OUCC DR 4-6

DATA REQUEST

City of Evansville
Cause No. 45073

Information Requested:

Please explain the following for the assistance program cash and cash equivalents as shown on the Accountants' Report DLB-1 page 37 of 50.

a. Provide any supporting documentation that explains the program, its inception, adoption, initial program approval, mechanisms for ascertaining assistance funds, and sustainability of assistance program.
b. How was the amount $8,291 determined?

Information Provided:

The Customer Assistance Program (CAP) is being funded through proceeds received from Evansville's partnership with HomeServe, the third-party line insurance company about which a concern was raised at the public field hearing. Through its arrangement with HomeServe, the City of Evansville received $50,000 up-front and will receive ten percent (10%) on every future contract sold in exchange for sharing customer information with the Company. All proceeds from this program will be used to fund the CAP and provide income-qualified EWSU customers with water and sewer bill payment assistance. Per the terms of the Marketing Agreement between Evansville and HomeServe, HomeServe is obligated under the Agreement to keep all customer data confidential. See Attachments OUCC DR 4-6, Attachments 1-5, for supporting documentation and a further explanation of the program, its inception, adoption, initial program approval, mechanisms for ascertaining assistance funds, and sustainability of the assistance program. The $8,291 represents the current cash balance of the assistance program fund as of September 30, 2017 which is determined through the monthly bank reconciliation process which is prepared for all funds.

Attachments:

OUCC DR 4-6, Attachment 1.pdf
OUCC DR 4-6, Attachment 2.pdf
OUCC DR 4-6, Attachment 3.pdf

OUCC DR 4-6, Attachment 4.pdf
OUCC DR 4-6, Attachment 5.pdf

MINUTES OF THE HUNDRED AND FORTY-FIRST MEETING OF THE BOARD OF DIRECTORS OF THE WATER & SEWER UTILITY **April 11, 2017**

The Board of Directors of the Water & Sewer Utility met in Room 307 in the City-County Administration Building, at 1:30 p.m., April 11, 2017.

ATTENDANCE

Present were members: Robert Dillow, Steven Heidorn, Archie Carter and Mike Weber

Allen Mounts, Director of Utilities; Michael Labitzke, Deputy Director of Utilities - Engineering; Ed Ziemer, Deputy Director of Utilities-Operations; Jenny Collins, Chief Financial Officer; Carl Gist, CSO Compliance Manager; Jennifer Lott, Senior Designer; Steve Capin, Construction Inspection Manager; J. Cris Cottom; Water Capital Projects Manager; Harry Lawson, Wastewater Superintendent; Duane Gilles, Water Distribution Manager; Ryan Mayer, Senior Designer; Rodney Steele, GIS/IT Coordinator; Travis Hildebrandt, Collection Systems Manager; Ron Deig, Deig Brothers; Andy Sucharitakul, Lochmueller Group; J Sloan, PCI Skaska; Eric Parsley, Commonwealth; Mike Duckworth, Commonwealth; Andy Scales, CHA; Tony Russo, CMT; Nick Jahn, VSE; Brian Fox, American Structurepoint; David Schminke, Wessler; Jim Kovacs, Wessler; Leo Gentile, Black and Veatch; Gale Brocksmith, CAPE; Craig Miller, Powers; James Mosley, EKI.

CALL TO ORDER

Board President Steven Heidorn called the meeting to order.

CONSENT AGENDA

A. Minutes – March 28, 2017

B. Payroll – Week ending – March 26, 2017 - $146,756.61

C. Payroll – Week ending – April 2, 2017 - $291,074.28

D. Accounts Payable Voucher Register

E. Pay Requests (**See Appendix A**)

F. Sewer – Approval of Plans and Water and Sewer– Acceptance for Maintenance (**See Appendix B**)

ON MOTION by Mike Weber, seconded by Archie Carter and unanimously carried, the Board approved the Consent Agenda as printed.

New Business

A. Approve the Marketing Agreement to HomeServe, recommended by Daniel Claspell and Allen Mounts.

Discussion

- Daniel Claspell – Good afternoon members of the board. HomeServe is a home warranty company that sells contracts to individual homeowners for protecting their pipelines, water lines, sewer lines and so on. Just with all the aging infrastructure, you know, the major concerns with the utilities across the United States are the drinking water and waste water and includes the distribution lines and the age of the actual lines going in and out of the house. HomeServe is going to partner with EWSU and they will help educate the homeowners of their water and sewer line responsibilities. Also, they will administer the entire program at no cost to the utility. The high cost of likelihood of unforeseen repairs and significant financial hardships to the customers it is a low-income way of funding these types of events if something would happen to their water or sewer lines or their internal plumbing at their house. The median household is about $36,000 here in Evansville. Water service line coverage is of course the responsibility of the home owners. Up in the front the sewer line coverage is for clogged replacement collapse lines, and also the interior plumbing. Also, HomeServe will go thru and they will use our local contractors. They will get the high-quality contractors here locally to get those folks to come and fix the repairs. They will also have meetings with those contractors and inspections with those contractors to make sure everything that their doing at the folk's property is a on the up and up. It is a simple straight forward claim process with them. If a problem occurs, you call HomeServe and HomeServe sends out a specialist to collect the data. They get with the local contractor and once they get with the local contractor, they will be called within one hour. The contractor will be onsite to provide the service, do the work and then they will provide a survey back to that client how they felt of how things were done at the place. Which leads us to the next slide, the Customer Assistant Program it is called CAP. This will be a partnership between Community Action Program of Evansville (CAPE), EWSU and HomeServe that will allow the utility to assist in low income customers thru a customer assistance program. CAP will provide assistance to customers who are unable to pay their monthly bills and are at risk of disconnection. The utility will partner with CAPE. The utility has partnered with CAPE during the JCI meter replacement project for water line replacement program. So we worked out with CAPE to work with them on this project where if someone is unable to pay their water bills they can ask for assistance thru CAPE and based on their income qualifications they can get assistance that way. The next slide covers the plans. The water line service is $5.99 per month, the sewer line would be $9.49 and if they want to do the interior plumbing it would be $12.99. Probably around $28 if they choose to do all the services. The utility, up front after we sign the contract, will receive the sum of $50,000 and ten percent on every contract that is sold. What we are going to do is take that money and help the low income and apply all that money into the CAP program. The next step would be to get the board's approval. It takes about seven to eight weeks for HomeServe to implement the

program and to get the contractors and those folks in place. EWSU will set up a separate bank account where all the funds will go into a separate account and EWSU and CAPE will communicate the assistance program to our customers. Any questions?

- Mike Weber – Have we talked about HomeServe in the past?
- Allen Mounts – We haven't. We have been vetting the HomeServe contract thru legal for several months but we haven't brought it before the board. We have, maybe in passing, talked to you about in concept, partnering with a HomeServe or that type of organization to generate non-rate based revenue which we could then use for low income assistance programs. It is kind of key terminology because we are not permitted to use rate based revenue for private purposes but non-rate based revenue we can.
- Mike Weber – Okay.
- Allen Mounts - So thru this relationship one we make available to our customer base this program. It is a voluntary program. If you are a property owner you probably receive a mailing from some company selling similar services, at least once a month probably. There are a multitude of them out there. Vectren sells the same kind of services, Indiana American in Warrick County sells that service and there is several of them. So our thought was why not partner with them, it generates a source of income, we recognize the need for low income assistance. This gives us a foundation to start with and perhaps grow but at no point would the funding for that or the reimbursement succeed the funding that is available. We have enjoyed partnering with CAPE and they have done an excellent job. They are the agency it is a social service agency and know how to administer low income assistance programs. We don't have to administer that. Fundamentally what we are agreeing to is not only the contract and a revenue source for us but we are associating our name with mailing that goes out. So we feel like it is a win win situation and one that addresses certainly an ongoing need in the community. They have to qualify for the low-income assistance and there is some other rules and regulations that mirror the programs that they already administer for other organizations.
- Mike Weber – Just one other question. I'm already a HomeServe client or customer and we signed up a couple years ago. Will they try to capture people that may already use this?
- Allen Mounts – I think the revenue source would be from new customers that sign up from this contract going forward. I'm not aware of any fee we would receive for existing customers. So they are looking to generate new business.
- Mike Weber – I understand. Okay. Thank you.
- Robert Dillow – How does this fee recommended here compare to what you are paying privately?
- Mike Weber – My wife pays the bill. I really have no idea. I think we just did the external not the internal. We did the water and the sewer but not the internal pipes.
- Allen Mounts – As with any personal decisions, it is a personal decision that you have to make for your property that is why it is a voluntary program. Anytime you buy any insurance coverages we would advise you to make sure you understand the rules and regulations around that. The big picture of what we are trying to do is generate a revenue source so we can provide income assistance or utility assistance to a certain segment of our customer base.
- Mike Weber – I think it is a great program and good service to the customer base. So it doesn't hurt to get the non-rate based revenue.

- Robert Dillow – Did we speak to any other municipalities that are currently using HomeServe.
- Daniel Claspell – I know we spoke with Louisville. I'm not sure of any of the other ones that we spoke with.
- Allen Mounts – They have probably 50 municipalities around the United States that they do business with. I've done online research but I talked specifically with Louisville. They had a similar approach. Their government system is a little bit different but fundamentally they were redirecting the money for low income assistance. So the concept is very similar. A lot of other utilities do the same thing. But they, from our due diligence they checked out. They felt, I felt like, we felt like they were a good solution for us. We vetted that. I certainly can provide you a list of the cities they do work with; it is major cities that they are doing work with. It is not small populations the cities are much larger than Evansville.
- Robert Dillow – Do you have any projects of the 10 percent that we will earn?
- Allen Mounts – There is a proforma that they prepared but that is based on their past experience. It is on kind of the next to last page of the presentation; that could generate probably $75,000 - $100,000 plus per year. We really don't know until we get into the program and as I said it is not going to result in incremental expenses to the utility. The more successful it is the more funds we have available to provide low income assistance.
- Robert Dillow – Well that is my point. I was just curious. What is the number that would be available for us to help low income families?
- Allen Mounts – We think it will be somewhere around $100,000. But this is a new program for us. They are basing those projections on past experience with other municipalities; we hope that is the case. We may situations where the demand for low income assistance exceeds our ability to fund those. And what we would do is wait unit we have accumulated some sufficient amount of funds to turn it back on again and underwrite the cost of low income assistance program.
- Robert Dillow – Are there any other questions for Daniel?
- Archie Carter – Who will be administrating this program? Will this be something done here locally or will this be done online?
- Daniel Claspell – Which part of the program are you talking about?
- Archie Carter – I'm talking about as far as a customer needs some type of assistance will they call into an 800 number?
- Daniel Claspell – They will call into an 800 number and HomeServe would completely administer that program. They will administer that thru them and then they will get with a contractor and then they will do all that.
- Archie Carter – So it will be no type of local entity that they will be able to deal with?
- Allen Mounts – None whatsoever. They administer the program completely in terms of vetting the contractors. If you wish to submit a claim they process all of that. CAPE will run point on administering the low-income assistance program. Actually, it will be far more efficient for us as opposed to if somebodies in a disconnect situation it creates more work for us than what this will be; in terms of trying to collect and disconnect and reconnect. This will avoid that happening to the customers; for those who qualify.
- Archie Carter – Now I guess also if the city challenge. Does he have to deal; he deals with them directly before we take on any responsibility.

- Allen Mounts – We do not. We aren't endorsing any. It is completely outsourced. There is no responsibility on our side in terms of them vetting the providers of service that would go out and do the repairs. The good thing about it is many times when you are talking to home owners they are going well who can I call and we are not in a position to make a recommendation on who to call and they are at a loss as how to determine who is the best. Well they have these protocols that they follow and the individuals that they hire to do the contract work will be ones who have proven that they have the ability to respond and to complete the work in a satisfactory manner.
- Archie Carter – Are we going to be vetting any of those?
- Allen Mounts – We are not. Once you make this decision, we have no responsibilities other than HomeServe does all the work related to it. CAPE will do all the work. It will take us a few weeks to get up and running and then they will be an initial mailing that goes out and then everything from the property owner to HomeServe is between those two and never thru us. If somebody happens to call in here, we are going to redirect them to HomeServe.
- Archie Carter – Thank you.
- Robert Dillow – Are there other questions or a motion to approve.

ON MOTION by Mike Weber, seconded by Steven Heidorn, and unanimously carried, the Board Approved the Marketing Agreement to HomeServe.

B. Approve Escrow Agreement with Evansville Water & Sewer Utility, Blankenberger Brothers, Inc. and Old National Wealth Management (the "Escrow Agent") for the 2017 Manhole Installation Project #1, Project No. S1544, recommended by Jennifer Lott and Jenny Collins.

Discussion

- Jenny Collins – Hi. I believe that we have brought similar agreements to you before but just as a reminder that venders have the opportunity to either do the escrow in house or choose to do it at a bank; which this one is Old National Bank. The programs run similar in that any interest earned at the bank will be able to be paid to Blankenberger and Marco has graciously reviewed this agreement and signed off on it.

ON MOTION by Archie Carter, seconded by Mike Weber, and unanimously carried, the Board Approved Escrow Agreement with Evansville Water & Sewer Utility, Blankenberger Brothers, Inc. and Old National Wealth Management (the "Escrow Agent") for the 2017 Manhole Installation Project #1, Project No. S1544.

LLOYD WINNECKE
MAYOR

ALLEN R. MOUNTS
DIRECTOR

EVANSVILLE WATER & SEWER UTILITY
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(812) 436-7846 FAX (812) 436-7863

FOR IMMEDIATE RELEASE

July 17, 2017

Contact:

Allen Mounts
amounts@ewsu.com
812.436.4560
812.470.0923 mobile

Utility Announces Water & Sewer Bill Assistance Program

EVANSVILLE, Ind. — The Evansville Water & Sewer Utility (EWSU), Community Action Program of Evansville (CAPE) and HomeServe USA (HomeServe) announce a collaborative service to provide income-qualified EWSU customers with water and sewer bill payment assistance.

The Customer Assistance Program will be managed by CAPE. Applications for the program may be completed at the CAPE office, located at 401 SE 6th Street, Suite 001. Customers may contact Gale Brocksmith to schedule an appointment at 812.492.3941.

Participants must meet program qualifications based on total household income, and have a water and sewer bill currently in disconnect status or have been disconnected for no longer than 12 months. Additionally, the water bill must be in the name of a household member age 18 years or older, landlord or Power of Attorney.

Qualifying participants must have a total household income for the past 12 months at or below the following:

Number in Household	Income
1	$17,820
2	$24,030
3	$30,240
4	$36,450

To submit an application, customers must provide 12 months' proof of income for all household members age 18 and older, and social security cards (copies of cards are accepted as well) and birth dates for all household members. Customers who are renting a residence must provide the current lease listing all household members.

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Evansville Water & Sewer Utility Selects HomeServe USA to Offer Optional Water and Sewer Line Service Plans to Customers

Evansville, IN – June 26, 2017 – HomeServe USA (HomeServe), a leading provider of home emergency repair solutions, today announced the launch of its partnership with Evansville Water & Sewer Utility (EWSU) to offer area homeowners optional repair service plans for the water and sewer lines connecting their homes to the EWSU system. Residents served by EWSU will be receiving information from HomeServe by mail later this month offering coverage plans designed to protect homeowners from the costs and inconveniences associated with repairs to these service lines.

Evansville homeowners are often under the impression the exterior water service lines on their property, which connect their home to the EWSU system, are not their responsibility. Unfortunately, in the event of a water line leak or break, the homeowner is in fact responsible to both cover the cost and facilitate the repair. As Evansville homes age along with the infrastructure serving them, HomeServe service plans provide local homeowners with an optional solution so they can be better prepared to manage these repairs when needed.

A Homeowner's Line of Defense

The water and sewer lines from the home to EWSU's water and sewer main connections are the responsibility of the homeowner. Since repairs to these pipes are not covered by basic homeowners insurance or by EWSU, homeowners find themselves having to deal with the inconvenience of navigating emergency repairs on their own. Additionally, homeowners are often caught off guard by the expense of these emergency repairs and the associated costs. HomeServe's plans serve as a line of defense, ensuring that in the event of an unexpected repair the burden on homeowners is minimized or eliminated, and the repair process, handled through HomeServe, is timely, seamless and high-quality.

Accessible, Reliable, 24/7

HomeServe plan holders have access to a Repair Hotline, which is accessible 24 hours a day, 365 days a year, as well as local, licensed, and insured contractors to provide high-quality home repair services in a timely manner. The Exterior Water Service Line Coverage will be available for $5.99 per month. HomeServe will also have available the combined Exterior Sewer and Septic Line Coverage for a total of $9.49 per month. An Interior Plumbing and Drainage plan to cover in-home plumbing is available for $12.99 per month. Residents who enroll in the optional plans will have convenient payment options available directly through HomeServe.

"Our service plans not only cover the cost of the repair, they also provide homeowners with reputable, local contractors who will do the best possible job," said Tom Rusin, CEO of HomeServe USA. "We're thrilled to be partnering with Evansville Water & Sewer Utility and look forward to the opportunity to provide EWSU customers with the assistance they need when faced with a home repair emergency."

Homeowners can also visit www.homeserveusa.com/EWSU or call 1-844-220-3244 for more information.

About Evansville Water & Sewer Utility

The Evansville Water & Sewer Utility provides service for approximately 60,000 residences in and around Evansville. The mission of the Evansville Water & Sewer Utility is to provide the Evansville metro area with high quality, safe, dependable water and sewer service at rates which encourage economic development. The Utility will manage land and water resources to ensure quality for future generations.

About HomeServe

HomeServe USA Corp. (HomeServe) is a leading provider of home repair solutions serving 3 million customers across the U.S. and Canada under the HomeServe, Home Emergency Insurance Solutions, Service Line Warranties of America (SLWA) and Service Line Warranties of Canada (SLWC) names. Since 2003, HomeServe has been protecting homeowners against the expense and inconvenience of water, sewer, electrical, HVAC and other home repair emergencies by providing affordable repair coverage and quality local service. As an A+ rated Better Business Bureau Accredited Business, HomeServe is dedicated to being a customer-focused company supplying best-in-class repair plans and other services to consumers directly and through over 450 leading municipal, utility and association partners. For more information about HomeServe, a 2016 Connecticut Top Workplace winner and recipient of seventeen 2017 Stevie Awards for Sales & Customer Service, please go to www.homeserveusa.com. For information on SLWA visit www.slwofa.com and for SLWC visit www.slwofc.ca. To connect with HomeServe on Twitter and Facebook, please visit www.twitter.com/homeserveusa and www.facebook.com/HomeServeUSA.

For Utility related questions:
Customer Service
Evansville Water & Sewer Utility
Email: EWSUcustomerservice@ewsu.com

For HomeServe Questions:

Myles Meehan
HomeServe USA
Phone: 203-356-4259
Email: Myles.Meehan@homeserveusa.com

OR

Sourav Das
ICR, Inc. for HomeServe USA
Phone: 203-682-8283
Email: hsusa@icrinc.com

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MARKETING AGREEMENT

THIS MARKETING AGREEMENT ("Agreement") is effective as of the "Effective Date" set forth on the signature page and is between **HOMESERVE USA CORP.**, a Pennsylvania corporation, and its affiliate, **HOMESERVE USA REPAIR MANAGEMENT CORP.**, a Delaware corporation (collectively, "HomeServe") and **THE CITY OF EVANSVILLE, BY AND THROUGH ITS WATER AND SEWER UTILITY** ("Utility"). HomeServe and Utility are referred to collectively as the "Parties" and individually as a "Party".

HomeServe provides services to homeowners for the emergency repair of domestic infrastructure and related systems.

Utility wishes to permit HomeServe to offer and market the products identified in **Exhibit A** ("Products") to homeowners within the Territory ("Customers").

In consideration of the foregoing and the mutual covenants contained in this Agreement, the Parties agree as follows:

1. **Intellectual Property; Member Data and Service Agreement Ownership.**

   1.1 As of the Effective Date and as represented by Utility, Utility provides water services to approximately fifty eight thousand (58,000) households in its territory as shown on **Exhibit B** ("Territory").

   1.2 Utility grants to HomeServe the exclusive non-transferrable right to use Utility Marks (identified in **Exhibit C**) in connection with the advertisement, marketing, sale and administration of the Products in the Territory as set forth in this Agreement. Except as expressly set forth herein, HomeServe shall not have or claim any right, title or interest in or to Utility Marks, which Utility Marks shall be and remain the sole property of the Utility. Conversely, all documentation (and any related intellectual property) relating to the Products shall remain the property of HomeServe.

   1.3 Utility shall provide name, postal address, residential telephone number, and, if available, email address of Customers ("Customer Data") to HomeServe for use by HomeServe in furtherance of the advertisement, promotion and operation of the program and the advertisement, marketing, sale and administration of the Products. Customer Data will be provided to HomeServe at such times and in such format as the Parties shall agree from time to time. Utility represents and warrants that (i) Customer Data has been collected in compliance with all applicable federal, state and local statutes, regulations or rules ("Law"); and (ii) Utility is permitted by Law (and permitted by any applicable privacy policy) to provide Customer Data to HomeServe and to permit HomeServe to use Customer Data for such purposes. As between the Parties Customer Data (to the extent it does not become Member Data) is the exclusive property of Utility. HomeServe shall use Customer Data in compliance with Law and in accordance with this Agreement. Except as necessary to market and administer the Products, HomeServe: (1) shall not sell, transfer or provide Customer Data to any third party and (2) shall keep such Customer Data confidential. HomeServe shall inform each of its contractors, subcontractors, agents and representatives, including, without limitation, any person or entity to whom HomeServe discloses Customer Data, of the confidential nature of such Customer Data and HomeServe's obligations hereunder, and HomeServe shall be responsible for and shall indemnify the Utility and its affiliates, agents and representatives for any disclosure or use of the Customer Data by HomeServe's contractors, subcontractors, agents or representatives if such actions would constitute a violation of this Agreement if such actions had been taken by HomeServe, subject to the provisions of Section 8.

   1.4 The agreement between a Customer and HomeServe for a Product is owned exclusively by HomeServe ("Service Agreement" and such Customer is called a "Member"). Name, address, phone number, email address and all other information about a Member obtained by or through HomeServe ("Member Data") is the exclusive property of HomeServe. HomeServe may adjust the amounts paid by Members for the Products ("Service Agreement Fees") in accordance with

Service Agreement terms and conditions for any reason including adverse claims experience or increased product costs. HomeServe may terminate, renew, amend and otherwise control Service Agreements in accordance with the terms of such Service Agreements.

1.5 HomeServe shall comply with all applicable Laws when performing its services under the Service Agreements for the Products.

2. Marketing.

2.1 At its discretion HomeServe will be permitted each twelve (12) month period during the Term (as defined in Section 3 below) to send to Customers and others in the Territory up to six (6) acquisition mailings per household per year of Product marketing materials using the Utility Marks and up to six (6) other mailings per household per year of product marketing materials using the Utility Marks. Among other uses, HomeServe is permitted to use the Utility Marks on both the letter and outer envelope of the marketing materials as well as a signature to be provided by Utility on the letter. Subject only to the specific restrictions contained in this Agreement, HomeServe may advertise, market and promote the Products using the Utility Marks through the use of such lawful methods, channels and activities as may be selected by HomeServe including, without limitation, direct mail, telesales (inbound and outbound), Customer callbacks, email, newspaper advertising, "yellow pages", magazine advertising, media activity, (such as Internet, television and radio), and other lawful methods. HomeServe may also participate in additional events and/or marketing campaigns to sell Products to Customers provided they are agreed to by both Parties in advance.

2.2 The Parties will link Utility's website to a HomeServe-sponsored website.

2.3 Any marketing and product-related materials to be delivered to Customers or others (including by Utility) under this Agreement will be supplied to Utility for prior approval, which approval will not be unreasonably denied or delayed.

3. Term. Unless terminated early in accordance with Section 9, this Agreement shall commence as of the Effective Date and shall continue for **five (5) years** thereafter. Following the initial term, this Agreement will renew for successive one (1) year renewal terms unless the Party wishing to terminate gives the non-terminating Party ninety (90) days written notice prior to the termination date (collectively, the initial term and any renewal term are referred to as "Term").

4. Compensation to Utility.

4.1 In exchange for the use by HomeServe of the Utility Marks as set forth herein, HomeServe shall pay Utility ten percent (10%) of the payments actually received from Members during the Term under any Service Agreement sold hereunder, net of any discount, rebates, refunds or sales taxes paid by HomeServe under such Service Agreements ("Administrative Fee").

4.2 HomeServe shall pay Utility an initial set-up fee of fifty thousand dollars ($50,000) simultaneously with the date of the first marketing mailing under the terms of this Agreement ("Set-Up Fee"). The Set-Up Fee is intended to compensate Utility for its initial cost to create the processes required by this Agreement. This fee is fully refundable to HomeServe if this Agreement is terminated during the initial twelve (12) months of the Term for any reason other than fraud, intentional misconduct or gross negligence of HomeServe. Per Section 9 below, the Parties have the right to terminate this Agreement if it is no longer beneficial or in their best interests to continue the relationship. If Utility exercises this right after the first twelve (12) months of the Term, then Utility will refund to HomeServe a pro rata portion of the Set-Up Fee equal to the Set-Up Fee multiplied by the percentage of whole months remaining in the initial Term relative to the initial Term. For example, if Utility exercises this right during month twenty four (24) of the initial Term, Utility will refund to HomeServe thirty thousand dollars ($30,000), or fifty thousand dollars ($50,000) multiplied by 36/60 (sixty percent (60%)).

5. Off-Bill Member Billing and Timing of Payments to Utility. HomeServe shall bill Service Agreement Fees to Members in accordance with its normal practices. No later than thirty (30) days after the last day of each calendar quarter during the Term, HomeServe shall submit to Utility a statement of the Administrative Fee due from Members for the previous quarter ("Administrative Fee Statement"). The Administrative Fee Statement shall be accompanied by payment of the Administrative Fee in a form to be mutually agreed upon. HomeServe shall track payments from Members, segregated into four categories: Water only services, sewer only services, water/sewer combined services and interior plumbing and drainage services, and HomeServe shall designate to the Utility how much of each Administrative Fee is derived from each category.

6. Confidential Information.

6.1 Definition of Confidential Information. "Confidential Information" means any confidential information whether or not it constitutes a trade secret under applicable Law. "Confidential Information" includes, but is not limited to, Customer Data, business plans and methods; marketing strategies and data; usage and claims data; financial, underwriting and customer information; engineering, operating and technical data, information concerning Utility's and HomeServe's business and activities and any other information that a reasonable person would expect to be confidential. "Confidential Information" does not include information that (a) has become part of the public domain other than by acts or omissions of the Recipient; (b) has been furnished or made known to the Recipient by a third person as a matter of legal right and without restriction on use; (c) was in the Recipient's possession prior to disclosure by the disclosing Party without restriction on use; or (d) is independently developed by the Recipient without access to the Confidential Information; provided, however, notwithstanding the foregoing exceptions, Customer Data shall for all purposes hereunder be and remain Confidential Information.

6.2 Each Party (for itself and its affiliates) who receives Confidential Information ("Recipient") from another Party or such other Party's affiliates ("Discloser") shall use Discloser's Confidential Information solely for the purposes of this Agreement. Except with the express prior written approval of Discloser, and subject to the third party's entering into obligations of confidentiality equivalent to those under this Agreement, Recipient will not disclose any of Discloser's Confidential Information to third parties except Recipient's affiliates and its and their directors, officers, employees, consultants, auditors, attorneys, agents and other professional advisors who have a need to know the Discloser's Confidential Information in connection with Recipient's participation hereunder ("Representatives"). Recipient will advise each such Representative receiving Confidential Information of the confidential nature thereof and of the obligations set forth in this Agreement. Recipient will be responsible for any breaches of the obligations of confidentiality and restricted use by its Representatives if such actions by such Representatives would constitute a breach hereof by Recipient if conducted by Recipient.

6.3 Recipient shall take, and shall cause its Representatives to take, all reasonable measures to protect the secrecy of, and avoid disclosure or use of, Discloser Confidential Information in order to prevent it from falling into the public domain or the possession of persons other than those persons authorized hereunder to have any such information, which measures shall include at least the same degree of care that Recipient uses to protect its own Confidential Information of a similar nature, and in any event, no less than reasonable care.

6.4 Recipient shall promptly notify Discloser of any misuse or misappropriation of Discloser's Confidential Information which may come to its attention. In the event that Recipient or its Representatives are required by legal process to disclose any of Discloser's Confidential

Information, Recipient shall give prompt notice to Discloser. The Party (and any of its Representatives) required to make such disclosure shall disclose only that portion of Discloser's Confidential Information which it reasonably believes it is legally required to disclose.

7. Representations and Warranties. Each Party represents and warrants to the other (i) that it has the full power and authority to carry on its business as it is now being conducted and to enter into and perform under this Agreement and (ii) that there are no agreements or Law that would prevent it from carrying out its obligations hereunder.

8. Indemnification, Limit of Liability and Disclaimer of Warranties.

8.1 To the extent permitted by applicable Laws each Party shall indemnify (the "Indemnifying Party") and save the other Party ("Indemnified Party") harmless from all claims, costs, expenses, damages, liabilities, or penalties (including, without limitation, attorneys' fees, costs and expenses) to any third party for personal injury, death or property damage incurred by such Indemnified Party resulting from the performance of any of the Indemnifying Party's obligations under this Agreement. To the extent permitted by applicable Laws, Utility shall also indemnify and save HomeServe harmless from all liability resulting from HomeServe's use of the Utility Marks. HomeServe shall indemnify and hold Utility harmless from any cost, expense, damage, claim, liability or penalty (including, without limitation, attorney's fees, costs and expenses) incurred by Utility arising out of or resulting from any breach(es) by HomeServe of this Agreement or any Service Agreement. Indemnities shall extend to the Indemnified Party, its officers, employees, or agents, and the Indemnifying Party shall indemnify and save the Indemnified Party harmless from and against all costs, reasonable attorneys' fees, costs, expenses and liabilities incurred in or about any third-party claim of or action for any such act; provided however, that the Indemnified Party shall promptly transmit to the Indemnifying Party all papers served in any suit involving such claim, the Indemnifying Party shall have entire charge and control of the defense of any such claim, and the Indemnified Party shall use reasonable efforts to mitigate damages. Notwithstanding anything contained herein to the contrary, the Parties agree and acknowledge that the Utility shall have no liability for any actions taken by HomeServe in marketing the Products, administering the Products or performing any of its services under the Service Agreement.

8.2 NEITHER PARTY SHALL BE LIABLE TO THE OTHER UNDER ANY CIRCUMSTANCES INCLUDING THOSE DETAILED IN SECTION 8.1 ABOVE, FOR ANY SPECIAL, INDIRECT, CONSEQUENTIAL, PUNITIVE, EXEMPLARY OR INCIDENTAL DAMAGES, INCLUDING LOST REVENUES OR LOST PROFITS UNLESS SUCH DAMAGES WERE INCURRED BY THE INDEMNIFIED PARTY AS A RESULT OF A THIRD PARTY CLAIM.

8.3 HOMESERVE UNDERSTANDS THAT THE UTILITY'S LIABILITY UNDER THIS INDEMNITY IS LIMITED BY LIMITATIONS ON THE LIABILITY OF THE UTILITY AVAILABLE TO THE UTILITY AS A POLITICAL SUBDIVISION OF THE STATE OF INDIANA UNDER THE LAWS OF THE STATE OF INDIANA, INCLUDING THE INDIANA TORT CLAIMS ACT.

9. Termination. Either Party may terminate this Agreement immediately by written notice to the other where: (i) the other commits a material breach of the Agreement that is either incapable of remedy (in which case the termination is effective upon receipt of notice) or, if such breach is capable of remedy, the breaching Party fails to remedy the breach within forty five (45) days of being notified (a termination described in this sub-Section (i) is a termination for "Cause"); or (ii) the other Party becomes insolvent or files or has filed against it any bankruptcy or similar proceeding. Either Party may terminate this Agreement effective upon notice to the other if the acts or omissions of the non-terminating Party cause the terminating Party to suffer any damages from third parties or any fine or other disciplinary process from any regulatory authority or if, due to any Law, the continued sale of the Products, disclosure of Customer Data or use of the Utility Marks would have a material adverse effect on the terminating Party or be or become unlawful. Notwithstanding anything contained herein to the contrary, in the event that either Party wishes to terminate

this Agreement because it believes that continuing the relationship is no longer beneficial or in its best interests, it may do so on ninety (90) days' written notice to the other Party (or earlier if required by Governmental Authorities or Law).

10. Effect of Termination.

10.1 Upon termination of this Agreement: (i) both Parties shall promptly return or destroy all Confidential Information of the other Party; (ii) both Parties shall cease holding itself out as being associated with the other; and (iii) HomeServe shall immediately cease any use of the Utility Marks apart from as set out in sub-Section 10.2 below. Termination shall not affect the operation of any provision of this Agreement that is intended to survive termination.

10.2 In the event of termination of this Agreement, HomeServe shall have no obligation to recall any marketing materials that have already been mailed to Customers. For the avoidance of doubt, HomeServe shall no longer have the right to use the Utility Marks to make new sales to Customers or otherwise communicate with Customers.

11. Insurance. Each Party shall maintain for the Term and for a period of one (1) year thereafter, at its cost, comprehensive liability insurance and such other insurance as shall be appropriate for the nature and extent of its business. At a minimum the comprehensive liability policies shall have combined single limits of $1,000,000 per occurrence and $2,000,000 aggregate. The Parties agree to a mutual waiver of subrogation. Certificates of insurance evidencing the coverages shall be provided prior to the commencement of any services, and certificates evidencing renewal or replacement policies shall be provided upon request. The Parties agree to maintain Workers Compensation insurance in compliance with applicable State law requirements.

12. Ruling by a Governmental Authority. The terms of this Agreement may be subject to review and regulation by various governmental authorities ("Governmental Authority"). If, as a result of an interpretation, policy, ruling or order by a Governmental Authority ("Ruling"), a Party is unable to comply with any one or more specific provisions of this Agreement, the Parties will meet in good faith to discuss potential amendments to those provisions of this Agreement, including renegotiating amounts that may become due hereunder (including commission levels), that will enable the Parties to remain able to perform hereunder. It is the intent of the Parties that any such amendment will be limited to addressing issues raised in the Ruling (such as a particular geographic region in the Territory or specific activity under this Agreement). Neither Party shall be obligated to agree to any proposed amendment to this Agreement and, pending agreement, the Parties will continue to perform under this Agreement to the extent permitted by applicable Law. The Parties will also discuss in good faith how they may meet with and discuss the Ruling with applicable Governmental Authorities with the goal of seeking relief such that the Parties shall be able to perform hereunder without material unanticipated financial loss or a material negative business impact to either Party. The Parties agree that any change in the terms of this Agreement may impact the economic effect of this Agreement to either or both Parties, and amendments to the Agreement may be warranted to lessen such impact. In the event that, notwithstanding the efforts described in this Section the Ruling remains in effect in a manner that impacts the ability of a Party to perform hereunder in compliance with the Ruling, then either Party may terminate this Agreement on thirty (30) days' notice (or sooner if required by such Ruling or such Governmental Authorities) to the other Party and the Parties will effect an orderly transition of responsibilities hereunder.

13. Miscellaneous.

13.1 The Parties shall be independent contractors, and neither Party shall incur any obligation or act in the name of the other. Each Party is responsible for its acts and the acts of its employees, agents and subcontractors.

13.2 Neither Party shall assign this Agreement or assign the benefit or delegate the obligations of this Agreement to any third party without the prior written consent of the other; which shall not be unreasonably delayed or withheld, except that HomeServe may assign and delegate its (i) obligations hereunder to its subcontractors to perform repairs for Customers, so long as it remains liable under this Agreement; and (ii) rights and obligations hereunder in connection with a sale of all or part of its business to a third party provided HomeServe gives notice to Utility of any such sale as soon as it is able.

13.3 No failure or delay to exercise rights hereunder shall operate as a waiver, and no single or partial exercise of rights shall preclude any other exercise thereof.

13.4 If a provision of this Agreement is held by any court to be illegal or void (in whole or in part), then such provision shall be excluded, and the remaining provisions shall be interpreted and enforced in full as if such provision (or part thereof) were never included.

13.5 This Agreement shall be governed by Indiana law without regard to choice of law provisions. The Parties submit to the exclusive jurisdiction of the Federal and state courts located in Vanderburgh County, Indiana to resolve all disputes and consent to service of process in any manner permitted by those courts. Prior to commencing any formal proceedings, the Parties shall use good faith efforts to resolve any dispute by negotiation for a period of thirty (30) days, which negotiation shall involve senior management of each Party.

13.6 Notices and communications shall be in writing and delivered at the addresses below.

UTILITY:

Utility of Evansville,
Evansville Water and Sewer
Utility
1 NW Martin Luther King Jr. Blvd
Evansville, IN 47710
Attn: Allen Mounts
EWSU Director

HOMESERVE:

HomeServe USA Corp. and
HomeServe USA Repair Management Corp.
601 Merritt 7, 6th Floor
Norwalk, CT 06851
Attn: Hilary E. Glassman
General Counsel

Notice shall be deemed given (i) upon personal delivery, (ii) three (3) business days after being sent by certified or registered mail or (iii) one (1) business day after being sent by recognized overnight delivery service.

13.7 Except for payment obligations, a Party shall not be held in breach of this Agreement by reason of any force majeure event. The nonperforming Party shall be excused from performance while the event continues, provided that the nonperforming Party provides prompt notice to the other of the force majeure event and resumes full performance as soon as is practicable.

13.8 Neither Party will make any public statement, including any press release, with respect to this Agreement or the transactions contemplated hereby without first allowing the other Party an opportunity to review and approve such statement which review and approval shall not be unreasonably withheld or delayed (except that a Party or its affiliates shall be permitted to make any press release or announcement required by applicable foreign or domestic Law or any recognized regulatory body, including, without limitation, FOIA requests).

13.9 This Agreement and the attached Exhibits are the entire agreement between the Parties with respect to the subject matter hereof which supersedes and replaces any prior agreements, discussions and proposals. This Agreement may be modified only in a writing signed by both Parties.

13.10 Each Party shall have the right, upon at least ten (10) days prior notice and during normal business hours, at the requesting Party's cost, to audit and inspect the other Party's records for the purpose of confirming the billing and payments made under this Agreement.

13.11 HomeServe shall enroll in and verify the work eligibility status of all newly hired employees of HomeServe through the E-Verify Program ("Program") or as may be necessary in order to comply with applicable Law. HomeServe is not required to verify the work eligibility status of all newly hired employees through the Program if the Program no longer exists. HomeServe shall execute an affidavit affirming that HomeServe does not knowingly employ an unauthorized alien and confirming HomeServe's enrollment in the Program, unless the Program no longer exists ("E-Verify Affidavit"). HomeServe shall sign the E-Verify Affidavit at the same time as it signs this Agreement which will then be submitted to Utility prior to Utility's execution of this Agreement.

IN WITNESS WHEREOF, the Parties enter into this Agreement as of the Effective Date as a binding agreement. This Agreement may be executed in counterparts.

EFFECTIVE DATE OF THIS AGREEMENT: April 11, 2017

EVANSVILLE WATER AND SEWER UTILITY

By: _____

Name: Robert L Dillow

Title: Board President

HOMESERVE USA CORP. and HOMESERVE USA REPAIR MANAGEMENT CORP.

_____

By: Thomas J. Rusin

Its: Chief Executive Officer

EXHIBIT A

Products

The Product list may be amended from time to time as mutually agreed by both Parties.

PRODUCT
Exterior Water Service Line coverage
Exterior Sewer/Septic Service Line coverage
Interior Plumbing and Drainage coverage

EXHIBIT B
Territory

The Evansville Water Department delivers water to approximately 58,000 customers in Vanderburgh, Gibson, and Warrick counties either directly or indirectly through wholesale customers of German Township Water, Gibson Water, Town of Elberfeld, or Town of Newburgh.

EXHIBIT C

Utility Marks

E-VERIFY AFFIDAVIT

The undersigned, Richard Gannon (Chief Financial Officer), of HomeServe USA Corp. and its affiliate HomeServe USA Repair Management Corp. being duly sworn upon their oath, does hereby state that HomeServe USA Corp. and its affiliate HomeServe USA Repair Management Corp., does not knowingly employ unauthorized aliens and participates in the E-Verify Program (the "Program") when it hires new employees to confirm their work eligibility and further acknowledges that it is not required to verify the work eligibility status of all newly hired employees through the Program if the Program no longer exists.

I swear or affirm, under the penalties for perjury, that the foregoing statements are true.

HomeServe USA Corp.

By: _____

Its: ~~Richard Gannon, Chief Financial Officer for~~ Tom Rusin, Chief Executive Officer

RESOLUTION OF THE
WATER AND SEWER UTILITY BOARD
OF THE CITY OF EVANSVILLE
ESTABLISHMENT OF SEGREGATED ACCOUNT

WHEREAS, the City of Evansville, by and through its Water and Sewer Utility ("Utility"), and HomeServe USA Corp., a Pennsylvania corporation, and its affiliate, HomeServe USA Repair Management Corp., a Delaware corporation (collectively, "HomeServe") entered into that certain Marketing Agreement, effective as of June 20, 2017 (the "Marketing Agreement"), whereby HomeServe shall provide certain services to customers of the Utility for the emergency repair of domestic infrastructure and related systems; and

WHEREAS, pursuant to the terms of the Marketing Agreement, the Utility will receive Administrative Fees and a Set-up Fee (as such terms are defined in the Marketing Agreement) from HomeServe related to the provision of services under the Marketing Agreement by HomeServe; and

WHEREAS, the Board of Utility has determined it is in the best interests of the Utility and the City of Evansville to utilize the Administrative Fees and the Set-up Fee to help fund past due water bills and related expenses for indigent customers of the Utility at the discretion of the Utility; and

WHEREAS, to accomplish such purpose, the Utility desires to set up a separate account into which all Administrative Fees and the Set-up Fee shall be deposited to be used for such purpose; and

NOW, THEREFORE, be it resolved by the Board of the Utility hereby authorizes the Utility to establish a segregated account (the "Account") to be used solely for the funds received from Administrative Fees and Set-up Fees received by the Utility pursuant to the Marketing Agreement;

FURTHER RESOLVED, the funds deposited in such Account shall be used solely for the purpose referenced above unless otherwise determined by the Board of the Utility.

FURTHER RESOLVED, that any and all actions heretofore taken by the Utility or its Board, employees or representatives on behalf of the Utility in connection with the Marketing Agreement or the Account are hereby ratified and approved.

This Resolution shall be placed in the records of the Utility.

PASSED AND ADOPTED as of this 20th day of ~~May~~ June, 2017.

Board of Directors of the
Evansville Water and Sewer Utility:

Robert Dillow, President

Steven Heidorn, Vice President

Archie Carter, Member

Barry Russell, Member

Mike Weber, Member

ATTEST:

Vivian Holiday
Board Secretary

From: Stephen Jenkins <stevejenkins.gwi@gmail.com>
Sent: Friday, July 13, 2018 12:24 PM
To: Mounts, Allen
Subject: Future Capacity

Mr. Mounts,

Based on where we are now in the process of our USDA/RD improvement project, we expect construction to begin and be completed in 2019. As we have discussed, one of the key elements of the improvement project is a second connection to Evansville and a parallel, or redundant, main from that connection to our pumphouse as well as upsizing our existing pumps in response to the continued growth in Gibson County and in preparation for future growth.

In discussions we have had recently with Toyota regarding their expansion plans, we are expecting their daily demand to increase by 300,000 gallons a day beginning some time in 2019. We also expect an additional 150,000 gallon per day increase from new developments or expansions surrounding Toyota in 2019 as well.

As we move forward with construction in 2019 and facilities are being put in place to provide for this increase in demand, we will certainly will want to discuss with Evansville the possibility of additional capacity beyond what we have in our current contract. Based on information we have now, we would expect our water purchase from Evansville in 2019 to grow by approximately 450,000 gallons per day. We are not aware of any other major expansion plans beyond 2019, however, it would be reasonable to expect continued commercial and residential growth to increase water purchase to between 500,000 and 550,000 gallons per day by 2022.

In looking ahead at a discussion with Evansville about additional capacity in the contract, I would anticipate requesting an increase from the current 2.5 MGD to 3.5 or 4 MGD.

I hope this helps to answer some of your questions about the growth we are experiencing. If you need additional information, please let me know.

--
Steve Jenkins
Utility Manager
Gibson Water, Inc.
(812) 768-6899

2017

STATE OF THE WATER INDUSTRY REPORT

American Water Works Association

Dedicated to the World's Most Important Resource®

2017 State of the Water Industry Report

Established in 1881, the American Water Works Association is the largest nonprofit, scientific, and educational association dedicated to providing solutions to manage the world's most important resource: water. With over 50,000 members and 5,000 volunteers, AWWA provides solutions to improve public health, protect the environment, strengthen the economy, and enhance our quality of life.

Contents

EXECUTIVE SUMMARY

The American Water Works Association (AWWA) has formally tracked issues and trends in the water industry since 2004 through its State of the Water Industry (SOTWI) study. The Association continues to conduct this annual survey in order to:

- Identify and track significant challenges facing the water industry
- Provide data and analysis to support water professionals as they develop, implement, and communicate strategies to address current and future issues
- Inform decision makers and the public of the challenges faced by the water industry

In September 2016, e-mails were randomly sent to a general list of AWWA members and contacts inviting participation in the 2017 SOTWI study. The major findings summarized below were developed from the results of 1,768 partially or fully completed surveys AWWA received during the survey period.

- The current health of the industry (i.e., soundness) as rated by all respondents was 4.3 on a scale of 1 to 7, where it was 4.5 in 2016; prior to this year, this soundness score had been in a range of 4.5 to 4.9 since the survey began in 2004.
- Looking forward five years, the soundness of the water industry declined to 4.3 (also on a scale of 1 to 7), where it was 4.4 in 2016; prior to this year, this score had been in a range of 4.4 to 5.0 since the survey's inception.
- The top five most important issues facing the water industry were identified as follows:
    1. Renewal and replacement (R&R) of aging water and wastewater infrastructure (#1 in 2016)
    2. Financing for capital improvements (#2 in 2016)
    3. Long-term water supply availability (#4 in 2016)
    4. Public understanding of the value of water systems and services (#3 in 2016)
    5. Public understanding of the value of water resources (#5 in 2016)
- On the subject of gender: 76% of the 2017 SOTWI respondents were men, but the gender gap diminished as age decreased. The greatest gender imbalance occurred for those 65 and older (only 7% women); the imbalance decreased as the age category decreased until women outnumbered men for those 25 years of age and younger (68% women).
- Thirty percent of utility personnel reported their utilities are currently struggling to cover the full cost of providing services, including R&R and expansion needs, through customer rates and fees, and this jumps to 37% when respondents considered the full cost of service in the future. Notably, 12% of respondents felt that their utilities were currently not at all able to cover the full cost of providing service. These levels are very similar to those observed in recent years.
- The most important issue in the area of infrastructure R&R was "Justifying R&R programs to ratepayers," with 39% of respondents rating this a critical issue. Other important R&R issues included "Establishing and following a financial policy for capital reinvestment," "Prioritizing R&R needs," and "Justifying R&R programs to oversight bodies (board, council, etc.)."
- Forty-nine percent of respondents reported that their utilities' access to capital was as good as or better than at any time in the last five years, down from 56% in 2016 and 53% in 2015.
- Forty percent of utility respondents reported declining total water sales (up from 38% in 2016), while 26% of these respondents reported their total water sales were flat or had changed little in the past 10 years; similar results were observed on a per-account basis. Taken together, this means that a large proportion of utilities potentially face issues associated with low or declining water demand if these trends continue while the costs for water services increase.

- When utility personnel were asked how their utilities are responding to cost recovery needs in the face of changing water sales and consumption patterns, the most reported response was shifting more of the cost recovery from consumption-based fees to fixed fees within the rate structure. Other commonly reported strategies included changes in growth-related fees and shifting the rate design to an increasing-block rate structure. Only 7% of the respondents indicated no changes were needed at their utilities.
- Utility personnel were asked how six groups would perceive a potential rate increase in the upcoming year; public officials were expected to be the most positive at 21%, with the next closest group being business leaders at 10%. The most negative responses (71% negative) were expected to come from residential customers.
- When utility personnel were asked how prepared their utilities would be to meet their long-term water supply needs, 10% indicated their utilities will be challenged (i.e., not-at-all or only-slightly prepared), up from 7% in 2016.
- Forty-five percent of utility personnel reported their utilities do not include any potential impacts from climate variability in their risk management or planning processes, down from 51% in 2016. Forty-one percent responded that planning at their utilities includes climate change effects while 14% indicated their utility is in the process of including climate change in their planning processes.
- Of the options for water reuse, nonpotable reuse to augment irrigation was the most reported option, with 16% of utility respondents indicating their utilities already have something implemented and another 18% responding their utilities are considering it.
- Both utility and non-utility personnel consider the water industry's communication somewhat ineffective; communication with state/local regulators was identified as the most effective of the groups that were rated, followed by federal regulators and public officials (the same as in 2016). The least effective communication was reported for youth, with approximately 51% responding that communication with young people was either poor or very poor.
- The most important current regulatory concern of the water industry was point source pollution, followed by chemical spills and per- and polyfluoroalkyl substances such as perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS). The most important future regulatory concerns were pharmaceuticals and hormones, security and preparedness (cyber, physical, and emergency response), and nonpoint source pollution.

The 2017 SOTWI report shows the general directions in which the North American water industry continues to move as well as specific insights on the critical areas the industry feels need investment. AWWA provides a forum for innovation and leadership in the water industry by not only identifying and tracking important water issues, but by focusing the efforts and contributions of its dedicated members and volunteers to address the challenges identified in the SOTWI survey.

PART 1 – PURPOSE AND METHODOLOGY

Purpose

AWWA supports the water industry by providing solutions to effectively manage the world's most important resource: water. AWWA first developed the SOTWI survey and report in 2004 to:

- Identify, explore, and track significant challenges facing the water industry
- Provide data and analysis to support water professionals as they develop and communicate strategies to address current issues
- Highlight and potentially mitigate problems on the water industry's horizon

The annual SOTWI survey allows participants to serve as a voice for their colleagues and encourages necessary reflection on the water industry's challenges and priorities. The water industry, which includes potable water, wastewater, stormwater, and reuse services, is foundational to modern society. The water industry typically provides excellent service, but it is often ignored until times of stress such as drought, water contamination, or rate disputes. Because these challenges can occur unexpectedly and with great variation, water professionals need a balanced understanding of today's issues and tomorrow's challenges so they can help communities respond effectively.

The SOTWI survey provides an industry-wide self-assessment, gathering information to support the water community's major tenets, which include safeguarding public health, supporting and strengthening communities, and protecting the environment. Figure 1 highlights these principles and how they are realized.

Figure 1. Basic tenets of the water industry

Methodology

The SOTWI survey population includes all water professionals, i.e., those with a working understanding of the issues facing the entire water industry. The SOTWI survey classifies participants based on which of the following 20 categories best describes the type of organization for which they work:

- Drinking water utility
- Wastewater utility
- Combined water/wastewater utility (may include other services too)
- Water wholesaler
- Reuse/reclamation utility
- Stormwater utility
- Consulting firm/consultant
- Manufacturer of products
- Manufacturer's representative
- Distributor
- Technical services/contractor
- Regulatory authority/regulator
- Non-utility government (municipal, federal, etc.)
- University/educational institution
- Laboratory
- Financial industry (ratings agency, investor/fund rep., etc.)
- Law firm/attorney
- Nonprofit organization
- Retired
- Other (please specify)

AWWA made deliberate efforts throughout the 2017 SOTWI study to anticipate and minimize errors from coverage, sampling, nonresponse, and measurement. Coverage errors can result when members of the survey population have an unknown nonzero chance of being included in the sample. Sampling errors can result if data are collected from only a subset instead of all members of the sampling frame, which is the list from which a sample is to be drawn in order to represent the survey population. The 2017 SOTWI sample frame consisted of a general list of AWWA members and contacts. The survey primarily reflects water industry concerns in the United States, Canada, and Mexico.

A survey sample consists of all units of a population that are drawn from the sample frame for inclusion in the survey. In order to minimize coverage errors, the sample for the 2017 SOTWI survey was distributed with the goal to provide uniform response from states and provinces. To avoid bias, AWWA membership was not considered in the survey distribution, meaning it was sent to members and nonmembers alike.

From the sample frame, the survey invitation distribution included the following criteria:

1. All North American utilities (water, wastewater, combined, etc.)
2. All North American service providers
3. All North American partner agencies and institutions
4. All Canadian individual members
5. All Mexican individual members
6. All international individual members
7. US individual members as by state with the goal of producing uniform response rate by state population

On Aug. 29, 2016, initial e-mail invitations were delivered to more than 70,000 e-mail addresses (excluding bounces), based on the criteria described. On Sept. 15, 2016, a follow-up e-mail was sent to this same group. After removing wholly incomplete responses (i.e., surveys submitted with no responses at all), **the total number of 2017 SOTWI survey respondents was 1,768**. See Appendix 1 for all of the 2017 SOTWI survey questions.

The data have not been weighted to reflect the demographic composition of any target population. Because the population size (i.e., water professionals in North America) is not well-defined and the amount of self-selection bias is unknown, no estimates of error have been calculated. For figures summarizing responses to multiple survey questions, the number of respondents (*n*) as reported or shown in headings reflects the question that returned the lowest number of respondents of the summarized questions asked.

Figure 2 shows the total number of respondents based on their designated current career; all categories received responses. Approximately 52% of respondents (*n* = 763) indicated they worked for a utility, while 48% (*n* = 704) were not directly employed by a utility. Utility workers consist of the following career categories: drinking water utility, wastewater utility, combined water/wastewater utility, water wholesaler, reuse/reclamation utility, and stormwater utility.

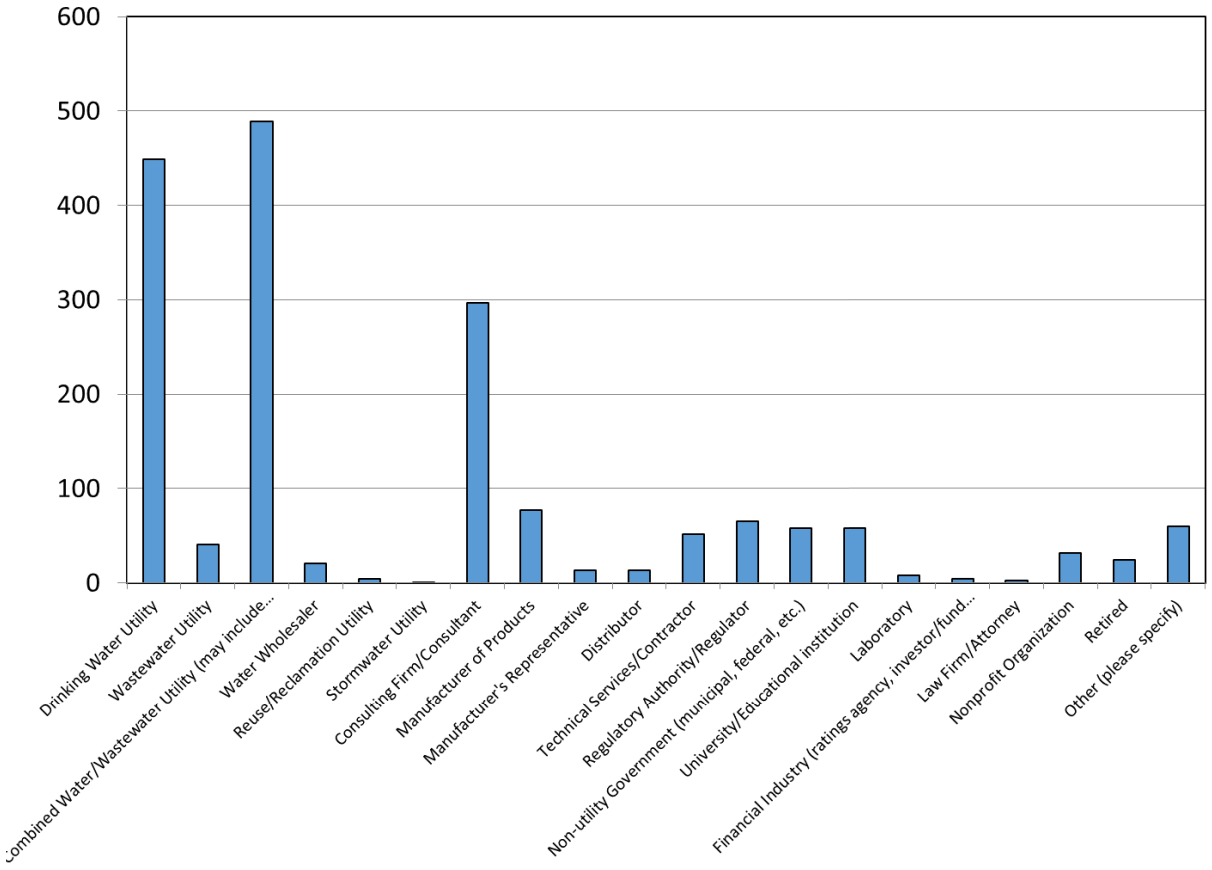

Figure 2. Number of respondents for the SOTWI survey by career category (*n* = 1,768)

The top three total responses by career category are as follows (all others were 4% or less):

1. Combined water/wastewater utility: 28% (489)
2. Drinking water utility: 25% (449)
3. Consultant/consulting firm: 17% (297)

Figure 3 shows the age distribution of the 2017 SOTWI survey respondents. The largest response was from the age group 55–64 (31%) while the smallest was the age group younger than 25 (~2%). The age distribution of respondents was slightly skewed to those who have likely been water professionals for a longer period, thereby allowing more time to engage with AWWA and more likely to receive the SOTWI survey, but overall there was reasonable representation in all age range categories.

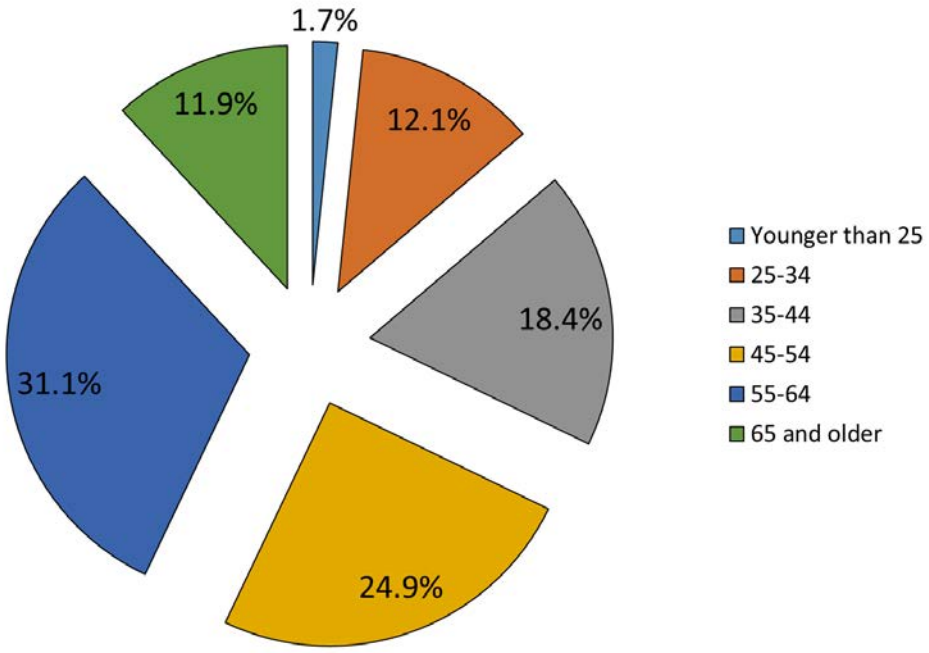

Figure 3. Age distribution of SOTWI survey respondents (*n* = 1,330)

Regarding gender, 76% of the 2017 SOTWI respondents were men and 24% were women. Interestingly, the gender gap diminished as age decreased, a positive development demonstrating a growing gender equity in the water industry. The results presented in Figure 4 show that the greatest gender imbalance occurs for those 65 and older (only 7% women). This imbalance decreased almost linearly as the age category decreased until women outnumbered men for those 25 years of age and younger (68%); however, as shown in Figure 3, the number of respondents at the lower age groups was somewhat low compared with the higher age brackets.

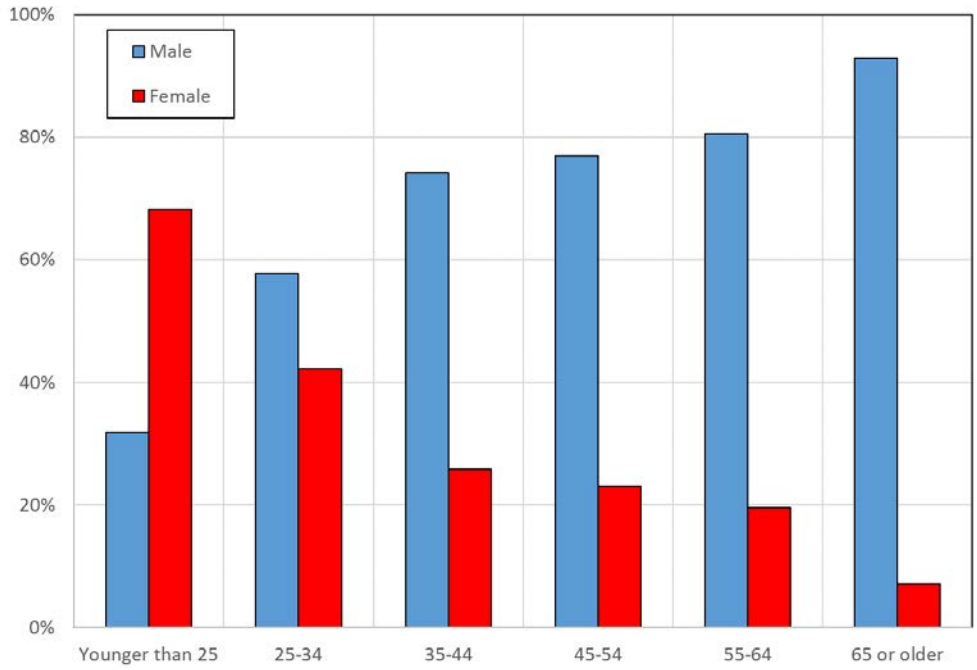

Figure 4. Gender distribution of SOTWI survey respondents by age category (*n* = 1,330)

While this overall trend is promising, dedicated resources are still needed to encourage female students to pursue career paths in science, technology, engineering, and math (STEM), and similarly in areas such as finance and management. Likewise, the water industry needs to strive for better gender and racial equity to ensure that women and minorities are recruited, retained, and promoted in all positions.

Figure 5 shows the ethnic distribution of the 2017 SOTWI survey respondents. The largest response was from those who identified as white/non-Hispanic (~84%). The next highest response came from those who identified themselves as having multiple ethnicities or others not identified.

Figure 6 shows the distribution of education levels of the 2017 SOTWI survey respondents. The largest response was from those who had completed a bachelor's degree (~37%). In general, the 2017 SOTWI sample was fairly well-educated, with 74% of respondents having a bachelor's degree or higher levels of education.

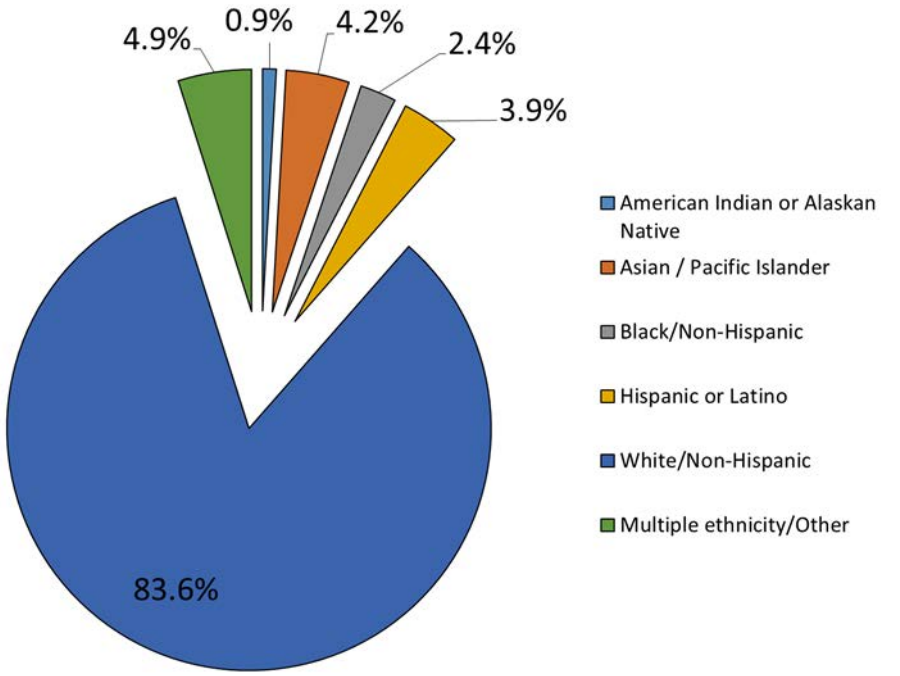

Figure 5. Ethnicity of SOTWI survey respondents (*n* = 1,325)

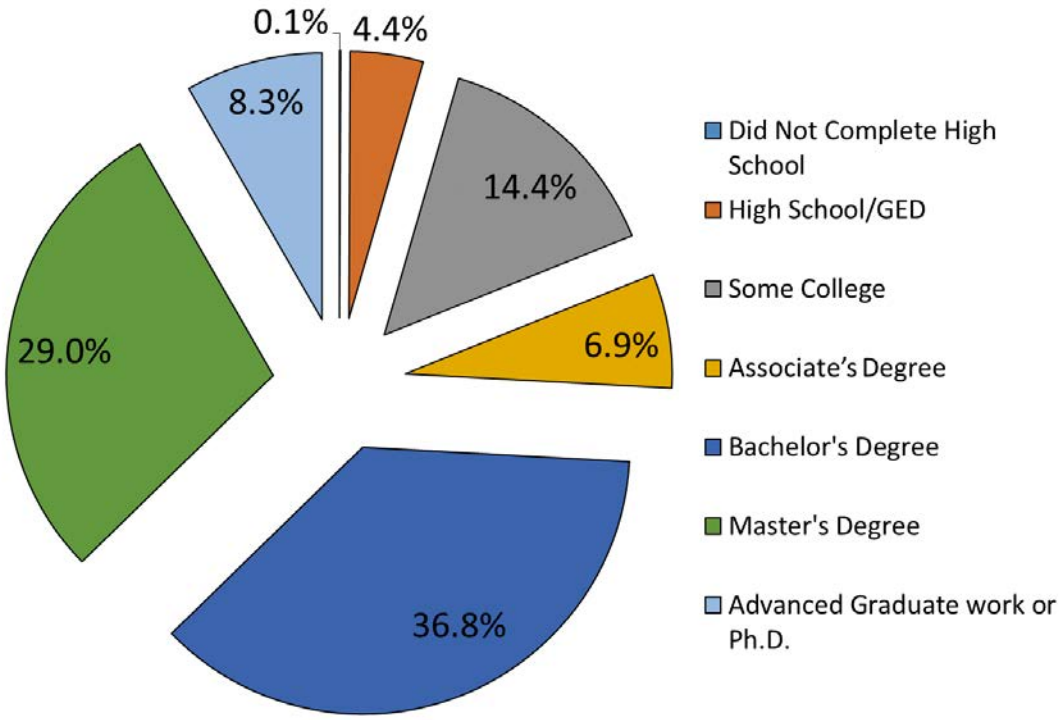

Figure 6. Education levels of SOTWI survey respondents (*n* = 1,357)

Figure 7 provides an overview of the number of water service connections or collection system connections served by the utility-career participants. Those responding for combined systems were instructed to use the larger between their systems' water and wastewater connections. The population served by a water or wastewater system can be estimated by multiplying the number of connections by 3.5, i.e., there are approximately 3.5 people served for each connection.

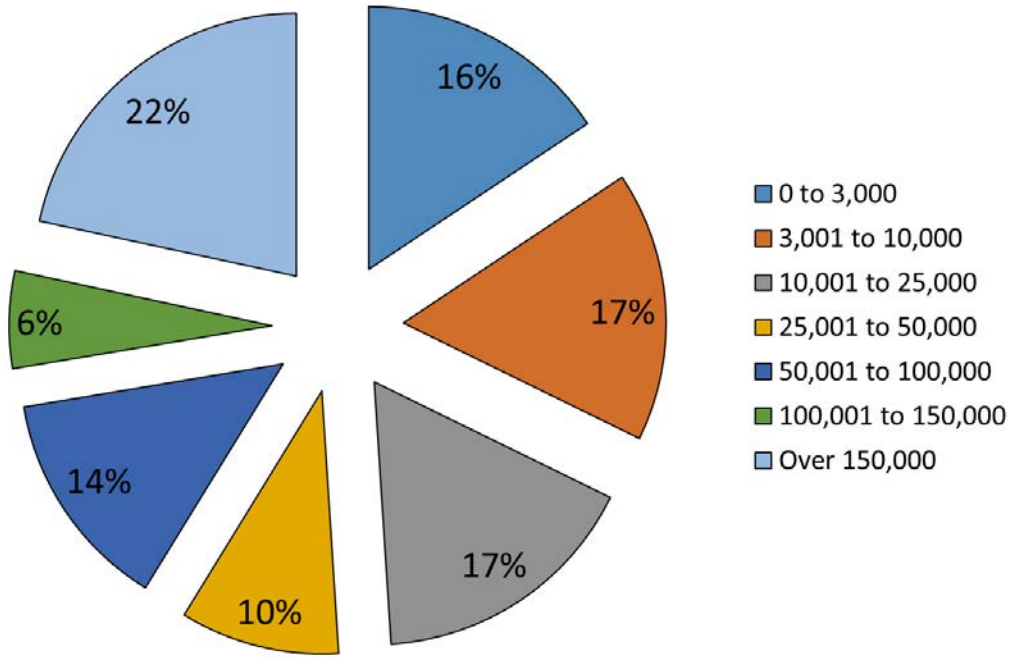

Figure 7. Summary of SOTWI respondents working for a utility by the number of service connections their utility serves (*n* = 735)

The largest group of utility respondents served more than 150,000 connections (meaning service populations greater than ~500,000 people), while the smallest group of respondents served between 100,000 and 150,000 connections. For this survey, a "small utility" is one that serves 3,000 or fewer connections (service populations of less than ~10,000 people). Ninety percent of the utility personnel who responded to the 2017 survey worked for public utilities, while 10% worked for private/investor owned utilities.

PART 2 – STATE OF THE WATER INDUSTRY

As has been done since the beginning of the SOTWI survey, the 2017 version asked participants for their opinion of the current and future health of the water industry through the following questions, using a scale of 1 to 7 where 1 = "not at all sound" and 7 = "very sound."

- *In your opinion, what is the current overall state of the water industry?*
- *Looking forward, how sound will the overall water industry be five years from now?*

Figure 8 shows the average scores as rated by all respondents to these two questions from 2004 to 2017. The current health of the industry (i.e., soundness) as rated by all respondents was 4.3 on a scale of 1 to 7, where it was ~4.5 in 2016; this score had been in a range of ~4.5 to 4.9 since the survey began in 2004 prior to this year. Looking forward five years, the soundness of the water industry declined to 4.3 (also on a scale of 1 to 7), where it was ~4.4 in 2016; this score had been in a range of 4.4 to 5.0 since the survey's inception prior to this year.

Although the minimum error associated with these responses cannot be estimated, it is reasonable to report that there is not a great difference in the water industry health scores over the last several years. However, even though slight, it does seem that there has been a slow decline in how water professionals perceive the health of the water industry (a term that is purposefully undefined) since the SOTWI survey began. Based on 1,768 responses, the overall health of the water industry in 2017 was found to be 4.3 on a scale of 1 to 7, whereas it had been ~4.5 for the past four years. Although this year's score falls very close to the running average of 4.6, it is still the lowest it has ever been and continues the gradual decline from an initial level of 4.9.

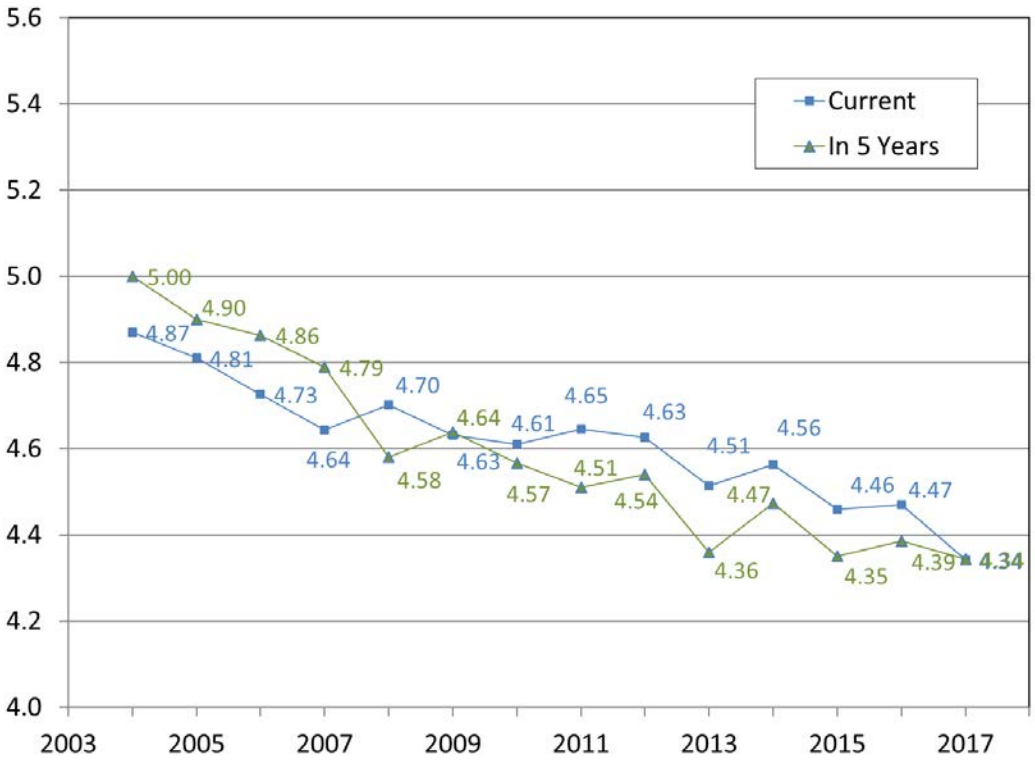

Figure 8. Health of the water industry – all respondents (rating scale: 1– 7)

Figures 9 and 10 show the soundness of the overall water industry as reported by those working in the United States and Canada, respectively. In terms of the current soundness of the water industry, the opinions of US respondents was the same in 2016 as in 2015. In contrast, the opinions of Canadian respondents were slightly more pessimistic in 2016 with small decreases over last year for both the current and future states of the water industry. The United States also maintains its trend of a relatively pessimistic future outlook (in comparison to the overall sample) with an expected average soundness score of 4.3 in 2022 (down from 4.4 currently). In contrast, Canadian participants continued their somewhat more optimistic outlook for the future with an average soundness score of 4.5 for 2022 (up from 4.3 currently).

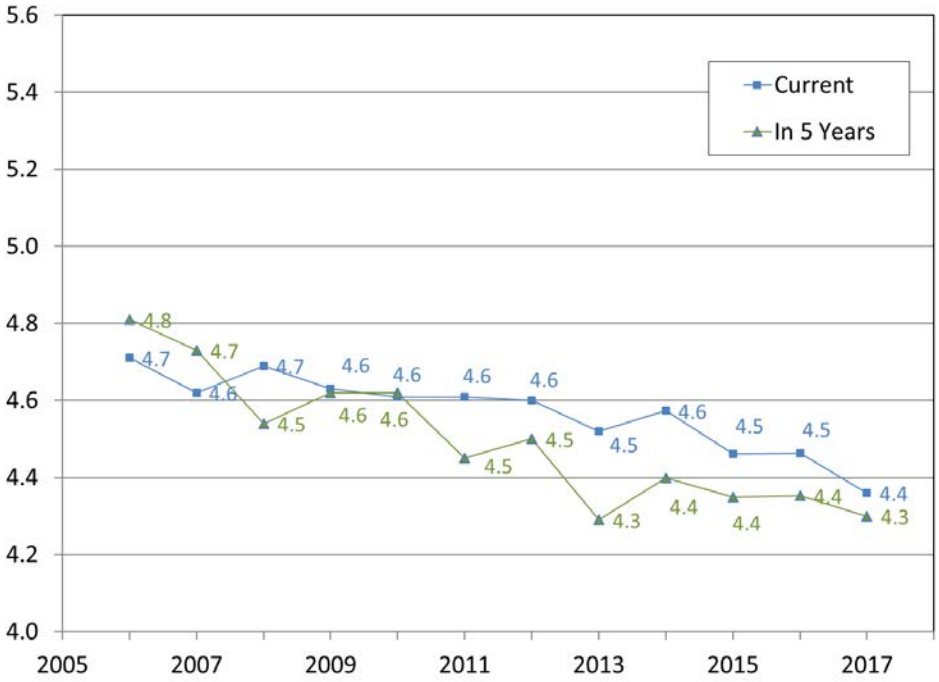

Figure 9. Health of the water industry – US respondents (rating scale: 1– 7)

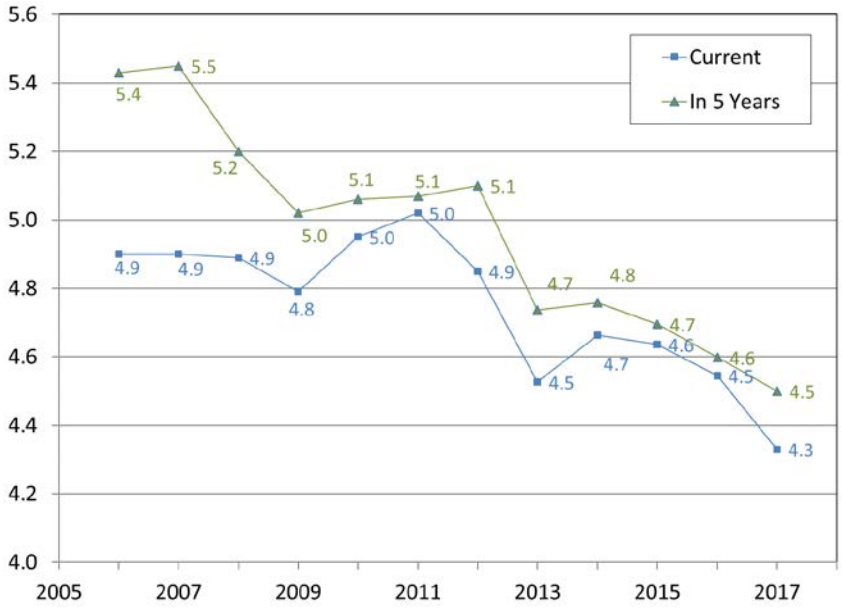

Figure 10. Health of the water industry – Canadian respondents (rating scale: 1– 7)

In addition to asking about the overall soundness of the water industry, the 2017 SOTWI survey also posed the following questions to better capture perspectives on regional soundness (focusing on the region in which respondents work most often), again using a scale of 1 to 7 where 1 = "not at all sound" and 7 = "very sound":

- *In your opinion, what is the current state of the water industry in the region where you work most often?*
- *Looking forward, how sound will the water industry be five years from now in the region where you work most often?*

As shown in Table 1, the region-specific scores were higher than the general scores by the same groups in the United States and Canada but not for the rest of the sample. The reasons for the results in the United States and Canada are not immediately apparent, but one explanation is that people likely have a better understanding of the water systems in the areas in which they work, and perhaps they are working to support these same systems so their opinions are naturally biased. In contrast, the water-related news and information from outside of the region respondents focus on is typically negative, leading to more negative perceptions regarding the overall industry. As for the responses outside the United States and Canada, the more pessimistic view expressed by this group may reflect their general level of development in comparison to those of fully developed countries.

Table 1. Overall and regional perceptions of the water industry soundness for total and country-specific respondents (rating scale: 1– 7; present and five years from now)

Sample	Overall		Regional		Counts
	2017	2022	2017	2022	
All respondents	4.3	4.3	4.6	4.6	1,768
US respondents	4.4	4.3	4.6	4.6	1,552
Canadian respondents	4.3	4.5	4.7	4.8	110
Other	4.1	4.8	3.9	4.5	106

The average scores for the health of the water industry on a scale of 1 to 7 for the current year and five years from now are provided in Table 2 for each career category. The majority of respondent groups indicated they thought the health of the industry would be slightly worse in five years than it is now. Leaving aside potential statistical differences, the regional soundness scores for most groups were slightly higher than the corresponding overall scores, again most likely reflecting the negative information delivered on a broader scope from outside the region that respondents work in and understand best.

Table 2. Overall and regional soundness of the water industry by respondent career category (scale: 1– 7; present and five years from now)

Career Category	Overall		Regional		Counts
	2017	2022	2017	2022	
Combined water/wastewater utility	4.5	4.5	4.8	4.8	489
Consulting firm/consultant	4.2	4.2	4.4	4.4	297
Distributor	4.4	4.8	4.9	4.8	13
Drinking water utility	4.5	4.4	4.8	4.7	449
Financial industry	3.5	3.5	4.0	4.0	4
Laboratory	4.1	4.6	4.5	4.9	8
Law firm/attorney	4.0	3.0	3.0	3.0	4
Manufacturer of products	4.3	4.5	4.6	4.8	77
Manufacturer's representative	3.9	4.0	3.8	3.9	13
Nonprofit organization	3.9	4.0	3.8	3.9	32
Non-utility government	4.0	3.9	4.1	3.9	59
Other (please specify)	4.5	4.4	4.6	4.6	57
Regulatory authority/regulator	4.3	4.2	4.4	4.4	65
Retired	4.4	3.9	4.6	4.2	24
Reuse/reclamation utility	4.5	4.8	5.3	5.5	4
Stormwater utility	4.0	3.0	3.0	2.0	1
Technical services/contractor	4.2	4.4	4.2	4.2	52
University/educational institution	4.3	4.5	4.4	4.6	58
Wastewater utility	4.2	4.2	4.6	4.6	41
Water wholesaler	4.1	4.0	4.4	4.4	21
Total sample (all respondents)	**4.3**	**4.3**	**4.6**	**4.6**	**1,768**

The average scores for the soundness of the water industry (on a scale of 1 to 7) for present and five years from now are broken out by age group in Table 3. There is little difference in these scores, with those in the

younger than 25 age group indicating a slightly more optimistic outlook for the future, although the somewhat lower number of responses may have led to errors from coverage, sampling, and/or nonresponse. Again, regional scores are for the most part higher than the overall scores.

Table 3. Health of the water industry by respondent age category (scale: 1–7; present and five years from now)

Age Range	Overall		Regional		Counts
	2017	2022	2017	2022	
Younger than 25	4.3	4.6	4.7	4.9	22
25-34	4.3	4.6	4.6	4.9	161
35-44	4.3	4.4	4.5	4.6	245
45-54	4.3	4.2	4.6	4.5	331
55-64	4.4	4.3	4.7	4.6	412
65 and older	4.3	4.1	4.4	4.3	157

Part 3 – Water Industry Challenges

To determine and rank the major issues currently facing the water industry, respondents were asked to rate the importance of several challenges on a scale of 1 to 5, where 1 = "unimportant" and 5 = "critically important." These issues, as ranked by 2017 SOTWI survey respondents, are shown in Table 4. In addition to the average scores, the percentage of respondents who scored the issue as critically important (i.e., 5 on the scale of 1 to 5) is also presented.

Table 4. Issues facing the water industry in 2017 as ranked by all respondents (*n* = 1,383)

Rank	Category	Score	% Ranked Critically Important
1	Renewal and replacement of aging water and wastewater infrastructure	4.53	63%
2	Financing for capital improvements	4.42	59%
3	Long-term water supply availability	4.39	57%
4	Public understanding of the value of water systems and services	4.34	54%
5	Public understanding of the value of water resources	4.22	45%
6	Watershed/source water protection	4.18	46%
7	Emergency preparedness	4.10	37%
8	Cost recovery (pricing water to accurately reflect its true cost)	4.04	35%
9	Public acceptance of future water and wastewater rate increases	4.01	34%
10	Water conservation/efficiency	4.00	36%
11	Groundwater management and overuse	3.98	35%
12	Aging workforce/anticipated retirements	3.98	40%
13	Asset management	3.91	26%
14	Talent attraction and retention	3.91	30%
15	Improving customer, constituent, and community relationships	3.91	29%
16	Data management	3.91	29%
17	Governing board acceptance of future water and wastewater rate increases	3.91	32%
18	Drought or periodic water shortages	3.90	33%
19	Water loss control	3.90	26%
20	Compliance with current regulations	3.87	26%
21	Compliance with future regulations	3.85	26%
22	Energy use/efficiency and cost	3.82	22%
23	Certification and training	3.81	24%
24	Expanding water reuse/reclamation	3.79	31%
25	Water rights	3.72	30%
26	Cyber-security issues	3.70	25%
27	Financing for water research	3.64	23%
28	Physical security issues	3.59	19%
29	Water quality issues from premise plumbing systems	3.57	20%
30	Climate risk and resiliency	3.53	23%

The most important issue to respondents in 2017, "Renewal and replacement of aging water and wastewater infrastructure," has consistently been the most important issue identified for several years

(previously called "State of water and sewer infrastructure"). A comparison of the top 10 issues from this year and the past three years is presented in Table 5. While the order of issues may change slightly, the most important issues are strikingly consistent year to year, aligning well with survey results prior to 2014 as well.

Table 5. Top 10 issues facing the water industry as ranked by all respondents, 2014–2017

Rank	2014	2015	2016	2017
1	State of water and sewer infrastructure	Renewal and replacement of aging water and wastewater infrastructure	Renewal and replacement of aging water and wastewater infrastructure	Renewal and replacement of aging water and wastewater infrastructure
2	Long-term water supply availability	Financing for capital improvements	Financing for capital improvements	Financing for capital improvements
3	Financing for capital improvements	Long-term water supply availability	Public understanding of the value of water systems and services	Long-term water supply availability
4	Public understanding of the value of water resources	Public understanding of the value of water systems and services	Long-term water supply availability	Public understanding of the value of water systems and services
5	Public understanding of the value of water systems and services	Public understanding of the value of water resources	Public understanding of the value of water resources	Public understanding of the value of water resources
6	Groundwater management and overuse	Watershed/source water protection	Watershed/source water protection	Watershed/source water protection
7	Watershed protection	Cost recovery (pricing water to accurately reflect its true cost)	Public acceptance of future water and wastewater rate increases	Emergency preparedness
8	Drought or periodic water shortages	Emergency preparedness	Water conservation/ efficiency	Cost recovery (pricing water to accurately reflect its true cost)
9	Emergency preparedness	Water conservation/ efficiency	Cost recovery (pricing water to accurately reflect its true cost)	Public acceptance of future water and wastewater rate increases
10	Cost recovery	Compliance with future regulations	Groundwater management and overuse	Water conservation/ efficiency

Grouping together utility workers (those in the career categories of drinking water utility, wastewater utility, combined water/wastewater utility, water wholesaler, reuse/reclamation utility, or stormwater utility) and non-utility workers (everyone else not directly employed by a utility), Table 6 shows the most important issues impacting these two groups. These lists are very similar, and the top six issues are the same for both groups.

Two issues identified by utility personnel that were not as highly ranked by non-utility personnel were (#9) "Aging workforce/anticipated retirements" and (#10) "Public acceptance of future water and wastewater

rate increases." Likewise, the two issues identified by non-utility personnel that were not as highly ranked by utility personnel were (#7) "Groundwater management and overuse" and (#8) "Water conservation/efficiency."

Table 6. Issues facing the water industry in 2017 as ranked by utility and non-utility respondents, respectively

Rank	Utility Employees (*n* = 920)	Non-Utility Employees (*n* = 728)
1	Renewal and replacement of aging water and wastewater infrastructure	Renewal and replacement of aging water and wastewater infrastructure
2	Long-term water supply availability	Financing for capital improvements
3	Financing for capital improvements	Long-term water supply availability
4	Public understanding of the value of water systems and services	Public understanding of the value of water systems and services
5	Public understanding of the value of water resources	Public understanding of the value of water resources
6	Watershed/source water protection	Watershed/source water protection
7	Emergency preparedness	Groundwater management and overuse
8	Cost recovery (pricing water to accurately reflect its true cost)	Water conservation/efficiency
9	Aging workforce/anticipated retirements	Cost recovery (pricing water to accurately reflect its true cost)
10	Public acceptance of future water and wastewater rate increases	Emergency preparedness

System Stewardship

In general, the water industry plans, builds, operates, maintains, and replaces the typically large and expensive assets that provide water services including potable water, wastewater, stormwater, and reuse. Overall system stewardship is a primary duty of each community, but implementation and ultimate responsibility resides with service providers (i.e., utilities) and the groups charged with their oversight. If overall water resource management is included under the umbrella of system stewardship, which is reasonable from the perspective of resource planning, all of the top issues identified in the 2017 SOTWI survey pertain to system stewardship—that is, how water and wastewater systems are operated, maintained, and replaced.

Viewing system stewardship from the more traditional view of asset and financial management, specific issues identified regularly through the SOTWI surveys include renewing and replacing aging infrastructure, financing for capital improvements, and cost recovery (i.e., pricing water to accurately

reflect its true cost). These issues continue to be important because many water and wastewater systems built and financed by previous generations are approaching or have exceeded their useful lives and are now facing R&R. Water system R&R can be challenging even for well-performing utilities because of capital funding restraints and/or limited public support for these efforts (AWWA 2012).

Full-Cost Pricing

AWWA holds that the public can best be provided water services by self-sustaining enterprises that are adequately financed with rates and charges based on sound accounting, engineering, financial, and economic principles. Revenues from service charges, user rates, and capital charges (e.g., impact fees and system development charges) should be sufficient to enable utilities to provide for the full cost of service, including the following:

- Annual operation and maintenance expenses
- Capital costs (e.g., debt service and other capital outlays)
- Adequate working capital and required reserves

Full-cost pricing, i.e., charging rates and fees that reflect the full cost of providing water and/or wastewater services, should include renewal and replacement costs for treatment, storage, distribution, and collection systems. Some utilities have previously kept their rates low by minimizing or ignoring these costs, but as the useful lives of their systems draw to a close, current managers and the communities they serve are forced to address these costs, sometimes through painful and unexpected rate increases. Issues related to equity and affordability must be considered as rates are adjusted, and each system has its own unique rate-setting challenges based on current conditions as well as recent developments and long-term history.

Full-cost pricing is in many ways a utility-specific issue defined by the specific community a utility services, so to explore the issue at this level, utility personnel were asked, "Is *your utility* currently able to cover the full cost of providing service(s), including infrastructure renewal and replacement and expansion needs, through customer rates and fees?" They were also asked, "Given *your utility's* future infrastructure needs for renewal & replacement and expansion, do you think *your utility* will be able to meet the full cost of providing service(s) through customer rates and fees?" Responses are provided in Figure 11.

The results shown in Figure 11 are not encouraging. Combining those who are not at all able and those who are slightly able, 30% of utilities are currently struggling to implement full-cost pricing, the same as in 2016. In addition, 37% of respondents think they will struggle to cover the full cost of service in the future, similar to the 38% observed in 2016.

Of the results in Figure 11, the most notable is that 12% of respondents felt that their utilities were currently not at all able to cover the full cost of providing service; unfortunately, this is up from 11% in 2016 and 9% in 2015. On the other hand, the percentage of respondents who felt their utilities were currently fully able to cover the cost of providing service through rates and fees was 21% in 2016, the same as reported in 2017. Utility personnel are perhaps still expecting challenges ahead, though, as the percentage of respondents who felt that their utilities would be fully able to cover the future cost of providing service was 17%, up from 15% in 2016 and 12% in 2015. As is typically the case, the SOTWI survey found a wide range of responses reflecting the variation in perceived ability to meet current and future funding requirements.

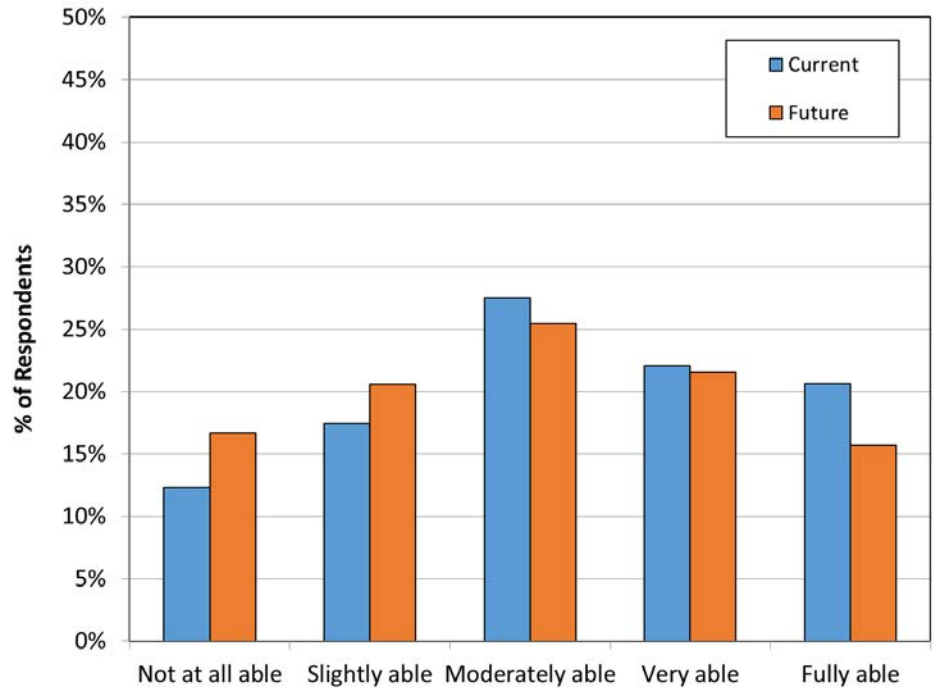

Figure 11. Responses (as % of total) from utility personnel regarding their opinions of whether the utilities they work for can cover the full cost of providing service, including infrastructure renewal/replacement and expansion needs, through customer rates and fees currently and in the future (*n* = 695)

Specific to infrastructure renewal and replacement, the 2017 SOTWI survey asked all participants to rate the importance of specific R&R challenges currently facing the water industry on a scale of 1 to 5. As shown in Table 7, the most important issue was "Justifying R&R programs to ratepayers," with 39% of respondents rating this issue as critical (i.e., 5 out of 5); this was also the second-most important issue identified in the 2016 SOTWI survey, which was behind "Establishing and following a financial policy for capital reinvestment," the second-most important challenge in the 2017 survey.

Table 7. Renewal and replacement (R&R) challenges as ranked by SOTWI respondents (*n* = 1,261)

Rank	Category	Score (1–5)	% Ranked Critically Important
1	Justifying R&R programs to ratepayers	4.19	39%
2	Establishing and following a financial policy for capital reinvestment	4.18	38%
3	Prioritizing R&R needs	4.14	37%
4	Justifying R&R programs to oversight bodies (board, council, etc.)	4.12	35%
5	Establishing and maintaining specific R&R reserves	4.09	34%
6	Coordinating R&R with other activities (e.g., road repair, redevelopment, etc.)	4.03	35%
7	Developing/implementing asset management programs	3.89	27%
8	Defining appropriate levels of service	3.73	18%

9	Obtaining R&R funding via federal, state, or territorial grants	3.71	28%
10	Obtaining R&R funding via bonds	3.71	21%
11	Addressing declining water sales	3.64	20%
12	Obtaining R&R funding via federal, state, or territorial loans	3.61	22%
13	Pay-as-you-go R&R funding	3.44	17%
14	Obtaining R&R funding involving public-private partnerships	3.31	15%
15	Obtaining R&R funding by taxation (e.g., property taxes)	3.07	12%

Access to Capital

To begin to understand the current financing environment for the water industry, utility personnel were asked, "If you can make an assessment, how would you rate your utility's current access to capital for financing infrastructure renewal/replacement projects?" As shown in Figure 12, 56% of respondents reported that their utility's access to capital was as good as or better than at any time in the last five years, the same as in 2016. Eleven percent reported that their utility's access to capital was as bad or worse than at any time in the last five years, slightly up from 10% in 2016. Combining these results with a likely slow increase in interest rates in the United States, it would appear that the capital markets for financing water infrastructure R&R projects are good but may be at the outset of tightening.

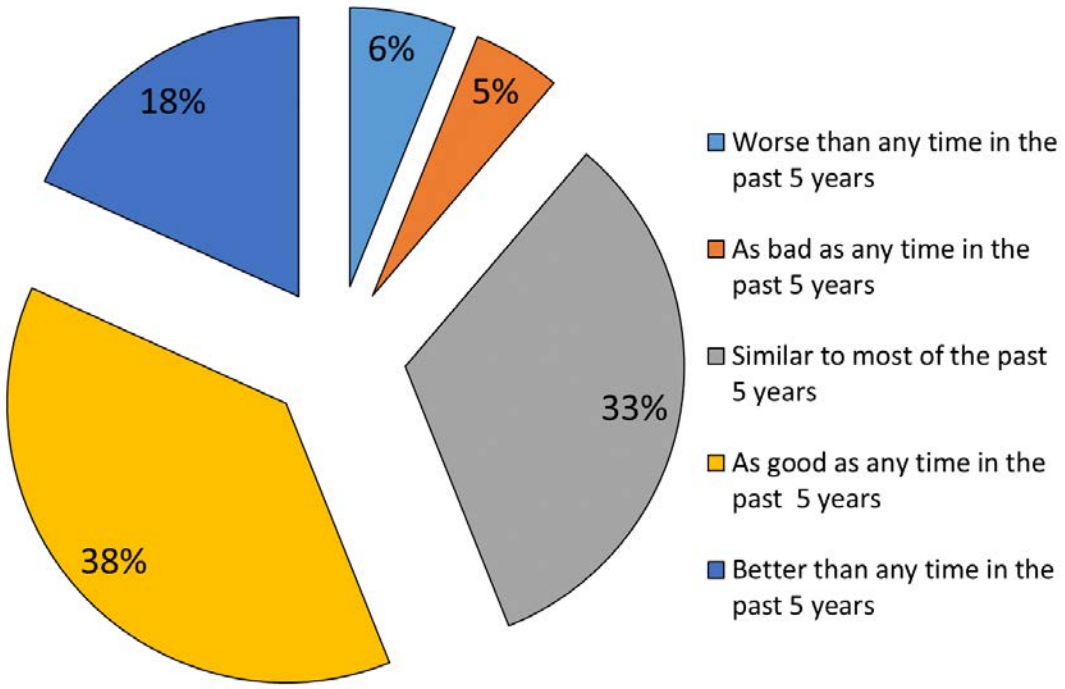

Figure 12. Responses (as % of total) from utility personnel regarding their opinion of their utility's access to capital (*n* = 587)

Changing Water Demands

Although more efficient use of water is a major goal of the industry, in areas where customer growth is slow or nonexistent, declining water use left unaddressed can decrease operating revenue and impact how costs are recovered through rates and charges. In some cases, utilities must explain to customers that their rates must go up even as their community uses the same or less amounts of water. This situation clearly demonstrates the need for ongoing and effective communication between utilities, their customers, and their broader community so that everyone understands how their water quality and supply depends on their system's regular operation, maintenance, and infrastructure R&R.

In order to explore this issue, utility staff members were asked a series of questions about their utilities' trends in water sales. Results regarding trends in total water sales, as shown in Figure 13, reveal that 40% of utility respondents reported declining total water sales (either a >10 year or <10 year trend) while 26% of respondents reported their total water sales were flat or little changed in the last 10 years. Taken together, this means that approximately two-thirds of utilities could face issues associated with low or declining water demand if it is assumed that the costs of water services have increased over this same period. In 2017, 30% of utility personnel reported their utility saw an increasing trend in total water sales (either a >10 year or <10 year trend), which is up from 26% in 2016 and 23% in 2015.

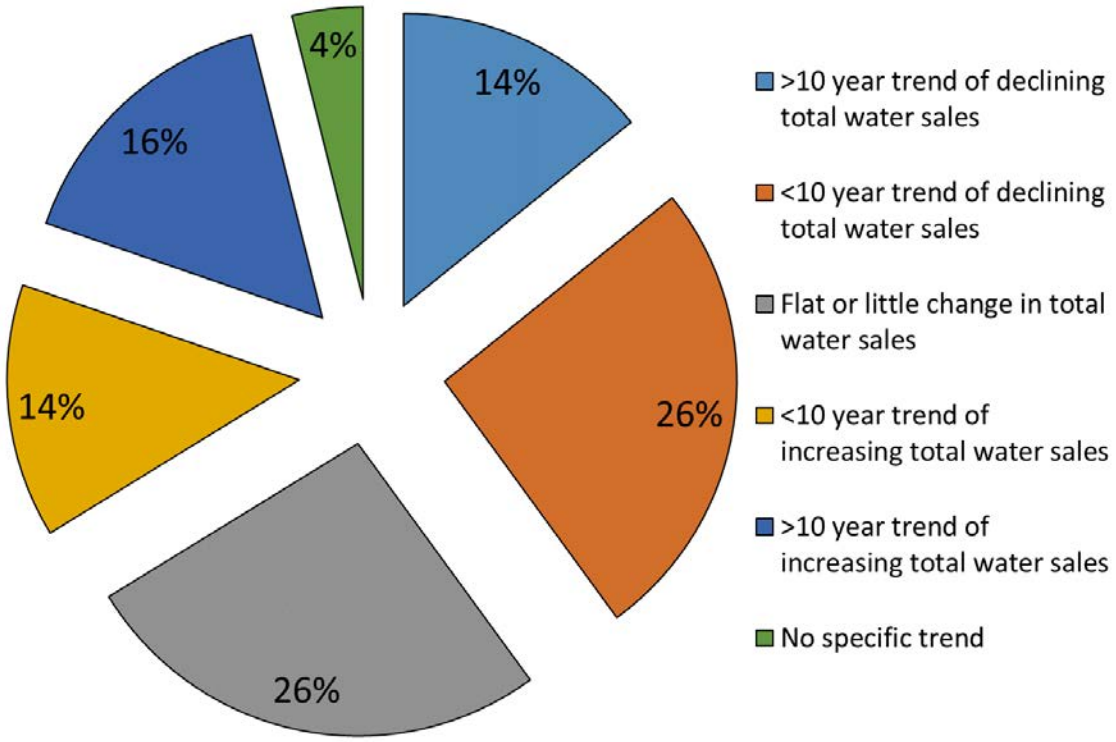

Figure 13. Responses (as % of total) from utility personnel regarding their opinion of their utility's trends in total water sales (*n* = 613)

Results from utilities regarding their trends in per account water sales are shown in Figure 14. Similar to the results for total water sales, 49% of utility respondents reported their utility was experiencing declining per account water sales (either a >10 year or <10 year trend), while 29% of respondents reported flat or little

change in per account water sales. Taken together, this means that nearly 80% of utility respondents must potentially address issues associated with low or declining water demand, at least on a per account basis. Eighteen percent of utilities reported increasing per account water sales (either a >10 year or <10 year trend), which is up from 15% in 2016.

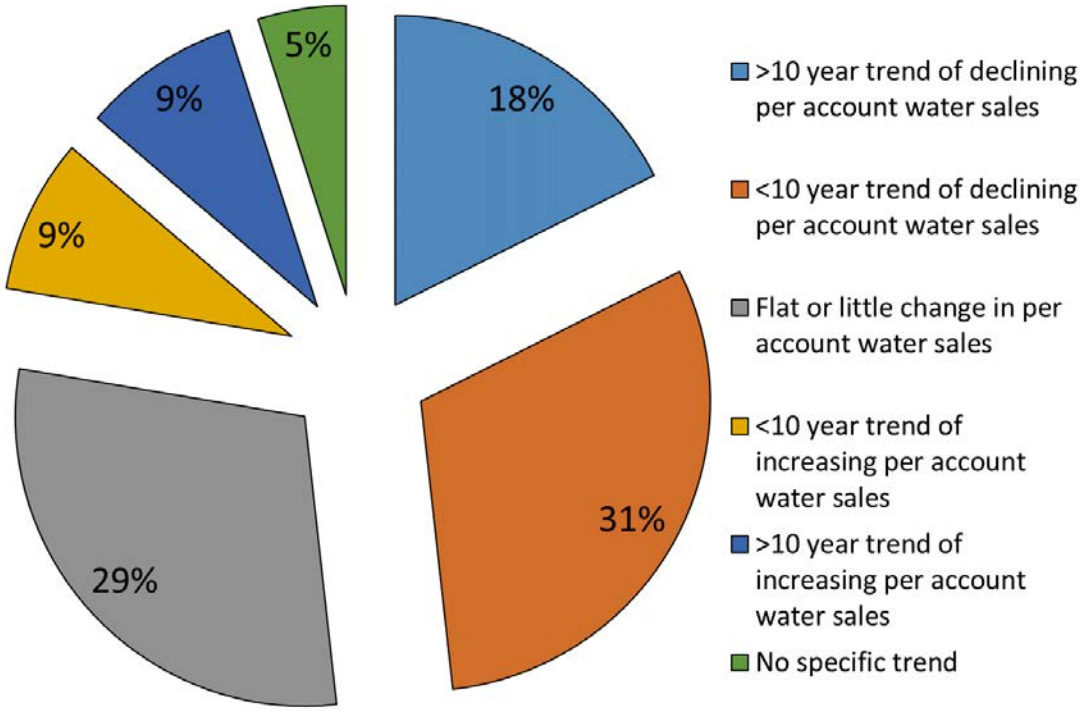

Figure 14. Responses (as % of total) from utility personnel regarding their opinion of their utility's trends in per account water sales (*n* = 568)

Cost Recovery

As mentioned previously, declining water sales can impact a utility's approach to cost recovery (the #8 overall issue, see Table 4). Cost recovery refers to pricing water and wastewater services to accurately reflect their true costs and then obtaining these from customers. To understand this more, utility staff members were asked how their utilities are responding to their cost recovery needs in the face of changing water sales and consumption patterns; results are shown in Table 8. For this question, utilities could respond to multiple approaches.

Ranking the cost recovery options, the most used option was to shift more of the cost recovery from consumption-based fees to fixed fees within the rate structure; this was also the most popular response in 2016. The next most popular option was to change growth-related fees, i.e., system development charges, impact fees, or capacity charges. Other popular options were to shift the rate design to an increasing-block rate structure and to increase financial reserves. Only 7% of the total responses indicated no changes were needed, down slightly from 8% in 2016.

Table 8. Responses (as % of total) from utility personnel regarding how their utilities are responding to cost recovery needs (*n* = 847 total responses)

Rank (based on # responses)	Category	% Response
1	Shifting more of the cost recovery from consumption-based fees to fixed fees within the rate structure	25%
2	Changes in growth-related fees (i.e., system development charges, impact fees, or capacity charges)	18%
3	Increasing financial reserves	15%
4	Shifting rate design to increasing-block rate structure	14%
5	Implementing rate stabilization reserves	9%
6	No changes needed	7%
7	Revenue diversification	7%
8	Incorporating seasonal rates	4%
9	Shifting rate design to decreasing-block rate structure	2%

Note: Utilities could respond to multiple options.

Public–Private Partnerships

As water and wastewater utilities deal with system stewardship issues, some are beginning to consider alternative management approaches including public–private partnerships (P3s). Figure 15 shows the results from utility employees regarding whether their utilities are considering or are implementing a P3. Approximately 22% of respondents indicated that their utility was considering, was planning to use, or was already involved in a public–private partnership; this figure was down from 24% in 2016.

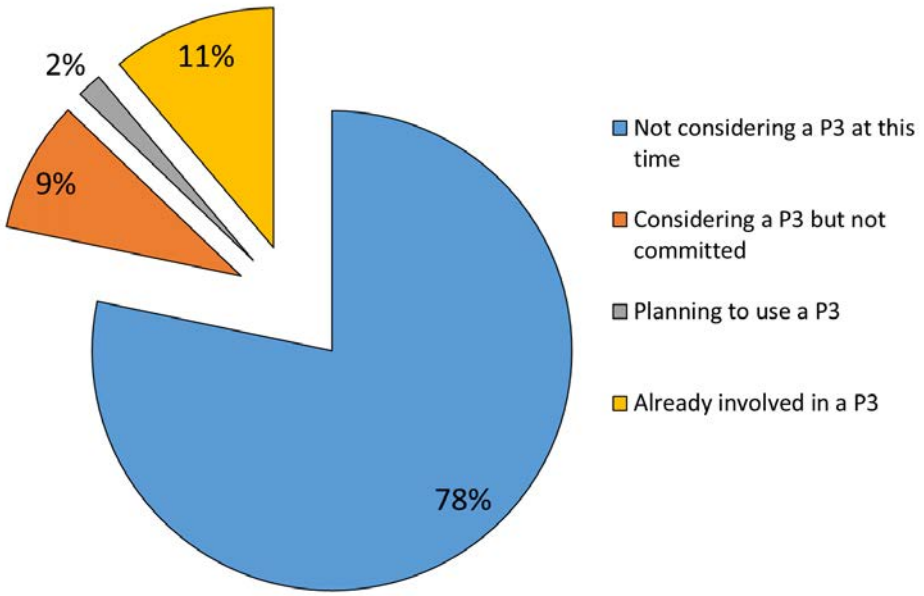

Figure 15. Responses (as % of total) from utility personnel regarding if their utilities are considering public–private partnerships (*n* = 530)

Rate Increases

Faced with increasing capital needs and potential funding shortfalls, many utilities must increase the rates they charge for water services in the immediate future. To understand how rate increases would be perceived, utility personnel were asked, "If your utility was to consider a rate increase in the coming year, how do you think it would be received by the following groups?" The groups presented were the general public, residential customers, nonresidential customers (industrial/commercial/institutional), public officials, business leaders, and the media. Response options were very negatively, negatively, indifferently, positively, and very positively. Figure 16 summarizes the responses from 2017 SOTWI survey respondents.

The results in Figure 16 are not unexpected; less than 2% of any of the six groups would be expected to view a rate increase as very positively. Public officials would be expected to be the most positive at 21%, with the next closest group being business leaders at 10%. The most negative responses (~71% negative) would be expected to come from residential customers (16.6% very negative and 54.7% negative). Again, "Public acceptance of future water and wastewater rate increases" was identified in Table 4 as the ninth most important challenge facing the water industry in 2017.

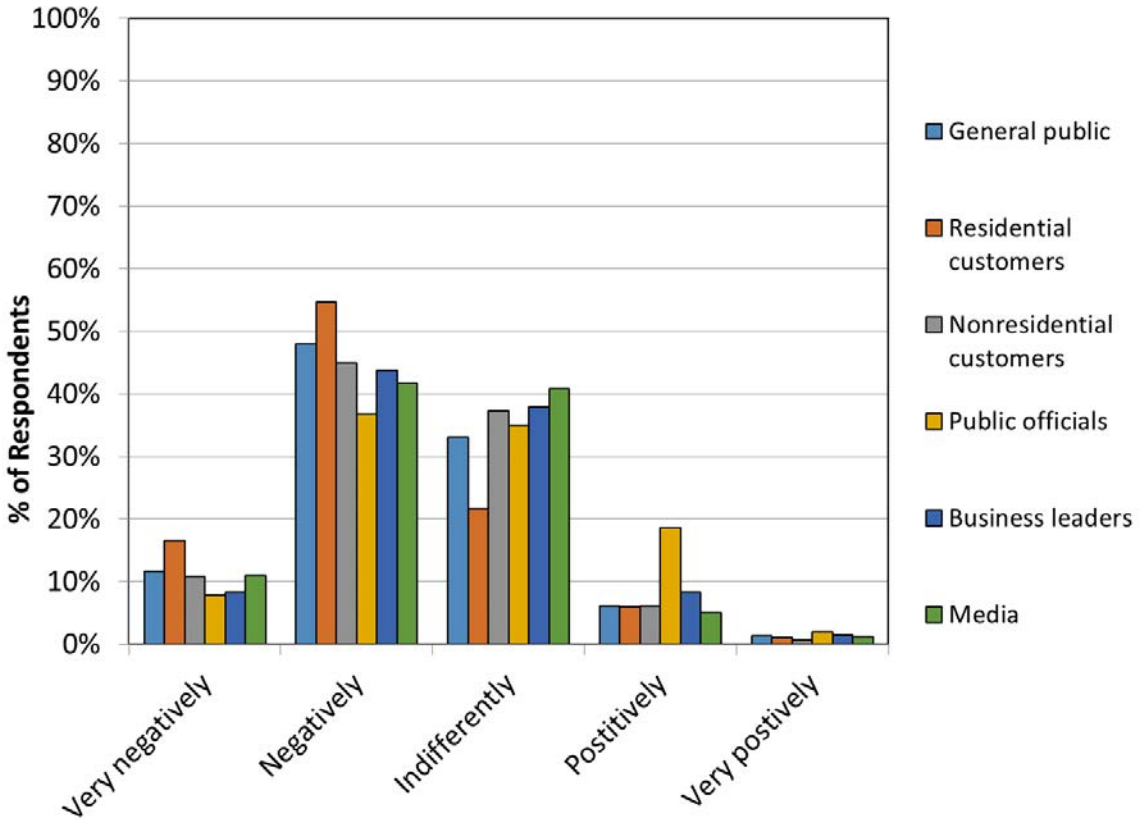

Figure 16. Responses (as % of total) from utility personnel regarding their opinion of how various groups would perceive a rate increase in the coming year (*n* = 653)

Affordability

As water utilities consider changes to their rates and fees, it is important they keep in mind low-income consumers who may find themselves choosing between paying their water bills or buying food or paying

rent. A first step in assessing a utility's need for a low-income program is to gather information about the community and begin a dialogue with community organizations and agencies that work with low-income people (AWWA 2014). Through this information-gathering process, a utility manager can develop a deeper understanding of the community's needs and identify ways to help address some of these needs.

In order to understand the extent of assistance programs, the 2017 SOTWI survey asked utility personnel if their utility offers an affordability program to assist low-income customers pay their water and/or wastewater bills; responses are presented in Figure 17. Over half of respondents indicated their utilities do not provide bill assistance to low-income customers.

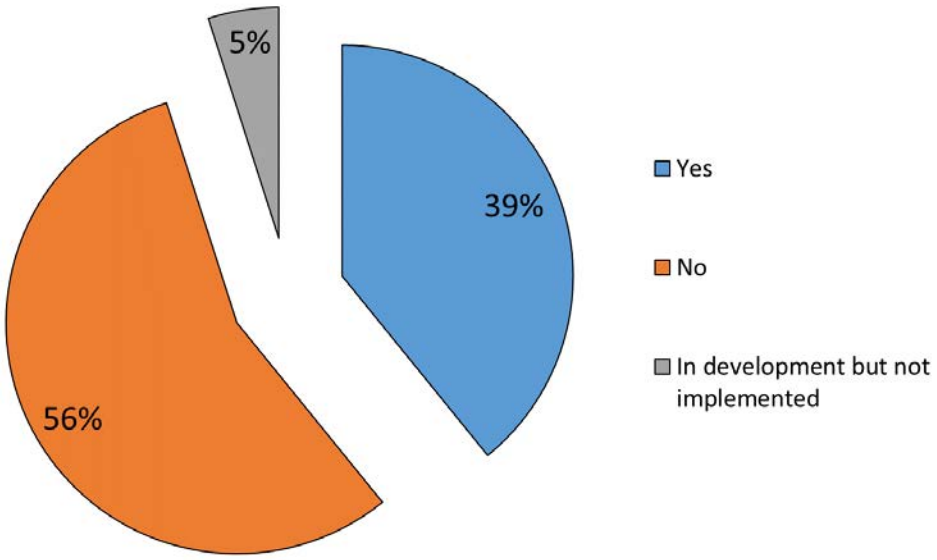

Figure 17. Responses from utility employees regarding whether their utility offers an affordability program to assist low-income customers pay water and/or wastewater bills (*n* = 567)

System Stewardship Summary

In the end, decision-makers charged with managing water and wastewater systems along with other community leaders and, ultimately, customers must face the challenges of optimizing water and wastewater infrastructure investments, balancing system upgrades to maintain service life goals and meet regulatory requirements, and trying to anticipate new technologies and forthcoming regulations. All of this requires significant planning and coordination from across the utility. It is important to remember that many systems were designed for past water quality and supply conditions, and these systems will need to meet changing demands while anticipating greater uncertainty. Because of the long-term nature of the necessary investments, utilities need to maintain a forward-looking and holistic approach to system stewardship.

Water Resources Management

Respondents rated highly several issues related to water resources management in the 2017 SOTWI survey (as shown in Table 4), including "Long-term water supply availability" (#3 most important issue), "Drought or periodic water shortages" (#18 most important issue), and "Water conservation/efficiency" (#10 most important issue), as well as other topics (i.e., desalination, climate change, water reuse). The following sections explore these and other areas in greater detail.

Long-Term Water Supply Availability

The main challenge of water resource management, namely long-term water supply availability, can result from full allocation, and in some cases over-allocation, of local and/or regional water resources. Communities need to establish how much water they have, how much water they need, and how they will meet any future gaps based on current and future supplies. Some areas are reaching the limits of their current supply options and are seeking additional water through conservation, desalination, and reuse. In addition, some water-limited areas may be susceptible to further water stress from climate change and increasing populations.

To understand the issue of long-term water supply availability, utility personnel were asked, "How prepared do you think your utility will be to meet its long-term water supply needs?" The summary presented in Figure 18 shows that 10% of utility personnel indicated their utility will be challenged to meet anticipated long-term water supply needs (i.e., not at all or only slightly prepared), up from 7% in 2016. In addition, 59% of respondents indicated that their utilities are very or fully prepared, up from 58% in 2016. Two percent of respondents indicated their utilities were not at all prepared to meet their long-term water supply needs.

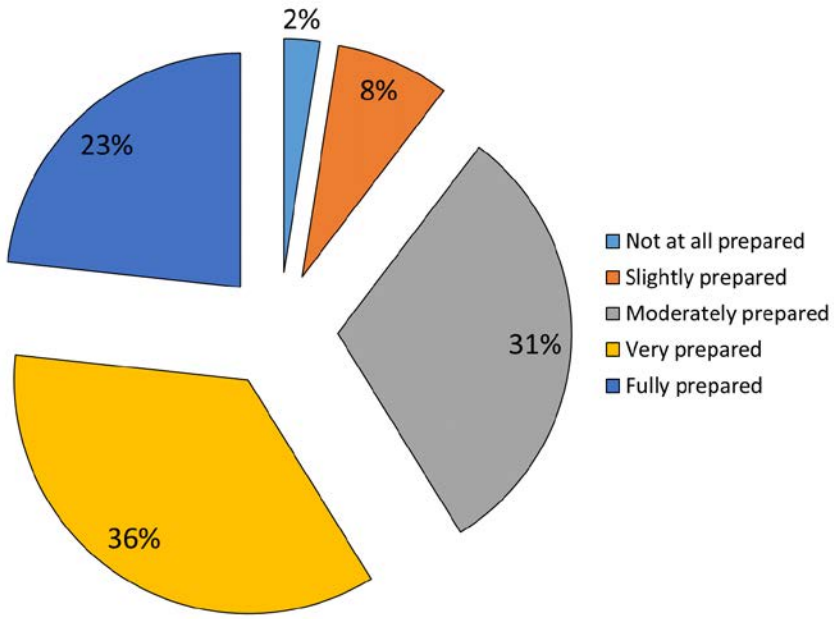

Figure 18. Responses from utility employees regarding their opinion of how prepared their utility is to meet long-term water supply needs (*n* = 526)

Drought and Water Shortages

Shifting from long-term to near-term water supply, water systems are dramatically affected by shortages resulting from drought, the severity of which will likely be influenced by climate change moving forward. Following a series of the hottest global years ever observed, many regions in North America may again face drought conditions in 2017, which is likely why "Drought or periodic water shortages" was the #18 most important issue identified by the 2017 SOTWI survey.

To gauge the extent of water shortages, utility personnel were asked how many years in the last decade their utilities had implemented voluntary or mandatory water restrictions. The responses summarized in Figure 19 reveal that the majority of respondents' utilities have had either zero or one period of voluntary restrictions (63% together), and either zero or one period of mandatory restrictions (74% together). Fourteen percent of utility personnel indicated their utilities had five or more years of voluntary restrictions and 10% had five or more years of mandatory restrictions.

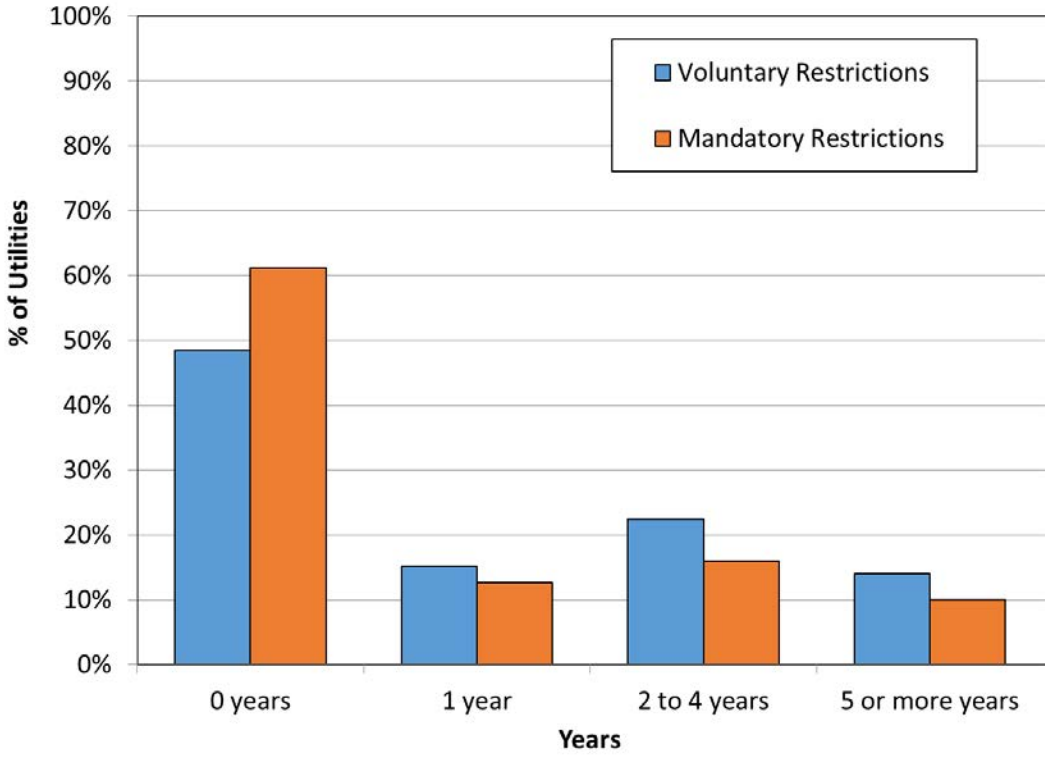

Figure 19. Responses from utility employees regarding how many years in the last decade their utilities implemented either voluntary or mandatory water restrictions (*n* = 593)

To understand the state of water shortage preparedness, staff members were asked, "Does your utility have a drought management or water shortage contingency plan?" The responses summarized in Figure 20 reveal that ~77% of utility respondents indicated their utility had such a plan or that one was in development. Twenty-two percent of respondents reported their utility did not have a drought management or water shortage contingency plan, down from 25% in 2016.

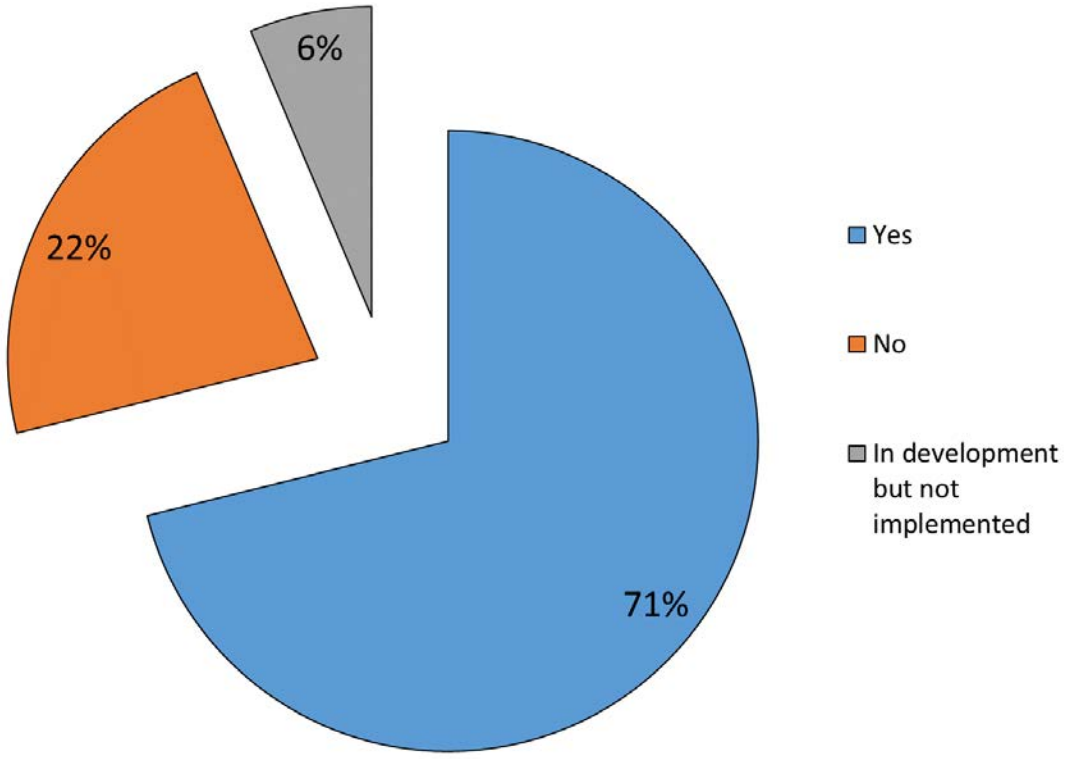

Figure 20. Responses from utility personnel regarding if their utility has a drought management or water shortage contingency plan (*n* = 627)

As communities evaluate their water shortage preparedness, it is also an opportunity to gain an overall better understanding of regional water supply sustainability and potential relationships with other large water users. In addition to reliability during water shortages, utilities and the communities they serve can also evaluate and/or determine their policies and practices for water conservation and alternative water supplies such as desalination of brackish groundwater or seawater, nonpotable reuse, potable reuse, and stormwater capture and reuse—these issues are explored in the following sections.

Water Conservation

A common perception of water conservation is that it only entails restricting or curtailing customer use as a temporary response to drought. Although water restrictions can be a useful short-term drought management tool, most utility-sponsored water conservation programs emphasize lasting long-term improvements in water use efficiency while maintaining quality of life standards. Water conservation, very simply, is doing more with less, not doing without (AWWA 2006).

In order to understand the status of conservation planning at water utilities, staff members were asked if their utilities have water conservation programs. The responses summarized in Figure 21 show that the majority of respondents' utilities have a water conservation program (68%), with an additional 6% reporting their utilities' plans are in development. Surprisingly, 26% of respondents reported their utility did not have a water conservation program, down from 28% of responding utilities in 2016.

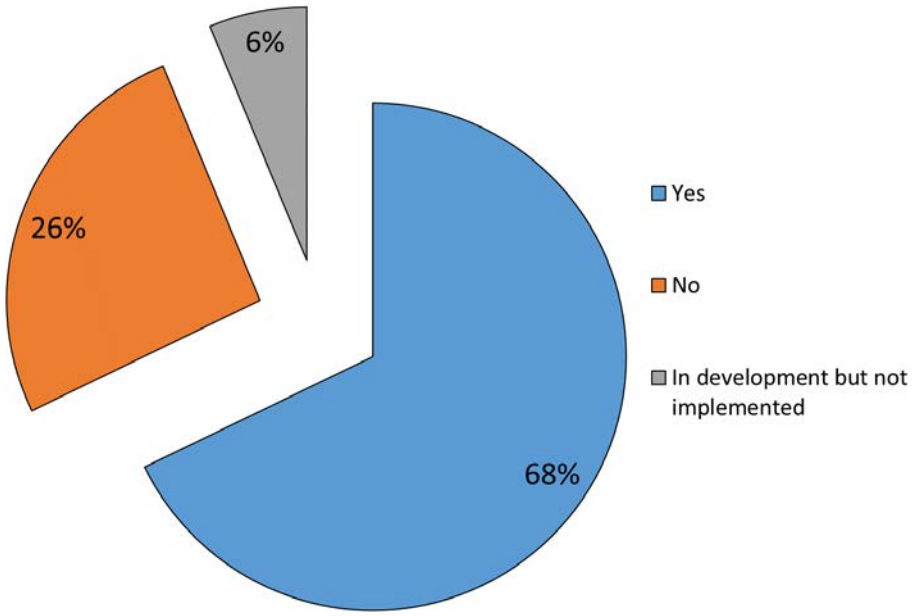

Figure 21. Responses from utility personnel regarding if their utility has a water conservation program (*n* = 656)

Desalination

In addition to water conservation, another non-traditional source of water supply is seawater or brackish groundwater. Utility participants were asked if their utilities were considering desalination of either brackish groundwater or seawater to augment existing drinking water supplies. Of the 459 responses, 11% responded that their utility is considering some sort of desalination project, while 6% responded that their utility currently already has something implemented.

Climate Change

For the water industry, potential outcomes of climate change include increasing temperatures/increasing evaporation rates, changing precipitation patterns (frequency, duration, and intensity), changing patterns of extreme weather events, and rising sea levels. Taken separately or in combination, these phenomena can result in the following challenges for the water industry:

- Degraded water quality and subsequent treatment challenges
- Reduced snowpack and groundwater recharge
- Stormwater management challenges
- Coastal flooding from increased sea level and/or storm surges
- Saltwater intrusion into coastal aquifers
- Increased frequency, duration, and extent of floods, droughts, and wildfires
- Loss of wetlands and coastal ecosystems
- Increased risk to infrastructure (at surface and underground)

To better understand the cascading consequences of potential climate change outcomes, water managers need an expanded information base and reliable models. They must make informed decisions under uncertain conditions to reduce vulnerabilities. The development of contingency and energy management

plans can address a wide range of climate scenarios, and such comprehensive planning efforts can lead to recommendations on water supply scenarios and related pricing strategies. However, managers also need better approaches that incorporate downscaled global climate model results into regional and local water utility planning.

Through the SOTWI survey, utility personnel were asked, "Does your utility include potential impacts from climate variability in your risk management or planning processes?" Forty-five percent of utility personnel responded that their utilities do not include potential impacts from climate variability in their risk management or planning processes, down from 51% in 2016. Forty-one percent responded that planning at their utilities includes climate change effects, up from 37% in 2016. The remaining 14% of respondents indicated their utility is in the process of including climate change in their planning processes. Viewed another way, more than half of utility personnel responding to the 2017 SOTWI survey indicated their utility was including potential climate change effects in their planning or risk management activities.

Water Reuse

Water supplies in some regions are strained, and systems in these areas are looking to meet the demands of new development, shortages from droughts, or ecological imperatives. The options for utilities and their communities to consider on the demand-side of the water balance equation include increased conservation efforts, restrictions, and improving water loss control. On the supply side, the use of reclaimed water can significantly reduce the demands placed on more conventional water supplies.

Reclaimed water properly treated to appropriate standards may serve as a sustainable supplement to a utility's water supply portfolio. Depending on the levels of treatment and safeguards to protect public health, reclaimed water can be used for nonpotable uses, including irrigation or industrial use; for indirect potable uses such as replenishing drinking water sources, maintaining aquifer levels, or increasing stream flow; and potentially for direct potable reuse.

In order to better understand the current status of water reuse in North America, utility staff members were asked if their utilities are considering any forms of reuse; the specific questions were as follows:

- *Is your utility considering nonpotable reuse to augment existing irrigation water supplies?*
- *Is your utility considering indirect potable reuse to augment existing drinking water supplies?*
- *Is your utility considering direct potable reuse to augment existing drinking water supplies?*

Figure 22 shows that the majority of utility personnel responded that their utilities are not considering any form of reuse. Of these reuse options, nonpotable reuse to augment irrigation was the most popular option with 16% of utility respondents reporting their utility already has something implemented, and 18% responded their utility was considering it; 7% responded that a nonpotable project was in development at their utility but not yet implemented.

Figure 22 also shows that 2% of utility respondents reported their utility already had an indirect potable system in place while another 13% are reportedly considering it; 6% responded that an indirect potable project was in development at their utility but not yet implemented. Approximately 1% of utility respondents reported their utility already had a direct potable system in place while another 9% are reportedly considering it; 3% responded that a direct potable project was in development at their utility but not yet implemented.

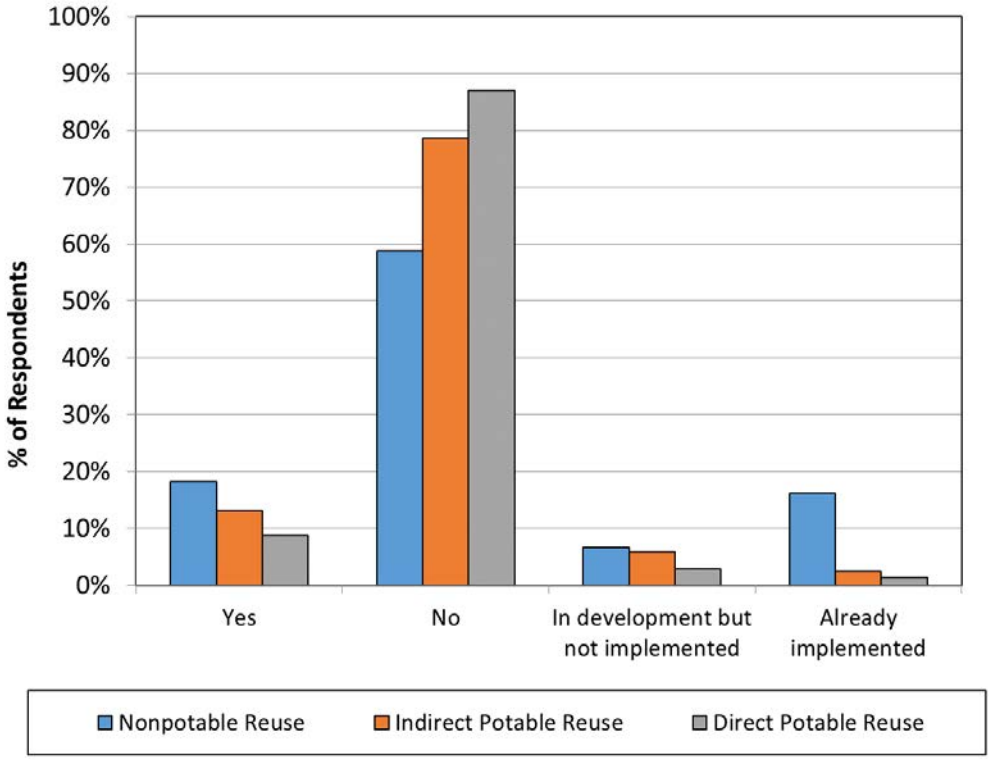

Figure 22. Responses from utility employees regarding if their utilities are considering nonpotable reuse, indirect potable reuse, or direct potable reuse to augment existing water supplies (*n* = 562)

In addition to domestic wastewater reclamation, several utilities have explored capturing, treating, and reusing stormwater specifically to augment potable water supplies. Figure 23 shows that of the 548 responses collected through the 2017 SOTWI survey in this area, 10% responded that their utilities are considering a stormwater reuse project while approximately 2% responded that their utilities already have something implemented and another approximately 3% responded that their utilities currently have something in development.

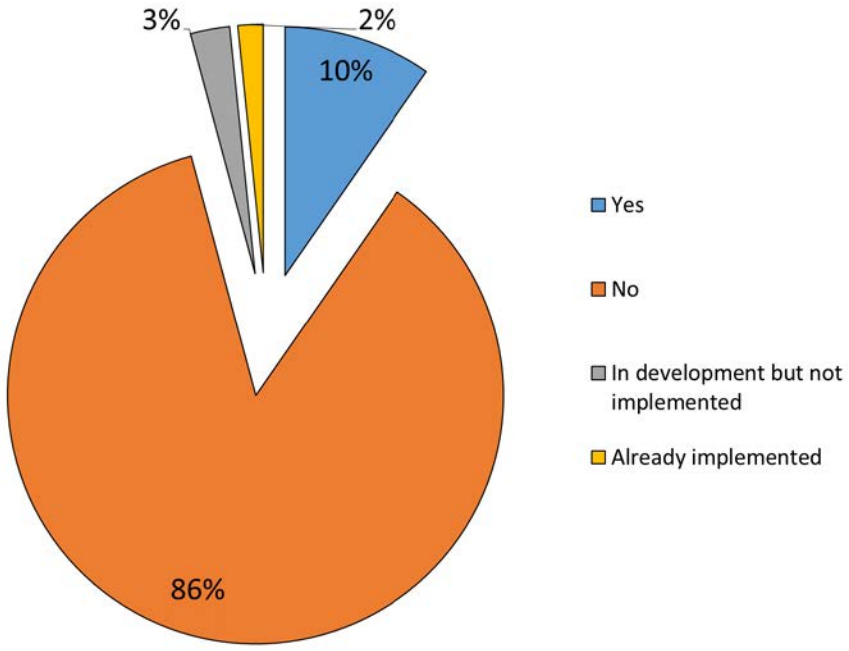

Figure 23. Responses from utility employees regarding if their utilities are considering collecting stormwater to augment existing water supplies (*n* = 548)

Communication

Results of the 2017 SOTWI survey highlight the industry's concern over communicating with stakeholders, in particular regarding the public's understanding of their water systems and resources (the #4 and #5 most important issues in Table 4, respectively). In addition, the need for communities to invest in their water systems, and ultimately for their customers to pay for these investments, is captured in the #9 most important issue, namely, public acceptance of future water and wastewater rate increases.

Effectively communicating infrastructure and water supply challenges to customers and key decision makers is vital, and the water industry has tried collectively to inform the public of the value of water services and resources for decades. However, local efforts to communicate with community stakeholders are key, so while tools and common messaging are important, it is the local connections that ultimately determine the success of any awareness campaign.

To explore the perceptions of communication with various groups, the 2017 SOTWI survey asked all study participants to rate the understanding of the following groups on a scale of 1 to 5, where 1 = "very poor" and 5 = "very good":

- General public
- Residential customers
- Nonresidential customers (industrial/commercial/institutional)
- Public officials
- Media

The specific questions asked were:

- *For non-utility personnel: How would you rate the effectiveness of the water industry's communication or outreach to the following groups?*
- *For utility personnel: How would you rate the effectiveness of your utility's communication or outreach to the following groups?*

The results presented in Figure 24 show that non-utility personnel think the water industry's communication with most of the groups identified is at least somewhat effective. Non-utility respondents felt that communication with state/local regulators was the most effective of the groups rated with 52% relaying that communication with state/local regulators was either good (31%) or very good (13%). Communication with federal regulators was ranked second in terms effectiveness, followed by communication with public officials. The least effective communication was reported for youth, with 60% responding that communication with youth was either poor or very poor. Communication with the media and the general public were also felt to be relatively ineffective in comparison to other groups.

The results presented in Figure 25 show that utility personnel think their utilities' communication with any of the groups identified is generally better than the industry in general. Utility respondents felt that communication with state/local regulators was the most effective of the groups rated, with 58% relaying communication with these regulators was either good (33%) or very good (25%). Communications with federal regulators were second in terms effectiveness, followed by public officials. As with non-utility personnel, utility workers felt the least effective communication was with youth, with 37% responding communication with youth was either poor or very poor. Communication with the media and the general public was also felt to be relatively ineffective in comparison to other groups.

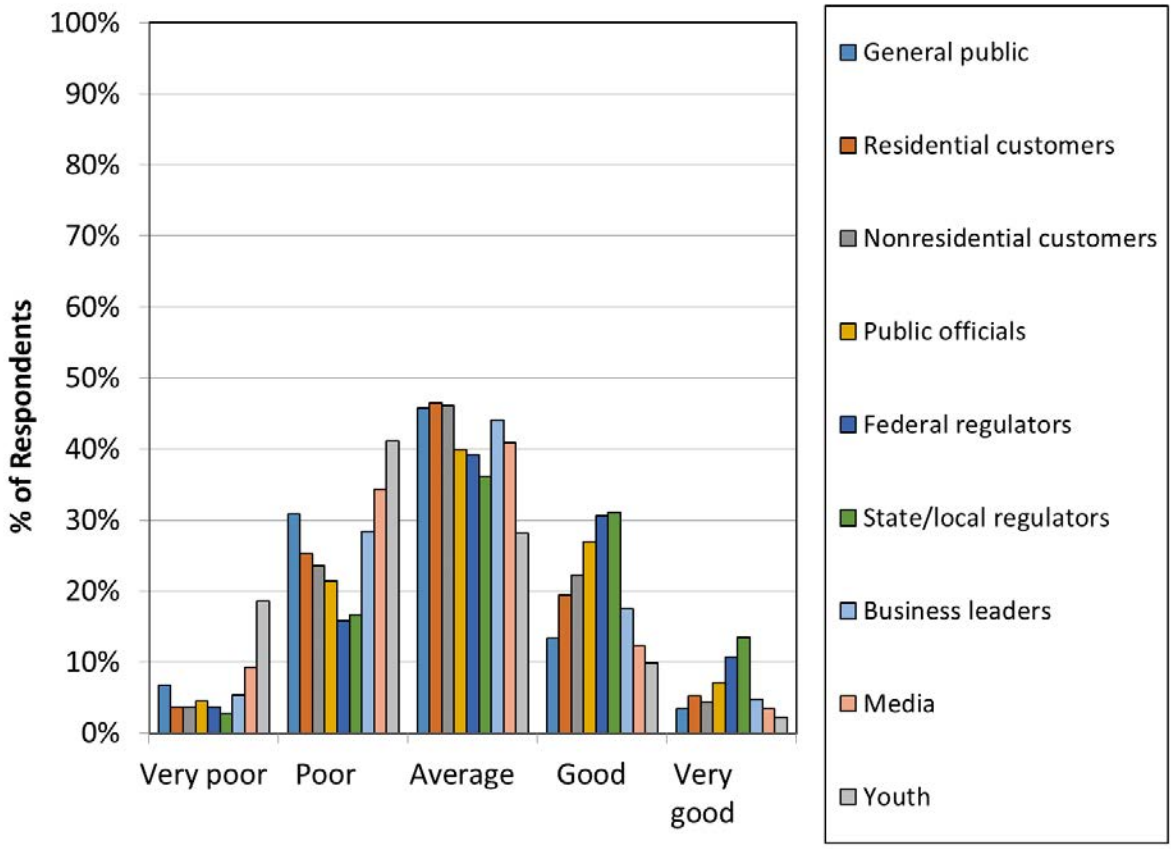

Figure 24. Non-utility worker perceptions of the effectiveness of the water industry's communication or outreach to various groups (*n* = 727)

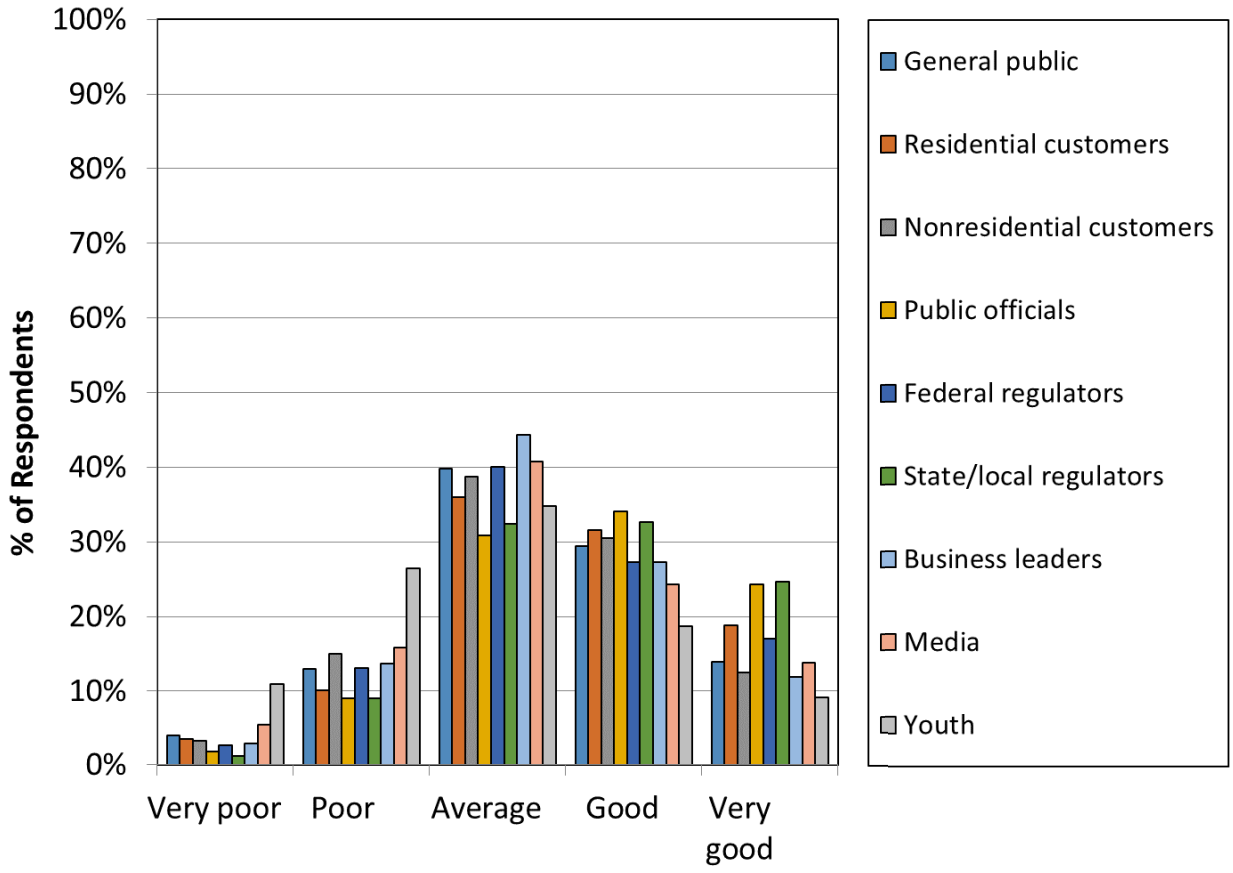

Figure 25. Utility worker perceptions of their utilities' effectiveness at communication or outreach to various groups (*n* = 707)

The water industry needs public support in order to effectively manage its systems and resources. Utility leaders often face a difficult challenge as they explain their systems' needs, the associated costs, and the way these costs are balanced equitably through rate structures and financing plans. If the groups identified in Figures 24 and 25 are unaware of the value of water systems and the cost of maintaining them, public officials may be less willing to support necessary investments—and associated rate increases—for fear of losing constituent support.

Regulations

The importance of current and future regulatory compliance were not as highly rated in the 2017 SOTWI survey as in past years. Referring to Table 4, "Compliance with current regulations" was rated #20 in importance and "Compliance with future regulations" was rated #21 in the current survey. The reasons regulatory compliance was not as highly rated this year are not readily apparent, but those utilities that are out of compliance or expect to be in the future will need to address all necessary changes to ongoing and future planning, treatment, and monitoring—all of which can result in increased operations and maintenance (O&M) costs and capital needs.

All survey participants were asked about their levels of concern regarding the water industry's ability to comply with current regulations, and their responses are summarized in Table 9. Scores are on a scale of 1 to 5, where 1 = "not at all concerned" and 5 = "extremely concerned." Current regulations regarding

chemical spills and point source pollution were the top two concerns identified from 2015–2017, but per- and polyfluoroalkyl substances such as PFOA and PFOS have moved up from past years. It is interesting that lead and copper regulations remained somewhat low on this list considering the high-profile lead event in Flint, Mich., that came to prominence in late 2015.

Table 9. Current regulatory concerns of the water industry (*n* = 1,124)

Rank	Current Regulatory Concern	Score	% Ranked Extremely Concerned
1	Point source pollution	3.16	14%
2	Chemical spills	3.15	15%
3	Per- and polyfluoroalkyl substances such as PFOA and PFOS	3.05	11%
4	Pathogens	3.03	12%
5	Disinfection by-products	3.01	12%
6	Lead and copper	2.99	12%
7	Radionuclides	2.98	13%
8	Combined sewer overflows	2.89	11%

In addition, all survey participants were asked about their concern over compliance with potential future regulations, and their responses are summarized in Table 10. Scores are on a scale of 1 to 5, where 1 = "not at all concerned" and 5 = "extremely concerned." As in 2015 and 2016, the 2017 SOTWI survey results show the most concern over future regulation of pharmaceuticals and hormones, security and preparedness, and nonpoint source pollution.

Table 10. Future regulatory concerns of the water industry (*n* = 970)

Rank	Future Regulatory Concern	Score	% Ranked Extremely Concerned
1	Pharmaceuticals and hormones	3.42	20%
2	Security and preparedness (cyber, physical, and emergency response)	3.30	15%
3	Nonpoint source pollution	3.23	14%
4	Lead and copper	3.18	17%
5	Per- and polyfluoroalkyl substances such as PFOA and PFOS	3.14	15%
6	Unknown chemical or hydrocarbon spills	3.11	14%
7	Disinfection by-products	3.11	12%
8	Point source pollution	3.08	13%
9	Cyanotoxins	3.06	12%
10	Chloramines	2.99	12%
11	Hexavalent chromium	2.99	11%
12	Combined sewer overflows	2.96	11%
13	Volatile organic compounds (VOCs)	2.95	9%
14	Perchlorate	2.94	10%
15	*Legionella*	2.93	11%
16	Chemical storage tanks	2.92	11%
17	*Naegleria fowleri*	2.92	10%
18	Arsenic	2.82	11%
19	NDMA and other nitrosamines	2.78	8%
20	Radionuclides	2.71	7%
21	Chlorate	2.68	7%
22	Manganese	2.67	7%
23	Selenium	2.63	7%
24	Vanadium	2.62	7%
25	Fluoride	2.61	9%
26	Molybdenum	2.60	7%
27	Strontium	2.56	6%

Workforce Issues

Workforce issues continue to be a concern the water industry with "Aging workforce/anticipated retirements" rated as #12, "Talent attraction and retention" rated as #14, and "Certification and training" rated as #23 among the most important issues. The water industry seems to continuously face difficulty in recruiting, training, and retaining skilled employees, especially for small systems. Likewise, a large number of water industry employees are nearing or are currently eligible for retirement; this group represents a significant amount of institutional knowledge that could be lost without proper succession planning and process documentation.

All 2017 SOTWI participants were asked "Overall, how prepared do you think the water sector is to address issues related to talent attraction and retention in the next five years?" Their responses are summarized in Figure 26. Only 1% of 2017 SOTWI respondents indicated that the water industry was fully prepared to address issues related to talent attraction and retention in the next five years, the same percentage going back to 2014. The challenge of talent attraction and retention is highlighted by the 17% of respondents who thought the industry is not at all prepared (compared with 12% in 2016) and the 37% who thought it was only slightly prepared (compared with 32% in 2016); although the trend is moving in a positive direction, there remains plenty yet to do. In summary, 54% of respondents have a negative perception of the water industry's preparation for talent attraction and retention.

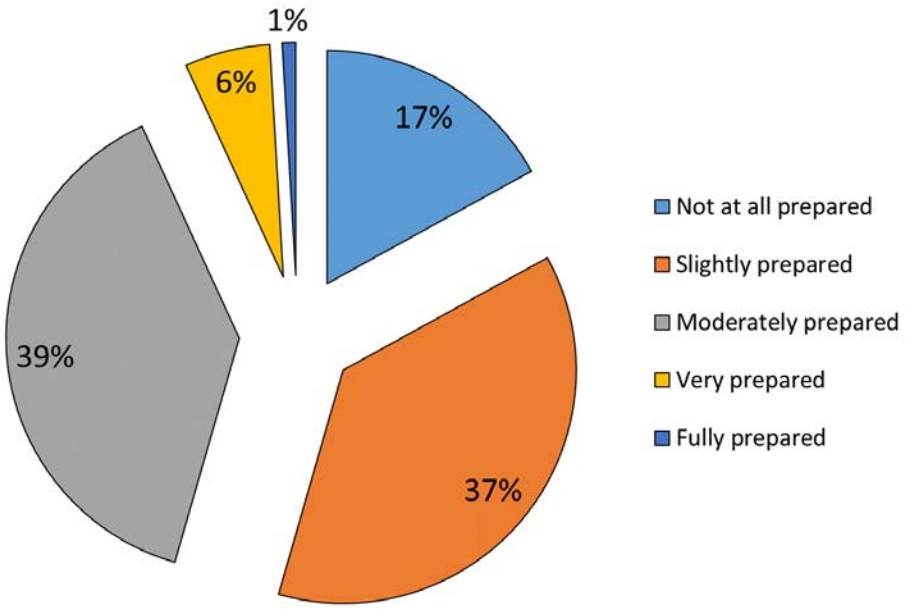

Figure 26. Responses from all SOTWI survey participants regarding how prepared they thought the water sector is to address issues related to talent attraction and retention in the next five years (*n* = 1,401)

All 2017 SOTWI participants were asked, "Overall, how prepared do you think the water sector is to cope with any expected retirements in the next five years?" The summary of responses provided in Figure 27 reveals that just 1% of respondents indicated that the water industry was fully prepared to cope with any expected retirements in the next five years, while 13% thought the industry was not at all prepared and

34% thought it was only slightly prepared. In summary, almost 50% of respondents have a negative perception of the water industry's preparation for retirement (slightly or not at all prepared).

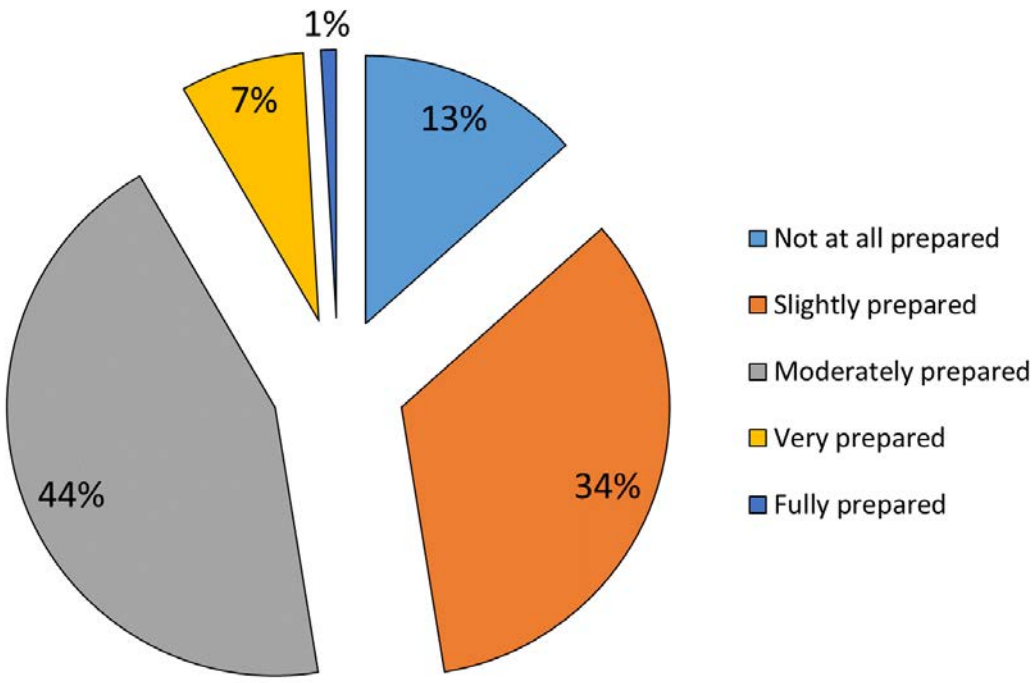

Figure 27. Responses from all SOTWI survey participants regarding how prepared they thought the water sector is to cope with any expected retirements in the next five years (*n* = 1,402)

Finally, all 2017 SOTWI participants were asked, "Overall, how prepared do you think the water sector is to address issues related to certification and training in the next five years?" Responses are provided in Figure 28. The majority of respondents (82%) indicated that the water industry was at least moderately prepared to address issues related to certification and training in the next five years, which is down from 85% who responded this way in 2016. Roughly 19% of respondents have a negative perception of the water industry's preparation for certification and training (slightly or not at all prepared), which is up significantly over the 14% who felt this way in 2016.

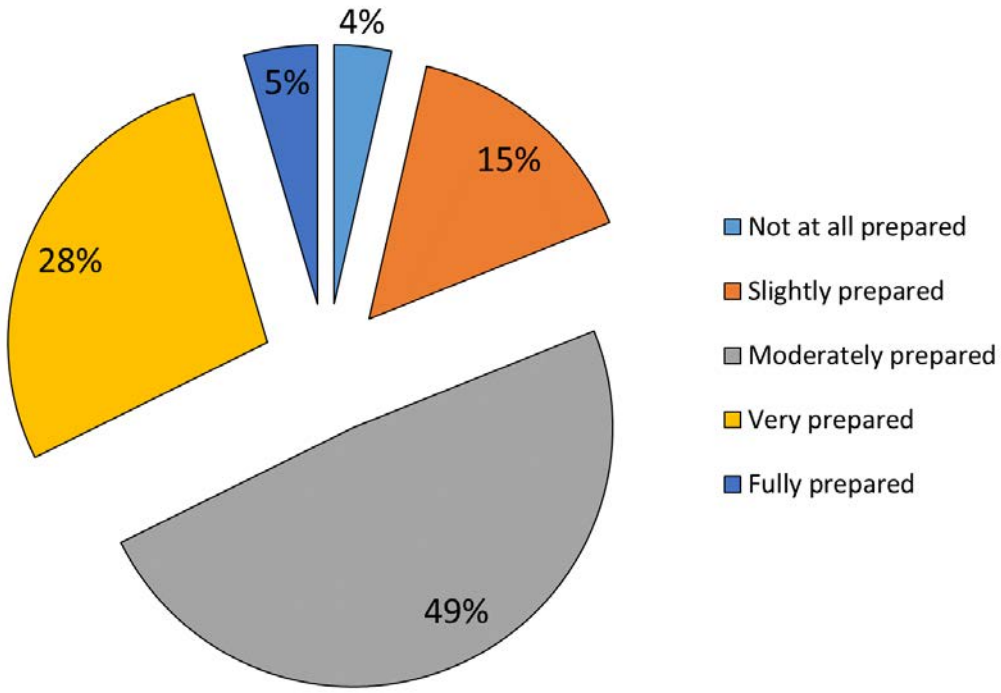

Figure 28. Responses from all SOTWI survey participants regarding how prepared they thought the water sector is to address issues related to certification and training in the next five years (*n* = 1,374)

Other Issues

Big Data

As we progress further into the era of "big data" or the internet of things, water and wastewater utilities have the ability to collect and analyze large quantities of information about their systems and customers. In order to understand where big data strategies and associated data mining were taking root, utility staff members were asked the following questions. Results are shown in Figure 29:

- *Is your utility using data mining techniques to better understand its customers?*
- *Is your utility using data mining techniques to better understand its water and/or wastewater system?*

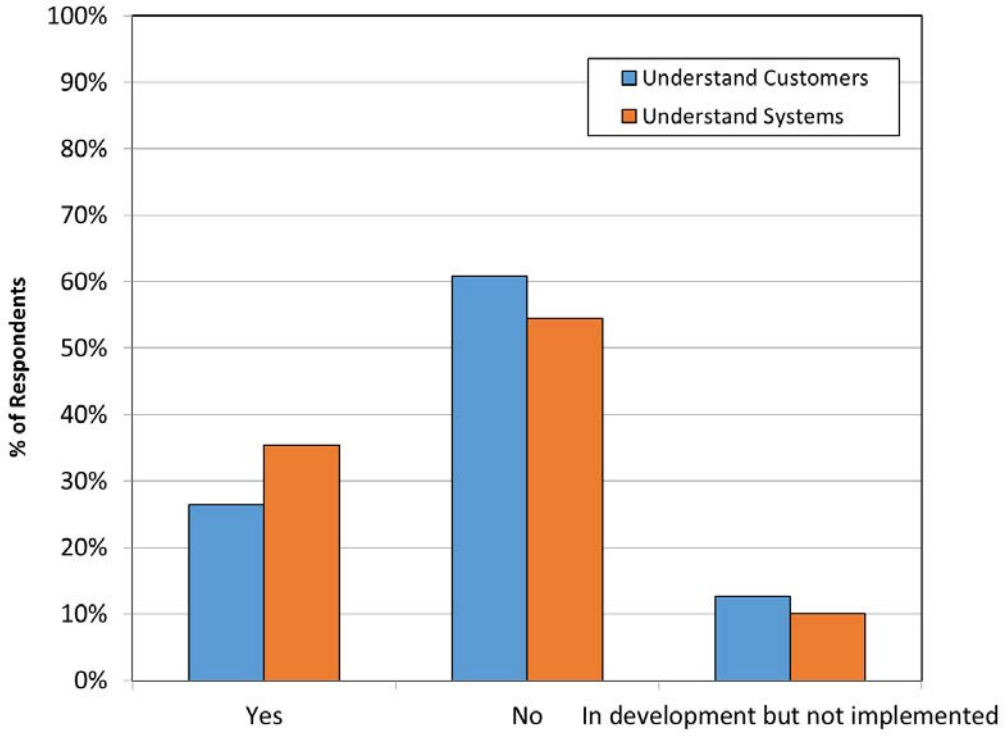

Figure 29. Responses from utility employees regarding how their utility is using data mining (*n* = 536)

As Figure 29 shows, more utilities appear to be using their big data strategies/data mining techniques to better understand their water and/or wastewater system (35%) in comparison to those using data mining techniques to better understand their customers (26%). With regard to utilities with a big data strategy in development, an almost equal percentage of respondents reported their utilities would be developing data mining techniques to better understand their water and/or wastewater system (10%) as those who plan to use data mining techniques to better understand their customers (13%).

Large-Scale Phenomena

In order to understand the potential impacts of several large-scale phenomena on the water industry, all SOTWI survey participants were asked to rank a list of macro-issues using the following scale:

(1) Significant negative impact
(2) Slight negative impact
(3) No impact at all
(4) Slight positive impact
(5) Significant positive impact

Table 11 provides a ranking of the large-scale phenomena provided to participants and a differential, which is the average score minus 3. A score of 3 is the median potential score reflecting no impact, while a positive differential indicates a positive impact and a negative differential indicates a negative impact. These results show that water industry professionals think housing markets will have a slight positive impact and business/industrial activities will have a neutral effect on the industry. On the other hand, political

instability, terrorism, and pollution are expected to have the greatest negative impacts; this was the same as the group of responses in 2016.

Table 11. Potential impacts to water industry from large-scale phenomena (*n* = 1,179)

Rank	Category	Score (median = 3)	Differential*
1	Housing markets	3.01	0.01
2	Business/industrial activities	3.00	0.00
3	Bond markets	2.99	-0.01
4	Stock markets	2.86	-0.14
5	Urbanization	2.85	-0.15
6	Unemployment	2.74	-0.26
7	Agriculture	2.61	-0.39
8	Energy costs	2.56	-0.44
9	Population growth	2.51	-0.49
10	Social instability	2.46	-0.54
11	Climate change/extreme weather events	2.45	-0.55
12	Inflation	2.42	-0.58
13	Labor costs	2.37	-0.63
14	War	2.34	-0.66
15	Chemical costs	2.32	-0.68
16	Political instability	2.31	-0.69
17	Terrorism	2.27	-0.73
18	Pollution	2.17	-0.83

***A positive differential indicates a positive impact, a differential of 0 means no impact, and a negative differential indicates a negative impact.**

PART 4 – CONCLUSIONS

Water is a vital component for all societies, and continuous access to safe and sufficient drinking water is a primary characteristic that distinguishes developed from undeveloped countries. For over a century, North America's water industry, which includes potable water, wastewater, reuse, and stormwater, has increased its technical, managerial, and financial proficiency while improving public health and environmental protection. While some systems still struggle to meet the expectation of continuous safe drinking water and clean water discharges, the majority of utilities in North America are effectively dealing with issues of system and resource stewardship; however, one area where they continue to struggle is in how best to communicate the ongoing and wide-ranging needs in these areas.

The overall successes of water professionals should continue to be a source of pride and inspiration; however, the current SOTWI survey highlights several important challenges, including the costs of system stewardship, water resource development and protection, and effective stakeholder communication. In addition to facing these mostly long-term problems, shorter-term water shortages related to drought and localized source water protection issues such as chemical spills continue to challenge watersheds across North America.

What can we make of the observation that the current health of the industry is at the lowest recorded level since the survey began in 2004? Last year was certainly a tumultuous one in North America with regard to

water issues such as lead service line replacement, ongoing and new droughts, Legionella outbreaks, etc., so a small decline was to be expected. Still, the long-term negative trend going back almost two decades (a 12% decrease) is troubling, and the underlying causes are not immediately clear. Perhaps this slight pessimism is an offshoot of a growing sense of urgency that we are not adequately addressing our persistent infrastructure, water resource, and communication issues. Or perhaps it reflects a perceived lack of concern for these issues from the public, local governments, and ratepayers. Regardless, this is change the water industry needs to correct, and water leaders should take this trend as a call to action.

AWWA's annual SOTWI report is intended to serve as a foundation for action and further discovery. Water professionals need to continue to meet society's expectations for safe and clean water by developing and implementing solutions that solve ongoing and new challenges. The quality of water services in Canada, Mexico, and the United States remains consistently high, but the larger message that is repeated consistently throughout this report is that at the system level we must address our water infrastructure and resource management challenges or else the reliability and resiliency of our water systems, the health of our environment, the prosperity of our economy, and the safety of our water will be increasingly at risk.

The continued credibility of the water profession requires open and ongoing communication that establishes relationships and creates a framework for understanding, trust, and cooperation. AWWA will continue to serve as a bridge organization, uniting the worlds of science and research, policy, and practice to address the issues identified in this report. With more than 50,000 members and more than 3,000 volunteers, AWWA is the community for water professionals to create and exchange knowledge to solve the challenges before us.

If you participated in the 2017 SOTWI survey, the Association thanks you. If you wish to participate in the 2018 survey scheduled to occur in September 2018, please make sure your contact information is current or create an AWWA login at www.awwa.org.

REFERENCES

AWWA (American Water Works Association), 2014. Thinking Outside the Bill: A Utility Manager's Guide to Assisting Low-Income Water Customers. A study sponsored by the AWWA Water Utility Council. www.awwa.org/resources-tools/water-and-wastewater-utility-management/affordability.aspx (accessed Jan. 3, 2017).

AWWA, 2012. 2012 Buried No Longer Report. www.awwa.org/legislation-regulation/issues/infrastructure-financing.aspx (accessed Jan. 3, 2017).

AWWA, 2006 (1st ed.). Manual of Water Supply Practices, M52. *Water Conservation Programs—A Planning Manual*. AWWA, Denver.

RESOURCES

AWWA, 2016. 2015 Establishing the Level of Progress in Utility Asset Management, a survey conducted by the AWWA Asset Management Committee (AMC) and funded by the AWWA Technical & Educational Council.

USGS (US Geological Survey), 2014. Estimated Use of Water in the United States in 2010. Circular 1405, U.S. Department of the Interior, USGS. http://pubs.usgs.gov/circ/1405/ (accessed Jan. 3, 2017).

World Bank, 2016: http://databank.worldbank.org/data/reports.aspx (accessed Jan. 16, 2017).

APPENDIX 1 – 2017 State of the Water Industry Survey

AWWA annually surveys water professionals to gauge their perceptions of the industry and to identify and track significant trends. This survey should take 10 to 20 minutes to complete. Individual responses are held strictly confidential. Thanks in advance for your contribution to this collective effort and for supporting AWWA's mission to provide solutions to effectively manage water, the world's most important resource.

Q*: In which one of the following states or territories do you work most often (grouped by country: Canada, U.S., Mexico)? If outside of North America please enter the country in the space provided.

Outside of North America - please specify:

Q: Which one of the following best describes the type of organization you work for?**

1. Drinking water utility
2. Wastewater utility
3. Combined water/wastewater utility (may include other services too)
4. Water wholesaler
5. Reuse/reclamation utility
6. Stormwater utility
7. Consulting firm/consultant
8. Manufacturer of products
9. Manufacturer's representative
10. Distributor
11. Technical services/contractor
12. Regulatory authority/regulator
13. Non-utility government (municipal, federal, etc.)
14. University/educational institution
15. Laboratory
16. Financial industry (ratings agency, investor/fund rep., etc.)
17. Law firm/attorney
18. Nonprofit organization
19. Retired
20. Other (please specify)

Q: In your opinion, what is the current overall state of the water industry?
1 = Not at all sound 2 3 4 5 6 7 = Very sound

Q: Looking forward, how sound will the overall water industry be five years from now?
1 = Not at all sound 2 3 4 5 6 7 = Very sound

Q: In your opinion, what is the current state of the water industry in the region where you work most often?
1 = Not at all sound 2 3 4 5 6 7 = Very sound

Q: Looking forward, how sound will the water industry be five years from now in the region where you work most often?
1 = Not at all sound 2 3 4 5 6 7 = Very sound

Q: Please rate the importance of the following industry challenges on a scale of 1 (unimportant) to 5 (critically important). [page 1 of 3]

1 = Unimportant, 2 = Slightly important, 3 = Important, 4 = Very important, 5 = Critical, No opinion/don't know

PAGE 1

1. Financing for capital improvements
2. Improving customer, constituent, and community relationships
3. Expanding water reuse/reclamation
4. Aging workforce/anticipated retirements
5. Public understanding of the value of water systems and services
6. Watershed/source water protection
7. Data management
8. Water conservation/efficiency
9. Water rights
10. Financing for water research

PAGE 2

11. Long-term water supply availability
12. Public understanding of the value of water resources
13. Groundwater management and overuse
14. Energy use/efficiency and cost
15. Renewal & replacement of aging water and wastewater infrastructure
16. Emergency preparedness
17. Asset management
18. Climate risk and resiliency
19. Water loss control
20. Water quality issues from premise plumbing systems

PAGE 3

21. Drought or periodic water shortages
22. Talent attraction and retention
23. Certification and training
24. Public acceptance of future water and wastewater rate increases
25. Governing board acceptance of future water and wastewater rate increases
26. Cost recovery (pricing water to accurately reflect the cost of service)
27. Compliance with current regulations
28. Compliance with future regulations
29. Physical security issues
30. Cyber-security issues

Any others rating at least "very important" but not listed (please specify):

Q: How would you rate the effectiveness of the water industry's communication or outreach to the following groups?

1 = Very poor, 2 = Poor, 3 = Average, 4 = Good, 5 = Very good, Don't know

1. General Public
2. Residential Customers
3. Nonresidential Customers (industrial/commercial/institutional)
4. Public Officials
5. Federal Regulators
6. State/Local Regulators
7. Business Leaders
8. Media
9. Youth

Q: Infrastructure renewal and replacement (R&R) encompasses several issues; how would you rate the importance of the following areas with regards to the challenge of renewing or replacing aging water and wastewater infrastructure? [page 1 of 2]

1 = Unimportant, 2 = Slightly important, 3 = Important, 4 = Very important, 5 = Critical, Don't know

1. Justifying R&R programs to oversight bodies (board, council, etc.)
2. Justifying R&R programs to ratepayers
3. Obtaining R&R funding via bonds
4. Obtaining R&R funding involving public–private partnerships
5. Obtaining R&R funding via federal, state, or territorial loans
6. Obtaining R&R funding via federal, state, or territorial grants
7. Obtaining R&R funding by taxation (e.g., property taxes)
8. Pay-as-you-go R&R funding
9. Establishing and following a financial policy for capital reinvestment
10. Establishing and maintaining specific R&R reserves
11. Addressing declining water sales
12. Developing/implementing asset management programs
13. Defining appropriate levels of service
14. Prioritizing R&R needs
15. Coordinating R&R with other activities (e.g., road repair, redevelopment, etc.)

Any others rating at least "very important" but not listed (please specify):

Q: Overall, how prepared do you think the water sector is to address issues related to certification and training in the next five years?
1 = Not at all prepared, 2 = Slightly prepared, 3 = Moderately prepared, 4 = Very prepared, 5 = Fully prepared, No opinion/don't know

Q: Overall, how prepared do you think the water sector is to cope with any expected retirements in the next five years?
1 = Not at all prepared, 2 = Slightly prepared, 3 = Moderately prepared, 4 = Very prepared, 5 = Fully prepared, No opinion/don't know

Q: Overall, how prepared do you think the water sector is to address issues related to talent attraction and retention in the next five years?
1 = Not at all prepared, 2 = Slightly prepared, 3 = Moderately prepared, 4 = Very prepared, 5 = Fully prepared, No opinion/don't know

Q: How concerned are you over the ability of the water sector to comply with current regulations in the following areas?
1 = Not at all concerned, 2 = Slightly concerned, 3 = Moderately concerned, 4 = Very concerned, 5 = Extremely concerned, Don't know

1. Lead and copper
2. Per- and polyfluoroalkyl substances such as PFOA and PFOS
3. Arsenic
4. Disinfection byproducts
5. Radionuclides
6. Combined sewer overflows
7. Point source pollution
8. Chemical spills
9. Pathogens

Any others rating at least "very concerned" but not listed (please specify):

Q: How concerned are you about future water sector regulations in the following areas? [page 1 of 3]
1 = Not at all concerned, 2 = Slightly concerned, 3 = Moderately concerned, 4 = Very concerned, 5 = Extremely concerned, No opinion/don't know

1. Lead and copper
2. Perchlorate
3. Hexavalent chromium
4. Chloramines
5. Fluoride
6. Pharmaceuticals and hormones
7. Per- and polyfluoroalkyl substances such as PFOA and PFOS
8. Arsenic
9. *Naegleria fowleri*

10. Disinfection by-products
11. Volatile organic compounds (VOCs)
12. Security and preparedness (cyber, physical, and emergency response)
13. Radionuclides
14. Vanadium
15. Molybdenum
16. Selenium
17. Manganese
18. Cyanotoxins

19. Strontium
20. Chlorate
21. NDMA and other nitrosamines
22. Combined sewer overflows
23. Legionella
24. Point source pollution
25. Nonpoint source pollution
26. Chemical storage tanks
27. Unknown chemical or hydrocarbon spills

Any others rating at least "very concerned" but not listed (please specify):

Q: What impact (positive or negative) do you think the following large-scale phenomena will have on the overall water industry in 2016? [page 1 of 2]
1 = Significant negative impact, 2 = Slight negative impact, 3 = No impact at all, 4 = Slight positive impact, 5 = Significant positive impact, Don't know

1. Unemployment
2. Housing markets
3. Stock markets
4. Bond markets
5. Business/industrial activities
6. Energy costs
7. Agriculture
8. Political instability
9. Social instability
10. Inflation
11. Population growth
12. Climate change/extreme weather events
13. Terrorism
14. War
15. Pollution
16. Urbanization
17. Chemical costs
18. Labor costs

Any others with significant impact but not listed (please specify):

Identifying Information

Q: What is your age?

- Younger than 25
- 25-34
- 35-44
- 45-54
- 55-64
- 65 and older
- Prefer not to answer

Q: What is your gender?

- Male
- Female

Q: What is the highest level of education you completed?

- Did not complete high school
- High school/GED
- Some college
- Associate's degree
- Bachelor's degree
- Master's degree
- Advanced graduate work or Ph.D.

Q: Which race/ethnicity best describes you? (Please choose only one.)

- American Indian or Alaskan Native
- Asian/Pacific Islander
- Black/Non-Hispanic
- Hispanic or Latino
- White/Non-Hispanic
- Multiple ethnicity/Other

End for non-utility career groups; the following question-sets are provided to the submitters based upon the answer to Q.**

- -

The following questions refer specifically to the utility you work for.

Q: Is the utility you work for publicly or privately owned?
1 = Publicly owned, 2 = Privately/investor owned

Q: Please select your utility's number of connections (drinking water OR collection system). If your utility provides both water and wastewater services, use the service with the greater number of connections (drinking water OR collection system).

The number of connections can be estimated by (population served)/3.5. If possible, please include an estimate of the number of connections in areas receiving wholesale water service in this count.

- 0 to 3,000
- 3,001 to 10,000
- 10,001 to 25,000
- 25,001 to 50,000
- 50,001 to 100,000
- 100,001 to 150,000
- Over 150,000

Q: Is your utility currently able to cover the full cost of providing service(s), including infrastructure renewal & replacement and expansion needs, through customer rates and fees? 1 = Not at all able, 2 = Slightly able, 3 = Moderately able, 4 = Very able, 5 = Fully able, No opinion/don't know

Q: Given your utility's future infrastructure needs for renewal & replacement and expansion, do you think your utility will be able to meet the full cost of providing service(s) through customer rates and fees?
1 = Not at all able, 2 = Slightly able, 3 = Moderately able, 4 = Very able, 5 = Fully able, No opinion/don't know

Q: Which of the following best describes any trend in your utility's total water sales?

- Not applicable
- >10-year trend of declining total water sales
- <10-year trend of declining total water sales
- Flat or little change in total water sales
- <10-year trend of increasing total water sales
- >10-year trend of increasing total water sales
- No specific trend
- Don't know

Q: Which of the following best describes your utility's trend in per account water sales?

- Not applicable
- >10-year trend of declining per account water sales
- <10-year trend of declining per account water sales
- Flat or little change in per account water sales
- <10-year trend of increasing per account water sales
- >10-year trend of increasing per account water sales
- No specific trend
- Don't know

Q: How is your utility responding to its cost recovery needs in the face of changing water sales/consumption patterns? (Choose all that apply.)

1. Not applicable
2. No changes needed
3. Shifting more of the cost recovery from consumption-based fees to fixed fees within the rate structure
4. Shifting rate design to increasing-block rate structure
5. Shifting rate design to decreasing-block rate structure
6. Incorporating seasonal rates
7. Changes in growth-related fees (i.e., system development charges, impact fees, or capacity charges)
8. Revenue diversification
9. Increasing financial reserves
10. Implementing rate stabilization reserves
11. Don't know
12. Other (please specify)

Q: Is your utility considering or currently involved in a public–private partnership (P3)?

Not considering a P3 at this time
Considering a P3 but not committed
Planning to use a P3
Already involved in a P3
Don't know

Q: How would you rate the effectiveness of your utility's communication or outreach to the following groups?

1 = Very poor/none, 2 = Poor, 3 = Average, 4 = Good, 5 = Very good, Don't know

1. General public
2. Residential customers
3. Nonresidential customers (industrial/commercial/institutional)
4. Public officials
5. Federal regulators
6. State/local regulators
7. Business leaders
8. Media
9. Youth

Q: If your utility was to consider a rate increase in the coming year, how do you think it would be received by the following groups?

1 = Very negatively, 2 = Negatively, 3 = Indifferently, 4 = Positively, 5 = Very positively

1. General public
2. Residential customers
3. Nonresidential customers (industrial/commercial/institutional)
4. Public officials
5. Business leaders
6. Media

Q: Does your utility offer an affordability program to assist low-income customers pay their water and/or wastewater bills?
Yes
No
In development but not implemented
Don't know

Q: If you can make an assessment, how would you rate your utility's current access to financial capital?
Worse than any time in the past 5 years
As bad as any time in the past 5 years
Similar to most of the past 5 years
As good as any time in the past 5 years
Better than any time in the past 5 years
Can't assess/don't know

Q: Does your utility include potential impacts from climate variability in your risk management or planning processes?
Yes
No
In development but not implemented
Don't know

Q: **How prepared do you think your utility will be to meet its long-term water supply needs?**
Not at all prepared
Slightly prepared
Moderately prepared
Very prepared
Fully prepared
Don't know
Not applicable

Q: Does your utility have a water conservation program?
Yes
No
In development but not implemented
Don't know
Not applicable

Q: Does your utility have a drought management or water shortage contingency plan?
Yes
No
In development but not implemented
Don't know
Not applicable

Q: How many years in the last decade has your utility implemented voluntary water restrictions?
Drop down: 0, 1 year, 2-4 years, >5 years

Q: How many years in the last decade has your utility implemented mandatory water restrictions?
Drop down: 0, 1 year, 2-4 years, >5 years

Q: Is your utility considering desalination of either brackish groundwater or seawater to augment existing drinking water supplies?
Not applicable
Yes
No
In development but not implemented
Already implemented
Not possible (no brackish groundwater or seawater options)
Don't know

Q: Is your utility considering nonpotable reuse to augment existing irrigation or industrial water supplies?

Not applicable
Yes
No
In development but not implemented
Already implemented
Don't know

Q: Is your utility considering indirect potable reuse to augment existing drinking water supplies?
Not applicable
Yes
No
In development but not implemented
Already implemented
Don't know

Q: Is your utility considering direct potable reuse to augment existing drinking water supplies?
Not applicable
Yes
No
In development but not implemented
Already implemented
Don't know

Q: Is your utility considering urban stormwater recovery for nonpotable or potable reuse?
Not applicable
Yes
No
In development but not implemented
Already implemented
Don't know

Q: Is your utility using data mining techniques to better understand its customers?
Yes
No
In development but not implemented
Don't know

Q: Is your utility using data mining techniques to better understand its water and/or wastewater system?
Yes
No
In development but not implemented
Don't know

Thank you for participating in the 2017 State of the Water Industry Survey. Your answers will be submitted to AWWA by clicking the submit button below. To see past results, go to awwa.org and search for State of the Water Industry.

DeOreo & Mayer | http://dx.doi.org/10.5942/jawwa.2012.104.0080
Journal - American Water Works Association
PEER-REVIEWED

Insights into declining single-family residential water demands

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Water use, especially indoor use, in single-family residences has declined since 1995 and is expected to continue to do so as new technologies enter the market. This conclusion is unavoidable when empirical data from residential end use studies dating back to 1995 are compared. Furthermore, the observed declines in indoor use are not related to economic conditions—the bulk of the data used for the analysis were taken before the 2008 recession. This article presents key data and findings from a 16-year data collection effort and closely examines changes in water use over that time as well as the potential for additional residential demand reductions in the future. The demand data presented here show patterns in single-family indoor and outdoor demands and provide a basis for future water supply planning and conservation program design.

KEYWORDS: *end uses, models of residential water demand, residential, trends in residential water demands, water demands, water use*

This article summarizes end-use data from a series of single-family residential studies over time and compares indoor and outdoor water use in order to demonstrate how water use is changing and what these trends suggest for water planning. Utilities need to know how low household and per capita water demands are likely to fall and what factors affect these demands. The data offer some reliable relationships on the question of future water demands.

Water use in single-family residences has declined since 1995, and this trend is expected to continue as new technologies enter the market. These declines are not a result of the 2008 recession—the majority of the data were collected before the last quarter of 2008 when the recession began. The data show clear decreases in household and per capita indoor water use over time, and additional indoor demand reductions are likely as high-efficiency fixtures and appliances further saturate the market. Key findings of the analysis are summarized here.

- Indoor water use for a family of three was observed to decrease from 187 gpd per household in the Residential End Uses of Water Study (REUWS; Mayer et al, 1999) to 162 gpd per household in the California Single-family Water Use Efficiency Study (CSFWUES; DeOreo et al, 2011) and to 132 gpd per household in the New Single Family Home Study (NSFHS) prepared for the US Environmental Protection Agency (USEPA; DeOreo, 2011a). The end-use data for these studies were collected in 1996, 2007, and 2006, respectively.
- Data collected in 2002 and 2006 reported indoor water use for a family of three in two sets of homes that were modified by retrofits or by design to use less water dropped to 117 and 107 gpd per household, respectively (DeOreo, 2011a; Aquacraft, 2005).
- In the above referenced studies, the greatest reductions at the end-use level were seen in the toilet and clothes washer categories. Water use in other indoor categories was more variable (DeOreo, 2011a; DeOreo et al, 2011).
- Water use in categories such as leakage and excess irrigation tend to be skewed by a small number of homes with large use in these categories. Skewed use raises the average for the group as a whole, whereas most households used significantly less than the average.
- Finding ways of targeting and reducing excess use in these skewed end-use categories remains an important challenge for demand-management efforts (Aquacraft, 2011a, 2011b).
- Trends observed in the data strongly suggest that typical indoor household water use will decrease further in the coming years barring wholesale abandonment of the efficiency improvements developed over the past decade (Aquacraft, 2011a, 2011b).

These findings have important implications for water supply planning. If future demands are based on historic consumption patterns rather than new lower-demand patterns, raw water requirements will be overestimated and expensive, and potentially environmentally damaging new supply projects could be developed needlessly. Reduced residential indoor and outdoor demand is the payoff for years of water conservation efforts made by water utilities, conservation professionals, policymakers, and others. Unless these water demand reductions are accepted as permanent by water planners, the reductions will not have the benefits intended by the programs from which they arose.

FOUR KEY END-USE STUDIES

Since 1995 a methodology developed by the authors—flow trace analysis—and the analytic software they created have been used in major residential end-use studies. Data for this article were drawn from four key end-use studies (REUWS, USEPA Combined Retrofit Report [Aquacraft, 2005], NSFHS, and CSFWUES) conducted by the authors. These four studies provide water use information from five groups of homes based on the period from which they were sampled or types of fixtures and appliances in the home.

REUWS. Conducted for the Water Research Foundation, this baseline study (Mayer et al, 1999) collected water use data from 1,188 single-family homes served by 12 water agencies in the United States and Canada. These served by provide information on water use patterns circa 1996–97. Most of the homes in this study were constructed before implementation of the Energy Policy Act of 1992 (USDOE, 1992) and relatively few had installed newer, more water-efficient fixtures and appliances.

USEPA Combined Retrofit Report. This report (Aquacraft, 2005) measured indoor water use in 100 homes spread across three utilities before and after a high-efficiency fixture and appliance retrofit. Before the retrofit, the water use in these homes was similar to what was found in the 1999 REUWS. After the retrofit, indoor water use in these homes was reduced by more than 30%. The data for this study were collected between 2000 and 2002.

NSFHS. DeOreo (2011a) measured water use patterns in two groups: a randomly selected sample of 240 "standard" new homes drawn from nine participating utilities and a group of 36 new homes built to the WaterSense new home specification. This study comprised the following two groups.

- Standard new home group: Approximately 240 homes built after Jan. 1, 2001, were selected at random from nine water agencies in Arizona, California, Colorado, Florida, Nevada, Oregon, and Utah. These homes represent water use in new homes built to Energy Policy Act of 1992 standards or better. The data for the standard new homes were collected between 2006 and 2008.
- High-efficiency new home group: Water use patterns at 36 new homes built to meet the WaterSense new home specification (as of 2009), with the addition of a high-efficiency Energy Star–rated clothes washer, were studied in 2008 and 2009 (DeOreo et al, 2011). This sample is the most water-efficient group of homes the authors have studied to date.

CSFWUES. For this study (DeOreo et al, 2011), 780 single-family homes were chosen at random from the general population in 10 water agencies throughout California. These homes represent a snapshot of water use in existing homes circa 2007, approximately 10 years after the REUWS.

RESEARCH APPROACH

Each of the four end-use studies in this article focused on different groups of single-family homes but used similar research methods. Readers wanting a more detailed description of the methodology are referred to the study reports themselves, which also include discussion of accuracy and verification of the flow trace analysis as a method of disaggregating single-family water use into end uses.

- Each participating water agency provided one year of historic monthly or bimonthly billed consumption data from a random sample of single-family customers in its service areas. The annual water use of each sample was compared against the average annual use of the population from which each sample was drawn to verify that the samples were representative of their respective populations.
- A detailed mail survey was sent to each household in every sample to collect demographic, physical, and economic data for modeling and statistical analysis.
- A sample of homes was drawn from the survey respondents for more detailed analysis including flow recording by data loggers, disaggregation of water use into end uses, and landscape analysis.
- A database was prepared that included the annual and disaggregated water use for each study home, survey information, and weather data.

In these studies, water use was disaggregated into the following end-use categories: toilets, clothes washers, dishwashers, showers, baths, miscellaneous faucets, irrigation, leaks, and special uses such as evaporative coolers, water treatment, and pools. The flow trace analysis technique used for the disaggregation has been described in detail in previous studies (Mayer et al, 1999; Lewis, 1998; DeOreo et al, 1996a, 1996b); a detailed explanation and validation of the technique is beyond the scope of this article.

The analytic database developed for each study enabled a variety of computations and analyses to be completed. Water use event data can be summarized by any of the available parameters such as the average daily use by end-use category. The event data for individual fixtures were analyzed to determine number of uses, average volume per use, and percent of uses that are equal to or less than a specified benchmark value.

In these studies, flow trace data were typically limited to a single two-week period. Outdoor use from manual or automatic irrigation occurring during the logging period was identified and analyzed with respect to the use patterns during the logging period. Because of the high variability of outdoor use over the course of a year, a limited two-week snapshot cannot be used to estimate annual outdoor use. Therefore outdoor use was usually estimated for each household by taking the total annual water use from the billing data and subtracting the projected annual indoor use as determined from the two-week flow monitoring period. In some cases, billed consumption data were used to estimate indoor use using a minimum month or average winter consumption method, which was then subtracted from annual use to obtain an estimate for annual outdoor use.

By combining the datasets developed for each of these four end-use studies, the authors were afforded a unique and powerful tool for examining changes in both indoor and outdoor residential water use over the past 15 years. With these data, it was also possible to determine the percent of homes meeting specified efficiency benchmarks for end uses such as toilet flushing and automatic clothes washing. Outdoor use efficiency was characterized by comparing the depth of irrigation water applied to each landscape against the theoretical irrigation demands calculated for each landscape using locally obtained evapotranspiration (ET) and precipitation data. Outdoor use tends to be more variable and unpredictable, but there are good relationships between outdoor water use and a few key parameters that will allow conservation planners to design better programs for managing these demands and reducing excess irrigation.

INDOOR USE

The analyses of the end-use studies are provided in the study reports. The results from the studies are compared here to show how the study groups' water use has changed and

which factors best explain their use. The analysis shows that indoor water use is measurably reduced on both a household and a per capita basis in the newer and more efficient homes. The results also show that older homes can be brought to a similar high-efficiency level through basic fixture and appliance retrofits and management of leaks.

Average daily indoor use. There have been significant reductions in residential indoor water use since the data for the 1999 REUWS were collected. The household data shown in Figure 1 indicate a trend in decreased household water use as consumption patterns from standard housing stock in the 1990s are compared with the standard new homes, retrofit homes, and the high-efficiency new homes. The household data from the CSFWUES, which shows a random sample of existing homes sampled around 2007, does not show a significant decrease in water use at the household level. However, as explained in subsequent sections and shown in Figure 2, when corrected for the number of occupants in the homes, there has been a significant reduction in per capita use.

Figure 2 shows the trend for reduced water use on both a household and per capita level by normalizing the water use in each study group for a family of three. In the REUWS (standard housing stock from the 1990s), a family of three used an average of 187 gpd per household for indoor purposes. A family of three in California in 2007 used an average of 162 gpd per household indoors—a 13.3% reduction from the use information reported in the REUWS. A family of three in a typical new home built after 2001 used an average of 132 gpd per household indoors—a 29.4% reduction from the data collected for the REUWS. A family of three in an older home that was retrofitted with water-efficient fixtures and appliances used an average of 117 gpd per household indoors—a 37.4% reduction from the REUWS. Most efficient of all, a family of three in a new home built to WaterSense specifications and with an Energy Star–rated clothes washer used an average of just 107 gpd per household indoors—a 42.7% reduction from the REUWS. This result shows the clear trend toward water efficiency in indoor use and suggests that further reductions in indoor use are likely as older toilets and clothes washers are replaced in the future.

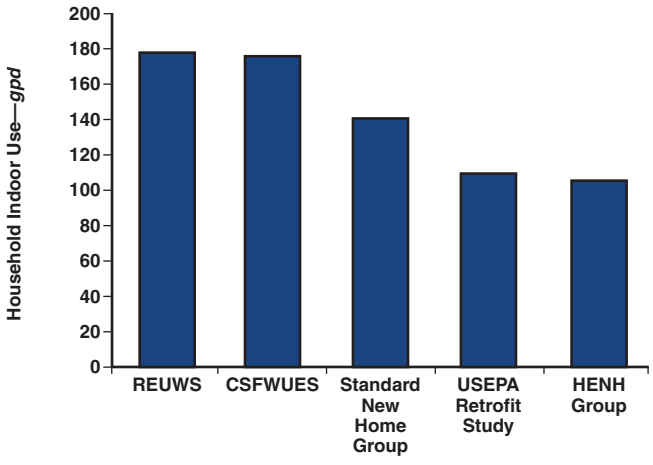
Comparison by end use. Indoor water use was disaggregated into individual categories and summarized by average daily gallons of use per household. The average daily per household water use from the four key studies is shown in Figure 3. These data show a dramatic reduction in household use in two major end-use categories: toilets and clothes washers.

Although the existing homes studied in the 1999 REUWS and the 2011 CSFWUES averaged more than 40 gpd for toilet flushing, retrofit homes equipped with a mixture of 1.6- and 1.28-gpf toilets averaged 20.3 gpd for flushing. The high-efficiency homes, built to the WaterSense new home specification and equipped exclusively with 1.28-gpf toilets, averaged 16.2 gpd for flushing.

The pattern for clothes washers was similar: the existing homes averaged around 35 gpd for clothes washing. The high-efficiency new homes used just under 12 gpd for clothes washing. These homes were equipped with clothes washers rated at tier 3 by the Consortium for Energy Efficiency.

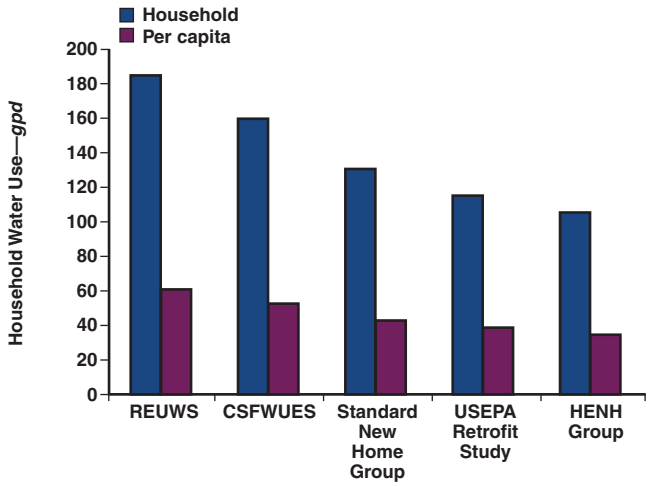
Water use for showers did not show a consistent decline. The existing homes from the REUWS and CSFWUES used an average of around 33 gpd for showering, whereas the two groups

FIGURE 1 Comparison of actual average daily per household indoor use from five groups of homes



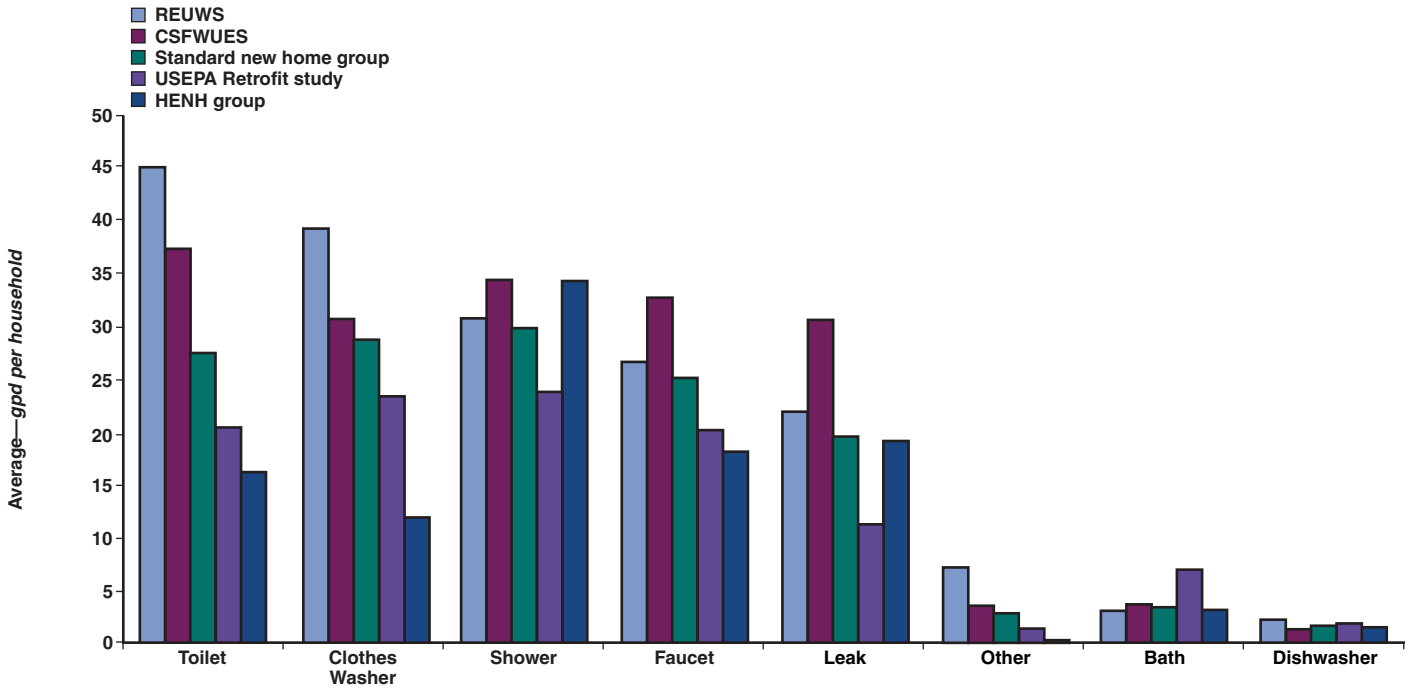
CSFWUES—California Single-family Water Use Efficiency Study, HENH group—high-efficiency new home group, REUWS—Residential End Uses of Water Study, USEPA—US Environmental Protection Agency

FIGURE 2 Comparison of per household and per capita water use normalized for a family of three



CSFWUES—California Single-family Water Use Efficiency Study, HENH group—high-efficiency new home group, REUWS—Residential End Uses of Water Study, USEPA—US Environmental Protection Agency

FIGURE 3 Comparison of end uses of water by study group



CSFWUES—California Single-family Water Use Efficiency Study, HENH group—high-efficiency new home group, REUWS—Residential End Uses of Water Study, USEPA—US Environmental Protection Agency

of high-efficiency homes from the USEPA Combined Retrofit Report and the NSFHS averaged 29 gpd. The lowest shower use was seen in the USEPA Retrofit Study homes, which averaged 24 gpd. Ironically, the high-efficiency new homes used more than 34 gpd, which spoiled the downward trend. Even though the shower flow rates in the new high-efficiency homes were lower than the other groups, the homes had more showers per day and longer shower durations, which masked the effects of the lower flow rates. Essentially, shower use was considered to remain flat across the study groups, even though the data from the USEPA Combined Retrofit Report suggest that lower shower use is possible.

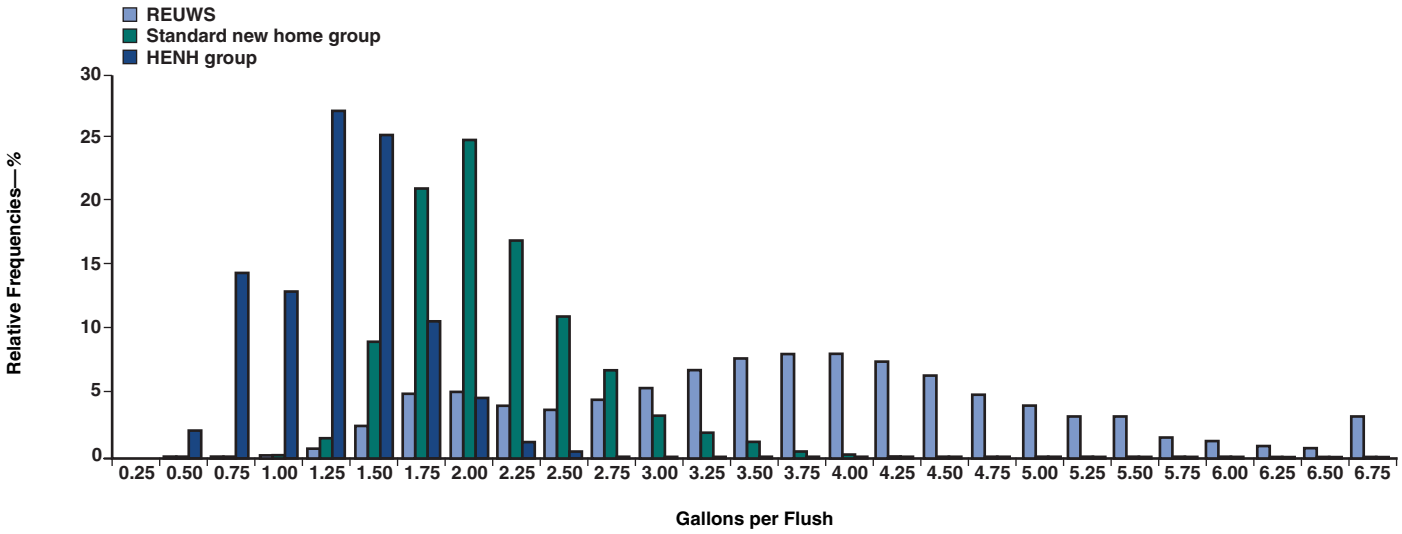
Faucet use did appear to decrease. The existing homes averaged 30 gpd, whereas faucet use in the high-efficiency homes averaged 19 gpd. Leakage volumes also dropped. The existing homes averaged 26 gpd for events that were classified as leaks, whereas the high-efficiency homes averaged 15 gpd. Events classified under the "other" category were also lower in the high-efficiency homes, whereas bathtub and dishwasher use remained essentially unchanged. Additional details of interest on individual end uses are given in the following section.

Changes in toilet flush volume. The volume of water used to flush a toilet has been reduced significantly over the past 15 years and is likely to decrease further as more 1.28-gpf high-efficiency toilets (HETs) are installed. In 1999, the average flush volume was measured to be 3.48 gpf in the REUWS (Mayer et al, 1999). In the 2011 CSF study, the average flush volume was measured to be 2.8 gpf. Standard new homes in the 2011 NSFHS had an average flush volume of 2.1 gpf. The group of homes built to meet the WaterSense new home specification (high-efficiency new home group) had an average flush volume of just 1.4 gpf.

One of the most interesting results from the data analysis was the shift in the distribution of toilet flush volumes. Figure 4 shows the relative frequencies of all the toilet flushes recorded in the REUWS, the standard new home group, and the combined high-efficiency new home group homes from the USEPA Retrofit and USEPA Combined Retrofit Report studies. The volume pattern is broadly distributed around 3.5 gpf in the REUWS group and contains a significant number of flushes at 6.75 gpf or more. In the standard new home group, the mean has shifted downward to less than 2 gpf and the distribution is much more tightly grouped, but there are still flushes at 3.5 gpf or more, which is somewhat surprising because these were all homes in which the expectation was to find 1.6-gpf or better toilets. Finally, the high-efficiency homes, in which only HET models were installed, had flushes grouped around 1.25 gpf and had relatively few flushes at more than 2 gpf.

Changes in clothes washer use. Clothes washers have become dramatically more efficient over the past 15 years. In the REUWS, the average clothes washer load consumed 41 gal per load (gpl). In the high-efficiency homes, this had dropped by 63% to 15 gpl. At the same time, the number of loads per day dropped by 20%,

FIGURE 4 Changes in distributions of toilet flush volume



HENH group—high-efficiency new home group, REUWS—Residential End Uses of Water Study

resulting in the decrease in household use for clothes washing shown in Figure 3.

Shower use comparison. Shower use has tended to remain relatively stable over time. Shower use comparisons are shown in Table 1. The number of showers per household per day has stayed between 1.9 and 2.1; the shower duration is between 8.2 and 9.6 minutes in all four studies. Although shower flow rates were reduced in the new high-efficiency homes, significant reductions in shower volumes were not observed because the average duration increased enough to maintain the average shower volume of around 16 gal. This explains why there is no clear downward trend in shower use. It appears that, at least in these samples, simply reducing the flow rate in showerheads is not sufficient by itself to cause a reduction in shower volume.

Faucet use comparison. Faucet use has decreased in both the new and the high-efficiency homes (Table 2), but research results indicate that this is primarily because people in the high-efficiency homes used the faucet less frequently. Many of the faucet parameters shown in Table 2 were similar across the four studies. Of interest was that in the CSF study statistical analysis showed that the presence of both dishwashers and garbage disposals was associated with lower faucet use.

Leak effects. Leakage data can be misleading. Leakage is one of several categories of water use that tend to be skewed by a relatively small number of homes with high leakage rates. These high-leakage accounts, although small in number, have a disproportionate effect on the average of the group as a whole. For example, the leakage data from the CSFWUES group were used to create Figures 5 and 6. Figure 5 shows the percentage of the study homes that fall into the various daily leakage bins ranging from 10 to > 200 gpd per household. From this figure, the homes in the upper bins appear fairly insignificant with only 7% of the houses leaking at greater than 100 gpd and only 4% leaking at more than 150 gpd.

If the data are expressed in terms of the percentage of the total leakage volume accounted for by the houses in each bin, a different picture emerges. Figure 6 shows that the 7% of homes with leakage greater than 100 gpd actually account for 44% of the

TABLE 1 Shower data comparisons

Parameter	REUWS	CSFWUES	Standard New Home Group	HENH Group
Average minutes	8.2	8.7	8.2	9.6
Average showers/day	2.1	2.0	1.9	2.1
Average flow	2.2	2.2	2.0	1.6
Average volume	17.2	18.2	15.9	15.9

CSFWUES—California Single-family Water Use Efficiency Study, HENH—high-efficiency new home group, REUWS—Residential End Uses of Water Study

TABLE 2 Faucet data

Parameter	REUWS	CSFWUES	Standard New Home Group	HENH Group
Average uses per day	41	57	48	33
Average gallons per use	0.65	0.60	0.53	0.60
Average peak flow—*gpm*	1.28	1.1	1.1	1.0
Average duration—*min*	0.59	0.62	0.58	0.68

CSFWUES—California Single-family Water Use Efficiency Study, HENH—high-efficiency new home group, REUWS—Residential End Uses of Water Study

FIGURE 5 Distribution of percentage of California Single-family Water Use Efficiency Study houses into leakage bins

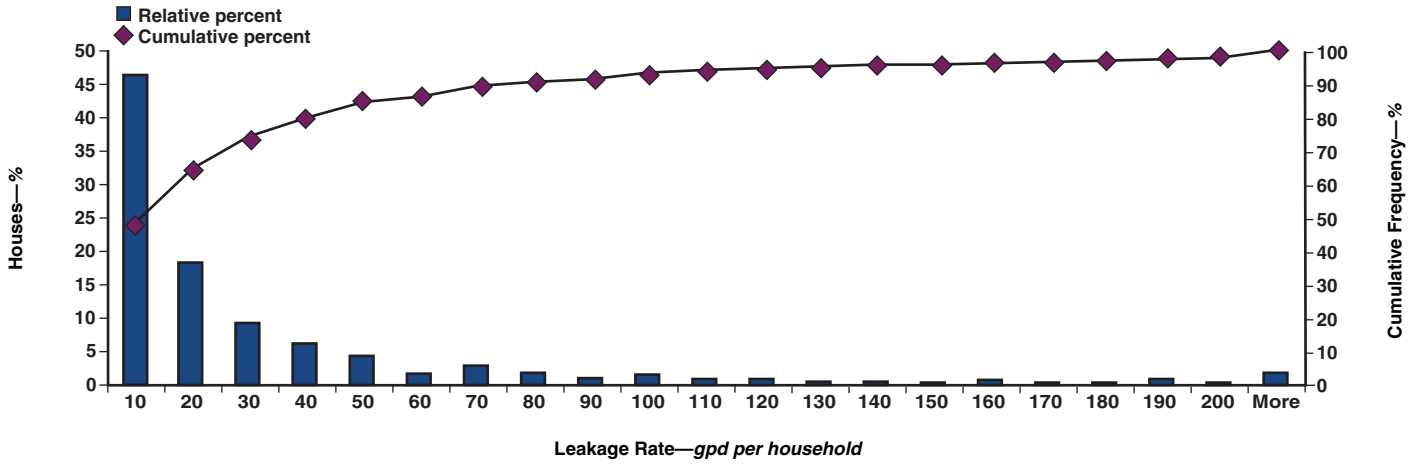
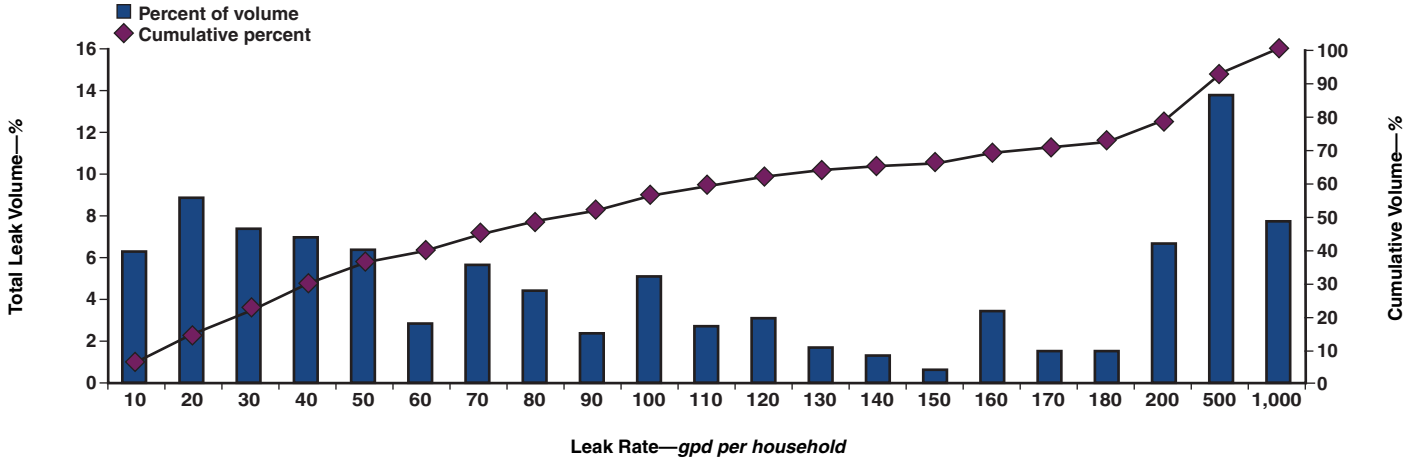


FIGURE 6 Distribution of percent of total leakage by leak bins for California Single-family Water Use Efficiency Study



total leakage volume of the entire group. Likewise, the 4% of homes that have leakage greater than 150 gpd account for 35% of the total leakage of the group. This result is not unusual. The average leakage for the CSFWUES group was approximately 30 gpd per household, but the median rate was only 11 gpd per household. Most of the houses had leakage of 10 gpd per household or less, and the few houses with very large leaks almost tripled the overall average.

This result suggests that leakage-reduction efforts should not be targeted at the general population but at the houses in the top 10% of the group, which in this case would be houses with leakage rates of 80 gpd or more. These top 10% of the houses account for 50% of the total leakage.

Household efficiency criteria. To judge the relative water efficiency level of the homes in these studies, the authors determined the percentage of homes in each study that met specific criteria for average toilet flush volume and average clothes washer load volume that indicate whether the house was equipped with high-efficiency devices. The criterion used for toilets was that the house had to have an average flush volume of 2.0 gpf or less to be considered meeting the high-efficiency criteria for toilet flushing. The value used for clothes washers was that the average gallons per load for the house had to be less than 30 gpl, which constituted a high-efficiency machine for the study period. Figure 7 shows the progression of homes meeting the toilet and clothes washer criteria. In the REUWS, only 10% of the homes met the 2.0-gpf toilet criteria and only 3% met the 30-gpl clothes washer criteria. Ten years later, 30% of homes in the CSFWUES met the toilet and clothes washer criteria. Not surprisingly, virtually all of the retrofit homes and new homes built to the WaterSense specification, here combined for convenience, met the toilet and clothes washer efficiency criteria. In addition, fewer than half of the standard new homes met thses criteria.

Unexpectedly high flush volumes in some new homes. An unexpected finding from the NSFHS houses built since 2001 was that a number of these new homes had toilet flush volumes that exceeded 1.6 gpf. In some cases, the flush volume in these homes

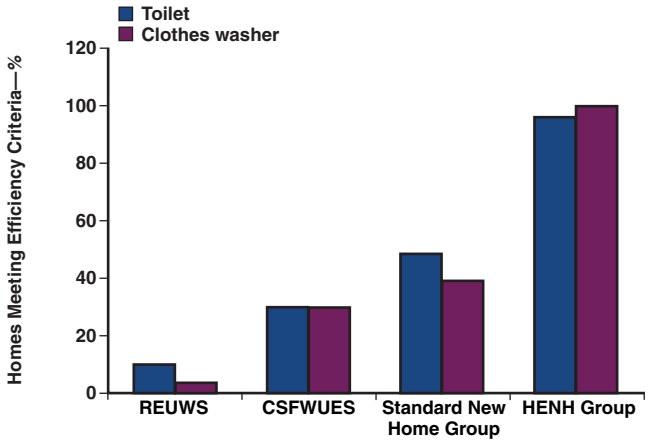
was substantially higher than 1.6 gpf. Because of the provision of the Energy Policy Act of 1992, standard new homes built after 2001 should all have been equipped with 1.6-gpf toilets or better, yet the data showed that fewer than half of the homes had average flush volumes of 2 gpf or less.

During the data logging study of the NSFHS group, 41,957 flushes were recorded. The distribution of the flush volumes for the new homes is shown in Figure 8. Approximately 40% of the flushes are ≤ 1.6 gpf, and 60% of the flushes are > 1.6 gpf. Flush volumes were recorded at up to 6 gpf because some homes were equipped with non–ultra-low-flush (ULF) toilets and many ULF design toilets installed in the homes are actually flushing at volumes greater than 1.6 gal. The researchers were not able to inspect the individual toilets to determine the cause of the overflushing, but it is likely that this is the result of both poor adjustments by the installers and toilets that do not meet the 1.6-gpf specification.

Per capita use relationships. As part of the modeling effort, total household water use (in gallons per day per household) was generally used as the dependent variable; a range of variables were tested for their ability to predict indoor use. In many cases, the number of people in the house was the only continuous independent variable that proved significant in predicting indoor water use. In all four end-use studies discussed here, the relationship between household use and number of residents was nonlinear and followed a power curve relationship. The other relationship that was observed was that the newer and more-efficient homes had curves that were generally below the curves of the older and less-efficient homes.

The actual relationships between household indoor use and number of residents for the five study groups are shown in Table 3 and Figure 9. As household populations increase, water use does not increase in direct proportion but follows a power curve relationship that has an exponent < 1.0. The data group themselves as a family of curves, with the REUWS homes having the highest daily use, followed by those in the CSFWUES, the standard new home group, the USEPA Combined Retrofit Report, and the high-efficiency new home group.

FIGURE 7 Comparison of percentages of households meeting toilet and clothes washer efficiency criteria



CSFWUES—California Single-family Water Use Efficiency Study, HENH group—high-efficiency new home group, REUWS—Residential End Uses of Water Study

The implication of the nonlinear relationship between household use and the number of residents is that water planners should use caution when using per capita demand values for planning. Also, when setting water budgets, the temptation to increase budgets directly in proportion to the number of residents should be resisted because doing so could create excessive budgets for larger households.

Factors that affect indoor water use. A wide range of continuous and conditional variables were tested with respect to their

FIGURE 8 Distribution of toilet flush volumes in standard new homes built after 2001

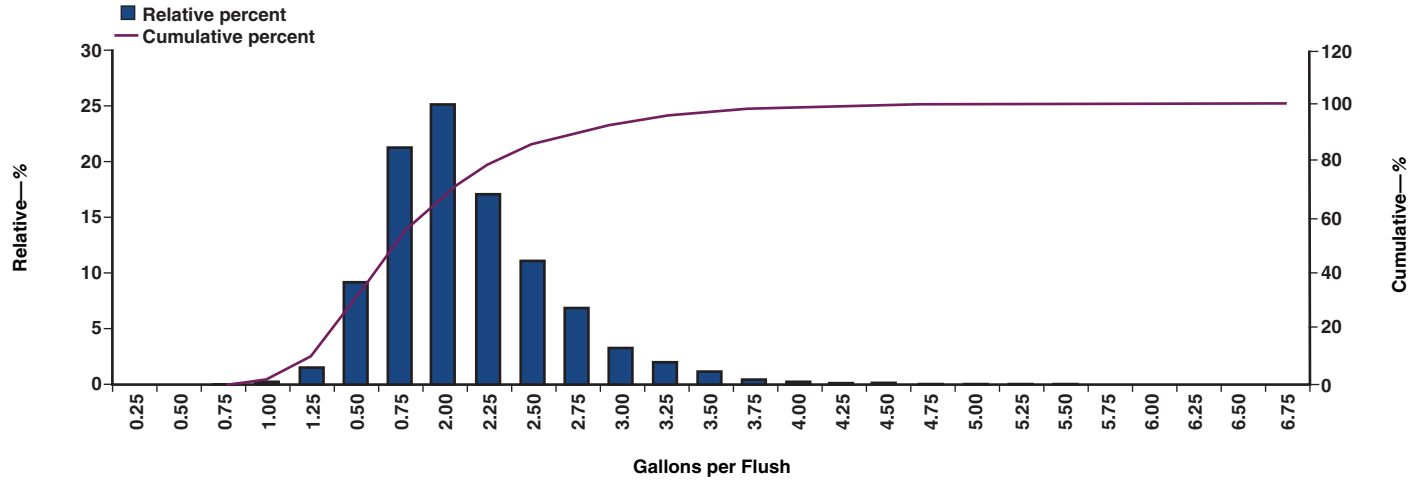


TABLE 3 Indoor household demands normalized for a family of three people

Parameter	REUWS (Built < 1995)	CSFWUES	Standard New Home Group (Built > 2001)	USEPA Retrofit Study	HENH Group
Number of households	1,188	728	302	96	25
Mean±95% CI—*gpd per household*	177±5.5	186±10.2	140±10.0	107±10.3	105±28
Median—*gpd per household*	160	165	125	100	90
Per capita relationship—*gpd per household*	87.41 × 0.69%	72.67 × 0.73%	66.30 × 0.63%	50.21 × 0.77%	59.58 × 0.53%
Household use for family of three people—*gpd per household*	187	162	132	117	107
Projected per capita use for family of three people—*gpcd*	62.18	53.9	44.15	39.0	35.6

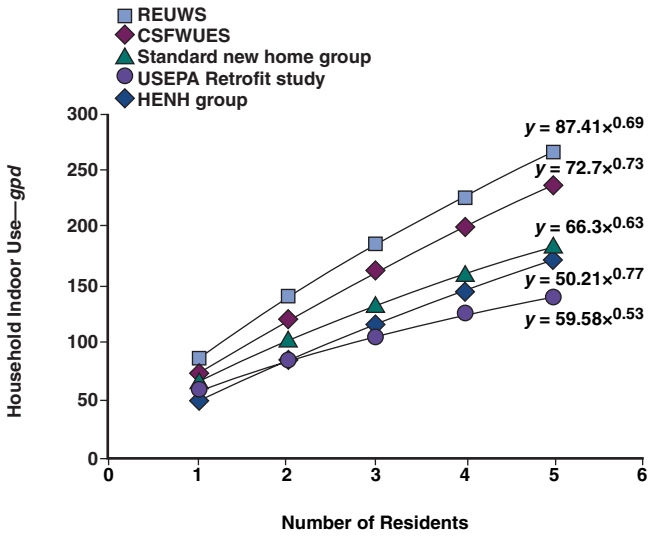
CI—confidence interval, CSFWUES—California Single-family Water Use Efficiency Study, HENH—high-efficiency new home group, REUWS—Residential End Uses of Water Study, USEPA—US Environmental Protection Agency

value for predicting indoor water use. The only continuous variable that was found to be statistically significant across all studies was the number of people in the home. These relationships are shown in Table 3. Others, such as the household income, age of the home, value of the home, number of bedrooms, or number of bathrooms, were not found to be significant. The living area of the home was found to be significant for some data sets, but to a smaller extent than the number of residents.

Analysis of variance was conducted on a range of conditional variables to see whether they affected the household water use. Several of these proved to be significant.

- The presence of a leak of more than 100 gpd on the flow trace was positively correlated with household use and increased the average daily indoor use by 223 gpd.

FIGURE 9 Per capita use relationships in five study groups



CSFWUES—California Single-family Water Use Efficiency Study, HENH group—high-efficiency new home group, REUWS—Residential End Uses of Water Study, USEPA—US Environmental Protection Agency

- The presence of a nonadult living in the home was negatively correlated with water use and decreased household water use by 42 gpd.
- The presence of high-efficiency (ULF or HET) toilets in the home was negatively correlated and reduced household water use by 22 gpd.
- The presence of a high-efficiency clothes washer was negatively correlated and reduced average indoor water use by 17 gpd.
- The presence of a dishwasher and a garbage disposal was linked to decreased faucet use.

OUTDOOR USE

It was not possible to demonstrate clear trends in outdoor water use from the four studies used for this analysis. The quality of the data for the analyses varied, and the only study groups that the authors felt to be comparable were the CSFWUES and the standard new home group. These two study groups provide a contemporaneous comparison for the period around 2007 of existing and new homes. In addition, the data from these studies showed consistent relationships between key parameters and outdoor use that can be used to make models of outdoor use from which projections can be made on how varying these parameters might affect outdoor use.

Comparison of outdoor parameters. The most important outdoor parameters for the study groups are shown in Table 4. These results show a relatively high degree of consistency between the existing and new homes for the key parameters shown. All of the variations between the new and existing homes are 15% or less—and most of them are less than 10%.

Lot sizes and irrigated areas in the new home sample are approximately 10% larger, but the outdoor use was 15% less in the new homes. The average application for both groups was close to 57 in. compared with similar reference ET values of 43 in. Both groups of homes were applying, on average, 30–36% more than the ET requirement. When the excess use was determined for the lots that were overirrigating, this value averaged close to 30,000 gal/year/lot for the entire group and approximately twice this amount on the overirrigating lots. At the same time, if the algebraic average of excess and deficit irrigation

TABLE 4 Comparison of outdoor use parameters

Parameter	CSFWUES	Standard New Home Group	Ratio of Standard New Home Group to CSFWUES
Average lot size—*sq ft*	9,179	10,146	1.11
Irrigated area—*sq ft*	3,387	3,714	1.10
Outdoor use—*gal/year*	93,400	78,000	0.85
Average application—*in.*	57	56	0.98
Average reference evapotranspiration	42	43	1.02
Average application ratio	1.36	1.30	0.96
Average excess application—*gal/year for overirrigators*	29,400	30,000	1.02
Net application for all homes—*gal/year*	6,500	7,300	1.12

CSFWUES—California Single-family Water Use Efficiency Study

applications was calculated, this averaged between 6,500 and 7,300 gal/lot. The value of 30,000 gal/year represents the amount of water that could be saved if all of the excess irrigation could be eliminated on the lots where it was occurring, while leaving the deficit irrigators alone. The values between 6,500 and 7,300 gal/lot represent the amount of water that could be saved if everyone's irrigation were brought precisely to the ET-based theoretical irrigation requirement.

Outdoor water use relationships. The models of outdoor use were similar for both the standard new home and high-efficiency new home groups. For illustration purposes, the analysis of the outdoor use data for the CSFWUES sample is shown in Eq 1, which provided the best fit for predicting outdoor water use in the CSF study.

$$\text{Outdoor Water Use} = 1.6207 \times 10^{-4} \times \text{NetET}_o^{1.66} \times \text{IrrArea}^{0.682} \times \text{Inc}^{0.125} \times \text{LRatio}^{0.506} \times \text{Pool} \times \text{Excess} \times \text{Sprinkler} + C_f \quad (1)$$

See Table 5 for definitions of all factors in Eq 1.

Outdoor use is most strongly affected by ET, irrigated area, and the water use intensity of the landscape as measured by the landscape ratio—which is the ratio of the actual irrigation requirement of the lot to the requirement based on a total turf landscape, whether a pool is present on the landscape, whether excess irrigation is occurring on the lot, and whether there is an automatic irrigation system present.

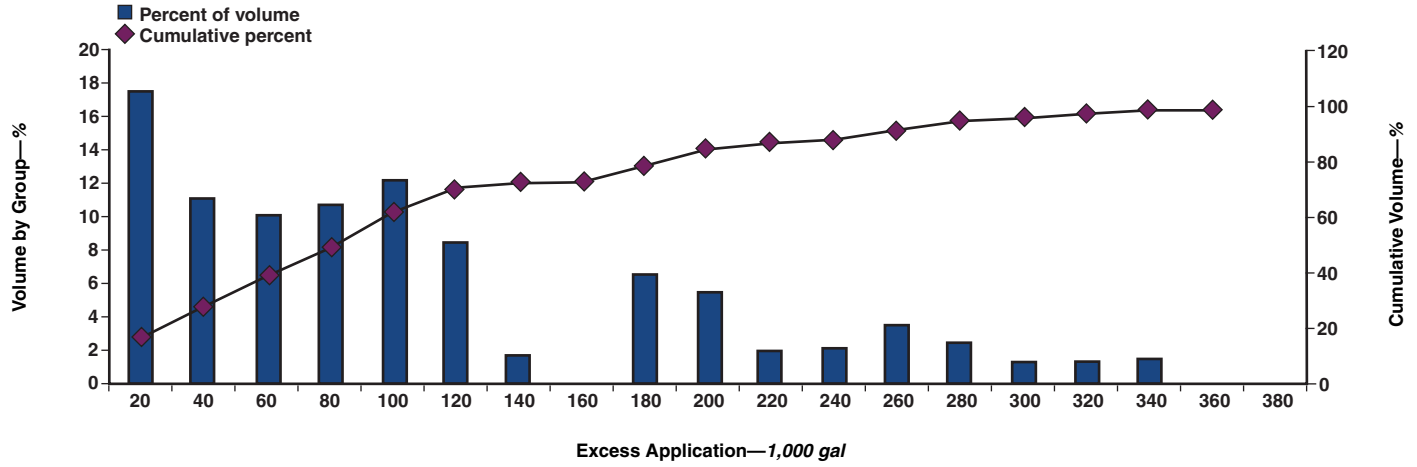
One of the key factors for predicting outdoor water use is whether the customer is overirrigating. Homes that overirrigate tend to have much larger outdoor use volumes. The situation with overirrigation is similar to that of leakage—a small number of homes influence the overall average far out of proportion to their numbers. Only a small number of homes were applying large volumes of excess irrigation: > 60% of the homes were applying 20,000 gal or less of excess water and only 8% of the homes were applying more than 100,000 gal of excess irrigation water (DeOreo et al, 2011). If, however, the percentage of excess irrigation water associated with the various bins of excess use (Figure 10) is investigated, this 8% accounts for 38% of the total excess irrigation (DeOreo et al, 2011).

The outdoor use model suggests that if the rate of overirrigation could be reduced from 50 to 25% of the households in California, the average outdoor use for all irrigating homes would decrease by approximately 25,000 gal/year, a savings of 29% in outdoor use. This would represent a total savings for the state of more than 630,000 acre-feet of raw water from simply reducing the percentage of homes that are overirrigating.

TABLE 5 Factors of interest for outdoor water use

Parameter	Description
Outdoor water use	The dependent variable (per 1,000 gal)
Net evapotranspiration (NetET_o)	Reference evapotranspiration—effective precipitation (in.)
Irrigated area (IrrArea)	Total irrigated area on lot (sq ft)
Income (Inc)	Household income (in $1,000s)
Landscape ratio (LRatio)	The ratio of the theoretical irrigation requirement to the reference requirement for the lot. This is a measure of the water requirements of the landscape relative to cool season turf (the reference crop).
Pool	Correction factor pool; multiply by 1.38 × percent of population with pools + percent without pools
Excess irrigation (Excess)	Correction factor for overirrigation; multiply by 3.13 × percent of homes that are overirrigating + percent that are not
Sprinkler	Correction factor for automatic sprinkler system; multiply by 1.21 × percent of homes with automatic sprinkler systems + percent without
C_f	Correction factor = –9,100 gal

FIGURE 10 Percent of volume of total excess use from California Single Family Water Use Efficiency Study homes



Additional outdoor savings can be achieved by reducing the irrigated areas and water requirements of the selected plant material or by prohibiting swimming pools, but all of these measures have effects on the quality of life. By comparison, the elimination of excess application seems like a fairly nonintrusive measure.

Although indoor use has been shown to be unaffected by household income, outdoor use is related to income. Consequently, it could be expected that during an economic downturn there would be a reduction in outdoor water use, which would add to declines in single-family water use from indoor efficiencies during times of economic downturn.

CONCLUSIONS

The results from four residential water use studies and five study groups summarized in this report lead to several important conclusions. There is a clear trend toward lower single-family indoor water use from both the household and the per capita perspective. Results from the CSFWUES show that existing homes sampled 10 years after the REUWS are using less indoor water. This demonstrates that water conservation efforts are bearing fruit and demand reductions are occurring. As time goes on, it is safe to assume that more homes will be retrofit with high-efficiency fixtures and appliances and that household water use in the existing customer pool will continue to decrease both on a per capita and a household basis. Water efficiency provisions are built into national building codes and the national Energy Policy Act of 1992. The effect of these provisions is measurable, as shown by the results of this analysis. Water planners should incorporate these changes in demand into future demand projections or run the risk of significantly overestimating future residential demands.

At the same time, the data from the two comparable outdoor studies show a remarkable degree of similarity in outdoor use between existing California homes and new homes across the country. They also show a similar set of factors affecting outdoor use and that the key of these is whether the home is overirrigating. Elimination of excess irrigation where it is occurring (while allowing the deficit irrigators to continue their practice) is the key to achieving outdoor water conservation that has minimal effects on quality of life.

The indoor end uses where the greatest decrease has been measured are toilets and clothes washers. This makes sense because toilets and clothes washers have been the target of the most intense design and manufacturing upgrades for the past 15 years. What were once specialized "water-conserving" devices are now common to the market. In contrast to toilets and clothes washers, water use for showering has stayed relatively constant in spite of concerted efforts to reduce shower flow rates.

Beyond fixture and appliance efficiency improvements, a key objective for future water conservation efforts should be to decrease the number of homes with significant leaks. Most large-volume leaks are caused by constant flows. These types of flows can be detected with smart water meters or automatic meter infrastructure (AMI) capable of detecting constant flows. Utilities equipped with AMI and automatic meter reading systems have used this capability to issue leak alerts to customers with ongoing continuous flows. This is a powerful targeting tool. If AMI is not a viable option, there are devices on the market that can detect constant flows, turn off the water, and alert the homeowner of the situation. These are the types of devices that could help reduce leakage and could be included in specifications for building codes or voluntary "green" building standards.

Dealing with leaks is important if the savings from future retrofits are to be fully realized. For example, as shown in Figure 3, the savings in water use associated with toilets and clothes washers in the California homes was approximately 17 gpd per household, but there also was a 9-gpd per household increase (from REUWS) in leakage that prevented the savings from fully showing on the bottom line of total daily indoor use.

The data on toilet flush volumes, shown in Figures 4 and 8, indicate that there may be problems with some off-the-shelf ULF design toilets that cause their flush volume to exceed the 1.6-gpf design. This could be the result of problems with installation or manufacturing. The 1.28-gpf HETs show a much closer flush volume distribution and much less excess flush volume than their 1.6-gpf counterparts. This is likely the result of increased third-party testing of toilets required by the WaterSense program.

Over time, the percent of households that can be classified as "high efficiency" with respect to toilet and clothes washer use has increased significantly. During the 10 years between the REUWS and the CSFWUES, the household efficiency rates for these devices have increased by a factor of 3 for toilets and a factor of 10 for clothes washers. However, the data for the standard new homes suggest a decrease in these rates of penetration because only about half of the new homes met the study criteria of 2.0-gpf average flush volume and a third met the 30-gpl clothes washer criteria. If a utility wants all new homes to meet these basic efficiency criteria, it is probably necessary to specify HETs (or WaterSense–labeled toilets) and Consortium for Energy Efficiency tier 3 clothes washers as the standards for new construction.

This research has found a nonlinear relationship between household domestic water use and the number of residents in the home. As the number of people in a home increases, water use does not increase proportionally. There are efficiencies associated with living in larger groups—each additional person in a home has a smaller effect on household water use. Because of this finding, water planners must use discretion when applying per capita demands to estimate household or population demands.

The relationships developed in these studies show that there are clear distinctions in household water use versus residents for the various groups. When these relationships are used to normalize the demands on the basis of the same number of residents, the demand patterns can be compared properly. Figures 2 and 9 show this dramatically and represent the key result for indoor use—agencies should be planning for per capita demands of around 40 gpcd or less for a family of three and household uses of 120 gphd or 44,000 gal/year or less for indoor use by the average home. Just as the mileage standards for automobiles are increasing in response to higher gas prices and oil shortages, the water use standards for households are, or should be, increasing as well.

The declines in indoor water use identified in this article were not an artifact of the economic recession of 2008–10. Most of the data on which these studies have been based were collected before the start of the recession. Outdoor water use, however, would be expected to decline during recessions as incomes fall because outdoor use is dependent on household income.

The results on outdoor use show that a key to outdoor water conservation is preventing excess irrigation. The results show that the majority of homes are irrigating at or below what appears to be a reasonable amount for their landscape and area, but the small number of homes that overirrigate raise the average for the group. The small numbers of homes that grossly overirrigate have a disproportionate effect on outdoor use, raising the averages further. Finding ways to target the water use in these homes, perhaps by use of water budgets linked to steeply inclining block rates, is an important goal of demand management efforts. Once excess irrigation is eliminated, then modest decreases in irrigated areas and shifting to less water-intensive plant materials can optimize outdoor use.

Overall, the results from the studies of single-family water use discussed in this article show that great strides have been made in reducing residential water demands and that there are also substantial opportunities for water savings remaining. The improved designs of household fixtures and appliances have made it possible to consider household demands of 40 gpcd (or 120 gphd for a family of three) a reasonable target. Better technologies for identifying leaks and preventing overirrigation of landscapes make it possible to envision significant demand reductions in these difficult categories. Finding better ways of providing customers with real-time information on their water use, along with reasonable budgets, can make allies of customers in a community-based effort of water conservation. Reduced residential demand is a cornerstone of future urban water resource management. Great progress has been made in the past 15 years, and the industry appears poised to realize further demand reductions in the future.

ABOUT THE AUTHORS

William B. DeOreo *(to whom correspondence should be addressed) is president of Aquacraft Inc., 2709 Pine St., Boulder, CO 80302; bill@aquacraft.com. His work has focused on issues related to water demand analyses, demand forecasting, and water conservation planning. He and his business partner and coauthor have developed the flow trace analysis technique for disaggregating residential water use into end uses for more than 15 years. By combining the results of end-use analyses with data from surveys and other sources, DeOreo has been able to show which factors best explain residential water use and show how both household and per capita demands have dropped in response to new technologies and changes in climate. Peter W. Mayer is vice-president of Aquacraft Inc.*

PEER REVIEW

Date of submission: 08/27/2011
Date of acceptance: 04/16/2012

REFERENCES

Aquacraft, 2005. USEPA Combined Retrofit Report. Water and Energy Savings From High Efficiency Fixtures and Appliances in Single Family Homes. Aquacraft Inc., Boulder, Colo., and US Environmental Protection Agency, Washington, DC. http://aquacraft.com/sites/default/files/pub/Aquacraft-%282005%29-EPA-Water-and-Energy-Savings-from-High-Efficiency-Fixtures-and-Appliances-in-Single-Family-Homes.pdf (accessed Apr. 24, 2012).

Consortium for Energy Efficiency, 2011. Clothes Washer Standards. www.cee1.org/resid/seha/rwsh/reswash_specs.pdf (accessed Apr. 18, 2012).

DeOreo, W.B., 2011a. Analysis of Water Use in New Single Family Homes. Aquacraft Inc., Boulder, Colo. www.aquacraft.com/sites/default/files/pub/DeOreo-%282011%29-Analysis-of-Water-Use-in-New-Single-Family-Homes.pdf (accessed Apr. 18, 2012).

DeOreo, W.B., 2011b. Report On In-Home Water Use Patterns In Single Family Homes From Jordan. Project Number 278-00-06-00329 Aquacraft Inc., Boulder, Colo. www.aquacraft.com/sites/default/files/pub/DeOreo-%282011%29-Report-on-in-Home-Water-Use-Patterns-in-Single-Family-Homes-from-Jordan.pdf (accessed Apr. 25, 2012).

DeOreo, W.B.; Mayer, P.W.; Martien, L.; Hayden, M.; Funk, A.; Kramer-Duffield, M.; & Davis, R., 2011. California Single-family Water Use Efficiency Study. Aquacraft Inc., Boulder, Colo. www.aquacraft.com/sites/default/files/pub/DeOreo-%282011%29-California-Single-Family-Water-Use-Efficiency-Study.pdf (accessed Apr. 18, 2012).

DeOreo, W.B.; Dietemann, A.; Skeel, T.; Mayer, P.W.; Lewis, D.M.; & Smith, J., 2001. Retrofit Realities. *Jour. AWWA*, 93:3:58.

DeOreo, W.B.; Heaney, J.P.; & Mayer, P.W., 1996a. Flow Trace Analysis to Assess Water Use. *Jour. AWWA,* 88:1:79.

DeOreo, W.B.; Lander, P.; & Mayer, P.W., 1996b. New Approaches in Assessing Water Conservation Effectiveness. *Proc. Conserv96,* Orlando, Fla.

Heinrich, M., 2007. Water End-use and Efficiency Project (WEEP)—A Case Study. SB07 NZ Conference: Transforming our Build Environment, Auckland, New Zealand. www.branz.co.nz/cms_show_download.php?id=1007e839aa7e3b02ab6d012ca78d3c411f21098b (accessed Apr. 18, 2012).

Lewis, D.M.; DeOreo, W.; & Dinatale, K., 1998. Flow Trace Analysis to Determine Irrigation Efficiency in a Large Municipal Water User. Proc. AWWA 1998 Annual Conference and Exhibits, Dallas.

Loh, M. & Coghlan, P., 2003. Domestic Water Use Study in Perth, Western Australia, 1998–2001. Water Corporation, Perth, Australia. www.watercorporation.com.au/_files/PublicationsRegister/12/Domestic_water_use_study.pdf (accessed Apr. 18, 2012).

Mayer, P.W.; DeOreo, W.B.; Opitz, E.M.; Kiefer, J.C.; Davis, W.Y.; Dziegielewski, B.; Nelson, J.O., 1999. Residential End Uses of Water. Water Research Foundation. Denver. www.waterrf.org/ProjectsReports/PublicReportLibrary/RFR90781_1999_241A.pdf (accessed Apr. 19, 2012).

Roberts, P., 2005. Yarra Valley Water. 2004 Residential End Use Measurement Study. Melbourne, Australia. www.yvw.com.au/yvw/groups/public/documents/document/yvw1001680.pdf (accessed Apr. 18, 2012).

USDOE (US Department of Energy), 1992. Alternative Fuels & Advanced Vehicles Data Center: Federal & State Incentives & Laws. www.afdc.energy.gov/afdc/laws/key_legislation (accessed April 19, 2012).

Willis, R.; Steward, R.A.; Panuwatwanich, K.; Capati, B.; & Guirco, D., 2009. Gold Coast Domestic Water End Use Study. Water, September 2009. Brisbane, Australia. www.manuelectronics.com.au/pdfs/willisetal2009goldcoastwater.pdf (accessed April 19, 2012).

JOURNAL ARTICLE

Declining Residential Water Use Presents Challenges, Opportunities

Margaret Hunter, Kelly Donmoyer, Jim Chelius and Gary Naumick

Opflow
Vol. 37, No. 5 (May 2011), pp. 18-20

Published by: American Water Works Association
Stable URL: https://www.jstor.org/stable/opflow.37.5.18
Page Count: 3

Topics: Water consumption, Water conservation, Utilities costs, Homes, Economic regulation, Water utilities, Environmental regulation, Subsidiary companies

Declining Residential Water Use Presents Challenges, Opportunities

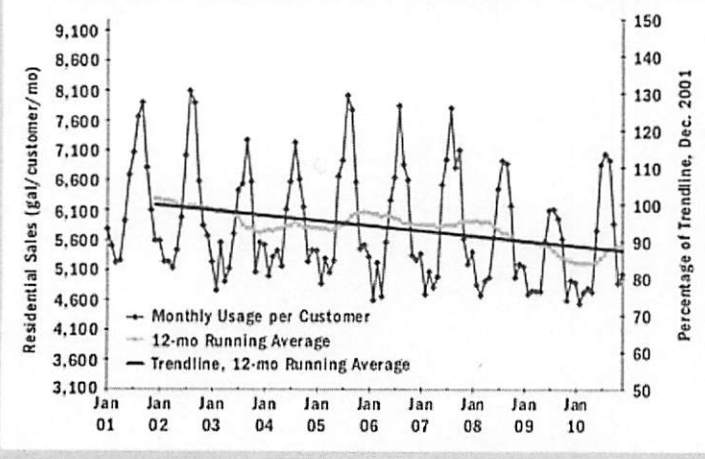
Conservation efforts and use of more efficient appliances are causing residential customers to use less water. How does this affect the way utilities conduct their business and operations?

BY MARGARET HUNTER, KELLY DONMOYER, JIM CHELIUS, AND GARY NAUMICK

FOR MANY North American utilities, residential water use has declined steadily for the last 20 years. In many locations, the trend has accelerated in the last decade. The long-term trend could significantly affect utilities.

A utility services company studied historic water usage trends for its US operations during the last 10 years. Figure 1 shows monthly residential use per customer. Overall, residential water use across the company's largest state subsidiaries declined about 1.4 percent/yr/customer between 2001 and 2010. The trend of declining use was consistent across widely ranging geographic locations and demographic characteristics. Similar results were found in a study of winter-only consumption in northern US service areas where there's little or no outdoor water use during winters.

Figure 1. Monthly Residential Sales Per Customer
Residential water use declined between 2001 and 2010 among state subsidiaries of a large utility services company.



The consistency of the findings indicates strong underlying drivers are affecting indoor residential usage patterns. These findings closely match data published in a 2010 Water Research Foundation Report, North America Residential Water Usage Trends Since 1992.

CAUSES OF DECLINING USE

Several factors appear to contribute to declining household water use, including high-efficiency plumbing fixtures; a decline in persons per household in many locations; utility-led water efficiency programs, such as consumer education, fixture retrofit, and water audit programs; increased conservation practices and awareness; economic conditions; and price elasticity.

The Energy Policy and Conservation Act of 1992 mandated the manufacture of water-efficient toilets, showerheads, and

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WaterNews

U.S. Household Water Use Continues to Decline

November 8, 2017 / in Water Management, Water News / by Brett Walton

Federal report tracks conservation pattern that began two decades ago.

A neighborhood in Weld County, Colorado, one of the few states where household water use is increasing. Photo © J. Carl Ganter / Circle of Blue

By Brett Walton, Circle of Blue

Continuing a trend that began in the early 1990s with tighter federal plumbing standards, U.S. household water use dropped again in 2015.

When assessing national figures, there are two main ways to gauge water use at home: the amount used per person and total water use, which incorporates changes

in population. By both measures, water use is declining [https://pubs.er.usgs.gov/publication/ofr20171131] , according to the latest report from the U.S. Geological Survey, the agency that gathers national data every five years.

For people served by public and private utilities, water use for cooking, drinking, showering, lawn watering, car washing, and other household tasks dropped to an average of 83 gallons per person per day in 2015, down seven percent compared to 2010. Household use was 105 gallons per person per day in 1990.

Total household use declined as well, even as the number of people supplied by utilities increased by 14 million. Household water use in the country dropped by 381 million gallons per day, or two percent. Savings are evident across all utility operations. Total water withdrawals for public supply, a category that includes household use as well as water provided by utilities for commercial and industrial purposes, are the lowest since 1995.

Three factors explain the decline, according to Molly Maupin, a U.S. Geological Survey hydrologist who helped to collect the water-use data. A severe drought in California prompted Gov. Jerry Brown in 2015 to order urban water utilities to cut demand by 25 percent. Those utilities are also implementing a state water conservation law that was passed in 2009. California, not surprisingly, showed the largest decline in total household water use in the country between 2010 and 2015.

Second is that water utilities are paying more attention — by fixing leaks and installing meters. The Georgia Legislature, for instance, passed a law in 2010 that requires utilities to conduct an annual audit to check for leaks.

"People are continuing to use water more carefully," Maupin told Circle of Blue.

Conservation yields financial benefits for residents, too. A study published earlier this year by the Alliance for Water Efficiency, a Chicago-based nonprofit, found that using less water in two Arizona cities [https://www.circleofblue.org/2017/water-management/saving-water-lowered-rates-two-arizona-cities/] led to cheaper rates than if new water supply projects were built in order to keep pace with higher demand.

The third factor is water-saving plumbing fixtures. The federal Energy Policy Act of 1992 dramatically strengthened the plumbing code, requiring toilets, showerheads, faucets, dishwashers, and clothes washers to cut down the flow of water. As a result of the act, toilets flush half as much water as before and showerheads spray 30 percent less.

Research bears this out. Nearly all the decline in residential indoor water use in the last two decades is due to more-efficient fixtures, according to a 2016 study [https://www.circleofblue.org/2016/water-management/infrastructure/study-efficient-fixtures-cut-u-s-indoor-water-use/] funded by the Water Research Foundation. That study examined in detail the behavior of households in nine large cities.

Some states have turned the screws even tighter. California ordered that toilets sold after January 1, 2014, flush 20 percent less water than the federal standard of 1.6 gallons. Texas, Georgia, and Colorado followed with similar laws.

Water use is not declining in every state, though. According to the USGS report, which uses data from

state agencies and water utilities, per person water use increased in the states of Alaska, Colorado, Idaho, Louisiana, Utah, Virginia, Wisconsin, and Wyoming.

Most of these states are in the American West, and three are in the upper basin of the Colorado River, where there is strong debate about whether to increase water withdrawals from the shrinking river [https://www.circleofblue.org/2016/world/colorado-rivers-tale-two-basins/] .

Bio [#ts-fab-bio-below]

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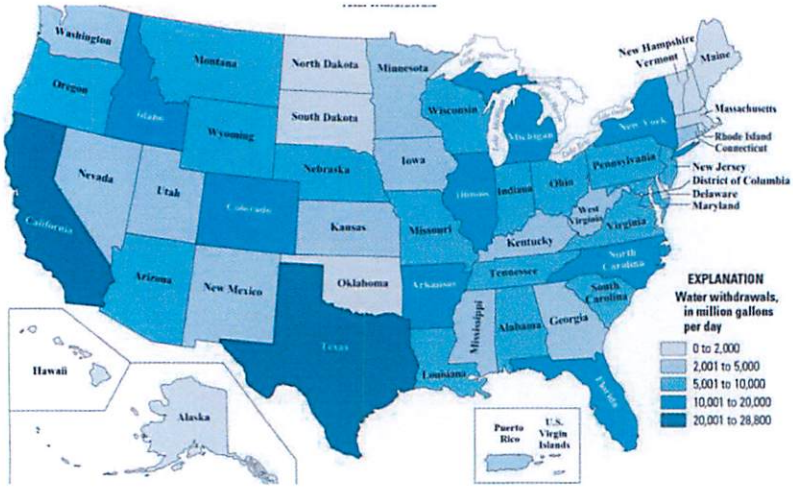
Brett Walton [https://circleofblue.org/autl

Brett writes about agriculture, energy, infrastructure, and the politics and economics of water in the United States. He also writes the Federal Water Tap [https://www.circleofblue.org/wate tap/] , Circle of Blue's weekly digest of U.S. government water news. He is the winner of two Society of Environmental Journalists reporting awards, one of the top honors in American environmental journalism: first place for explanatory reporting for a series on septic system pollution in the United States [https://www.circleofblue.org/201((2016) and third place for beat reporting in a small market (2014). Brett lives in Seattle, where he hikes the mountains

Water use across the US declines to levels not seen since 1970

June 25, 2018, United States Geological Survey



Total water withdrawals by State, 2015 [1 Bgal/d = 1,000 million gallons per day]. Credit: Public domain

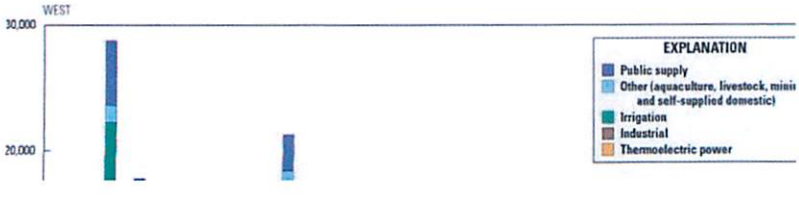
Reductions in water use first observed in 2010 continue, show ongoing effort towards "efficient use of critical water resources."

Water use across the country reached its lowest recorded level in 45 years. According to a new USGS report, 322 billion gallons of water per day (Bgal/d) were withdrawn for use in the United States during 2015.

This represents a 9 percent reduction of water use from 2010 when about 354 Bgal/d were withdrawn and the lowest level since before 1970 (370 Bgal/d).

"The downward trend in water use shows a continued effort towards efficient use of critical water resources, which is encouraging," said Tim Petty, assistant secretary for Water and Science at the Department of the Interior. "Water is the one resource we cannot live without, and when it is used wisely, it helps to ensure there will be enough to sustain human needs, as well as ecological and environmental needs."

In 2015, more than 50 percent of the total withdrawals in the United States were accounted for by 12 states (in order of withdrawal amounts): California, Texas, Idaho, Florida, Arkansas, New York, Illinois, Colorado, North Carolina, Michigan, Montana, and Nebraska.



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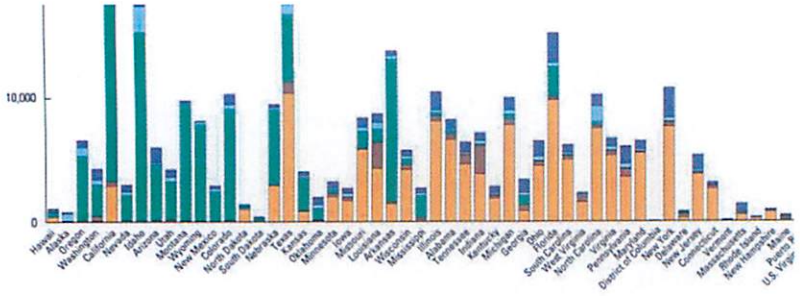


Total water withdrawals by category and by State from west to east, 2015 [1 Bgal/d = 1,000 million gallons per day]. Credit: Public domain

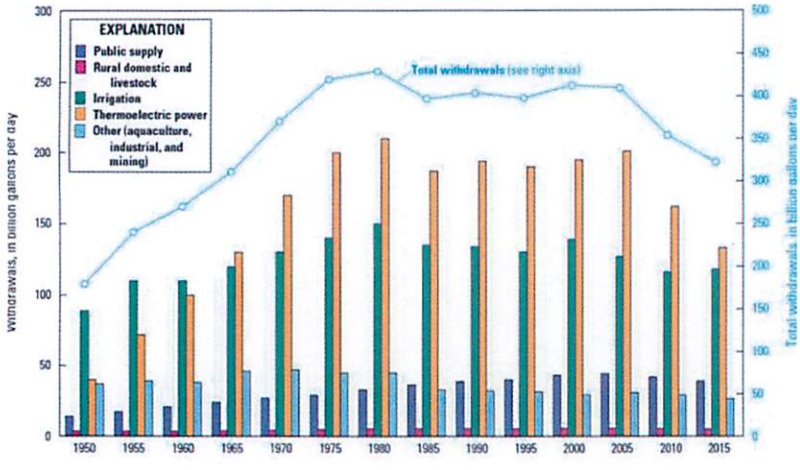
California accounted for almost 9 percent of the total withdrawals for all categories and 9 percent of total freshwater withdrawals. Texas accounted for about 7 percent of total withdrawals for all categories, predominantly for thermoelectric power generation, irrigation, and public supply.

Florida had the largest share of saline withdrawals, accounting for 23 percent of the total in the country, mostly saline surface-water withdrawals for thermoelectric power generation. Texas and California accounted for 59 percent of the total saline groundwater withdrawals in the United States, mostly for mining.

"The USGS is committed to providing comprehensive reports of water use in the country to ensure that resource managers and decision makers have the information they need to manage it well," said USGS director Jim Reilly. "These data are vital for understanding water budgets in the different climatic settings across the country."

For the first time since 1995, the USGS estimated consumptive use for two categories—thermoelectric power generation and irrigation. Consumptive use is the fraction of total water withdrawals that is unavailable for immediate use because it is evaporated, transpired by plants, or incorporated into a product.

"Consumptive use is a key component of the water budget. It's important to not only know how much water is being withdrawn from a source, but how much water is no longer available for other immediate uses," said USGS hydrologist Cheryl Dieter.



Trends in total water withdrawals by water-use category, 1950-2015. Credit: Public domain

The USGS estimated a consumptive use of 4.31 Bgal/d, or 3 percent of total water use for thermoelectric power generation in 2015. In comparison, consumptive use was 73.2 Bgal/d, or 62 percent of total water use for irrigation in 2015.

Water withdrawn for thermoelectric power generation was the largest use nationally at 133 Bgal/d, with the other leading uses being irrigation and public supply, respectively. Withdrawals declined for thermoelectric power generation and public supply, but increased for irrigation. Collectively, these three uses represented 90 percent of total withdrawals.

- Thermoelectric power decreased 18 percent from 2010, the largest percent decline of all categories.
- Irrigation withdrawals (all freshwater) increased 2 percent.
- Public-supply withdrawals decreased 7 percent.

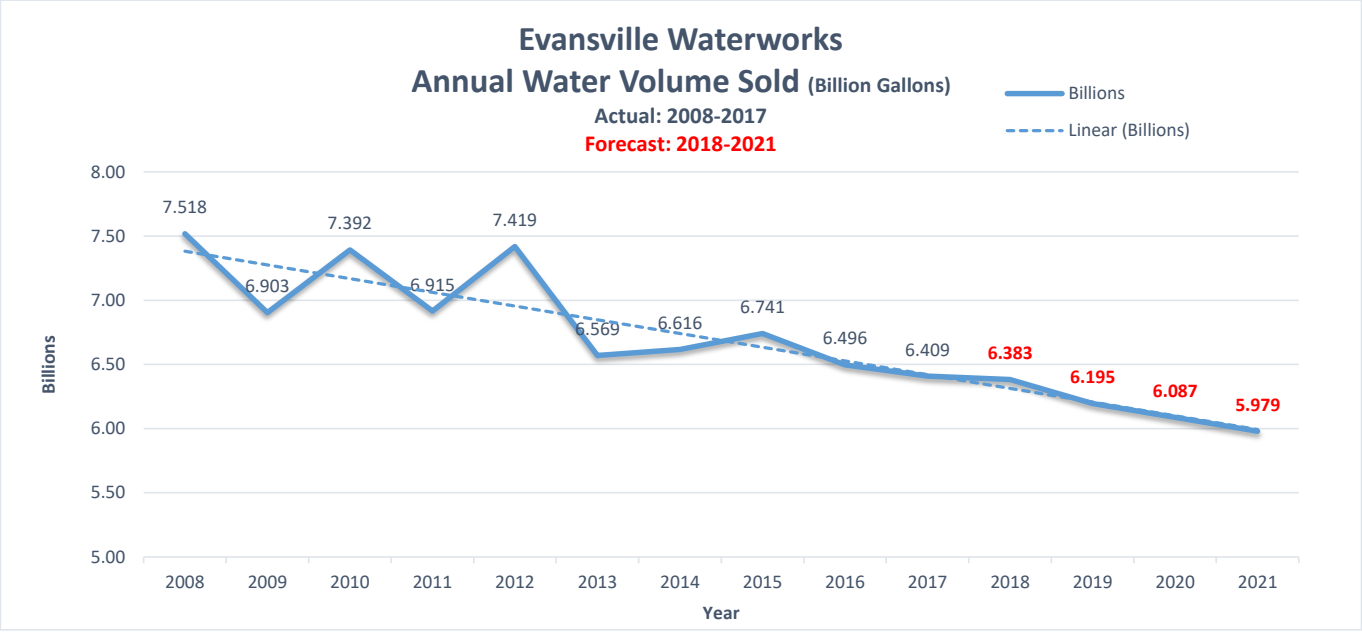
A number of factors can be attributed to the 18 percent decline in thermoelectric-power withdrawals, including a shift to power plants that use more efficient cooling-system technologies, declines in withdrawals to protect aquatic life, and power plant closures.

As it did in the period between 2005 and 2010, withdrawals for public supply declined between 2010 and 2015, despite a 4 percent increase in the nation's total population. The number of people served by public-supply systems continued to increase and the public-supply domestic per capita use declined to 82 gallons per day in 2015 from 88 gallons per day in 2010. Total domestic per capita use (public supply and self-supplied combined) decreased from 87 gallons per day in 2010 to 82 gallons per day in 2015.

Explore further: DNR approves pulling Lake Michigan water for Foxconn plant

More information: Cheryl A. Dieter et al. Estimated use of water in the United States in 2015, (2018). **DOI: 10.3133/cir1441**

Provided by: United States Geological Survey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