The Water Confidence Index (WCI): Its Development and Construction

By Noah Portman

This report describes the development and methodology of the **Water Confidence Index (WCI)**, an environmental composite index that seeks to compare the overall reliability and environmental health performance of public water systems (PWS), or utilities, across the United States. The WCI is an index that uses data mainly reported by the U.S. Environmental Protection Agency (EPA) of violations to the Safe Drinking Water Act (SDWA). The following section includes the background information and purpose as to creating this index and its implications for ranking and measuring the country's national water infrastructure.

Introduction and Purpose

A simple online search for water utility indexes will yield results navigating you to lists of companies by market value cap. However, currently there does not exist a single index in the country or world that seeks to rank PWS in an open and clear method based on their environmental impact. While the CDC suggests that the United States is fortunate to have one of the safest public drinking water supplies in the world, there are many utilities that are struggling to keep up with regulations due to financial strain and aging infrastructure ("Public Water Systems | Drinking Water | Healthy Water | CDC" 2021). Increasing concerns over the health of the infrastructure and the maintenance of the systems warrants ongoing investigation. The American Society of Civil Engineers (ASCE)'s 2021 *Report Card for America's Infrastructure*, released on March 3, signals a gradual move forward for the nation's infrastructure ("ASCE's 2021 Report Card Marks the Nation's Infrastructure Progress" 2021). Of the 16 existing individual infrastructure categories assessed as part of the 2021 report card, five sectors, including drinking water, improved. The last report, released four years ago in 2017, ranked the nation's drinking water infrastructure at a "D", but since then the score has improved to a "C-". According to ASCE, this is due to an improvement in the pace at which water agencies are replacing their existing waterlines. The rate of replacement of waterlines has gone from 0.5 percent per year to nearly 1.5-4.8 percent, depending on the utility ("ASCE's 2021 Report Card Marks the Nation's Infrastructure Progress" 2021). Due to the much-needed investment in our drinking water infrastructure, an index that seeks to determine the overall PWS reliability and health, such as the WCI, is necessary and will help potentially advocate for companies and services that are outperforming those not complying with regulations and perhaps also experiencing declining water use.

The latest ASCE report ultimately states that sustained investment is the only way to ensure that the drinking water category continues to improve, even in the face of pressing issues such as emerging contaminants. Additionally, an earlier economic study, "The Economic Benefits of Investing in Water Infrastructure: How a Failure to Act Would Affect the U.S. Economic Recovery" found that the annual drinking water and wastewater investment gap will grow to $434 billion by 2029. Drinking water utilities also face increasing workplace challenges. Much of the current drinking water workforce is expected to retire in the coming decade, taking their institutionalized knowledge along with them ("Drinking Water" 2017).

The Biden Administration recently announced an extremely ambitious $2 trillion dollar infrastructure plan, The American Jobs Plan, aimed at creating jobs and rebuilding U.S. infrastructure. The plan includes $111 billion dedicated towards clean water and drinking water investments, proposing $56 billion toward upgrading and modernizing wastewater, stormwater, and drinking water systems through grant and low-cost loans, another $45 billion specifically towards a goal of removing 100 percent of lead service lines across the country, and $10 billion for monitoring and remediating per- and polyfluorinated substances (PFAS) in drinking water (WFM Staff 2021). This is in stark contrast to past funding of water infrastructure, since about two-thirds of public spending for capital investment in water infrastructure since the 1980s has been by state and local governments ("Drinking Water" 2017).

In addition to the problem of underfunded water infrastructure in the past, PWS experience rising threats from other places, both foreign and domestic. In February, a cyberattack at a wastewater utility in Oldsmar, Florida was hacked, and levels of sodium hydroxide were adjusted to dangerous levels (Kardon 2021). Luckily, the attack was spotted and stopped in time before a release into the public drinking water system. Infrastructure facilities, especially smaller ones, are more vulnerable to cybersecurity issues, and need to stay up to date with the latest security measures to prevent these sorts of hackers from infiltrating such critical resources.

The winter storm in Texas this past February left millions of people without power and tens of thousands of water main breaks forced localities to issue boil-water notices (Booker and Romo 2021). ASCE's 2021 Report found that there is a water main break every two minutes, and an estimated 6 million gallons of treated water is lost each day in the U.S., enough to fill over 9,000 swimming pools. There are 2.2 million miles of pipe in the United States, all of which needs to be monitored and maintained. However, water utilities are improving their resilience by developing and updating risk assessments and emergency response plans, as well as deploying innovative water technologies like sensors and smart water quality monitoring ("Drinking Water" 2017).

EPA has been protecting the public health by regulating the nation's public drinking supply since instituting the SWDA in 1974. The law was amended in 1986 and 1996 and requires many actions to protect drinking water and its sources – rivers, lakes, reservoirs, springs, and ground water wells. SDWA authorizes the EPA to set national-based standards for drinking water to protect against both naturally occurring and man-made contaminants that may be found in drinking water (US EPA 2015). However, there are approximately 155,693 PWS in the United States, which is an overwhelming number to regulate and report on annually.

Framework

As detailed above, there are a variety of factors that determine the overall maintenance and safe operation of public water services. However, not all these factors can be taken into consideration when creating an environmental composite indicator due to limitations in data availability and complexity. Therefore, the WCI focuses exclusively on two unique components to help rank the different states in the country.

The two components to the WCI are Environmental Compliance (EC) and Truthful Reporting (TR). As part of the SDWA, the EPA has set maximum contaminant levels (MCL), as well as treatment requirements for over 90 different contaminants in public drinking water. Additionally, every public water system or community water supplier must provide an annual report, sometimes called a Consumer Confidence Report (CCR), to its customers. These reports provide information on local drinking water quality, including the water's source, contaminants found in the water, and how consumers can help protect their drinking water.

The WCI is calculated by taking the arithmetic mean of the EC and TR components. EC is calculated from multiple indicators related to environmental health (see next section for more on data sources). These include health-based and acute health-based violations by PWS (40% weight), percentage of serious violators subtracted by the percentage of return to compliance serious violators (40%), and violations per site visit (20%). TR is calculated primarily from the enforcement per violations indicator (60%), as well as the monitoring-based and public notice violations (40%). Some of these indicators undergo transformations using the min-max method to improve the data handling, as discussed in the following section.

Data and Methods

The Enforcement and Compliance History Online, or ECHO, website is designed to provide easy access to EPA's compliance and enforcement data. There are facility search features and customizable onscreen display and downloads. ECHO has compiled datasets available for download for developers, programmers, academics, and analysts. The data is available towards the bottom of the webpage (https://echo.epa.gov/tools/data-downloads) and the dataset is titled "Drinking Water Data Downloads". A help page and description are also available on the website.

The dataset is also called The Safe Drinking Water Information System, or SDWIS, and contains information on public water systems from the Public Water System Supervision (PWSS) Program, including monitoring, enforcement, and violation data related to requirements established by the SDWA for the years 2011-2020. While a drinking water dashboard is available through ECHO, which provides an overview of the regulatory activities of EPA and the implementing states, tribes, and territories, it does not necessarily rank or order them in a format that is easily interpretable. There are seven downloadable comma-separated value (CSV) files that comprise the SDWIS data (see Figure 12).

According to the EPA, public drinking water systems consist of community and non-community systems ("Public Water Systems | Drinking Water | Healthy Water | CDC" 2021). A community water system (CWS) supplies water to the same population year-round. It serves at least 25 people at their primary residences or at least 15 residences that are primary residences (i.e., municipalities, mobile park, or sub-divisions). Non-community water systems (NCSW) are composed of transient and non-transient water systems. Transient non-community water systems (TNCWS) provide water to 25 or more people for at least 60 days/year, but not to the same people and not on a regular basis (i.e., gas stations or campgrounds). Non-transient non-community water system (NTNCWS) regularly supply water to at least 25 of the same people at least six months per year, but not year-round (i.e., schools, factories, office buildings, and hospitals which have their own water systems). Approximately 33.5% of the PWS in the U.S. are CWSs and 66.5% are NCWSs (see Figure 1) ("Public Water Systems | Drinking Water | Healthy Water | CDC" 2021). However, over 286 million Americans get their tap water from a CWS and only 8% of U.S. CWSs provide 82% of the U.S. population through large municipal water systems.

For the sake of developing the WCI, I determined that I would use only "large" and "very large" PWSs, which serve between 10,001-100,000 people and >100,000 people, respectively. As previously mentioned, most of the population (approximately 77%) is serviced by large municipal water systems, so cutting down the number of PWSs in the original ECHO dataset from over 166,000 to 4,366 helps manage the data and computations. Additionally, Tribal water systems and Territories were not evaluated for the index. Annual estimates of the resident population for the United States, Regions, States, and Puerto Rico for the dates from April 1, 2010 to July 1, 2019 was retrieved from the United States Census Bureau (Bureau n.d.).

There are many SDWIS-derived elements that appear in the ECHO SDWA download and using the SDWA Data Element Dictionary (https://echo.epa.gov/tools/data-downloads/sdwa-download-summary) is useful in being able to decipher and navigate the various CSV files. When filtering in the downloaded files, I was able to filter out by PWS size and only consider the large and very large systems. Additionally, I needed to count the total number of PWS, serious violators, and return to compliance serious violators, by deleting duplicates over the 9 years of reporting and using pivot tables to sum each state. Total violations, site visits, and enforcements were calculated using all years of available data, even repeating PWSs. Serious violators are public water systems with unresolved serious, multiple, and/or continuing violations that is designated as a priority candidate for formal enforcement, as directed by EPA's Drinking Water Enforcement Response Policy. EPA designates systems as serious violators so that drinking water system and primacy agencies will act quickly to resolve the most significant noncompliance. Many public water systems with violations, however, are not serious violators. When a serious violator has received formal enforcement action or has returned to compliance, it is no longer designated a serious violator. EPA updates its serious violator list on a quarterly basis ("SDWA Data Download Summary and Data Element Dictionary | ECHO | US EPA" n.d.).

Violation names are required to be reported under the SDWA and are grouped into the four categories previously mentioned: health-based, acute health-based, monitoring, and public notification (see Figure 2). Regulations recorded as violations in the SWDIS are broken down by chemical contaminants, microbial contaminants, and right-to-know rules. Chemical contaminant regulated rules include the arsenic rule, chemical contaminant rule, lead and copper rule, radionuclides rule, and variance and exemptions rule. Microbial contaminant regulated rules include ground water rule, stage 1 and stage 2 disinfectant/disinfection byproduct rule, surface water rule, and total coliform rule. Right-to-know rules include consumer confidence report rule and public notification rule.

Table 1 lists the parameters in a "Code Book" that are used in calculating the WCI. The parameters denoted with an asterisk (*) before the name are transformations of the code of the same name without the asterisk. The min/max method was chosen as the preferred method of normalization. The normalization of some parameters was necessary before further data manipulation were conducted to calculate the arithmetic mean of both EC and TR. The following equations summarizes how both EC and TR are calculated.

*EC = 0.4 x *ENV_HEALTH_%_POP +* *(Equation 1)*
0.4 x %_RTC +
*0.2 x *VIOLATIONS_PER_SITE_VISIT*

*TR = 0.4 x *PUBLIC_HEALTH_%_POP -* *(Equation 2)*
*0.6 x *E/V*

The environmental health category is the summation of violations of acute health-based and health-based violations, while public health is the summation of monitoring and public notice violations. Both parameters are multiplied by the percentage of population served in each state to account for the actual consumption from these utility sources. Therefore, states with higher percentages of population served by the larger public utilities will have a greater weight attributed from the violations on their EC and TR scores. Note how in Equation 2 the enforcement over violation (E/V) indicator is subtracted. A greater E/V suggests greater management and/or agency action as opposed to a lower score which shows that there are a larger number of violations than enforcements. The state with the highest E/V score is Indiana with an E/V ratio of 6.39. The state with the lowest E/V score is Washington with an E/V ratio close to zero.

According to Nardo and Saisana (2008) who composed the *OECD/JRC Handbook on Constructing Composite Indicators*, due to methodological issues doubts are often raised about the robustness of the composite indicators and the significance of the associated conclusions (Nardo and Saisana, n.d.). In the handbook, there are numerous statistical methodologies and technical guidelines that can help constructors of composite indicators to improve the quality of their outputs. One such analysis is the multivariate analysis, which is a useful preliminary step in assessing the suitability of the data set and will provide an understanding of the implications of the methodological choices, e.g., weighting and aggregation, during the construction phase of the composite indicator (Nardo and Saisana, n.d.).

Different analytical approaches, such as principal components analysis (PCA), cluster analysis (CA), or factor analysis (FA) can be used to explore whether the dimensions of the phenomenon are statistically well-balanced in the composite indicator. If not, a revision of the individual indicators might be needed. Although a PCA was not used in the construction of the WCI to measure the statistical significance of each component on the total uncertainty, correlation curves and matrices were used to measure the individual significance of the components to one another and to the overall WCI. The correlation matrix of each component's indicators can be found in Table 2. None of the input indicators for EC (Table 2a) or TR (Table 2b) were found to be significantly correlated. Figure 6 plots the correlation between the EC and TR scores among the states and shows that they are also not significantly correlated (0.46), which also helps validate considering these indicators as separate components in the final WCI and generally supports the robustness of the WCI construction. (The correlation between the number of violations and the WCI score was determined to be 0.70 and the correlation between the percentage of population served and the WCI was 0.28, which are both relatively insignificant). Results and sensitivity analysis are discussed in the following section.

Results

The results after calculating the WCI using the filtered ECHO data (i.e., without Territories and Tribes, and only using PWS with populations served >10,001) yielded the results in Table 3. Table 3 contains the transformed calculations for EC and TR, using Equations 1 and 2 listed in the previous section, as well as the final WCI score on a scale of 0-1 and the final state ranking between 1-50. A lower ranking corresponds to a lower WCI score, which indicates a state with better environmental compliance and more truthful reporting from PWSs. States with higher WCI scores are likely to have worse overall environmental compliance and worse truthful reporting from PWSs. The top five states with the highest ranking (i.e., low WCI scores) are Indiana, North Dakota, Minnesota, South Dakota, and Michigan. The five worst ranking states (i.e., high WCI Scores) are Oklahoma, Texas, California, Mississippi, and Idaho. Idaho had the highest WCI score of 0.86, while Indiana had the lowest WCI score of 0.03. (All raw data from data sorting and calculations are included in the Appendix in Table AT-2.)

To better visualize the results, I plotted the WCI scores in addition to the EC and TR scores separately for each state using QGIS (see Figures 8-10). Table 3 contains all the same information as these figures, but having the data displayed in a visual format helps interpret the data more easily and makes it more apparent which states are performing better or worse in each component. The quantile scales for each map are different, as can be seen by the legend in Figures 8-10, and the map helps visualize the full range of the scores better than a list of data in tabular form. Each of the scores was multiplied by 100 to show an integer score on the map.

I was also interested in determining how the results could be presented based on ranking of EPA regions as opposed to individual states. Formatting the ranking in this way also allows the EPA to see the bigger picture on which EPA regions are performing better than others, or where large public water utilities are experiencing less violations, more enforcements, and overall stronger water confidence. To calculate the ranking of the 10 EPA regions I assigned the designated EPA region (see Figure 11) to each state and performed an AVERAGEIF function to find the average for each specified region. Afterwards, the rank was assigned to each of the 10 regions. The results from that calculation can be seen in Table 4. The EPA region with the lowest WCI score (0.15) is Region 5, headquartered in Chicago and serving Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin. The EPA region with the highest WCI score (0.59) is Region 10, serving Idaho, Alaska, Washington, and Oregon. Region 6 and Region 9 are not far behind with 0.56 and 0.55, respectively. Region 9 serves California, Arizona, Nevada, and Hawaii (and Guam, Northern Mariana Islands, and American Samoa - not included in this study). Region 6 serves Texas, New Mexico, Oklahoma, Arkansas, and Louisiana. The divide between high- and low-ranking EPA regions are clearly separated by the northern Midwest states and southern central states, which is more obvious by looking at Figure 8.

Sensitivity Analysis

I conducted several different sensitivity analyses (SA) on the dataset to better determine the robustness of the WCI as a composite indicator. SA studies how much each individual source of uncertainty contributes to the variance of a country's composite indicator score or rank (Nardo and Saisana, n.d.). Histograms are helpful to determine the general distribution of the indicator variables. See Figure 3 for histograms of the number of violations, as well as EC, TR, and WCI scores when using the weighting and aggregation scheme described in the methodology. Before applying any sensitivity tests, at first glance, it appears that the indicator is well distributed between 0-1, meaning there are not many outliers that do not fit on the best fit curve. This can be seen by looking at the histogram of the WCI scores (Figure 3d). The histogram also has a nice bell shape curve, with a slight leaning towards lower WCIs. Another way to tell that the WCI scores fall on a nice linear plot is by plotting the WCI score and rank distribution curve (see Figure 7).

Different aggregating and weighting schemes can test the robustness of the data and skew the distribution, as well as determine sensitivity to change in rank. For my first sensitivity analysis, SA-1, I chose to change the weighting of EC from 0.4/0.4/0.2 to 0.7/0.2/0.1, more heavily weighted towards the ENV_HEALTH indicator. For the second sensitivity analysis, SA-2, I chose to change the weighting of TR from 0.4/0.6 to 0.7/0.3, more heavily weighted towards the PUBLIC_HEALTH indicator. For SA-3, equal weighting was assigned to both EC (0.33/0.33/0.33) and TR (0.5/0.5) scores. The corresponding histograms for the three sensitivity tests and the resulting change in ranks can be seen in Figure AF-1 and Table AT-1, respectively, in the Appendix.

The histograms for the more heavily weighted EC (SA-1) and TR (SA-2) reflect how distribution can become quite disproportional with too much weighting on the violation indicators (i.e. ENV_HEALTH and PUBLIC_HEALTH). The EC and TR histograms in A1 both tend to distribute more heavily on the lower ends. This can also be seen by the more sensitive change in rank of a few states in A2 for SA-1 and SA-2. For SA-1, Kentucky and West Virginia improve in WCI, and New Hampshire declines. For SA-2, there are also shifts in rank like SA-1, but primarily towards the middle ranks, and less so on the high WCI scores. Hawaii improves by several ranks, while Maine and Alabama decline in rank. The more heavily weighted TR towards violations in SA-2, shows that most of the sensitivity lies with the states with worse WCI (higher scores), since they have more violations. Number of violations and rank appear to be more correlated in SA-2 than the other sensitivity tests. Also, for SA-1 and SA-2, the top 10 WCI states (lowest ranks) do not shift much at all.

SA-3 tests to see how an equal weighting scheme for each of the components would affect the state ranks. The top states are not affected much from equal weighting, and generally not as drastic rank shifts occur throughout the states. However, Alabama and Kentucky both improve by 6 ranks with an equal weight for both components, indicating that these states are currently overestimated with the current weighting and aggregation method and are most sensitive in the WCI. The top two performing and worst two performing states do not drop out of their corresponding two spots in both SA-2 or SA-3, indicating that both ends of the WCI spectrum are not overly sensitive to a change in weight and it is more difficult to move from these positions. Further, I tested how many violations Mississippi would have needed to attain to drop out of bottom 10 ranks, and the number is close to 3,700 violations, which is the more than the total number of violations of the top 25 ranked states combined. The general distribution of scores is mostly linear (with an R^2 value greater than 0.96, see Figure 7), with some flattening occurring in the mid-rankings and a steeper slope at the very tails, indicating that rank shifts will occur more readily in the middle-ranked states.

Discussion

After ranking all the states and EPA regions by the newly established Water Confidence Index as discussed in the previous sections, we can begin to formulate suggestions and determine how this index can best be utilized by both the public and government agencies to improve policy.

Most Americans who are concerned about their tap water's quality can check the WCI to get a better idea as to where their state ranks against others. If the state is in a higher WCI range or lower WCI range easily indicates whether the large public water utilities in that state are complying with the SDWA drinking regulations and truthfully reporting to the public any issues with the water supply, such as reporting contaminants or annually releasing the CCR in a timely manner. The WCI makes it easier for someone to check the EPA ECHO website and discern through the noise of abundant regulation report statistics, i.e., it is not as easily interpretable in its current state due to the high quantity of PWS that are of less concern to the general public (i.e. NCSWs).

The EPA or whichever governing body that is given the authority to distribute federal funding for The American Jobs Plan, whether for state water infrastructure projects or larger loans or investments, will potentially wish to see which states are more in accordance with the SDWA. Therefore, a constructed index such as the WCI can give guidance or assurance to more influential agencies to decide how to best allocate funds and provide aid.

Self-Evaluation and Conclusion

I set out to devise an environmental indicator that can show how reliable and environmentally compliant large public water utilities are in the United States. The WCI in its initial stage of development seems to do a good job at evaluating many data indicator inputs, such as number of large (and very large) PWS, population served, number of violations, types of violations, number of enforcements, number of site visits, and serious violator status, and using these to calculate a state ranking. The two components do a fair job separating the WCI into its two primary goals: a) environmental compliance, and b.) truthful reporting. Given that all the data (besides for population data) comes from the ECHO database that is provided by the EPA, there may be some issues with the data. On the ECHO site, they even have the following notice about the available data:

> *"EPA is aware that the completeness and accuracy of state data are variable, and without investigation and program knowledge, data can be misleading or misinterpreted. Often,*

> *there is important context around data that must be taken into account to provide an accurate picture. For example, not all activities and violations may be required to be reported to EPA, and current year data may still be in the process of being reported." ("Analyze Trends: Drinking Water Dashboard | ECHO | US EPA" n.d.).*

Additionally, the data that is provided by the EPA is only the data that is reported and may not reflect all compliance and noncompliance within the state. Ultimately, attaining data at the individual public utility level is challenging and tedious, so using simplified state data can be helpful. The ECHO database for the SDWA is kept up to date each year and is therefore a good resource to continually download and update the WCI.

Wyoming was the only state that did not have any violations occur at large and very large PWS in the state, and therefore the top-sized medium PWS (3,301–10,000 people) were also considered when determining the number of violations in the state. This presents one weakness in the final WCI calculation. Similarly, small- to medium-sized PWSs and small private wells not regulated by the EPA are not included in this study. Future WCIs may wish to include smaller PWSs (i.e., a greater estimated population) and those from Territories and Tribes.

Other limitations exist in the WCI since the types of violations and component differentiation are assumed to be equally split, but the number of health violations is significantly less than the number of public health (i.e., monitoring and public notice) violations (see Figure 2). This uneven split is why the TR component accounts for less indicators than the EC component, however, perhaps a better breakdown of violations would be more appropriate for the WCI. This could include a third component for public notification and/or going into the various forms of how enforcement notice was given – State vs. EPA. In the future, the WCI may want to incorporate water-related negative health implications (i.e., hospital visits or rate of childhood waterborne diseases) into the truthful reporting category. This data is difficult to find on a state level and to attribute to specific violations and was therefore not included.

Furthermore, the ASCE 2021 report card measures the quality of drinking water infrastructure of each state by determining the overall projected cost over a 20-year period based on their needs. These were not included in the current WCI, however, integrating these state costs and dividing the number by state population could be included as an additional category as "cost of repair". Ultimately, these values could be tracked over time based on how much money is distributed by the federal and state governments. An economic component built into the WCI could allow for greater index value and connects funding with compliance and greatest need.

Constructing the WCI was an insightful way to think about the utility of data and its simplification of larger systems. Environmental composite indexes allow for straightforward comparison and tracking between groups to achieve sustainable goals and collective wellbeing. I believe that the WCI achieves its goal in its functionality as an environmental composite indicator and can influence people's behavior and perspective on the quality of their drinking water utilities, as well as encourage good government management and planning for future water infrastructure projects. Like any good index, the WCI presented in this report is only the start to pursuing this topic and should encourage future iterations and enhanced development.

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Figures

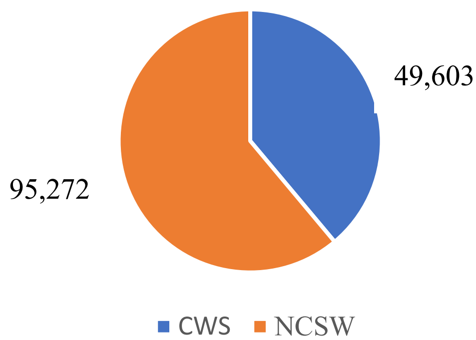


Figure 1. PWS by type (2021).

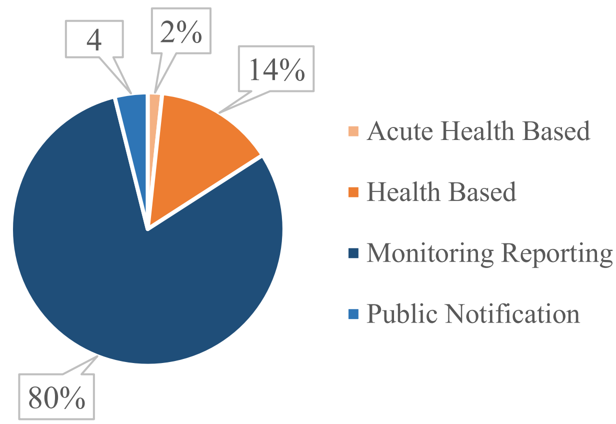


Figure 2. Violation categories.

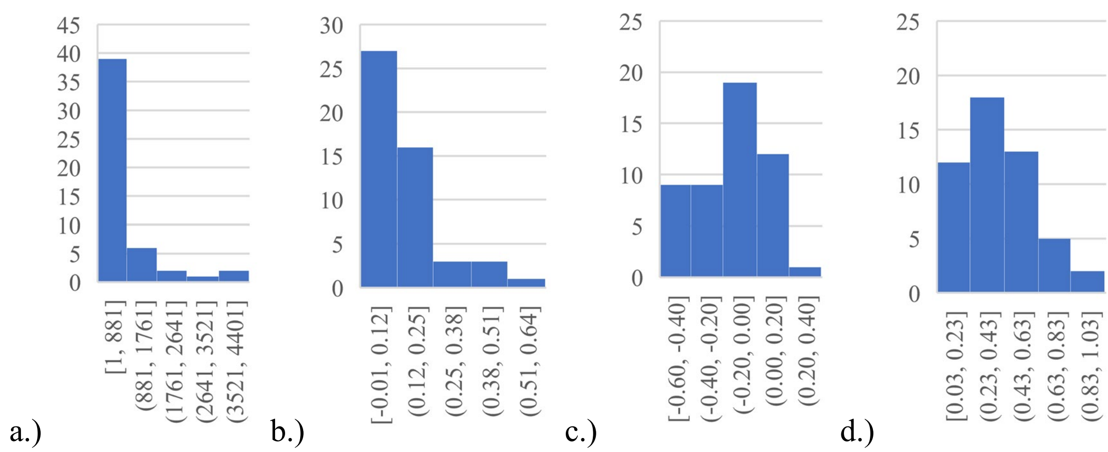


Figure 3. Histograms of a.) the number of violations, b.) EC (unnormalized), c.) TR (unnormalized), and d.) WCI scores.

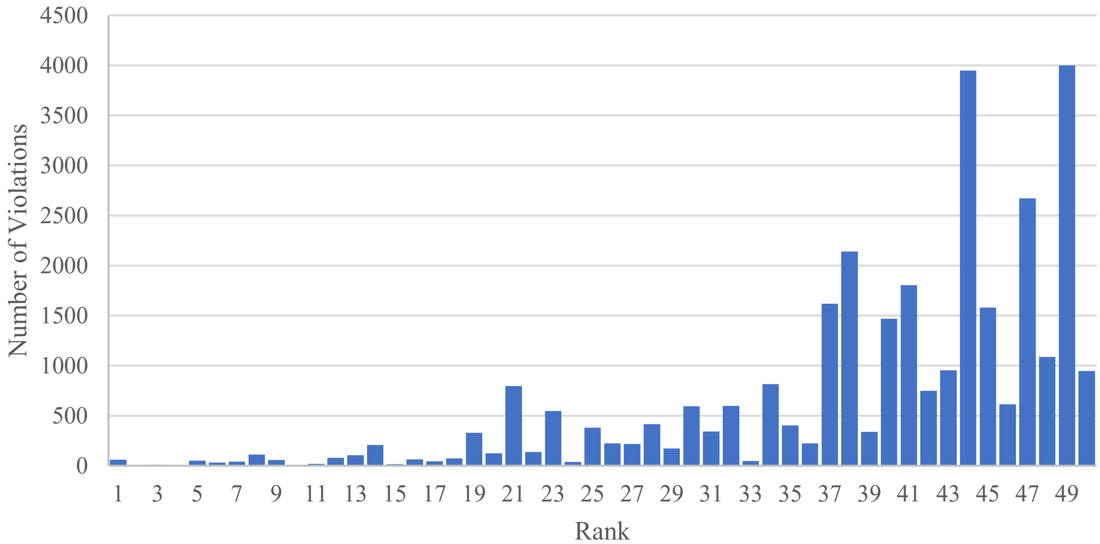


Figure 4. Number of violations vs. WCI rank.

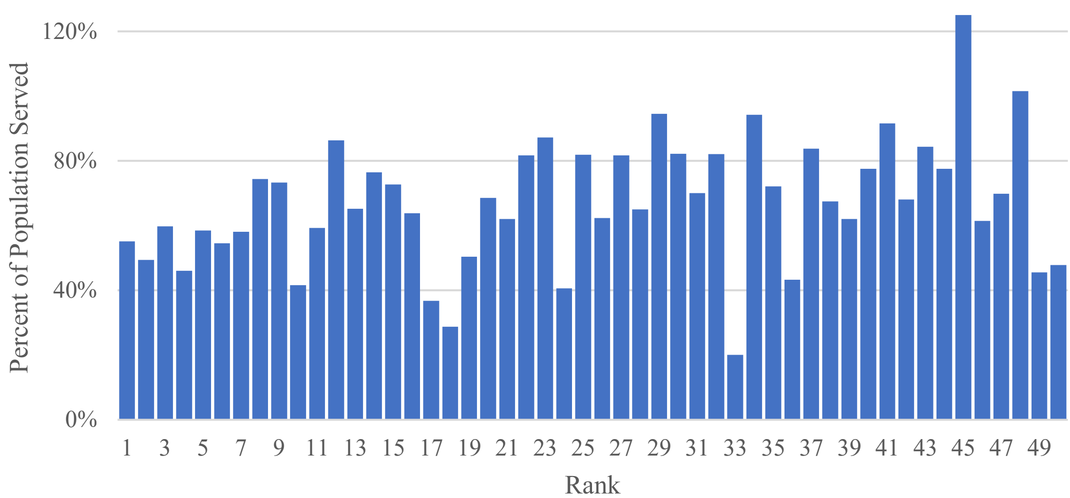


Figure 5. Percent of population served vs. WCI rank.

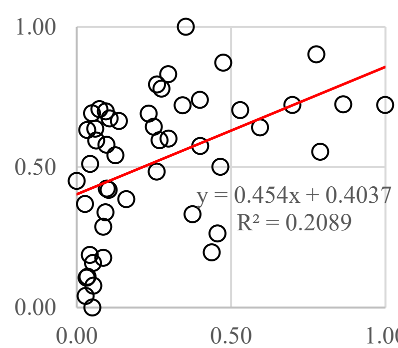


Figure 6. Correlation curve for *EC vs. *TR

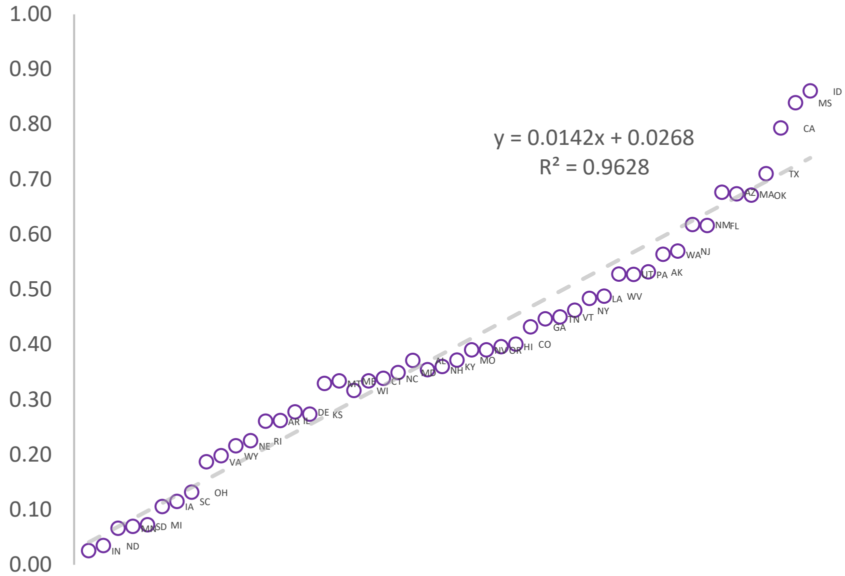


Figure 7. WCI scores and rank distribution.

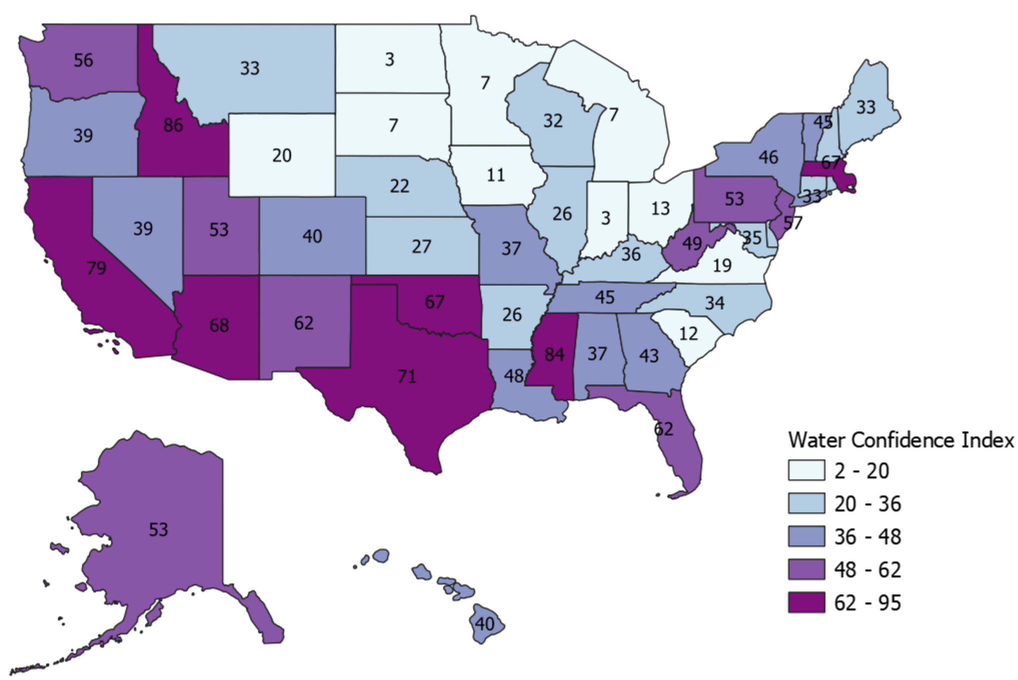


Figure 8. Map of the United States with WCI scores (multiplied by100).

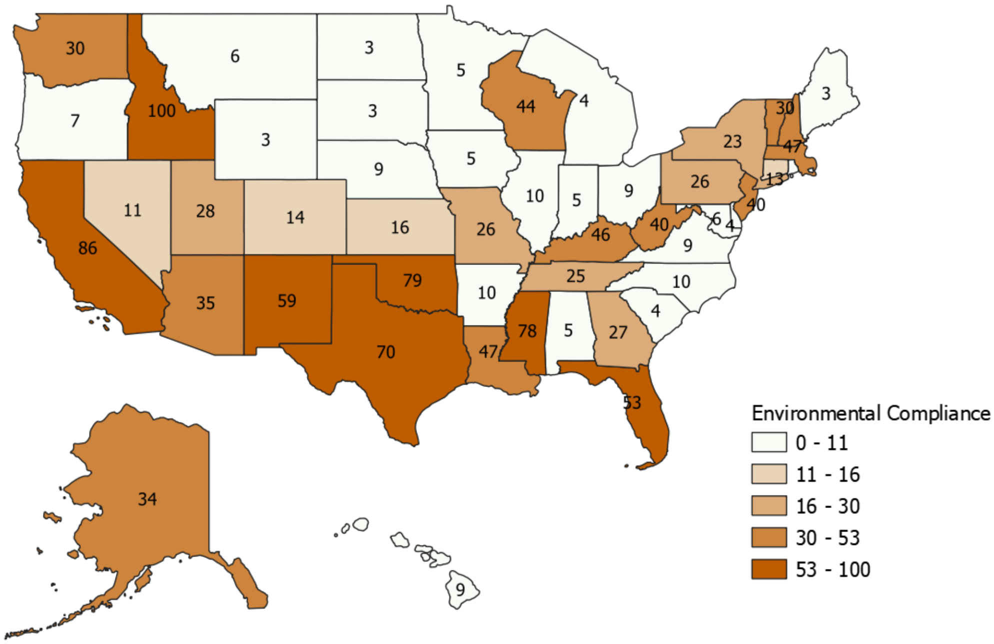


Figure 9. Map of the United States with Environmental Compliance (EC) scores (multiplied by 100).

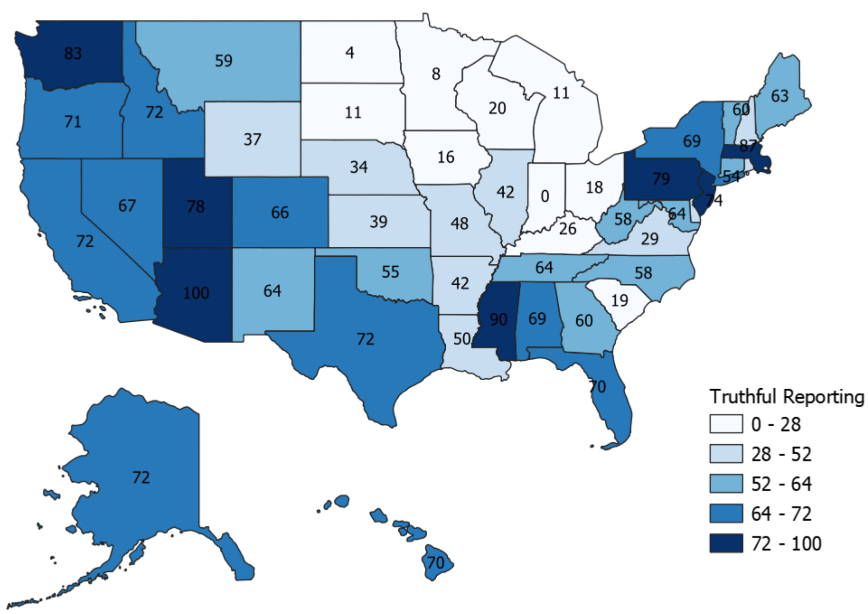


Figure 10. Map of the United States with Truthful Reporting (TR) scores (multiplied by 100).

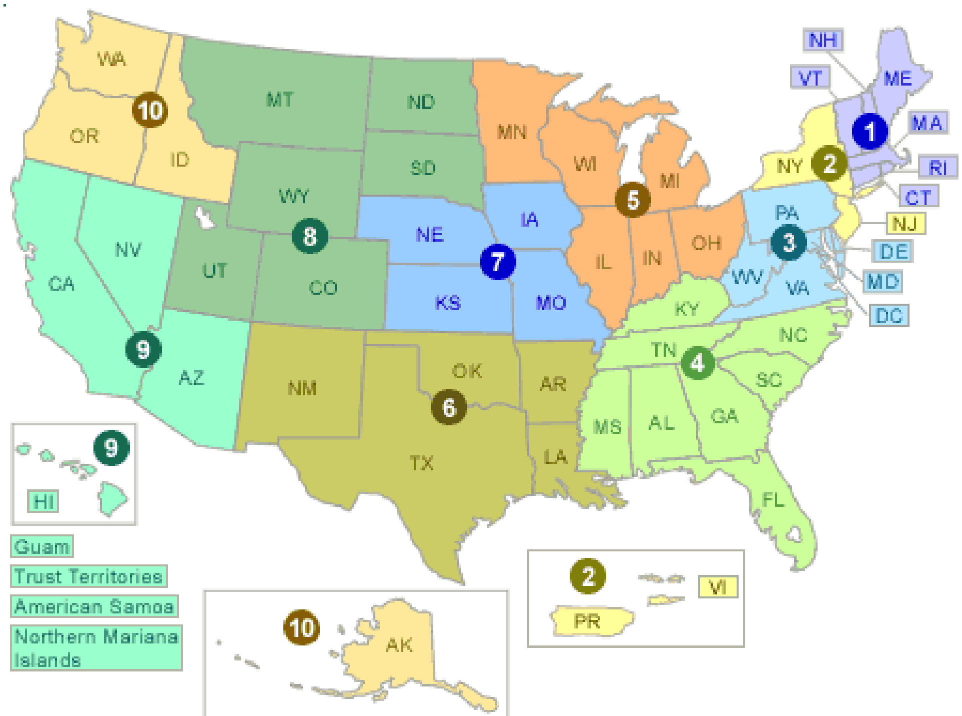


Figure 11. EPA's 10 regions split up by state
(Source: https://www.epa.gov/aboutepa/regional-and-geographic-offices)

Name	Date modified	Type	Size
SDWA_ENFORCEMENTS	4/16/2021 3:57 PM	Microsoft Excel Comma Sepa...	229,151 KB
SDWA_PUB_WATER_SYSTEMS	4/16/2021 3:56 PM	Microsoft Excel Comma Sepa...	165,859 KB
SDWA_RETURN_TO_COMPLIANCE	4/16/2021 3:57 PM	Microsoft Excel Comma Sepa...	19,489 KB
SDWA_SERIOUS_VIOLATORS	4/16/2021 3:57 PM	Microsoft Excel Comma Sepa...	5,628 KB
SDWA_SITE_VISITS	4/16/2021 3:56 PM	Microsoft Excel Comma Sepa...	89,151 KB
SDWA_VIOLATION_TO_ENFORCEMENT	4/16/2021 3:57 PM	Microsoft Excel Comma Sepa...	175,085 KB
SDWA_VIOLATIONS	4/16/2021 3:57 PM	Microsoft Excel Comma Sepa...	584,624 KB

Figure 12. ECHO SDWA downloadable data folders.

Tables

Table 1. Code book for data input for WCI calculation.

CODE	Name/Description
STATE	State acronym
NUM_PWSID	Number of large and very large public water systems in the state
POPULATION_SERVED	Population that is serviced by the NUM_PWSIDs
*POPULATION_SERVED	Transformation of POPULATION_SERVED (min/max)
POPULATION_STATE	The population of the state
%_POP_SERVED	The percentage of the state's population that is serviced by the NUM_PWSIDs
SUM_VIOLATIONS	The total number of violations over the period that are amassed from the NUM_PWSIDs
*SUM_VIOLATIONS	Transformation of SUM_VIOLATIONS (min/max)
SUM_ENFORCEMENTS	The total number of enforcements made over the period
E/V	Enforcements divided by the number of violations
*E/V	Transformation of E/V (min/max)
NUM_ACUTE_HEALTH	The total number of acute health violations during the period
NUM_HEALTH_BASED	The total number of health-based violations during the period
ENV_HEALTH	The sum of NUM_ACUTE_HEALTH and NUM_HEALTH_BASED violations
*ENV_HEALTH	Transformation of ENV_HEALTH (min/max)
*ENV_HEALTH_%_POP	The multiplication of *ENV_HEALTH and %_POP_SERVED
NUM_MONITORING_BASED	The total number of monitoring-based violations during the period
NUM_PUBLIC_NOTICE	The total number of public notice violations during the period
PUBLIC_HEALTH	The sum of NUM_MONITORING_BASED and NUM_PUBLIC_NOTICE violations
*PUBLIC_HEALTH	Transformation of PUBLIC_HEALTH (min/max)
*PUBLIC_HEALTH_%_POP	The multiplication of *PUBLIC_HEALTH and %_POP_SERVED
NUM_RTC_SERIOUS_VIOLATOR	The number of return to compliance serious violators
%_RTC_SERIOUS_VIOLATORS	The percentage of return to compliance violators out of the total number of utilities in the state
NUM_SERIOUS_VIOLATORS	The number of serious violators
%_SERIOUS_VIOLATORS	The percentage of serious violators out of the total number of utilities in the state
%_RTC	The subtraction of %_SERIOUS_VIOLATORS by %_RTC_SERIOUS_VIOLATORS
NUM_SITE_VISITS	The number of site visits made over the period
VIOLATIONS_PER_SITE_VISIT	The number of violations per site visit
*VIOLATIONS_PER_SITE_VISIT	Transformation of VIOLATIONS_PER_SITE_VISIT (min/max)
EC	Environmental Compliance. The sum of *ENV_HEALTH_%_POP, %_RTC, and *VIOLATIONS_PER_SITE_VISIT
TR	Truthful Reporting. The subtraction of *PUBLIC_HEALTH_%_POP and *E/V
*EC	Transformation of EC (min/max). The final score for EC
*TR	Transformation of TR (min/max). The final score for TR
WCI	Water Confidence Index. Weighted average between *EC and *TR

Notes: “*”: denotes a transformed version of the data parameter of the same name.

Table 2. Correlation matrix for input parameters of each WCI component a.) EC, and b.) TR.

a.)

	*ENV_ HEALTH_ %_POP	%_RTC	*VIOLATIONS_ PER_SITE_VISIT
*ENV_HEALTH_%_POP	**1.00**		
%_RTC	0.20	**1.00**	
*VIOLATIONS_PER_SITE_VISIT	-0.05	0.41	**1.00**

b.)

	*PUBLIC_ HEALTH_ %_POP	*E/V
*PUBLIC_HEALTH_%_POP	**1.00**	
*E/V	-0.46	**1.00**

Table 3. WCI, EC, and TR scores and overall ranks for all states in the United States (with EPA regions listed beside each state acronym).

State	EPA	EC	TR	WCI	Rank
IN	5	0.05	0.00	0.03	**1**
ND	8	0.03	0.04	0.03	**2**
MN	5	0.05	0.08	0.07	**3**
SD	8	0.03	0.11	0.07	**4**
MI	5	0.04	0.11	0.07	**5**
IA	7	0.05	0.16	0.11	**6**
SC	4	0.04	0.19	0.12	**7**
OH	5	0.09	0.18	0.13	**8**
VA	3	0.09	0.29	0.19	**9**
WY	8	0.03	0.37	0.20	**10**
NE	7	0.09	0.34	0.22	**11**
RI	1	0.00	0.45	0.23	**12**
AR	6	0.10	0.42	0.26	**13**
IL	5	0.10	0.42	0.26	**14**
KS	7	0.16	0.39	0.27	**15**
DE	3	0.04	0.51	0.28	**16**
WI	5	0.44	0.20	0.32	**17**
MT	8	0.06	0.59	0.33	**18**
ME	1	0.03	0.63	0.33	**19**
CT	1	0.13	0.54	0.33	**20**
NC	4	0.10	0.58	0.34	**21**
MD	3	0.06	0.64	0.35	**22**
NH	1	0.38	0.33	0.35	**23**
KY	4	0.46	0.26	0.36	**24**
AL	4	0.05	0.69	0.37	**25**

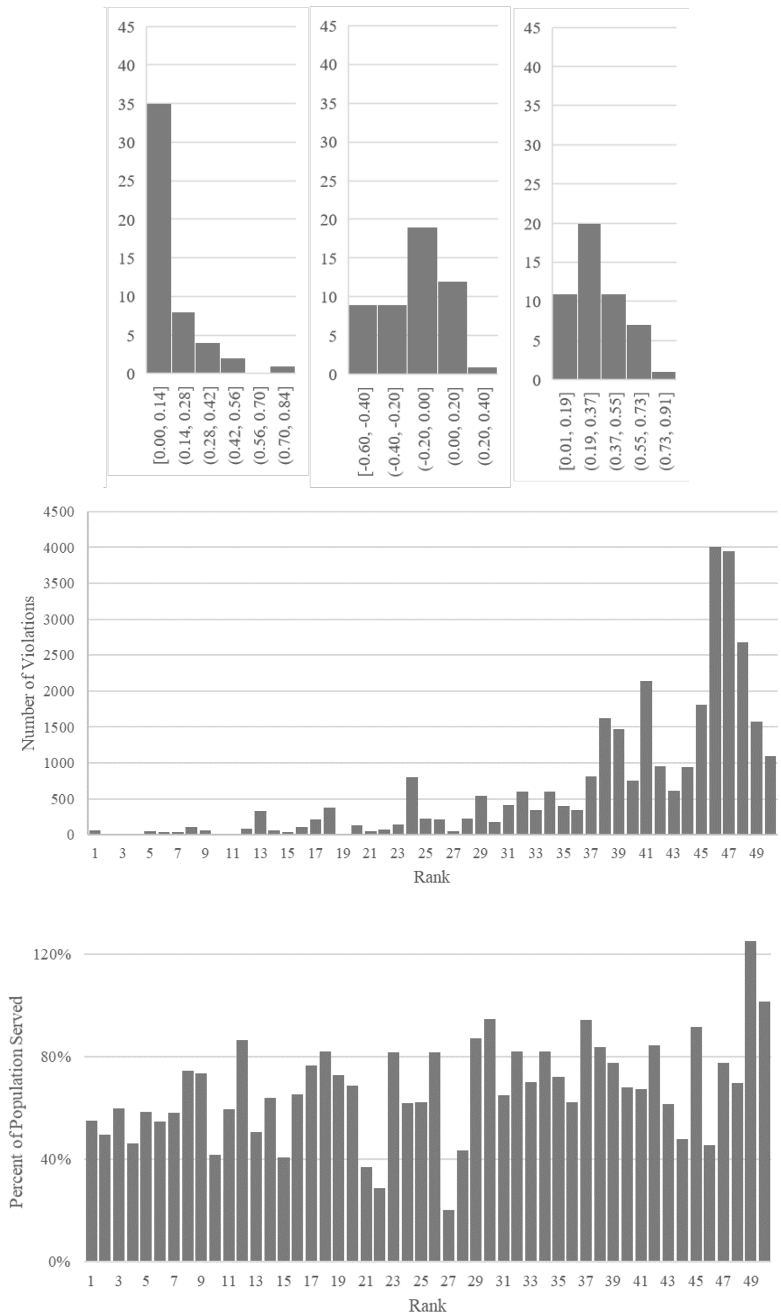
State	EPA	EC	TR	WCI	Rank
MO	7	0.26	0.48	0.37	**26**
NV	9	0.11	0.67	0.39	**27**
OR	10	0.07	0.71	0.39	**28**
HI	9	0.09	0.70	0.40	**29**
CO	8	0.14	0.66	0.40	**30**
GA	4	0.27	0.60	0.43	**31**
TN	4	0.25	0.64	0.45	**32**
VT	1	0.30	0.60	0.45	**33**
NY	2	0.23	0.69	0.46	**34**
LA	6	0.47	0.50	0.48	**35**
WV	3	0.40	0.58	0.49	**36**
PA	3	0.26	0.79	0.53	**37**
UT	8	0.28	0.78	0.53	**38**
AK	10	0.34	0.72	0.53	**39**
WA	10	0.30	0.83	0.56	**40**
NJ	2	0.40	0.74	0.57	**41**
FL	4	0.53	0.70	0.62	**42**
NM	6	0.59	0.64	0.62	**43**
OK	6	0.79	0.55	0.67	**44**
MA	1	0.47	0.87	0.67	**45**
AZ	9	0.35	1.00	0.68	**46**
TX	6	0.70	0.72	0.71	**47**
CA	9	0.86	0.72	0.79	**48**
MS	4	0.78	0.90	0.84	**49**
ID	10	1.00	0.72	0.86	**50**

Table 4. Rankings and WCI averages for the EPA Regions.

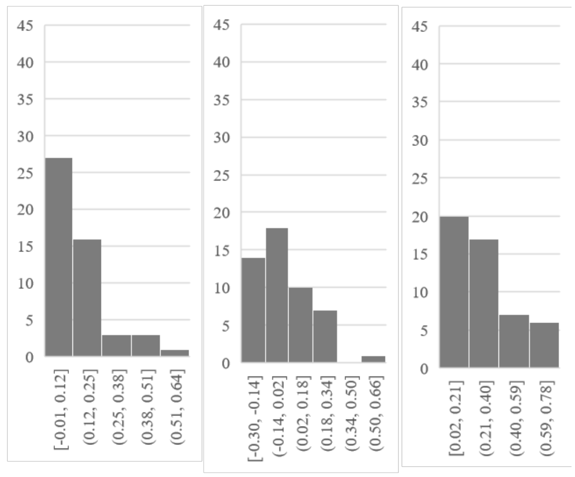
EPA_Rank	EPA Region	WCI_Ave
1	5	0.15
2	7	0.24
3	8	0.26
4	3	0.37
5	1	0.40
6	4	0.44
7	2	0.52
8	6	0.55
9	9	0.56
10	10	0.59

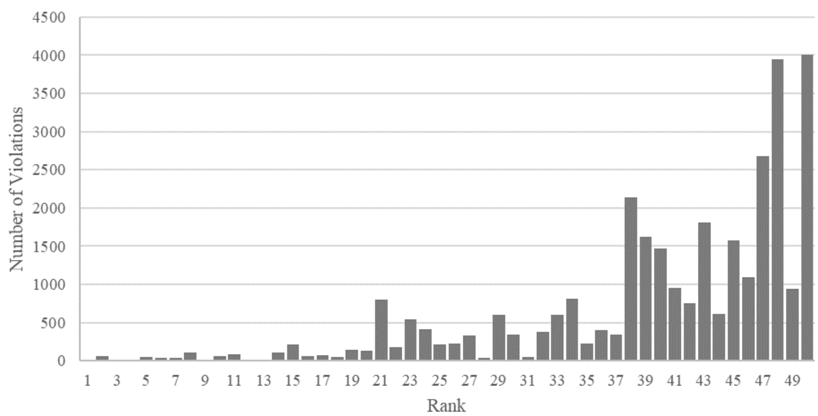
Appendix

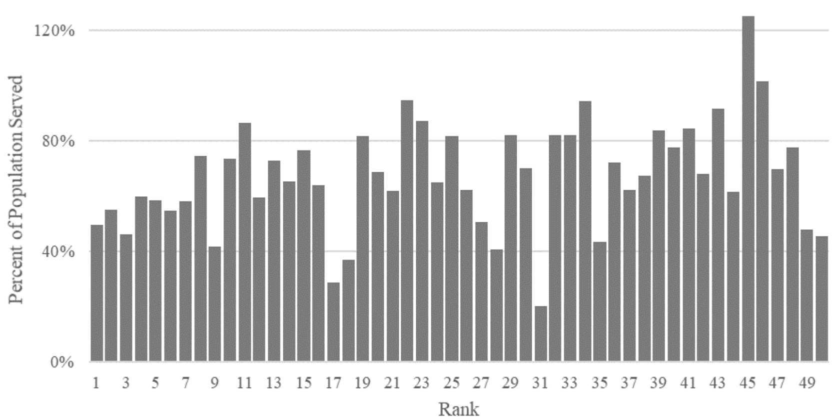
AF- 1. Histogram results (Top (from left to right): EC (unnormalized), TR (unnormalized), and WCI. Center: Number of violations vs. rank). Bottom: Percent of population served vs. rank) from sensitivity analysis: a.) SA-1, b.) SA-2, and c.) SA-3.



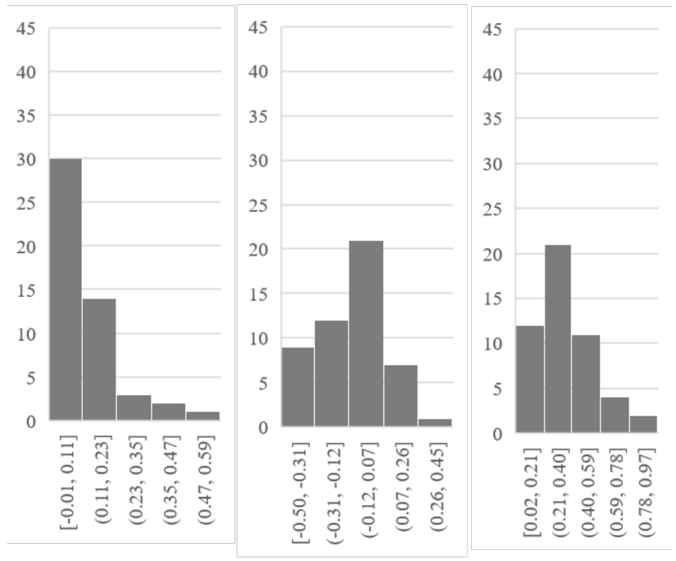
a.) SA-1: EC weighting changed from 0.4/0.4/0.2 to 0.7/0.2/0.1.

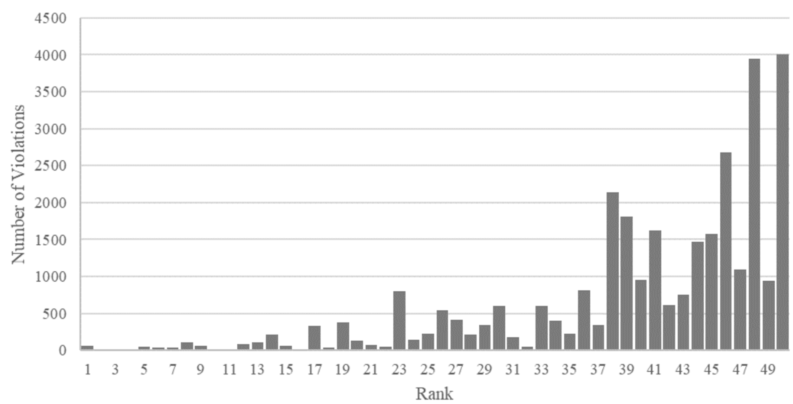


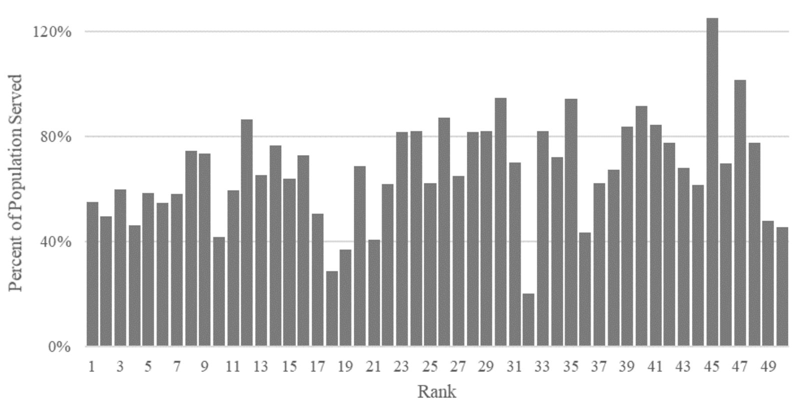




b.) SA-2: TR weighting changed from 0.4/0.6 to 0.7/0.3.







c.) SA-3: Equal weighting for EC (0.33) and TR (0.5)

AT- 1. Table of results in ranking change from various sensitivity analysis tests.

State	Rank	SA-1	change	SA-2	change	SA-3	change
IN	**1**	1	-	2	1	1	-
ND	**2**	2	-	1	-1	2	-
MN	**3**	3	-	4	1	3	-
SD	**4**	4	-	3	-1	4	-
MI	**5**	5	-	5	-	5	-
IA	**6**	6	-	6	-	6	-
SC	**7**	7	-	7	-	7	-
OH	**8**	8	-	8	-	8	-
VA	**9**	9	-	10	1	9	-
WY	**10**	10	-	9	-1	10	-
NE	**11**	11	-	12	1	11	-
RI	**12**	12	-	11	-1	12	-
AR	**13**	16	3	14	1	13	-
IL	**14**	17	3	15	1	14	-
KS	**15**	19	4	13	-2	16	1
DE	**16**	14	-2	16	-	15	-1
WI	**17**	21	4	18	1	22	5
MT	**18**	22	4	17	-1	21	3
ME	**19**	13	-6	**27**	**8**	17	-2
CT	**20**	20	-	20	-	20	-
NC	**21**	24	3	21	-	23	2
MD	**22**	23	1	19	-3	24	2
NH	**23**	**29**	**6**	23	-	26	3
KY	**24**	**15**	**-9**	28	4	**18**	**-6**
AL	**25**	18	-7	**32**	**7**	**19**	**-6**
MO	**26**	25	-1	26	-	25	-1
NV	**27**	26	-1	25	-2	28	1
OR	**28**	31	3	24	-4	27	-1
HI	**29**	30	1	**22**	**-7**	31	2
CO	**30**	32	2	29	-1	30	-
GA	**31**	33	2	30	-1	29	-2
TN	**32**	34	2	33	1	33	1
VT	**33**	27	-6	31	-2	32	-1
NY	**34**	37	3	34	-	36	2
LA	**35**	35	-	36	1	34	-1
WV	**36**	**28**	**-8**	35	-1	35	-1
PA	**37**	38	1	39	2	41	4
UT	**38**	41	3	38	-	38	-
AK	**39**	36	-3	37	-2	37	-2
WA	**40**	39	-1	40	-	44	4
NJ	**41**	45	4	43	2	39	-2
FL	**42**	40	-2	42	-	43	1
NM	**43**	42	-1	41	-2	40	-3
OK	**44**	47	3	48	4	48	4
MA	**45**	49	4	45	-	45	-
AZ	**46**	43	-3	44	-2	42	-4
TX	**47**	48	1	47	-	46	-1
CA	**48**	50	2	46	-2	47	-1
MS	**49**	46	-3	50	1	50	1
ID	**50**	44	-6	49	-1	49	-1

AT-2. Raw data of indicators that go into the components and WCI score and rankings.

STATE	NUM_ PWSID	POPULATION_ SERVED	*POPULATION_ SERVED	POPULATION_ STATE	%_POP_SERVED	SUM_VIOLATIONS
IN	90	3,710,771	0.09	6,732,219	55%	61
ND	10	376,666	0.01	762,062	49%	4
MN	89	3,368,649	0.08	5,639,632	60%	9
SD	14	407,552	0.01	884,659	46%	5
MI	141	5,840,724	0.14	9,986,857	58%	51
IA	47	1,720,832	0.04	3,155,070	55%	33
SC	75	2,990,003	0.07	5,148,714	58%	40
OH	163	8,689,433	0.21	11,689,100	74%	110
VA	80	6,259,372	0.15	8,535,519	73%	58
WY	9	240,854	0.00	578,759	42%	1
NE	14	1,146,812	0.03	1,934,408	59%	18
RI	16	914,196	0.02	1,059,361	86%	80
AR	61	1,967,955	0.05	3,017,825	65%	105
IL	227	9,686,815	0.24	12,671,821	76%	209
DE	17	707,989	0.01	973,764	73%	17
KS	33	1,860,316	0.04	2,913,314	64%	63
MT	10	392,548	0.01	1,068,778	37%	43
ME	13	387,007	0.01	1,344,212	29%	72
WI	79	2,934,437	0.07	5,822,434	50%	329
CT	38	2,444,232	0.06	3,565,287	69%	125
NC	139	6,502,038	0.16	10,488,084	62%	795
MD	32	4,937,268	0.12	6,045,680	82%	138
AL	115	4,276,887	0.10	4,903,185	87%	547
NH	18	551,477	0.01	1,359,711	41%	39
KY	110	3,660,196	0.09	4,467,673	82%	381
MO	74	3,823,498	0.09	6,137,428	62%	223
NV	19	2,515,514	0.06	3,080,156	82%	216
OR	55	2,740,102	0.07	4,217,737	65%	415
HI	19	1,338,169	0.03	1,415,872	95%	173
CO	84	4,731,577	0.12	5,758,736	82%	595
GA	117	7,438,374	0.18	10,617,423	70%	343
TN	137	5,605,889	0.14	6,833,174	82%	598
VT	7	125,286	0.00	623,989	20%	47
NY	155	18,337,971	0.46	19,453,561	94%	815
LA	74	3,352,344	0.08	4,648,794	72%	402
WV	24	776,065	0.02	1,792,147	43%	223
UT	63	2,684,987	0.06	3,205,958	84%	1620
PA	151	8,636,772	0.21	12,801,989	67%	2140
AK	10	453,688	0.01	731,545	62%	338
WA	129	5,904,056	0.14	7,614,893	78%	1468
NJ	165	8,136,050	0.20	8,882,190	92%	1805
NM	28	1,427,907	0.03	2,096,829	68%	749
FL	244	18,123,397	0.45	21,477,737	84%	954
AZ	68	5,644,366	0.14	7,278,717	78%	3949
MA	171	8,706,019	0.21	6,949,503	125%	1579
OK	54	2,429,585	0.06	3,956,971	61%	615
TX	348	20,257,259	0.50	28,995,881	70%	2673
CA	450	40,103,836	1.00	39,512,223	101%	1088
MS	57	1,355,834	0.03	2,976,149	46%	3999
ID	23	853,798	0.02	1,787,065	48%	946

AT-2. Raw data (continued from previous page)

STATE	*SUM_ VIOLATIONS	SUM_ ENFORCEMENTS	E/V	*E/V	NUM_ACUTE_ HEALTH	NUM_ HEALTH_ BASED	ENV_ HEALTH	*ENV_ HEALTH	*ENV_HEALTH _%_POP
IN	0.02	390	6.39	1.00	8	16	24	0.04	0.02
ND	0.00	24	6.00	0.94	1	1	2	0.00	0.00
MN	0.00	51	5.67	0.89	1	3	4	0.01	0.00
SD	0.00	27	5.40	0.84	1	4	5	0.01	0.00
MI	0.01	275	5.39	0.84	3	10	13	0.02	0.01
IA	0.01	163	4.94	0.77	3	7	10	0.02	0.01
SC	0.01	187	4.68	0.73	0	22	22	0.03	0.02
OH	0.03	529	4.81	0.75	9	27	36	0.06	0.04
VA	0.01	219	3.78	0.59	2	12	14	0.02	0.02
WY	0.00	3	3.00	0.47	0	0	0	0.00	0.00
NE	0.00	59	3.28	0.51	3	15	18	0.03	0.02
RI	0.02	186	2.33	0.36	0	4	4	0.01	0.01
AR	0.03	263	2.50	0.39	2	93	95	0.15	0.10
IL	0.05	552	2.64	0.41	0	84	84	0.13	0.10
DE	0.00	29	1.71	0.27	0	6	6	0.01	0.01
KS	0.02	180	2.86	0.45	4	49	53	0.08	0.05
MT	0.01	41	0.95	0.15	1	6	7	0.01	0.00
ME	0.02	44	0.61	0.10	0	7	7	0.01	0.00
WI	0.08	1528	4.64	0.73	1	212	213	0.33	0.17
CT	0.03	188	1.50	0.24	0	1	1	0.00	0.00
NC	0.20	1212	1.52	0.24	8	119	127	0.20	0.12
MD	0.03	92	0.67	0.10	0	2	2	0.00	0.00
AL	0.14	301	0.55	0.09	0	20	20	0.03	0.03
NH	0.01	130	3.33	0.52	4	31	35	0.05	0.02
KY	0.10	1601	4.20	0.66	8	103	111	0.17	0.14
MO	0.06	439	1.97	0.31	5	193	198	0.31	0.19
NV	0.05	86	0.40	0.06	0	8	8	0.01	0.01
OR	0.10	80	0.19	0.03	2	11	13	0.02	0.01
HI	0.04	28	0.16	0.03	2	5	7	0.01	0.01
CO	0.15	465	0.78	0.12	4	48	52	0.08	0.07
GA	0.09	376	1.10	0.17	7	118	125	0.19	0.14
TN	0.15	575	0.96	0.15	8	61	69	0.11	0.09
VT	0.01	41	0.87	0.14	0	44	44	0.07	0.01
NY	0.20	628	0.77	0.12	32	84	116	0.18	0.17
LA	0.10	795	1.98	0.31	6	157	163	0.25	0.18
WV	0.06	271	1.22	0.19	0	0	0	0.00	0.00
UT	0.40	1077	0.66	0.10	2	48	50	0.08	0.06
PA	0.54	1244	0.58	0.09	38	89	127	0.20	0.13
AK	0.08	4	0.01	0.00	0	4	4	0.01	0.00
WA	0.37	2	0.00	0.00	4	6	10	0.02	0.01
NJ	0.45	2035	1.13	0.18	42	231	273	0.42	0.39
NM	0.19	721	0.96	0.15	14	124	138	0.21	0.15
FL	0.24	579	0.61	0.09	16	219	235	0.36	0.31
AZ	0.99	1690	0.43	0.07	5	141	146	0.23	0.18
MA	0.39	253	0.16	0.02	32	248	280	0.43	0.54
OK	0.15	871	1.42	0.22	76	373	449	0.70	0.43
TX	0.67	3845	1.44	0.22	80	393	473	0.73	0.51
CA	0.27	271	0.25	0.04	7	638	645	1.00	1.01
MS	1.00	290	0.07	0.01	3	58	61	0.09	0.04
ID	0.24	203	0.21	0.03	0	106	106	0.16	0.08

AT-2. Raw data (continued from previous page)

STATE	NUM_MONITORING_BASED	NUM_PUBLIC_NOTICE	PUBLIC_HEALTH	*PUBLIC_HEALTH	*PUBLIC_HEALTH_%_POP	NUM_RTC_SERIOUS_VIOLATORS	%_RTC_SERIOUS_VIOLATORS	NUM_SERIOUS_VIOLATORS	%_SERIOUS_VIOLATORS
IN	37	0	37	0.01	0.01	9	0.10	10	0.11
ND	2	0	2	0.00	0.00	0	0.00	0	0.00
MN	5	0	5	0.00	0.00	1	0.01	4	0.04
SD	0	0	0	0.00	0.00	3	0.21	3	0.21
MI	37	1	38	0.01	0.01	2	0.01	2	0.01
IA	23	0	23	0.01	0.00	4	0.09	5	0.11
SC	18	0	18	0.00	0.00	2	0.03	2	0.03
OH	68	6	74	0.02	0.01	17	0.10	23	0.14
VA	44	0	44	0.01	0.01	6	0.08	11	0.14
WY	1	0	1	0.00	0.00	0	0.00	0	0.00
NE	0	0	0	0.00	0.00	4	0.29	5	0.36
RI	72	4	76	0.02	0.02	3	0.19	2	0.13
AR	10	0	10	0.00	0.00	9	0.15	8	0.13
IL	96	29	125	0.03	0.02	6	0.03	6	0.03
DE	10	1	11	0.00	0.00	1	0.06	1	0.06
KS	9	1	10	0.00	0.00	10	0.30	14	0.42
MT	35	1	36	0.01	0.00	0	0.00	0	0.00
ME	63	2	65	0.02	0.00	0	0.00	0	0.00
WI	32	84	116	0.03	0.01	1	0.01	29	0.37
CT	112	12	124	0.03	0.02	1	0.03	5	0.13
NC	644	24	668	0.17	0.11	8	0.06	4	0.03
MD	133	3	136	0.03	0.03	5	0.16	6	0.19
AL	524	3	527	0.13	0.12	15	0.13	14	0.12
NH	3	1	4	0.00	0.00	3	0.17	11	0.61
KY	192	78	270	0.07	0.06	43	0.39	90	0.82
MO	18	7	25	0.01	0.00	22	0.30	30	0.41
NV	208	0	208	0.05	0.04	1	0.05	1	0.05
OR	400	2	402	0.10	0.07	6	0.11	5	0.09
HI	166	0	166	0.04	0.04	2	0.11	1	0.05
CO	540	3	543	0.14	0.11	6	0.07	8	0.10
GA	138	80	218	0.06	0.04	11	0.09	32	0.27
TN	481	48	529	0.13	0.11	11	0.08	37	0.27
VT	3	0	3	0.00	0.00	1	0.14	3	0.43
NY	679	20	699	0.18	0.17	20	0.13	34	0.22
LA	239	0	239	0.06	0.04	18	0.24	48	0.65
WV	202	21	223	0.06	0.02	3	0.13	15	0.63
UT	1567	3	1570	0.40	0.33	16	0.25	21	0.33
PA	1938	75	2013	0.51	0.34	31	0.21	37	0.25
AK	328	6	334	0.08	0.05	1	0.10	3	0.30
WA	1428	30	1458	0.37	0.29	1	0.01	19	0.15
NJ	1434	98	1532	0.39	0.36	61	0.37	73	0.44
NM	573	38	611	0.16	0.11	17	0.61	31	1.11
FL	554	165	719	0.18	0.15	31	0.13	120	0.49
AZ	3704	99	3803	0.97	0.75	26	0.38	32	0.47
MA	1261	38	1299	0.33	0.41	7	0.04	6	0.04
OK	156	10	166	0.04	0.03	16	0.30	48	0.89
TX	1969	231	2200	0.56	0.39	85	0.24	199	0.57
CA	426	17	443	0.11	0.11	5	0.01	50	0.11
MS	3871	67	3938	1.00	0.46	27	0.47	54	0.95
ID	829	11	840	0.21	0.10	1	0.04	15	0.65

AT-2. Raw data (continued from previous page)

STATE	%_RTC	NUM_SITE_ VISITS	VIOLATIONS_ PER_SITE_VISIT	*VIOLATIONS_ PER_SITE_VISIT	EC	TR	*EC	*TR	WCI	RANK
IN	0.01	1063	0.06	0.00	0.01	-0.60	0.05	0.00	0.03	**1**
ND	0.00	73	0.05	0.00	0.00	-0.56	0.03	0.04	0.03	**2**
MN	0.03	537	0.02	0.00	0.01	-0.53	0.05	0.08	0.07	**3**
SD	0.00	33	0.15	0.01	0.00	-0.51	0.03	0.11	0.07	**4**
MI	0.00	1971	0.03	0.00	0.00	-0.50	0.04	0.11	0.07	**5**
IA	0.02	166	0.20	0.01	0.01	-0.46	0.05	0.16	0.11	**6**
SC	0.00	453	0.09	0.00	0.01	-0.44	0.04	0.19	0.12	**7**
OH	0.04	1666	0.07	0.00	0.03	-0.45	0.09	0.18	0.13	**8**
VA	0.06	894	0.06	0.00	0.03	-0.35	0.09	0.29	0.19	**9**
WY	0.00	25	0.04	0.00	0.00	-0.28	0.03	0.37	0.20	**10**
NE	0.07	212	0.08	0.00	0.04	-0.31	0.09	0.34	0.22	**11**
RI	-0.06	126	0.63	0.04	-0.01	-0.21	0.00	0.45	0.23	**12**
AR	-0.02	210	0.50	0.03	0.04	-0.23	0.10	0.42	0.26	**13**
IL	0.00	1158	0.18	0.01	0.04	-0.24	0.10	0.42	0.26	**14**
DE	0.00	35	0.49	0.03	0.01	-0.16	0.04	0.51	0.28	**16**
KS	0.12	230	0.27	0.02	0.07	-0.27	0.16	0.39	0.27	**15**
MT	0.00	31	1.39	0.09	0.02	-0.09	0.06	0.59	0.33	**18**
ME	0.00	290	0.25	0.02	0.00	-0.06	0.03	0.63	0.33	**19**
WI	0.35	307	1.07	0.07	0.22	-0.43	0.44	0.20	0.32	**17**
CT	0.11	151	0.83	0.05	0.05	-0.13	0.13	0.54	0.33	**20**
NC	-0.03	10516	0.08	0.00	0.04	-0.10	0.10	0.58	0.34	**21**
MD	0.03	367	0.38	0.02	0.02	-0.05	0.06	0.64	0.35	**22**
AL	-0.01	1332	0.41	0.03	0.01	0.00	0.05	0.69	0.37	**25**
NH	0.44	190	0.21	0.01	0.19	-0.31	0.38	0.33	0.35	**23**
KY	0.43	874	0.44	0.03	0.23	-0.37	0.46	0.26	0.36	**24**
MO	0.11	438	0.51	0.03	0.13	-0.18	0.26	0.48	0.37	**26**
NV	0.00	73	2.96	0.20	0.04	-0.02	0.11	0.67	0.39	**27**
OR	-0.02	200	2.08	0.14	0.03	0.01	0.07	0.71	0.39	**28**
HI	-0.05	43	4.02	0.27	0.04	0.00	0.09	0.70	0.40	**29**
CO	0.02	331	1.80	0.12	0.06	-0.03	0.14	0.66	0.40	**30**
GA	0.18	850	0.40	0.03	0.13	-0.09	0.27	0.60	0.43	**31**
TN	0.19	783	0.76	0.05	0.12	-0.05	0.25	0.64	0.45	**32**
VT	0.29	23	2.04	0.14	0.15	-0.08	0.30	0.60	0.45	**33**
NY	0.09	1340	0.61	0.04	0.11	-0.01	0.23	0.69	0.46	**34**
LA	0.41	1631	0.25	0.02	0.24	-0.17	0.47	0.50	0.48	**35**
WV	0.50	1063	0.21	0.01	0.20	-0.10	0.40	0.58	0.49	**36**
UT	0.08	281	5.77	0.38	0.13	0.07	0.28	0.78	0.53	**38**
PA	0.04	496	4.31	0.29	0.13	0.08	0.26	0.79	0.53	**37**
AK	0.20	50	6.76	0.45	0.17	0.02	0.34	0.72	0.53	**39**
WA	0.14	229	6.41	0.43	0.15	0.11	0.30	0.83	0.56	**40**
NJ	0.07	1346	1.34	0.09	0.20	0.04	0.40	0.74	0.57	**41**
NM	0.50	202	3.71	0.25	0.31	-0.05	0.59	0.64	0.62	**43**
FL	0.36	3104	0.31	0.02	0.27	0.00	0.53	0.70	0.62	**42**
AZ	0.09	734	5.38	0.36	0.18	0.26	0.35	1.00	0.68	**46**
MA	-0.01	760	2.08	0.14	0.24	0.15	0.47	0.87	0.67	**45**
OK	0.59	1524	0.40	0.03	0.41	-0.12	0.79	0.55	0.67	**44**
TX	0.33	1252	2.13	0.14	0.36	0.02	0.70	0.72	0.71	**47**
CA	0.10	1871	0.58	0.04	0.45	0.02	0.86	0.72	0.79	**48**
MS	0.47	267	14.98	1.00	0.41	0.18	0.78	0.90	0.84	**49**
ID	0.61	50	18.92	1.26	0.53	0.02	1.00	0.72	0.86	**50**