

# Moving the Political Will: Tales from the field

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***How safe and secure are  
our water sources?***

***Is there a  
WATER CRISIS BREWING?***

***How are we solving current  
problems and challenges?***

# Critical Infrastructure Sectors

<https://www.dhs.gov/critical-infrastructure-sectors>

There are 16 critical infrastructure sectors whose assets, systems, and networks, whether physical or virtual, are considered so vital to the United States that their incapacitation or destruction would have a debilitating effect on security, national economic security, national public health or safety, or any combination thereof.



**Health Care and Public Health**

**Transportation**



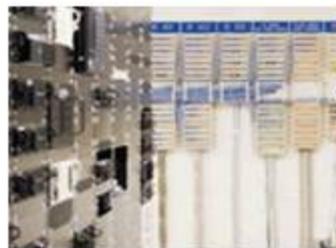
**Energy**



**Food and Agriculture**

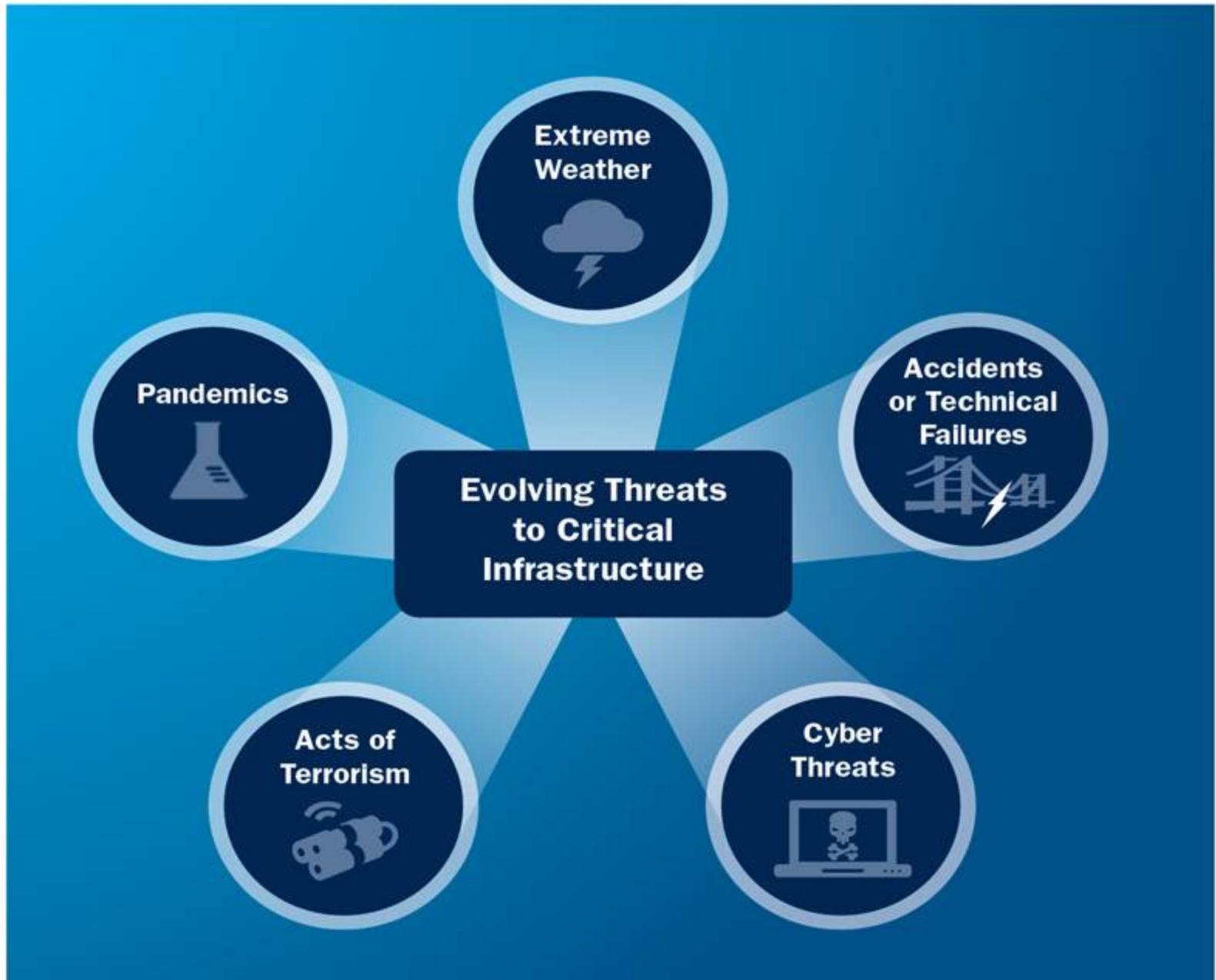


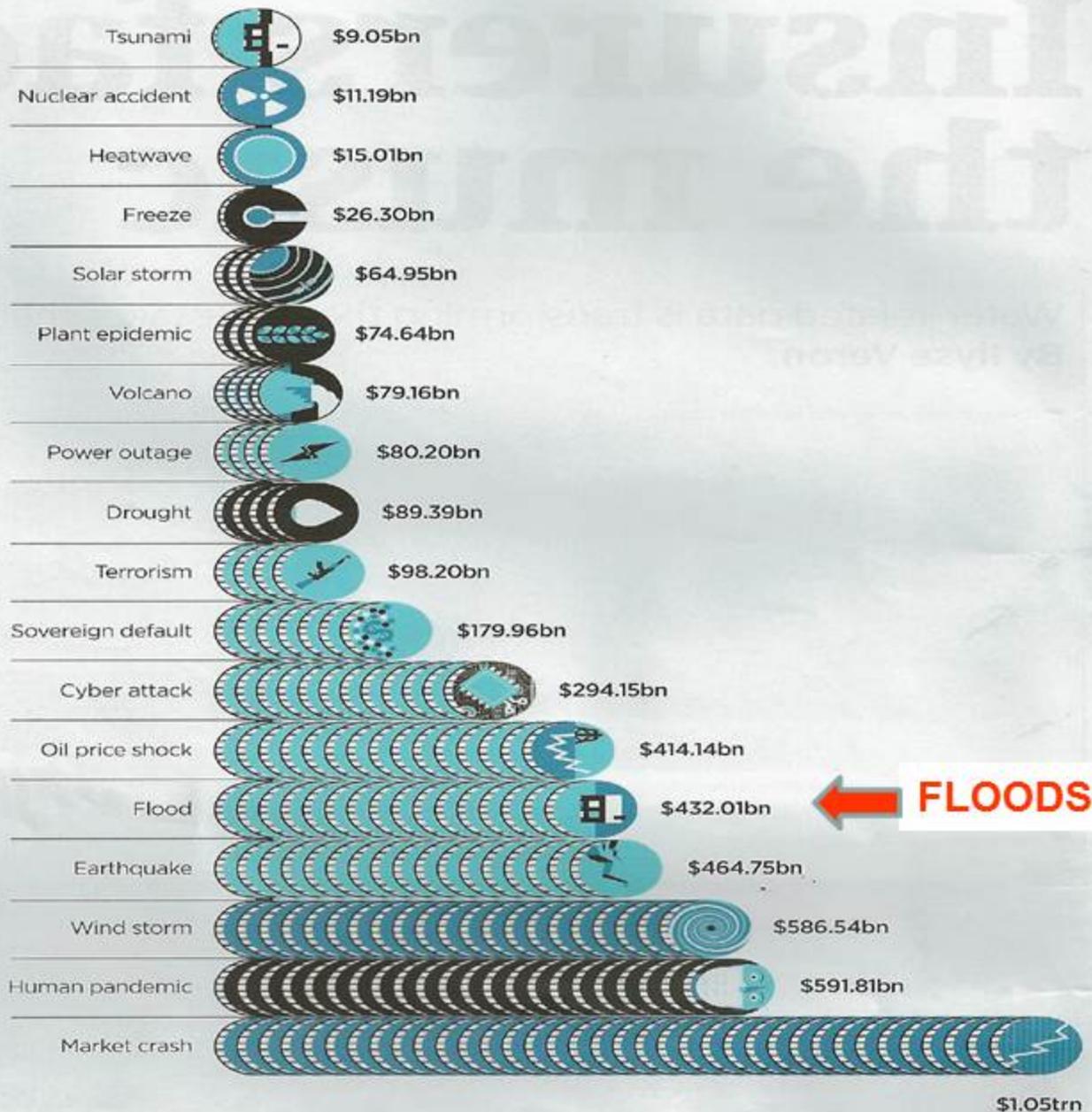
**Information Technology**



**Water and Wastewater**

Figure 2 – Evolving Threats to Critical Infrastructure





Lloyd's City Risk Index of 301 cities shows natural threats are estimated at \$2.43 trillion dollars in risk.

# Infrastructure by the Numbers

## Water

- 1.8 million miles of distribution lines
- 14.5% of Americans rely on their own water sources (wells)
- As of 2016, there are over 150,000 public drinking water systems in the United States—systems that have 15 or more connections or serve more than 25 people
- 3% serve are large and serve 79% of the population
- **\$1 trillion needed in the next 25 years for restoration**

## Sanitation

- 1.2 million miles of sewers
- 17% of Americans are served by on-site sanitation (septic tanks)
- Publicly owned wastewater treatment plants serve 189.7 million people and treat 32.1 billion gallons per day
- 15,848 wastewater treatment plants 9,388 facilities provide secondary treatment, 4,428 facilities provide advanced treatment, and 2,032 facilities do not discharge
- **\$271 billion to meet current and future demands in the next decade**

# FRESH WATER RESOURCES DEGRADATION

## Loss of Habitat & Water Supply

## Impacts the Health of Animals and Humans



By [Todd C. Frankel](#) August 11 2014  
Follow [@tcfrankel](#) The Washington Post



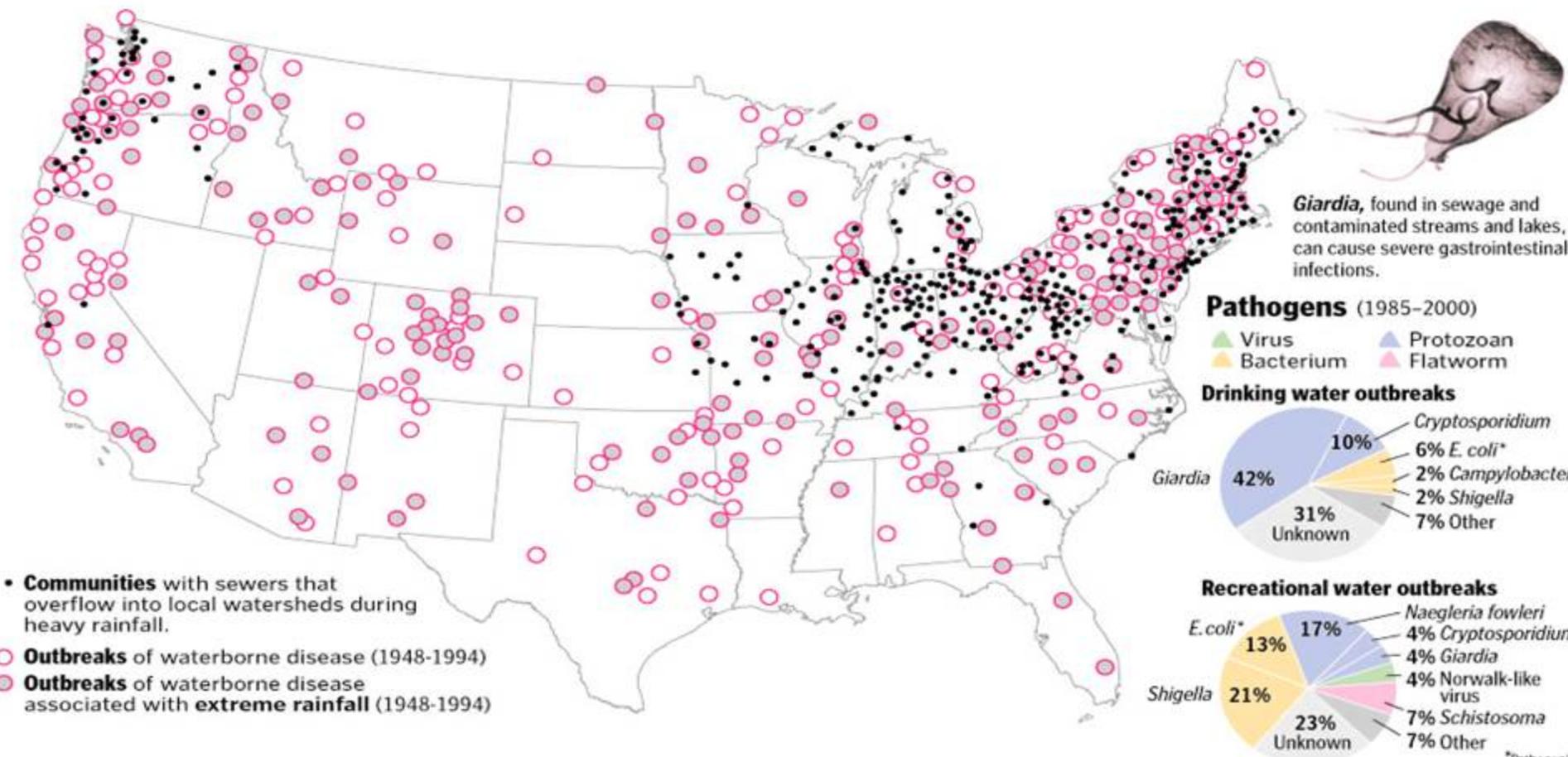
A sample glass of Lake Erie water is photographed near the Toledo water intake crib in Lake Erie. (Haraz N. Ghanbari/Associated Press)



# Risk of Disease Rises With Water Temperatures

By Kari Lydersen Washington Post Staff Writer

Monday, October 20, 2008



# Is Tap Water Safe? Here's How To Tell

As many as 63 million Americans may be consuming dangerous H2O.



By Laura Beil Mar 23, 2018



The public believes the Safe Drinking Water Act protects water at the tap

NOV 26, 2018 f t g+ in

## ELEVATED LEAD LEVELS FOUND IN BENTON HARBOR, MICH.

10 homes have found lead levels double the federal action level in drinking water



Elevated lead levels discovered in drinking water

Elevated lead levels in drinking water have been found in Benton Harbor, Mich. While the city was put under an advisory for its drinking water results in October, additional homes have detected lead above the federal action level of 15 ppb.

An additional 27 out of 100 homes tested found lead levels above the federal action level, with 10 of those homes reporting lead more than double the action level.

City officials are still investigating how lead got into the city's drinking water, according to Michigan Radio.

### contaminants



chemical contaminants into  
er investigation.

in Industrial Pretreatment

Act that show that 16 of  
ial sources of

## Bill to require water testing in schools passes committee

Holiday Specials

SAVE UP TO 25%

REEDS

SHOP NOW

### MOST POPULAR

- 1 Employee reports racist remark hanging at Request Funds  
Nov 25 at 1:14 PM
- 2 Eighth Street construction ongoing, businesses making plans  
Nov 26 at 8:58 AM
- 3 7 Weeks Photo release in Midland



News

## Disturbing Discoveries In Toronto's Waters Indicate Why E. Coli Levels Are Still So High

The water pollution in the Toronto Harbour is worse than ever.



## Scientist: PFAS has been contaminating Michigan population years

Detroit Press

## Homeless People Dying Of Hepatitis A

By Alex Berzow — November 2, 2018



Credit: Storyblocks

The homelessness crisis in several major cities across the United States is a national embarrassment. And the news keeps getting worse.

Beginning in November 2016, the homeless population in San Diego underwent an outbreak of hepatitis A that just now ended, according to the San Diego Union-Tribune. During that two-year-long nightmare, more than 600 people got sick and 20 died.

### Related article:

- Homeless Update: Typhoid Outbreak in Los Angeles
- Homeless Camps Are Infection Time Bombs
- 6th Circuit Court Of Appeals Denies EPA WOTUS Effort
- Rabies in Seattle, Tuberculosis in San Diego, Hepatitis A in Nashville. Why?
- A Parent with Shingles Gave Chickenpox to Their

## US water security falls short

BY BEBA YOUNG, OPINION CONTRIBUTOR — 11/16/18 03:00 PM EST  
THE VIEWS EXPRESSED BY CONTRIBUTORS ARE THEIR OWN AND NOT THE VIEW OF THE HILL

29 SHARES



Just In...

Maryland, DC plan flurry of subpoenas in emoluments lawsuit  
ADMINISTRATION — 2M 55S AGO



## Hepatitis A Outbreaks Hit Four U.S. States, Killing 41

CDC reports that four states in 2017 (California, Michigan, Utah, and Kentucky) experienced outbreaks of hepatitis A, 1,521 people got sick and 41 died. (All of the deaths occurred in California and Michigan).

# Cyanobacteria

The toxin that shut off Toledo's water  
The feds don't make you test for it.

500 million  
people  
impacted  
from the  
water shut  
down

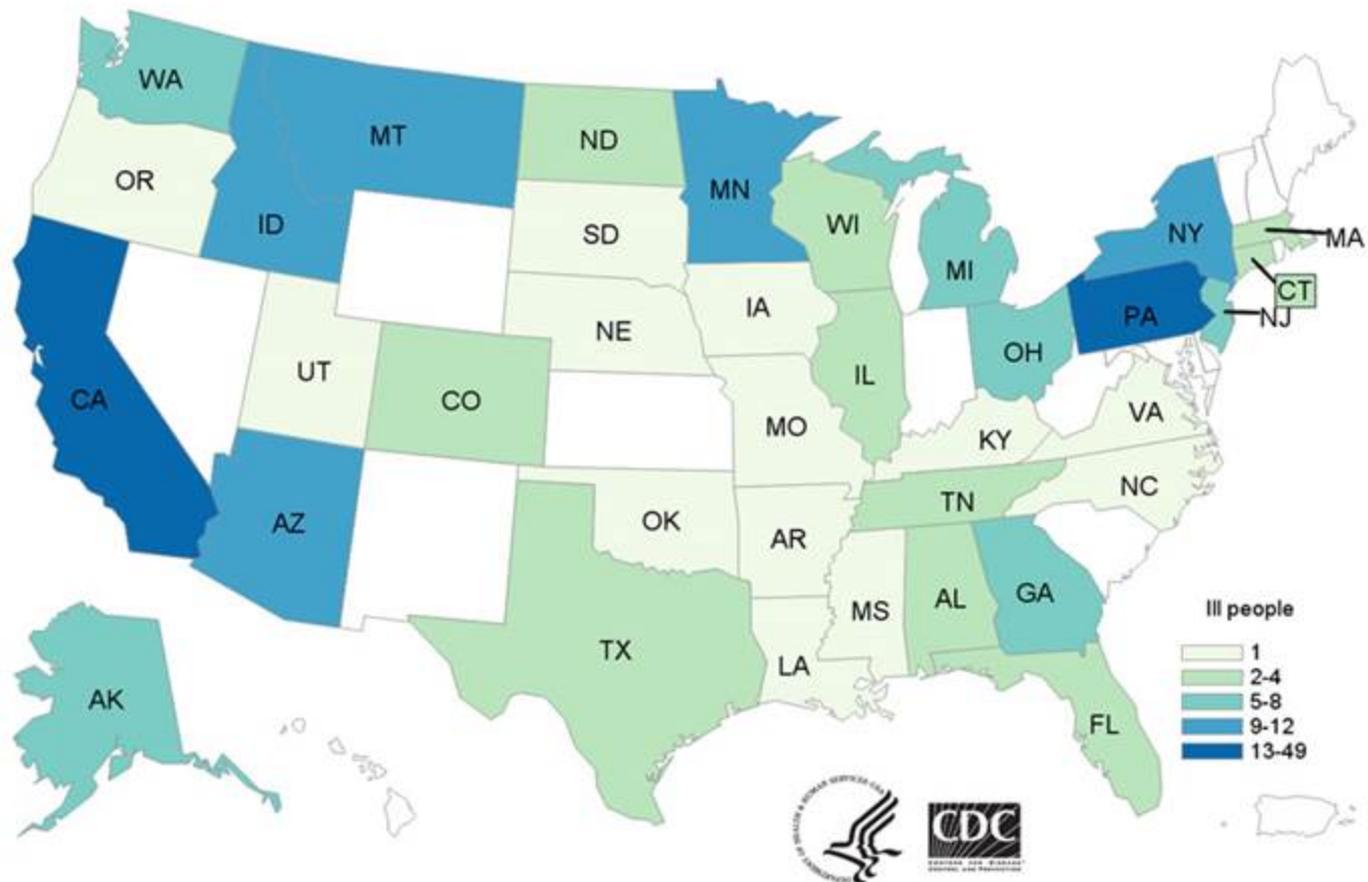


A sample glass of Lake Erie water is photographed near the Toledo water intake crib in Lake Erie. (Haraz N. Ghanbari/Associated Press)

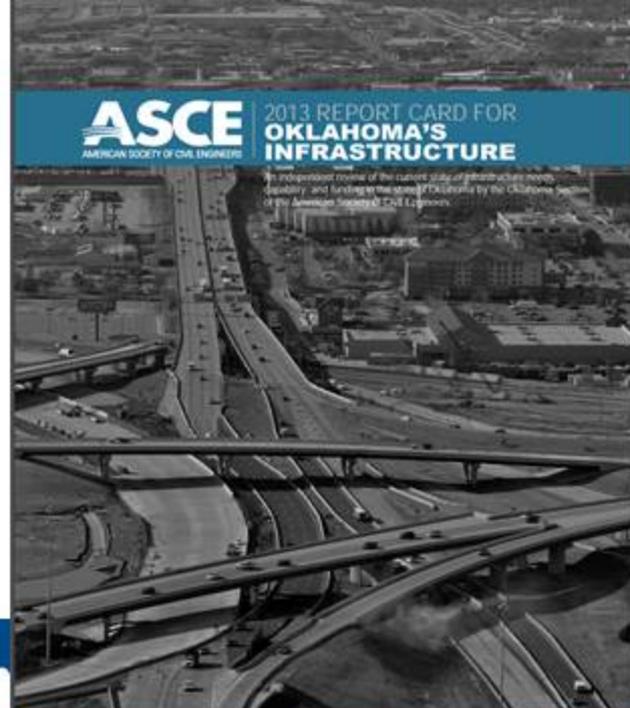
[https://www.washingtonpost.com/news/storyline/wp/2014/08/11/watching-toledos-toxic-water-troubles-with-a-wary-eye-and-few-regulations/?utm\\_term=.d31ce774f464](https://www.washingtonpost.com/news/storyline/wp/2014/08/11/watching-toledos-toxic-water-troubles-with-a-wary-eye-and-few-regulations/?utm_term=.d31ce774f464) - <https://www.epa.gov/nutrient-policy-data/cyanobacteriacyanotoxins%20>



# *E coli* 0157H7 Outbreak Linked with Romaine Lettuce contaminated irrigation water: Yuma AZ



# Oklahoma's Report Card



TRANSIT



WATER AND  
WASTEWATER



Oklahomans have an abundance of water but many communities lack access to dependable water sources due to the distance of supplies, insufficient infrastructure or storage, water quality constraints, and other limiting factors. Increasing water use coupled with growth and development pose water quality challenges throughout the state. A majority of existing water infrastructure has aged beyond its useful life and with stringent water quality requirements, a significant financial burden faces Oklahoma's water systems.

# SOURCES IMPACTING RIVER AND STREAM MILES

<https://www.deq.ok.gov/wp-content/uploads/water-division/2016-Integrated-Report-and-Appendices.pdf>

- Unknown • 11,344
- Grazing in Riparian or Shoreline Zones • 7,703
- Wildlife Other than Waterfowl • 7,517
- Rangeland Grazing • 7,322
- On-site Treatment Systems (Septic Systems and Similar Decentralized Systems) • 7,298
- Residential Districts • 5,807
- Wastes from Pets • 5,467

# SOURCES IMPACTING RIVER AND STREAM MILES

<https://www.deq.ok.gov/wp-content/uploads/water-division/2016-Integrated-Report-and-Appendices.pdf>

- Highway/Road/Bridge Runoff (Non-construction Related) • 3,982
- Non-Irrigated Crop Production • 3,893
- Impacts from Land Application of Wastes • 3,871
- Municipal Point Source Discharges • 3,574

# (Some) SOURCES IMPACTING LAKE MILES

<https://www.deq.ok.gov/wp-content/uploads/water-division/2016-Integrated-Report-and-Appendices.pdf>

- Unknown • 530,735
- Mine Tailings • 38,322
- Rangeland Grazing • 22,554
- Wildlife Other than Waterfowl • 22,554
- Natural Sources • 18,249
- Grazing in Riparian or Shoreline Zones
- Wastes from Pets • 17,522
- Animal Feeding Operations Impacts • 9,476
- from Land Application of Wastes • 4870
- Septic Tanks

# OK in THE NEWS

**TOPICAL**  
Illinois River watershed committee holds first meeting eyes water quality credit program

By Clifton Adcock | The Frontier | Nov 11, 2019



Home > Foodborne Illness Outbreaks > 11 in Washington, California, Colorado, Kansas, Oklahoma, Texas And Iowa Hit By Salmonella Dublin Hamburger

## 11 in Washington, California, Colorado, Kansas, Oklahoma, Texas and Iowa hit by Salmonella Dublin Hamburger

By Bill Marler on November 19, 2019

POSTED IN [FOODBORNE ILLNESS OUTBREAKS](#)

According to the CDC, since the last update on November 1, 2019, one additional ill person has been reported from Washington. As of November 19, 2019, a total of 11 people infected with the outbreak strain of Salmonella Dublin have been reported from seven states – Washington, California, Colorado, Kansas, Oklahoma, Texas and Iowa.



## [Federal appeals court judges may dismiss WOTUS lawsuit](#)

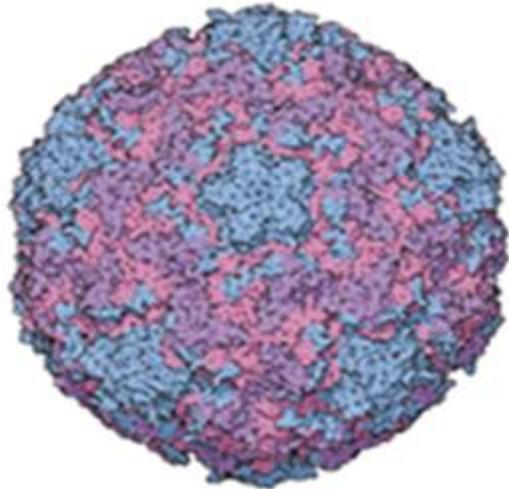
Judges Scott Matheson and Gregory Phillips of the 10th US Circuit Court of Appeals have refused to pause a Waters of the US lawsuit involving Oklahoma and business groups. The judges say they "would like to investigate further" and may dismiss the case since the Trump administration is preparing to replace WOTUS.

[E&E News \(subscription required\)](#) (10/8)

## EPA awards Oklahoma nearly \$239K grant to support state's water pollution control program

# Waterborne Pathogens from animal fecal waste and human wastewater

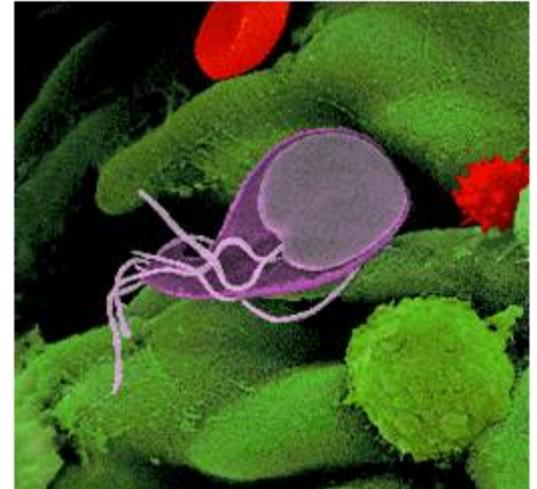
## Viruses



## Bacteria



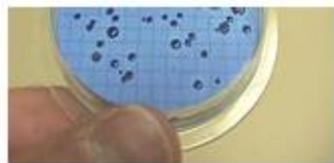
## Parasites



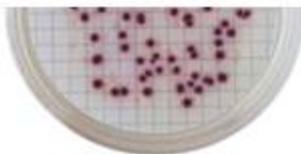
**THE DISEASES:** diarrhea, respiratory illness, liver damage, kidney failure, heart disease, cancer, nervous system disorders; birth defects, death.

**Our current compliance bacterial-based fecal indicators are insufficient to address public health, sources and remediation.**

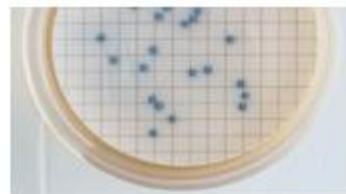
## **NEED Better Water Diagnostics**



Fecal  
coliforms



*E.coli*



Enterococci

All bacterial, non-sporeformers

**BETTER INFORMATION**  
**MORE SPECIFIC INFORMATION**

**ADDRESS PATHOGENS SUCH AS VIRUSES,**  
**ADDRESS SOURCE TRACKING**  
**ADDRESS HEALTH RISKS**

**UNDERTAKE COMMUNITY BASED RESEARCH**

**USE NEW TECHNOLOGY**

**SUPPORT RISK-BASED**  
**DECISION SCIENCE**

### Pathogen Water Diagnostics

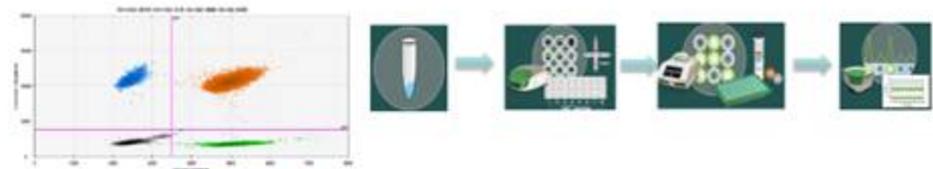
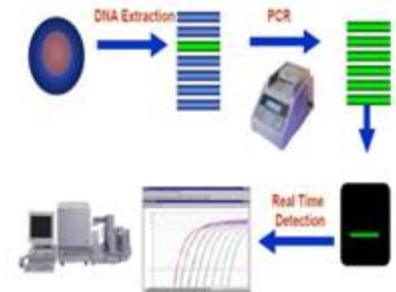
Polymerase chain reaction (PCR):

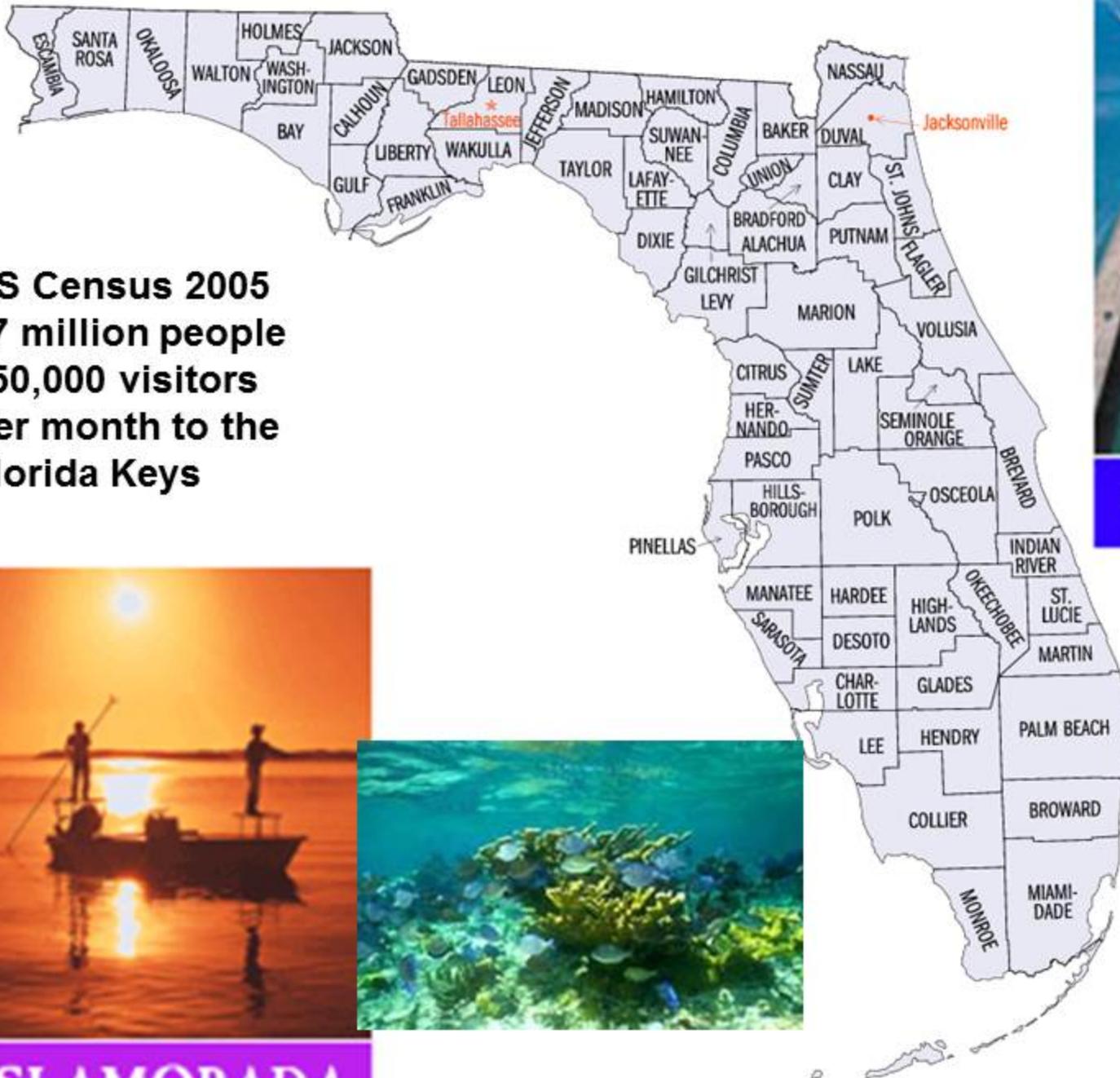
Small amount of DNA amplified  
in a thermal cycler

Amplified products are measured  
at the end point of amplification  
by agarose gel electrophoresis

Quantitative PCR (qPCR)

Digital droplet PCR





**MARATHON**

**US Census 2005  
17 million people  
250,000 visitors  
Per month to the  
Florida Keys**



**ISLAMORADA**





# Sewage Sinking Florida Waters

Marine Environment Stretched to Limits

By Warren Richey  
The Christian Science Monitor

# Pollution Still Mars Beaches

## Another El Nino migraine: overflowing septic tanks

■ Heavy rains since December bring a flood of sewage troubles to north Tampa.

By SABITA PERALDO  
Times Staff Writer

bles due to flooding.  
"It's a big problem," said Jimmerson. "I've never seen anything like this, and I've been in the business 11 years."  
About half of north Tampa homes have septic tanks, mostly in the Lutz and Odessa areas.  
Typically, a septic tank holds 950 to 1,000 gallons, Jimmerson said.  
Wastewater from the house flows into the under-

Jimmerson said.  
That can cost homeowners anywhere from \$175 to \$500, depending on how serious the problem is, said Bob McDonald of Austin Septic Systems.  
In a few cases, McDonald said, he has had to replace septic tanks. That can cost about \$5,000, he said.  
So far, Fry's septic tank problems have cost her about \$875. A county easement near her house has flooded to the point that it almost looks like a lake.

LUTZ — A bubbling toilet was the first sign

CHARLOTTE

**Herald-Tribune**  
A New York Times Company

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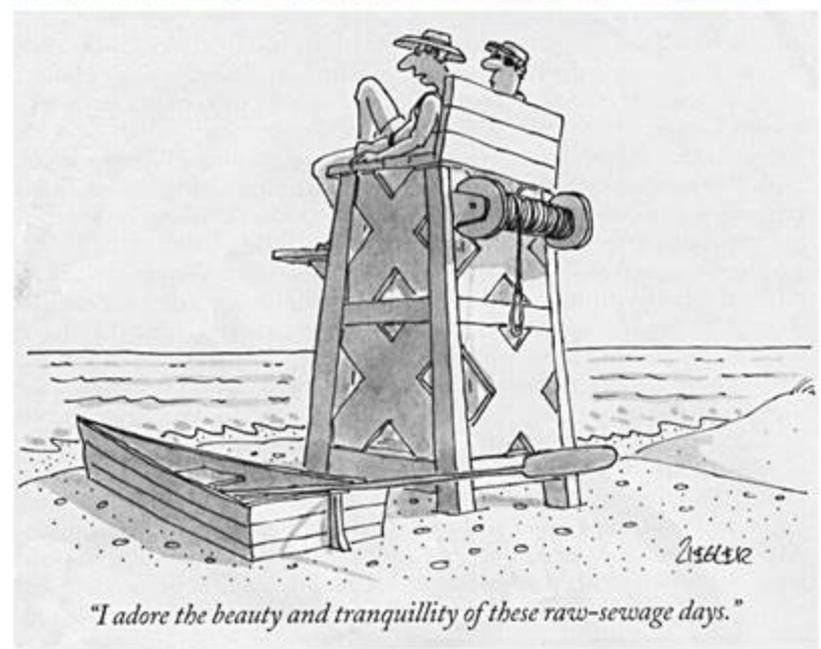
### HERALD-TRIBUNE EDITORIALS

## Septic-tank study

*Florida should ensure that the problems don't get worse.*

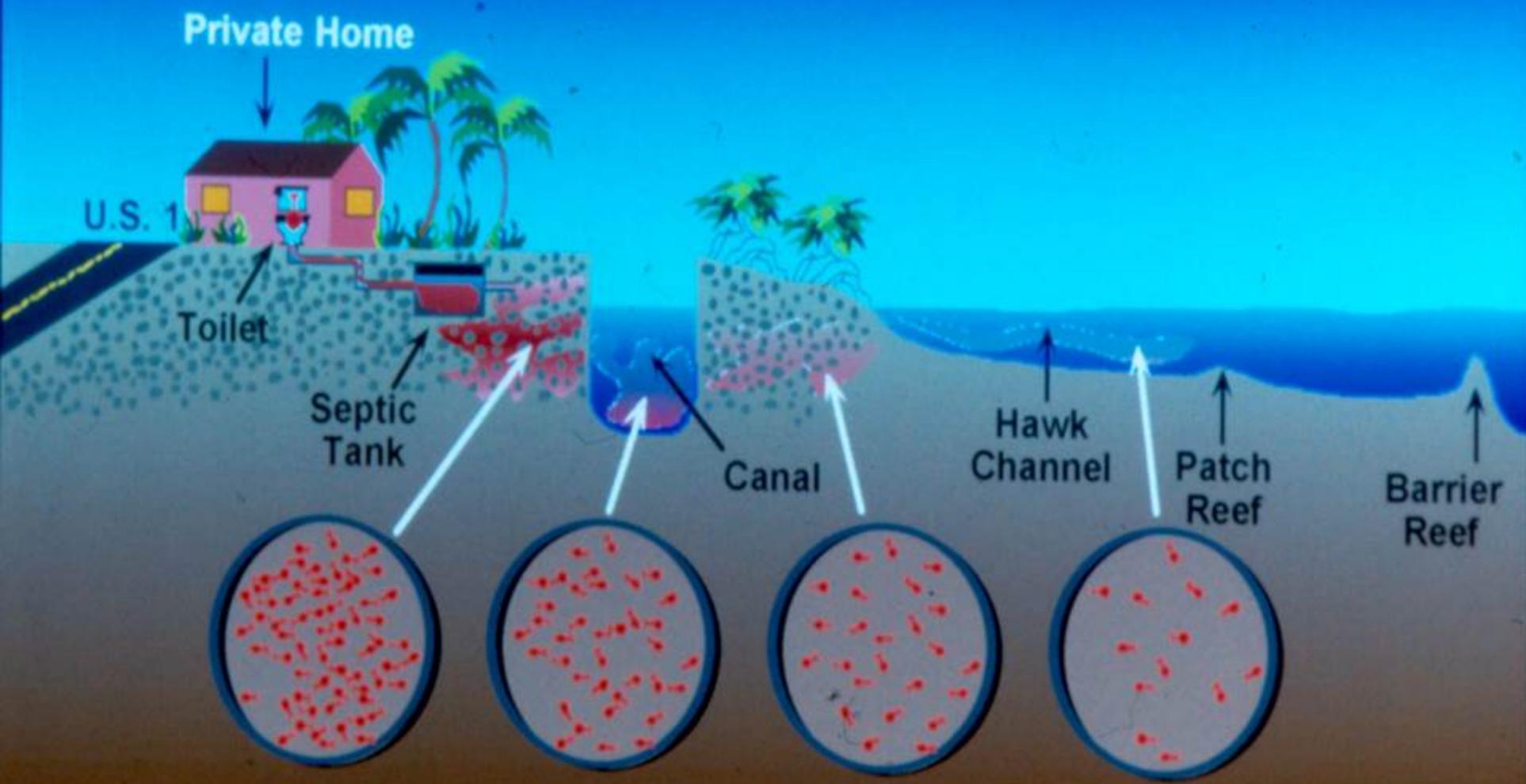
A statewide study of septic-tank permitting is warranted, based on the potential for problems similar to those associated with the pollution of Phillippi Creek in Sarasota County. Septic tanks can be an effective and safe form of sewage treatment — depending on the soil conditions, water tables and installation methods. But when septic tanks are installed too close together or insufficiently separated from saturated soils and water tables, they can contribute to pollu-

tion by nitrates, viruses and organic pathogens that degrade water quality and pose human-health risks. The conditions that have contributed to the pollution of Phillippi Creek are common throughout Florida. Septic-tank permitting has been improved over the years but it makes sense to regularly review a practice that has significant public health and environmental implications. Florida should take the necessary precautions to ensure that its problems don't get worse.

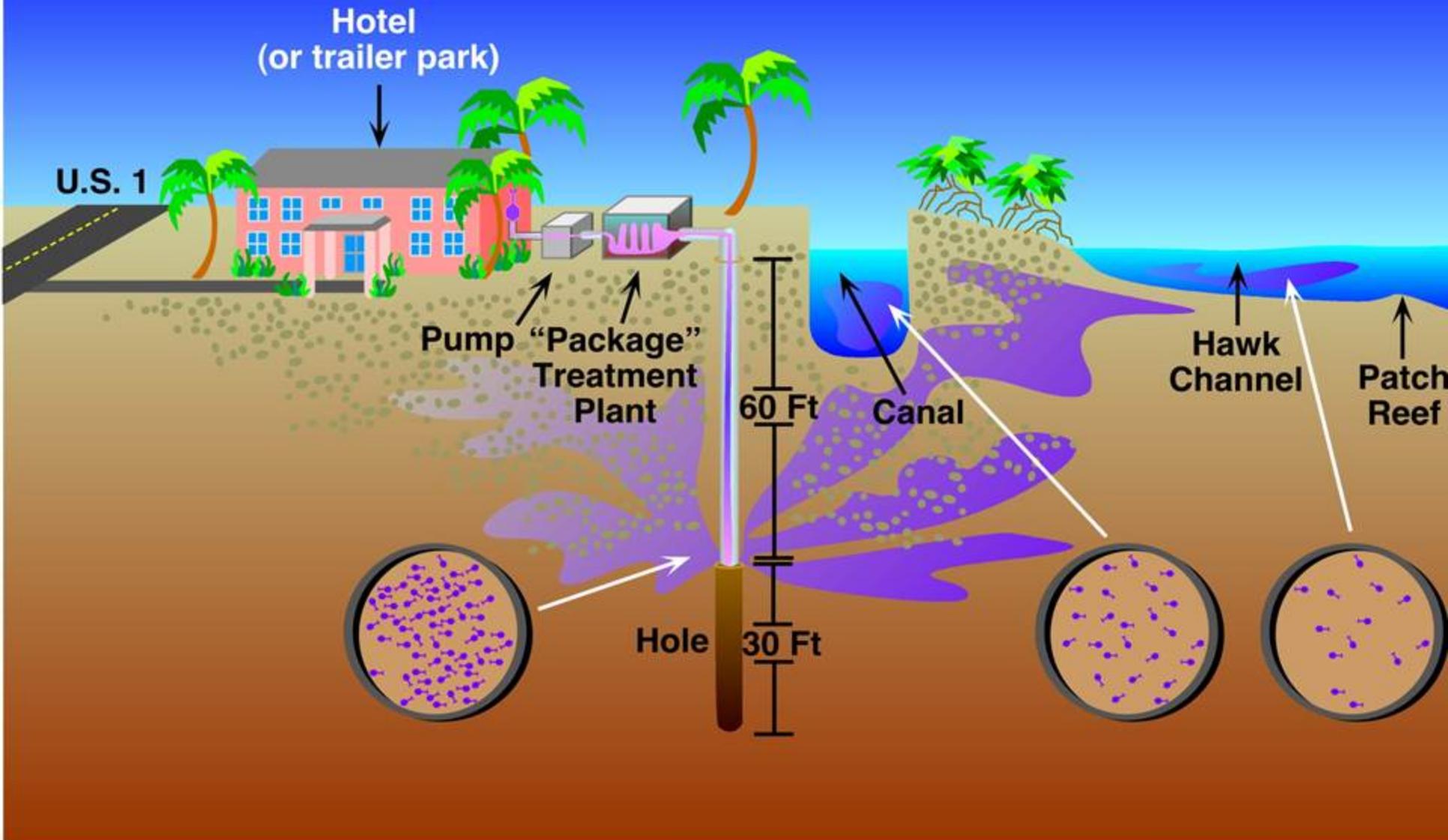


*"I adore the beauty and tranquillity of these raw-sewage days."*

# Septic Tank



# Injection Well



# What we learned from viral tracer Studies

1. Both septic tanks and injection wells Rapidly contaminated surface water (often in as little as 3 hr).
2. Rates of migration of wastewater ranged from  $<1$  to  $>150$  m/h
3. These results have shaped future Waste disposal policy in the Keys

## What will be done?

1. Septic tanks are being removed.
2. Sewers and wastewater treatment is being built.
3. Advanced treatment is being used to remove nutrients (nitrogen and phosphorous) and disinfection is used to destroy the viruses and bacteria.
4. More attention is being paid to storm waters.

# THREATS TO THE GREAT LAKES

Sewage; Combine sewer overflows; Storm water; Non-point source pollution; Invasive species

Algal blooms

Climate change and  
Inadequate infrastructure



# Sources of *E.coli* and Pathogens

Septic systems



Waste water/Sewage treatment



Animal farming operations



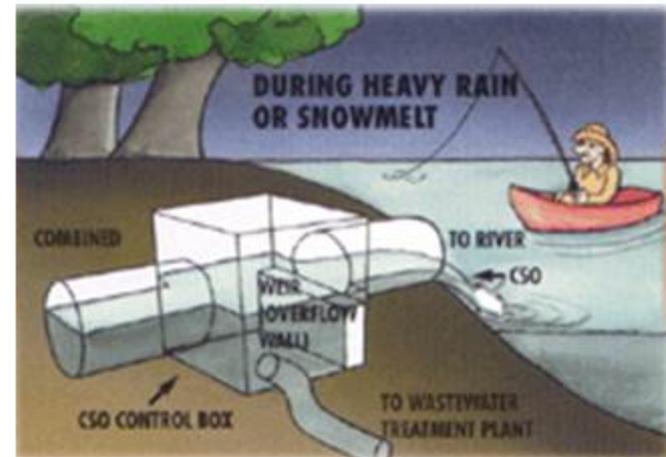
Agricultural run-off



Wildlife



Combined Sewer Overflow



# Microbial Source Tracking

- Tools are now available to determine to link specific molecular markers to the source of the fecal pollution

- **Health risks**
- **Remediation**
- **Prioritization**
- **Responsibility**



# Sampling water quality and The Landscape

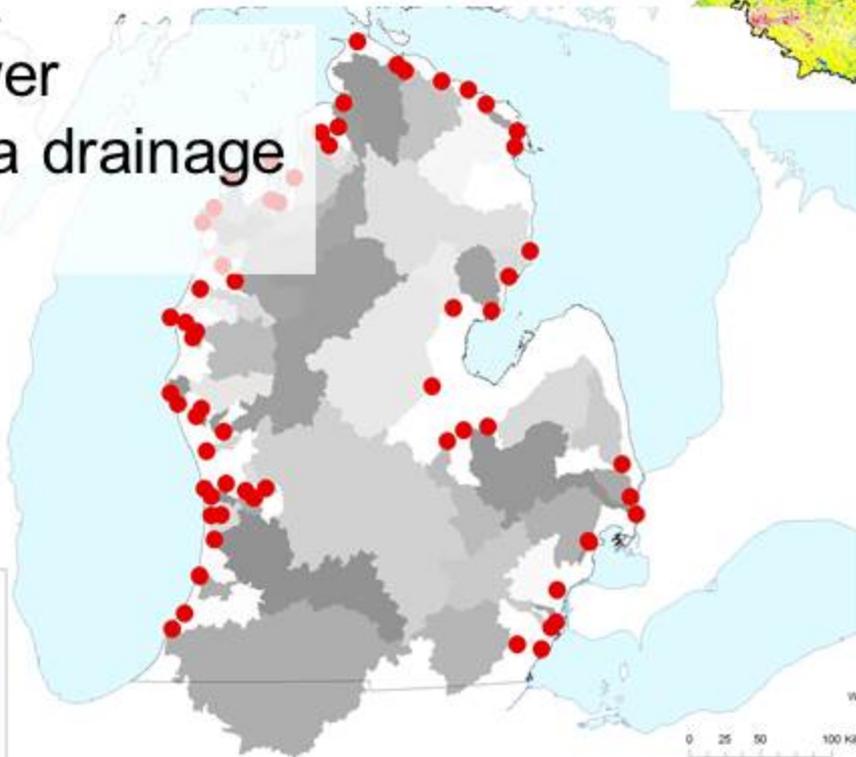
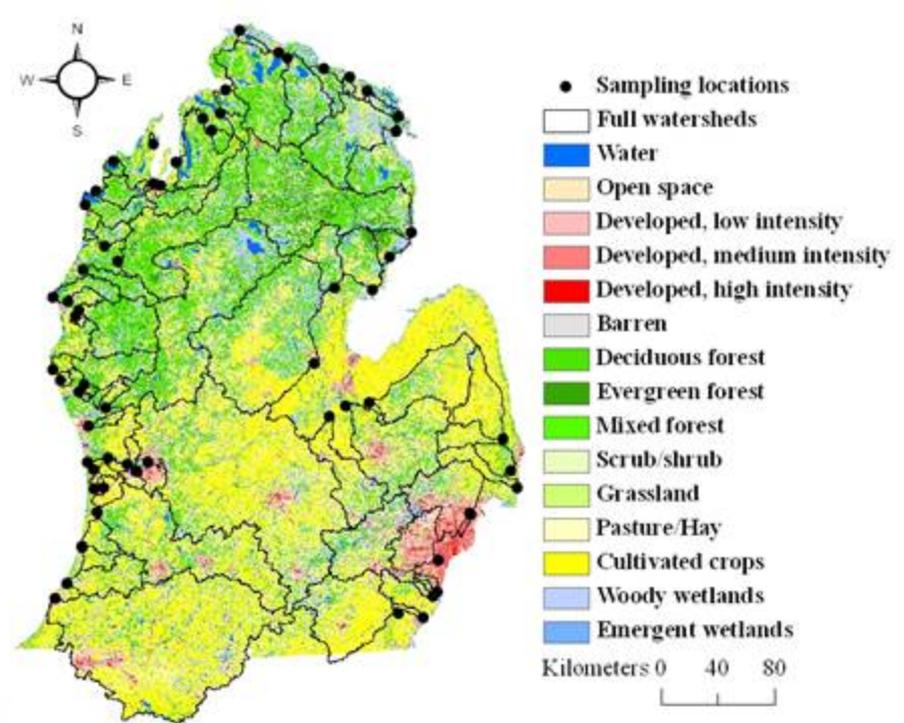
Baseflow (October 2010)

Spring thaw (March 2011)

Early summer rain (June 2011)

64 River systems

84% Lower Peninsula drainage area



## In Stream Conditions:

- River discharge (ADCP and USGS)
- Temperature
- Physical chemistry (pH and specific conductance)

## Chemistry and Nutrients:

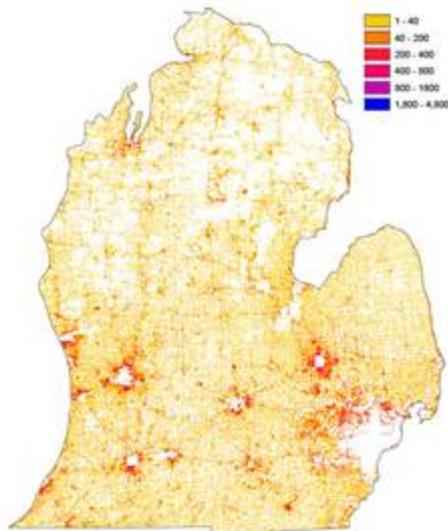
- Nutrients (N, P, TN, TP, TDN, TDP, SRP)
- Ions (Na, Ca, Mg, Cl, K, NO<sub>3</sub>, SO<sub>4</sub>, NH<sub>3</sub>)
- Dissolved organic carbon
- Alkalinity
- Stable isotopes ( $\delta$ H2 and  $\delta$ O18)

## Algae and Chlorophyll:

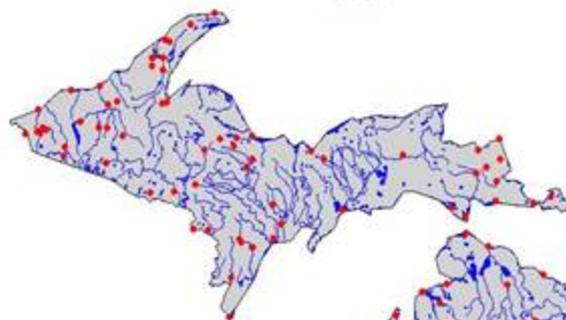
- Chlorophyll a
- Epiphytic algae (hard and soft substrate)

## Microbes and Pathogen Indicators:

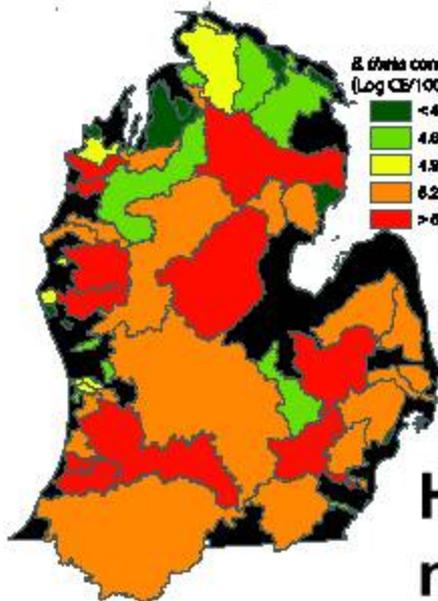
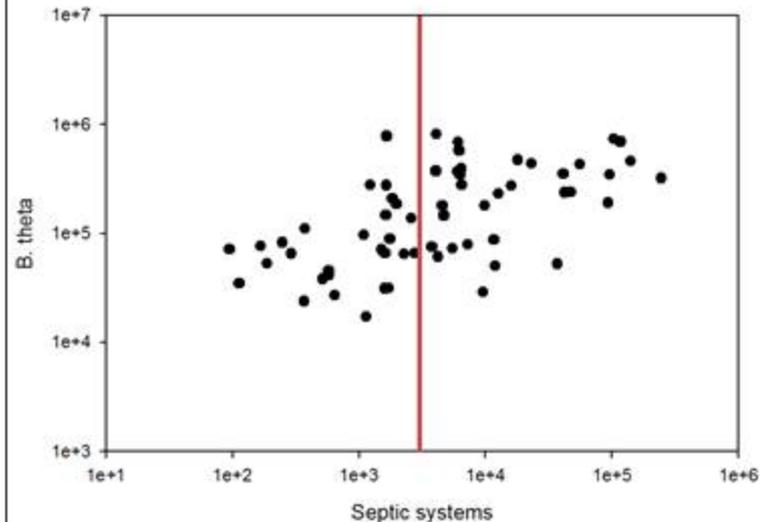
- *E. coli*
- *Bacteroides thetaiotaomicron*  $\alpha$ -1-6 mannanase (B. thetaiotaomicron)
- M2 Bovine marker (*Bacteroides*)
- Pig2bac (*Bacteroides*)



**Septic system density**



**Wastewater treatment plants**



**Human marker**

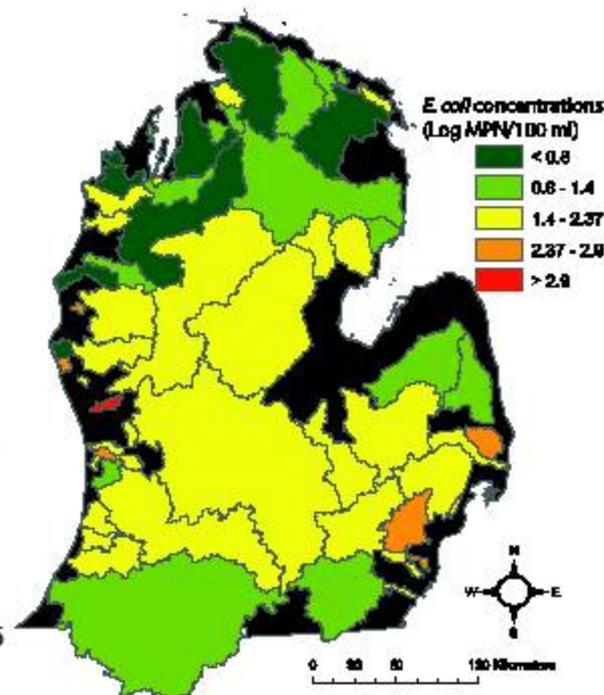
***E. coli* concentration (Log CFU/100 ml)**

- <math>< 4.0</math>
- 4.6 - 4.9
- 4.9 - 6.2
- 6.2 - 6.6
- > 6.6

- Wastewater Treatment Plants
- Major Rivers
- Major Lakes
- Michigan

Data Courtesy of MDEQ

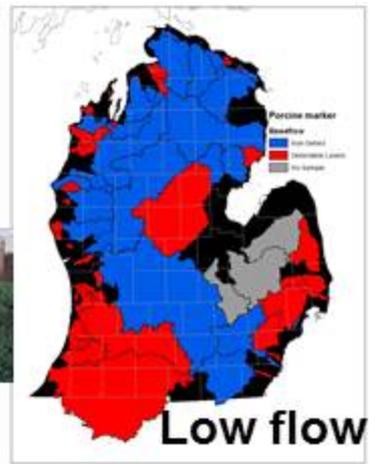
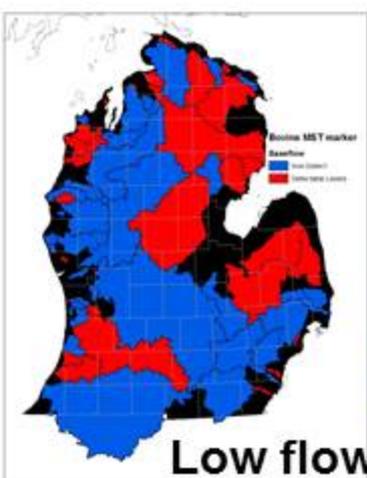
Verhougstraete, M.P., Martin, S.L., Kendall, A.D., Hyndman, D.W. and Rose, J.B. 2015 Linking Fecal Bacteria in Rivers to Landscape, Geochemical, and Hydrologic Factors and Sources at The Basin Scale. *Proceedings of the National Academy of Sciences*. [www.pnas.org/cgi/doi/10.1073/pnas.1415836112](http://www.pnas.org/cgi/doi/10.1073/pnas.1415836112), pages1-6.



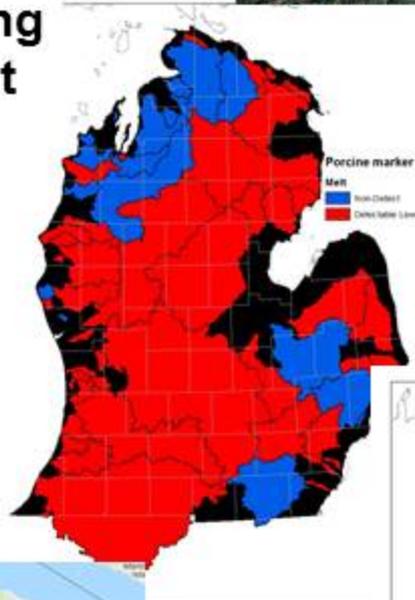
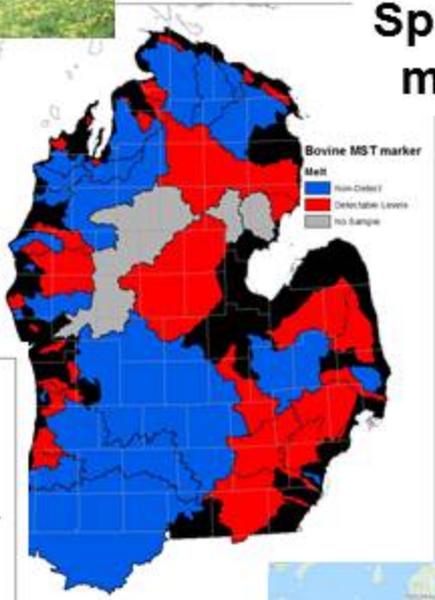
***E. coli* concentrations (Log MPN/100 ml)**

- <math>< 0.8</math>
- 0.8 - 1.4
- 1.4 - 2.37
- 2.37 - 2.9
- > 2.9

Nshimiyimana, J.P., Martin, S.L., Flood, M., Verhougstraete, M.P., Hyndman, D.W., and Rose, J.B. 2018. **Regional Variations of Bovine and Porcine Fecal Pollution as a Function of Landscape, Nutrient, and Hydrological Factors.** *J. Environmental Quality* 47 (5): 1024-1032

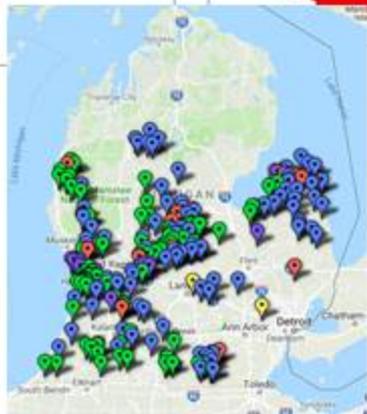
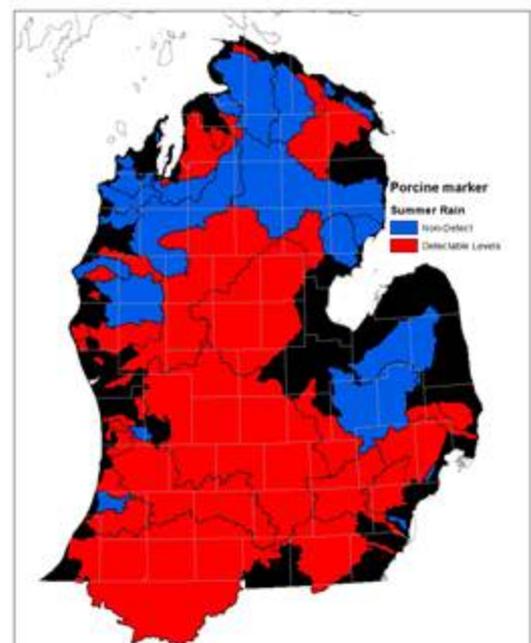
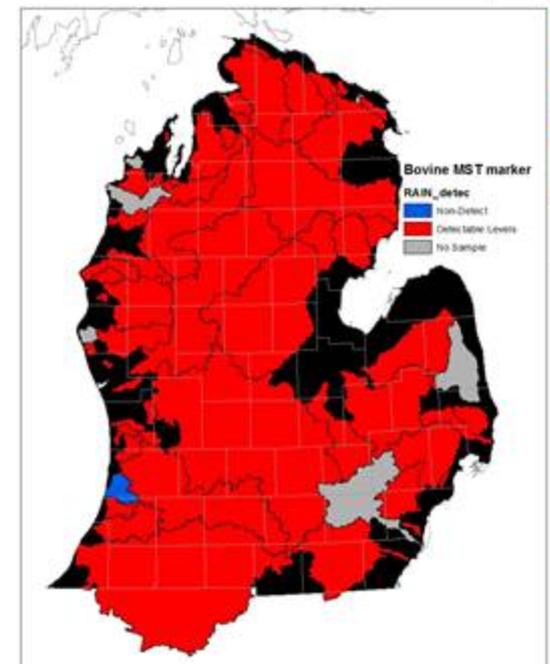


**Spring melt**



**Summer rain**

**Summer rain**



**Legend**  
 ● cattle, hofers, veal  
 ● dairy  
 ● horse or mixed

# Recommendations

- Michigan needs a state sanitary code
- Michigan needs to build better data bases
- Michigan needs to understand BMP for non point sources especially manure (tile drains, tillage practices and use of buffers and wetlands as sinks)

# Community Decision Making with Community engaged research

**Relevant**

**Timely**

**Economical**

**Realistic**

**Communicated**

**With consultation & Partners**



- Identify the important sources of pollution.
- Pathogen/ source tracking monitoring address risk and help to move the political will.
- Tracer studies provide a better way to address the source and the timing of pollution risks.
- Data provide a way to use the community dollars wisely.

# How do we solve the water pollution problems and protect water quality?

**INVEST IN TECHNOLOGY**



**INVEST IN ASSESSMENT**



**IMPROVE YOUR KNOWLEDGE  
& DECISION MAKING**

# THANK YOU FOR YOUR ATTENTION



## Acknowledgements

- **Rose Lab Group**
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- Anthony Kendall
- David Hyndman



Michigan Corn  
Marketing Program



**MSU**  
**Hydrogeology**  
<http://hydrogeology.glg.msu.edu>

Project  
**GREEN**

A green leaf icon with a white vein, positioned to the right of the text "Project GREEN".

Research Funded by the Michigan Corn Growers Association and MSU's  
Project Green