Innovative Technologies and Approaches to Address Decentralized Wastewater Infrastructure Challenges in the Alabama Black Belt

May 26, 2021, 1:00-3:00 p.m. ET

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EPA's Decentralized Wastewater MOU Partnership

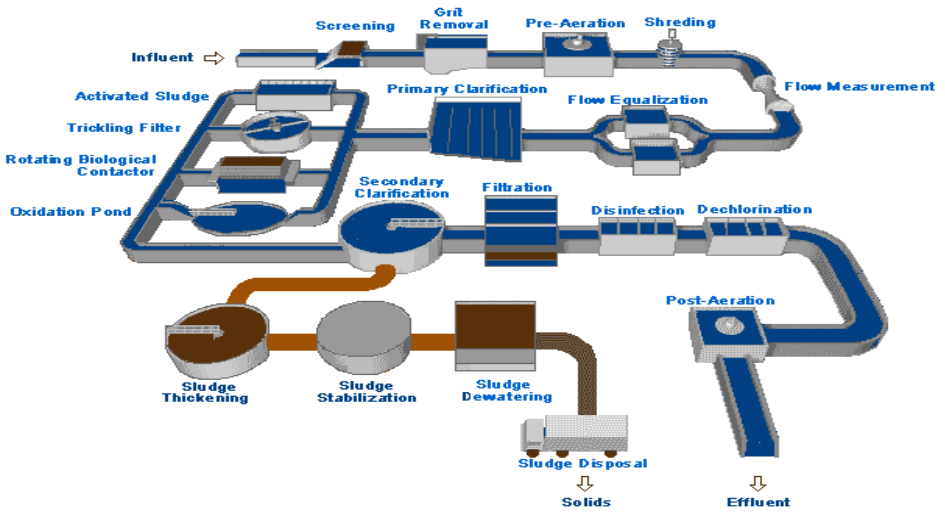
Part I: Background and Scope

Mark Elliott, Ph.D.

University of Alabama

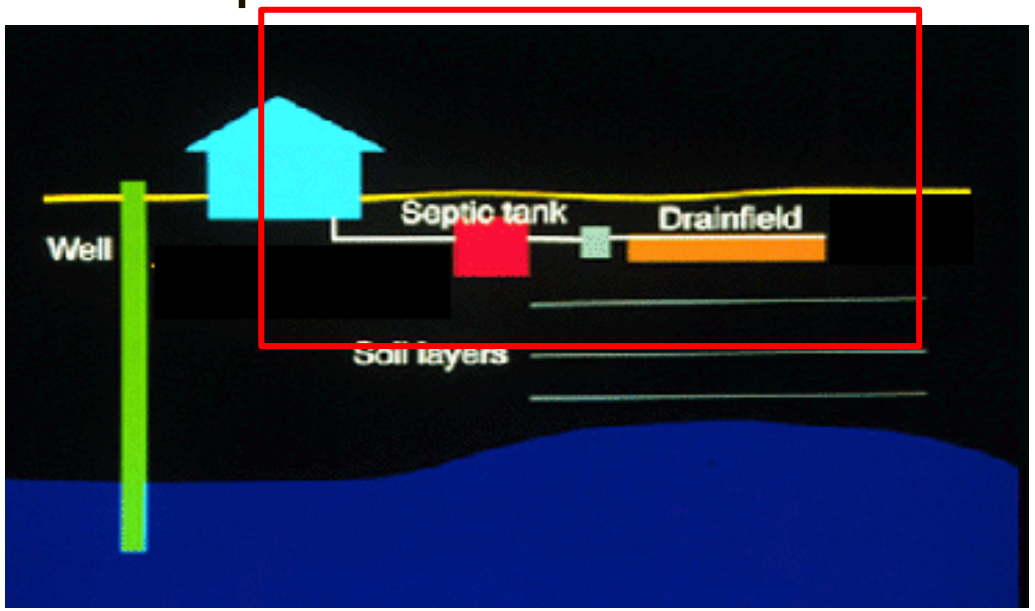
Wastewater Treatment by U.S. Population

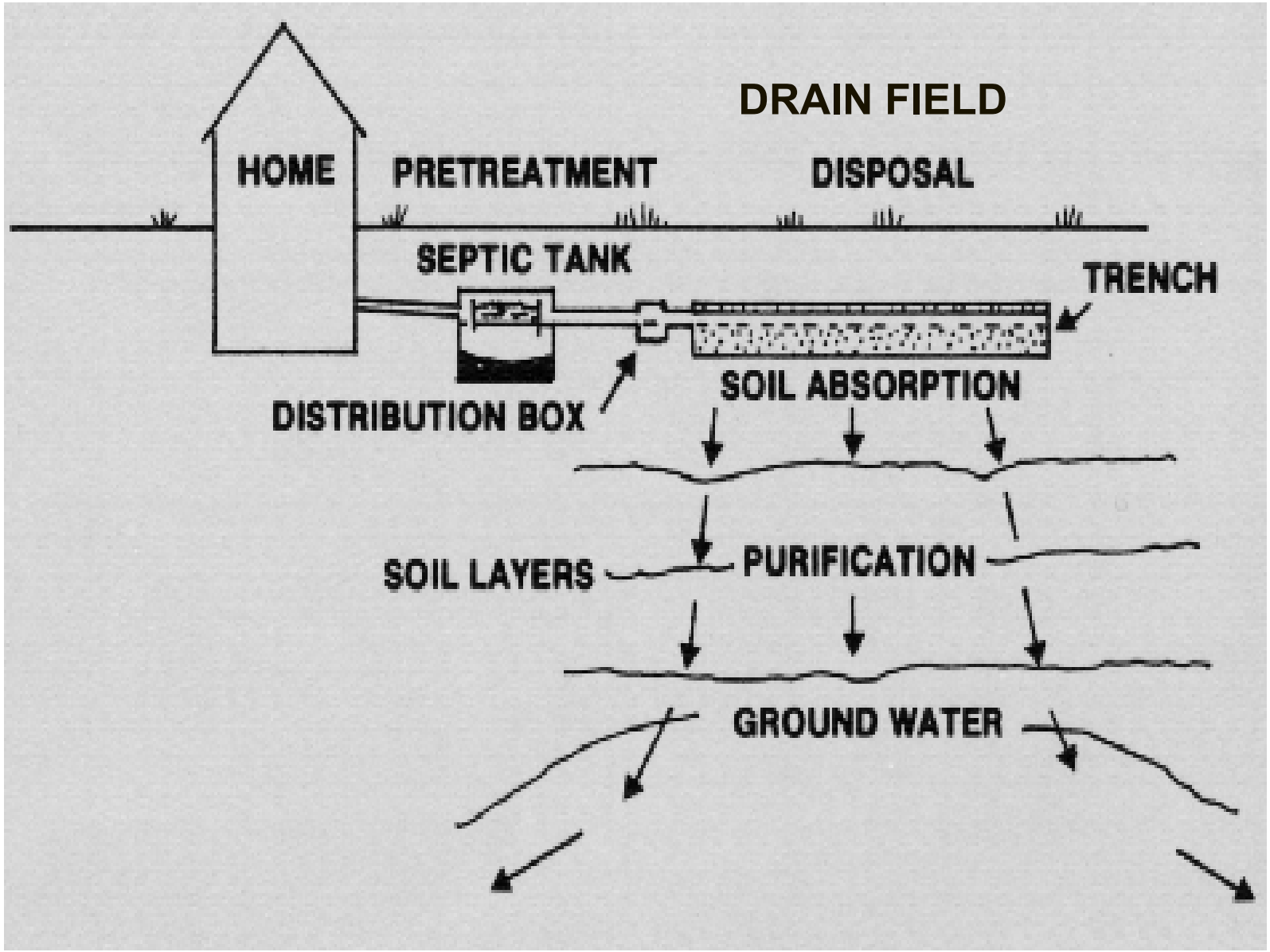
~75% Municipal



Municipal: POTW / WWTP

~25% Onsite



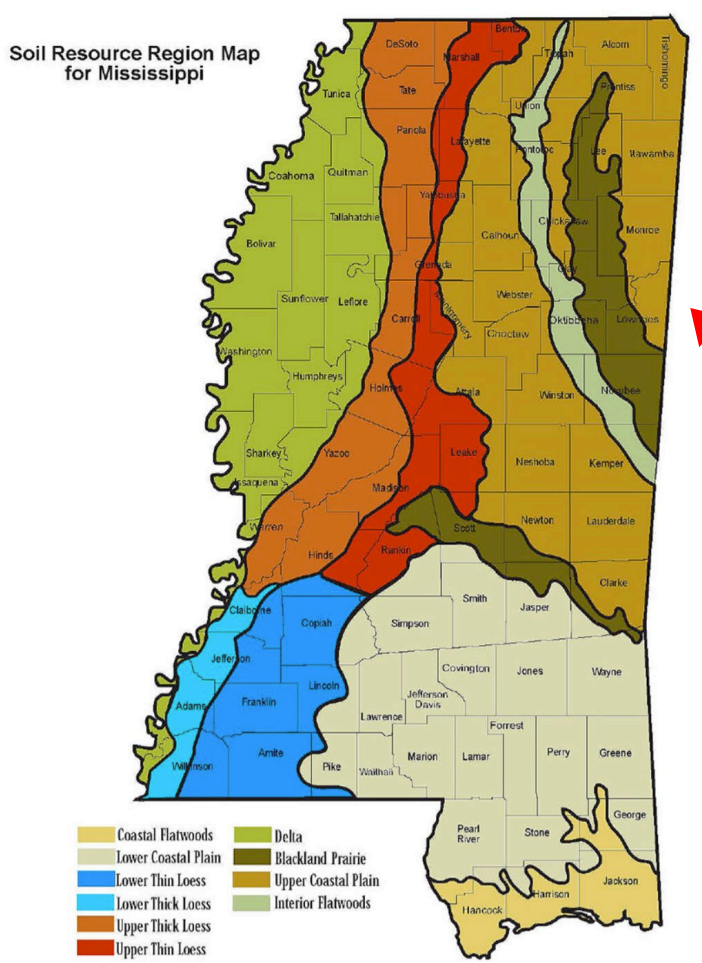


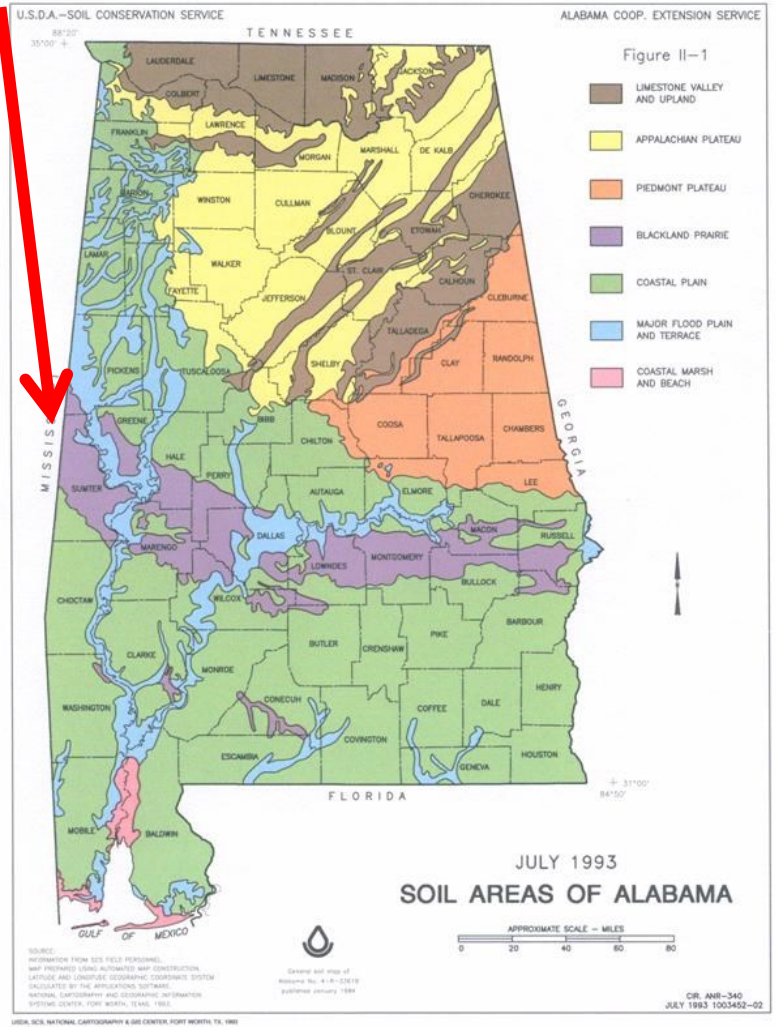
Source: Purdue Univ. Extension Service (Jones et al., 1990)

The Black Belt Region

"Prairie-like" Landscapes

Blackland Prairie Soil





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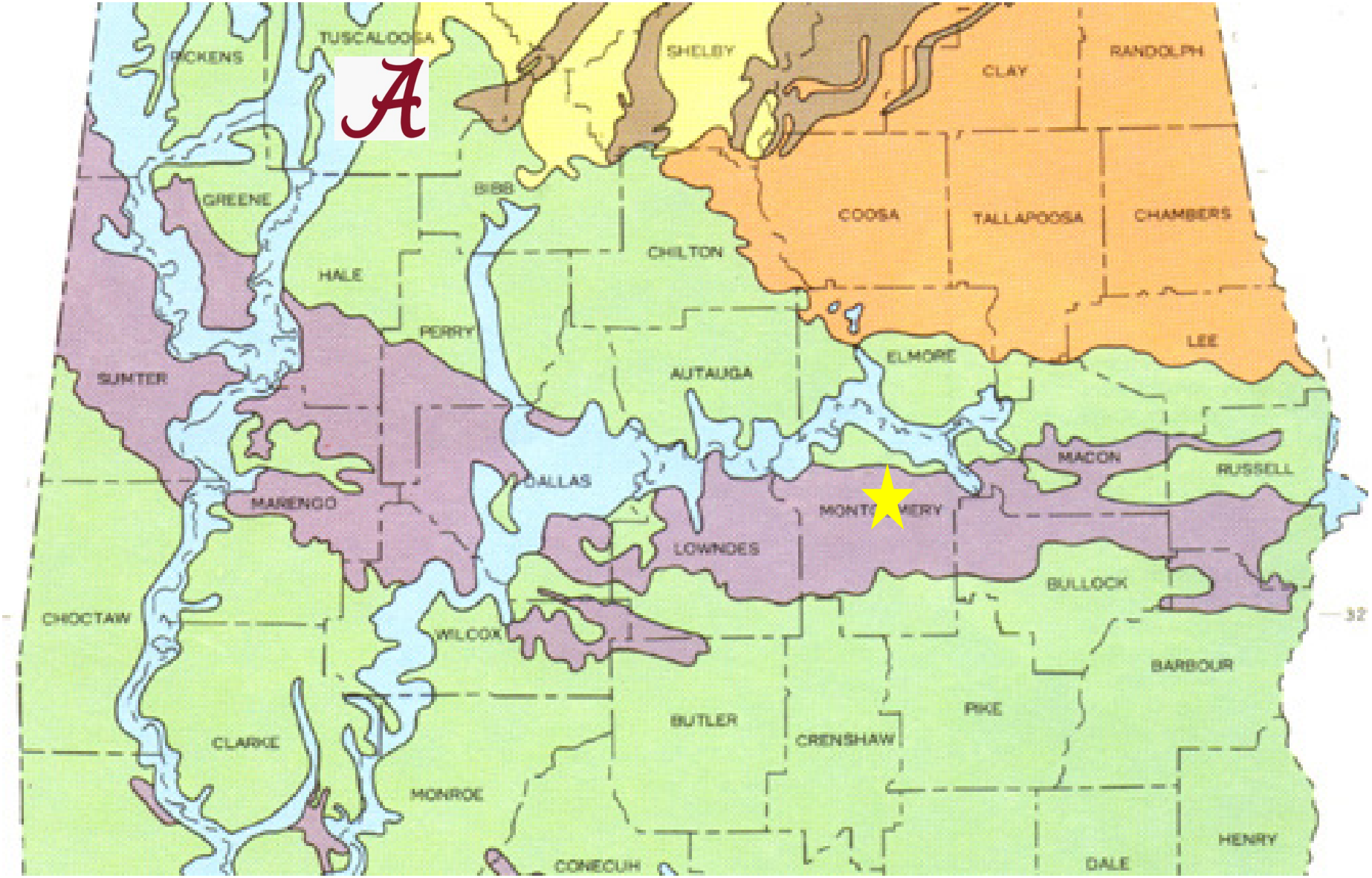


Vertisol Soils "*Blackland Prairie*"

Vertisols are clay-rich soils that shrink and swell with changes in moisture content. During dry periods, the soil volume shrinks, and deep wide cracks form. The soil volume then expands as it wets, becoming basically impermeable.

dry

wet

Alabama Black Belt Demographics

Table 1. Selected Demographics in Black Belt Counties

County	Pop. Density (per sq.mi.)	Median Household Income[1]	% of Pop. on Disability[2]	College Graduation[3] (% > age 25)	Median Age
Bullock	16.6	$26,580	18.7	10.3	39.4
Dallas	40.8	$26,602	19.5	13.8	38.8
Greene	13.0	$26,504	27.9	10.0	42.2
Hale	23.2	$33,315	20.4	14.0	40.5
Lowndes	14.4	$30,675	20.4	12.3	41.6
Macon	31.1	$28,518	17.8	20.0	38.6
Marengo	20.1	$32,977	23.6	14.8	42.0
Perry	13.3	$27,403	25.3	14.5	37.7
Russell	90.7	$35,585	18.1	17.0	35.9
Sumter	14.4	$25,413	20.6	18.1	36.5
Wilcox	12.4	$24,035	17.7	11.3	40.3
Black Belt avg	**26.4**	**$28,873**	**20.9**	**14.2**	**39.4**
AL avg	95.4	$42,917	16.3	24.0	38.6
US avg	89.5	$53,657	12.5	33.4	37.8

[1]U.S. Census Bureau, 2014

[2]U.S. Census Bureau, 2015

[3]U.S. Census Bureau, 2017

Wastewater Infrastructure Lacking

- Low tax base
- Low population density (rural)
- Few cities and towns large enough to support traditional sewer
- And because of soils, most onsite systems (septic tanks and drain fields) do not work

Black Belt Counties

- Named for rich, dark topsoil
  - in many places underlain by impermeable shrink/swell clay (vertisol)
- Poverty limits alternatives
  - 25-40% of households below poverty line
- With no sewer access, poverty and unsuitable soil…

Impermeable soils, Poverty, High-cost Alternatives…we get → → failures and straight pipes

Photos: acrecdc.com

Media Coverage/Anecdotal Evidence

ALABAMA HAS THE WORST POVERTY IN THE DEVELOPED WORLD, U.N. OFFICIAL SAYS

BY CARLOS BALLESTEROS ON 12/10/17 AT 10:21 AM

- UN report on Human Rights to Water and Sanitation 2011
- New York Times - Sept. 26, 2016
- The Guardian - Sept. 5, 2017
- UN visit and Newsweek article Dec. 10, 2017
- PBS News Hour – July 7, 2018
- The New Yorker – Nov. 20, 2020
- Washington Post – Dec. 17, 2020

Bryan Meltz for The New York Times

What we knew when we started investigating this issue:

- Overall wastewater management in the BB is lacking
- Few municipal sewer systems
- Many rural residents have no viable options
- Impacts a large percentage of Black Belt
- This lack of key infrastructure (sewer, proper wastewater management) limits economic development
- Many anecdotal reports but little on the scale of the problem

Unanswered Questions

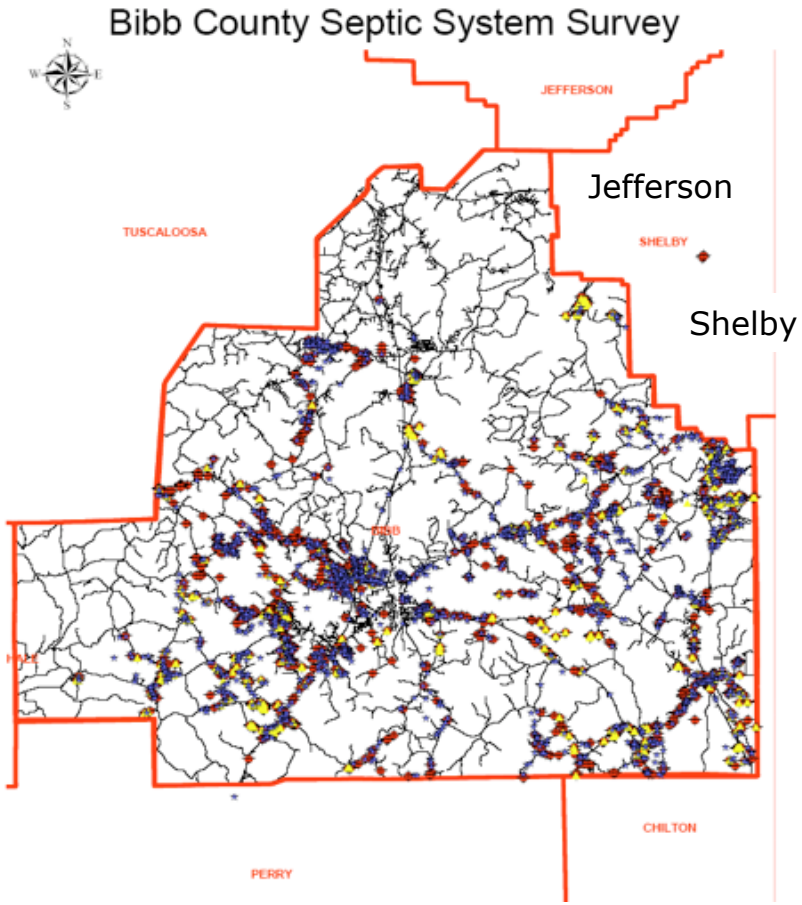
- What is the scope of the onsite wastewater problem?
  - Geographic scope
  - Number of households
  - Volume of untreated wastewater
- What are the impacts?
  - On water quality
  - On public health

Evidence from one Alabama County

Bibb County Field Survey
(White and Jones, 2006)

- ~4000 Rural homes (non-sewered)
- 15% straight pipe
- 50% total showed
  - Sewage on surface

Soil and poverty are not as bad in Bibb County as most Black Belt counties



Bibb County vs. Black Belt counties

Black Belt counties compared to Bibb Co.:

- More poverty (% of households below the poverty line, according to US Census Bureau):
  - Bibb Co. : 18.1%
  - Hale Co.: 26.6%
  - Wilcox Co.: 39.2%
- Much worse soil: Black Belt counties have much more impermeable clay

Therefore, straight pipe and failing septic likely to be even higher in Black Belt counties

Health Impacts?

Poor access and surveillance

- Poor access to primary care physicians (1 per 7000-10,000 population)
- Little surveillance for infectious diseases “of the 19th Century”

Last survey of sewage-associated helminth infection in Wilcox County

- 1/3 of children under-10 tested positive for one or more helminths (Badham, 1993)

Recently published data from Lowndes County

- More than 1/3 of adults with poor sanitation reportedly infected with hookworm (McKenna et al., 2017).

UAB/UNC and Baylor Univ. teams following up

Research Approach

Methods:

- Site-by-site inspections/surveys in Black Belt
- Data from local stakeholders (expert knowledge)
- Flow-routing
- Water sampling (microbiological and chemical)

Research Approach

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Wilcox County Inspection Data

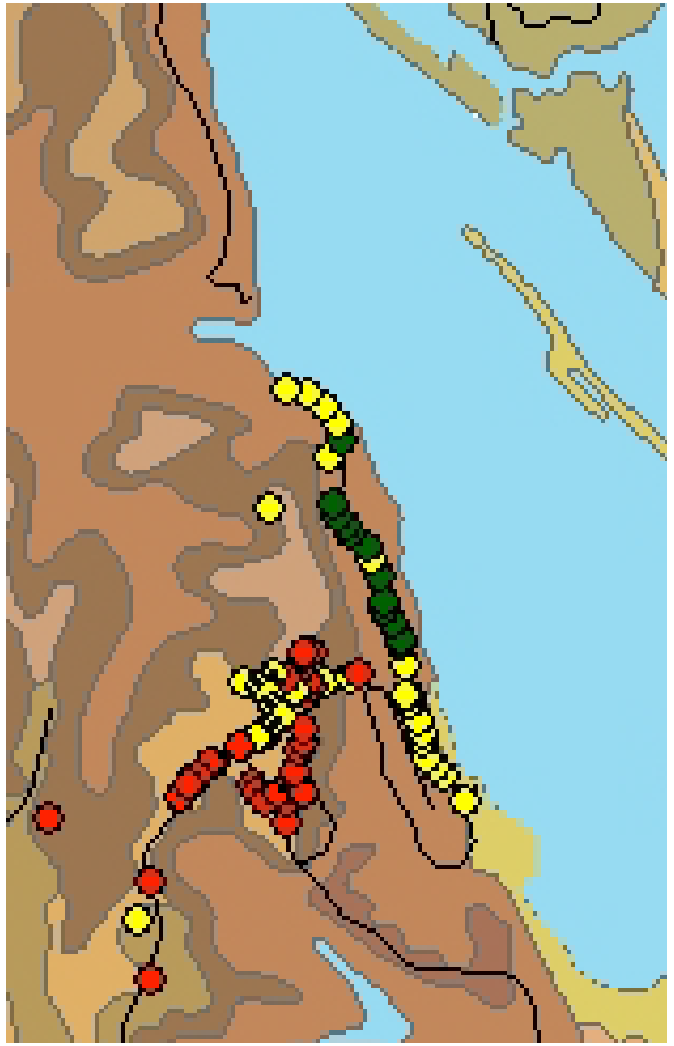
- **289 dwellings surveyed**
- 104 houses, 185 mobile homes
- Representative of county demographics and soil
- 19 **(6.6%) Health Dept.-permitted systems**
- 270 (93.4%) without permitted systems
- 172 **(60%) with straight pipe** visible upon inspection
- 98 (34%) unpermitted, either some form of in-ground disposal or straight pipe buried/not visible

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

Wilcox County Inspection Data

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

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



Research Approach

Methods:

- Site-by-site inspections/surveys in Black Belt
- **Data from local stakeholders (expert knowledge)**
- Flow-routing
- Water sampling (microbiological and chemical)

Newbern (Hale Co) – Preliminary Expert Knowledge Data

- Local experts
- Septic system installers
- Health dept. staff
- Newbern, AL (impermeable clay soil)

Newbern (Hale Co) – Preliminary Expert Knowledge Data

- **Newbern, AL (impermeable clay soil)**
- 10% with permitted systems
- **90% unpermitted**
  - 40% have some field lines
  - **50% straight pipe**
    - 30% solids settling (septic tank or 55-gal drum)
    - 20% no solids setting

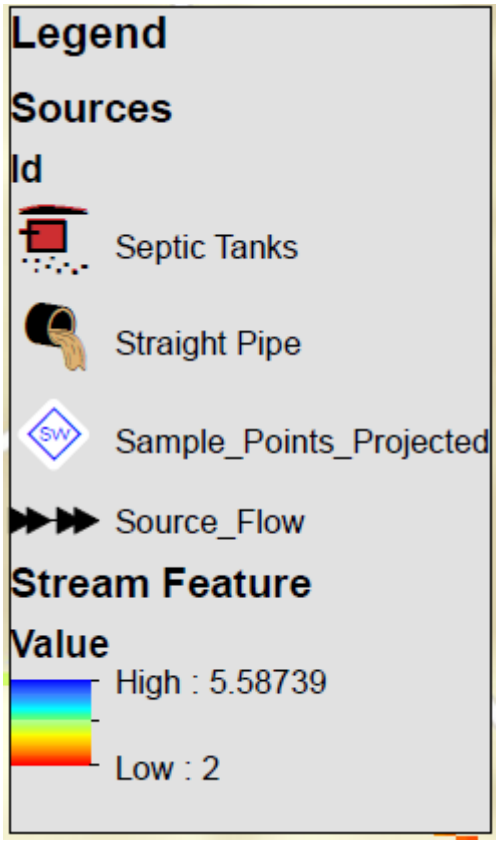
Estimates by Tim Wenger of Cedar Ridge Excavating (work ongoing with other stakeholders)

Research Approach

Methods:

- Site-by-site inspections/surveys in Black Belt
- Data from local stakeholders (expert knowledge)
- **Flow-routing**
- **Water sampling (microbiological and chemical)**

Flow Routing



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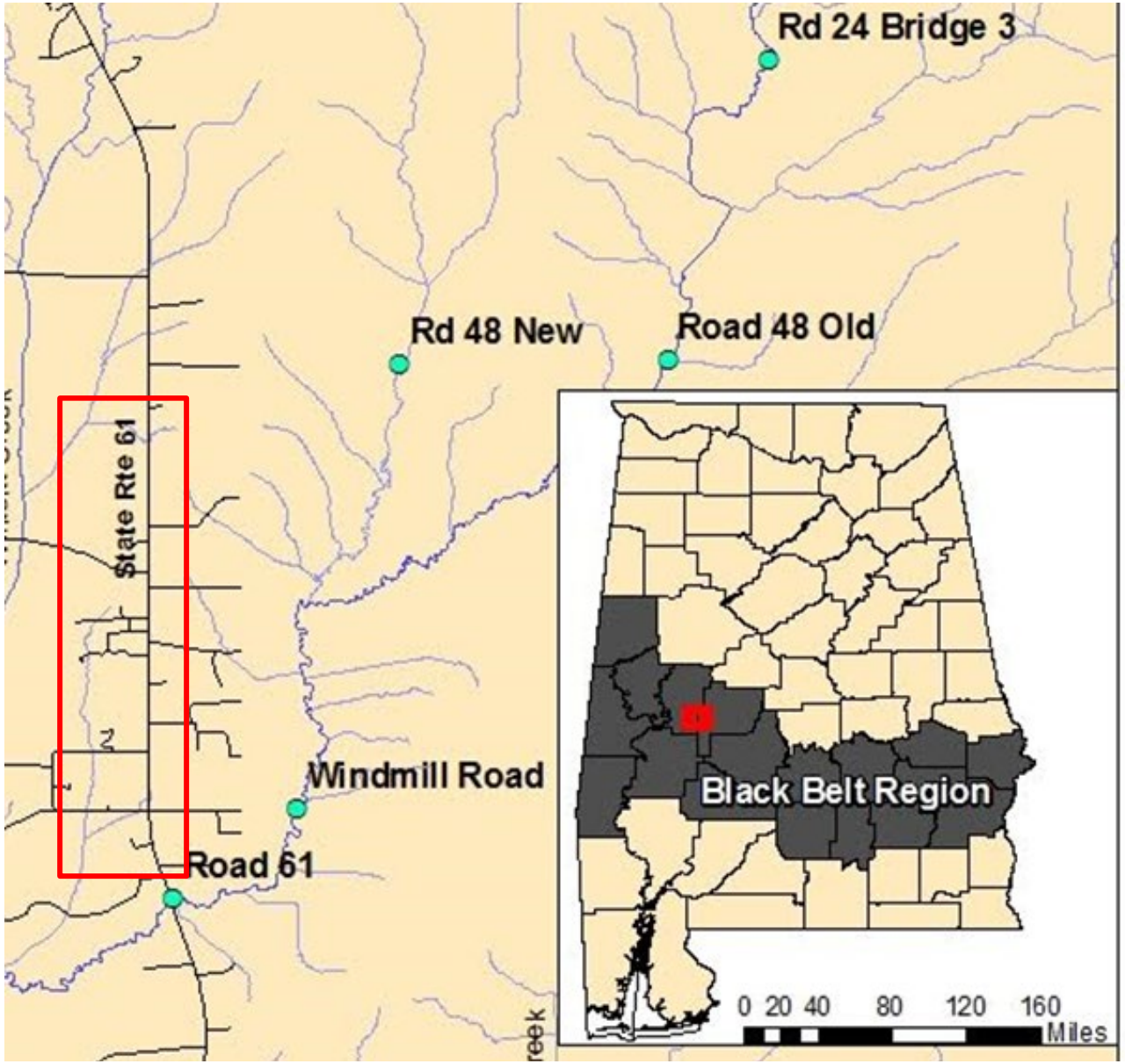
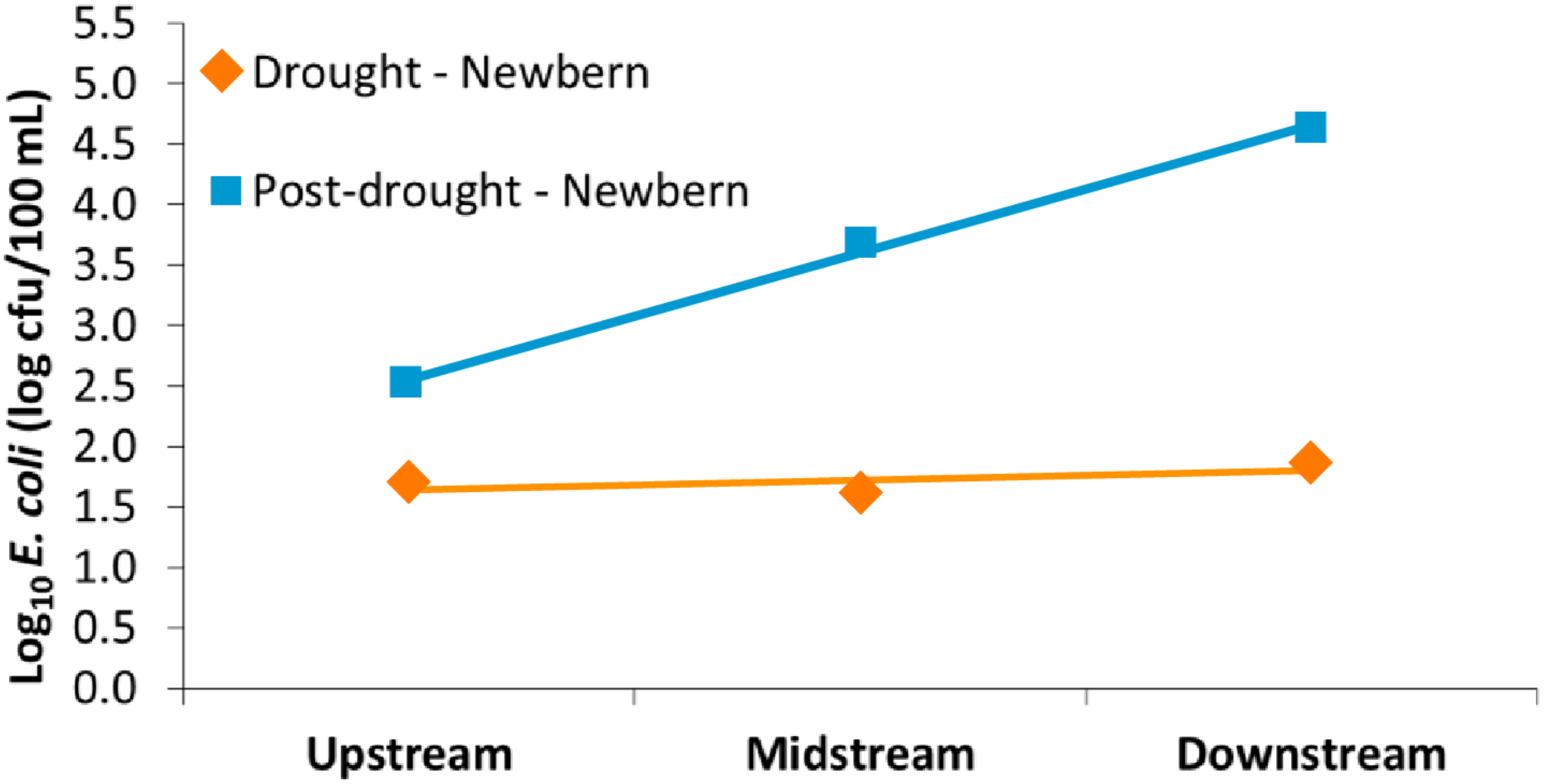


Drought/Post-drought



From characterizing to addressing the problem

Our work has largely focused on:

- Defining the nature of the problem and its impacts
- Characterizing its geographic scope

This continues, but we are shifting the major emphasis to addressing the problem:

- Categorizing and defining the various barriers to wastewater solutions
- Developing solutions appropriate for each community
- Leveraging partnerships and resources to implement solutions

What do we do? Path Forward…

Communities and residents need help

1. Expand/upgrade existing municipal sewer systems
2. Appropriate onsite system – tech, funding, ADPH
3. Identify clusters of homes – decentralized collection/treatment
4. Identify cost-effective treatment technologies
5. Identify management entities
6. Explore viable financial models (capital and O&M)
7. Develop alternative regulatory strategies
8. Develop a “how-to” guide

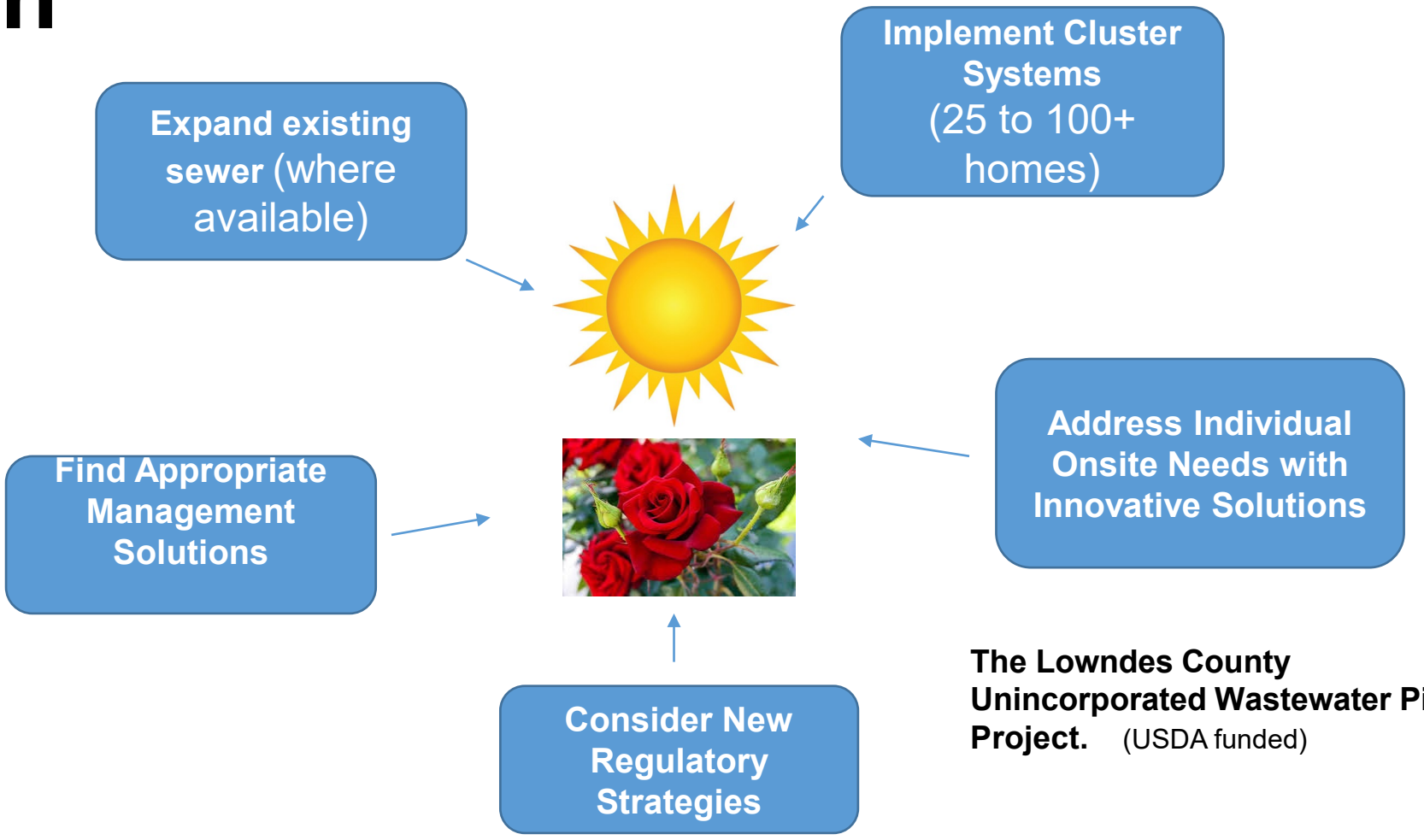
Part II: Proposed Solutions

Kevin D. White, Ph.D., P.E.
University of South Alabama

Obstacles in this Region

- Soils
- Population Density
- Poverty/Economics
- Technology
- Management Models (entities)
- Financial Models
- Community Guidance

A Plan



The Lowndes County Unincorporated Wastewater Pilot Project. (USDA funded)

Broad Path Forward…

Rural and Underserved Communities and Residents Need Help – Public Health and Economic Development

1. Expand/upgrade existing municipal sewer systems

- Cost-effective collection and treatment upgrades
- Get more residents onto “managed sewer”

2. Individual onsite systems

- Affordable and functional options

3. Decentralized (cluster) infrastructure

- Identify Rural clusters of homes (25 – 100+)
- Cost effective collection, treatment, disposal/reuse

Broad Path Forward…

Continued

4. Identify Effective Management Models

- Rural Water, County, Multiple County, Electric Coops, etc.

5. Explore viable financial models

- Capital, O&M

6. Develop alternative regulatory strategies

- General Permits, Special Permit Districts, etc.

7. Create a “how to” guide

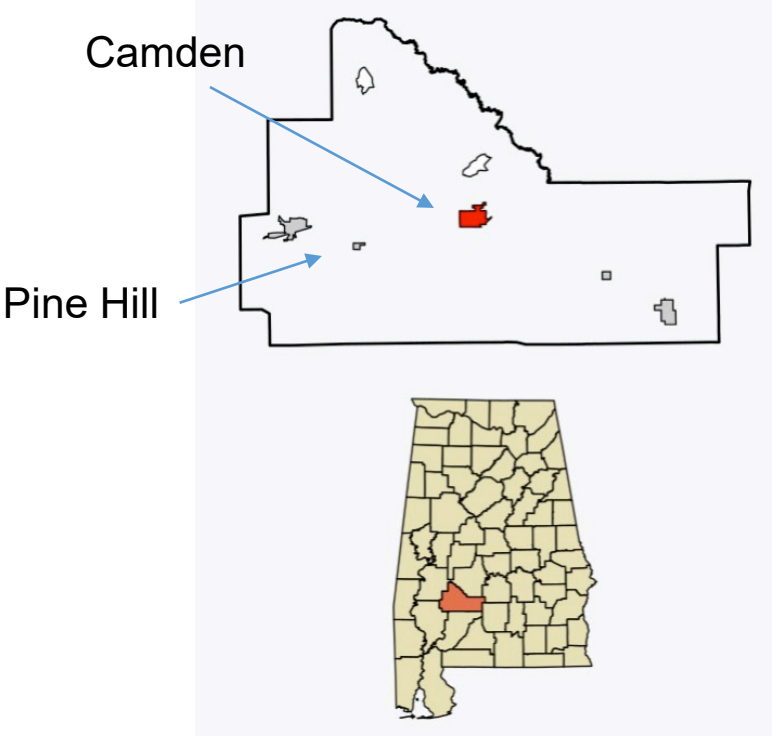
Expand Existing Sewer

Small towns w/ sewer – typically 2 to 3 per county

- Most sewers run to the city limit & no further
- Connection fees $$

Wilcox County (pop. 10,685)

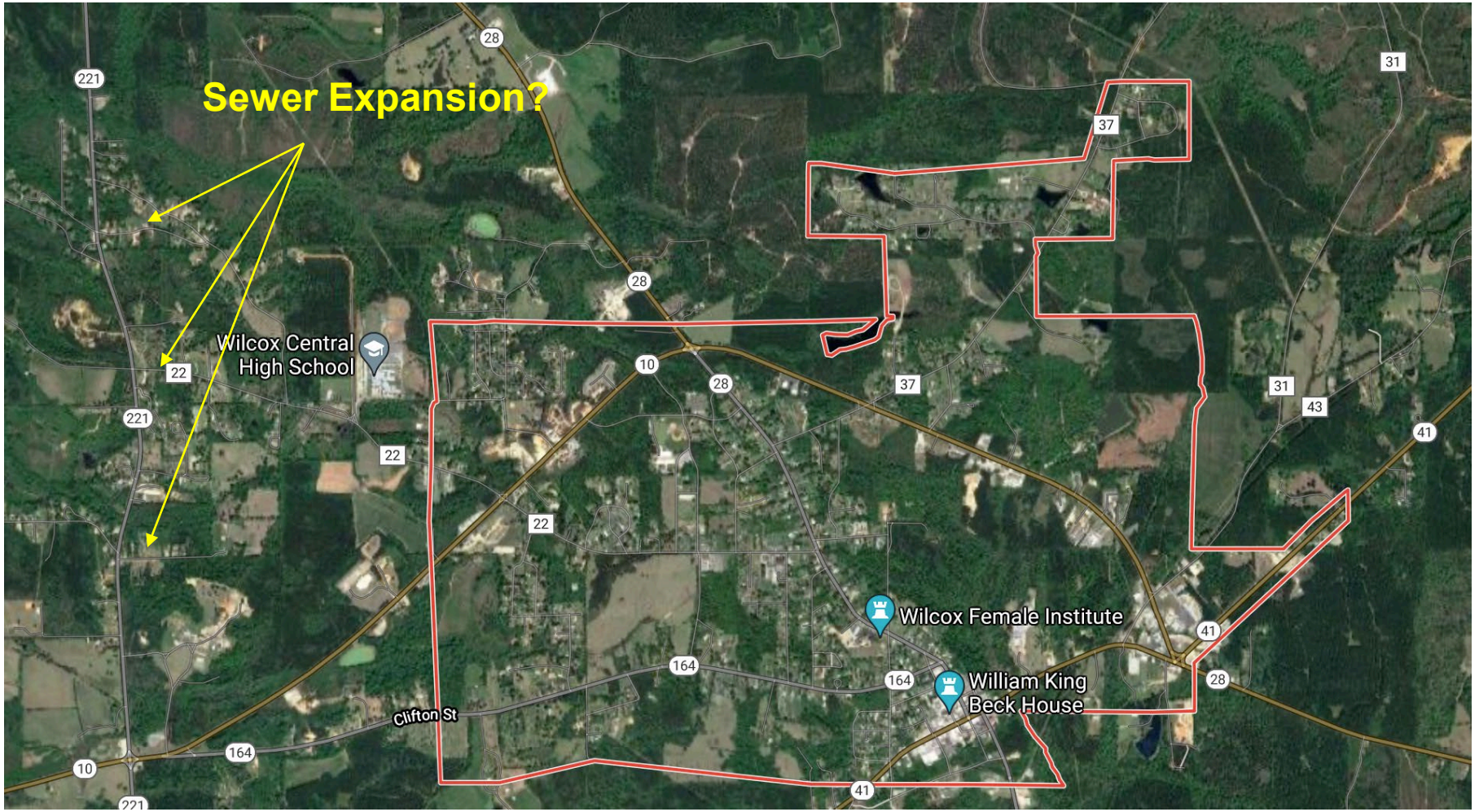
- 2 municipal sewer systems
- Camden (pop. 2177)
- Pine Hill (pop. 927)
- Current EPA project is identifying
  possible municipal sewer expansions
  (geographical extent and cost) &
  treatment capacity in 5 targeted Black Belt counties



1. **Single-home appropriate systems**
   - Subsidies from USDA (ADPH pilot program in Lowndes Co)
   - More comprehensive soil surveys to identify best soil?
   - Pump effluent to another property with drain field?
2. **Clustered, decentralized collection and treatment**
   - Remote monitoring, components decreasing in price
   - Economies of scale

Expand Existing Sewer (cont.)

- Camden



Expanding/Connecting to Sewer

Sewer Line Cost Considerations

Task	Total Cost Including Labor
Sewer Line Per Foot	$50-$250 + manholes
Trenching	$800
Backflow Preventer	$150-$1,150
Sewer Cleanout	$2,000
Hookup	$500-$20,000

Mostly Labor

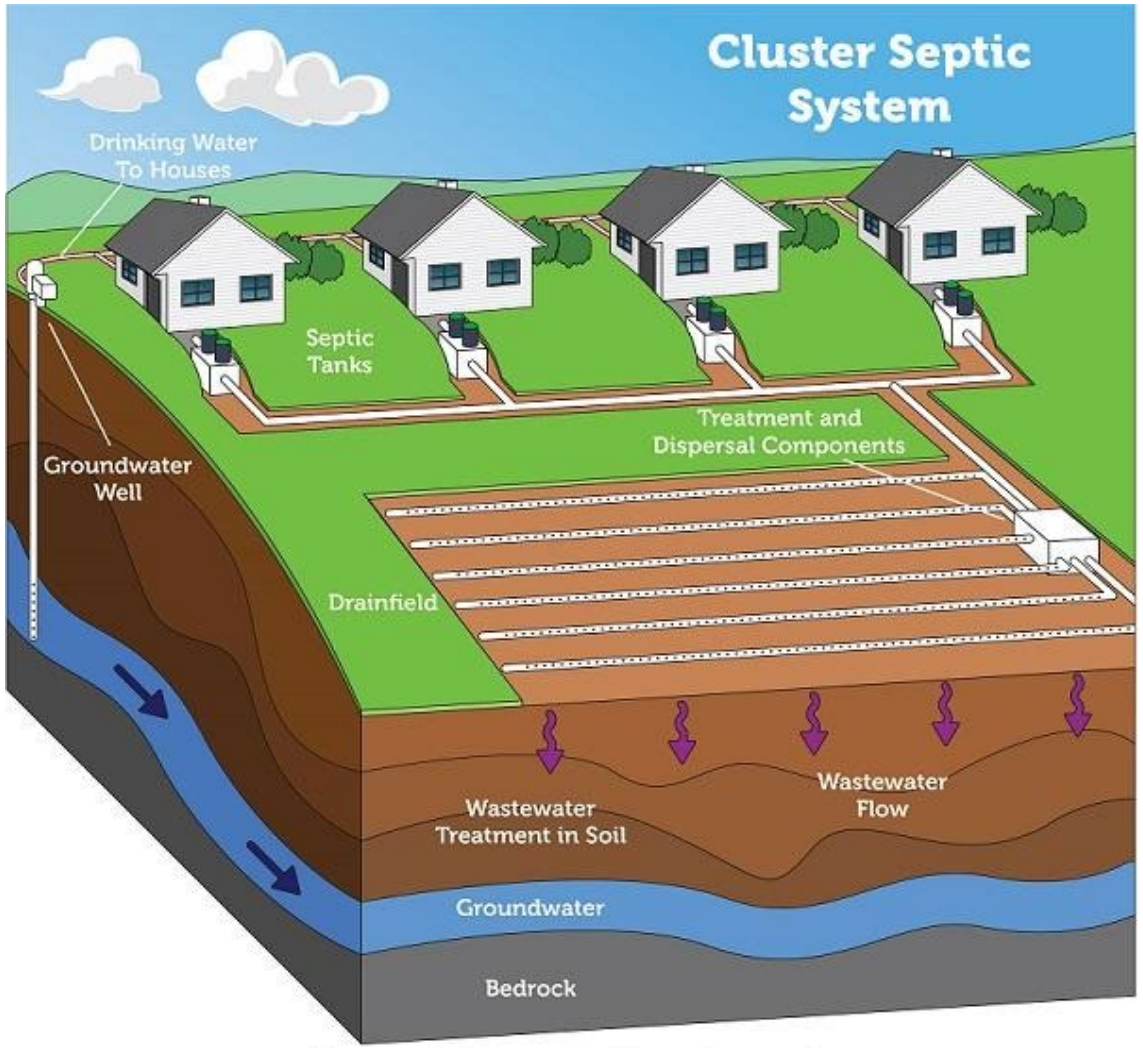
Per home costs for homeowner

Decentralized Clustered Systems

Need to find cost-effective collection, treatment, disposal/reuse, and management

- Remote monitoring
- Multiple systems

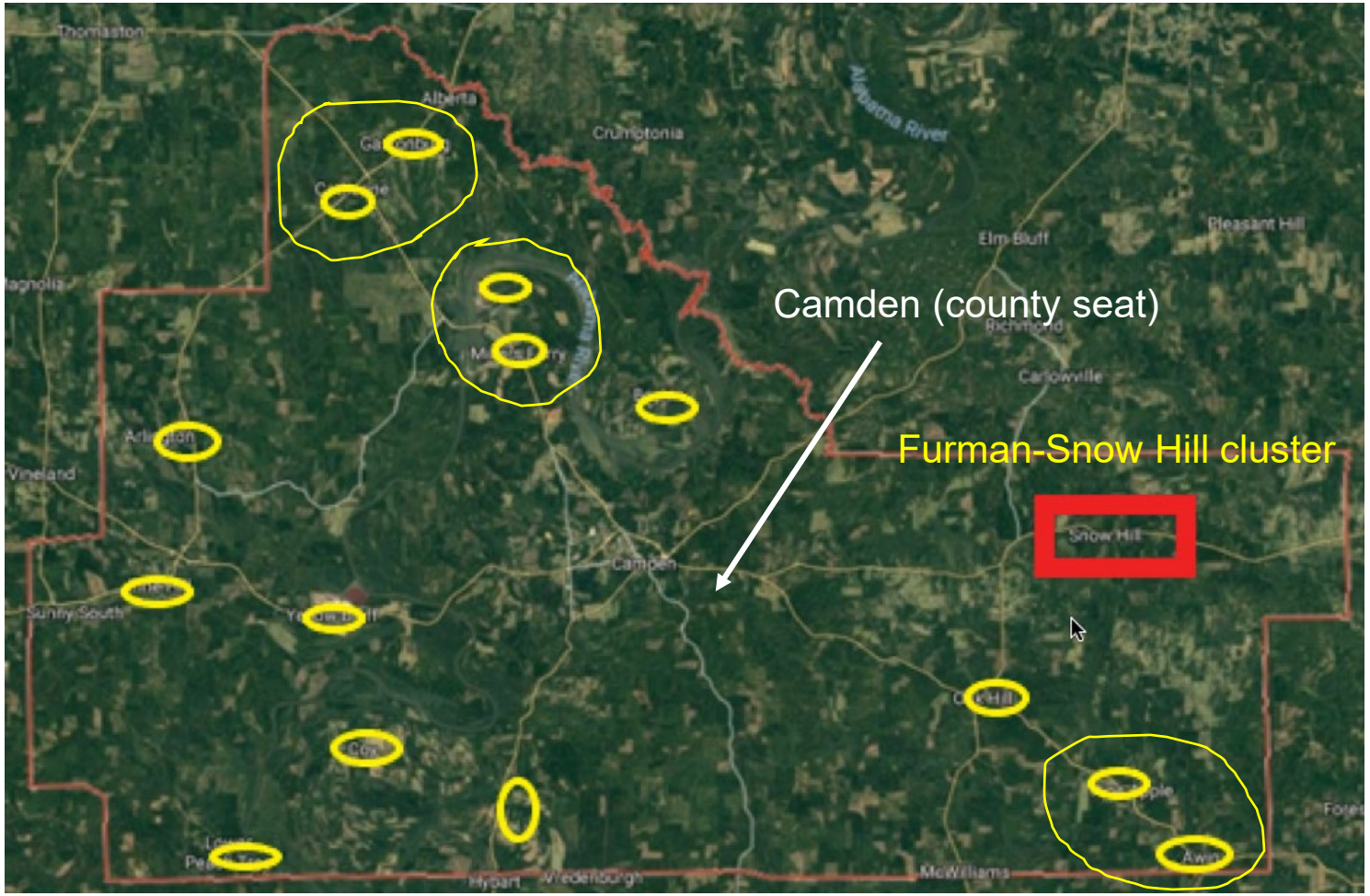
  in each of several counties
- Economies of Scale



Source: EPA

Decentralized Clusters

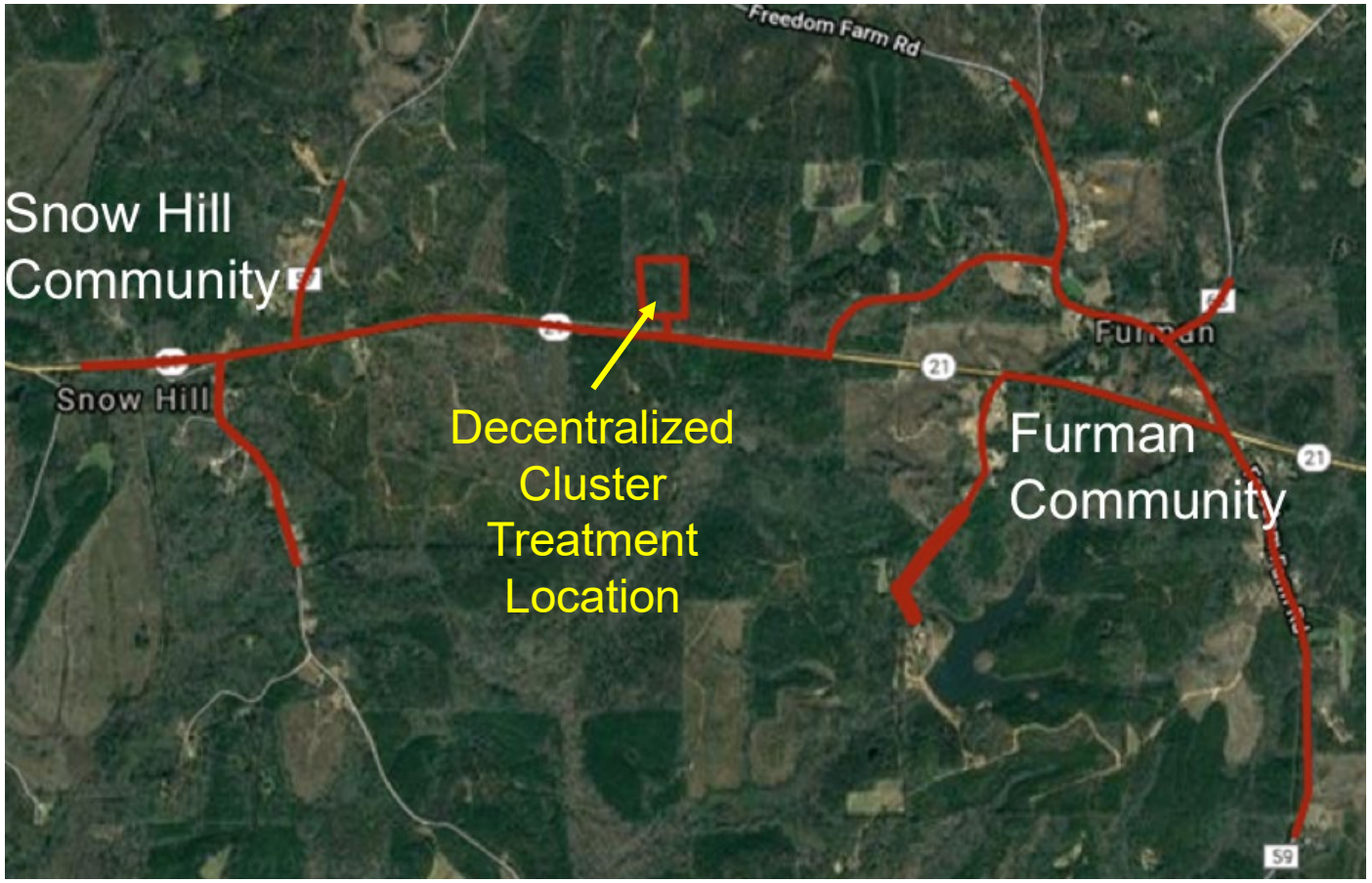
Wilcox County Alabama (15 possible clusters of 30+ homes)



Decentralized Clusters

Furman-Snow Hill Communities

~ 75 homes in two small communities (19,000 gpd)



Decentralized Cluster - Options

Collection

- Gravity? BOD 250-450 mg/L, TSS 250-500 mg/L
- Pressure (grinder pumps)? BOD 250-450 mg/L, TSS 250-500 mg/L
- STEP? **BOD 120-150 mg/L, TSS 20-40 mg/L**

STEP Costs: $340,000 - $510,000 materials/installation for 50,000 gpd (200 homes)

Gravity Costs: $2,182,000 - $3,273,000

Pressure Costs: $344,000 - $516,000

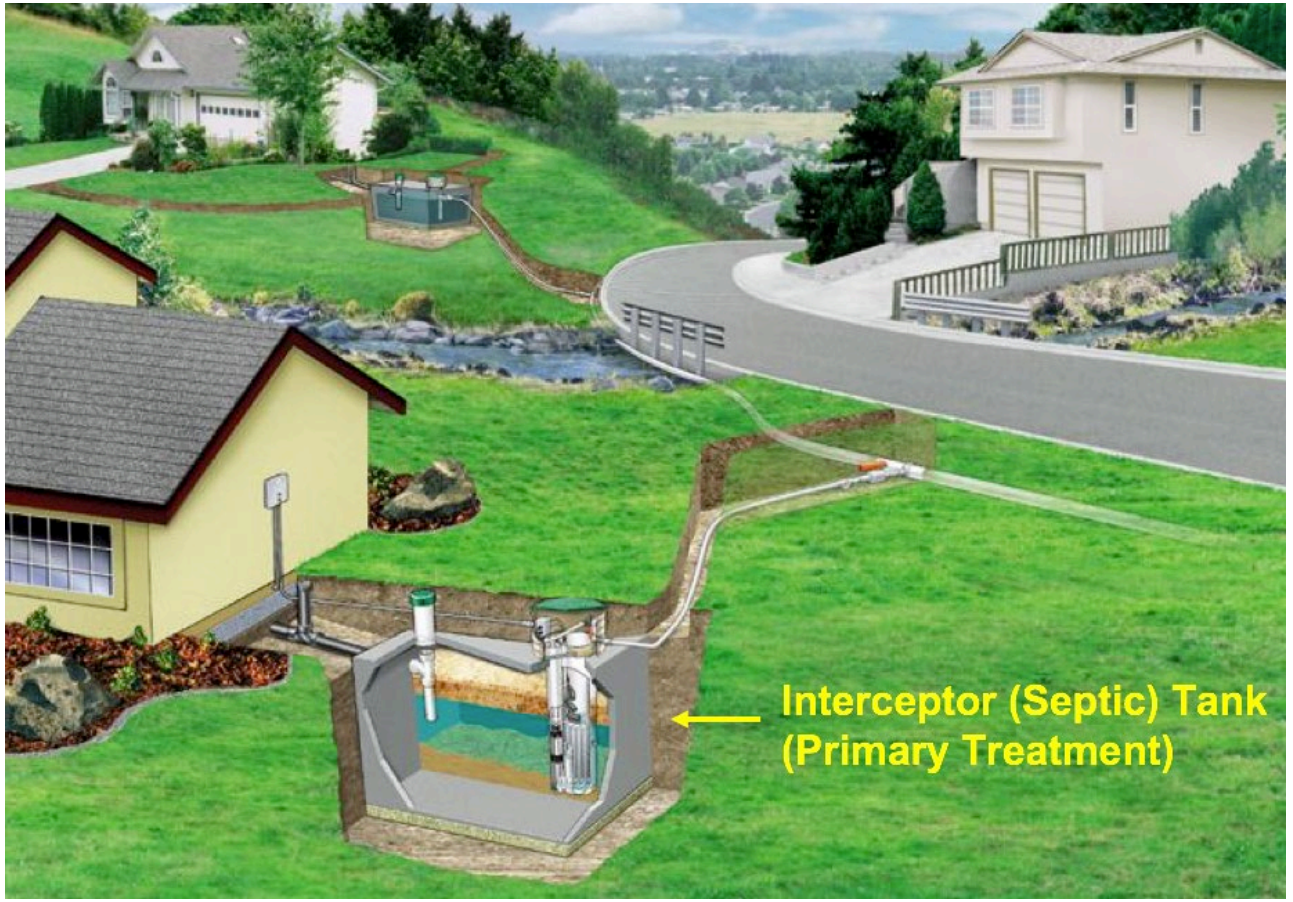
With STEP, get small diameter sewer lines, minimal solids handling

more (& better?) treatment options

Cluster System Approach

STEP (Septic Tank Effluent Pump)

- Each home/business has a septic tank (primary treatment)
- Liquids-only enter 2-inch line and flow to treatment unit



Orenco Systems, Inc.

Cluster System - Options

Treatment (depends on effluent fate & cost)

- Pond/Wetlands
- Recirc Media Filters
- Aerated Systems
- MBRs
- Etc.

Life Cycle Costs	Operation per hh/mo.	w/ Capital Recovery. per hh/mo	w/ Capital Recovery & 30% overhead. per hh/mo.
Aerated-Attached Growth	$20	$28	$36
Recirc Media Attached Growth	$16 - $20	$22 - $28	$28 - $37
Constructed Wetland	$14	$17	$22
Membrane Bioreactor	$31	$42	$55

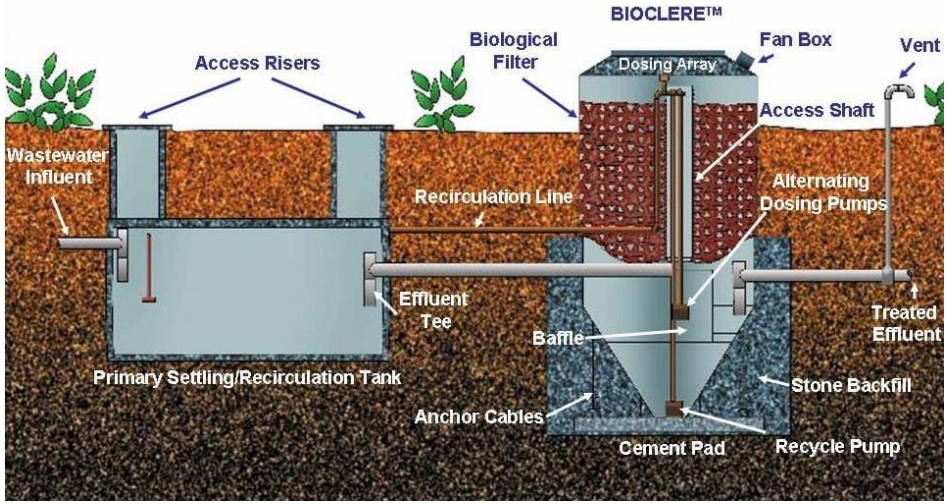
Characteristics

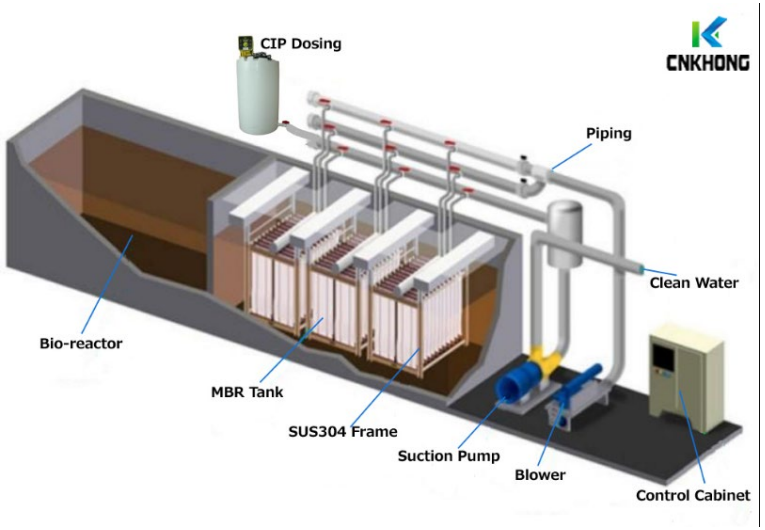
- Modular
- Simple to operate (remotely?)
- Low O&M costs

Cluster System - Options

Treatment

- Modular
- Simple Operation
- Low O&M Costs

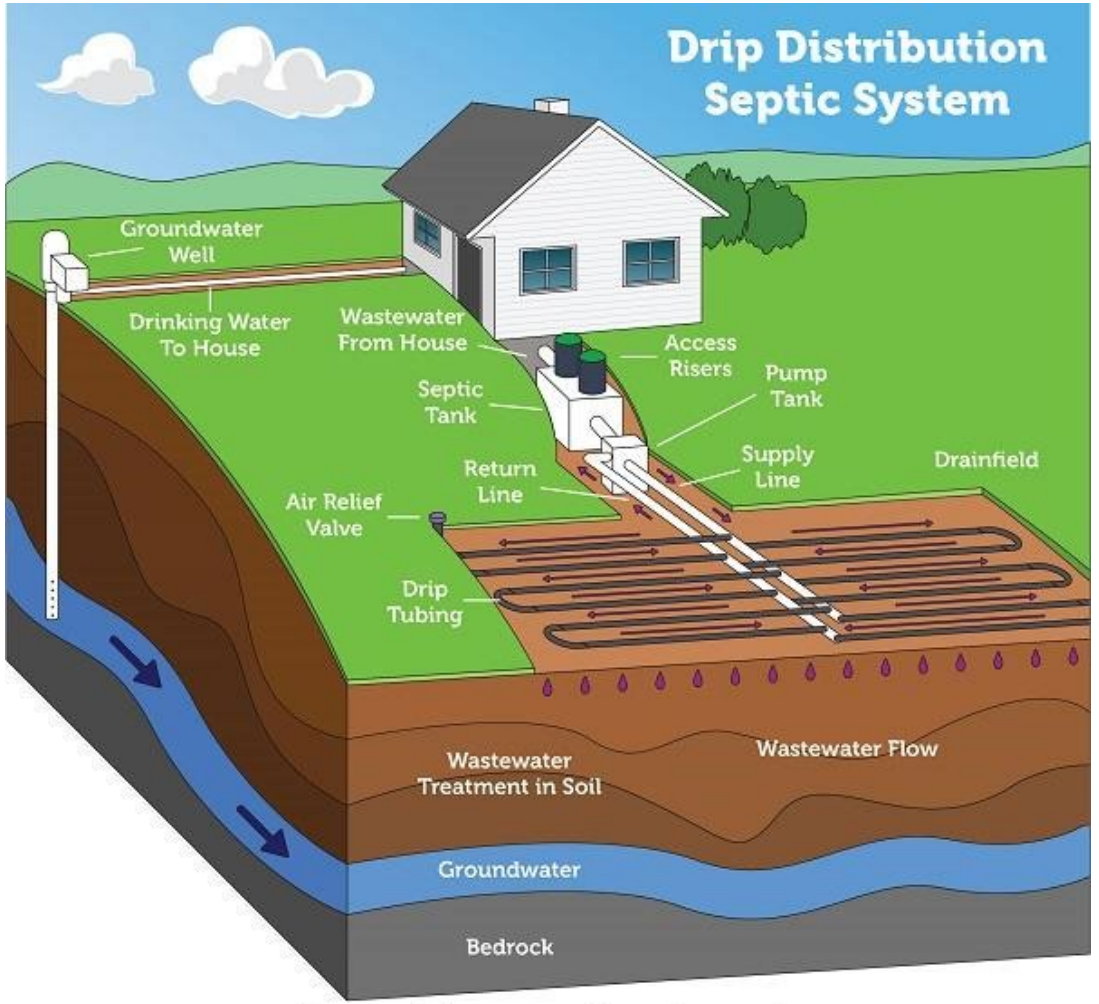




Cluster System - Options

Disposal/Reuse

- Drip Irrigation
- Spray Irrigation
- Stream Disposal
- Reuse
  - Timberland
  - Hayfields
  - Plant nurseries



Source: EPA

Management Models

Can large, existing utilities manage small, rural, decentralized wastewater systems?

- Public vs. Private?
- Community Level Mgt?
- County Level Mgt?
- Multiple County?
- Large, existing, municipal
  - wastewater utilities?
- Rural water providers?
- Electric Coops?
- Solid Waste Managing Entities?

Management Entity	Description	Example
Public Water/Wastewater Utility	A large, established, centralized utility branches out and manages smaller, decentralized systems.	MAWSS, MWWSSB, Daphne Utilities
Private Management Company	A private utility manager is hired to oversee operations and maintenance of decentralized facilities.	ADENUS, Alabama Wastewater
Electric/Gas Utility	An electric or gas provider expands their services to provide decentralized wastewater management.	Alabama Power, Rural Electric Cooperatives
Waste Collection	Where composting toilets are used, the homeowner pays a monthly fee to have the waste cassettes picked up.	Waste Management

Regulation and Permitting

Health Dept vs State EPA

- In-ground vs. surface
- Flow demarcations
- Spray Irrigation

State Revolving Loan Funds, USDA, CDBGs ???

Reuse --irrigation

- Silviculture
- Hay, Plant nurseries

Local ordinances to require sewer connection

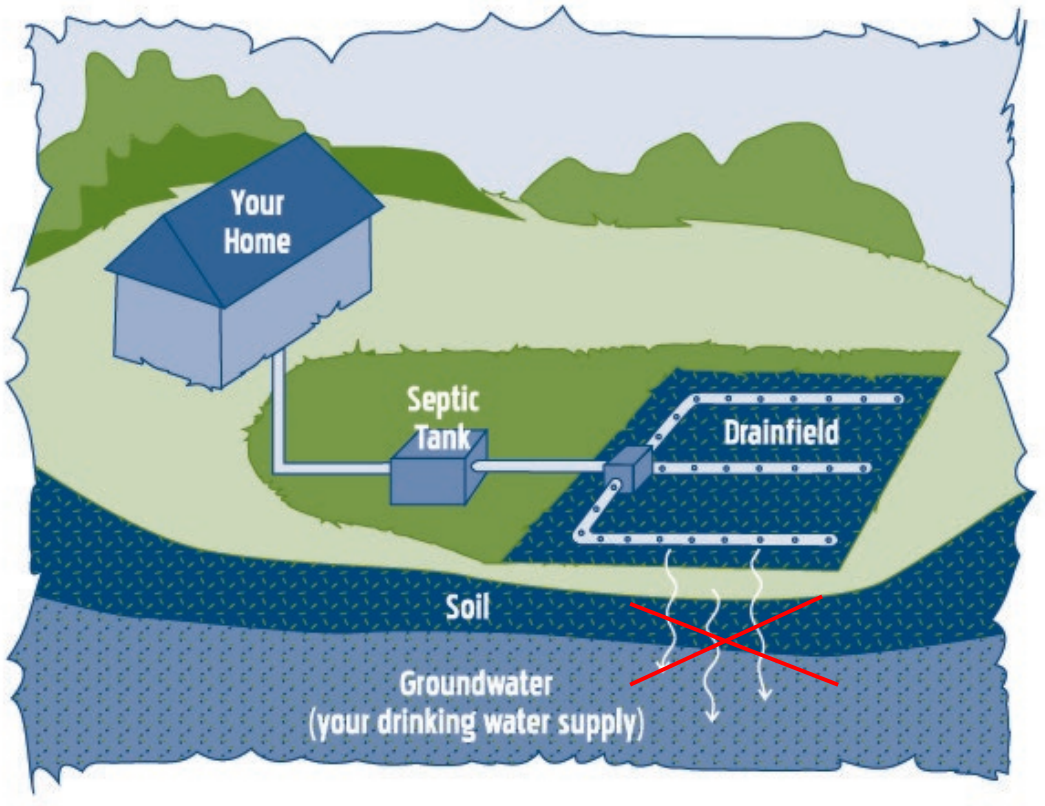
Special Permit District? (clay soil related)

- General Permits (Louisiana, Ohio, etc.)

Onsite Options

Conventional in-ground disposal does not work

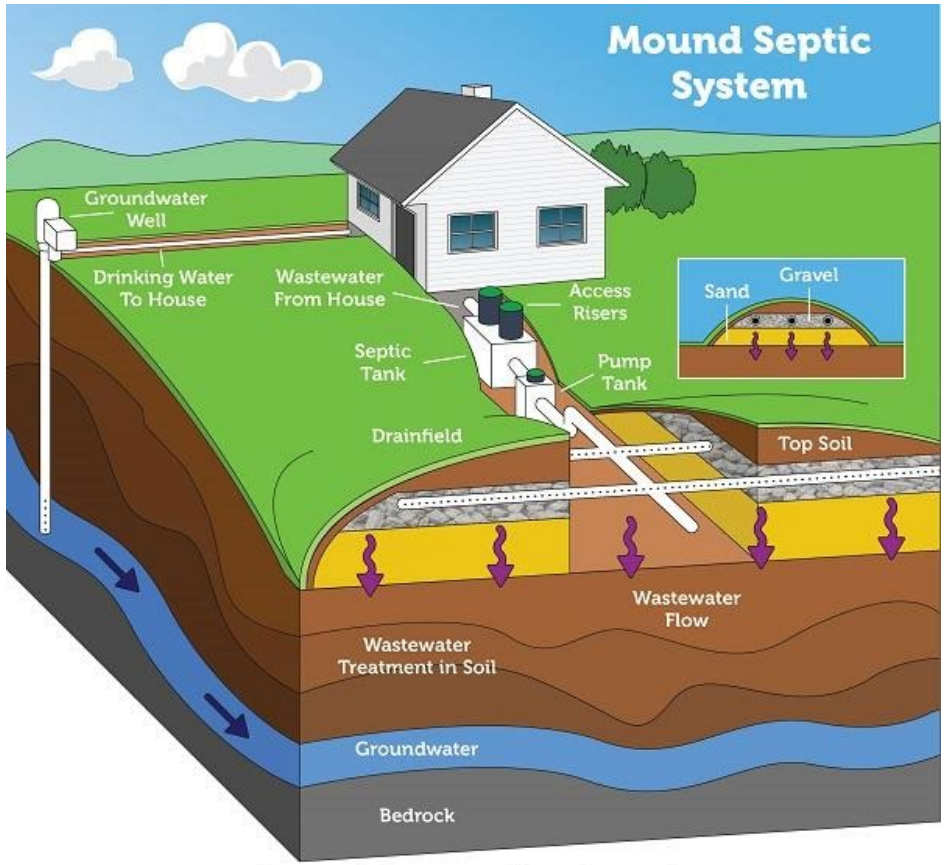
Perc rates >240 min/in



Source: EPA

Onsite Options: Drainfield Mounds

Very large and costly for this population ($6000 - $10,000+)

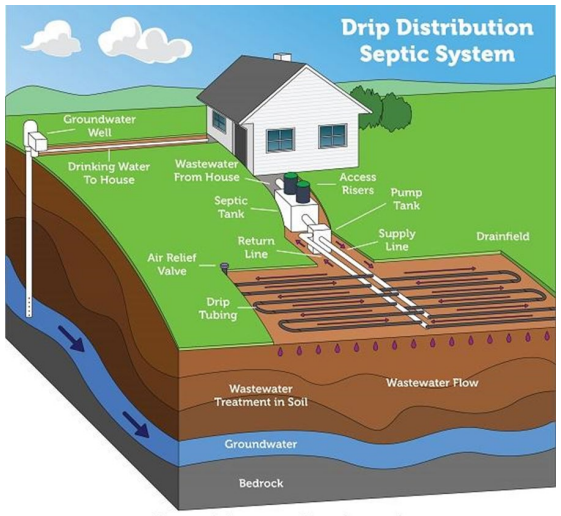


Source: EPA

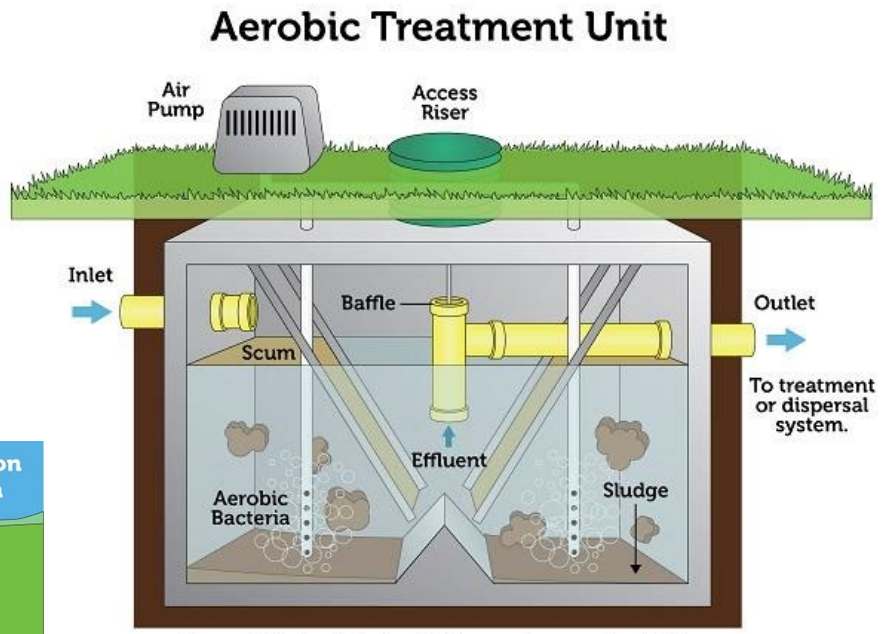
Onsite Options: Advanced

Expensive and
Require Maintenance

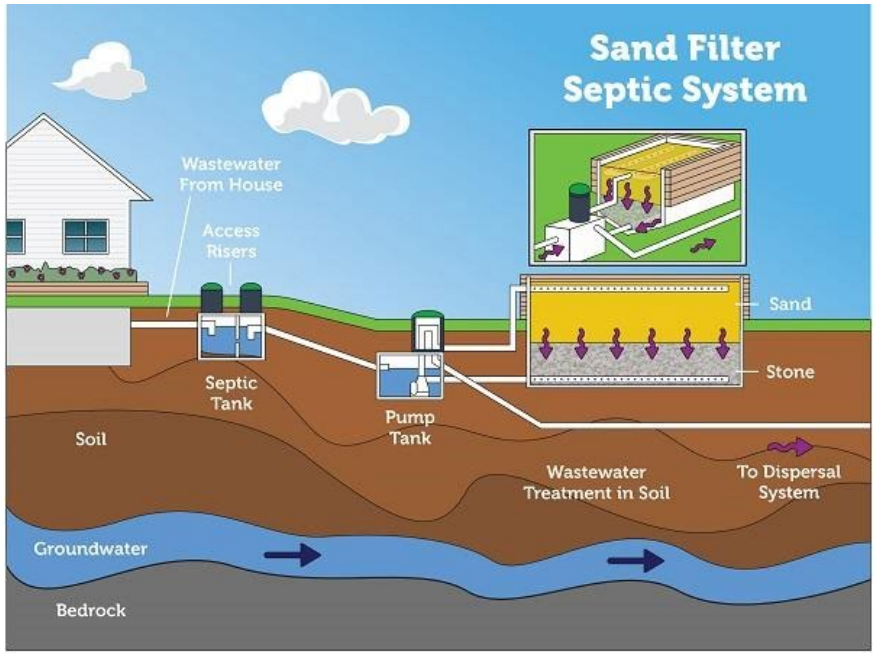
Source: EPA



Please note: Septic systems vary. Diagram is not to scale.



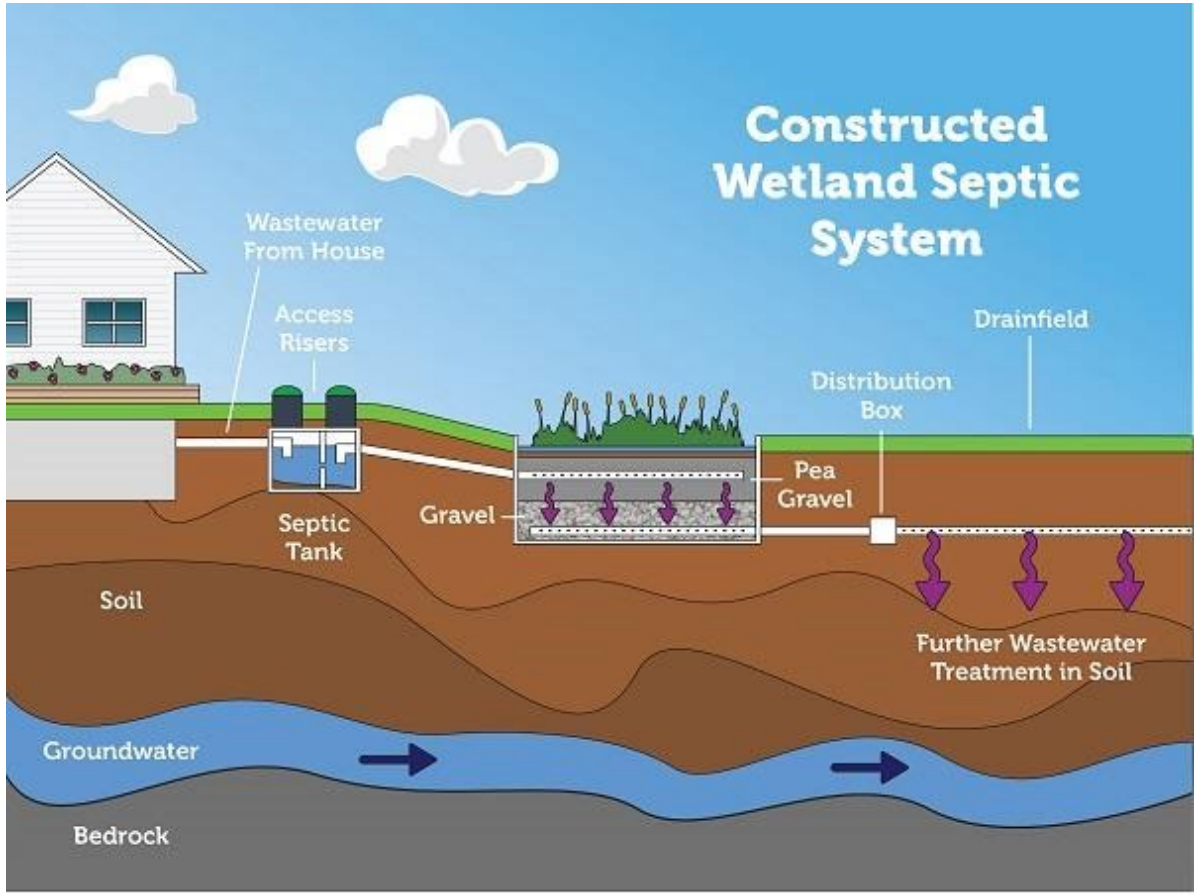
Please note: The Aerobic Treatment Unit can vary in components and design



Please note: Septic systems vary. Diagram is not to scale.

Onsite Options: Wetland Systems

Typically require infiltration



Please note: Septic systems vary. Diagram is not to scale.

Source: EPA

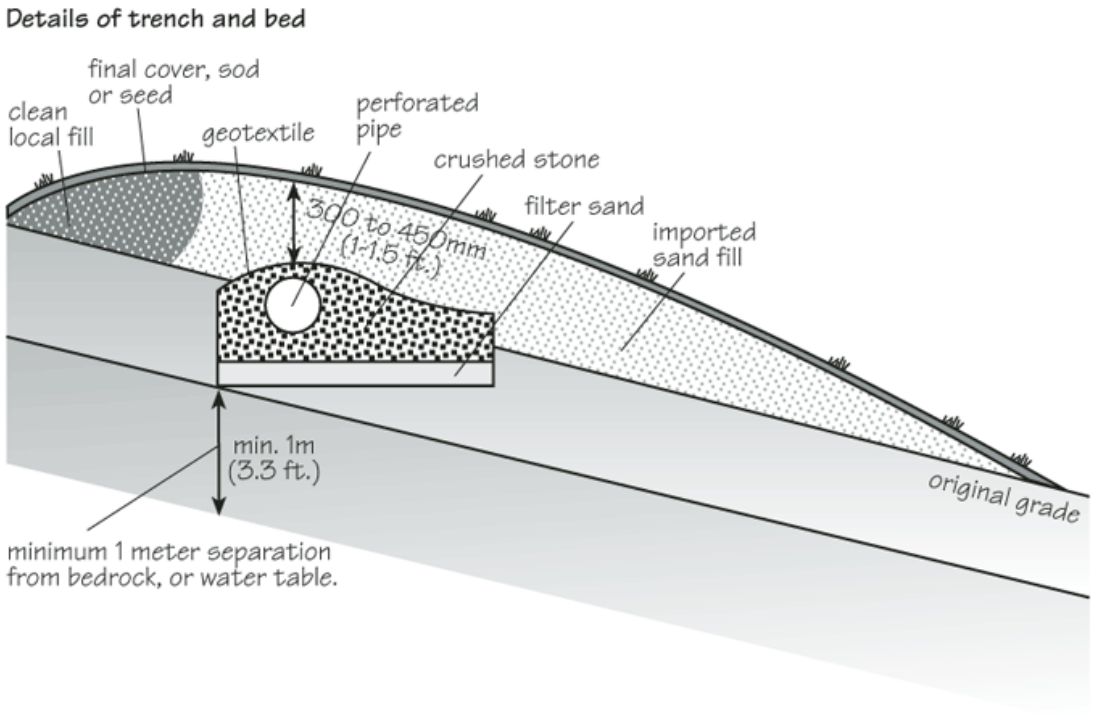
Onsite -- Black-Gray Water Separation

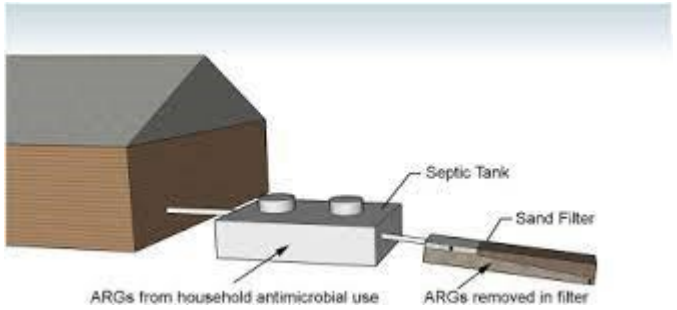
- Potential black-water separation (40 gpd vs 250 gpd)
- Wetlands-sand/gravel mound
- Black Water Septic Tank
  - 400 gallons or less
- Black Water Wetland Treatment
  - 6’ x 14’ area, HRT 8 days
- Spray irrigation of gray water
  - New 2020 option in AL
  - < 500 gpd (no NPDES permit)

Onsite -- Lateral Flow Sand Filter

Sand mound-type system

Uses capillary action to move water up and out for evapotranspiration





Several Ongoing Collaborative Activities

- Formed Consortium for Alabama Rural Water and Wastewater
  - Universities, ADPH, ADEM, USDA, Gov. office, Congressional
  - Offices, trade associations, private companies, community organizations

- UNLEASH Hack – Sanitation in Black Belt Alabama
  - Unleash.org June 5 and June 12 ….online

- Lowndes County Unincorporated Wastewater Pilot Project
  - lcuwp.org
  - ADPH with USDA funding
  - Repair/install 100+ failing onsite systems

Part III: Challenges Encountered: The Lowndes County Unincorporated Wastewater Program (LCUWP) Lowndes County, Alabama

Sherry Bradley, M.P.A., Director
Alabama Department of Public Health
Bureau of Environmental Services

Lowndes County Unincorporated Wastewater Program (LCUWP)

Background

- Regulatory Bureau
- December 2017 UN representative visited rural Lowndes County (“I think it's very uncommon in the first world…”)
- New State Health Officer
- Prior meetings futile

2018 Meetings and Donations

- First Meeting, January 12, 2018 – 5 Lowndes County citizens attended

Lowndes County Unincorporated Wastewater Program (LCUWP)

Congresswoman Terri Sewell Meeting

- Introduced bills for wastewater disposal
- USDA Water and Waste Disposal Grant Application
- USDA Conditions:
  - 75% - 25% Grant
  - Do not compete with municipalities
  - Local legislation needed – Lowndes Co. Commissioners
  - Buy-in by homeowners – $500 or $1000 /$20.00 per month
  - Sewer Board Utility – Attempts with Lowndes Water Authority

Lowndes County Unincorporated Wastewater Program (LCUWP)

Bureau of Environmental Service

- Maintenance for LCUWP – AWOB - Enforcement
- June 19, 2019, LCUWP Sewer Board created
- Engineer Firm – Land Surveyors
- Complexity of the USDA application – 2 1/2 years
- Budget Expert (100 homes – 175 homes)
- One (1) person donated funds for LCUWP
- December 2020 – met 25% match ($695,749.00)

Lowndes County Unincorporated Wastewater Program (LCUWP)

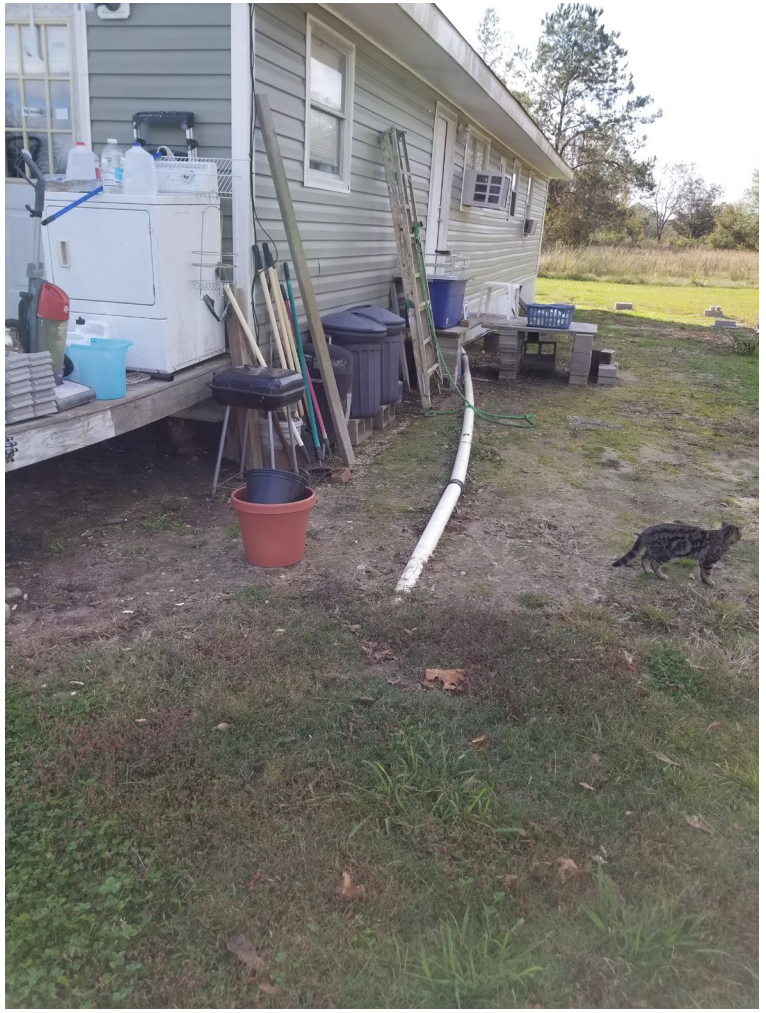
Back-End Concerns

- Residents not wanting to change from straight-piping
- No donations from Lowndes Co political leaders
- Heir property/Lots too small – ½ acre for engineered design systems
- Homes located on wrong property line
- Onsite system cost more than the dwelling
- Make-shift systems that keep sewage off the ground
- Impersonators of the LCHD
- $20 payment – Can't pay
- Some don't want the Program to succeed
- LCUWP Administrative cost needed – Attorney/Clerk/Insurance/etc

Straight Pipe 3’Deep – Child Hazard

Property Line Issues

Gray Water Positive Outlet



Water Table Contamination

Onsite System is more expensive than the dwelling

Two days after a rain (Impermeable Soil)

Homemade Sewage Treatment – 55 Gallon Drum Illegal Installations/Repairs

Results - Black Water Surfaces

Questions?