Public Perception of Michigan Water Quality and Affordability: A Case Study of Benton Harbor

GRACE RODRIGUEZ

College of Engineering, University of Michigan
School of Environment and Sustainability, University of Michigan

MARY NAGY

School of Public Health, University of Michigan

JONATHAN BYE

School of Law, University of Michigan

KATE MEIXNER

School of Medicine, University of Michigan

MADELEINE WAX

College of Engineering, University of Michigan

Volume 6, Issue 1

<http://dx.doi.org/10.3998/mjs.12333712.0006.105>

ABSTRACT

Michigan's complicated history with drinking water quality and, to a lesser extent, affordability is well chronicled, most prominently during the Flint water crisis. Recognizing there are likely other communities with water concerns, the researchers set out to understand the water quality and affordability concerns of Michigan's resi-

dents. Benton Harbor, a city of about 10,000 residents in southwestern Michigan, was chosen as the case city as it has a similar socioeconomic background to Flint. In order to ascertain the opinions and perceptions of the Benton Harbor residents, a survey was developed around issues relating to water quality, affordability, and communication of information. A convenience sample was used ($N = 104$) and represented approximately 1% of the city population. As a follow-up to the survey, two focus groups ($N = 9$) were conducted to examine specific issues with greater depth, including bottled water use, affordability, and preferred information sources. From the survey analysis and focus group discussions, five themes were identified to describe the common concerns of Benton Harbor residents and the issues that arose within the water system. These themes focused on the residents' concern about the municipal water quality, bottled water consumption, utility costs, knowledge gaps, and the level of trust for various information sources. Based on these themes and the experiences gained from interacting with the Benton Harbor community, three recommendations aimed at the water utility and the city government are provided to encourage citizen engagement, increase trust, and generate useful data.

Introduction

Michigan's difficulties with drinking water quality and, to a lesser extent, affordability are well chronicled. Most notably, the mismanagement of Flint, Michigan's drinking water system, which was partially precipitated by increasing water rates, resulted in hundreds of the community's children being poisoned by lead (Zahran, McElmurry, and Sadler 2017; Lynch 2016). Recognizing there may be other Michigan communities with similar water concerns, the researchers saw a need to investigate the state of water quality and affordability in other Michigan communities.

Benton Harbor, a city of nearly 10,000 people, is similar to Flint in that, like Flint, the city's population is shrinking, many large manufacturing businesses have left, and it recently experienced an economic recession that resulted in the appointment of an emergency manager (U.S. Census Bureau 2017b; Walsh 2016; Oosting 2014). However, unlike Flint, Benton Harbor does not appear to have violated any major drinking water standards since 2014 (City of Benton Harbor 2017; City of Benton Harbor 2015; O'Malley, Watson, and Jenkins 2016). Due to the economic and demographic similarities with Flint and its relatively high quality of water, the City of Benton Harbor was selected for this case study, which focuses on the eco-

nomic, health, and communication challenges currently facing many Michigan communities and their drinking water systems.

Benton Harbor's water utility, like 88% of community water systems in the United States, is publicly owned (Kopaskie 2016). The city's water utility is responsible for ensuring the quality of treated water at its water treatment plant and maintaining the network of pipes that distributes clean water throughout the city. State and federal regulations determine water quality standards and require utilities to monitor and maintain infrastructure. Ill-maintained infrastructure can negatively impact the quality of treated water flowing through it.

In many communities, the pipes that make up the drinking water distribution system are near the point of retirement. This problem is particularly prominent in the Midwest "Rust Belt," where many cities experienced a swift and significant increase in population followed by a slow decline. The inevitable restructuring and replacement of our nation's aging infrastructure will require an estimated 500 billion dollars over the next 20 years (Krantz and Spitzig 2016; U.S. Environmental Protection Agency 2011).

To fund these necessary infrastructure upgrades, municipal water rates nationwide have greatly increased in recent years. This trend is especially noticeable in many Midwestern cities where declining populations mean that the fixed costs of water treatment and distribution are spread over a smaller consumer base (Mack and Wrase 2017). The average annual cost of water for a household using 60,000 gallons/year in the Midwest was \$305 in 2016, but this could quadruple in the next few decades (Food and Water Watch 2016). However, even these estimates do not provide a clear picture of the water costs in individual communities because water rates can vary greatly between municipalities due to differences in water loss, the age and size of the infrastructure, and the size of the consumer population. For example, in 2014, Benton Harbor residents paid \$3.80 per ccf (100 cubic feet) while residents of St. Joseph, a neighboring city, paid \$1.80 per ccf ("City of St. Joseph and City of Benton Harbor Public Water System Interconnection Agreement" 2014). While this may not pose a large problem for wealthier consumers, low-income consumers will find it increasingly difficult to pay water bills and will likely face water shut-offs, such as the 50,000 shut-offs that occurred in Detroit, Michigan in 2014 (Mack and Wrase 2017).

The objective of this study was to better understand drinking water quality and affordability from the perspective of Michigan residents and develop recommendations that the utilities and local decision makers could use to further open the lines

of communication and understanding between the consumer and their water utility. A comprehensive survey and follow-up focus group guide was developed that prompted Benton Harbor residents to consider their perceptions of water quality and cost, preferred communication pathways, and knowledge of the water treatment and distribution system.

Methodology

Study IRB

This study was reviewed and given exempt status by the University of Michigan International Review Board (IRB). The IRB identification number is HUM00131281.

Survey Design and Implementation

A comprehensive survey was developed to gather information on consumer water usage and communication preferences and to uncover consumer perceptions of water quality and affordability. The basic structure of the survey built upon a short, but similar study conducted by the Ann Arbor Public Services Administration (“Cost of Service Study for Water and Wastewater” 2017). A draft version of the survey was piloted with six Benton Harbor residents on June 9, 2017. Each resident who participated in the pilot survey received a \$15 gift card to Meijer, a regional grocery store chain, as compensation. Based on feedback collected during the pilot, the survey was shortened, and the language was simplified to increase reader accessibility and understanding.

In its final version, the survey includes thirty-eight questions in the form of Likert scale, multiple choice, rating, and open-ended. The questions targeted aspects of the community water system, quality and personal usage, information and communication preferences, and demographics. (It should be noted that in this study “water quality” is considered a subjective term that may include aspects of the water’s color, smell, taste, and health effects.) In accordance to survey objectives and IRB requirements, two questions at the beginning of the survey select for Benton Harbor residents who were at least 18 years of age.

Surveying was conducted on July 18 and July 21, 2017, and took place in the Benton Harbor Public Library. Participants were recruited through posters and word of mouth, and both a hard copy and an online (via Qualtrics software) ver-

Demographic characteristics of Benton Harbor survey respondents (N = 104)	
Characteristic	%
Gender	
Male	47.6
Female	51.5
Age	
18-24	7.8
25-44	35.0
45-64	44.6
65+	12.6
Race/Ethnicity	
Black	85.4
White	4.9
Hispanic, Latino, or Spanish origin	2.9
American Indian or Alaska Native	2.9
Highest Education	
Less than high school or GED	33.0
High school diploma/GED	39.8
Professional certification	3.9
Some college or Associate degree	18.4
Bachelor or graduate degree	4.9
Some demographic response categories with minimal response rates were excluded in this presentation.	

Figure 1. Demographics of Benton Harbor Survey.

sion of the survey were made available to the residents. All participants received a \$10 gift card to Meijer upon completion of the survey. Individual survey responses were kept confidential and residents' names were not linked with their completed surveys.

The target response number for the survey was 100 individuals. This represents approximately 1% of Benton Harbor's population of 9,919 residents (Hawthorne 2017).

A total of 114 Benton Harbor residents participated in the survey, with 109 residents opting for a paper copy and five opting for the online form. On average, the survey required 15-20 minutes to complete. Of the 114 complete surveys, 10 were deemed not suitable for analysis (due to very short completion times, patterned or largely incomplete responses, and other factors). Therefore, the final sample size was $N = 104$, and the demographics are shown in Figure 1. Compared to Flint, Benton Harbor has a greater percentage of minority residents and has a lower average household income (U.S. Census Bureau 2017a).

One of the main limitations of survey data is that they were collected via a convenience sample and therefore have a high vulnerability to bias (Etikan, Sulaiman, and Alkassim 2016). Bias introduced through convenience sampling is difficult to quantify and adjust for, which is important to keep in mind when interpreting results. Survey respondents were residents who happened to be present in the Benton Harbor Public Library during survey outings (provided they met the basic criteria of being at least 18 years old and a customer of the Water Utility) and were self-selected in that they were willing to participate. Additionally, survey outings occurred during weekday afternoons, which might exclude residents who work or perform child or elder care during those times, while over-selecting for residents who are unemployed, disabled, retired, or not working for a myriad of other reasons.

The survey software Qualtrics was used to organize and analyze the survey results. Microsoft Excel was also used for a portion of the analysis.

Focus Group Design and Implementation

Two focus groups were conducted to connect with residents and develop a deeper understanding of themes identified via surveying. Two one-hour-long focus groups were conducted in the Benton Harbor Public Library on October 11, 2017 with one group comprised of four residents and three researchers, and a second group comprised of five residents and two researchers. Focus group participants were recruited based on previous indication of interest during the survey portion of the study.

During the focus groups, residents were asked broad, open-ended questions informed by the survey data. The discussions focused on the drinking water-based topics that participants considered to be most important in order to more fully capture resident experiences and give residents a platform to provide greater detail than was possible in the survey. Focus group recordings were transcribed and independently analyzed by researchers who identified representative quotes and further refined main themes.

Results

An analysis of survey results and focus group discussion led to a deeper understanding of the drinking water concerns of Benton Harbor residents and the larger scale issues facing the community. Based on the data collected, the researchers propose five themes focused on quality concerns, bottled water consumption, affordability, resident knowledge, and preferred avenues of communications. From these themes, recommendations related to the potential opportunity for the improvement of Benton Harbor's water system.

Theme 1: Quality concerns, including health effects and physical characteristics, limit residents' use of tap water for drinking.

While a plurality of Benton Harbor residents (47%) drink their tap water every day, over one-third of residents (35%) rarely or never drink it (Figure 2). The qual-

Figure 2. Respondents tap water daily usage. [N = 103]

Figure 3. (A) Water quality concerns of residents who drink their tap water every day [N = 44 to 49].
(B) Water quality concerns of residents who rarely or never drink their tap water [N = 33 to 35].

ity and health concerns of the respondents and their self-reported understanding of the water system as a whole differs among those who regularly consume their water out of their home faucet and those who do not. Of the residents who do not (or rarely) drink water from their home faucet, there is a higher level of dissatisfaction for several physical characteristics (Figure 3). Of those respondents who rarely or never drank tap water, the greatest concerns center around the overall quality (71% unsatisfied), taste (82% unsatisfied), odor (60% unsatisfied), and appearance (64% unsatisfied) of their tap water. The presence of chemical additives is also a concern with the majority of respondents who never or rarely drink tap water dissatisfied with the presence of chlorine (61%) and the presence of fluoride (53%). It is unclear from the survey questions whether the chlorine concern is health-based or taste/odor-based; however, a focus group participant specifically mentioned the presence of a chlorine odor and associated it with poor water quality.

In general, many of the focus group discussions centered on concerns about the odor, taste, and appearance of Benton Harbor's tap water, indicating a general sense of mistrust regarding the quality of the water itself.

It is difficult to identify where in the distribution system water quality begins to worsen. The available Consumer Confidence Reports (CCRs) published annually by the Utility do not list any major violations of drinking water standards since 2014 (City of Benton Harbor 2017; City of Benton Harbor 2015; O'Malley, Watson, and Jenkins 2016). However, due to the oversized drinking water system, high water age, suspected high leakage and intrusion rates, and low system pressure, there are many potential causes of water quality deterioration.

Aging infrastructure and in-home plumbing and threats to Benton Harbor's water supply (Lake Michigan) are also concerns in the community. Sixty-one percent of survey respondents are either very concerned or extremely concerned about lead in their in-home plumbing. A slightly higher number (66%) are very or extremely concerned about lead in the distribution system. It should be noted that at present Benton Harbor is not in violation of the LCR (O'Malley, Watson, and Jenkins 2016). Therefore, the concern may stem from increased awareness due to the water crisis in Flint and/or a lack of information on the city's water treatment system, which treats for corrosion. During the focus group, residents did connect their water quality concerns to the Flint water crisis. However, there was not a direct connection to lead.

Representative responses from the focus group participants relating to Themes 1-5 are seen in Figure 4.

Figure 4. Representative samples of resident responses during the focus groups.

Theme 2: High levels of bottled water consumption are reported for variety of reasons including quality, value, and health.

According to the survey results, bottled water consumption in Benton Harbor is widespread (Figure 5). The majority (59%) of residents reported drinking at least one bottle of water every day, while only 12% drink bottled water rarely or never. Additionally, the number of water bottles consumed by those who drink them daily appears to be high. Of the daily bottled water drinkers, 50% drink four or more bottles per day. (The survey did not ask residents to indicate the volume of the bottle, so the average volume of bottle water consumed cannot be estimated.) However, it is clear that of the residents surveyed more prefer to drink bottled water (59% daily) than tap water (48% daily).

Bottled water consumption is driven by concerns about taste and safety. When asked about the primary reason for drinking bottled water, residents indicated that they feel bottled water is safer (41%), tastes better (37%) and is more convenient (15%) than tap water.

Figure 5: (A) Bottled water consumption of survey respondents [N = 103]. (B) Daily bottle water consumption of respondents who drink bottled water every day [N = 56]. (C) Primary motivation for drinking bottled water of respondents who drink bottled water.

The researchers were intrigued by the high bottled water use given that Benton Harbor is a lower-income community and bottle water costs on average 300 times as much as the average cost of tap water when normalized by volume (Boesler 2013). As a follow up to the survey results, the focus group moderators asked participants the following questions:

- Raise your hand if you buy bottled water sometimes. What influences your decision to drink (or not drink) bottled water?

- Think back to the last time you paid for drinking water, whether it was your tap water bill or buying a pack of bottled water. What sticks out to you about the amount you paid?

Notably, focus groups participants largely discussed the purchase of bottled water as having high value and cost-benefit. The ubiquitous nature of bottled water in Benton Harbor and the preference of bottles over tap due to taste and safety concerns was further supported during the discussion with residents.

Theme 3: The high cost of water bills and increasing rates represent a significant concern for residents.

Though information about the average Benton Harbor water and wastewater utility bill is not publicly accessible, general comparison can be made between the utility costs reported in the survey and estimated national and city averages. Based on self-reported bill averages, water costs in Benton Harbor are similar to the national average of \$120 per month for a family of four, as estimated by researchers at Michigan State University (Mack and Wrase 2017). Circle Blue, an organization focused on achieving safe and affordable drinking water, reported a slightly higher average bill for the city of Detroit at \$139 per month for the same size household (Walton 2015). In Benton Harbor, the majority (51%) of respondents, who report to be the primary bill payer in their household, spend between \$80 to \$160 on their combined water and wastewater bill every month, and about 13% of respondents spend more than \$160 per month (Figure 6A). However, although our survey results indicate that Benton Harbor has a near average water and wastewater utility bill, residents' incomes are lower than the national average with the median household income at \$18,085 (compared to \$56,516 nationally) (U.S. Census Bureau 2017b), (U.S. Census Bureau 2017a). Therefore, the water utility bill is a higher percentage of Benton Harbor residents' income than the average American citizen.

Of residents surveyed, 42% are extremely concerned regarding affordability of water bills, while 34% are moderately or very concerned (Figure 6C). A plurality of residents also believe that their water bills have risen over the last five years with 48% indicating that it has increased "a lot" and 28% indicating it has increased (Figure 6A). Given the high utility bills and resident concern about water affordability, it is surprising that the majority (57%) of survey respondents did not know about any community assistance programs in their area. However, residents do appear to be taking water costs into their own hands and are actively trying to lower

Figure 6. (A) Self-reported monthly water bill of survey respondents [N = 45]. (B) Perceived changes in the cost of water [N = 42]. (C) Affordability concerns of survey respondents [N = 100]. (D) Awareness of Community Assistance Programs in community [N = 100].

their water bill. For example, 51% of respondents stated they attempt to conserve water in order to reduce their bill. Despite the burden of water utility bills on the already economically stressed residents, many believe their bills are reasonable; 43% strongly agree or agree that the amount their household spends on tap water is appropriate for the water they receive.

In focus groups, frustration with the cost of water was a prominent theme with several participants voicing concern or confusion about the ultimate use of the money they send (in the form of bill payment) to the utility. Two residents voluntarily brought copies of their water bill to the focus group to illustrate both the high cost and the difficulty in deciphering the bill's charges. There was a general concern that the payment residents were sending to the utility was not being reinvested in infrastructure or used to improve water quality. There appeared to be some lack of trust in the government of Benton Harbor to manage money and address resident concerns. Additionally, a few participants were frustrated with the perceived lack

of payment by others in their community as they felt they were personally paying higher water bills because others were failing to pay theirs.

Theme 4: Many residents have limited knowledge of their water delivery system and monitoring but are deeply concerned about water quality and cost.

Self-reported knowledge of water source, treatment, and distribution was mixed among survey participants with approximately half (54%) reporting they strongly agreed or agreed that they understood these topics. Interestingly, the level of self-reported knowledge differed between those who drink their tap water every day and those who drink their tap water rarely or never. Participants who drink tap water every day are much more confident about their knowledge of the water system, with 68% reporting they understand the treatment and distribution process and only 12% indicating they do not (Figure 7). Conversely, participants who do not (or rarely) drink their tap water report lower knowledge of the system, with only 34% reporting they understand the treatment and distribution process and 40% indicating they do not (Figure 7). Due to limits in the survey, it is unclear whether higher knowledge of the drinking water system leads to higher trust of the tap water (and thus higher consumption) or if there is another unseen causative agent influencing these patterns. However, it is reasonable to assume that a minimal knowledge of drinking water treatment combined with frequent water quality concerns would cause some residents to be skeptical of the quality of their tap water, even when the water meets all of the drinking water standards.

The survey population also expressed high interest in communicating with the water utility (with 62% of respondents indicating they have had questions about their drinking water), but limited knowledge about where to turn for answers. Consumers' knowledge of contacts mirrored the water system's knowledge in that responders who drink their tap water every day have more confidence in their ability to contact someone about concerns (42%), while respondents who rarely or never drink their tap water report much lower levels of confidence (29%), with over half (52%) indicating that they do not know who to contact (Figure 7). Of residents who have contacted someone with questions or concerns about their drinking water, the local health department and city officials were the most frequently contacted entities, followed by City Officials, the Benton Harbor Drinking Water Plant, and Community Organizations.

The Consumer Confidence Report (CCR), a federally mandated annual report

Figure 7. (A) Self-reported knowledge of the drinking water system from respondents who drink tap water every day and rarely or never [N = 44 & 35]. (B) Self-reported awareness of contact information from respondents who drink tap every day and water rarely or never [N = 45 & 35].

How much do you trust each group to give you information regarding the quality of your tap water?		
	Completely or somewhat trust	Somewhat or completely distrust
State of Michigan	43.75%	36.46%
City of Benton Harbor	44.21%	34.73%
Benton Harbor water plant	45.83%	34.38%
Federal EPA	50.53%	28.42%
Friends or neighbors	51.04%	21.88%
News outlets	53.19%	22.34%
*Percentages for "Neutral" trust in these sources ranged from 19.79%–27.08%		

Figure 8. Trusted (and distrusted) sources of information of survey respondents [N = 94 – 96].

of the water quality, is largely absent from residents' experience with the vast majority of respondents (75%) never receiving the document. Older residents were more likely to have received a CCR (46% of those 65 or older and 39% of those 55-64), while younger residents (under 55) were less than 20% likely to have seen a CCR in the past.

Theme 5: Communication between the water utility and consumers is minimal and largely consists of water utility bills, water advisories, media coverage (e.g. Flint), and word of mouth from community networks. Residents report wide variation in whom they trust for water information.

Residents were asked to rank their levels of trust for a variety of sources of information about their water. News outlets were regarded as most trustworthy with 53% of residents feeling they could completely or somewhat trust, followed by friend or neighbors (51%), and the EPA (50%). Conversely, residents reported the most distrust in the State of Michigan (37% distrusted), the City (35%), and the City water plant (34%) (Figure 8). For information regarding drinking water, residents strongly preferred television and newspaper to other sources presented such as mailings, meetings, and websites.

Discussion

Perceptions of Water and Health

According to the survey results, many Benton Harbor residents avoid using tap water for drinking and instead rely on bottled water for a large portion of their drinking water needs. These water use habits appear to be driven partially by residents' concern about tap water characteristics—most notably odor, taste, and appearance—as well as beliefs about the quality and safety of the water. Despite Benton Harbor's recent history of acceptable water quality based on federally mandated monitoring, public perception is not aligned with the view the city's water is safe to drink.

The widespread replacement of tap water by bottled has far-reaching impacts. Residents discussed their avoidance of drinking tap water as a behavior common throughout the community. Additionally, under a backdrop of mistrust in the city's water supply, many residents loosely associated a large array of symptoms and/or their state of health with their consumption of tap water. Their concerns about the water appear to be partially driven by news stories of similar communities with water crises (e.g. Flint) and from conversations with peers, neighbors, and family.

From a public health perspective, distrust of drinking water supply may reduce consumption of water, which can be associated with a host of downstream health problems. For example, residents who choose more convenient, taste-pleasing beverages to tap water may have increased risk factor that could tip the scale toward obesity and diabetes (Gibson 2008; Greenwood et al. 2014). Additionally, residents who are not drinking enough water may also be at higher risk for dehydration, a particular concern to the elderly (Campbell 2012).

Affordability

Benton Harbor residents are very concerned about the current and future affordability of tap water and they indicate poor understanding of how bills are determined. Two community members involved in the focus groups voluntarily brought in examples of their utility bills in order to point out the bill's confusing format and the minimal information provided. Since many residents do not regularly use their water for drinking, the high rates and perplexing format may contribute to negative attitudes toward paying their water utility bill. If a resident believes the water provided is not of sufficient quality, frustration may ensue when high bills arrive in the mail possibly leading to increased payment delinquency.

An additional affordability concern affects those residents who do not directly pay their water bill, but instead rely on a landlord, building manager, family member, or other individual for water service. This increases consumer vulnerability as these residents rely on the bill payer to complete payment on time and often depend on them to resolve any issues regarding water service. Contacting the water utility may be more confusing or difficult to navigate when the primary source of this information may be in the bill and Consumer Confidence Reports, which typically go only to the bill payer. There are previous examples of such a situation leading to water shut off in Benton Harbor, such as the three-day water shut off in a 90-unit apartment building caused by a building manager that did not pay the bills (Dalglish 2017).

Communication

The survey and focus groups revealed that many residents of Benton Harbor trust information from their city and state government less than information provided by the federal government or other sources such as the news. These findings suggest an urgent need to consider the communication employed by the city and water utility as well as from officials at the state level. Since residents who are dissatisfied with their water were more likely to rate their knowledge of the water system as poorer, education should be an integral component of any communication effort. However, beyond educating the public, the role for information communication should be to release relevant water monitoring data within appropriate and understandable context and to consistently keep the line of communication open in order to facilitate dialogue, transparency, and information-sharing between the utility and consumers.

Public perception of the city government and water utility is influenced by a multitude of local, regional, and national factors. In addition, there are certainly very few regulations or industry norms to encourage a utility to set a higher expectation and responsibility for improving communication practices.

Recommendations

The provision of safe, accessible water is a critical responsibility carried on the shoulders of water utilities, governing bodies at the local, state, and federal level, and a number of other intervening and intermediary stakeholders. However, the emerg-

ing role of citizens has become evident with the Flint water crisis and other recent examples of threats to the quality and affordability of water throughout the nation.

In Benton Harbor, residents are deeply concerned about the quality and safety of their tap water. Many study participants rely primarily on bottled water for their drinking water needs and express value in the purchase and consumption of this commercialized water supply. Conversely, paying rising water utility bills is burdensome, even impossible, for many residents who see this cost obligation as an unfair bargain. The limited knowledge base of residents regarding water issues combined with the ever-present coverage of the Flint water crisis have led many residents to assume the worst about their water. Furthermore, communication and outreach efforts from the city and utility have met little success in the past.

Based on the results of this study, the researchers developed three recommendations aimed at addressing the concerns and realities of public water utility customers. First, water utilities and governmental agencies should promote consumer engagement and education by encouraging frequent and meaningful communication between the water utilities, policy makers, and community residents. Well-planned and regularly scheduled surveys and focus groups (similar to the ones used in this study) are two examples by which this much-needed communication can occur. Based on the experiences undertaken during this study, the researchers recommend that future surveys occur in a variety of locations and times in order to achieve a greater diversity of respondents. In addition, it is recommended that all surveys should be written at an eighth-grade reading level in order to reach a wider audience. Secondly, a comprehensive, yet accessible, educational platform should be assembled for consumers interested in learning more about their community's water system, quality, and policies. (Many such education platforms are available online but are either very general or are written at a level that a large proportion of residents may find daunting.) Lastly, there is a need for a consumer-driven database on which Michigan residents could collect, contribute, and access information on their community's current water quality. Water utilities and public health offices could encourage this type of data sharing by providing in-home test kits to residents interested in testing their tap water. This information could then be uploaded to an online database that would provide information on the current water status service throughout the entire service area. In-home testing could both empower residents to take ownership of ensuring the quality of water at their tap, while also encouraging two-way communication between consumers and utility that could lead to a true long-term partnership.

Acknowledgements

The following were integral to the work done to prepare this project and report: the residents of Benton Harbor; our advisor, Dr. Glen Daigger; our client, the Michigan Environmental Council; the University of Michigan Urban Collaboratory; the Center for Statistics, Computing, & Analytics Research; the University of Michigan Graham Sustainability Institute; and the Dow Sustainability Fellows Program. We also express our sincere appreciation to: the City of Benton Harbor; the Benton Harbor Public Library; Charlie's Piggin' N' Grinnin' of Benton Harbor; the Southwest Michigan Community Action Network; and the Berrien County Health Department.

Funding Sources

This project was funded by Dow Chemical Company through the University of Michigan Dow Sustainability Fellowship.

Literature Cited

- Boesler, Matthew. 2013. "You Are Paying 300 Times More for Bottled Water than Tap Water." *Business Insider*.
- Campbell, Naomi. 2012. "Dehydration : Best Practice in the Care Home." *Nursing and Residential Care* 14 (1): 21–26.
- City of Benton Harbor. 2017. "City of Benton Harbor - Water Plant." Accessed November 26. <http://www.bentonharborcity.com/water-plant>.
- . 2015. "2015 Benton Harbor Water Quality Report." Benton Harbor: Michigan.
- "City of St. Joseph and City of Benton Harbor Public Water System Interconnection Agreement." 2014. Benton Harbor: Michigan.
- "Cost of Service Study for Water and Wastewater." 2017. *City of Ann Arbor Public Services Administration*. Accessed November 14. <https://www.a2gov.org/departments/public-services/Pages/Cost-of-Service-Study.aspx>.
- Dalgleish, Jim. 2017. "Water Returns to Benton Harbor Apartment Complex." *The Herald Palladium*, September.
- Etikan, Ilker, Musa Sulaiman, and Rukayya Alkassim. 2016. "Comparison of Convenience Sampling and Purposive Sampling." *American Journal of Theoretical and Applied Statistics* 5: 1–4. doi:10.11648/j.ajtas.20160501.11.

- Food and Water Watch. 2016. "The State of Public Water In the United States."
- Gibson, Sigrid. 2008. "Sugar-Sweetened Soft Drinks and Obesity: A Systematic Review of the Evidence from Observational Studies and Interventions." *Nutrition Research Reviews* 21 (2): 134–47. doi:10.1017/S0954422408110976.
- Greenwood, D. C., D. E. Threapleton, C. E. L. Evans, C. L. Cleghorn, C. Nykjaer, C. Woodhead, and V. J. Burley. 2014. "Association between Sugar-Sweetened and Artificially Sweetened Soft Drinks and Type 2 Diabetes: Systematic Review and Dose–Response Meta-Analysis of Prospective Studies." *British Journal of Nutrition* 112 (05): 725–34. doi:10.1017/S0007114514001329.
- Hawthorne, Sydney. 2017. "Do Desperate Times Call for Desperate Measures in the Context of Democracy? Michigan's Emergency Manager Law & The Voting Rights Act." *New York University Review of Law and Social Change*. 41 (2): 181. <https://advance.lexis.com/document/?pdfid=1000516&crid=57fd9c12-5c69-4c91-99e4-c718f0898971&pddocfullpath=%2Fsharedd%2Fdocument%2Fanalytical-materials%2Furn%3AcontentItem%3A5NNK-R460-00SW-41DV-00000-00&pddocid=urn%3AcontentItem%3A5NNK-R460-00SW-41DV-00000>.
- Kopaskie, Andrea. 2016. "Public vs Private: A National Overview of Water Systems." <http://efc.web.unc.edu/2016/10/19/public-vs-private-a-national-overview-of-water-systems/>.
- Krantz, Adam, and Erica Spitzig. 2016. "Flint, Michigan: The Water Crisis We Must Not Forget." *Public Sector Digest*, no. Spring: 61–64. <https://www.epa.gov/sites/production/files/2017-10/documents/final-2016-michigan-program-review-full-report-20171024.pdf>.
- Lynch, Jim. 2016. "Officials: Flint Water Rates Could Double in Five Years." *The Detroit News*, July 22. <http://www.detroitnews.com/story/news/michigan/flint-water-crisis/2016/07/22/officials-flint-water-rates-double-five-years/87461748/>.
- Mack, Elizabeth A., and Sarah Wrase. 2017. "A Burgeoning Crisis? A Nationwide Assessment of the Geography of Water Affordability in the United States." *Plos One* 12 (1): e0169488. doi:10.1371/journal.pone.0169488.
- O'Malley, Michael, Darwin Watson, and Kaye Jenkins. 2016. "City of Benton Harbor Utility Services Department's 2016 Consumers Confidence Report." Benton Harbor.
- Oosting, Jonathan. 2014. "Four Years Later, Benton Harbor's Financial Emergency Is over, According to Manager." *MLive*. http://www.mlive.com/lansing-news/index.ssf/2014/03/benton_harbor_run_by_emergency.html.
- U.S. Census Bureau. 2017a. "Household Income: HINC-01." Accessed November 28. <https://www.census.gov/data/tables/time-series/demo/income-poverty/cps-hinc/hinc-01.2015.html>.
- . 2017b. "U.S. Census Bureau QuickFacts: Benton Harbor, Michigan." Accessed November 17. <https://www.census.gov/quickfacts/fact/table/bentonharborcitymichigan/PST045216>.
- U.S. Environmental Protection Agency. 2011. "Drinking Water Infrastructure Needs Survey and Assessment: Fifth Report to Congress." http://water.epa.gov/grants_funding/dwsrf/upload/epa816r13006.pdf.
- Walsh, Dustin. 2016. "Whirlpool Seeks Socioeconomic Balance in Its 2 Southwest Michigan Homes." *Crain's Detroit Business*, April 10. <https://perma.cc/9VEL-VD7Z>.
- Walton, Brett. 2015. "Price of Water 2015: Up 6 Percent in 30 Major U.S. Cities; 41 Percent Rise Since 2010 - Circle of Blue." *Circle Blue*. <http://www.circleofblue.org/2015/world/price-of-water-2015-up-6-percent-in-30-major-u-s-cities-41-percent-rise-since-2010/>.

Zahran, Sammy, Shawn P. McElmurry, and Richard C. Sadler. 2017. "Four Phases of the Flint Water Crisis: Evidence from Blood Lead Levels in Children." *Environmental Research*. 157 (February). Elsevier Inc.: 160–72. doi:10.1016/j.envres.2017.05.028.

The Michigan Journal of Sustainability (MJS) is hosted by Michigan Publishing,
a division of the University of Michigan Library
For more information about Michigan Publishing please contact mpub-help@umich.edu
For more information about MJS please contact mjseditors@umich.edu
Online ISSN: 2332-0621