Quantifying Soil Suitability and Affordability of Septic Systems using Alabama State-Specific Analysis

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2026 ONSITE WASTEWATER MEGA CONFERENCE
Westminster, Colorado

AUBURN UNIVERSITY

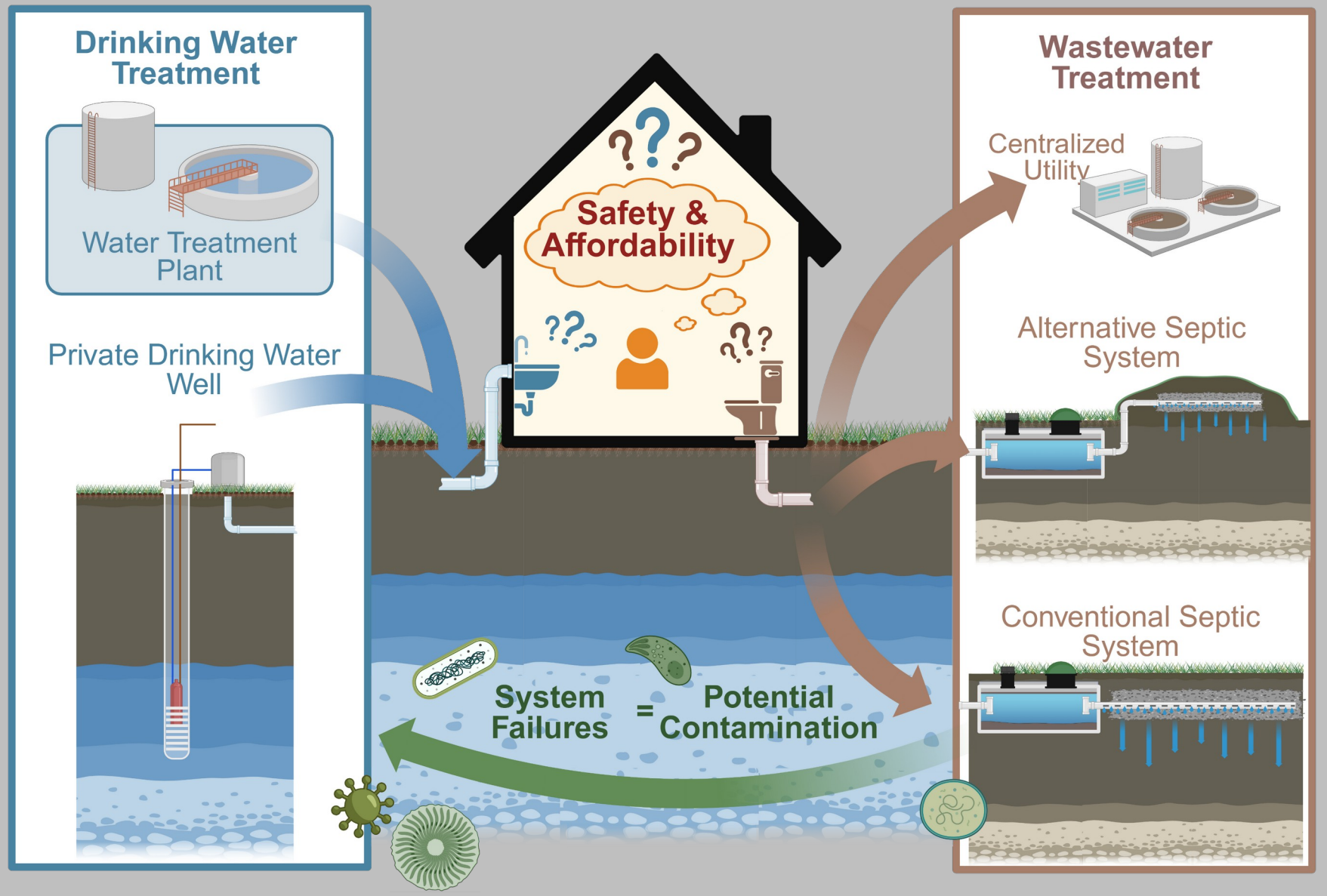
WATERS
WATER AND THE ENVIRONMENT'S RESILIENCY AND SUSTAINABILITY

The materials being presented represent my own opinions, and do NOT reflect the opinions of NOWRA.

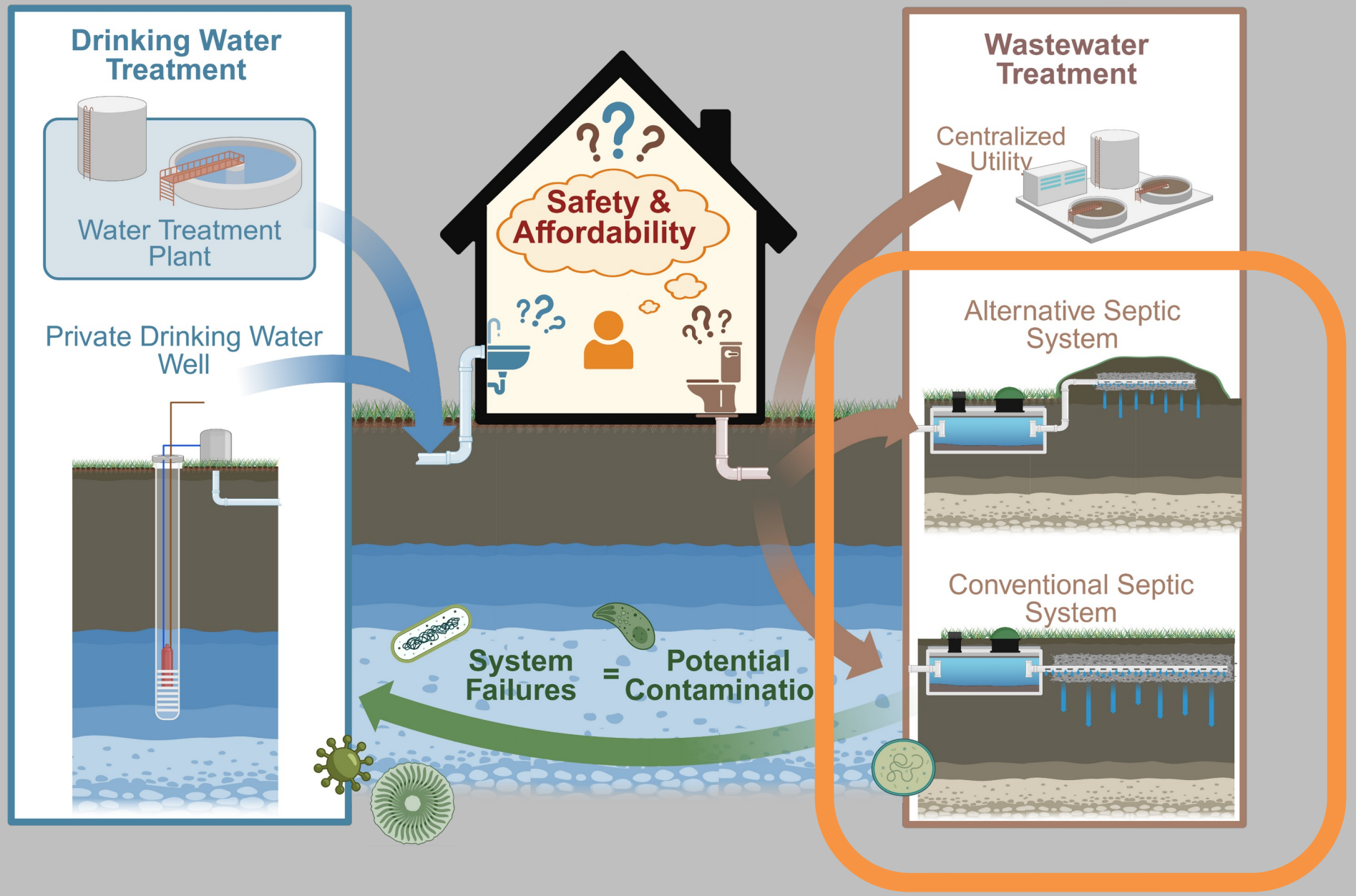
What affects septic system costs

Affordability challenges?

Soil suitability for septic systems?


Drinking Water Treatment
Water Treatment Plant
Private Drinking Water Well
Safety & Affordability
Wastewater Treatment
Centralized Utility
Alternative Septic System
Conventional Septic System
System Failures
=
Potential Contamination

4


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Water Treatment Plant
Private Drinking Water Well
Safety & Affordability
Wastewater Treatment
Centralized Utility
Alternative Septic System
Conventional Septic System
System Failures
=
Potential Contaminatio

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Background

- “Promote prosperity while protecting the planet” (United Nations, n.d.)
- Safety
  - On premise
  - Available
  - Uncontaminated
- Affordability
  - Not defined by United Nations (UN)



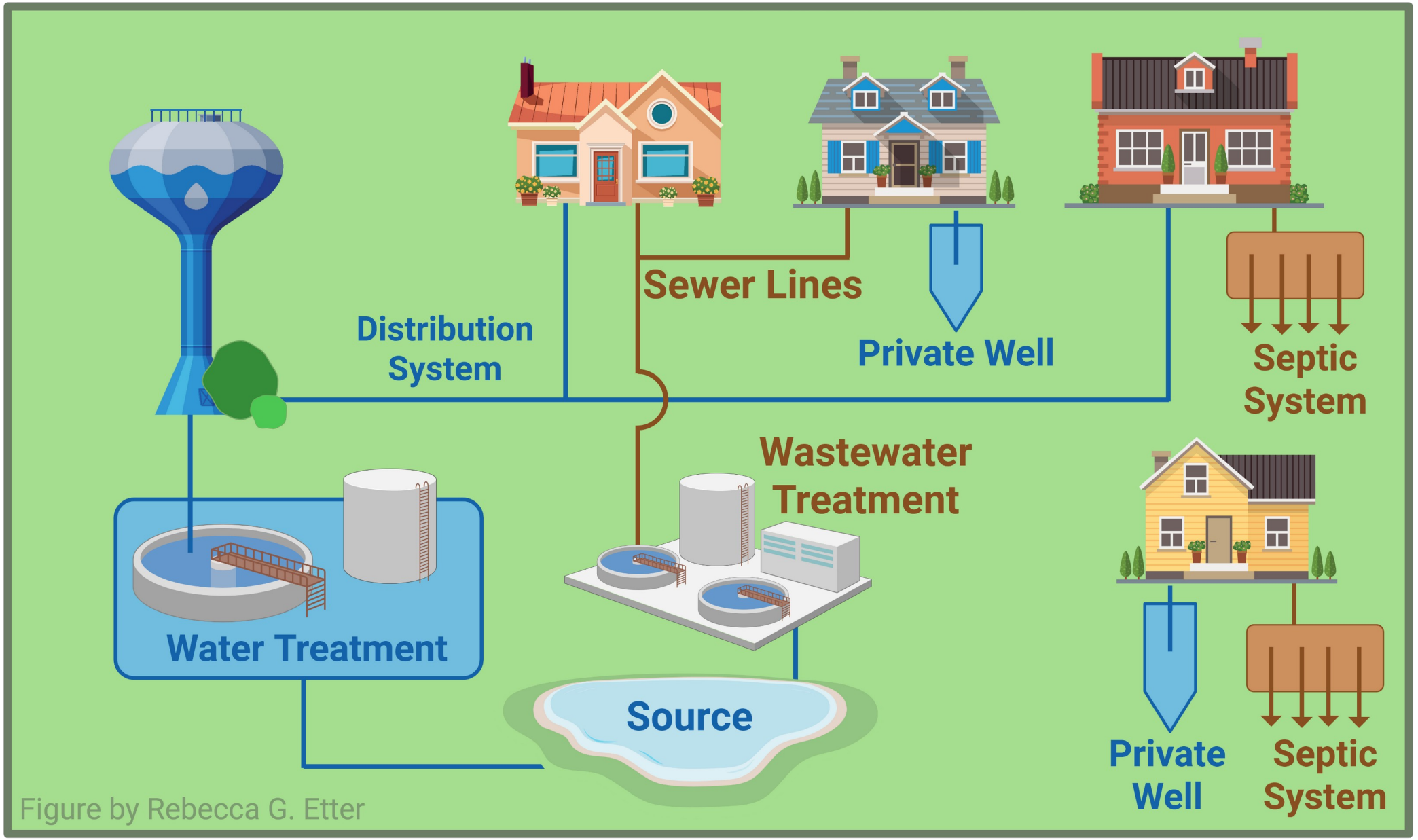
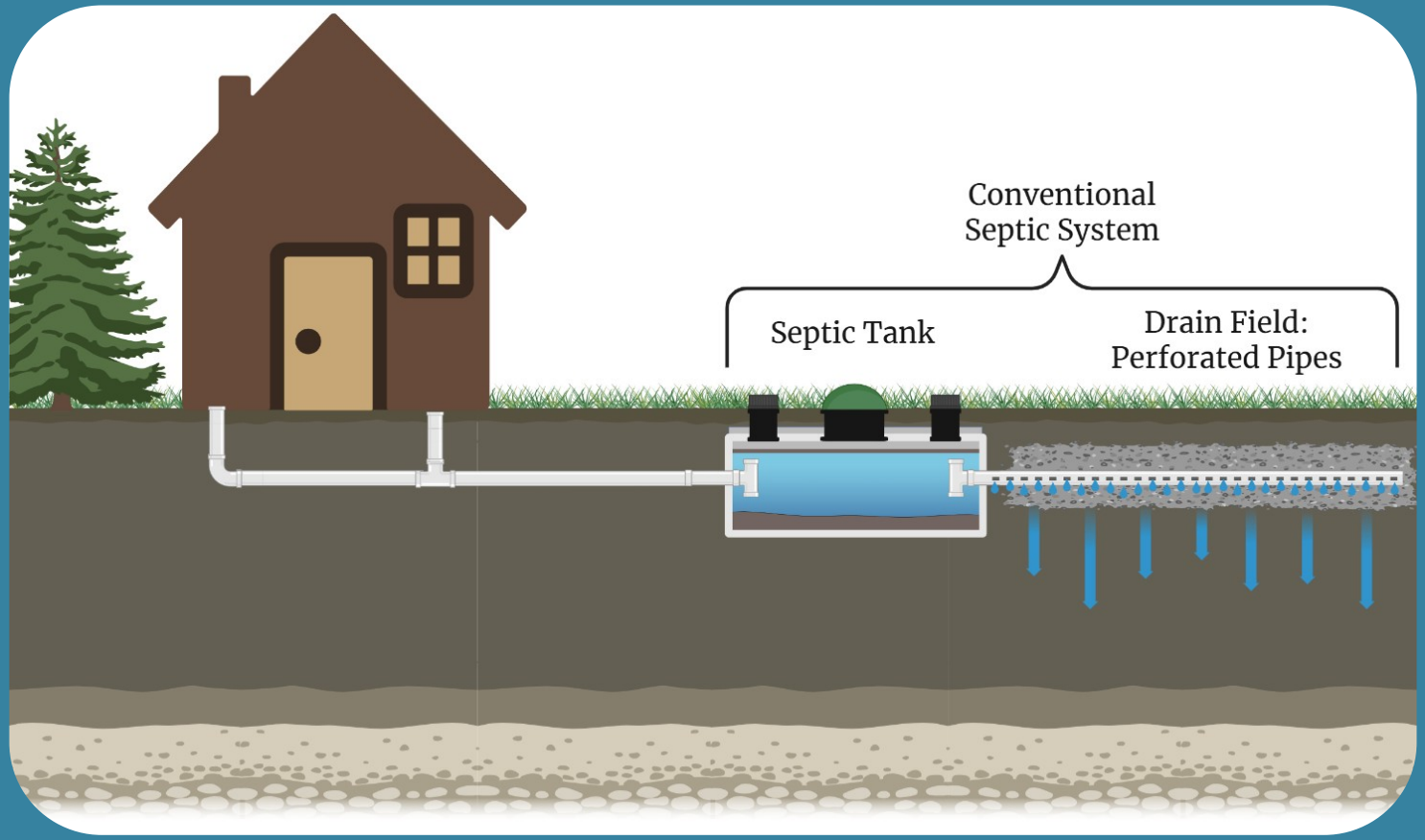


Figure by Rebecca G. Etter

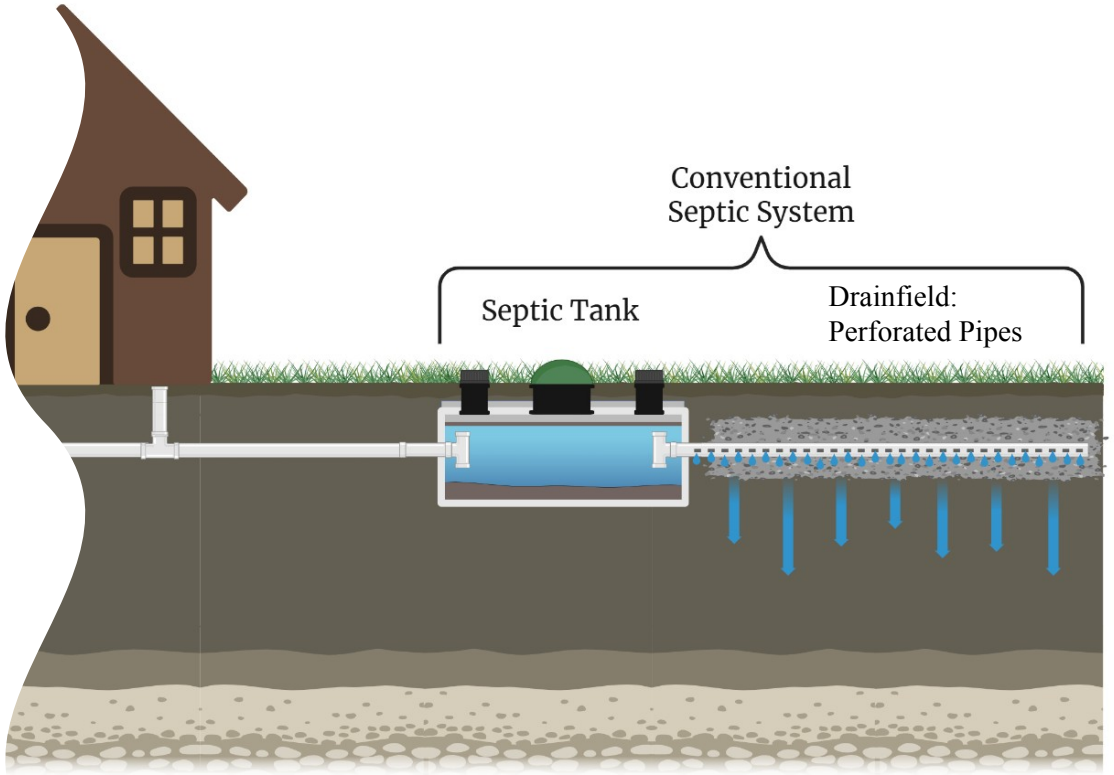
Background: Septic Systems

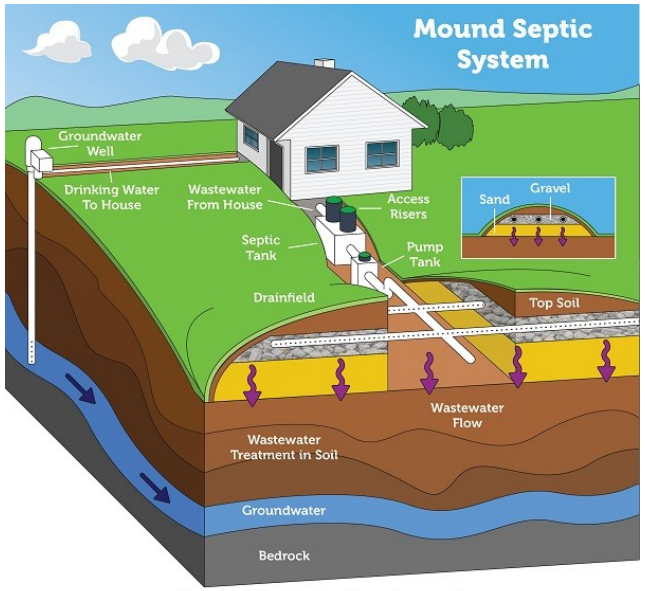
- Used for wastewater treatment when centralized systems are unavailable
  - May cause pollution (private well contamination) if improperly functioning



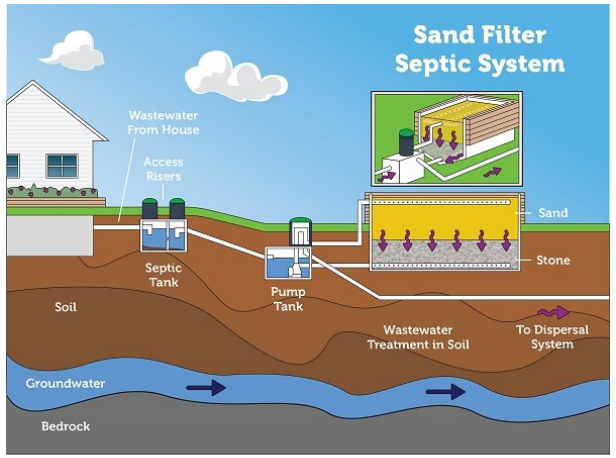
Background: Septic Systems

- Types of systems
  - Conventional (**$8,000**)
  - Alternative/Engineered
    (**$8,350-$34,000 and UP!**)

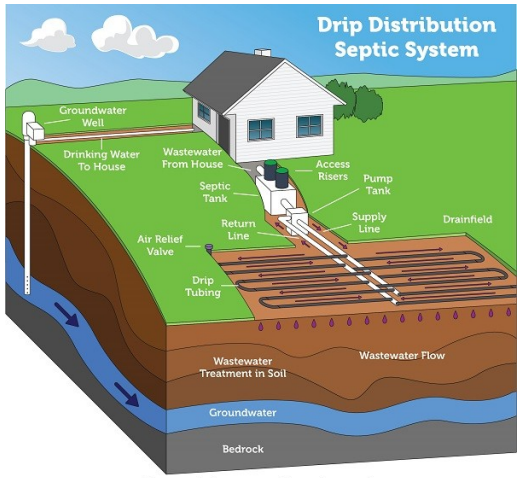




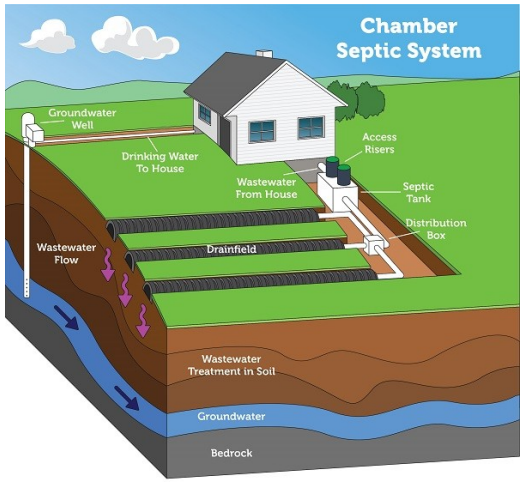
Please note: Septic systems vary. Diagram is not to scale.



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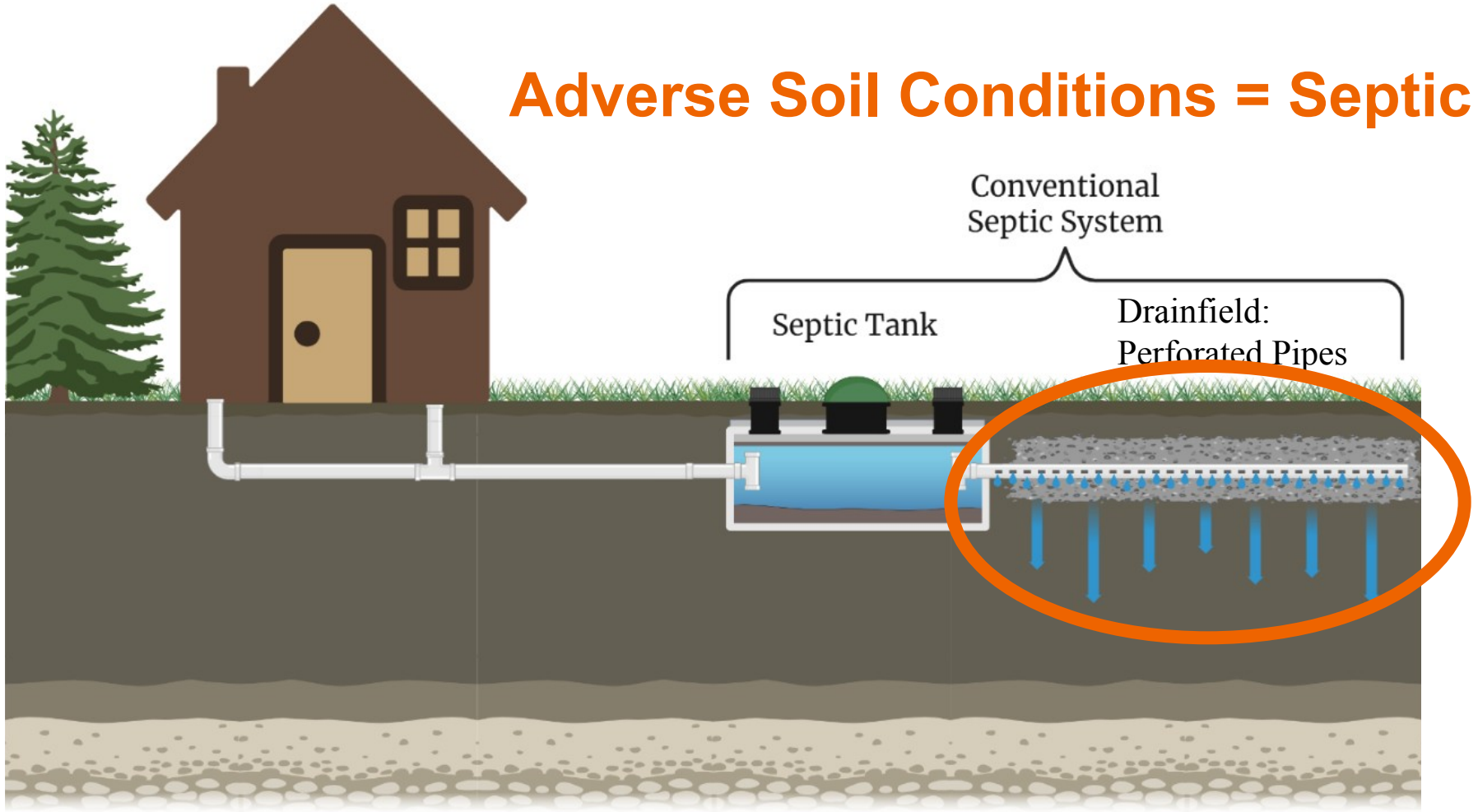


Please note: The ends of the chamber system lines are open for illustrative purposes only. In reality, and when properly installed, these lines are closed at the end. Septic systems vary. Diagram is not to scale.

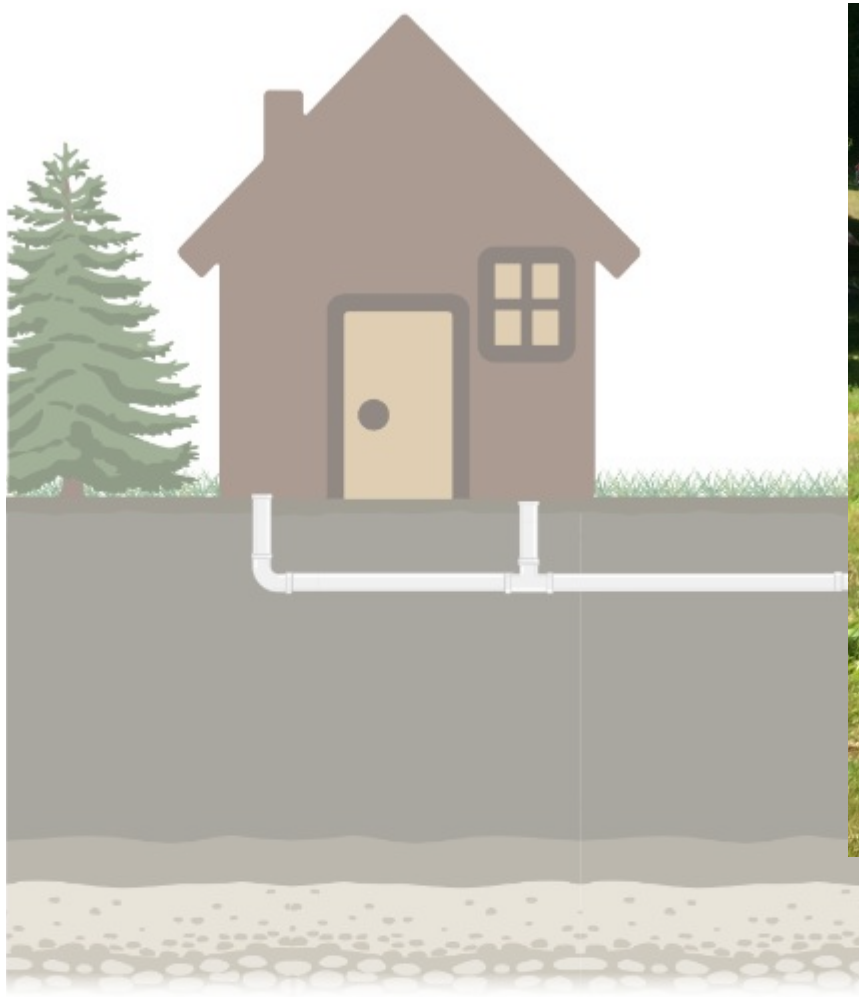
(United States Environmental Protection Agency, 2026)

Background: Conventional Septic Systems

Adverse Soil Conditions = Septic Failure



Background: Conventional Septic Systems





Background: Straight Piping

- Inability to pay for system replacement/repair
  - Conventional Septic
    - Average cost: $8,000
  - Alternative/Engineered Systems
    - $8,350 - $34,000 (and up)
    - Leads to straight piping



(Maxcy-Brown et al., 2024; Vedachalam et al., 2011; Ohio Department of Health, 2008; Rudman et al., 2023)

Background: Straight Piping

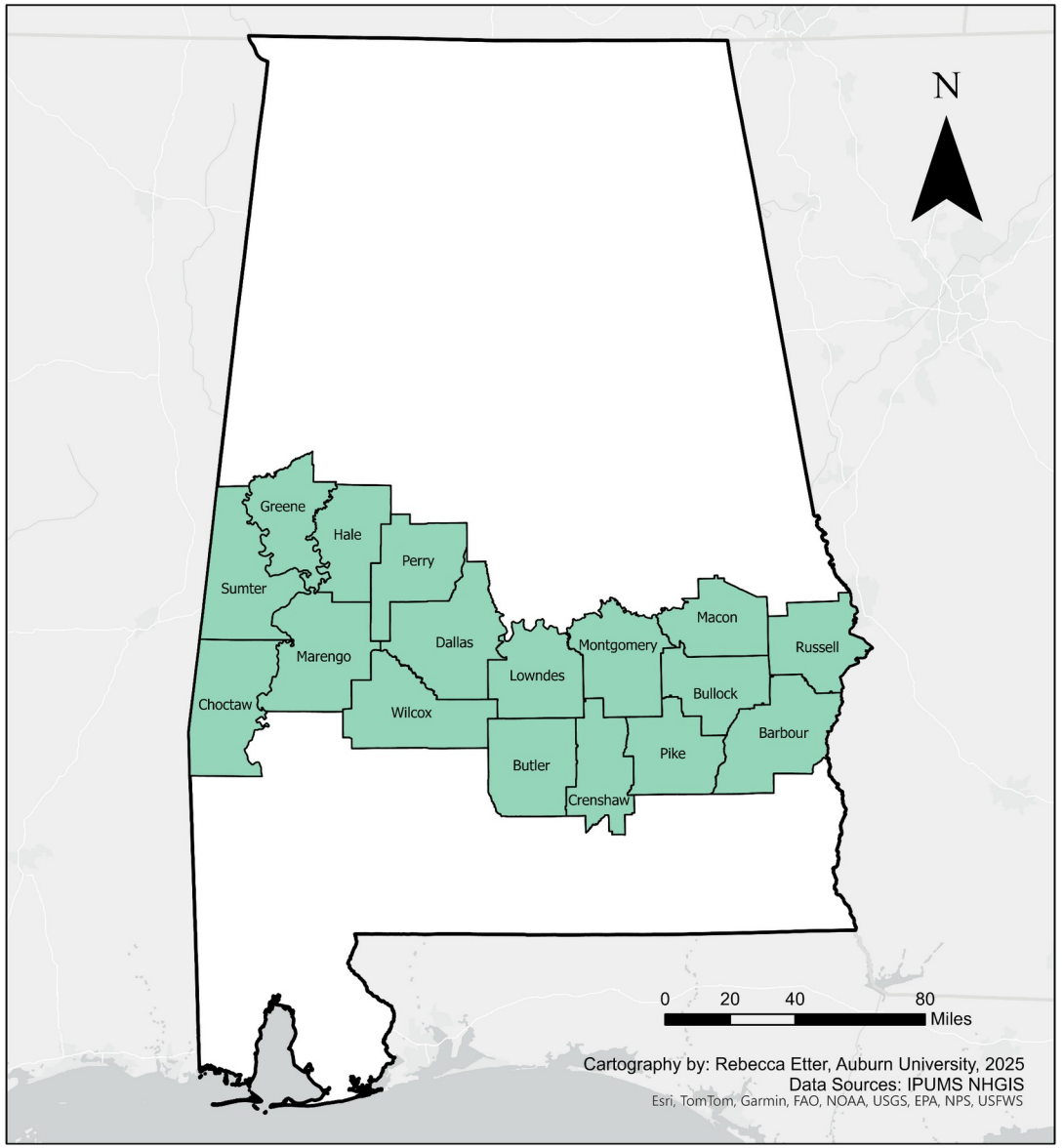


Background: Equity

- Communities of color are often excluded from utility access and equitable loan options
- Consequences
  - Increased health risks
  - Affordability concerns
- Social and environmental justice concerns abound for **underserved** and **underrepresented** populations

Background: Alabama Black Belt

- For this study:
  - 17 counties
  - Characteristics:
    - Dark prairie soil, **poorly draining**
    - Few centralized sewer systems
    - Low socio-economic status



(UA Center for Economic Development, n.d.; Dexter 2021)

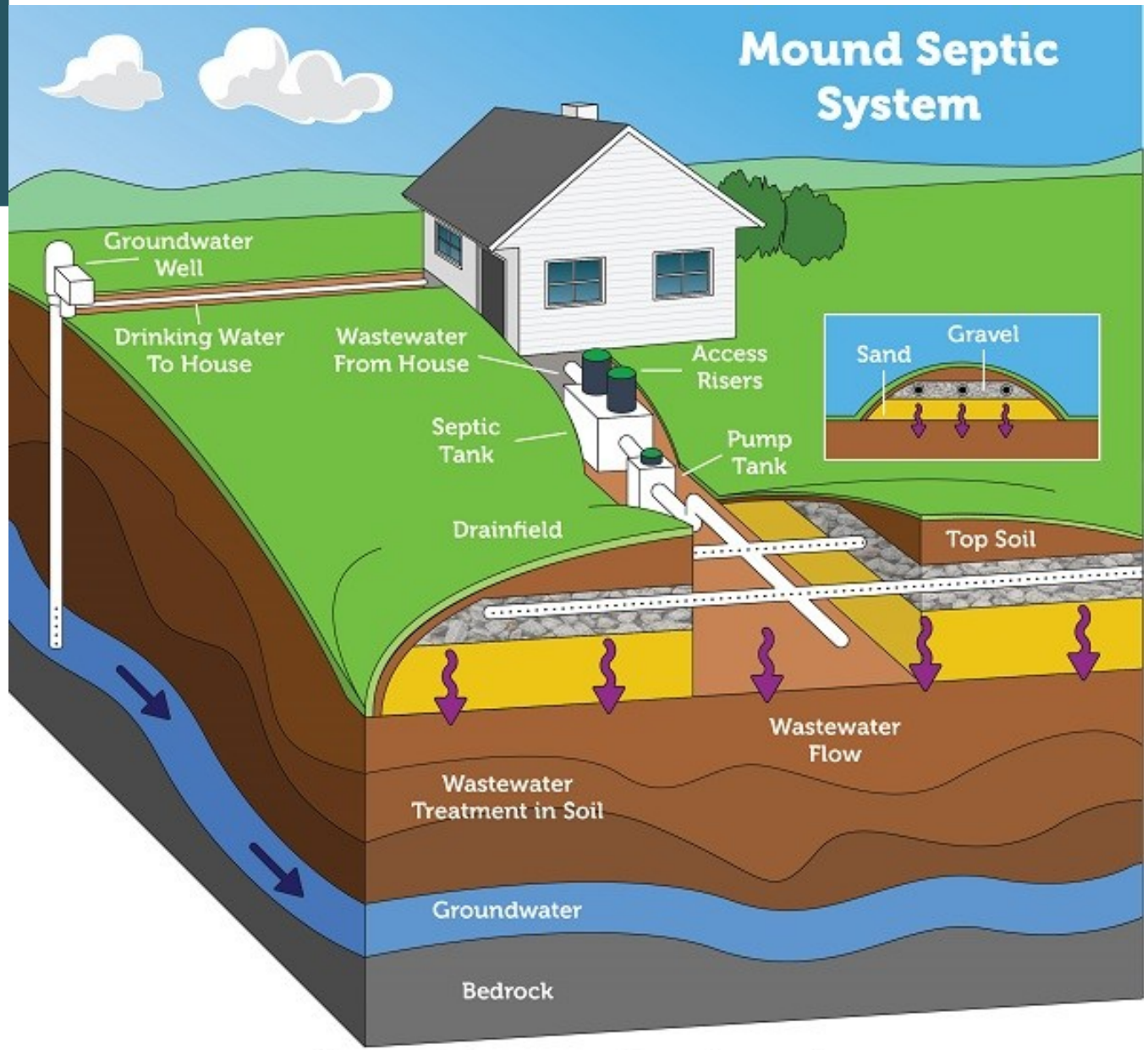
Objectives

Quantify septic suitability and affordability:

1. Apply Alabama Department of Public Health (ADPH) metrics for suitability
2. Evaluate differences between state regulations and the existing national metrics
3. Analyze affordability burden for the usage of conventional and alternative septic systems.

Objectives

- First affordability study to calculate affordability with state-regulation-specific metrics
  - Statewide study area
  - Based on ADPH regulations



Methodology: Data Sources

- Soil Survey Geographic Database (SSURGO)
  - Database of soil properties
  - Created by the National Cooperative Soil Survey through observations and lab analysis
- Soil Properties of Interest
  - Existing septic suitability
  - For creation of state specific suitability:
    - Soil permeability
    - Depth to average seasonal high extended saturation
    - Slope
    - Potential for frequent flooding
    - Presence of surface saturated soils

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Methodology: Data Sources

- Soil Properties
  - SSURGO
- Distance to underground features
  - Geological Survey of Alabama
- Septic serviced population
  - Maxcy-Brown et al. (2024)
  - NPDES permits

Soil Suitability

Soil Survey Geographic Database (SSURGO)

Alabama Department of Public Health (ADPH)

Property	SSURGO†*	ADPH†
Filtering Capacity	Highest soil conductivity	Low and high percolation rates
Flooding	Flooding frequency	Flooding frequency
Large Stones	Concentration of rock fragments	Bedrock, massive structures, fragipans, mine spoil, etc.
Restricted Permeability	Lowest hydraulic conductivity	Permeability
Ponding	Standing water	Swamps, wetlands, etc.
Bedrock	≤ 100 cm	Depth based on limiting permeability
Cemented Pan	≤ 100 cm	Tilted or variable depth to bedrock
Slope	<15%	<26%
Subsidence	≥ 60 cm	Caves, sinkholes, etc.
Saturation Depth	< 120 cm	Depth based on limiting permeability
Seepage	≥14 µm/sec	Not Included
Unsuitable Fill	Land reclamation, stone fragments, etc.	Low permeability, brittle horizons, mine spoil, etc.

†Suitabiltiy is determined based on the most limiting soil type present onsite.
*SSURGO considers null values (e.g., blanks) to be non-limiting for septic suitability.

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Methodology

- Suitability
  1. Existing SSURGO Suitability
  2. State-Specific Suitability: Majority of Information Available
  3. State-Specific Suitability: All Information Available
- Affordability

Conventional Method	Income Bracket/Affordability Threshold

Methodology

Conventional Method

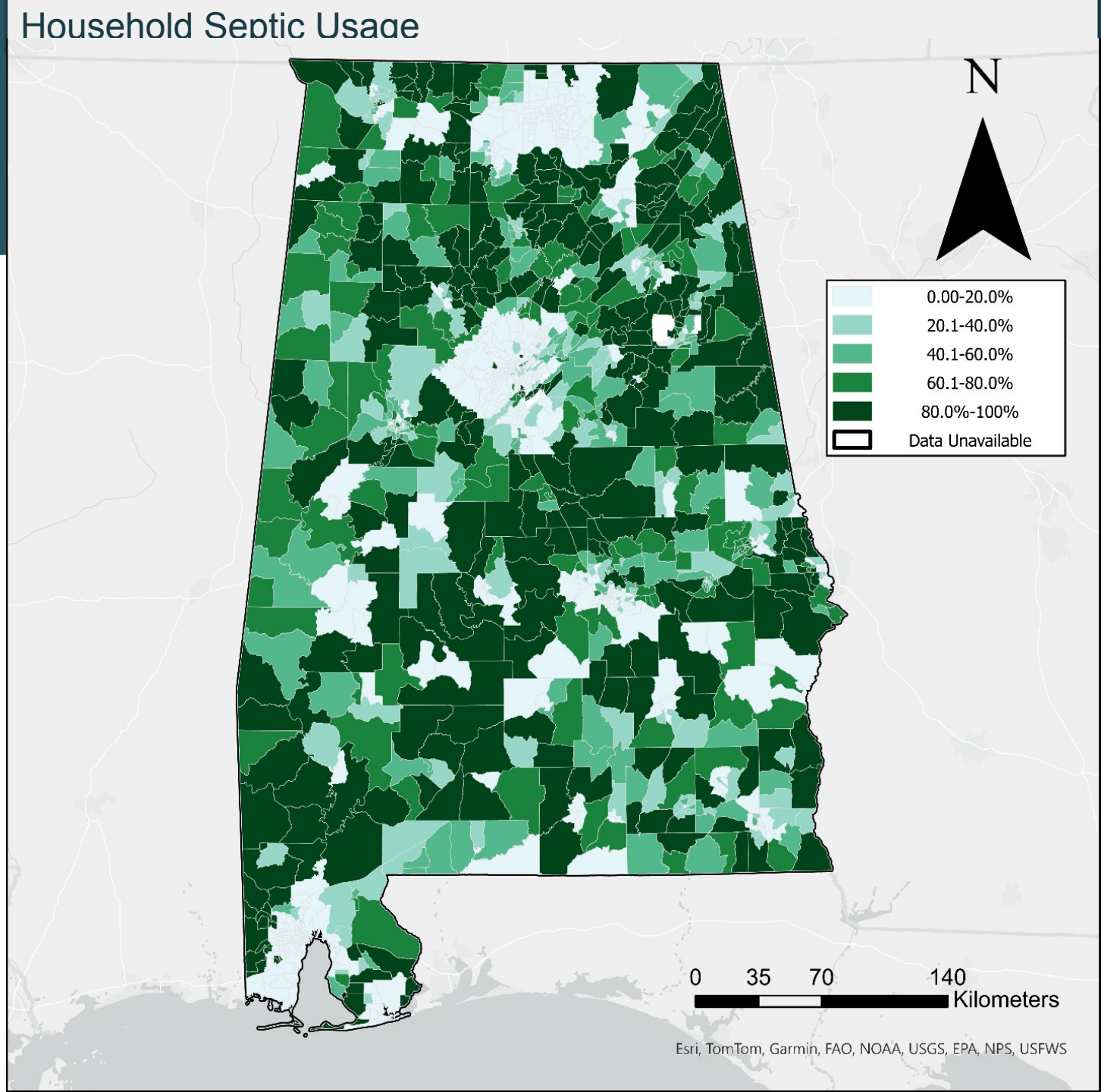
- Affordable if <2.0% of Median Household Income (MHI)

Income Bracket/Affordability Threshold

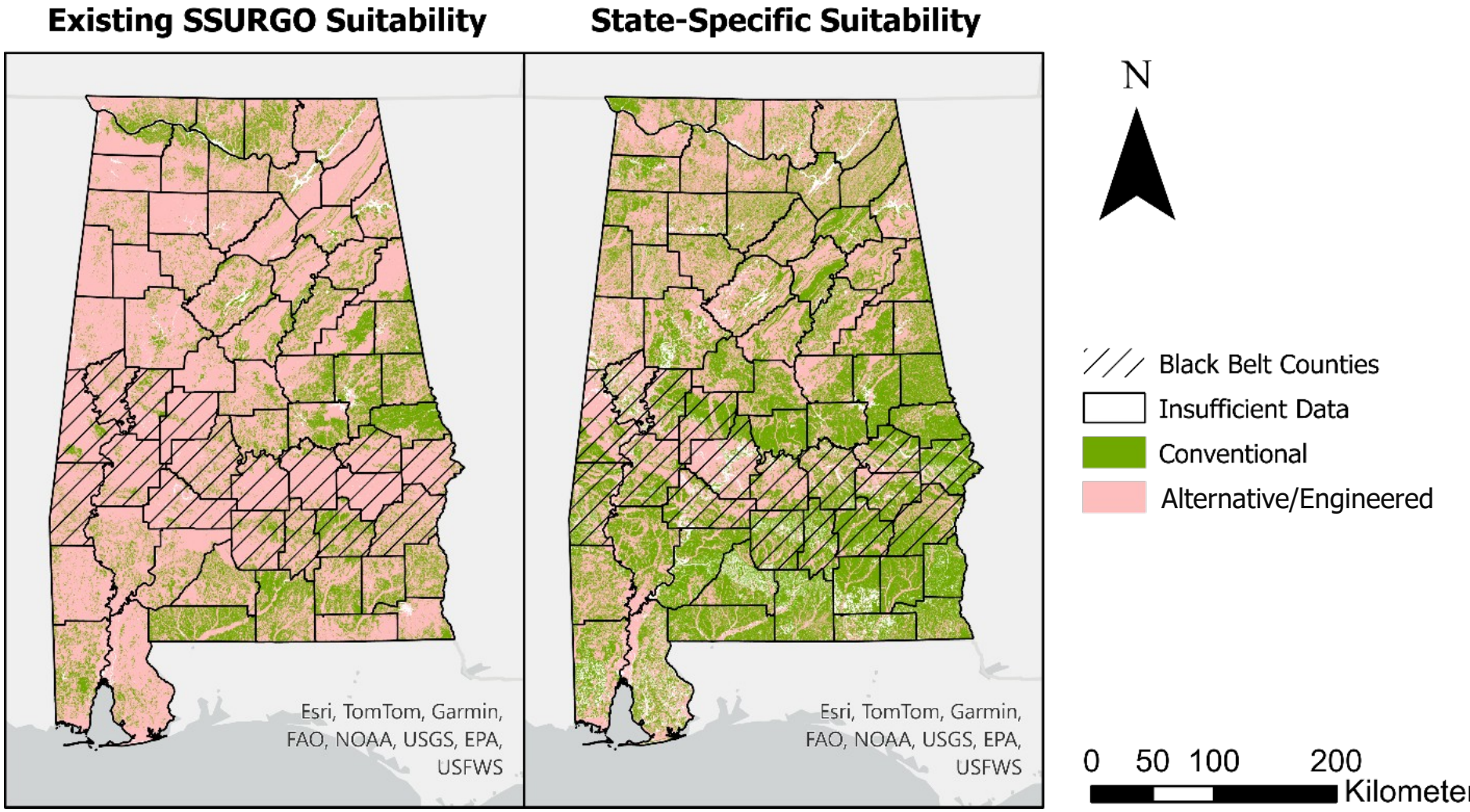
- Percentage of Households with Income Beneath Threshold determined by 2.0% MHI

Results and Discussion: Septic Usage

- Septic usage:
  38% of AL households



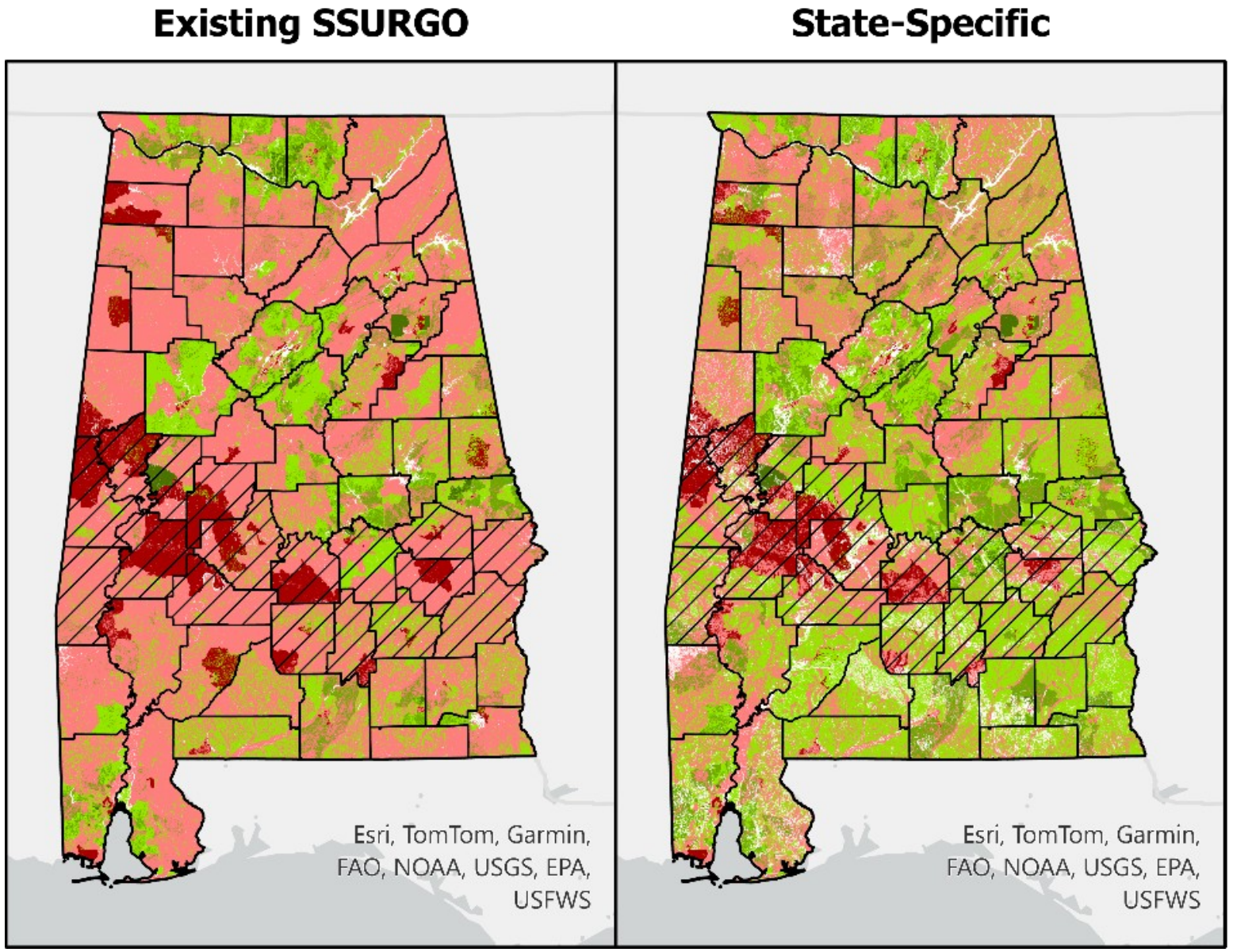
Results and Discussion: Suitability



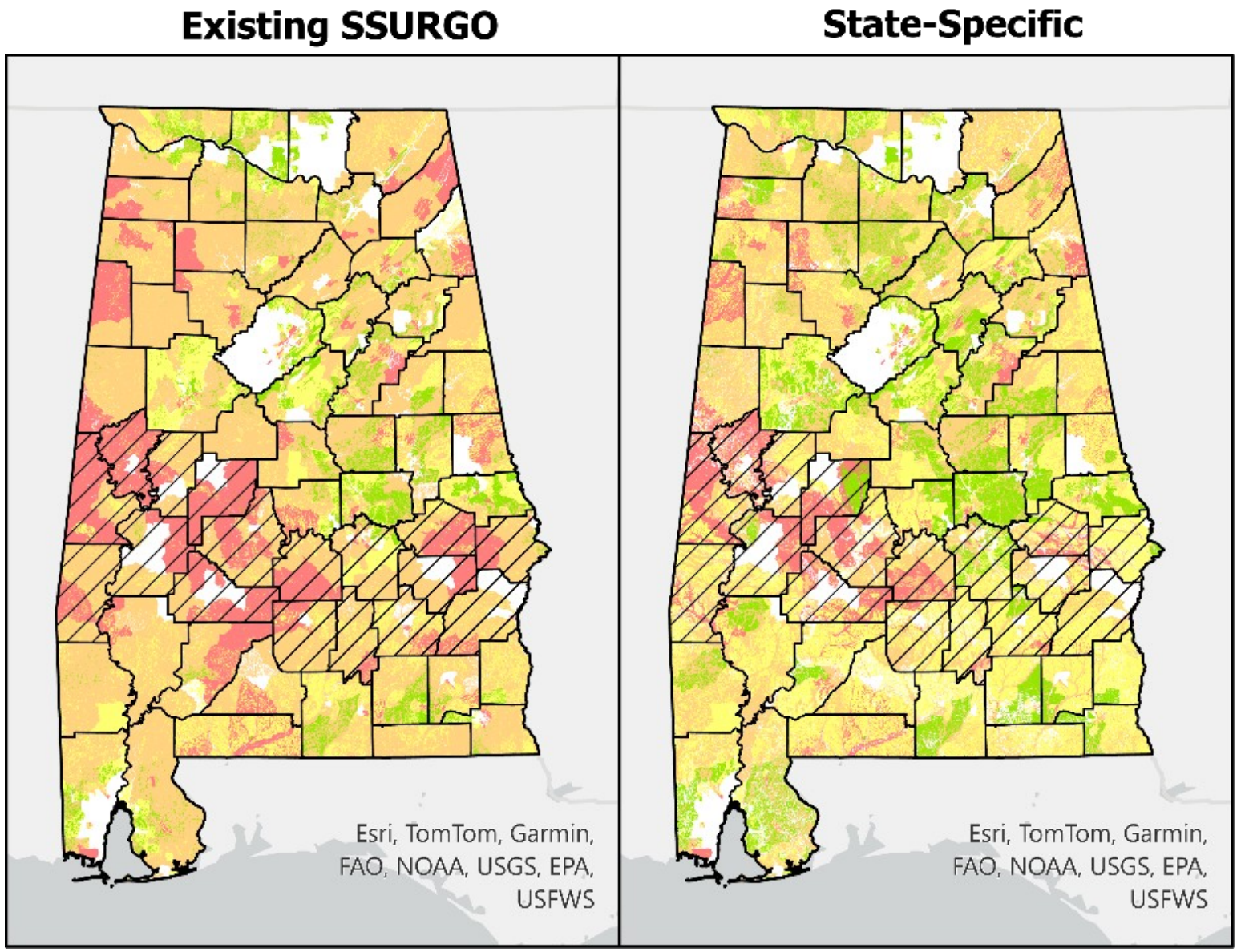
Results and Discussion: Suitability

	System Type	Area (mi^2)	Area (%)	Area Difference from Existing SSURGO Metric (mi^2)	Percent (%) Difference from Existing SSURGO Metric
Existing SSURGO Metric	Insufficient Data	2,011	3.8	0	0%
	Conventional	9,985	19.0	0	0%
	Alternative	40,423	77.1	0	0%
Majority	Insufficient Data	5,276	10.1	3,265	162%
	Conventional	22,760	43.4	12,776	128%
	Alternative	24,383	46.5	-16,041	**-40%**
All	Insufficient Data	51,076	**97.4**	49,065	2440%
	Conventional	-	0.0	-9,985	-100%
	Alternative	1,343	2.6	-39,081	-97%

Results and Discussion: Percent Median Household Income



Results and Discussion: Income Threshold



Unaffordable Households (Income Threshold): 44.1%-51.9%

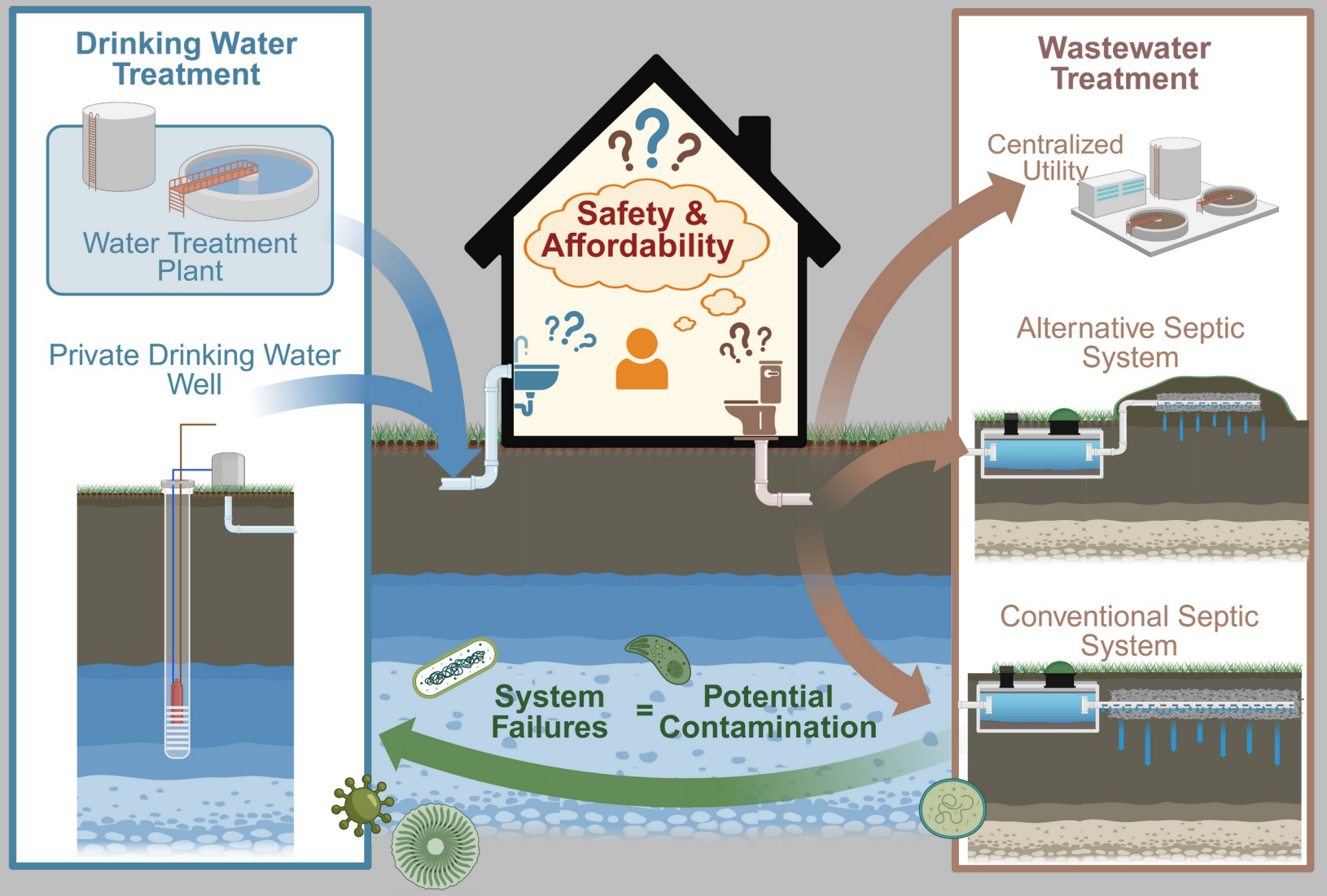
Conclusion and Recommendations

- Existing SSURGO over predicts:
  - Need for alternative systems
  - Affordability challenges
- Overextends funds for mitigation
  - Less effective mitigation measures over large areas
- State specific metrics:
  - Guide research for improving septic technologies
  - Determine areas of unaffordability
  - Plan funds for mitigation

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Thank You

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