



# Flint

A Cautionary Tale

# What happened?

April  
2014

City switches water source  
from Huron River (Detroit  
water system) to Flint River

October  
2015

City switches source back to  
Detroit water system

# What else happened?

Corrosion control not implemented

Residents' concerns about water quality continually dismissed by MDEQ and EPA

Independent studies showed alarming problem with lead

- Flint Water Study (Virginia Tech)
- Blood Lead Level (Hurley Medical Center)

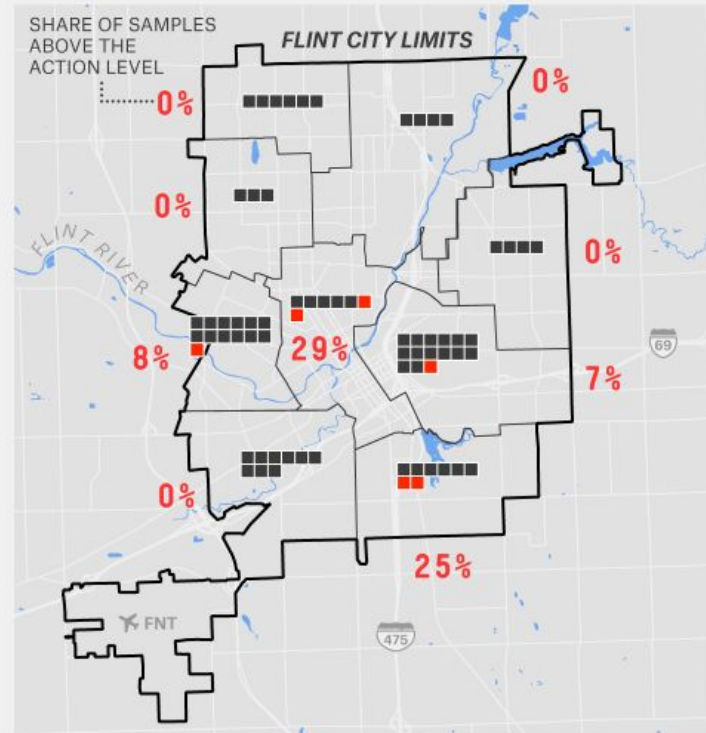
# Water sampling in two separate studies

How the sampling and results from city and state testing and the Flint Water Study compare, by ward

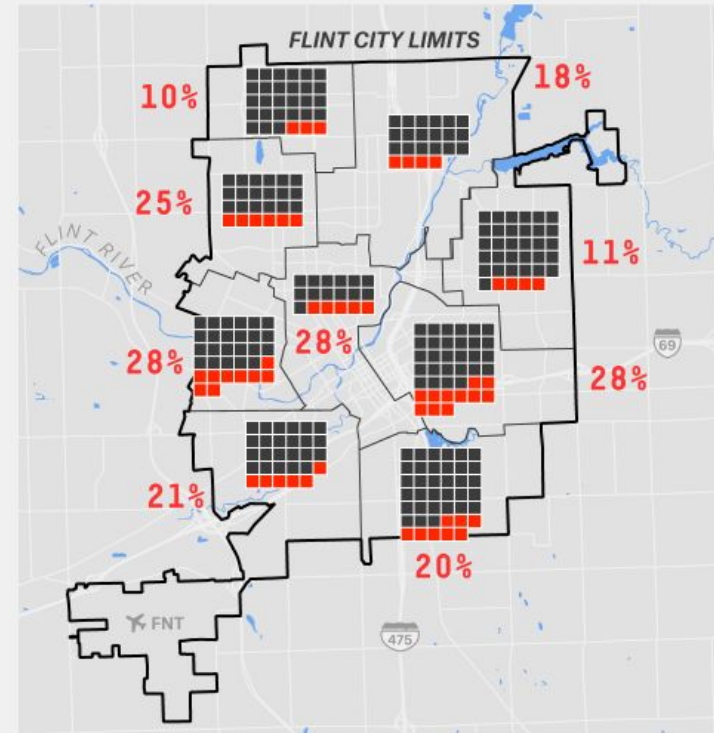
## WATER SAMPLES

■ BELOW EPA ACTION LEVEL (15 PPB) ■ ABOVE ACTION LEVEL

## Michigan Department of Environmental Quality



## Flint Water Study's analysis



MICHIGAN

Flint

## How blood lead levels changed in Flint's children

Before and after the city's water source was switched to the Flint River in April 2014



### Percentage of children younger than 5 years old with elevated blood lead levels

BEFORE THE CHANGE  
IN WATER SUPPLY (2013) ..... AFTER (2015)



Share of water samples containing at least 15 ppb lead (EPA action level) as of Sept. 26, 2015

# What's the problem with lead?

## **Neurotoxin**

### **No safe level of exposure**

Can increase incidences of:

- Miscarriages
- Attention deficit hyperactivity disorder
- Learning disabilities
- Potentially violent behavior

Can decrease:

- Birth weight
- IQ
- Cognitive function

# Why? How?

## Physical infrastructure

- Aging water service lines
- Corrosivity of Flint River

## Mismanagement

- Undersampling
- Improper sampling protocol

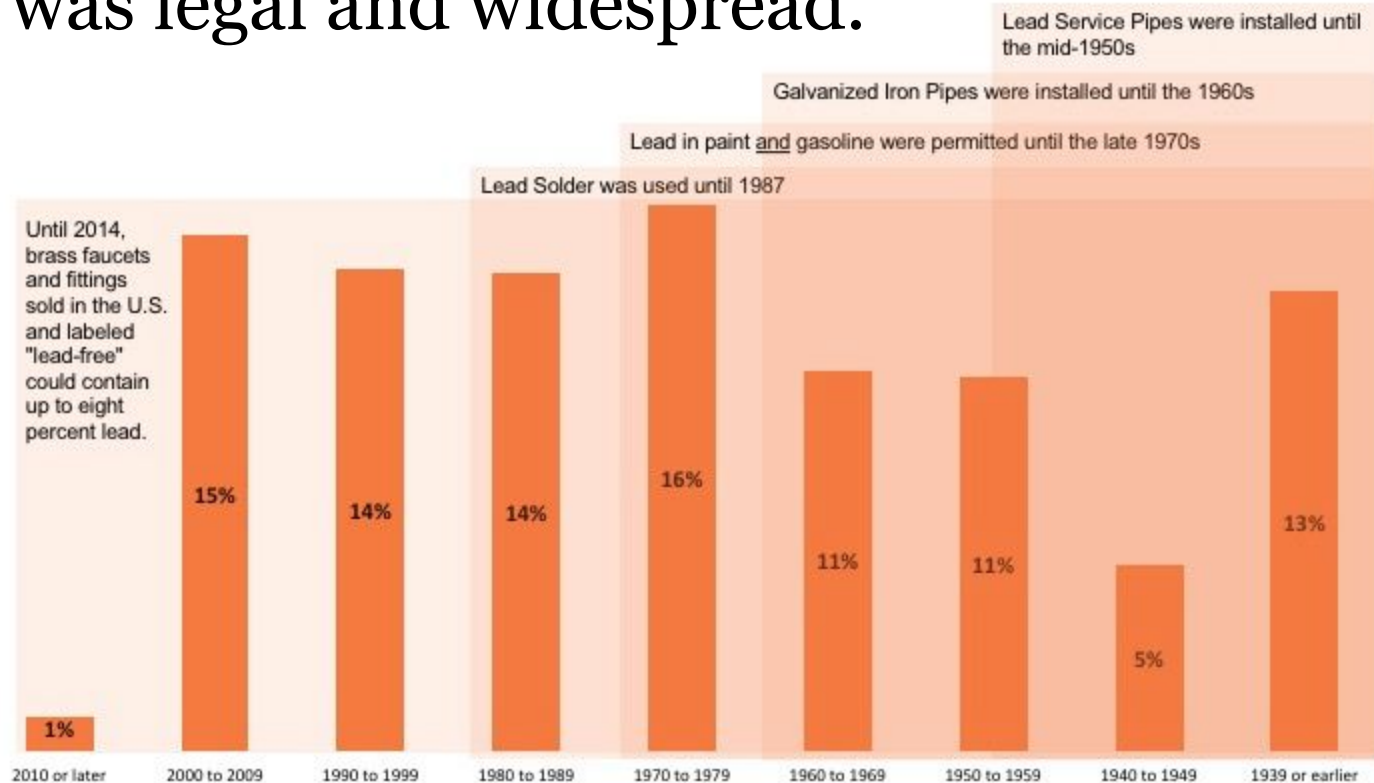
## Socio-economic factors

- Accusations of environmental racism



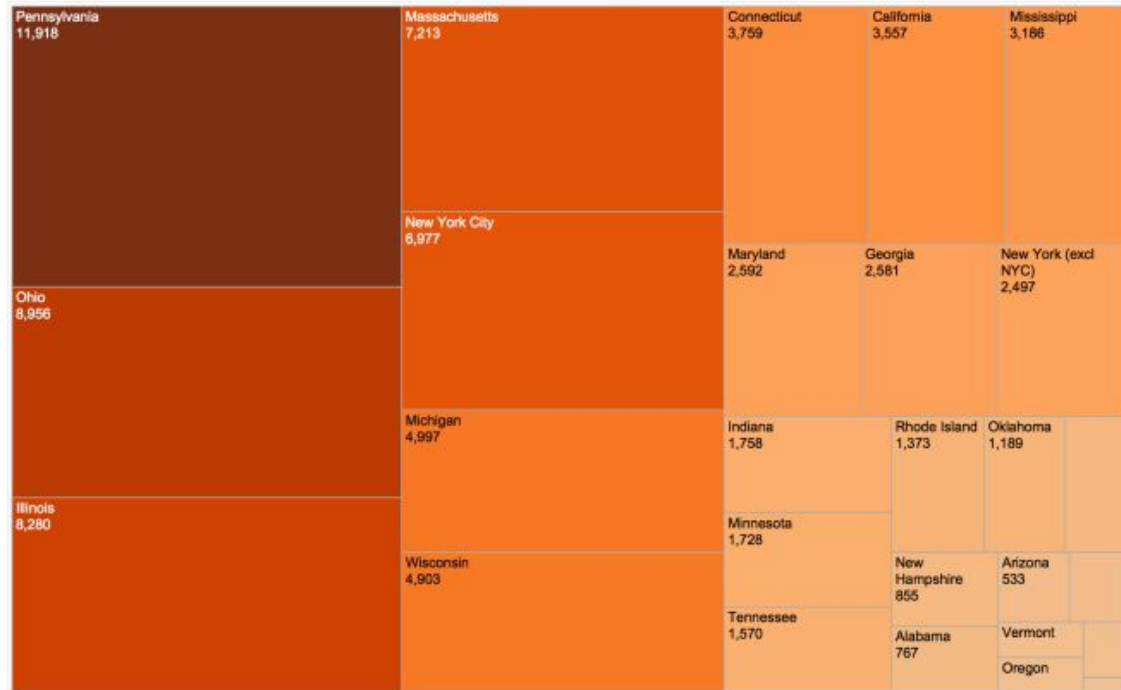
We all have a lead problem.

# Over 70% of US housing stock was built while lead use was legal and widespread.



Source: <https://govex.jhu.edu/8-for-lead/>

# Children with elevated blood lead levels can be found all across the county.



Source: Centers for Disease Control (CDC)  
Year: 2014

Source: <https://govex.jhu.edu/8-for-lead/>



# Assistance Program for Lead in School Drinking Water

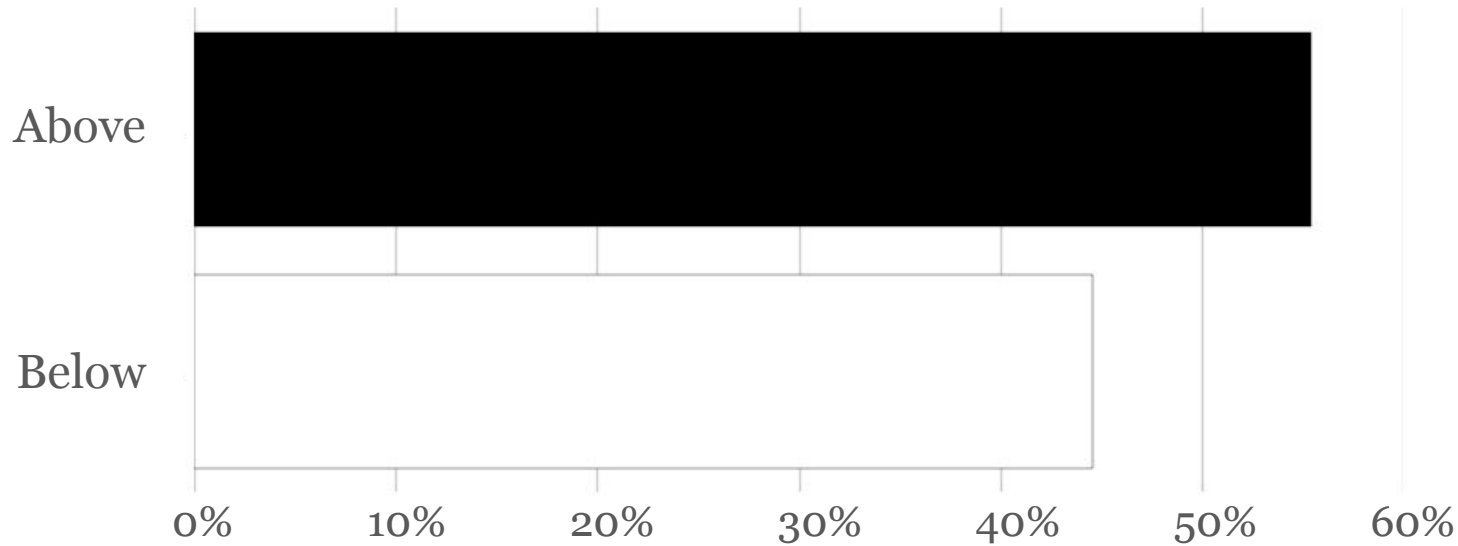
MassDEP Technical Assistance  
Program

Funding to provide drinking water  
sampling and analysis for lead and  
copper

Open to public schools, early  
education, and early child care  
facilities

Since April 2016, 875 schools have  
participated

Over **55%** of schools had at least one sample with lead concentrations above the action level.



Is water quality in Massachusetts related to the same issues as it was in Flint?

Can I use data about  
schools & public water supplies  
to learn what influences  
lead concentrations in drinking  
water at Massachusetts schools?

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# Schools

What features might be important to predicting lead concentrations?

## Physical Infrastructure

- Age of building
- Value of parcel

## Socio-economic factors

- Environmental justice status
- Type of school

# Public water supplies

What features might be important to predicting lead concentrations?

## Physical infrastructure

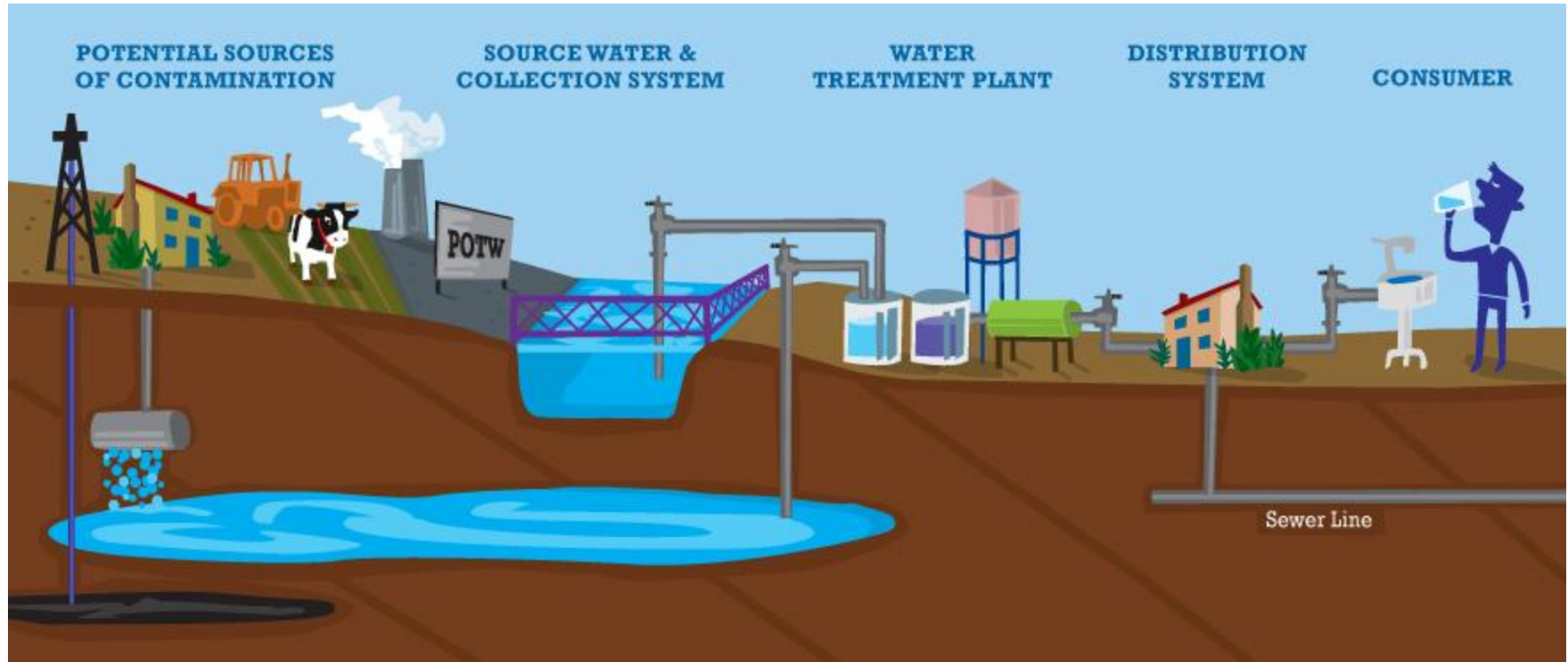
- Type and size of system
- Type of source

## Management indicators

- MWRA
- Compliance status
- Response to lead survey

Physical infrastructure

# Public Water Systems 101



# Massachusetts Public Water Systems 101

## Water systems classifications

### Community

- Year-round service to at least 25 year-round residents
- Ex: town water system

### Non-community, non-transient

- Intermittent service to at least 25 of the same people
- Ex: workplace or school

### Non-community, non-transient

- Intermittent service to 25 different people
- Ex: restaurant or campground

## Types of sources

Groundwater only

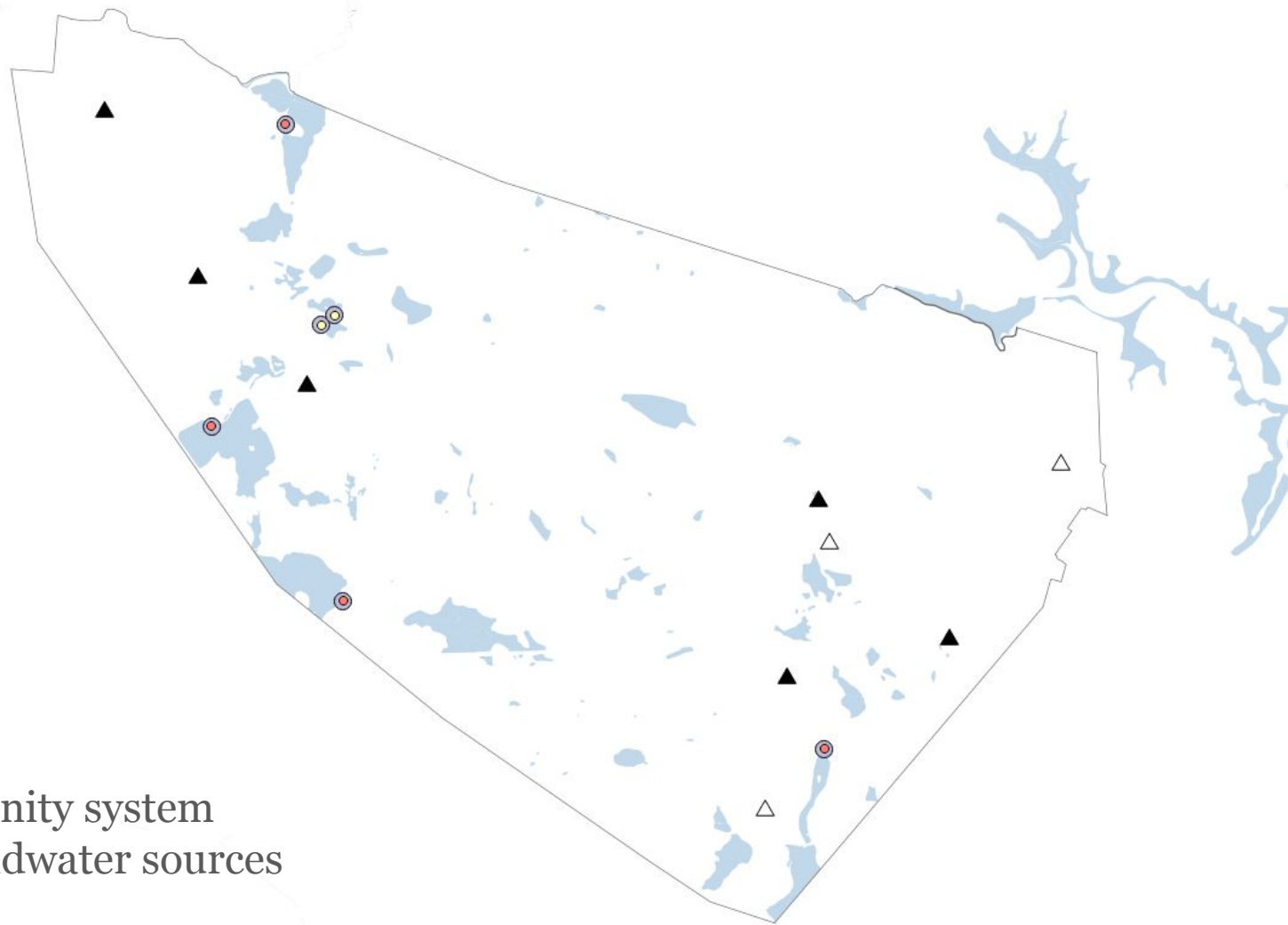
Surface water only

Mix of groundwater and surface water

If Massachusetts has three different water system classes and three different water sources, how many different types of systems are there in the state?

# Peabody

- Community
- Non-community
- Surface water
- Groundwater
- ▲ School - above PBAL
- △ School - below PBAL



Municipal community system  
Surface and groundwater sources

# Northfield

- Community
- Non-community
- Surface water
- Groundwater
- School - above PBAL
- School - below PBAL

Pioneer Valley  
Regional School

Northfield  
Elementary School

Grandin Reservoir

Municipal community system  
Municipal non-transient non-community system  
Surface water and groundwater sources

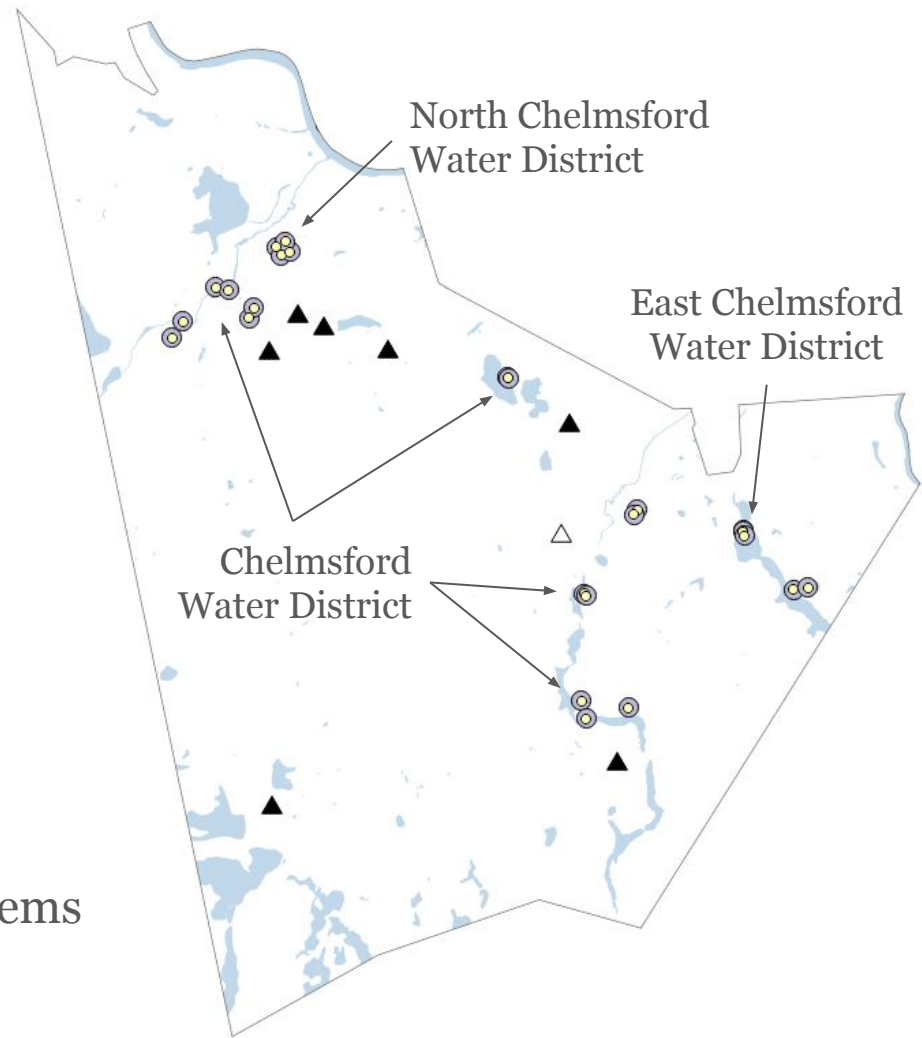




# Chelmsford

- Community
- Non-community
- Surface water
- Groundwater
- School - above PBAL
- School - below PBAL

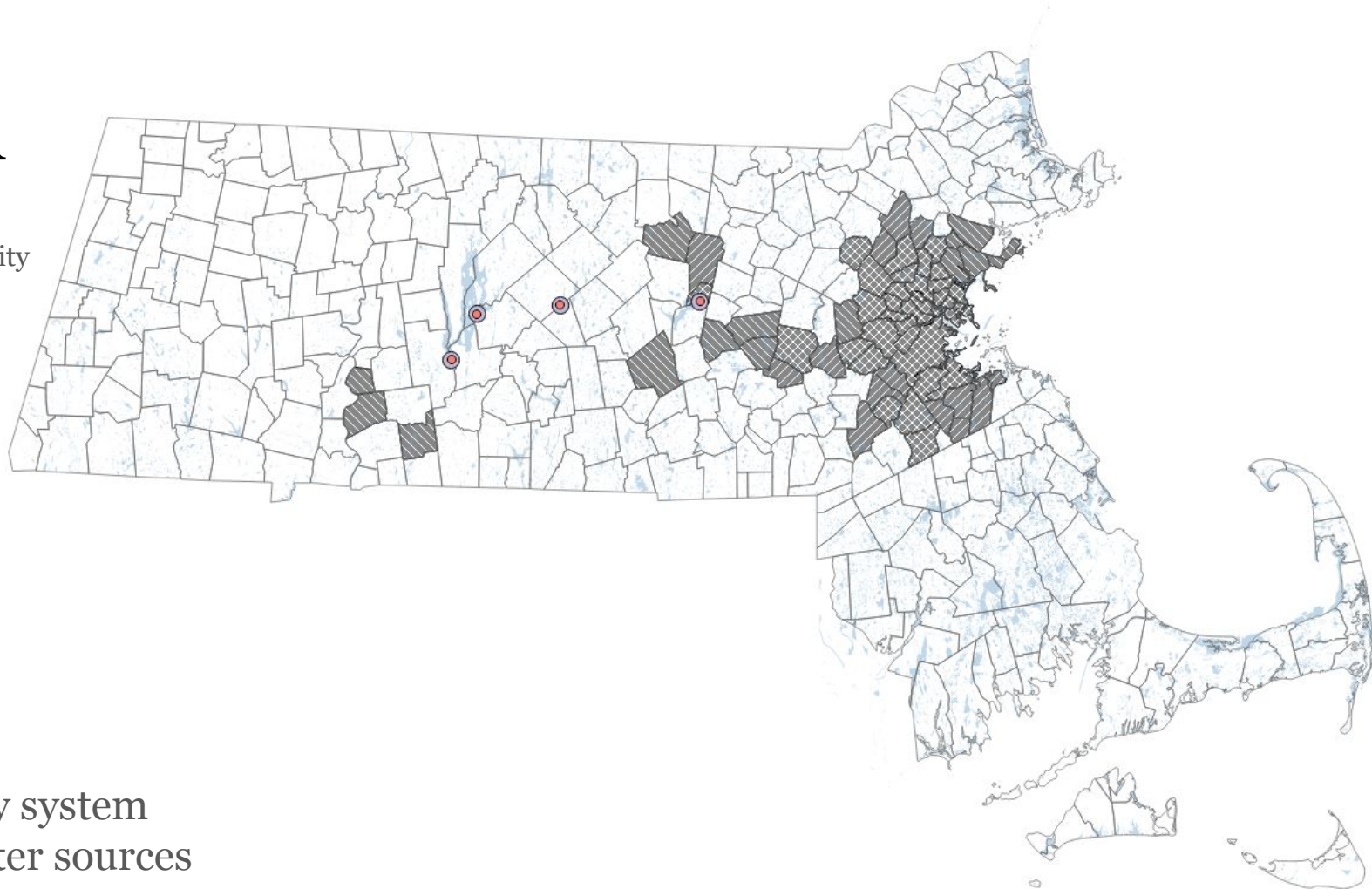
Multiple municipal community systems  
Groundwater sources only



# Management Indicators

# MWRA

- Community
- Non-community
- Surface water
- Groundwater



Community system  
Surface water sources

# Lead and Copper Rule

Federal regulation implemented  
by MassDEP and EPA

Focused on reducing corrosiveness  
of drinking water

Requires semi-annual to annual  
monitoring, based on past  
performance

Establishes Lead Action Level  
(PBAL) of 15 mg/L

Voluntary survey conducted during  
Summer 2016

# Schools & Public water supplies

What features might be important to predicting lead concentrations?

## Physical infrastructure

- Age of building
- Value of parcel
- Type and size of PWS
- Type of water source

## Management indicators

- MWRA
- Compliance with LCR reporting
- Response to lead survey

## Socio-economic factors

- Environmental justice status
- Type of school

# Prediction time

Will a school will have at least one sample with a concentration above the lead action level?

# Classification

## Dummy

- Most frequent

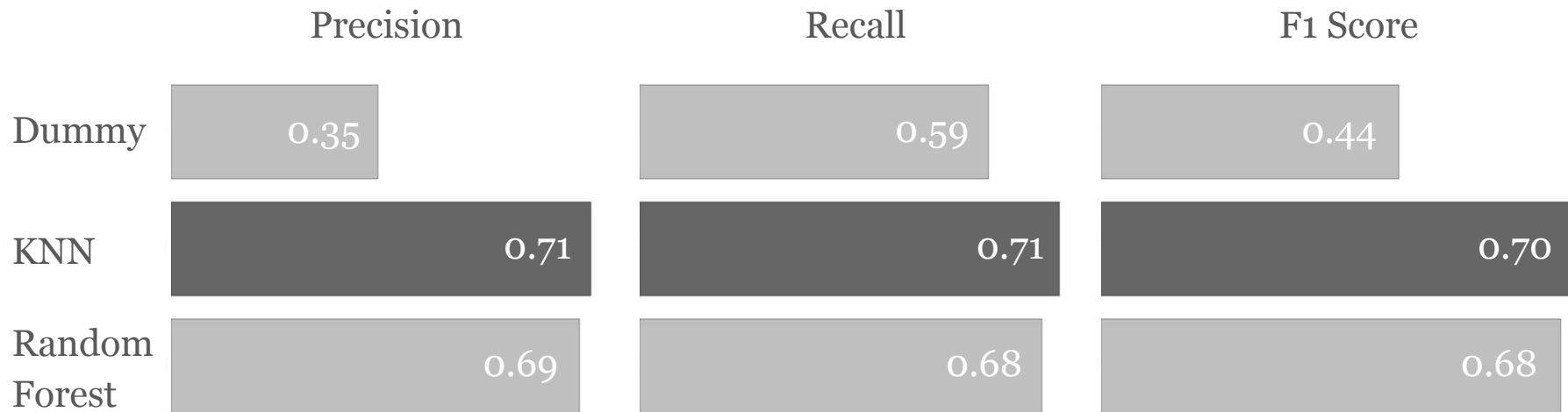
## KNN - grid search

- 63 neighbors
- Weighted distance

## Random Forest - random search

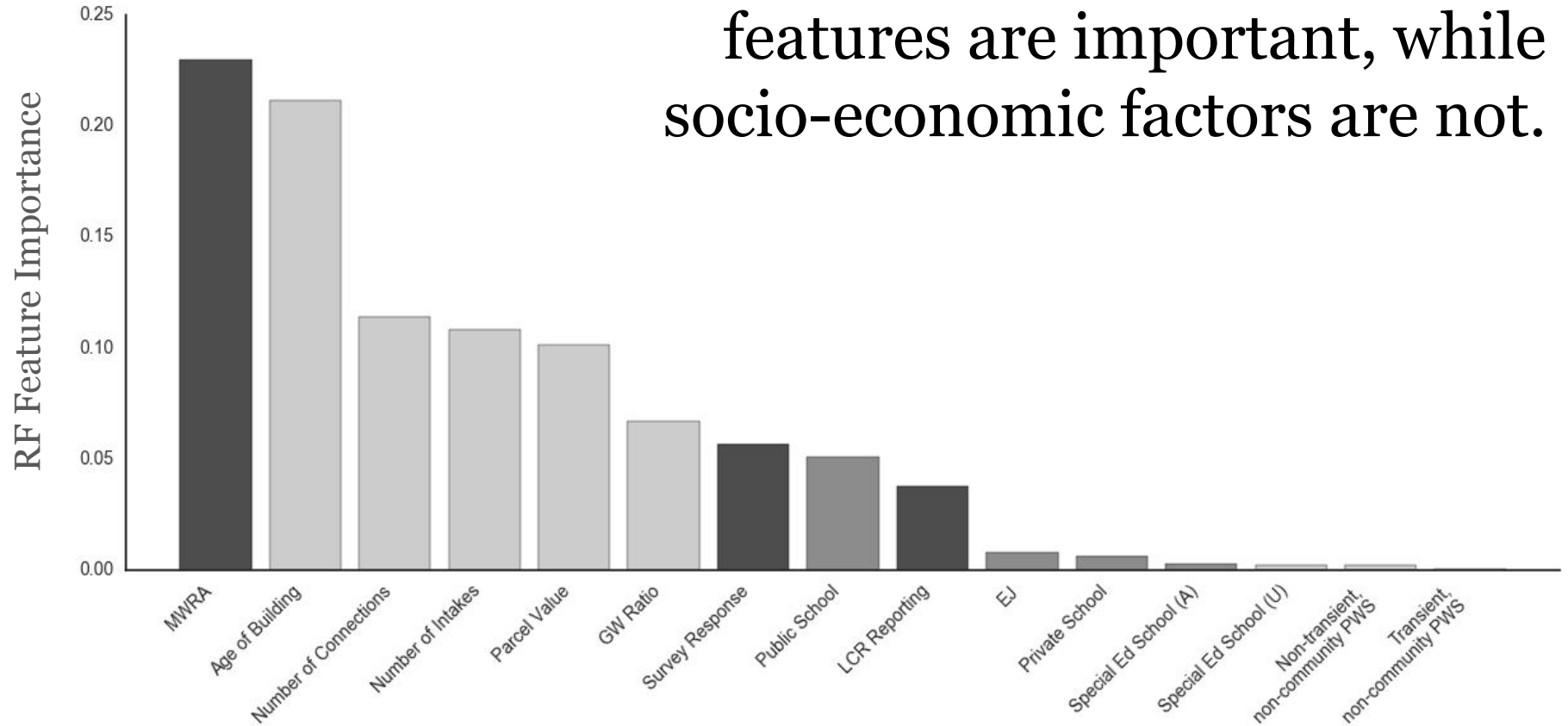
- 500 trees
- Limited to depth of 5

KNN outperformed on precision, recall, and f1 score.





Most of the physical infrastructure features are important, while socio-economic factors are not.



Does Massachusetts have the  
same issues as Flint?

# MWRA influences feature importance.

