# Measuring Progress Toward Universal Access to Water and Sanitation in California

## Defining Goals, Indicators, and Performance Measures

Laura Feinstein

PACIFIC INSTITUTE

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**Author**
Laura Feinstein

**Pacific Institute**
654 13th Street, Preservation Park
Oakland, California 94612
510.251.1600 | info@pacinst.org
www.pacinst.org

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## ABOUT THE AUTHOR

### LAURA FEINSTEIN

Laura Feinstein joined Pacific Institute in 2016 as a Senior Researcher. Laura conducts research on aquatic ecosystems; the water-energy nexus; and environmental health and justice. Prior to joining the Pacific Institute, she was a research scientist and project manager with the California Council on Science and Technology. She also served as a Science and Technology Policy Fellow with the California Senate Committee on Environmental Quality and was a California Delta Science Fellow. Laura holds a bachelor's degree in Anthropology from the University of California, Berkeley and a doctorate in Ecology from the University of California, Davis.

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## EXECUTIVE SUMMARY

Most people in California take for granted the water and sanitation in their homes. They turn the tap and clean, relatively inexpensive, abundant water flows out. They flush the toilet, and waste vanishes.

Yet there are communities in California who do not have these basic necessities in their homes. In January 2018, over half a million Californians were served by water utilities that were out of compliance with the Safe Drinking Water Act (SDWA). The worst outbreak of Hepatitis A in recent memory occurred in 2016-2018 due to open defecation and lack of handwashing facilities for persons experiencing homelessness. California's tribes continue to face problems of poor housing and water and sanitation service, with two-thirds of tribal communities reporting inadequate home plumbing in 2015.[1] And the cost of water has increased for many, particularly among small and medium size systems, with 39 community water systems in the state charging more than $100 a month for 12 CCF of water. [2]

In response to the problem, California enacted the Human Right to Water in 2012, declaring that "Every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes."

*Source:* J. Carl Ganter, Circle of Blue

Vicente Tapia filling buckets of water to bring home when his well ran dry during the 2012-2017 drought.

The California State Water Resources Control Board (State Water Board) further recognized the need to address water and sanitation for disadvantaged communities when it adopted a resolution directing staff to "develop performance measures for the evaluation of the board's progress towards the realization of the human right to water, evaluate that progress, and explore ways to

1 California Department of Housing and Community Development, Rural Community Assistance Corporation, and California Coalition for Rural Housing. "Tribal Housing Study," in press.

2 CA Water Board. "Water System Electronic Annual Reports," 2015.

make that information more readily available to the public," and to "work with… stakeholders to develop new or enhance existing systems to collect the data needed to identify and track communities that do not have, or are at risk of not having, safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes."

This report offers a unified framework on how to measure progress toward universal access to water and sanitation in California. Tables ES-1 and ES-2 provide an overview of goals and qualitative service indicators, while quantitative performance measures can be found in the body of the report. These service ladders offer a checklist of the numerous and disparate components of a

**Table ES-1**

**Overview of Drinking Water Service Ladder for California – Goals and Service Indicators**

| | | Safe | Affordable | Accessible |
|---|---|---|---|---|
| | **Goal:** | **Chemicals regulated by state and federal SDWA standards should be consistently below levels that pose a significant risk to health.** | **Cost of essential water and sanitation should be inexpensive enough that cost does not prevent access, nor interfere with other essential expenditures.** | **Water should be available in the home, in sufficient volumes to meet domestic needs, at hot and cold temperatures, at the times needed.** |
| **Service Indicator** | **Satisfactory** | Water has met state and federal SDWA standards for Public Water Systems for the past three years. | Household can afford safe, accessible water without facing tradeoffs with other essential expenditures. | Sufficient hot and cold indoor piped water reliably available 24 hours a day. |
| | **Moderate** | Water has met state and federal SDWA standards for Public Water Systems for the vast majority of time in the past three years. | " | Sufficient hot and cold water from an improved source available on premises (indoors or outside) and reliably available 24 hours a day; bottled or delivered water acceptable in some circumstances. |
| | **Marginal** | Water meets standards set by US Food and Drug Administration, is treated by Point of Use/Entry filter that meets California Title 22 regulations, or meets voluntary domestic well guidelines. | Household ocassionally cannot afford safe, accessible water without facing tradeoffs with other essential expenditures. | Sufficient water from an improved source, including bottled water or tanks of water delivered by truck, provided collection time is not more than 30 minutes round-trip (including waiting time), and reliably available at least 12 hours a day. |
| | **Unacceptable** | Drinking water quality that is not regularly tested and verified as meeting at least the Marginal standard for safety. | Household regularly cannot afford safe, accessible water without facing tradeoffs with other essential expenditures. | Water that does not meet at least the Marginal standards for access. |

*Notes:* Drinking water refers to water for indoor domestic purposes: consumption, cooking, cleaning, laundry, personal hygiene, and sanitation (operating a toilet). It does not include the treatment and disposal of wastewater, which is covered in the sanitation service ladder. Improved sources of water are piped running water, protected wells, protected springs, and rainwater. Discretionary income is income minus all essential expenses but water: housing, health care, food, energy, child care, essential transportation, and taxes. SDWA - Safe Drinking Water Act.

fully-developed approach to tracking adequate water and sanitation service at the household and individual level.

The service ladders are themselves sets of recommendations for goals, indicators, and performance measures for the state to adopt. Even for those who only use this report as a starting point, rather than a template for their work, there are general principles that can be used as guidelines for any attempt to measure water and sanitation in the state. Below we make a series of recommendations on how to improve our understanding of water and sanitation service in California and use that knowledge to improve the quality of service.

**Table ES-2**

**Service Ladder for Adequate Sanitation in California – Overview of Goals and Service Indicators**

| | | Safe | Affordable | Accessible |
|---|---|---|---|---|
| | **Goal:** | **A sanitation system should separate waste from human contact until it can be safely treated and released to the environment or reused.** | **Sanitation should be inexpensive enough that cost does not prevent access, nor interfere with other essential expenditures.** | **Toilets should be private, located in the home, safe to visit, and available when needed.** |
| **Service Indicator** | **Satisfactory** | Flush toilet connected to a system that hygienically separates waste from human contact, where waste is safely disposed of on-site, or transported and treated off-site. | Household can afford safe, accessible sanitation without facing tradeoffs with other essential expenditures. | Private, secure, well-maintained, in-home facility, not shared with other households, available 24 hours a day. |
| | **Moderate** | An improved facility that hygienically separates waste from human contact, where waste is safely disposed of on-site, or transported and treated off-site. | " | Private, secure, well-maintained, on-site facility, possibly shared with other households, available 24 hours a day. |
| | **Marginal** | An improved facility that hygienically separates waste from human contact. | Household ocassionally cannot afford safe, accessible sanitation without facing tradeoffs with other essential expenditures. | Private, secure, well-maintained facility, possibly shared with other households, no more than 50 meters from home, available 24 hours a day. |
| | **Unacceptable** | Use of unimproved facilities or open defecation. | Household regularly cannot afford safe, accessible sanitation without facing tradeoffs with other essential expenditures. | Facility is more than 50 meters from home, not available 24 hours a day, or use of the facility compromises personal safety or privacy. |

*Notes:* Sanitation refers to the physical structure of a toilet and the infrastructure and management for safe disposal of human waste and wastewater. Improved sanitation facilities refer to equipment that hygienically separates waste from human contact, such as flush toilets, pit latrines, and composting toilets.

## Recommendations on Metrics

- **Safe Water:** When tracking compliance with the California Safe Drinking Water Act, consider duration and frequency of time out of compliance in a given time period.
- **Affordable Water and Sanitation:** Consider water, wastewater, and the costs of basic non-water needs when calculating affordability, and consider both regional- and household-scale metrics.
- **Accessible Water:** Consider facets of location, volume, and availability over short and long time scales (i.e., both running 24 hours a day and resilient to drought and climate change). Update common assumptions about volumes of water used indoors to reflect declining use in California and recognize that this trend will continue as appliances and fixtures are replaced.
- **Safe Sanitation:** Consider both the adequacy of the toilet facility as constructed and the functioning of the sanitary system, which should include a centralized or on-site wastewater system that adequately treats and disposes of or recycles human waste.
- **Accessible Sanitation:** Consider proximity, privacy, security, cleanliness, and maintenance. If the toilet is shared, consider whether the number of people using the toilet is below reasonable limits.

## Recommendations on Developing a Unified Set of Metrics to Inform Policy

- **Adopt a single, consistent set of indicators and performance measures, and designate a single entity entrusted with regularly assessing those metrics.** Efforts by the California Department of Water Resources to develop sustainable water management indicators as part of the California Water Plan, the State Water Board's resolution directing staff to develop goals and performance measures as part of its Human Right to Water Portal, and the Office of Environmental Health Hazard Assessment's evaluation of the status of the Human Right to Water are all valuable efforts. Each will be more useful if they are merged into a unified framework that is employed by all stakeholders in California. The Governor should convene the appropriate cabinet secretaries to identify the lead responsible agency for assessing water and sanitation service.
- **Use a unified set of water and sanitation performance measures to direct funds and resources to the most pressing problems.** The current approach to allocating funds to disadvantaged communities relies on local actors applying for resources; it is unknown to what degree needs go unmet because local entities do not have the capacity to seek assistance. Measuring a set of drinking water and sanitation performance measures regularly would yield detailed information on the number, location, and characteristics of those households with the greatest need for improved water and sanitation services. Funds to address drinking water and sanitation problems, such as the proposed Safe and Affordable Drinking Water Fund (SB 623, Monning), should use performance measure results to identify and reach out to communities that are likely eligible for assistance.

## Recommendations on the Scope and Scale of Water and Sanitation Service Metrics

- **Shift from using performance of centralized water and sanitation systems as exclusive proxies for the quality of service to also tally households and individuals that are not**

**adequately served by large institutions.** The Human Right to Water implies the importance of considering water and sanitation for every person. Yet for many indicators, the best or only data available are collected at regional scales – often the Public Water System or centralized wastewater system. While most people are served by these systems, many of the people without adequate water and sanitation are not. These are small, disadvantaged, and remote rural communities outside of service area boundaries, or persons within service area boundaries that are not connected to centralized systems, have an on-premises plumbing problem, or lack shelter. Regional-scale data are useful, but it is important to acknowledge its limits and to supplement it with granular information at the individual and household level when available.

- **Recognize sanitation as an essential component of the Human Right to Water.** Current statute recognizes a right to water for sanitary purposes, but does not address the other components of sanitation: a toilet for personal use, and a system for safely treating and disposing of the waste. Like safe and sufficient water, sanitation is necessary to ensure human health, prevent epidemics of water-borne diseases, and safeguard the quality of drinking water resources. Adequate water without sanitation is insufficient for meeting the overriding objective of preventing waterborne health threats from chemical contaminants and disease.
- **Measure water and sanitation services in non-residential settings.** Schools, preschools, and hospitals host high concentrations of people vulnerable to disease. Ensuring the basics of clean water, a functional sanitation facility, and a place to wash one's hands are vital for the health and safety of children and the ill. While this publication does not address institutional settings, this is a clear next step for further investigation.

## Recommendations on Remedying Key Data Gaps

- **Investigate quality of water delivered by Very Small Systems, i.e., domestic wells.** Mapping these problems requires understanding the quality of source water as well as the treatment of the water by the well operator. If the state begins to offer more financial support for domestic well owners to test and treat their water, the program may yield useful data.
- **Identify Public Water Systems that persistently fail to deliver water that meets Safe Drinking Water Act standards.** In their present format, it is difficult to use the Safe Drinking Water Information System and the Human Right to Water Portal to distinguish temporary, one-time violations of the Safe Drinking Water Act from long-term problems.
- **Measure how many Californians face trade-offs between paying their water bill and other necessary expenses, and how often that trade-off results in long-term debt accumulation or service disconnections.** A regional-scale understanding of households likely to have difficulty paying their water bill can be gleaned from datasets on cost of living, household income, and local water rates, though the data on water rates are not complete. There is relatively little information, however, on the number of households who face difficulty paying their water bill, and almost none on whether difficulties in paying water bills results in long-term debt accumulation or service disconnections.

- **Collect information on service disconnections that distinguishes between occupied and unoccupied residences.** Community water systems typically track service disconnections, but it is not possible to distinguish between occupied households that lose service for failure to pay and unoccupied households where residences simply neglected to notify the utility when they vacated their home. Yet utilities are required to notify the occupants of a home before disconnecting service and also routinely receive communications from the occupants, offering multiple opportunities to record whether the unit appears to be occupied. Medium and large community water systems should record when service disconnections are for units that are known to be occupied.
- **Compile locally-held information on leaking septic systems or other onsite wastewater treatment systems.** Anecdotally, community organizations working with disadvantaged communities report that they serve households with improperly maintained septic systems. Information on permit violations is collected by local government entities and transmitted to the Regional Water Quality Control Boards (Regional Water Boards). The State Water Board should compile this information in a single statewide electronic database to develop a greater understanding of wastewater problems in the state.
- **Regional Water Board stormwater permits should require municipalities to collect data on publicly-accessible toilets and handwashing facilities.** Given the well-established role of universal sanitation in preventing water pollution and disease, public toilets and handwashing facilities should be regarded as a primary strategy to safeguard the quality of California's waterways. Yet resources to improve stormwater quality have focused on strategies to clean stormwater, rather than prevent fecal matter from entering in the first place. Regional Water Boards could alter this by placing greater emphasis on provision of public toilets to reduce fecal matter in stormwater. The first step would be to systematically collect information on location, usability, hours of public toilets, and proximity to homeless encampments.

## Recommendations for Policy Solutions to Address Failures in Drinking Water and Sanitation Service

- **Use the Eligibility for Customer Assistance Program (ECAP) metric described in "Ancillary Performance Indicators for Affordable Water and Sanitation" to qualify households for a water affordability assistance program.** The ECAP metric is relatively simple to calculate, aligns with other well-established social service programs enrollment thresholds, and addresses disparities in cost of living around the state.
- **Expand CalFresh benefits to include soap for handwashing.** Lack of access to soap is a persistent problem among food-insecure families. California has recently experimented with expanding CalFresh assistance by providing a supplementary drinking water benefit for customers of public water systems with unsafe drinking water (California 2017-18 Budget, enacted June 2017). Adding soap to CalFresh benefits would be a relatively inexpensive way to ensure that low-income children obtain access to an essential component of hygiene.

We live in a time of extraordinary progress toward reducing poverty worldwide. Between 1990 and 2013, the number of extremely poor people globally fell by over a billion, even as the

world's population grew by more than one and a half billion.[3] But the final steps of eradicating poverty are perennially plagued by the "last mile problem:" the pace of progress slows as a society nears the goal of eliminating extreme poverty.[4]

California is no exception. Only a small percentage of California's population lives without adequate water and sanitation, yet progress toward eliminating these last inequities is long overdue — all the more so in comparison to the magnitude of the infrastructure we have constructed to transport and treat water for the vast majority of the state's residents. But, seen from another perspective, the state's problems in ensuring universally adequate water and sanitation are surmountable. We have the resources to bridge these last gaps in service. With concerted effort, the vision of universal water and sanitation for all Californians can be realized.

3 The World Bank. "Poverty Overview." 4/11/2018. Accessed January 9, 2018. http://www.worldbank.org/en/topic/poverty/overview.

4 Chandy, Laurence, Hiroshi Kato, and Homi Kharas. "The Last Mile in Ending Extreme Poverty." Brookings Institution Press, July 20, 2015. https://www.brookings.edu/book/the-last-mile-in-ending-extreme-poverty/.

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## ACRONYMS AND ABBREVIATIONS

**CCF** – Centum (Hundred) Cubic Feet

**CCR** – California Code of Regulations

**CFR** – Code of Federal Regulations

**DWR** – Department of Water Resources

**EIU** – Essential Indoor Use

**FPL** – Federal Poverty Line

**GPCD** – Gallons Per Capita Day

**HHS** – Health and Human Services

**HUD** – Housing and Urban Development

**JMP** – Joint Monitoring Programme

**LAMP** – Local Area Monitoring Program

**MCL** – Maximum Contaminant Level

**NPDES** - National Pollutant Discharge Elimination

**OEHHA** – Office of Environmental Health Hazard Assessment

**OWTS** – Onsite Wastewater Treatment Systems

**PHG** – Public Health Goal

**PWS** – Public Water Systems

**SDGs** – Sustainable Development Goals

**SDWA** – Safe Drinking Water Act

**SRO** – Single Resident Occupancies

**TT** – Treatment Technique

**UNICEF** - United Nations Children's Fund

**US EPA** – United States Environmental Protection Agency

**VLI** – Very Low Income

**WASH** – Water, Sanitation, and Hygiene

**WHO** – World Health Organization

# GLOSSARY

## Key Terms in California Water Governance

**Public Water Systems (PWS)** – All domestic water suppliers large enough to be regulated under the California Safe Drinking Water Act. A Public Water System serves 15 or more connections or at least 25 individuals at least 60 days out of the year (California Health and Safety Code §116275(h)). The term encompasses both publicly-owned utilities (commonly referred to as municipal systems) and privately-owned utilities.

There are three categories of Public Water Systems:

- **Community Water Systems** – Public Water Systems that serve at least 15 connections used by year-long residents or at least 25 year-long residents (California Health and Safety Code §116275(i)). Tribal Water Systems are Community Water Systems that serve a federally recognized tribe and consequently are regulated by the United States Environmental Protection Agency rather than the California State Water Resources Control Board (State Water Board). Community Water Systems serve about 96% of Californians, of which less than 1% receive water from a Tribal Water System (State Water Board 2013; US EPA 2016b).
- **Transient Non-Community Water Systems** – Public Water Systems that deliver water to places where there are few or no long-term residents or consistent visitors, such as parks, motels, and campgrounds. Do not regularly serve at least 25 of the same persons over six months per year (California Health and Safety Code §116275(o)).
- **Non-Transient Non-Community Water Systems** – Public Water Systems that deliver water to places where the same people visit regularly but do not reside there, such as schools and workplaces. Serve at least 25 of the same persons over six months per year (California Health and Safety Code §116275(k).

**Very Small Systems** – All domestic water systems too small to be regulated under the Safe Drinking Water Act. Serve fewer than 15 connections and 25 individuals at least 60 days out of the year. Encompasses a few subcategories differentiated by size. Most Very Small Systems are supplied by domestic wells, although some are supplied by surface diversions. Very Small Systems supply the homes for an estimated 4% of Californians (California State Water Board 2013; Johnson and Belitz 2015).

- **State Small Water Systems** – Systems that serve 5–14 service connections and do not regularly serve drinking water to more than an average of 25 individuals daily for more than 60 days out of the year (California Health and Safety Code §116275(n)). The requirements for operation of a State Small Water System are less stringent than the requirements for a Public Water System, such as testing for a truncated list of potential contaminants.
- **Private Wells (and Surface Diversions)** – Water sources not regulated by federal or California state government agencies. The category is subdivided into local systems, serving 2–4 service connections, and private water sources serving only one service connection (DWR 2014).

**Centralized Municipal Wastewater Systems** – The systems of pipes and treatment facilities for conveying, treating, and discharging domestic sewage from residential and commercial customers. Municipal wastewater systems are regulated in California by the State Water Board under the Clean Water Act via the National Pollutant Discharge Elimination and Waste Discharge Requirements programs.

**Onsite Wastewater Treatment Systems (OWTS)** – Individual disposal systems, community collection and disposal systems, and alternative collection and disposal systems that use subsurface disposal. As of 2012, there were an estimated 1.2 million OWTS operating in California (California State Water Board 2012). A septic system is the most common type of OWTS, and for readability, we primarily use the term "septic system" in this report.

## Key Terms Used in Service Ladders in this Report

**Goals** – a set of aspirational objectives for delivering clean, affordable, accessible water and sanitation to all Californians. The Human Right to Water is realized through gradual and consistent progress up the levels of service provision toward the eventual goal.

**Water Service** – the means by which a person obtains water for domestic purposes. Based on the language of the California Human Right to Water statute, we consider water in this report only for indoor domestic purposes: consumption, cooking, cleaning, laundry, personal hygiene, and sanitation (operating a toilet).

**Sanitation Service** – the means by which a person disposes of their excreta. Sanitation refers to the physical structure of a toilet and the infrastructure for safe disposal of human waste and wastewater. It does not include the water for operations, which is included in the water service ladders (see below).

**Service Level** – the safety, affordability, and accessibility of water or sanitation service received by a household.

**Service Ladder** – a set of service levels with respect to water, sanitation, or hygiene, with the service levels forming the "rungs" of the ladder. In this report, we define two service ladders, one for water and one for sanitation, both with four service levels ("rungs").

***The Four Service Levels:***

- **Satisfactory** – protective of human and environmental health; meets or exceeds statutory and regulatory standards. Examples include water that has met Safe Drinking Water Act standards consistently for a sustained period of time, indoor running water, and an indoor flush toilet connected to a well-functioning treatment and disposal system.
- **Moderate** – meets minimum human needs, compliant with statutory and regulatory requirements most of the time, and unlikely to cause long-term health or environmental harm if used on a temporary basis, but would be regarded as unusual and inferior for regular at-home use by most Californians. Moderate service would be regarded by most Californians as acceptable for a weekend stay at a campground, but not for long-term, in-home service. Examples include water delivered by a system with one violation of the Safe Drinking Water Act in the past three years, obtaining water from an outdoor standpipe, or using a properly maintained and serviced latrine (such as a porta potty, or an outhouse connected a properly maintained septic system).

- **Marginal** – requires sacrifices in quality of life that most Californians would regard as unacceptable on a regular basis. Examples include households that rely on bottled water because their tap water is unsafe to drink, households that rely on a toilet that is near but not inside their home, or households using a toilet that is not connected to a properly functioning treatment and disposal system. Marginal service is clearly deficient, but is nonetheless an improvement compared to unacceptable service. Providing marginal service may be an appropriate recourse in short-term emergency scenarios, such as delivering bottled water to homes experiencing an unexpected water shortage, or providing shared outdoor toilets following a natural disaster.
- **Unacceptable** – near or complete absence of any water or sanitation service. Drinking directly from unprotected surface water, outdoor defecation, or using pit latrines without a seat would qualify for unacceptable service.

**Adequate Water Service/Adequate Sanitation Service** – satisfactory service across the three dimensions of safety, affordability, and accessibility.

**Service Indicators** – a qualitative description of a service level for each service ladder and dimension.[1]

**Performance Measures** – an objectively quantifiable metric for clean, affordable, and accessible water. We use the phrase based on the California State Water Resources Control Board's Resolution on the Human Right to Water, which references "performance measures" as the tool to measure progress towards the realization of the Human Right to Water (California State Water Board 2016b).

**Ancillary Metrics** – metrics that complement the main service ladder by measuring the service dimension among a marginalized community, or focusing on a dysfunction in service that is relatively uncommon but severe for those affected.

1 There are many competing definitions for the terms "service indicators," "performance measures," and "metrics" in public policy, both in and outside California (e.g., see OECD 2002 for a glossary of terms in policy evaluation). While we define and use the terms consistently in this document, other documents assign distinct and equally legitimate definitions.

# INTRODUCTION

## California's Human Right to Water in an International Context

California's Human Right to Water, passed in 2012, states that "every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes" (California Water Code §106.3, Chaptered 2012). While a laudable declaration of the state's values, the statute requires no action to reach this goal beyond requiring state agencies to "consider" the right to water when revising or establishing policy.

To formalize its commitment to the Human Right to Water, the California State Water Resources Control Board (State Water Board) adopted Resolution No. 2016-0010, which "directs State Water Board staff to… develop performance measures for the evaluation of the board's progress towards the realization of the Human Right to Water, evaluate that progress, and explore ways to make that information more readily available to the public." The resolution also "directs State Water Board staff to work with relevant stakeholders to, as resources allow, develop new or enhance existing systems to collect the data needed to identify and track communities that do not have, or are at risk of not having, safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes."

*Source:* J. Carl Ganter, Circle of Blue

Inequities persist for Californians in water, sanitation, and hygiene service. In this photo, Belan Ruia carefully washes dishes in her Porterville home. Like her neighbors, her well ran dry during the 2012-2017 drought. She and her husband Artemio fetched water from a nearby fire station.

California's effort to recognize, define, and measure progress toward realization of the Human Right to Water is part of an international movement to address the need for water, sanitation, and hygiene, often referred to as WASH. The United Nations (UN) General Assembly recognized the Human Right to Water and Sanitation in 2010, calling upon states and international organizations to "provide safe, clean, accessible and affordable

drinking water and sanitation for all" (UN General Assembly 2010). This language was echoed in the California statute, with some notable differences, such as the shift from the UN language on "sanitation" to the more ambiguous and indirect phrase, "water for… sanitary purposes."

As in the California statute, the UN Human Right to Water is aspirational rather than prescriptive. Though lacking an enforcement mechanism, the Resolution on the Human Right to Water urges nations and international organizations to direct resources toward the delivery of drinking water and sanitation for all. With the aim of ending global poverty, the United Nations laid out seventeen Sustainable Development Goals (SDGs), which reflect and recognize human rights standards as a key component of global development. The sixth SDG aims to "ensure availability and sustainable management of water and sanitation for all."

Progress toward SDG 6 is monitored by the World Health Organization (WHO) and United Nations Children's Fund (UNICEF) through the Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP). Since 1990, JMP has produced regular estimates of national, regional, and global progress on WASH, with the most recent update issued in 2017 (WHO and UNICEF 2017a). The JMP has developed service ladders to measure progress in WASH, with a set of service levels making up the "rungs" forming a ladder of gradual progression from low- to high-quality service. They describe service ladders for water, sanitation, and hygiene. For water, the lowest service level is Unprotected Surface Water, followed by Unimproved, Limited, Basic, and at the top, Safely Managed Service. For sanitation, the lowest service level is Open Defecation, moving up through Unimproved, Limited, Basic, and Safely Managed Service (Figure 1).

While the majority of Californians enjoy water and sanitation service that meets or exceeds the highest tier of service described in the JMP service ladders, there still are persistent inequities in WASH for Californians. Water quality problems stem from a variety of natural sources, such as arsenic, and anthropogenic causes, such as nitrate contamination and Trichloropropane (TCP) 1,2,3. In January 2018, 520,000 Californians were served by water utilities that were out of compliance with the Safe Drinking Water Act (SDWA) (State Water Board 2018a). Problems are particularly persistent in small, low-income, rural communities, and are particularly prevalent in the Central Valley and Salinas Valley. Tribal lands also grapple with poor water quality and a lack of indoor plumbing: a 2012 Indian Health Services report estimated that 36,000 persons on California tribal lands had insufficient or unsafe water (DWR 2014). During the 2012-2016 drought, nearly 5,000 households, primarily reliant on private wells, reported a shortage of water to their county government (Feinstein, Phurisamban, and Ford 2017). Meanwhile, the homeless population has reached 120,000 persons statewide (US Department of Housing and Urban Development 2016). The homeless population largely relies on public facilities for water and sanitation, but such services are often hard to reach, unclean, poorly maintained, or simply unavailable (Los Angeles Central Providers Collaborative 2017).

Safe, relatively inexpensive indoor running water and flush toilets are taken for granted by many Californians, but they are not universal. The passage of California's Human Right to Water was in response to a growing realization that persistent problems in delivery of water and sanitation persist in the state. According to Horacio Amezquita, general manager of a housing cooperative that had unsafe water for decades

**Figure 1**

## Joint Monitoring Programme (JMP) Service Ladders on Water, Sanitation, and Hygiene

### Drinking Water Services

| Service Level | Definition |
|---|---|
| **SAFELY MANAGED** | Drinking water from an improved water source that is located on premises, available when needed and free from faecal and priority chemical contamination |
| **BASIC** | Drinking water from an improved source, provided collection time is not more than 30 minutes for a round trip, including queuing |
| **LIMITED** | Drinking water from an improved source for which collection time exceeds 30 minutes for a round trip, including queuing |
| **UNIMPROVED** | Drinking water from an unprotected dug well or unprotected spring |
| **SURFACE WATER** | Drinking water directly from a river, dam, lake, pond, stream, canal or irrigation canal |

*Note:* Improved sources include: piped water, boreholes or tubewells, protected dug wells, protected springs, rainwater, and packaged or delivered water.

### Sanitation Services

| Service Level | Definition |
|---|---|
| **SAFELY MANAGED** | Use of improved facilities that are not shared with other households and where excreta are safely disposed of in situ or transported and treated offsite |
| **BASIC** | Use of improved facilities that are not shared with other households |
| **LIMITED** | Use of improved facilities shared between two or more households |
| **UNIMPROVED** | Use of pit latrines without a slab or platform, hanging latrines or bucket latrines |
| **OPEN DEFECATION** | Disposal of human faeces in fields, forests, bushes, open bodies of water, beaches or other open spaces, or with solid waste |

*Note:* Improved facilities include flush/pour flush to piped sewer systems, septic tanks or pit latrines; ventilated improved pit latrines, composting toilets or pit latrines with slabs.

### Hygiene

| Service Level | Definition |
|---|---|
| **BASIC** | Availability of a handwashing facility on premises with soap and water |
| **LIMITED** | Availability of a handwashing facility on premises without soap and water |
| **NO FACILITY** | No handwashing facility on premises |

*Notes:* Handwashing facilities may be fixed or mobile and include a sink with tap water, buckets with taps, tippy-taps, and jugs or basins designated for handwashing. Soap includes bar soap, liquid soap, powder detergent, and soapy water but does not include ash, soil, sand or other handwashing agents.

*Source:* Figure reproduced from WHO and UNICEF (WHO and UNICEF 2017a).

and an outspoken advocate of the Human Right to Water, the law's passage was groundbreaking because it recognized the problems experienced by his community (Box 1). However, the tangible effect of the law is limited and will continue to be so unless it is linked to identifying problems and prioritizing resources.

**Box 1**

### The Human Right to Water in Disadvantaged Communities: Interview With Horacio Amezquita, General Manager, San Jerardo Cooperativa

*Source:* Bree Zender, KCBX Central Coast Public Radio

Horacio Amezquita of San Jerardo Cooperativa in Salinas, California, says that the Human Right to Water is meaningful only if it is accompanied by resources and action.

"With the Human Right to Water campaign, it took hundreds of people making noise to get Sacramento to pay attention to us. Decision makers aren't impacted by these problems and county and state governments don't take affected communities into account.

"We've had clean water for five years now. It started back in 1990, when one by one, wells were contaminated. People were sick and had to spend a lot of money on bottled water. No one believed us.

"The Human Right to Water law was really important for me. San Jerardo suffered. It was a long struggle, but we won.

"Here's the thing. Anyone who has money and water contamination issues can solve the problem quickly. It's not hard for them. But when it's a poor community… there are still communities that have been waiting for 20 or 30 years for water.

"The Right to Water, in reality, isn't being applied equally for all people. The solutions require resources—financial resources and people. We need technical assistance and action. It's not actually complicated—prioritize communities with the most need. This could have been solved decades ago, and it's only getting worse. No one wants to take responsibility, and it's the people who pay the price.

"What is the Human Right to Water worth, if communities don't have clean water, and polluters keep polluting? As a law, it should help people and the environment. But if there isn't a way to apply the law, to enforce the law, if there aren't financial and human resources dedicated to making it a reality, the law isn't meaningful. It's dormant, just sitting there."

*Horacio Amezquita is the General Manager of the San Jerardo Cooperative in Salinas, California, which provides housing and community services for over 350 low-income farmworker families. He has lived in the community with his family since the 1970s.*

## MOTIVATING QUESTIONS, APPROACH, AND OUTCOMES

In this report, we attempt to answer the question: what would realizing the Human Right to Water in California mean in terms that are concrete, measurable, and socially acceptable within the context of a developed country?

We modeled our approach on the service ladder framework employed by JMP, as well as other international practitioners of WASH monitoring and development (WHO and UNICEF 2017a; Moriarty et al. 2011). This approach offers a range of service levels as a way of measuring incremental progress and providing benchmarks for appropriate service in contexts where there are insurmountable barriers to offering excellent service.

Service ladders are a common approach to define norms and develop benchmarks for comparison of broad categories of service. The service ladder reflects trade-offs between complex, multivariate systems for evaluating the quality of water and sanitation service, and the oversimplification of dividing service levels into the binary categories of "good" and "bad" service. By assessing the range of variation in problems, the ladder framework encourages stakeholders to consider both how to help the large population with modest problems, and the relatively small population burdened by the most extreme inequities. While we employed JMP's service ladders as a template, we modified both the content and structure as needed to reflect common expectations and legal standards relevant to California. This is a common approach in the literature on developing metrics for water and sanitation. Norms are not objectively determined; rather, they reflect communities' values, resources, and political choices (Moriarty et al. 2011).

Each service ladder describes a goal, with four levels of service reflecting the full range of quality observed in California. To avoid confusion with JMP standards, we employed different terms for service levels: Satisfactory, Moderate, Marginal, and Unacceptable. Each rung is described qualitatively by a service indicator, and more precisely with a quantitative performance measure. Figure 2 provides a schematic to illustrate the structure of the service ladders described in this report.

The service ladders for water and sanitation each have three dimensions: safe, affordable, and accessible, which can vary independently from one another. For example, a household with high-quality running water that is severely cost-burdened would have Satisfactory drinking water service for the safety and accessibility dimensions, but only Marginal service for affordability. Although California Water Code §106.3 also declares a right to "clean" water, we do not call out "clean" as a separate, fourth dimension of the service ladders in this report. It seems equally plausible that "clean" is redundant with "safe," or that it was intended to refer to the SDWA's voluntary secondary drinking water standards governing the aesthetics of how drinking water looks and smells. We deemed an extensive discussion of the aesthetics of drinking water to be beyond the scope of this document. We restrict the service ladders to aspects of water and sanitation service with a clear nexus to human health.

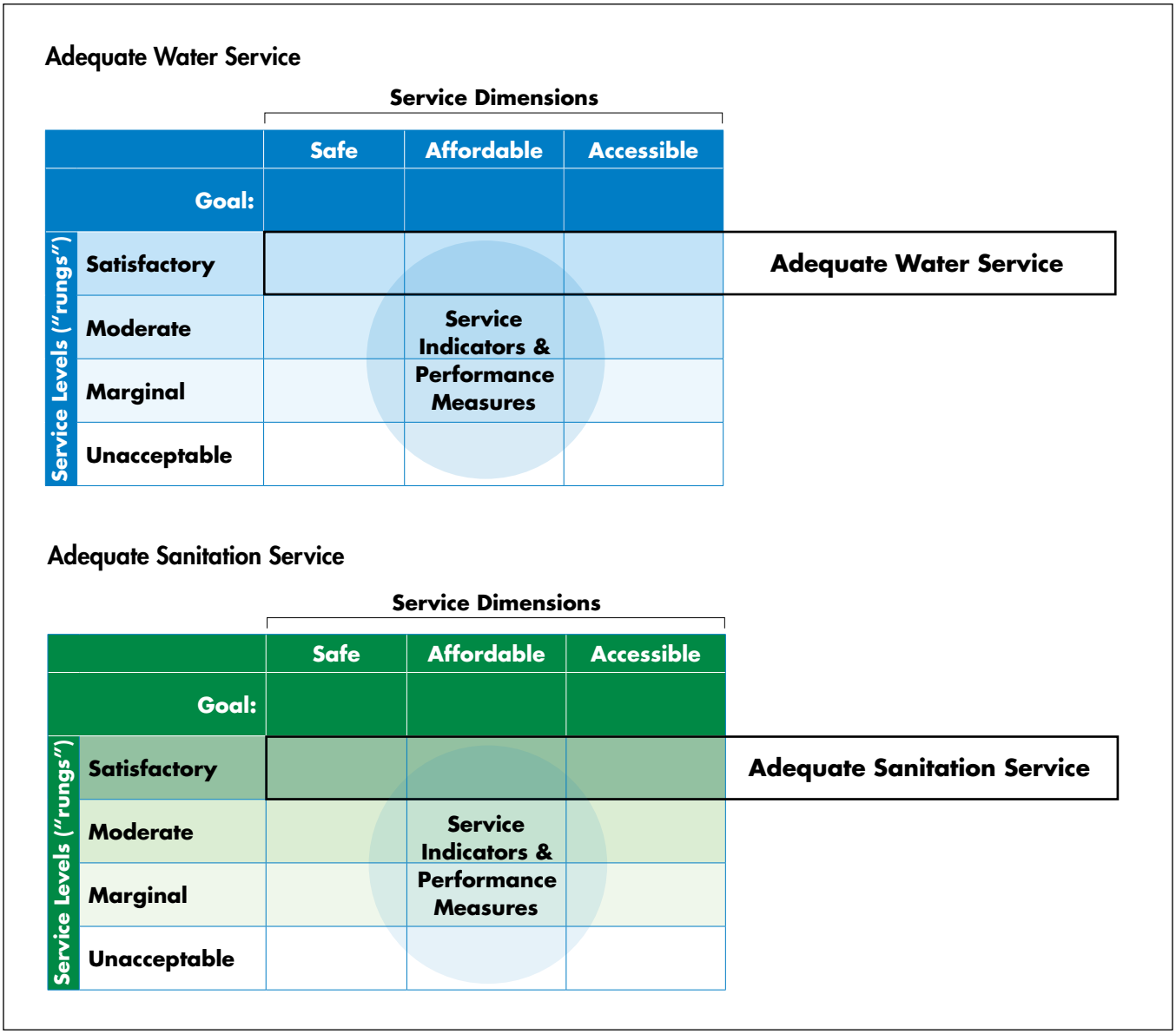
The service ladders we describe formalize a normative framework for water and sanitation in California. The ladders include goals and service indicators for water and sanitation service in California that align with statute, regulation, and common practice. The performance measures for quantifying water and sanitation service were designed whenever possible such that they

can be informed by available statewide public datasets. Where data are not available to inform a performance measure, the missing information is identified in the accompanying "data gaps" section for the dimension. The ladders' broad classes of service levels simplify complex datasets to communicate broad patterns and identify high-priority areas for improvement to a general audience. They also serve as an opportunity to articulate commonly-held but unstated goals in meeting the Human Right to Water implied by existing statutes, regulations, and societal norms.

This report focuses on water and sanitation service in homes, including standard housing types, such as single-family and multi-family units; unconventional housing, such as RVs, vans, and boats; group residences, such as dormitories, Single Resident Occupancies (SROs), and homeless shelters. To a limited extent, we address access to

**Figure 2**

**Structure of Water and Sanitation Service Ladders**



water and sanitation in public spaces as it affects those experiencing homelessness, who must make use of such public facilities as their primary points of access. We did not address water and sanitation outside the place of residence, i.e., in schools, workplaces, or health care facilities. The home is the primary place where people consume, cook, and clean with water, and adequate service in the place of residence is of primary importance in meeting basic needs. Developing service ladders for non-residences in California remains a topic for future work.

## COMPARING JOINT MONITORING PROGRAMME STANDARDS TO CALIFORNIA CONTEXT

There are five ways in which JMP's standards for safely managed water and sanitation diverge from what is commonly regarded as acceptable in California. Usually - though not always – it is because the highest level of service in JMP would be below legal standards in the state, or below the standards found in most California households.

1. **Water quality standards are much lower in JMP than is commonly considered acceptable in the United States.** JMP defines safely managed water as free from fecal and priority chemical contaminants, arsenic and fluoride. In California, most households receive tap water from a Public Water System (PWS) regulated under the state and federal SDWAs, which set limits on 88 contaminants as of 2017 (US EPA 2016a). Bottled water is subject to US Food and Drug Administration oversight, which sets limits on nearly as many contaminants (CFR 21 2017). Under JMP's definition, communities affected by contaminants apart from arsenic and fluoride, such as nitrate contamination in California's Central and Salinas Valleys, would be regarded as having safely managed water service. We set water quality standards for Satisfactory, Moderate, Marginal, and Unacceptable service to be commensurate with what is found in state and federal regulations.
2. **Affordability is not included in JMP service ladders.** JMP determined that there was "no commonly agreed-upon way to measure affordability" and decided to defer incorporating affordability into its service ladders in 2017 until a designated work group could develop and test metrics (WHO and UNICEF 2017a, p. 20). Given that affordability is one of the key components called for in the California Human Right to Water, we chose to include affordability and propose a measurable index.
3. **"Improved" water sources and sanitation facilities include infrastructure that would be considered illegal under California housing laws.** JMP defines safely managed water and sanitation as having access to an improved water source and sanitation facility, respectively. "Improved" facilities, while generally protective of human health, do not necessarily imply indoor piped water or flush toilets, which are mandatory under state

*Source:* Peeterv, iStock

Poor access to water and sanitation is often found in substandard housing.

housing laws. We treat indoor plumbing as a necessary element of adequate water and sanitation.

4. **Packaged and delivered water is regarded as meeting JMP requirements for safely managed water.** While packaged (e.g., bottled) and delivered water is typically safe for domestic purposes, an essential component to meeting the Human Right to Water is having safe water in the home not just for consumption, but also for bathing and cleaning. There is a substantial population in California consuming packaged or delivered water because their tap water is unsafe to drink, or because of water shortages exacerbated by drought (Feinstein et al. 2017; Moore et al. 2011). Reliance on packaged and delivered water as a replacement for piped water is problematic because of high costs, safety concerns, and environmental consequences, and only occurs in the most severely disadvantaged communities. Thus, adequate water service in California assumes piped water that is safe for consumption in the home.
5. **Shared toilets are regarded as inherently problematic.** JMP classifies any sanitation facility shared between two or more households as limited service, based on evidence that such facilities are often poorly maintained and become unhygienic and unsafe for vulnerable users, particularly women and girls. This is a concern in California as well, where shared toilets in SROs and homeless shelters are often unhygienic and unsafe to use. But in other contexts, such as dormitories, group homes, and any group living quarters that are well-maintained, shared toilets are an important component of affordable housing. As such, we classified shared toilets as representing moderate access.

In consideration of the differences between how JMP benchmarks and measures water and sanitation service and the common standards and practices found in California, we found it necessary to adapt the goals, indicators, and performance measures so that they are specific to California and its unique framework of statute and regulation, available datasets, and prevailing norms and resources.

## SERVICE LADDERS: DEFINING GOALS AND INDICATORS

The Service Ladder Overviews for Water and Sanitation in California (Tables 1 and 2) present goals and service indicators for water and sanitation in California. We used the language of the California Human Right to Water as the organizing framework: "every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes" (California Water Code §106.3). Each ladder covers three dimensions of water and sanitation service: safety, affordability, and accessibility.

Water refers to water for indoor domestic purposes: consumption, cooking, cleaning, laundry, personal hygiene, and sanitation (operating a toilet). Sanitation refers to the physical structure of a toilet and the infrastructure and management for safe disposal of human waste and wastewater; it does not include the water for operations, which is measured in the water service ladders. Hygiene refers to a facility for handwashing, accompanied by soap. In this report, we address facilities for handwashing in the home as a component of access to water. Soap is not included as a component of the service ladders, but it is often a difficult-to-acquire staple for families who are struggling to makes end meet (see Box 2).

Each service ladder is described by a set of service indicators and performance measures. The service indicators give abstract, qualitative descriptions of each service level. Performance measures focus on translating abstract concepts into measurable items, and are heavily circumscribed by the datasets available. The subsequent section,

"Every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes"

— California Water Code §106.3

**Table 1**

**Overview of Drinking Water Service Ladder for California – Goals and Service Indicators**

| | | Safe | Affordable | Accessible |
|---|---|---|---|---|
| | **Goal:** | **Chemicals regulated by state and federal SDWA standards should be consistently below levels that pose a significant risk to health.** | **Cost of essential water and sanitation should be inexpensive enough that cost does not prevent access, nor interfere with other essential expenditures.** | **Water should be available in the home, in sufficient volumes to meet domestic needs, at hot and cold temperatures, at the times needed.** |
| **Service Level** | **Satisfactory** | Water has met state and federal SDWA standards for Public Water Systems for the past three years. | Household can afford safe, accessible water without facing tradeoffs with other essential expenditures. | Sufficient hot and cold indoor piped water reliably available 24 hours a day. |
| | **Moderate** | Water has met state and federal SDWA standards for Public Water Systems for the vast majority of time in the past three years. | " | Sufficient hot and cold water from an improved source available on premises (indoors or outside) and reliably available 24 hours a day; bottled or delivered water acceptable in some circumstances. |
| | **Marginal** | Water meets standards set by US Food and Drug Administration, is treated by Point of Use/Entry filter that meets California Title 22 regulations, or meets voluntary domestic well guidelines. | Household ocassionally cannot afford safe, accessible water without facing tradeoffs with other essential expenditures. | Sufficient water from an improved source, including bottled water or tanks of water delivered by truck, provided collection time is not more than 30 minutes round-trip (including waiting time), and reliably available at least 12 hours a day. |
| | **Unacceptable** | Drinking water quality that is not regularly tested and verified as meeting at least the Marginal standard for safety. | Household regularly cannot afford safe, accessible water without facing tradeoffs with other essential expenditures. | Water that does not meet at least the Marginal standards for access. |

*Notes:* Drinking water refers to water for indoor domestic purposes: consumption, cooking, cleaning, laundry, personal hygiene, and sanitation (operating a toilet). It does not include the treatment and disposal of wastewater, which is covered in the sanitation service ladder. Improved sources of water are piped running water, protected wells, protected springs, and rainwater. Discretionary income is income minus all essential expenses but water: housing, health care, food, energy, child care, essential transportation, and taxes. SDWA - Safe Drinking Water Act.

"Service Ladders: Indicators and Performance Measures," examines each dimension of water and sanitation in greater detail, defining the meaning precisely, proposing specific numeric definitions for the abstract qualitative terms in the service indicators, and suggesting data sources to inform the performance measures.

Water and sanitation service can be measured at varying scales. For example, a household-level measurement of sufficient water would calculate the number of households in California with access to sufficient water. A system-level approach would quantify the number of PWSs with sufficient supply to meet the needs of its residential customers. In California, much of the available data on water and sanitation is collected on PWSs and centralized wastewater, but this approach potentially masks variation between households or individuals, and excludes those that are not served by such systems. This document focuses on household-level performance measures as the

**Table 2**

**Service Ladder for Adequate Sanitation in California – Overview of Goals and Service Indicators**

| | | Safe | Affordable | Accessible |
|---|---|---|---|---|
| | **Goal:** | **A sanitation system should separate waste from human contact until it can be safely treated and released to the environment or reused.** | **Sanitation should be inexpensive enough that cost does not prevent access, nor interfere with other essential expenditures.** | **Toilets should be private, located in the home, safe to visit, and available when needed.** |
| **Service Level** | **Satisfactory** | Flush toilet connected to a system that hygienically separates waste from human contact, where waste is safely disposed of on-site, or transported and treated off-site. | Household can afford safe, accessible sanitation without facing tradeoffs with other essential expenditures. | Private, secure, well-maintained, in-home facility, not shared with other households, available 24 hours a day. |
| | **Moderate** | An improved facility that hygienically separates waste from human contact, where waste is safely disposed of on-site, or transported and treated off-site. | " | Private, secure, well-maintained, on-site facility, possibly shared with other households, available 24 hours a day. |
| | **Marginal** | An improved facility that hygienically separates waste from human contact. | Household ocassionally cannot afford safe, accessible sanitation without facing tradeoffs with other essential expenditures. | Private, secure, well-maintained facility, possibly shared with other households, no more than 50 meters from home, available 24 hours a day. |
| | **Unacceptable** | Use of unimproved facilities or open defecation. | Household regularly cannot afford safe, accessible sanitation without facing tradeoffs with other essential expenditures. | Facility is more than 50 meters from home, not available 24 hours a day, or use of the facility compromises personal safety or privacy. |

*Notes:* Sanitation refers to the physical structure of a toilet and the infrastructure and management for safe disposal of human waste and wastewater. Improved sanitation facilities refer to equipment that hygienically separates waste from human contact, such as flush toilets, pit latrines, and composting toilets.

**Box 2**

### What About Hygiene?

*Source:* Thepalmer, iStock

JMP defines safely managed hygiene as access to a basic handwashing facility with soap and water available on premises. In this report, we include sufficient water for hygiene under access to water. We do not explicitly discuss soap, but it is an essential component of hygiene. Recent surveys and disease outbreaks indicate that lack of soap for handwashing among low-income families may be an unappreciated problem in the United States. One survey of nearly 2,000 low-income families with children found that one in three reported that at times they could not afford to purchase soap for handwashing and bathing (Feeding America 2012). Recent Hepatitis A outbreaks in southern California indicate that homeless populations are burdened by lack of access to handwashing facilities, which exacerbates their problems with inadequate sanitation (San Diego County Health and Human Services Agency 2018; Karlamangla 2017).

Given that soap is inexpensive and necessary for human health, it would be reasonable to include it in food assistance programs. Yet social welfare programs, such as CalFresh, do not provide funds for non-food items, nor is soap commonly found at food pantries (Department of Social Services 2018; Feeding America 2012). There is a clear nexus between handwashing and nutrition. Long-term lack of handwashing among children causes intestinal dysfunction that limits their ability to absorb the full nutritional value in their food; thus handwashing, sanitation, and nutrition are inextricably linked (Mbuya and Humphrey 2016; Syed, Ali, and Duggan 2016).

most relevant level for understanding the service actually received by individuals in California. For most of the dimensions, the household- and system-level performance measures are simple corollaries. In cases where the system-level metric is not a simple corollary of a household-level measurement, we explicitly define system performance measures.

## SERVICE LADDERS: INDICATORS AND PERFORMANCE MEASURES

This section presents a series of tables describing indicators and performance measures for each aspect of the Human Right to Water, as well as information on the relevant data sources and data gaps. The tables in this section can also be found in the companion online appendices, which include additional detail on context and rationale, as well as useful links.

We address affordability of drinking water, wastewater, and sewer costs collectively in one combined performance measure. A large proportion of households in California pay the costs for water, wastewater, and sewer on a single bill, and inability to pay any substantial proportion of the total can result in a water service disconnection. Since inability to pay any one of the costs results in losing access to the other services, it is best to address the costs collectively whenever possible. This is aligned with how current research on the topic recommends handling affordability (NAPA 2017; Teodoro 2018). There are cases when one might have information on the cost of drinking water for a region, but not for wastewater and sewer; in those cases, we offer alternative measures that isolate the costs of each.

## Drinking Water Indicators and Performance Measures

### SAFE DRINKING WATER

Unsafe drinking water is perhaps the most pervasive problem in drinking water service provision in California, and the problem affects every aspect of life in the affected communities (Box 3). Estimates for the number of Californians with unsafe drinking water vary widely because of uncertainties about the quality of water delivered by Very Small Systems, and differing definitions of what constitutes "unsafe." One of the best indicators we have at this time of the number of Californians with unsafe water is the State Water Board's Human Right to Water Portal, which records whether community water systems are in compliance with key requirements of the SDWA. Of the approximately 38 million Californians served by a community water system, 520,000 Californians were served by a system that was out of compliance in January 2018 (State Water Board 2018a).

In January 2018, 520,000 Californians were served by a community water system that was out of compliance with the Safe Drinking Water Act.

The goal for safe drinking water sounds straightforward: chemicals regulated by the state and federal SDWAs should be consistently below levels that pose a significant risk to health. In practice, however, determining what constitutes safe water is complicated. First, although 96% of the population in California is served by a PWS, not every person drinks water governed by the California SDWA (State Water Board 2013). Some people drink bottled water regulated by the Food and Drug Administration. Others use water from domestic wells that are subject only to voluntary guidelines (State Water Board 2015b). And in some unusual circumstances, a PWS can receive a temporary permit to use point-of-use treatment, such as under-the-sink filters, in lieu of centralized drinking water treatment.[1]

Even for the majority of Californians who use and consume water governed under the California SDWA, there are complexities to understanding who receives water that is "safe" or "unsafe." There are several distinct legal standards encapsulated in California's SDWA: Public Health Goals (PHGs), Maximum Contaminant Levels (MCLs), and Treatment Techniques (TTs).[2] Of these, PHGs issued by the California Office of Environmental

1 Point-of-Use Treatment. CCR, Title 22, Article 2.5. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/regulations/docs/pou_poe_draft_reg_text.pdf.

2 California Safe Drinking Water Act. California Health and Safety Code, Division 104, Part 12, Chapter 4, §116270 et seq.

The goal for safe water is that chemicals regulated by the state and federal Safe Drinking Water Act should be consistently below levels that pose a significant risk to health.

Health Hazard Assessment (OEHHA) are the most rigorous standards. PHGs for drinking water contaminants are set at levels that should pose no significant health risk if consumed for a lifetime. PWSs, however, are not required to meet PHGs; rather, they are required to meet MCLs and TTs. The State Water Board sets MCLs at a level that balances the primary objective of meeting the PHGs against technological and financial limitations. In cases where there is no feasible method to measure contaminant levels, the state may use a TT to limit exposure, rather than an MCL. A TT is a procedure that, if followed, should reduce the presence of a contaminant in drinking water to acceptable levels. Lead and copper, for example, are governed by TTs rather than MCLs.[3]

It is important to keep these caveats in mind when attempting to connect exceedances of PHGs, MCLs, and TTs to a measurement of populations with "safe" and "unsafe" water:

- California SDWA violations are recorded as binary yes/no events, but the degree and duration of elevated contaminant levels determines the health impact. PHGs and MCLs are set to minimize the risk caused by consuming a contaminant over a human lifetime. An exceedance that is modest in quantity or duration does not necessarily measurably increase human health risk.
- Drinking water quality is measured at centralized places in the water distribution system. The water is often diluted or undergoes further treatment before delivery, or may not be delivered to all connections served by a utility.
- The California SDWA regulates the quality of water delivered by a PWS before it leaves the system's pipes to enter a service connection. Similarly, domestic well guidelines focus on the quality of water up to the time it enters the home. There is scant information on the water quality problems that originate on private premises.
- Quality standards set by the California SDWA are intended to prioritize human health, but they also must consider economic and technical feasibility. Consequently, water can meet SDWA requirements but fail to meet more rigorous standards set by the PHGs.
- The process of identifying and setting new drinking water quality regulations can be slow and lag behind the emergence of evidence that a contaminant of concern is found in drinking water. For example, OEHHA set a PHG for TCP 1,2,3 in 2009; the state did not adopt an associated MCL until July 2017 (State Water Board 2018c). Similarly, there has been a PHG for hexavalent chromium since July 2011, but the final MCL has been delayed following an adverse court decision (State Water Board 2017).

Safe drinking water is the dimension of water and sanitation service with the most technical complexity, given that there are approximately a hundred enforceable standards for clean drinking water. The ladder we propose is based on the number of violations of primary California SDWA standards over the previous three years. This offers a relatively simple way to translate compliance with laws governing safe drinking water to an indicator

3 California Lead and Copper Rule, CCR §64670.

of whether a household is likely to receive safe drinking water. The approach also has the benefit of relying on data in the Safe Drinking Water Information System that is updated multiple times a year. We selected a three-year period because that is the length of one SDWA compliance period. Systems are generally required to test for MCLs at least once per compliance period, and usually more frequently, although systems deemed lower-risk for specified contaminants can be granted intervals as long as nine years between testing (US EPA 2004). We also suggest treating violations for contaminants that are occasionally found at levels associated with acute health impacts more stringently than contaminants typically found far below the level at which they have immediate, acute effects. Specifically, violations of MCLs and TTs pertaining to microorganisms, nitrates, and nitrites are occasionally found in California PWSs at levels high enough to cause serious harm in short time periods, and we recommend treating even violations of these acute contaminants more stringently (US EPA 2007; Senate Office of Research 2015).

Given the caveats listed above, while water meeting the definitions of Marginal, Moderate, and Satisfactory can reasonably be considered "safe," water that does not meet these definitions should not be assumed to be "unsafe." Populations served by systems failing to reach at least the Marginal level should be characterized as being potentially exposed to unsafe water.

We developed the rungs of the safe drinking water service ladder to be categories that can be informed with a relatively simple analyses of compliance with relevant statutes and regulations (Table 3). It would be more rigorous, but more complex, to categorize water quality using a quantitative risk assessment approach. A quantitative risk assessment entails using measured concentrations of multiple chemicals along with data on the health impacts of those contaminants to model the risk of disease caused by consuming a given water supply. California OEHHA took an approach that was not as exhaustive as a full quantitative risk assessment, but did take into account the relative concentrations of different contaminants and whether multiple contaminants are present for their California Communities Environmental Health Screening Tool (CalEnviroScreen 3.0, OEHHA 2017). Our approach is more closely aligned with that of the State Water Board's Human Right to Water Portal (State Water Board 2018a). It allows a more rapid analysis of water quality, lending itself to frequent updates, and has the virtue of being clearly aligned with enforceable laws (or, in the case of private wells, with state-issued voluntary guidelines).

"The pistachio trees have better water than we do. They care a lot about the crops here. Not the people."- Maricela Mares-Alatorre

We consider a household receiving water from a PWS that has met California SDWA standards every monitoring period for three years to be Satisfactory in the safe water dimension.

We define the Moderate rung as applying to households receiving water from a PWS that has had no more than one enforcement action for non-acute drinking water standards in the past three years. The Moderate definition intends to acknowledge that a short-term violation of the SDWA for a chronic contaminant does not necessarily result in serious harm to human health. In fact, the Moderate standard still represents a rather high bar, given the wide gap between a violation lasting less than a few months and the standard of harm caused by lifelong exposure set by the PHG.

**Box 3**

## Living Without Safe Water: Interview With Maricela Mares-Alatorre, Community Organizer, Kettleman City


*Source:* Bradley Angel, Greenaction for Health and Environmental Justice

Maricela Mares-Alatorre, a community organizer in Kettleman City, California, says her community has been fighting for years for their right to water.

"It is so ingrained in us now. We just don't drink the water."

Maricela Mares-Alatorre is a community leader in Kettleman City, a small unincorporated community of 1,500 people, halfway between Los Angeles and San Francisco.

"We are seen as disposable people, and disposable people don't need clean water. We aren't disposable people. We're hardworking people. Maybe we don't have high paying jobs, but we're hardworking and we deserve dignity. We deserve the dignity of clean water just like anyone else."

In Kettleman City, residents – along with organizations such as People for Clean Air and Water, California Rural Legal Assistance, and Greenaction – have been fighting for years for their right to water. After a cluster of severe birth defects and infant deaths in 2008 and 2009, the state finally tested the water. As residents already knew, it wasn't safe to drink.

"But the state took their time in addressing the problem," Maricela says. "The pistachio trees have better water than we do. They care a lot about the crops here. Not the people."

After years of delays, a plan to finance a new water treatment plant with help from the waste management company is nearing completion. The plant is now projected to be finished in early 2019 – nine years after the state recommended the water problem be fixed.

Maricela says it was "nine years too long," given the hardships unsafe drinking water imposes on her community. "We get bottled water for drinking. But we still have to bathe in the tap water, brush our teeth with it, cook with it. People can't afford to buy more bottled water for all those things.

"You change your cooking and your diet. Things that are going to be drained or not in water for a long time, like pasta, you can cook in tap water. But things like beans, that you boil for hours and then stay in the pot the whole week, you have to cook in bottled water.

"I was over 40 the first time I heard 'water is a human right.' Here, it is a given that we don't have clean water."

*Maricela Mares-Alatorre is a Community Organizer and Policy Advocate with Greenaction for Health and Environmental Justice. Maricela is also coordinator for El Pueblo Para el Aire y Agua Limpia/People for Clean Air and Water of Kettleman City.*

The Satisfactory and Moderate rungs in Table 3 are similar to the State Water Board's definition of systems that are in compliance for the Human Right to Water Portal. The key difference is the way the portal treats the duration and period of time without an enforcement action. On the portal, "in compliance" reflects a system's current status, while "returned to compliance" indicates a system is currently in compliance but had at least one enforcement action since January 2012. The problem with the portal's categories is that they do not reflect consistent criteria over time; as time passes, the "return to compliance" group will grow, while "in compliance" will shrink. We attempt to correct for that be defining a constant time horizon of three years as the assessment window.

We define the Marginal rung as applying to households that rely primarily on bottled water, Very Small Systems, or water from PWSs that do not have a centralized treatment facility. Bottled water is regulated by the Food and Drug Administration with a less restrictive set of testing and treatment protocols than tap water from PWSs. Very Small Systems are not regulated under the SDWA and are encouraged to follow California's voluntary guidelines for domestic well owners (State Water Board 2015b). Last, PWSs under specified circumstances can apply for a permit to use point-

**Table 3**

**Service Indicators and Performance Measures for Safe Drinking Water in California**

| **Goal:** Chemicals regulated by state and federal SDWA standards should be consistently below levels that pose a significant risk to health. | | | |
|---|---|---|---|
| **Service Level** | | **Household-Level Service Indicator** | **Household-Level Performance Measure** |
| | **Satisfactory** | Water has met state and federal SDWA standards for Public Water Systems for the past three years. | Household served by Public Water System that has been without an enforcement action during the last three years for state or federal drinking water standards. |
| | **Moderate** | Water has met state and federal SDWA standards for Public Water Systems for the vast majority of time in the past three years. | Household served by Public Water System that 1) has been without an enforcement action for an acute drinking water standard during the last three years, and 2) has been without an enforcement action lasting more than one monitoring period during the last three years for state or federal chronic drinking water standards. |
| | **Marginal** | Water meets standards set by US Food and Drug Administration, is treated by Point of Use/Entry filter that meets California Title 22 regulations, or meets voluntary domestic well guidelines. | Household uses bottled water regulated by US Food and Drug Administration, or water from a Public Water System that does not have a centralized treatment facility but is treated by a Point of Entry/Use filter that meets State Water Board resolution 2016-0015, or water from well serving fewer than 15 connections that meets voluntary domestic well guidelines. |
| | **Unacceptable** | Drinking water quality that is not regularly tested and verified as meeting at least the Marginal standard for safety. | Any one of the characteristics of Marginal access to water is not met. |

*Notes:* Acute contaminants are microorganisms, nitrates, and nitrites. California's voluntary guidelines for domestic well owners are described in A Guide for Private Domestic Well Owners (State Water Board 2015b). Regulations for point-of-use and point-of-entry water treatment devices are described in California Code of Regulations (CCR) Title 22 Article 2.5. SDWA – Safe Drinking Water Act.

of-entry or point-of-use water treatment devices, which treat water at the point it enters a building or at a single tap, in lieu of centralized treatment. Any of these are unlikely to harm human health if used on a temporary basis, but lack the extensive quality safeguards of the SDWA.

## DATA SOURCES FOR SAFE DRINKING WATER

Table 4 describes data sources to inform the performance measures on safe drinking water. The first three, the two Safe Drinking Water Information Databases and the Human Right

**Table 4**

**Data Sources for Safe Drinking Water Performance Measures**

| Description | Collected By | Information | Geographic Scale | Significance |
|---|---|---|---|---|
| Safe Drinking Water Information System (SDWIS): State-Regulated Systems | California State Water Board | SDWA reports from Public Water Systems. | Public Water System | Relevant for understanding water quality for the 95% of Californians served at home by a state-regulated Community Water System, as well as water quality for non-community water systems. |
| Safe Drinking Water Information System (SDWIS): Tribal Systems | US EPA Region 9 | SDWA reports from federally regulated tribal Public Water Systems. | Public Water System | Relevant for understanding water quality for the 1% of Californians served at home by a tribal Community Water System. |
| Human Right to Water Portal | California State Water Board | A subset of SDWA enforcement actions. | Community Water Systems and Non-Community Water Systems serving schools and daycares | Similar information to SDWIS, simplified, focused on priority SDWA violations, and provided in spreadsheet and map format. |
| Domestic Wells | United States Geological Survey | Location and population served by domestic wells (Very Small Systems reliant on groundwater). | Census Tract | Relevant for understanding surface location and population served by Very Small Systems. |
| Domestic Well Completion Reports | California DWR and county well permitting agencies | Location and depth of domestic wells (Very Small Systems reliant on groundwater). | Public Land Survey System Sections | Relevant for understanding surface location and source water depth for Very Small Systems. |
| Groundwater Ambient Monitoring and Assessment (GAMA) Program | California State Water Board | Groundwater quality monitoring. | Groundwater basin | Quality of groundwater aquifers in California. Relevant to quality of source water for Public Water Systems and Very Small Systems reliant on groundwater, but does not necessarily reflect the quality of the water at point of use. |
| CalEnviroScreen Drinking Water | California OEHHA | Indicator of likely exposure to drinking water contaminants. | Census Tract | Information on exposure to 13 drinking water contaminants for areas served by Public Water Systems and areas likely to be served by Very Small Systems using wells. |

*Notes:* Additional details on data sources, including links to online resources and update schedule, are available in Online Appendix II. OEHHA - Office of Environmental Health Hazard Assessment; SDWA - Safe Drinking Water Act; DWR - Department of Water Resources.

to Water Portal, directly inform the Satisfactory and Moderate Safe Drinking Water performance measures. The datasets on location and depth of drinking water wells, coupled with information from the Groundwater Ambient Monitoring and Assessment (GAMA) Program, could potentially be synthesized to generate estimates of drinking water wells reliant on contaminated aquifers (though the degree to which well-owners treat the water remains unknown). CalEnviroScreen provides a synthetic indicator of drinking water contaminants in California, although their approach provides information that does not directly align with how we have constructed the safe drinking water service ladder.

### DATA GAPS AND ANALYTICAL CHALLENGES FOR SAFE DRINKING WATER

A major challenge in obtaining comprehensive estimates of Californians with safe drinking water is a lack of information on systems too small to be regulated under the SDWA. For PWSs, while we have excellent information on the quality of water at centralized points in the distribution system, this may differ from the quality of water at the point of use.

**Quality of water as delivered by Very Small Systems:** small systems are subject to highly variable local regulation on their water quality, and private domestic wells have no mandatory requirements on management of water quality. As such, we have very little understanding of the quality of water delivered by Very Small Systems, including the extent to which they are monitored and treated before use.

**Quality of water at point-of-use:** water quality tested at a central point in the distribution system of a PWS may differ from the quality of water at the tap. The water can be further treated, diluted, or exposed to additional contaminants before it is consumed. On-premises problems are a poorly-understood source of potential contamination. PWSs perform a limited set of tests at a handful of taps in their service area for lead and copper levels. A more extensive sampling protocol would likely reveal water quality problems, as has been demonstrated by the recent efforts to expand testing for lead at taps in schools (State Water Board 2018b). In addition, we do not know the extent to which point-of-use and point-of-entry filters mitigate water quality problems.

## Affordable Drinking Water and Sanitation

The goal for affordable water and sanitation is that essential drinking, wastewater, and sewer needs should be inexpensive enough that cost does not prevent access, nor interfere with other essential expenditures (Heller 2015). The Human Right to Water does not imply that it should be free. Indeed, to do so would endanger the financial sustainability of water and sanitation systems, undermining quality of service for future generations. However, the Human Right to Water does imply that public entities have a responsibility to consider affordability for low-income customers and assist households who have difficulty paying for essential expenses.

The affordability of water and sanitation should be measured together if the household is billed jointly, as the cost of one impacts the affordability of the other. For the many households paying combined drinking water and wastewater bills, the inability to pay one part of the bill results in loss of both services. For households receiving separate bills, affordability for water and sanitation can be calculated separately.

While the WASH sector has long identified affordability as a key factor in ensuring equitable water and sanitation service, there is no

Essential drinking, wastewater, and sewer needs should be inexpensive enough that cost does not prevent access, nor interfere with other essential expenditures.

commonly-agreed upon performance indicator for affordability (WHO and UNICEF 2017a, 20; Hutton 2012). A common instrument for measuring affordability is to calculate the percent of income spent on water and compare it to some designated threshold. Some of the most commonly-cited thresholds for affordable water are 3% of household income (attributed to the United Nations Development Programme), 4.5% of median household income (attributed to the US EPA), and 1.5% of median household income (attributed to the California State Water Board). These thresholds for the proportion of income spent on water are commonly referenced in the literature as accepted rules for household water affordability (e.g., see Christian-Smith et al. 2013; Feinstein et al. 2017; Mack and Wrase 2017). However, as described below, these thresholds were not intended to provide institutional recommendations on the maximum an individual household should spend on water.

In the international setting, there have been attempts to develop guidelines on affordability, but these are more back-of-the-envelope suggestions than firm standards. For example, the commonly referenced "guideline" from the United Nations Development Programme (UNDP) on affordability originates from a brief mention in a single publication, "One rule of thumb is that no household should be spending more than 3% of its income on water and sanitation" (UNDP 2006). Viewed in context, this passing statement was

*Source:* J. Carl Ganter, Circle of Blue

Guillermina Andrade and Vicente Tapia filled five 55-gallon barrels twice a week from this water depot outside the Porterville fire station in winter 2016.

clearly not intended to make a formal, universal recommendation on water affordability. It appears with no rationale or citation for the figure. However, it was likely derived from studies and government agencies that had consistently found that most households spent a proportion of their income that was in the low single digits. A review of water expenditures for median-income households in mid- to high-income countries found they spent between 0.5% and 2.4% of their income on water (OECD 2003, Table 2.2). Households in the lower 20th percentile of incomes spent somewhat more, ranging from 0.7% to 2.7% of income on water (OECD 2003, Table 2.3). The UNDP may also have based their rule of thumb on other institutional precedents. For example, the World Bank and United Kingdom have used thresholds of 3% to 5% of income as indicators of water cost burdens, although in both cases these were intended to be used as approximate guides, rather than categorical designations of whether water was or was not affordable (OECD 2003, p. 43).

Another set of commonly-referenced affordability thresholds are the US EPA cost benchmarks, which are often applied outside of their intended scope. The 4.5% benchmark originates from US EPA recommendations on assessing the cost of compliance with federal regulations (US EPA 1997, 2006, 1998). The EPA's benchmarks were intended to assess impacts of regulations on affordability as measured against average household incomes regionally or nationally; they were not intended to be the target for individual household spending for water or wastewater (US Conference of Mayors, American Water Works Association, and Water Environment Federation 2013). The US EPA affordability metric of 2.5% of median household income for drinking water was developed to evaluate the impact of regulations on average water bills across the country. The corresponding metric from US EPA for wastewater and combined sewer overflows was intended to evaluate an individual community's financial capacity to comply with regulatory mandates and schedules. Both metrics are misapplied when they are used as targets for household-level spending (US Conference of Mayors, American Water Works Association, and Water Environment Federation 2013).

Finally, in California, it is common to reference 1.5% of median household income as an affordability benchmark (Christian-Smith et al. 2013; Feinstein et al. 2017). The figure appears in documentation from the California State Water Board on eligibility for particular funding streams. However, the 1.5% threshold used by the California State Water Board was only intended to evaluate affordability within low-income communities and to inform a specific set of funding decisions (State Water Board 2016c).

While the general approach of measuring the ratio of cost of water to income is sound, the commonly-used indices often measure the wrong factors: focusing on average water use rather than basic needs, median household income rather than the full range of incomes in a community, and accounting only for the cost of drinking water, leaving out wastewater and sewer costs. They also ignore the cost of other essential needs, failing to indicate whether a household is likely to face a financial trade-off in paying for water. Upon closer examination, these commonly-used benchmarks are slender reeds to form the basis of major decisions on water rates and social assistance programs.

Citing the lack of commonly agreed-upon metrics, JMP did not include affordability in the service ladders in their 2017 progress report. They noted that they are engaged in a collaborative process "to develop and test indicators that will enable more systematic and consistent monitoring of affordability in the future." (WHO and UNICEF 2017a, p 20).

A recent report by the National Academy of Public Administration concluded that the approach of calculating affordability as a percentage of mean household income was inadequate for assessing affordability, making a set of six broad recommendations on how to develop better affordability metrics. The report suggested several characteristics of an improved user affordability metric:

- Water needs should be defined broadly, to include water and wastewater;
- The cost of other essential expenses besides water should be factored into the analysis;
- Variability in household income, and specifically the impact of water costs on low-income households, should be considered;
- The focus should be on essential water needs and not discretionary uses;
- The metric should be easy to calculate from readily available data; and
- The metric should be simple to understand.

Two recent papers (Davis and Teodoro 2014; Teodoro 2018) proposed calculating an Affordability Ratio (AR) as essential water needs divided by discretionary income. Discretionary income is defined as income minus essential expenses apart from water. They offer a "rule-of-thumb" that AR should be no more than 10% for a four-person household with an income in the 20th percentile for the utility service area. Their formula for calculating the affordability metric addresses some of the shortcomings of other definitions used in the past. It calculates affordability for essential indoor water needs rather than average usage, focuses on lower-income households rather than the median, and makes an adjustment for the local cost of living. The authors are clear that the offered 10% threshold is arbitrary and that it can and should be viewed as an expression of community values around water affordability and not regarded as a fixed, immutable number.

For household affordability, we suggest calculating the percentage of discretionary income an individual household spends on essential indoor needs. We recommend 43 gallons per capita per day (GPCD) as a reasonable volume of water to meet basic needs. Detailed calculations for the volume of water required for household uses are described below, in "Accessible Drinking Water." The cost of water should be defined broadly to include drinking water and wastewater. For areas with poor-quality domestic water, the cost of water includes bottled water purchases. For those reliant on private domestic wells and septic systems, costs should include construction costs, as well as operations and maintenance costs.

Our recommendation for an affordability service indicator is to calculate an Affordability Ratio (AR) for a given household as the cost of 43 GPCD of drinking water and wastewater, divided by discretionary income:

Affordability should be calculated as the percentage of discretionary income an individual household spends on essential indoor needs.

$$AR_{household} = \frac{cost\ of\ 43\ GPCD\ drinking\ water\ and\ wastewater}{discretionary\ income}$$

Where discretionary income equals household gross income minus expenses on shelter, health care, transportation, food, laundry and cleaning, telephone, home energy, and taxes.

The cutoffs between Satisfactory, Moderate, Marginal, and Unacceptable Affordability service indicators are more-or-less arbitrary. It is clear that the cost of water should be less than 100% of discretionary income, and more than 0%, but there is no clear set of guidelines to determine precisely where to place affordability thresholds. We suggest defining Satisfactory affordability as a household spending no more than 10% of their discretionary income on all water costs (or 5% on drinking water and 5% on wastewater, if information on one is unavailable). We suggest a maximum of 20% of discretionary income as the cutoff for Moderate, and 30% for Marginal (Table 6). We selected 10% of discretionary income for the Satisfactory standard because it aligned with the suggestion in Teodoro (2018). It seems reasonable to infer that a household spending more than 30% of discretionary income would face unreasonable tradeoffs with other necessary expenditures, especially when unanticipated large expenses arise.

At face value, these thresholds seem higher than other affordability ratios, such as the 1.5% of

MHI used in California. This first impression is misleading. The threshold for the proposed Affordability Service Indicator is set at a higher percentage than other metrics because the proposed indicator has a larger numerator and a smaller denominator. The numerator incorporates water and wastewater, while replacing gross or disposable income with discretionary income vastly reduces the denominator. Consequently, the dollar amount that would be considered "unaffordable" is lower for the household-level performance measure than for 1.5% of MHI, or even 1.5% of total income for a very low income family (Table 5).

For example, in Tulare county, where median household income was $43,000 in 2017 (US Census Bureau 2017), a water bill would be considered unaffordable according to the State Water Board standard of 1.5% MHI if drinking water cost more than $53 a month. For a family classified as Very Low Income for Tulare County, earning $27,000 annually, 1.5% of monthly income equals $34. By contrast, 5% of discretionary income for a very low-income family in Tulare County is only $13 a month. A satisfactory combined water and wastewater bill would be twice that, or $26. For all 58 California Counties, the Satisfactory Drinking Water standard sets a lower dollar limit on an "affordable" bill than does 1.5% of gross income for a very low-income family.

The data to inform this metric are typically available at the Census Tract scale or larger. Consequently, we also outline how to calculate an aggregate, system-level analysis as a system-level affordability indicator. For the System-Level Performance Measure described in Table 7, we consider a system in which half or more of its customers spend more than 10% of their discretionary income on water as Unacceptable. When at least half the ratepayers are heavily burdened by the cost of water, it is a strong indication that systemic reforms should be considered to bring the cost of water in line with what the community can afford to pay. We suggest that a system in which 40% to 50% of households spend more than 10% of discretionary income on water would be considered Marginal, 33% to 40% would be Moderate, and less than 33% would be Satisfactory.

**Table 5**

**"Affordable" Drinking Water Bills According to Three Metrics for Three Representative Counties**

| | Metric 1 | Metric 2 | Metric 3 (this report) | | | |
|---|---|---|---|---|---|---|
| | CA State Water Board definition ≤1.5% of MHI | ≤1.5% of VLI | Satisfactory Drinking Water Cost ≤5% of DI | Moderate Drinking Water Cost >5-10% of DI | Marginal Drinking Water Cost >10-15% of DI | Unacceptable Drinking Water Cost (>15% of DI) |
| | dollars ($) | | | | | |
| Santa Clara County | ≤126 | ≤67 | ≤40 | >40 - 81 | >81 - 121 | >121 |
| Tulare County | ≤53 | ≤34 | ≤13 | >13 - 26 | >26 - 39 | >39 |
| Trinity County | ≤44 | ≤34 | ≤13 | >13 - 25 | >25 - 38 | >38 |

*Notes:* Figures are for drinking water alone, excluding wastewater. All values in dollars. Cost for non-water essentials based on US Housing and Urban Development Fair Market Rate for a 2-bedroom unit in 2018; other figures from US Census Bureau Customer Expenditure Survey results for households earning $20-29,000 annually in the Western United States. VLI – Very Low Income for a household of 3 according to US Housing and Urban Development (2017). DI – Discretionary Income for a VLI household.

The System-Level Performance Measure indicator could be used to evaluate the impact of management decisions. Rate-setting, investment decisions, and conservation and efficiency programs can all be considered in the context of how they will impact the System-Level Performance Measure. Every system is unique, and the cost of service can vary greatly depending on factors such as the quality and reliability of the source water and the size of the ratepayer base. Yet, there are management decisions that can, depending on circumstances, lower the cost of essential water needs. Options include consolidation and regionalization (Wolff and Hallstein 2005), rate structures that reduce the cost of indoor water use relative to outdoor use (Feinstein et al. 2017; Donnelly and Christian-Smith 2013), accurate demand forecasting that does not drive overinvestment in new supplies (Heberger, Kristina, and Cooley 2016; Diringer et al. in press), and prioritizing the lowest-cost sources of new supply (Cooley and Phurisamban 2017).

We caution that water priced too low to cover the long-term costs of maintaining the system may appear affordable but is merely deferring expenses until later. Many water systems in the United States have consistently underinvested in infrastructure needs, which leads eventually to failures to deliver safe and accessible water, and in the long run, are likely to result in rate hikes that make water unaffordable for future generations (Kane 2016). Truly affordable water is priced with a trade-off in mind: revenue should be high enough that the service provider can maintain their system and make necessary infrastructure investments, but household bills should be low enough that customers can afford their other essential expenses.

We caution that water priced too low to cover the long-term costs of maintaining the system may appear affordable but is merely deferring expenses until later.

To calculate discretionary income, one can use a simple approach to identify a lower-limit estimate of essential expenses. US Housing and Urban Development gives estimates of Fair Market Rents by county or metropolitan area for shelter. For other items (healthcare, transportation, food at home, laundry and cleaning, telephone, home energy, and taxes), US Bureau of Labor Statistics' Customer Expenditure Surveys information on expenses for households earning $20,000 to $30,000 a year for the United States Western Region provides an approximation of a basic cost of living.[4] We selected expenses in the $20,000 to $30,000 annual income category as an indicator of a conservative basic cost of living because spending on essential expenses increases sharply up to this income bracket, than gradually levels off for households in higher-earning categories. There are limits to this approach to estimating cost of living: first, it does not account for fine-scale variation in cost of living, and it leaves out childcare, which is necessary for families that do not have a stay-at-home parent or other caregiver. A sensitivity analysis could illuminate the degree to which these limitations impact the estimate of water affordability.

4 The Western Region for the Customer Expenditure Survey is composed of Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

**Table 6**

**Household-Level Service Indicators and Performance Measures for Affordable Drinking Water and Sanitation in California**

| **Goal:** Cost of essential water and sanitation needs should be inexpensive enough that cost does not prevent access, nor interfere with other essential expenditures. | | | |
|---|---|---|---|
| | | **Household-Level Service Indicator** | **Household-Level Performance Measure** |
| **Service Level** | **Satisfactory** | Household can afford safe, accessible water and sanitation without facing tradeoffs with other essential expenditures. | Household spends ≤10% of discretionary income on essential water and sanitation needs. |
| | **Moderate** | " | Household spends >10% but ≤20% of discretionary income on essential water and sanitation needs. |
| | **Marginal** | Household occasionally cannot afford safe, accessible water and sanitation without facing tradeoffs with other essential expenditures. | Household spends >20 but ≤30% of discretionary income on essential water and sanitation needs. |
| | **Unacceptable** | Household regularly cannot afford safe, accessible water and sanitation without facing tradeoffs with other essential expenditures. | Household spends >30% of discretionary income on essential water and sanitation needs. |

*Notes:* To provide the best indication of true cost burden per household, these costs should be calculated after any applicable low-income bill discount is applied. In many areas there is data available only for the cost of drinking water, in which case we suggest halving the percentage of discretionary income (i.e. 5% of discretionary income would meet the Satisfactory standard for affordable water). Essential water and sanitation needs covers 43 GPCD of water and wastewater (Table 9).

It is important to note that spending 10% of discretionary income on water is only attainable for those with some discretionary income. The most severely impoverished persons will be unable to cover any substantial portion of the costs of water service. The goal of providing affordable water to all implies the need for customer assistance programs to ensure water is affordable for the poorest households, who have little or no income remaining after meeting basic living expenses.

## ANCILLARY PERFORMANCE MEASURES FOR AFFORDABLE DRINKING WATER AND SANITATION

We propose two related metrics to consider when evaluating affordability at the system level. These are intended to supplement the main affordability performance measures.

**Eligibility for Customer Assistance Program (ECAP):** A persistent question in water affordability is who should qualify for a low-income customer assistance program. The household-level metric we propose is challenging to calculate and would be difficult for customers to understand. Ultimately, if the goal of an affordability program is to prevent low-income families from being forced to make trade-offs to pay their water bill, or do without sufficient water, then it is unnecessary to construct an elaborate metric to determine who should qualify. It is sufficient simply to identify households with very limited discretionary income and offer them customer assistance. A simple eligibility standard for customer assistance programs is whether a household earns less than 200% of the Federal Poverty Line (FPL), or less than the US Housing and Urban Development's Very Low Income (VLI) cutoff for the county, whichever

**Table 7**

**System-Level Service Indicators and Performance Measures for Affordable Drinking Water and Sanitation in California**

| **Goal:** Cost of essential water and sanitation needs should be inexpensive enough that cost does not prevent access, nor interfere with other essential expenditures. | | | |
|---|---|---|---|
| | | **System-Level Service Indicator** | **System-Level Performance Measure** |
| Service Level | **Satisfactory** | Most households spend a minority of their discretionary income on essential drinking and wastewater needs without financial assistance; households with a high water cost burden receive financial assistance. | More than 33% of households do not meet the Satisfactory standard for affordability, disregarding low-income bill discount programs. For those spending more, a low-income bill discount program is available. |
| | **Moderate** | " | More than 40% of households do not meet the Satisfactory standard for affordability, disregarding low-income bill discount programs. For those spending more, a low-income bill discount program is available. |
| | **Marginal** | Nearly half of households spend a substantial proportion of their discretionary income on essential drinking and wastewater needs without financial assistance, and financial assistance is not available. | More than 50% of households do not meet the Satisfactory standard for affordability, disregarding low-income bill discount programs. |
| | **Unacceptable** | More than half of households spend a substantial proportion of their discretionary income on essential drinking and wastewater needs without financial assistance, and financial assistance is not available. | More than 50% of households do not meet the Satisfactory standard for affordability, disregarding low-income bill discount programs. |

is greater. Thus a relatively simple formula to determine whether a household in a given county qualifies for customer assistance would be:

$$\textit{gross household income} \leq \textit{200\% FPL or VLI, whichever is greater}$$

This standard can be calculated from readily-available data. It has the advantages of scaling with household size (FPL and VLI account for the number of persons in a household), and also adjusting to some extent for local cost of living (VLI is higher than 200% FPL in high-earning counties). This approach also would facilitate cross-enrollment with other programs that use the 200% FPL and VLI standards.

**Involuntary Shutoff Rate:** The involuntary shutoff rate, calculated as the number of involuntary shutoffs for residential customers divided by the number of residential connections, is a coarse but useful metric for gauging the affordability of water rates. The number is an imperfect metric for households unable to pay for water, because it may include involuntary service disconnections to households that choose not to pay along with those unable to pay.[5] Nonetheless, it provides a useful relative index of affordability; for example, one

5 Ideally, one would be able to measure disconnections for low-income households separately, but at this time, the State Water Board plans to collect information solely on total number of shutoffs ordered by each water utility.

would expect involuntary shutoffs to decline after instituting a customer assistance program. Indeed, when a group of customers with delinquent bills in St. Petersburg, Florida were randomly selected to receive debt restructuring and financial counseling, they had a decreased rate of shutoffs relative to control groups (Moulton et al. 2016). Most importantly, measuring involuntary shutoffs should generate information on the degree to which affordability acts as a barrier to water access, and whether existing affordability programs are sufficient to ensure that even very low-income customers can afford to consistently pay their water bill. A related, useful approach to measuring involuntary shutoffs would be to compare rates between households that are enrolled in a customer assistance program to similar households that are not enrolled.

## DATA SOURCES FOR AFFORDABLE DRINKING WATER AND SANITATION

Table 8 describes data sources to inform the performance measures on affordable water and sanitation. The Electronic Annual Reports, California American Water Rate Survey, and Wastewater User Charge Survey provide information on water rates for PWSs and centralized municipal wastewater systems. The Electronic Annual Reports also began to collect information on service disconnections in 2018.

**Table 8**

**Data Sources for Affordable Water and Sanitation Performance Measures**

| Description | Collected By | Information | Geographic Scale | Significance |
|---|---|---|---|---|
| Electronic Annual Reports | California State Water Board | Self-reported data on rate structures for Public Water Systems; calculates residential bill at 6, 12, and 24 CCF (4,500, 7,500, and 1500 gals). Also collects information on service disconnections. | Public Water System | Cost of drinking water for Public Water Systems. In 2015 public version of report, had information for ~650 large systems. Rates information is not extensively screened for accuracy. Also useful for estimating the Involuntary Shutoff Rate. |
| California American Water Rate Survey | California American Water (private sector) | Rate structures for Public Water Systems; calculates residential bill at 10 CCF (7,500 gals). | Public Water System | Cost of drinking water for Public Water Systems of a variety of sizes, mostly larger. 2015 version had information for ~900 systems. Detailed structure information allows user to calculate cost at any volume. |
| Wastewater User Charge Survey | California State Water Board | Self-reported rate structures for ~650 wastewater systems; gives estimate of average residential bill. | Wastewater Agency | Gives an approximation of wastewater costs, though few details are provided on how systems estimated the "average bill." |
| American Community Survey | US Census Bureau | Table S1901 gives number of households by income category; B19080 gives income quintile limits; S2501 gives household size. | Census Tract | Information on the income levels and household sizes for calculating the affordability ratio. |

Continued on Next Page

**Table 8 (Continued)**

**Data Sources for Affordable Water and Sanitation Performance Measures**

| Description | Collected By | Information | Geographic Scale | Significance |
|---|---|---|---|---|
| US Customer Expenditure Survey | US Department of Labor Bureau of Labor Statistics | Information on household expenditures by income category. | Aggregated for American West and large metro areas; microdata for county and metro area | Information on non-water essential expenses for calculating the affordability indicator. |
| Family Budget Calculator | Economic Policy Institute | Information on essential expenditures by category based on family size and composition. | County and metropolitan area | Information on non-water essential expenses for calculating the affordability indicator. |
| American Housing Survey (topics: Income and Housing Costs) | US Census Bureau | Information on income and housing costs. | Statewide and select metro areas; full geographic data in classified version | Survey of income and housing costs, including shelter and utilities. |
| American Community Survey Public Use Microdata Samples | US Census Bureau | Self-reported information on income and the amount of money spent on water. | Public Use Microdata area | Asks individual households to report their spending on water and income. |
| Federal Poverty Guidelines | US HHS | Threshold for poverty defined by income and household size. | National | Relevant for calculating Eligibility for Customer Assistance Program (ECAP) performance measure. |
| Affordable Housing Income Thresholds and Fair Market Rents | US HUD | Lists Area Median Incomes, defines regional income categories (e.g. VLI), and lists Fair Market Rents for housing. | County and metro area | Relevant for calculating Eligibility for Customer Assistance Program (ECAP) performance measure. |

*Note:* Additional details on data sources, including links to online resources and update schedule, are available in Online Appendix II.

The American Community Survey, US Customer Expenditure Survey, Family Budget Calculator, American Housing Survey, and American Community Survey Public Use Microdata Samples provide information on household incomes and expenditures. Federal Poverty Guidelines and Affordable Housing Income Thresholds and Fair Market Rents provide information on thresholds for poverty and baseline housing costs.

## DATA GAPS AND ANALYTICAL CHALLENGES FOR AFFORDABLE DRINKING WATER AND SANITATION

There are a number of topics relevant to affordability where information is unavailable, data have not been compiled in a centralized dataset, or important numbers are challenging to calculate.

**Sewer charges not billed by the utility:** Sewer charges are often levied through other means besides a utility bill, such as through annual property taxes. To our knowledge, there is no centralized dataset of such charges.

**Fine-resolution method to calculate discretionary income:** The Customer Expenditure Survey provides fine-scale information on expenditures for the largest metropolitan areas. For other areas, the information is generally classified at the state or multi-state level. It is possible to use regression models to account for regional variability (e.g., see Teodoro 2018), but this approach compromises the goal of ease of use and transparency.

**Data that disaggregate income and household size simultaneously:** Both income and household size impact affordability, but American Community Survey data do not disaggregate both simultaneously, preventing one from understanding the interaction between the two factors. For example, a household of one earning $30,000 a year may not be burdened by the cost of water, but a household earning a similar amount with seven members may be. Generally, analysts have looked at the variation in household income while assuming that all households are average or slightly above average size, ignoring the interaction between income and household size.

**Costs to construct, operate, and maintain a Very Small System or septic system:** The capital costs of constructing, operating, and maintaining decentralized infrastructure are not often addressed in conversations around affordability, nor are we aware of authoritative estimates of the costs. The maintenance costs of decentralized systems, while low on a per-month basis, often arrive in lump sums that are difficult to pay for families with limited cash and credit. For example, drilling or deepening a well in the San Joaquin Valley in 2016 cost $25,000 to $35,000, which was prohibitively expensive for many households whose wells ran dry in the 2012-2016 drought (Feinstein et al. 2017). Septic systems require routine maintenance every 2-5 years that costs a few hundred dollars (US EPA 2005).

## Accessible Drinking Water

We describe standards for accessible drinking water in Table 10 as meeting defined requirements for volume, location, and reliability of drinking water access, similar to the approach employed by JMP (WHO and UNICEF 2017b). The goal for accessible water should be available in the home, in sufficient volumes to meet domestic needs, at hot and cold temperatures, twenty-four hours a day. The goal has four components: volume, temperature, physical proximity, and temporal availability. We generated estimates of sufficient volume both from existing literature and recent data collected in California and North America, described in greater detail in the section on "Sufficient Volume." The standards for temperature, location, and times available were derived from statutory guidelines.

California statute expressly defines residences fit for habitation as including indoor hot and cold running water (California Civil Code §1941 and Health and Safety Code §17920.3).[6] This standard also aligns with the best available dataset on access to water, the American Community Survey, which asks respondents whether they have hot and cold piped water in their dwelling unit (US

6 California Civil Code §1941.1(a) deems dwellings "untenantable" if they lack a water supply capable of producing hot and cold running water furnished to appropriate fixtures and connected to a sewage disposal system. Likewise, California Health and Safety Code §17920.3 defines a substandard building as lacking hot and cold running water to plumbing fixtures in a dwelling unit or hotel.

Census Bureau 2016). Consequently, we defined Satisfactory water access as including hot and cold indoor piped water, available 24 hours a day, in sufficient volumes for an average Californian to use for drinking, cooking, cleaning, and operating a flush toilet.

For Moderate access, we allow for hot and cold running water that is on the premises but either shared with other units or outdoors. For example, shared living situations, such as SROs, boat marinas, and parks for vans and trailers typically offer shared access to piped hot and cold drinking water. Moderate access should provide sufficient enough water to meet typical indoor needs for a house with indoor plumbing, including a flush toilet. Marginal access would constitute traveling some distance, no more than half an hour round-trip, to collect a minimum volume of water sufficient for cooking, cleaning, and modest sanitation needs, such as flushing an efficient toilet two or three times a day.

Estimating sufficient volume to meet essential indoor needs in a developed country was challenging. We found that most existing estimates are based on volumes necessary for survival in short-term circumstances, such as refugee camps. On the other hand, estimates of typical indoor use in California and the United States were generally not based on recent, empirical data that separate leaks and outdoor irrigation from essential, indoor uses of water. In the following section, we offer an empirical estimate of the amount of water needed for essential indoor uses. In brief, we recommend 43 GPCD as a reasonable volume of water to meet indoor needs in a building with indoor plumbing. We incorporated the 43 GPCD figure into the Satisfactory and Moderate standards. We suggest 14 GPCD as a volume sufficient to meet basic human needs in the short term and employ that figure for the Marginal standard.

## SUFFICIENT VOLUME

There have been several attempts to quantify the amount of water required to meet basic human water needs in the international community. One of the most commonly-cited figures is from Gleick (1996), which estimated that 13 GPCD was sufficient to provide a minimum standard for drinking, sanitation, bathing, and food preparation. The WHO (2015) suggests that a lesser amount (6-9 GPCD) is sufficient in the medium-term to meet basic needs. Further, UNDP (2006) recommends an additional 2 GPCD for personal consumption to account for the greater needs of lactating women. We used a combination of Gleick's estimates for sanitation, bathing, and food preparation, plus the UNDP's higher estimate for consumption, to recommend 14 GPCD as meeting the Marginal standard for access to water in California. These volumes, while sufficient for survival, nonetheless reflect an austere standard of living – for instance, they would not accommodate the use of a flush toilet. To develop the Moderate and Satisfactory standards for volume, we looked to legal and observed precedents developed for indoor residential use in California.

Various statutes, regulations, and government documents have suggested reasonable volumes for basic indoor use in California. Specifically, the State Water Board's resolution on the Human Right to Water (State Water Board 2016b) pointed to two precedents for estimating a reasonable maximum daily per capita human use: the 55 GPCD "provisional indoor standard" referred to in California Water Code §10608.20, and the 50 GPCD maximum for domestic use diversions filed in the California Code of Regulations (CCR) during the height of drought in 2014 (CCR §878.1)[7]. The 55 GPCD figure in the California Water Code was offered as a "provisional indoor standard" when

7 CCR §878.1 was repealed in 2015.

*Source:* Mshch, iStock

A typical Californian requires 43 gallons a day for consumption, cooking, cleaning, and to flush a toilet.

California adopted laws on water conservation in 2009. Based on an earlier study (Mayer et al. 1999), California Department of Water Resources (DWR) estimated that baseline indoor use in California was 69.3 GPCD (DWR 2010a). A 20% reduction in per capita usage, as required under Senate Bill 7x-7, would reduce indoor usage to 55 GPCD. DWR recognized that the 55 GPCD indoor standard was arbitrary and committed to conduct a study to allow the legislature to re-evaluate the standard in 2016 (California Water Code §10608.20; DWR 2010b). To the best of our knowledge, the eventual report to the legislature on the topic did not revisit the indoor standard (DWR 2017).

The 50 GPCD standard has a more enigmatic origin. In their resolution adopting a maximum of 50 GPCD for domestic diversion, the State Water Board noted that there were "data indicating that basic human needs require between 37 and 50 gallons per person per day" (State Water Board 2015a). Without a citation, it is difficult to infer the basis for the volumes, but 50 GPCD is a common benchmark for minimum indoor water use in the United States, supported by US EPA work from the 1990s to estimate flows for sewer system design (Bowne, Naret, and Otis 1994).

We estimated a volume of water to meet Essential Indoor Uses (EIU) including to operate a shower or bath, run a faucet, wash dishes and clothes, and flush a toilet. We calculated indoor water requirements by determining the expected water use from each device in the home and summing the volumes. We exclude water loss from household leaks. The average water use for each appliance or fixture in California was based on data from the California Single Family Water Use Efficiency Study (DeOreo et al. 2011). This study found that total indoor use (including leaks) was 58 GPCD, although observed indoor use was highly variable, with a standard deviation of 36 GPCD. The study was conducted between 2006-2008, and we expect average indoor use to have declined since then as new, high-efficiency devices have become more common in both new and existing homes. Based on studies documenting a 0.9% annual decline in average indoor water use from the 2006-2008 period to 2016 (DeOreo et al. 2016), we estimate that average indoor water use likely declined to slightly less than 10% from 2007 to 2018, from 47 to 43 GPCD (Table 9; detailed calculations in Appendix I, Sufficient Water). Residents in California tend to use less water indoors than residents of other regions in North America. For example, residents of nine North American cities in the United States and Canada in 2016 still used slightly more water indoors than residents did a decade earlier in California (DeOreo et al. 2016).

We also provide estimates of the water required to meet EIU for households with appliances that meet current state standards and leading-edge technology. For these estimates, we multiply

## Table 9

### Volume of Drinking Water to Meet Essential Indoor Uses

| Use(s) | A<br>Adjusted Water Use in California Cities, 2018 | B<br>Observed Water Use in California Cities, 2006-2008 | C<br>California Standard Flow Rating | D<br>Leading Edge Technology Flow Rating | E<br>Observed Water Use in North American Cities, 2016 |
|---|---|---|---|---|---|
| Essential Indoor Use | 43 | 47 | 37 | 24 | 49 |
| Leaks | 9 | 10 | NA | NA | 8 |
| Total Indoor Use | 52 | 58 | 37 | 24 | 57 |

*Notes:* Detailed calculations and additional estimates for average behavior are available in Online Appendix I, worksheet "Sufficient Water," Tables B-D. Units in gallons per capita day (GPCD). Observed Water Use for California and North American Cities (Cols. B and E) are derived from residential end uses of water studies. The Adjusted Water Use (Col A) is based on Col B, with the assumption that per capita indoor water use declined by .9% annually from 2007-2018. Cols. C and D are the product of observed water use behavior multiplied by California and leading-edge device flow ratings. Numbers are rounded to the nearest whole number and may not sum to total because of rounding errors.

*Source:* Cols. A and B from DeOreo et al. 2016. Cols. C and D are average indoor water use behavior from DeOreo et al. 2011, multiplied by California 2018 flow rating standards and leading-edge technology flow ratings given in Online Appendix I. Col E is observed residential end uses of water for cities in the United States and Canada.

## Table 10

### Service Indicators and Performance Measures for Accessible Drinking Water in California

| **Goal:** Water should be available in sufficient volumes to meet domestic needs, at hot and cold temperatures, in a location near home, at the times needed. | | | |
|---|---|---|---|
| | | **Household-Level Service Indicator** | **Household-Level Performance Measure** |
| **Service Level** | **Satisfactory** | Sufficient hot and cold indoor piped water reliably available 24 hours a day. | At least 43 GPCD hot and cold indoor piped potable water available 24 hours a day. |
| | **Moderate** | Sufficient hot and cold water from an improved source available on premises (indoors or outside) and reliably available 24 hours a day; bottled or delivered water acceptable in some circumstances. | At least 43 GPCD hot and cold piped potable water available on the premises 24 hours a day. |
| | **Marginal** | Sufficient water from an improved source, including bottled water or tanks of water delivered by truck, provided collection time is not more than 30 minutes round-trip (including waiting time), and reliably available at least 12 hours a day. | Improved, potable water source providing at least 14 GPCD within 30 minutes round-trip of place of residence (including waiting time), available at least 12 hours a day. |
| | **Unacceptable** | Water that does not meet at least the Marginal standards for access. | Any one of the characteristics of Marginal access to water is not met. |

*Notes:* The rationale for 43 GPCD as sufficient to meet Essential Indoor Uses is shown in Table 9. The figure of 14 GPCD for marginal access sums figures given in Gleick (1996) for sanitation services, cooking and cleaning, and bathing, plus the figure given in UNDP (2006) as a minimum requirement for drinking. Gleick states that 5 liters is a true minimum of drinking water to sustain life in moderate climatic conditions, but UNDP (2006) states that the basic requirement for a lactating woman engaged in moderate physical activity is 7.5 liters a day. We selected the higher number as a precaution.

average daily use rates for each device, e.g., number of flushes per day, from DeOreo et al. (2011) by the flow rates of devices meeting current state standards and ultra-high efficiency devices. Leaks in California households result in an average loss of 10 GPCD, although we do not include leaks in the estimate of EIU. Based on these assumptions, we estimate that the water required for EIU is 37 GPCD and 24 GPCD for a household equipped with devices that meet current standards and cutting-edge technology, respectively. Upgraded devices could yield substantial improvements in water efficiency. More efficient devices will continue to penetrate the market over time and new, water-efficient technologies are regularly being developed.

Based on available data, we estimate that current EIU in California is 43 GPCD, which is equivalent to 5 Centum Cubic Feet (CCF) per month for an average-sized household of 2.95 persons in California (US Census Bureau 2018). This is likely a somewhat generous estimate of EIU, given that it is higher than what was observed for many cities during winter months in 2016 and 2017. (Outdoor irrigation is lower in the winter, so residential usage during these months reflects mostly essential indoor uses, plus leaks and winter outdoor irrigation). In February 2017, 34 out of 409 urban water suppliers had a per capita residential usage of 43 GPCD or lower (Heberger 2018). This indicates that many Californians are already using 43 GPCD or less, even when including leaks and some winter outdoor irrigation.

## ANCILLARY METRICS ON ACCESSIBLE DRINKING WATER

One of the most challenging aspects of evaluating access to water is that it can fluctuate over time due to factors such as a shutoff for delinquent payment or long-term supply vulnerabilities. We recommend a number of ancillary metrics to consider not just current access to water but also long-term factors that may impact access.

**Water Supply Resilience:** While a household may have sufficient water in the short term, its water supply may be vulnerable to drought and other natural disasters in the long term. Indicators of supply resilience include:

- **Drought Contingency Plan in Place:** Resilience for urban water suppliers can be evaluated based on the results of the Urban Water Management Plans submitted to California Department of Water Resources. Urban water suppliers are defined as serving more than 3,000 customers or supplying more than 3,000 acre-feet of water annually. Water systems below the size threshold to qualify as urban suppliers may develop drought contingency plans voluntarily. DWR began a stakeholder process in 2015 to develop a county-wide drought contingency planning process to encompass small and medium water suppliers, but this policy has not been finalized.
- **History of Past Water Shortages:** Water shortages among public water systems have been tracked through several datasets: Applications for Drought Assistance Funding (California State Water Board 2016e), Small Supplier Conservation Reports (California State Water Board 2016d), and Drought Vulnerability and Risk Assessments for Tribal Drinking Water Systems (Indian Health Services 2015). These three datasets were compiled for the 2012-2016 report Drought and Equity in California (Feinstein et al. 2017). Water shortages in Very Small Systems have been tracked through voluntary reporting to counties and compiled statewide in the Household Water Supply Shortage Reporting System (State of California 2017).

- **Groundwater Levels and Trends Relative to Domestic Water Well Depth:** In over-drafted water basins, groundwater levels are declining over the long term. The trend may reverse during wet years, but not enough to compensate for over drafting during dry periods. Shallow domestic water wells are vulnerable to supply shortages as the groundwater level drops. The Sustainable Groundwater Management Act should bring groundwater levels into equilibrium once the Groundwater Management Plans go into effect; however, it is unclear whether these plans will universally set groundwater levels above the depth of existing domestic wells. An understanding of long-term trends in groundwater relative to the completion depths of domestic wells would provide an index of supply vulnerability by groundwater basin.
- **Urban Water Supplier Reliability:** Urban water suppliers (water utilities serving more than 3,000 customers, or over 3,000 acre-feet annually) report information on supply reliability under the California State Water Board's Emergency Urban Water Conservation Requirements, as well as DWR's Urban Water Management Plans.

*Source:* InnaPoka, iStock

Lack of indoor running water and toilets is closely linked to problems of poor-quality housing.

## DATA SOURCES ON ACCESSIBLE DRINKING WATER

Table 11 describes data sources to inform the performance measures on accessible water. Much of these data sources focus on the quality of housing, which is a major determining factor in water access. Other focus on water supply vulnerabilities, either as reported in the past or projected in the future.

## DATA GAPS AND ANALYTICAL CHALLENGES FOR ACCESSIBLE DRINKING WATER

Persons with inadequate access to water typically reside in homes not built to code, do not have a home, or rely on a very small water system that cannot consistently supply sufficient quantities of water. Marginalized and disadvantaged communities are also typically the most difficult to count in surveys. Persons with inadequate housing or water may avoid reporting problems because they fear repercussions such as eviction or deportation. While American Community Survey and homeless Point-in-Time counts described in Table 10 provide a relatively robust overview of persons without adequate access to water by region of California, they may undercount vulnerable persons.

In terms of understanding water supply vulnerabilities, we have information on shortages during the 2012-2016 drought, which affected thousands of Very Small Systems and more than one hundred small to medium public water systems in the state (Feinstein et al. 2017). The chief analytical challenge is projecting the likelihood of future supply shortages. For Very Small Systems

## Table 11

### Data Sources for Accessible Drinking Water Performance Measures

| Description | Collected By | Information | Geographic Scale | Significance |
|---|---|---|---|---|
| American Housing Survey (topics: Equipment and Appliances, Healthy Homes, Housing Problems) | US Census Bureau | Source of water, indoor plumbing fixtures, water supply outages, hot water availability. | Statewide and select metro areas; full geographic data in classified version | Household survey on source of water, supply outages, and nature of indoor plumbing fixtures. |
| American Community Survey tables | US Census Bureau | Complete plumbing. | Census Tract | Useful for understanding rates of housing with incomplete plumbing at a fairly fine geographic scale. However, results conflate lack of hot piped water, lack of cold piped water, lack of tub or shower, and lack of toilet. |
| American Community Survey Integrated Public Use Microdata Series | US Census Bureau | Hot and cold piped water, bath/shower; toilet (discontinued in 2016). | Public Use Microdata Areas (103 counties) | Useful for understanding rates of housing units lacking hot and cold running water. |
| Homeless point-in-time counts | US Housing and Urban Development | Annual counts of homeless persons. | Continuums of Care (cities or counties) | Gives the number of homeless persons in an area. |
| Household water shortages | California DWR | Reports of household water shortages resulting from a dry well, stream, creek, or other surface water supply. | County | Voluntary reporting of shortages for households supplied by very small systems. |
| Water well completion reports | California DWR | Well location, completion depth, perforation depth, and intended use. | Public Land Survey System sections (1 m2) | Perforated depths in conjunction with local groundwater level and trend can indicate likelihood of groundwater supply vulnerability. |
| California Statewide Groundwater Elevation Monitoring | California DWR | Groundwater depth over time. | Groundwater basin | In conjunction with well completion reports, can indicate likelihood of groundwater supply vulnerability. |
| Urban Water Management Plans | California DWR | Projects future supply and demand, describes drought contingency plan. | Public Water System | Indicator of potential for future supply shortages. |
| Safe Drinking Water Information System | California State Water Board | Type of water source (groundwater, surface water); number of interties. | Public Water System | Information on water sources for public water systems. |

*Notes:* Additional details on data sources, including links to online resources and update schedule, are available in Online Appendix II.

that are strictly reliant on groundwater, it would be useful to bring together information on groundwater basin levels, trends, and well depths to predict locations where domestic wells are vulnerable to shortages. For small and medium Public Water Systems too small to be required to develop Urban Water Management Plans and the associated drought contingency plans for DWR, there is little information to understand and predict their supply resilience. The Safe Drinking Water Information System offers some information about the primary type of water supply (ground versus surface water) and number of interties to other systems. However, this is insufficient to develop a strong understanding of the supply resilience of small- to medium-sized Public Water Systems.

## SANITATION INDICATORS AND PERFORMANCE MEASURES

The California Water Code states that "every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes" (California Water Code §106.3). The last phrase designates water for sanitary purposes – i.e., operating a toilet – as part of the Human Right to Water. However, the infrastructure required for sanitation – namely a toilet for hygienically separating a person from their waste and a system for safely treating and disposing of waste, such as a connection to a centralized wastewater treatment plant or a functional septic tank – are not explicitly mentioned, and have been treated as lower priorities by government programs and civil society organizations dedicated to improving access to water (see companion report by Cador and Salceda 2018 for more discussion on efforts to improve access to water and sanitation).

While the law is ambiguous, sanitation and hygiene are essential to realizing the public health benefits of adequate water. Sanitation reduces the incidence of water-borne diseases, such as cholera, bacillary dysentery, Escherichia (E.) coli infections, viral hepatitis A, and typhoid. The advances made in the late 19th and early 20th centuries to remove bacteria from drinking water and provide access to sanitation systems are the principle reason that mortality rates dropped by around half in major cities in the United States during that period (Cutler and Miller 2005). Additionally, improved sanitation and the associated reduction in disease burden is a prerequisite for humans to realize their full potential cognitive and physical development (Hammer and Spears 2016).

There is evidence of serious gaps and failures in California's sanitation systems.

Today, the public is often more preoccupied with drinking water contaminants stemming from industrial or agricultural pollution than from human waste. Yet, there is evidence of serious gaps and failures in California's sanitation systems. For example, between September 2017 and January 2018, there was a Hepatitis A outbreak concentrated in San Diego and Los Angeles counties, with 588 cases reported in San Diego and 42 in Los Angeles (County of Los Angeles Public Health 2018; San Diego County Health and Human Services Agency 2018).[8] Hepatitis A is transmitted by oral contact with feces, and is associated with a lack of proper sanitation and hygiene facilities, or the failure to use those facilities properly, such as not washing one's hands after changing a diaper or before preparing food (County of Los Angeles Department of Public Health 2017). The majority of those affected were homeless, and transmission

8 By comparison, 770 cases were reported annually in the state in 2013-2014, according to California Department of Public Health's database of infectious diseases.

The goal for safe sanitation is that waste be separated from the person by a well-designed toilet and then safely transported, treated, and discharged to the environment.

stemmed from open defecation and lack of handwashing facilities.

Public health officials tend to prioritize water over sanitation, and within the realm of sanitation, to focus on the toilet to the exclusion of the waste treatment system. However, there is growing recognition that the benefits of improved drinking water are only fully realized when there is also access to improved sanitation (Lipson et al. 2010). Additionally, field studies have shown that toilets not connected to a treatment system offer little health benefit to the users (Null et al. 2018; Luby et al. 2018). Safe water, a toilet, a system for treating human waste, and facilities and soap for handwashing are all necessary to reduce fecal pathogen contamination and a disease burden that limits human potential.

## Safe Sanitation

The goal for safe sanitation is that waste be separated from the person by a well-designed toilet and then safely transported, treated, and discharged to the environment. Problems can arise at both stages if people lack clean and properly-designed toilets, or because the toilet is not connected to a functioning sanitary system.

Problems with unsafe sanitation, stemming from the lack of a toilet or other improved facility (such as a latrine with a seat or platform) are closely linked to inadequate housing conditions. In 2015, there were 89,000 Californians living in substandard housing without private, indoor flush toilets (ACS 2015). Lack of indoor toilets is a particularly prevalent on California's tribal lands (California Department of Housing and Community Development, Rural Community Assistance Corporation, and California Coalition for Rural Housing in press).

There are also problems with inadequate sanitation that arise at the stage of treatment and disposal. Proper treatment and disposal (or reuse) of waste can be accomplished with onsite wastewater treatment systems, such as septic tanks, or by centralized municipal wastewater systems. While there are no comprehensive data on the numbers or extent of inadequate treatment of human waste in California, there are known incidents of improper treatment and leaks. In 2014 and 2016, 30% of 1,967 California waterways were designated as impaired for fecal indicator bacteria under section 303(d) of the federal Clean Water Act (California State Water Board 2016a). Fecal indicator bacteria can originate from any warm-blooded animal, and it is technically difficult to determine whether the source is human or another animal. However, at least some of the sources are human. In the San Diego Bay watershed, it has been established that humans are the main source of fecal indicator bacteria in the waterways, though the precise leakage pathway is undetermined (Steele et al. 2017). Sanitary sewer overflows – accidental releases of untreated or partially treated water from centralized wastewater systems – occur thousands of times each year in California, with 3,361 releases reported in 2017 (State Water Board 2018d). The City of Oakland has a particularly egregious history of large sewage spills, accompanied by inadequate reporting and public notification (Canon 2018).

The indicators for measuring safe sanitation are informed by variation in the quality of the toilet and the caliber of the treatment and disposal system (Table 12). Satisfactory sanitation consists of a flush toilet connected to a system that hygienically separates waste from human contact, where waste is safely disposed of on-site, or transported and treated off-site. This is consistent with various California statutes and regulations. California statutes on owner-occupied and rental housing require that residences have hot and cold water connected to "appropriate fixtures" and connected to a sewage disposal system (California Civil Code §1941, Health and Safety Code §17920.3). State plumbing regulations describe standards for flush toilets connected to a sanitary drainage system (CCR, Title 24, Part 5). Data to make reasonable estimates of the number of people with a satisfactory standard of service are available, although gaps exist, as is described further in the sections exploring data on clean sanitation, below.

Thirty percent of California waterways were impaired for fecal indicator bacteria in 2016.

Moderate sanitation is essentially the same as the Satisfactory standard, but can be met by any improved facility, including a pour-flush or non-flush toilet, as long as the toilet separates a person from their waste and is connected to a system for treatment and disposal. The Moderate standard is

**Table 12**

**Service Indicators and Performance Measures for Safe Sanitation in California**

| **Goal:** A sanitation system should separate waste from human contact until it can be safely treated and released to the environment or reused. | | | |
|---|---|---|---|
| | | **Household-Level Service Indicator** | **Household-Level Performance Measure** |
| **Service Level** | **Satisfactory** | Flush toilet connected to a system that hygienically separates waste from human contact, where waste is safely disposed of on-site, or transported and treated off-site. | Flush toilet connected to a well-maintained sewage system or an onsite wastewater treatment system. |
| | **Moderate** | An improved facility that hygienically separates waste from human contact, where waste is safely disposed of on-site, or transported and treated off-site. | Pit latrine, improved pit latrine (pit latrine with a slab or ventilated pit latrine), or composting toilets connected to a sewage system or an onsite wastewater treatment system. |
| | **Marginal** | An improved facility that hygienically separates waste from human contact. | Flush toilet, pit latrine, improved pit latrine, or composting toilet not connected to a functional sewage system or an onsite wastewater treatment system. |
| | **Unacceptable** | Use of unimproved facilities or open defecation. | Pit latrines without a seat, hanging latrines, bucket latrines, or open defecation. |

*Notes:* Improved facilities safely separate a person from their waste and include flush toilets, pour flush toilets, and latrines with a platform or seat. Unimproved facilities do not safely separate a person from their waste while using the toilet. Septic systems are the most common type of Onsite Wastewater Treatment System (OWTS).

consistent with the JMP Safely Managed Standard. Non-flush toilets are legal in California and standards for such "alternate plumbing systems" are described in regulations (CCR Title 24, Part 5, Appendix C), but typically non-flush toilets are meant to supplement, not replace, an indoor flush toilet.

Marginal sanitation is met by an improved facility not connected to a functional sewage system or Onsite Wastewater Treatment System (OWTS), such as a septic system. Such systems separate the person from their waste in the moment but allow release of pathogens to the environment that raise the disease burden of the population. Such sanitation systems are an improvement over open defecation but still represent an unacceptable risk to the environment.

Unacceptable sanitation is characterized by the use of an unimproved facility, such as a pit latrine without a seat or platform, or open defecation. While not common among persons with housing, open defecation is a growing problem as the homeless population rises in California and has been a topic of vigorous debate in cities as diverse as Chico, Sacramento, San Francisco, Los Angeles, San Diego, and Anaheim (Halverstadt 2017; Scharaga 2018; Street Sheet Staff 2017; Sacramento Bee Editorial Board 2018; Los Angeles Central Providers Collaborative 2017).

### DATA SOURCES FOR SAFE SANITATION

Table 13 describes data sources to inform the performance measures on safe sanitation. Households report whether they have a flush toilet in the home, and information on whether they are connected to a centralized sewer or OWTS, via the American Community Survey and American Housing Survey. Information on discharges of inadequately treated wastewater from centralized municipal systems is tracked by the State Water Board in their Interactive Sanitary System Overflow Report. There is relatively little centralized information available on the maintenance and illegal discharges from OWTS. There is no California statewide database of OWTS locations, which are regulated by Local Area Monitoring Programs (LAMPs). Pursuant to the OWTS Policy adopted in 2012, the LAMPs are required to transmit information annually to the Regional Water Boards on complaints, investigations, and permit issues for new and replacement OWTSs (State Water Board 2012). Acquiring copies of this information requires filing requests with the Regional Water Boards; we have not reviewed the data and have limited insight into the content of the datasets.

### DATA GAPS AND ANALYTICAL CHALLENGES FOR SAFE SANITATION

**Lack of granularity for information on quality of toilets in the home:** Both the American Community Survey and American Housing Survey collect information on toilets, but there are some barriers to effective use of these data. The principle challenge in evaluating information on the location and adequacy of OWTS is that the information is collected by LAMPs and transmitted to Regional Water Boards; it is not aggregated for the state, nor is it readily available online. The information is far more decentralized and difficult to access than comparable information on safe drinking water. Additionally, the American Community Survey collected information on toilets in the home until 2015 but discontinued the question in 2016 due to privacy concerns.

## Accessible Sanitation

The goal for accessible sanitation is that toilets should be private, located in the home, safe to visit, and available when needed. Accessibility is tightly interrelated with questions of safety and

**Table 13**

**Data Sources for Safe Sanitation Performance Measures**

| Description | Collected By | Information | Geographic Scale | Significance |
|---|---|---|---|---|
| American Housing Survey (topics: Equipment and Appliances, Healthy Homes, Housing Problems) | US Census Bureau | Availability and functionality of indoor toilet, type and functionality of sewer system. | Statewide and select metro areas; full geographic data in classified version | Household survey on nature of sanitation equipment, sewage system (sanitary sewer, OWTS, or none), and recent breakdowns of the toilet and sewage system. |
| American Community Survey tables | US Census Bureau | Complete plumbing. | Census Tract | Useful for understanding number of housing units with incomplete plumbing at a fine geographic scale. However, results conflate lack of hot piped water, lack of cold piped water, lack of tub or shower, and lack of toilet. |
| American Community Survey Integrated Public Use Microdata Series | US Census Bureau | Hot and cold piped water, bath/shower; toilet (discontinued in 2016). | Public Use Microdata Areas (vary from 1-3 counties) | Useful for understanding rates of housing units lacking indoor private flush toilets. |
| Interactive Sanitary System Overflow Report | California State Water Board | Sanitary sewer overflows for permitted SSOs and private lateral sewage discharges. | County | Useful for identifying centralized sanitary sewers and private lateral connections that are discharging untreated human waste to the environment. |
| Local Area Monitoring Programs (LAMPs) Onsite Wastewater Treatment System Permits | LAMPs and Regional Water Boards | Permits for Onsite Wastewater Treatment Systems (OWTS); impact of OWTSs on regional water quality. | LAMP (usually a county) | Information on discharges to the environment of untreated wastewater from OWTS. |

*Note:* Additional details on data sources, including links to online resources and update schedule, are available in Online Appendix II.

cleanliness addressed in the previous section. But the focus in the access dimension is on the factors affecting usability of a toilet: the number of people who share it, its location, and whether it is properly maintained and cleaned.

As with the safety dimension of sanitation, housing conditions are a major determining factor in access to sanitation. The vast majority of homes in California have a flush toilet in the unit. According to the American Community Survey and the American Housing Survey, between 99.5 and 100% of housing units in California had an indoor toilet in 2015 (US Census Bureau 2015b). Nonetheless, there are some important regional differences in the rates of housing units without toilets, with some counties reaching rates as high as 2% (Feinstein and Daiess in prep). Many of those reporting that they lack their own toilet likely have access to a shared facility.

## San Francisco touts its 22 public restrooms. Yet all the toilets close by 8 PM or earlier.

For those who have a home, problems arise either because the toilet breaks down or is shared with too many people and non-relatives (Box 4). In 2015, 2% of households reported experiencing a period of at least six hours in the past three months when they had no working toilet (US Census Bureau 2015a, see Housing Quality Table). Crowded living conditions and non-relatives sharing a home also present problems for access to sanitation. Problems of inadequate numbers of toilets have been documented for low-income farmworkers in crowded housing, and for inhabitants of SROs reliant on shared facilities (California Institute for Rural Studies 2018; SRO Families United Collaborative n.d.; San Francisco DPH 2016).

While there are problems of access to sanitation facing some Californians with housing, by far the most serious problems are experienced by the homeless community. As noted above in the Safe Sanitation section, homeless persons must regularly resort to using buckets or defecating in the open because of a lack of nearby, public toilets (McGahan 2018; Green 2017; Walker 2017; Schneider 2018). There are also more subtle issues around access, wherein a public toilet is available but is unusable for a multitude of reasons: toilets become unusable or unclean because they are shared by many people, are subject to careless treatment and vandalism, lack doors for privacy, or are insufficiently maintained. But there are also problems that are unique to public toilets. These include bathrooms occupied by people for unintended purposes, or the problem that people, especially women, are physically vulnerable when they approach a public restroom. Many

*Source:* Diane Bentley Raymond, iStock

Persons experiencing homelessness lack ready access to toilets, which compromises their and the community's health.

public agencies close public restrooms at night, to reduce the potential that they will be used for illegal activity. One report on access to toilets for the homeless living on Los Angeles's Skid Row found that while there were 43 toilets open at peak daytime hours, that number dropped to only 9 between the hours of 8 PM and 6 AM (Los Angeles Central Providers Collaborative 2017). Many of the open toilets were broken or lacked some basic feature, such as a door or minimum cleanliness. The same report also interviewed homeless women who avoided public bathrooms because approaching them made the women vulnerable to assault. These problems are not restricted to Los Angeles. For instance, San Francisco touts the 22 restrooms. Yet all the toilets close by 8 PM or earlier (San Francisco Public Works n.d.).

### DATA SOURCES FOR ACCESSIBLE SANITATION

Table 15 describes data sources to inform the performance measures on accessible sanitation. For housing units with private toilets, the American

**Box 4**

### Shared Toilets: Context and Controversies

Are shared toilet facilities an adequate solution for meeting the right to sanitation? The answer depends on how well the facilities are managed. Residences of group facilities, such as dormitories with professional cleaning staff, routinely share toilets without difficulties. How well these facilities function depends on whether there are sufficient cleaning and maintenance resources, and the number of people sharing a toilet. Originally, the JMP Sanitation Task Team recommended a benchmark which would consider households using facilities shared by no more than five families and no more than 30 people (taken as a proxy for adequate management) as having access to "basic" sanitation. Ultimately, JMP designated shared facilities as having "limited" sanitation service, due to a lack of data on households and people sharing facilities, and insufficient evidence to demonstrate that there is a link between the number of people and households sharing a toilet and how well it is operated (Evans et al. 2017).

Ultimately, the question of whether a shared toilet is adequate for access to sanitation depends on whether it is hygienic, well-maintained, and available when needed. Shared toilets do not always fail to meet these standards but regularly do. In SROs and homeless shelters, tenants routinely encounter toilets too dirty to use, and must resort to chamber pots instead. A 2016 survey by the San Francisco Department of Public Health of the city's SROs found more than 400 sanitation violations and 170 plumbing violations from 2008 to 2012 (SF DPH 2016). The department noted that exposure to diseases transmitted through feces are a "real hazard" for SRO residents. Local news media profiles vividly documented problems San Francisco residents of SROs and homeless shelters face when using the toilet:

**The Tan family:** *"The Tans immigrated to San Francisco from Canton in 2011. They moved into this hotel a year later. Life in the US is better than in China, they say, but life in the hotel isn't easy. Each of the two rooms in the apartment costs $900 per month. There is one communal toilet per floor (shared by 15 families) and one communal kitchen. In the morning, it's not uncommon to wait 20 minutes for the bathroom. Sometimes the family uses a bucket in their room instead"* (Lybarger 2014).

**Clarence:** *"With nowhere else to turn, he got a bed in the Sanctuary, a men's shelter administered by Episcopal Community Services. He describes it as 'a ward of broken men who coughed and cursed all night. In the morning, half a dozen would file into the bathroom and shit on everything'"* (Lybarger 2014).

**Ivy Gao and her family:** *"Their three-year-old son uses a chamber pot, she says. 'The bathroom on our floor is too dirty, so I'm reluctant to let him use it. If we had our own house, I could let him go to the bathroom without worrying'"* (Kam 2015).

SROs and shelters can have clean, safe shared toilets if they are well-maintained, but given the well-documented shortfalls, one cannot simply assume that physical access to a toilet ensures that it is in usable condition.

**Table 14**

**Service Indicators and Performance Measures for Accessible Sanitation in California**

| Goal: Toilets should be private, located in the home, safe to visit, and available when needed. | | | |
|---|---|---|---|
| | | **Household-Level Service Indicator** | **Household-Level Performance Measure** |
| **Service Level** | **Satisfactory** | Private, secure, well-maintained, in-home facility, not shared with other households, available 24 hours a day. | Household has 24-hour access to a functioning toilet not shared with other households. |
| | **Moderate** | Private, secure, well-maintained, on-site facility, possibly shared with other households, available 24 hours a day. | Household has 24-hour access to a functioning toilet either in the structure (not necessarily in their unit for multi-unit buildings) or on the property, with at least one toilet per 10 male residents plus one toilet per 8 female residents. |
| | **Marginal** | Private, secure, well-maintained facility, possibly shared with other households, no more than 50 meters from home, available 24 hours a day. | Household has 24-hour access to a functioning toilet shared with no more than 20 people, within 50 meters of their usual place of residence. |
| | **Unacceptable** | Facility is more than 50 meters from home, not available 24 hours a day, or use of the facility compromises personal safety or privacy. | Any one of the characteristics of Marginal access to sanitation is not met. |

Housing Survey collects information on the number of toilets, frequency of breakdowns, and the number of people sharing a housing unit. For units without their own toilet, there is a follow-up question on the location of the toilet (under Interior Features, variable "BATHEXCLU"). However, the rate of households in California is so small – less than 0.5% - that the results do not report any units without a toilet in its sample of 12,900 housing units statewide. The dataset is useful for tracking more common problems, such as the number of households that lacked a usable toilet recently because of breakdowns and the number of people sharing a bathroom.

The American Community Survey is a larger survey, reaching nearly 2 million California households over a 5-year period. Consequently, it is more useful for tracking problems that occur at very low frequency, such as lack of a toilet. However, it does not contain the same level of detail on breakdowns and number of bathrooms per household as the American Housing Survey.

## DATA GAPS AND ANALYTICAL CHALLENGES FOR ACCESSIBLE SANITATION

**Access to sanitation for homeless persons:** To our knowledge, there is no centralized, extensive dataset on sanitation access for this population. San Francisco posts some disconnected datasets on the locations of public toilets operated by a variety of city agencies (San Francisco Public Works n.d.), but to the best of our knowledge, most cities do not offer even that level of information. A model for surveying availability of toilets for the homeless can be found in "No Place to Go: An Audit of the Public Toilet Crisis in Skid Row" (Los Angeles Central Providers Collaborative 2017).

**Adequacy of shared toilets:** Given the format of data collection on group quarters and SROs with shared toilets, we are left to assume that they are moderately accessible if they do not serve more than the appropriate number of people. In practice, that may be far from the case, but we have little information on their condition, outside of any Department of Public Health inspections that may have taken place.

*Source:* Phi2, iStock

Shared toilets should be used by no more than 20 people, within 50 meters of their usual place of residence, and available 24 hours a day.

**Table 15**

**Data Sources for Accessible Sanitation Performance Measures**

| Description | Collected By | Information | Geographic Scale | Significance |
|---|---|---|---|---|
| American Housing Survey (topics: Structural, Demographics) | US Census Bureau | Number of persons, bathrooms per household, location of bathroom (in unit, out of unit, outdoors). | Statewide and select metro areas; full geographic data in classified version | Useful for understanding number of persons per bathroom. |
| American Community Survey microdata | US Census Bureau | Hot and cold piped water, bath/shower; toilet (discontinued in 2016). | Public Use Microdata Areas (vary from 1-3 counties) | Useful for understanding rates of housing lacking hot and cold running water, tub/shower, or toilet. |
| American Community Survey tables | US Census Bureau | Complete plumbing. | Census Tract | Useful for understanding rates of housing units with incomplete plumbing at a fine geographic scale. However, results conflate lack of hot piped water, lack of cold piped water, lack of tub or shower, and lack of toilet. |

*Note:* Additional details on data sources, including links to online resources and update schedule, are available in Online Appendix II.

# CONCLUSIONS AND RECOMMENDATIONS

This report offers a unified framework on how to measure progress toward universal access to water and sanitation in California. The various indicators and performance measures are tightly linked, and it is not useful to work toward any subset in isolation. What use is affordable water if it is undrinkable? What is the value of clean water if it is unreliable? What benefit is it to provide a sanitation facility with no place to wash your hands, or a toilet that is connected to a leaky sewage system? But taken as a whole, these service ladders offer a checklist of the many items that compose a fully-developed approach to adequate water and sanitation service at the household and individual level.

The service ladders are themselves sets of recommendations for goals, indicators, and performance measures for the state to adopt. Even for those who only use this report as a starting point, rather than a template for their work, there are general principles that can be used as guidelines for any attempt to measure water and sanitation in the state. Below we make a series of recommendations on how to improve our understanding of water and sanitation service in California and use that knowledge to improve the quality of service.

## Recommendations on Metrics

- **Safe Water:** When tracking compliance with the California SDWA, consider duration and frequency of time out of compliance in a given time period.
- **Affordable Water and Sanitation:** Consider water, wastewater, and the costs of basic non-water needs when calculating affordability, and consider both regional- and household-scale metrics.
- **Accessible Water:** Consider facets of location, volume, and availability over short and long time scales (i.e., both running 24 hours a day and resilient to drought and climate change). Update common assumptions about volumes of water used indoors to reflect declining use in California and recognize that this trend will continue as appliances and fixtures are replaced.
- **Safe Sanitation:** Consider both the adequacy of the toilet facility as constructed and the functioning of the sanitary system, which should include a centralized or on-site wastewater system that adequately treats and disposes of or recycles human waste.
- **Accessible Sanitation:** Consider proximity, privacy, security, cleanliness, and maintenance. If the toilet is shared, consider whether the number of people using the toilet is below reasonable limits.

## Recommendations on Developing a Unified Set of Metrics to Inform Policy

- **Adopt a single, consistent set of indicators and performance measures, and designate a single entity entrusted with regularly assessing those metrics.** Efforts by DWR to develop sustainable water management indicators as part of the California Water Plan, the State Water Board's resolution directing staff to develop goals and performance measures as part of its Human Right to Water Portal, and OEHHA's evaluation of the status of the Human Right to Water are all valuable efforts. Each will be more useful if they are merged into a unified framework that is employed by all stakeholders in California. The Governor should convene the appropriate cabinet secretaries to identify the lead responsible agency for assessing water and sanitation service.

- **Use a unified set of water and sanitation performance measures to direct funds and resources to the most pressing problems.** The current approach to allocating funds to disadvantaged communities relies on local actors applying for resources; it is unknown to what degree needs go unmet because local entities do not have the capacity to seek assistance. Measuring a set of drinking water and sanitation performance measures regularly would yield detailed information on the number, location, and characteristics of those households with the greatest need for improved water and sanitation services. Funds to address drinking water and sanitation problems, such as the proposed Safe and Affordable Drinking Water Fund (SB 623, Monning), should use performance measure results to identify and reach out to communities that are likely eligible for assistance.

## Recommendations on the Scope and Scale of Water and Sanitation Service Metrics

- **Shift from using performance of centralized water and sanitation systems as exclusive proxies for the quality of service to also tally households and individuals that are not adequately served by large institutions.** The Human Right to Water implies the importance of considering water and sanitation for every person. Yet for many indicators, the best or only data available are collected at regional scales – often the Public Water System or centralized wastewater system. While most people are served by these systems, many of the people without adequate water and sanitation are not. These are small, disadvantaged, and remote rural communities outside of service area boundaries, or persons within service area boundaries that are not connected to centralized systems, have an on-premises plumbing problem, or lack shelter. Regional-scale data are useful, but it is important to acknowledge its limits and to supplement it with granular information at the individual and household level when available.
- **Recognize sanitation as an essential component of the Human Right to Water.** Current statute recognizes a right to water for sanitary purposes, but does not address the other components of sanitation: a toilet for personal use, and a system for safely treating and disposing of the waste. Like safe and sufficient water, sanitation is necessary to ensure human health, prevent epidemics of water-borne diseases, and safeguard the quality of drinking water resources. Adequate water without sanitation is insufficient for meeting the overriding objective of preventing waterborne health threats from chemical contaminants and disease.
- **Measure water and sanitation services in non-residential settings.** Schools, preschools, and hospitals host high concentrations of people vulnerable to disease. Ensuring the basics of clean water, a functional sanitation facility, and a place to wash one's hands are vital for the health and safety of children and the ill. While this publication does not address institutional settings, this is a clear next step for further investigation.

## Recommendations on Remedying Key Data Gaps

- **Investigate quality of water delivered by Very Small Systems, i.e. domestic wells.** Mapping these problems requires understanding the quality of source water as well as the treatment of the water by the well operator. If the state

begins to offer more financial support for domestic well owners to test and treat their water, the program may yield useful data.

- **Identify Public Water Systems that persistently fail to deliver water that meets Safe Drinking Water Act standards.** In their present format, it is difficult to use the Safe Drinking Water Information System and the Human Right to Water Portal to distinguish temporary, one-time violations of the SDWA from long-term problems.
- **Measure how many Californians face trade-offs between paying their water bill and other necessary expenses, and how often that trade-off results in long-term debt accumulation or service disconnections.** A regional-scale understanding of households likely to have difficulty paying their water bill can be gleaned from datasets on cost of living, household income, and local water rates, though the data on water rates are not complete. There is relatively little information, however, on the number of households who face difficulty paying their water bill, and almost none on whether difficulties in paying water bills results in long-term debt accumulation or service disconnections.
- **Collect information on service disconnections that distinguishes between occupied and unoccupied residences.** Community water systems typically track service disconnections, but it is not possible to distinguish between occupied households that lose service for failure to pay and unoccupied households where residences simply neglected to notify the utility when they vacated their home. Yet utilities are required to notify the occupants of a home before disconnecting service, and also routinely receive communications from the occupants, offering multiple opportunities to record whether the unit appears to be occupied. Medium and large community water systems should record when service disconnections are for units that are known to be occupied.
- **Compile locally-held information on leaking septic systems or other onsite wastewater treatment systems.** Anecdotally, community organizations working with disadvantaged communities report that they serve households with improperly maintained septic systems. Information on permit violations is collected by local government entities and transmitted to the Regional Water Boards. The State Water Board should compile this information in a single statewide electronic database to develop a greater understanding of wastewater problems in the state.
- **Regional board stormwater permits should require municipalities to collect data on publicly-accessible toilets and handwashing facilities.** Given the well-established role of universal sanitation in preventing water pollution and disease, public toilets and handwashing facilities should be regarded as a primary strategy to safeguard the quality of California's waterways. Yet resources to improve stormwater quality have focused on strategies to clean stormwater, rather than prevent fecal matter from entering in the first place. Regional Water Boards could alter this by placing greater emphasis on provision of public toilets to reduce fecal matter in stormwater. The first step would be to systematically collect information on location, usability, hours of public toilets, and proximity to homeless encampments.

## Recommendations for Policy Solutions to Address Failures in Drinking Water and Sanitation Service

- **Use the Eligibility for Customer Assistance Program (ECAP) metric described in "Ancillary Performance Indicators for Affordable Water and Sanitation" to qualify households for a water affordability assistance program.** The ECAP metric is relatively simple to calculate, aligns with other well-established social service programs enrollment thresholds, and addresses disparities in cost of living around the state.
- **Expand CalFresh benefits to include soap for handwashing.** Lack of access to soap is a persistent problem among food-insecure families. California has recently experimented with expanding CalFresh assistance by providing a supplementary drinking water benefit for customers of public water systems with unsafe drinking water (California 2017-18 Budget, enacted June 2017). Adding soap to CalFresh benefits would be a relatively inexpensive way to ensure that low-income children obtain access to an essential component of hygiene.

We live in a time of extraordinary progress toward reducing poverty worldwide. Between 1990 and 2013, the number of extremely poor people globally fell by over a billion, even as the world's population grew by more than one and a half billion (The World Bank n.d.). But the final steps of eradicating poverty are perennially plagued by the "last mile problem:" the pace of progress slows as a society nears the goal of eliminating extreme poverty (Chandy et al. 2015).

California is no exception. Only a small percentage of California's population lives without adequate water and sanitation, yet progress toward eliminating these last inequities is long overdue — all the more so in comparison to the magnitude of the infrastructure we have constructed to transport and treat water for the vast majority of the state's residents. But, seen from another perspective, the state's problems in ensuring universally adequate water and sanitation are surmountable. We have the resources to bridge these last gaps in service. With concerted effort, the vision of universal water and sanitation for all Californians can be realized.

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# Appendices (Online)

**Appendix I.**
**California Service Ladders for Measuring the Human Right to Water and Sanitation**

**Appendix II.**
**Data Sources For Performance Measures on Water and Sanitation**

**Appendices are available at http://pacinst.org/publication/measuring-progress.**


**Pacific Institute**
654 13th Street, Preservation Park
Oakland, California 94612
510.251.1600 | info@pacinst.org
www.pacinst.org

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