Decentralized Wastewater MOU Partnership Webinar Series

This webinar was sponsored by EPA's Decentralized Wastewater MOU Partnership, which consists of 18 organizations that work collaboratively to encourage proper decentralized system management and education on system maintenance in order to protect the nation's public health and water resources.

Direct Discharge of Household Wastewater in Rural Alabama - Scope and Impacts

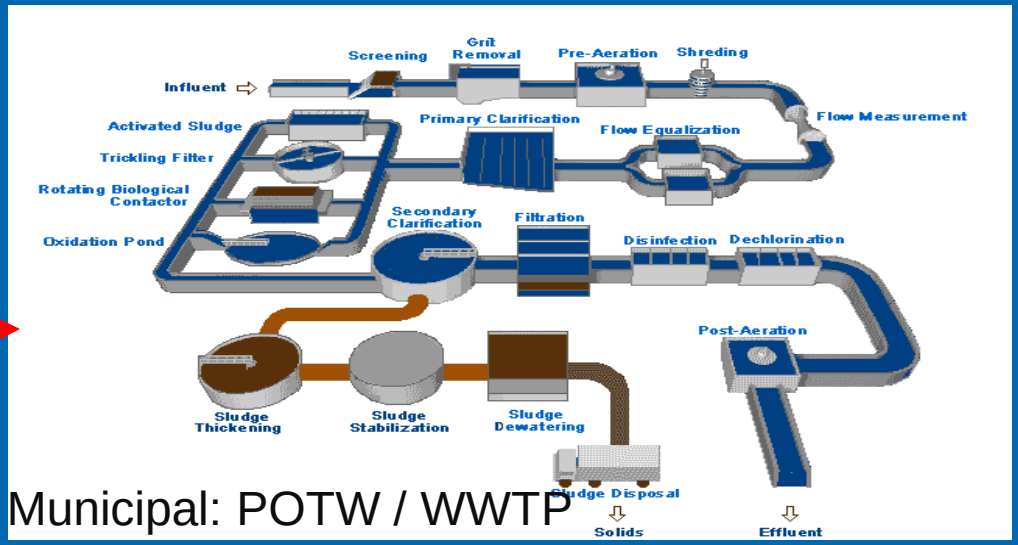
Mark Elliott, Kevin White, Robert Jones, Parnab Das, Matthew Price, Zachary Stevens & Yuehan Lu

College of
Engineering
Civil, Construction and Environmental Engineering

UNIVERSITY OF
SOUTH ALABAMA

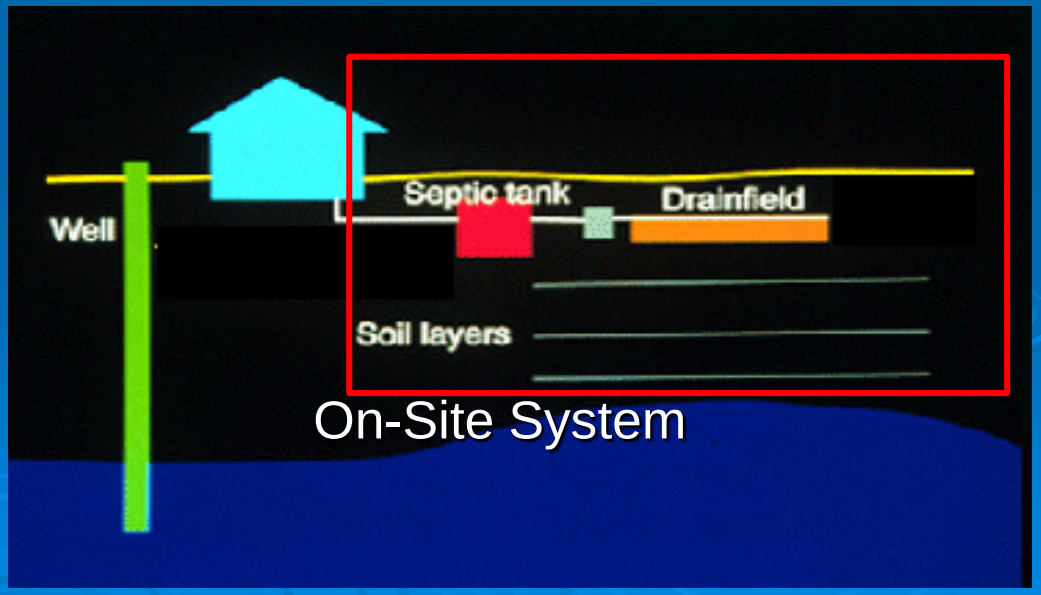
~80%
Municipal

Wastewater Treatment by US Population



Municipal: POTW / WWTP

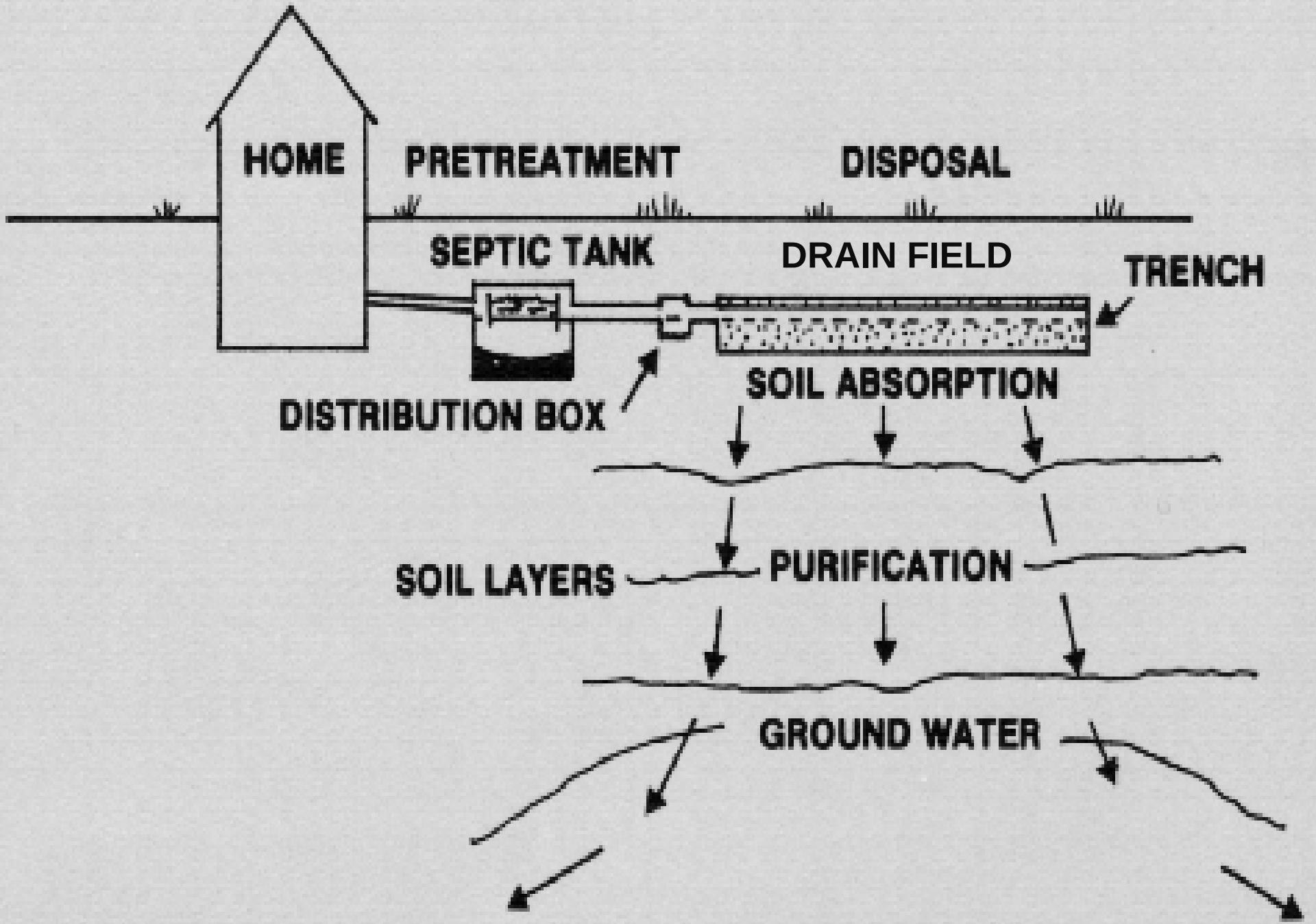
~20%
Onsite



On-Site System

Background: Septic Systems

- In the US, ~20% of households use an on-site wastewater treatment system (OWTS)
  - Vast majority of OWTS are conventional septic systems



Source: Purdue Univ. Extension Service (Jones et al., 1990)

Background: Septic Systems

- Nearly all of the ~20% of households using on-site wastewater treatment system (OWTS) have conventional septic systems
  - 1 trillion gallons of wastewater are discharged from septic systems in the US each year
- Affordably protect public health and environment in most rural areas of the US
  - Septic system ~$2500
  - Alternative systems $6000+

Black Belt Counties

- Named for rich, dark topsoil
- In many places underlain by impermeable clay soil
  - Shallow chalk layer

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- Poverty limits alternatives
  - Counties typically 25-40% below poverty line

Media Coverage/Anecdotal Evidence

- UN Special Rapporteur report on Human Rights to Water and Sanitation
- Al Jazeera online article June 3, 2015

Media Coverage/Anecdotal Evidence

HOME SEARCH The New York Times GIVE FREE GIFTS

HEALTH

A Toilet, but No Proper Plumbing: A Reality in 500,000 U.S. Homes

By SABRINA TAVERNISE SEPT. 26, 2016

- UN Special Rapporteur report on Human Rights to Water and Sanitation
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Bryan Meltz for The New York Times

Black Belt Counties

- Black Belt characterized by impermeable clay soil
  - Shallow chalk layer
- >50% of Black Belt area unsuitable for septic systems (He et al., 2011):
- Poverty limits alternatives
  - Counties typically 25-40% below poverty line
- How bad is it?

Data from an Adjacent County

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Photos: acrecdc.com

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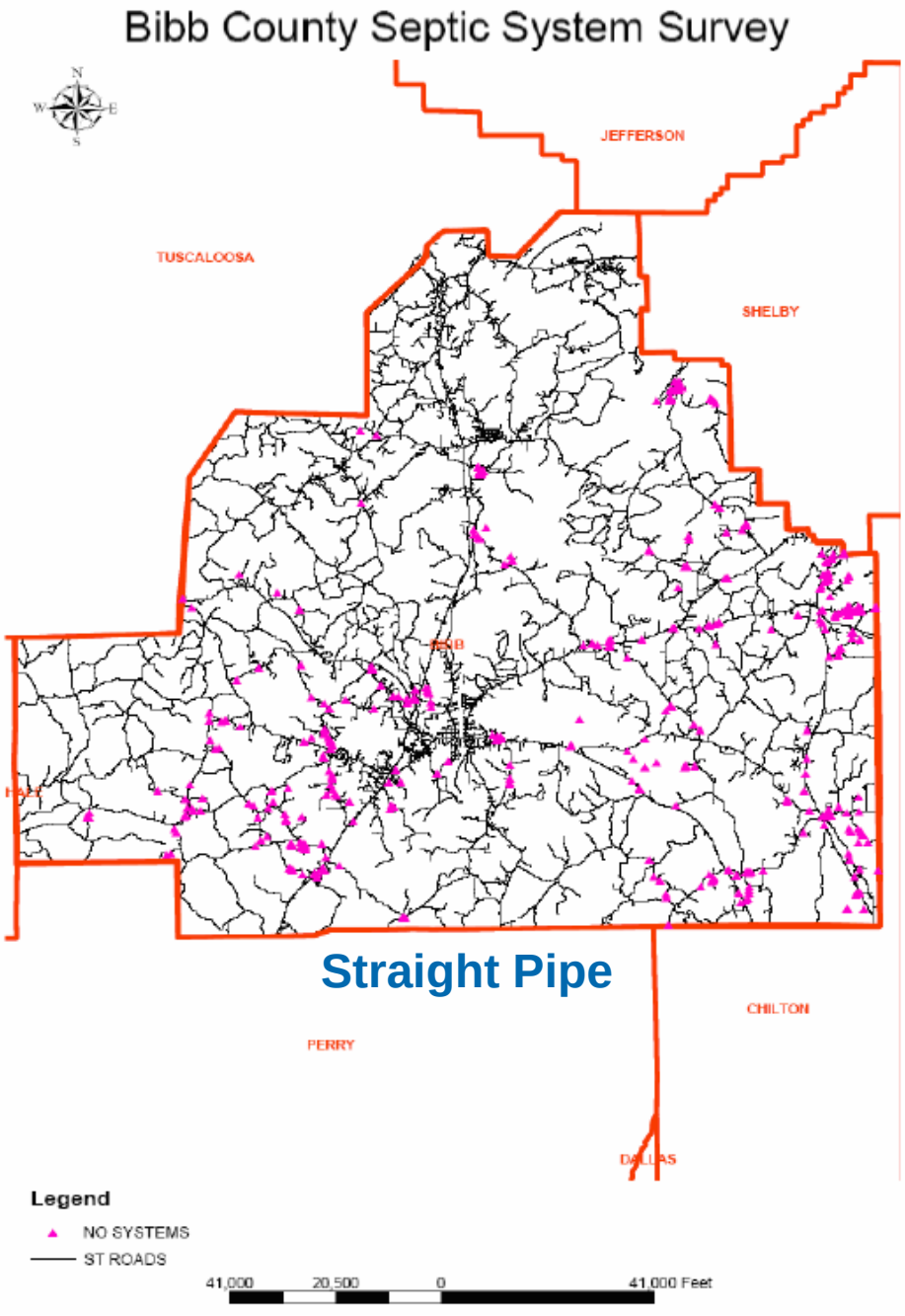
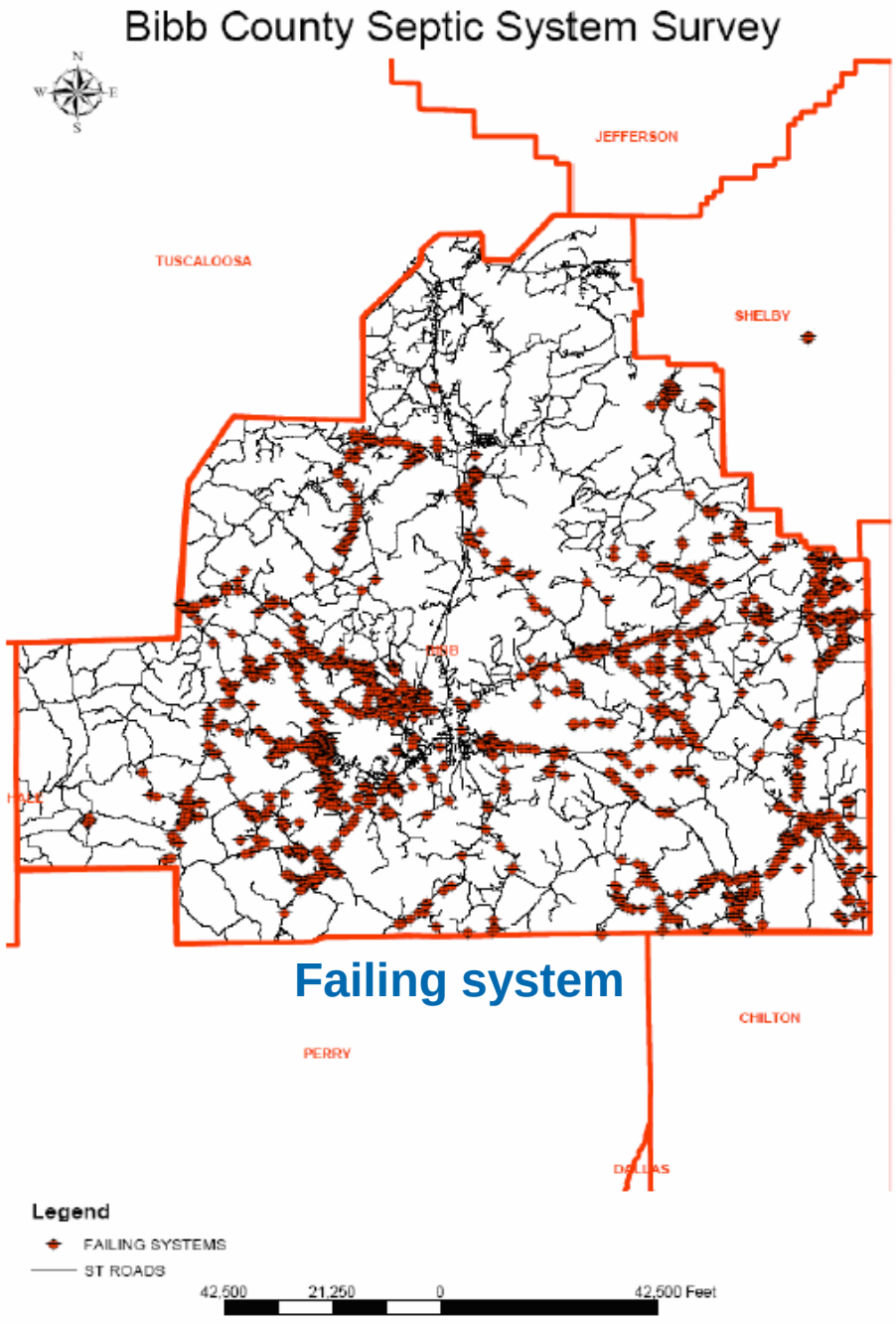


Straight Pipe



Failing system

Maps: White and Jones (2006) study of Bibb County

Bibb County – Straight Pipe

- Bibb County: 15% straight pipe (White and Jones, 2006)
- This corresponds to (Bibb Co only):
  - >60,000 gallons (>200,000 L) of raw sewage discharged to the ground per day (20 million gal/80 million L per year)
  - Billions of pathogens discharged into watershed per day (just three types listed):
    - >1 billion enteric viruses
    - >1 billion *Giardia* cysts
    - >300 million *Cryptosporidium* oocysts

Black Belt Counties

- Bibb County compared to Black Belt counties:
  - Less poverty (% of households below the poverty line, according to 2010 US Census):
    - Bibb Co. : 18.1%
    - Hale Co.: 26.6%
    - Wilcox Co.: 39.2%
  - Possibly more importantly: Bibb Co. has much better soil for conventional septic systems
- Straight pipe and failing septic likely to be even higher in Black Belt counties

Health Impacts?

- Poor access and surveillance
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- Georgia Tech follow-up this summer (Joe Brown)

Diverse Evidence

- Various lines of evidence point to onsite wastewater as a substantial threat to
  - Water quality
  - Public health

Research Approach

- Investigating the scope and impacts on water quality with funding from:
  - EPA Gulf of Mexico Program
  - Alabama WRRI through USGS
  - UA Center for Freshwater Studies
- Methods:
  - Site-by-site inspections/surveys in Black Belt
  - Data from local stakeholders
  - Flow-routing
  - Water sampling (microbiological and chemical)

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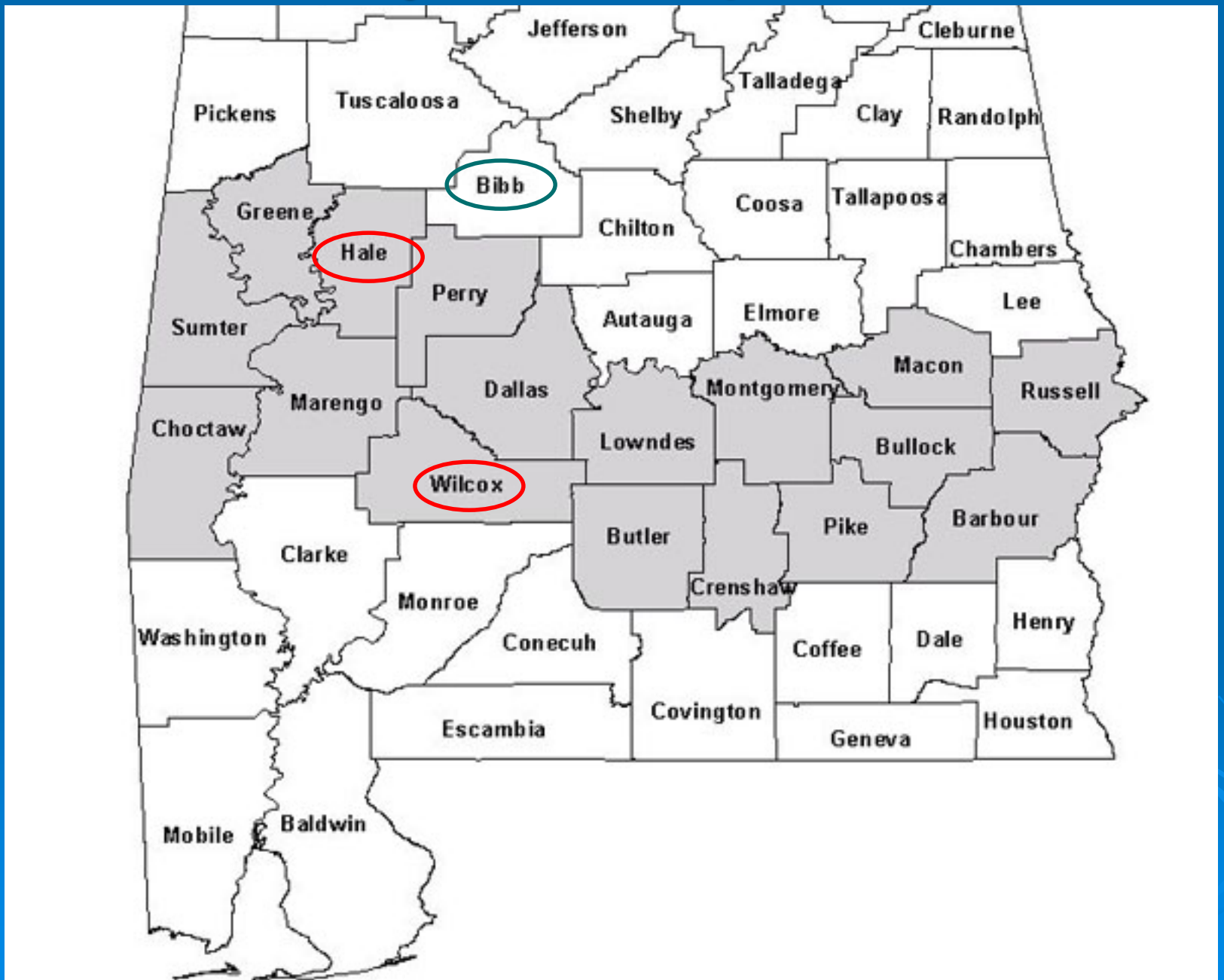
Site-by-site Inspections



Wilcox County Inspection Data

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  - 104 houses, 185 mobile homes
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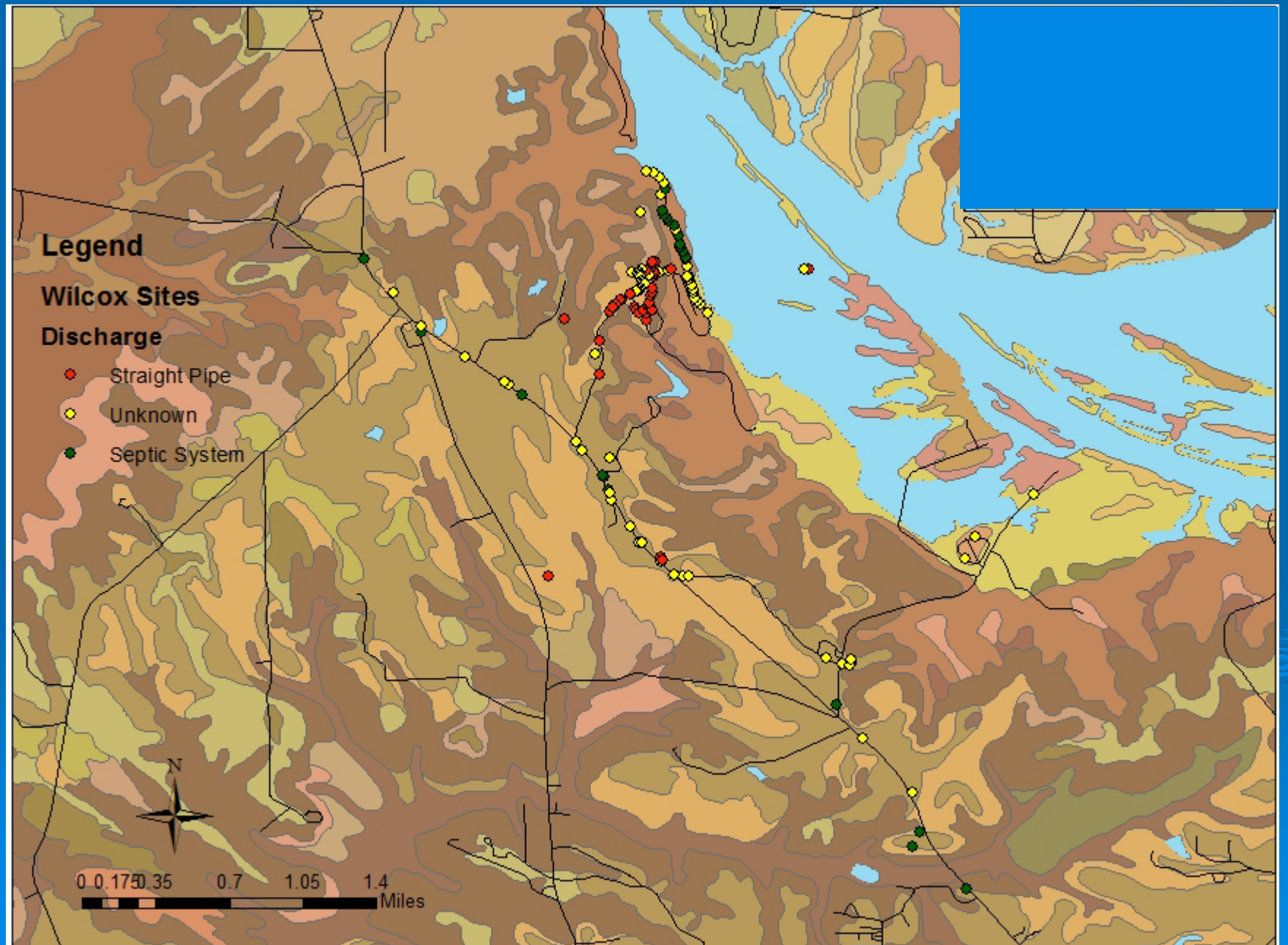
  - 172 (60%) with straight pipe visible upon inspection
  - 98 (34%) unpermitted, either some form of in-ground disposal or straight pipe buried/not visible

Data from Lynn and Robert Jones – Down to Earth, Inc.

Wilcox County Inspection Data



Wilcox County Inspection Data

- Zoomed in on communities adjacent to Alabama River
- Desirable real estate on river
- Less desirable, informal community up hill

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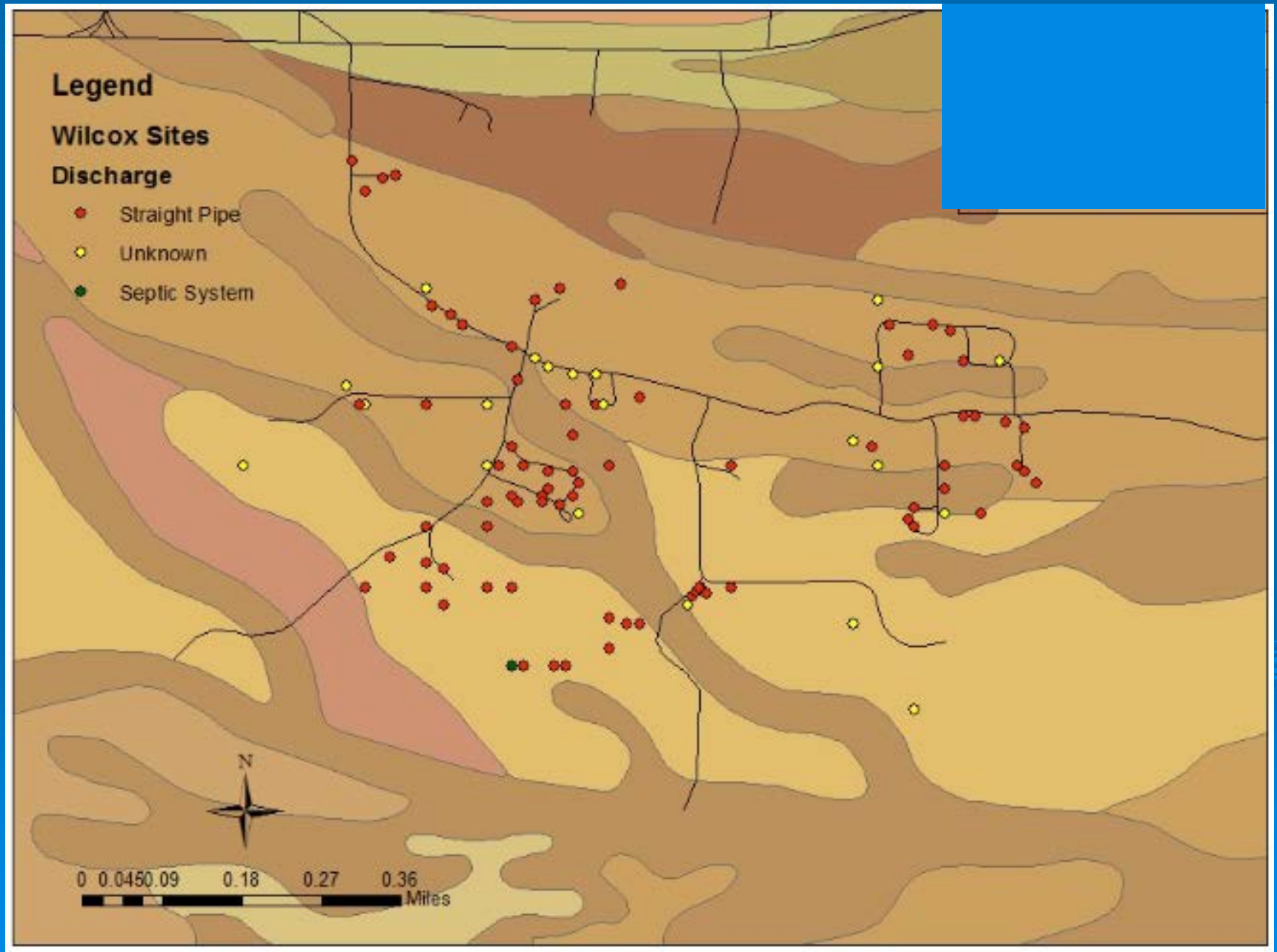
Wilcox County Inspection Data



Hale County Preliminary Inspection Data

- 411 dwellings surveyed
  - 194 houses, 217 mobile homes
- 144 (35%) Health Dept.-permitted systems
- 267 (65%) without permitted systems

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Image from Hale County

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Estimates by Tim Wenger of Cedar Ridge Excavating (work ongoing with other stakeholders)

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    - 40% have some field lines
    - 50% straight pipe

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    - 40% have some field lines
    - 50% straight pipe
      - 30% solids settling (septic tank or 55-gal drum)
      - 20% no solids setting

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Flow-routing to Identify Sampling Points

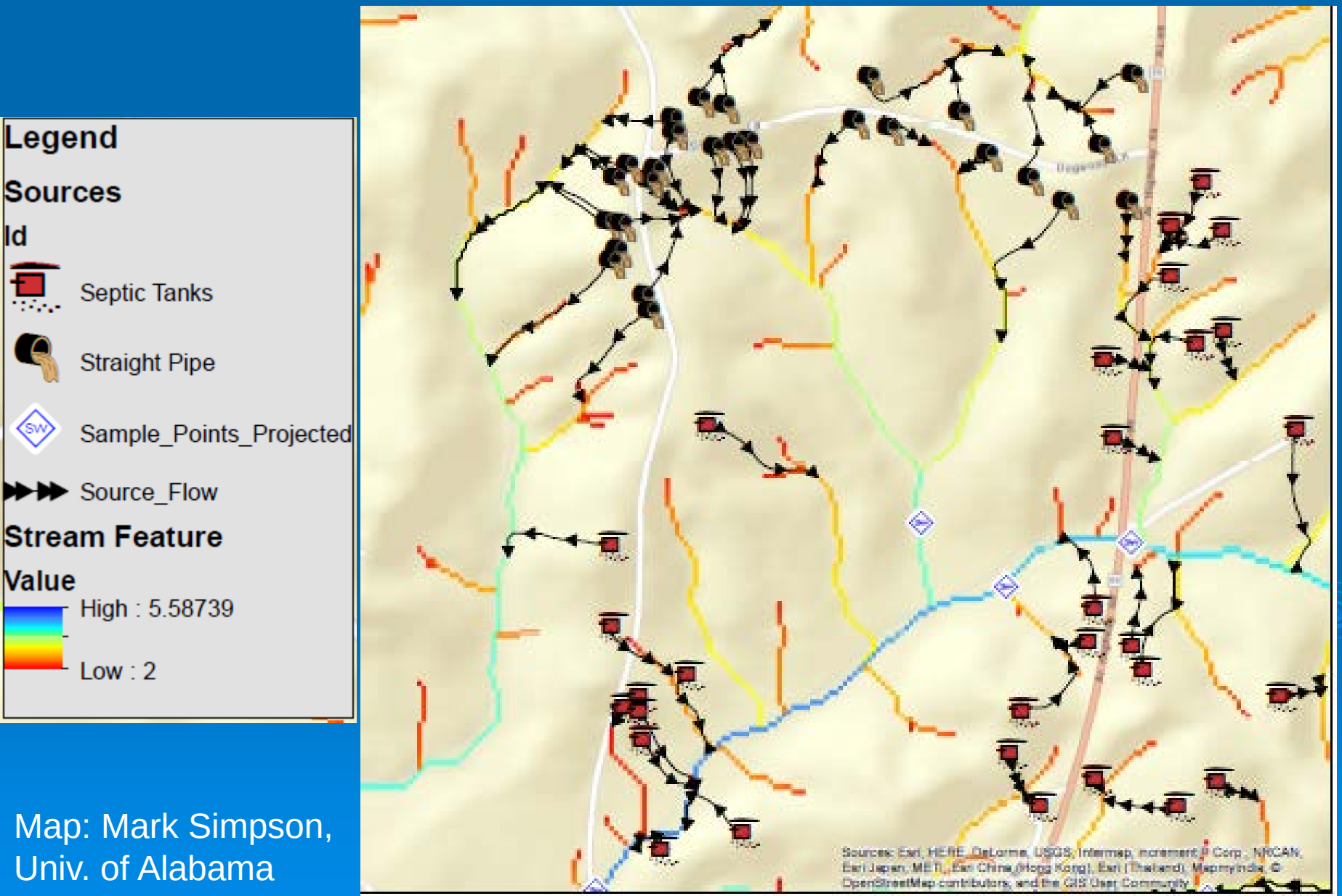
Determine drainage patterns to identify possible sampling points

- In collaboration with GIS groups at UA

- GIS team conducting drainage pattern modeling to determine
  - Flow direction of wastewater on the surface
  - Flow accumulation at any point on map

Mark Simpson (UA MS grad) and Sagy Cohen (UA Geography)

Flow Routing and Description



Map: Mark Simpson, Univ. of Alabama

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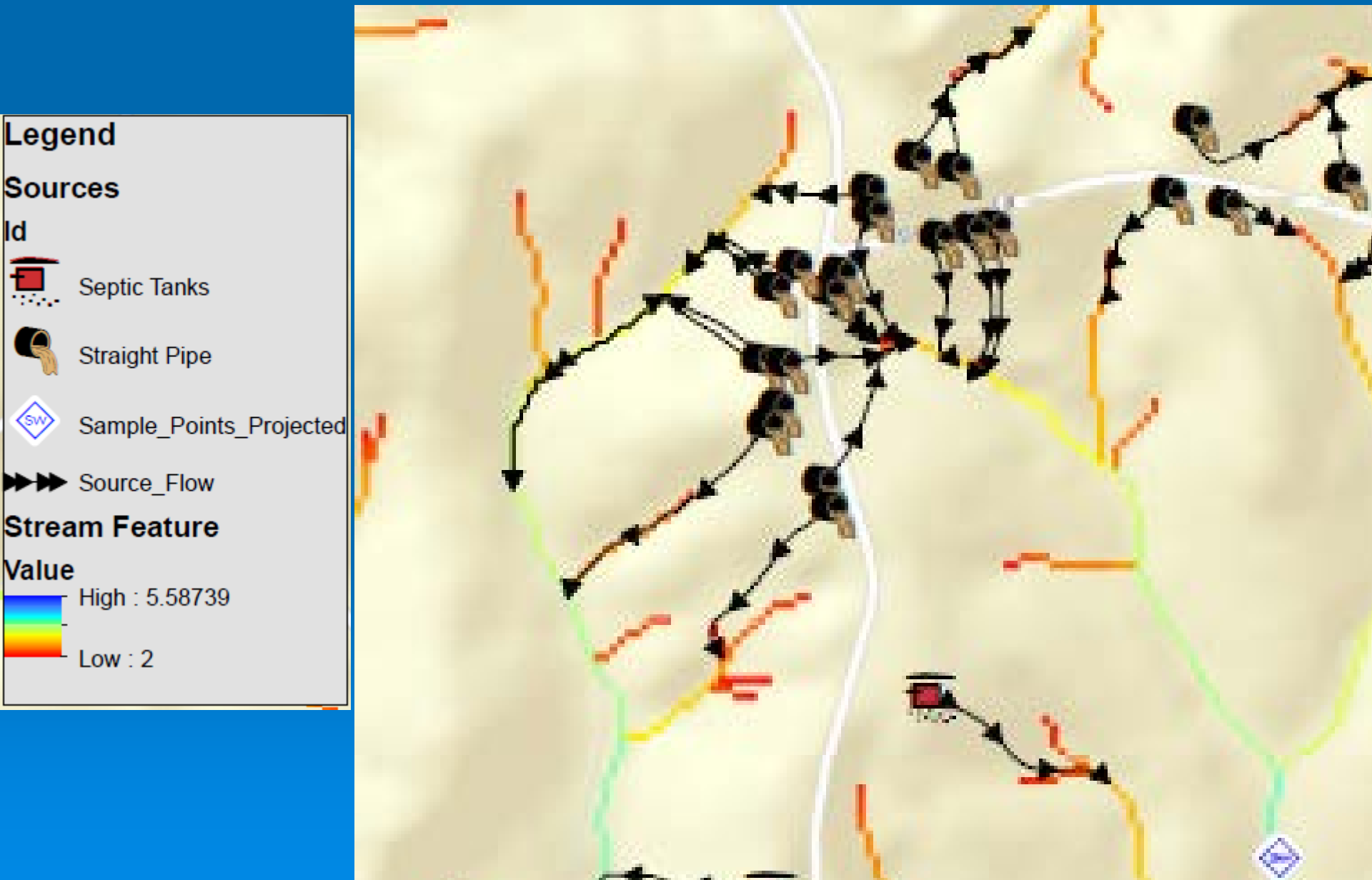

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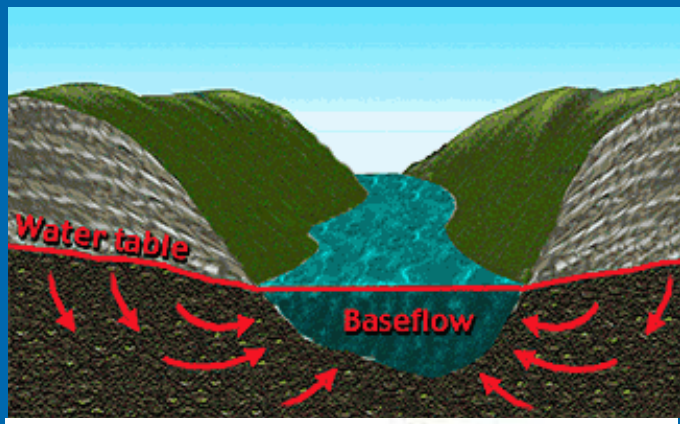
Water Sampling and Analysis

- Baseflow and “first flush” samples
  - Baseflow under dry conditions
  - “First flush” samples
    - Autosamplers inserted in stream beds – automatically collect sample when water level rises
  - With Yuehan Lu of UA Geology



Water Sampling and Analysis

- We also choose our sampling sites to ensure:
  - Control (not impacted) sites are included
    - Yuehan Lu (UA Geology) has pristine sampling sites in study area
  - Sites represent the major geological/soil types in our study area

Water Sampling and Analysis

Water Sampling - multi-parameter approach:

- Collaborating with Prof Emeritus Bob Pitt (UA Environmental Engineering)
  - Developed EPA “illicit discharge detection” guidelines for urban areas
- Statistical analysis to classify samples by various methods, including:
  - Similarity indices
  - Classification and Regression Tree analysis

Water Sampling and Analysis

Analytes for water analysis:

- Fecal indicator bacteria (*E. coli* and coliforms)
- Conductivity, turbidity, pH
- Anions and cations
- Nutrients

Water Sampling and Analysis

Analytes for water analysis:

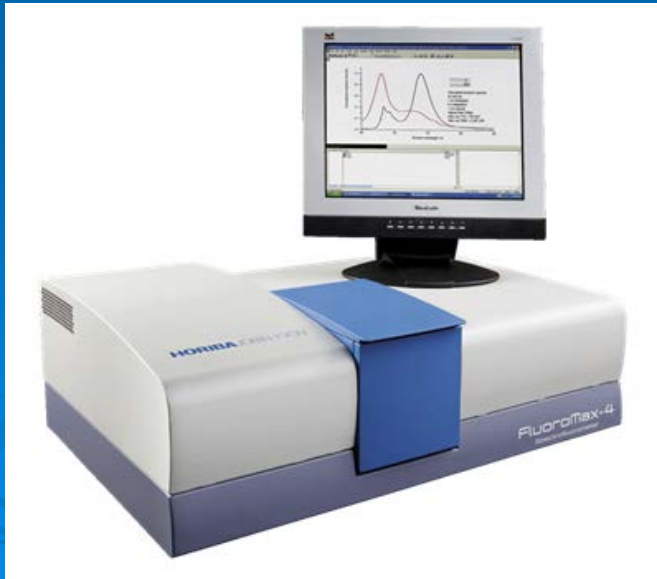
- Human-specific bacterial genes (by PCR & qPCR)
  - High specificity if successful
- F+ coliphages

Water Sampling and Analysis

Dissolved organic analytes for water analysis:

Yuehan Lu (UA Geology) is leading

- Fluorescence/organic matter fingerprinting
- Detecting “optical brighteners” from laundry detergent



How widespread is this problem?

- Not just Alabama
  - Anecdotal evidence that direct discharge of sewage is common in rural:
    - Kentucky
    - West Virginia
    - southwestern Virginia
    - North Carolina
    - Mississippi

Why is it happening?: one theory

- In rural areas with impermeable soils
  - Possibly an unintended consequence of the Clean Water Act
    - Cannot legally surface discharge gray water while treating “black water” (sewage/kitchen waste)

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    - “Straight pipes” become widespread

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    - Conventional septic systems fail, alternative too costly
  - Households learn that septic systems are a poor investment
    - “Straight pipes” become widespread
  - Problem becomes too large to be addressed by health department
    - Too expensive, too many households out of compliance

What Next?… Findings to Solutions

- We don’t have the resources to solve this problem by connecting everyone to sewer or replacing all the failing systems

What Next?… Findings to Solutions

- Possibility to make a difference: households with septic systems
  - Education and outreach to homeowners
  - Small monetary incentives toward proper inspection, maintenance, pumping
  - Decreasing barriers to homeowners having their systems inspected, pumped, repaired
  - Forming committee to study and report on the feasibility of alternatives: engineered OWTS, community systems and connection to sewer

What Next?… Findings to Solutions

- Possibility to make a difference: households without septic systems
  - Education and outreach to homeowners
  - Forming committee to study and report on the feasibility of alternatives: engineered OWTS, community systems and connection to sewer
  - Pursuing exemption for gray water discharge to surface in specific situations – enable treatment of black water only

Interested in partnering?

- Looking for research partners
  - Human-specific fecal indicators (e.g., by qPCR) and gastrointestinal pathogens (any method)
  - Data analysis of soil, demographic data
  - Exposure pathways and QMRA
- Looking for donors to help fund pilot implementation of solutions
  - Hooking up small communities to nearby sewer
  - Decentralized systems for small communities
  - Alternative onsite systems

Project Funding

- EPA Gulf of Mexico Program – an EPA regional program (also Great Lakes, Chesapeake Bay)
  - "Gulf Regional Partnerships"
- Supplementary funding:
  - USGS through AL Water Resources Research Institute
  - UA Center for Freshwater Studies

Collaborators and Students

- EPA Gulf Program – Lael Butler
- AOWATC (UWA) – Allen Tartt
- ADPH – Parrish Pugh, Becky Wilson
- ADEM – Carmen Yelle
- AL Clean Water Partnership – Kellie Johnson
- Down to Earth, Inc. – Robert Jones, Lynn Jones
- GSA – Marlon Cook
- HERO – Pam Dorr
- U of South Alabama – Kevin White
- UA Geology - Yuehan Lu
- UA Geography – Sagy Cohen
- UA Civil/Environmental Eng. – Bob Pitt, Mark Simpson
- UA Students: Parnab Das, Phillip Grammer, Erdogan Aytekin, Aaron Miller, Elliot McCandless, Charlotte Sheridan, Chad Barber, George Uku, Peng Sheng, Zachary Stephens, Brittany Shake, Mark Simpson

Questions?