmental Protection Agency (EPA), water rates have been steadily increasing nationwide, outpacing inflation and placing a strain on household budgets, especially for low-income families. The American Water Works Association (AWWA) reports that the average residential water bill has more than doubled since 2000, with some areas experiencing even steeper rate hikes. These rising costs are driven by various factors, including the need for infrastructure investments, compliance with water quality regulations, and the impacts of climate change on water supply and distribution systems.

The affordability of drinking water is a critical concern, as higher rates disproportionately burden households with limited financial resources. Studies by organizations such as the Water Research Foundation and the Brookings Institution have highlighted the growing affordability gap, with a significant portion of low-income households facing challenges in meeting basic water needs without sacrificing other essential expenses like food, healthcare, or education. The issue is compounded by disparities in income, race, and geography, with marginalized communities often bearing a disproportionate burden of water rate increases. Addressing drinking water affordability requires a multifaceted approach that includes targeted assistance programs, rate structures that promote equity and conservation, and investments in infrastructure efficiency to mitigate the need for continual rate hikes while ensuring access to safe and affordable drinking water for all.

Table 1

NOMINAL VALUES SUMMARY STATISTICS						
Columns	2008		2015		2022	
	Mean	STD	Mean	STD	Mean	STD
Population	9,431	15,491	9,481	15,866	9,567	16,012
Total_Assets	$ 10,490,678	$ 19,904,294	$ 11,300,740	$ 20,637,990	$ 14,508,312	$ 32,920,225
Total_Current_Assets	$ 1,735,803	$ 3,903,583	$ 2,049,228	$ 4,182,489	$ 3,092,473	$ 6,632,178
Total_Noncurrent_Assets	$ 8,819,992	$ 16,667,474	$ 9,275,694	$ 16,991,956	$ 11,395,533	$ 26,924,784
Total_Liabilities	$ 3,181,636	$ 7,093,582	$ 3,615,885	$ 7,821,374	$ 4,468,584	$ 14,212,094
Total_Current_Liabilities	$ 445,539	$ 1,068,017	$ 456,443	$ 902,915	$ 632,169	$ 1,483,980
Total_Noncurrent_Liabilities	$ 2,845,264	$ 6,119,202	$ 3,268,639	$ 7,112,453	$ 3,892,075	$ 13,027,456
Total_Net_Position	$ 6,977,230	$ 13,009,559	$ 7,853,766	$ 15,252,518	$ 10,389,486	$ 21,720,162
Operating_Income_(Loss)	$ 1,862,566	$ 1,666,851	$ 15,145,141	$ 151,752,629	$ 2,411,065	$ 2,140,605
Pooled_Cash_Investments	$ 780,103	$ 1,378,368	$ 986,785	$ 1,553,768	$ 1,660,179	$ 3,881,288
Cash_and_Cash_Equivalents	$ 100,008	$ 572,243	$ 167,843	$ 1,010,601	$ 322,398	$ 1,633,995
Operating_Expenses	$ 1,280,238	$ 3,036,385	$ 1,627,367	$ 3,429,190	$ 2,125,205	$ 4,290,930
Charges_for_Service	$ 1,263,451	$ 2,499,924	$ 1,582,153	$ 2,990,902	$ 1,813,479	$ 3,763,688
Non_Operating_Revenue_(ALL_POSITIVE)	$ 123,910	$ 226,626	$ 66,620	$ 185,603	$ 86,709	$ 217,602
Non_Operating_Revenue_(ALL_NEGATIVE)	$ 102,102	$ 231,505	$ 124,944	$ 234,177	$ 131,227	$ 337,311

Table 2

Columns	2008		2015		2022	
	Mean	STD	Mean	STD	Mean	STD
REAL VALUES SUMMARY STATISTICS						
Population	9,431	15,491	9,481	15,866	9,567	16,012
Total_Assets	$ 13,968,946	$ 26,503,720	$ 13,598,965	$ 24,835,126	$ 14,508,312	$ 32,920,225
Total_Current_Assets	$ 2,311,322	$ 5,197,846	$ 2,465,979	$ 5,033,079	$ 3,092,473	$ 6,632,178
Total_Noncurrent_Assets	$ 11,744,330	$ 22,193,707	$ 11,162,087	$ 20,447,600	$ 11,395,533	$ 26,924,784
Total_Liabilities	$ 4,236,532	$ 9,445,515	$ 4,351,245	$ 9,412,002	$ 4,468,584	$ 14,212,094
Total_Current_Liabilities	$ 593,261	$ 1,422,127	$ 549,269	$ 1,086,541	$ 632,169	$ 1,483,980
Total_Noncurrent_Liabilities	$ 3,788,634	$ 8,148,071	$ 3,933,380	$ 8,558,909	$ 3,892,075	$ 13,027,456
Total_Net_Position	$ 9,290,586	$ 17,322,982	$ 9,450,982	$ 18,354,414	$ 10,389,486	$ 21,720,162
Operating_Income_(Loss)	$ 1,862,566	$ 1,666,851	$ 15,145,141	$ 151,752,629	$ 2,411,065	$ 2,140,605
Pooled_Cash_Investments	$ 1,038,752	$ 1,835,377	$ 1,187,467	$ 1,869,757	$ 1,660,179	$ 3,881,288
Cash_and_Cash_Equivalents	$ 133,167	$ 761,974	$ 201,978	$ 1,216,127	$ 322,398	$ 1,633,995
Operating_Expenses	$ 1,704,711	$ 4,043,123	$ 1,958,324	$ 4,126,582	$ 2,125,205	$ 4,290,930
Charges_for_Service	$ 1,682,358	$ 3,328,794	$ 1,903,915	$ 3,599,160	$ 1,813,479	$ 3,763,688
Non_Operating_Revenue_(ALL_POSITIVE)	$ 164,994	$ 301,765	$ 80,169	$ 223,349	$ 86,709	$ 217,602
Non_Operating_Revenue_(ALL_NEGATIVE)	$ 135,955	$ 308,263	$ 150,354	$ 281,802	$ 131,227	$ 337,311

Table 3

PER CAPITA SUMMARY STATISTICS												
Columns	2008				2015				2022			
	Mean		STD		Mean		STD		Mean		STD	
Population		9,431		15,491		9,481		15,866		9,567		16,012
Total_Assets	$	2,131	$	5,629	$	1,835	$	1,526	$	1,778	$	1,438
Total_Current_Assets	$	306	$	381	$	333	$	418	$	361	$	311
Total_Noncurrent_Assets	$	1,973	$	5,433	$	1,589	$	1,550	$	1,424	$	1,298
Total_Liabilities	$	707	$	912	$	698	$	865	$	623	$	791
Total_Current_Liabilities	$	81	$	103	$	80	$	133	$	78	$	99
Total_Noncurrent_Liabilities	$	673	$	842	$	704	$	1,168	$	559	$	746
Total_Net_Position	$	1,190	$	1,255	$	1,192	$	985	$	1,203	$	997
Operating_Income_(Loss)	$	14	$	61	$	15	$	64	$	27	$	73
Pooled_Cash_Investments	$	580	$	515	$	2,886	$	17,003	$	652	$	637
Cash_and_Cash_Equivalents	$	189	$	214	$	215	$	249	$	314	$	339
Operating_Expenses	$	252	$	229	$	240	$	273	$	222	$	151
Charges_for_Service	$	197	$	120	$	272	$	267	$	249	$	191
Non_Operating_Revenue_(ALL_POSITIVE)	$	37	$	99	$	15	$	36	$	21	$	73
Non_Operating_Revenue_(ALL_NEGATIVE)	$	28	$	97	$	31	$	34	$	23	$	26

Table 4 offers a summary of growth in percentage terms for municipal population and each inflation-adjusted per capita fiscal measure in our dataset. Over the period, the average growth rate of assets was a modest 4%. Note that the average growth rate of current assets was 34%, suggesting that some communities invested significantly in their water infrastructure over the period of evaluation. Liabilities increased by more than 5%, on average. On average, charges for services increased by about 8%.

Table 4

PER CAPITA % CHANGE SUMMARY STATISTICS MEAN			
Columns	2008 - 2022	2008 - 2015	2015 - 2022
Population	1.44	0.53	0.91
Total_Assets	3.86	-2.65	6.69
Total_Current_Assets	33.80	6.69	25.41
Total_Noncurrent_Assets	-2.97	-4.96	2.09
Total_Liabilities	5.48	2.71	2.70
Total_Current_Liabilities	6.56	-7.42	15.09
Total_Noncurrent_Liabilities	2.73	3.82	-1.05
Total_Net_Position	11.83	1.73	9.93
Operating_Income_(Loss)	29.45	713.13	-84.08
Pooled_Cash_Investments	59.82	14.32	39.81
Cash_and_Cash_Equivalents	142.10	51.67	59.62
Operating_Expenses	24.67	14.88	8.52
Charges_for_Service	7.79	13.17	-4.75
Non_Operating_Revenue_(ALL_POSITIVE)	-47.45	-51.41	8.16
Non_Operating_Revenue_(ALL_NEGATIVE)	-3.48	10.59	-12.72

Shrinking, Stable, Growing Municipalities

While the evaluation thus far offers useful information about overall conditions across the state, the standard deviations presented in Table 3 indicate that there is considerable variability in each of the fiscal measures. For example, the per capita charges for services in 2022 were $249, but the standard deviation was a substantial $191. A community with a one standard deviation higher level of per capita annual service charge is $440; affordability is a major issue in such communities. Table 4 shows changes in percentage terms over the entire period (2008-2022) as well as for 2008-2015 and 2015-2022. These data show that both assets increased substantially over the 2015-2022 period. The reinvestment that occurred in the latter period may have been catapulted by the federal government's Coronavirus Aid, Relief and Economic Security Act where $150 billion were allocated to state, local, and tribal governments.[3]

Tables 5a and 5b present real per capita fiscal measures in 2008 and 2022, respectively. These data are split into shrinking, growing, and stable communities, where the cut-off for shrinking and growing is ±3%. In these tables we see that relatively larger changes occurred in municipalities with decreasing populations, though the differences are not large. However, in shrinking cities per capita water assets are substantially higher than for increasing and stable communities. Per capita fees are also higher and increased substantially more in shrinking communities. There were no notable differences in the growth of assets and liabilities across decreasing, increasing, and stable communities.

Table 5a

2008							
Population Change	**Count**	**Population Change (%)**	**Per Capita Total Assets**	**Per Capita Total Liability**	**Per Capita Total Net Position**	**Per Capita Charges of Service**	**Per Capita Operating Expenses**
Decrease	81	-11	$ 2,202	$ 935	$ 1,472	$ 274	$ 223
Increase	105	12	$ 1,526	$ 523	$ 1,046	$ 234	$ 179
No Change	64	0	$ 1,690	$ 721	$ 1,068	$ 253	$ 191

Table 5b

2022							
Population Change	**Count**	**Population Change (%)**	**Per Capita Total Assets**	**Per Capita Total Liability**	**Per Capita Total Net Position**	**Per Capita Charges of Service**	**Per Capita Operating Expenses**
Decrease	81	-11	2362	873	1576	318	282
Increase	105	12	1402	433	1008	203	179
No Change	64	0	1655	616	1053	238	218

Evaluation of Outliers

In 2022, there was considerable variability in per capita charges for services among the 250 communities. On the high end is Fruitport Charter Township in Muskegon County where per capita charges for services are $1,515, followed by the Village of Lexington in Sanilac County with $1,083. Evar, Harbor Beach, Charlevoix, New Buffalo, Flint, and Ontonagon all have more

[3] The $550 billion Bipartisan Infrastructure Investment and Jobs Act was also passed in 2021 but given that the last year of our data is 2022 it is likely that not enough time had passed for these funds to be expended.

than $700 per capita water charges. Of the 20 most expensive water charge communities, just two experienced an increase in population between 2008 and 2022.

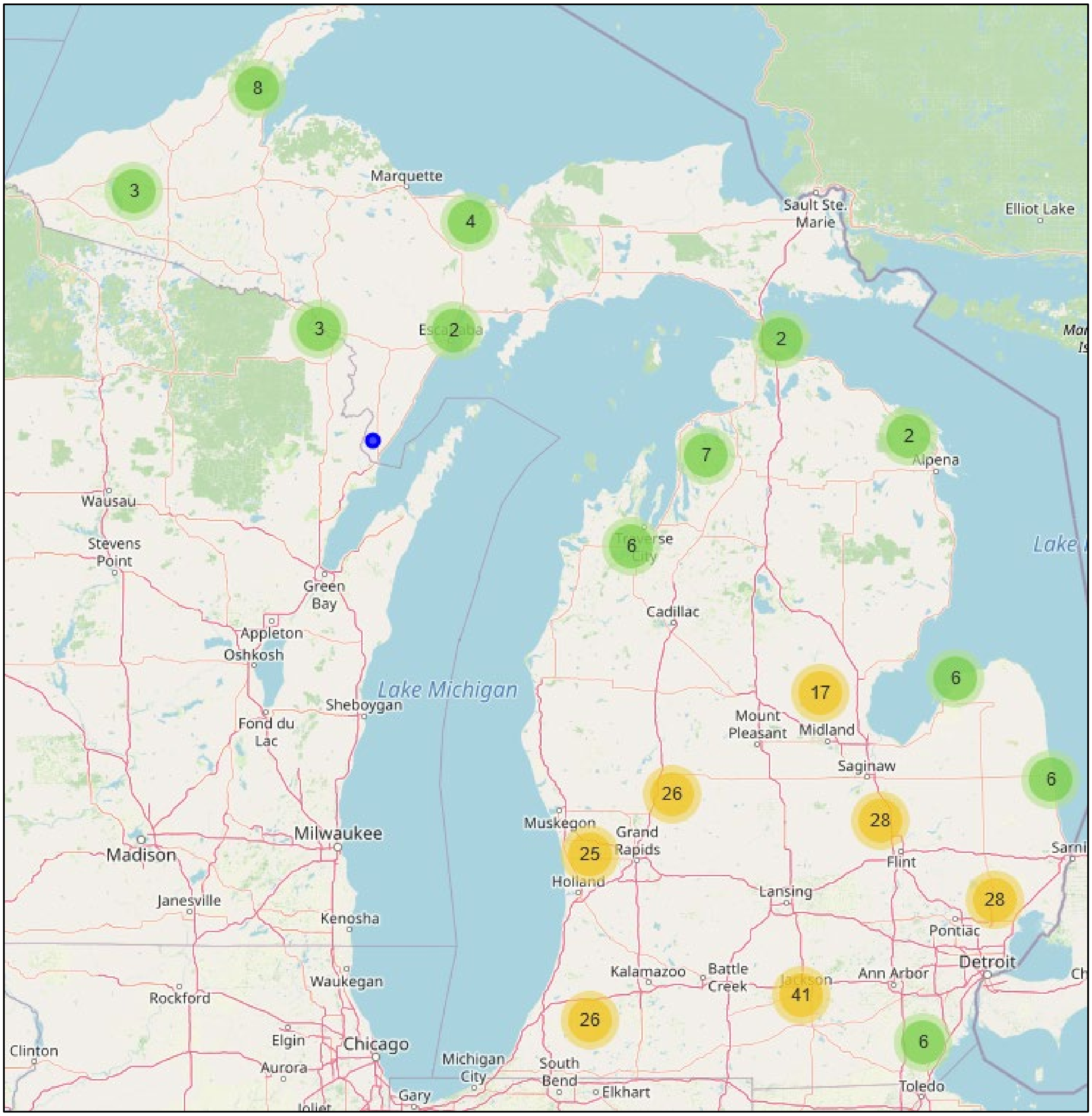
On the low end, 23 communities charge less than $100 per capita including municipalities such as Kentwood, White Lake Charter Township, and Blackman Charter Township, all with populations greater than 20,000. Among these 23 low water charge communities, only five experienced a decrease in population between 2008 and 2022. Overall, the more expensive communities tend to be those with declining populations and the less expensive communities tend to be those that are growing in population. However, water charges per capita do not seem to be related to population size.

Net position worsened in 113 communities and improved in 138 communities over the 2008-2022 period. Net position fell by more than 50% in 19 communities, including Portage, St. Claire, and Grand Blanc. However, net position improved by more than 50% in 52 communities. There was no discernable correlation between population change and net position.

Map

Figure 1 below provides an overview of the locations of the communities included in this study. In addition, this link will take you to the map where it is possible to zoom in on specific regions to see which of the communities across the state are shrinking, growing or stable. Generally, communities in the Flint, Saginaw, Bay City areas, and generally many rural communities are shrinking. However, more communities are growing than shrinking in our sample.

Figure 1: Map of Michigan Cities Included in Study



Status of Water Infrastructure in Flint

As described in the introduction of this report, Flint experienced a major drinking water crisis that significantly affected the health of residents. In this section, we offer comparisons of the Flint experience with (1) other communities in Genesee County, Michigan, and (2) Newark, New Jersey and Jackson, Mississippi where these cities have also faced challenges with drinking water quality and infrastructure.

Flint and Genesee County

This section provides a more in-depth financial analysis of the City of Flint from 2008 to 2022. Flint, located in Genesee County, faced significant financial challenges, which arguably resulted in the 2014 water crisis, which had far-reaching economic, social, and infrastructure consequences. The city saw major changes in key financial metrics during this period, influenced by federal and state aid, population decline, and ongoing economic hardship.[4] Consider Table 6, which reports trends in total assets, total liabilities, charges for services, and operating expenses.

Table 6: Key Water-related Financial Data for Flint

Year	Total Assets	Total Liabilities	Charges for Service	Operating Expenses
2008	$1,912.18M	$990.88M	$810.18M	$875.06M
2015	$1,874.96M	$1,664.98M	$504.19M	$875.06M
2022	$6,638.16M	$3,613.99M	$722.87M	$875.06M

In 2008, Flint's population was about 120,000, already in decline due to the collapse of the local automotive industry. By 2015, Flint's population further declined to less than 100,000 by 2015, and by 2022 the population dropped even further to 80,000, reflecting continued economic and social challenges. Below, we highlight the key water infrastructure and finance metrics for Flint over time.

Total Assets**:** Flint's total water infrastructure assets saw a slight decrease from $1,912M in 2008 to $1,875M in 2015. However, by 2022 Flint's total assets increased significantly to $6,638M, largely due to federal and state funding aimed at addressing the water crisis and restoring infrastructure.

Liabilities**:** Flint's total water-related liabilities in 2008 stood at $991M, of which $823M were non-current liabilities. By 2015, total liabilities had increased substantially to $1,665M, as Flint borrowed more to manage the water crisis and other operational challenges. In 2022, Flint's liabilities ballooned to $3,614M.

[4] See the following sources for details on Flint Water Crisis and its overall financial condition: University of Michigan Financial Impact of the Flint Water Crisis, University of Michigan Gerald Ford School, C&EN Report.

Net Position: Flint's water-related net position in 2008 was $921M, indicating stable financial footing before the water crisis. By 2015 the city's net position had fallen to $241M but had recovered to $3,044M in 2022 after a substantial infusion of federal and state assistance in the wake of the water crisis.

Operating Income and Expenses: Flint's water-related operating income showed a minor loss of $9.1M in 2008 but conditions worsened to $321.47M by 2015. Operating losses were reduced to $151.07M by 2022 but were still substantial.

The Flint water crisis had catastrophic health and financial consequences, leading to state and federal intervention. Specifically, the federal government allocated $100M for water infrastructure investment, and state government provided over $350M. Overall, from 2008 to 2022 Flint experienced dramatic changes in its water-related fiscal conditions, where the water crisis was a key factor. While the city's total assets and net position saw improvement due to intergovernmental financial support, its liabilities also increased substantially such that long-term debt challenges remain. Additionally, Flint continues to face difficulties in generating operating revenue, exacerbated by population loss and an anemic housing market.

In Figures 2-4 below, we offer a comparison of several fiscal measures between Flint and other communities in Genesee County. Figure 2 shows that Flint was similar to other communities in Genesee County in per capita total assets until 2022. Between 2015 and 2022, there was a significant investment in Flint water infrastructure, pushing per capita assets from about $2,000 to more than $6,500. The investment was certainly motivated by the water crisis.

Figure 2: Per Capita Total Assets for Communities in Genesee County

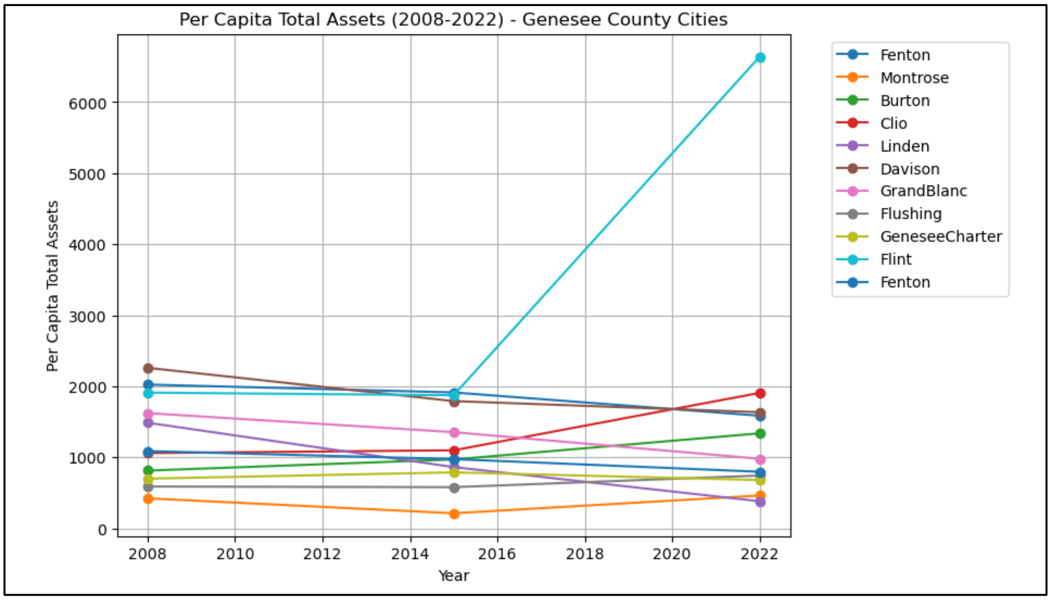


Figure three shows that by 2022 Flint's per capita liability increased from $1,000 in 2008 to more than $3,500 in 2022, much higher than other communities in Genesee County. However, because total assets increased by more than liabilities, Flint's net position improved substantially.

Figure 3: Per Capita Total Liabilities for Communities in Genesee County

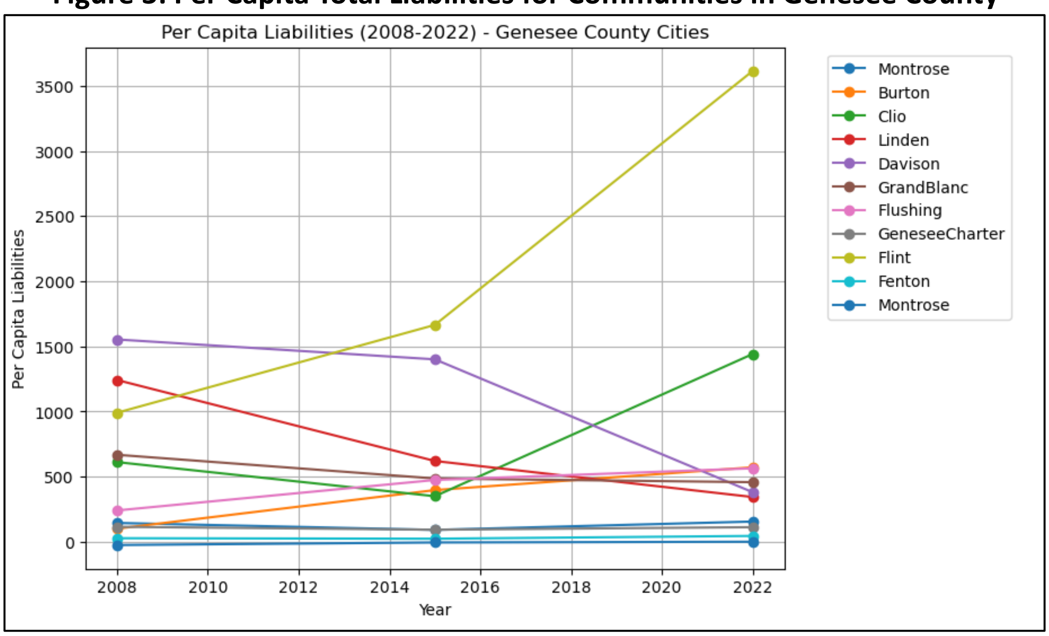
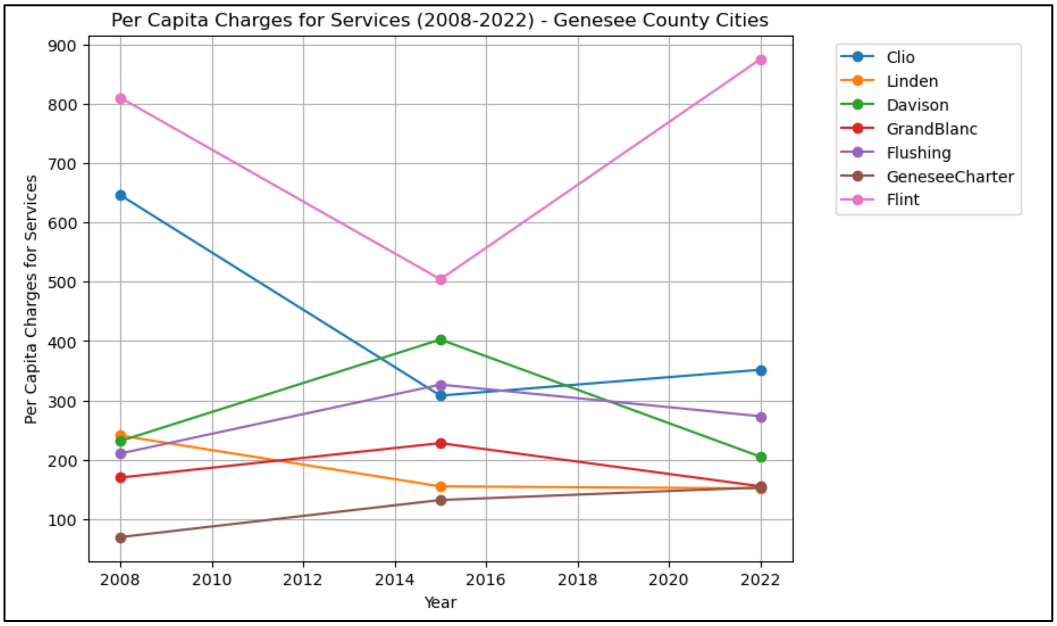


Figure 4 also shows that per capita water charges are more than double other communities in Genesee County, putting Flint at a competitive disadvantage.

Figure 4: Per Capita Charges for Services for Communities in Genesee County



Comparison of Flint with Newark and Jackson

We now turn to a comparison of Flint with other cities that have encountered challenges with water infrastructure and water quality in other parts of the country. The discussion below presents conditions for Flint, Michigan, Newark, New Jersey, and Jackson Mississippi.

Flint, Michigan

Economic Situation: Flint was once a thriving industrial city with a strong reliance on the automotive industry. However, the downsizing of the industry led to significant economic decline and population loss.

Water Crisis**:** In 2014, Flint switched its water source from Lake Huron and the Detroit River to the Flint River to save money. The water from the Flint River was not treated with corrosion inhibitors, leading to lead leaching from old pipes into the water supply. The impacts were felt in several ways (United States, Environmental Protection Agency, Flint):

- Health Impact: Elevated lead levels in the water led to widespread health issues, including lead poisoning, especially among children. (Kennedy, et al., 2016)

- Economic Impact: The crisis further exacerbated the city's economic struggles as it deterred investment and increased public health costs. (City of Flint Department of Finance and Administrative Services)
- Population Decline: The crisis led to a further decline in population as residents moved away in search of safer living conditions. (United States Census Bureau Quick Facts, Flint, Michigan)

To address the crisis, several measures were taken:

- Federal and State Intervention: Emergency declarations, federal funding, and intervention from the Environmental Protection Agency (EPA) were necessary. (United States Environmental Protection Agency, Flint Drinking Water Response)
- Lead Pipe Replacement: A comprehensive program was initiated to replace lead service lines throughout the city. (City of Flint, Pipe Replacement Program)
- Water Quality Monitoring: Ongoing efforts to monitor water quality and ensure safety.

As a result of these actions, the following outcomes were observed:

- Progress: Significant progress in replacing lead pipes and improving water quality.
- Challenges: Continued public distrust and health impacts from prolonged exposure to contaminated water.

Newark, New Jersey

Economic Situation: Newark has faced long-term economic challenges, including high poverty rates and population decline. (United States Census Bureau, Newark Demographics)

Water Crisis: The city experienced lead contamination in its water supply due to aging lead pipes, similar to the situation in Flint. The impacts were felt in several ways:

- Health Impact: Elevated lead levels posed significant health risks, particularly to children and pregnant women. (United States Centers for Disease Control and Prevention, New Jersey Childhood Poisoning Prevention)
- Economic Impact: The contamination led to increased public health costs and necessitated expensive infrastructure repairs. (City of Newark, Department of Finance)
- Population Decline: While not as severe as Flint's, Newark has also experienced a population decline due to economic challenges. (United States Census Bureau, Newark, New Jersey QuickFacts)

To address the crisis, several measures were taken (City of Newark, Lead Service Line Replacement Program):

- Lead Service Line Replacement: Newark launched an ambitious program to replace all lead service lines, completing over 20,000 replacements in under three years.
- Distribution of Filters and Bottled Water: Interim measures included distributing water filters and bottled water to residents.
- Federal Funding and Support: Secured federal and state funding to support infrastructure improvements.

As a result of these actions, the following outcomes were observed:

- Success: The rapid replacement of lead pipes has significantly reduced lead levels in the water, showing a successful mitigation of the crisis.
- Ongoing Monitoring: Continued efforts to monitor water quality and maintain infrastructure improvements.

Jackson, Mississippi

Economic Situation: Jackson has struggled with economic decline, high poverty rates, and a shrinking population. (United States Census Bureau, Jackson, Mississippi QuickFacts)

Water Crisis: The city has faced long-standing issues with its water system, including frequent boil-water notices and low water pressure due to aging infrastructure. The impacts were felt in several ways (Mississippi State Department of Health):

- Health Impact: Repeated water quality issues have posed health risks to residents, including potential contamination during boil-water notices. (O'Neal, 2024)
- Economic Impact**:** The crisis has strained the city's finances, making it difficult to fund necessary repairs and upgrades. (City of Jackson, Finance and Administration)
- Population Decline**:** Economic decline and water system issues have contributed to ongoing population loss. United States, Jackson Mississippi QuickFacts)

To address the crisis, several measures were taken:

- Infrastructure Repairs**:** Efforts to repair and upgrade the water system have been undertaken, though progress has been slow due to financial constraints. (City of Jackson Infrastructure Management Programs)
- Federal Funding Requests**:** The city has sought federal funding to assist with infrastructure improvements. (United States Environmental Protection Agency, Jackson, MS Drinking Water)
- Community Efforts**:** Local organizations and community groups have played a role in advocating for better water quality and infrastructure investment. (McArthur)

As a result of these actions, the following outcomes were observed:

- Challenges**:** Progress has been hampered by financial difficulties and governance challenges.
- Ongoing Issues**:** Residents continue to face periodic water quality issues, and the city requires sustained investment to fully resolve the crisis.

In summary, all three cities experienced significant economic challenges and population decline, hampering their ability to address water infrastructure issues. Flint's population declined from a peak of 196,940 in 1960 to around 80,000 today. Newark's population decreased from over 400,000 in 1950 to about 282,000 today. Jackson's population has declined from a peak of around 200,000 in 1980 to approximately 160,000 today. Each city's water crisis was precipitated by aging and inadequate water infrastructure. Elevated lead levels and other water quality issues resulted in significant health risks in all three cities.

Flint's crisis was triggered by a switch in water sources without proper treatment, while Newark and Jackson faced issues primarily due to aging infrastructure. Newark has made notable progress with its lead pipe replacement program. While Flint has made significant strides, it still faces challenges. Jackson continues to struggle with financial constraints and ongoing water quality issues.

In Flint, water lead levels exceeded 15 parts per billion (ppb), with some homes showing levels over 100 ppb. Newark's lead levels also exceeded 15 ppb, prompting the aggressive replacement program. Jackson's issues have been less about lead and more about the overall reliability of the water system.

While Flint, Newark, and Jackson have all faced significant water crises, Newark's successful lead pipe replacement program stands out as a notable success story. Flint has made considerable progress but continues to face challenges related to public trust and health impacts. Jackson remains in a precarious situation due to financial and governance issues, highlighting the ongoing struggle many cities face in addressing water infrastructure problems amidst economic decline. Each city's experience underscores the critical need for sustained investment in infrastructure and robust governance to prevent and mitigate such crises.

Summary and Conclusion

In this report we have summarized water infrastructure and finance data for 250 Michigan municipalities for the years 2008, 2015, and 2022. The database is used to make comparisons across communities and through time. The analysis reveals significant changes in financial conditions that have occurred over the period. Specifically, the new database shows the following:

- On average per capita assets have fallen over time, but there is substantial variation across communities.
- There are higher per capita assets and liabilities in communities experiencing population decline.
- Per capita water fees are higher and increasing more rapidly in communities experiencing population decline.

- Flint has higher per capita fees, assets, and liabilities than other communities in Genesee County.
- Flint is not alone in water infrastructure and water quality challenges as shown in comparison of experiences across Flint, Michigan, Newark, New Jersey, and Jackson, Mississippi.
- While data allow for an assessment of whether water assets increased (decreased) and whether net position improved (worsened), financial information does offer specific determination of overall quality of water infrastructure. However, financial conditions are likely correlated with that quality of water infrastructure and even water quality, the evaluation of which is one component of the 2024-2025 Mott grant proposal as briefly discussed below.

This project has resulted in a new database on local government owned and operated water infrastructure and capital assets. This database provides the first steps towards a statewide comprehensive fiscal analysis of the drinking water systems in Michigan. The next step is to use the new database to conduct a comprehensive fiscal analysis of drinking water systems in Michigan. In the 2024-2025 Mott grant proposal, we propose adding key community-level socio-economic information to the new water infrastructure database so that a systematic evaluation can be conducted to determine the factors associated with better (or worse) fiscal management of water infrastructure systems. Importantly, the new database enables us to observe changes in water infrastructure over time. Factors such as population, population change, property values, property value change, household income, change in household income, age structure, racial composition, and other variables will be collected. Regression analyses will help identify which factors are associated with better (or worse) public infrastructure management. We will use the work of McDonough and Yan (2019, 2021) as a guide to structuring our evaluation (McDonough and Yan, 2024). Where data are accessible, we will also conduct an evaluation of the linkages between the existence of water infrastructure asset management plans, the quality of water infrastructure, and the quality of drinking water.

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