

Falling Short of Data-Driven Policy: Better Resources are Needed to Track Water Utility Consolidation and Health Outcomes



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Executive Summary

Many low-income and rural communities in America still struggle to obtain reliable access to water, and overall, risks to reliable drinking water have increased. There are approximately 48,000 water systems providing drinking water in the U.S. A majority of them serve less than 10,000 people and more than half serve 500 persons or less. A utility with a small customer (revenue) base might do fine when pipes and treatment facilities are new, but struggle or fail to finance upgrades for older infrastructure, putting public health at risk. This public health problem has been exacerbated by the COVID-19 pandemic. Among the several alternatives to mitigate this risk among small systems is to consolidate with a larger system, for two or more smaller systems to consolidate, or to purchase water from a neighboring system, merge staffing, management, water treatment or other functions.

EPA's Safe Drinking Water Information System (SDWIS) can be used to assess consolidations and other shared service arrangements among water systems that could improve water quality, affordability and trust in drinking water supplies. For the purpose of this report, we sought to understand the extent to which SDWIS could be used to evaluate consolidations, both managerial and physical, and shared water services between water systems, denoting physical points of connections between water systems where water supplies may be formally purchased or shared in the case of an emergency.

Shared water services are often not as studied, but can be a helpful marker for water stewardship, resilience and management. Unfortunately, we found that this data set is inadequate to understand the pace and type of consolidations and shared services occurring across water systems.

What the EPA data does show is that most states - with the exception of a few such as Colorado and Hawaii - have a shrinking number of systems and that new utilities are being created all the time in nearly every state. EPIC believes that the total number of drinking water systems needs to shrink by approximately 75% to reduce public health impacts caused by small system constraints. Based on the historical rate of consolidation, the total number of systems would still be roughly 43,000 in twenty years, while reaching the goal of 75% reduction to 12,500 systems would only occur in the 2130s.

At least in some states, data tracking and consolidation policy is far ahead of federal efforts. State efforts like those in California or North Carolina and newer policies in West Virginia and Kansas can serve as models to other states and federal regulators for the types of record keeping that might facilitate better utility consolidation outcomes.



¹ Mullin, M. (2020). The effects of drinking water service fragmentation on drought-related water security. *Science*, 368(6488), 274–277. <https://doi.org/10.1126/science.aba7353>

Policy Recommendations



Finalize an expansive Water Systems Restructuring Rule. The Environmental Protection Agency (EPA) is considering the Water Systems Restructuring Rule to encourage states to have greater authority to enable consolidation. This rule is overdue for being finalized and we believe this federal policy and relevant state policies need to be a higher priority. This rule must include provisions that create stronger incentives for voluntary consolidation and more authorities to mandate consolidation when a utility cannot meet its customers' needs. In addition, health equity should be a driver of consolidation.

Adopt more state policies and programs. More states should pass laws and build consolidations programs like these West Virginia, North Carolina, Kansas, and California have done - such policies should include a focus on explicit record-keeping around new utility creation, consolidation, and shared service agreements, mandatory consolidation authorities for repeated violations and fiscal insolvency problems, and incentives and state funding to support it.



Expand the scope of SDWIS data. Easily accessible data such as identification of persistent violators, which systems have consolidated and when, as well as which systems share services between one another will provide a more complete understanding of water systems to policy makers and water experts. This contextual data will also be vital to the EPA's forthcoming [Water Systems Restructuring Rule](#).

Improve the quality of SDWIS data. As noted in prior research, SDWIS may not have accurate information on water systems. All of these inconsistencies complicate the inferences made about consolidation in the U.S.



Track consolidation outcomes. Little is known about how consolidation efforts affect water quality, affordability and consumer trust. When state or federal officials do not have easily accessible information about the health, affordability, and financial sustainability effects of consolidation it's hard to help others do it better. EPA and states should track outcomes over five years in systems which go through (or fail to go through with) consolidation and shared service approaches.

Keep track of utility boundaries at national or state levels. Roughly 15 states publish data of the boundaries their water system serves, and even for those that publish this information, data on points of interconnection between systems as well as any water sharing agreements between systems are lacking. Moving forward, states should collect and share this data to guide policy making and the implementation of improved water management plans.



Increase communication between water systems: The EPA and states need to increase programs that facilitate the communication between systems to better understand the feasibility, desirability and potential benefits of consolidation in the U.S. The [Water and Wastewater Agency Response Networks \(WARN\)](#) could either serve as a model for improving water system communications, or be expanded to include topics related to consolidation or regionalization efforts.

Introduction

America's water systems, used to deliver drinking water and remove wastewater from the homes and businesses of 327 million people, are broken. Far too many Americans lack consistent access to affordable and safe water supplies to meet their needs. Far too many Americans distrust their tap water, even when it is safe. Far too many Americans experience sewage overflows, polluted riverfronts, and flooded streets. The failures of our water systems prevent all Americans, and especially low-income individuals and people of color, from having the healthy and prosperous lives they deserve.

While communities of color gained access to water treatment and sewer infrastructure in the early 1900s, race is now the strongest predictor of lack of water and sanitation access, especially in the South. Native American, Black, and Latino households are less likely to have indoor plumbing compared to their white counterparts. Even when racially disadvantaged households have access to piped water and wastewater infrastructure, communities of color report greater levels of drinking water health violations and sewage backups during heavy storm events. Small community water systems (CWS) struggle to meet today's health standards while staying solvent, resulting in inequity for those served by small CWSs. Improved utility partnerships, such as that which could be achieved through consolidations, is a health equity issue because the smallest utilities disproportionately serve isolated, rural and lower-income communities and we see no circumstances in which a large fraction of these utilities can provide safe and sustainable water in the future.



Addressing this issue is complicated by the sheer number of water systems across the U.S. There are 50,000 CWSs, 15,000 wastewater systems, and a growing number of stormwater systems operating in the U.S. In contrast, there are around 3,300 electric utilities, 2,600 internet service providers, or 54 state and territorial state highway agencies.² With so many water systems, that means more than half the CWSs each serve 500 persons or less.

However, the stark number of 50,000 CWS may also be misleading as water systems share services, such as purchasing water from nearby systems, sharing operators or staff, or being owned by the same utility. However, this type of data is not captured in federal or state databases. The Safe Drinking Water Information System (SDWIS) is the most likely source for this information, as it provides a record of all federally-regulated drinking water systems and regulatory violations in water quality, but it does not include such details. This absence of information about consolidations or shared services is one of [several limitations of SDWIS](#),³ yet it remains the primary source experts and policymakers use to assess [contaminant violations over time](#),⁴ [rate of regulation compliance](#),⁵ and the [environmental justice implications](#)⁶ of water systems management.

² Ibid.

³ Norriss, J. (2021, March 2). Improving federal record-keeping for enhanced understanding of water systems in the US. Environmental Policy Innovation Center.

<http://policyinnovation.org/improving-federal-record-keeping-for-enhanced-understanding-of-water-systems-in-the-us>

⁴ Pennino, M. J., Leibowitz, S. G., Compton, J. E., Hill, R. A., & Sabo, R. D. (2020). Patterns and predictions of drinking water nitrate violations across the conterminous United States. *Science of The Total Environment*, 722, 137661.

<https://doi.org/10.1016/j.scitotenv.2020.137661>

⁵ Statman-Weil, Z., Nanus, L., & Wilkinson, N. (2020). Disparities in community water system compliance with the Safe Drinking Water Act. *Applied Geography*, 121, 102264. <https://doi.org/10.1016/j.apgeog.2020.102264>

⁶ Schaidler, L. A., Swetschinski, L., Campbell, C., & Rudel, R. A. (2019). Environmental justice and drinking water quality: Are there socioeconomic disparities in nitrate levels in U.S. drinking water? *Environmental Health*, 18(1), 1-3.

<https://doi.org/10.1186/s12940-018-0442-6>

To develop a national strategy to improve the quality, affordability and access of drinking water to all Americans, we first must have a comprehensive understanding of the consolidations and shared services between water systems. In this report, we sought to evaluate how the federal Safe Drinking Water Information Systems (SDWIS) database could be used to understand: 1) how states use SDWIS to track consolidations, 2) the distribution and timing of water system deactivations as a proxy for consolidations, and 3) the geospatial distribution of wholesalers and water purchasers to shed light on potential shared services. This analysis provides a foundation from which stakeholders can develop a national regionalization or consolidation strategy that creates sustainable, equitable and resilient water systems.

Systems versus utilities

It is important to clarify terminology between water systems and water utilities as they are often used synonymously, but are [very different in practice](#).⁷ This can also inform our understanding of different forms of collaboration or consolidation between water systems.



Water Systems: This is the unit that the Environmental Protection Agency (EPA) regulates, which is captured in the EPA Safe Drinking Water Information System (SDWIS) Federal Reporting Services system.



Water Utilities: A water utility may be made up of a collection of several water systems, but is not the entity that is regulated. For example, “larger private holding companies such as the American Water Works Company, own and operate hundreds of systems and may also operate other publicly or privately held systems.”

Within SDWIS, it is very difficult, if not impossible, to link water systems to the utility that operates them. For the purpose of this article, we use the deactivation date as a proxy for consolidation and evaluate water systems that may buy wholesale from one another, but have not formally consolidated.

Background

This is a critical moment to address the problems of water accessibility and safety in the United States. COVID-19 and destructive weather incidents across the U.S emphasized the importance of clean and safe drinking water in homes as thousands of Americans have had their access to water compromised or shut off in the past year. To contextualize these problems, we first briefly summarize the structure and management of water and wastewater systems.

Due to a history of permissive policies regarding water systems formations, even in dense urban areas, there are more than 50,000 community water systems (CWS) which supply water to the same people year-round. These systems are owned and operated by local governments and private companies within each state and are largely independent from each other despite their geographic proximity. Nearly 90% of water utility systems in the U.S serve less than 10,000 people and more than half serve less than 500 people.⁸

⁷ Beecher, J., Redican, K., & Kolioupoulos, M. (2020). (Mis)Classification of Water Systems in the United States. SSRN, 1–38. <https://dx.doi.org/10.2139/ssrn.3627915>

⁸ Mullin, M. (2020). The effects of drinking water service fragmentation on drought-related water security. *Science*, 368(6488), 274–277. <https://doi.org/10.1126/science.aba7353>

Small utilities that produce only a few thousand gallons of water per day are disadvantaged by their size because they have a smaller user base to charge and are thus more vulnerable to shocks such as population loss, changes in the local economy, or weather patterns. Additionally, small utilities have trouble hiring and retaining qualified operators, have few resources to improve their overall infrastructure, and are more likely to experience water quality violations.^{9,10}

They also often lack resources to keep track of and apply for government grants that are specifically targeted for small utilities. This exacerbates the water sector's challenges such as aging infrastructure, affordability, technical know-how to deal with contaminant pollution, and sustainability especially in light of climate change.

Without the proper resources and management to handle these challenges, small CWS are unable to ensure the safety and the reliability of their water services, posing a serious public health issue in the U.S.



EPA's Water Restructuring Rule

The EPA is currently exploring a rule, which is expected to be finalized in January 2022, to encourage states to have greater authority to enable consolidation. The Water Restructuring Rule would govern mandatory restructuring assessments and will authorize primary agencies to mandate restructuring assessments for Public Water Systems (PWS) that don't comply with or violate health standards frequently. PWS are the broader category that Community Water Systems fall within and consist of those systems that provide year round water service to a population, among other characteristics. Restructuring assessments will be designed specifically for the water system based on its size, type, etc. in order to prevent assessments from being "overly burdensome." The rule will also include consolidation incentive provisions, which are currently available only in some states like California. The EPA estimates that there are 740 public water systems that are "persistently in violation" and are considered very likely candidates for restructuring assessments. There are additionally another 3,508 PWS with health violations from the past year that are considered potential candidates if the underlying issues at hand are not addressed.

⁹ Fedinick, K. P., Taylor, S., & Roberts, M. (2019). Watered Down Justice (No. 19-09-A; pp. 1–52). Natural Resources Defense Council. <https://www.nrdc.org/sites/default/files/watered-down-justice-report.pdf>

¹⁰ Teodoro, M. P., & Switzer, D. (2016). Drinking from the Talent Pool: A Resource Endowment Theory of Human Capital and Agency Performance. *Public Administration Review*, 76(4), 564–575. <https://doi.org/10.1111/puar.12571>

Consolidations or shared services of CWS are widely considered an important part of the solution to these challenges. This can either be physical – sharing infrastructure, source water, and treatment technology – or managerial – sharing of expertise in planning and operations, as well as streamlined paths to better management structures.¹¹ In either case, better service and financial outcomes are expected.¹² Consolidation is considered a feasible option for struggling CWS for two reasons: achieving economies of scale and potential ability to integrate with a neighboring system. With greater economies of scale from a larger customer base, water rates can decrease without a parallel decrease in profits which will in turn allow systems to use more of their budget for other improvements, such as upgrading infrastructure and treatment processes. The proximity of systems is another reason for the viability for consolidation. 86% of small CWS are within 5 miles of another, and their proximity “demonstrates many opportunities for small systems to form cooperative agreements, share services, or join together under common management.”¹³ Distance need not limit the scope of consolidation; spatially-distant systems can enter into similar arrangements or administratively consolidate.



Importance of tracking consolidations and shared services

It is often said that you can't fix what you can't see, and water systems experience this in two compounding ways:

- 1) water infrastructure is largely underground and potential contaminants are mostly naked to the human eye, and
- 2) there is no centralized database to track struggling systems or shared services of systems.

The federal database that is used as a catalog of water systems (SDWIS) is the primary source for the analysis of this report. We sought to understand the extent to which SDWIS could be used to evaluate consolidations, both managerial and physical, and shared water services between water systems, meaning physical points of connections between water systems where water supplies may be formally purchased or shared in the case of an emergency. While we remain curious about tracking other forms of sharing services (e.g. operators, staff, management or treatment systems), there is not a database to investigate such information.



Consolidation Visualization Tool

Consolidation policies, including prioritization of State Revolving Fund monies, vary among states, as do urbanization levels which generally correlate with more consolidated utility arrangements. To compare and identify states with potentially promising policies, we developed a [Community Water System Consolidation Analysis](#) tool for public use. This tool is comprised of a series of Tableau dashboards, utilizing charts, maps, and filters to enable the identification of states that differ from national and regional trends based on data from EPA's Safe Drinking Water Information System (SDWIS), supplemented by urbanization data from the U.S. Census Bureau. Data from SDWIS and Census Bureau were collected in April 2020.

[View Visualization Tool Here](#)

¹¹ System Partnership Solutions to Improve Public Health Protection (Volume II; pp. 1–10). (2006). United States Environmental Protection Agency Office of Water. <https://www.epa.gov/sites/production/files/2017-07/documents/p100399z.pdf>

¹² Ibid.

¹³ Ibid.

However, a handful of states have started to collect consolidation and water system information independently of federal requirements. [North Carolina's Local Water Supply Plan](#)¹⁴ provides an example of how data on water systems can be collected and organized for enhanced management. The state's [General Statute 143-355\(l\)](#)¹⁵ "requires all units of local government that provide or plan to provide public water services to prepare a Local Water Supply Plan" that reports annually on the system's continued ability to meet the needs of their customers. In effect, the Plan creates a database of all the active water systems in the state that allows the local North Carolina governments to plan for water shortages and other system improvements. The information provided by each system in the state can also benefit consolidation efforts. Systems in need of improvement, as well as neighboring systems that could provide the support, can [be easily identified](#) and, if need be, consolidated. Through the cooperation of state legislators and systems themselves, similar plans can be adopted by other states that do not actively have tracking systems as detailed as North Carolina's Local Water Supply Plan.



West Virginia's "[Distressed and Failing Utilities Improvement Act](#)"¹⁶ passed in 2020 presents a legislative framework that states can take to improve the quality of their small systems. Each year, the Public Service Commission (PSC) of West Virginia – a state agency that monitors utility rates and services – will create a list of water and wastewater systems in the state that are struggling financially; systems themselves can also petition to be added to the PSC's list for assistance. If a system is found to satisfy the conditions of either a "distressed" or "failing" system, the PSC has the authority to require the system to be consolidated with a neighboring system.



Most recently, Louisiana approved [Act No. 98](#)¹⁷ in June of 2021 that requires the Louisiana Department of Health to develop a grading system from A through F for water utilities based on their history of federal and state water quality violations, financial sustainability, operations and performance, customer satisfaction and other benchmarks. The bill's chief sponsor, Sen. Fred Mills expressed the hope that "communities that get water from poorly rated systems might have discussions about consolidating with better rated systems."¹⁸

States like West Virginia and Louisiana do not currently have a state database for their water and wastewater systems. These new laws are an example of how a detailed database of systems could be advantageous to consolidation efforts. If information on service quality of a system is available, it would be possible to identify which systems are struggling to provide safe and reliable water service and of those, which ones could benefit from being consolidated and with whom. With a comprehensive database of water systems in the state, the state itself as well as other agencies could require systems to consolidate, addressing water service problems and public health concerns.



With an up-to-date database, water systems that may benefit from consolidation can be more easily identified, reducing friction for this process to occur where necessary. North Carolina's system is one example of the benefits of improved data infrastructure and this report aims to highlight the limitations of the federal database (SDWIS) and demonstrate the possibilities if a system like North Carolina's was adopted at a national scale.

¹⁴ Local Water Supply Planning. (n.d.). North Carolina Department of Environmental Quality. <https://www.ncwater.org/WUJDC/app/LWSP/index.php>

¹⁵ North Carolina General Statute 143-355. https://www.ncleg.gov/enactedlegislation/statutes/html/bysection/chapter_143/gs_143-355.html

¹⁶ Distressed and Failing Utilities Improvement Act, Wv. 24-2H (2020). <http://www.wvlegislature.gov/wvcode/code.cfm?chap=24&art=2H>

¹⁷ Act No. 98, Louisiana, (2021). <https://legiscan.com/LA/bill/SB129/2021>

¹⁸ Deslatte, M. (2021, June 29). Louisiana Lawmakers Eyeing Hurricanes Tackle Water System Upgrades. Insurance Journal. <https://www.insurancejournal.com/news/southcentral/2021/06/29/620619.htm>

Data

In 1994, the EPA launched a federal database called the Safe Drinking Water Information System (SDWIS), which provides a record of all federally-regulated drinking water systems and regulatory violations in water quality. Currently, it has information on 145,610 active and 256,011 inactive water systems across the U.S. For the purpose of this analysis, we were interested in state-regulated, community water systems (CWS) that either served more than 25 people or had greater than 15 connections, not including territories or the District of Columbia. That resulted in 47,980 active CWS and 40,243 inactive CWS.

Data from 1985 to 2020 was analyzed and the fields most relevant to consolidation and shared water services efforts were included:

1. Deactivation date

The deactivation date was used as a proxy for consolidation, as it indicates whether a system is active or inactive, and provides the best available data to inform a national picture of consolidation.

2. First reported date

The first reported date was used as a proxy for the activation date of the system as it indicates the first record of a system in SDWIS. This was used in conjunction with the deactivation date to quantify the net number of water systems across the U.S.

3. Population served and number of connections

The number of people served by the water system and the number of connections from the water main. To adjust for potential data errors, we used the maximum number of either population or connections for each water system which represents how many points of contact the system has with their customers through water service lines.

Starting in 2013, SDWIS has annual records of their database which allows changes from year to year to be tracked and compared. Data from 2013 to 2020 were then analyzed and the following fields were reviewed:

1. Primary water source:

The EPA defines the primary source to be the “type of water which requires the most stringent monitoring and treatment.” The primary water source is organized into six categories: ground water (GW), groundwater purchased (GWP), surface water (SW), surface water purchased (SWP), groundwater under influence of surface water (GU), and purchased groundwater under influence of surface water source (GUP). To simplify the analysis, these categories were separated into two groups:

2. Whether the system is a wholesaler:

This is a binary field indicating whether the water system sells wholesale water to other systems rather than (or in addition to) direct sale to customers.

- A. “independent” primary water sources in which the water was not purchased, and
- B. “purchased” primary water sources in which water is purchased by the system.

We interpret a change from an “independent” source to a “purchased” source as a form of consolidation between systems, while a change from “purchased” to “independent” as an instance of de-consolidation.

To illustrate shared services between CWS, we conducted a deeper dive in Texas and also utilized water system boundaries accessed from the Texas Water Development Board.¹⁹ We assume from the resulting maps that any systems that purchase water and are also close to a wholesaler system will be purchasing water from the wholesaler system. This, in turn, can suggest that these two systems are connected and serve as a form of consolidation, with one system providing water to another.

¹⁹ Water Service Boundary Viewer. (n.d.). Texas Water Development Board. <https://www3.twdb.texas.gov/apps/WaterServiceBoundaries>

Data Limitations

As mentioned above, [SDWIS data may be mis-classified](#)²⁰ and only provides proxy variables to track consolidation and shared water services. Thus, we recognize that the results produced by our analysis include both Type 1 and Type 2 error.



Type 1 error in our data occurs as our proxies, number of deactivations and primary source changes, encompass a larger number of systems within SDWIS. A system being deactivated or a primary source change may simply be what the name suggests and not an instance of consolidation.

Type 2 error occurs in our data because systems that have been consolidated may not be encompassed in our proxy variables. When a system is consolidated, it may still remain active in the SDWIS database and will not be included in the number of consolidated systems represented by deactivation dates. Similarly, consolidation as we understand it in our report as either technical or managerial consolidation may not be accounted for by primary source change.

Methods

There are three primary components of this analysis:

- 1) frequency and distribution of consolidation across the U.S.,
- 2) interconnectedness of water systems, and
- 3) illustrating the geospatial distribution of shared water services, using Texas as an example.

To evaluate the frequency and distribution of consolidations across the U.S., we analyzed CWS deactivations and activations from 1985 to 2020.

We then focused our analysis on the ten states that have indicated²¹ the use of SDWIS deactivation dates to track consolidation: Oklahoma, Utah, Kansas, North Dakota, Vermont, Colorado, Arizona, Maryland, New York, and Iowa. The data analyzed from these states may better represent consolidation within them.

Secondly, we evaluated the relationship between primary source changes and wholesalers as a measure of shared water services. Yearly changes from 2013 to 2020 were analyzed where a CWS changes from an “independent” to a “purchased” primary source or vice versa. If a water system is purchasing water, it indicates they have a connection with a nearby system, and therefore, may represent a consolidated system, though the information of where they purchase water is not captured in SDWIS.

Lastly, we conducted a deeper dive in Texas to illustrate the geospatial distribution of shared water services between purchasers and wholesalers of water. By mapping the water system boundaries of wholesalers and comparing it to the maps of water districts that purchase water, we are able to do a rudimentary analysis of whether systems that are wholesalers neighbor systems that purchase water. If such connections exist, this could point to the possibility of interconnected systems and provide a useful understanding of water security.

²⁰ Norriss, J. (2021, March 2). Improving federal record-keeping for enhanced understanding of water systems in the US. EPIC. <http://policyinnovation.org/improving-federal-record-keeping-for-enhanced-understanding-of-water-systems-in-the-us>

²¹ In collaboration with the Association of State Drinking Water Administrators (ASDWA) and Rural Community Assistance Partnership (RCAP), we conducted a survey of drinking water administrators across the United States in March 2021 to understand the role of consolidation in water system management. In particular, we looked at the frequency of consolidation in each state; the reasons that systems may choose to consolidate; barriers to consolidation; agencies involved in the consolidation process at the state level; and planning, financing or policy mechanisms that facilitate consolidation. A summary of the survey findings is forthcoming in Journal AWWA.

Results

How much consolidation is happening and where?

The simplest way to potentially understand consolidation is to review the “deactivation date” of water systems. This is the date at which the water system no longer remains active and can be used as a proxy for consolidation. Deactivations, however, are not happening in isolation. New water systems are constantly being created or “activated,” so at any point in time there are deactivations and activations taking place in a state; the net difference is the change in active water systems at that point.

Activations and Deactivations of Community Water Systems



Figure 1. CWS Activated and Deactivated per capita per year from 1985 to 2020

Figure 1 shows a national overview of the deactivated and newly activated systems per capita from 1985 to 2020. This snapshot of CWS reveals that more systems are being deactivated than activated; in 1985, there were 56,614 active community water systems, and in 2020 there were 47,980 active community water systems, a 15% decrease in the number of community water systems nationwide. States such as Arkansas, Idaho, and Wyoming have had large numbers of systems being deactivated prior to the 2000’s. Other states like South Dakota and West Virginia show large spikes in deactivations compared to activations between 1990-1995 and 2010-2015, respectively.



Figure 2. Net Number of CWS per year

Visualizing the net number of activated systems, the difference between new activations and deactivations in any given year, nationwide from 1985, we can see more clearly that most states have experienced system deactivations. The deactivations between 1990-1995 of California and North Carolina stand out in particular with 807 and 456 net deactivations, respectively. Furthermore, from 1985 to 2020, there was a net number of 7,941 system deactivations nationwide, which corresponds to a 14% decrease in the number of systems since 1985.

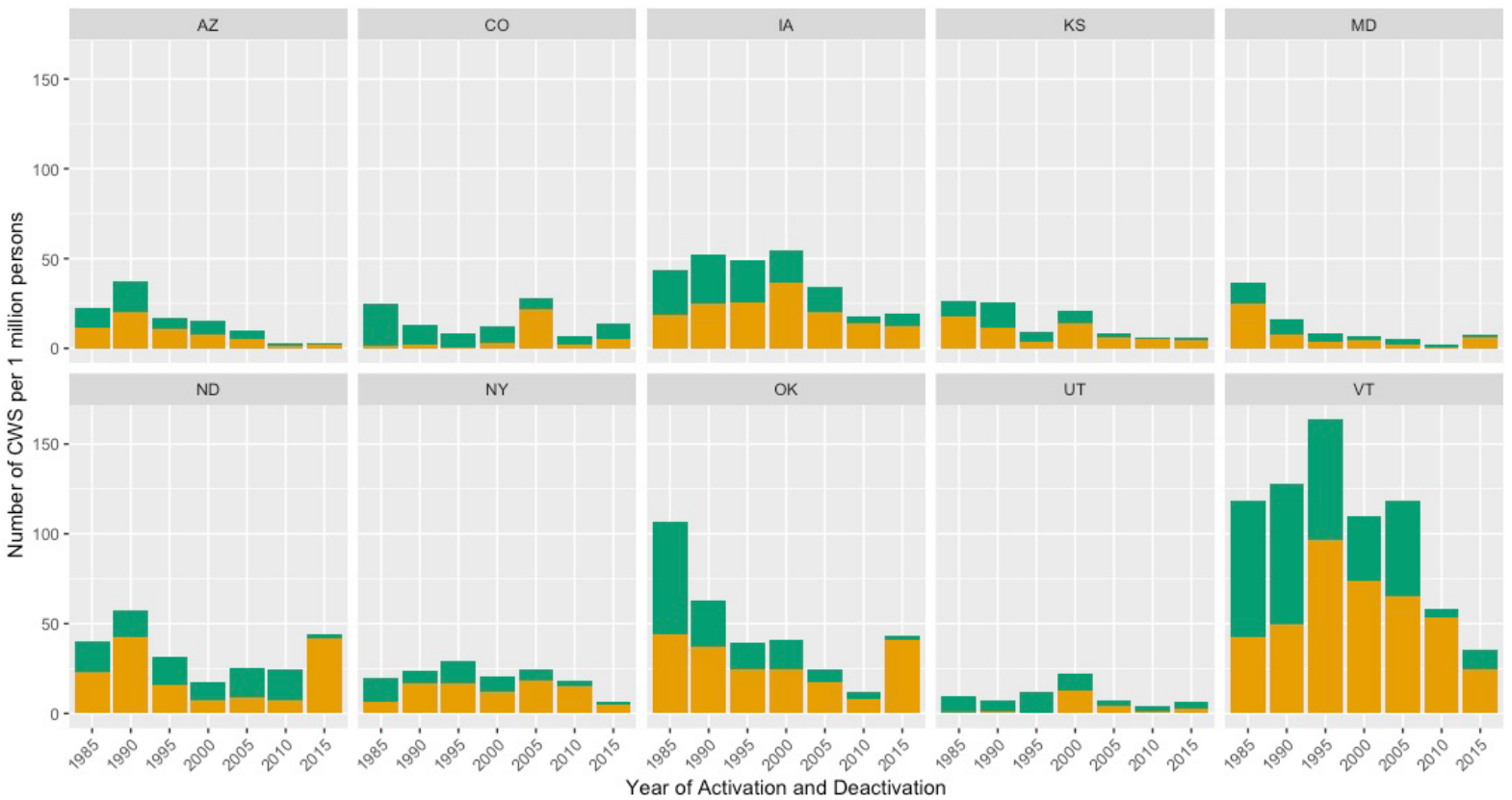


Figure 3. Number of CWS activated and deactivated per capita per year from 1985-2020 (Survey States)

Among the states that participated in the EPIC-ASDWA-RCAP survey (see Footnote 22), Figure 3 shows the 10 states that have stated they use SDWIS to track consolidations. We assume these states have accurate records of activation and deactivation dates, and thus, that their SDWIS records are likely to be more reliable. This figure shows that, on average, more systems are being deactivated than activated. For example, we can see that New York and Oklahoma consistently have deactivated more systems than they have activated per capita, with the exception of years from 1985 to 1990. Additionally, despite the large number of system activations for Vermont, the state has a net number of around 78 deactivations from 1985 to 2020 per capita. Colorado is the only state that has more system activations than deactivations; this may be attributed to Colorado’s 180% increase in population during this 35 year time period. In contrast, the U.S. as a whole experienced only a 139% increase in population over the same period of time.²²

²² Population and Housing Unit Estimates. (n.d.). The United States Census Bureau. <https://www.census.gov/popest>

Shared water services between systems

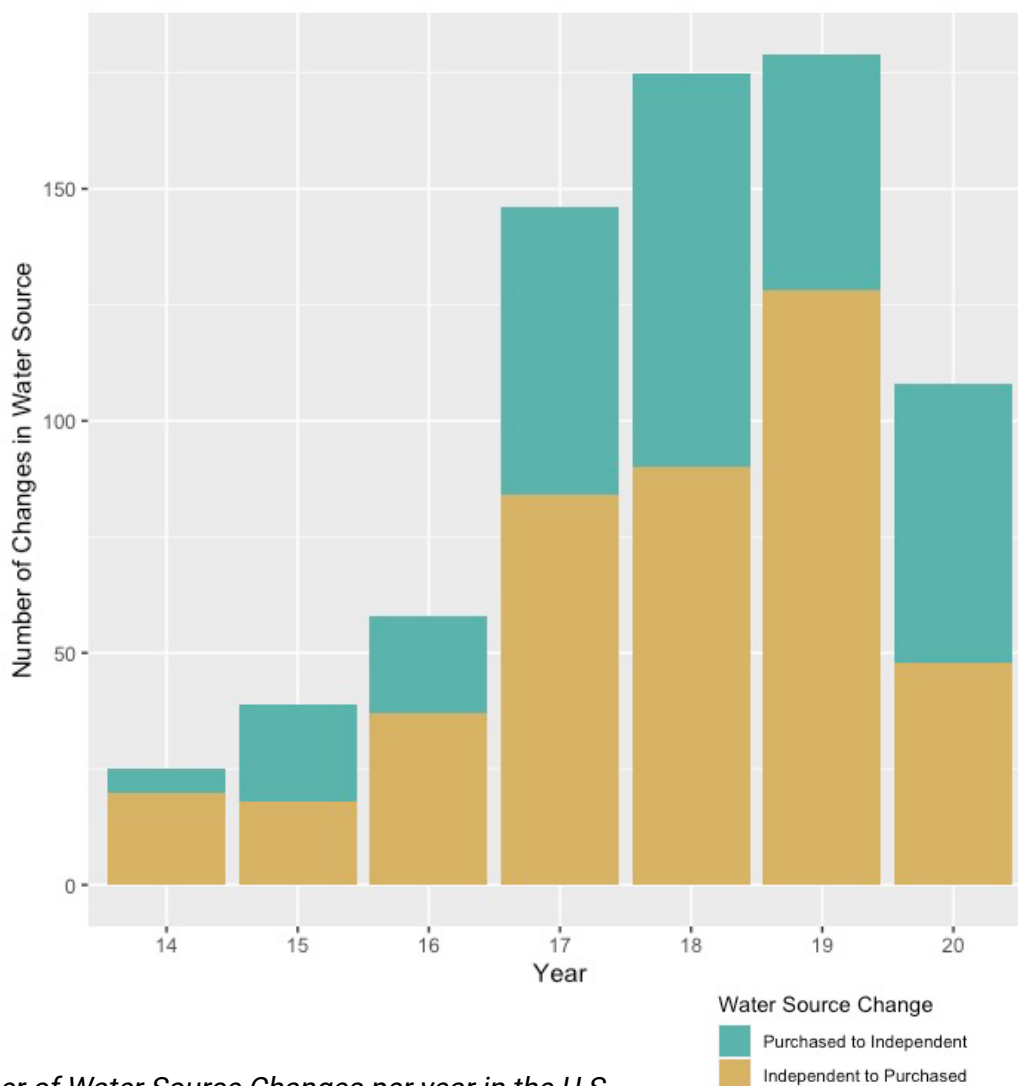


Figure 4. Number of Water Source Changes per year in the U.S.

Purchasing water from another system is one example of sharing water services. With SDWIS data, we can measure the instances where any given system's water source changes from independent to purchased and use that as a proxy for consolidation. It is important to note that water systems' primary water source is changing in both directions; some water systems are switching from independent primary sources to purchased ones suggesting some level of consolidation, while others are moving away from consolidation.

Figure 4 displays a clear trend of the increasing number of systems changing their primary water sources with the exception of 2020. Between 2013 to 2020, there were 730 changes in the sourcing of the primary water source, of which 58% of system changes were from independent to purchased primary sources and 42% of changes were the inverse.²³ Therefore, more systems overall are changing from independent to purchased primary sources. A majority of these source changes were in a handful of states, namely Texas and Washington.

²³ Overall, however, systems that experienced changes make up a small fraction of the total number of CWS nationwide.

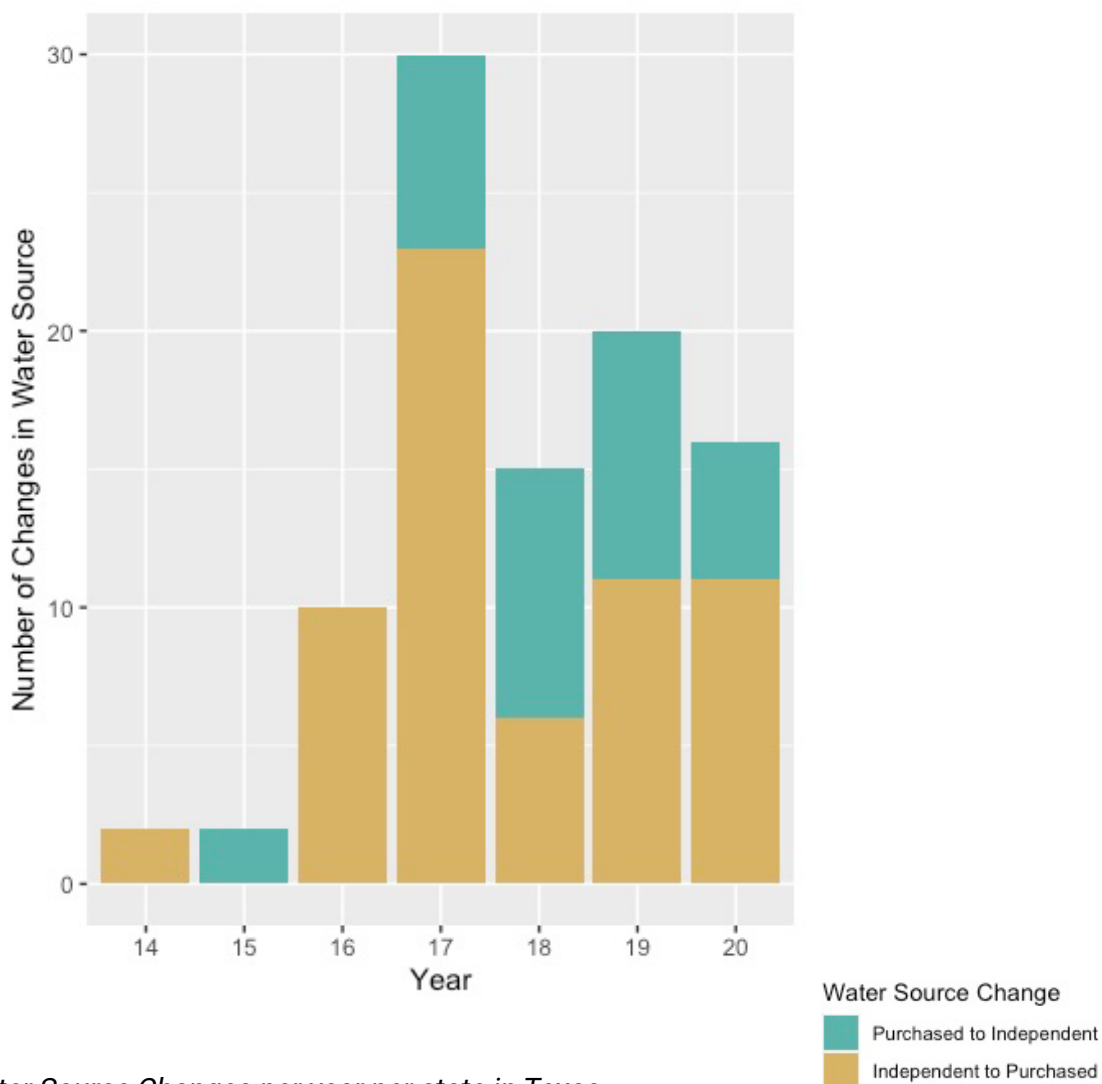


Figure 5. Number of Water Source Changes per year per state in Texas

Texas has the second highest number of wholesaler systems, with almost 63% of all wholesale systems in the U.S. in 2020. And on average, more systems in Texas are changing from independent water sources to purchased sources. This is representative of the national trend seen in Figure 4 with more systems changing to purchased water sources. In Texas from 2013 to 2020, there were a total of 95 system changes; around 66% were changes from an independent primary source to a purchased primary source.

Geospatial distribution of water systems connectedness in Texas

To further this analysis we mapped the Texas water system boundaries to evaluate the geospatial distribution of purchased versus independent water sources. We understand that Texas is unique in its use of Municipal Utility Districts (MUDs)²⁴, but we only focus our analysis on what we can learn about the shared services between CWS from SDWIS.

To contextualize the results, SDWIS data shows that in 2020, there were 9,045 CWS in the US that used purchased water as their primary source (19%) and 36,420 systems, or 76%, that had an independent primary source. Comparatively, in 2020, Texas only had 1,123 systems, or 25%, using purchased primary source water and 3,342, or 75%, systems using independent primary sources.

²⁴ Municipal Utility Districts (MUDs) are special governments that are made up of various utility systems such as water and electricity, as an alternative way to finance their facilities.

Primary Water Source

● Independent ● Purchased

Is Wholesaler?

● Yes ● No

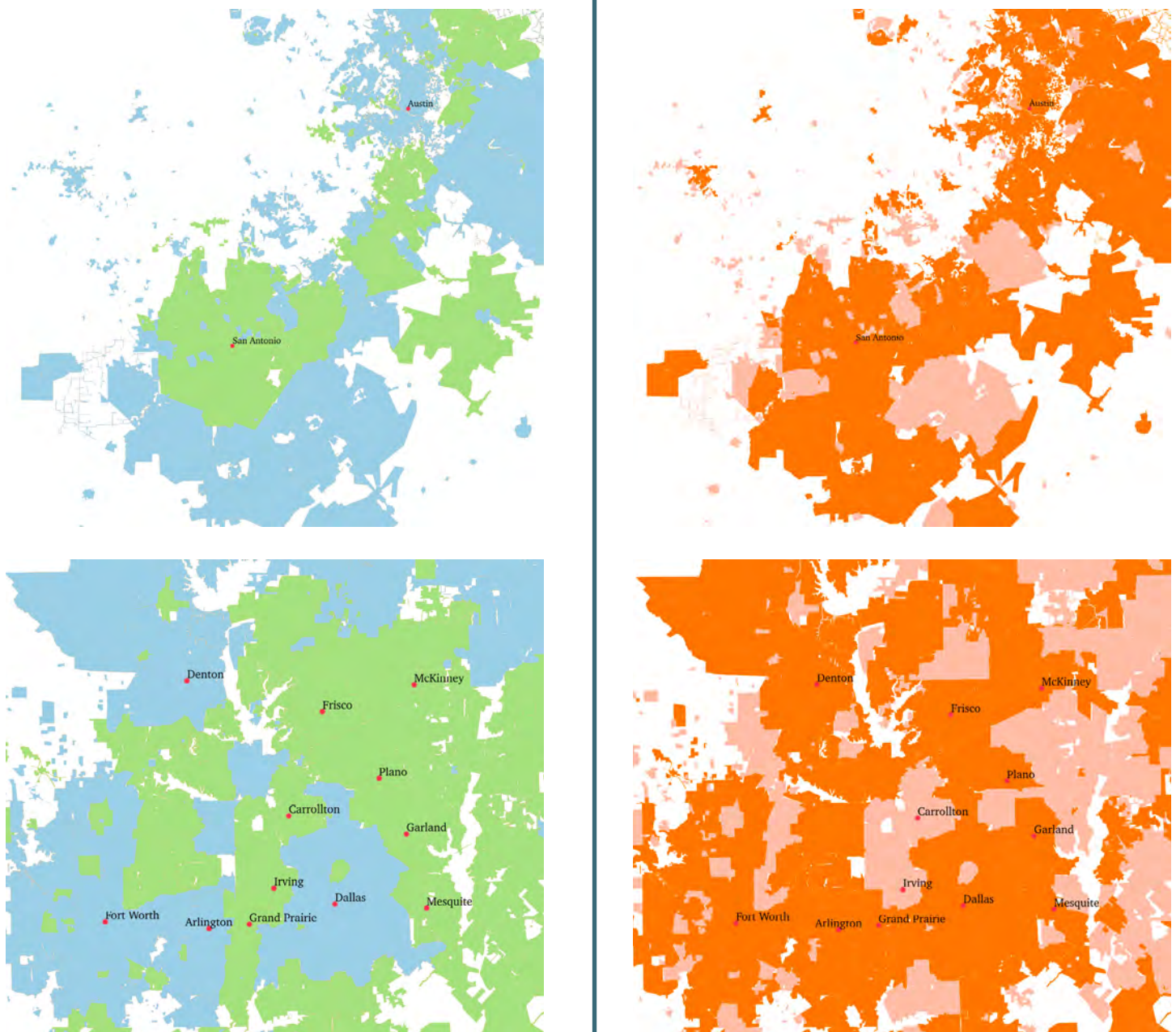


Figure 6. Systems purchasing water or having an independent water source (left) and Systems that act as a wholesaler (right) in Austin and San Antonio (top) & Dallas (bottom) regions in Texas

Looking at the systems surrounding the three major cities in Texas – Austin, San Antonio, and Dallas – we can see that there is no relationship between water wholesalers and systems that use purchased water as their primary source. For example, a majority of the systems in and around San Antonio that purchase water are also wholesalers of water. This would mean that systems that are selling water are at the same time purchasing their water from a different source, and with the current data we have, we are unable to fully understand these relationships and tell how any of these systems are connected. Although Dallas has more systems that are wholesalers with their own independent primary water source, the map shows no consistency with this correlation as some systems are still wholesalers that use purchased water as their primary source.

Discussion

The main takeaway from our analysis of SDWIS data is that EPA's federal database is not robust enough to capture partnerships in the U.S. Key information on the water systems are missing, including the most critical piece that tracks when the system was deactivated due to consolidation and which other system it consolidated with. Without this data, proper tracking of consolidation cannot be done; this limits the assessment of current and proposed strategies that aim to improve the water quality of CWS.

Amidst these significant limitations, there were some components of our analysis that were valuable to inform how consolidation may be occurring and where there are opportunities for improvement in water system data tracking and consolidation processes:

- 1) More systems are being deactivated than are activated, suggesting that consolidation is occurring, but at a much slower pace than experts recommend. Based on the historical rate of consolidation, the total number of systems would still be roughly 43,000 in twenty years, while reaching the goal of 75% reduction to 12,500 systems would only occur in the 2130s.
- 2) Water systems switch their water source regularly and most of these switches are from "independent" water sources to "purchased" which suggest additional forms of consolidation that are currently harder to track.
- 3) With enough information on water system service boundaries, it is possible to create a map of the geographical location of water systems, but more information is needed to understand the shared water services between systems.



First, using deactivation dates of the water systems as a proxy for consolidation, the data from SDWIS suggests that the consolidation of systems is happening throughout the U.S. However, with the current data available for analysis, we are unable to tell how many instances of consolidation are happening in each state per year, or even if the number of consolidations per state are rising or decreasing each year. Additionally, other than the ten states shown in Figure 3 that have explicitly stated they use deactivation dates to track consolidation, we do not know whether any other states track consolidations the same way and, therefore, are unable to accurately infer instances of consolidation from deactivation dates. The limited data of SDWIS also leaves questions about the time frame of any consolidation process completely unanswerable.



Second, tracking primary water source changes is an alternate method to understand consolidation trends in the U.S. Figures 4 and 5 show that more systems are changing to purchasing their primary water source. Although this trend is currently not captured in the traditional assessment of consolidation of water systems, the increased number of systems purchasing water suggests sharing water services could be an effective form of collaboration to increase water security and quality. That said, without more information on the details of which systems are purchasing from one another, it is not possible to determine which are physically connected to one another. Furthermore, data on the primary water source for systems face the same inaccuracies as data on deactivation and activation dates. States may fail to properly report a system's primary water source or fail to update a change that complicates any analysis that can be done through the data available through SDWIS.

Finally, the geospatial analysis reveals little in terms of how systems share water between one another. If systems that purchase their primary water source neighbor a wholesaler system, this might suggest that the two systems are interconnected as the system could be purchasing water from the wholesaler, or have other water sharing agreements in place. However, within our preliminary analysis of Texas, we are unable to see this relationship as SDWIS data reveals that wholesaler systems are at the same time also purchasing water. From the current data we have, we are unable to make inferences about the shared services between water systems. What's more, only 15 states have their water system boundaries published online at all. Without this information, no conclusion about the current shared services between water systems in the U.S. can be drawn.

Policy Recommendations

Based on this analysis of the feasibility of using SDWIS for tracking consolidations and shared services, we make the following policy recommendations:



Finalize an expansive Water Systems Restructuring Rule. The Environmental Protection Agency (EPA) is considering the Water Restructuring Rule to encourage states to have greater authority to enable consolidation. This rule is overdue for being finalized and we believe this federal policy and relevant state policies need to be a higher priority. This would include policies that create stronger incentives for voluntary consolidation and more authorities to mandate consolidation when a utility cannot meet its customers' needs. In addition, health equity should be a driver of consolidation.

Adopt more state policies and programs. More states should pass laws and build consolidations programs like these West Virginia, North Carolina, Kansas, and California have done - such policies should include a focus on explicit record-keeping around new utility creation, consolidation, and shared service agreements, mandatory consolidation authorities for repeated violations and fiscal insolvency problems, and incentives and state funding to support it.



Expand the scope of SDWIS data

A more comprehensive database will allow for better analysis and research on water system consolidation, and therefore, better policy outcomes. An important step to achieving that is to create a better system of tracking water systems, as well as shared services, so that struggling systems can be promptly identified and solutions to their challenges developed. This will also be vital to the EPA's forthcoming [Water Systems Restructuring Rule](#) which would provide a framework for states to assess restructuring for systems that are persistently in violation or have recent health-based violations. A comprehensive database to support these efforts should include data on:

- (1) Identification of persistent violators and those with recent health-based violations,
- (2) Systems that have been physically consolidated,
- (3) The date of consolidation between systems, and
- (4) Systems that are managerially consolidated or share services with another system.

In addition, the following components would also be helpful to include:

- (1) The date that negotiations between systems for consolidation started,
- (2) What type of consolidation—physical or managerial—was implemented, and
- (3) Which systems have shared services, e.g. water sharing agreements, shared operators or staff. This should also include with whom the shared services are with.

Contextual data, as outlined above, will provide a comprehensive understanding of water systems, which is currently unavailable, not just to the general public, but also to policymakers and water experts.

Improve the quality of SDWIS data

As noted in prior research, the fidelity of SDWIS data on water systems is not guaranteed. Errors identified by other researchers include: the wrong dates of deactivations, failure to update the database when systems are deactivated, and wrong dates of system activations.²⁵ Inconsistencies in data entry prevent meaningful inferences to be drawn about water system consolidation in the U.S.



Track consolidation outcomes

Little is known about how consolidation efforts affect water quality, affordability and consumer trust. This is due, in part, to the lack of data on when and how consolidation happened, but also because collecting information on consolidation outcomes is not required. Outside of case studies, there are few studies that report on consolidation outcomes across several instances of water system consolidation, making it harder for decision-makers to rely on empirical evidence. When state or federal officials do not have easily accessible information about where consolidation is a feasible option or the effects of consolidation, they are less likely to promote this as a pathway for improved water stewardship.

Keep track of water system boundaries at national or state levels

Roughly 15 states publish data of the boundaries their water system serves. Very rarely are they easily available to the public or for research and analysis. However, even for those that publish this information, data on points of interconnection between systems as well as any water sharing agreements between systems are lacking. Additional data that are currently not collected but would significantly aid consolidation efforts include water system boundaries and system interconnection. Moving forward, states should collect and share this data to guide policy making and the implementation of improved water management plans.



Increase communication between water systems

The EPA and states need to increase programs that facilitate the communication between systems to better understand the feasibility, desirability and potential benefits of consolidation in the U.S. Then, there must be clear leadership and guidance to initiate contact between small water utilities and nearby systems that have sufficient resources to consolidate, either physically or managerially.

The [Water and Wastewater Agency Response Networks \(WARN\)](#) is designed to provide one-on-one response to affected utilities during emergencies. WARN could either serve as a model for improving water system communications, or be expanded to include small systems that would benefit from consolidation or regionalization efforts.

The proactive nature and efforts of federal and state governments will determine the resilience of water systems in the U.S. By following guidelines and models already established, in combination with better tracking of data, partnerships, through consolidation or regionalization, can address many of the challenges plaguing small systems and help achieve better water quality standards for the people they serve.

Tracking of the additional information we recommend would benefit policy and programmatic assessment of the current state of water system partnerships across the country, flag potential situations where consolidation may be needed to address chronic problems, and also help identify successful partnerships that could be scaled broadly. State efforts like those in California or North Carolina can serve as models to the EPA for the types of outcomes that are enabled by better record keeping, funding and communications around consolidation. Examining each of these pieces of policy more closely will provide a greater understanding of the various approaches, outcomes, and factors involved.

Given the scale of water system challenges, we are already observing a heightened level of state action and in the next few years likely to see measures at the state level to assess, track, and consolidate poorly performing water systems. This will provide us with large-scale data and allow us to monitor the implementation of these laws and assess the outcomes.

²⁵ Beecher, J., Redican, K., & Kolioupoulos, M. (2020). (Mis)Classification of Water Systems in the United States. SSRN, 1–38. <https://dx.doi.org/10.2139/ssrn.3627915>

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