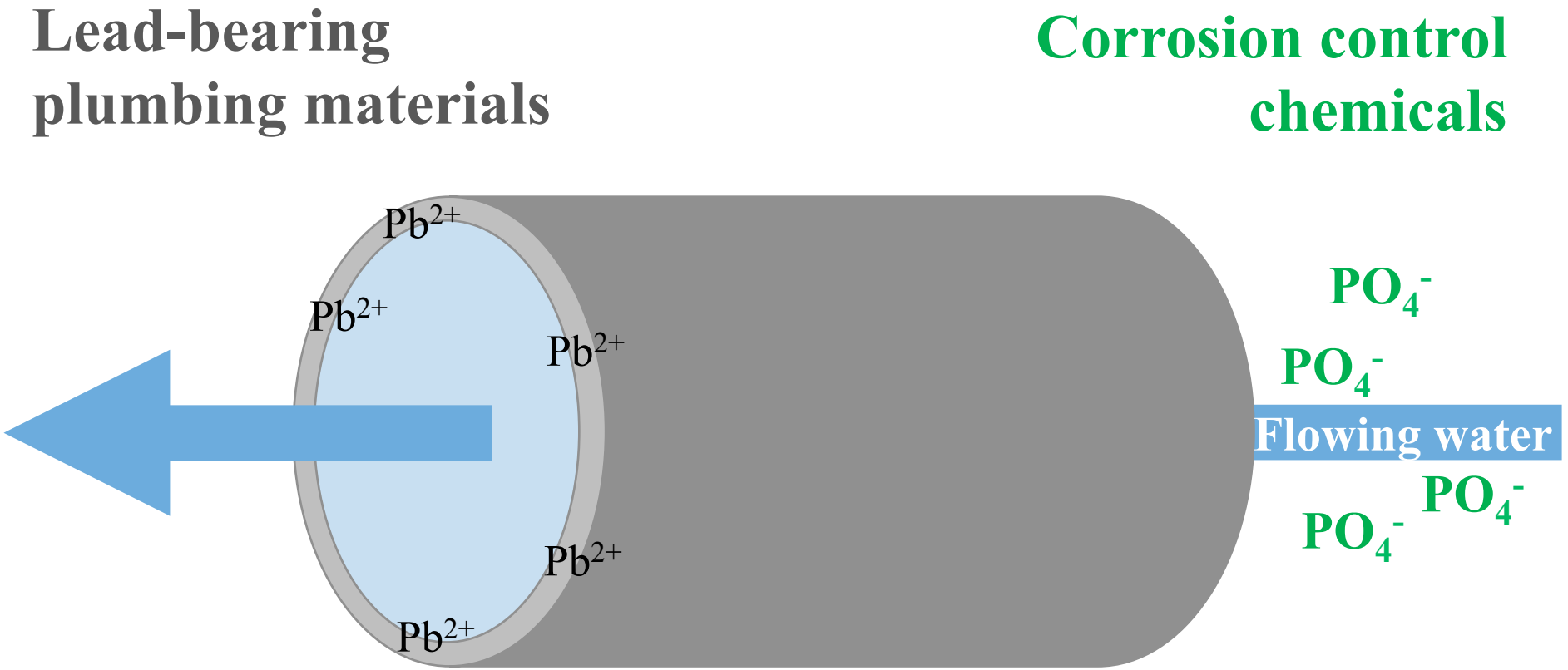
# Update on Special Flint Sampling: Flushing and Lead, Disinfection By-Product and Legionella Sampling

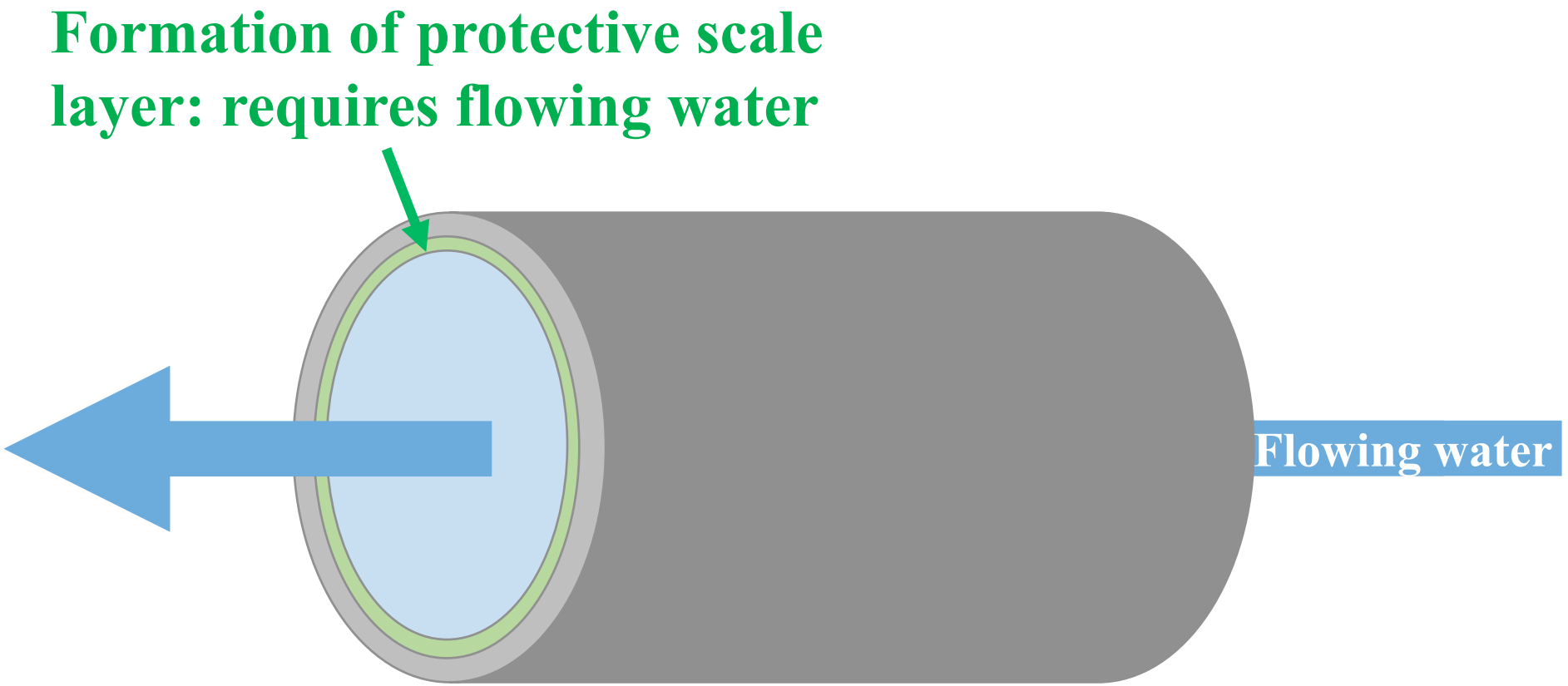
U-Mass, Wayne State, Virginia Tech

Virginia Tech
Invent the Future

# Formation of scale within the distribution system



# Formation of scale within the distribution system



# Water from Flint River disrupted developed scales and biofilms

***Flushing at low flow will clean lead deposits very slowly: Maybe months to years***

# Water from Flint River disrupted developed scales and biofilms

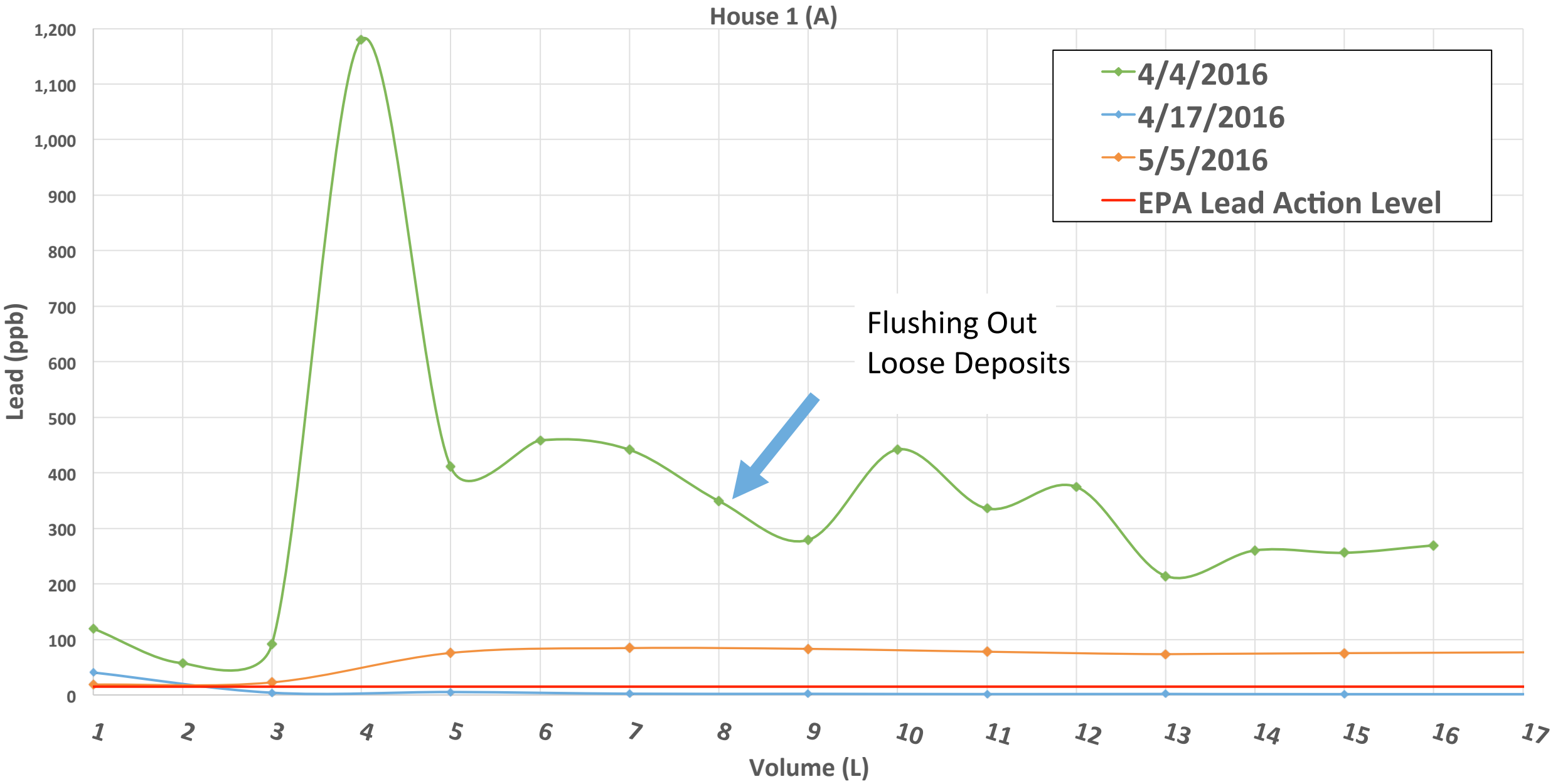
***Flush pipes clean:***

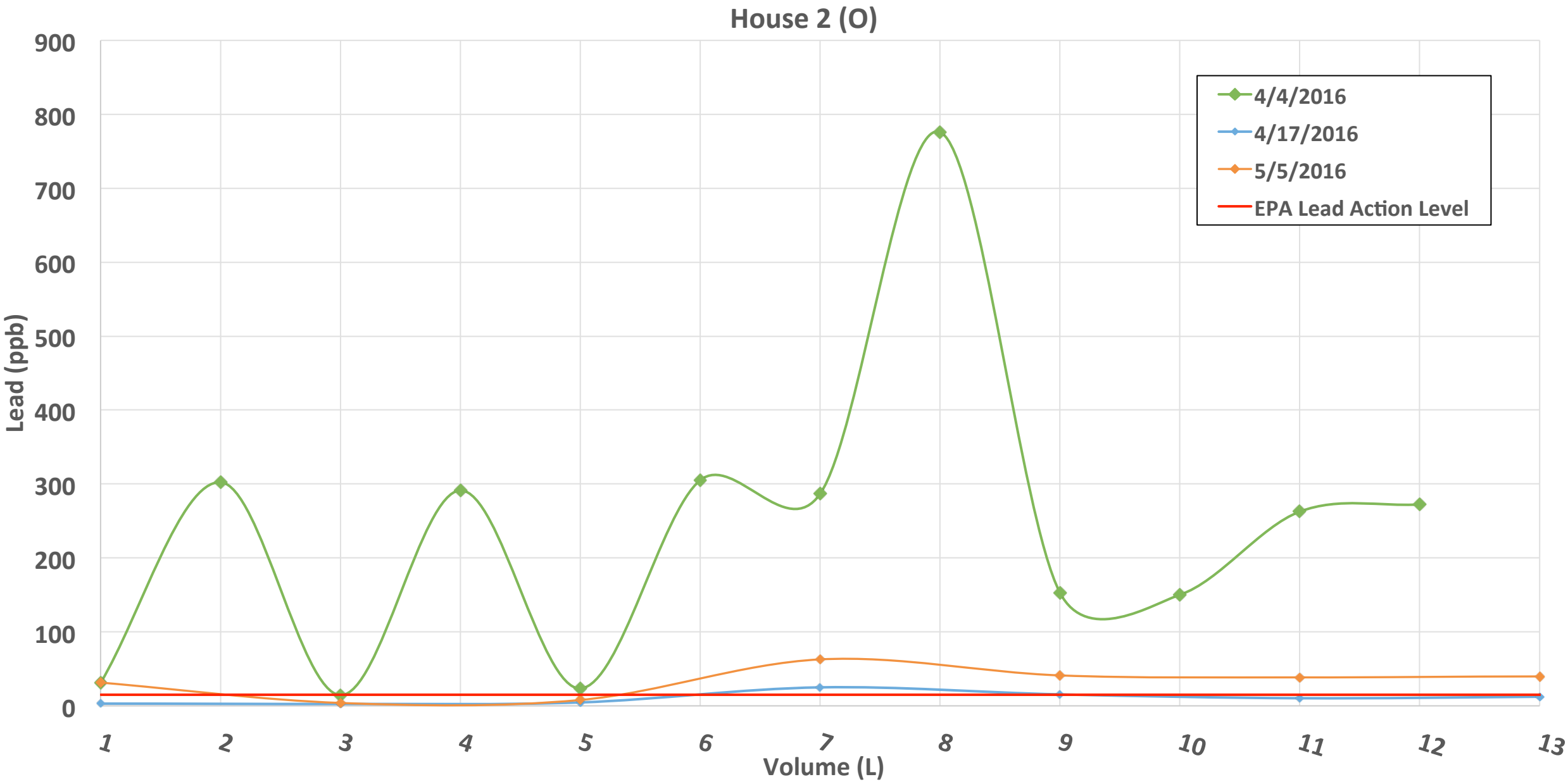
*Remove lead and iron deposits in weeks*

# Promote biofilm (bacteria) control

***Chlorine disinfection can treat water***

# Benefits of Flushing:
# Hose Bib Profiles at Two Houses


House 1 (A)
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
Lead (ppb)
4/4/2016
4/17/2016
5/5/2016
EPA Lead Action Level
Flushing Out
Loose Deposits
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Volume (L)


House 2 (O)
900
800
700
600
500
400
300
200
100
0
Lead (ppb)
1
2
3
4
5
6
7
8
9
10
11
12
13
Volume (L)
4/4/2016
4/17/2016
5/5/2016
EPA Lead Action Level

# The Water Flushing Program Appears to Have Helped the Situation

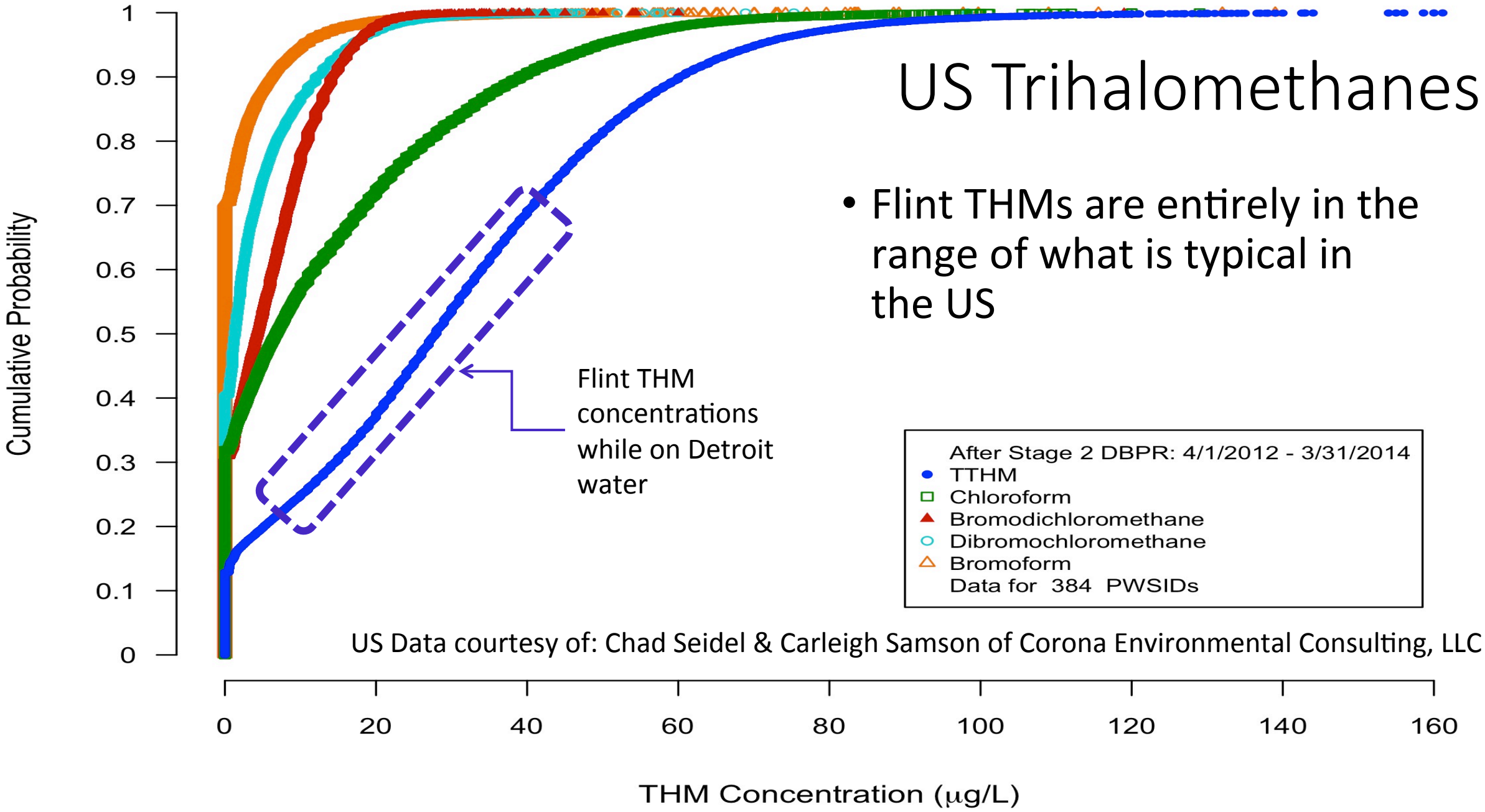
- EPA will be funding another round of lead sampling, coordinated by Flint residents, in early July

# Recent claims of unusual and unprecedented levels of DBPs in Flint Water

**“The untold story and the breaking news today, is the chloroform and trihalomethane ….I have been to 62 disasters, and I have never seen the levels of contamination for chloroform in water like it is here. The ultimate solution here is….to create green jobs, to create solar powered water filtration…and help the economy in the process. Chloroform goes through your skin….As part of 62 disasters, I have tested bathtubs and showers all over the country, and most of the time there is nothing there. ..Data…is irrefutable.”**

**BRING IN WORLDs FOREMOST EXPERT ON DBPs to CONDUCT SPECIAL SAMPLING IN FLINT**

# US Trihalomethanes

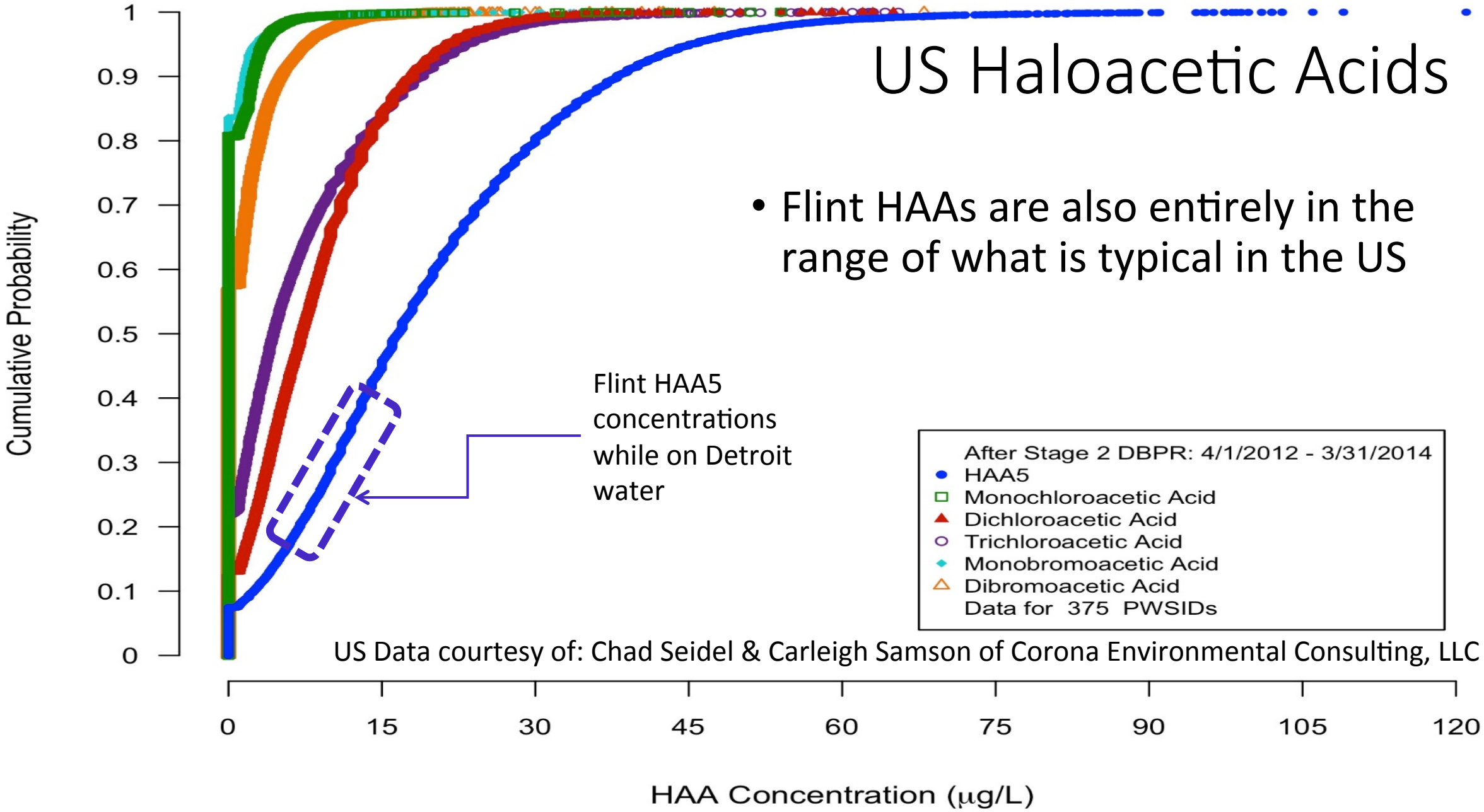



- Flint THMs are entirely in the range of what is typical in the US

US Data courtesy of: Chad Seidel & Carleigh Samson of Corona Environmental Consulting, LLC

# US Haloacetic Acids

- Flint HAAs are also entirely in the range of what is typical in the US



# Special Studies on Flint's DBPs

- Conducted by UMass and US EPA
- Focus on Flint homes with that may have higher DBP levels and on water from the  water heaters in those homes
  - Expect to see higher DBPs (e.g., THMs and chloroform) from these locations due to greater "water age" and warmer temperatures
- Studies were designed to find unusual levels and types of DBPs
  - As compared to other Cities in the US
  - And as compared to homes in the region that never left the Detroit water system

# Water Heaters

- High temperature
  - Speeds up formation of THMs
  - Causes loss of chlorine residual
  - Can also result in loss of other disinfection byproducts

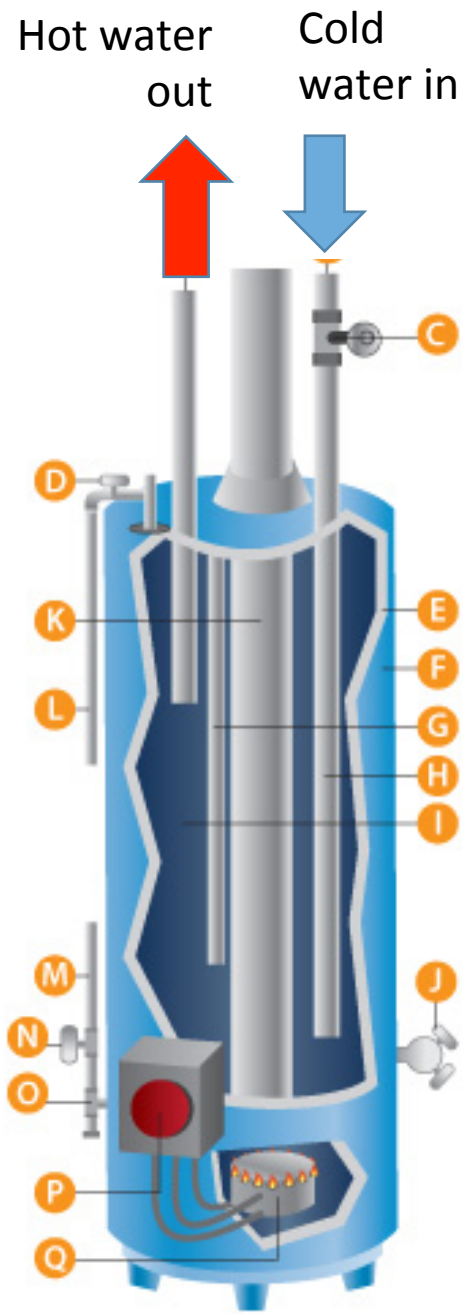



Figure courtesy of Air conditioning, heating & refrigeration institute

# Impact of Water Heating on DBPs in Flint

- Previously published UMASS studies of changes in water heater TTHMs as well as some new unpublished data show changes in TTHMs ranging from a 250% increase to a 40% decrease (Normal Change = -40%  to +250% )

<u>Special Preliminary UMASS sampling on 5/5/2016</u>

- 1 sample from a building that always received Detroit water increased 63%

- 3 samples from Flint (now Detroit water, previously Flint River) changes were decrease of 4%, increase 3% and increase 91%

**VERY CONSISTENT WITH DATA IN OTHER CITIES.**

**NOTHING UNUSUAL OCURRING IN WATER HEATERS RECEIVING DETROIT WATER EITHER IN FLINT, OR OUTSIDE OF FLINT.**

# UMass Study: 5/5/2016 sampling

**Regulated Compounds**

- Trihalomethanes (THMs)
  - Chloroform (TCM)
  - Bromodichloromethane (BDCM)
  - Chlorodibromomethane (CDBM)
  - Bromoform (TBM)
- Haloacetic Acids (HAA5)
  - Chloroacetic Acid (CAA)
  - Bromoacetic Acid (BAA)
  - Dichloroacetic Acids (DCAA)
  - Dibromoacetic Acid (DBAA)
  - Trichloroacetic Acid (TCAA)

**Unregulated Compounds I**

- Iodinated THMs
  - Dichloroiodomethane (DCIM)
  - Bromochloroiodomethane (BCIM)
  - Dibromoiodomethane (DBIM)
  - Chlorodiiodomethane (CDIM)
  - Bromodiiodomethane (BDIM)
  - Iodoform (TIM)
- Other HAAs
  - Bromochloroacetic Acid (BCAA)
  - Bromodichloroacetic Acid (BDCAA)
  - Chlorodibromoacetic Acid (CDBAA)
  - Tribromoacetic Acid (TBAA)

None of the Regulated DBPs exceeded Federal Standards, even when they were sampled in water heaters, where they might be expected to be higher than at approved cold water monitoring sites

# UMass Study: 5/5/2016 sampling (cont).

**Unregulated Compounds II**

- Haloacetonitriles (HANs)
  - Dichloroacetonitrile (DCAN)
  - Bromochloroacetonitrile (BCAN)
  - Dibromoacetonitrile (DBAN)
  - Trichloroacetonitrile (TCAN)
- Haloketones (HKs)
  - 1,1-Dichloropropanone (DCP)
  - 1,1,1-Trichloropropanone (TCP)
- Halontromethanes (HNMs)
  - Dichloronitromethane
  - Chloropicrin (CP or TCNM)

**Unregulated Compounds III**

- Haloacetamides (HAMs)
  - Chloroacetamide (CAM)
  - Bromoacetamide (BAM)
  - Dichloroacetamide (DCAM)
  - Bromochloroacetamide (BCAM)
  - Dibromoacetamide (DBAM)
  - Trichloroacetamide (TCAM)
  - Bromodichloroacetamide (BDCAM)
  - Chlorodibromoacetamide (CDBAM)
  - Tribromoacetamide (TBAM)
- Halobenzoquinones
  - 2,6-Dichlorobenzoquinone (DCBQ)
  - 2,6-Dichloro-3-methylbenzoquinone (DCMBQ)
  - 2,6-Dibromobenzoquinone (DBBQ)
  - 2,3,6-Trichlorobenzoquinone (TCBQ)

# UMass Study: 5/5/2016 sampling (cont).

**Unregulated Compounds IV**

- N-Chloro-haloacetamides
  - N-Choro Dichloroacetamide (N-Cl-DCAM)
  - N-Choro Bromochloroacetamide (N-Cl-BCAM)
  - N-Choro Dibromoacetamide (N-Cl-DBAM)
  - N-Choro Trichloroacetamide (N-Cl-TCAM)
  - N-Choro Bromodichloroacetamide (N-Cl-BDCAM)
  - N-Choro Chlorodibromoacetamide (N-Cl-CDBAM)
  - N-Choro Tribromoacetamide (N-Cl-TBAM)
- Total Organic Halogen (TOX)
  - Total Organic Chlorine (TOCl)
  - Total Organic Bromine (TOBr)
  - Total Organic Iodine (TOI)

**Unregulated Compounds V**

- Oxyhalides
  - Bromate
  - Iodate
- Aldehydes
  - Formaldehyde
  - Acetaldehyde
  - Propanal
  - Butanal
  - Hexanal
  - Heptanal
  - Octanal
  - Nonanal
  - Decanal
  - Glyoxal
  - Methylglyoxal

None of the Unregulated DBPs tested in our special study, showed anything out of the ordinary or unprecedented, based on my 35 years studying DBPs in waters all over the United States

# Other compounds found by Water Defense

- 1,4-Dichlorobenzene (aka, para-dichlorobenzene)
  - Used in home products
    - Moth balls, air fresheners, disinfectants
  - High volatile and readily circulated in indoor air
  - 75 ug/L is MCL in drinking water
  - May reasonably be anticipated to be a carcinogen
- 2-Butanone (aka, methyl-ethyl ketone, or MEK)
  - Common solvent found in many homes
    - Denatured alcohol, varnishes, glue
- Methylene Chloride (aka, dichloromethane)
  - Paint stripper, aerosol spray propellant
  - May be carcinogenic
- Acetone
  - Widely used solvent for household use
  - Also a known DBP

Only found with WaterBug sampler

Not found using accepted aqueous sampling methods

# KEY POINTS

- CHLOROFORM, THMs and OTHER DBPs ARE EXPECTED IN THE WATER OF EVERY CITY USING CHLORINE
- IF WE DID NOT USE CHLORINE, VERY HIGH LEVELS OF WATERBORNE DISEASE AND DEATHS WOULD OCCUR, INCLUDING LEGIONAIRRES DISEASE
- ALL AVAILABLE DATA SHOW REASONABLE AND EXPECTED LEVELS OF CHLOROFORM, TTHMs and OTHER DBPs IN FLINT SINCE RETURNING to DETROIT WATER
- NOTHING UNUSUAL DETECTED BY EPA OR UMASS, EVEN FROM FLINT WATER HEATERS

# Flint DBPs

Shawn P. McElmurry, PhD, PE

Associate Professor

Wayne State Unviersity

# Wayne State University Sampling

**October 18, 2015** – Same weekend drinking water was switched back to “Detroit” water

**December 5-9, 2015** – Immediately prior to additional phosphate being added to drinking water

**January 29, 2016** – Following reports of problems with chlorination unit

# Wayne State University DBP results

| | | TTHM (ppb) | | | |
|---|---|---|---|---|---|
| | # Sites | Min | Mean | Max | # > MCL |
| October 2015 | 19 | 34.3 | 68.9 | 145.4 | 6 |
| December 2015 | 31 | 21.0 | 35.8 | 62.4 | 0 |
| January 2016 | 30 | 15.0 | 24.1 | 58.0 | 0 |

| (ppb, µg/L) | TTHM | Trichloromethane (Chloroform) $CHCl_3$ | Bromodichloro-methane $CHCl_2Br$ | Dibromochloro-methane $CHClBr_2$ | Bromoform $CHBr_3$ | RSD % |
|---|---|---|---|---|---|---|
| Cold Water | 23.8 | 10.4 | 7.6 | 5.1 | 0.7 | 0.9 |
| Hot Water | 31.7 | 16.2 | 9.6 | 5.4 | 0.5 | 0.4 |

## SUMMARY OF EPA DISINFECTION BIPRODUCT SAMPLING RESULTS

EPA has been conducting monitoring for total trihalomethanes (TTHM) and nine haloacetic acids (HAA9) on a monthly basis in Flint in conjunction with distribution system optimization work initiated by EPA. The results are summarized below and will be posted to EPA's website in the near future once a final quality assurance review of the data has been completed. For comparative purposes, the level of the regulated haloacetic acids (HAA5) is included separately as well. Four additional haloacetic acids included in the HAA9 numbers are not currently regulated.

| Month | No. of Sites | TTHM (ppb) | | | HAA5 (ppb) | | | HAA9 (ppb) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Ave | Max | Min | Ave | Max | Min | Ave | Max |
| March 2016 | 21 | 11.7 | 14.9 | 23.7 | 6.3 | 12.5 | 19.7 | 6.3 | 16.1 | 26.6 |
| April 2016 | 21 | 14.2 | 18.2 | 26.3 | 9.5 | 11.8 | 18.1 | 11.5 | 14.7 | 23.2 |
| May 2016 | 24 | 17.8 | 21.6 | 26.9 | 12.7 | 14.7 | 19.6 | 14.9 | 18.8 | 25.4 |

TTHM MCL = 80 ppb

HAA5 MCL = 60 ppb

# Summary DBPs

Data has been collected on Disinfection By-Products (DBPs), chloroform and total trihalomethanes (TTHMs) by 5 independent groups including:

1) State of Michigan
2) U.S. EPA,
3) U-Mass Special Sampling (5/4/2016)
4) Wayne State University
5) Virginia Tech (August 2015)

# Conclusions:

1) There is nothing unexpected in data of hot or cold water DBPs since the switch
2) Levels of all DBPs are in the low-normal range for a chlorinated system
3) Changes with DBPs, and levels of DBPs found in the water heaters, are normal

# Update on Testing for *Legionella* in Flint Tap Water

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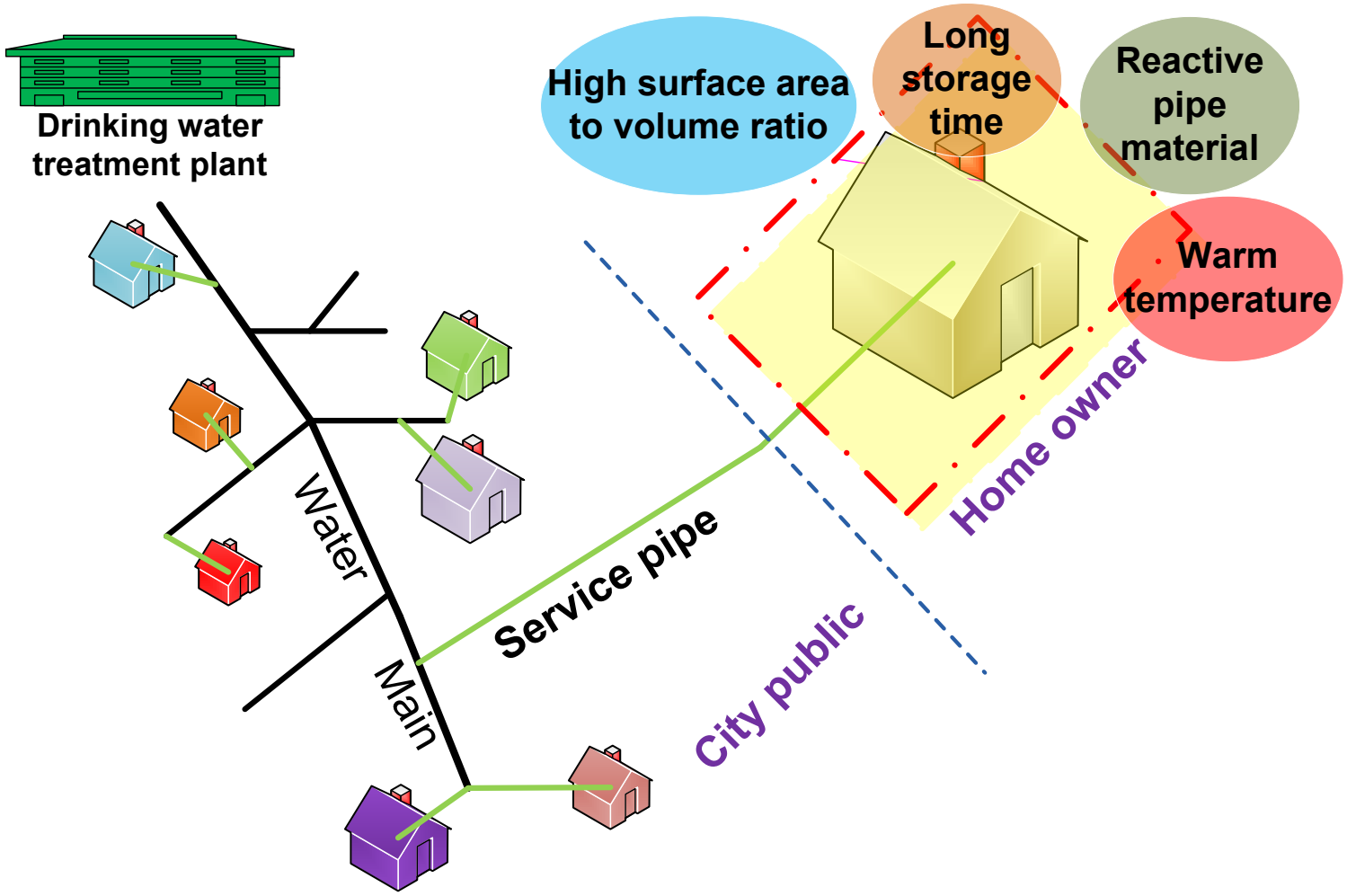
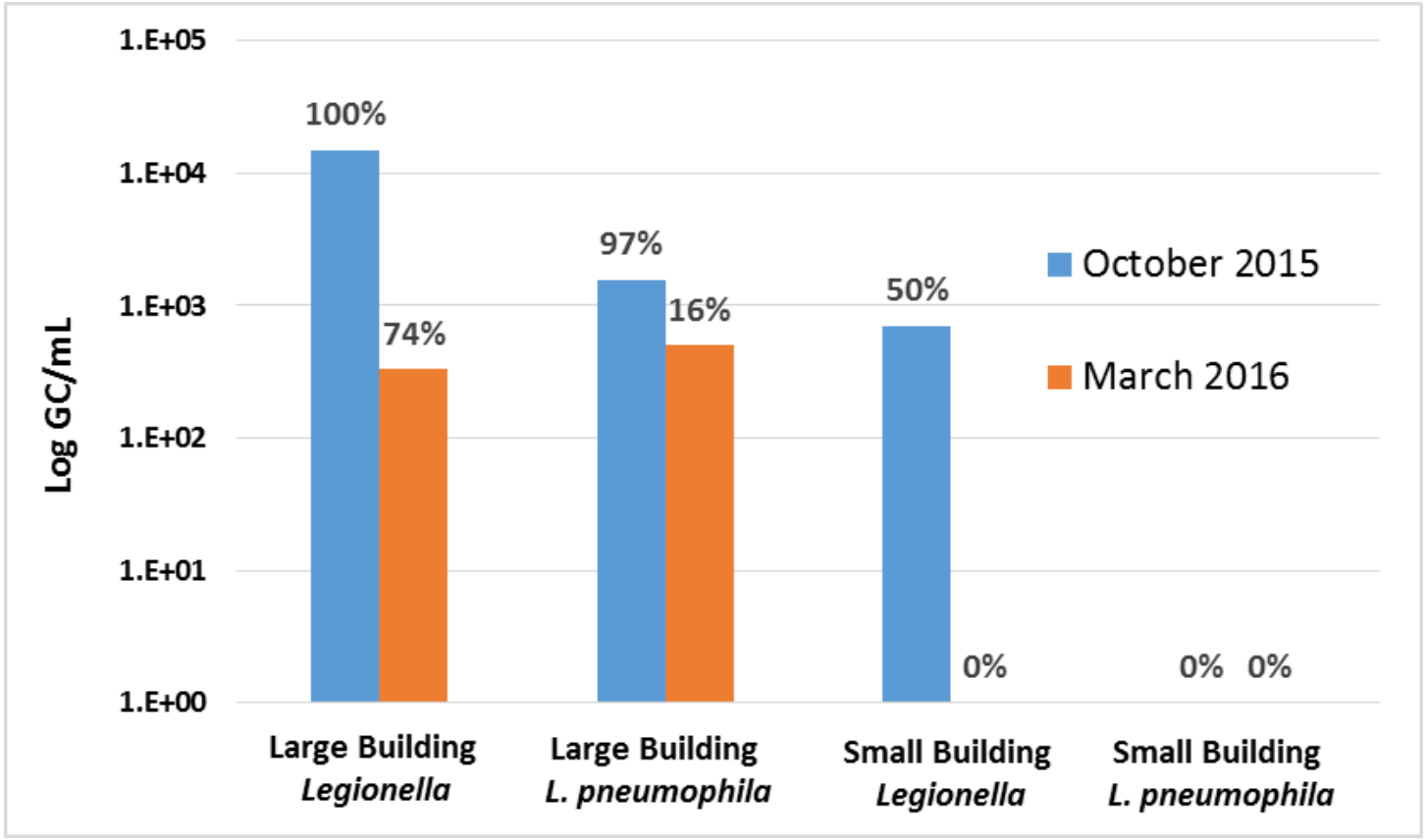
Marc Edwards, Ph.D. Virginia Tech
Otto Schwake, Ph.D. Virginia Tech
Emily Garner, Virginia Tech

National Science Foundation RAPID
Award #1556258

# Influence of City Drinking Water Quality on *Legionella* in Tap Water



# *Legionella* numbers decreased from October to March



# How to keep *Legionella* numbers down

- Avoid stagnation of water
  - Normal flushing of the system is helpful
  - Flushing will help stop corrosion and better deliver chlorine to the tap, where it will kill *Legionella*
- Increase water heater temperatures > 140°F
- Continued monitoring and vigilance
- EPA working to improve water quality and Health Department is monitoring and reporting illness

# Water Heater Study- Summer 2016

- Initial testing did not find *Legionella pneumophila* in small buildings, even in August 2015
- This summer will intensively monitor for *Legionella pneumophila* in electric and gas water heaters water heaters
- Work with State of MI to study water heaters, and see if routine flushing improves any dimension of water coming from heaters:
  - Increased Chlorine levels
  - Decreased Micro-organisms