



Long-term Water Use Efficiency Progress in Municipal Water Systems in Washington State (2014-2023)

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Disclaimer:

The “*Long-term Water Use Efficiency Progress in Municipal Water Systems in Washington State (2014-2023)*” study (the Study) was conducted through contract with the Washington State University School of the Environment and is separate from the “[Situation Assessment of Washington’s Municipal Water Efficiency Statute and Regulation](#)” report (the Report). While the two reports are separate entities, the Report did use the research and findings from Appendix F as an additional information sources.



Introduction

Water use efficiency (WUE) has become a cornerstone of sustainable water resource management, particularly in regions such as Washington State, where the availability of water is increasingly limited due to expected changes in climate variability and population growth. In response to this changing water availability, municipal water systems and other water users have been embracing WUE strategies to promote responsible consumption, delay the need for infrastructure expansion, and protect ecological water flows (Gleick, 2003). In 2003, the Washington State legislature passed Engrossed Second Substitute House Bill 1338, also known as the Municipal Water Law, to directly call for municipal water suppliers to use water more efficiently. Since the Department of Health (DOH) is the regulatory agency that works most regularly with municipal water suppliers, DOH was tasked with implementing and tracking progress towards WUE goals for each water supplier under its jurisdiction. As part of this process, each water supplier is required to complete an annual WUE report that details current water loss (as the difference between the volume of water produced and consumed), the number of connections that are metered, and any demand side goals and progress towards those goals. In its current format, these reporting questionnaires request both numerical and narrative responses from the respondents. Reports have been collected annually since 2009 and must be completed by all municipal water systems that serve more than 15 connections that are used year-round by residents for at least 180 days a year, or that regularly serve at least 25 year-round residents (Washington State Department of Health, n.d.-b).

For the past 15 years, approximately 2,000 water providers have been reporting on WUE annually. This time series of data has the potential to offer valuable insights into how efficiency goals and conservation have evolved over time for individual providers, and for municipal water systems as a water use sector. However, to date, DOH has had limited capacity to explore or utilize these data (*William D. Ruckelshaus Center, 2025*). This lack of human and financial resources within DOH for WUE programmatic management and evaluation means that long-term trends in WUE progress have yet to be understood. There remains potential to reveal insights into many factors that influence WUE including the role that institutional (dis)incentives play in motivating WUE progress, how conservation is framed both to water providers and to customers, and the extent to which strategic implementation of goals is effective (Callejas Moncaleano, Pande, & Rietveld, 2021).

To this end, this study explores two years of WUE reporting data, 2014 and 2023, to assess long-term progress towards meeting WUE goals related to leakage, metering, and WUE strategies and progress over a ten-year time period. This assessment provides key insights into progressive efforts towards increasing WUE in municipal water systems in Washington,

highlighting both the diversity of conservation strategies used across water systems, but also the challenges of comparing unstandardized self-reported data across systems and years.

Methods

To examine potential long-term progress towards WUE goals, we requested the full set of water provider responses for the years 2014 and 2023. Each year contains responses from approximately 2,000 water providers and includes information on self-reported leakage, metering coverage, and demand-side goals and progress. The data analyzed in this study were publicly available and were obtained from the Washington State DOH's Office of Drinking Water (Washington State Department of Health, n.d.-a).

Quantitative data was analyzed in Microsoft Excel. Qualitative data was coded using Dedoose, a cloud-based software for mixed-methods research (Dedoose, n.d.). Given the narrative nature of the qualitative data to be analyzed, a hybrid coding approach was employed. Initial codes were developed deductively based on prior literature on institutional goal setting, water conservation strategies, and reporting behaviors (Apio, Thiam, & Dinar, 2024; Callejas Moncaleano et al., 2021). These themes were supplemented by inductive coding as additional patterns emerged during the review of system-level narratives. The coding framework focused on several key analytical categories: the *structure and specificity* of demand-side efficiency goals, the *strategies used* to achieve those goals, the *timesteps used* to measure or evaluate progress, and *how goals were measured* whether through targeted system-level reductions (e.g., distribution leakage) or household-level use (e.g., gallons per capita). A total of 60 codes were generated throughout the process, though only those with substantial recurrence and relevance were used in the final synthesis. To ensure reliability and to illustrate thematic variance, representative quotations were recorded across both the 2014 and 2023 datasets.

Analysis

Results

System Characterization

Between the two reporting years, there were slightly more responses in 2014 (n=2084) than in 2023 (n=1838). Of these, 433 reported in 2014 and only 187 reported in 2023. The remaining 1651 records were common across both sets of years evaluated (representing 79% of systems reporting in 2014 and 90% of systems reporting in 2023). For the water systems that reported in both years (Table 1), we saw that most (n=1513, 92%) reported a moderate increase in the number of connections served (0-5% increase in the number of connections). Only a small number of systems showed no change between the two years assessed (n=137, 8%). One

system reported a large increase in the number of connections served over our study time period (>15% increase in the number of connections).

Table 1. Change in number of connections served between 2014-2023 by water system.

Change in connections	Number of water systems	Percent of water systems
<0%	137	8%
0-5%	1513	92%
5-10%	0	0%
10-15%	0	0%
>15%	1	0%
Total	1651	100%

Metering

One of the requirements for meeting WUE regulations is that water providers must be fully metered by 2017. Of those providers who reported in both years, 1255 (76%) of water systems showed no change in the percent of connections metered, indicating that there was no significant shift in the number of meters being added to the service area during this time. Of those reporting across both years, 187 of these systems reported that their system was less than 50% metered, and 1049 systems reported being 100% metered in both 2014 and in 2023. There were some systems that increased the number of metered connections during the study time period (n=363, 22%). Of these, 315 (19%) increased from not fully metered to 100% metered by 2023, indicating achieving WUE goals from this dimension (Table 2).

Table 2. Changes in the percent of connections metered between 2014 and 2023.

Metering Status	Number of water systems	Percent of water systems
No change from 2014-2023	1255	76%
Remain at <50%	187	11%
Remain at 50-75%	2	0%
Remain at >75%	17	1%
Remain at 100%	1049	64%
Increased from 2014-2023	363	22%
Increased to 100%	315	19%

Leakage

Reducing leakage is another key component of the suite of strategies by which water systems can become more efficient. Evaluating leakage has been problematic in the past for WA

municipal water providers in part due to the lack of standardization in what counts as “leakage” and how to measure it. For the WUE annual reports, the percent of water lost (or “unaccounted for water”) is determined via a simple difference between the amount of water produced and the amount of water consumed. As a rule of thumb, DOH warns that systems reporting negative, zero, less than 2%, or more than 50% water loss likely have inaccurate leakage values (Washington State Department of Health, 2025), a concern corroborated by studies highlighting the prevalence of unreliable self-reported leakage data in Washington compared to other states (Jernigan, 2015; Washington Department of Health, 2016). Of those systems reporting in both years, 478 (29%) show a percentage of unaccounted for water (UAW) that would be considered by DOH to be inaccurate (reporting either a negative, zero, less than 2% or more than 50% UAW amount). There were 133 systems (8%) that moved from likely accurate reports of UAW (values falling between 2-50% of UAW) to inaccurate reporting values. In contrast, 320 water systems (19%) went from reporting a likely inaccurate UAW value in 2014 to something considered to be more likely to be accurate in 2023. Only 720 systems (44%) reported likely accurate values in both 2014 and 2023 (Table 3).

Table 3. Changes in the accuracy of unaccounted for water reporting in 2014 and 2023.

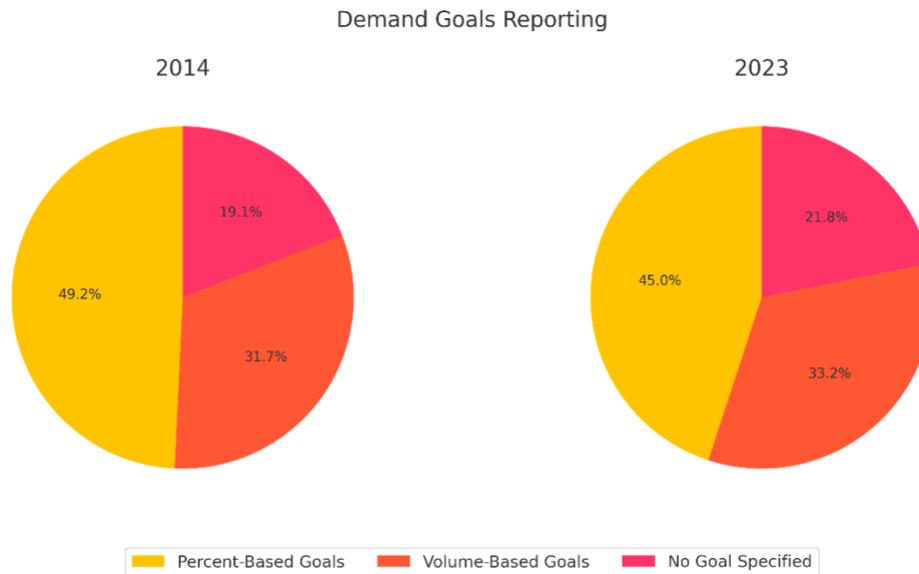
Status of UAW reports	Number of water systems	Percent of water systems
Likely inaccurate in both years	478	29%
Likely accurate in 2014, inaccurate in 2023	133	8%
Likely inaccurate in 2014, accurate in 2023	320	19%
Likely accurate in 2014 and 2023	720	44%
Total	1651	100%

Demand Goals and Progress

The comparative analysis between the 2014 and 2023 WUE datasets revealed both quantitative and qualitative shifts in reporting behavior, goal structures, and implementation strategies. A total of 2,051 systems submitted reports that contained a narrative element in 2014, accounting for 98% of total responses that year. In 2023, 1,728 systems provided a narrative response, representing 94% of submissions—a 4% drop in participation.

It’s important to note that this analysis does not track the same individual systems over time. Rather, it examines trends in the dataset as a whole, comparing the overall characteristics and reporting behaviors of systems in each respective year. While separate portions of this study may analyze individual-level change, this specific comparison is based on cross-sectional proportions within each year’s dataset.

Figure 1. Proportion of water systems reporting demand reduction goal types in 2014 and 2023. Goals are categorized as percent-based, volume-based, or no goal specified.



In both 2014 and 2023, water systems reported demand reduction goals across three primary categories: percent-based, volume-based, and no goal specified (see *Figure 1*). Percent-based goals framed conservation in relative terms. For example, one system wrote, “*To reduce outdoor water usage by 3% by December 2020.*” This approach was the most frequently reported in 2014, cited by 49.2% of systems (1,009 out of 2,051). However, by 2023, the share of percent-based goals had declined to 44.9% (777 out of 1,728), suggesting a modest shift in how systems conceptualize measurable targets.

Volume-based goals, by contrast, used fixed numeric units, such as, “*Our goal is to reduce per person use by 2 gallons per day in 5 years.*” These goals increased slightly from 31.6% in 2014 (649 systems) to 33.2% in 2023 (574 systems), reflecting greater use of absolute metrics over time.

The “no goal specified” category represented systems that submitted either blank responses, reports of “undefined goals, or general statements without quantifiable targets. In 2014, this group accounted for 19.1% (391 systems), increasing slightly to 21.8% (377 systems) in 2023. For example, one system explained, “*No goal has been set as there is no way to meter consumption,*” while others described broad strategies such as education or infrastructure improvements without linking them to specific outcomes.

While this analysis does not track individual systems across both reporting periods, it compares the proportion of systems in 2014 and 2023 that reported specific types of goals. Overall, these

proportions remained fairly stable. Percent-based goals declined slightly, volume-based goals increased modestly, and nearly one-fifth of systems in both years still failed to define a clear, measurable objective. This consistency suggests ongoing variation in how systems interpret and implement Washington’s water use efficiency reporting requirements.

Table 4. Unit of analysis counts and percentages

Unit of Analysis	2014 Count	2014 Percent	2023 Count	2023 Percent
Household (total)	824	40.2%	882	51.0%
└ Per-Capita	212	10.3%	163	9.4%
└ Per Connection	123	6.0%	305	17.7%
└ Household (other)	489	23.8%	414	24.0%
System	403	19.6%	330	19.1%
Not Specified	824	40.2%	516	29.9%
Total	2,051	100%	1,728	100%

The data in Table 4 shows a shift in how systems in a given reporting year defined their goals using specific units of analysis. Household-based units—including per capita, per connection, and general household framing—increased from 40.2% in 2014 to 51.0% in 2023. Notably, per connection goals more than doubled, while per capita goals, such as “*to reduce consumption by 10 gallons per capita,*” remained consistent. The share of system-wide metrics held steady across both years at around 19%. Meanwhile, the portion of systems each year that did not report any unit of analysis declined by over 10 percentage points, suggesting gradual movement toward more structured and measurable reporting frameworks.

Figure 2. Proportion of water systems reporting demand reduction goal types in 2014 and 2023. Goals are categorized as percent-based, volume-based, or no goal specified.

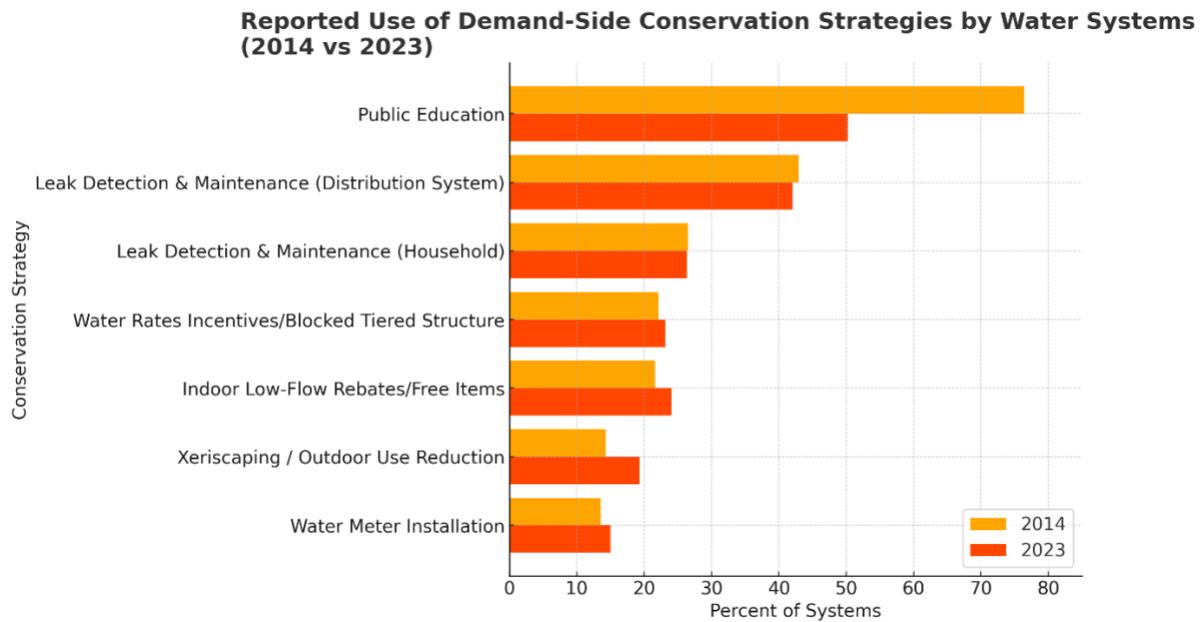


Table 5. Reported Use of Main and Sub-Strategies for Demand-Side Conservation by Water Systems (2014 and 2023)

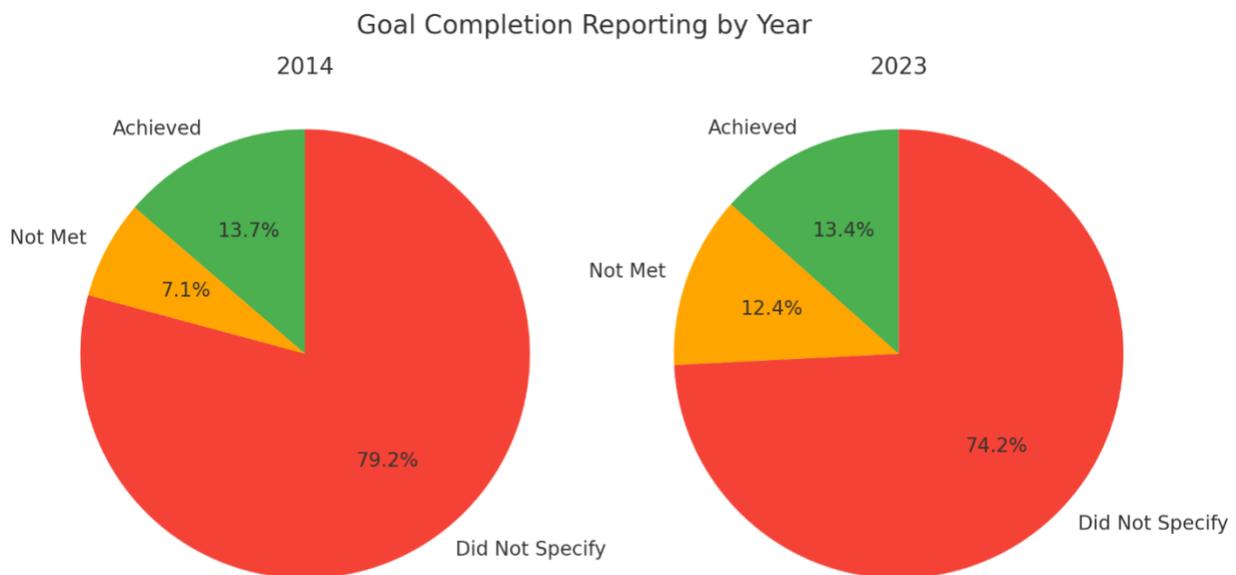
Main Strategy	Sub-Strategy	2014 Count	2014 %	2023 Count	2023 %
Public Education	Provide Customers with Usage History	272	13.3%	137	7.9%
Leak Detection (System)	Infrastructure Maintenance	267	13.0%	135	7.8%
Water Meter Installation	Update Old Meters	171	8.3%	115	6.7%

Figure 2 presents the percentage of water systems in 2014 and 2023 that reported using specific demand-side conservation strategies. Because systems often list multiple approaches to reach their goals, the categories are not mutually exclusive. Many utilities provided responses referencing several strategies within a single goal description. For instance, one noted: *“Customer education is accomplished with the annual Consumer Confidence Report. Members are encouraged to use separate irrigation water systems for outdoor watering rather than domestic water. A tiered billing structure has been implemented, resulting in substantial decreases in water usage.”* This single response was classified in multiple ways; under public education, xeriscaping/outdoor use reduction, and water rates incentives.

In both years, public education was the most frequently reported conservation strategy, cited by 76.4% of systems in 2014 and 50.3% in 2023. Leak detection and maintenance in the distribution system was the second most common, with relatively stable reporting rates, 42.9% in 2014 and 42.0% in 2023. Other commonly mentioned strategies across both years included leak detection at the household level, water rates incentives, and indoor low-flow rebates/free items.

While many of the most popular strategies remained consistent over the years, some shifts were evident. Systems were more likely to mention indoor low-flow rebates and xeriscaping/outdoor use reduction in 2023 than in 2014, suggesting modest growth in adoption of those approaches. In contrast, water meter installation appeared in a similar proportion of systems both years, while public education saw the sharpest decline in reported use.

Figure 3. Proportion of systems reporting achieved, not met, or unspecified water use efficiency goals in 2014 and 2023.



Across both datasets, a key area of focus was whether systems explicitly reported the outcome of their water use efficiency goals. Specifically, whether goals were achieved, not met, or left unspecified. In 2014, a majority of systems fell into the "did not specify" category, with only a small proportion clearly stating whether their goals had been met or not. While 13.7% of systems indicated that they achieved their goals and 7.1% reported they did not meet them, 79.2% offered no clear outcome assessment. In 2023, the trend shifted slightly: a larger share of systems acknowledged falling short of their goals (12.4%), and nearly the same proportion (13.4%) reported successful achievement. However, a substantial number of systems, 74.2%,



still did not specify an outcome. Many of these systems described general strategies or provided consumption data without linking them back to goal performance. The persistence of vague or incomplete reporting across both years points to a broader disconnect between goal setting and evaluative follow-up in the narrative components of water use efficiency reporting.

Timesteps varied across both 2014 and 2023, with multi-year planning—often framed as six-year targets—emerging as the most common structure. In 2014, 85.8% of systems that reported a goal used multi-year timelines, compared to 74.5% in 2023. The use of yearly timeframes increased modestly from 5.9% to 11.4%, and daily tracking rose from 7.8% to 13.5%, indicating a shift toward more granular monitoring and evaluation. Some systems provided detailed multi-year data to support long-term progress assessment. One utility reported, *“Annual average water use per single family residence (ERU) has changed as follows: 2015 – 232 gpd... 2023 – 297 gpd.”* Others focused on more immediate, quantitative targets, such as the goal to *“Reduce average daily demand by 5 gallons per connection.”* These examples demonstrate variability in how water systems define the timeframe and scale of their goals.

Discussion

The findings from this analysis reveal a broad diversity of ways in which Washington water systems report goals, assess outcomes, and describe conservation strategies. Despite some movement toward more structured reporting between 2014 and 2023, a diversity of responses between systems and across years remains a defining feature across these datasets. While the total number of systems submitting narrative components decreased slightly, from 2,051 in 2014 to 1,728 in 2023, the data reflect only marginal changes in how goals are structured and described.

One key area for consideration is the amount of unanalyzable data that exists in these datasets. For example, a large portion of systems failed to identify a quantifiable reduction target. Although volume-based goals saw slight growth in 2023, nearly one in five systems still provided no numerical target at all. These entries often included generalized statements—such as intentions to install meters, promote education, or maintain infrastructure—but without tying those strategies to specific performance benchmarks it is difficult to see how these systems will reduce water consumption and be held accountable to reach these goals. This trend suggests ongoing confusion about regulatory expectations or a continued emphasis on effort-based rather than outcome-based compliance (EPA, 2018). In other words, many systems appear to interpret the Water Use Efficiency (WUE) reporting requirements as a call to describe

activities and intentions, such as increasing public education or replacing infrastructure rather than tangible goals of consumption reduction.

The reported units of analysis further highlight this variation. While household-based framing (per capita, per connection, or general household use) became more common in 2023, system-wide metrics remained static, and nearly 30% of systems in 2014 still failed to specify any unit. This makes the comparability of goals across systems and years difficult and poses challenges for statewide planning and evaluation. The increase in household-specific framing may reflect broader shifts in conservation discourse, where personal and per-household behavior is increasingly emphasized (Chappells & Shove, 2005).

Program strategy reporting offers another window into how systems understand and implement WUE planning. Public education remained the most cited approach, but the sharp decline in systems mentioning public education in 2023, alongside modest increases in more tangible efforts like indoor rebates and xeriscaping, suggests a potential shift in priorities, constraints on outreach capacity, or a disinclination to report about activities that continue over multiple years. At the same time, the number of systems reporting strategies like leak detection and tiered rate structures remained consistent across time, reinforcing their centrality to municipal conservation. The use of sub-strategies, such as providing billing history or updating old meters, also underscores that many systems are adopting, at least in part, more targeted operational methods. However, the low overall frequency of such strategies (Table 5) indicates that capacity and resources may still limit broader implementation (Ingram et al., 2013).

Notably, the vast majority of systems across both datasets did not indicate whether their goals were met. This gap in evaluative reporting points to a disconnect between planning and performance measurement. While the proportion of systems explicitly stating "not met" outcomes increased slightly in 2023, most systems continued to omit progress updates or provide only raw consumption data without interpretation. As prior studies have shown, the lack of follow-through in water conservation programs is often tied to reporting fatigue, limited enforcement, or insufficient feedback mechanisms (Gleick, 2003; EPA, 2018).

The increase in utilities referencing multi-year plans, combined with expanded descriptions of technical interventions (e.g., enhanced monitoring, leak audits), suggests that institutional learning is occurring; however, and is consistent with the literature on performance management and adaptive governance (Apio, Thiam, & Dinar, 2024; Pahl-Wostl, 2009). At the same time, the decline in participation, 323 fewer systems reporting in 2023, may indicate a growing administrative burden, a lack of regulatory response for non-compliance, or shifting



priorities within water systems. This warrants further investigation to determine whether reporting lapses stem from disengagement, structural barriers, or system closures and consolidations.

In summary, while specific trends, such as increased use of multi-year planning and greater incorporation of technical conservation strategies, reflect institutional progress over the time period studied, other findings, like reduced participation rates and more frequent omission of clearly defined goals, highlight problematic areas of data collection in the current reporting system that might be occurring more broadly over annually reported datasets. A central recommendation emerging from this analysis is the development of a standardized reporting framework that explicitly prompts utilities to define measurable goals, identify timeframes, and report on outcomes. Equally important is the role of regulatory oversight: without consistent review and feedback from the Washington State Department of Health (DOH), reporting risks becoming a procedural formality rather than a tool for accountability and improvement. Strengthening agency engagement in reviewing submissions could improve data quality and reinforce expectations for outcome-based compliance. A more structured framework would also support comparability across systems and years, enhancing the potential of the WUE dataset as a monitoring tool. Future research could further explore how system size, ownership type, or resource capacity shapes reporting behaviors over time, providing additional insight into how to support diverse systems in meeting conservation expectations.

Conclusion

This study demonstrates that narrative WUE reports, though often underutilized, offer critical insights into the evolving strategies and priorities of water systems across Washington State. The comparison between 2014 and 2023 indicates a modest shift toward more structured goal setting, with increased use of specific timeframes, unit-based metrics, and technical conservation strategies. Yet, the persistence of vague or incomplete reporting, particularly the frequent omission of goal outcomes, underscores ongoing challenges in clarity, consistency, and regulatory alignment. These inconsistencies suggest that many systems continue to approach WUE reporting as formality rather than a tool for evaluating measurable outcomes. As climate change and population growth place mounting pressure on municipal water supplies, the importance of transparent, standardized, and comparable reporting cannot be overstated. A more robust narrative reporting framework, backed by consistent review from regulatory agencies such as the DOH, would strengthen the utility of these datasets and support more adaptive, data-informed water governance statewide.

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