Analyzing the Affordability of Wastewater Management for Onsite Wastewater Treatment Systems and Sewer Networks in Alabama

Jillian Maxcy-Brown

Co-Authors: Mark Elliott, Mark Barnett, Lacey Christian, and Katie Krummen

Clean Water for Healthy Communities

Onsite Wastewater Mega-Conference | 2023 Hampton, Virginia

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Biography

- Ph.D. in Civil Engineering from The University of Alabama in August 2023
  - Dissertation: *Wastewater Access and Affordability Challenges in the U.S.: The Current Situation and Proposed Solutions for Equitable Access to Safely Managed Sanitation*
  - Advisor: Dr. Mark Elliott
- B.S. in Engineering, Civil Concentration (Water Resources Emphasis) from LeTourneau University in May 2019
  - Minor: Cross-Cultural Studies

History of Water and Wastewater Affordability in the U.S.

- Few studies on water and wastewater affordability in U.S.
  - Focus on national scale
  - Do not consider users of OWTS
- Federal investments
  - Decreased after 1970s
  - Shifted from grants to loans
  - 2021 American Rescue Plan Act (ARPA) and Bipartisan Infrastructure Law (BIL) changed landscape

EPA Affordability Threshold

- 1996- Safe Drinking Water Act (SDWA) Amendment requested EPA to establish national affordability threshold
- 1998- EPA released approach to use 2.5% of median household income (MHI) for drinking water
- 2002/2003- Two EPA Advisory Committees offered comments
- 2006- EPA proposed revising threshold
  - Met with criticism
  - Appeared to favor large public water systems
- Today- No finalized revisions

- Wastewater
  - 1997- 2.0% of MHI suggested in EPA's Report "Combined Sewer Overflows- Guidance for Financial Capability Assessment and Schedule Development"
  - Many studies assume this means 4.5% of MHI for combined affordability

Challenges with EPA's National Affordability Threshold

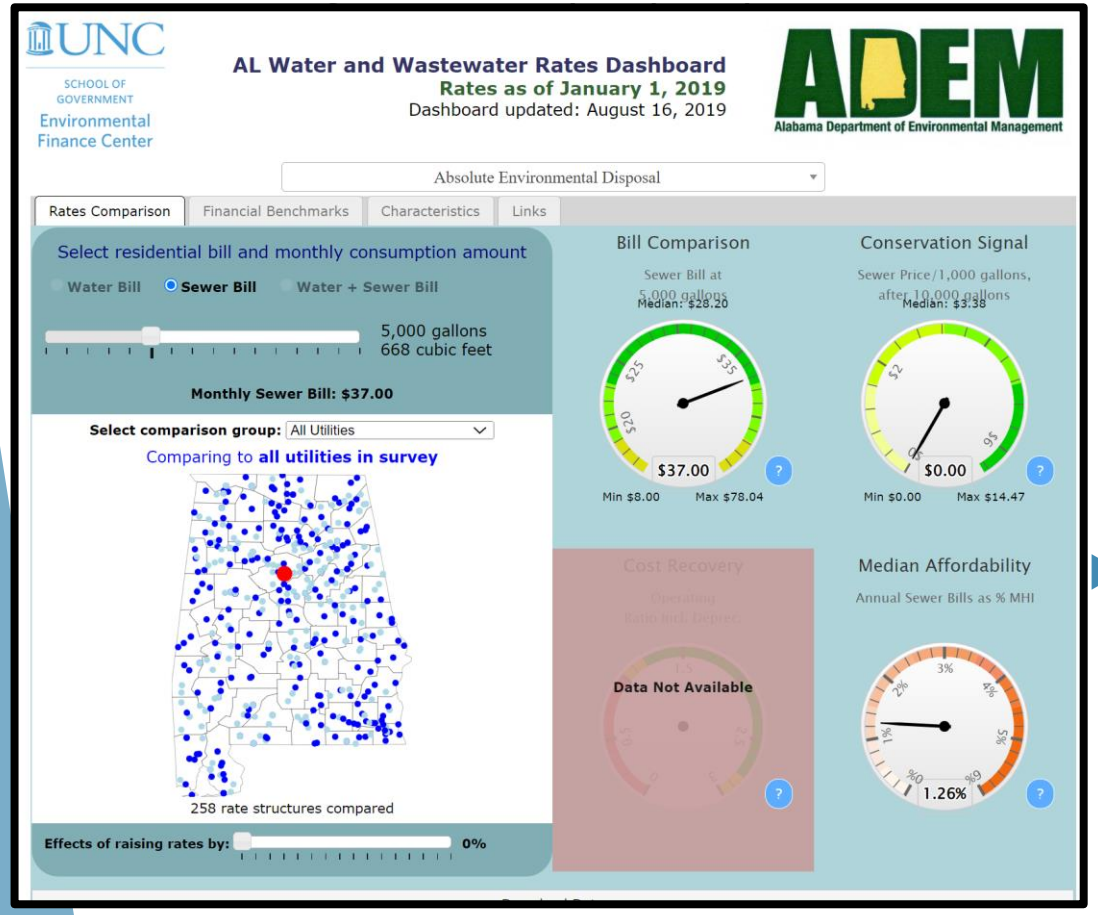
- Rough indicator of the economic capacity of communities to meet infrastructure costs
- Inability to give distinctions for system variability based on utility size or geographical region
- Favors large utilities (strong economies of scale for water systems)
- No clear conceptual framework → appears highly arbitrary

Importance of Including OWTS

- Typically in areas with low population densities (rural)
  - Also found in areas where development rate exceeds the rate of sewer system extensions
- Rural counties have higher rates of poverty
- 70% of OWTS permits are issued for new installations
  - Only 30% for repairs/replacements
  - Potentially indicates increases in OWTS usage
- Households must pay capital and ongoing costs
  - Lump sums

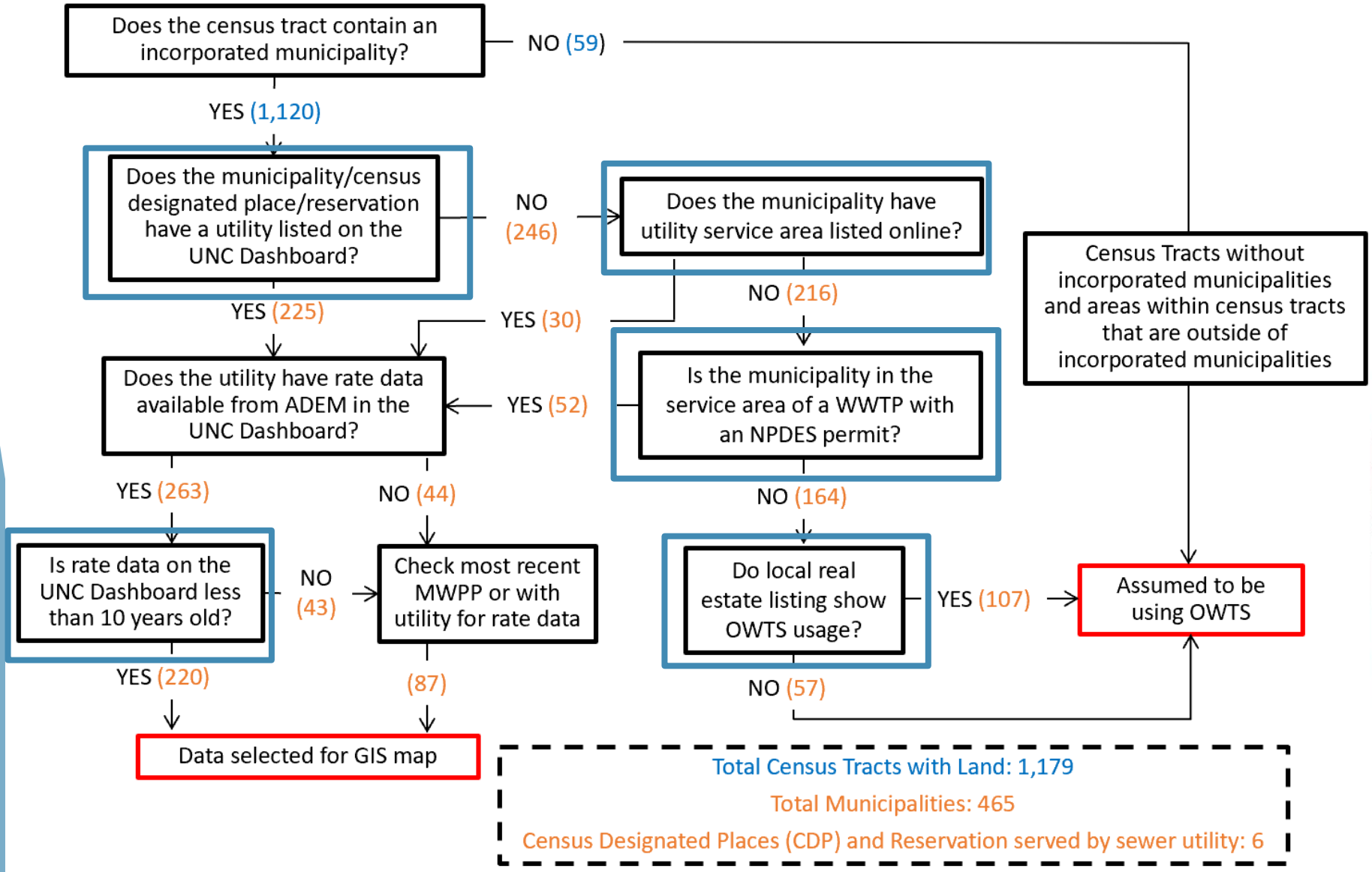
Project Methodology

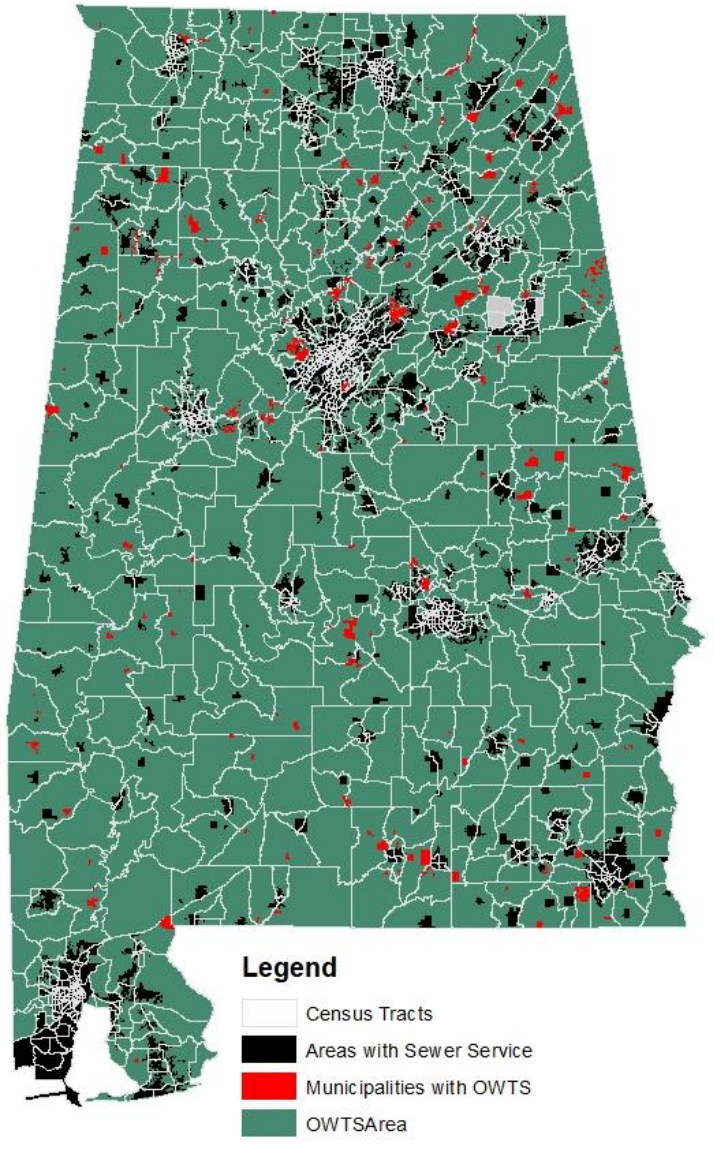
- Focus on Alabama



- Sewer Rate Data for AL
  - Utility Financial Sustainability and Rates Dashboard published by Environmental Finance Center at the University of North Carolina (UNC Dashboard)
  - Provided by the Alabama Department of Environmental Management (ADEM)
  - 222 Sewer Utilities
- 2019 Median Household Income Data from ACS

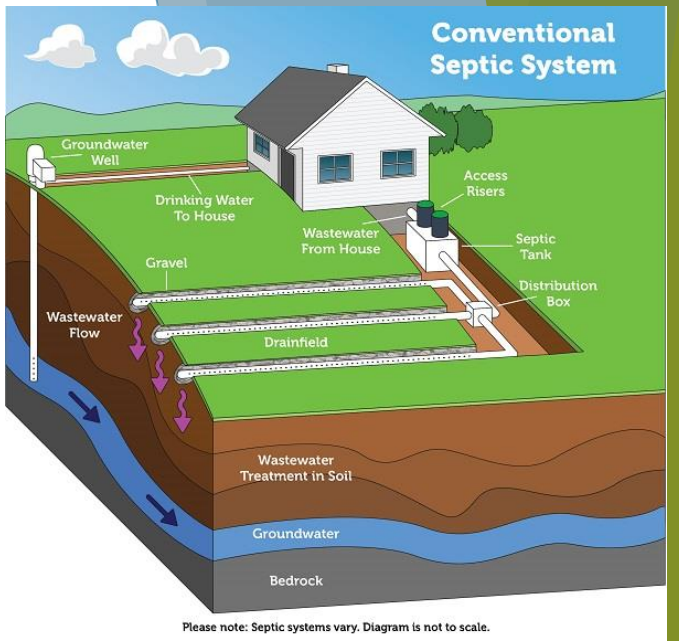
Wastewater Rate Data Collection





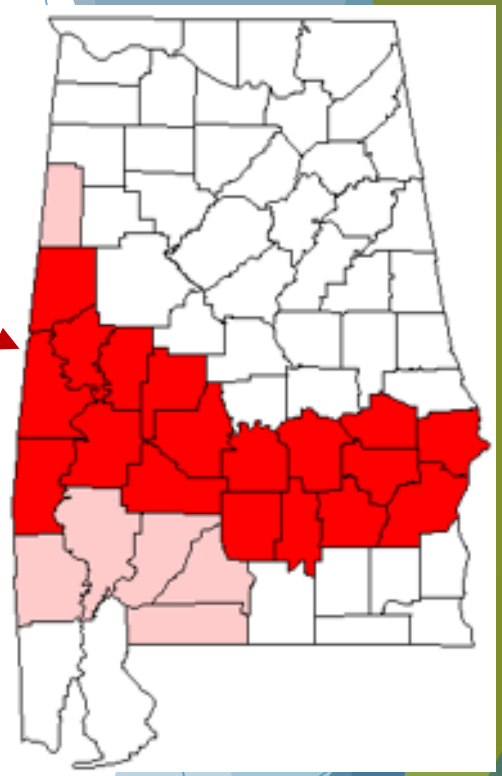
Onsite Wastewater Treatment Systems (OWTS)

- Assumed all households in AL are able to install conventional OWTS (estimated to cost $5,000)
  - The households in the Black Belt counties will need to install advanced mound systems (estimated to cost $20,000)
- OWTS have a tank that must be pumped every 5 years (estimated to cost $500 or $8.33 per month)
- **OWTS Cost represented as:**
  1. Monthly mortgage/loan payment + pumping cost
  2. Capital Costs as lump sum
  3. Pumping cost



Onsite Wastewater Treatment Systems (OWTS)- Black Belt Region

- Typically defined as **17 counties**
- Named for its fertile black topsoil & **impermeable clay**
- No water percolation into the soils—**septic tank systems do not work**



dry

wet

Estimated Monthly Loan Payments for OWTS

	Conventional Septic System	Mound Septic System
Cost of System:	$5,000	$20,000
Loan Term:	30 years	30 years
Monthly Loan Payment:		
Interest Rate:		
2.5%	$19.76	$79.02
5.0%	$26.84	$107.36
7.5%	$34.96	$139.84
7.75% National Average 1971-2023	$35.82	$143.28
10.0%	$43.88	$175.51
Monthly Expenses (loan payment + pumping costs):		
	$44.15	$151.62

GIS Mapping Methodology

- Shapefiles: polygons for census tracts and municipality/places boundaries for AL
- Projection: NAD 1983 State Plane Alabama East FIPS 0101 Feet

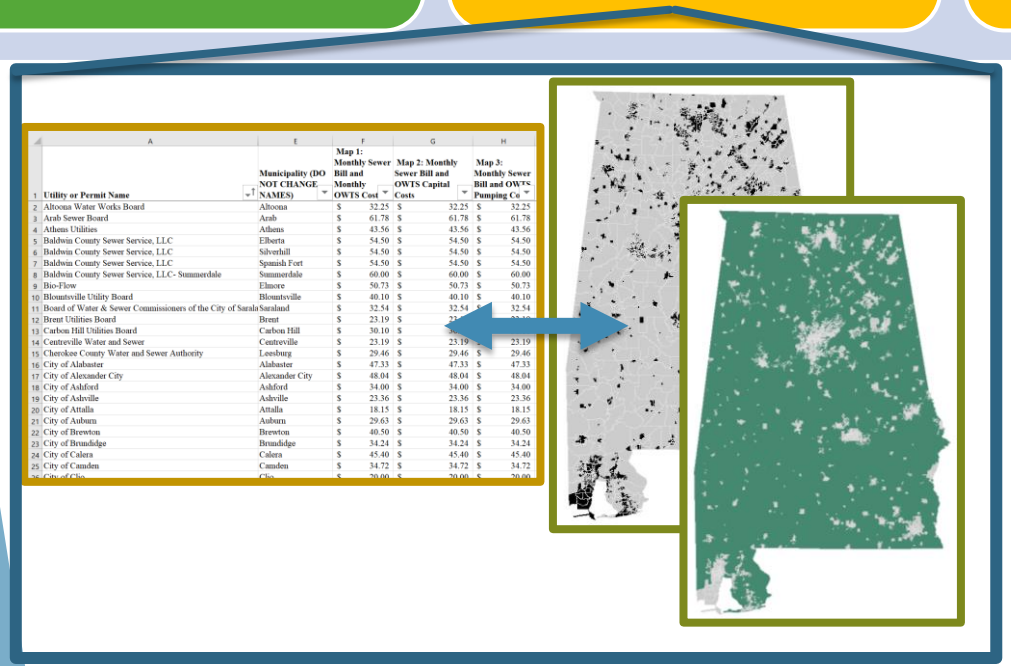
ArcToolbox conversion tool turns Microsoft Excel files (utility rate data and household income data) into tables compatible with ArcMap

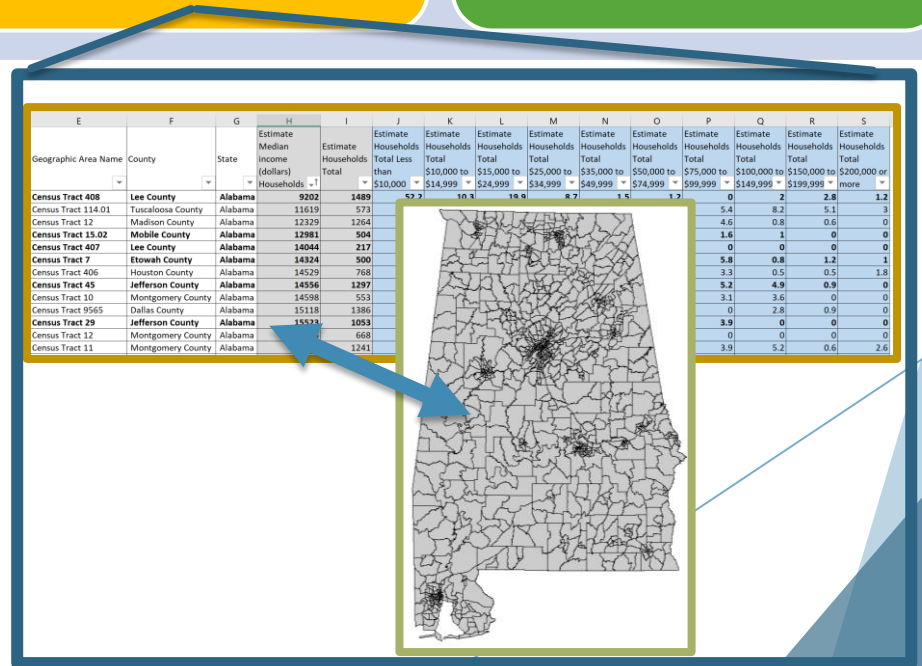
Join utility service area and rate table to the municipality polygons. Assign OWTS costs to all other areas.

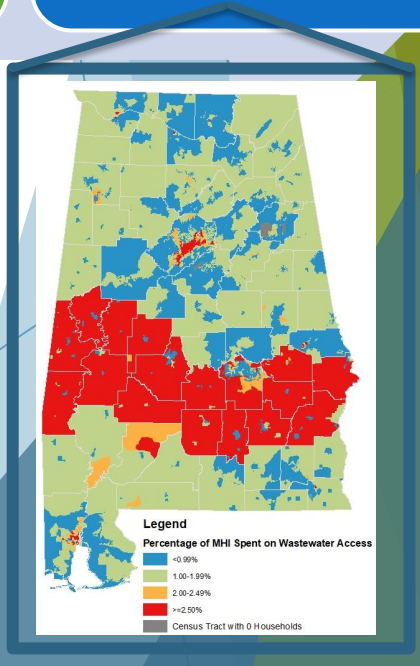
Join household income data with census tracts

Split polygons along the boundaries of the census tract to spatially associate the household income data with the utility rate data

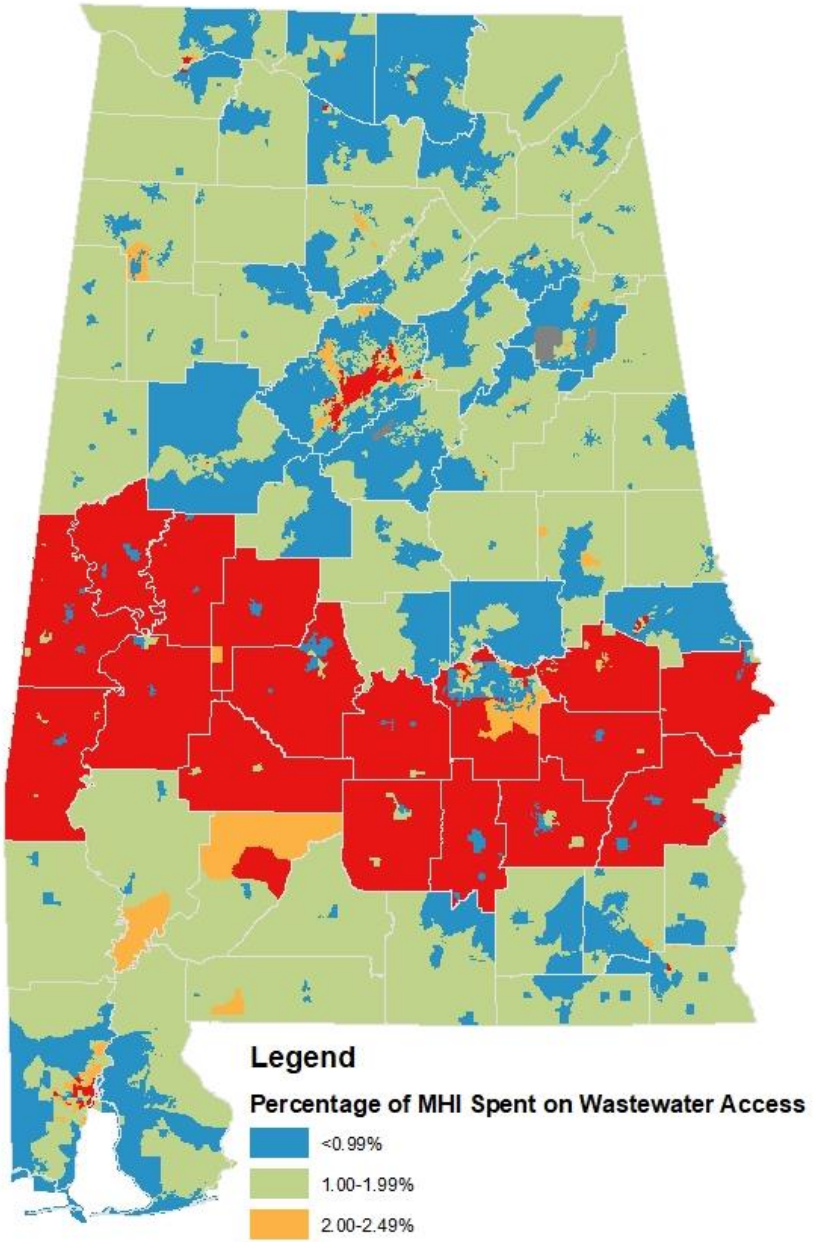
Analyze the annual cost of wastewater access as percentage of MHI



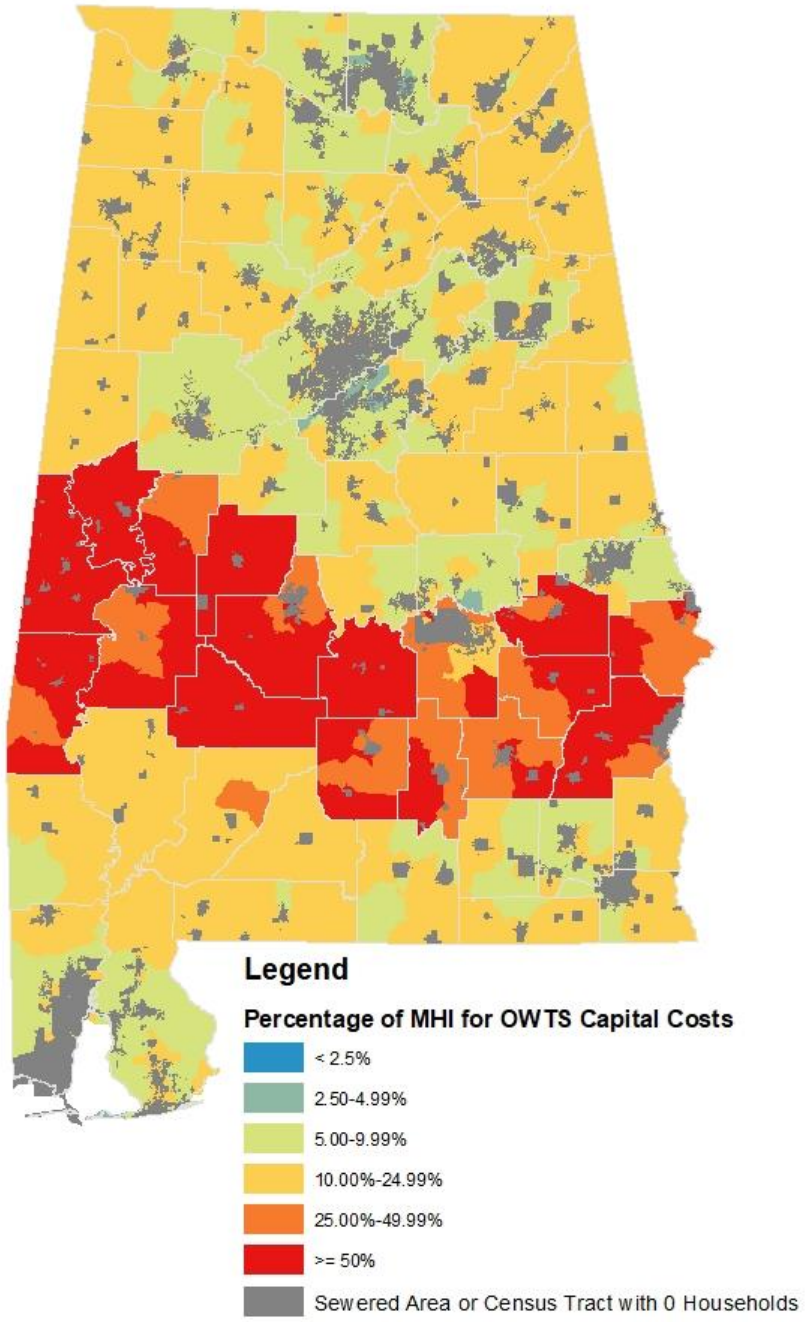




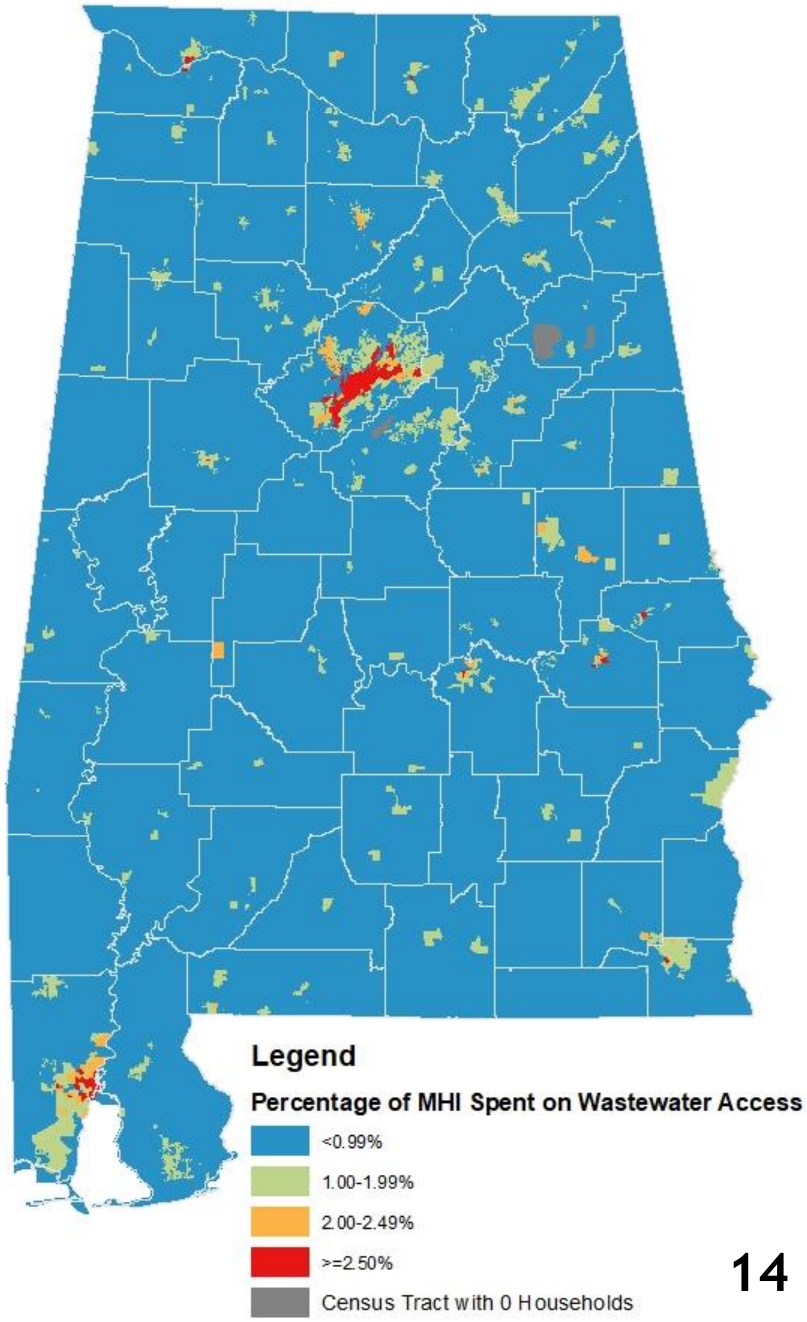
Map 1: OWTS loan + pumping



Map 2: OWTS capital costs

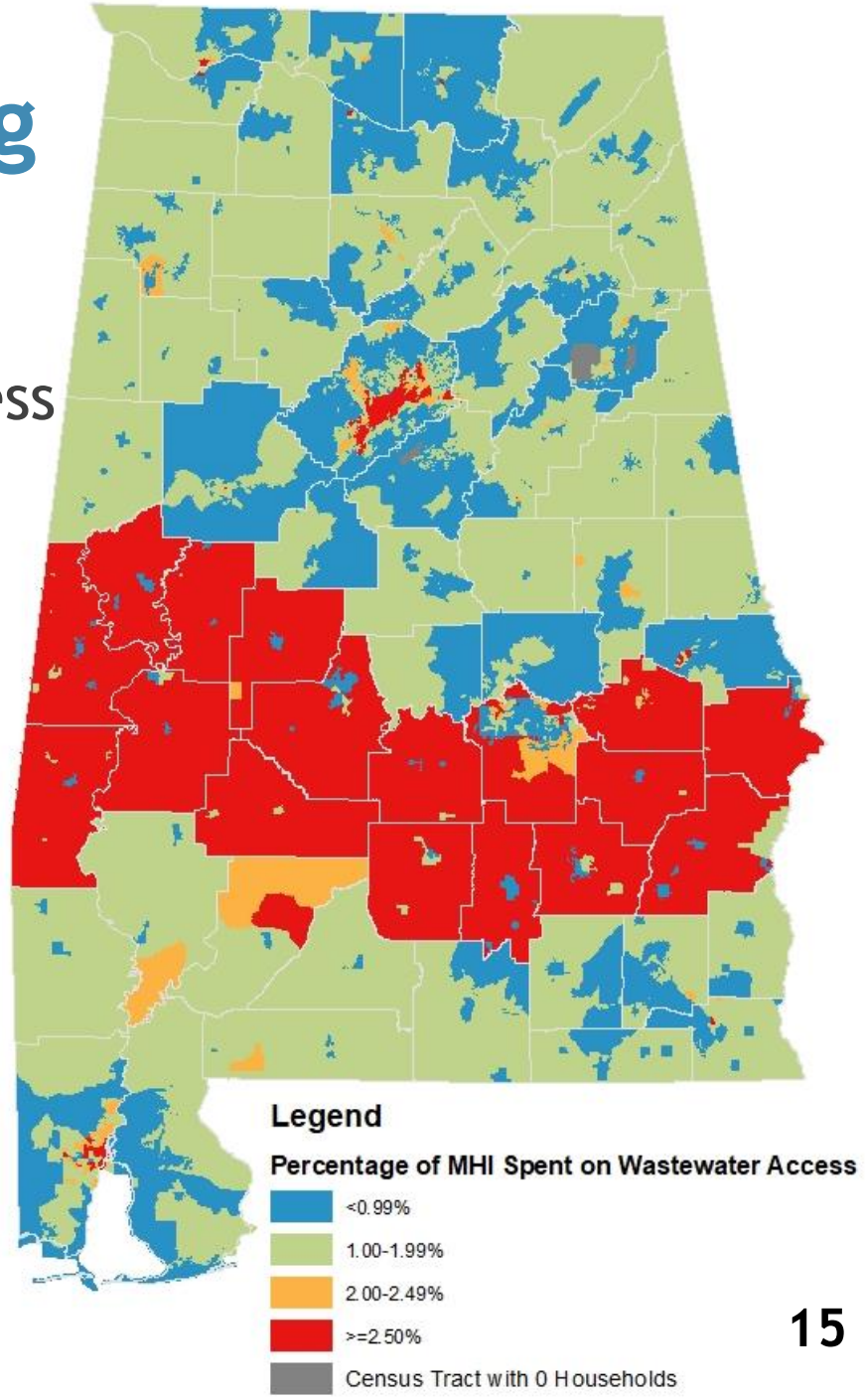


Map 3: OWTS pumping costs



MHI Map 1: OWTS as loan + pumping

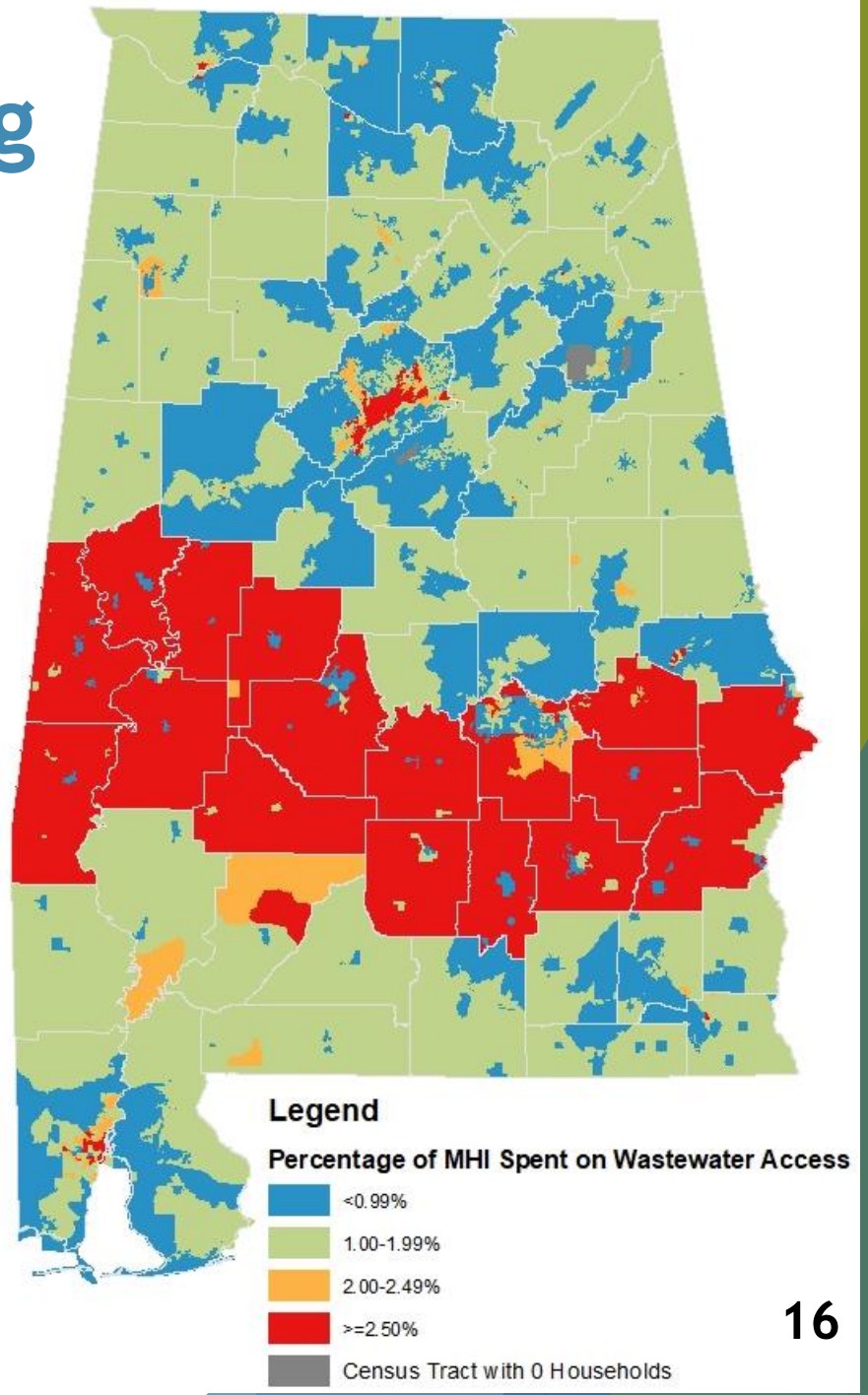
- Red areas have wastewater expenses > 2.5% of MHI
- 236 census tracts with unaffordable wastewater access
  - 102 census tracts unaffordable sewer rates
  - 127 census tracts unaffordable OWTS expenses
  - 7 census tracts with unaffordable sewer and OWTS expenses
- 72 census tracts with over 5.0% of MHI spent on ww
  - Greatest is 12.0% of MHI spend on wastewater expenses
- ~247,000 households in areas where wastewater expenses are greater than 2.5% of MHI



MHI Map 1: OWTS as loan + pumping

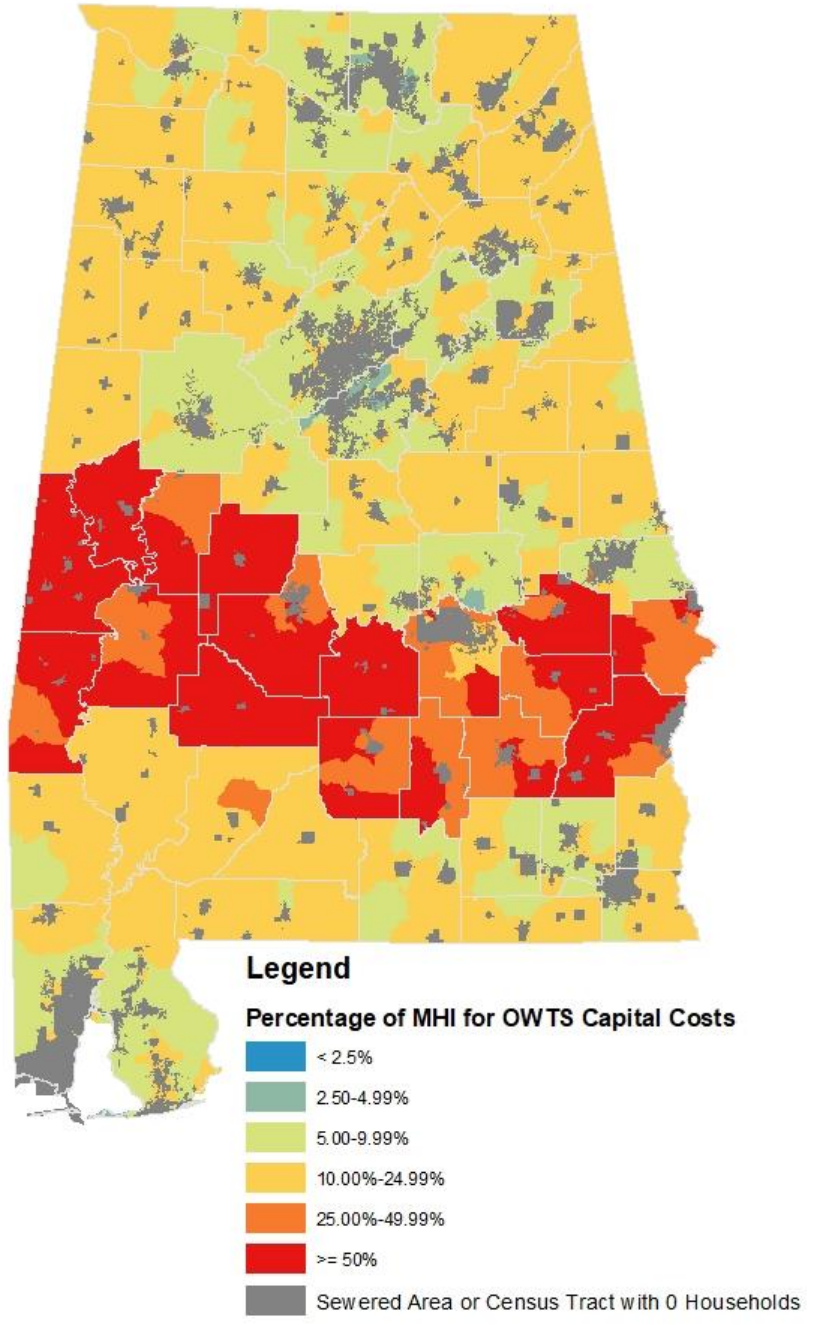
- Orange areas are at-risk for affordability challenges (2.00%-2.49% of MHI is spent on wastewater expenses)

- 87 census tracts at-risk of unaffordable wastewater access
  - 60 census tracts at-risk due to sewer rates
  - 23 census tracts at-risk due to OWTS expenses
  - 4 census tracts at-risk due to sewer and OWTS expenses



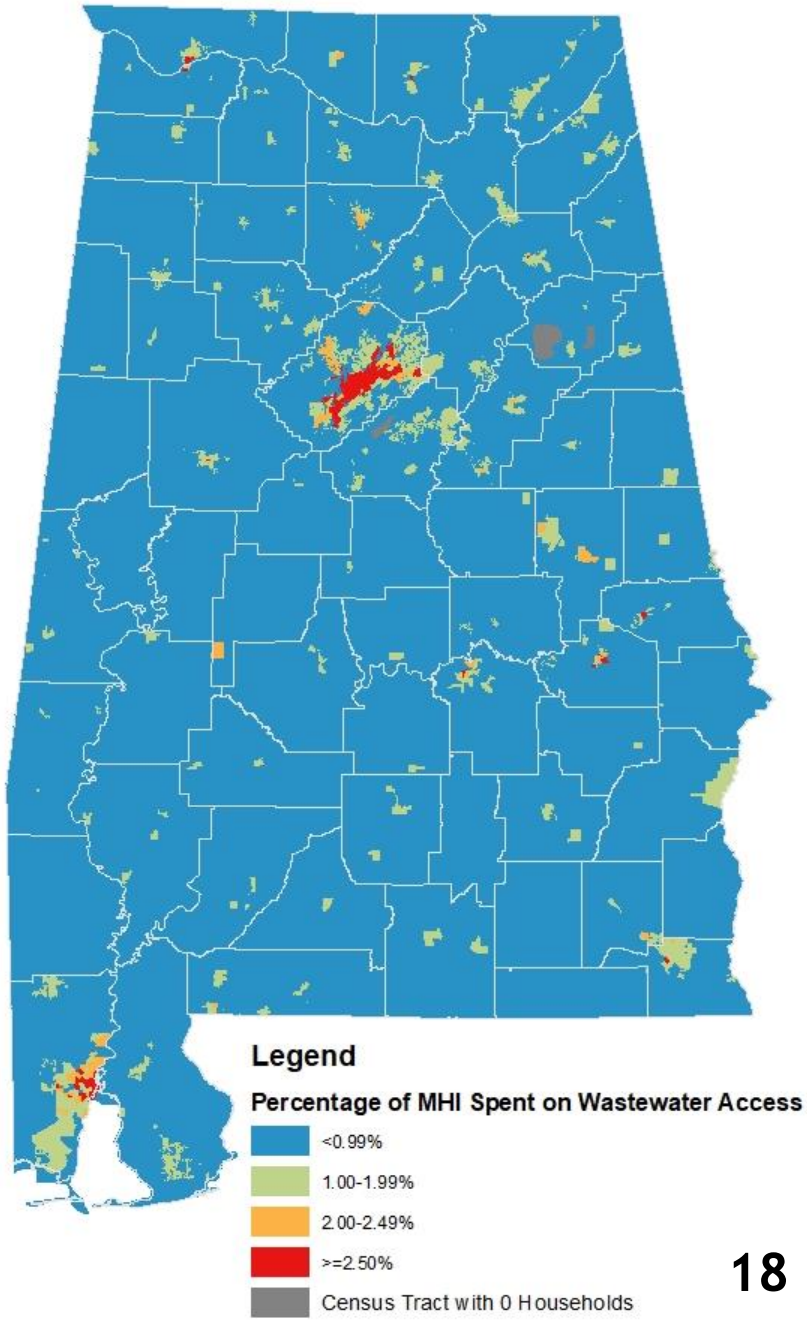
MHI Map 2: OWTS as capital costs

- Sewer affordability stays the same
- For OWTS to be affordable as lump sum of capital costs:
  - Conventional: MHI ≥ $200,000
  - Mound: MHI ≥ $800,000
- 6 census tracts where OWTS capital costs are > 100% of MHI
  - All in Black Belt counties
- 73 census tracts where OWTS capital costs are > 50% of MHI



MHI Map 3: OWTS as pumping costs

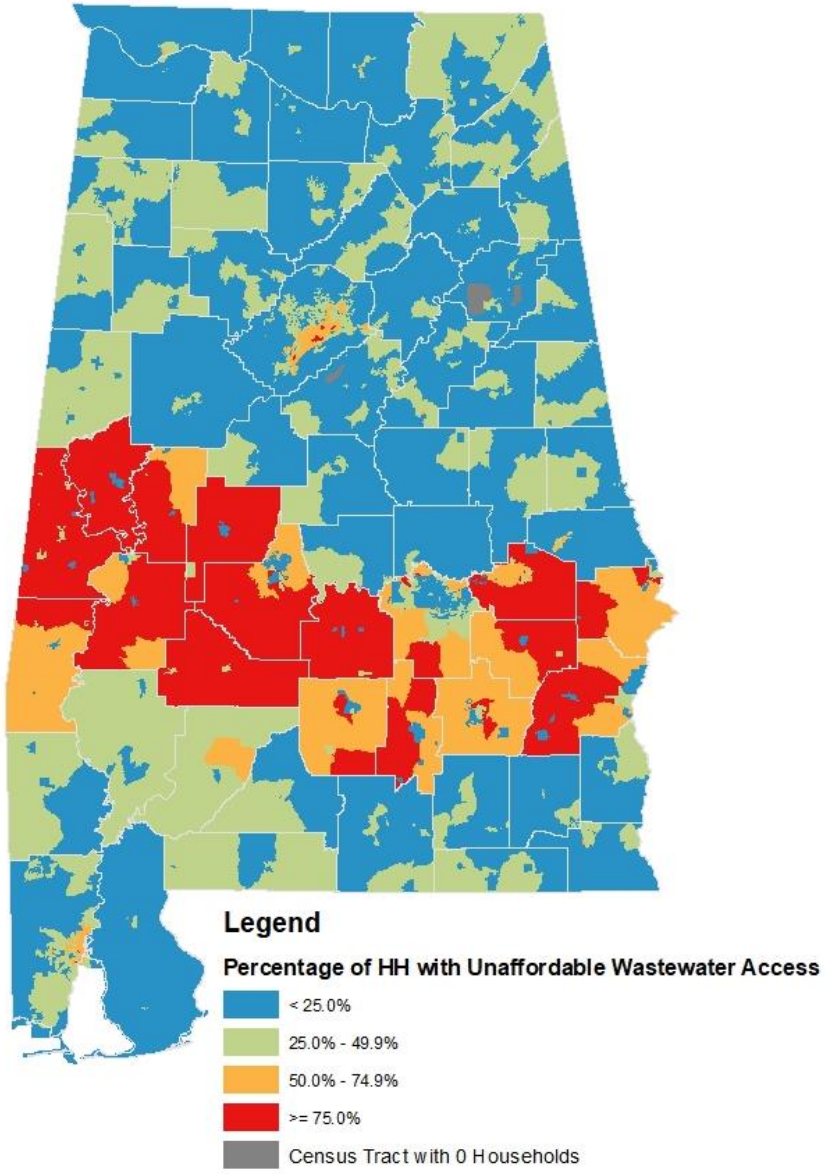
- Sewer affordability stays the same
- Only unaffordable areas are on sewer



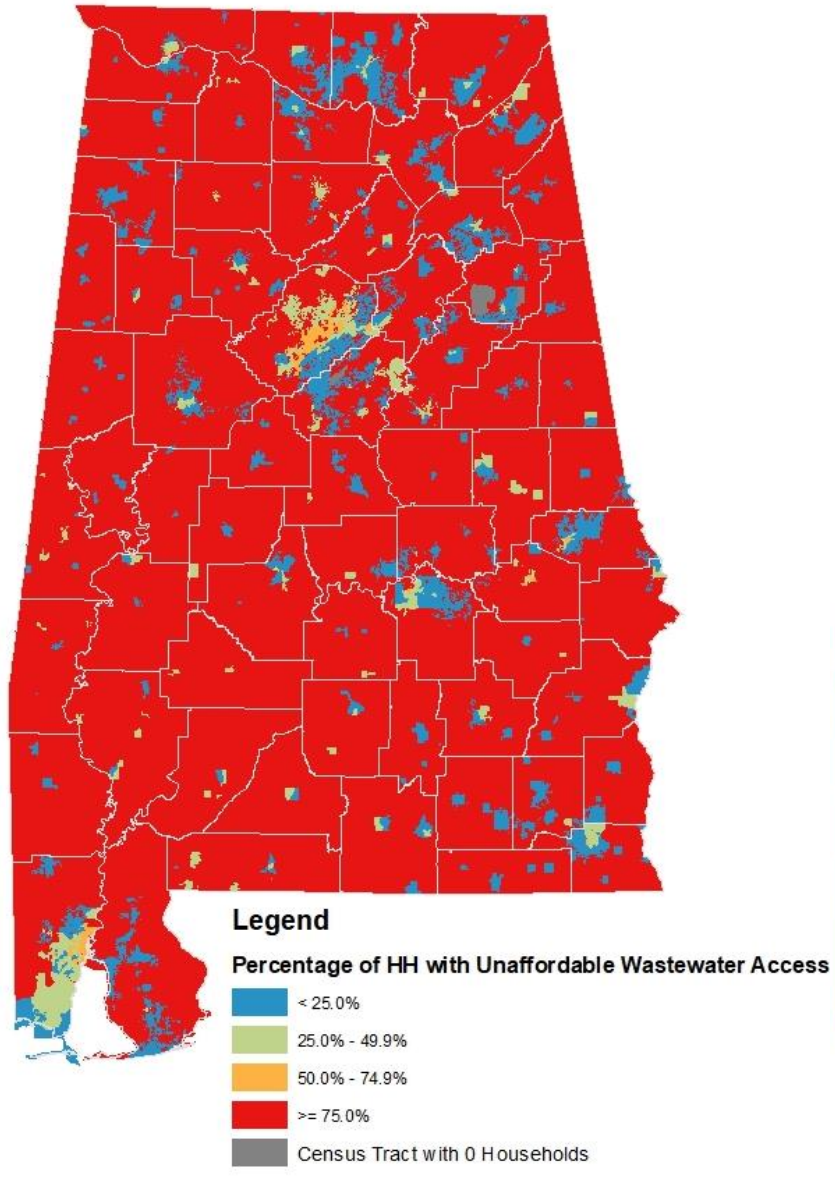
Method 2: Evaluating Affordability Based on Income Brackets

- Use annual brackets instead of the census tract's average MHI
- Calculate income threshold of unaffordable access for each wastewater rate
- Sum % of households within the unaffordable income brackets:
  1) less than $10,000
  2) $10,000 to $14,999
  3) $15,000 to $24,999
  4) $25,000 to $34,999
  5) $35,000 to $49,999
  6) $50,000 to $74,999
  7) $75,000 to $99,999
  8) $100,000 to $149,999
  9) $150,000 to $199,999
  10) $200,000 or more

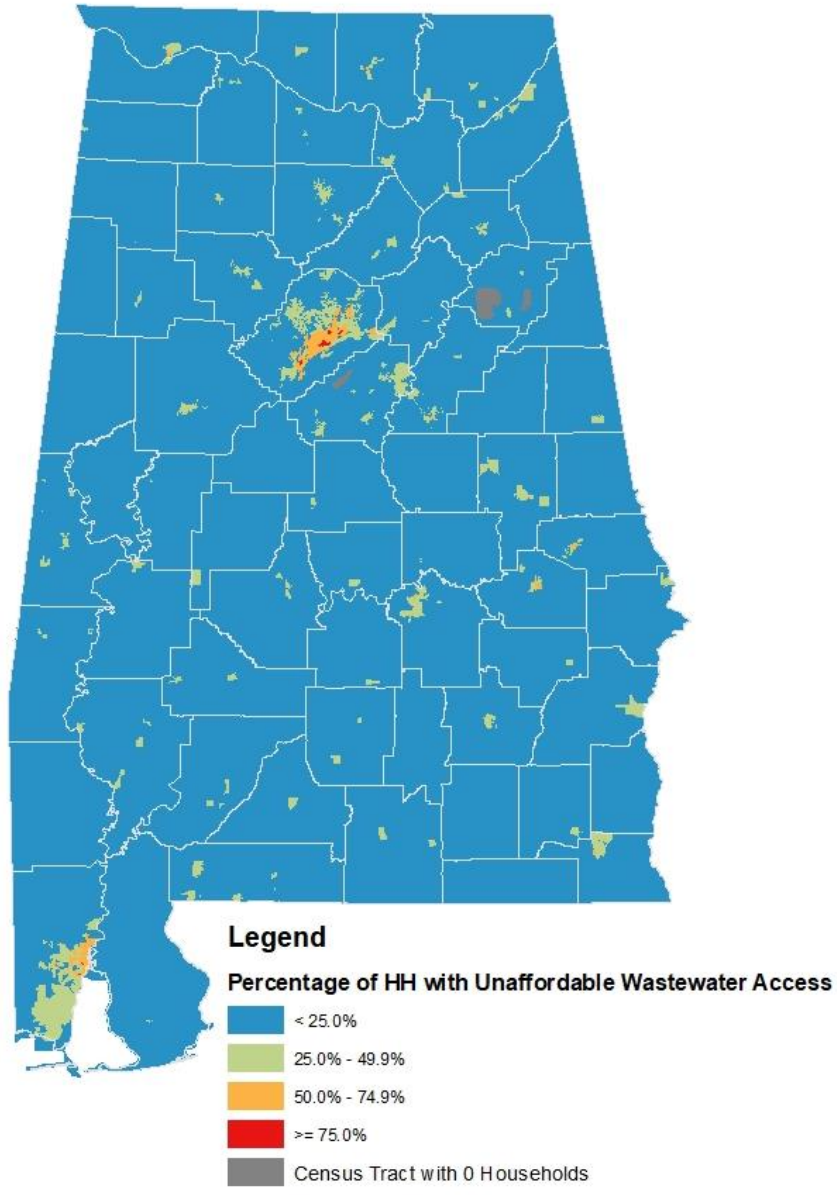
Map 4: OWTS loan + pumping



Map 5: OWTS capital costs



Map 6: OWTS pumping costs



Key Findings

Total Households in Alabama	1,867,893	
Estimated Number of Households on Sewer	1,223,659	(65.5% of HH in AL)
Estimated Number of Households on OWTS	644,234	(34.5% of HH in AL)
Households with Unaffordable Sewer Access	278,086	(14.9% of HH in AL)
(Map 4) OWTS Represented as Annual Loan Payment and Pumping Cost		
Household with Unaffordable OWTS Access	165,151	(8.8% of HH in AL)
Households with Conventional Systems	116,168	(6.2% of HH in AL)
Households with Mound Systems	48,983	(2.6% of HH in AL)
(Map 5) OWTS Represented as Lump Sum of Capital Costs		
Household with Unaffordable OWTS Access	644,234	(34.5% of HH in AL)
Households with Conventional Systems	576,830	(30.9% of HH in AL)
Households with Mound Systems	67,404	(3.6% of HH in AL)
(Map 6) OWTS Represented as Annual Savings for Pumping Costs Every Five Years		
Household with Unaffordable OWTS Access	20,109	(1.1% of HH in AL)
Households with Conventional Systems	16,767	(0.9% of HH in AL)
Households with Mound Systems	3,342	(0.2% of HH in AL)

Discussion

- Cost of Living in AL
  - Sewer bills range from $2.00 to $87.87 per month (**average is $34.06** - *0.6% of monthly expenses*)
  - Conventional OWTS is $35.82 per month *0.6% of monthly expenses*
  - Advanced OWTS is $143.28 per month *2.5% of monthly expenses*

Expense	Average Monthly Cost	Percentage of Total Monthly Expenses	Data Source
Rent *(2 bedroom apartment)*	$852	15.5%	(U.S. Census Bureau, 2021b)
Electricity	$161	2.9%	(Find Energy, 2021)
Internet	$65	1.2%	(AT&T, 2022)
Car Insurance	$108	2.0%	(Shinn et al., 2022)
Groceries	$610	11.1%	(Comen and Stebbins, 2021; Economic Policy Institute, 2020)
Health Care	$997	18.1%	(Comen and Stebbins, 2021)
Transportation	$1138	20.6%	(Comen and Stebbins, 2021; Economic Policy Institute, 2020)
Childcare *(for 1 child)*	$417	7.6%	(Comen and Stebbins, 2021; Economic Policy Institute, 2020)
Taxes	$507	9.2%	(Comen and Stebbins, 2021; Economic Policy Institute, 2020)
Miscellaneous	$500	9.1%	(Comen and Stebbins, 2021; Economic Policy Institute, 2020)
Cell Phone	$120	2.2%	(AT&T, 2023)
Water *(from a utility)*	$36	0.7%	(UNC Environmental Finance Center, 2019)
Total	**$5,511**		

$66,000 annually

Alabama Median Household Income is $54,943
National Median Household Income is $70,784
Federal Poverty Level (family of 3) is $24,860

Recommendations

- Accessibility of Financial Assistance for:
  - Utilities
  - Rate Payers
  - OWTS Users

AFFORDABILITY OF WASTEWATER SERVICE

How Do CWSRF Decentralized System Financing Programs Work?

Lending Structure	How does it work?	Who is doing it?
Direct homeowner loan	The state CWSRF signs a loan directly with the property owner.	DE
Linked deposit loan	The borrower applies for funding at a participating bank. The CWSRF buys down the interest rate that the bank charges the borrower.	IA, MD, OH
Pass-through loan	The CWSRF makes a loan to a state or local government unit (agency, county, or special district), which uses the funds to make loans for decentralized projects. The government unit ensures repayment of the CWSRF loan.	CT, MA, MN, NJ, OH, PA, WV
CDFI pass-through	Same as above, but through a CDFI or other financial institution.	ID, OR, WA, WV
Sub-state revolving fund	The CWSRF makes a loan to the partner to capitalize another revolving fund. Returns on the sub-state revolving fund are used to repay the CWSRF and to make new loans.	MO, OH, RI, VA, WA
Sponsorship	A utility increases the size of its loan to sponsor a NPS project. In exchange, the CWSRF reduces the interest rate on the loan to cancel out the cost of the NPS project.	DE, IA, OH, OR all have sponsorship programs but they have not been used for decentralized projects
Co-funding	The CWSRF co-finances projects with another funding entity.	Every state does this, but may not have used this approach for financing decentralized projects.

in the form of below-market interest rate loans to eligible borrowers. However, it is important to note that States are afforded extensive flexibility in administering their program, including defining project and applicant eligibilities, financing terms, and loan forgiveness options for qualified borrowers. Contact your state for details.

can be customized to fit your needs.

Recommendations

- Expand funding and accessibility
  - Many homeowners do not have new mortgages or access to loan opportunities
  - Grant subsidies for capital costs of OWTS could reduce wastewater affordability challenges
    - Decrease from 165,000 households (8.8% of households in Alabama) to 20,109 households (1.1% of households in Alabama)

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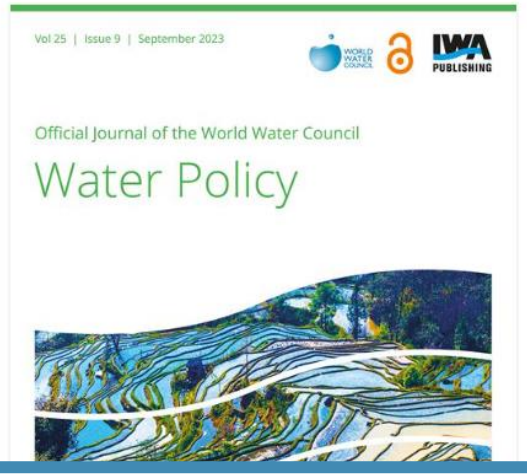

RESEARCH ARTICLE | SEPTEMBER 16 2023

Household level wastewater management and disposal data collection in the U.S.: the history, shortcomings, and future policy implications

Jillian Maxcy-Brown; Mark A. Elliott; Bennett Bearden

Check for updates

Water Policy (2023) 25 (9): 927–947.
https://doi.org/10.2166/wp.2023.147 **Article history**

Est S in 2021

U.S. Decennial Census and American Housing Survey

Year	Total Number of Occupied Housing Units	Occupied Housing Units with OWTS	Percentage of Occupied Housing Units with OWTS	Average Percentage of New Housing Units with OWTS	Number of New Occupied Housing Units Since Previous Year of Data	Estimated Total Number of New Occupied Housing Units with OWTS	Estimated Occupied Housing Units with OWTS	Estimated Percentage of Occupied Housing Units with OWTS	Difference in OWTS Estimate and AHS Estimate
1990	91,947,410	22,182,101	24.12%	-	-	-	22,182,101	24.12%	-
1991	93,147,000	21,672,000	23.27%	23.76%	1,199,590	284,991	22,467,092	24.12%	795,092
2007	110,692,000	21,927,000	19.81%	27.20%	1,821,000	495,223	26,835,813	24.24%	4,908,813
2009	111,806,000	22,307,000	19.95%	27.88%	1,114,000	310,560	27,146,375	24.28%	4,839,375
2011	114,833,000	22,378,000	19.49%	28.56%	3,027,000	864,502	28,010,877	24.39%	5,632,877
2013	115,852,000	21,498,000	18.56%	29.24%	1,019,000	297,981	28,308,857	24.44%	6,810,857
2015	118,290,000	23,217,000	19.63%	29.94%	2,438,000	729,847	29,038,704	24.55%	5,821,704
2017	121,560,000	21,718,000	17.87%	31.35%	3,270,000	1,025,114	30,063,818	24.73%	8,345,818
2019	124,135,000	20,293,000	16.35%	29.78%	2,575,000	766,717	30,830,534	24.84%	10,537,534
2021	128,504,000	19,489,000	15.17%	30.47%	4,369,000	1,331,389	32,161,923	25.03%	12,672,923

Based on these calculations, it would be more accurate to estimate that in **2021** there were about **32.2 million OWTS** in use across the U.S. which is 12.7 million more systems than were estimated by the 2021 American Housing Survey

alues

alues

Questions?

Jillian Maxcy-Brown jmaxcybrown@crimson.ua.edu

Recent AHS Data

Year	Total Number of Occupied Housing Units	Occupied Housing Units with OWTS	Percentage of Occupied Housing Units with OWTS
2011	114,833,000	22,378,000	19.49%
2013	115,852,000	21,498,000	18.56%
2015	118,290,000	23,217,000	19.63%
2017	121,560,000	21,718,000	17.87%
2019	124,135,000	20,293,000	16.35%
2021	128,504,000	19,489,000	15.17%

"In general, the existing data sources do not provide the information necessary to accurately characterize use of decentralized systems nationally." – U.S. EPA Report to Congress in July 2021

Estimating OWTS Usage in U.S.

1990 U.S. Decennial Census Data

Year	Total Number of Occupied Housing Units	Occupied Housing Units with OWTS	Percentage of Occupied Housing Units with OWTS
1990	91,947,410	22,182,101	24.12%

NESC Percentage of New Housing Units with OWTS

1993	1998	2015	2016	2017	2018
23.2 %	24.3 %	30.1 %	31.0 %	31.7 %	29.1 %

American Housing Survey
Estimate of Total Occupied Housing Units
1991-2021