

# Investigations in Water Quality

# Since Last Fall

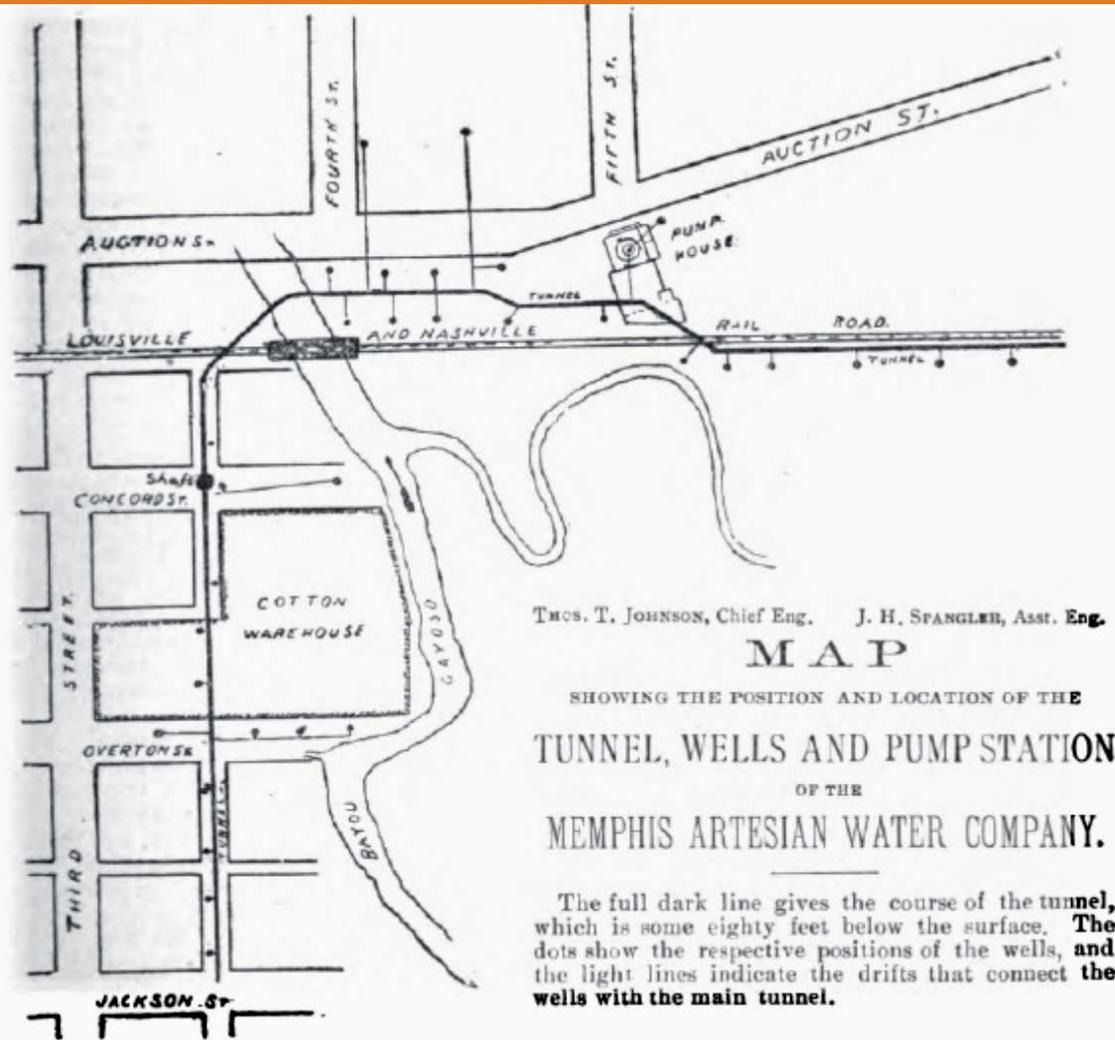
- EHS-Net Water Close out
- Splash Pad Survey
- Drinking Water GIS
- Private Well Water Quality Survey
- Oak Ridge Reservation Offsite Groundwater Study
- Illness/Outbreak Investigations



# Splash Pads



# Drinking Water GIS

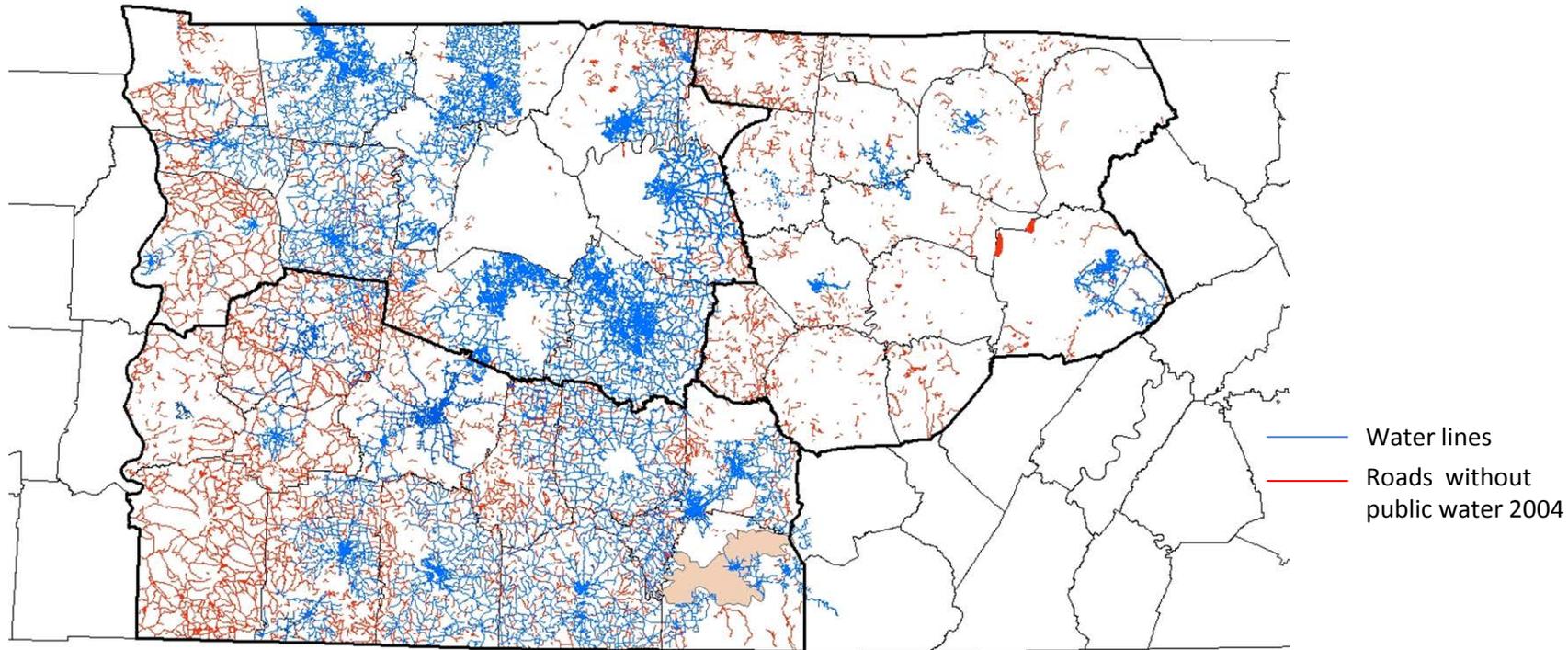


# Public Water Distribution



# Progress on Public Drinking Water GIS

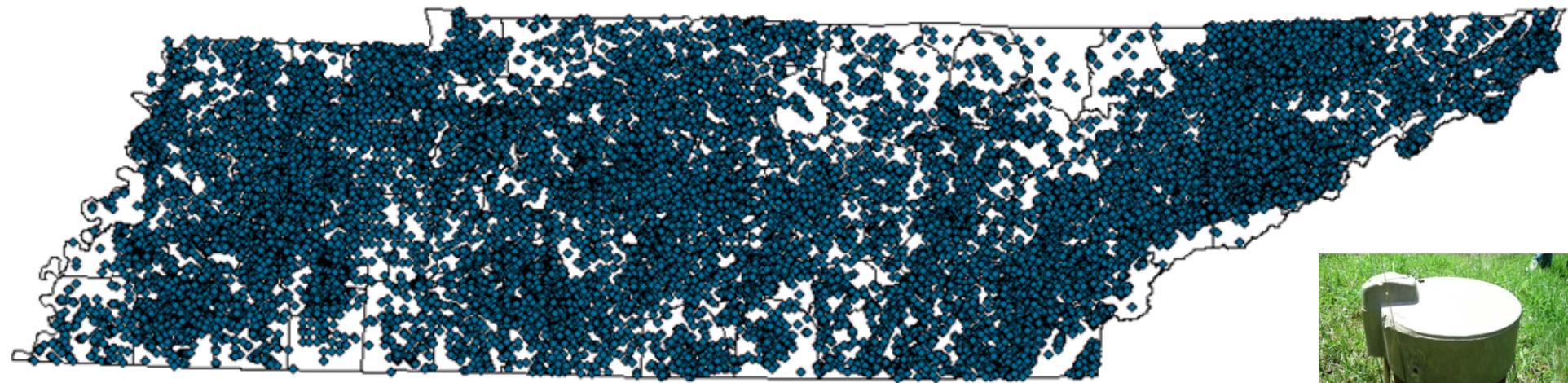
- Collaboration with TDEC
- Water utility involvement
- Critical infrastructure



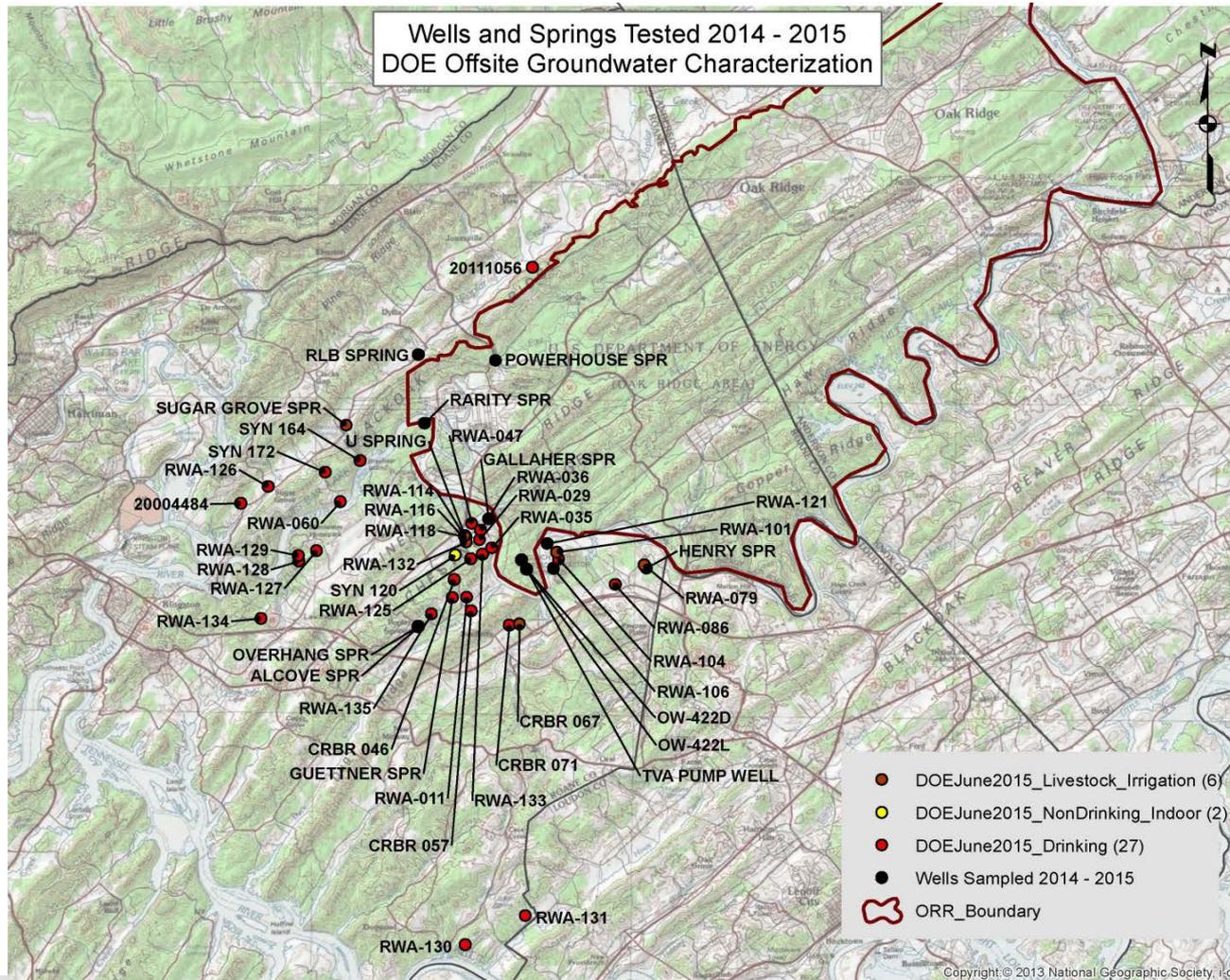
# Private Well GIS

- Collaboration with TDEC
  - Water well installer information
  - TDEC inspection data

**Wells Installed Since 2000**



# Oak Ridge Offsite Groundwater Investigation

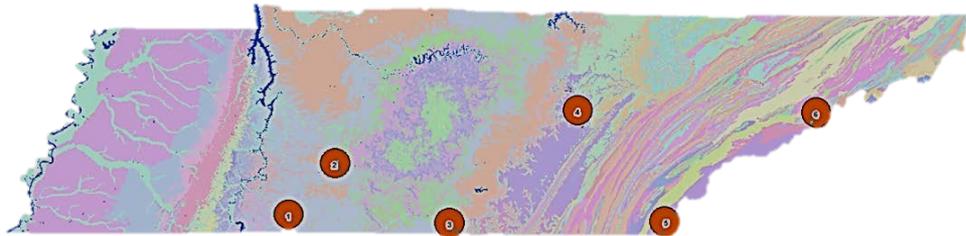


- TDEC Collaboration
- Indoor Air
- Water quality
- Consultation
- Health impacts
  - High pH
  - Lead, Lithium
  - Strontium 90
  - Radioactive isotopes



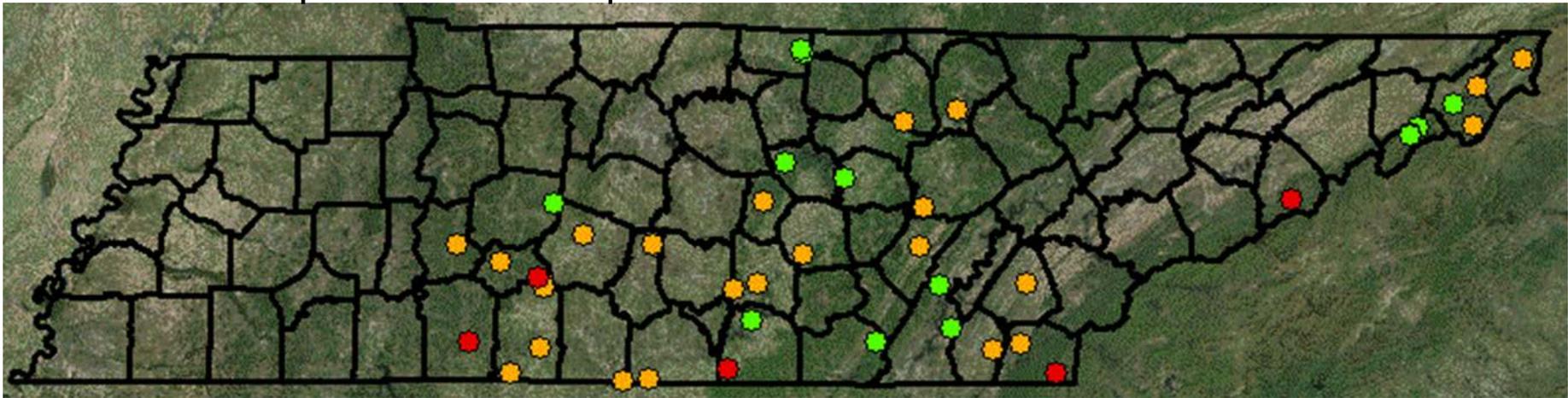
# Private Well Water Quality Study

- Water sampling
  - 143 wells
  - 7 springs
  - 9 surface streams
- January to July 2014
- 6 geographic regions



# Why?

- TDEC public water well sampling
  - 92 samples, 37% over 300 piC/L
  - Range 30.6 – 9,910 piC/L
  - 5 over 1,000 piC/L
- EPA Draft Maximum Contaminant Level (MCL)
  - 300 piC/L or 4,000 piC/L Alternative MCL



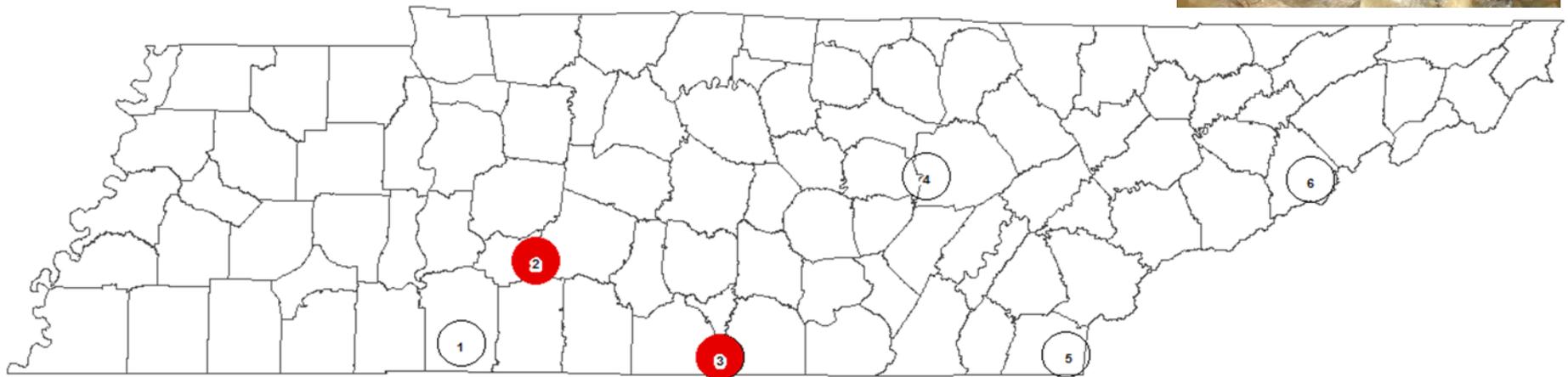
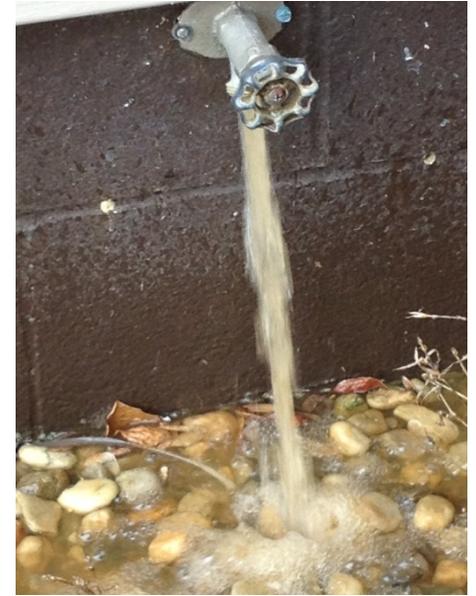
# Radon

- Naturally occurring radioactive, carcinogenic gas
  - breakdown of uranium or thorium
  - Half life of about 4 days
- In indoor air
  - 2nd leading cause of lung cancer
  - Concentrations  $> 4$  pCi/L in air = action
- In water
  - Ingestion linked to some cancers
  - 10,000 pCi/L in water =  $\pm 1$  pCi/L in air

<http://water.epa.gov/lawsregs/rulesregs/sdwa/radon/regulations.cfm>

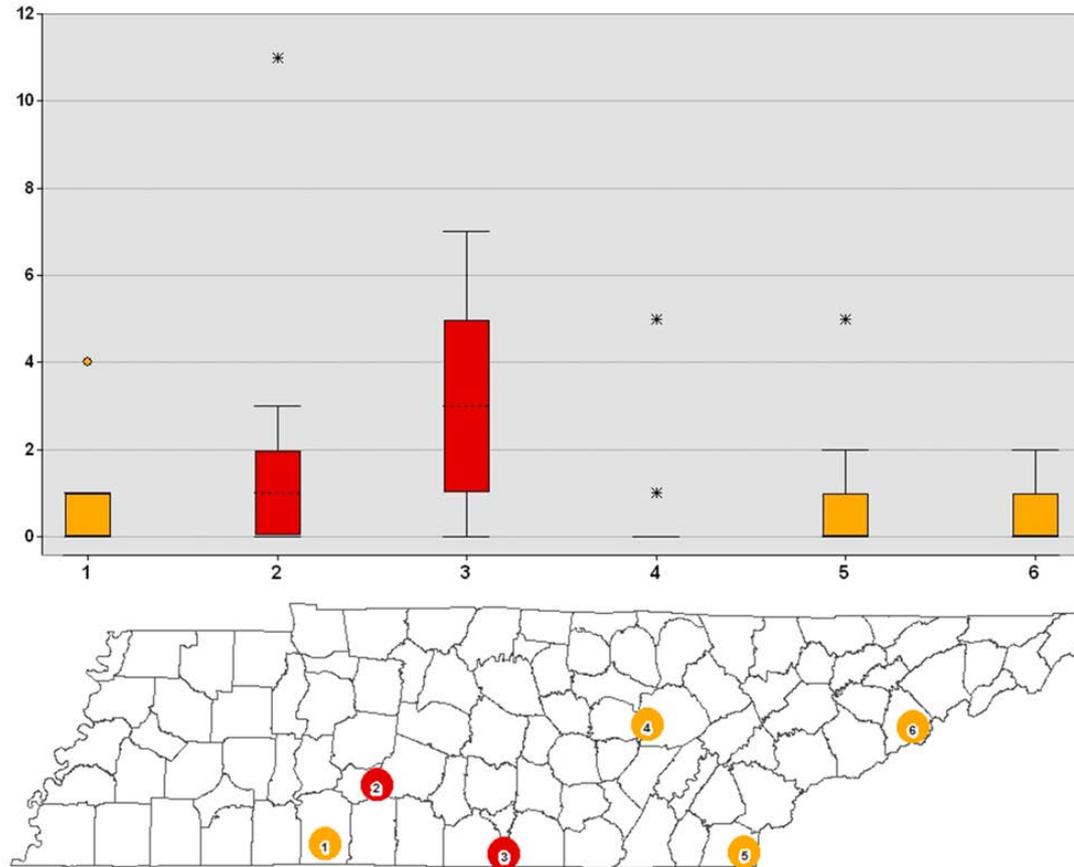
# Bacteria Results

- 50 total coliform positive (35.0 %)
  - Range 1 - >2,420 MPN/100mL
- 15 fecal coliform positive (10.5%)
  - Range 2 – >2,100 MPN/100 mL
- 11 *E. coli* positive (7.7%)
  - Range: 1 – 1,986 MPN/100 mL
  - EPA MCL = 0



# Nitrate (as Total Nitrogen), Results (mg/L)

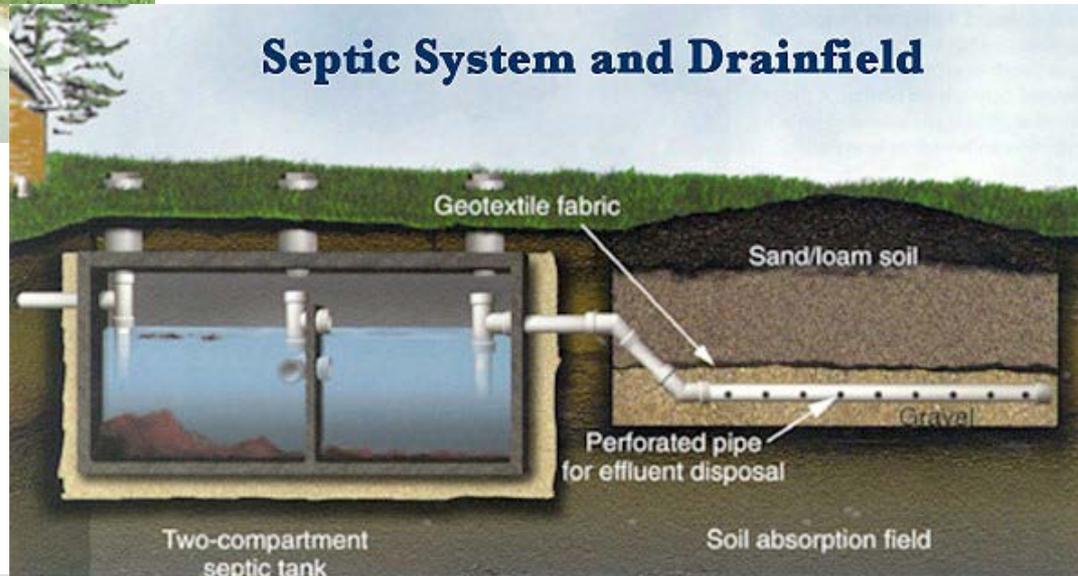
- EPA MCL
  - 10 mg/L nitrates
  - 1 mg/L for Nitrites
- Sum of nitrogen, nitrates, nitrites
  - Can't determine individual components
- Maximum detected
  - 11 mg/L



# Landuse



## Septic System and Drainfield



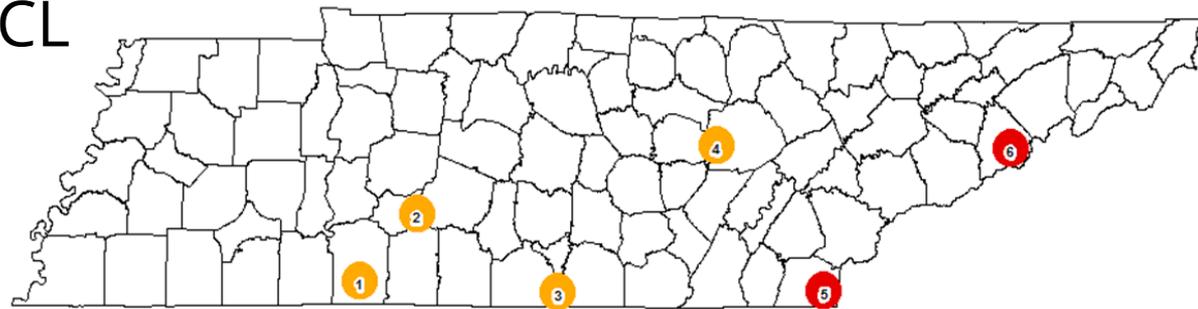
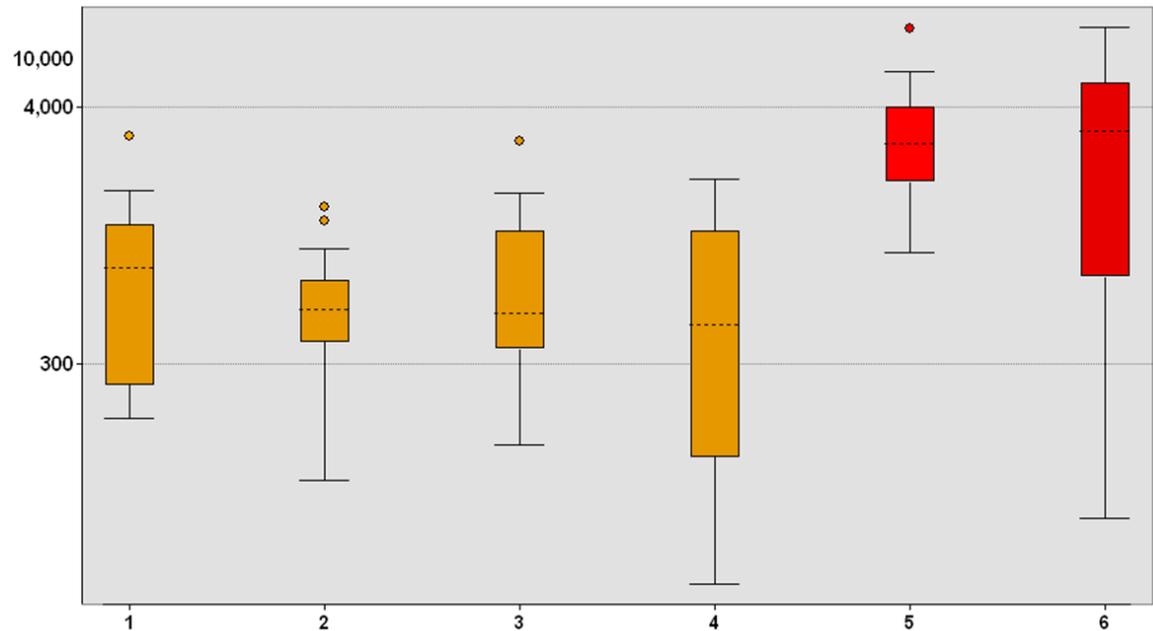
# Geologic Formation

- Karst
  - Conduit for contaminants to enter groundwater
  - Contaminants transported rapidly



# Radon Results

- Radon detected in every well, N= 143
  - Range 30.6 - 8,878 pCi/L
- 115 above 300 MCL (80.4%)
- 18 above 4,000 AMCL (12.6%)



# Primary MCL Metals Results

- Lead
  - 66 wells (46%)
  - 2 over the 0.015 mg/L action advisory
- Mercury
  - 3 wells, one over 0.002 mg/L MCL
- Arsenic
  - 11 wells (8%), none over 0.01 mg/L MCL
- Barium
  - 139 wells (97%), one over 2.0 mg/L MCL
- Chromium
  - 46 wells (32%), one over 0.1 mg/L MCL



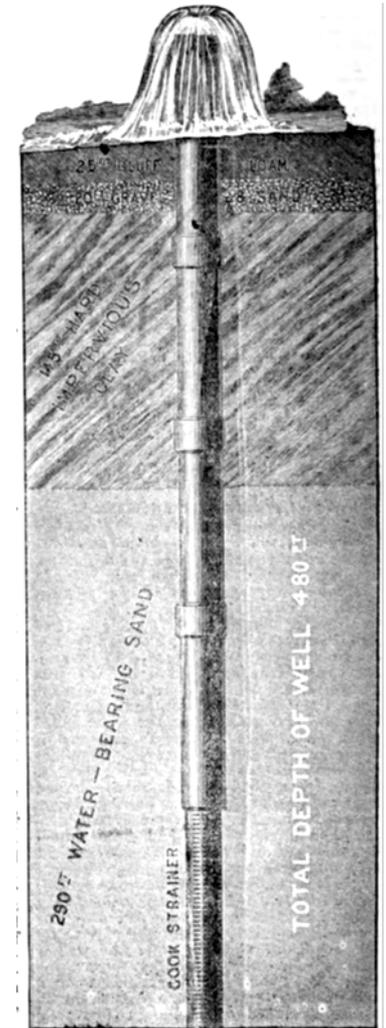
# Secondary MCL Metals

- Secondary MCL Metals
  - Taste, odor, staining
  - Health effects in high concentrations
  - Sensitive populations
    - Pregnant women, infants
    - Immunocompromised

Metal	Secondary MCL (mg/L)	Average (mg/L)	Maximum (mg/L)
Aluminum	0.05 to 0.2	0.19	10
Copper	1.0	0.03	1.9
Iron	0.3	0.75	31
Manganese	0.05	0.10	3.8
Zinc	5	0.05	6

# Moving Forward

- Unregulated Drinking Water Initiative
  - Private drinking water sources
    - Less than 15 connections or less than 25 people
    - Less than 60 days per year
    - Wells and Springs
  - Family Health and Wellness collaboration
  - Waterborne illness awareness training
    - water well installers
    - public water utility workers
  - Continue drinking water GIS
    - Southeast region
  - Spring and well sampling, statewide but limited
    - Participants in FH&W program
    - TDEC study areas

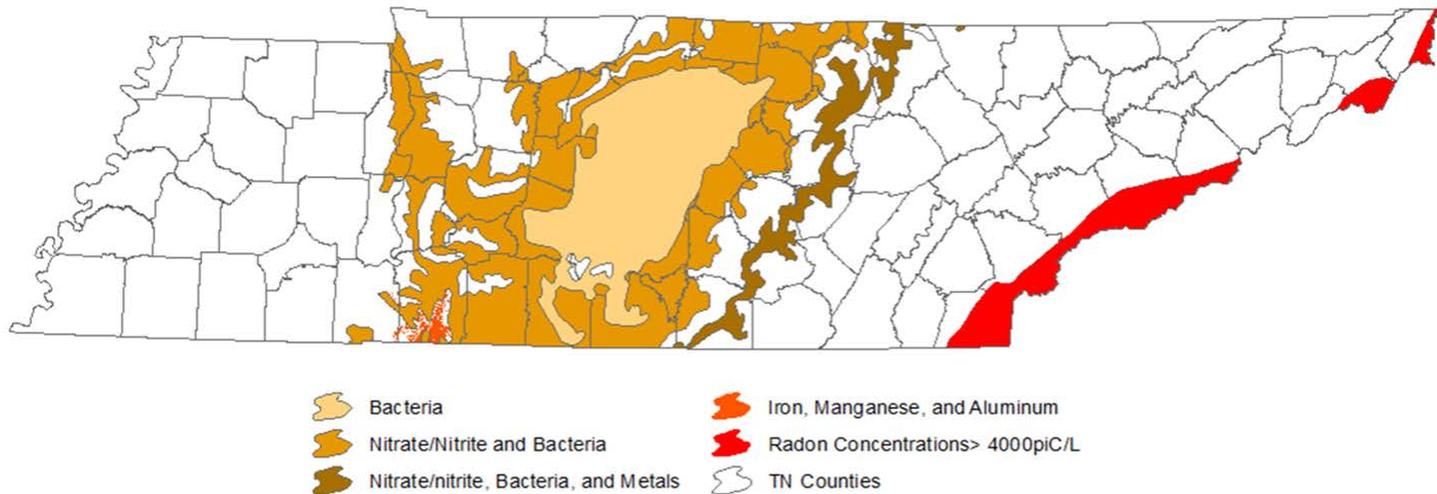


# Springs Used as Drinking Water



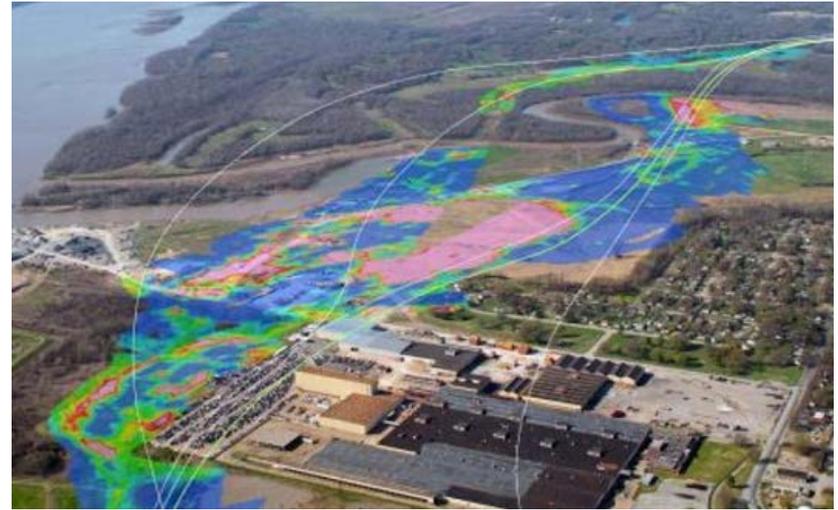
# The Goal

- Raise awareness about health implications
- Identify communities without access to safe drinking water
- Provide limited number of free water tests
- Contribute to TDEC's Groundwater Quality Report

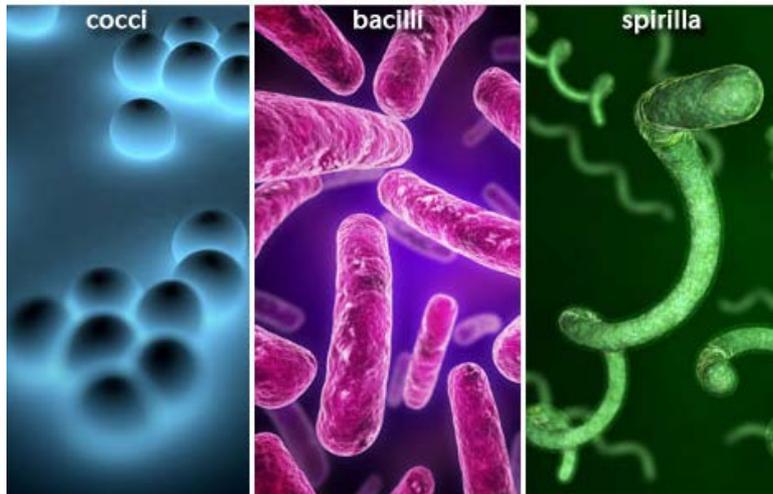


# Common Non-pathogenic Contaminants

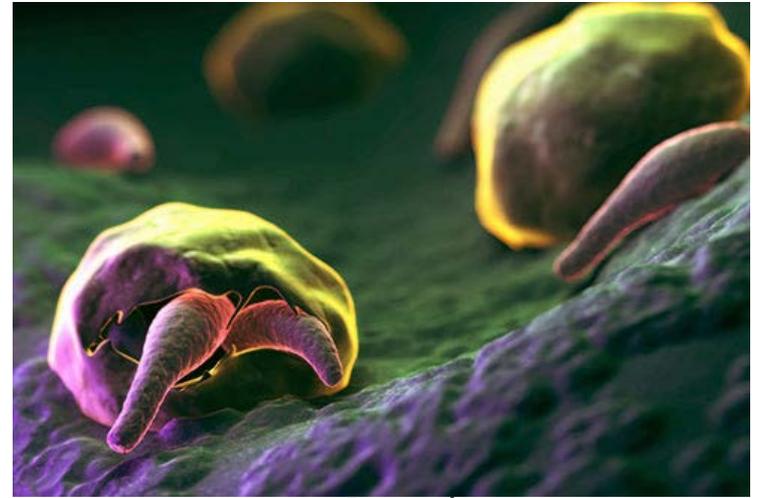
- Metals
  - Lead, Copper, Mercury, Aluminum
- Radiologics
  - Radon
  - Alpha & Beta particles
  - Radioactive metals
- Volatile Organic Compounds
  - Petroleum based
  - Perchloroethene or Tetrachloroethylene (PCE); Trichloroethylene (TCE); Vinyl Chloride (VC); Benzene; Polycyclic Aromatic Hydrocarbons (PAHs)



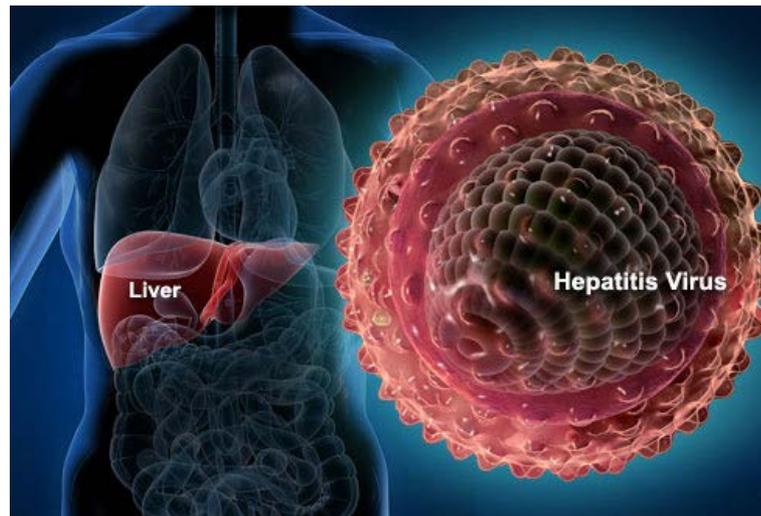
# Infectious Pathogens in Water



Bacteria



Parasites



Viruses

<http://www.webmd.com/a-to-z-guides/videos/h.htm>

# Common Waterborne Illnesses

## Neurologic infections

*Echovirus, Naegleria fowleri*

## Eye Infections & irritation

*Acanthamoeba keratitis, Adenovirus*

## Ear Infections

*Pseudomonas*

## Hepatitis

*Hepatitis A virus*

## Respiratory Infections & irritation

*Legionella, non-tuberculus mycobacteria, chemicals*

## Acute gastroenteritis

*Cryptosporidium, Giardia, toxigenic E. coli, Shigella, norovirus, chemicals*

## Urinary Tract Infections

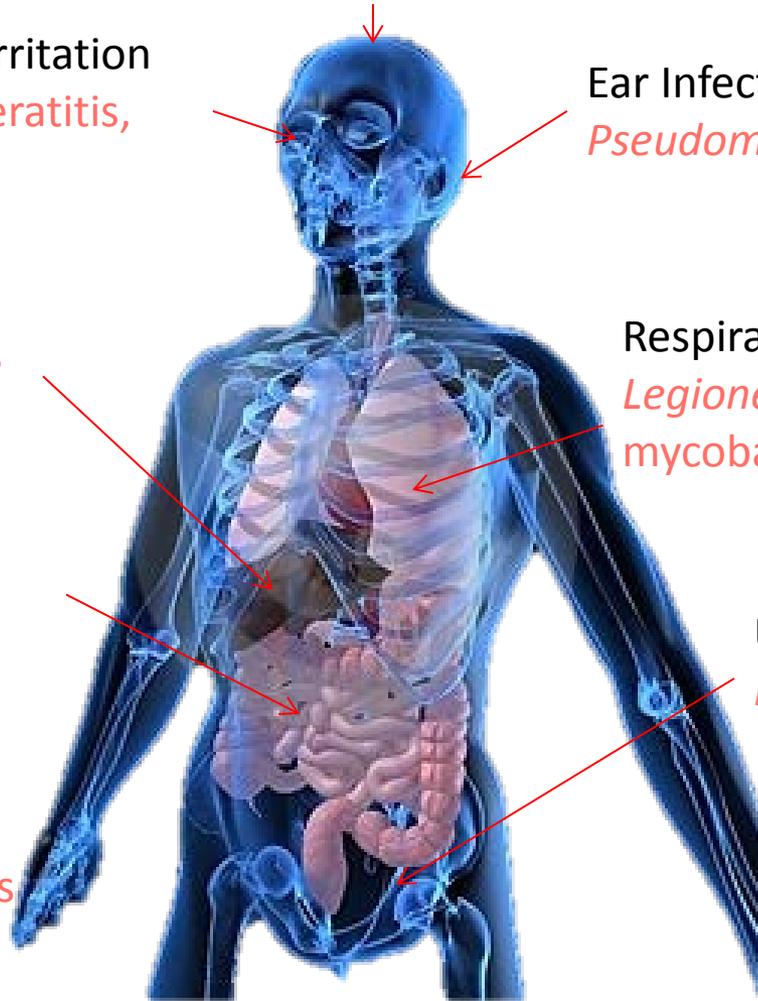
*Pseudomonas*

## Skin Infections

*Pseudomonas dermatitis/ folliculitis, fungal infections*

## Wound Infections

*Vibrio, Aeromonas, Pseudomonas*



# Water Related Illnesses and Outbreaks

- Splash Pads
- Hotel pool
- Camps
- Lake swimming beach
- The Year of *Crypto*



**General**  
**National Outbreak Reporting System**  
**Waterborne Disease Transmission**

This form is used to report waterborne disease outbreak investigations. This form has 6 parts, indicated by tabs at the top of each page. Part 1 asks for the minimum or basic information about the outbreak investigation. Part 2 asks for epidemiological data and clinical specimen test results. Parts 3, 4, 5 and 6 collect information about types of water exposure (treated recreational water, untreated recreational water, drinking water, and water not intended for drinking/unknown intent). Only 1 of these 4 water exposure parts should be completed for an outbreak investigation report.

CDC USE ONLY

CDC Report ID: \_\_\_\_\_ State Report ID: \_\_\_\_\_

Form Approved  
OMB No. 0910-0044

**General Section**

**Primary Mode of Transmission (check one)**

Food (Complete CDC 52.13)  Person-to-person (Complete CDC 52.13)

Water (Complete tabs for General, Water-General and type of water exposure)  Environmental contamination other than food/water (Complete CDC 52.13)

Animal contact (Complete CDC 52.13)  Indeterminate/Other/Unknown (Complete CDC 52.13)

**Investigation Methods (check all that apply)**

Interviews only of ill persons  Treated or untreated recreational water venue assessment

Case-control study  Investigation at factory/production/treatment plant

Cohort study  Investigation at original source (e.g., farm, water source, etc.)

Food preparation review  Food product or bottled water traceback

Water system assessment: Drinking water  Environment/food/water sample testing

Water system assessment: Nonpotable water  Other

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Dates (mm/dd/yyyy)**

Date first case became ill (required) \_\_\_\_/\_\_\_\_/\_\_\_\_ Date last case became ill \_\_\_\_/\_\_\_\_/\_\_\_\_

Date of initial exposure \_\_\_\_/\_\_\_\_/\_\_\_\_ Date of last exposure \_\_\_\_/\_\_\_\_/\_\_\_\_

Date of report to CDC (other than this form) \_\_\_\_/\_\_\_\_/\_\_\_\_

Date of notification to State/Territory or Local/Tribal Health Authorities \_\_\_\_/\_\_\_\_/\_\_\_\_

**Geographic Location**

Reporting state: \_\_\_\_\_

Exposure occurred in multiple states

Exposure occurred in a single state but cases resided in multiple states

Other states: \_\_\_\_\_

Reporting county: \_\_\_\_\_

Exposure occurred in multiple counties in reporting state

Exposure occurred in a single county but cases resided in multiple counties in reporting state

Other counties: \_\_\_\_\_

City/Town/Place of exposure: \_\_\_\_\_

Do not include proprietary or private facility names

**Primary Cases**

Number of Primary Cases		Sex (estimated percent of the primary cases)	
# Lab-confirmed cases	(A)	Male	%
# Probable cases	(B)	Female	%
# Estimated total primary ill			

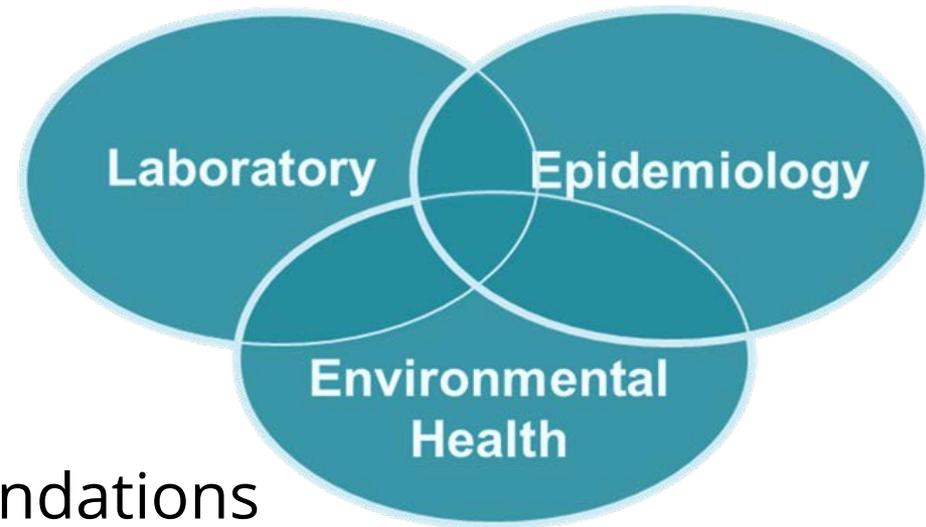
	# Cases	Total # of cases for whom info is available	Approximate percent of primary cases in each age group			
# Died			<1 year	%	20-49 years	%
# Hospitalized			1-4 years	%	50-74 years	%
# Visited Emergency Room			5-9 years	%	≥ 75 years	%
# Visited health care provider (excluding ER visits)			10-19 years	%	Unknown	%

CDC © 12 Nov 2010

[http://www.cdc.gov/nors/pdf/CDC\\_5212\\_guidance.pdf](http://www.cdc.gov/nors/pdf/CDC_5212_guidance.pdf)

# Environmental Assessment

- Water Samples
  - Link to illness
  - Molecular testing
- System Analysis
  - Routes of contamination
  - Exposure pathways
- Water Treatment Recommendations
  - Refer to EPA Drinking Water Standards
  - Model Aquatic Health Code
  - Tennessee Rules and Regulations



# Strength of Evidence

- CDC evaluation of outbreak reporting
- Outbreak identification

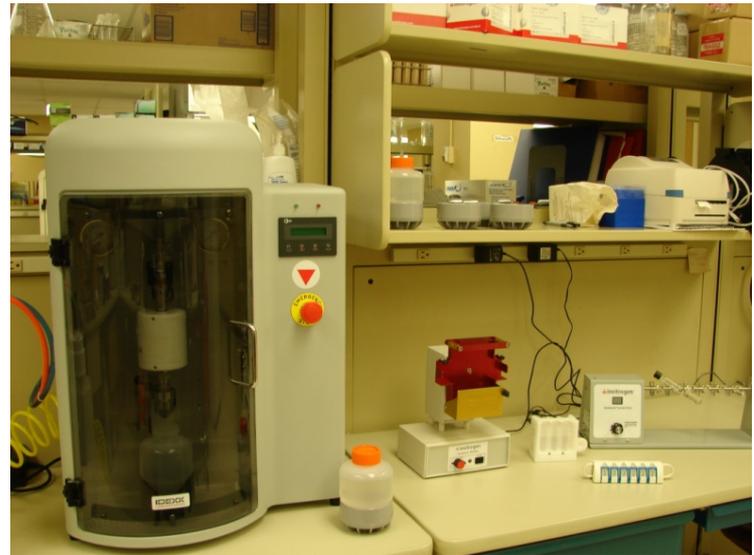
Class	<b>Epidemiologic and clinical laboratory data</b>	<b>Environmental data</b>
I	Provided and adequate	Provided and adequate
II	Provided and adequate	Not Provided or inadequate
III	Provided but limited	Provided and adequate
IV	Provided but limited	Not provided or inadequate

# Field Parameters

- pH
- Temperature
- Conductivity
- Turbidity
- Dissolved Oxygen
- Disinfection Residual
  - Chlorine or Bromine
- GPS Location



# IDEXX FiltaMax *Crypto/Giardia* Water Filtration



# TDH Division of Laboratory Services

- Routinely receives water samples from water utilities and the Tennessee Department of Environment and Conservation to determine water quality based on a number of indicators
- Water quality is monitored as mandated by the Environmental Protection Agency (EPA).
- Private drinking water wells may be tested, but are not regulated.
- Examines water samples across the State in the Knoxville, Nashville and Memphis-Shelby County Laboratories.

# Traditional Water Testing at our Laboratory

- Bacteria-Culture, enzyme, molecular
  - Total coliform group and heterotrophs
  - *E. coli*
  - *Legionella*
  - *Salmonella*
  - *Campylobacter*
- Parasites-DFA, molecular
  - *Cryptosporidium* (CryptoNet)
  - *Giardia*
- Viruses-Molecular
  - Norovirus
  - Hepatitis A-others

# New /experimental methods?

- Biofire
- Deadend ultrafiltration
- Others?



# CryptoNet

- CDC funded through ELC
- Subspecies differentiation
- Not yet used for water



# THANK YOU!

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