Synergistic Impacts of Corrosive Water and Interrupted Corrosion Control on Chemical/Microbiological Water Quality: The Flint, MI Water Crisis

NSF RAPID:

“used for proposals having a severe urgency….., including quick-response research on natural or anthropogenic disasters and similar unanticipated events.”
Flint water is very corrosive. Detroit water is not.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Before $^1$</th>
<th>After $^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.38</td>
<td>7.61</td>
</tr>
<tr>
<td>Hardness (mg/L as CaCO$_3$)</td>
<td>101</td>
<td>183</td>
</tr>
<tr>
<td>Alkalinity (mg/L as CaCO$_3$)</td>
<td>78</td>
<td>77</td>
</tr>
<tr>
<td>Chloride (mg/L)</td>
<td>11.4</td>
<td>92</td>
</tr>
<tr>
<td>Sulfate (mg/L)</td>
<td>25.2</td>
<td>41</td>
</tr>
<tr>
<td>CSMR$^3$</td>
<td>0.45</td>
<td>1.6</td>
</tr>
<tr>
<td>Inhibitor (mg/L as P)</td>
<td>0.35</td>
<td>NONE</td>
</tr>
<tr>
<td>Larson Ratio$^4$</td>
<td>0.5</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Corrosive Water: Destroys Pipe Infrastructure
Steel Exposed One Month to Detroit vs. Flint River Water
Phosphate would have helped. But Flint River Still 3.5X Worse than Detroit.
Corrosive Water:
Causes Odors, Colors, Bad Tastes
High Levels of Corrosion Causing Bacteria
**Corrosive Water:** Increases Lead. Effects VISIBLE immediately in lab tests!

White Particles Are Lead Solids

Lead Solder Sample with Copper pipe

Flint

Detroit
5000 ppb = Hazardous Waste Levels of Lead
Phosphate (P) corrosion inhibitor would have helped. But still 4X worse than Detroit water after 5 weeks.
INITIATED CONFIRMATION TESTING OF LEAD CORROSIVITY AT ONE LOCAL ELEMENTARY AND ONE HIGH SCHOOL

Vickie Weiss
City School ~ Room 00
11920 S. Saginaw
Grand Blanc MI – 48439

4-5th Graders
12+5 Bottles

Emily Cizmas
2283 E. Scottwood Ave.
Burton, MI 48529

Bendale High School,
Burton
14+5 Bottles

Experimental Rigs has also been sent to:

Brad Wurfel
Director of Communication
Michigan DEQ
P.O. Box 30473
Lansing, MI 48909-6700

9 Bottles
Aug 20 - Sep 8

#FlintWater sampling response from #FlintCitizenScientists

No. of samples tested for Lead

- City Sampling: 69
- Sampling Target: 75
- Our sampling: 277
- 3 samples/home: 831

12 times
The Team in Flint and from ACLU-Michigan
PEDDIATRIC LEAD EXPOSURE IN FLINT, MI: CONCERNS FROM THE MEDICAL COMMUNITY

Higher Risk Zip Codes For EBL

90%’ile from low risk homes
> EPA Action Level
Corrosion control treatment to reduce lead in Flint water.

1. **Switch back to the non-corrosive Detroit water.**
   Flint’s lead levels would drop markedly in about one month.

2. **Add orthophosphate to Flint River water.** Orthophosphate will not reduce lead leaching from all lead plumbing sources. Based on experimental data, lead levels would likely be reduced by 5X, but still 4X higher than Detroit. Iron corrosion still much higher than Detroit.

If orthophosphate had been added to Flint water, continuing the corrosion control used in Detroit water, the Flint Water Crisis would not have occurred.
About us

Research Team
Undergraduate Students: Margaret Carolan, Kim Hughes, Rebecca Jones


Principal Investigators: Dr. Marc Edwards, Dr. Amy Pruden, Dr. Joseph Falkingham III
Acknowledgements

• NSF
• Flint Citizens
• Wateryoufightingfor (Melissa Mays and Lee-Anne Walters)
• Miguel Del Toral (Region 5 EPA)
• ACLU-MICHIGAN (Curt Guyette)
• Senator Ananich and Dan Kildee (and Great Staff)
• **Flint Medical Community** (esp. Mona Hanna-Attisha and Hurley team)
• Genesee County Health Department
• Concerned Pastors for Social Action
• Democracy Defense League
• Others

• City of Flint Water Department (Glasgow/Croft)
Treatment Option 1

- Add potassium permanganate
- Double ferric dosage
- Reduce ozone dosage
- Reduce lime dosage
- Add cationic anionic polymer
- Replace filters with GAC
- Reduce pre-chlorination
- Add corrosion control
Treatment Option 2

- Add potassium permanganate
- Alum
- Add lime dosage
- Lime cationic anionic polymer
- Replace filters with GAC
- Carbon dioxide
- Reduce pre-chlorination
- Chlorine
- Fluoride
- Chlorine
- Phosphate
## CSMR for Ferric Chloride vs Alum

<table>
<thead>
<tr>
<th></th>
<th>Cl⁻</th>
<th>SO⁻</th>
<th>CSMR</th>
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<tbody>
<tr>
<td>Ferric Chloride</td>
<td>80</td>
<td>27</td>
<td>2.96</td>
</tr>
<tr>
<td>Alum</td>
<td>44</td>
<td>77</td>
<td>0.57</td>
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