

Flint Water Crisis
Can it Happen
CANADA ?



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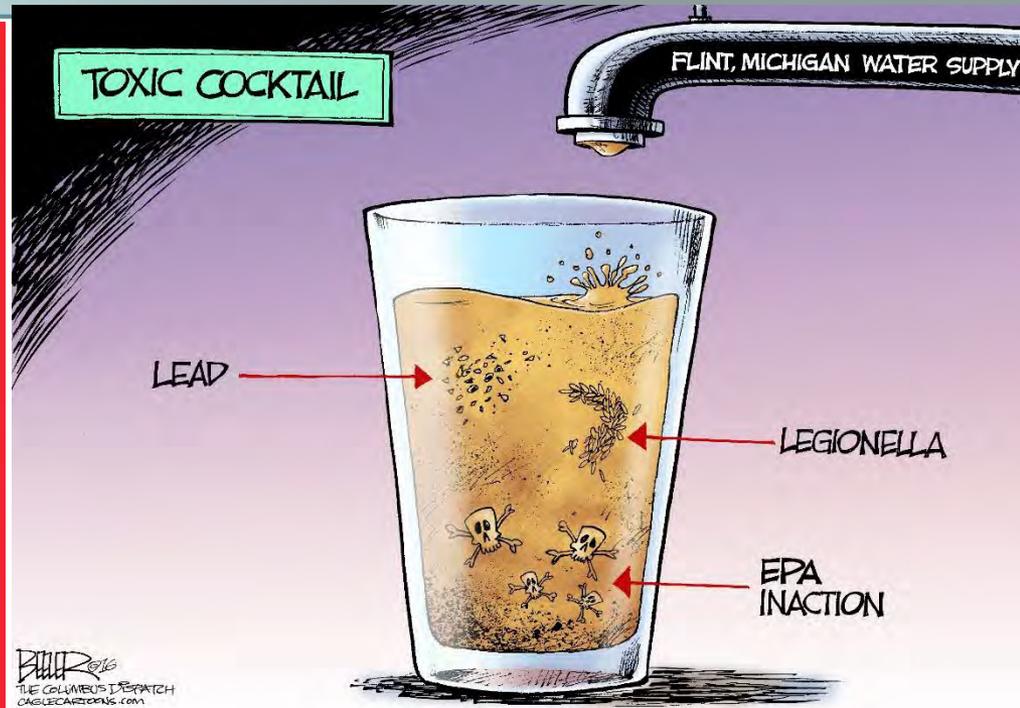
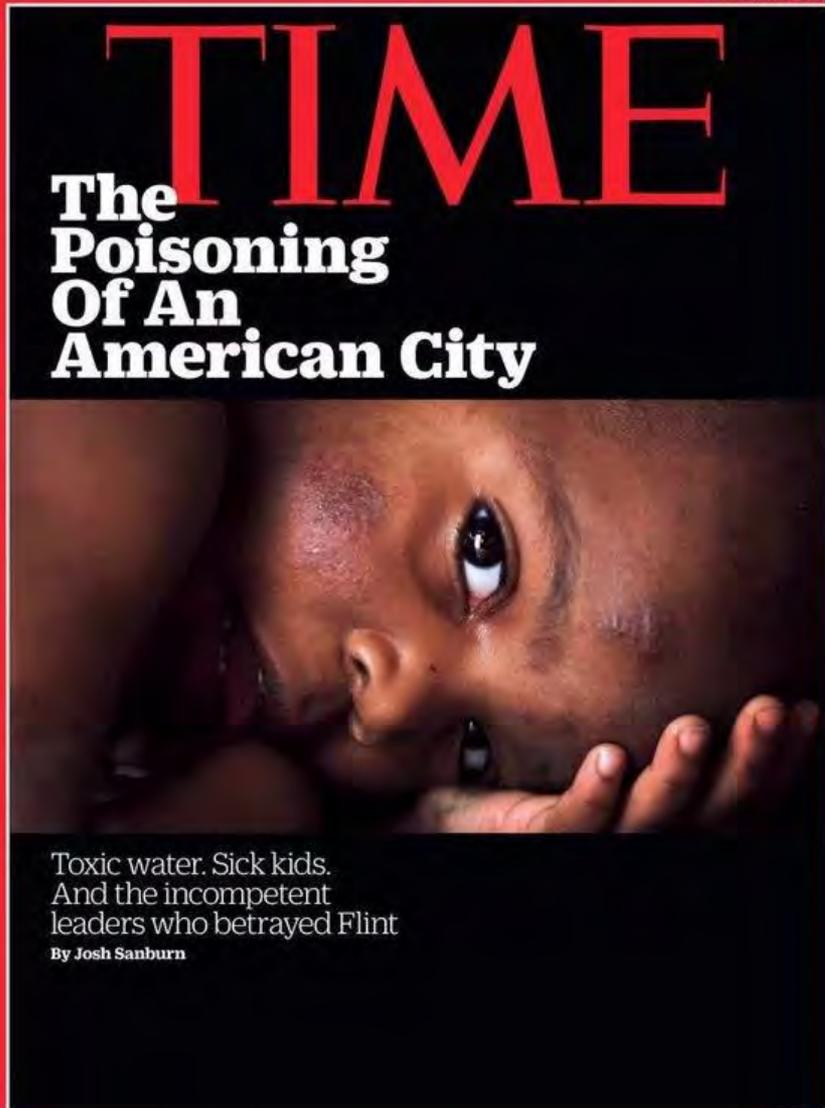
Centre de collaboration nationale
en santé environnementale

<http://www.ncceh.ca/>

Lydia Ma
Emily Peterson
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The Crisis in Flint



What happened in Flint?
Can this kind of crisis
occur in Canada?

The Crisis in Flint



A presentation on the changes in water chemistry and the circumstances leading to the crisis so we may learn from others and not to repeat their mistakes

The Crisis in Flint

In the US, the Lead and Copper Rule sets the Action Level for lead in water at 15 ppb.

If more than 10% of samples tested exceeded AL, the water system must increase monitoring, undertake additional corrosion control and implement training and public education for customers

Pregnant women and children should switch to bottled water if > 15 ppb



The Crisis in Flint

No safe limit of lead in children blood but in 2012 CDC recommended a reference level of 5 $\mu\text{g}/\text{dL}$ to identify children with blood lead levels that are **'elevated'**, as compared to the previous 10 $\mu\text{g}/\text{dL}$ "level of concern"



The Crisis in Flint

In Flint, one of the earlier sample found lead level in a residential home at 13,200 ppb as compared to AL of 15 ppb

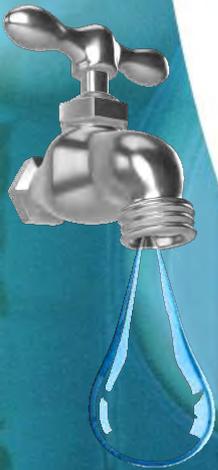
A high blood lead level reading of 38 $\mu\text{g}/\text{dL}$ was detected in a child in Flint, as compared to a level of 5 $\mu\text{g}/\text{dL}$ **that is considered as 'elevated'**



The Crisis in Flint

Canadian MAC for lead is set at $10 \mu\text{g}/\text{L}$, designed for infants and children under age of 6

Guidelines for Canadian Drinking Water Quality –Lead



The Crisis in Flint

Lead testing should be done without flushing after 6 hours stagnation. If 10% samples over 15 ppb (action Level), utility needs to take action

Two Tier Protocol, Guidance on Controlling Corrosion in Drinking Water Distribution Systems, Health Canada 2010

4 consecutive 1-L samples after 5 minutes flushing and 30 minutes stagnation

LSL Protocol, Guidance on Controlling Corrosion in Drinking Water Distribution Systems, Health Canada 2010



The Crisis in Flint

Health Canada blood lead intervention level at $10 \mu\text{g}/\text{dL}$, but acknowledged there is sufficient evidence that BLL below $5 \mu\text{g}/\text{dL}$, as low as $1\text{-}2 \mu\text{g}/\text{dL}$, are associated with adverse health effects, but uncertainty associated with effects at these levels

Health Canada, Final Human Health State of the Science Report on Lead, Feb 2013



FEBRUARY 1, 2016

TIME

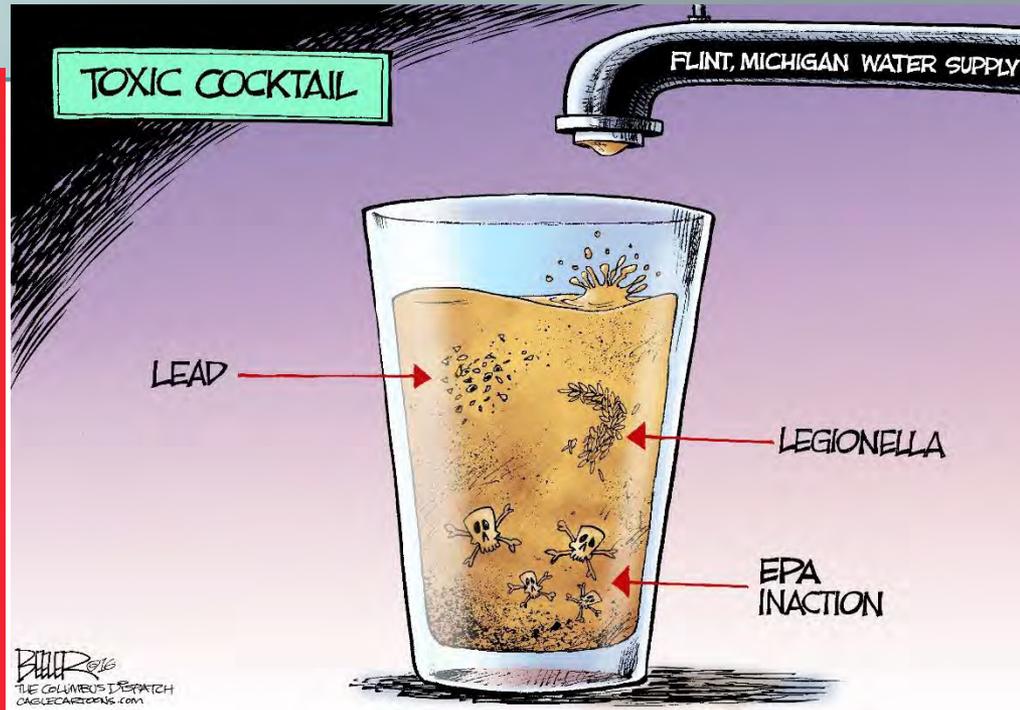
The Poisoning Of An American City



Toxic water. Sick kids. And the incompetent leaders who betrayed Flint

By Josh Sanburn

TIME.COM



What happened in Flint?

THE PERFECT STORM



OPINION

Trump: A Perfect Storm of Voter Rage, Reality TV and Social Media





I've Been
POISONED
By
Policy

Sequence of Events (simplified)

- Factors contributing to crisis
- Role of Health

US Regulatory Setting

Canadian setting

What we can learn from
the crisis



Sequence of Events

Ref: Flint Water Advisory Task Force, 2016; APHA educational webinars and other reports

City of Flint long-term water supply contract with Detroit Water and Sewerage Department (DWSD) started in 1967. Flint water treatment plant was converted to a backup supply source. The contract with DWSD expired in 2000, negotiations for extension failed. Flint explored alternatives



Sequence of Events

A 2011 study determined that the Flint River water would need to be treated with phosphate in order to reduce its corrosiveness. The report was sent to Michigan Department of Environmental Quality (MDEQ)

April 2013: Flint joined Karegnondi Water Authority to take water from Lake Huron, but will need 3 years to built a new pipeline

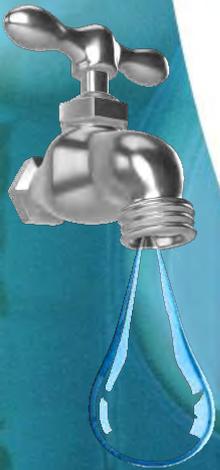
As a temporary measure, Flint began treating Flint River water at their WTP on a full-time basis after spending \$171,000 in 10 months to upgrade their plant



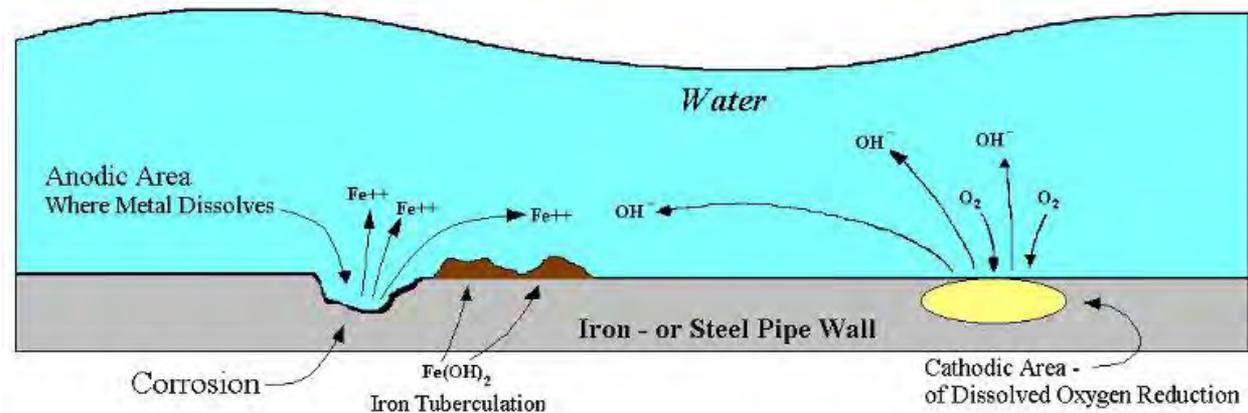
Sequence of Events

To save money, they did not start using corrosive inhibitor

Flint MDEQ incorrectly determined corrosion control was not needed until it has completed two 6-month monitoring. There was no EPA oversight



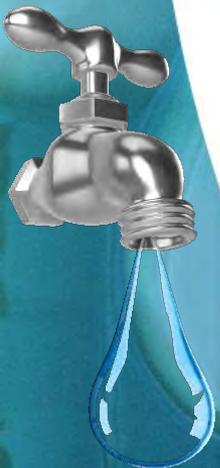
The Corrosion Cell:



Sequence of Events

The plan for switch was implemented by state-appointed Emergency Manager to save money

April 25 2014: Mayor officially turned off the Detroit water feed



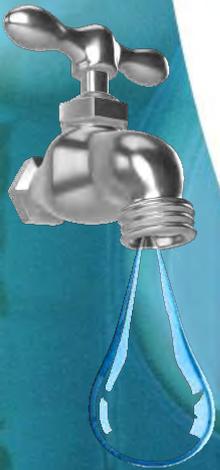
Sequence of Events

May 2014: Federal EPA and state health officials received complaints of rashes in residence of Flint, discoloured and foul smelling water. Emergency Manager continued to tell residents the water is safe, that it is a quality issue



Sequence of Events

Aug 15 2014: Four months after the switch, the city issued a boil-water advisory after fecal coliform was found in the city water. There were monthly coliform MCL violations in August and September



Sequence of Events

Legionella Outbreak

- Water contained more organics, serving as food source
- Corrosion resulted in more iron in water. Chlorine oxidized iron in water, resulting in no residual within distribution system
- More iron and organic reaching buildings, increasing food source and favour the formation of biofilm
- No residual to control growth and release of *Legionella*

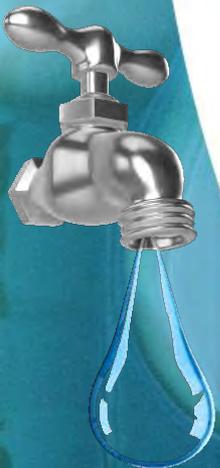


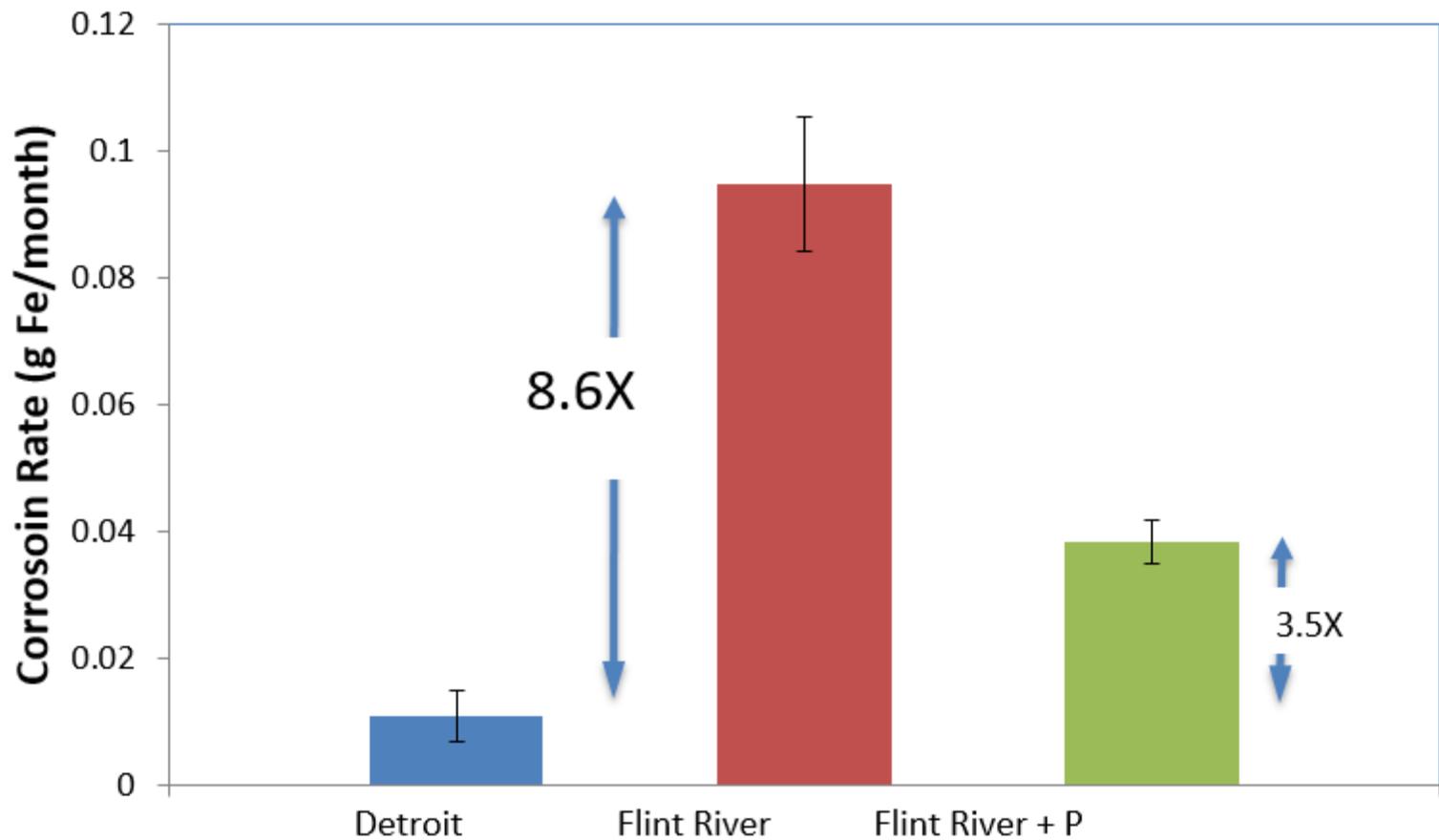
Water in flint hospital



Sequence of Events

October 13, 2014: GM stopped using Flint water at its engine plant because it was corroding engine parts. GM switched back to Detroit water. This further reduce water usage within Flint





8 times more chloride (Cl^-) than in Detroit water. Chloride is corrosive to iron





Illustrative photograph of a nail after 1 month exposure to Detroit water (above) and Flint River water with no inhibitor (below)

flintwaterstudy.org/



Sequence of Events

Dec 2014: After six months of LCR monitoring, Flint reported the 90th percentile for lead was 6 ppb with only 2 samples above AL of 15

However, samples were not taken from homes with Lead Service Lines (LSL) (high risk homes) and were pre-flushed 3 to 4 minutes to lower lead level, not representatives of what public may be using



Sequence of Events

Flint submitted result to MDEQ, with the original sample pool showing an average reading of 71 $\mu\text{g}/\text{L}$, above AL of 15

MDEQ directed the City of Flint to drop two high readings to make sure the average was below **15, including a reading from Lee Anne Walters's** house, which had a reading of 104 ppb. The reason to drop the reading was because she had a filter, which would have LOWERED reading. The second reading of 20 ppb was from a **'business'**



Sequence of Events

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
OFFICE OF DRINKING WATER AND MUNICIPAL ASSISTANCE
**LEAD AND COPPER REPORT AND
CONSUMER NOTICE OF LEAD RESULT
CERTIFICATE FOR COMMUNITY WATER SUPPLY**

DRAFT DEQ

Issued under authority of 1976 PA 399, MCL 325.1001 et al., and Administrative Rules, as amended.
Failure to submit this information is a violation of Act 399 and may subject the water supply to enforcement penalties.

Administrative Rule R 325.10710d requires water supplies to report lead and copper monitoring information within 10 days after the end of the monitoring period. This form may be used to meet this requirement. Submit the information to the appropriate Department of Environmental Quality (DEQ) district office. For district office addresses, visit www.michigan.gov/deq and click on Locations.

1. Water Supply Name: City of Flint Water Plant
 2. County: Genesee 3. WSSN: 2310
 4. Population: 99,763 5. Monitoring Period: From: 1/1/15 To: 6/30/15
 6. Minimum # of Samples Required: 100 7. # of Samples Taken: 71
 8. Name of Certified Laboratory: DEQ Drinking Water Laboratory

9. SAMPLE CRITERIA:

Yes	No	Explain No responses in Comments block.
<input type="checkbox"/>	<input checked="" type="checkbox"/>	a. Are the same sampling points used as in the previous monitoring period?
<input type="checkbox"/>	<input checked="" type="checkbox"/>	b. Are all samples from Tier 1 sites?
<input checked="" type="checkbox"/>	<input type="checkbox"/>	c. Are all samples from Tier 1, 2, or 3 sites giving Tier 1 priority?
<input checked="" type="checkbox"/>	<input type="checkbox"/>	d. If no Tier 1, 2, or 3 sites are available, do all sites have plumbing materials commonly found at other locations in the system?
<input checked="" type="checkbox"/>	<input type="checkbox"/>	e. Is the minimum number of lead service line samples taken (when applicable)?

For more information see *Instructions* paragraph 11, subparagraph "Sample Category."

Comments:
 A total of 175 sample bottles and instructions were distributed to city residents. We are continuing to solicit samples due to the fact that we did not reach the minimum number for this monitoring period.

Lead service line materials (2000)

10. NAME:

Name: Michael Glasgow
 Title: Utilities Administrator Phone: 810-766-7135 Date: 7/28/2015

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
OFFICE OF DRINKING WATER AND MUNICIPAL ASSISTANCE
**LEAD AND COPPER REPORT AND
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1. Water Supply Name: City of Flint Water Plant
 2. County: Genesee 3. WSSN: 2310
 4. Population: 99,763 5. Monitoring Period: From: 1/1/15 To: 6/30/15
 6. Minimum # of Samples Required: 60 7. # of Samples Taken: 69
 8. Name of Certified Laboratory: DEQ Drinking Water Laboratory

9. SAMPLE CRITERIA:

Yes	No	Explain No responses in Comments block.
<input type="checkbox"/>	<input checked="" type="checkbox"/>	a. Are the same sampling points used as in the previous monitoring period?
<input type="checkbox"/>	<input checked="" type="checkbox"/>	b. Are all samples from Tier 1 sites?
<input checked="" type="checkbox"/>	<input type="checkbox"/>	c. Are all samples from Tier 1, 2, or 3 sites giving Tier 1 priority?
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<input checked="" type="checkbox"/>	<input type="checkbox"/>	e. Is the minimum number of lead service line samples taken (when applicable)?

For more information see *Instructions* paragraph 11, subparagraph "Sample Category."

Comments: Revised report after conference call with DEQ staff. Two samples were removed from list for not meeting sample criteria, and due to population the number of samples required was reduced to 60.

10. NAME:

Name: Michael Glasgow
 Title: Utilities Administrator Phone: 810-766-7135 Date: 8/20/2015

Sequence of Events

Second round of 6 month monitoring showed lead level of 11 ppb, still below the AL of 15

Fail to understand that lead level had doubled, and regardless of AL, it is a concern: regulation compliance and not public health

Just a Number



Sequence of Events

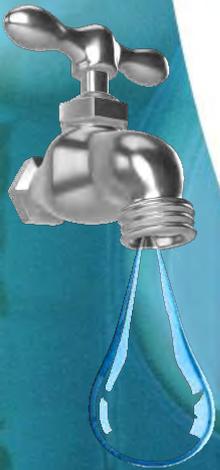
January 2015: Advisory was issued due to high level of THM. The first three samples in 2014 were so high they guaranteed a quarterly average was over the limit regardless of the fourth-quarter reading. Flint was putting in more chlorine in order to maintain a residual (used up by corrosion and biofilm), resulting in high THM level



Sequence of Events

To lower THM level, Flint started to add ferric chloride, a coagulant, to remove THM precursors. They used ferric chloride instead of the more common alum to save money

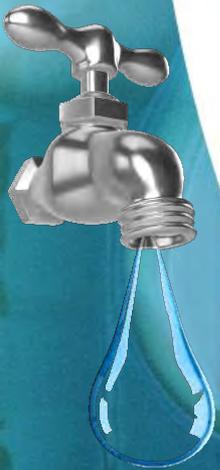
However, the increase in the chloride-to-sulfate mass ratio in the water adversely affect lead levels by increasing the galvanic corrosion of lead in the plumbing network



Sequence of Events

February 2015: City council voted for a switch back to Detroit water. Detroit said it will not charge a \$4 million connection fee

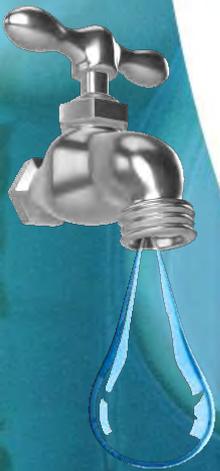
However, their decision was overruled by the Emergency Manager



Sequence of Events

April 2014

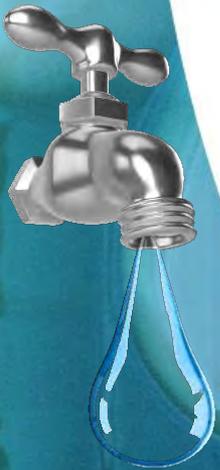
Federal EPA advised MDEQ to have corrosion control in place. EPA took no action when MDEQ did not comply



Sequence of Events

Flint resident Lee Anne Walters requested testing of lead in her water after her child developed skin rashes over entire body after bathing. Results showed 104 $\mu\text{g}/\text{L}$ and 397 $\mu\text{g}/\text{L}$ (after flushing). The level of iron in the water also exceeded the capability of the measurement ($>3.3 \text{ mg}/\text{L}$).

Flint claimed internal lead plumbing but EPA inspection found low lead faucets, plastic pipes within her home



Sequence of Events

Flint health department tested her child and showed a low blood lead level at 3 $\mu\text{g}/\text{dL}$ (2 $\mu\text{g}/\text{dL}$ prior to the source water switch). She re-tested her child at a healthcare facility at a different location and found an elevated blood lead level of 6.5 $\mu\text{g}/\text{dL}$

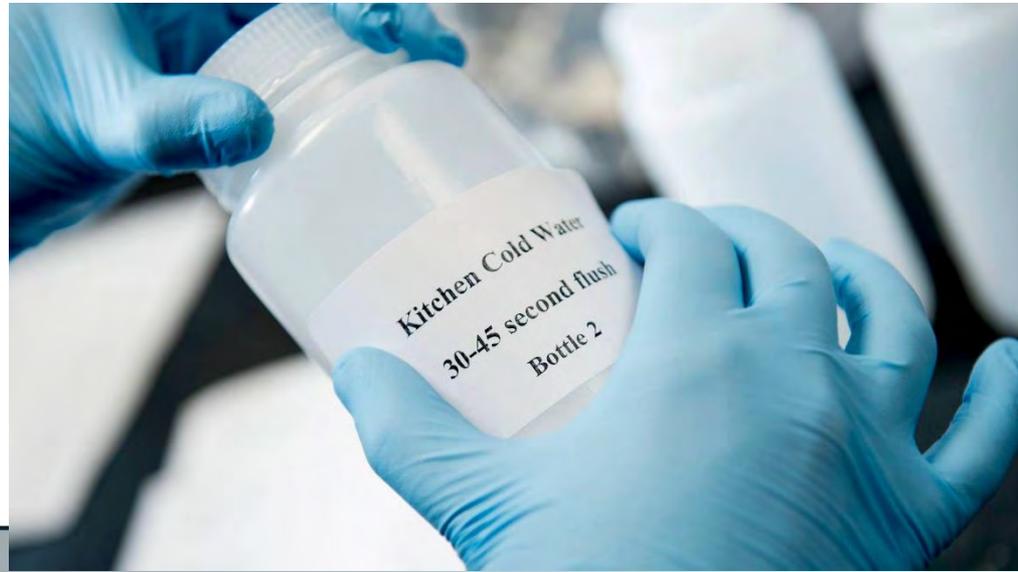
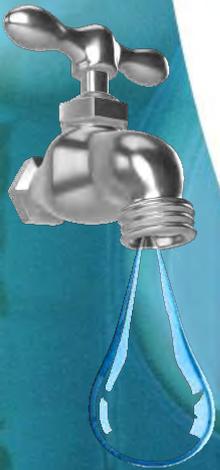
She also monitored chlorine levels in her tap water using a Hach Pocket Colorimeter II device everyday from Aug 17 till Sep 3 and found no detectable chlorine out of 18 days tested



Sequence of Events

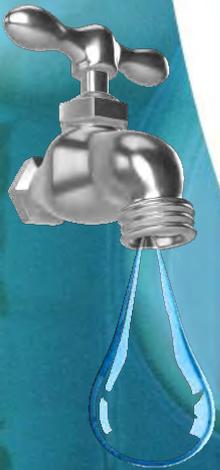
Water samples from her home was sent to Virginia Polytech for analysis. The minimum lead value was 200 $\mu\text{g/L}$, the average was 2,429 $\mu\text{g/L}$ and maximum was 13,200 $\mu\text{g/L}$

The source was traced to lead service line and not internal plumbing



Sequence of Events

April to June 2015: Internal memo from EPA Regulations Manager, Miguel del Toral noted the high lead content and potential health concern and questioned why Flint did not have corrosion control. The information was dismissed by EPA and MDEQ. When memo was leaked, MDEQ told **public to 'relax'**



Sequence of Events

July 2015: A Michigan Department of Health and Human Services (MDHHS) epidemiologist analyzed 2014 BLL data and found a concerning pattern of elevated levels in Flint. But the data manager concluded that 2014 data were not substantially different than preceding years. His analysis was flawed because he failed to take into consideration size of cohort

MDHHS also believed MDEQ when they were told that the water was safe



Sequence of Events

September 2: Virginia Polytech professor Marc Edwards found the corrosiveness of the water is causing lead to leach into water and was surprised no corrosive inhibitor was used. The information was sent to EPA

The state and city said the water met state and federal standards but will introduce a lead-reduction plan by 2016



Sequence of Events

MDEQ continued to discredit information from EPA and Virginia Polytech

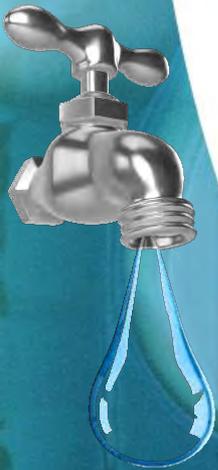
More testing by Virginia Polytech found >50% of home tested had lead levels >5 ppb and 30% of samples had lead > 15 ppb. 90%ile was 25 ppb and several samples >100 ppb with one over 1,000 ppb



Sequence of Events

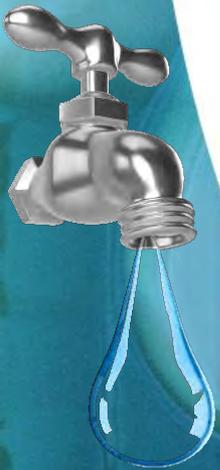
Dr. Mona Hanna-Attisha, a pediatrician at a medical center data showed infants and children had elevated levels of lead in their blood since the switch, from 2.4% before Flint switched water to 4.9% after the switch. One high risk ward had 15.7% with high BLL

County health officials used data for children living outside the city and drinking water supplied by Detroit to show there was no elevated blood lead levels



Sequence of Events

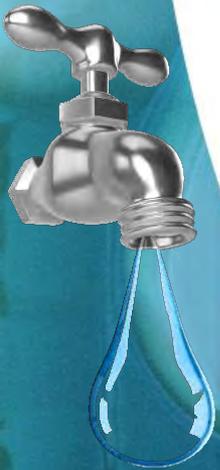
October 2 2015: State officials finally acknowledged the problem and confirmed high BLL findings and switched back to DWSD water



Sequence of Events

August 2016

Eight state officials face counts ranging from willful neglect of duty to conspiracy over allegations they withheld information from the public about lead contamination. This include the Chief of the Office of Drinking Water and Municipal Assistance at the MDEQ. One City of Flint employee had also been charged. Three lower level officials were charged in the spring.



Perfect Storm of Incompetence

Corrosion of Pipes, Erosion of Trust

- Aging infrastructure: Up to 80% of household had lead service line
- Distribution system build for >200,000, but now has less than 100,000. The reduce in water usage increases water age and stagnation in water. It takes an average of 144 hours for water from plant to reach city center, increasing contact and corrosion



Perfect Storm of Incompetence

Corrosion of Pipes, Erosion of Trust

- Rushing plant back to operation without proper assessment with cost being a major factor. Also not to use corrosive inhibitor (\$140/day) and changed to ferric chloride coagulant to save money
- Decisions made by non-professional with political interference in public health decisions with money saving as the major objective



Perfect Storm of Incompetence

Corrosion of Pipes, Erosion of Trust

- Dubious sampling and data analysis methods
- Failed to respond to complaints
- Inadequate knowledge among utility personnel and water quality engineers on corrosion control, treating it as an after thought as compared to microbial and DBP control
- Actions to control bacteria and THM resulted in higher leaching of chemical – not understanding water chemistry, cannot look at water treatment in isolation



Perfect Storm of Incompetence

Heroes

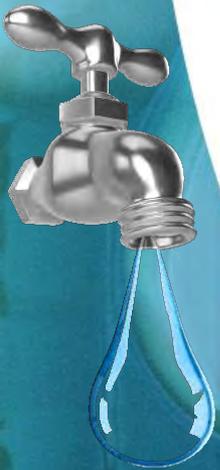
- Lee Anne Walters, mother and Flint resident
- Miguel del Toral, EPA Regulations Manager
- Dr. Marc Edwards, Virginia Polytechnic Institute
- Dr. Mona Hanna-Attisha, pediatrician



Lessons learnt

Never let a crisis go to waste

- Regulation compliance and not public health protection (doing without understanding)
- Regulation tells you how to produce safe water (food) but not how safe the water is
- Need to understand the water treatment system as a whole
- Just a number



Role of Health

Grocery store inspection is under the jurisdiction of Michigan Department of Agriculture and Rural Development

Restaurant, recreational water, sewage, lead poisoning is under Genesee County Health

Public Health (disease control) is under MDHHS

Water quality and safety is not the mandate of health



Role of Health

MDHHS in theory, had the right to issue order to correct deficiencies but failed to act based on info from MDEQ despite increasing trend

Task Force found MDHHS had the lead role in coordinating follow-up for high BLL but failed to do so



Role of Health

Two state health department employees are being **charged for 'burying' an epidemiologist's July 28, 2015, report** showing a significant year-over-year spike in blood lead levels in Flint children

The state's top epidemiologist also ordered a DHHS employee to delete emails about that July 28 report and prevented action to alert top state health officials and the public

All three MDHHS employees are under criminal investigation for their conduct during the crisis



Role of Health

Sep 2016

Announced that Flint had the "largest healthcare-associated Legionnaires' outbreak known in the U.S.," 46 cases with 12 dead

Flint hospital asked a judge to uphold a County **judge's order barring MDHHS from being** involved in the investigations of new and old cases of Legionnaires. Flint hospital believed there were numerous crimes and cover-ups by state employees



US System - Pros

US has better and more stringent regulations (?), Federal regulatory oversight; LCR to prevent what had happened; Public Notification Rule (disclosure rule)

Mandated low lead faucets

More frequent national blood lead sampling and reporting



US System - Cons

Recent survey estimated a total of 6.1 million LSLs, either full or partial, are in place today in US community water systems (down from 10.2 million), providing water to an estimated 15-22 million people

Cornwell 2016

LSL location may not be known to utilities

More concerns with lead in paint and dust

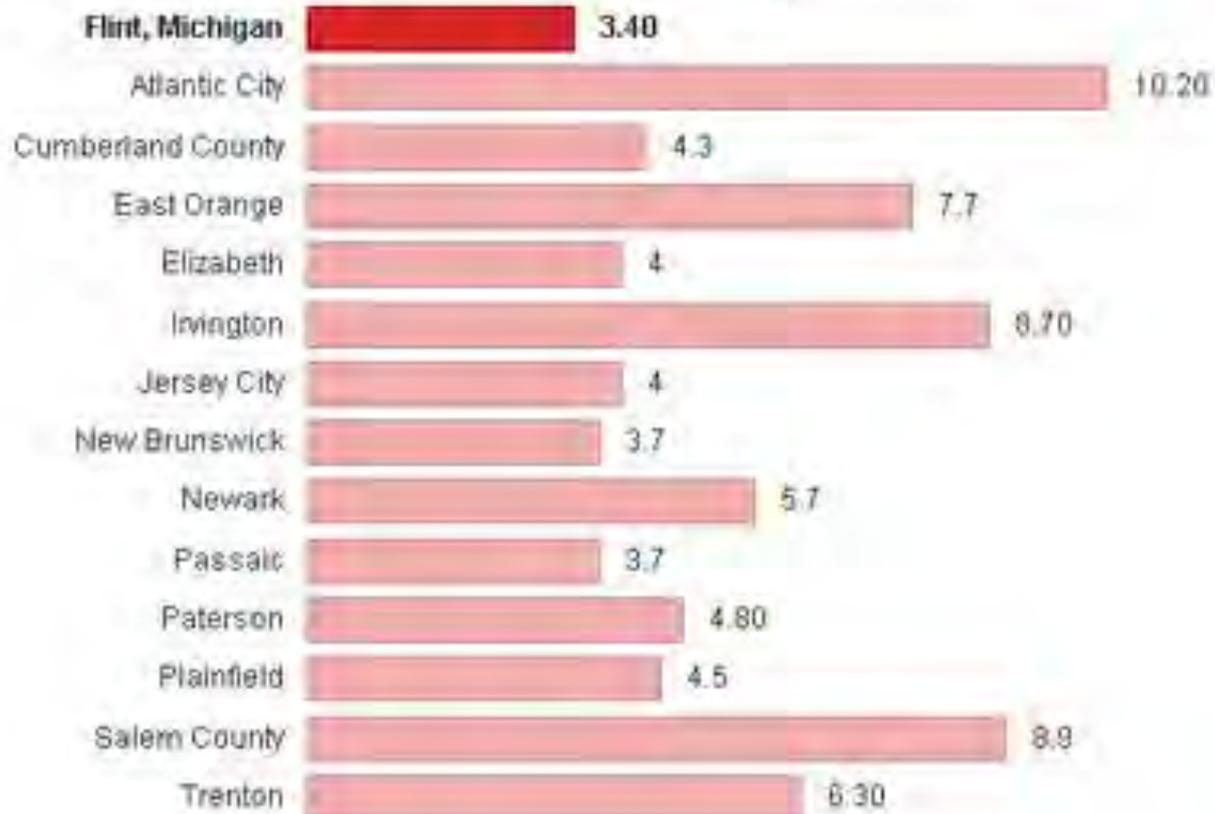
US System - Cons

U.S. Government Accountability Office has reported that EPA does not have enough power or resources to properly oversee sampling that cities carry out to show they are complying with the Lead and Copper Rule

US System - Cons

Lead levels in 11 N.J. cities, 2 counties vs. Flint, Michigan

Percent of children tested with lead levels > 5 mg/dL



Canadian Setting

In Canada, one estimate is about 165,000 homes with LSL, with 35,000 in Toronto

Ontario Ministry of the Environment tested water in the province and Toronto did four rounds of testing between 2007 and 2009 and found about 20% of residential test had lead level above 10 $\mu\text{g}/\text{L}$

In 2007, Ontario legislation made it mandatory for older day cares and all schools to test their water



Canadian Setting

1.4% (3,400) of homes in Edmonton and 0.2% of homes in Calgary had high lead

Prince Rupert BC found 48% of schools tested had elevated levels of lead

Montreal has 60,000 LSL and planned to eliminate them by 2026

Other health regions



Canadian Setting

Guidelines for Canadian Drinking Water Quality is a guideline only and not uniformly applied across Canada. Example: Quebec did not adopt the 10 $\mu\text{g/L}$ MAC, set in 1992, till 2001

Corrosion guideline, similar to LCR, is designed to measure lead concentration within the water system and in residential homes. However, it is a guideline and carries no legal power



Canadian Setting

Ultimately, the Flint crisis was picked up by blood lead testing data after other signals were ignored
In the US, blood lead screening is a routine practice for high-risk populations and children insured by Medicare at 1-2 years of age

Testing is done due to increased risk of elevated exposures from dust and soil

No regular blood lead surveillance in Canada



Canadian Setting

Blood lead surveillance is important for detecting exposures when the first line of defence fails (water testing)

Action Level in the US is 5 $\mu\text{g}/\text{dL}$ but 10 $\mu\text{g}/\text{dL}$ in Canada, may make it more challenging to pick up signal as there are many other sources of lead in the home setting

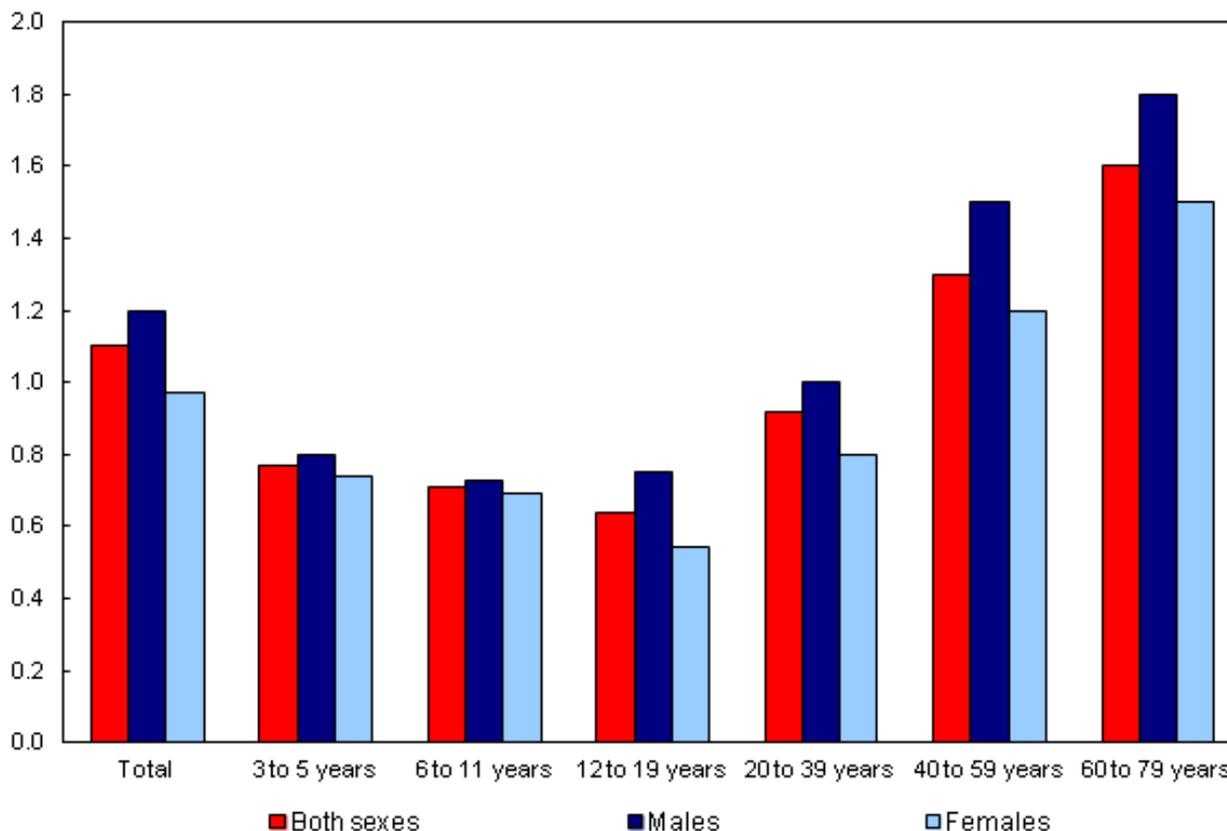


Canadian Setting

Chart 1

Lead concentrations in blood ($\mu\text{g}/\text{dL}$) in Canadians aged 3 to 79, by sex and age group, household population, Canada, 2012 and 2013

$\mu\text{g}/\text{dL}$



Note: Concentrations are presented as a geometric mean, which is a type of average that is less influenced by extreme values than the traditional arithmetic mean. The geometric mean provides a better estimate of central tendency for highly skewed data. This type of distribution is common in the measurement of environmental chemicals in blood and urine.

Source: Canadian Health Measures Survey, 2012 and 2013



Canadian Setting

In theory, have better working relationship between environment and public health. Although some health departments do not take direct responsibility on municipally treated drinking water, would still respond and investigate complaints.

Walkerton is an good example of where health was depending on inputs from utility on the safety of the water





Summary – Can this Happen?

Less Stress:

- Less aging infrastructure
- Cooperation between environment and health
- **More 'complete' public health programs**
- **Unlikely 'sequence of events'**



Summary – Can this Happen?

Similar:

- Unknown LSL locations
- LSL replacement (cost and future use)
- Limited blood and water monitoring of lead: Not looking for problem (example: day care)
- Political interference?



Summary

Public Health

- Inspection focuses on preparation process and regulation compliance
- Need to modify and enhance role to improve effectiveness of program through better education and focus on competency of operators



Summary

Public Health

- LAST line of defence
- Working with people for people
- Cooperation and work with others
- Maintain trust and credibility by making the right decisions through understanding of science and compassion of public issues
- Prevent, Protect and Educate





SAFE WATER:



At What Cost?