Investigating the Impacts of Septic Systems and Straight Pipes in the Alabama Black Belt

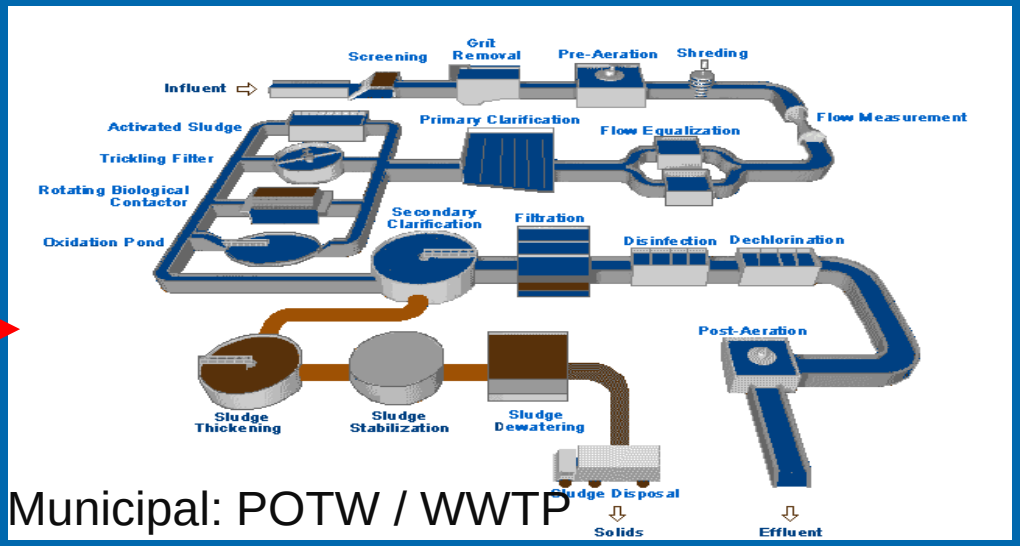
Mark Elliott

College of Engineering

Civil, Construction and Environmental Engineering

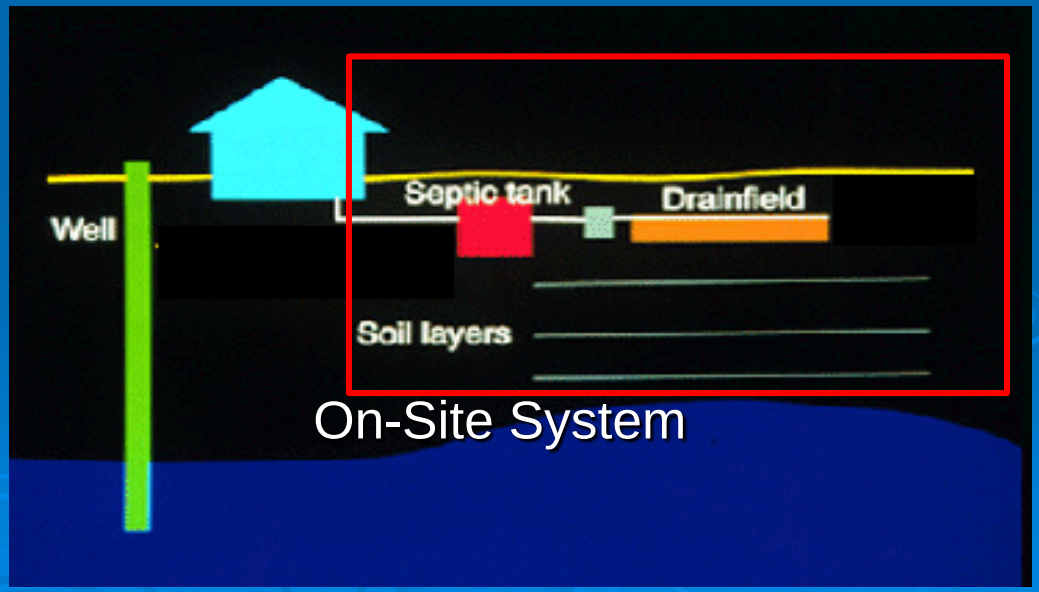
Wastewater Treatment by US Population

~75%
Municipal



Municipal: POTW / WWTP

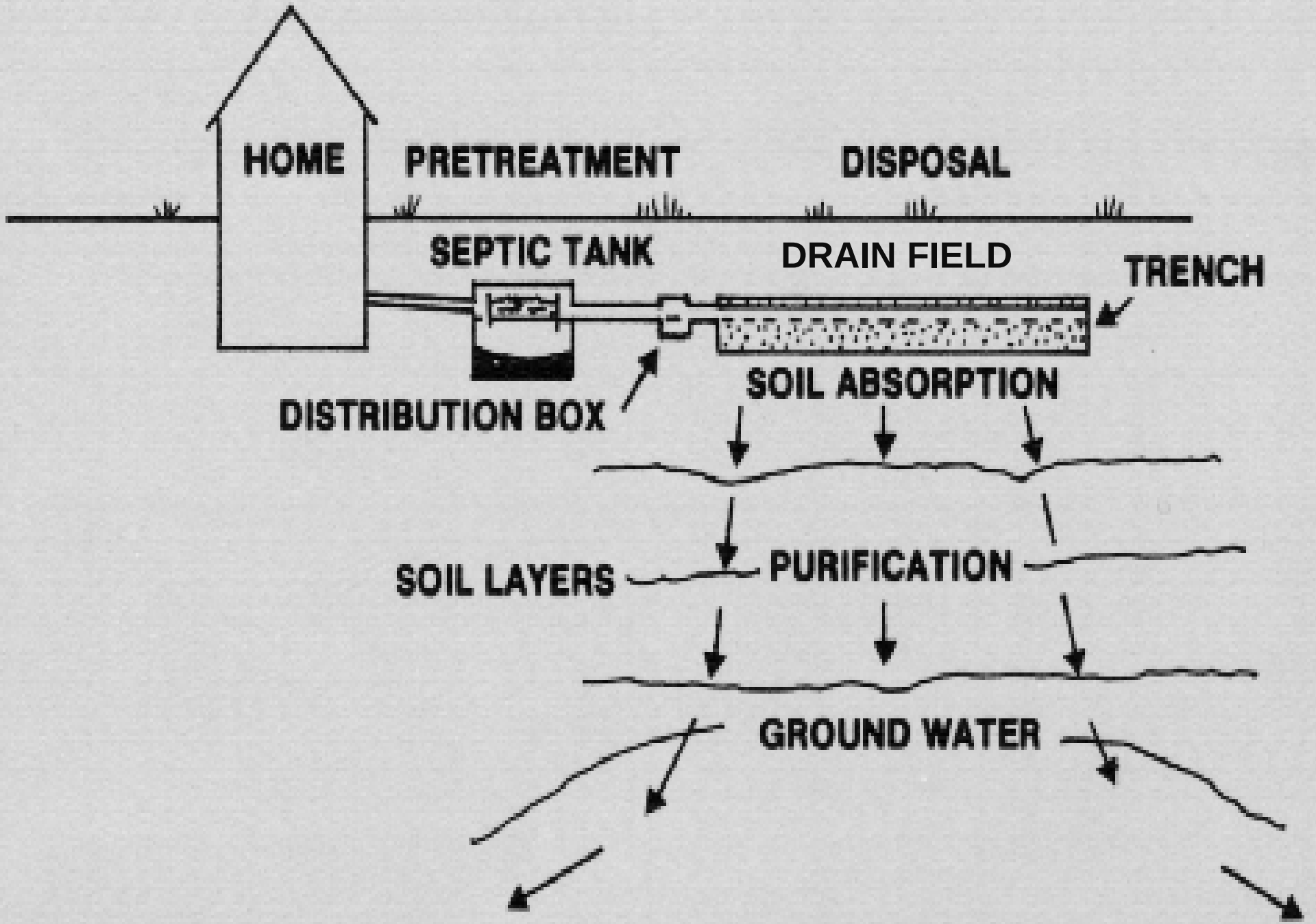
~25%
Onsite



On-Site System

Background: Septic Systems

- In the US, ~25% of households use an on-site wastewater treatment system (OWTS)
  - Vast majority of OWTS are conventional septic systems



Source: Purdue Univ. Extension Service

Background: Septic Systems

- Nearly all of the ~25% 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

- Black Belt characterized by impermeable clay soil
- >50% of Black Belt area unsuitable for septic systems (He et al., 2011):

Black Belt Counties

- Black Belt characterized by impermeable clay soil
- >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?

Black Belt Counties

- Black Belt characterized by impermeable clay soil
- >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?

Best Case Scenario for the Black Belt

- Bibb County: detailed study of >4000 homes not connected to public sewer (White and Jones, 2006)

Photos: acrecdc.com

Best Case Scenario for the Black Belt

- Bibb County: detailed study of >4000 homes not connected to public sewer (White and Jones, 2006)
  - 35% had failing septic system
  - 15% “straight pipe” (direct discharge)

Photos: acrecdc.com

Best Case Scenario for the Black Belt

- Bibb County: detailed study of >4000 homes not connected to public sewer (White and Jones, 2006)
  - 35% had failing septic system
  - 15% “straight pipe” (direct discharge)

Bibb County – Straight Pipe

- Bibb County: 15% straight pipe (White and Jones, 2006)
- This corresponds to (Bibb Co only):
  - >60,000 gallons of raw sewage discharged to the ground per day (20 million gal 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 the US Census):
    - Bibb Co. : 18.1%
    - Hale Co.: 26.6%
    - Wilcox Co.: 39.2%
  - Bibb Co. has much better soil for conventional septic systems
- Straight pipe and failing septic likely to be even higher in Black Belt

Health Impacts?

- Possible impacts on health?
  - Little surveillance for infectious diseases

Health Impacts?

- Possible impacts on health?
  - Little surveillance for infectious diseases
- Last survey of sewage-associated helminth infection (Wilcox Co)
  - 1/3 of children under-10 tested positive for one or more helminths (Badham, 1993).

Health Impacts?

- Possible impacts on health?
  - Little surveillance for infectious diseases
- Last survey of sewage-associated helminth infection (Wilcox Co)
  - 1/3 of children under-10 tested positive for one or more helminths (Badham, 1993).
- Unpublished data from Lowndes County
  - More than 1/3 of adults with poor sanitation were infected with helminths (Walton, 2015).

Health Impacts?

- Possible impacts on health?
  - Little surveillance for infectious diseases
- Last survey of sewage-associated helminth infection (Wilcox Co)
  - 1/3 of children under-10 tested positive for one or more helminths (Badham, 1993).
- Unpublished data from Lowndes County
  - More than 1/3 of adults with poor sanitation were infected with helminths (Walton, 2015).
- Georgia Tech follow-up in 2017 (Joe Brown)

Diverse Evidence

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

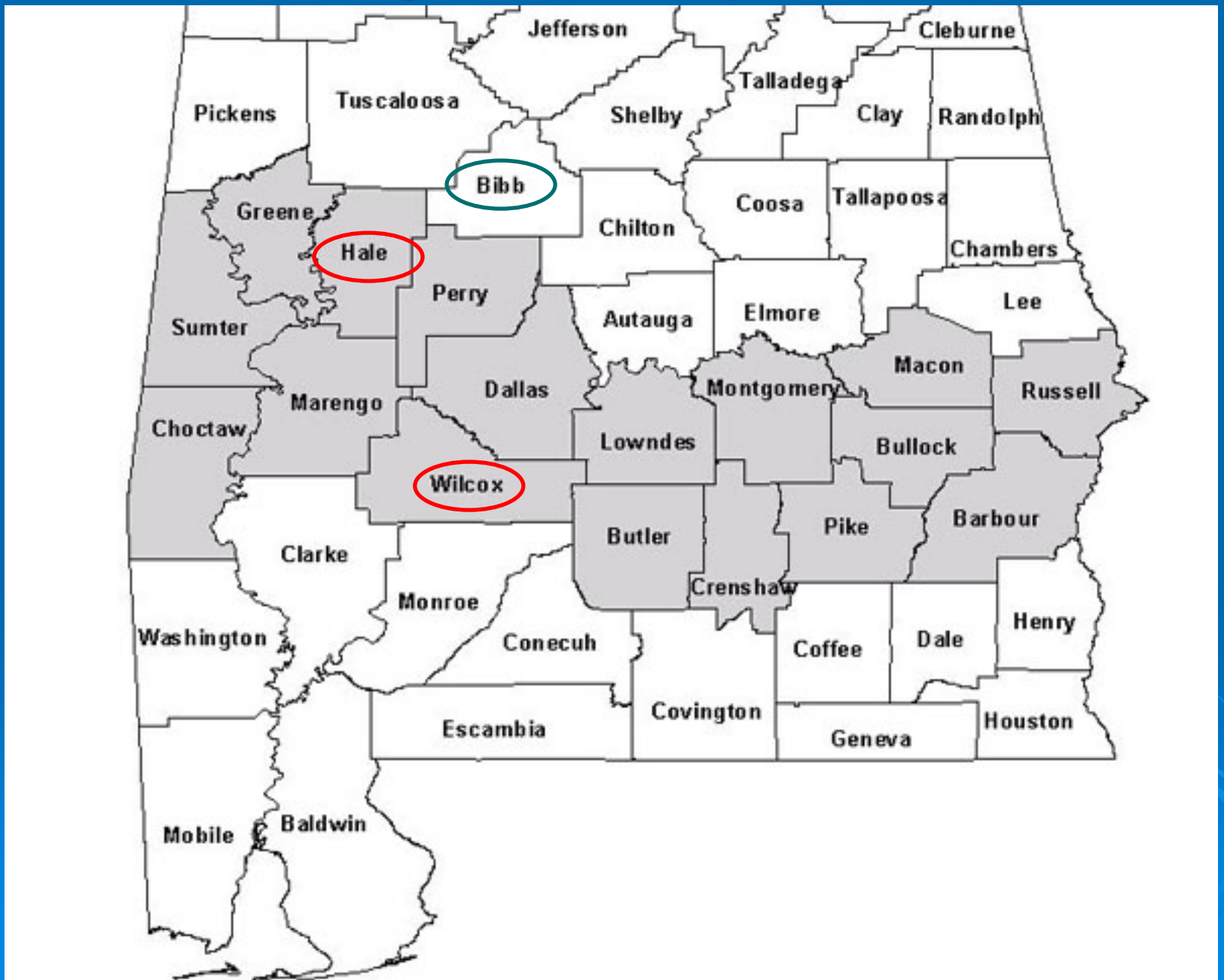
Research Approach

- 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)

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)

Site-by-site Inspections



Wilcox County – Preliminary Data

- 119 homes surveyed
  - Includes 74 mobile homes
  - Representative of county demographic and soil

Wilcox County – Preliminary Data

- 119 homes surveyed
  - Includes 74 mobile homes
  - Representative of county demographic and soil
- 23 (19%) ADPH-permitted systems

Wilcox County – Preliminary Data

- 119 homes surveyed
  - Includes 74 mobile homes
  - Representative of county demographic and soil
- 23 (19%) ADPH-permitted systems
- 96 (81%) without permitted systems
  - 37 (31%) with straight pipe visible upon inspection
  - 59 (50%) unpermitted, but some form of in-ground disposal or straight pipe buried/not visible

Wilcox County – Preliminary Data

- 119 homes surveyed
  - Includes 74 mobile homes
  - Representative of county demographic and soil
- 23 (19%) ADPH-permitted systems
- 96 (81%) without permitted systems
  - 37 (31%) with straight pipe visible upon inspection
  - 59 (50%) unpermitted, but some form of in-ground disposal or straight pipe buried/not visible

Data from Lynn and Robert Jones – Down to Earth, Inc. (ongoing work, also Hale Co.)

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)

Newbern (Hale Co) – Preliminary Data

- Septic system installers/ADPH staff reporting on their experience and knowledge

Newbern (Hale Co) – Preliminary Data

- Septic system installers/ADPH staff reporting on their experience and knowledge
- Newbern, AL
  - 10% with licensed systems
  - 90% unlicensed

Newbern (Hale Co) – Preliminary Data

- Septic system installers/ADPH staff reporting on their experience and knowledge
- Newbern, AL
  - 10% with licensed systems
  - 90% unlicensed
    - 40% have some field lines

Newbern (Hale Co) – Preliminary Data

- Septic system installers/ADPH staff reporting on their experience and knowledge
- Newbern, AL
  - 10% with licensed systems
  - 90% unlicensed
    - 40% have some field lines
    - 50% straight pipe
      - 30% solids settling (septic tank or 55-gal drum)
      - 20% no solids setting

Data from Tim Wenger of Cedar Ridge Excavating (work ongoing with others)

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)

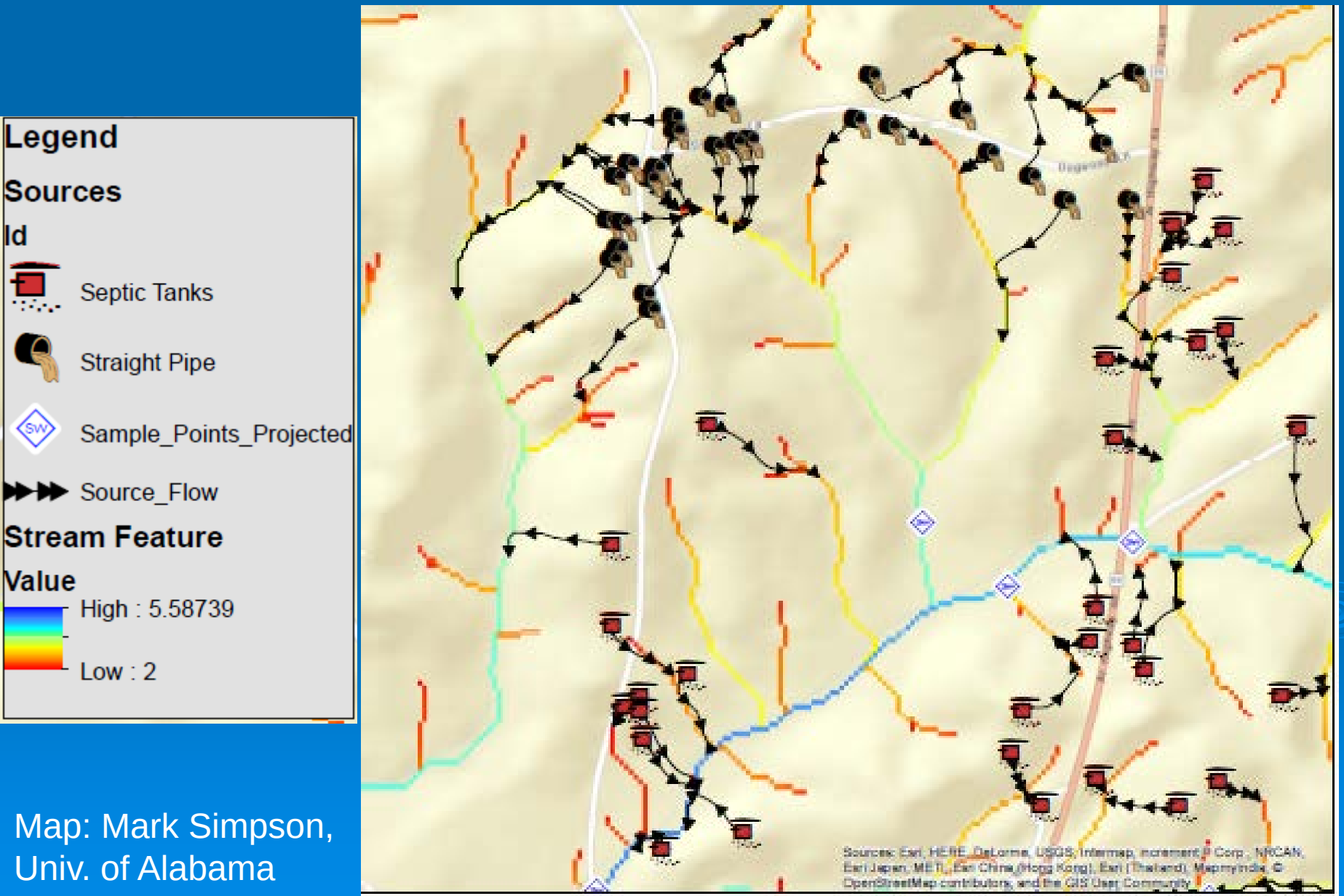
Flow-routing to Identify Sampling Points

Determine drainage patterns to identify possible sampling points

- In collaboration with the GIS groups at UA
- GIS team is conducting drainage pattern modeling to determine
  - Flow direction of wastewater on the surface
  - Flow accumulation at any point on map

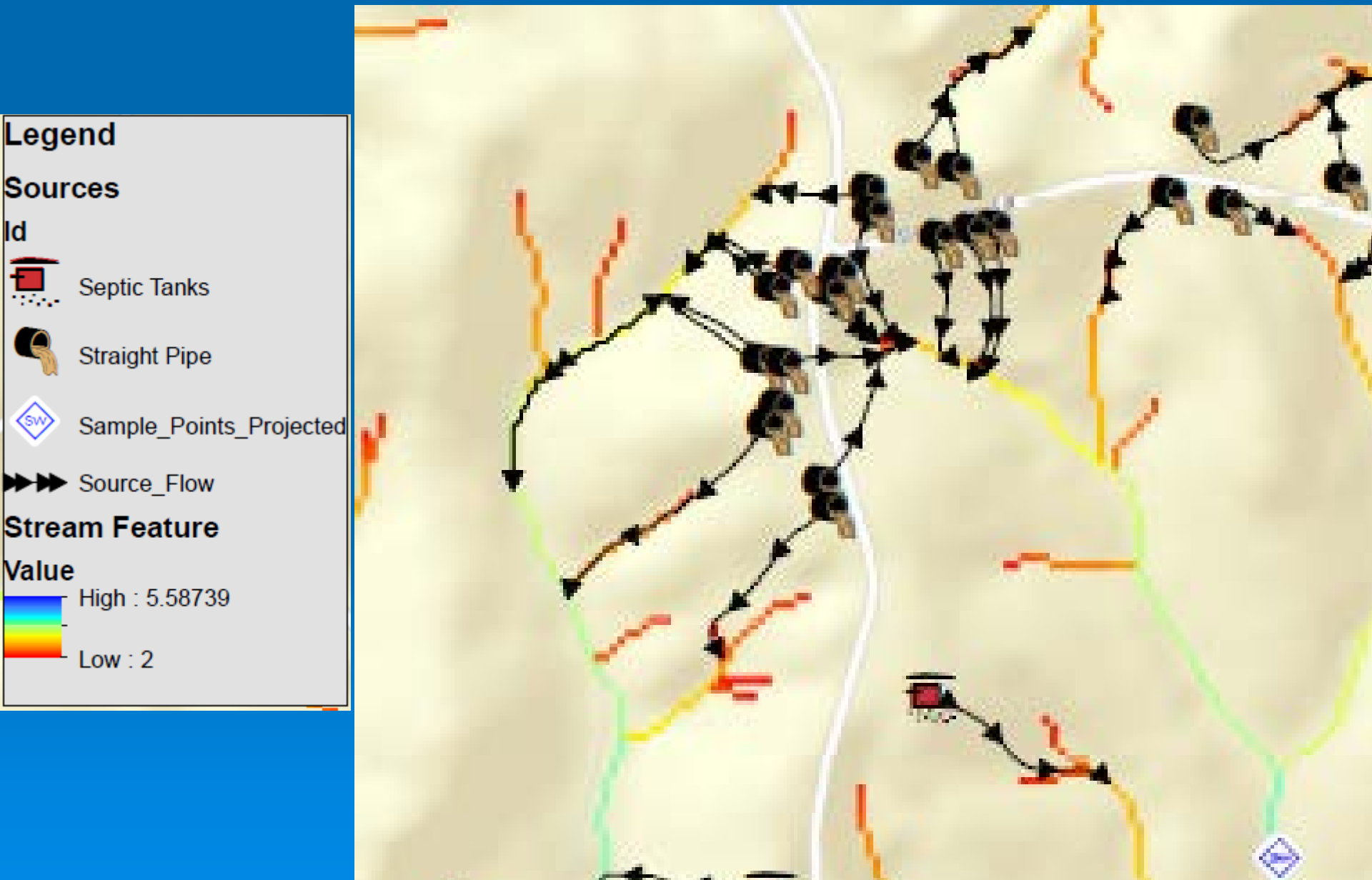
Mark Simpson (UA master's grad) and Sagy Cohen (UA Geology)

Flow Routing and Description



Map: Mark Simpson, Univ. of Alabama

Flow Routing and Description

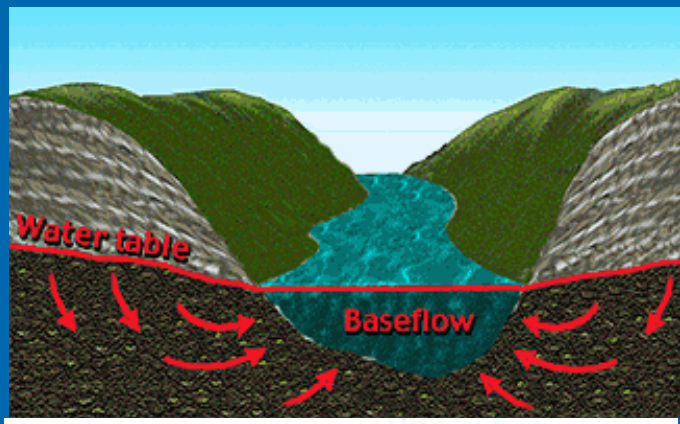


Research Approach

- 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)

Water Sampling and Analysis

- Baseflow and “first flush” samples will be collected
  - Baseflow under dry conditions
  - “First flush” samples
    - Autosamplers will be inserted in stream beds – automatically collect sample when water level rises
  - With Yuehan Lu
    - Parnab Das
    - Zachary Stephens
    - Other students



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:

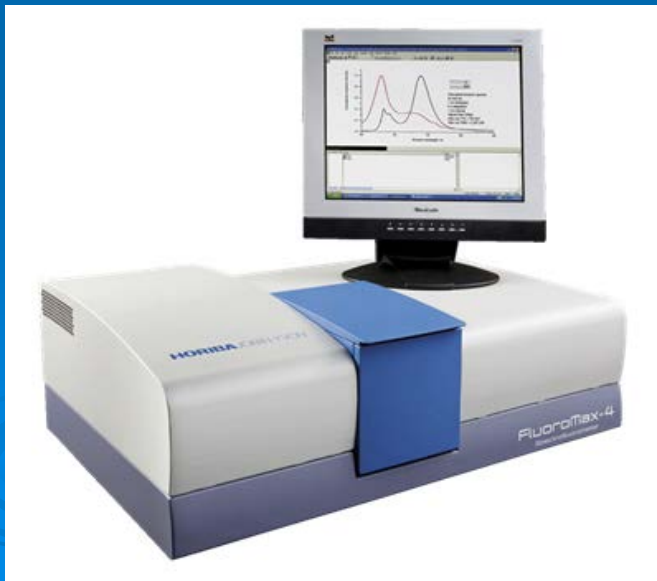
- Human-specific bacterial genes (by qPCR)
  - High specificity if successful
- F+ coliphages

Water Sampling and Analysis

Dissolved organic analytes for water analysis:

Yuehan Lu (UA Geology) will lead

- Organic matter fingerprinting
- Fluorescence to detect “optical brighteners” in laundry detergent



What Next?… Findings to Solutions

- EPA Gulf Regional Partnerships emphasizes measurable impacts on environment and people
- 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:
  - Education and outreach to homeowners
  - Small monetary incentives toward proper inspection, maintenance, pumping
  - Decreasing barriers to homeowners having their systems inspected, pumped, repaired
  - Study and report on the feasibility of alternative onsite systems, community systems and connection to sewer

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?