

THE FLINT WATER CRISIS: TIMELINE OF EVENTS, EVALUATION OF TECHNICAL AND HUMAN FACTORS, AND WHY IT MATTERS

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Abstract: The lead contamination of the Flint, Michigan drinking water supply had its easiest specific “point source” in the economic downturn, which resulted in financial problems for the city, as well as the individual residents, and the eventual appointment of an Emergency Manager by the Governor of The State of Michigan. Bewilderingly, this seemingly well qualified financial manager acted as if he had no legal obligation to consider scientific facts related to enforcement of the Federal Safe Drinking Water Act, and repeatedly ignored warnings given by those with technical backgrounds. He prohibited the City of Flint from continuing their long-term practice of purchasing Lake Huron water from Detroit, and then refused to approve the \$137.00 daily cost for the corrosion prevention chemical to be used in the new water supply, taken from the historically polluted Flint River. The combined result of these major factors was a drinking water supply that, at least once, fell within the Federal range for hazardous waste.

The most significant physical root cause of the lead contamination was the low pH of the untreated water, which attacked the protective layer of lead oxide which builds up in properly maintained lead and leaded brass water lines. These are an unknown fraction of the total services lines that constituted much of the piping system that delivered the water to the individual homes in Flint. At this time, it is unclear to the writer if the low pH was related to the inherent nature of the water drawn from the river, or to the chlorine compounds used to sterilize it, or both, or other factors. The water was so corrosive that General Motors was forced to stop using it for lubrication in their machining operation, due to corrosion of their engine blocks. [1] Members of Governor Rick Snyder’s inner circle urged the governor’s office to request the Emergency Manager to return the system to the original Detroit source. Yet, the residents of Flint continued to get untreated corrosive water for another year after General Motors switched to a new supply. [2] Almost two years after a local pediatrician started diagnosing multiple infants and children with lead poisoning, two State of Michigan and one City of Flint employee were served with criminal indictments. The City of Flint employee, who, early on, tried to blow the whistle on the situation, has made a plea deal.

Potential sources of the severity of the crisis, including the low-ranking science education in the USA, political divisiveness, and lack of critical thinking, will be explored. The human costs of lead poisoning will be summarized.

Key words: Civil Rights, Corrosion, Crime Rates, Critical Thinking, Department of Environmental Quality, Drinking Water, Educational Outcomes, Environmental Protection Agency, Failure of Democracy, Flint River, Lead Contamination, Lead and Copper Rule, Lead Oxide, Social Justice, Systemic Discrimination, Water Safety,

Introduction: In November of 2011, elected officials in Flint, Michigan were stripped of their powers by the state governor, through use of the Emergency Manager Law. In April of 2014, the Emergency Manager ended the decade's long water purchase agreement with the neighboring city of Detroit, and ordered the Flint Water Department to pump their water from the nearby Flint River. The Emergency Manager (EM) also refused to approve the \$137.00 daily expense for the corrosion prevention treatment. The EM was warned by the Supervisor of the Flint Water Department that they had inadequate staff to monitor the water quality. [3] There does not appear to have been a specific warning at that time about the danger of lead poisoning. However, the requirements of the Safe Drinking Water Act are complex, requiring attention to biological and inorganic contaminants, as well as balancing the detrimental health effects of residual traces of the biocides routinely used to minimize the chances of immediate outbreaks of waterborne illnesses. [4] There were multiple obvious problems with the water first pumped from the Flint River, including strong odors, dark coloration, numerous reports of skin rashes from bathing, and a possible outbreak of Legionnaires' Disease.

A recent report by the Michigan Civil Rights Commission has concluded that the "people of Flint have been subjected to unprecedented harm and hardship, much of it caused by structural and systemic discrimination and racism that have corroded your city, your institutions, and your water pipes, for generations." [5]

Why did the Commission come to that conclusion? My research has revealed that systemic racism isn't what I thought it was. I believe that most people from all parts of the political spectrum want all of us to do well, and, aside from a small population of people who voluntarily associate with hate groups, are not racist. How is systemic racism different from regular racism? In short, systematic racism is not a personal characteristic. It's perhaps best defined as an effect, rather than an intentional action. We end up with systemic racism because of decisions made by people who are most likely long gone from the positions where they made the decisions. For the purposes of this paper, I'll define systemic racism an unanticipated effect of multiple complex factors. Feeling guilty, or trying to make others feel guilty, is not helpful to eliminate systemic racism.

I will look at the necessity of using critical thinking skills to address the problems of systemic and structural racism; perhaps even to understand the concepts of structural and systemic discrimination. One of the most important benefits of using critical thinking is the expanded ability to see a broader, more relevant frame of reference, from which to address problems.

This paper is intended to help us focus on the wider background of this monumental failure. Flint is but one city that has lead service lines. In fact, the EPA estimates that

there are about 10 million lead service lines / connections with the public water systems of the United States. [6] The New York Times recently ran an article documenting multiple additional lead related water crises in major American cities. [7]

This paper is also intended to remind its likely readers, most of whom have strong technical backgrounds, that lead is a potent neurotoxin, which has been linked to behavioral problems, including ADHD and an increase in violent criminal behavior, trends that affect every human being. [8-10] The health costs of the lead poisoning, much more potent in young children, were not taken into consideration, as may be required by federal law, when the benefits of lower cost water were being taken advantage of in the City of Flint. Perhaps that is related to the fact that it is extremely difficult to determine these costs, human or financial, as the above referenced researchers, and their predecessors and colleagues, have learned.

As economic challenges in the US have arisen since the boom days of World War II, some people have taken to commenting that we are “becoming a third world country.” In fact, the water access situation for many Flint residents failed to meet the recommendations of The Sphere Handbook [11], a resource used by non-governmental organizations involved in disaster relief efforts in developing nations. This document suggests 7.5 - 15 liters per person per day for drinking, cooking, and personal hygiene. It also suggests that people should not have to travel more than 500 meters to get their water, nor queue for more than 30 minutes. The actual average indoor water use per household in the US is 210 gallons per day. [12] This is an approximate factor of 41 difference, using the lower value from Sphere, and assuming 2.53 people per household in the US today. [13]

The writer of this document had no personal involvement in the investigation. References used are all publicly available. Several news organizations have made up timelines, still available on the internet, which were helpful in preparing the oral presentations on which this paper is founded, and this introduction. If the topic interests you further, please search for “Flint Water Crisis Timelines” on the internet. The conclusions that the ACLU reached about the civil rights violations have now been entered into the public record.

Some people reacted negatively to a portion of my original presentation, which reported that there was a contribution of systemic racism to the poor water quality. As previously mentioned, the role of systemic racism by US Government officials, in reference to their actions toward communities of low income African-Americans, has now been established. The important thing to understand about systemic racism is that it keeps on doing its damage, even if the current people running the system are not racist. The damaging effects are embedded in the way daily business is carried out. Thus, the accusation of systemic racism does not mean that the current government officials and employees are necessarily racist. There is no need to blame, but our Western cultural heritage might push some to act to minimize the effects of systemic discrimination. When I first started researching the Flint Water Crisis, I assumed, or perhaps heard someone say, that the cause of the problem was a white governor forcing a racist and incompetent white Emergency Manager to oversee African-American’s affairs. This, I

found out, could not have been further from the truth. Darnell Earley, the EM in charge at the time of the water source switch, was an upstanding African-American citizen, and well qualified in his field. He was a member of the National Forum for Black Public Administrators, and a former president of the International City/County Management Association. [14] See Figure 1.



Figure 1: Former Flint Emergency Manager Darnell Earley
Credit Steve Carmody / Michigan Radio

Many people, on all parts of the political spectrum, do not understand the concept of systemic bias, perhaps a manifestation of the generally bewailed lack of critical thinking. People on the left are more likely to “believe” that systemic discrimination exists, even if they can’t give a definition, and certainly would not give highly consistent definitions if they tried to give one. People on the right are more likely to simply not hear the term, or to write off its purported effects as whining by the lazy and willfully ignorant. My own understanding of this term is greater as a result of my research for this paper.

Simple racism comes from both our cultural programming, and our experience. Chris Hayes, a conservative leaning white journalist and author who has investigated the economic divide in America, pointed out on the NPR talk show 1A, that fear of those outside of our own cultural group is justified and natural in certain situations. [15]

It is much easier to understand the concept of simple racism. Its manifestations are well known. Systemic bias, also known as institutional or structural bias, is harder to grasp. It requires knowledge of historical facts, and to truly understand, statistical analysis by specialists is needed to show whether real damage is being done. In this case, the policies of the US federal government at the time of the end of World War II are a factor. Many African-Americans had served in the armed forces, and there were political promises made of civil rights to be enjoyed on arrival back home. The way that the US government kept those promises to help the black Americans was to create segregated housing developments for blacks and whites, [16] in the name of racial harmony. This was before

the (now overturned) legal doctrine of “separate but equal” for educational institutions. The persistence of resource inequality in education is thus self-evidently linked to inequality in housing, through the mechanism of local tax bases funding schools. Of course, there is more to school quality than money.

The writer believes that another contributing factor to the Flint Water Crisis, in its full manifestation, is the generally low standard of science education in the US, and accompanying low levels of respect for those working in the field. Engineers in manufacturing routinely bemoan the “bean-counters” getting to make decisions that are technically without merit. This has nothing to do with racism. It is related to the influence given to those with financial backgrounds. The financial manager apparently felt entitled to ignore the technical supervisor. Some statistics on educational achievement will be provided, as will some more uplifting facts regarding public responses to the crisis.

In researching this paper, I have found a lot of recent academic activity relating to the effects of lead poisoning. The complex and troubling situation of health damaging lead levels in the drinking water of significant numbers of residents of the United States of America is certainly going to continue to be a subject of public concern for the foreseeable future, as we strive to replace and maintain our aging water infrastructure.

Background: In December of 2011, Governor Rick Snyder made the first of what would become five successive appointments of Emergency Managers, by April of 2015, to deal with an ongoing financial crisis in the City of Flint. [17] Note that Flint used to be a thriving city with a large tax base, and the infrastructure reflected that. By one measure, the current GM workforce in Flint is 8% of what it was in its heyday. [18] In November of 2012, the voters of Michigan repealed the law that authorized Emergency Manager appointments, but almost immediately, in a lame duck session of the state legislature, a new measure, which was immune to citizen repeal, was put into place. [19] This is at least one foundation of the argument that, at its center, the Flint Water Crisis was due to a failure of democracy. Of course, the US is not a democracy, but a republic, and thus this failure was legal, and in line with our Constitution, which gives enhanced power to our elected officials. Early in the tenure of the Emergency Managers, a decision had been made to get a new water source. However, that source was not ready when Emergency Manager Darnell Earley decided that the water costs had to be reduced right away. Thus, he decided to have the water department temporarily get their water from the Flint River, a historically polluted body, [20] over the strong and repeated objections of the water plant supervisor. The writer is still struggling to understand this latest inappropriate trumping of evidence based technical opinions, and the law, by financial “realities.” However, the idea that spendable dollars in a nation are to be limited in the same way that they are in a household is problematic, due to the existence of the system of banks, which are allowed to leverage collateral to a high degree. Money has never represented a fixed amount of goods. It has always represented an amount of goods modified by some function of good will. This is one of the major premises of the fascinating book “Debt: The First 5,000 Years.” [21] Nations take the right to print, control and manipulate the money source, for political ends. It causes major problems sometimes, as history has

shown, and continues to show. There is a spectrum of attitudes about how much money governments should make available.

Timeline: Note that the following events are documented on Michigan Radio's website, www.michiganradio.org, among other places.

The switch of water supply was made toward the end of April 2014, and by May, the brown, stinking water was called to the attention of the city leadership by concerned citizens who had a sudden increase in skin rashes. To no avail, General Motors tried reverse osmosis purification to prevent corrosion of the engine blocks machined with lubricant diluted with the new water. Elevated coliform bacteria and mutenogenic levels of trihalomethanes were also found in the water. [1, 2] By January of 2015, Detroit's water department offered to reconnect their prior customer, but the Emergency Manager declined.

In February of 2015, resident Lee Anne Walters notified the Environmental Protection Agency (EPA, a Federal Agency), that 104 ppb of lead had been detected in the water coming out of her faucet, far in excess of the (allowed but unsafe) EPA "Action Level" of 15 ppb. By this time, Miguel Del Toral, a water expert at the EPA, had reported that the testing method was likely to be understating the lead levels. EPA regulations require the water to be tested after the water system has remained out of use for the night. Instead, residents were instructed to flush the pipes before collecting the samples. A second round of testing at Ms. Walters' home found 397 ppb, while the third round showed over 13,000 ppb, almost three times the level that would be classified as hazardous waste. How was this happening? Despite the historical pollution of the Flint River, it was not polluted with lead. It took until July of 2015 for a brave EPA employee to leak a memo with the information about the high lead levels to the ACLU, who publicized it, with the facts of the high lead levels.

Immediately, the EPA stated that no action was required. Maybe they just did not believe that the lead levels could be so high, as widespread knowledge about the effect of the low pH water did not yet exist among politicians and the general public. However, in August 2015, the (Michigan) Department of Environmental Quality (DEQ), acting on a documented level of 11 ppb between January and June 2015, instructed the City of Flint to "optimize corrosion control." By this time, it appears that someone in the government was aware that the lead was coming from service lines leading off the mains (rather than the main lines themselves), to and within the homes, as a result of the low pH, possibly related to the high chlorine needed to kill the coliform bacteria [1, 2] and other corrosion enhancing factors, that were breaking down the previously passive and protective film of lead oxide that builds up in lead pipes over time.

Also in August, a citizens group hired some researchers from Virginia Tech to test the water, which resulted in confirmation of the high lead levels. However, the Michigan DEQ denied the accuracy of the Virginia Tech tests. Again, denial from government authorities was the response in September, when pediatrician Dr. Mona Hannah-Attisha reported that she had found a tripling of blood lead levels in some Flint neighborhoods,

along with signs of lead poisoning in multiple children. The Michigan authorities denounced her work. A week later, they finally publicly admitted that she was correct, and by October, the water supply was switched back to Detroit. However, the damage to the passive lead oxide film could not be immediately repaired, and lead levels remained sporadically high. Figure 2 (color key in 2A) shows the results of lead tests from January of 2016. From April of 2014, until October of 2015, there was, as far as the writer can determine from the sources described, no effective corrosion control. It appears that the Director of the Department of Environmental Quality for the State of Michigan ruled that the water analysis tests themselves constituted “corrosion control.” Only in October of 2015, did the Director of the DEQ admit to any mistakes.



Figure 2: Key to Color Code from Figure 1, same attribution

By October, the complexity of the technical issues was starting to become apparent. Records could not be located to determine the location of the service lines, and their materials of construction were unknown. Furthermore, some attempts at replacing old lines started to reveal that it was steel lines with leaded brass fittings that were sometimes the “culprits” in the higher lead water supplies. It was starting to become apparent that the high costs of providing bottled water, water filters, medical help and behavioral training to affected children, were only a small portion of the costs to be incurred in replacing a system that was now essentially untrustworthy.

In December of 2015, Flint added additional chemical corrosion controls, based on the new understanding that was emerging about the corrosion mechanisms. December 2015 also saw the first Emergency Declaration (aside from the financial emergency that started the whole problem), which set the stage for help from the state. A task force held Michigan DEQ Director Wyant responsible for the situation, and he resigned before the end of the year.

On January 5, 2016, Governor Rick Snyder declared a State of Emergency for Genesee County, where Flint, Michigan, is located. Governor Snyder followed his declaration with a request for help from the Federal Emergency Management Administration. This

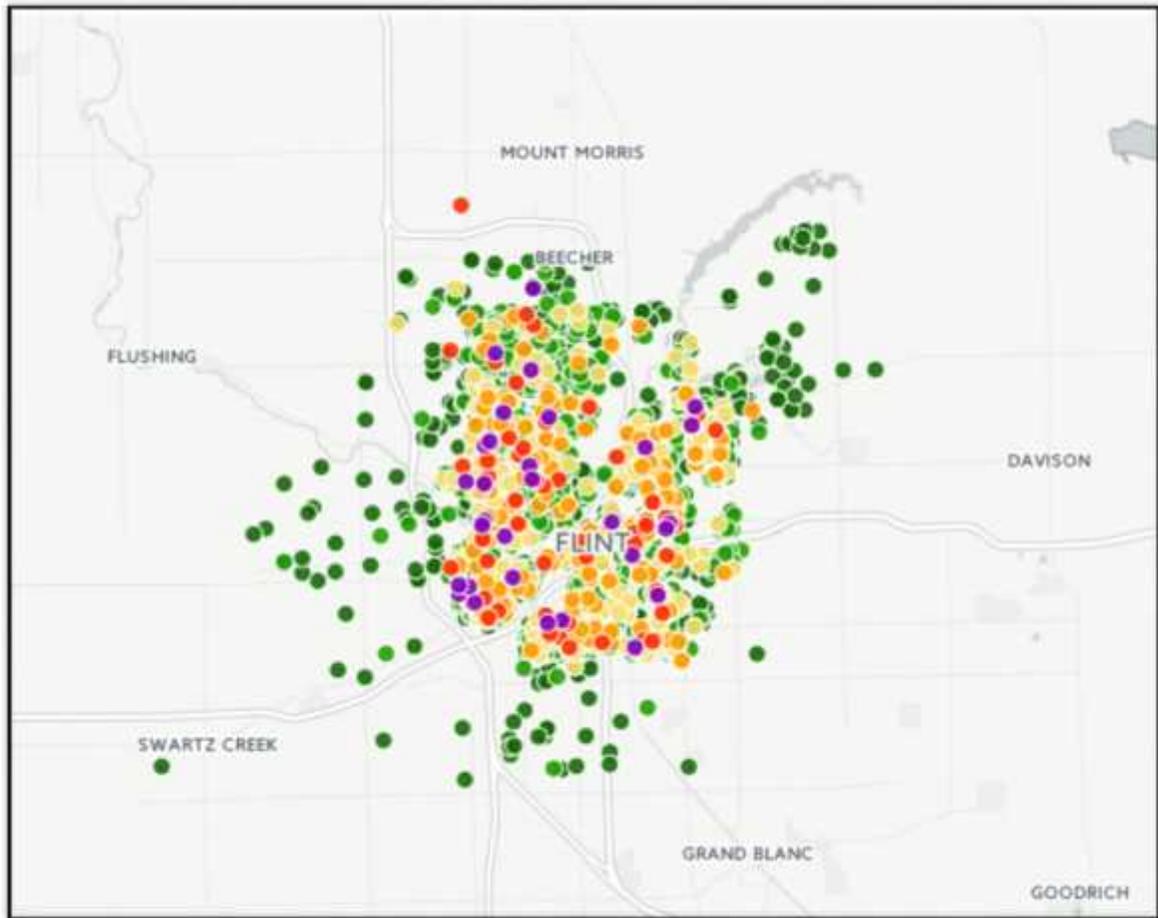


Figure 2A: A screenshot of a map generated by Mark Brush, with the help of Elias Brush, Cass Adair, and SmartyStreets, found at slide 2 of 3 on <http://michiganradio.org/post/when-will-we-know-water-flint-safe-drink>

eventually resulted in \$5 million in Federal Aid, but the US Senate declined the \$600 million aid request from the Michigan delegation. The Michigan State legislature approved \$28 million in aid for bottled water, filters, medical treatment for lead poisoning, services for those children who have developed or are at risk to develop life-long behavioral problems, and an infrastructure integrity study. By early February of 2016, the EPA Regional Administrator had resigned. In April of 2016, the first criminal charges were filed.

At some point, subsequent to the switch to the Flint River, the Michigan Department of Environmental Quality ruled that the monitoring of the water itself constituted the required corrosion control. This was perhaps, to me, the most egregious human failure. It certainly shows a lack of critical thinking, and a willful lack of understanding of the purpose of the law, which is to protect the health of the members of the public. Despite this ruling (that the testing constituted corrosion control), someone in the chain of

command thought it best to falsify the data, by eliminating the high outlier values of lead from the tests record.

Calling the testing corrosion control is using logic perhaps similar in some ways to the inaccurate thinking that lets the health care industry call screening tests “preventive care.” Change of life-style, medications, and meditation are all preventive care. Blood tests and mammograms, in and of themselves, do nothing to improve our health or prevent disease. Yet I have never heard anyone of the media, or being interviewed by the media, make this point. It is, in my opinion, a sad state that people cannot distinguish monitoring from prevention. This situation is representative of the intellectual level of our national discussion on questions of interest to the political body. Even people who have a science background are not immune from confusion regarding monitoring and control.

Mike Glasgow, the Flint Water Department Supervisor, who had tried to keep the state officials from making the switch to the Flint River, based on concerns of lack of personnel trained to monitor the water quality, was ultimately charged with evidence tampering. Citizen action resulted in his being able to make a plea deal, as he was seen as having tried to do the right thing.

Governor Snyder eventually activated the Michigan National Guard to distribute bottled water and filters. Note that water filters cannot be used with hot water, so all bathing water had to be filtered and then separately heated. The unfiltered tap water was even unsafe to wash vegetables.

By June of 2016, the new corrosion control measures had partially “healed” the lead oxide film, and the EPA announced that children and even pregnant women could safely drink the tap water, as long as it was filtered. In November of 2016, the situation was unchanged.

Lead and Its Effect on Humans

The first two times I presented on the topic of “The Flint Water Crisis,” I was surprised that listener response was more appreciative of the material regarding mechanisms of the corrosion than the human factors. Perhaps the listeners, one audience of which were 100% Michigan residents, were unaware of the severity of the consequences of even small amounts of lead ingestion. Maybe, due to the success of environmental regulation, we are too far from the days of the 1970’s, when we had to worry about lead in the air from leaded gasoline. The fact is that health researchers and the Environmental Protection Agency say that there is no safe level of lead in drinking water, especially for children. [22]

The paper of Feigenbaum and Muller [9], who obtained data from the early 1900’s, a time when lead exposure was due to use of the latest new-fangled trend: city-wide, tap-water delivery systems, is interesting. The authors showed that lead related behavioral problems can be disentangled from sociological and economic factors. Rich white people were just as likely to become murderers as poor black people, if they were hooked up to

the same low pH water that was delivered through lead pipes. (This is a simplification, interpretation and selection from the data they display. Please read the paper.) While the original leaded water problem had random victims, today it is a social justice problem that our democracy has been unable to solve. Interestingly, the paper was written with help from the NSF-IGERT Multidisciplinary Program in Inequality & Social Policy at Harvard University (Grant No. 0333403) and the Robert Wood Johnson Foundation Health & Society Scholars Program. There are 18 named authors, and additional groups that contributed to this paper. The well documented correlation between lead and homicides is only one facet to the lead problem. See Figure 3. The World Health Organization (WHO) Lead Fact Sheet provides the information shown in Figure 4. [23]

The History of Water Treatment: Water treatment goes back to the Bronze Age [24] in Egypt, where aluminum sulfate was used to clarify drinking water in 1500 BCE. There was not much progress made until the 1700's of the Common Era, when Europeans started using sand to filter out particulate. Not until the 1800's did humans understand the link between epidemics and water. In the 1900's, Americans started to use chlorine for disinfection, while the Europeans used ozone. In 1914, the first American standards limited bacteria in drinking water. Major revisions were made to the US Public Health Service standards in 1925 and 1946. By the 1962 revision, there were 28 regulated substances in drinking water. However, it was not until 1975 that the Safe Drinking Water Act was passed, which was the first time America had enacted enforceable standards for drinking water. Even then, the standards did not go into effect until 1977. The 1996 version of the regulation was the first time that the (long term) health risks from the disinfectants had to be balanced against immediate risks from bacteria borne illness.

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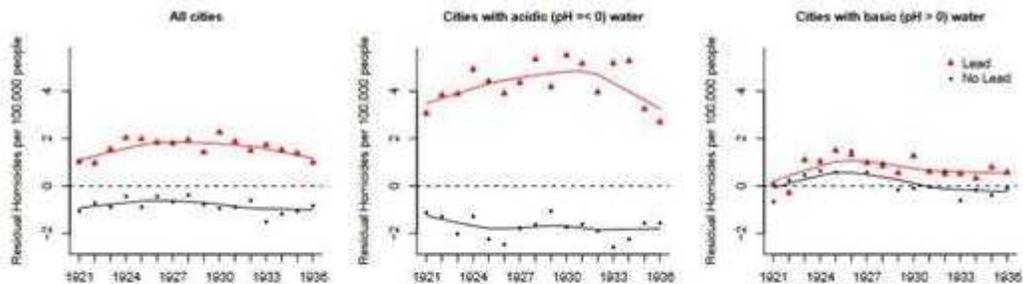


Figure 5: Residual homicide rate in US cities, 1921-1936. Homicide rates were consistently higher in cities using lead pipes than in cities using non-lead pipes. The gap between the lead and the non-lead cities is much wider in the sample of cities whose water was acidic and negligible in the sample of cities whose water was basic. The trend lines are constructed by capturing the residuals after regressing the homicide rate on all covariates other than the lead pipe indicator. The homicide data are drawn from cities reporting data to the *Mortality Statistics* between 1921 and 1936. The population data are interpolated using decennial census data. Cities with only lead pipes and cities with a mix of lead and iron pipes are included in the "lead" category. Cities using either galvanized iron or wrought iron are included in the "no lead" category.

Figure 3: From Reference 9, Used by permission. Their pH value of "0" being neutral is a standardized value equivalent to a regular pH value of 7 (page 64 of the paper)

Note: Left graph is all data, center graph is low pH, right graph is high pH.

Water Quality Monitoring: The concerns of the Supervisor of the Flint Water Department, that they had inadequate staff to monitor the water quality, might seem unjustified. The Flint Water plant had been open for years. However, there's a difference between monitoring drinking water taken from a source that has been used for decades, and a new source with a long history of industrial contamination. There are currently seven micro-organisms, four disinfection by-products, three disinfectants, 16 inorganic chemicals, 53 organic chemicals, and four radio-nucleotides that are regulated by the Environmental Protection Agency. [4] The Nalco Water Handbook [24] gives the Equation 1 to calculate the time water needs to be in contact with the disinfectant, chlorine in this case, based on Giardia, a hard-shelled parasite, harder to kill than viruses.

$$\text{Contact Time (CT)} = 0.2828 (\text{pH}^{2.69})(\text{FRC}^{0.05})(0.933^{(T-5)})(L) \quad (1)$$

Where

FRC= Free Residual Chlorine, T= Temperature, Degrees C, L= Log removal

Proper use of this equation obviously requires someone who has a working knowledge of chemistry, as well as high school math.

The State of Science Education in the USA: As of 2015, the Programme for International Student Assessment, an effort of the Organization for Economic Co-operation and Development, showed the United States at 25th place among 70 nations whose 15-year-olds took a standardized science test. [25] See Figure 5. Figure 6 shows the comparison between the three top and bottom ranked countries and the USA, between performance of girls and boys. Note that in the very bottom ranked countries, where the averages are dismal, the girls are doing better than the boys in two of those countries. Overall, students in the US are slightly more likely to have to attend at least one science class per week than the average of all 70 countries. Only 6.4% of US students do not have to attend even one science class per week. Compare that to the number 1 country, Singapore, where only 1.3% of students attend no science class. [26]

How did this happen? When I first decided to look into the social causes of the Flint Water Crisis, and started to understand that corrosion was nominally “the physical root cause,” I wanted to “blame” the influence of the evangelical religious movement, for confusing the natures of belief in revealed truth (through the “Creation Science” movement) and the fruits of the scientific process of learning about the world through our senses and intellect. Many people, since the time of World War II and the Cold War, also struggle with the difficulties brought along with the benefits of technology (overpopulation, pollution, threat of nuclear war, etc.), and don't want to have anything to do with science. The existential angst of the postwar period has been documented elsewhere. [27]

Social Justice and Educational Opportunity: I have already provided references which document the scourge of systemic racial discrimination in the American housing market. Its consequences in the justice system, a recent topic of frequent discussion in the news media and talk shows since the events that precipitated the Black Lives Matter

movement, is a disproportionately small fraction of two parent households in minority communities. Raising kids is hard enough when there are two parents, and one parent families have greater struggles. This is one factor in the decline of the stable, nuclear family.

This decline of the stable, nuclear family, and its consequences in all aspects of education, influence the amount of learning that takes place in our country. Finally, I thought about the fact that systemic discrimination against minorities, who are making up an increasingly large fraction of our country, will have a larger and larger effect on the overall average educational achievement. When a large sub-group does poorly, the whole group does worse than it would have if the large sub-group had done well. It's simple algebra. The lower educational achievement of poorer Americans has been well documented in the news for decades.

In concluding this section on the effects of social injustice, I would like to encourage the reader to do a web-search on the term "social justice." It's not a new-fangled idea. It's the foundation of the moral imperatives of charity in the Judeo-Christian tradition. I did find one reference on-line that addresses the reason that part of our political spectrum stops listening when they hear the term "social justice."

R. Dozier Gray, on the web-page of the National Leadership Network of Conservative African-Americans, writes "In one sense, social justice is the basis for a sound and civil society. The struggle for social justice is, in its purest form, the struggle for equality of opportunity over outcome. That's not necessarily a problem." But, Gray goes on to say, "In this new interpretation, social justice can more appropriately be considered 'collective retribution' or 'restorative justice.' The lingering question, however, is to restore what to whom and at what cost. It opens up a Pandora's Box of unsettling possibilities." [28]

I thank R. Dozier Gray for his insightful piece. I'd also like to thank David Levy [29] for articulating an important concept of critical thinking, which is that some questions have either-or answers, while most issues have a spectrum along the black-white continuum. I believe that we can't be forced into an either-or position on the subject of social justice. It has been said that the major contribution at the time of the founding of the Jewish religion was an emphasis on the balance of the responsibility of the community members to first, preserve the community, and second, to preserve the freedom and independence of the individual. Social justice, or its lack, in a society that has systemic racial discrimination, is always going to come down to the issue of whether pure, real time justice is "fair," indeed, is really justice, or whether restorative justice is a beneficial policy to follow. A national dialogue about how much restorative justice Americans want to have, and how we want to implement it, would be more productive than the one we're currently having, where progressives say they want social justice, and conservatives close their ears.

Lead poisoning and health

Key facts: Lead is a cumulative toxicant that affects multiple body systems and is particularly harmful to young children.

-) Lead in the body is distributed to the brain, liver, kidney and bones. It is stored in the teeth and bones, where it accumulates over time. Human exposure is usually assessed through the measurement of lead in blood.
-) Lead in bone is released into blood during pregnancy and becomes a source of exposure to the developing fetus.
-) There is no known level of lead exposure that is considered safe.
-) Lead poisoning is entirely preventable.

Lead is a naturally occurring toxic metal found in the Earth's crust. Its widespread use has resulted in extensive environmental contamination, human exposure and significant public health problems in many parts of the world.

Important sources of environmental contamination include mining, smelting, manufacturing and recycling activities, and, in some countries, the continued use of leaded paint, leaded gasoline, and leaded aviation fuel. More than three quarters of global lead consumption is for the manufacture of lead-acid batteries for motor vehicles. Lead is, however, also used in many other products, for example pigments, paints, solder, stained glass, lead crystal glassware, ammunition, ceramic glazes, jewelry, toys and in some cosmetics and traditional medicines. Drinking water delivered through lead pipes or pipes joined with lead solder may contain lead. Much of the lead in global commerce is now obtained from recycling.

Young children are particularly vulnerable to the toxic effects of lead and can suffer profound and permanent adverse health effects, particularly affecting the development of the brain and nervous system. Lead also causes long-term harm in adults, including increased risk of high blood pressure and kidney damage. Exposure of pregnant women to high levels of lead can cause miscarriage, stillbirth, premature birth and low birth weight, as well as minor malformations.

Figure 4: WHO Fact Sheet: Lead Poisoning and Health (Aliya highlights)

The Hebrew Bible [30] provides the description of the “perfect” human judge: “and he shall not judge after the sight of his eyes, neither decide after the hearing of his ears; But with righteousness shall he judge the poor, and decide with equity for the meek of the land.” When I first read this, I really wondered how the judge who ignored the plain physical evidence was going to do a good job. Trying to put myself into the mindset of an ancient prophet, I realized that Isaiah must be predicting a person of divine knowledge, perfect intuition, an interpretation that Christians have long assumed to be obvious. As Niels Bohr, the great physicist said, “The opposite of a great truth is another great truth.”



Figure 5: PISA Data from Interactive BBC Website

Science rankings		
	Girls	Boys
#	Score	Score
01	Singapore	559
02	Finland	545
03	Estonia	536
28	USA	500
68	Kosovo	374
69	Algeria	369
70	Dominican Republic	333

Figure 6: PISA Data from Interactive BBC Website

As noted by journalist and political writer Chris Hayes, in an interview with Joshua Johnson on the NPR program 1A, on March 22 (podcast available at <http://www.npr.org/podcasts/510316/1a>), the difficulty in eliminating systemic injustice is related to the idea of a zero sum game, the belief that if the poor have more, others must have less. The New Testament articulates and addresses this fear: “To everyone

who has something, more will be given, and he'll have more than enough. But from the person who has nothing, even what he has will be taken away from him.” [31]

As Gray points out in his essay, life is unfair, and his piece seems to indicate that “equity,” social justice, or just plain “justice,” (there should only be one kind, according to him) will leave an unfair world unfair, and that unfairness is better than the alternative: unfairly restoring justice, thereby adding new layers of unfairness. That is the human condition, and we’re fated to experience it.

I reminded myself as I was writing this paper, that since the days of the ancient Israelites (Bronze Age) and Classical Greeks (6th to 4th Centuries BCE), humans have been struggling to understand exactly what justice is. Sophocles (c496-406) [32] addressed this in his classical tragedy, *Antigone*, where the heroine invokes her moral requirement to disobey the king, because he has prohibited her from carrying out a religious obligation (burying her brother), and she gets the death penalty. The King was using his political power to carry out his duty to preserve order in Thebes, depriving a person unrelated to the crime committed, of carrying out her duty to the highest truth.

The reason, I believe, that we still have human judges in this age of Artificial Intelligence is that it is often a difficult balancing act to provide both individual and community justice. In other words, the judge is obligated to be fair to the individual while avoiding setting precedents that would be bad for the group. This is the true job of judges, and the reason that the idea of “Originalism” in regards to Constitutional law is problematic. Specific human laws are always approximate recipes for good behavior, as no legal system can anticipate every potential frame of reference. Going back to Sophocles, it wasn’t Antigone’s fault that her brother took the actions that he did, but she was the one who ultimately suffered. King Kreon perceived no way to achieve both justice and fairness, if he even cared about fairness. Sophocles paints him as fairly heartless. A new interpretation of the Hebrew Bible’s story of the Tower of Babel indicates that the “sin” of the residents of Babel was the leaders’ forcing the individuals of that city into the excessive degree of conformity in their private lives, in order to achieve the public goal of building the tower. [33] In my view, the regular citizens of Babel were also at fault, for tolerating the bad leadership. Otherwise, the leaders could have been punished rather than the whole community.

The Safe Drinking Water Act: Title XIV of the Public Health Service Act (also known as US Code Title 42 Public Health and Welfare Chapter 6A Subchapter XII) is called “Safety of Public Water Systems” or the Safe Drinking Water Act. [34] It is very complicated and difficult to follow and understand, for anyone who is not a water treatment specialist, which the writer of this paper is not. A few highlights of recent changes in the law will be presented.

Until very recently, “plumbing fixtures” could have up to 11% lead. Only since Jan 4, 2014, three months before the switch to the Flint River water, were new systems require to be “lead free.” The maximum weighted average of lead in a “lead free” system is 0.25%. Calculations are based on the maximum allowable lead for the alloy and the wetted surface area. It is not specified whether the minimum or maximum value of inside

surfaces of the pipes is to be used. Nowhere in this 80-page document are maximum contaminant levels given. But the rule does require systems to monitor drinking water. The monitoring must be done at customer taps. If lead concentrations exceed an action limit of 15 ppb or copper concentrations exceed an action limit of 1.3 ppm in more than 10% of customer taps sampled, the system must undertake additional actions to control corrosion. If the action level for lead is exceeded, the system must also inform the public about steps they (the members of the public) should take to protect their health. This may include advising them to replace lead service lines under their control. Note the law only protects “the herd” (the totality) of citizens. No actions are required if the number of homes with excess contaminants is below 10%. This is another example of how our society manages responsibility to the individual (none in this case) versus the community. Advice, education, and even pressure to vaccinate children follows the same “protection of the herd” logic.

At the time of the water crisis, the lead “action limit” for both the US and Michigan was 15 ug/L. By April 15, 2016, Governor Snyder was calling the federal lead standard "dumb and dangerous." His new proposal calls for lowering Michigan’s lead action level standard to 10 parts per billion by 2020. His plan also calls for removing all lead service lines in Michigan within 10 years. The governor’s cabinet director says it will take time just to identify where all the lead service lines are. The proposal prioritizes removal of lead service lines "based on vulnerable populations, high blood levels (and) high test results." [35]

Conclusion: The roots of the Flint Water Crisis are complex, and understanding its origin requires many forays into the most basic ideas about what it means to be a human, a member of a complex, modern society, and to enjoy the exercise of free will. Dealing with the consequences of lead exposure in the Flint, MI, population, and elsewhere, will take time and money and thought. New academic approaches to understanding and documenting injustice, in all its forms, are being brought forward in a divisive political environment. Those who wish to set an example of using critical thinking techniques to address these problems have their work cut out, as implied by the artwork shown in Figure 7.

The sword of Justice is rusted.
The eyes of the Lady are crusted
with the Dust of Ages.
The pans of her balance droop
under the weight of the years,
while softly Mercy calls us
through the masks of our fears.

The sword of Justice is rusted.
Her daughter’s echoes faintly reach our ears.



Figure 7: Sculpture “Simple Justice,” [36] created by Vivienne Thaul Wechter, near Fordham School of Law, in New York City. (Aliya photo credit)

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