ADDRESSING THE LEAD CRISIS THROUGH INNOVATION AND TECHNOLOGY

FIELD HEARING

BEFORE THE

SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

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C O N T E N T S

October 15, 2019

Appendix II: Additional Material for the Record

ADDRESSING THE LEAD CRISIS THROUGH INNOVATION AND TECHNOLOGY

TUESDAY, OCTOBER 15, 2019

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Subcommittee met, pursuant to notice, at 10:06 a.m., at the Early Childhood Center at Forest Glen, 280 Davey Street, Bloomfield, New Jersey, Hon. Mikie Sherrill [Chairwoman of the Subcommittee] presiding.

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT
U.S. HOUSE OF REPRESENTATIVES

HEARING CHARTER

Addressing the Lead Crisis Through Innovation & Technology
Tuesday, October 15, 2019
10:00 am EST

Early Childhood Center at Forest Glen
280 Davey Street
Bloomfield, New Jersey

PURPOSE

The purpose of the hearing is to discuss the prevalence and effects of lead in drinking water and the challenges that local leaders face in addressing lead contamination. The Committee will consider innovative, science-based solutions for anticipating risk and preventing contamination and explore research opportunities to help municipalities reduce lead exposure more quickly and cost-effectively.

WITNESSES

Panel I

- **The Honorable Joe DiVincenzo, Jr.** County Executive, Essex County, New Jersey
- **The Honorable Joseph Scarpelli,** Mayor of Nutley, New Jersey
- **The Honorable Michael Venezia,** Mayor of Bloomfield, New Jersey

Panel II

- **Dr. Diane Calello,** Executive Medical Director, New Jersey Poison Information and Education System and Associate Professor of Emergency Medicine, Rutgers University
- **Dr. Marc Edwards,** University Distinguished Professor, Virginia Polytechnic Institute
- **Mr. Michael Ramos,** Chief Engineer, Chicago Public Schools and inventor, the Noah Auto Flushing device
- **Dr. Eric Roy,** Founder, Hydroviv

KEY QUESTIONS

- How extensive is lead exposure in drinking water and how does it affect human health?
- What are some best practices and facts about lead in drinking water that can help families protect themselves during a lead contamination event?

- What are some new technologies and strategies that municipalities can pursue to identify lead hazards and reduce exposures more quickly and cheaply?
- What is the federal role in helping bring these innovations to the marketplace?

BACKGROUND

The most common material for water service line construction prior to 1950 in the United States was lead. New lead service lines (LSLs) were not outlawed until 1986.[1] The U.S. Environmental Protection Agency (EPA) estimates that 6.5-10 million LSLs remain nationwide. Lead exposure is also caused by remaining lead goosenecks, solder, brass fittings, faucets and valves (which could be manufactured with up to 8% as late as 2014) and galvanized pipes downstream from lead plumbing.[2]

Unfortunately, lead is a severe and irreversible neurotoxin at even low levels of exposure. Children ages six and under are particularly susceptible to effects like behavior and learning problems, lower IQ, hyperactivity, hearing problems, and anemia. The EPA's 2007 Lead and Copper Rule establishes a minimum action standard of 15 parts per billion, but EPA, the Centers for Disease Control and the American Academy of Pediatrics agree that there is no safe level of lead exposure for children.

Given the health effects of lead in drinking water, the ideal solution is to replace all LSLs in the United States, but the status quo methods for replacement are expensive and time-consuming. On October 10, 2019, EPA released a proposed update to the Lead and Copper Rule, which would maintain the action level of 15 ppb but create new requirements for testing and mapping of lead service lines.[3]

IN NEW JERSEY

In January 2019, local New Jersey outlets began to report on alarming lead levels in homes across Bergen and Hudson counties[4]. In February, the New Jersey Department of Health released its annual report on childhood lead exposure.[5] The report found a slight increase in the number of children with elevated lead blood levels. Following these reports, the Suez water company announced as $15 million project to replace about 25% of the LSLs in Bergen and Hudson counties.[6] In March, the City also announced that the Newark Department of Water and Sewer Utilities would continue its "vigorous efforts to distribute replacement filter cartridges to residents throughout the city."[7]

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[1] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2509614/

[2] file:///C:/Users/jthompson5/AppData/Local/Packages/Microsoft.MicrosoftEdge_8wekyb3d8bbwe/TempState/Downloads/SCHOCK%20ET%20AL%202019%20AWWA%20ACE%20AS%20GIVEN%20(1).PDF

[3] https://www.epa.gov/ground-water-and-drinking-water/proposed-revisions-lead-and-copper-rule

[4] https://www.northjersey.com/story/news/environment/2019/02/01/lead-new-jersey-drinking-water-towns-pressure-suez-speed-up-pipe-replacements-bergen-hudson-county/2729904002/

[5] https://www.state.nj.us/health/childhoodlead/documents/reports/childhoodlead2017.pdf

[6] https://www.northjersey.com/story/news/environment/2019/03/21/suez-water-nj-to-replace-9-miles-of-lead-pipes-in-nj-in-2019-lead-water-nj/3206123002/

[7] https://www.newarknj.gov/news/city-continues-vigorous-campaign-to-distribute-filter-replacement-cartridges-to-residents

Unfortunately, reporting in May 2019 saw additional municipalities served by Newark's water system showed elevated lead levels in the drinking water.[8] "Lead levels in Newark's water supply tested at 52 parts per billion between January 1 and June 30 of 2019, the highest levels ever recorded in Newark".[9] These statistics sent shockwaves through the region, causing the City to provide filters and bottled water to its constituents. On August 9, 2019, U.S. EPA sent a letter to the City noting that "use of the specific filtration devices distributed by Newark may not be reliably effective.[10]

In order to address the problem, in May 2019 the Pequannock Water Treatment system announced a new corrosion control program, and the Suez utility rolled out adjustments to its anti-corrosion strategies in September. In August 2019 Essex County announced a $120 million bond program with the City of Newark to expedite service line replacements.[11] In September, Newark Mayor Ras Baraka introduced an ordinance requiring Newark homeowners to replace lead service lines.[12] And the New Jersey Department of Education has announced that it will require schools to test for lead every three years, rather than every six years.

CHALLENGES IN ADDRESSING LEAD IN DRINKING WATER

The price and time needed to replace LSLs: Newark is in the process of rolling out a $75 million program to replace 18,000 LSLs. The program is expected to take 8 years. The NJ State Department of Environmental Protection estimated that "It could cost up to $2.3 billion to replace all of the estimated 350,000 water-service lines in New Jersey with lead issues.[13] The cost to replace a full lead service line (public and private side) that serves a residence is $2,500-5,500 per line, but some industry estimates are as high as $8,700. According to EPA, the cost for replacing all LSLs in the United States would be as high as $80 billion.[14]" The National Conference of State Legislatures estimates the national cost at $30 billion.[15]

Where are the LSLs? Although EPA requires cities to maintain an active inventory of lead service line locations, few cities satisfy the full requirement. Most LSLs were installed long before digital records were kept and as such, data about where they may be located is limited. The status quo strategy for locating LSLs with absolute confidence is to dig them up with a backhoe, a disruptive approach which can cost thousands per household.

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[8] https://www.nj.com/morris/2019/05/another-nj-town-finds-spiked-lead-levels-in-its-drinking-water.html
[9] https://www.insidernj.com/press-release/newark-lead-levels-hit-record-endangering-families/
[10] https://www.epa.gov/sites/production/files/2019-08/documents/r2letteraugust092019.pdf
[11] https://www.nj.com/essex/2019/08/newarks-fix-to-lead-water-crisis-wont-take-so-long-thanks-to-120m-county-bond.html
[12] https://www.nj.com/essex/2019/09/newark-wants-to-replace-lead-pipes-on-private-property-with-or-without-owners-ok.html
[13] https://www.njspotlight.com/stories/19/04/04/state-dep-getting-lead-out-of-nj-water-pipes-could-cost-2-3-billion/
[14] https://www.epa.gov/sites/production/files/2016-10/documents/508_lcr_revisions_white_paper_final_10.26.16.pdf
[15] http://www.ncsl.org/research/environment-and-natural-resources/lead-water-service-lines.aspx

Hardware for lead testing remains expensive: While at-home lead test kits are relatively cheap, residents must send their samples back to their water utility or a water quality lab for evaluation. No rapid, inexpensive and user-friendly kits for homeowners to do their own evaluation of water samples exist today. The devices that meet federal standards for reading a water sample usually cost over $100,000, and state-of-the-art portable handheld lead analyzers can still cost over $20,000.[16]

Public/private ownership of LSLs: Typically, a lead service line is owned by the local water utility from the water main up to the property line for a household or business, and then the property owner is responsible for the portions of the line under their land and into the home. This means that multiple parties must participate – and pay – in order to do a full LSL replacement. Research has shown that ironically, partial LSL replacements can result in a *surge* of lead exposure over several months. This is because the replacement process disturbs the remaining lead material and affects their scale buildup.[17] In March 2019, the state of Michigan banned partial replacements in order to avoid such exposure surges.[18]

Deficiencies in sampling methods: A June 2019 EPA study found sampling methods under the current Lead and Copper Rule sometimes missed peak lead concentrations or did not accurately capture actual lead exposure.[19] Furthermore, home lead test kits allow a lot of opportunity for user error, because they require the test to be conducted when the pipes have not been flushed (i.e. water run or a toilet flushed) for several hours.

As lead contamination concerns have grown in the public conscience, new innovative strategies for detection, exposure reduction and LSL replacement have emerged. See the Addendum for a sampling of innovative strategies for addressing lead in drinking water.

FEDERAL RESEARCH RESPONSIBILITIES

The EPA Office of Research and Development (ORD) is authorized in Section 1442 of the Safe Drinking Water Act, Section 104 of the Clean Water Act, and the Environmental Research, Development, and Demonstration Authorization Act (ERDDAA) to conduct research on new technologies to identify and address water-borne exposures to lead. The Fiscal Year 2020 budget request outlines the Safe and Sustainable Water Resources Research Program's (SSWR) priorities for lead in drinking water as follows:[20]

(1) establishing reliable models for estimating lead exposure from drinking water,
(2) developing improved sampling techniques and strategies for identifying and characterizing lead in plumbing materials, including lead service lines
(3) developing guidance on optimizing lead mitigation strategies, and
(4) testing and evaluation of treatment processes for removing lead from drinking water.

[16] https://www.the74million.org/article/boser-holman-new-innovation-fund-seeks-affordable-ways-to-test-for-eliminate-toxic-lead-in-and-around-our-nations-schools/
[17] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2866705/
[18] https://www.evart.org/N.%20DEQ-Partial%20Lead%20Service%20Line%20Replacement%20Ban.pdf
[19] https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=NRMRL&dirEntryId=345550
[20] https://www.epa.gov/sites/production/files/2019-04/documents/fy20-cj-03-science-technology.pdf Page 118

The EPA ORD budget set aside for Safe and Sustainable Water Resources to cover all contaminants, not just lead, was $106.26 million in Fiscal Year 2019.[21]

The EPA Drinking Water State Revolving Fund is already available to help states finance a wide variety of drinking water infrastructure projects, including LSL replacement programs. The Revolving Fund creates no specific limitations on the use of innovative technologies.

Performance certifications of the physical components of the drinking water system – e.g. paint coatings, valve filters, fittings, and pipes – are conducted by independent standards bodies. NSF/ANSI Standard 61 is the standard for components and Standard 53 addresses point of use filters. The Federal government does not require the use of NSF/ANSI, but 49 of 50 states adhere to their requirements under the state primacy responsibilities they are granted under the Safe Drinking Water Act.

[21] https://www.epa.gov/sites/production/files/2019-04/documents/fy20-cj-03-science-technology.pdf Page 115

Appendix:
Innovative Methods and Technologies for Identifying and Addressing Lead in Drinking Water

For Locating Lead Service Lines

Machine learning statistical models: In 2016, researchers from Georgia Tech and the University of Michigan worked with officials in Flint, Michigan create a new statistical model to find lead service lines by digitizing historical records and comparing it to field data from ongoing removal efforts and information from home inspections. The city recently mandated the use of this statistical model.[22] Its success led to the creation of Blue Conduit, a public-private-partnership now working with multiple cities to locate pipes. Another startup, Indiana-based 120Water Audit, has developed a user-friendly predictive module that can pinpoint properties that are likeliest to have LSLs.

Precision or hydro vacuuming: Springfield, Illinois uses precision vacuuming to inspect underground pipes through tiny, concentrated holes drilled into the curb box, a less disruptive and cheaper method of visually identifying LSLs. Precision vacuuming has been used to locate LSLs outside Springfield daycares. Michigan has directed the City of Flint to use a similar method called hydrovacing, which costs $300 or less per LSL to dig. Flint has used hydrovacing in conjunction with their statistical modeling to precisely pinpoint the location of LSLs.

Remote sensing techniques: In 2018, an Environmental Defense Fund project to remove lead piping in a Chicago daycare center used ground radar and sonar detection technologies to locate a LSL after an unsuccessful search using traditional digging methods.[23] Radar and sonar techniques that were originally used by the Department of Defense to locate land mines may be a scalable strategy for locating LSLs without digging.

Crowdsourcing LSL locations: The Greater Cincinnati Water Works runs an LSL replacement program that allows residents to do low-tech tests in their own homes to kickstart the replacement process.[24] Identification of private LSLs is often possible through simple "scratch tests," magnet tests, and a GCWW-provided test kit. Residents send their findings and pictures of their service line through an online form. However, this method only applies to the private side of the service line, and only to service lines accessible to the homeowner.

For Sampling Methodology, Home Testing and Data Sharing

Improved sampling methods: EPA researchers issued new findings this summer that sequential sampling and proportionate composite sampling may more accurately reflect home lead exposure. One new method would take multiple samples in a row to build a profile of a "plug" of

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[22] https://www.mlive.com/news/flint/2019/02/flint-agrees-to-return-to-data-driven-approach-to-find-remaining-lead-service-lines.html
[23] https://www.edf.org/sites/default/files/documents/edf_child_care_report-062518.pdf
[24] https://la.mygcww.org/do-i-have-a-lead-service-line/

water passing through the house's piping. Another would install a filter to capture the lead content in 5% of the water passing through a faucet over a the course of a week..[25]

Platinum electrode sensors: Researchers from the University of Michigan recently tested inexpensive platinum electrodes to determine heavy metals exposure in drinking water.[26] These sensors could distinguish lead from other metals. The study recorded no false positives and estimated a cost of about $20 per sensor.

Carbon nanotube testing: In 2017, 12-year old Gitanjali Rao from Lone Tree, CO designed Tethys, a prototype of an at-home lead testing device using detachable, disposable carbon nanotube sensors. The device, which aims to be available publicly in the next two years, connects via Bluetooth to an app interface to communicate test results to homeowners.[27]

Biosensors: FREDsense Technologies of Calgary, Alberta is developing a biosensor platform to detect water-borne lead. The company currently has commercially available biosensors aimed at detecting arsenic, iron, and manganese.[28]

Smartphone nanocolorimetry: University of Houston researchers published a 2018 study on a smartphone-based technique to detect and quantify dissolved lead in drinking water.[29]

Mitigating Exposure where Lead Service Lines Remain

Chemical additives for corrosion control: A common method for reducing lead exposure is to add chemicals to the water supply that create scales on the inside of pipes, which act as a protective barrier. The most common chemical additive, orthophosphates, have been demonstrated effective over decades, but water managers must implement these programs with care.[30] Changing water supplies to a more corrosive source can break down the scaling created by corrosion control additives, resulting in new lead leaching. This is the phenomenon that led to the Flint water crisis.[31] Furthermore, it takes many months or years for a new corrosion control program to develop an adequate layer of protection on previously-untreated pipes.

Automatic flushing: The chief engineer for Chicago Public Schools, Michael Ramos, recognized that water stagnation overnight, when schools are empty and the water system is stagnant, creates a surge of lead content in the first few sips of a water fountain at the beginning of the school day. He developed a device called the NOAH that automatically flushes drinking water systems to eliminate students' exposure to the morning lead surge.

[25] https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=NRMRL&dirEntryId=345550
[26] https://pubs.acs.org/doi/abs/10.1021/acs.analchem.7b00843
[27] https://www.cpr.org/2019/01/28/13-year-old-gitanjali-raos-lead-detecting-invention-lands-her-on-forbes-30-under-30/
[28] https://www.fredsense.com/technology
[29] https://pubs.acs.org/doi/abs/10.1021/acs.analchem.8b02808?journalCode=ancham&
[30] https://www.bu.edu/rccp/files/2018/12/Supplement_4_Corrosion_Study.pdf
[31] https://cen.acs.org/articles/94/i7/Lead-Ended-Flints-Tap-Water.html

Improved filters: Homeowners and businesses may use point of use filters, installed at the water inlet under the sink or tap, or pitcher filters to reduce their exposure. Product certification is conducted by NSF/ANSI, which collects a fee from manufacturers to test filter performance in a controlled laboratory setting. Researchers are exploring strategies to improve the performance of filters themselves – to make them last longer or to control for more contaminants, for example. There are also efforts underway to improve the consumer experience with filters and reduce the risk for misuse, e.g. automatic alerts when it is time for the filter to be replaced.

Epoxy lining: Companies like CuraFlo in Mesa, Arizona, or ACE Duraflo in Santa Ana, California, can coat the inside of pipes with about a 1/16th inch of epoxy or another material through a process that takes 4 hours, creating a lining that purports to eliminate contact between the pipe and the water supply. This technique has been deployed widely in Europe, but concerns remain about the how the lining material itself may degrade or leach into drinking water.

Other methods for corrosion control: In 2019, Denver Water sent a proposal to EPA for an alternative corrosion control strategy to orthophosphates. Denver seeks to use hydroxide to adjust the pH (acidity) of the source water itself, thus reducing its corrosivity to the lead pipe.[32] And researchers at University of California at Berkeley have developed a process that could accelerate the formation of protective scaling around pipes. By running an electrical current through phosphate-treated water in lead piping, they accelerated the chemical reaction to reduce the scale build-up time from months or years to a few hours.[33]

Advanced LSL Replacement Techniques

Trenchless digging / threading: Lansing, Michigan pioneered an LSL replacement technique in which the LSL is pulled out of the ground horizontally while a new pipe is pulled in behind it, a process which requires minimal excavation. Under earlier methods, it cost Lansing $9,000 and a full day to remove an average lead pipe. Using the trenchless method, Lansing was able to reduce the cost to about $3,600 and four hours on average. In 2016 Lansing became one of the first municipalities to completely remove all LSLs, and this method has been adopted by several other U.S. municipalities.[34]

Slip-lining: This method pulls a new, smaller pipe made of PVC or other safe material into an existing lead pipe and seals the ends, leaving the old pipe in place but isolating it from the water. The technique can also help with pipe structural integrity, but there has been little testing of this method to date.

Innovative Financing models

Some municipalities and states have developed creative funding solutions to incentivize replacement with homeowners. The Greater Cincinnati Water Works implemented a 40% cost

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[32] https://www.cpr.org/2019/07/01/denver-water-wants-to-replace-the-last-of-the-citys-lead-pipes-with-a-comprehensive-environmentalist-approved-plan/

[33] https://www.scientificamerican.com/article/zapping-lead-pipes-with-electricity-could-make-them-safer-for-drinking-water/

[34] https://www.detroitnews.com/story/news/local/michigan/2016/12/14/lansing-lead-service-line/95435604/

sharing program for homeowners to replace the private-side LSL, with additional support for low-income residents. Madison, Wisconsin reimburses half of the cost of LSL replacement up to $1,500, financing the program by renting space on water towers for cellular antennae. Denver Water and the Denver Urban Renewal Authority help finance homeowners' LSL removal with 5-15 year low-interest loans. Low-income customers may receive a rate as low as 0%.[35]

In some cases, local government and utilities absorb full financial responsibility for the private-side LSL. In September 2019, the city of Newark announced that it would pay for the full replacement of the 18,000 LSL's under city property at zero cost to property owners.

[35] https://www.lslr-collaborative.org/community-access-to-funding.html

Chairwoman SHERRILL. Without objection, the Chair is authorized to declare recess at any time.

Good morning, and welcome to a hearing of the Investigations and Oversight Committee of Science, Space, and Technology. We have quite a few people here from throughout the community, and I'd like to recognize County Executive Joe DiVincenzo—thank you for coming—his Chief of Staff, Phil Alagia; from Senator Booker's staff, Zach McCue; from Senator Menendez's staff, Casim Gomez; from Representative Gottheimer's staff, Cheryl Cruz. We also have Frijoler Carlos Caveras, Councilman Nick Joanow, Councilwoman Jenny Mundell, Fire Chief Lou Venezia, Police Director Sam DeMaio, and from our Board of Ed. Mr. Tom Heaney. And then I would also like to give a special welcome to our A.P. students from Bloomfield High School. Thank you for coming.

Well, it's a pleasure to do this field hearing right here in Bloomfield. I wish we could do every hearing here in the district, not sure our Virginian panel members would appreciate that, but I would love it.

We're here to talk about an environmental issue that threatens millions of Americans and is hitting our State hard in 2019. A new analysis by New Jersey Future found that over 5 million New Jerseyans may be exposed to lead contamination from water. The Pequannock Water System, which serves half a million people across Bloomfield, Belleville, and Pequannock Townships and part of Nutley, as well as the western part of Newark, has seen escalating lead levels as far back as 2017.

The U.N. General Assembly and the Human Rights Council recognized access to safe drinking water as a basic human right. We know in Flint, Michigan, fair enough, 6 to 12,000 children were impacted by unsafe drinking water. When we see contamination that threatens human health, especially the health of our children, we need to deploy all available resources to address it.

But in April, the New Jersey Department of Environmental Protection (NJ DEP) reported that it could cost up to $2.3 billion dollars to replace all of the lead services lines in New Jersey. So to put that in context, the entire budget of the New Jersey Department of Environmental Protection in 2018 was $214 million. So it's agonizing for everyone when we see a desperate need for improvement in a public good, but that need comes with a high price tag and a slow timeline.

Addressing lead is a diffuse problem where the exposure comes from millions of little pieces of hardware under our yards, in our basements, and up to our taps. So, first, let me say how fantastic it is that countless New Jersey State and local officials, the water utilities, and the Department of Health and Environmental Protection have locked arms to confront this issue in recent months.

Under Mr. DiVincenzo's leadership, Essex County has extended an incredible $120 million dollars in bond authority to support lead service line replacement in the greater Newark region. Thank you. And just last week, Governor Murphy rolled out a comprehensive Lead Action Plan that will beef up lead testing, public disclosures, and public funding for lead removal efforts.

But lead exposure in New Jersey is a kitchen-sink problem, and we need to throw everything we have at it. We have two powerful tools in our toolkit: Innovation to find solutions that are faster, cheaper, and safer; and public education so that families and businesses can better protect themselves. And in times like these, America's small businesses and university researchers can really shine.

In preparing for this hearing, we have run across dozens of brilliant new ideas for tackling lead in drinking water, from new methods for locating lead service lines where they exist, to strategies for getting lead service lines out of the ground at a lower cost and with less disruption. I want to make sure that the Federal Government is doing everything it can to get these smart ideas out of the lab and into the community and educating as many people in our community as possible and best practices and available services.

So I'm delighted to welcome two panels of distinguished witnesses today to guide our discussion. And here in New Jersey's 11th District, we've been celebrating the contributions of our Italian-American community, and I am proud that we see that on full display here today in panel one. So in panel one—I was told as an Irish American that I'm outnumbered today.

So in panel one I would like to welcome Mayor Venezia, Mayor Scarpelli, and County Executive DiVincenzo. They are on the front lines of the response to New Jersey's lead crisis, and I'm so glad we will have this opportunity to hear what they're hearing so we in Washington can be as responsive as possible.

I'm also thrilled to have Congressman Beyer and Congresswoman Wexton here today. I was just informed—something I didn't know—Congresswoman Wexton's maiden name is Tosini, so she's here celebrating as well the contributions of Italian Americans and carrying that banner.

Congressman Beyer has been a stalwart champion on clean water throughout his tenure in Congress. Congresswoman Wexton was a tireless environmental advocate when she served in the Virginia State Senate, and she is keeping up the good fight as a Member of Congress.

And now we just have Congressman Payne here, and Congressman Payne has been laser-focused on solutions to address lead exposures his constituents are facing in Newark. We're proud to have him join us today. So with some of the most capable Members of Congress on today's panel, we are off to a good start.

[The prepared statement of Chairwoman Sherrill follows:]

Good morning and welcome a hearing of the Investigations & Oversight Subcommittee. It's a pleasure to be able to have this meeting right here in Bloomfield. I wish we could do every hearing in the district! We're here to talk about an environmental issue that threatens millions of Americans, but sadly is hitting our state hard in 2019. A new analysis by New Jersey Future found that over five million New Jerseyans may be exposed to lead contamination from water. The Pequannock Water System- which serves half a million people across Bloomfield, Belleville and Pequannock Township and part of Nutley as well as the western part of Newark - has seen escalating lead levels as far back as 2017.

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Its agonizing for everyone when we see a desperate need for improvement in a public good, but that need comes with an high price tag and a slow timeline. Addressing lead is a diffuse problem, where the exposure comes from millions of little pieces of hardware under our yards, in our basements and up to our taps.

First let me say that it is fantastic how countless state and local officials, the water utilities, and the Departments of Health and Environmental Protection have locked arms to confront this issue in recent months. County Executive DiVincenzo and Essex County have extended an incredible $120 million dollars in bond authority to support lead service line replacement in the greater Newark region. And just last week Governor Murphy rolled out a comprehensive Lead Action Plan that will beef up lead testing, public disclosures, and public funding for lead removal efforts.

But lead exposure in New Jersey is a kitchen sink problem. We need to throw everything we have at it.

We have two powerful tools in our toolkit: innovation, to find solutions that are faster, cheaper, and safer; and public education, so that families and businesses can better protect themselves. And in times like these, America's small businesses and university researchers can really shine. In preparing for this hearing, we have run across dozens of brilliant new ideas for tackling lead in drinking water, from new methods for locating lead service lines where they exist, to strategies for getting lead service lines out of the ground at a lower cost and with less disruption. I want to make sure that the federal government is doing everything it can to get these smart ideas out of the lab and into the community.

I know that not every new invention will be available to help New Jersey with the crisis we're facing today. But if our discussion today helps protect even one township from lead exposure, we can be proud of that effort.

I'm delighted to welcome two panels of distinguished witnesses today to guide our discussion. It looks like the Italian roots of so many New Jerseyans will be particularly well-represented on Panel I! Mayor Venezia, Mayor Scarpelli and County Executive DiVincenzo are on the front lines of the response to New Jersey's lead crisis.

I'm so glad we will have this opportunity to hear what they're hearing so we in Washington can be as responsive as possible.

I'm also thrilled to have Congressman Payne, Congressman Beyer and Congresswoman Wexton here today. Congressman Beyer has been a stalwart champion on clean water protections throughout his tenure in Congress. Congresswoman Wexton was a tireless environmental advocate when she served in the Virginia State Senate, and she is keeping up the good fight as a freshman Member. And Congressman Payne has been laser-focused on solutions to address lead exposures his constituents are facing in Newark. We're proud to have him join us. With three of the most capable Members of Congress on today's panel, we're off to a good start.

Thank you all for being here and I look forward to our discussion.

Chairwoman SHERRILL. So I'd like to first ask unanimous consent that Congressman Payne be permitted to join the panel. Without objection.

So thank you all for being here today, and I'm looking forward to a good discussion.

I now recognize Congressman Payne of Newark for an opening statement.

Mr. PAYNE. Good morning. For those who don't know me, I am Congressman Payne—Donald Payne—I'm Congressman Donald Payne, Jr., Representative from the 10th congressional District, State of New Jersey, which also represents part of Bloomfield.

I want to thank Representative Sherrill for conducting this timely hearing. She's the Chair of the Subcommittee on Investigations and Oversight for the House Science, Space, and Technology Committee, and I want to thank her for allowing me to participate in today's hearing.

Now, I've been working diligently on this crisis since it began and looking to provide Federal resources—financial and educational—to help for the issue in Newark that we have seen that has become a crisis. Residents need to know what is being done to improve Newark's water as quickly and effectively as possible. So once again, I thank her for conducting this hearing, and I'm proud to be here today.

When I first learned that there were unsafe levels of lead in Newark's drinking water, I was shocked. This is the same water my family and I drink and use to clean our food. It is something I never thought could happen here. For decades, Newark was known for having some of the cleanest, purest water in the country, and it still is, but aging pipes and inadequate filters have taught us that clean water is something we cannot take for granted. That is why I am doing everything I can to help my constituents during this crisis.

In 2016, I introduced the *Test for Lead Act* into Congress. This bill would establish stronger tests for lead in schools across the country. I've signed onto a letter to the U.S. Environmental Protection Agency (EPA) to make sure that we have enough bottled water to supply residents until their drinking water is safe. I have signed onto another letter through the Department of Health and Human Services to make sure none of the tainted water ends up being used for mixed formula for infants. In addition, I've handed out bottled water to constituents at two different distribution centers to get an idea of what my constituents are going through on a day-to-day basis. It gave me a chance to meet people affected by the crisis to discuss their fears about the drinking water and learn what other solutions might be available to help them get through it.

No issue is more important than clean drinking water right now, and I know that today's hearing will help clarify the actions taken to clean that water and protect the health of our residents.

And with that, Madam Chair, I yield back.

[The prepared statement of Mr. Payne follows:]

Good Morning.

I am Congressman Donald M. Payne, Jr., representative for New Jersey's 10th District. I want to thank Representative Mikie Sherrill for conducting this hearing.

She is the Chair of the Subcommittee on Investigations and Oversight for the House Science, Space and Technology Committee.

We have been working diligently since this crisis began to provide federal resources, financial and educational, to help Newark in this time of crisis.

Residents need to know what is being done to improve Newark's water as quickly and effectively as possible.

So again, I thank her for conducting this hearing and I am proud to be here today.

When I first learned that there were unsafe levels of lead in Newark's drinking water, I was shocked. This is the same water my family and I drink and use to clean our food.

It is something I never thought could happen here.

For decades, Newark was known for having some of the cleanest, purest water in the country.

But aging pipes and inadequate filters have taught us that clean water is something we cannot take for granted.

That is why I am doing everything I can to help my constituents during this crisis.

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I have signed onto another letter to the Department of Health and Human Services to make sure none of the tainted water ends up being mixed with formula that is fed to infants.

In addition, I handed out bottled water to constituents at two distribution centers in Newark- the Bo Porter Sports Complex and the Boylan Street Recreation Center.

It gave me a chance to meet with people affected by this crisis to discuss their fears about the drinking water and learn what other solutions might be available to help them get through it.

No issue is more important than clean drinking water.

And I know that today's hearing will help clarify the actions being taken to clean that water and protect the health of our residents.

Thank you!

Chairwoman SHERRILL. Thank you so much, Congressman Payne, and thank you for being here today.

I also just want to recognize Senator Ruiz. Thank you so much for coming. And then all the way from Morris County we have Mayor Grayzel. Thank you for coming.

At this time I'd like to introduce the witnesses for our first panel. First, we have the County Executive of Essex County, New Jersey, Mr. Joseph DiVincenzo.

TESTIMONY OF HON. JOSEPH N. DIVINCENZO, JR., COUNTY EXECUTIVE, ESSEX COUNTY, NEW JERSEY

Mr. DIVINCENZO. Essex County is very, very fortunate to have two great Congresspeople that represent Essex County, Congresswoman Mikie Sherrill and Congressman Donald Payne. Congresswoman Sherrill, I just want to thank you for hosting this meeting here in Essex County. We surely appreciate it. I don't remember any Committee hearing here. Maybe Congressman Payne could correct me. Did you ever have one of your Committee meetings here?

Mr. PAYNE. I've had three since I've been in Congress, yes, thank you.

Mr. DIVINCENZO. Yes? In Essex County?

Mr. PAYNE. In Essex County, yes.

Mr. DIVINCENZO. OK. I'm sorry. Phil gave me wrong information, Phil Alagia.

Chairwoman SHERRILL. Members of Congress are often underappreciated here in New Jersey.

Mr. DIVINCENZO. Congresswoman Wexton and Congressman Beyer, I want to thank you also for being here in Essex County. We have a slogan: Putting Essex County First, so welcome to Essex County. Don't take it the wrong way that you see three Italians to the right-hand side here.

Essex County has 22 towns. We have over 800,000 people, and our strength in this county is our diversity. It just so happens there would be three Italians up here, me, Venezia, and Scarpelli, great elected officials.

Congresswoman Sherrill, thank you for holding this Subcommittee meeting in Bloomfield, Essex County.

The presence of lead in our drinking water cause us all great concern and creates a public health emergency. The public was first alerted to high levels of lead in the drinking water in Newark in 2017. Since then, the city has been chemically treating the water to help re-coat services lines, passed out bottled water, and distribute filters. All of these initiatives address the immediate issue of providing clean drinking water to our residents.

However, in the many discussions in which I have participated, the only permanent solution is to replace lead service lines with copper pipes. Although Essex County does not maintain a municipal water system, I recognized that this is a public health concern and drastic measures needed to be taken. Newark has started a program to replace the 18,000 service lines, but it would have taken Newark at least a decade to complete the task, given the fiscal restraints of the city. This includes digging up the old lines and replacing the lead piping with copper piping.

In order to speed up the process, I realized that Newark needed a quick infusion of cash, which would allow the city to hire more contractors and get the work done more quickly, reducing the amount of time to 24 to 30 months. Because of our AAA bond rating we received in 2017, Essex County and our Improvement Authority were in a good position to help. With the AAA rating, the highest rating available which indicates financial strength, we were able to bond $120 million and loan that to Newark at a low interest rate. Newark is then repaying the bond over a 30-year period and is not charging the property owners to have the pipe replacement done.

We have extended the same program to Bloomfield, Nutley, and Belleville, which purchase water from the city of Newark. As of today, we know our municipal partners in those three communities are still doing their due diligence to determine if this program is feasible for them.

But let's be honest. Replacing lead service lines can be and probably will affect all of our communities throughout our county, State, and country—sooner or later. Homes built before 1950 probably were constructed with lead service lines. How long will the chemical treatment be effective in coating the interior service lines so the lead doesn't leach into the supply? Again, the only real solution is to replace lead service lines, which can be expensive for any property owner.

Are there more modern, advanced alternatives that may be more affordable and less disruptive? Currently, property owners are inconvenienced when the roads in front of their property and front yard are dug up. No matter how the pipes are replaced, cost will always be the biggest concern. In Essex County, we stepped up to the plate and backed the investment with a $120 million loan. Senator Cory Booker sponsored legislation that makes $100 million available to Newark and other municipalities to replace lead service lines.

So while this Committee investigates ways to streamline the lead service lines replacement, we also ask that you consider how much it will cost our municipalities and property owners. Thank you, Congresswoman Sherrill.

[The prepared statement of Mr. DiVincenzo follows:]

House Committee on Science, Space and Technology
Subcommittee on Investigations and Oversight
Testimony by Essex County Executive Joseph N. DiVincenzo, Jr.
Tuesday, October 15, 2019

Congresswoman Sherrill, thank you for holding this subcommittee meeting in Bloomfield, Essex County. The presence of lead in our drinking water causes us all great concern and creates a public health emergency.

The public was first alerted to high levels of lead in the drinking water in Newark in 2017. Since then, the city has been chemically treating the water to help re-coat services lines, passed out bottled water and distributed filters. All of these initiatives address the immediate issue of providing clean drinking water to our residents. However, in the many discussions in which I have participated, the only permanent solution is to replace lead service lines with copper pipes.

Although Essex County does not maintain a municipal water system, I recognized that this is a public health concern and drastic measures needed to be taken. Newark had started a program to replace the 18,000 service lines, but it would have taken Newark at least a decade to complete the task given the fiscal restraints of the City. This includes digging up the old lines and replacing the lead piping with copper piping.

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But let's be honest. Replacing lead service lines can and probably will affect all of our communities throughout the County, State and County sooner or later. Homes built before the 1950s probably were constructed with lead service lines. How long will chemical treatments be effective in coating the interior of service lines so the lead doesn't leach into the supply?

Again, the only real solution is to replace lead service lines, which can be expensive for any property owner. Are there more modern, advanced alternatives that may be more affordable and less disruptive? Currently, property owners are inconvenienced when the road in front of their property and front yard are dug up.

No matter how the pipes are replaced, cost will always be the biggest concern. In Essex County, we stepped up to the plate and backed the investment with a $120 million loan. Senator Cory Booker sponsored legislation that makes $100 million available to Newark and other municipalities replace lead service lines.

So while this subcommittee investigates ways to streamline the lead service line replacement, we also ask that you consider how much it will cost our municipalities and property owners.

Joseph N. DiVincenzo, Jr., *Essex County Executive*

Joseph N. DiVincenzo, Jr., has changed the face of Essex County both fiscally and physically in the past 16 years.

Running Essex in the most efficient manner, he has turned the County into a model for good government. He raised the bond ratings from junk level to Aaa, eliminated unnecessary contracts, cut expenses, reduced the workforce size and increased revenue. The Hospital Center, Correctional Facility and Juvenile Detention Facility have been widely recognized, allowing us to create recurring revenue streams through shared services agreements with Federal, State and other county governments.

DiVincenzo developed the Essex County South Mountain Recreational Complex by building the Treetop Adventure Course, McLoone's Boathouse Restaurant, miniGOLF Safari, Park-N-Ride, Regatta Playground, Clipper Pavilion and paddle boats on the Reservoir, modernizing the Codey Ice Arena and vastly improving Turtle Back Zoo. It has become a premiere family destination, welcoming visitors from throughout the tri-state area.

DiVincenzo guided the restoration of the Historic Courthouse, and completely overhauled the Government Complex, including the creation of Veterans Memorial Park, the construction of a 1,000-car parking garage and the installation of landscaped plazas and statues of people important in Essex County history. Totally new jury quarters plus the LeRoy Smith Public Safety Building, converted from an old jail into a revenue-producing office building, complete the government complex. A Correctional Facility in Newark, a new psychiatric Hospital Center in Cedar Grove and a state-of-the-art Public Works Garage in Cedar Grove also have been completed.

The Essex County Parks System has been improved for the public's benefit. Rubberized playground surfaces, upgraded basketball and tennis courts, and synthetic grass surfaces and rubberized running tracks were installed. Six new parks were added to the historic Parks System, and more than 5,000 new cherry blossom trees were planted to replenish the glorious orchards in Essex County Branch Brook Park.

According to Joe D, (as everyone calls him) he and the 3,500 County employees are part of a team and working together they continue *Putting Essex County First.*

Chairwoman SHERRILL. Thank you, County Executive DiVincenzo.

Next, I'd like to recognize Mayor Joseph Scarpelli of Nutley, New Jersey, for 5 minutes.

TESTIMONY OF HON. JOSEPH P. SCARPELLI, MAYOR OF NUTLEY, NEW JERSEY

Mr. SCARPELLI. Good morning. Chairwoman Sherrill and Members of the Committee, thank you for the opportunity to speak with you today about lead in drinking water. I hope I can enlighten you on some of the issues our small town of Nutley, New Jersey and the surrounding municipalities have been experiencing.

Although the issue of lead in drinking water received its most recent publicity in Newark, lead pipes exist throughout the country and will continue to plague us until all those lines are replaced. As a Mayor of a small town, and as a result of this recent issue, my knowledge about lead pipes, water treatment, and water testing has grown to a level I did not expect.

Despite the known dangers of lead pipes, they continued to be installed for years as it was less expensive, more durable than other options, and could be easily bent, allowing pipes to be shaped to conform to the contours of existing buildings or other structures. Lead enters drinking water when plumbing materials that contain lead corrode. The most common sources of lead in drinking water are from lead pipes, faucets, and fixtures.

It's important to understand the way the water enters the home. The water is collected in reservoirs, travels through transmission lines to the various utilities. Through an interconnection, the water enters a municipality's water mains. Attached to the water mains are service lines, which deliver the water to each property. The service line has two sections, one from the main and one to the curb shut-off and another from the shut-off to the house. And then the water passes into the internal plumbing of the home.

Homes with lead service lines are the most significant source of lead in the water. If lead concentrations exceed 15 parts per billion in more than 10 percent of water sampled, the local water system must undertake actions to control corrosion. Corrosion is a dissolving or erosion of metal caused by a chemical reaction between the water and the plumbing.

Many factors affect the amount of lead that's entering the water, including the pH of the water, the water temperature, the age of the pipes, how long the water sits in the pipes, and the presence of protective coatings inside the plumbing material.

The Newark crisis came to light in 2017 when the city reported elevated lead levels. Newark Water had been using sodium silicate for corrosion control. How sodium silicate works is really unknown, but it definitely raises the pH, making the water less corrosive. Somewhere along the way the pH of water coming out of the Newark Water System became neutral to acidic, which allowed the lead to leach into the water. In May 2019, Newark Water switched to zinc orthophosphate for corrosion control. Orthophosphate is the more effective corrosion control additive but takes months to be completely effective.

The Township of Nutley has two water suppliers. There are 436 homes that are supplied by Newark Water, accounting for less than 5 percent of our total homes and businesses. The rest of our township receives water through another supplier. When the media and newspaper accounts reported that the water filters distributed to Newark residents had failed, there was a public outcry, and EPA and NJ DEP took action.

We in Nutley have participated in many meetings and calls with the NJ DEP, the Governor's office, County Executive DiVincenzo, Mayor Venezia, and other elected officials for updates on Newark Water and the effect on our community. After consultation with our professionals, Nutley has taken proactive measures to address the situation. We encourage all residents to run their water for 1 to 2 minutes each morning. We have begun replacing all known lead service lines. Unfortunately, recordkeeping over the years has been inconsistent. Therefore, we must undertake the labor-intensive work of investigating what type of service lines exist beneath the ground. This process involves hand digging to see if lead exists on either side of the curb shutoff. If lead lines are found, they must be removed or abandoned and replaced with new copper line. The cost of this process across our entire town will be exorbitant.

We have also initiated a study to determine the steps needed to switch to a different water supplier, providing free testing of tap water and free lead testing of children. Thankfully, all our testing has been negative.

Although lead has been our primary concern, our township is also dealing with elevated levels of haloacetic acid from the same Newark water source. Haloacetic acids are formed when disinfectants such as chlorine react with organic and inorganic matter in our source water. In July 2019, Newark changed their disinfection process. Hopefully, these changes decrease the disinfection byproducts. In the meantime, we had to notify our residents that drinking the water over many years may increase the risk of cancer.

In conclusion, let me offer some ideas that this Committee can look into: technology that offers the ability to detect water lines underground without having to excavate; the development of new anticorrosive water treatments and technologies that offer superior protection from not only lead but also prevent copper from leaching into our water supply; innovative, cost-effective physical, chemical, or biological water treatments that eliminate bacteria, control disinfection byproducts, and eliminate any unpleasant color, odor, and taste. Our collective goal is to continue to offer all our residents clean, safe drinking water. Thank you for your time and attention.

[The prepared statement of Mr. Scarpelli follows:]

Nutley Mayor Joseph P. Scarpelli Statement to the House Committee on Science, Space, & Technology

Congresswoman/Chairwoman Sherrill, Congressman/Ranking Member Norman, and members of the Committee. Thank you for the opportunity to speak with you today about lead in drinking water. I hope I can enlighten you on some of the issues our small town of Nutley, NJ, and the surrounding municipalities, have been experiencing over the last few months.

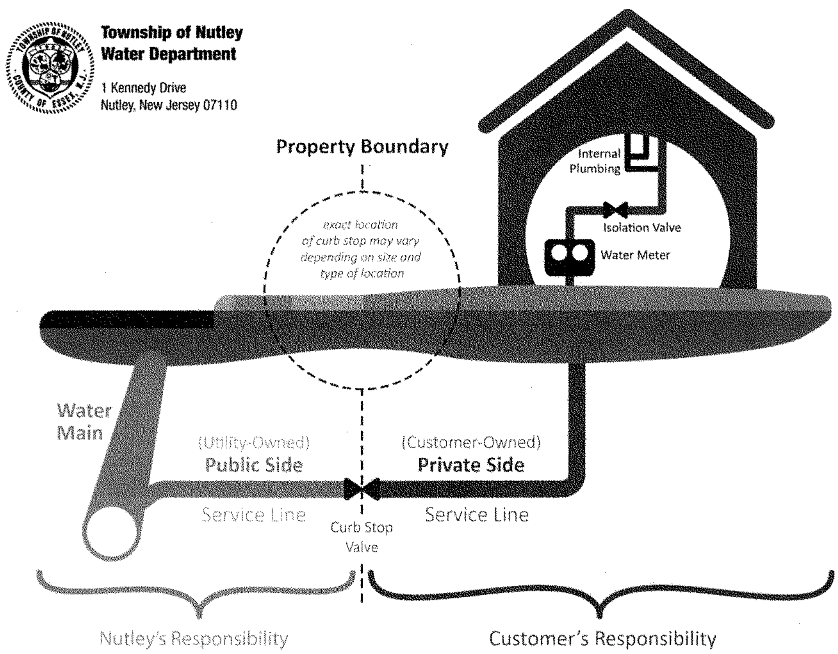
Although the issue of lead in drinking water received its most recent publicity in Flint, MI, and now in Newark, NJ, lead pipes throughout the country, especially in older towns and neighborhoods, is an issue that will continue to plague us until all those lines are replaced.

As a mayor of a small town, and as a result of this recent issue, my knowledge about lead pipes, water treatment, and water testing has grown to a level that I did not expect.

Despite the many years of literature on the dangers of lead water pipes and a national trend to restrict and prohibit the use of lead for water distribution, the lead industry continued to promote and sell lead pipes for many years. Lead material was less expensive and more durable than the other options available. Lead pipes could also be easily bent, allowing pipes to be shaped to conform to the contours of existing buildings or other structures.

Lead can enter drinking water when plumbing materials that contain lead corrode, especially where the water has high acidity or low mineral content. The most common sources of lead in drinking water are from lead pipes, faucets, and fixtures.

It is important to understand the way water enters the home. The water is collected in reservoirs or other surface water. It travels from the source water supply to treatment facilities. At these facilities, water is treated and sent via transmission lines to the various water utilities. It is important to note that at a municipal level, the water utility does not treat the incoming water. There is an interconnection which is metered and allows water into the individual municipality's water mains. Attached to the water mains are service lines which deliver the water to each property. That service line is divided into two sections. One from the main to the curb shut-off and one from the shut-off to the house. The water then passes through the home's water meter and into the internal plumbing of the home.



Homes with lead service lines are typically the most significant source of lead in the water. Lead pipes are more likely to be found in older cities and older homes. The homes without lead service lines can also be problematic; as lead can leach from brass or chrome-plated brass faucets and plumbing with lead solder.

The EPA requires monitoring of the drinking water at the customer's tap. Although zero lead in our potable water is the goal, if lead concentrations exceed an action level of 15 parts per billion (ppb) in more than 10% of customer taps sampled, the local water system must undertake a number of additional actions to control corrosion.

Corrosion is a dissolving or erosion of metal caused by a chemical reaction between water and the plumbing. A number of factors are involved in the extent to which lead enters the water, including:

- The chemistry or pH (acidity and alkalinity) of the water and the types and amounts of minerals in the water,
- The amount of lead that comes into contact with the water,

- The water temperature,
- The age of the pipes,
- How long the water sits in the pipes, and
- The presence of protective coatings inside the plumbing materials.

The Newark Crisis came to light in 2017 when the city reported that lead levels exceeded 15ppb. In October 2018, Newark started distributing filters to those homes that exceeded these lead levels. The Pequannock treatment plant, which is part of the Newark Water System, had been using sodium silicate as a corrosion inhibitor. The exact mechanism of how sodium silicate works is really unknown, but experts theorize that there is a thin gel-like layer that coats the inside of the pipes. In addition, the sodium silicate raises the pH making the water less corrosive. Somewhere along the way, the pH of the water coming out of the Newark Water system became neutral to acidic, which allowed the lead to leach into the water.

In May 2019, Newark Water switched to zinc orthophosphate for corrosion control. Orthophosphate forms a mineral crust on the inside of the pipes preventing oxidation of the pipes. Although orthophosphate is the more effective corrosion control additive, the downside is that this method takes months to create the protective coating.

The Township of Nutley has two water suppliers. There are 436 homes that are supplied by Newark Water. That accounts for less than 5% of the total homes and businesses. The rest of our Township receives water through another supplier.

The most recent media and newspaper accounts reported that the water filters, distributed by the City of Newark to residents, had failed to remove the lead out of their drinking water. This prompted not only a public outcry, but also provoked the EPA and NJ DEP to take action. (It should be noted that subsequent extensive testing revealed that 97% of these filters removed lead to below acceptable levels).

We, in Nutley, have participated in various meetings and conference calls with the NJ DEP, the NJ Governor's office, state legislative leaders, the Essex County Executive, and other local officials for updates on Newark Water and the effect on our community.

After careful consultation with our professionals, Nutley has taken proactive measures to address the situation thrust upon us merely be being a customer of Newark Water.

We encourage all residents, as a matter of habit, to run their water for 1-2 minutes at the start of each morning. This daily practice will introduce fresh water into their homes.

The Township of Nutley has already begun the replacement of all known lead service lines as part of our long term infrastructure upgrades. Of the eight "known" lead service lines in the Newark area, three were lead and five had been changed over to copper and never documented.

Unfortunately, like many small townships with limited resources and manpower, our record keeping over the years has been inconsistent. Therefore, we must undertake the labor intensive work of investigating what type of service lines exist beneath the ground. This process involves the digging, mostly by hand, between the curb and sidewalk, to expose the pipes on both sides of the curb shut-off. Once the lead lines are identified, the lead line must be removed or abandoned and replaced with new copper lines. Our first goal is to change-out the service lines in our system that are supplied by Newark Water. The overall goal is to change-out all lead service lines in the Township of Nutley. The cost of this process across our entire town is exorbitant and will require capital improvement bonding.

The Township of Nutley has initiated a study to determine the steps needed to have the 436 homes receiving Newark Water switched to a different water supplier. We have provided free testing of the tap water in those homes. In addition, we offered free lead testing of children for all our families.

Thankfully, all our testing has been negative.

Although lead has been our primary concern, our Township is also dealing with elevated levels of haloacetic acid from the same Newark source water. Haloacetic acid is a byproduct of the disinfection process. Haloacetic acids are formed when disinfectants, such as chlorine, are used to treat water and react with naturally occurring organic and inorganic matter present in source waters.

In July 2019, Newark began addressing the disinfection byproduct levels by introducing potassium permanganate and moving their pre-chlorination location. These changes should lower the haloacetic acid to below the allowable limit.

In the meantime, we had to notify our residents that drinking this water in excess of the allowable 60 micrograms/liter:

- May over many years increase the risk of cancer, and

- If you have a severely compromised immune system, have an infant, are pregnant, or are elderly, you may be at increased risk and should seek advice from your health care providers about drinking this water.

In conclusion, let me offer some ideas that this committee can look into, and hopefully, these suggestions will come to fruition in the future.

- Technology that offers the ability to detect lead water lines underground without having to excavate. This would result in the savings of both money and manpower, not only at a local level, but when extrapolated nationwide would result in 100s of millions of dollars in cost savings.
- The development of new anticorrosive water treatments and technologies that offer superior protection from not only lead, but also prevent copper leaching into our drinking water.
- Innovative, cost-effective physical, chemical, and biological water treatments that eliminate bacteria, along with controlling disinfection byproducts, while at the same time results in the elimination of any unpleasant color, odor, and taste.

Our collective goal is to continue to offer all our citizens clean, safe drinking water.

Thank you for your time and attention.

Mayor Dr. Joseph P. Scarpelli

Dr. Joseph P. Scarpelli is currently serving his third term on the Township of Nutley Board of Commissioners and first term as Mayor. Elected in May 2008, he is the Director of Public Works.

Dr. Joseph P. Scarpelli was born and raised in Nutley, NJ. He attended the Nutley Public Schools and graduated from Nutley High School where he was a three sport varsity letter man and vice president of his class. He was also named Who's Who Among American High School Students in 1976.

As a pre-med major he attended Upsala College where he was a member of the nationally ranked Division III varsity football team. He was also president of the Theta Epsilon Omicron Iota fraternity.

In 1980, he entered New York Chiropractic College graduating with honors in 1983. Dr. Scarpelli served his internship at the prestigious Levittown Outpatient Facility in Levittown, New York. Upon graduation, Dr. Scarpelli returned to his hometown to open his practice and has cared for his patients in the same location for the last 27 years. Dr. Scarpelli is licensed by the New Jersey Board of Chiropractic Examiners. He is also licensed to practice in the state of New York.

Dr. Scarpelli and his family have a history of public service. His grandfather, Peter Scarpelli, Sr., was a respected community activist and his father, Peter C. Scarpelli, a former Mayor of Nutley, had over 24 years of service on the Nutley Board of Commissioners. Continuing in this tradition, Dr. Scarpelli has served on the Essex County College Board of Trustees, the Nutley Board of Education, and the Essex County Board of Freeholders.

Dr. Scarpelli has a well deserved reputation as a proven tax cutter. During his service on the Board of Freeholders, he promoted a policy of reining in spending, eliminating duplicity of services, and minimizing tax increases. In his three years as a county representative, he voted in favor of balanced budgets that did not raise the tax levy on Essex County residents. He supported the creation of the Essex County Open Space Trust Fund, which established a mechanism for preserving and acquiring open space. He also supported the preserving of over 300 acres of landscape, known as the Hilltop, which kept this property out of the hands of developers, converting this prime real estate into a passive park for future generations to enjoy. In an effort to make county government more accessible, he opened a satellite suburban office to better serve his constituents. "County Government Day", was one of his innovations to introduce high school students to the inner workings of Essex County government.

In addition to his governmental experience, Dr. Scarpelli has devoted his entire adult life to youth and civic activities. His past volunteer service includes the Nutley American Little League, the Nutley Senior Baseball League, Nutley Midget Football League, the Nutley Chamber of Commerce, the Nutley Columbus Parade Committee, and League of Women Voters. He has served on the Board of Directors of the Nutley Family Service Bureau, Scarpelli Civic Association and the Montclair/Glen Ridge/Nutley chapter of the American Red Cross. He is a past president of the Nutley chapter of Unico National and remains an active member. Additionally, he has served on the Marconi Centennial Committee and the Nutley Columbus Quinncentennial Committee. Dr. Scarpelli coordinated the citizen committees for both the Franklin School Improvement Project and Elementary School Improvement Plan. He currently serves as Executive Secretary to the Essex County Mental Health Advisory Board and is recognized as one of the leading advocates for the mentally ill in Essex County.

Some of the honors Dr. Scarpelli has received is his inclusion in the 1985 Outstanding Young Men of America and being named Who's Who of Among American's of Italian Descent by the Italian Tribune News in 1995. He was Nutley Unico's 1996 Man of the Year and was honored by the Nutley Jaycees with their Distinguished Service Award in 1999.

Dr. Scarpelli is married to the former Suzanne Kent and have three grown children: Salvatore, Arielle, and Gianna.

Chairwoman SHERRILL. Thank you, Mayor Scarpelli.

And our final witness for the panel is Mayor Michael Venezia of Bloomfield, New Jersey. And, Mayor, thank you so much for hosting us here in Bloomfield today as well.

TESTIMONY OF HON. MICHAEL J. VENEZIA, MAYOR OF BLOOMFIELD, NEW JERSEY

Mr. VENEZIA. Good morning, Chairwoman. I would like to welcome you and your colleagues from the House of Representatives to Bloomfield, my colleague from Nutley, and our County Executive and other distinguished guests here this morning. I would like to also thank the witnesses and look forward to hearing your testimonies.

My name is Michael Venezia. I am the Mayor of Bloomfield. As everyone in this room knows, over the past couple of years, the city of Newark, Townships of Bloomfield, Belleville, and Nutley have experienced high concentrations of lead in the water to varying degrees. Moreover, this issue is not limited to this part of New Jersey but in fact a growing problem throughout the State and in the United States.

Chairwoman Sherrill has given me the opportunity to address what the Township of Bloomfield has done to remediate this critical issue. We appreciate this opportunity.

To begin, my town gets its water from a shared system with the city of Newark. We are termed the Consecutive Water System. We purchase all our water from the Newark Water System. We do not have facilities to treat or manage the quality of water we receive from Newark's system. However, since 2017, we have been testing the quality of water as it comes into the township.

In the fall of 2017, the township learned it had a lead exceedance beyond which was acceptable under Federal EPA regulations. While the exceedance level was barely over the Federal limit, it still existed and prompted the township to take action to resolve the matter as best as possible.

In November 2017, we held a public hearing to inform our residents of the issue and how to protect themselves from the potential of lead contamination. At that time, we embarked on a program to discover those locations in town where lead existed in the pipes. What was clear at that time and remains to this day is we did not find lead exceedance levels in the township's water mains. We learned that the nature of the water we receive from the city of Newark had components that produced a corrosive reaction in lead water lines.

Bloomfield Water Department distributed educational material on lead to each one of our water customers. The notice also described the potential serious health effects associated with lead, as well as sources of lead in drinking water.

Bloomfield took steps that each resident can take to reduce their exposure to lead in drinking water. Bloomfield informed their customers via education materials that homes with known lead service lines should use extra precaution when flushing their water lines. We instructed these customers with known lead lines or high lead test results to flush their water for up to 5 minutes by running cold water from the tap if water had gone unused for more than 6 hours. Users without known lead lines were advised to flush their systems for 60 seconds before use. Their homes could still contain internal pipes or fixtures with lead-containing materials.

Further, we started working with the city of Newark to address the issues of water quality. In August 2018, our second round of testing indicated we still had homes in the township whose water exceeded acceptable lead levels. We again held a public hearing to advise our residents, along with sending the mandatory written notification to every household and business within the township.

Additionally, we started providing free PUR water filters in an effort to assist our residents who believed that lead was in their water. Thus far, Bloomfield has distributed nearly 3,000 PUR filters to residents, and we continue to this day.

We also started an in-house township program of replacing lead service lines that we discovered in areas where formal testing showed lead exceedance of over 15 parts per billion. At the same time, we applied for a low-interest loan from the New Jersey Infrastructure Bank in the amount of $1.1 million to fund more repairs where we found lead service lines. To date, I am happy to report that we have repaired over 60 lead service lines using mostly township staff. We have also retained a contractor to replace an additional 60 lines over the next 2 months.

Since November 2017, we have provided self-testing kits to any resident who wanted their water tested. Since that time, we have submitted over 600 tests, most of them coming back with no indication of lead. Any test that comes back in exceedance of 15 parts per billion for lead, we have or will investigate and schedule a replacement of the discovered lead lines. It is important to note that the only way to be sure there are lead lines is to dig the service connection to the property and physically examine the line itself. Clearly, this cannot be done easily or quickly, plus, it requires staff or contractors to perform.

In August while Bloomfield was making these repairs and providing information to our residents, there was a test of PUR water filters used by Newark residents that indicated the filters were not working. Frankly, this created a panic.

On August 19, 2019, we held our third public hearing on this matter. In the previous two public hearings, although advertised the same way, we had no more than 20 people attend those hearings. This hearing had over 150 people in attendance, all very upset and concerned about their water quality. Clearly, the panic generated by the EPA's demand to distribute bottled water in Newark brought greater attention and a lot of confusion to Bloomfield residents.

Bloomfield has taken many steps to improve our water quality. Over the past 4 years, we have invested over $10 million in improvements to our system. We have eliminated dead-end lines, started a systematic water flushing and valve exercising program. We are in the second phase of our major water relining program, an investment of over $1 million.

Furthermore, we are in the final design phase of two major improvements to our system: First, we are investing nearly $2.5 million to change water our supply from Newark's water treatment plant at the Pequannock Reservoir to North Jersey Water District's system at the Wanaque Reservoir. We believe this will help our water quality and provide a redundancy of supply.

Second, we have started a $6 million water meter replacement program. The timing of this is significant. During installation of the meters, the contractor will inspect the exposed water lines for any lead, including lead solder. As mentioned before, locating lead in homes is very difficult, and many residents do not know if they have lead lines. This will help us and our residents know if that type of piping is present.

For Bloomfield, and I imagine all municipalities who are facing this problem, the need for assistance is extensive. To be sure, financial assistance is a critical matter. We have spent over $500,000 in the last 2 years on additional testing fees, line replacement, distribution of filters, and every form of public information possible—none of which was planned or anticipated. When I think of the money that our residents will have to pay, let alone the anxiety of not knowing, I believe there needs to be some form of assistance from our Federal Government. We will literally spend millions in Bloomfield alone. We need help. Further, the time that it takes to make these repairs or even investigate lines is too long. We need both the Federal and State governments to assist us with the procurement of additional help from qualified contractors.

As I mentioned before, we have secured $1.1 million to replace our lead lines, but that process took months to secure the funding. Our people want repairs now, not to be told that they have to wait 8 to 12 months. We need help.

As I said before, Bloomfield is a consecutive water system. We purchase all of our water fully treated from Newark. While we continue to work with our neighbors to resolve this matter, we hope that the Federal and State governments will continue to aggressively assist the city of Newark in fully complying with EPA Clean Water regulations.

We need your assistance now. We are talking about millions—actually I would estimate billions—of dollars in order to protect our residents. In the meantime, Bloomfield has, and will continue to do, everything we can, within our water limits as a consecutive system customer to protect and advise our customers.

Chairman Sherrill, I want to just thank you for your time and opportunity to be here this morning.

[The prepared statement of Mr. Venezia follows:]

Committee on Science, Space, & Technology

Subcommittee on Investigations & Oversight

Addressing the Lead Crisis through Innovation & Technology

TESTIMONY OF MAYOR MICHAEL J. VENEZIA, BLOOMFIELD

Good Morning Chairwoman. I would like to welcome you, my colleagues from Nutley and Belleville and other distinguished guests here this morning. I would also like to thank all the witnesses and look forward to hearing your testimonies. My name is Michael Venezia and I am the Mayor of the Township of Bloomfield. As everyone in this room knows, over the past couple of years, The City of Newark, Townships of Bloomfield, Belleville and Nutley have experienced high concentrations of lead in the water to varying degrees. Moreover, this issue is not limited to this part of New Jersey but, in fact, is a growing problem throughout our State and the United States. Chairwoman Sherrill has given me the opportunity to address what the Township of Bloomfield has done to remediate this critical issue. We appreciate this opportunity.

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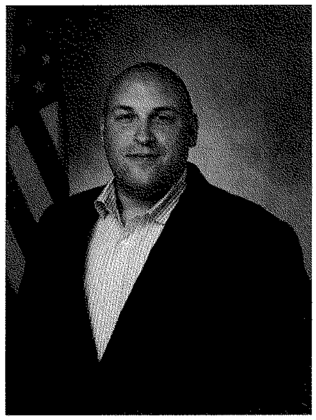
In the meantime, Bloomfield has, and will continue to do, everything we can, within our limits as a consecutive system customer, to protect and advise our customers.

Chairwoman Sherrill, thank you for this time and opportunity.

Michael J. Venezia,
Mayor
Bloomfield Township
October 15, 2019



Michael J. Venezia

Mayor

Bloomfield, NJ

Michael Venezia is a third- generation Bloomfield Resident who was first elected into office as Councilman at Large in 2011 before running for Mayor in 2013. After winning the election, Mayor Venezia became the youngest mayor in Bloomfield to be elected into office at the age of 31. Now on his second term in office, Mayor Venezia has proven that his progressive leadership can open many new doors for Bloomfield. Aside from being mayor, he is also the current Director or Human Resources for Essex County Schools of Technology.

Over the past 5 years, Mayor Venezia has worked to stabilize property taxes, attract new developments that create jobs for the public while providing our police and fire departments with the necessary equipment and top of the line training to keep our neighborhoods safe. One of the Mayor's biggest accomplishments was the purchase of 13 acres of land that was originally set for 110 townhomes but instead is being constructed to restore wetlands and be a recreational site for all to enjoy. Bloomfield has also become a popular destination for developers interested in the flourishing downtown district.

Furthermore, Bloomfield has seen a significant reduction in crime over the past couple years thanks to the leadership of the Public Safety Director Sam DeMaio, hired under Mayor Venezia. The Bloomfield Police Department is now an accredited agency by the New Jersey Chiefs of Police Association. The Fire Department has also excelled and was awarded a class 2 distinction by the Insurance Service Organization putting them in the top 5% of all municipal fire departments.

Prior to Bloomfield, Mayor Venezia was the Assistant County Administrator under the direction of the County Executive of Essex County. He also served as a senior advisor for the late Senator Lautenberg and served as a field representative for U.S Representative Bill Pascrell. Mayor Venezia's extensive accomplishments were recently recognized at the 2018 NJMMA Awards Luncheon where he was honored with the Elected Officials Award. He currently also sits on the Executive Board Committee for the New Jersey League of Municipalities and is a member of the U.S Conference of Mayors. Mayor Venezia continues to reside in Bloomfield with his beautiful wife Laura and their two daughters Ella and Sophia.

Chairwoman SHERRILL. Thank you so much to our first panel. We'll now start—I'm going to recognize myself for 5 minutes of questions for the panel, and we'll start with Mr. DiVincenzo.

So Essex County is supporting the Newark region with bonding authority so that property owners won't be charged for pipe replacement, which is a critical component to managing this problem. I want to clarify. So, County Executive DiVincenzo, this will enable homeowners to have both the public and private side of their lead pipes replaced at no cost to them. Is that correct?

Mr. DIVINCENZO. It's only going on in Newark now. It's not happening in Bloomfield, Belleville, and Nutley because they're still doing their due diligence there to decide what they're—it's not working? Now you can hear. This right now is just for Newark only because they're the only ones who agreed to take on the $120 million loan as far as borrowing it. It does not affect Belleville, Nutley, or Bloomfield. And Newark is—all the work that's being done is at no cost to the property owners.

Chairwoman SHERRILL. Who will be responsible for doing the replacements, the water utilities?

Mr. DIVINCENZO. Newark will be responsible for doing that, and then they have contractors who they have hired to do that work.

Chairwoman SHERRILL. Oh, great. And then, how can homeowners who wish to take advantage of this opportunity get the ball rolling?

Mr. DIVINCENZO. You know, what they have to do is just contact the city of Newark and Newark Water Sewage Commission, and contact them and let them know that they're interested.

Chairwoman SHERRILL. And I just want to get—this is just for the record so we can get this on the record, but we've heard testimony from Mayor Venezia about how expensive the cost of lead remediation is. And I assume Essex County has competing needs for the bond authority that you've extended. Is that correct?

Mr. DIVINCENZO. Yes, we do, but to us this was a priority. It's a public health issue, so I decided to—you know, there's no way I could make our residents wait for a whole decade for this to be completed, so I wanted to shore up the timetable. So I met with Mayor Ras Baraka and his team, we met with the Port Authority from our team, and we came together and we came up with a solution how we can get this thing done within 24 to 30 months.

And I can tell you right now it's going very well. The replacement, I think they got approximately about 1,400 done, maybe more at this particular time. I've seen it in process. It's going well. It's going well.

Chairwoman SHERRILL. But if we could find a less-expensive way, less-expensive technology to mitigate lead issues, would that be helpful?

Mr. DIVINCENZO. Absolutely, anything that's going to save money and get it done quicker, we're all for it.

Chairwoman SHERRILL. Certainly. Thank you very much. And, Mayor Scarpelli, as part of your duties, you oversee the Nutley Water Department. Can you talk to the Committee and walk through the process and what it's like for homeowners when they get a lead service line replacement?

Mr. SCARPELLI. Sure. Well, one, you have to—like I explained before, there's two sections of the service line, one from the main to the shut off, which is—normally, that's—the city owns or the utility owns, and then one from the shut off to the home, which, under normal circumstances, would be the homeowner's responsibility. So you either have to dig up that lead line on both sides of the shut off and replace it with copper or you leave it abandoned, and then it has to be hooked up by a plumber into the water meter on the inside of the home.

Policy decisions going forward by all the municipalities would be what do we do on that private side? What do we do on the homeowner's side? Newark has taken the initiative to—they're going to replace that at the cost on the utility. As we evaluate what it's going to cost, we'll make that decision later on.

Mr. DIVINCENZO. Congresswoman, Newark has decided to go from the main all the way to the private, to the water meter itself.

Chairwoman SHERRILL. Great. And then, Mayor Venezia, in your testimony you described the episode in August where tests showed that the PUR water filters distributed to residents of Bloomfield, Belleville, and Newark were not working. So I understand why this led to a sense of panic. Can you explain what the conclusion eventually was about those filters, and can we tell the people today that you can usually trust filters that are certified to remove lead?

Mr. VENEZIA. So when we got the news, it was three filters from the city of Newark that still had high exceedances lead from the EPA, so in Bloomfield we decided to test five homeowners that we knew had lead lines of high exceedance that also had PUR filters. And all five of those came back below the 15 parts per billion that the EPA recommends. And in the city of Newark they went—they did extensive testing. I believe there was over 300 PUR filters, and I think the number was 98 percent came back that were under 15 parts per billion.

Chairwoman SHERRILL. Great. Well, thank you so much to our first panel. Before we proceed, I'd like to bring the Committee's attention to two statements. The first is from NACE International, a professional organization that equips communities with tools to address the adverse effects of corrosion. The second is from BlueConduit, a water infrastructure company that uses data analytics and machine learning to predict which homes have lead service lines. These documents highlight just two of the innovative groups my staff and I spoke to in preparation for this important field hearing, so thank you for your hard work in addressing an issue that is impacting communities across our country.

Without objection, I'll enter these documents into the record.

At this point, we will begin our first round of questions, and the Chair recognizes—oh, I already did my questions, and so, next, I would like to recognize Congressman Beyer for 5 minutes.

Mr. BEYER. Thank you very much, Madam Chair. And then thank you for the invitation to come to New Jersey. It's a pleasure to be here and actually be not just on the turnpike but actually in the communities. And thank you very much to our panel of witnesses. I thought that local elected politics was the most difficult forum because you're so close to the people and you know exactly what's going on.

Mayor Scarpelli, in your testimony you talked about the technology that offers the ability to detect lead water lines underground without having to excavate and hundreds of millions of dollars in savings. I just wanted to follow up on comments that Chairwoman Sherrill just made about machine learning statistical models like BlueConduit and 120WaterAudit, precisional hydro vacuuming, and remote sensing techniques and recommend all of them to you and to your associates as the ways that technology is moving forward to avoid having to dig up to find out where the lead line is or not. On one of the testimonies we read today was that something like two-thirds of the ones you're digging up aren't lead, but you don't know that until you've actually dug it up.

County Executive DiVincenzo, you wrote that the only permanent solution is to replace lead service lines with copper lines. I know you have a huge county, first-or second-largest in New Jersey—at filters, epoxy lining, threading, the slip lining, some of the other methods of doing it?

Mr. DIVINCENZO. Yes. Congressman, you know, we're open to anything. I have not heard of that right now. The only thing I got for my people is replacing the lead line that would be the most effective at this time, but I'm willing to learn. I know my people are willing to learn to see if it could be done. If it could be done quicker and save money, we're all for it.

Mr. BEYER. The only reason I know to ask you this question is the excellent research that Mikie Sherrill's staff has already done on this, so we will pass that research onto you——

Mr. DIVINCENZO. OK.

Mr. BEYER [continuing]. Because it sounds like there are at least alternatives evolving for this.

And then finally for Mayor Venezia, one of the startling things was that in a lead testing earlier this year in Newark's water supply from January 1st to June 30th, they found that the level got to 52 parts per billion, which is 3.5 times higher than what the EPA says is healthy. So you've had all these self-testing kits, but then there was also a note that EPA discovered—let me see if I can find the note—that a June 20, 2019, EPA study, just 4 months ago, said that the current lead and copper rule sometimes missed peak lead concentrations so that the question again back to Mikie Sherrill's wonderful research is, do you have access yet to the many different ideas that are coming forward on how you test for lead, everything from platinum electrode sensors to carbon nanotube testing?

This is with a fear that those self-testing kits are not going to prove to be fairly accurate.

Mr. VENEZIA. Well, so right now what we're doing—so we don't have an accurate count of lead service lines in Bloomfield right now. There were some fixed in the 1970s and 1980s, and, as you know in government, records aren't exactly always kept the best. It's actually fortunate timing for us because we are going around and fixing each house's water meter reader. And as the contractor that's doing that is going to look for us to see if there's a lead service line, and then we'll go out and fix it for the homeowner. So we don't have an accurate count—so I know like some towns are using every house built before 1950 where that's kind of not an accurate count because you don't know if the homeowner did something on their own.

But yes, I saw Congresswoman Sherrill's new document and the new way of testing, and that's something we could look into in the future.

Mr. BEYER. OK. Great, great. I don't want to suck up to the Chairwoman of our Committee, but I want to say it's wonderful that she's gathered all this data to use in New Jersey and throughout the country, and, Madam Chair, I yield back.

Chairwoman SHERRILL. That's kind, but I have to give most of that credit to my staff for doing that, but thank you very much.

Next, I would like to recognize Congresswoman Wexton, the former Tosini, Ms. Tosini, for 5 minutes.

Ms. WEXTON. Thank you, Madam Chair, and thank you to the Early Childhood Center at Forest Glen for hosting us. I know that we can be kind of disruptive when we come to town, so I very much appreciate your allowing us to use this fine venue. And thank you to the panelists for coming.

It is quite alarming to hear what the residents of Essex County have been faced with, and we know that, as time goes by, it's not a matter of if, it's when other municipalities are going to be going through the same thing. This has become a part of the public awareness after what happened in Flint and what's happened here, but even in our own home State of Virginia, we have many, many places that have elevated levels of lead that are going to need to be dealt with.

And experts tell us that as long as lead service lines remain in the ground and more proactive measures aren't taken to reduce risk, one American city after another is likely to go through what you guys have been through.

I know that there are measures that can be taken with chemical additives to change the acidity or alkalinity of the waters, and there are innovative measures with epoxy coatings for these pipes as well. But those seem like second-best measures, and we don't know what the collateral impacts of those can be. So it seems that removing the pipes is really the best and only way to make sure that the risk is averted.

And my question for all of you because you have had to deal with this and be on the frontlines and kind of the tip of the spear for the rest of us in the country is if you had one piece of advice for executives or for leaders in other towns and counties where this will become an issue, what would that piece of advice be?

Mr. DIVINCENZO. First of all, Congresswoman, I want to clarify because Congresswoman Wexton—we don't—the county doesn't control the—we don't have a water system that we actually control. That's all done by the municipalities and stuff, the 22 municipalities. But the thing—what I would say is, you know, we have been very fortunate here is, you know, we're one county, 22 towns, and we're able to be able to communicate on a daily basis and what's going on. And when there is an emergency in any situation, no matter what town is there, we all get together make sure we do the right thing here.

And I have to tell you the leaders of these particular towns, you could hear from Nutley or from Bloomfield and also from Newark that they've been doing the right thing.

Mr. SCARPELLI. I think the first piece of advice would be because of both Newark and in Flint it was the water chemistry that got changed that caused the problem. So the first thing would be to make sure that you don't change that chemistry, you don't mess with it. If it's working, keep it the way it is.

The second piece of advice is to be proactive. When you have your water departments going out making repairs and they encounter lead lines, replace them then. That is something we've been doing for the last 5 to 10 years in Nutley, and we'll continue to do that. We're just going to have to move up the process now because of the crisis. But be proactive, change those lines out as you come across them.

Mr. VENEZIA. Yes, just, you know, following up what Mayor Scarpelli said, you know, being proactive communication-wise and just getting as much information out there about the lead service lines, the lead in your water, and being there for the public obviously, you know, like one of our community meetings we had over 150 people there, and I literally sat there for 3 hours just taking every question possible. But it worked. You know, the more information you get out there to the people, the more they'll understand and see that you have a plan and what's going on.

Ms. WEXTON. Thank you. I have no further questions at this time.

Chairwoman SHERRILL. Thank you, Congresswoman Wexton.

Next, I'd like to recognize Congressman Payne for 5 minutes.

Mr. PAYNE. Thank you, Madam Chair.

Let me just first say that when this initially was found in a school in Newark, I had just come back from Flint, Michigan, observing the issue around water there. And I was in the company of several Mayors from the 10th District, and I expressed to them my concern of what I saw in Flint, that they needed to start really paying attention and checking their water systems. And, lo and behold, that Tuesday it was found in a school, Louise A. Spencer, in Newark. And it had been an issue that had been going on for quite some time. And what they were doing at the Newark school system was flushing the lines in the morning, but I think over a period of time, you know, staff changes, people get a little more complacent, and then, lo and behold, the issue was brought to the attention of the residents of Newark.

And so the other thing that, you know, I just want to make clear is when we talk about the source of the water, Newark's source, the reservoir is fine. It is when it comes down through the system and hits the lead service lines is where the issue becomes. In Flint, the water source was changed and was an impure source of water, so from the source Flint had issues. Our issue starts at the service lines going into the homes.

I'd just like to once again commend our local elected officials for their proactiveness in supporting their towns on this issue and also to the County Executive for looking and seeing an issue and stepping in and helping find a solution. It's not the first time that he's done that for the city of Newark. In another administration, he was able to support that community. But it just goes to show when people ask, you know, what county government does, these are two really good examples of what county government can do in helping support the communities in which they find themselves.

So I just want to commend the County Executive once again for stepping up and stepping in and filling a void where the residents and the administration in Newark weren't sure how long this was going to take.

My one question would be to the Mayors. So in light of this, you are looking at other sources of water as opposed to the Newark system?

Mr. VENEZIA. So we are in the process of switching. So far, 60 percent of our residents in probably about 18 months to 2 years will be switched over to North Jersey District water supply, which gets their water from the Wanaque Reservoir. We're coming up with a 5- to 10-year plan to be 100 percent to the Wanaque Reservoir for the North District water supply. We were able to connect at one point in the township. That was an abandoned gas station that the township now owns, and we will be putting a water pumping station at that location.

Mr. SCARPELLI. Congressman, yes, so we have the 436 homes in Nutley receive Newark water. The rest of the homes receive Passaic Valley water. The issue with those homes that are receiving Newark is a pressure issue. There's not enough pressure for the Passaic Valley water to get up to those homes. They're on higher elevations. Newark has a little increase in pressure, so it's been, you know, 100 years that Newark water has supplied those homes. We're in the process to see what we have to do to switch everyone over to Passaic Valley water. That's what we're doing.

Mr. PAYNE. Madam Chair, I yield back.

Chairwoman SHERRILL. Well, thank you so much to our witnesses for your testimony today. I know that many of us here on this panel and in Congress have spoken to Representative Kildee, who serves Flint, Michigan, and I think the lack of attention to the problem there by public officials was incredibly disheartening. So to see the attention that this is getting here in New Jersey is impressive, and I sincerely appreciate it. Thank you very much to everyone who was here today.

So we're now going to have a short break while we seat our next panel of witnesses. Thank you.

[Recess.]

Chairwoman SHERRILL. Welcome back. At this time I would like to introduce our second panel of witnesses. First, we have Dr. Diane Calello. Dr. Calello is the Executive Medical Director at the New Jersey Poison Information and Education System.

If you could please take your conversations into the hallway as we begin our next session. Thank you.

She is also an Associate Professor of Energy Medicine at Rutgers University.

Dr. Marc Edwards is a Distinguished Professor of Civil and Environmental Engineering at Virginia Polytechnic Institute and State University.

Mr. Michael Ramos is a Chief Engineer at Chicago Public Schools. He is also the inventor of the Noah Auto Flushing Device for Lead Mitigation.

And last, we have Dr. Eric Roy, the founder of Hydroviv, a home water filtration company based in Washington, D.C.

So we will start with Dr. Calello.

TESTIMONY OF DR. DIANE CALELLO, EXECUTIVE AND MEDICAL DIRECTOR, NEW JERSEY POISON INFORMATION AND EDUCATION SYSTEM, AND ASSOCIATE PROFESSOR OF EMERGENCY MEDICINE, RUTGERS UNIVERSITY

Dr. CALELLO. Thank you. Good morning, and thank you to Chairwoman Sherrill and Congressman Beyer, Congresswoman Wexton, Congressman Payne, and everyone convened here, for inviting me to speak on the health effects of lead exposure.

So, as a medical toxicologist, I have seen firsthand many patients with the health effects of lead exposure. And, as a pediatrician, I've witnessed the unique effects of lead on the young child. As Director of the State's only Poison Control Center, we have advised and assisted in several drinking water lead contamination incidents, most recently in our own city of Newark. I'm very glad to be here today to find the way forward for this critically important issue in public health.

Lead is ubiquitous in our environment. It is even found in the Earth's crust. It's been with us since the beginning of recorded time. It is thought to have poisoned Roman aristocrats and metalworkers in colonial America, and many sources in our environment have been removed, for example, leaded automotive gas and leaded food cans with leaded solder. So advances have been made, but hazards remain. And this includes, first and foremost, deteriorating residential lead paint in older homes but also cultural sources, occupational hazards, and of course drinking water.

At the New Jersey Poison Center, most cases with lead poisoning we manage are in children exposed to that residential paint who suffer adverse developmental consequences. Although paint for interior residential surfaces was banned in 1976, lead paint remains in older homes. And when it peels or falls into disrepair, it fills the child's home with a fine particulate dust that gets first onto their hands and then into their mouth. You know, this is a 2- or 3-year-old child.

Children in these situations have very elevated lead levels and demonstrate developmental delay, attention deficit, behavioral and cognitive challenges, conduct disorder, and loss of intellect. They may need hospitalization and even chelation therapy, which removes lead from the bone but does very little to reverse the effects on the brain.

Children like these have very elevated lead levels in the blood, far above the CDC (Centers for Disease Control and Prevention) threshold of 5 micrograms per deciliter. However, it has become increasingly clear that even very small elevations in blood lead are harmful to the developing brain. This was demonstrated in the work of Canfield in the *New England Journal of Medicine* in 2003, who showed that in a population, the higher the blood lead levels in that population of children, the lower the IQ. And the IQ loss per point of blood lead level was actually steepest at the lowest range. So a child with a blood lead level of 30, which is very elevated, is worse off than a child with a lead level of 10, but a lot more damage is done in that first 10 points than in the subsequent 20. And this has been demonstrated by multiple studies and can be seen in figure 1 of my written testimony. For this reason, the CDC lowered the threshold from 10 to 5 in 2012, and further lowering is anticipated. These small blood lead level elevations are precisely what has been reported with lead contaminated municipal drinking water.

So both in Washington, D.C., and Flint, Michigan, the cities experienced a rise in the number of children with elevated lead at the time of water contamination. Both Dr. Edwards to my right and Dr. Hanna-Attisha demonstrated that the prevalence of children with elevated levels doubled or even tripled after their water lead level rose. Of note, no child had severely elevated levels as a result of drinking water alone, and no child required hospitalization. But lead-contaminated drinking water can feasibly be expected to cause more children to have higher lead levels and subsequent loss of IQ.

A common misconception is that lead in drinking water is an immediately life-threatening exposure, and that is not the case. And that's an important message to communities who have fear about whether they are acutely poisoned or at acute threat at this moment to their life.

So risk communication is challenging in these situations and requires very careful messaging. People in cities with drinking water lead acquire attentive guidance about preventing further exposure from all sources, including flushing drinking water—many of the strategies we have talked about already today—logistics of obtaining bottled water, but also minimizing paint dust and other sources of lead in the environment. But these communities also require attentive and cautious reassurance and recognition of any developmental effects as they arise. Knowledge is power, and if a child has a delay, catching it early and intervening can make a tremendous difference.

Here in New Jersey we have higher lead levels than the national average, and the city of Newark has the greatest number of children with high lead levels than the other cities. Now, some of that is because many more children in Newark get tested, but we know that the problem is certainly in the city of Newark. Sources vary, but this is mostly attributable to lead paint. The contribution of drinking water has not yet been determined, and more recent statistics are not yet available. Families can receive services through the city, as well as our Poison Control Center, regarding how to mitigate exposure to lead in the environment.

Newark also has important resources like funded relocation housing and a partnership for lead-safe children. But as lead levels continue to be elevated, environmental hazards continue to persist, and the threshold continues to appropriately be lowered. Resources Statewide and nationally risk depletion.

Municipal water crises are complicated and require a great many decisions, often in the context of fear, outrage, and distrust. How do we fix the water? How do we contact citizens—by phone, by door to door? What do we tell them? Should we use filters? What kind? Where can people go for information? Should we offer universal testing? Who is most at risk? So many questions.

I urge the Subcommittee to consider one advance in this area. Aside from all the important advances we're talking about to remove lead from water is to craft a municipal playbook for cities in the future who face water crises, deploying the right expertise at the right time can make a tremendous difference. And Flint was not the first city to face this issue, and Newark will certainly not be the last. And formal guidance for cities I think would be tremendously useful.

So, in conclusion, while drinking water is only one source of lead exposure, removing this hazard is imperative, so, too, is addressing other sources. And the prioritization of lead hazard reduction is complex, but we must envision a future in which our water and our homes are leadfree. Thank you.

[The prepared statement of Dr. Calello follows:]

Testimony to Subcommittee on Investigations & Oversight

House of Representatives Committee on Science, Space, and Technology

Field Hearing, October 15, 2019

Introduction

Good morning and thank you to Chairwoman Sherrill and the Members of the Subcommittee for inviting me to speak on the health effects and implications of lead exposure, with specific focus on drinking water. As a pediatric toxicologist and national expert on the management of lead poisoning in both adults and children, I have seen firsthand and managed many patients with the health effects of excess lead exposure. In addition, I have advised in a medical capacity in several drinking water lead contamination incidents, in healthcare facilities, schools, and municipalities. As director of the state's Poison Control Center, our 24/7/365 hotline manages many calls regarding treatment and prevention of lead poisoning, and I serve as the medical consultant to the State of New Jersey for all children requiring hospitalization for significantly elevated blood lead levels.

Executive Summary

1) The health effects of lead are proportional to elevations in blood lead level, but even small elevations in blood lead level are associated with intellectual deficits in young children that may carry into adulthood
2) In 2012, in response to new scientific evidence repeatedly demonstrating this fact, the Centers for Disease Control (CDC) has lowered the blood lead level (BLL) threshold for concern from 10 micrograms per deciliter (mcg/dL) to 5 mcg/dL, and it is anticipated this level will be lowered again in the future.
    a. BLL is negatively correlated with IQ, and the effects are steepest at the lowest levels of elevation.
    b. In children with BLL < 10mcg/dL, studies estimate a loss of seven IQ points. Further IQ loss is seen as levels rise beyond 10 mcg/dL.
    c. The threshold was loweredin response to studies demonstrating diminished IQ , and also in response to the decline in blood lead levels in the general population.
3) The effects of drinking water lead elevations on blood lead levels are variable, but several cities with elevated water lead levels demonstrate a concomitant rise in the number of children whose BLLs exceeded the CDC threshold.
    a. At the time of the Washington, DC water contamination incident, the CDC threshold was 10 mcg/dL.
    b. At the time of the Flint, MI water contamination incident, the CDC threshold was 5 mcg/dL.
    c. Both cities had demonstrated increases in proportion of children with levels above the threshold.
4) Statistics in New Jersey and greater Newark:
    a. The State of New Jersey has higher lead levels than the national average.

  b. The City of Newark exceeds every other large NJ municipality in the number of young children with elevated BLLs, and had the highest number of new cases in the most recent report. The role of drinking water in these elevations has not been established.

5) For every child with an elevated BLL, resources must be mobilized at the local and state health department level to determine and mitigate the source of exposure.
6) Preserving and improving the drinking water infrastructure to prevent and diminish further lead exposure is essential to mitigate adverse health effect in our children and prevent overwhelming existing systems in place to assist these children and their families.
7) Strategies to prevent lead exposure vary depending on the source of exposure, but include minimizing lead-based paint dust, removal of imported lead-contaminated toys, foods, and cookware, elimination of cultural sources of lead such as contaminated cosmetics and alternative medicines, and use of bottled water in the event of a drinking water contamination. Materials can be obtained from NJPIES or any regional Poison Control Center for more information.

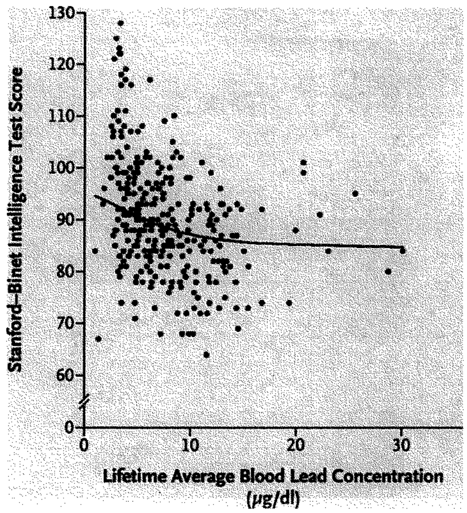
Testimony

Lead is an element which is ubiquitous in our environment, and exposure comes from a variety of sources. Much has been done to remediate these sources, including the prohibition of leaded automotive fuel, residential lead paint, and lead-soldered canned food. These measures have brought the average blood lead level in the population down significantly, however sources remain, particularly in the environment of the young child, which pose a persistent hazard. These are predominantly deteriorating residential lead paint in older homes, industrial contamination of soil, cultural sources (imported food, cosmetics, toys, and folk medicine), parental occupational hazards, and drinking water.

The majority of cases of lead poisoning which are managed through the New Jersey Poison Information and Education System (NJPIES), known to the public as the New Jersey Poison Control Center, are in children exposed to residential paint, who suffer adverse developmental consequences. These children have blood lead levels far above the CDC threshold of concern of 5 mcg/dL, and demonstrate developmental delays, attention deficit and hyperactivity, behavioral and cognitive challenges, school performance and reading readiness deficits, and conduct disorder. Children in this group usually have BLLs over 45 mcg/dL and are often admitted to the hospital for chelation therapy, which removes lead from their blood but has uncertain benefit in the aforementioned issues, which may be permanent.

However, it has become increasingly clear that even very low-level elevations in blood lead are associated with cognitive, intellectual and behavioral deficits in the young child. This has been demonstrated in the work by Canfield in the New England Journal of Medicine, who concluded that while a blood lead level >10 mcg/dL was associated with a quantifiable IQ loss per BLL rise, in children with BLL 1-10 mcg/dL the IQ drop-off per point of BLL was much steeper. This has been demonstrated by several other authors as well.

Fig 1. IQ as a function of Lifetime Average Blood Lead Concentration. From: Canfield RL, Henderson CR, Cory-Slechta DA, et al. Intellectual impairment in children with blood lead concentrations below 10 ug per deciliter. N Engl J Med 2003; 348:1517-1526.



This has led to a re-evaluation of low-level lead exposure. The Centers for Disease Control previously set the threshold of concern for blood lead level at 10 mcg/dL, but in 2012 the threshold was lowered to 5 mcg/dL. This was a reflection of the notion that there is no safe level of lead in young children, and also in response to population-based data in which 97.5% of the population have lead levels below 5.8 mcg/dL.

Low-level blood lead elevations are precisely what has been reported with lead-contaminated municipal drinking water. Both Washington, DC and Flint, Michigan demonstrated an elevated proportion of children with BLLs over the level of concern. This correlated in particular with high-risk regions within the cities for elevated water lead. Both Drs. Edwards and Hanna-Attisha demonstrated that, after drinking water contamination was detected, the prevalence of children with levels over the threshold doubled or even tripled. Notably, the magnitude of the blood lead level rise did not rise to the chelation threshold of 45 mcg/dL in either population.

Figure 2. Temporal variation of lead in water (90th percentile water lead) and key events related to lead exposure in Washington, DC (top). Trends in Elevated Blood Lead (EBL) incidence for children aged e1.3 years (bottom). From Edwards M, Triantafyllidou S, Best D. Elevated blood lead in young children due to lead-contaminated drinking water: Washington, DC, 2001-2004. Environ Sci Technol 2009; 43:1618-1623.

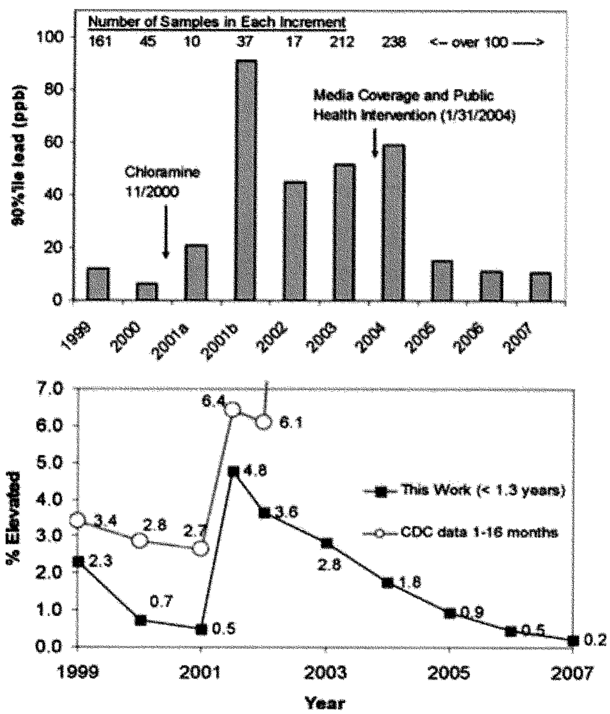
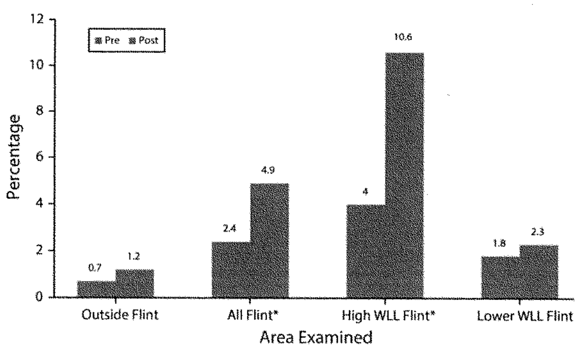


Fig 3. Comparison of Elevated Blood Lead Level Percentage, Before (Pre) and After (Post) Water Source Change from Detroit-Supplied Lake Huron Water to the Flint River. From Hanna-Attisha M, LaChance J, Sadler RC, Champney Schnepp A. Elevated blood lead levels in children associated with the Flint drinking water crisis: a spatial analysis of risk and public health response. Am J Public Health 2016; 106:283-90.



The effects of lead-contaminated drinking water can feasibly be expected to cause low-level blood lead elevations in many children, and subsequent loss of IQ. It is not, however, likely to cause severe elevations, require hospitalization, or be immediately threatening to life and health to any person. This is a common myth which complicates risk communication. Already exposed populations require reassurance yet careful guidance about how to best prevent further lead exposure in a child's environment. Recognition and anticipation of developmental challenges as they arise is also essential.

According to the 2017 report, in the State of New Jersey, average BLLs are higher than the national average (3.4 mcg/dL vs 1.8 mcg/dL), and the 97.5th percentile mark is 8.0 mcg/dL compared to the national 5.8 mcg/dL. These elevations are largely concentrated in urban areas, where many of the common sources of lead exposure are most prevalent. Moreover, the City of Newark has the greatest absolute number of children with elevated BLLs compared to other municipalities, and in the most recent report, had the highest number of new cases of elevated BLLs. The sources vary, but most cases can be attributed at least in part to residential lead paint. The contribution of drinking water is not clear, and more recent statistics are not yet available. Newark has a number of resources in place to address this disparity, including being the only NJ city with funded lead-safe relocation housing and a Partnership for Lead-Safe Children.

Any time a child has an elevated BLL within the State of New Jersey, local and state public health resources are deployed to determine and mitigate the source of exposure. This involves multiple property inspections, nursing visits, blood lead level testing, and case management to assist the family whose home may need remediation. This may also involve relocation housing, and the cost of remediation is significant. As programs struggle to meet the growing demands of risk assessment and mitigation, this predictably increases in the context of drinking water contamination. For example, at the New Jersey Poison Center our caseload of lead-exposed patients more than doubled in the past 8 months to over 300 calls, largely in response to the Newark water concern.

Removing the contribution of drinking water is imperative if the systems in place are to be able to respond to this public health threat. Other sources still predominate in more severely affected children, and the prioritization of lead hazard reduction is complex. The role of deteriorating housing stock must be emphasized and taken into account. However, given the scientific evidence that there is no safe level of lead for a child's environment, we must envision a future where our water, and our homes, are lead free.

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Offered by:

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Newark, NJ

Chairwoman SHERRILL. Thank you so much. And before we move to our next witness, I simply want to recognize Assemblyman Caputo. Thank you so much for coming today, sir. Thank you.

And next, we're going to hear from Dr. Marc Edwards, who is the distinguished professor from VPI.

TESTIMONY OF DR. MARC EDWARDS, UNIVERSITY DISTINGUISHED PROFESSOR, CIVIL AND ENVIRONMENTAL ENGINEERING, VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Dr. EDWARDS. Thank you. I'll start by noting that this is the fifth time I've testified to Congress on this issue in relation to lead and drinking water crises. The first two were in relation to Washington, D.C., in 2004, 2010, and then twice again in 2016 in Flint, Michigan, and I'm really optimistic that today's hearing related to this water lead problem in New Jersey is going to help bring an end to our ongoing national nightmare.

So I want to start by noting that approaches to dealing with the lead in water problem around the world vary. For instance, in Australia they tell consumers frankly that they're on their own and that they don't consider lead in water to be a significant public health threat. And other countries take some responsibility for protecting consumers from lead.

But our approach in the United States has been the worst of all worlds. Essentially, too frequently, people are being told that they're being protected from lead in water when that's not the case. And when you couple that with our public health warnings that there's no safe level of lead exposure with warnings of brain damage and other horrific health consequences, you have a basis for undermining trust and panic in water crises, and that's what happened over and over again.

And, unfortunately, we have severely damaged the public trust and public confidence in water supplies in the United States as a result of this problem. Too many of our poorest and most vulnerable citizens are spending too much of their precious financial resources worried about lead in water, testing for lead in water, protecting themselves, purchasing filters. And our Nation's failure to upgrade this antiquated infrastructure and to uphold Federal law has really effectively ended trust in potable water in this country as we once knew it.

And the following steps could really help go a long way toward restoring justifiable trust in U.S. public water supplies and prevent future water crises. So, first and foremost, the culture associated with implementation and enforcement of this law in the United States has really been just a national scandal. Whatever the provisions of the new lead and copper rule are, it must be enforced, and it must be taken seriously. And, as an aside, I was very pleased to see that the U.S. EPA was not as complicit in the problems that occurred in Newark as they have been in water problems that occurred in the recent past.

The second issue is that the current official language that there is no safe level of lead exposure should be reconsidered. We routinely identify consensus standards of human exposure for other contaminants, below which health risks are considered relatively low, and we should do the same for lead. The no-safe-level-of-lead-exposure language is actually proving to be an impediment to fixing the problem at its core, which is replacing lead in our plumbing, and is increasing dependency on bottled water and filters.

We also must eventually identify where these millions of lead service line pipes are and where they are not, and this is a major, major challenge. Consumers have to be made fully aware when they have to live with this hazard, and they should be given some relative peace of mind if they do not have a lead pipe in front of their house. And ultimately, these lead pipes do have to be replaced.

But until that day comes—and I'm resigned to the fact that it's probably not going to happen in my lifetime or my children's lifetime at our current rates of pipe replacement—we do have to do a better job of protecting consumers with filters, with bottled water, with corrosion control, and flushing strategies. And the U.S. EPA and HUD (Department of Housing and Urban Development) have been investing in research in these areas that can help us improve our response.

Thank you.

[The prepared statement of Dr. Edwards follows:]

Testimony of Marc Andrew Edwards
to the House Committee on Science, Space & Technology. October 15, 2019

"ADDRESSING THE LEAD CRISIS THROUGH INNOVATION & TECHNOLOGY"

Over the last 15 years I have testified to Congress on lead in drinking water crises in Washington D.C. twice (2004, 2010), the Flint water crisis twice (2016), and I am optimistic that today's hearing related to Newark's water lead problems will help bring an end to our ongoing national nightmare.

Approaches to protecting consumers from problems with lead in drinking water vary worldwide. Some countries such as Australia provide some simple recommendations on flushing to avoid high lead and tell consumers that water lead exposure is not a significant public health concern, . Other governments take at least some level of responsibility for protecting consumers.

By comparison, our implementation of the U.S. Environmental Protection Agency (EPA) Lead and Copper Rule (LCR) has been a national disaster. It starts with official assertions that "no safe level of lead exposure has been identified," with warnings of brain damage and other horrific health consequences, and ends by providing public assurance that drinking water is meeting a legally defined lead standard when it often does not. When consumers occasionally discover that the federal LCR and public trust have been broken, they consider the consequences to their families and communities, and are understandably outraged.

Our 21st century lead in drinking water crises are not primarily about elevated lead in water—they are caused by government agencies first implying that any level of lead exposure is dangerous, and then willfully hiding significant problems with elevated lead in water from the public. These 21st Century water crises are caused by bureaucrats and scientists, who have twisted the Golden Rule, into willful deceptions that ultimately go over like a leaded water balloon.

We have now severely damaged public confidence in the safety of our drinking water systems. Too many of our poorest and most vulnerable citizens, feel compelled to spend too much of their precious financial resources, on purchase of bottled water and filters to protect themselves and their families. Because trust has been repeatedly and justifiably lost, the perception that such deception will likely happen again, and does, has caused uneasiness and outright fear that their own cities and towns may be next. Our nation's failure to upgrade antiquated water infrastructure and uphold federal law, has effectively ended trust in potable water, as we once knew it.

The following steps could help restore justifiable trust in U.S. potable water supplies and bring an end to future water crises:

1) The culture associated with implementation and enforcement of the U.S. EPA Lead and Copper rule is a national scandal that tolerated and even encouraged data manipulation, outright cheating, and unconscionable scientific misconduct at government agencies. Whatever the provisions of the new LCR may be, the U.S. EPA and other entities must no longer engage in public deception—the new rule must be taken seriously, and its provisions must be enforced. As an aside, I was pleased to see that the U.S. EPA, was

much more aggressive in protecting consumers in Newark, NJ in 2019, than they were in prior high profile water crises in Flint, Michigan (2014-2016), Washington, D.C. (2001-2004), or cities like Portland, Oregon where the LCR has been broken for decades.

2) Official language that there is "no safe level of lead exposure" should be reconsidered. We routinely identify consensus standards of human exposure for other contaminants, below which health risks are relatively low and should not cause major concern. We should identify such standards for lead. The "no safe level" language, can actually impede replacement of leaded water infrastructure and increase dependency on bottled water and filters, because even modern plumbing systems can contribute trace amounts of lead to drinking water.[1,2]

3) We must identify where millions of lead service line pipes are located. Consumers must be made fully aware of whether they are living with this serious environmental hazard, or whether they can have relative peace of mind because they are not. Ultimately, these lead service line pipes and other plumbing with high-lead content must be replaced.

4) Until lead pipes and leaded plumbing are replaced, strategies are needed to help consumers cope with elevated lead in water. These strategies include use of flushing, water filters whose performance is certified, and bottled water. The EPA and HUD have recently funded significant new research projects to investigate filter performance and improve the effectiveness of these strategies.[3,4]

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Marc Edwards is a University Distinguished Professor of Civil Engineering at Virginia Tech, where he teaches courses in environmental engineering, applied aquatic chemistry and engineering ethics. His research group conducted the investigative science uncovering the 2001-2004 D.C. Lead Crisis and the 2014-2016 Flint Water Disaster. Time Magazine dubbed Edwards "The Plumbing Professor" in 2004, listing him amongst the 4 most important "Innovators" in water from around the world. The White House awarded him a Presidential Faculty Fellowship in 1996, he won a MacArthur Fellowship in 2007, and in 2013 Edwards' was the 9th recipient (in a quarter century) of the IEEE Barus Award for *"courageously defending the public interest at great personal risk."* In 2016 he was named amongst TIME Magazine's 100 Most Influential people in the World, the World's 50 Greatest Leaders by Fortune Magazine, Politico Magazine's Top 50 Visionaries who have transformed American politics, Foreign Policy Magazines 100 World's Greatest Thinkers, and was short-listed amongst Flint whistleblowers as Time person(s) of the year. He was co-recipient of the inaugural 2017 MIT Disobedience Award, received the 2018 AAAS Scientific Freedom and Responsibility award, and the Hoover Humanitarian Medal in 2019.

Chairwoman SHERRILL. Thank you so much. And again, I would just like to recognize our School Superintendent Sal Goncalves. Thank you so much for joining us. Thank you.

And next, we have Mr. Michael Ramos, who is the Chief Engineer at the Chicago Public Schools.

TESTIMONY OF MICHAEL RAMOS, CHIEF ENGINEER, CHICAGO PUBLIC SCHOOLS, AND INVENTOR OF THE NOAH AUTO FLUSHING DEVICE FOR LEAD MITIGATION

Mr. RAMOS. Good morning, everyone. Thank you for holding this hearing today and inviting me here to testify. My name is Michael Ramos, the inventor of Noah, the Auto Flusher. I have over 30 years' experience in building automation, electrical engineering, direct digital control, and HVAC. I'm an Engineer for Chicago Public Schools and Chief Engineer of Von Steuben High School.

I'm going to talk to you today about the Noah device. Noah was originally designed to be attached to the lead service line in my home to automatically flush for 3 minutes every 3 hours. In 2016, I began following the Flint water crisis and quickly discovered water standing inside pipes for long periods of time can generate high lead and copper levels. I also discovered water treatment plants across the country use orthophosphates to coat the pipes' interior as a measure of corrosion control. In order for the orthophosphate to be effective, it has to be routinely applied by running water through the pipes.

I used this information to create an auto flusher that I attached to the main lead service line of my home. I believe this would be an effective way to prevent stagnation and effectively apply and maintain a protective barrier of orthophosphates for my family.

Later that year, Chicago Public Schools (CPS) began testing all schools in the district. Initial test results showed that 37 percent of the schools had at least one fixture test above the 15-part-per-billion action level. As an engineer in the school system, it is my responsibility to provide a safe environment for all who attend Von Steuben. I took it upon myself to modify my residential design into a retrofit device that can be installed in drinking fountains. Installing directly into a fountain utilizing its existing plumbing meant that I could supply fresh, clean, lead-free water to my students at all times. For the last 3 years, students at Von Steuben have been using the fountains to refill their bottles and not relying on single-use bottled water.

I'm going to quickly go over the before and after results of two pilot programs that I participated in with CPS. I donated and installed the devices in these schools myself. Orr High School, before Noah, its average reading was 45.65 parts per billion, and its highest reading was 530 parts per billion. After installing Noah, today, the average reading is 0.840, less than 1.

Onahan Elementary School, before Noah, its highest reading was 520 parts per billion; after Noah, 0.528, less than 1 part per billion.

Katie Brandt this was a residential install. In her home she had readings ranging between 4.9 and 17 parts per billion. After Noah was installed, 0.001, no detection.

We can test these locations today, tomorrow, next month, next year. The results will always be the same, less than 1.

In closing, Noah's an effective, practical solution in both residential and public buildings everywhere. It works by doing two things: It doesn't allow water to stagnate in the pipe; and two, it applies and maintains the orthophosphate corrosion control. It is also 100 percent maintenance-free, requires no filters, strainers, batteries, or clocks to program.

In closing, I would like to ask for the funding for a controlled residential in-school pilot program in Newark, New Jersey, and Flint. The funding values will be determined by controlled program needs. Thank you, and I look forward to answering any questions you might have.

[The prepared statement of Mr. Ramos follows:]

Good morning everyone ,
Thank you for holding this hearing today and inviting me here to testify.
My name is Michael Ramos , I am an engineer from Chicago Public Schools and the Chief Engineer of Von Steuben High School, I have over 30 years experience in Building automation, Direct digital control, electrical engineering and HVAC.

I'm going to talk to you today about my device Noah, how I developed it,and more importantly why I developed it. In Early 2016 I began following the Flint water crisis , I became aware of the irreversible, permanent damage that lead causes to humans , especially children. Although the water quality in Chicago was nothing like what they were experiencing in Flint, I learned that Chicago had more lead service lines than any other city in the country. As a father and grandfather I became concerned about what my family is exposed to on a daily basis and what can I do besides relying on filters to protect them. I began researching the water quality that was being distributed from the treatment plant, it was during this research that I discovered that orthophosphates are added to the water at the treatment plant , this chemical is implemented as a measure to prevent lead and copper from leaching into our water. Orthophosphates adhere to the inside of the pipes to create a protective barrier which prevents the water from coming into contact with the metals. I also learned that in order to build a sufficient barrier, the water has to routinely flow through the pipe. I believe you cannot maintain a sufficient coating of orthophosphate in a home without a deliberate effort. My research and discussions with chemists from loyola university verified that stagnation and leaching will begin within 6 hours. Water sitting in pipes for long periods of time will strip away the phosphate rendering it ineffective. Most of us spend on average 8 hours a day away from home, parents go to work , kids go to school, and while we are away from home our pipes are leaching into our water . I began developing a proactive automated device that can attach to the service line in my home which will prevent stagnation while building and maintaining the protective orthophosphate barrier.
In the spring of 2016 Chicago Public Schools launched a pilot program to test all potable water outlets in the district, concentrating on testing elementary schools first. The first round of testing revealed 37% of the buildings had at least 1 fixture test above the 15ppb action level. CPS then issued a mandatory protocol that is still in place today. This protocol instructs all engineers to manually flush every drinking fountain in their respective buildings for 1 minute every Monday morning.This daunting task is to be completed and verified before 8 am, although every effort is made to complete this task, it is impossible and unrealistic for all engineers to accomplish . If it is beneficial to flush fountains on a monday morning why not flush every day ? As a building engineer with limited resources , the lack of available options on the market and CPSs standing ban on the use of filters in its buildings, I modified my residential design to a retrofit for

drinking fountains. My intention was to provide a point of use solution that comes pre programmed and requires no maintenance, no filters, no strainers , no batteries or clocks to program that will target and treat the fountains directly . The retrofit connects to the internal plumbing of virtually any type of fountain and utilizes the fixtures bubbler to automatically purge for 3 minutes every 3 hours to stay ahead of stagnation . If we automate the flushing we can supply fresh clean water daily, not just for the first few hours of the week. I wanted to utilize Noah throughout the district or at least share the technology with the engineers within my cluster of 5 buildings. I approached my supervisors to be granted permission from CPS to install Noah in Von Steuben, I received the green light from CPS and on October 16, 2016 the first Noah was installed. While Von Steuben would be the first school to pilot Noah , I remained conscientious of water conservation and did not want to flush overnight or on weekends. I utilized the hall lighting circuit to supply power to all the devices, when the lights are turned on, Noah activates and begins its flushing cycle , when the lights are turned off at the end of the night Noah shuts down. I continued to install Noahs in fountains throughout the building and completed the entire building by December of 2016. Von Steuben is the first school in the country to fully automate flushing and deliver fresh clean lead free water to its students at all times.
Having access to safe water , students launched a campaign against single use plastic bottles. They created and posted signs above all fountains encouraging everyone to use hydroflasks. Having Noah has drastically diminished the use of plastic bottles and is raising awareness in the student body of the importance of recycling and conservation.

In the Spring of 2017, Chicago Public Schools asked if I would be willing to participate in a pilot program to utilize Noah in a building that had the highest lead readings in the district. I jumped at the idea and donated all the devices for the project, not only did I want to prove my concept further and show CPS that I had a viable solution to eradicate and maintain lead levels , I was eager to participate in a project that was based on the protection of our kids. Orr high school is a building on the west side of Chicago, which houses a neighborhood high school , an elementary charter school and a YMCA. The average lead reading in 2016 was 45.65 ppb , while its highest reading was 530.00ppb. The scope of this project did not include replacement of any of the existing piping in the building. I provided and assisted with the installation of 18 Noahs throughout the building and the project was completed and fully operational in August of 2017.

In January 2018 Loyola university tested all the drinking fountains that had a Noah device .
Results showed the average ppb per test is 0.840!! <1ppb

These results are outstanding, its a strong indication that Noah has applied a substantial coating of orthophosphate .

In February of 2018 CPS asked if I would be willing to help them at Onahan elementary school with 1 particular set of side by side fountains. It was a new fountain that had been recently installed but continued to give off erratic lead readings.
Between June and August of 2016 its lowest reading was 109 ppb while its highest reading was 520ppb.Between September of 2016 through January 2018 it had an average reading of 12.75ppb. In February of 2018 Noah was installed and tested a few weeks later with a reading of 0.528ppb. < 1ppb

Lastly I want to talk about how Noah is performing in homes in Chicago.

December 2018 , I was interviewed by Katie Brandt of Chicago Health Magazine for a story that was published in March titled " Leads dangerous legacy". Katie had been dealing with elevated lead levels in her recently remodeled home that has a lead service line. The city had sent engineers and officials from the water department to test her water on two separate occasions. Lead readings ranged from 4.9ppb to 17ppb. She was advised since she only had 1 reading above 15ppb she should flush her tap for 5 minutes before using and their investigation was complete. Unsatisfied with the cities response Katie reached out to me requesting to purchase a Noah for her home.
Noah was installed in mid December 2018 and tested by Loyola University in June of 2019, the results are <0.001 ppb.No detection.

It is important to note that these results will remain constant , we can test today , tomorrow , next week or next year, the results will be the same. Less than 1ppb.
Having a Noah device in your home , school , daycare or anywhere will ensure lead service lines are properly coated and maintained .

Many cities have lead service line replacement projects that are going to take years to complete. What do we do in the meantime to protect the people? Installing Noah in these homes, will prevent leaching from stagnation and maintain corrosion control applications " orthophosphate".

In closing, I strongly recommend that the EPA require ALL schools and daycare centers perform lead and copper tests yearly and set the action level to 2ppb.
We know that there is NO SAFE LEVEL OF LEAD , so setting the bar to minimize exposure is of monumental importance.
I believe districts across the nation are reluctant to test because of what they might find. Without having a viable economical solution like Noah available they are left to decide for themselves as to what the best approach is to mitigate their findings.
I would also like to ask for funding for a controlled residential and schools Pilot Program in Newark, New Jersey and Flint. The funding values would be determined by controlled program needs.

I would like to submit the following items for the record:
1.Photo of evidence of orthophosphate applied by NOAH.
2.Illustration published by Seattle Times
3.Orr High School Water Analysis Report written by Loyola University
4.Seattle Times Newspaper Article
5. Von Steuben student supporting testimony
6. Orr High school Water Mitigation pilot project Written by CPS
7. Noah PowerPoint presentation

Again, I thank you for the opportunity to share my invention with you. I believe Noah can be a significant asset in defeating the silent epidemic that is lead in our drinking water.

Thank You

Michael Ramos is a licensed engineer in the City of Chicago. He is also a certified HVAC technician by the Environmental Protection Agency. He is currently a Chief Building Engineer with the Chicago Public Schools (CPS) at Von Steuben High School.

Michael has extensive experience in electrical engineering, direct digital control (low voltage automation), building automation and HVAC.

It was with this extensive background in engineering logistics that Michael was able to create a solution to lead in all potable water sources and thus "NOAH" was born.

"Noah" is an innovative technology that updates the current platform from manual flushing to automated for water mitigation efforts.

This new technology removes the element of human reliance, as a pre-programmed automated flushing device, "Noah" will stay ahead of stagnation and ensure that the corrosion control application is applied and maintained on a pre-set timing sequence.

Noah is currently utilized at the CPS headquarters, three (CPS)schools Von Steuben, Orr and Onahan. Noah is also implemented at the City of Chicago's Jardin Water Purification Plant and is also being utilized in numerous residential homes in the Chicagoland area.

Michael's work in lead mitigation is gaining recognition in various cities across the country with acknowledgements in and with the Water Equity Conference hosted by Public Health Advocates in Sacramento, CA. Noah has been presented in webinars such as "Let's Tackle Public School Drinking Water Safely" hosted by National Drinking Water Alliance, "Guidance on Mitigation" hosted by Environmental Defense Fund (EDF), School & Childcare Facility Lead Sampling Programs hosted by 120 Water Audit.

Michael was interviewed in Chicago Health Magazine and featured in The Seattle Times as" Chicago may have an answer."

Michael aspires to raise awareness of this innovative approach to lead mitigation and eradicating lead and copper in our drinking water.

"Noah if properly utilized per its intent is a lifesaving tool for all to benefit for generations to come."

Michael Ramos

Michael aspires to continue his work in lead mitigation efforts as well as develope a new platform for energy efficiency in aged or outdated infrastructures utilizing today's technology.

Chairwoman SHERRILL. Thank you so much. Next, we are going to hear from Dr. Eric Roy, the founder of Hydroviv.

TESTIMONY OF DR. ERIC ROY,
FOUNDER, HYDROVIV

Dr. ROY. Thank you, Chairwoman Sherrill and Members of the Subcommittee, for your invitation to testify on how the Federal Government can better support scientists, entrepreneurs who develop technologies that detect, predict, and fix water quality issues like the one currently underway in Newark.

While today's testimony is informed by my experience working at companies that were either funded by or sold technology to EPA and Department of Defense, I'm not speaking on behalf of any of these employers or organizations.

Hydroviv is a water filter company that I started in response to the Flint lead crisis. At the time, I was leading product development for a company that develops technology used by first responders and military personnel to detect chemical warfare agents and other harmful chemicals. I was able to use my experience as a chemist in connections and manufacturing to develop custom water filters that were specifically designed to handle the high lead levels in Flint, and I donated these filters to families and child-centric organizations. This wasn't really intended to be more than a charitable effort run from my apartment, but as public awareness of water quality has grown, Hydroviv's scope expanded, and the company was able to air on Shark Tank this past year.

From the experience gained throughout my career, I've seen how companies working on water quality face barriers in commercializing their technology that are not encountered by those that develop solutions for other national interests like defense and homeland security. In this testimony, I will focus on two specific areas where I believe the Federal Government can help reduce these barriers.

First, the first barrier I want to talk about today is a lack of access to the problem. For these high-priority interests, it would be beneficial for Federal agencies to take an active role in aligning academic, government, and private-sector personnel in the same way that they do for defense and homeland security priorities. This deliberate alignment is different than what I've encountered with Federal agencies that work on water.

An example relevant to this hearing has to do with the water filters that the city of Newark distributed to families with high levels of lead in their water. Despite these filters being rated to remove lead, at first they were found to be surprisingly ineffective, and scientists from various government and academic institutions are actively conducting research on why this was the case. However, according to the scientists that I've spoken to, there's no component of their work that focuses on developing more effective filtration technologies, which is the actual problem that we need to solve.

The results of these studies won't necessarily be published fully for months or even years, which means that scientists and engineers who innovate on filtration technology have to wait before they can try and recreate the problem and attempt to find a solution to it. This is a missed opportunity.

The second thing I want to discuss today is a cost barrier faced by companies that transition technology from the laboratory to the community where economies of scale can fully be realized. Cost-effective third-party validation is a major barrier to entry for water-centric technologies, especially products that are aimed at the consumer. Without cost-effective validation, technology developers struggle to establish their products as credible and distance themselves from the snake oil products that pollute this market.

The organizations that government bodies point to for product validation are often cost-prohibitive for small companies and therefore act as a barrier to market entry. For security interests, the Federal Government reduces these barriers by establishing cost-effective programs and proving grounds that allow technology companies to validate their products under laboratory and real-world conditions.

If this type of thing existed for companies working on water quality, a successful trial would establish trust and credibility between that company and the other stakeholders, and it would also open up outside investment. In turn, there would be an established path for credible diagnostic, predictive, and treatment technologies to go to market, and these innovation areas would become more attractive to outside investors. The problem would be solved.

I've seen how the Federal Government can support companies that develop technology for national priorities, and I believe that there's a real opportunity to do this for water quality.

I want to finalize by thanking everyone for their time, and I'd be happy to answer any questions and/or work with Members of the Subcommittee on solutions to barriers that I raised today. Thank you.

[The prepared statement of Dr. Roy follows:]

Written Testimony of Eric Roy, Scientific Founder | Hydroviv

Field Hearing: Addressing the Lead Crisis Through Innovation & Technology before the United States House of Representatives Committee on Science, Space, and Technology

October 15, 2019

Thank you Chairwoman Sherrill, Ranking member Norman, and members of the subcommittee for your invitation to share my views on how scientist-entrepreneurs can be better supported by the Federal Government to develop technologies that predict, detect, and treat water quality issues like the crisis currently underway in Newark. While today's testimony is informed by my experience working at companies that were funded by or sold technology to the Department of Defense, Department of Homeland Security, Environmental Protection Agency (EPA), I am not speaking on behalf of any of these employers or organizations.

Hydroviv is a water filter company that I started as a charitable effort in response to the Flint lead crisis. At the time, I was working for a startup that developed technology used by First Responders and Military personnel to detect chemical warfare agents, explosives, illegal drugs, and other hazardous substances. I was able to use my experience in chemistry and advanced materials as well as my manufacturing connections to build custom water filters that could handle Flint's lead levels, and donated them to families and child-centric organizations. This was never intended to be anything more than a charitable effort run from my apartment, but public awareness of water quality problems in the US has continued to grow, which eventually led to Hydroviv launching nationwide on Shark Tank this past April.

From this and other entrepreneurial pursuits dealing with water, I've learned that companies working on water quality problems face barriers getting their technology in the field that are not encountered by companies that develop solutions for other interests of the Federal Government like defense and homeland security. In this testimony, I will focus on two specific areas where I believe the Federal Government can help reduce these barriers.

The first barrier faced by entrepreneurs that work on water quality problems is fundamental access to the highest priority problems. For these high-priority interests, it would be beneficial for federal agencies to align private sector, academic, and government stakeholders in the same way that they do for Defense and Homeland Security priorities. This deliberate alignment is different than what I've encountered with federal agencies that work on water.

A recent example relevant to this hearing has to do with the water filters that were distributed by the City of Newark to families with high levels of lead in their water. Despite being rated to remove lead, these filters were surprisingly ineffective under real-world conditions, and scientists from various government and academic organizations are actively researching why this is the case. However, according to the scientists that I've spoken to who are working on this problem, the scope of their work is limited to researching the problem and does aim to make improvements to water filtration technology, which is ultimately the problem that needs to be solved. Moreover, the results of these studies won't be published for months, or even years, which means that the scientists and engineers who are in a position to make improvements on filtration technology have to wait before they can start working on the solution. Active alignment of these scientists by federal agencies would undoubtedly shorten the time it takes to get improved filtration technologies in the hands of impacted citizens.

The second thing I'd like to discuss today is a cost barrier faced by companies that are looking to transition technology from the laboratory to the public. Cost-effective third party validation is a major barrier to entry for water-centric technologies. Without it, technology developers struggle to establish their products as credible and distance themselves from ineffective products that use marketing gimmicks. This is particularly common in the consumer products space because most consumers don't have the expertise or access to tools that would allow them to evaluate a technical product, and the certifying bodies that the government points consumers to for validated products are cost-prohibitive, and therefore serve as a barrier to market entry.

For security interests, the Federal Government reduces these types of barriers by establishing cost-effective programs and providing access to "proving grounds" that allow technology developers to validate their products under real-world conditions so they can go to market. If this existed for companies working on water quality, a successful trial would establish credibility and enable them to go to market with a municipal pilot project or raise investment so they would be able to pay for the costly certifications that governments point consumers to. In turn more prediction, diagnostic, and treatment technologies would graduate from the laboratory to the public, and as a result these innovation areas would become more attractive to outside investment.

I've seen first-hand how alignment between government, academic, and private sector stakeholders can shorten the time to market and lead to more effective technologies. I want to thank everyone for their time and I would be happy to work with members of this subcommittee on anything that has been discussed today.

Chairwoman SHERRILL. Thank you very much. I'll now recognize myself for 5 minutes for questions.

Dr. Edwards, I want to talk about what has happened in New Jersey. Some people have lived in their homes here and their neighborhoods for a generation, and they didn't change anything at their property but suddenly one day they're learning the water is unsafe to drink. So can you tell me for the record what changed that led to these higher levels of lead exposure?

Dr. EDWARDS. Yes. As was the case in Washington, D.C., changes were made to the water supply to try to comply with other U.S. EPA regulations. And those changes, which reduced the risk from disinfection byproducts and bacteria, also increased the risk from lead. And in particular what the utility did was to try to lower the pH, make it more acid in order to reduce the danger from the bacteria and the disinfection byproducts. And, as expected, that reducing the pH or increasing the acidity made more lead to go into the water.

Chairwoman SHERRILL. Thank you. And, Dr. Calello, a pediatrician in Flint played a big part in exposing the Flint water crisis, but she said she ran into roadblocks when she sought blood lead data from local officials. So how can we make sure that you get all the data you need to serve children's health?

Dr. CALELLO. Thank you for that question. I think it's important that lead levels drawn on children in general and even just the whole population be contained in a central data repository. So currently what we have in New Jersey is a pretty robust system that tracks lead levels in children but primarily abnormal lead levels. And so I think when we want to assess risk, it's important not only to know what child had a lead level of 6 or 12 or 40 but also how many in that area had undetectable lead levels or, you know, even just small elevations.

And I think every State does this a bit differently, but requiring that the collection of lead levels be a reportable and clinical entity that is contained in a central—ideally, a national data repository would help a lot.

Chairwoman SHERRILL. Thank you. And how often should at-risk families get tested?

Dr. CALELLO. I think as soon as an exposure is identified, that testing should happen right away. And although we have centered primarily on testing children and pregnant women, because those are certainly the populations most at risk, I think it helps for people to know, if they're very concerned about their lead exposure to get a level tested.

So Dr. Edwards made an important point about there being no safe level of lead exposure, and that's not really true. I mean, our bodies handle a little bit of lead in our environmental the time, but if lead accumulates in the body and shows up in the blood, that's where we say it's really not safe to have it there, at least that's when I say there's no safe level. That's what I'm referring to.

So a test should happen right away, I think when the exposure is discovered. And then, you know, we often test children every 9 to 12 months in early childhood. If the exposure is ongoing, that testing should be more like every 3 to 6 months, and it's kind of

I think just determined how much lead is in the environment that we have to monitor, so it's case-by-case.

Chairwoman SHERRILL. Thank you. I yield back, and now I'd like to recognize Congressman Beyer for 5 minutes.

Mr. BEYER. Thank you, Madam Chair. And again, thank you all very much. This has been very educational this morning.

Dr. Calello, first of all, thank you for helping us understand the impact of lead in the blood and its impact on IQ. It was very interesting. And I just want to point out that a difference of 7 IQ points is a lot. It doesn't sound like a lot, but that's the difference between whether you go to college or not, what kind of college you go to, just significantly moves where you are in the overall population.

But in talking with some of the people who have visited here today—talked about in the city of Newark, not in Nutley or Bloomfield—but that they have had independent testing as high as 400 parts per billion of lead. Is there anything from a poison control perspective that you can offer to make sure that people feel that the respective governments are testing appropriately?

Dr. CALELLO. The role of the Poison Control Center is to, you know, operate a 24/7 hotline to people with questions. And whether it's in the State of New Jersey, we actually did partner with the Department of Health to make sure that any information they wanted disseminated through the city was available at the Poison Control Center, so if any citizens wanted to know is my address affected, how can I get testing, where can I pick up bottled water, where can I get my child tested. So here in New Jersey I think the State Poison Control Center really played an important information disseminating role. That sometimes has been the case elsewhere and not always. Does that answer the question?

Mr. BEYER. Is there a connection between the lead poisoning and Legionnaires' disease?

Dr. CALELLO. No. You know, both can be a waterborne illness, but lead and Legionnaires' disease are not connected——

Mr. BEYER. OK.

Dr. CALELLO [continuing]. You know, in the body.

Mr. BEYER. And someone just pointed out that many of the deaths in Flint were due to Legionnaires' disease.

Dr. CALELLO. Right.

Mr. BEYER. But these are co-determined. It's not causal I guess?

Dr. CALELLO. Correct. You know, water can be contaminated with a lot of different things, and I think there was some co-contamination. But Dr. Edwards could probably speak to that a little more.

Mr. BEYER. And do we need to worry about copper? If we've solved the lead problem as you imagine, is copper leaching an issue for all of us and our kids?

Dr. CALELLO. Copper does not have the developmental effects at very low levels as far as we know scientifically. Copper in very high levels can cause health problems as well, organ damage and what have you, but it's not been observed clinically in drinking water contamination to cause illness.

Mr. BEYER. OK. All right. Thank you. Mr. Ramos, thanks for telling us all about the Noah device. Is the orthophosphate linings required ahead of time for Noah to be effective?

Mr. RAMOS. As long as the districts are applying orthophosphate at the treatment plant, Noah could deliver that orthophosphate to the residents and the schools.

Mr. BEYER. So those have to go together essentially?

Mr. RAMOS. Yes. Yes.

Mr. BEYER. And you said that in an attempt to hold costs down you weren't running Noah on weekends, but you also said earlier that if the water sits for more than 6 hours, it starts to eat away at the orthophosphate. Why wouldn't you——

Mr. RAMOS. That's correct.

Mr. BEYER [continuing]. Run it 24 hours, 7 days a week?

Mr. RAMOS. For residential, I would recommend that we do 7 days a week, 24 hours, but in a school, what I did at Von Steuben is I hooked all the devices up to the hallway lighting circuit, so it turns on only when the building is occupied. But given enough time having the system running, there will be enough coating of orthophosphate that it can survive over the weekend. Monday morning, we turn the lights on, the system activates and starts replenishing it with fresh water and the orthophosphate.

Mr. BEYER. And you did mention cost. What would it cost a home to have a Noah device?

Mr. RAMOS. I'm ranging around $250.

Mr. BEYER. OK. Great. Great, thank you.

Mr. RAMOS. And they last for years. Tomorrow's the 3-year anniversary of the very first one installed at Von Steuben High School, and it's still running today 3 years later.

Mr. BEYER. OK, great. Thank you. And one last question. Dr. Roy, you talked about how Federal agencies, Federal Government needs to do this alignment of the scientists and bureaucrats, civil servants to make this happen faster. Can you tell the four of us who go back to legislate what that legislation would look like?

Dr. ROY. Of course. I think there's really two ways that this could happen. I think for long-term priorities there should be programs set up that are kind of longitudinally based that, you know, around infrastructure-type stuff so you can have program managers that, you know, actively work to put those people in a room and develop long-term solutions.

For short-term priorities what I would recommend is some sort of—you know, the funding instrument is—are like prizes, and that allows technology developers to come in and pitch their prize, and they're able to kind of matriculate through. And the winners—it's not about the money; it's about the access to the problem and an opportunity to solve it. And I've seen this work multiple times for security and drug interdiction-based national priorities.

Mr. BEYER. Thank you, Madam Chair.

Chairwoman SHERRILL. Thank you. I'd now like to recognize Congresswoman Wexton for 5 minutes.

Ms. WEXTON. Thank you, Madam Chair. I want to thank the panelists for coming today and sharing with us your knowledge about this issue. And I would really be remiss if I did not use this opportunity to talk a little bit about the EPA's proposed changes to the lead and copper rule.

Dr. Calello, in 2012 the CDC reduced the threshold level of blood lead level that was of concern for it to be elevated from 10 micrograms per deciliter to 5, is that correct?

Dr. CALELLO. Yes.

Ms. WEXTON. And, you know, so that was in 2012. At that time the EPA's lead parts per billion was 15. And when the EPA announced that they were going to revisit that rule, a lot of us hoped that, given the changes that the CDC had had, that the EPA would also reduce that threshold. And they declined to do that. The trigger level in their proposed rule is still 15 parts per billion.

Not only that, they would allow more time for water sanitation authorities to replace lead pipes even when that trigger level is reached. They are taking away the 7 percent requirement of replacement per year and replacing it with a 3 percent requirement. So instead of taking 13 years to replace all of the lead pipes in a sanitation authority area, it would take 33 years. That is a couple generations of young people who could be living with elevated levels of lead in their blood and have the collateral consequences of that.

Dr. Calello, could you speak a little bit—I know that you can't draw a straight line from 15 parts per billion to 5 micrograms per deciliter or anything like that, but could you speak a little bit to the long-term consequences in terms of brain development and development overall IQ points and everything that happens with these elevated levels of lead in children's systems?

Dr. CALELLO. Just to repeat the question, it's two comments on the long-term intellectual effects of low lead levels in the blood?

Ms. WEXTON. That's correct.

Dr. CALELLO. OK. Thank you. You know, the data behind looking at is a child with a lead level of even 4 or 3 below the threshold going to potentially have a developmental consequence comes from large populations, so it's impossible scientifically to demonstrate in a given child that they were normal before they had exposure, and they had an—you know, a developmental event as a direct result of lead exposure. It's just very difficult to do in particular because most children when they have discovered elevated blood levels are in the first 2 years of their life.

So what we rely on are large, reproducible population studies that demonstrate, again, in children with elevated—populations where children have elevated lead levels, and some of them are just in that very low range, those children in that same group also have lower IQ. And that is controlled for things that also affect intellectual testing like parental education and parental IQ and socioeconomic status. And so it is a pretty good indicator at least on a large population-based level of IQ deficits at low levels—I mean, at small elevations.

But when I see a child with an elevated lead level, whether it's 5 or 10 or 40 or 60, I tell their parents that there is no way to predict exactly what's going to happen. Our first job is to get the lead exposure out of their environment so the level does not continue to climb. And then our next job is to watch the child closely, and if anything developmentally happens, then we can respond.

The deficits are not likely fixed and a foregone conclusion. It's important to not assume that children who are exposed to lead are, you know, damaged, you know, automatically. So it's a little bit of a complicated risk assessment, but in individual children I just try to provide guidance and hope and attention to where the sources are.

Ms. WEXTON. Thank you. Mr. Ramos, I was very interested to hear about what you have done in the Chicago Public Schools. And I am reminded of when I was growing up my dad would always—I have a very distinct memory of him standing at the kitchen sink running the faucet, running the tap for several minutes before he would fill the coffee pot in the morning. And I, being the budding environmentalist in, you know, first grade or whatever would say, "Dad, why are you wasting the water like that?" And he said, no, I needed to do that to get the clean—you know, to get the—to flush the water make sure that there's no bad stuff there. And it turns out it sounds like he was right. And I really appreciate what you have done for the Chicago Public Schools and beyond and your technology.

Now, you spoke about a pilot program that the schools did to test out your technology, the Noah process. Is that something that Chicago Public Schools picked up the tab entirely for that, or was there any Federal or State support available for that?

Mr. RAMOS. For all the pilot programs in Chicago Public Schools I donated all the devices, so CPS only had to pay the plumbers and electricians to actually do the infrastructure work.

Ms. WEXTON. OK.

Mr. RAMOS. But the devices themselves were free to CPS and the schools.

Ms. WEXTON. So this sounds like a pretty good, reliable, low-cost way to mitigate the damage when lead is already present in the system, is that correct?

Mr. RAMOS. Absolutely. I believe that it is.

Ms. WEXTON. OK. Thank you very much——

Mr. RAMOS. Thank you.

Ms. WEXTON [continuing]. And I yield back.

Chairwoman SHERRILL. Thank you very much. I now recognize Congressman Payne for 5 minutes.

Mr. PAYNE. Thank you, Madam Chair.

Mr. Ramos, my question was going to be the cost of the system, and in your remarks you mentioned that—well, Congressman Beyer's question, the replacement of the unit, what do you feel its life expectancy will be, and how many times will you have to replace it during a lifetime?

Mr. RAMOS. Well, since it's the first of its kind, I can just give the testimony on the success that we're seeing in Chicago. We've had devices running for 3 years without having to replace any of the components or the device itself. So I can say at least 3 years.

Mr. PAYNE. So it's still an ongoing test on the life expectancy——

Mr. RAMOS. Yes.

Mr. PAYNE [continuing]. Yes, the unit. So you really don't know yet basically?

Mr. RAMOS. I really don't know yet, but I could say at least 3 years.

Mr. PAYNE. OK. And so—and the cost of the unit is—would be—you're looking at a residential around $250?

Mr. RAMOS. That's correct.

Mr. PAYNE. OK.

Mr. RAMOS. And we're here to work with the willing. Anyone or any district, we're willing to work with budget constraints because it is a very, very, very important topic, and anything we could do to help, I think we all need to chip in together and just get it done.

Mr. PAYNE. OK. Thank you. Madam Chair, I yield back.

Chairwoman SHERRILL. Thank you very much. And thank you to all our panel members. It's been a great hearing today and wonderful to hear from you.

The record will remain open for 2 weeks for additional statements from the Members and for any additional questions the Committee may ask of the witnesses.

The witnesses are excused, and the hearing is now adjourned. Thank you so much.

[Whereupon, at 11:55 a.m., the Subcommittee was adjourned.]The Honorable Joe DiVincenzo, Jr.The Honorable Joseph ScarpelliThe Honorable Michael VeneziaDr. Diane Calello

Appendix I

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Marc Edwards

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON INVESTIGATIONS & OVERSIGHT

Addressing the Lead Crisis though Innovation & Technology

Questions for the Record to:
Marc Edwards, PhD
Virginia Polytechnic Institute and State University
Submitted by: Chairwoman Mikie Sherrill (NJ)

- You have been very close to the recovery from the crisis in Flint. How do you think New Jersey can avoid some of the mistakes made in Flint after their lead crisis came to light? Should we implement special oversight measures for contractors, should we enhance public disclosure requirements, etc.?

- You've worked hard to help the city of Flint optimize its corrosion control program in the wake of the 2014 crisis.
  - Why is corrosion control so challenging to optimize and what are some basic steps the federal government can help support in order to enable corrosion control programs are conducted thoughtfully?
  - Do we have adequate test beds and training outlets through industry consortia like NACE, or could there be more tools to help water managers build their expertise?
  - Could better sensor technologies help water managers evaluate their corrosion control programs in real time?

- The proposed Lead and Copper Rule that EPA released in October 2019 would take some steps to discourage partial replacements of lead service lines. Anytime utilities undertake a replacement of the public, utility-owned side of the line, it would be required to replace the private side of the line simultaneously.
  - Why is it so important to avoid partial lead service line replacements?
  - Will a surge in lead content occur in a partial replacement whether just the private side or just the public side is being replaced?
  - Should EPA eliminate partial lead service line replacements entirely? Or as an alternative, should EPA require either simple replacement or slip-lining of the private side of the service line when the public side is being replaced?

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON INVESTIGATIONS & OVERSIGHT

Addressing the Lead Crisis though Innovation & Technology

Questions for the Record to:
Marc Edwards, PhD
Virginia Polytechnic Institute and State University
Submitted by: Representative Jennifer Wexton (VA)

- The EPA's proposed Lead and Copper Rule released in October 2019 would require utilities to create detailed inventories of where lead service lines exist and make those findings public. It would also require lead testing for child-care facilities and schools. These are big steps forward. I understand it is not always easy to find out where lead service lines are, and there could be improvements in lead testing protocols. If finalized, would these new requirements underscore the need for new innovations for locating lead plumbing and testing water supplies?

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON INVESTIGATIONS & OVERSIGHT

Addressing the Lead Crisis though Innovation & Technology

Questions for the Record to:
Marc Edwards, PhD
Virginia Polytechnic Institute and State University
Submitted by: Representative Troy Balderson (OH)

- There are likely pros and cons in the different available trenchless technologies when compared to traditional digging and replacing. Are water utilities using both dig-and-replace and trenchless technologies to remedy our nation's deteriorating drinking water conveyance challenges?

- Is removal of lead from the ground the most prevalent method being employed by municipalities? What happens to the lead after it is removed from the ground and who is tasked with handling the lead after it is out of the ground and paying for it (transportation, toxic testing, reclamation, recycling costs, and access to those facilities)? Using trenchless methods leaves the lead in the ground – do we know if this is the most efficient and safe place for it?

You have been very close to the recovery from the crisis in Flint. How do you think New Jersey can avoid some of the mistakes made in Flint after their lead crisis came to light? Should we implement special oversight measures for contractors, should we enhance public disclosure requirements, etc.?

Answer. The key is transparency and making sure that the best expertise is obtained, to work on and solve the problems. Many opportunists took advantage of the Flint Water Crisis to promote their own interests at the expense of quality science. Oftentimes, they actively worked to spread rumors and undermine the public trust.

You've worked hard to help the city of Flint optimize its corrosion control program in the wake of the 2014 crisis.

- o Why is corrosion control so challenging to optimize and what are some basic steps the federal government can help support in order to enable corrosion control programs are conducted thoughtfully?
- o Do we have adequate test beds and training outlets through industry consortia like NACE, or could there be more tools to help water managers build their expertise?
- o Could better sensor technologies help water managers evaluate their corrosion control programs in real time?

Answer. The fundamental scientific understanding of existing corrosion control knowledge is weak. We have not invested sufficiently in developing improved understanding, because corrosion control was always considered to be a temporary measure, putting a "band-aid" on problems until lead pipes were replaced. It is now clear that this "band-aid" will be important for many more decades. I have often said that existing corrosion control is mostly based on "trial and error, with a modicum of experience as a guide."

There is also very little expertise on water lead corrosion control nationally. I would estimate that there are probably only 5 individuals who have a thorough understanding of lead corrosion control science in the U.S.. Most of these individuals are older and nearing retirement. Training is poor and our thin existing knowledge base is in danger of being lost. NACE is a wonderful organization, but they have never really emphasized potable water lead corrosion control, as a key part of their mission.

The sensor technologies are running up against limits of chemistry and physics. Specifically, the best methods, can detect soluble lead at levels around 5-10 ppb. While this would have provided useful insights years ago, nowadays, the lead is mostly particulate (i.e., not soluble), and is therefore not readily detected by most sensors. And in the aftermath of Flint, the medical community has become concerned about water lead exposures on the order of 1 ppb, which is well below the limits of real time inexpensive sensor detection for soluble lead. While a breakthrough is always hypothetically possible, it seems highly unlikely at the present time.

- The proposed Lead and Copper Rule that EPA released in October 2019 would take some steps to discourage partial replacements of lead service lines. Anytime utilities undertake a replacement of the public, utility-owned side of the line, it would be required to replace the private side of the line simultaneously.

- o Why is it so important to avoid partial lead service line replacements?
- o Will a surge in lead content occur in a partial replacement whether just the private side or just the public side is being replaced?
- o Should EPA eliminate partial lead service line replacements entirely? Or as an alternative, should EPA require either simple replacement or slip-lining of the private side of the service line when the public side is being replaced?

Answers: Partial service line replacements can create both short- and long-term problems for consumers. In the short-term, disrupting the hazardous lead pipe material, can cause release of lead particles to water. The duration of this problem can last weeks to months. In some cases, if a copper pipe is connected to a lead pipe, galvanic corrosion can force even more lead into the water than was present with a full lead pipe. In other words, you can actually pay money for partial pipe replacements, and occasionally leave the problem worse than you found it: replace less than half the pipe, and end up with 2-5 times more lead in water.

The worst problems arise when a copper pipe is placed in front of a lead pipe (i.e., public side replacement), although some problems can still occur if a lead pipe is left in front of a new copper pipe (i.e., private side replacement). Sometimes the surge in lead release does not occur. We have very little ability to predict how serious, or how long, the problems with partial pipe replacements will occur.

I believe EPA should either eliminate partial lead service line replacements, or at a minimum, require use of plastic pipes instead of copper, for the public side replacements. Plastic pipes do not cause long term problems with galvanic corrosion.

The EPA's proposed Lead and Copper Rule released in October 2019 would require utilities to create detailed inventories of where lead service lines exist and make those findings public. It would also require lead testing for child-care facilities and schools. These are big steps forward. I understand it is not always easy to find out where lead service lines are, and there could be improvements in lead testing protocols. If finalized, would these new requirements underscore the need for new innovations for locating lead plumbing and testing water supplies?

Answer: One can only hope. In Flint and Washington D.C., we literally had to dig up every yard, to identify the public and private pipe material by eye. The EPA requirement for detailed inventories can spur innovation, that can include 1) teaching consumers how to identify the private owned lead pipe coming into their home, 2) use of new software to predict pipe occurrence, and 3) develop better technologies for identifying lead pipe.

There are likely pros and cons in the different available trenchless technologies when compared to traditional digging and replacing. Are water utilities using both dig-and-replace and trenchless technologies to remedy our nation's deteriorating drinking water conveyance challenges?

Answer: Yes, both have been used. For instance, Lansing MI became very proficient at trenchless approaches, whereas Flint MI opted for dig and replace. Requiring lead pipe replacement is likely to spur innovation and lower unit costs.

Is removal of lead from the ground the most prevalent method being employed by municipalities? What happens to the lead after it is removed from the ground and who is tasked with handling the lead after it is out of the ground and paying for it (transportation, toxic testing, reclamation, recycling costs, and access to those facilities)? Using trenchless methods leaves the lead in the ground - do we!mow if this is the most efficient and safe place for it?

Answer: I am not an expert on this subject, unfortunately, and therefore I cannot answer this important question.

Responses by Mr. Michael Ramos

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON INVESTIGATION & OVERSIGHT

Addressing the Lead Crisis through Innovation & Technology

Questions for the Record to:
Michael Ramos
Chief Engineer, Chicago Public Schools
Inventor, the Noah Auto Flushing Device for Lead Mitigation
Submitted by: Representative Jennifer Wexton (VA)

Q: Was there federal support for this pilot or did Chicago Public Schools pay out of its pocket.
A: CPS funded the pilot programs out of its own capitol budget, did not solicit for the state or federal funding.

Q: Do you think it's especially important to have field testing of control technologies not just lab testing?
A: It would be absolutely beneficial to have reliable accurate field testing equipment available to do regular on the spot testing, unfortunately to my knowledge this technology is not readily available or reliable at this time. Lab testing is the best method of accurately determining what is present in potable water sources.

Q: What would be the ideal technology test bed for lead control technologies and new methods for replacing lead service lines look like?
A: I believe most treatment plants across the country do a good job treating our water and abiding by the EPA lead and copper rule to apply corrosion control during the filtration process. It is critical that the lead and copper rule be followed, if it is followed, we can deliver untainted water to all, however if it's not followed it won't matter if there are lead or copper pipes, there will be major health risks.

For schools and day care centers, I Believe and recommend potable water temperature readings and Total Dissolved Solids tests be performed daily, these two simple tests can be useful in determining water quality in facilities.

Lead service line replacement is an important daunting task that needs to be accomplished, however automatically changing over to copper is not always the obvious choice. I don't have a recommendation on the material service lines should be made of, I can only state that the treatment policies set forth by the EPA need to be followed, following the rule will sustain water quality and help to maintain ageing infrastructures.

Responses by Dr. Eric Roy

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON INVESTIGATIONS & OVERSIGHT

Addressing the Lead Crisis though Innovation & Technology

Questions for the Record to:
Eric Roy, PhD
Scientific Founder, Hydroviv
Submitted by: Chairwoman Mikie Sherrill (NJ)

- The National Sanitation Foundation is the primary voluntary standards body that certifies the effectiveness of water infrastructure components and filters.
    - Can you talk a bit about the process of going through NSF certification?
    - Do you think the NSF certification represents a market barrier for small businesses?
    - Do you have ideas for ways the federal government can help make the certification process more workable for small businesses?

- You have pointed out that when it comes to testing for water-borne contaminants, there aren't many economies of scale to be had using current technologies. The EPA regulates more than 90 water-borne contaminants.
    - Would it be possible to design new tests that can evaluate levels of multiple contaminants more effectively?
    - What are your ideas for how the federal government can enable these kinds of innovations?

- You mentioned in your testimony that maybe there needs to be more test beds or proving grounds to demonstrate the effectiveness of water quality technologies in the real world.
    - Why are demonstration opportunities so important for lead control and lead service line replacement technologies?
    - What would an ideal water technology test bed look like? Would it make sense to include more contaminants than just lead?

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON INVESTIGATIONS & OVERSIGHT

Addressing the Lead Crisis though Innovation & Technology

Questions for the Record to:
Eric Roy, PhD
Scientific Founder, Hydroviv
Submitted by: Representative Beyer (VA)

- During the hearing you suggested the federal government could set up prize challenges to seek private sector and academic help in resolving issues related to lead contamination of drinking water. Can you please expand on those comments?

Answers to Questions for the Record Submitted by Dr. Eric Roy

The National Sanitation Foundation is the primary voluntary standards body that certifies the effectiveness of water infrastructure components and filters.

Can you talk a bit about the process of going through NSF certification?

There are different standards, but the relevant one for lead is Standard 53 (Health Effects). In general, the certification process for water filters has several components including:

Technical Review: In this part of the process, NSF's technical team reviews all aspects of our product, and prescribes a test plan.

Testing: Requirements can vary here, but in general, the testing component ensures that the product:

1. Is mechanically suitable for its intended process
2. Doesn't leach toxic chemicals into the water
3. Meets the performance specs set forth by the standard. In the case of lead, this means making sure that the filter reduces inflowing water at 150 ppb to under 10 ppb for 2x the rated lifetime of the filter. You do this test at 2 different pH values (6.5 and 8.5).

Administrative: This has several aspects including:

1. Facility audit
2. Product literature/packaging/graphics undergo review to ensure that they meet the criteria laid out in the standard.
3. Final review

o ***Do you think the NSF certification represents a market barrier for small Businesses?***

The cost definitely is a market barrier to many small businesses, and the lack of accountability for uncertified creates a great deal of market confusion. Simply put, companies that sell uncertified products are able to make performance claims as they wish. Credible companies test their products to the same standards used to certified products (where standards exist), while others do misleading things like present performance data that was collected for the first gallon of water passed through the filter (instead of test throughout the filter's lifetime), use marketing gimmicks that imply a visual representation of performance, or just use sales copy that imply performance.

O Do you have ideas for ways the federal government can help make the certification process more workable for small businesses?

I agree that the certification process should be the ultimate goal for all companies who sell credible products into the space. I believe that the federal government could play a crucial role in creating some sort of testing program that water filter companies can use as a platform to demonstrate that the product performs, so the company can establish themselves as credible to investors, lenders, and potential partners, and be able to raise enough money to undergo certification.

You have pointed out that when it comes to testing for water-borne contaminants, there aren't many economies of scale to be had using current technologies. The EPA regulates more than 90 water-borne contaminants.

o Would it be possible to design new tests that can evaluate levels of multiple contaminants more effectively?

I would suggest that instead of focusing R&D efforts on technologies that measure multiple contaminants simultaneously, resources would be better spent focusing on lead, because it has the highest potential for variability among homes. A reliably accurate, low cost, in-home lead test for lead would be a game-changer because it would allow consumers to test their water regularly.

o What are your ideas for how the federal government can enable these kinds of innovations?

Much in the same way that I proposed some sort of "proving ground" for water filters, I think a positive result in a government-sponsored proving ground would give consumers the confidence that the sensing technology is sound.

You mentioned in your testimony that maybe there needs to be more test beds or proving grounds to demonstrate the effectiveness of water quality technologies in the real world.

o Why are demonstration opportunities so important for lead control and lead service line replacement technologies? What would an ideal water technology test bed look like? Would it make sense to include more contaminants than just lead?

Simply put, the demonstration opportunities are so important because companies need to earn the public's trust. Consumers (in general) lack the resources and expertise to make these evaluations on their own, so it's imperative that there's some sort of consistency.

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON INVESTIGATIONS & OVERSIGHT

Addressing the Lead Crisis though Innovation & Technology

Questions for the Record to:

Eric Roy, PhD Scientific Founder, Hydroviy
Submitted by: Representative Beyer (VA)

During the hearing you suggested the federal government could set up prize challenges to seek private sector and academic help in resolving issues related to lead contamination of drinking water. Can you please expand on those comments?

An example of a topic that I think would be perfect for a challenge is something like: "Agency X is soliciting proposals for solutions that will make lead undetectable in all water fountains within a school." I would imagine that the Agency X would receive proposals from various technological sectors, including solution providers (academic, commercial) that produce standalone water filters, integrated water filter/drinking fountain fixtures, flushing devices, and probably some things that I'm not considering. Experts from Agency X, could choose the top contenders and have them undergo some sort of controlled laboratory simulation, and receive some sort of nominal amount of money. The solutions that perform well in the laboratory evaluation would undergo another downselect and be deployed in a real-world environment, perhaps at a time when children are not using the building (for example summer break), and receive another nominal amount of money to cover their cost of participation. During that real-world trial, performance and cost data are collected and the solutions with the best performance and/or performance to cost ratio could be recognized and awarded the prize.

Appendix II

Additional Material for the Record

STATEMENTS SUBMITTED BY REPRESENTATIVE MIKIE SHERRILL

NACE INTERNATIONAL

October 14, 2019

The Honorable Mikie Sherrill
Chairman
House Committee on Science, Space and Technology
Subcommittee on Investigations & Oversight
1208 Longworth House Office Building
Washington, DC 20515

The Honorable Ralph Norman
Ranking Member
House Committee on Science, Space and Technology
Subcommittee on Investigations & Oversight
319 Cannon House Office Building
Washington, DC 20515

Dear Chairwoman Sherrill and Ranking Member Norman –

As president of NACE International, the worldwide corrosion authority, I'm submitting the following letter for the record for your October 15th hearing on the lead crisis. NACE's mission is to equip society to protect people, assets, and the environment from the adverse effects of corrosion. Our 38,000 members work daily to ensure critical infrastructure and public safety is protected. As a technical association, we view the alarming rise of lead in drinking water systems throughout the country with an eye toward immediate solutions and look forward to sharing our expertise with the Subcommittee and Members of Congress to eliminate this issue.

Unmitigated corrosion affects everyone. Whether in the form of a dead car battery, a pipeline failure, a bridge collapse, or the ongoing water crises in Flint and Newark, the consequences of corrosion can be catastrophic and tragic. Corrosion also burdens state and local governments with unnecessary costs. According to a Federal Highway Administration study, corrosion costs the U.S. economy over 3% of its gross domestic product or roughly $500 billion with drinking water and sewer systems costing over $76 billion annually. These costs waste funds and limit state and local governments at a time when investment in technology and innovation are needed for critical infrastructure projects.

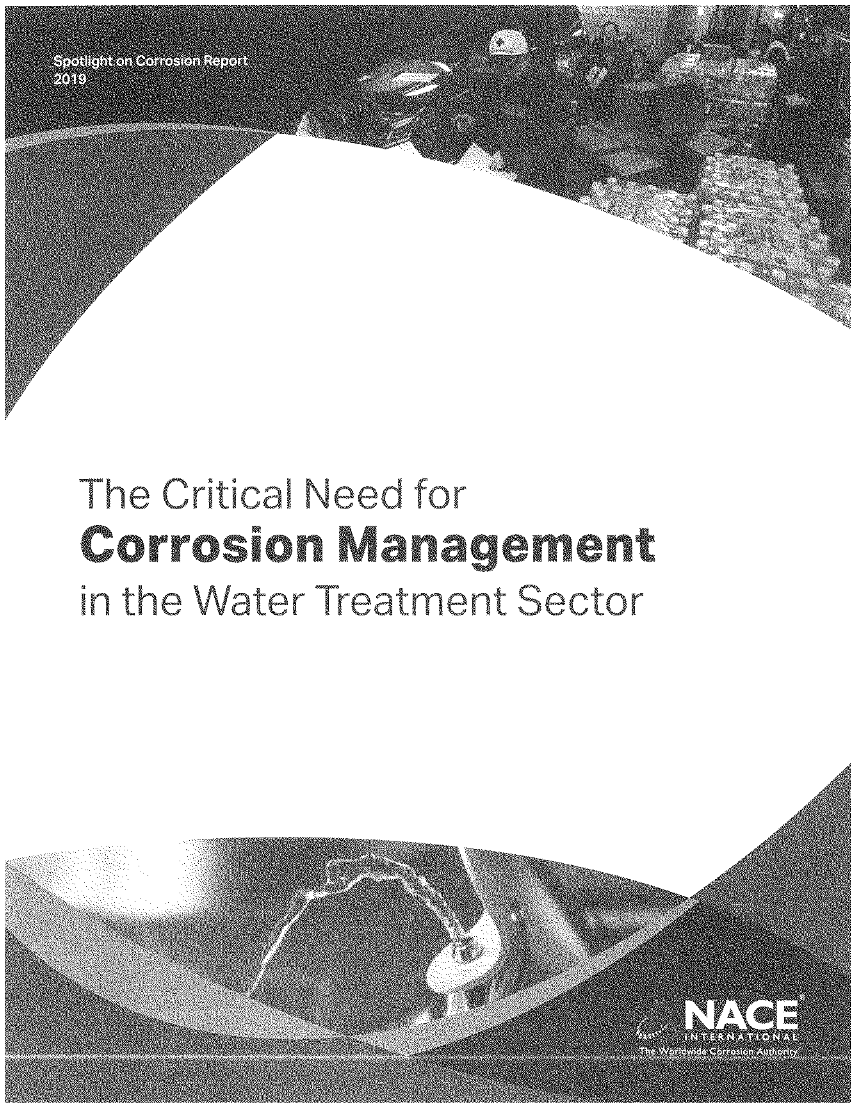
Last year, NACE experts published the Spotlight on Corrosion Report, which examined the water sector's efforts to combat corrosion. The report notes that a lack of corrosion expertise and training is a significant factor leading to ongoing issues throughout the country. Both experience and training are required to make good decisions, and bad decisions are costly in many ways. While a comprehensive corrosion prevention plan should be administered by every community to ensure the highest quality of drinking water, this is not happening nationwide. The report found that most communities lack a formal corrosion prevention plan and funding to support a plan. An effective plan must include the following aspects: management that understands potential threats and is committed to sound policies and strategies, best practices and standards for the design of new systems, and a life cycle cost analysis that examines condition and performance. Policy makers can improve our national water infrastructure by pursuing policies that incentivize these actions, including options to require corrosion prevention planning and increased training opportunities for local communities. For more detailed information, please review our attached report on drinking water systems.

Technology and innovation combined with training and experience, are the key to solving these challenges and preventing more communities from facing similar water crises as Flint and Newark. Corrosion management is so simple, yet absolutely critical to public safety. As the subcommittee works to resolve issues with the nation's water systems, NACE welcomes the opportunity to provide expertise and knowledge to help eliminate the impact of corrosion on our communities.

Thank you for your time and consideration.

Sincerely,

Terry Greenfield
NACE International, *President*


Spotlight on Corrosion Report
2019
The Critical Need for
Corrosion Management
in the Water Treatment Sector
NACE
INTERNATIONAL
The Worldwide Corrosion Authority

Executive Summary

Infrastructure in the United States is reaching the end of its economically useful and serviceable life cycle, primarily due to corrosion. As stated in 2014 by the former U.S. Secretary of Transportation, Ray LaHood, in an appearance on 60 Minutes, "(The U.S.) infrastructure's on life support."

When much of the nation's infrastructure was designed, in most cases more than 100 years ago, it was expected to function for 50 to 100 years. At the time, corrosion management solutions and techniques were limited.

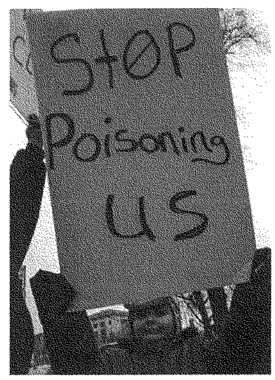
Today, bridges, pipelines, roads, power generation and transmission, and water treatment facilities all are at risk of corrosion-related failure. To prevent escalation of this crisis, NACE International, The Corrosion Society, has undertaken the *Spotlight on Corrosion Project* to increase awareness of the underlying causes of infrastructure deterioration and to provide guidance on how to proactively manage corrosion of global infrastructure. NACE is a professional technical society and a leader in corrosion protection with more than 35,000 members in 130 countries, dedicated to protecting the public from the adverse effects of corrosion. The monetary global cost of corrosion is estimated to be more than $2.5 trillion. Implementation of existing corrosion control techniques can save up to $875 billion, or 35 percent, of that cost; this equates to more than 3 percent of GDP in most developed countries.

This report describes the U.S. drinking water infrastructure and reflects on the water crisis in Flint, Michigan, a cautionary tale of lead poisoning due to water treatment that lacked proper corrosion management.

This report also recommends an action plan to remove corrosion-related contaminants from public drinking water—the cause of the Flint crisis—and addresses mitigation of external corrosion of buried steel and reinforced concrete pipes associated with water treatment.

While it is well known that the magnitude of the water crisis in Flint was caused by lack of action to counter the threat of corrosion, the case spotlights how financial avoidance influences the ongoing infrastructure crisis in the U.S. water sector. Fortunately, the tools and expertise needed to prevent this type of corrosion and its consequences are already available to schools, agencies, and companies that must begin to consider the impact of corrosion on aging systems. This report focuses on the need for a Corrosion Management System (CMS), and a methodology for reducing corrosion costs through proactive corrosion planning—the kind that would have prevented the Flint crisis and is critical to preventing a similar catastrophe in the future.

Given the grave consequences of corrosion failures, this report also recommends that water utilities and water safety organizations work collaboratively with NACE International to develop a CMS template to assess the corrosion management level of the most common water system designs. The template could be used throughout the drinking water treatment sector to prevent corrosion-related contaminants from entering the drinking water supply, while improving asset management along with reducing costs through proactive corrosion planning. The NACE International Institute has developed a program called IMPACT PLUS which provides practical evidence of how a CMS works and demonstrates to asset owners and decision-makers why corrosion management is a necessity.



Flint is an extreme case of what can go wrong, but it's an important one that effectively raised awareness of the magnitude of the problems—loss of public health, loss of public trust, costly infrastructure improvements, and on and on, all preventable with a CMS.

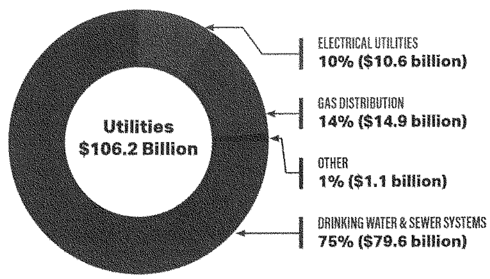
The Water Treatment Sector

Water distribution is a critical public service in the U.S., with more than 151,000* drinking water systems, comprising millions of miles of pipe.

These systems, after removing solids and organic, organic and inorganic contaminants, provide drinking water to more than 300 million people. See below for an illustration of the process. Each year these systems experience 240,000 pipeline leaks and breaks caused mainly by third party damage or corrosion, wasting more than two trillion gallons of drinking water.

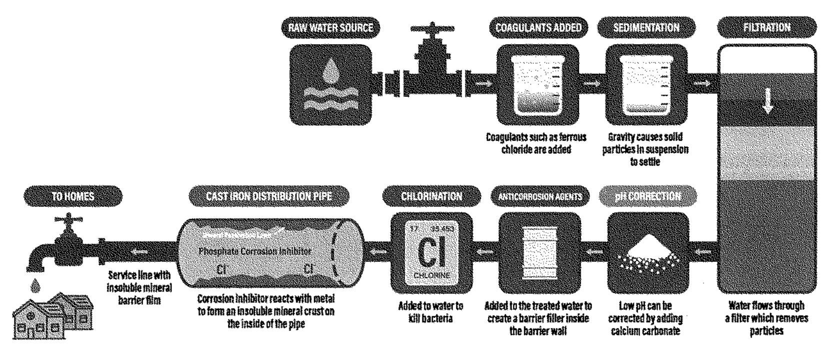
** Source: EPA*

Annual Cost of Corrosion in the Utilities Category



** Source: Corrosion Costs and Preventive Strategies in the United States a U.S. cost of corrosion study by the Federal Highway Administration in 2001*

Water Treatment Process



Corrosion in the Water Treatment Sector

The threat of corrosion has long been a challenge to the water treatment sector, specifically internal and external corrosion of pipes.

The use of externally and internally coated steel pipe, reinforced concrete and plastic pipe are the current best practices used to effectively combat corrosion of buried pipelines.

Both coated steel and reinforced concrete require corrosion protection to maximize their service life and minimize public safety hazards caused by leaks and breaks. To develop a corrosion mitigation/management strategy for a water distribution system, it is necessary to first understand the basic forms of corrosion that affect the internal and external areas of a pipe system.

Internal Corrosion

Internal corrosion of unlined steel, cast iron, or ductile iron pipe shortens service life and can result in poor water quality for consumers because corrosion releases metals into the water being transported through the pipe—water that consumers will eventually drink. The first line of defense against internal pipe corrosion is an effective water treatment program. However, the quality of the water can degrade over time as it travels from the treatment plant to the consumer. For example, water that stops moving and becomes stagnant in the distribution system for several days or more can become corrosive as the chemicals used to disinfect the water are consumed during transit. Water system hydraulics (flow rates, consumer demands, pressures) control the amount of time the water remains in the distribution system. The consumers located farthest from the treatment plant or in areas where water stagnates, or where consumption is low, may receive water that is very different from the treated water that leaves the plant. Localized corrosion problems can occur in these remote and/or low-usage areas.

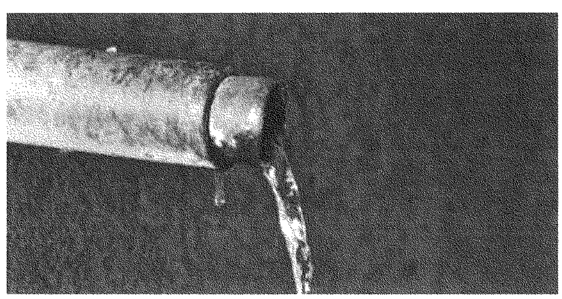
Another possible cause of internal pipe corrosion is inconsistent water quality over time. Inconsistent water quality prevents pipes from forming the sort of protective films that a corrosion inhibitor creates when properly added to the system. Systems that obtain water from multiple sources (often for security and reliability reasons) can be especially vulnerable to this problem.

Replacing the millions of miles of aging water pipe in the U.S. with plastic or coated steel pipe has been estimated by the American Water Works Association to cost $2.1 trillion. Even if that cost were incurred over 25 years, it would still require an $84 billion annual investment each of those years. The better, more affordable answer here is corrosion management, to extend the life of the existing systems.

External Corrosion

External corrosion of unlined steel, cast iron, or ductile iron pipe used for water distribution is caused by the type of soil chemistry surrounding the pipe, which includes parameters such as low pH, salts, low resistivity, and presence of bacteria—all conditions that can induce corrosion. The presence of oxygen is also required for corrosion to occur, and oxygen is typically dissolved in moisture, therefore, moist soil will cause corrosion of unprotected steel.

Cathodic protection (CP) is a corrosion prevention technology that can protect the exterior of the metal or reinforced concrete pipes using a sacrificial anode, making the metal inert, or non-reactive, so that it will not corrode. If a CP system is properly monitored and maintained, corrosion will not occur on the outside surface of the pipe.



Case Study: Flint, Michigan Water Crisis

The Flint water crisis began when the municipality changed its source of drinking water from Lake Huron, through an agreement with the Detroit Water Department, to the Flint River.

The Flint River water was more corrosive compared to the water from Lake Huron. This was primarily due to contamination from excessive chloride, which got into the river as runoff from road de-icing salts used during Michigan winters. When introduced to the drinking water distribution system, the new Flint River water immediately caused extensive corrosion, resulting in widespread health issues, particularly lead exposure.

Prior to switching the source of water, municipal staff failed to analyze, and then appropriately treat, the Flint River water with a corrosion inhibitor. Flint's older distribution system contained lead service lines, which quickly deteriorated when they came into contact with the highly corrosive Flint River water. Without a corrosion inhibitor to create a protective film inside the pipe, lead began to leach into the Flint drinking water supply.

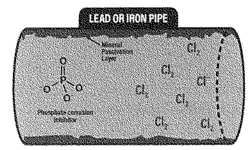
Chlorine, added to control bacteria, reacted with the lead pipes rather than the bacteria. In its absence, bacteria multiplied. To resolve this issue, staff added more chlorine, and the excess created disinfection byproducts (DBPs). DBPs have been linked to liver, kidney, lung, heart, and central nervous system problems.

At its core, the Flint water crisis was caused by a lack of understanding of water chemistry, and the need to preemptively counter the threat of corrosion as described above. This crisis, however extreme as an example, effectively illustrated the magnitude of problems caused by the absence of a proactive corrosion management system. Stakeholders may perceive the cost of corrosion management to be prohibitive. Yet, as the Flint tragedy so painfully proved, the cost of the risks—the public health crisis, water loss, system failures, and loss of trust in municipal officials—far exceeded the cost of prevention. **When an effective CMS is implemented, the cost of corrosion prevention has a positive return on investment (ROI) by providing a proactive approach that efficiently and cost-effectively protects public health, quality of life and existing facilities.**

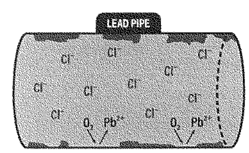
The Flint case spotlights how financial avoidance has driven the ongoing infrastructure crisis in the U.S. water treatment sector. What happened in Flint was an extreme case; it's an important caution to all utilities who have not given earnest consideration to a proactive Corrosion Management System.

See Appendix for a detailed explanation of the Flint corrosion processes.

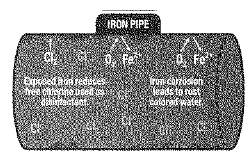
Before: Treated Detroit Water
Phosphate corrosion inhibitor helps maintain a mineral passivation layer on the inside of Flint's pipes, protecting them from corrosion. With little corrosion, chlorine disinfectant levels remain stable.



After: Treated Flint River Water
Lack of corrosion inhibitor, high chloride levels, and other factors cause corrosion in Flint's pipes. As the pipes corrode, chlorine disinfectant breaks down.



Oxidants such as dissolved O_2 corrode pipes and leach soluble metal



CMS Solution

The process of controlling corrosion in water distribution systems starts with regular maintenance and inspection. With those ongoing programs in place, when a problem is detected, its cause can be found and evaluated in a timely fashion, so the nature of the problem can be characterized and addressed quickly, and the severity of the issue can be minimized.

While this idea is straightforward and helpful, it's not perfect. Many problems can go undetected until widespread failures have occurred. The water system operator in this case may be caught by surprise because the routine water testing at the treatment plant did not detect remote and/or localized corrosion or water corrosivity problems. Pipes can be inspected manually using internal video cameras or leak detection devices, but these techniques are expensive and only give an operator a one-time "snapshot" of the system's condition. To identify and characterize corrosion issues requires a proactive and comprehensive approach.

A CMS is a set of objectives, policies, processes and procedures for planning and executing corrosion protection of existing and future assets. Most municipalities lack a formal CMS and the additional short-term funds to support a CMS. However, the following benefits of a CMS make for a sound, long-term municipal investment:

- **Added protection of public health**
- **Decreased maintenance, inspection and monitoring costs**
- **Fewer failures, reducing lost water supply**
- **Less property damage and environmental release**
- **Life extension of the asset and potential postponement of capital expenditures**

For a successful implementation of a CMS, the following steps are necessary:

Step 1

Management must understand the potential threat that exists without a CMS and demonstrate commitment to preventing that threat by establishing policies and strategies that set goals and objectives. This includes allocating the resources, such as securing an appropriate budget, and planning and implementing training for personnel involved in corrosion assessments, prevention and mitigation.

A CMS designed to specifically manage the threat of corrosion should be integrated into an organization's asset integrity management system as shown in **Figure 1**. Management systems that address safety, quality, structural integrity, and environment often already exist in many organizations.

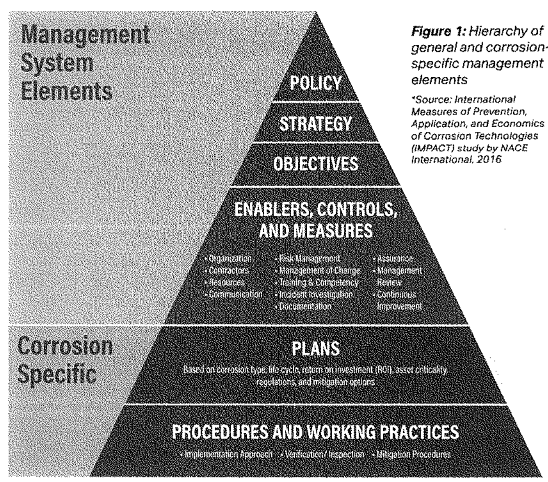


Figure 1: *Hierarchy of general and corrosion-specific management elements*

**Source: International Measures of Prevention, Application, and Economics of Corrosion Technologies (IMPACT) study by NACE International, 2016*

CMS Solution

Step 2

Corrosion control begins with system design. Correct design ensures proper materials selection based on industry standards and implementation of the correct protective industrial coatings for corrosion protection of buried metallic and concrete pipes, and water and waste water tanks.

Corrosion specialists, when given the proper authority, will follow industry best practices appropriate for the water treatment sector to evaluate corrosion control technologies and associated costs.

Step 3

Critical assets should be inventoried and evaluated for condition and performance. In addition, a successful strategy includes a life cycle cost analysis, which balances the cost of corrosion management over the life of an asset (from design to decommissioning) with the potential cost of corrosion. **The most realistic and effective life cycle cost analyses take a quadruple bottom line approach to consider not just the operational costs of the investment, but also the regulatory, environmental, and social (human) costs.**

The benefits are real and obtainable, while difficult to measure and slowly occurring. Two examples where implementation of corrosion management planning has proven successful include the automobile industry, and the Department of Defense. With time, commitment, and continuous improvement, corrosion mitigation through a managed prevention plan was accomplished.

Replacing lead water pipes with copper piping between the street and homes in Flint, Michigan. (Copper Development Association)

IMPACT PLUS

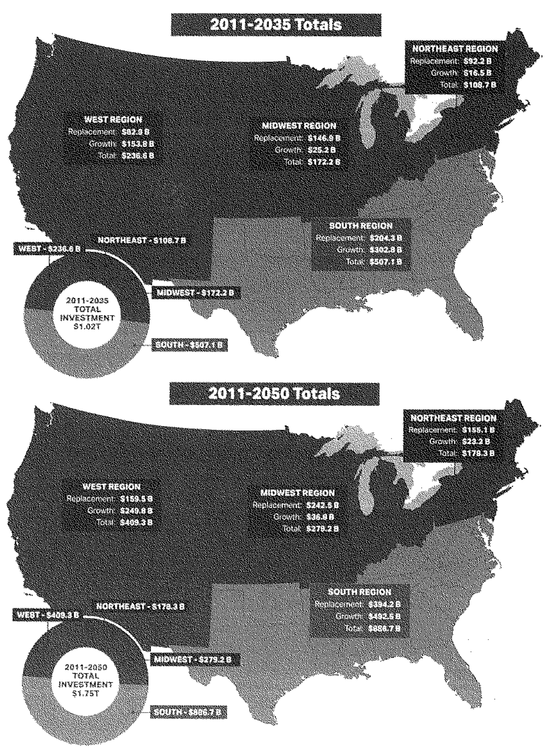
To support a strategic CMS, the NACE International Institute developed an innovative corrosion management tool called IMPACT PLUS, an online network of tools that benchmark practices and improve corrosion management.

IMPACT PLUS offers a customized corrosion management process classification framework, corrosion management maturity model, and an extensive reference library, for improving safety and reducing the cost of corrosion. Users have the option to manage their own systems or use a trained navigator with corrosion management expertise. IMPACT PLUS evaluates asset management strategies, future asset protection, and corrosion management strategies. This helps users identify gaps that could lead to a reduced asset life cycle and creates a road map to help them achieve higher performance.

NACE is currently seeking to work collaboratively with water utilities and water safety organizations to assess the corrosion management level of the most common water system designs. Through use of the IMPACT Plus platform, water system asset managers can compare their corrosion management maturity level to not only other utilities, but also to the aggregate corrosion community. This intra- and cross-industry benchmarking will give utility management, legislators and decision makers necessary information to determine whether a water system meets or exceeds the minimum standard for corrosion management and what, if any, would need to change to protect or improve a community's water safety.

Aggregate Needs for Investment in Water Mains Through 2035 and 2050 by U.S. Region (AWWA, 2012)*

** (2010 $Billion)*



Conclusion

Corrosion management, when considered proactively and systemically, can reduce the economic, environmental, social, and human costs of water pipeline failures.

To achieve these savings, policies, regulations, standards, and sound management practices to support corrosion mitigation must be implemented. Advanced design practices for new construction and corrosion prevention of existing systems through application of predictive models and performance assessment methods must be applied.

Water treatment decisions can no longer be based on a singular parameter such as Flint's attempt to use the least expensive option. When decisions are made like this, without regard for testing water or considering the composition of the pipeline system, including the presence of lead service lines, catastrophic failure can occur. To avoid the monumental, long-term health risks and financial implications of such an incident, corrosion management must be recognized as an investment and not as a cost. In addition to implementing the CMS system, the water treatment and distribution sector must require employees to be proficient in water chemistry and treatment through training and education.

As this document shows, corrosion control in the water treatment process and distribution system is multifaceted, requiring consideration of all the influencing parameters. A Corrosion Management System (CMS) is designed to consider the influencing parameters. Development of a site-specific CMS is possible through tools such as IMPACT PLUS, an on-line corrosion management tool developed by the NACE International Institute.

To support this approach, influential organizations, private companies, government bodies, professional societies, trade-workers' associations, the media, and the public must be made aware of the threat of corrosion, and the ways to prevent it. Proactively preventing both internal and external corrosion must be a stated goal for water utilities.

Spotlight on Corrosion Task Force

Dr. Frank Cheng, FNACE
Professor & Canada Research Chair, University of Calgary

Vincent F. Hock, FNACE
Senior Scientist and Technical Advisor, U.S. Army Corps of Engineers Rehired Annuitant Office

Michael Joosten, FNACE
Vice President of Engineering & Chief Metallurgist, Corrosion Integrity Solutions

Dr. Pierre Raymond Roberge, PE, FNACE
Vice Principal & Dean of Continuing Studies, Royal Military College of Canada

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About NACE International

Founded in 1943, NACE International, The Corrosion Society is a nonprofit organization serving 38,000 members worldwide. The association is based in Houston, Texas, and has offices in China, Malaysia, India, Brazil and Saudi Arabia, and a training center in Dubai. NACE offers the world's most specified technical training and certification programs, industry standards, reports, and publications focused on corrosion prevention and mitigation.

BlueConduit

Using AI to bring clarity to service line replacement

Statement for the record provided by BlueConduit to the U.S. House of Representatives Committee on Science, Space, and Technology, Subcommittee on Investigations and Oversight

October 15, 2019

Dear Chairwoman Sherrill and Ranking Member Norman:

Ending the ongoing public health crisis created by lead service pipes requires identifying the pipes most likely to pose a risk in order to replace them. We currently do not have enough information to identify these pipes in a way that responds to the immediacy of the crisis and reduces the time people live with lead pipes. A data-driven approach, like the predictive model we developed for and employed in Flint, Michigan, helps identify lead service pipes in a sustainable manner that can be replicated across communities.

Please accept the following statement for the record regarding the Committee's October 15th *Addressing the Lead Crisis through Innovation & Technology* hearing. We applaud the Committee for holding this hearing and for recognizing the urgent need to respond to this public health crisis. Our hope is that this hearing will demonstrate how data-driven approaches can help provide safe drinking water for millions of Americans in a financially sustainable manner.

In response to the Flint Water Crisis in 2016, we developed a data-driven approach to help the city discover and replace its most harmful lead service lines to stop the ongoing lead exposure to its residents, within its budgetary constraints. This same approach, strengthened through insights gained in Flint, can be replicated nationwide, as our team has started to do. Our team is led by Dr. Eric Schwartz, Assistant Professor of Marketing at the University of Michigan, and Dr. Jacob Abernethy, Assistant Professor of Machine Learning at Georgia Institute of Technology, who co-authored related peer-reviewed research[1] and collaborated with Brigadier General (ret.) Michael McDaniel, the coordinator for Flint's service line replacement program in 2016-17. Dr. Schwartz and Dr. Abernethy also co-founded BlueConduit, LLC, a social venture created to help other water systems replace lead service lines quickly and efficiently.

We respectfully offer our perspective to the Committee and the public in the hope that public-health concerns and data will drive decision making in lead service-line replacement efforts across the country. The following are the key takeaways from our work in Flint we believe that communities should and can incorporate as they structure their service-line replacement and inventory programs.

<u>A. The Number of Lead Services Lines is Currently Unknown</u>

1. National and regional estimates are unreliable because local data is unavailable. Unfortunately, community water systems, some of which were installed over a century ago, have not maintained good records about the composition of service lines. In Flint, like in other cities across the country, outdated and incomplete records make it difficult to identify that quantity and location of hazardous pipes. Only 10% of Flint's historical records indicated a lead service line. Now, after excavations at more than 20,000 homes, the data show that almost 60% of Flint had lead pipes. As a result the original budget allocation was highly insufficient.

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2. The federal rules are inadequately enforceable. Current rules require local governments to replace a specified percentage of lead service lines. But because localities do not know how many lead service lines they have, enforcing a percentage of an unknown number is unfeasible and can disincentivize identification of lead service lines. In addition to requiring lead replacement, rules could also better aim to locate all of the lead by requiring the inspection of a certain percentage of all service lines with *unverified* materials.

3. When ignoring the challenge of identifying homes with lead lines, stated costs can both underestimate and overestimate the real costs of replacement. Service line replacement costs are underestimated by failing to incorporate the costs of discovering lead-tainted service lines. For example, a typical estimate for the cost of replacing a single home's water service line is $5,000. Yet this quote ignores the excess cost of the same crews digging at a home only to discover it does not need a replacement, which typically costs around $2,500. If a city digs like this at 300 homes, replacing lead service line at 100 homes and discovering copper at the other 200 homes, the average cost of a *successful* replacement is $10,000. Likewise, using wholesale approaches to dig everywhere instead of data-driven approaches to prioritize efforts unnecessarily overestimates costs by requiring excess spending on service line discovery, while also diverting resources from successful service line replacement.

4. Even existing verified service lines may not be representative of the whole system. Identifying lead service lines based on previous discoveries of lead service lines is also not sufficient. In Flint, the first 171 attempted replacement excavations found lead pipes more than 96% of the time.[2] In other cities, existing data on verified service lines are commonly collected in settings like water main breaks. While this information is helpful, the occurrence of lead service lines found in such settings may not be representative of the whole community.

B. Identifying Lead Service Lines Using Statistics and Machine Learning

5. There are inexpensive methods to inspect a home's service line materials. The cost of digging under the street and into a home's yard with a backhoe can be thousands of dollars. But the pipe material can be inspected just as accurately for only hundreds of dollars by combining an in-home inspection and an excavation method with a hydro-vacuum. A hydro-vacuum truck can be dispatched around a city to perform inspections quickly and at more homes for the same budget.

6. Local governments should begin service line replacement programs by inspecting materials at a representative set of homes. Best practice in statistics suggests that localities perform inspections at a uniformly random set of homes, representing the whole community, in order to provide the best estimate of the total numbers of lead service lines. This provides a dataset, which then serves as a reliable basis for other analyses like estimates for funding requests. In Flint, we recommended crews conduct inspections with a hydro-vacuum truck at a statistically representative set of homes to get a better estimate of the number of lead pipes in the city. Based on a few hundred inspections in late 2016, this estimate[3] proved to be accurate three years later.

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7. The initial data enables statistical models to guide local governments in targeteting areas most likely to have lead. The representative set of homes in Flint, combined with other publicly available information about homes, enabled Schwartz and Abernethy to use a statistical machine-learning model, which produced home-by-home predictions of the probability of lead service lines for every home in the city. The probabilities allowed General McDaniel's team to prioritize homes with the highest likelihood of lead and direct the crews where to go next for replacing lead. The approach's success led a 2019 federal court settlement agreement to require its use in Flint.

C. Being transparent with data and clarifying stakeholders' incentives will help align financial and public health goals.

8. Statistical models need transparency in implementation to best serve the public. Data-driven models are not sufficient on their own. They require transparent implementation and the collection of representative data, including by recognizing competing interests of stakeholders. For example, the proper collection of data requires a division between crews inspecting service pipes and those replacing the pipes. Data must also be easily accessible to the public, and in turn, the community should be able to participate in data collection. On a broader level, Flint has illustrated how empowering local communities is necessary to promote public health.

The nation's aging infrastructure presents grave risks to public health. Making data-driven decisions by applying established statistical approaches, as we have in Flint, can help other communities remove lead from their drinking water systems and maximize any budget's impact on public health.

Sincerely,

Eric M. Schwartz, Ph.D.
Assistant Professor of Marketing, Stephen M. Ross School of Business, University of Michigan
Co-Founder, BlueConduit

Jacob Abernethy, Ph.D.
Assistant Professor of Computer Science, College of Computing, Georgia Institute of Technology.
Co-Founder, BlueConduit

Ian Robinson
Managing Director, BlueConduit

Jared Webb
Chief Data Scientist, BlueConduit

Michael McDaniel, Brigadier General (Ret.)
Professor, Director of LL.M. in Homeland and National Security Law, and Associate Dean, Cooley Law School, Western Michigan University
Director of Government and Customer Relations, BlueConduit

BlueConduit

Endnotes

1. Abernethy, Jacob D., Alex Chojacki, Arya Farahi, Eric M. Schwartz, Jared Webb (2018). ActiveRemediation: The Search for Lead Pipes in Flint, Michigan. KDD 2018, Proceedings of *SIGKDD Conference on Knowledge Discovery and Data Mining*, London, England, U.K. <https://www.kdd.org/kdd2018/accepted-papers/view/activeremediation-the-search-for-lead-pipes-in-flint-michigan>

2. Letter to DNR Director Keith Creagh from General Michael McDaniel dated September 28, 2016: Inventory of Service Lines. <https://www.michigan.gov/documents/flintwater/Letter_to_DNR_Creagh_from_Flint_McDaniel_092816_re_Service_Line_Inventory_536293_7.pdf>

3. Letter to DNR Creagh from City General McDaniel dated November 1, 2016 re: estimated number of service lines needing replacement. <https://www.michigan.gov/documents/flintwater/Letter_to_DNR_Creagh_from_Flint_McDaniel_dated_110116_545761_7.pdf>

Supporting documents submitted by Mr. Michael Ramos

10/31/2019

WATER QUALITY MITIGATION & FLUSHING CHICAGO PUBLIC SCHOOLS

A Case study in Water Quality Management

05/23/17

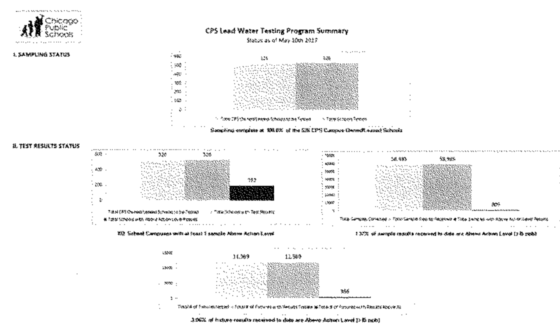
CPS Lead Testing Overview

About the CPS Testing Program

- Our top priority is the health and safety of our students, staff and community. Testing was initiated out of an abundance of caution to ensure the water in our schools is safe.
- Testing Completed in 2016
- Five Sequential testing very helpful in profiling a fixture and the building. (Example of 3-5)
- Leads to understanding of plumbing systems and how they are used.
- Allows for the ability to plan, program and allocate resources based on data.
- CPS analyzed 11 schools that each had multiple above actionable fixtures and readings. The analysis concluded the 9 of the 11 schools had fixtures in which the 1st above actionable result was the third sequential or later. This confirms the need to continue to take 5 - 250mL

05/10/17

Water Testing Dashboard



CPS Lead Water Testing Program

Water Testing Program Details

- CPS has a total of 527 Campuses; 470 School Campuses have building(s) built prior to 1986
  - 324 have Pre-K classrooms
    - 30 of these schools were completed in Pilot (Phase I)
    - CPS completed 327 campuses by June 21, 2016
  - Action Plan
    - Based on test results from each school an individual action plan will be produced including repairing, updating or removing fixtures.
    - Plan will be reviewed with Principal/Network Chief prior to work being started
  - CPS completed the remaining school campuses in November 2016
  - CPS Lead Testing results can be found at www.cps.edu/LeadTesting

05/10/17

Lead Water Problem Definition

Environmental Protection Agency (EPA) Definition and Allowable Standards

- Lead comes from many different sources: paint, soil, consumer products, and water, to name a few.
- Drinking water in Chicago comes from Lake Michigan. The Great Lakes system is the largest source of fresh surface water in the world.

- Lead enters drinking water when service pipes containing lead corrode. This is most commonly associated with chrome-plated brass faucets or fixtures connected with lead solder leaching into the water.

- ***The amount of lead in water depends on the temperature of the water, how long the water sits in the pipes, the acidity and the types of minerals found in the water.***

- Buildings built before 1986 are at a greater risk of exposure due to lead being an allowable building material.

- Per EPA's Lead and Copper Rule (LCR), EPA's action level for lead in water is set at 15 parts per billion (ppb).

Source: epa.gov

05/10/17

Water Testing Methodology

Water Sampling Method

- Testing of water source outlets require
  - All school water sources be unused for minimum 8 hours
  - If school has been inactive for more than 3 days, all potable water outlets are to be flushed completely the day prior to testing-Not Needed. Only tested on a day after a break.

- 5 (five) 250mL sequential samples of cold water collected per water outlet described below - Totaling 1.25 Liters

- Samples will be collected at only food and drink water sources, which include the following:
  - Pre-K & K classroom sinks, drinking fountains, water coolers, kitchen area & culinary sinks for food and drink preparation only and faculty lounges, nursing stations and health clinics
  - Samples are sent to EPA Accredited Lead Testing Laboratories daily, with an estimated turnaround time of up to 4 weeks.

05/10/17

Water Testing Vendors

Vendor Details

- Carnow Conibow & Associates and GSG Consultants are selected as the Board's environmental consultants - through July 31, 2018
- Depending on size of school campus, teams of 1, 2 or 3 people will be used to conduct sampling
- Weekday testing starts between 5AM and 6AM with vendors gone by start of school
- Saturday (if necessary) testing is between 5AM and 2PM
- Interviews building engineer or custodial staff member for specific information on the plumbing system at that school

05/10/17

Water Testing Communication

Communication

- CPS
  - Water Testing Schedule is regularly on the CPS Website
  - Principals are notified through email of when their school is to be tested
  - Daily Communication is conducted with Facility Managers and Building Engineers in conjunction with environmental consultants on availability for access to the School Campuses
- Family Notification
  - Schools with test results below EPA's actionable 15 ppb: parents will receive a note home conveying this information
  - Schools with test results above the EPA's 15 ppb: parents will receive a note home immediately after CPS receives and performs a quality assurance check on the test results. The note will contain information about next steps.
- Reference Sites for further Information
  - Center for Disease Control and Prevention-Lead (www.cdc.gov/lead)
  - EPA Basic Information about Lead in Drinking Water (www.epa.gov/ground-water-and-drinking-water)

05/10/17

Lead Water Testing Expanded Program

Phasing Schedule

	Phase II	Phase III
Scope	Pre-1986 Building(s) with Pre-K Students 294 Schools	Pre-1986 Building(s) ES, Post-1986 Building(s) ES, Pre-1986 HS Building(s) and Post-1986 HS Building(s) 199 Schools
Schedule	Testing completed by 2015-2016 school year end	September 13^{th} – November 3^{rd}
Cost	Estimated $1M	Estimated $1.3M

Lessons Learned

- Inactive Fixtures are at significantly Higher Risk for high Lead levels
- Lead can be Anywhere, but age does matter. In the buildings that tested positive
  - Percentage of buildings Pre-1986 with Above Action Level Fixtures-86%
  - Percentage of buildings Post-1986 with Above Action Level Fixtures-14%
  - Two brand new schools tested positive with at least one fixture above AAL
- Preventive Maintenance flushing helped with underutilized schools
- Stagnation is a key contributor to particulate build up in our systems
- Need to turn over building water system
- Plumbing system construction- water main or fixture replacement can impact WQ

Remediation Protocols

- **Protocols -** Developed in collaboration with CDWM, flushing consists of:
  - Replacing or cleaning aerators or screens (if applicable) + 7 days of light flushing or running of cold water + 1 day of normal usage + 1day for re-sampling
- Remediation Steps / Minor Repairs / Major Repairs
  - If Below Actionable (<15 ppb), the fixture is placed back into service.
  - If Above Actionable levels (>=15 ppb), the Building Engineer is to remove the supply lines, bubbler or faucet head (if present), repeat flushing protocol above
    - If Below Actionable, the Building Engineer will replace the supply line and either the bubbler or faucet head (Minor Repairs)
    - If Above Actionable, CPS' mechanical engineer consultant will assess the fixture and develop a remediation procedure to be followed (Minor to Major Repairs)
- **CPS Water Testing Application Notifications Development**

New Water Testing Notification

ALERT - Water Test Results submitted for Ericson (51201) with Below Action reading(s) requiring Notification Inbox x

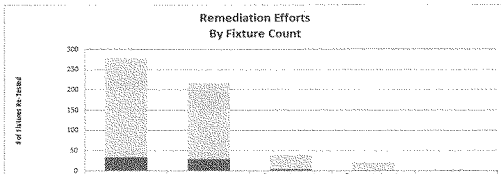
eacsupport@cps.k12.il.us via cps.edu Apr 26

Dear administrator

The water quality lead test results for **Ericson (51201)** have been submitted with Below Action alert (BA) reading(s) between 5.00-14.99 parts per billion (ppb) reading(s). Please log in to Oracle and select **Facilities Water Assessment** responsibility to review these results. Please email environmental@cps.edu with any questions and take appropriate action.

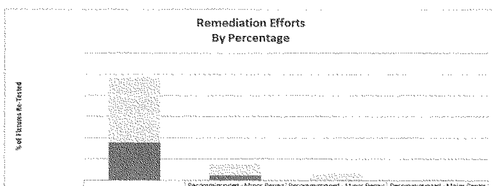
Fixture Number	Fixture Type	Location	Sample Collected	Max ppb
51201-1-109-S10	Sink	First Floor, Room 109, Sink	04/21/2017	5.91
51201-1-111-S11	Sink	First Floor, Room 111, Sink	04/21/2017	5.22

Remediation Protocols Breakdown



	Total Fixtures	Recommissioned - Flushing	Recommissioned - Minor Repair Work (1st Re-Test)	Recommissioned - Minor Repair Work (2+ Re-tests)	Recommissioned - Major Repair Work
Sinks	80	63	10	8	0
Drinking Fountains	167	125	25	12	4
Kitchen Sinks	33	29	4	0	0
TOTAL	280	217	39	20	4

Remediation Protocols Breakdown Continued



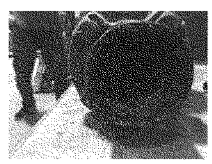
	Recommissioned - Flushing	Recommissioned - Minor Repair Work (1st Re-Test)	Recommissioned - Minor Repair Work (2+ Re-tests)	Recommissioned - Major Repair Work
Sinks	79%	13%	10%	0%
Drinking Fountains	75%	15%	7%	2%
Kitchen Sinks	88%	12%	0%	0%
TOTAL	78%	14%	7%	1%

Next Steps

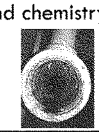
- **Next Steps**
  - Short Term
    - Based upon current data of ~**80%** of fixtures being remediated after the 1st flushing and current EPA recommendations, it is recommended to continue the flushing protocol of all potable fixtures. CPS should target unused fixtures and fixtures that have produced multiple above actionable levels first.
  - Long Term
    - Strategically identify capital dollars to replace oldest fixtures in phases. Based on correlation of age of the building, CPS should identify older facilities and fixtures and target fixtures that continually produce above actionable results.
    - Investigate installation of automatic flushing devices to make the flushing protocol implementation more efficient.

The Tea Bag Principle

- Our Water, from the source is good, its what is picked up along the way, the Tea Bag, that raises the issues



- All pipes will leach.
- Older systems are bigger tea bags,
- Newer systems are smaller tea bags
- Stagnation is the brew time
- Both will make tea, it just a question of time, physics and chemistry
- Time is the one aspect of this equation we can impact



Flushing

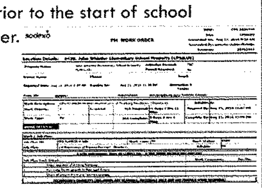
- Flushing counteracts the effects of stagnation
  - Start day with fresh water by turning over building plumbing. Limits stagnation to a brief time before typical occupancy starts, versus 10-18 hours
  - Flushes any settled particulates
  - Ortho-phosphate application with each use.
    - Stimulates application and replenishment
  - Flushing Simulates usage, where non would occur normally
- Improve water quality and perception

CPS Flushing- A Brief History

- With the Spring testing, we very quickly learned that unused fixtures were our biggest risk and flushing can significantly reduce that risk. (Nightingale)
- What and how much?
- Time studies & testing for riser flushing ranged from 1 hour for ES (60k sf) to 4.5 hours for Lane Tech (750k sf)
- 470 Building engineers, but 527 Campuses
- Other responsibilities Snow removal, Boilers, cooling, misc stuff
- Food Services (NSS) has an ongoing food prep/kitchen flushing protocol

Drinking Fountain Preventative Maintenance Flushing

- PM added to Work Order system after Phase II testing completed (late June 2016) to flush all drinking fountains for 1-2 minutes prior to the start of school after a day off. Completed once a week during summer.
- Concern about Implementation Rate
  - Easy to sign off on WO, but hard to track QA/QC
  - 80% Compliance in early August
  - 100% Prior to Start of school
- Short term solution, but big benefits
- PM was helpful in reducing our exposure to positive tests from orphan fixtures in some of our larger, yet underutilized schools tested during Phase III
- Building Risers were turned over prior to the start of school as an additional PM



CPS is a unique Environment

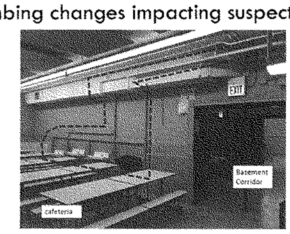
- Water Quality Team Concept
- Reluctance to shift responsibility to End users
- Contractual Requirements
- Community Expectations
- Integrated Facilities Management Transition
- Resources are finite

Long Term Solutions & Strategies

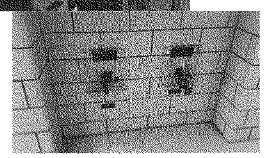
- How do we maintain water quality between tests?
- How do we comfortably state the water is safe on a daily basis?
- Testing is just a snapshot in time.
- Potential Solutions Discussed- Water Quality Management Plan
  - Fixture Replacement
  - System Replacement
  - Filters
  - Flushing

Fixture Replacement

- Can be routine maintenance replacement
- Existing Conditions and Unrelated issues up the Anti
- ADA height adjustments require plumbing changes impacting suspect material
  - Environmental Costs and impacts
  - Small projects
- Slow process

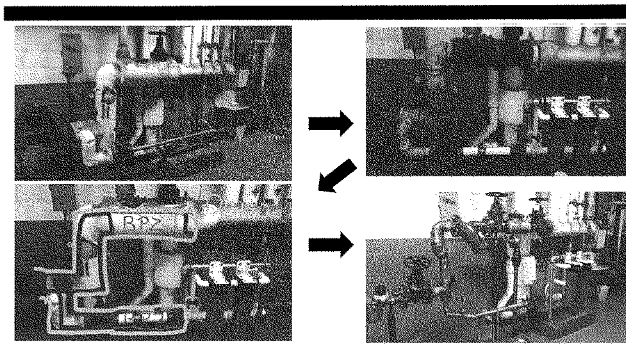


System Replacement

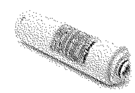


- Not an option for CPS
- Cost prohibitive
- Disruptive
- Ripple effects- (Pictures of Tanner)
  - ADA
  - Environmental
  - Programmatic impacts
- Limited system replacement –Potable Water System

Tanner Potable Water System



Filters



- Discussed early, but significant operational concerns
  - Cost
  - Preventative Maintenance- Most don't have indicators
  - Short usable life in high volume areas. Replacing every couple of weeks in HS.
  - Concerns about exposure to high tempetures resulting in breakdown
    - 60% of schools have AC in classrooms only
    - Extreme temperatures in hallways, lunch room, gyms during summer months
  - Easy to slip through the cracks

Flushing

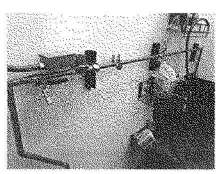
- CPS's Preferred Method based upon experience and data
- Scalable
- Every school is unique
- Use Manual, Automatic and Combination
- Verification required, QA/QC
- Long Term Goal is to install and monitor automatic flushing systems
  - Auto Flushing allows daily and even hourly flushing
  - Reduced Stagnation
  - Tailored to the school
  - Control for Occupancy

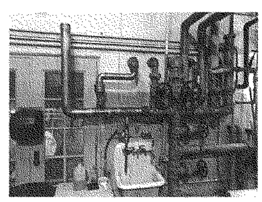
Automated Riser Flushing

- Onahan Riser Pilot Project
  - Basic requirements- ½, ¾ or 1" Solenoids, Control Timer, throttle and discharge – Discharge Design flow is 20-25% of potential –Slow and steady
  - Discharge can cause issues when drain backs up due to flow and volume.
  - Good option when access and space allow for install and monitoring
  - 5 Versions based upon Building BAS or lack there of.
  - Basic stand alone model

Onahan Riser Pilot Project

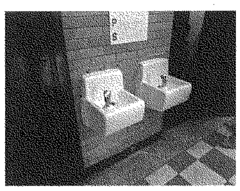
- Pictures of Onahan – Have one of each location

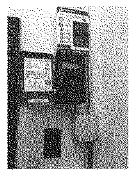


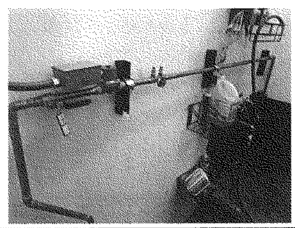


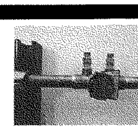
Riser Flushing Pictures

- Picture with Notes showing floor three East









Riser Flushing Calcs

- Simple Flow Calculation

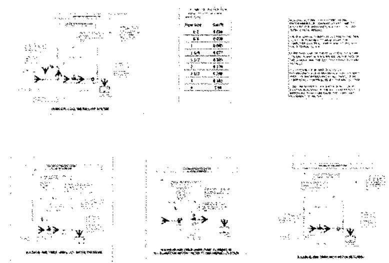
	Length of Pipe	*	Size of Pipe/ Volume of water	=	Gallons of water to flush pipe	/	GPM of discharge from solenoid valve and circuit setter	=	Total time to run flushing system
Example: 200 ft of pipe at 2" :	200	*	0.174		34.8	/	5		6.96

VOLUME OF WATER PER LINEAL FOOT OF PIPE PER SIZE

Pipe Size	Gal/ft
1/2	0.016
3/4	0.028
1	0.045
1 1/4	0.077
1 1/2	0.105
2	0.174
2 1/2	0.248
3	0.383
4	0.66

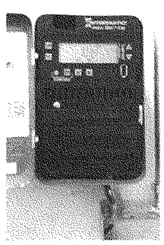
Riser Flushing Models

- Riser Control Options

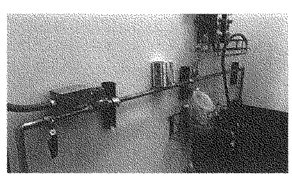


Automatic Flushing Devices- Onahan

Auto-Flush Prototype at Drinking Fountains with Porcelain Body (Onahan)

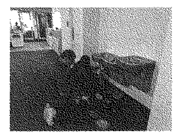


Multi-Circuit Timer



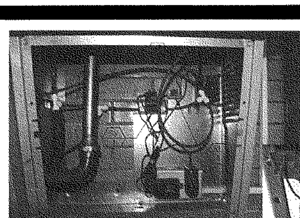
Copper piping with Solenoid Valve controlled by Timer, draining to open hub drain

Automated Drinking Fountain Flushing



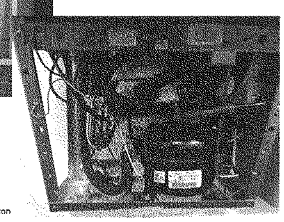
- Necessity is the mother of invention. Developed by BE
- Fits in the DF, needs 110 power supply
- Flushes fixture and Riser
- Lower volume for a longer period
- Significantly reduces stagnation time at the fixture
- Using Building Hall lighting as control (occupied mode)
- Two stage Flushing- start of day 10 mins, then 1 min per hour
- Simple install, I module can do multiple fixtures
- Greatest impact at Top of Riser

Automatic Flushing Devices



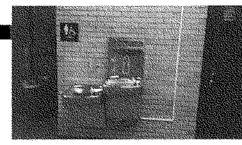
Von Steuben High School

Self-Contained Auto-Flush Prototypes at Drinking Fountains with Stainless Steel Housing



42 W Madison

Von Steuben & 42 W Pilots



- 42 W-Demonstration & Reliability Pilot-
- Von Steuben High School (300K SF)
  - Site of first working prototype
  - Building has 7 Risers. 3 Risers w/ Auto Flushing System, plus Main and Original Prototype
  - Bottle Fillers installed in Conjunction with Auto Flusher on 3rd Floor stimulates building usage
  - Water is cooler
  - Seeing significant particulate count reductions versus non flushed risers

Constant or Trickle Flow Flushing

Developed by CWM

Simple system that constantly flushes system-

Best at TOR or EOB

Downside is vandalism

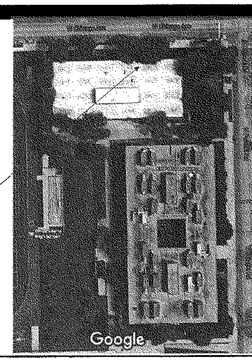
The Spout and Constant flow =Enticing

Orr High School Pilot Project

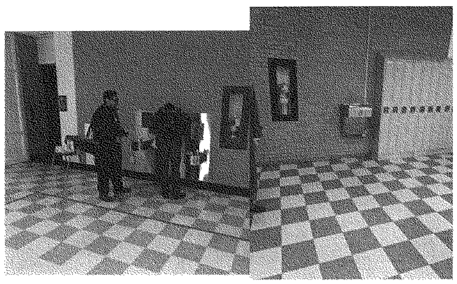
- Identified as having Poor Water Quality Prior to Testing
- Building is shared by a High School, a Charter School and YMCA Daycare
- 10/ 30 Fixtures had at least one sample above AL of 15 ppb, Highest at 530 ppb
- Goal is to comprehensively flush the Potable Water System
- Develop models and templates for application system wide
- Initially, Orr's SOW focused on Riser Flushing- but Top of Riser was contained in a masonry chase with pipe wrapped in ACM
- Appling Drinking Fountain Auto Flushing to Riser Flushing by increasing duration and locations.
- Use of Auto Flushing Commercial Sink Fixtures in key areas

Orr High School Pilot Project

- 18 Drinking Fountain Systems
- 1 Riser Flushing
- 6 Lavatory (Non Potable) Flushing
- Total Potable Fixture Count 30
- Number of main risers and branches?
- Water service from North via Athletic Annex



Orr High School Pictures



Automatic Flushing Devices

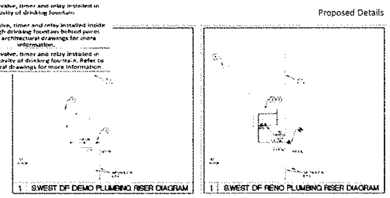
DRINKING FOUNTAIN SCHEDULE

TAG	LOCATION	REMARKS
PS-1	LOWER LEVEL KITCHEN	Solenoid valve controlled by timer.
DF-1	LOWER LEVEL KITCHEN	Solenoid valve, timer and relay installed in extended cavity of drinking fountain. Refer to architectural drawings for more information.
DF-2	LOWER LEVEL SW CORRIDOR	Solenoid valve, timer and relay installed in extended cavity of drinking fountain. Refer to architectural drawings for more information
DF-3	LOWER LEVEL NW CORRIDOR	Solenoid valve, timer and relay installed in extended cavity of drinking fountain. Refer to architectural drawings for more information
DF-4	1ST FLOOR SOUTH CORRIDOR 07	Solenoid valve, timer and relay installed in cavity of drinking fountain
DF-5	1ST FLOOR SE CORRIDOR	Solenoid valve, timer and relay installed inside wall of high drinking fountain behind panel. Refer to architectural drawings for more information.
DF-6	1ST FLOOR SW CORRIDOR	Solenoid valve, timer and relay installed in extended cavity of drinking fountain. Refer to architectural drawings for more information.

Examples of variations on each prototype

Proposed Implementation at Orr High School

Proposed Details



S.WEST DF DEMO & RENO PLUMBING RISER DIAGRAM

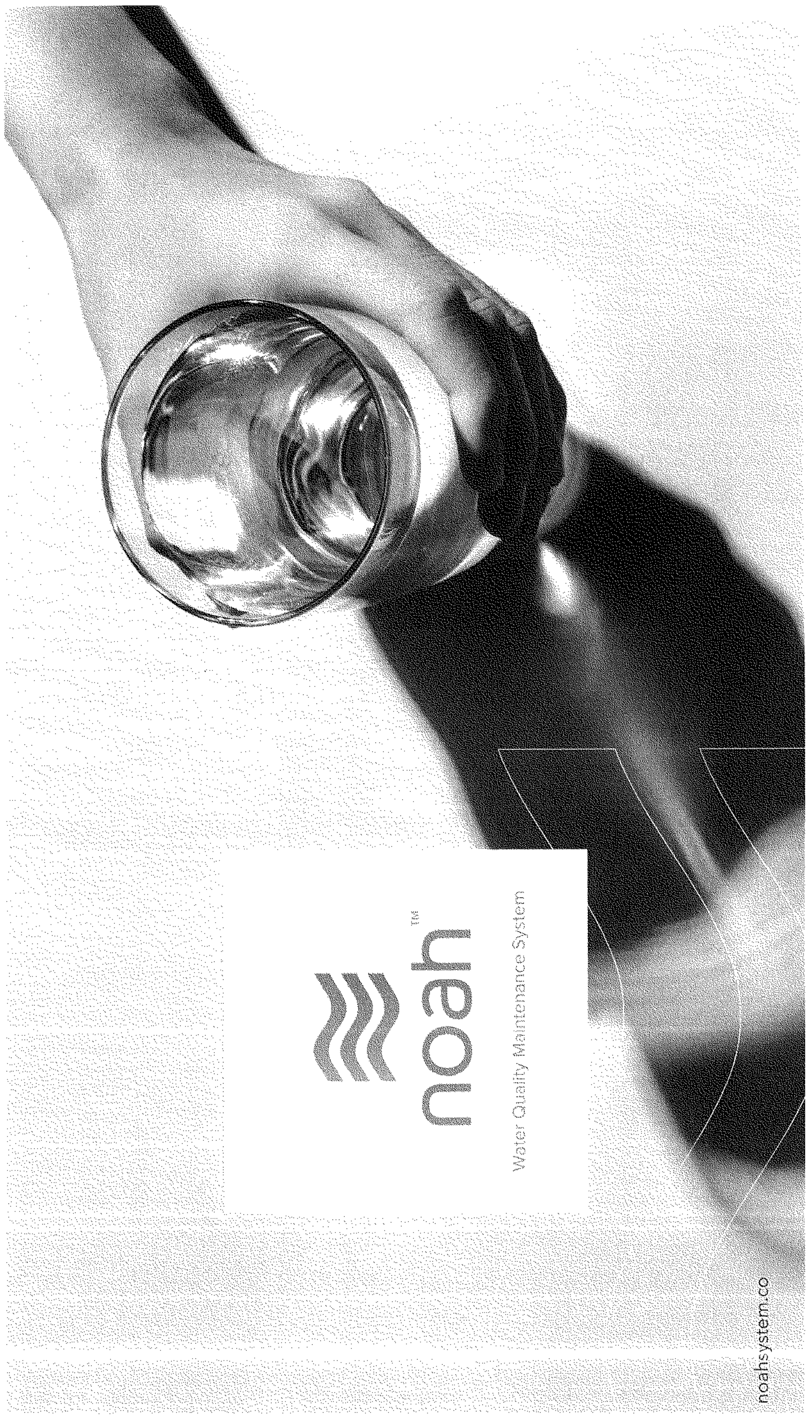
CPS Water Quality Management Plan and Next Step

- Expand and Refine Prototypes
- Developing Program to Apply across the system
- Continue Flushing Protocols and PM's with shift to Auto Flushing
- Retest all Potable Water Sources on a Four Year Cycle
- Use of Big Data and Spot Revivification
  - Flow Verification & Logging
  - Leverage our WiFi Network for Data collection, System monitoring & Verification
  - Spot Testing (Palintest)
  - Use of Temperature as control

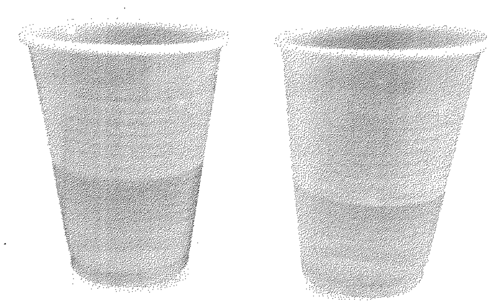
CPS Mitigation and Flushing

- Questions

- rmchristlieb1@cps.edu
- http://cps.edu/Pages/LeadTesting.aspx


noah™
Water Quality Maintenance System
noahsystem.co

NOAH is reducing and maintaining lead and copper levels in Homes and Schools across the Chicagoland area.



Before After

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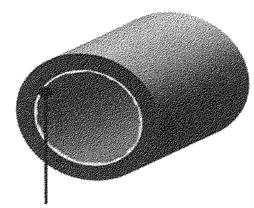
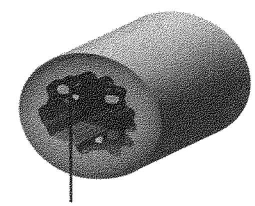
Elevated lead and copper levels persist

One major reason there are elevated lead and copper levels in drinking water is stagnation. The longer water sits in pipes, the stronger the concentration of lead and copper. Think of it like a tea bag.



A protective layer of **Orthophosphate** forms to prevent pipe corrosion.



Lack of corrosion control allows lead to leach from pipes into water.

Running Water

Manually running the water for a period of time before drinking helps some, but it is a waste of water and energy.

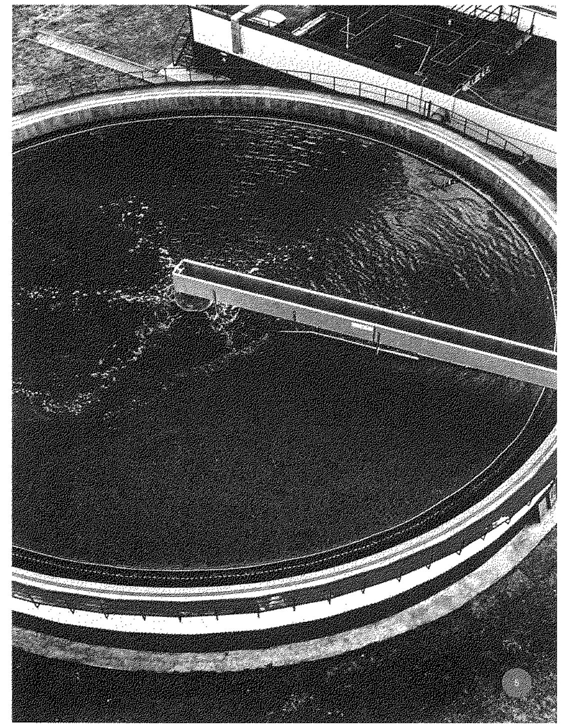
In commercial and public buildings, like schools, it is also a waste of money and resources since you must pay people to do this.

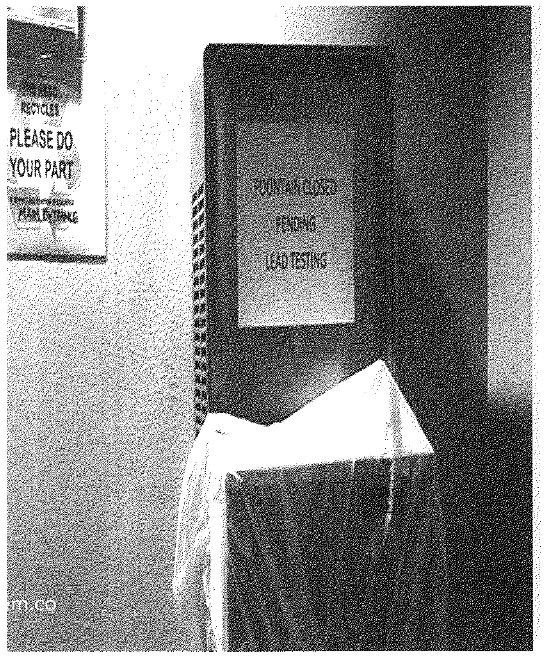
Orthophosphates

Orthophosphates are added to the water at treatment plants to help prevent corrosion of pipes which leads to particulates in the water.

Water stagnation begins to break down orthophosphates after 6 hours.

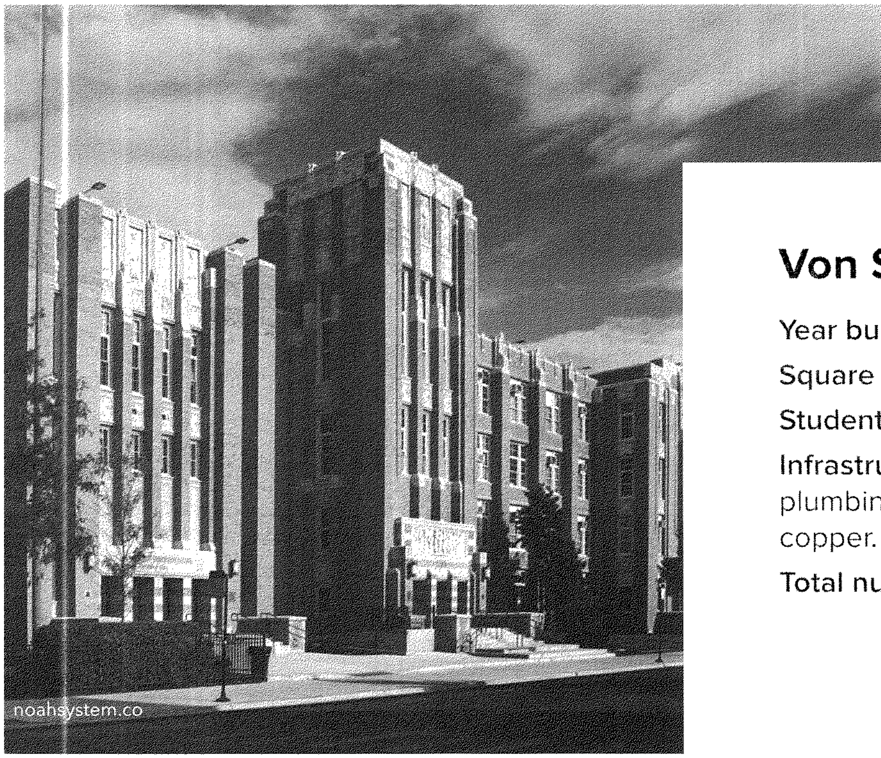
Reducing stagnation ensures corrosion control measures are consistently applied and maintained.





High lead levels

In 2016, CPS conducted district wide testing of their drinking water and found 37% of buildings had at least 1 fixture test above the action level of 15ppb.



Von Steuben High School

Year built: 1930

Square footage: 300,000

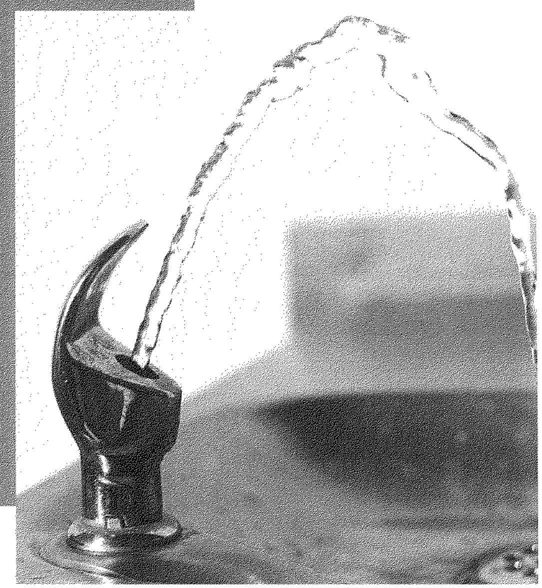
Student and staff population: 1,800

Infrastructure mechanicals: Mostly original plumbing. Combination of galvanized and copper.

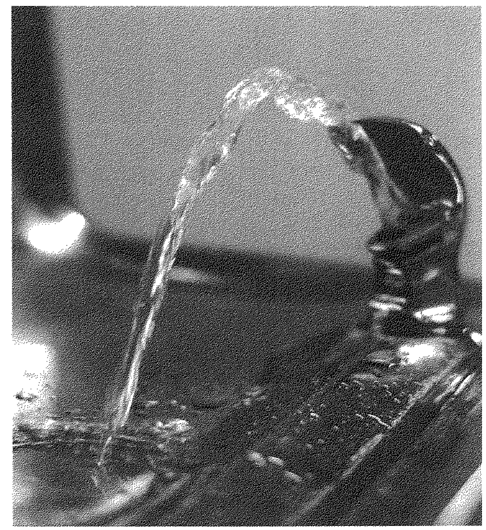
Total number of drinking fountains: 42

Spring 2016 CPS issues a manual flush protocol

Mandatory for all building engineers to manually flush all drinking fountains in their respective buildings for 1 minute every Monday before 8 am.



Moving water was the answer. Making that happen without dedicated staff was the question.



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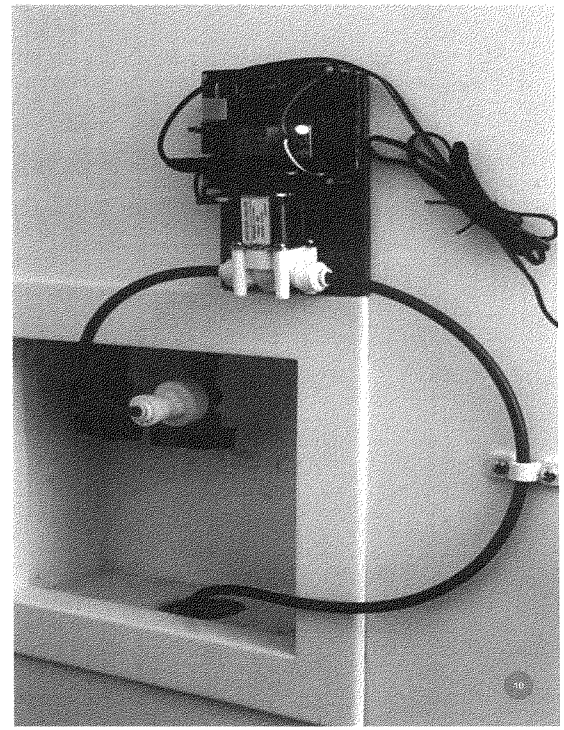
Noah

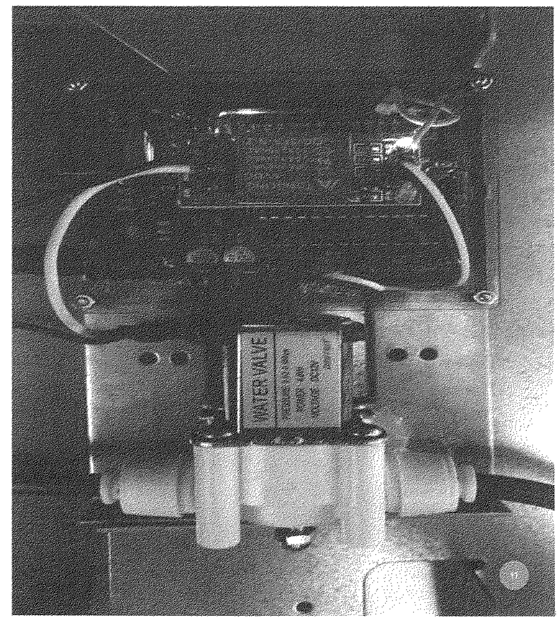
I had been working on something for my own home to flush my system automatically, and began investigating whether the idea could work for this purpose as well. I called it Noah.

Image shows Noah connected to the cold water line of laundry hookup in basement. Pulls directly from the main service line.



Noah

The Noah is a single board low voltage computer that is lightweight, dependable, easy to install and requires absolutely no maintenance. No batteries. No filters. No clocks to program.



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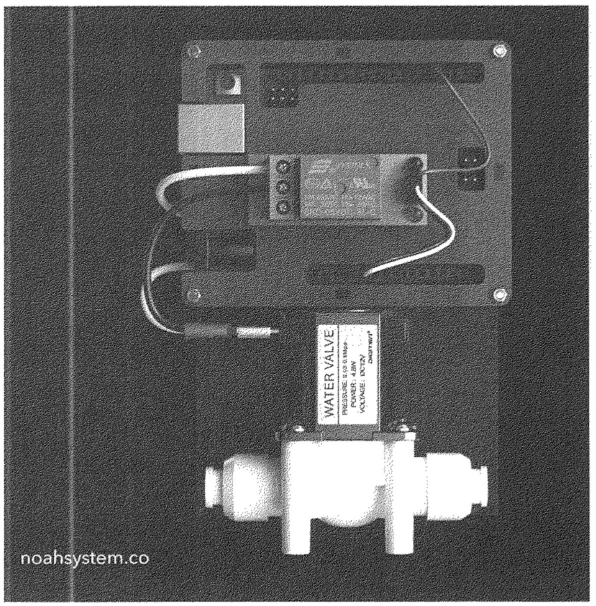
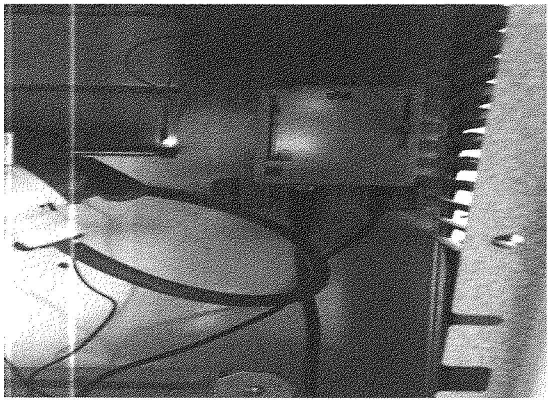


Prototype development

I began working on a prototype to test at Von Steuben. I researched the water quality coming from the water treatment plant to set benchmarks for the device including:

TDS
Temperature
Ph. levels.

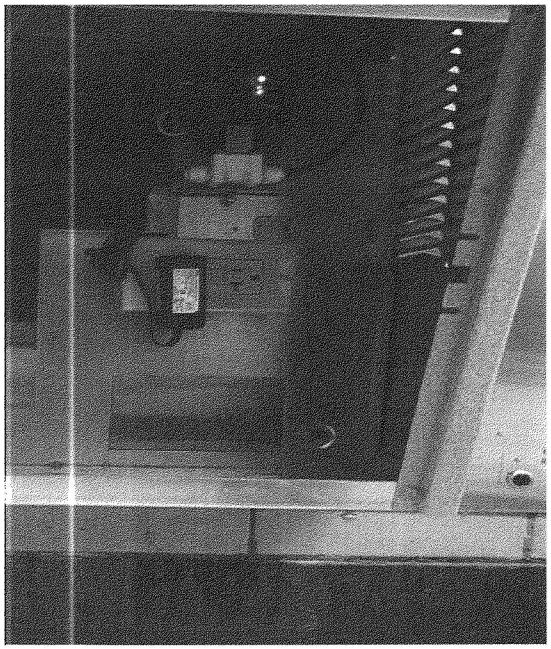


October 2016 First prototype Installed at Von Steuben

Working prototype installed Oct 16, 2016. Retrofitted into an existing fountain set to automatically flush fixture for 3 minutes every 3 hours.

Power to this fixture is tied into the hall lighting circuit. When the lights are turned on the system runs. When the lights are turned off, the system shuts down. No unnecessary overnight or weekend flushing.

Bottom: Drinking Fountain Retrofit Install. Connects directly to the supply line for the fountain and utilizes the fixture's bubbler to flush.



Continued to install auto Flushers on the top of all 6 risers

Installing at the top of the risers assured I was effectively treating the entire pipe that feeds all fountains on the floors below with orthophosphate while keeping supply pipe filled with fresh water.

Water temperature taken daily on all fixtures in the building.

Matching water temperature in the building to water temperature leaving the treatment plant meant I was delivering fresh water.

Daily TDS tests taken.

As I could not test for lead specifically, I used TDS meters to take daily samples to monitor the reduction of particulates.

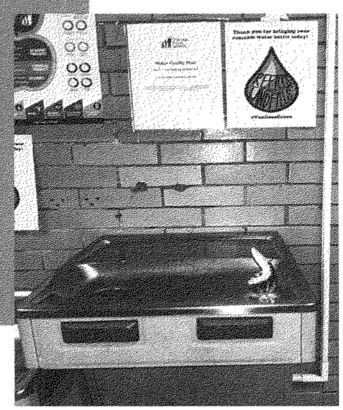
Positive Results

Tests showed Von Steuben was a success.

More importantly, because there was now clean, fresh water at the fountains, students began to bring refillable bottles from home, which cut down on single-use plastic bottles.

00616-011

06/07/2017	14:16	0010	<2	µg/L	Pb	Lead in water girls gym
06/07/2017	14:11	0010	<2	µg/L	Pb	Lead in water 2nd floor SE
06/07/2017	14:04	0010	<2	µg/L	Pb	Lead in water 2nd floor S
06/07/2017	13:58	0010	<2	µg/L	Pb	Lead in water 2nd floor N
06/07/2017	13:51	0010	<2	µg/L	Pb	Lead in water 2nd floor NW
06/07/2017	13:43	0010	<2	µg/L	Pb	Lead in water 2nd floor NE
06/07/2017	12:10	0010	<2	µg/L	Pb	Lead in water 1St floor Engineers office
06/07/2017	12:03	0010	<2	µg/L	Pb	Lead in water 2nd floor Lunchroom
06/07/2017	11:54	0010	<2	µg/L	Pb	Lead in water 2nd floor
06/07/2017	11:47	0010	<2	µg/L	Pb	Lead in water 3rd floor NE
06/07/2017	11:40	0010	<2	µg/L	Pb	Lead in water 3rd floor N
06/07/2017	11:32	0010	<2	µg/L	Pb	Lead in water 3rd floor S
06/07/2017	11:25	0010	<2	µg/L	Pb	Lead in water 3rd floor SW
06/07/2017	11:10	0010	<2	µg/L	Pb	Lead in water 3rd floor SE
06/07/2017	11:03	0010	<2	µg/L	Pb	Lead in water 4th floor S
06/07/2017	10:54	0010	<2	µg/L	Pb	Lead in water 4th floor N
06/07/2017	10:48	0010	<2	µg/L	Pb	Lead in water 1st floor SE
06/07/2017	10:38	0010	<2	µg/L	Pb	Lead in water 1st floor SW
06/07/2017	10:31	0010	<2	µg/L	Pb	Lead in water 1st floor S
06/07/2017	10:23	0010	<2	µg/L	Pb	Lead in water 1st N
06/07/2017	10:15	0010	<2	µg/L	Pb	Lead in water 1st floor NW
06/07/2017	10:07	0010	<2	µg/L	Pb	Lead in water 1st floor NE
06/07/2017	09:58	0010	4	µg/L	Pb	Lead in water
06/07/2017	09:54	0010	E1	µg/L	Pb	Lead in water



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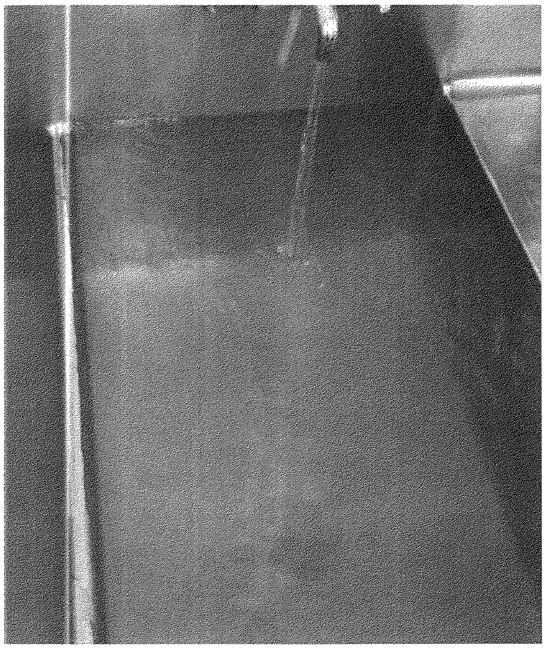
17



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Orr High School Pilot
Summer of 2017

After successfully installing Noah at Von Steuben and eliminating lead levels, CPS asked if I would participate in a pilot program at Orr High School.

Orr had some readings as high as 500+ ppb.

Orr test results Fall 2016

Provided the district with18 devices and assisted with installation and configuration.

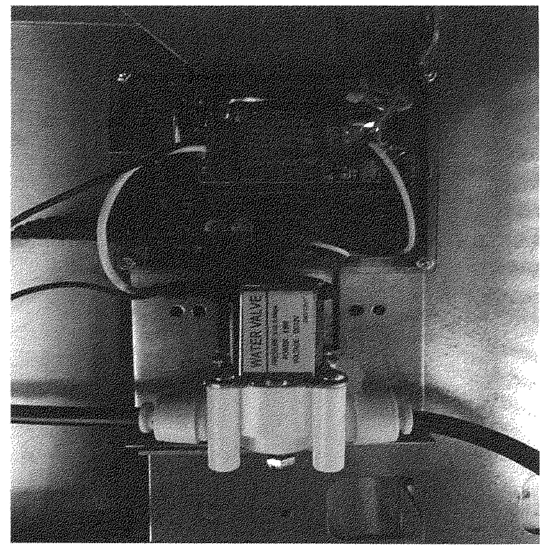
Average ppb per location: 45.65 ppb

Number of Locations	28.00
Total PPB All Samples	1278.20
Number of Tests	140.00
Average PPB per Test	9.13
Median PPB	2.00
90th Percentile	16.00
95th Percentile	25.00
Average Total PPB per Location	45.65
Max Value of Any Test	530.00

Install completed system operational August 2017

Installed 18 devices, all programmed to flush for 3 min every hour.

No pipes were replaced in the project.



First round of tests revealed lead levels plummeted to average less than 1 ppb.

January 2018 first round of tests revealed.

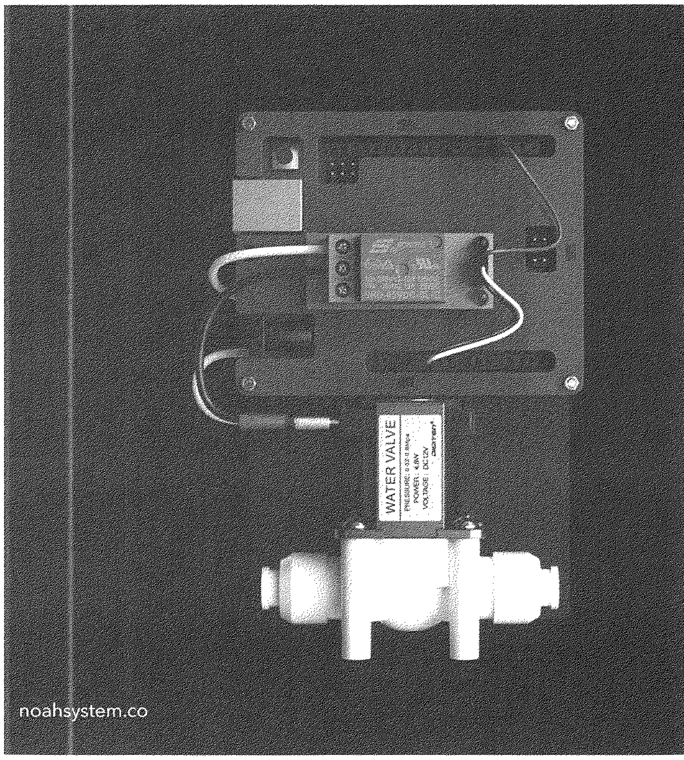
3 Min AF – Hourly Flushing	1st Round	2nd Round	Combined
Total PPB All Samples	15.1150	14.09	29.205
Number of Tests	18	18	36
Average PPB per Test	0.840	0.783	0.811
Median PPB	0.470	0.555	0.505

Noah successfully cured this building. Students now have access to clean fresh water daily. We can test this location today and the results will be the same. Noah will maintain less than 1 ppb at all times.

Onahan Elementary School February 2018

CPS asked if I would be willing to help them at Onahan School with 1 particular set of side by side fountains. It was a new fountain that had been recently installed but continued to give off erratic lead readings.

Between June and August of 2016 it's lowest reading was 109 ppb while its highest reading was 520 ppb. Between September of 2016 and January 2018 it had an average reading of 12.75 ppb. In February of 2018 Noah was installed and tested a few weeks later with a reading of 0.528 ppb. < 1 ppb



Noah works everywhere

What started as a solution to prevent stagnation in my home turned into a reliable, effective retrofit for drinking fountains in commercial buildings, schools and daycare centers.

Orr High School water analysis report

Summary of Lead analysis in drinking water on March 23 and 29, 2018

Prepared by Zhenwei Zhu
Date: April 4, 2018
Loyola University Chicago, IES

Introduction:

The auto flushers at Orr High School (OHS) have been operated with new flushing protocol (one minute per two hours) at 17 drinking fountains and one kitchen faucet since January 27, 2018. In order to evaluate the effectiveness of new flushing protocol, water analysis were scheduled on March 23, (before spring break). After the school was off, the auto flushers were turned off on the same day in order to study stagnation effect on water quality. Another round of water sampling was scheduled on March 29, 2018.

Even description:

On March 23, the water sampling started at 6:00 AM and completed around 7:30 AM. The water fountain 52378-1-HAL-F02 in the athletic building was out of order due to drainage pipe removal. The water fountain 51558-3-CAF-F06 in the third floor north cafeteria was susceptible to malfunction, based on the dryness of fountain water basin surface. This suspicion was confirmed by Michael Ramos on March 29 when I met him at the end of water sampling. The water flow rate from each drinking fountain was also measured.

On March 29, the water sampling started at 9:15 AM and completed around 10:30 AM. The water fountain 52378-1-HAL-F02 in the athletic building was out of order due to water leakage. I also met Michael Ramos who went there to turn on the auto flusher. I got the update about the cafeteria fountain in third floor and current flushing protocol.

Sampling procedure:

There were two water samples taken from each drinking fountain and kitchen faucet. The first draw was taken straightly from the drinking fountain without pre-flushing. The second draw was consecutively taken after the first draw. The glass sample bottle is 100mL. After sampling, 0.1 μL of concentrated nitric acid was added into sample bottle to preserve the water sample. All samples were taken back to Loyola University Chicago to be analyzed on ICP-MS.

Result summary:

The water lead analysis result and the flow rate for each faucet are summarized in the Table 1. The CPS ID number and water fixture location are also given in the Table 1. The flow rate is described in two units both liter per minute and gallon per minute. The unit for lead concentration in water sample is parts per billion.

Table 1. Lead analysis on sampling date March 23 & 29and flow rate measurement on March 23, 2018

Sample ID #	Sample Location	Tested	Fountaion ID	Fountain flow rate L/minute	Fountain flow rate Gal/minute	1st draw Pb (ppb)	2nd draw Pb (ppb)	1st draw Pb (ppb)	2nd draw Pb (ppb)
51558-B-KIT-KS07	Main- Basement Kitchen, Single Fixture Sink	x	PS-1	21.028	5.56	0.18	0.02	0.82	1.13
51558-B-KIT-F01	Main- Basement Kitchen, Fountain	x	DF-1	1.414	0.37	0.03	0.04	0.13	0.21
51558-B-HAL-F02	Main- Across From Room 014, Fountain	x	DF-2	1.370	0.36	0.15	0.07	0.34	0.36
51558-B-HAL-F03	Main- Across From Room 024, Fountain	x	DF-3	1.039	0.27	0.43	0.35	0.52	0.66
51558-1-HAL-WC03	Main- Next to Room 140, Water Cooler	x	DF-4	1.244	0.33	1.23	1.24	0.84	0.87
51558-1-HAL-F02	Main- Next to Room 100, Left Fountain	x	DF-5	1.241	0.33	0.63	0.74	0.34	1.85
51558-1-HAL-F06	Main- Outside Room 112, Fountain	x	DF-6	1.216	0.32	0.59	0.56	1.02	1.00
51558-1-HAL-F05	Main- Next to Room 118, Fountain	x	DF-7	1.399	0.37	0.27	0.21	0.90	0.33
51558-1-HAL-F13	Main-Outside Room 122, Middle	x	DF-8	1.508	0.40	0.94	0.87	1.94	2.00
51558-1-HAL-F04	Main- Across From Room 134, Fountain	x	DF-9	1.384	0.37	2.57	2.55	2.37	2.54
51558-3-HAL-WC08	Main- 3rd Floor North End Outside Mens Toilets, Water Cooler	x	DF-16	1.745	0.46	0.28	0.44	0.31	0.27
51558-3-HAL-WC09	Main-3rd Floor North End Outside Womens Toilets, Middle	x	DF-17	1.415	0.37	0.29	0.31	0.81	0.53
51558-3-CAF-F06	Main- 3rd Floor North Cafeteria, West Fountain	x	DF-18	0.817	0.22	16.2	6.40	0.99	2.47
51558-3-CAF-F01	Main- 3rd Floor South Cafeteria, East Fountain	x	DF-19	1.048	0.28	1.56	1.07	1.60	2.84
51558-3-HAL-WC04	Main- 3rd Floor South End Outside Mens Toilets, Water Cooler	x	DF-20	1.333	0.35	<0.003	0.003	1.64	1.18
51558-3-HAL-WC03	Main-3rd Floor South End Outside Womens Toilets, Water Cooler	x	DF-21	1.595	0.42	0.68	0.73	0.72	0.81
52378-1-HAL-F01	Athletic Bldg- 1st Floor Hallway Next to Boys Gym, Left Fountain	x	DF-22(left)	1.351	0.36	0.25	0.86	0.53	1.25
52378-1-HAL-F05	Athletic Bldg- 1st Floor Hallway Next to Boys Gym, Right Fountain	x	DF-22(right)	1.615	0.43	0.45	0.42	1.29	0.84
52378-1-HAL-F02	Athletic Bldg- 1st Floor Hallway Next to Girls Gym, Fountain		DF-23						
Sampling date				3/23/2018		3/23/2018		3/29/2018	

Conclusion:

The lead analysis on March 23, 2018 clearly shows the current protocol, one minute per two hours, is very effective in maintaining the lead level in drinking water below five parts per billion, which is the threshold level that Illinois Department of Public Health (IDPH) requires individual written or electronic notification to be sent to parents and legal guardians of all enrolled students in schools. The one troubled fixture 51558-3-CAF-F06 was out of order because the auto flusher did not work at all for unknown period.

The lead analysis on March 29, 2018 shows a rising trend of lead concentration in most of the water fixtures after more than 130 hours stagnation at Orr High School. However, the lead concentration still did not exceed the five parts per billion. Even the troubled fixture 51558-3-CAF-F06 gave good lead level after it was repaired.

The improved water quality from all drinking water fountains at Orr High School could be attributed to the following reasons. Firstly, the auto flushing helps flush out the existing loose lead particles in the water distribution pipe. Secondly, the fresh water brought in by frequent flushing supplies sufficient orthophosphate to keep the pipe coating intact over time, which results in the reduction of lead leaching from pipe material. **Therefore, auto flushing is a very economical and effective approach to mitigate lead in drinking water for outdated water infrastructure.**

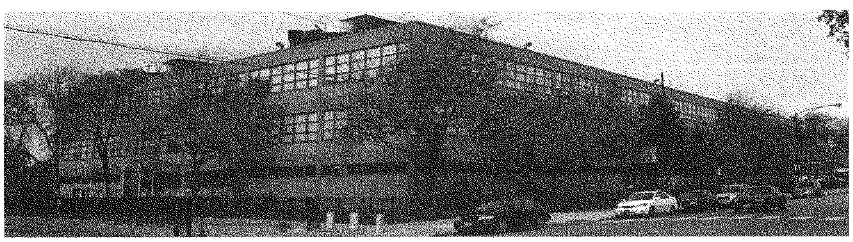
Reference:

Lead In Water, http://www.dph.illinois.gov/topics-services/environmental-health-protection/lead-in-water

Orr High School Water Mitigation Pilot Project

Auto Flushing System Case Study
For Lead Water Mitigation - Orr High School
Chicago Public Schools

April 15, 2018



Robert Christlieb
Environmental Services
Capital Planning & Construction
Chicago Public Schools

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EXECUTIVE SUMMARY

In July of 2016, the Chicago Public Schools (CPS) kicked off their Water Quality Testing & Mitigation program in conjunction with City of Chicago Department of Water Management. CPS developed a comprehensive district wide testing and mitigation protocols that focuses on identifying the root causes of lead contamination in drinking water. Once the root cause was identified, CPS would mitigate the problems to provide long term cost effective solutions.

The goal of this case study is to confirm the effectiveness of flushing in general and the *Automated Flushing System* in particular, for maintaining water quality during high occupied periods and to develop best practices for timing and frequency of flushing to maintain non-detectable lead levels in the system, confirm flush timing and levels based upon follow up water quality testing to be completed by the Loyola Sustainability Lab, and to develop programmatic templates for application across the district and establish design criteria for future projects.

The overarching goal is to maintain non-detectable (<2 ppb) levels in all potable water sources while building is occupied and the system is operating.

Post March 2018 Testing Summery

Automated Flushing is a highly efficient and effective methodology for reducing overall lead exposure in a facility. As seen in the Six Day Stagnation test conducted over Spring Break 2018, the Automated Flushing program disrupts the Lead Equilibrium timeline and protects the plumbing against lead leaching even when disabled for an extended period of time.

The improved water quality from all drinking water fountains at Orr High School could be attributed to the following reasons. Firstly, the auto flushing helps flush out the existing loose lead particles in the water distribution pipe. Secondly, the fresh water brought in by frequent flushing supplies sufficient orthophosphate to keep the pipe coating intact over time, which results in the reduction of lead leaching from pipe material. ***Therefore, auto flushing is a very economical and effective approach to mitigate lead in drinking water for outdated water infrastructure.*** *Dr. Zeinwei Zhu,* Loyola University - Institute of Environmental Sustainability

INTRODUCTION

Lead is recognized as the single most significant environmental health threat to America's children, according to the 1997 National Resources Defense Council study, *Our Children at Risk: The Five Worst Environmental Threats to Their Health*. The toxicity of lead in relatively small doses is associated with learning disabilities, poor attention spans and lowered IQ scores.

Although lead concentrations leaving a water treatment plant are generally low, corrosive water can result in lead leaching from lead pipes within a distribution system, lead solder used to connect pipe, or brass fixtures which may contain a small percentage of lead. The 1986 Amendments to the Safe Drinking Water Act (SDWA) required EPA to develop regulations to control for lead in drinking water. The Lead and Copper Rule (LCR), issued in 1991, is focused on controlling corrosion within the distribution system that delivers water to customers. The Rule requires that public water systems monitor a fixed number customer taps for lead. If more than ten percent of taps tested exceed 15 parts per billion (ppb), the system must undertake activities to control corrosively of water, increase monitoring, educate the public, and possibly replace lead service lines within the distribution system. Additional information on the LCR can be found at www.epa.gov/safewater/lead .

In 1989 and subsequent years, EPA released guidance and information to inform states and school systems how to test for and reduce the risk of lead exposure in school drinking water. EPA's guidance provides a protocol for testing water in schools and recommends that schools take action at fixtures where the lead concentration exceeds 20 ppb. This concentration differs from the 15 ppb action level that public water systems are required to follow. The 20 ppb action level is based on a smaller sample collection volume of 250 milliliters (ml) and is designed to pinpoint specific fountains and outlets that require attention. When testing fixtures, the levels of lead are expected in the initial flush of water that has been sitting in the pipes. The 15 ppb action level required for compliance with the LCR calls for a tap sample volume of 1000 ml (1 liter), and is designed to identify system-wide problems. If a one liter sample was collected from a drinking water fountain in schools, the initial high concentrations might be diluted by the later part of the sample, which could show lower concentrations. The 20 ppb school level is not inconsistent and likely is more stringent because it reflects a more concentrated sample; 20 ppb in a 250 ml sample would correspond to about 12 ppb in a one liter sample.

THE PROBLEM

Discolored water and high lead action levels at the start of day and during periods of low or no occupancy. Several fixtures tested above the action level during testing in the fall of 2016.

After recent experiences with the CPS Onahan Elementary School riser flushing project and non-draining plumbing, the design team began to rethink the approach. It was determined that riser flushing can work, but only if the drain works. Otherwise one experiences a high volume of water at a rapid rate, causing a waterfall. With the *Drinking Fountain Automated Flushing System*, this risk is decreased due to the volume of water at any given location being limited to .5-1 gpm. Onahan also had some significant environmental cost associated with the system install. The project had to access the riser in the masonry wall, abate the ACM insulation and then make the pipe install. This added cost and complexity to the project. The advantage of flushing at the fountain versus the riser is that it significantly decreases the potential for environmental issues and eases the complexity of installation and thus cost.

October 2016 Testing Data

Oct 2016 Test Summery -5 Sequential	
Number of Locations	28
Total PPB All Samples	1278.20
Number of Tests	140
Avg PPB Per Test	9.130
Median PPB	2.000
90th Percentile	16.000
95th Percentile	25.000
Avg Total PPB per location	45.650
Max value of any test	530.000

Note for purposes of this summery all ND <2 test results are considered to be =2.

CASE STUDY- AUTO FLUSHING SYSTEMS FOR LEAD WATER MITIGATION

BUILDING INFORMATION

Location name: Orr High School
Address: 730 N Pulaski Rd, Chicago, IL 60624
Size: 260,474 sf
Students: 550+ total (2017-1018)
Utilization for shared campus is 30%
Year Built: 1973

USER GROUPS

Academy for Urban School Leadership (AUSL)
Orr Academy High School
Kipp One Charter
YMCA Day Care Facility

PARTNERS

The Chicago Public Schools

Chicago Department of Water Management

Loyola University - Institute of Environmental Sustainability

Illinois Department of Public Health

Environmental Defense Fund

Moen North America

C|Z Design Strategies LLC

Coyne & Associates Architects

Maestro Ventures, LLC

Murphy & Jones Co.

Lead Out Manufacturing LLC

Carnow, Conibear & Associcates Ltd

THE PILOT

The Orr pilot is focused on flushing the potable drinking water systems, while trying various, timing methodology and locations for flushing. While Orr was originally designed to be a riser flushing demonstration project, after review, the cost comparison between riser flushing and the *Drinking Fountain Automated Flushing System*, as well as the understanding the *Drinking Fountain Automated Flushing System* ease of install, caused CPS to shift focus to the *Noah Automated Flushing System* as A solution with the Orr Pilot. Riser flushing installs cost about $3,000 – 3,500 per location plus any environmental abatement costs. *Drinking Fountain Automated Flushing System* installs are running $1,200 to $1,500 per location if power is nearby.

In addition to the seventeen *Drinking Fountain Automated Flushing System* devices planned for installation, this pilot project includes one riser/branch flusher servicing the kitchen at the basement level. The intent is to pre-flush the horizontal supply from main water service located in the athletic building to the north which supplied via the city main. This will pre-flush the main bulk of the system's volume, reducing the flushing run time required for each Noah Automated Flushing System above to reach fresh water.

In addition to installing riser flushing and *Drinking Fountain Automated Flushing System* at water fountains, the pilot also tested *Moen 8500* self-flushing vanity fixtures in remote bathrooms to assist in the flow of remote non potable locations.

Cost is always a factor with any capital expenditure and as such, the goal is to maximize water quality in Orr while minimizing capital investment. While Orr is problematic building, the goal is to develop design and maintenance best practices in a cost effective manner that can be applied district wide. The Orr pilot bypasses mid-level drinking fountains and focus on the key end of run locations to maximize the impact of flushing. The *Drinking Fountain Automated Flushing System* is being installed at the Top of the Riser (TOR) End of a Branch (EOB).

The pilot project is designed to use the school's hall lighting system as a facsimile for a Building Automation System (BAS). The *Drinking Fountain Automated Flushing System*'s at Orr are tied to the building hallway lighting circuits. When the lights are turned on at the start of the day, the *Drinking Fountain Automated Flushing System* runs it program.

Due to the observed water conditions and test results at Orr, the *Drinking Fountain Automated Flushing System* will initially start with a flushing program of 20 mins at the start of the day (when the lights are turned on), and 5 mins per hour thereafter while the lights are on. The goal is to reduce flushing timing to the minimum required to maintain exceptional water quality and Pb testing below 2 ppb throughout the potable water system (maintenance level) while minimizing water usage.

The Loyola Institute of Sustainability has partnered with CPS on developing numerous testing protocols (Orr WQ Tests) to be used over the next 6-9 months at Orr to test the effectiveness of the auto flushing concept, and develop best practices for timing and design. CCA & the Loyola Institute of Sustainability are working together to providing testing and lab services for the pilot. .

PROJECT SCHEDULE

Design Development & Bid Documents 1/2017-May 1, 2017

Install Completed 7/21/2017

System Operational 8/1/2017

Testing & Monitoring 8/1/2017 TO 06/2018

January 2018 Testing

All of the SOW for the bid package has been completed with the exception of the pipe sampling portion. Due to the upcoming testing, we decided to delay this portion of the work until after the Spring Break round of testing is completed. Work is now scheduled for the last day of Spring Break.

As of January 2018 the system has basically been running for about 6 months. 16 of the DFAF were programed to run in 24/7 with a three minute run time. One unit was on a 7 day schedule with weekends programmed off. We have received antidotal feedback back from the facilities team and teachers of better water quality. Cloudy start up water is no longer an issue, water is cool and clear. In hind sight, we consider this an aggressive flushing scheme given the results we were seeing.

Building Wide Testing - CCA 1/12/2018

Prior to testing CPS verified with the Building Engineer that the system was 100% operational. We believe that may not have been the case but cannot confirm. After the second round of Loyola testing, Mike Ramos surveyed and reprogramed the system noting a couple of issues detailed at the end of this report. We are not sure if the issues discovered (disconnected units) impacted any or all rounds of testing in January.

CCA tested all potable fixtures as required under our standard protocol as well as the sink locations with Moen vanity fixture installed. Students had returned from Winter break on January 3rd, occupying the building for a week before CCA tested. The results are impressive given the overall improvement in lowering lead levels in the facility.

January 2018 Test Summery- 5 Sequential	
Number of Locations	53
Total PPB All Samples	484.239
Number of Tests	247
Avg PPB Per Test	1.960
Median PPB All Samples	1.120
90th Percentile All Samples	4.246
95th Percentile All Samples	5.408
Avg Total PPB per location	9.137

(6 vanity @ 2 tests, 47 Full Sample)

The test did indicate some outlier fixtures that are being addressed. Some bypassed flushed fixtures on 2 have higher levels that stand out in underutilized areas of the building.

Dr. Zhu also did a review and analysis of the 1/12/2018 testing results. Please see attached for lessons learned. *Short Summary of the TEST AMERICA lead analysis at OHS*

Loyola Testing January 2018

Testing scheduled for Monday January 15th MLK Day. No students present. Goal of this round of testing by Dr. Zhu was to test the effects of stagnation by shutting off the system for 2 days, test, turn back on for 24 hours and test again on January 16th. BE was directed to turn off the AFS on Friday, January 12th. That was not completed and the testing turned into a sampling of the existing flushing protocol focusing on locations with an AFS only with the exception of the Kitchen location and riser flusher. See attached report: *OHS Drinking Water Lead Analysis Summery-Sampling Jan 15+21 2018*

Auto Flushing System Testing –Three Minute Flushing

Below is a brief summary of the test results from sampling the operational AFS with flushing of 3 minutes per hour on 1/15/2018.

3 Min AF -Hourly Flushing	1st Round	2nd Round	Combined
Total PPB All Samples	15.1150	14.09	29.205
Number of Tests	18	18	36
Avg PPB Per Test	0.840	0.783	0.811
Median PPB	0.470	0.555	0.505

90th Percentile	2.442	2.243	2.315
Avg Total PPB per location	0.840	0.783	0.811

44 Hour Stagnation Testing

The Stagnation test was rescheduled for January 21st at 1:00 pm the Building Engineer and Dr. Zhu completed the testing. The AFS was confirmed off by the BE on Friday afternoon the 19th.

Please See **Orr High School Drinking Water Lead Analysis Summary** for detailed results and findings.

AFS w/44 Hour Stagnation	1st Round	2nd Round	Combined
Total PPB All Samples	50.9400	23.59	74.53
Number of Tests	18	18	36
Avg PPB Per Test	2.830	1.311	2.070
Median PPB	0.865	0.690	0.795
90th Percentile	6.252	3.385	2.880
Avg Total PPB per location	2.830	1.311	2.070

Pilot Note: Issues were discovered after testing was completed with the Drinking Fountain AFS during reprogramming to the lower flush rate, but we can cannot confirm when these issues occurred. All four Drinking Fountain AFS are now operational as of 1/27/2018.

Comments from Building Engineer checking Units:

Here are my notes taken on my last visit to Orr, 1/27/18.
Found following devices disconnected:
1st floor NE fountain outside of room 126.
3rd floor by 312
3rd floor south lunchroom Orr side
3rd floor north lunchroom Charter side

Athletics building west fountain damaged needs repair.
All devices are now running at 1 minute every two hours.

Lessons Learned -January Testing:

- Direct flushing is highly effective in reducing particulate counts in the water.
- The consistent application of water flow results in the buildup of the orthophosphate in the pipes, which helps inoculate the plumbing system even when the AFS are turned off for the weekend.
- Indirect flushing of fixtures can be beneficial but there is still the issue of minimum use and the last few feet a pipe from the riser to the fixture.
- Fixtures on the third/upper floor were more prone to stagnation effects due to position relative to the buildings water use during non-school hours. TOR
- The flushing mechanisms help reduce the risk of lead accumulation from gradual leaching.

- Need a way to easily verify operations of the Auto Flushing Systems and Riser Flushing Systems.
- Need for PM (preventative maintenance) check

Questions & Potential Tests moving forward - January Rounds of Testing:

- Now that the building has been aggressively flushed, can we reduce the flow rate to a lower level and still maintain reduced test levels?
    - AFS Timing has been reduced to 1 minute every 2 hours as of 1/27/2018.
    - Test Pre Spring Break- 3/23/2018 for effectiveness of 1 minute Flush Timing.
- What if system is off for a week?
    - Test over Spring Break. 3/29 Scheduled Test by Loyola
- A serial sampling up to 10 samples from one fountain on each floor will describe the lead concentration gradient up to 140 inches in the pipe. Therefore, this sampling protocol will diagnose the existence and seriousness of inner pipe leaching.
- How effective would TOR flushing be in a given building?
- Potential Criteria for ranking building flushing needs in individual buildings:
    - Age of students in the building
- High/Low Utilization Rates
- Water Usage per Square Foot
- Building design simplicity vs remodeled older structures
        - Powell- 1 Riser/3 stories- concentrated flow
        - Typical older HS- 8-12 Risers/3 Stories- diversified flow
    - Age of Building

March 2018 Testing

March 23, 2018 Testing for 1 Minute Flush Timing

Dr. Zhu completed another round of testing on March 23 to test the effectiveness of reducing the hourly flushing timing from 3 minutes every hour to 1 minute every two hours. Dr. Zhu also took flow rate measurements in order to calculate water usage. Please see attached report and test results for 3/23, 3/29/2018 testing. *Orr High School Water Analysis Report April 4, 2018*

1 Min AF -Hourly Flushing	1st Round	2nd Round	Combined
Total PPB All Samples	26.72	16.87	43.59
Number of Tests	18	18	36
Avg PPB Per Test	1.484	0.937	1.211
Median PPB	0.454	0.500	0.454
90th Percentile	5.295	2.937	2.560
Avg Total PPB per location	1.484	0.937	1.211

Our primary take away from this round of testing is that once a building has stabilized from flushing, maintenance flushing rates can be reduced without impacting results.

Please note that over all test results were skewed by the fixture located in the 3rd Floor Cafeteria, 51558-3-CAF-F06 (DF 18). The Auto Flusher at this location was disconnected at the time of testing and the results of 16.19 ppb are indicative of that loss of flushing. Fixture 52378-1-HAL-F05 (DF-23) is disabled and out of service due to vandalism.

March 29, 2018 Testing for 6 Day Stagnation after 1 Minute Flush Timing

On March 23, after Dr. Zhu completed his sampling, all the AFS units were disconnected. DF-18 which was not operational at the time of testing on 3/23 and had been unplugged for an unknown period was checked to confirm operation and ran for one cycle. It was then deactivated along with the other 17 AFS. The riser flusher servicing the basement and main water loop was not deactivated since the kitchen was occupied during the break. During Spring Break (3/23-4/1, students returned 4/2) the building was still in use by both schools office staff, the building engineers, minimal kitchen staff and the custodial crew. Average daily occupancy was in the range of 7-10 adults. All drinking fountain AFS were deactivated Friday afternoon and not reactivated until testing was completed on Thursday, 3/29.

Summary of 3/29 6 Day Stagnation Test Results Summery

6 Day Stagnation	1st Round	2nd Round	Combined
Total PPB All Samples	17.1100	21.1400	38.25
Number of Tests	18	18	36
Avg PPB Per Test	0.951	1.174	1.063
Median PPB	0.830	0.935	0.855
90th Percentile	1.983	2.570	2.400
Avg Total PPB per location	0.951	1.174	1.063

These samples taken after six days of stagnation and minimal building use surprised our team. We were expecting a visible uptick in the lead concentrations, especially at the 90th Percentile. The system returning to Lead Equilibrium should have been more evident. Even with the DF-18 fixture that tested Above Action Level (AAL) on 3/23 in the calculation, the Median PPB almost doubles to 0.86 ppb from 0.45 after 6 days of stagnation. While this is a large percentage jump (XX%) in the Median score, it is still well below the 2 ppb standard. If the DF-18 score is corrected/ adjusted to the average of all 18 first draw samples and replaced with the average value of 1.45 ppb, the 90th Percentile score only increases from 1.76 ppb to 1.98 ppb after six days of stagnation.

Our working theory is that the consistent and almost constant flushing since August 2017 has built up a significant coating of orthophosphates, protecting the water even under prolonged near stagnation conditions, effectively reducing the lead equilibrium point in the system to safe levels over the given time period.

Conclusion from Dr. Zhu's 4/4 Report:

The lead analysis on March 23, 2018 clearly shows the current protocol, one minute per two hours, is very effective in maintaining the lead level in drinking water below five parts per billion, which is the threshold level that Illinois Department of Public Health (IDPH) requires individual written or electronic notification to be sent to parents and legal guardians of all enrolled students in schools. The one troubled fixture 51558-3-CAF-F06 was out of order because the auto flusher did not work at all for unknown period.

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The improved water quality from all drinking water fountains at Orr High School could be attributed to the following reasons. Firstly, the auto flushing helps flush out the existing loose lead particles in the water distribution pipe. Secondly, the fresh water brought in by frequent flushing supplies sufficient orthophosphate to keep the pipe coating intact over time, which results in the reduction of lead leaching from pipe material. ***Therefore, auto flushing is a very economical and effective approach to mitigate lead in drinking water for outdated water infrastructure.***

Items to Review:

Staged flushing: Heavy, Medium and Maintenance- How long for each?

If we have effectively shifted the Lead Equilibrium point downward, how long will it remain effective?

It would seem that tying the AFS to the Lighting system as an Occupied/Unoccupied Mode controller (16 Hours a day, 5 Days a week) would work well in maintaining water quality even when school is not in use. Need to test in a building with 110-120 lighting systems

Water Usage Calculations

Below are the water usage calculations for the Pilot based upon Dr. Zhu's sampling on 3/23. We are currently attempting to gather information on historic and current water usage in the building. At this time, CPS does not track water meter numbers, service locations or usage due to the simple fact that we do not pay for water service or usage. We are currently working on a project to identify and track water meters in our Oracle Facilities Database and determine building water usage. Table below.

Fountain ID	Notes	Fountain flow rate					
		L/minute	Gal/minute	3 min/hr	3min/24 hr	0.5 min/hr	0.5 min/24 hr
PS-1	15 min program	21.028	5.56	*83.4*	*83.4*	*83.4*	83.4
DF-1		1.414	0.37	1.11	26.64	0.185	4.44
DF-2		1.37	0.36	1.08	25.92	0.18	4.32
DF-3		1.039	0.27	0.81	19.44	0.135	3.24
DF-4		1.244	0.33	0.99	23.76	0.165	3.96
DF-5		1.241	0.33	0.99	23.76	0.165	3.96
DF-6		1.216	0.32	0.96	23.04	0.16	3.84
DF-7		1.399	0.37	1.11	26.64	0.185	4.44
DF-8		1.508	0.4	1.2	28.8	0.2	4.8
DF-9		1.384	0.37	1.11	26.64	0.185	4.44
DF-16		1.745	0.46	1.38	33.12	0.23	5.52
DF-17		1.415	0.37	1.11	26.64	0.185	4.44
DF-18		0.817	0.22	0.66	15.84	0.11	2.64
DF-19		1.048	0.28	0.84	20.16	0.14	3.36
DF-20		1.333	0.35	1.05	25.2	0.175	4.2
DF-21		1.595	0.42	1.26	30.24	0.21	5.04
DF-22(left)		1.351	0.36	1.08	25.92	0.18	4.32
DF-22(right)		1.615	0.43	1.29	30.96	0.215	5.16
DF-23	Assumed		*0.36*	1.08	25.92	0.18	4.32
			Gal/minute*	**3 min/hr**	**3min/24 hr**	**0.5 min/hr**	**0.5 min/24 hr**
		Totals	11.93	102.51	542.04	86.59	159.84

Pipe Sampling for Lead Leaching Rates

As part of the Pilot, we are removing and replacing three (3) 3'-4'sections of water supply pipe from various locations in school. Sample sections will be submerged in water and delivered to Loyola University for analysis on lead leaching rates and pipe material components. Samples locations will be selected by the AOR and removed and replaced by a licensed plumber. This work is currently scheduled for the summer break in order to minimize disruption to plumbing system during the school year.

Katie Scarlett Brandt
Chicago, Illinois
katie@katiescarlettbrandt.com

October 10, 2019

Congress of the United States, House of Representatives
Committee on Science, Space, and Technology
2321 Rayburn House Office Building
Washington, DC 20515-6301

To the Members of the Committee on Science, Space, and Technology:

When my husband and I bought our home last year, we were beyond excited. Our baby was two months old, and we couldn't wait to start building our family in our own space. The home was a dream we'd been working toward for years: room to grow for our son, a yard for our dogs, an office for myself.

But worry tugged at the edges. As a new mom, I felt the weight of responsibility for another life like never before. As a medical journalist, I tracked news about Flint, soon followed by reports of high lead levels in 3 out of every 10 homes in my own city.

Lead is a neurotoxin that damages developing brains, and a heavy metal that contributes to heart disease and kidney failure. No one wants to hear that, especially not a new mom. So when I learned Chicago was offering free water tests, I ordered one and hoped for the best.

Months later, my phone rang. On the other end: the Water Department, telling me that my home's water lead level surpassed the EPA action level. The city conducted further testing. I hoped for a mis-read of the initial test, but results came back even higher: 22.6 ppb. We'd used that water daily.

The city workers left us with a water filter—a temporary solution at best, a brush off at worst. I felt at a loss. Replacing our service line was unaffordable with the expenses of a new baby and a new mortgage.

Coincidently as this unfolded, I was reporting on lead for Chicago Health Magazine. I read studies and interviewed physicians, teachers, other moms, public health researchers, and aldermen. Those conversations eventually led me to Michael Ramos, an engineer at Chicago Public Schools.

Acutely aware of Chicago's lead issue, Mr. Ramos had invented an automatic water flushing device, which he called The Noah. The device runs the water intermittently to prohibit lead from percolating while also adding a protective coating to the water pipes. I asked Mr. Ramos if he could install one residentially, specifically in my home. The cost ($250 for the device, along with slightly elevated water bills) was far more affordable than replacing our service line.

And it worked. Our water now runs every three hours, for three minutes at a a time. When I tested our water again, the results showed less than 1 ppb lead. After months of uncertainty: relief. I feel safe giving our water to my now 20-month old to drink. I don't hesitate to cook his favorite pasta in it, or to use it to make my coffee each morning.

This problem impacts my family's health, my home's value, and our society as a whole. Lead hits hardest in the brain's prefrontal cortex, the area associated with impulse control and decision-making. So while ridding an entire city of lead is undeniably a major undertaking, ignoring lead costs us all even more—in crime, medical bills, lost wages and support for children with behavioral and learning challenges.

In my dream world, local, state, and federal governments prioritize lead mediation, ensuring safe drinking water. I thank you for giving this your time and attention. And I hope you've tested your water.

Sincerely,

Katie Scarlett Brandt

P.S. You can read my story on lead for Chicago Health at chicagohealthonline.com/leads-dangerous-legacy/. Thank you again.

Von Steuben
METROPOLITAN SCIENCE CENTER

February 12, 2018

To Whom It May Concern,

I'm a senior at Von Steuben High School. For the past 3 years I was never a fan of the water fountains. I used to bring a water bottle from home since the water tasted a lot better than when I drank from the water fountain at school. Like majority of my fellow students I was concern about the level of contamination in our water at school since at home our water tasted fresher due to our filtration systems, but at school it was a different story. However, recently I began to notice a lot more students filling up their water bottles at the north side of the building near our lunch room. I was informed that a new filtration system was put in, I gave it a try. The water tasted a lot fresher, and clean due to the Noah Filtration system. I feel a lot more safe and content knowing our water is just as clean and fresh as the water in our homes.

Sincerely
Mellisa Merchan

Von Steuben
METROPOLITAN SCIENCE CENTER

February 12, 2018

To Whom It May Concern,

I always bring water bottles to school, and I'm constantly refilling them with the fountains at school. More recently, I do find that the water has been a lot more fresh and colder too. I believe since the Noah Filtration system has been installed more people are using the water fountains.

Thank you,
Kaleigh

Von Steuben
METROPOLITAN SCIENCE CENTER

February 12, 2018

I've always avoided the water fountains at school, because of how quickly the water would get warm. However, when the Noah Filtration System was put into use I've been using the water fountain more because of how cool the water stays and how fresh it tastes. This way I've been filling up my bottle more often which leads to drinking more water. This filtration system should be put in all of the fountains.

Jasmina Buzaljko

Von Steuben
METROPOLITAN SCIENCE CENTER

February 12, 2018

Being a senior at Von Steuben High School I feel less worried drinking water from the water fountain. In freshman year I would avoid drinking water from the fountain at all costs, I felt like the water was grey and dirty when I would fill up my water bottle. The taste was also awful, I continued to bring my own water and not drink from the water fountain. Now that the Noah Filtration system was set up around my school I feel more secure about drinking water from the fountain. Now that the filtration system cleans the particles of the water, purifying the water to make it safe and clean to drink I use it more. I think because of the filtration system I'm going to the fountains more and they should be set up in every school.

Alma Duderija

THE BIGGEST CHILL

Glaciers gave Puget Sound its remarkable, sculpted landscape
PACIFIC NW > INSIDE

Get back out there
Outdoor gear gets a second life in new store THE MIX > E1

Huskies stay perfect in Pac-12
Three-point shooting was key to 69-55 win over UCLA Bruins SPORTS > C1

The Seattle Times
Sunday
FEBRUARY 3, 2019
SHOWERS
High, 42. Low, 31. > B8
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TRAFFIC LAB

How the Highway 99 tunnel might shake up your routine

On Monday, the long-awaited route opens under Seattle

ELLEN M. BANNER / THE SEATTLE TIMES
Thousands of walkers head from the northern entrance of the new Highway 99 tunnel to its southern exit as part of tunnel-opening festivities Saturday. Other events included an 8-kilometer run, and tours of the viaduct and the old Battery Street Tunnel. > SEE STORY, B1.

By MIKE LINDBLOM
Seattle Times staff reporter

In the time Washington state took to debate, design and build the Highway 99 tunnel, newborn babies grew old enough to drive inside it.

The passage between Sodo and South Lake Union, to open early Monday, serves a different Seattle than we inhabited in February 2001 when the Nisqually earthquake weakened the Alaskan Way Viaduct, or in January 2009 when Gov. Christine Gregoire decided to build the replacement tunnel.

Since the quake, the city's population has grown nearly one-third to 730,000, while Everett to the north now endures the nation's worst highway delays. Amazon built towers, and commute habits evolved. Nowadays, half of downtown workers take transit and only one-fourth drive alone, fundamentally changing how people experience traffic congestion.

The tunnel is built to last 100 years, so future generations might find new ways to use the $3.3 billion investment with cleaner vehicles or other innovations. Meanwhile, Seattle now has waterfront without the 80-decibel roar of the viaduct, which closed for good last month.

This is the longest (2 miles) and widest (53 1/3 feet) multilane tunnel in North America. It snakes about 18 stories below Pike Place Market.

And beginning Monday, the tunnel will upend traffic patterns across the city center and funnel cars into neighborhoods already becoming more congested, more dense and more crowded with pedestrians.

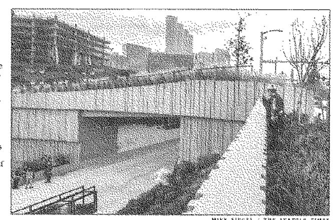
Drivers might need three months to settle into consistent patterns, based on experience when new tolls were imposed on the Highway 520 bridge in late 2011. Highway 99 traffic will vary during viaduct demolition, construction of surface Alaskan Way, and tunnel tolls beginning in the summer.

"Be patient. Things are going to be different at both ends. There's going to be increased demand on some streets where people haven't seen it before, and others less, as people experiment with new routes," said Mike Swires, traffic engineer for the Washington State Department of Transportation (WSDOT).

Tunnel critics, meanwhile, still argue the project was a missed opportunity to reduce the use of fossil-fuel vehicles and spend more money on transit. A state law says Washington must reduce greenhouse gases 25 percent by 2030.

Tunnel-design engineer Susan Everett of WSDOT notes that the tunnel serves a key

See > TUNNEL, A10



MIKE SIEGEL / THE SEATTLE TIMES
The north portal of the new Highway 99 tunnel shows the entry to the southbound lanes under Harrison Street.

ONLY ON SEATTLETIMES.COM

If you missed the Facebook Live session with Traffic Lab reporters about the viaduct and the tunnel, watch it here: st.news/answers

From fire sprinklers to surveillance cameras, the Highway 99 tunnel is loaded with safety features

By MIKE LINDBLOM
Seattle Times staff reporter

Sooner or later a crash or fire will occur inside the new Highway 99 tunnel, where the vehicle exits are a daunting 2 miles apart.

To quell the dangers, designers equipped the deep tube with a 21-mile network of sprinkler pipes, along with jet fans, surveillance cameras and instant message signs, that together reflect the world's newest safety features.

"This is one of the best," said Brian Russell, regional vice president of HNTB, an engineering firm for builder Seattle Tunnel Partners.

The need for preparedness was driven home last month, when a charter bus carrying the Stanford University track team burst into flames on northbound Interstate 5 near Columbian Way. What if a vehicle catches fire in the tunnel?

Temperature sensors on the walls would trip alarms. Water would automatically start spraying in 87 seconds, or sooner if engineers at the regional traffic-control center in Shoreline turn them on. Tunnel decks are fully covered by security cameras that make a quicker response likely, said Susan Everett, tunnel design manager for the Washington State Department of Transportation (WSDOT).

Water would fall at a rate of one-third of an

See > EMERGENCY, A11

EDUCATION LAB

Lead found in water at many city schools

SEATTLE PUBLIC SCHOOLS

Districts' own levels were exceeded in 42 of 99 sites; Chicago may have answer

By NEAL MORTON
Seattle Times staff reporter

Water sources at more than half the city's South End schools, which serve many students of color and children living in poverty, exceeded the Seattle Public Schools' limit for lead, according to a recent analysis of the district's data.

The Seattle school district tests the water in drinking fountains and classroom sinks at each campus at least once every three years. Through early 2018, the results of those tests showed 53 percent of schools in South Seattle registered lead readings above what the district considers an acceptable level of exposure.

And the environmental risk isn't limited to children in less-privileged neighborhoods: Elevated levels of lead appeared in tests at 36 percent of schools in whiter and more affluent North Seattle schools.

District officials say the high lead readings don't pose a danger to students, because the failed fixtures are classroom sinks, not

See > WATER, A12

MIKE SIEGEL / SEATTLE TIMES
A Seattle Public Schools administrator collects water for testing from a drinking fountain at Emerson Elementary School in South Seattle.

Boeing, FAA decisions face scrutiny after Lion Air crash

By JAMES GLANZ, JULIE CRESWELL, THOMAS KAPLAN AND ZACH WICHTER
The New York Times

In the brutally competitive jetliner business, the announcement in late 2010 that Airbus would introduce a more fuel-efficient version of its best-selling A320 amounted to a frontal assault on its archrival Boeing's workhorse 737.

Boeing scrambled to counterpunch. Within months, it came up with a plan for an upgrade of its own, the 737 MAX, featuring engines that would yield similar fuel savings. In the years that followed, Boeing pushed not just to design and build the new plane, but to convince its airline customers and, crucially, the Federal Aviation Administration

See > BOEING, A6