



Managing Wastewater in a Changing Climate

Technical Appendix: Results from the PPIC Survey of Wastewater Agencies

CONTENTS

Introduction	2
Methods	2
Wastewater Agency System Characteristics	6
Long-term Trends in Wastewater Management	11
Drought Impacts on California's Wastewater Sector	15
Challenges and Opportunities Ahead	24

Caitrin Chappelle, Henry McCann, David Jassby, Kurt Schwabe, Leon Szeptycki
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Introduction

The report *Managing Wastewater in a Changing Climate* included an online survey of wastewater managers in California. The survey was designed to collect information on four topics from managers of wastewater collection and treatment agencies: (1) characteristics of agency services and systems, (2) long-term trends in wastewater management, (3) the impacts of the 2012–16 drought on wastewater agencies, and (4) challenges and opportunities ahead.

This appendix describes survey methods (design, implementation, and sample representativeness) and presents an overview of the findings.

Methods

Survey Design and Implementation

We developed the survey with input from local and regional wastewater managers and academic experts familiar with the state’s wastewater management sector. In October 2017, we held a workshop for wastewater managers from around the state in order to gather feedback on the draft survey questions. The final survey was distributed to recipients in December 2017.

We used the survey software Qualtrics to implement the online survey. The survey was programmed with conditional rules and formatting to streamline the respondent’s experience. The survey consisted of 74 multiple choice and write-in questions, with an estimated response time of 23 minutes.¹ To avoid response bias related to the order of lists in questions with multiple categories, the order was randomized wherever practical.² In addition to multiple-choice responses, respondents also had multiple opportunities to elaborate with optional write-in questions.

PPIC distributed the survey to senior wastewater managers (general managers or other senior officials) via email on December 5, 2017, with several follow-up reminders sent to non-respondents. Each email contained individualized information for accessing the online survey. Respondents were required to identify their home agency at the beginning of the survey and were assured of the confidentiality of their individual responses. The survey was closed on June 6, 2018.

In summer 2018, PPIC held several follow-up focus groups with some of the local agency respondents to gain insights into interpreting the results. PPIC also met with state agency officials to get feedback on preliminary survey results.

Representativeness of Wastewater Survey Responses

The survey was sent to managers of 501 wastewater systems across the state—based on permit information of the agencies regulated by the federal National Pollution Discharge Elimination (NPDES) or state Waste Discharge Requirement (WDR) permitting process. We received 116 fully completed surveys and 17 surveys with partial

¹ Estimates of survey response time are calculated by Qualtrics based on the number of questions and response options. The survey may have required some respondents to spend additional time to collaborate with other staff in the utility to provide accurate responses or additional nuance, or to review final survey responses.

² Questions with responses based on Likert scales or other types of scales, along with several yes or no questions, were not randomized.

responses, for an overall response rate of 27 percent. Feedback suggests that respondents generally found the survey format to be clearly designed and useful.

The survey collected responses from a wide array of wastewater agencies reflecting the diversity of California's wastewater management sector. To gauge the representativeness of the survey sample, we compared the sample group with all wastewater agencies by region and discharge permit design flow. We found very similar patterns between the 133 survey respondents and all 501 wastewater agencies in California. The sample responses collected in the survey are broadly representative of the wastewater sector as a whole.

Regions

The 2012–16 drought—characterized by below-average rainfall and above-average temperatures—was widespread in California (Ježdmirovic and Mount 2016). Drought required significant adaptations within the state's urban water supply sector—especially in response to widespread reductions in indoor and outdoor water demand (Mitchell et al. 2017). Most wastewater agencies also had to adapt their management practices to accommodate drought conditions and increases in urban water conservation (California Urban Water Agencies 2017). However, both climatic characteristics and water supply and demand conditions vary across regions. Inland areas are generally warmer than coastal areas, and they tend to have higher per capita residential water use, reflecting in part the higher demands for outdoor landscape irrigation (Hanak and Davis 2006). Wastewater agencies in different regions may also have different approaches to managing for short-term and long-term changes in wastewater characteristics and demand for water reuse.

Survey respondents are located in all ten of the state's hydrologic regions—representing a broad array of hydrologic and climatic contexts. For purposes of analysis, we combined these regions into five groups (Figure A1). The location of survey respondents is broadly representative of the geographical distribution of all wastewater agencies in the state. Northern California and the San Joaquin Valley wastewater agencies are both slightly underrepresented in our sample. Central Coast, San Francisco Bay, and South Coast wastewater agencies are slightly overrepresented in our sample.

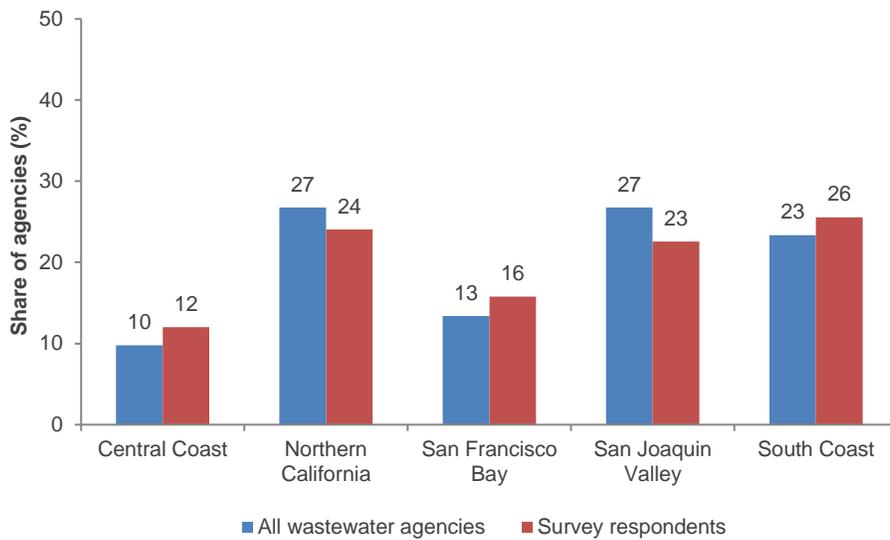
Wastewater System Size

Another way to measure the representativeness between the universe of wastewater agencies and our survey sample is by comparing agency design flows. As a proxy for the physical dimensions of conveyance and treatment systems, design flow provides a metric for comparing the relative sizes of wastewater systems.

The survey sample is broadly representative of all wastewater agencies, ranging from small community services districts serving unincorporated rural communities to public utility districts serving major metropolitan areas (Figure A2). Large systems are overrepresented in our survey sample, while small, medium-small, and medium size suppliers are slightly underrepresented.

FIGURE A1

Regions served by wastewater agencies and survey respondents

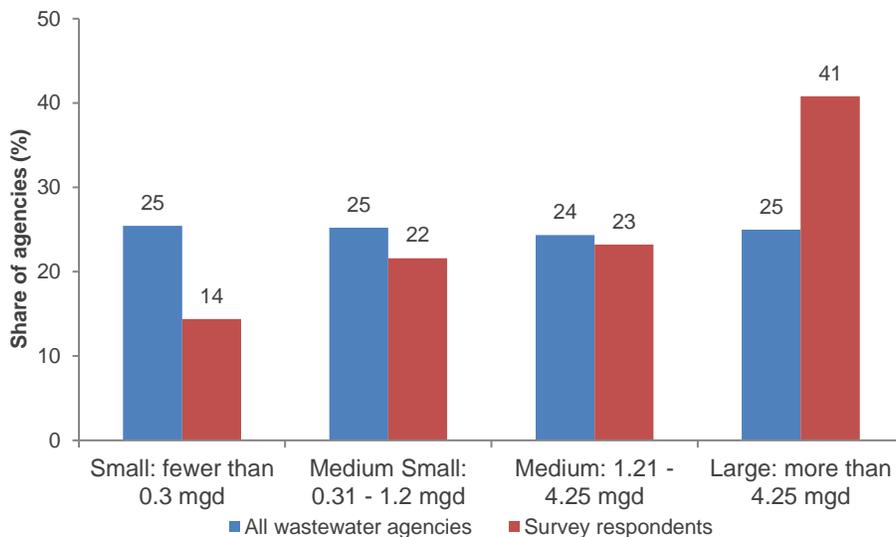


SOURCE: NPDES and WDR permit databases. PPIC California Wastewater Agency Survey 2017.

NOTES: Northern California includes the North Coast, North Lahontan, and Sacramento River hydrologic regions. The San Joaquin Valley includes the San Joaquin River and Tulare Lake hydrologic regions. The South Coast includes the South Coast, South Lahontan, and Colorado River hydrologic regions.

FIGURE A2

Wastewater facility design flows for wastewater agencies and survey respondents



SOURCES: NPDES and WDR permit databases. PPIC California Wastewater Agency Survey 2017.

NOTES: The supplier size categories were determined by calculating the quartiles of populations served by 464 wastewater agencies. Design flow data was not available for all 501 wastewater agencies that received the survey. "mgd" stands for millions of gallons per day.

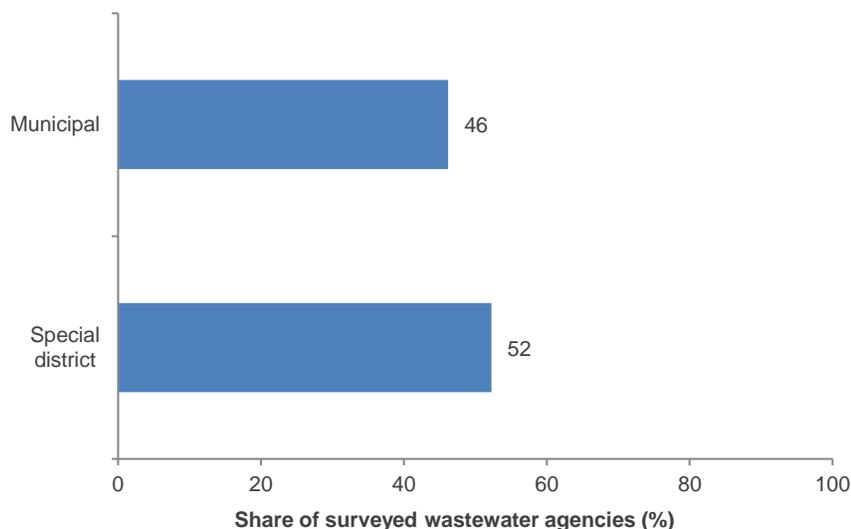
Governance Type

The governance structure of wastewater agencies in California may be generally categorized as municipal (owned and operated by cities or counties) or special district (a local special-purpose public agency focused on

wastewater management). Each type has a unique set of regulations and rules that shape decision making. Both types of wastewater agencies are generally responsible for planning, funding, building, and maintaining wastewater facilities on behalf of their customer base (Water Education Foundation 2013). For the most part, wastewater agencies fund local wastewater services through a combination of property taxes and ratepayer fees. Just over half of the survey respondents are special districts (Figure A3). The other half of the respondents are municipal agencies.

FIGURE A3

Survey respondent governance types



SOURCES: California State Controller revenues and expenditures dataset. PPIC California Wastewater Agency Survey 2017.

NOTE: Overall sample size: 131.

Statistical Analyses

In the presentation of survey findings below, we also report some results of statistical tests used to gauge whether there are statistically meaningful differences in response patterns for agencies with different characteristics. We used chi-square tests for this purpose. We include p-values for these tests, which show the probability that differences across respondent characteristics are statistically significant. Results are considered significant at the 99 percent confidence level if the p-value is less than or equal to 0.01, at the 95 percent confidence level if p-value is less than or equal to 0.05, and at the 90 percent confidence level if the p-value is less than 0.1. Results at the 90 to 95 percent confidence level can be considered marginally or weakly significant; above 95 percent indicates high statistical reliability. This appendix occasionally presents results from chi-square comparison tables that contain cells with expected values less than five.³ These p-values are marked with a superscript dagger (†) which signifies that the comparison table resulting from the chi-square test contained at least one cell with a small expected value (less than or equal to five). The presence of several cells in a comparison table with expected values less than five can limit the accuracy of chi-square tests. Key findings of interest are reported below. Comparison tables and test results are available upon request.

³ Expected values are the frequencies predicted when we assume independence between the rows and columns of our comparison table.

Wastewater Agency System Characteristics

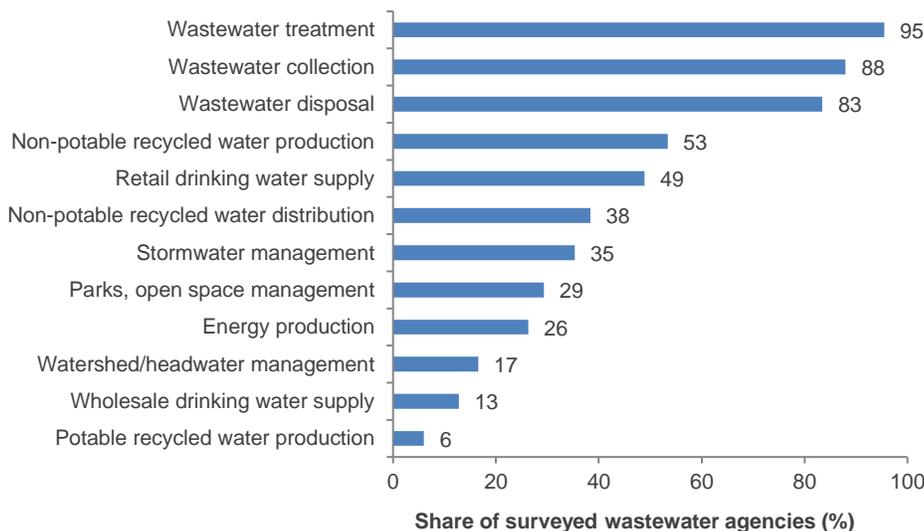
The first section of the survey included questions on the services provided by wastewater agencies, wastewater service populations, sources of influent to treatment plants, end uses of treated wastewater, recycled water production, and wastewater service revenues.

Services Performed by Wastewater Agencies

Managers were asked to identify the services their agency provides (Q 1.1; Figure A4). Respondents could select from a list of 12 services. All of the survey respondents perform at least one core wastewater management function (treatment, collection, or disposal).⁴ Many respondents perform all three core functions (77%). A small share of the respondents perform collection only (2%) or treatment only (5%). About half of the respondents perform retail water supply or non-potable recycled water production in addition to core wastewater functions. Nearly 40 percent of respondents also distribute non-potable recycled water supplies. About one-third of respondents perform stormwater management or manage parks and open spaces. About one-quarter of respondents provide some form of energy production. To a lesser extent, respondents were engaged in watershed management, wholesale drinking water supply, or potable recycled water production.

FIGURE A4

Survey respondents perform a range of functions in addition to wastewater services



SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTE: Overall sample size: 133.

Wastewater Agencies that Perform Stormwater Management

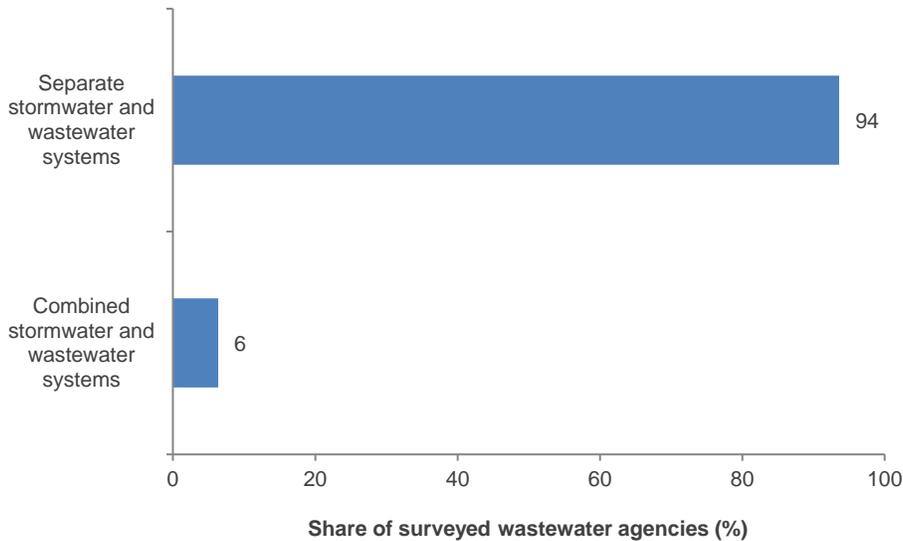
The nearly one-third of survey respondents who indicated that they performed stormwater management in addition to wastewater management were asked to elaborate on aspects of their stormwater systems. The survey asked these respondents if their sewer systems combine stormwater and wastewater (Q 1.1.1). Almost all of the

⁴ Note that there were two exceptions. Two agencies perform wastewater recycling production or distribution but none of the other core wastewater functions.

respondents who perform stormwater management had separate collection systems for stormwater and wastewater (Figure A5).

FIGURE A5

Most wastewater agencies with stormwater responsibilities have separate collection systems



SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTES: Overall sample size: 47. Respondents limited to those performing stormwater management services.

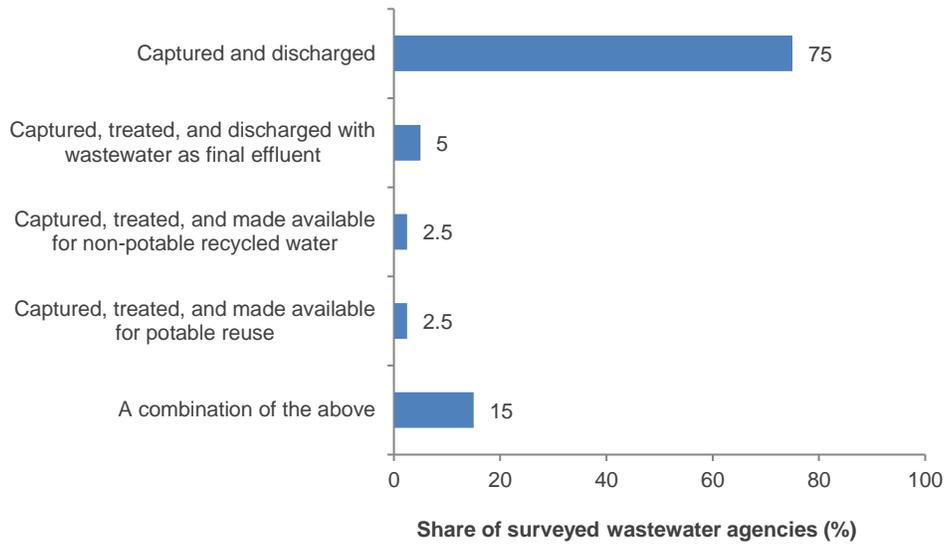
Respondents were also asked to describe the end use of any captured stormwater runoff (Q 1.1.2). Respondents could select one of five options. Three-quarters of the respondents who perform stormwater management capture and discharge urban runoff without treatment. The other quarter of respondents treat captured urban runoff before discharging or providing for use as recycled water supply (Figure A6).

Service Population

Managers were asked to indicate the number of customers they serve with wastewater collection and/or treatment services (Q 1.1.3 and Q 1.1.4). The wastewater collection and treatment populations ranged from several hundred to several million. Half of the respondents provided wastewater treatment services to less than 20,000 people (16,000 for wastewater collection service populations)—approximately the size of a small- to mid-size urban area. Three-quarters of the respondents had treatment service population of less than about 100,000 customers (around 80,000 for wastewater collection service populations).

FIGURE A6

Survey respondents perform a range of functions in addition to wastewater service



SOURCE: PPIC California Wastewater Agency Survey 2017.

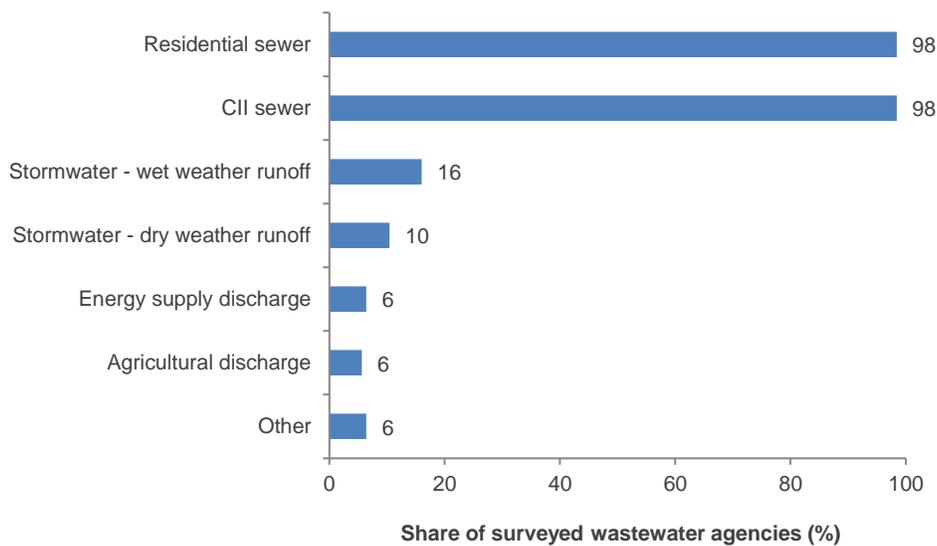
NOTES: Overall sample size: 40. Respondents limited to those performing stormwater management services.

Sources of Influent to Wastewater Treatment Plants

Wastewater treatment plants collect sewage from a variety of sources (Figure A7). The survey asked respondents to indicate the sources of influent to their wastewater treatment plants (Q 1.2). Almost all of the survey respondents collect untreated wastewater from residential and commercial, industrial, and institutional (CII) sources. To a lesser extent, respondents collect untreated water from stormwater, wastewater produced in the energy production process, and agricultural discharge.

FIGURE A7

Wastewater treatment plants received wastewater from a variety of sources



SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTES: Overall sample size: 125. Respondents limited to those performing wastewater treatment services.

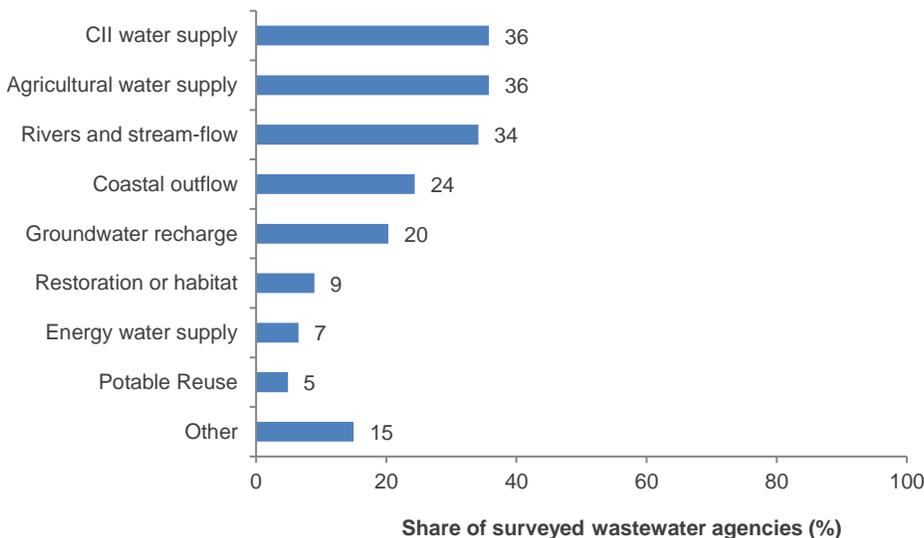
End Uses of Treated Wastewater

Wastewater treatment plants are designed to improve the quality of wastewater influent and either discharge the treated wastewater to the environment or re-distribute the product for other uses. Wastewater systems will often perform a combination of both. The survey asked respondents to indicate the array of end uses of treated wastewater for their system (Q 1.3). Respondents reported that their treated wastewater product has a variety of end uses (Figure A8). Just over one-third of respondents report CII water supply, agriculture water supply, or discharge to rivers and streams as an end use for treated wastewater. Around one-quarter of respondents discharge treated wastewater to the ocean. One-fifth of respondents discharge treated wastewater for groundwater recharge.⁵ To a lesser extent, treated wastewater was used for ecological restoration, energy water supply, or potable reuse. The number of types of end uses per agency ranged from one to seven. Respondents have on average 1.9 end uses. Just less than half of respondents (46%) have a single end use for their treated wastewater.

Respondents were also asked to describe the approximate share of treated wastewater flows for each of their end uses (Q 1.3.1; Table A1). Respondents discharging to coastal areas discharge on average over 80 percent of their treated wastewater to that end use. Respondents discharging to rivers and streams discharge on average nearly three-quarters of their treated wastewater to that end. Respondents discharging wastewater to recharge groundwater dedicated just under 70 percent of their treated wastewater to that end. Three-quarters of respondents indicate at least one non-potable or potable end use.

FIGURE A8

Treated wastewater has a wide range of end uses



SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTES: Overall sample size: 123. Respondents limited to those performing wastewater treatment services.

⁵ In the survey, groundwater recharge was described as groundwater recharge for seawater barrier. Several respondents used the “other” option to describe groundwater recharge generally. These responses were recoded as groundwater recharge and the category was expanded to include groundwater recharge for uses other than seawater barriers.

TABLE A1

Share of wastewater end use flows by type

	Mean share of end use flow (%)	N
Coastal outflow	82	29
Rivers and stream-flow	72	41
Groundwater recharge	69	23
Agricultural water supply	57	42
Potable reuse water	54	5
Energy water supply	39	7
Restoration or habitat	31	9
CII water supply	25	39
Other	52	17

SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTES: The survey used conditional program to tailor this question to the previous selections of the respondent. In this case, respondents were asked to estimate the approximate share of outflows for each of their end uses. The number of respondents is reported in the N column.

Recycled Water Production

Wastewater agencies with at least one non-potable or potable recycled water end use were asked to provide an estimate of total recycled water and potable reuse production in 2016 (Q 1.3.2). Annual production of recycled water ranged from up to five acre-feet to several hundred thousand acre-feet. On average, respondents produced 17,000 acre-feet of recycled water in 2016, with a standard deviation of 70,000 acre-feet. Half of the respondents produced less than 1,800 acre-feet of recycled water. Three-quarters of the respondents produced less than 7,000 acre-feet of recycled water. The five largest recycled water producers in 2016 comprise over three-quarters of the total recycled water production reported in the survey.

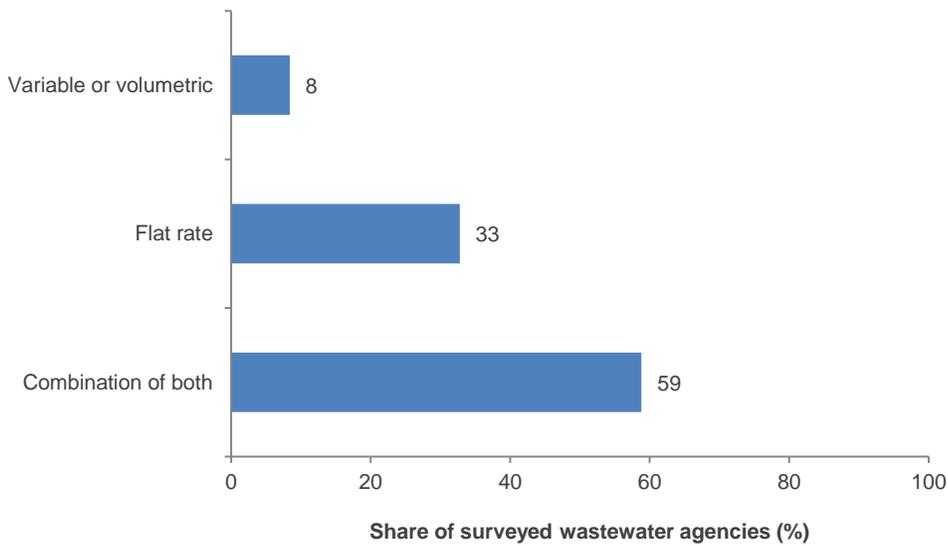
Revenues from Wastewater Service

Wastewater agencies collect revenues from customers to support the costs of providing wastewater services. The survey asked respondents how their agency's wastewater service rates are structures. Respondents categorized rate structures into one of three categories (Q 1.4; Figure A9). Nearly 60 percent of the respondents indicated that a portion of their wastewater service revenues are based on at least some volumetric charge. One-third of the respondents charge wastewater customers a flat rate for wastewater service. Only eight percent of respondents indicate having an exclusively variable or volumetric rate structure.

Respondents with variable or volumetric rates were asked to indicate the portion of their revenues that is based on variable or volumetric charges (Q 1.4.1; Figure A10). Forty-four percent of the respondents indicate that less than one-quarter of their revenues are derived from variable or volumetric charges. Nearly one-quarter of respondents indicate that 25 to 50 percent of their revenues are derived from variable or volumetric charges. One-third of respondents indicate that more than half of their wastewater service revenues are derived from variable or volumetric charges.

FIGURE A9

Customer rate structures for wastewater service

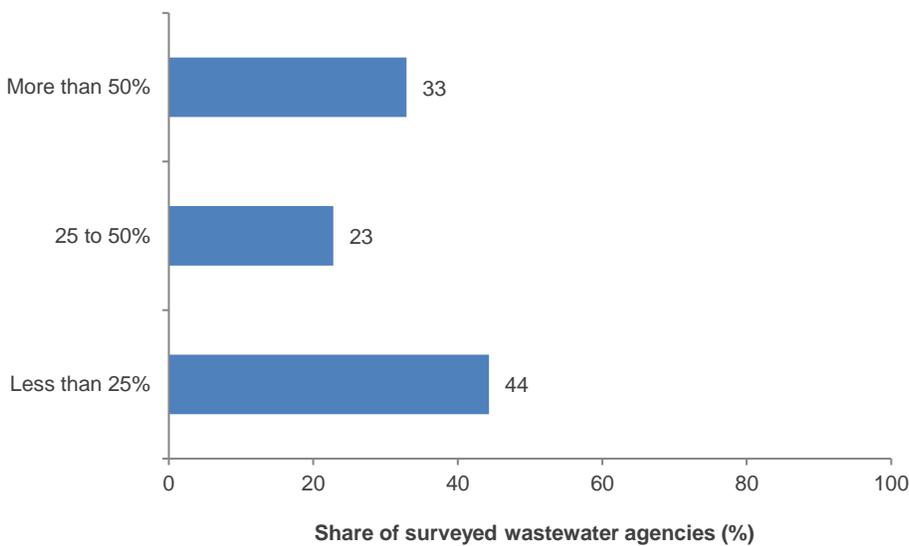


SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTE: Overall sample size: 119.

FIGURE A10

Some wastewater service rates have larger variable components than others



SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTES: Overall sample size: 79. Limited to respondents that indicate that some portion of their rate structure is variable.

Long-term Trends in Wastewater Management

The second section of the survey asked wastewater managers to provide information on long-term trends in wastewater management. Respondents were asked about changes in wastewater service population, influent flows and quality, treated wastewater quality, and demand for recycled water before the onset of the latest drought. The

survey language specifically asked respondents to consider changes over the decade leading up to the 2012-16 drought.

Long-term Changes in Wastewater Flows and Demands

The survey asked respondents to characterize long-term changes in aspects of their wastewater programs, including the service area population, volume of influent flows, and demands for non-potable and potable recycled water (Q 2.1). Respondents could select from a list of four options for describing trends: no change, change, staying about the same but becoming more variable, or unsure.

About half of respondents reported that their service population increased over the decade prior to the drought (Table A2). A very small share of respondents (1%) reported decreasing service populations. Ten percent of respondents characterized service area populations as staying the same but becoming variable. Nearly one-third of respondents reported decreasing volume of influent flows. About one-quarter of respondents experienced an increase in influent flows. Twelve percent reported that influent flows were staying about the same but becoming more variable over the long-term. Over one-third of respondents reported increasing demand for non-potable recycled water, compared to only two percent reporting a decrease. Only 11 percent of respondents reported increasing demand for potable reuse, compared to three percent who reported a decrease. The majority of respondents reported no long-term changes in demand for non-potable or potable recycled water.

Respondents were also asked to characterize long-term changes in the quality of wastewater influent and treated product (Q 2.1.A; Table A3). The question asked respondents to report if water quality changed, but did not specifically ask whether water quality improved or declined over the long-term.

The majority of respondents did not experience any long-term changes in influent or treated water quality. Over one-quarter of respondents reported long-term changes in influent water quality, while just under one-quarter reported change in treated wastewater quality. Nearly ten percent of respondents indicated that influent water quality stayed about the same but became more variable. Only four percent of respondents reported increasing variability in treated wastewater quality.

TABLE A2

Long-term trends in wastewater inflows and demands

	Decreasing (%)	No change (%)	Increasing (%)	Becoming variable (%)	Unsure (%)	N
Service area population	1	41	46	10	3	116
Volume of influent flows	31	32	23	12	3	114
Demand for non-potable recycled water	2	53	34	4	8	114
Demand for potable reuse	3	62	11	2	22	107

SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTES: Response sample sizes are provided in the N column. Respondents were asked to indicate how four aspects of their wastewater programs have changed over the last decade. "Becoming variable" is the abbreviated form of the language seen by respondents, which was "staying about the same, but becoming more variable."

TABLE A3

Most wastewater agencies did not experience long-term changes in influent or treated water quality

	No change (%)	Change (%)	Becoming variable (%)	Unsure (%)	N
Influent water quality	60	28	9	3	116
Treated wastewater quality	74	21	4	1	115

SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTES: Response sample sizes are provided in the N column. Respondents were asked to indicate how four aspects of their wastewater programs have changed over the last decade. "Becoming variable" is the abbreviated form of the language seen by respondents, which was "staying about the same, but becoming more variable."

Patterns

We used statistical methods to examine the relationship between changing service populations and changes in wastewater volume and quality. We also examined the relationship between changing influent volume and changes in influent and effluent wastewater quality.

- Long-term increases in service population:** Wastewater agencies that reported long-term increases in service population were more likely to experience long-term increases in influent volumes compared to agencies that experienced no change in service population (p-value = 0.000†). Nearly one-third of agencies reporting long-term increases in service populations experienced long-term decreases in influent volumes. Agencies reporting long-term increases in service population were also more likely to report long-term changes in influent (p-value = 0.050†) and effluent quality (p-value = 0.081†).
- Long-term changes in influent volume:** Wastewater agencies that reported long-term decreases in influent volumes were more likely to experience long-term changes in influent (p-value = 0.000†) and effluent water quality (p-value = 0.079†). Agencies that reported no long-term changes in influent volumes were more likely to experience no long-term change in influent quality (p-value = 0.000†).

Motivations to Change Operational or Capital Plans

The survey asked respondents to indicate whether or not long-term trends and changes in aspects of their wastewater collection and treatment systems motivated any capital or operational plans before the onset of drought in 2012 (Table A4).⁶ These responses provide a sense of how the wastewater sector adapts to changing conditions and the drivers of any major changes. Nearly 40 percent of respondents who experienced change in influent flows before the drought indicate that it motivated change in capital or operational plans (Q 2.1.1, Q 2.1.2, and Q 2.1.3). Over half of respondents who experienced change in influent quality indicate that it motivated change in capital or operational plans (Q 2.1.4 and Q 2.1.5). Over three-quarters of respondents who experienced changing effluent water quality indicate that it motivated change in capital or operational plans (Q 2.1.6 and Q 2.1.7).

⁶ The survey asked respondents a series of questions about whether or not long-term trends prior to the drought motivated any changes in capital or operational plans (Q 2.1.1–Q 2.1.7). Questions were tailored to respondent's response to Q 2.1 and Q 2.1.a. For example, a respondent who reported increasing influent flows to wastewater treatment plans prior to the drought was then asked if increasing influent flows to treatment plants motivated any changes in their capital or operational plans (Q 2.1.1). Table A4 presents aggregate responses for questions 2.1.1–2.1.7. Changes to influent flows refer to increases, decreases, or increased variability in influent flows. Changes to influent and effluent quality refer to changes or increasing variability.

TABLE A4

Changes in influent and effluent characteristics before the drought motivated some adaptations

	Motivated change (%)	Did not motivate change (%)	Unsure (%)	N
Long-term changes in influent flows	39	60	1	72
Long-term changes in influent quality	54	41	5	41
Long-term changes in effluent quality	77	19	4	26

SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTES: Response sample sizes are provided in the N column. Conditional programming was used to tailor the questions respondents answered based on previous responses. For example, only respondents who indicated changing influent flows before the drought were asked to characterize any capital or operational plans they undertook as a result of changing influent flows before the drought.

Respondents who indicated changing effluent water quality before the drought were asked whether or not water quality protection regulations played a role in motivating capital or operational changes (Q 2.1.8). Nearly 60 percent of these respondents indicated that capital or operational changes due to changing wastewater effluent were motivated by water quality protection regulations (Table A5).

TABLE A5

Regulatory requirements for treated wastewater quality resulted in capital or operational changes

	Yes (%)	No (%)	Unsure (%)
Capital or operational changes were needed to meet regulatory requirements for treated wastewater quality	59	36	5

SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTES: Overall sample size: 22. Conditional programming was used to tailor the questions respondents answered based on previous responses. For example, only respondents who indicated changing treated wastewater quality before the drought were asked to characterize any capital or operational plans they undertook as a result of changing treated wastewater quality before the drought.

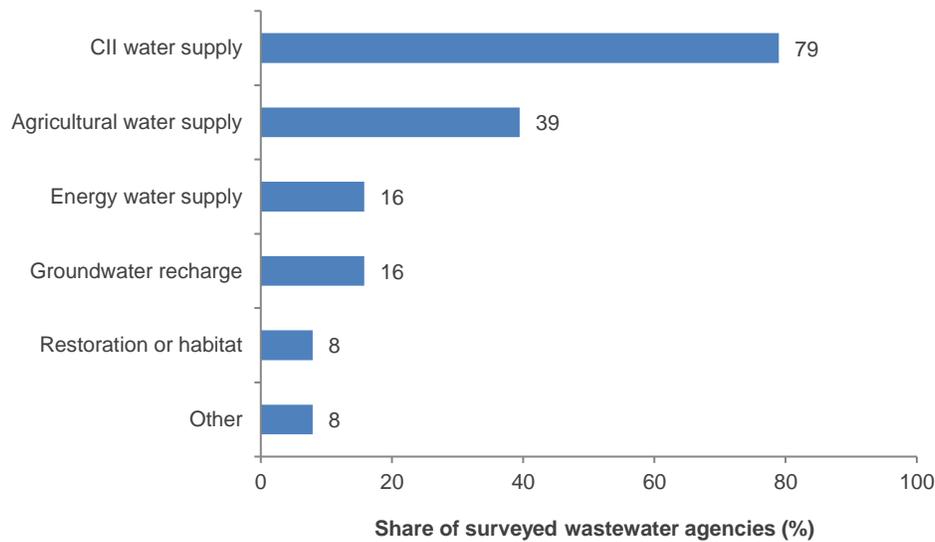
Drivers of Growth in Demand for Non-potable Recycled Water

The survey asked respondents who experienced increasing demand for non-potable recycled water before the 2012-16 drought to describe the drivers of increasing demand (Figure A11, Q 2.1.9). Respondents could select up to six options: commercial, industrial, institutional (CII) water supply, agricultural water supply, energy water supply, groundwater recharge, restoration or habitat, or other.

Nearly 80 percent of respondents indicated that CII customers were driving increasing demand for non-potable recycled water. About 40 percent indicated that agricultural water customers were driving increased demand. To a lesser extent, energy water supply, groundwater recharge, and restoration were other drivers for increasing demand in non-potable recycled water demand.

FIGURE A11

CII and agricultural water supply are driving the increase in demand for non-potable recycled water



SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTES: Overall sample size: 38. Question limited to respondents indicating an increase in non-potable recycled water supplies before the onset of drought in 2012.

Drought Impacts on California’s Wastewater Sector

The third section of the survey gathered information on changes to wastewater systems as a result of the 2012-16 drought. Respondents were specifically asked to describe any changes, impacts, responses, or adaptations that occurred during the period in which urban water use declined as a result of local and state policies.

Managers were asked to describe any changes in their wastewater systems or trends in demand for recycled water during the latest drought (Q 3.1). Respondents could select up to six trends:

1. Reduced influent flows to wastewater treatment plants
2. Change in influent water quality to wastewater treatment plants
3. Change in treated wastewater quality (i.e., effluent quality)
4. Increase in demand for non-potable recycled water (both volume and hook-ups)
5. Increase in demand for potable reuse
6. Decrease in demand for non-potable recycled water (i.e., irrigation)

Respondents observed a wide range of trends during the drought, including changes in influent volume and quality to wastewater treatment plants, changes in treated water quality, and changing demand for non-potable and potable recycled water (Table A6). The majority of respondents indicated a reduction in influent flows to wastewater treatment plants (85%) and changing influent water quality (58%) during the 2012–16 drought. Thirty-eight percent of respondents experienced an increase in demand for non-potable recycled water. Ten percent experienced an increase in demand for potable recycled water, and eight percent reported a decrease in non-potable recycled water demand.

TABLE A6

Most wastewater agencies experienced reduced influent flows and changes to influent quality during the drought

	Count	%
Reduced influent flows to wastewater treatment plants	89	85
Change in influent water quality to wastewater treatment plants	61	58
Increase in demand for non-potable recycled water (both volume and hook-ups)	40	38
Change in treated wastewater quality	24	23
Increase in demand for potable reuse	10	10
Decrease in demand for non-potable recycled water (i.e., irrigation)	8	8

SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTES: Overall sample size: 105.

Most of the questions asked in the third section of the survey asked respondents to provide more specific information on how their agency’s experiences during the drought impacted specific aspects of wastewater infrastructure and operations. The following sections describe those results.

Changing Influent Volume and Quality to Wastewater Treatment Plants

Changes in influent volume and quality to wastewater treatment plants during the drought resulted in changes to wastewater infrastructure and operations. This includes changes to recycled water production, adaptations needed to protect water quality, challenges meeting demands, and complications in the collection and treatment process.

The survey asked respondents who experienced reduction in influent volumes during the drought to estimate the magnitude of the reduction (Q 3.1.A.1). For almost 60 percent of wastewater managers, the reduction in wastewater inflow volume experienced during the drought exceeded ten percent of normal conditions (Table A7). Nearly ten percent of respondents experienced wastewater influent volume reductions of 25 to 50 percent. Influent volumes drive critical aspects of the wastewater collection and treatment processes, including solids management, treatment equipment and processes, and ability to meet regulatory discharge requirements. Changing influent inflows require management adaptations to protect infrastructure and maintain water quality requirements.

TABLE A7

Wastewater managers experienced a range of reductions in influent volumes during the drought

	Count	%
Influent reduction greater than 50%	0	0
25 – 50% influent reduction	8	9
10 – 25% influent reduction	44	50
Influent reduction less than 10%	36	41

SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTES: Overall sample size: 88. Limited to respondents who reported reduced influent flows to wastewater plants during the drought.

The survey asked respondents who produce recycled water and experienced a reduction in influent flows during the drought about changes in the ability to produce recycled water (Q 3.1.A.2). During the drought, over forty

percent of these respondents experienced impairment of recycled water production (Table A8). Fifty-three percent of these respondents did not experience impaired ability to produce recycled water. Three percent of respondents were unsure. These results indicate that recycled water production is not “drought-proof,” as production can be impaired by short-term changes in influent volume.

TABLE A8

Reduction in influent flows during the drought resulted in decreased recycled water production

	Count	%
Recycled water production decreased due to reduction in influent flows	25	43
Recycled water production did not decrease due to reduction in influent flows	31	53
Unsure if recycled water production decreased due to reduction in influent flows	2	3

SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTES: Overall sample size: 58. Limited to entities that perform non-potable or potable recycled water production.

Reduction in influent flow volumes and changes in influent water quality during the drought required many wastewater agencies to adapt aspects of the collection and treatment processes to meet regulatory requirements or resulted in challenges meeting quantities demand by end users, including recycled water customers (Q 3.1.A.B.1; Table A9). Adaptations to protect water quality included changes to characteristics of the treatment process, like modifying the application of treatment chemicals or mixing highly concentrated wastewater influent with other sources of water.

TABLE A9

Some wastewater agencies adapted to meet regulations and were challenged to meet end-use demands during drought

End Uses	Adaptations needed to meet regulatory requirements (%)	Challenge meeting quantity demanded (%)	N
Rivers and stream flow	36	9	33
Coastal outflow	17	10	30
CII water supply	14	26	42
Agricultural water supply	18	24	33
Energy water supply	0	14	7
Groundwater recharge	20	30	20
Restoration or habitat	0	10	10
Potable reuse	0	83	6
Other end uses	10	5	20

SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTES: Question 3.1.A.B.1 used conditional language to tailor the question to specific characteristics of respondents. In this case, respondents were asked about adaptations to meet regulatory requirements and challenges meeting quantity demanded with respect to the end uses they indicated in Section 1 of the survey. The question was also only presented to respondents who indicated in Question 3.1 that they experienced either reduced influent flows to treatment plants or change in influent water quality to wastewater treatment plants. The conditional language programming, coupled with the overall response rate, contributed to low Ns for each end use.

The survey asked respondents to indicate more specifically how changes in influent characteristics (quantity or quality) during the drought impacted aspects of their infrastructure and operations (Q 3.1.A.B.2). Respondents could select up to six impacts from a list:

1. Increased odor problems
2. Increased corrosion of conveyance infrastructure
3. Increased deposition of solids
4. Issues in the treatment process (e.g., increased water temperature and bacterial regrowth)
5. Damage of treatment infrastructure
6. Other

Over one-third of respondents indicated that changing influent volume or quality resulted in issues in the treatment process during the drought (Table A10). Over one-quarter of respondents indicated increased deposition of solids into their collection and treatment systems. While solids management is a routine aspect of wastewater management, the lower flows during the drought required more frequent monitoring and removal of solids. One-fifth of respondents indicated increased corrosion of collection infrastructure due to changes in influent characteristics—suggesting that the highly concentrated influent may have shortened the life of their conveyance infrastructure. One-fifth of respondents reported an increase in odor from sewers, which can be a quality of life problem in some urban areas.

TABLE A10

Wastewater agencies experienced issues with operations and infrastructure during the drought

	Count	%
Issues in the treatment process	36	37
Increased deposition of solids	26	27
Increased corrosion of conveyance infrastructure	19	19
Increased odor problems	18	18
Damage of treatment infrastructure	6	6

SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTES: Overall sample size: 98. Limited to respondents reporting reduced influent flow or change in influent water quality to treatment plants during the drought.

Patterns

We used statistical methods to examine the relationship between the magnitude of reduction in influent inflows and operational and infrastructural challenges experienced during the drought. The only relationship detected was between the magnitude of reduced influent inflows during drought and increased odor problems. Agencies with a higher reduction in influent inflows were more likely to experience increased odor problems (p-value = 0.052).

Changes in Treated Wastewater Quality

Nearly one-quarter of survey respondents reported changes in their effluent water quality during the drought (Table A6). The subset of survey respondents who experienced changes in effluent water quality during the drought were asked to indicate whether these changes required adaptations to meet water quality regulatory requirements or otherwise impacted the ability to meet demand for their end uses (Q 3.1.C.1). While the response

rate for this question is too small to provide an overall picture of the sector, responses indicate that some wastewater agencies adapted wastewater collection and treatment practices to accommodate changes in treated wastewater effluent quality (Table A11). Wastewater agencies also had challenges meeting the quantities demanded by end users like agricultural water supply, groundwater recharge, and in some cases river and stream flows.

TABLE A11

Changes in effluent water quality prompted adaptation to protect water quality and challenges meeting end-use demands

End Uses	Adaptations needed to meet regulatory requirements (%)	Challenge meeting quantity demanded (%)	N
Rivers and stream flow	50	17	12
Coastal outflow	13	0	8
CII water supply	9	27	11
Agricultural water supply	25	25	12
Energy water supply	0	0	3
Groundwater recharge	29	29	7
Restoration or habitat	0	17	6
Potable reuse	25	25	4
Other end uses	50	0	2

SOURCE: PPIC California Wastewater Agency Survey 2017.

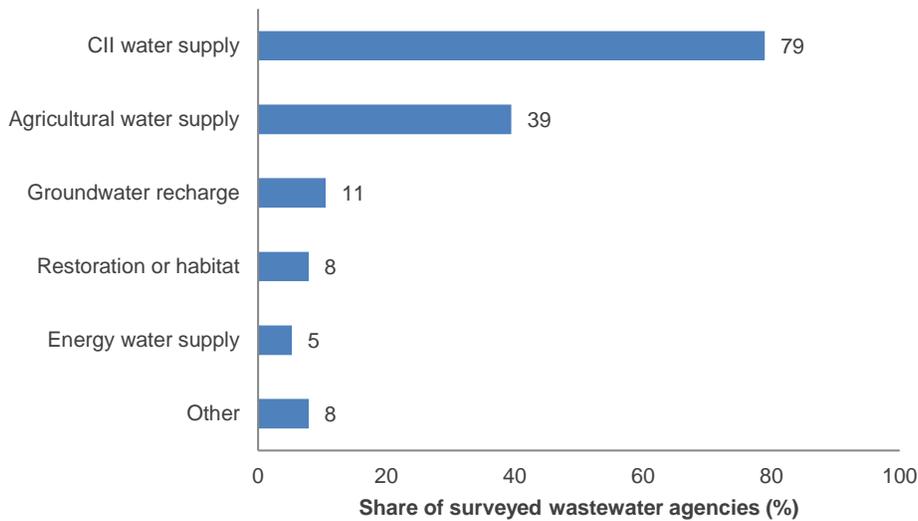
NOTES: Question 3.1.C.1 used conditional language to tailor the question to specific characteristics of respondents. In this case, respondents were asked about adaptations to meet regulatory requirements and challenges meeting quantity demanded with respect to the end uses they indicated in Section 1 of the survey. The question was also only presented to respondents who indicated in Question 3.1 that they experienced changes in effluent water quality. The conditional language programming, coupled with the overall response rate, contributed to low Ns for each end use.

Changing Demand for Non-potable and Potable Recycled Water

Agencies who experienced an increase in demand for non-potable recycled water during the drought were asked to describe the drivers of the increase (Q 3.1.D.1). Most respondents (79%) reported that the commercial, institutional, and industrial water sector drove increasing demand for non-potable recycled water (Figure A12). Over one-third reported that the agricultural sector drove increasing demand for non-potable recycled water. To a lesser extent, groundwater recharge, restoration or habitat, and energy water supply drove increases in non-potable water demand during the drought.

FIGURE A12

CII sectors drove an increasing demand for recycled water during the drought



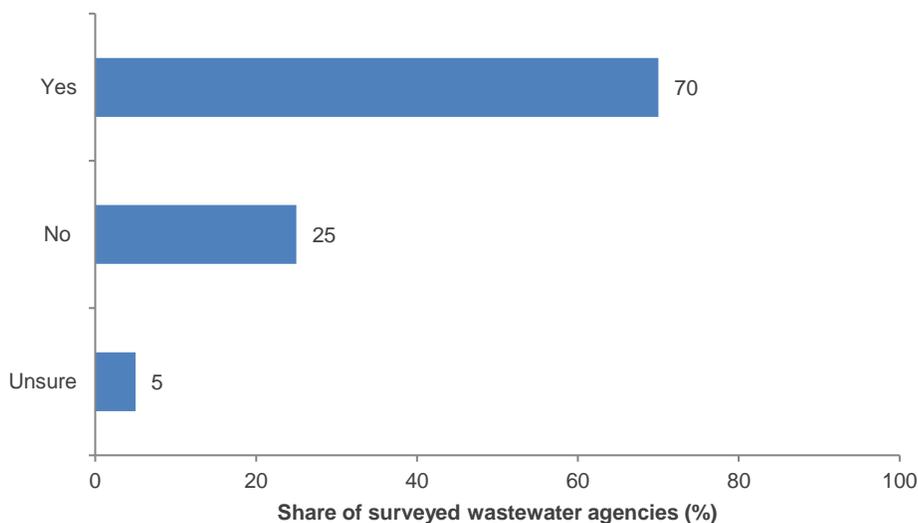
SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTES: Overall sample size: 38. Limited to respondents who observed an increase in demand for non-potable recycled water due to drought.

Survey respondents who experienced increased demands for non-potable recycled water during the drought were also asked whether or not they were able to meet the surge in demand (Q 3.1.D.2). While most respondents were able to meet increased demands (70%), one-quarter of respondents were not able to meet increased demands during the drought (Figure A13). Barriers to meeting demand for non-potable recycled water include supply constraints, regulatory restrictions, technological limitations, lack of infrastructure, financial constraints, and tradeoffs with demand for stream or river flows (Q 3.1.D.3).

FIGURE A13

Most wastewater agencies were able to meet increased demands for non-potable recycled water during the drought



SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTE: Overall sample size: 40. Limited to respondents who observed an increase in demand for non-potable recycled water due to drought.

Only a small portion of respondents (10%) indicated an increase in demand for potable reuse during the drought (Q 3.1). The survey asked follow-up questions to examine whether or not these agencies were able to meet increased demand (Q 3.1.E.1) and barriers to meeting that demand (Q 3.1.E.2). However, the small number of responses limited our ability to generalize these results. At least one respondent indicated that barriers to meeting demand for potable reuse included either supply constraints, regulatory restrictions, technological limitations, lack of infrastructure, financial constraints, or tradeoffs with demand for stream or river flows.

Financial Stability of Wastewater Agencies during Drought

Many wastewater agencies experienced changes to influent and effluent flows during the drought, triggering adaptations and responses to mitigate water quality concerns and meet demands for recycled water. Adaptations like increasing management of solids, increasing system monitoring, or changing aspects of the treatment process have associated costs. In addition, many wastewater agencies derive at least some portion of their rate structure from a volumetric charge (Q 1.4). Reduction in indoor urban water use therefore translated into reduced revenues in some cases.

The survey asked wastewater managers to characterize changes to their agency’s financial stability during the drought (Q 3.3). Managers rated each financial category using a five-point Likert scale ranging from “Greatly reduced” to “Greatly increased” with the option of indicating “Unsure.”

Overall, around one-third of respondents experienced some increase in treatment (35%), operational and maintenance (34%), and capital costs (32%) during the drought (Table A12). One-fifth of respondents reported an increase in wastewater collection costs during the drought. As described in write-in comments (Q 3.4.1), many of these costs are related to necessary adaptations to reduction in influent volumes and concentration of influent quality. Respondents noted that concentrated wastewater influent required additional chemicals and electricity to adequately treat the influent, driving costs up.

TABLE A12

During the drought, wastewater managers experienced some reduction in revenues along with some increase in costs

	Greatly reduced (%)	Somewhat reduced (%)	No change (%)	Somewhat increased (%)	Greatly increased (%)	Unsure (%)	N
Revenues	4	28	60	6	0	2	109
Wastewater collection costs	0	3	74	17	3	3	109
Wastewater treatment costs	0	7	58	31	4	0	110
Other operational and maintenance costs	0	5	61	30	4	1	111
Capital costs	1	1	65	28	4	2	109

SOURCES: PPIC California Wastewater Agency Survey 2017.

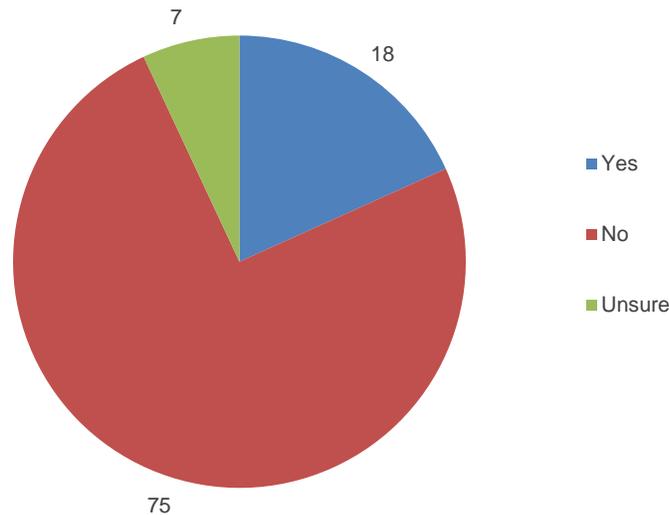
NOTES: Response sample sizes are provided in the N column. “Capital costs” was abbreviated for the table, the full response category is “Capital costs, including construction and administrative costs.”

Wastewater revenues also declined during the drought for some respondents. This was especially true for the two-thirds of wastewater agencies have at least some volumetric portion of their wastewater service rate (Q 1.4). Managers were asked whether or not they are considering changing any component of their wastewater rate structure as a result of the drought (Q 3.4). Three-quarters of wastewater agencies do not intend to change their rate structure as a result of the drought (Figure A14). Respondents provided written remarks on rationales for changes to wastewater rates (Q 3.4.1). Some agencies that intended to change their rate structure are incorporating

more fixed charges to better reflect the fixed costs of wastewater management. Others are evaluating opportunities to incorporate loading of source pollutants into wastewater service rates as a method for controlling commercial and industrial source water quality—charging users higher rates for more polluted influent.

FIGURE A14

Most wastewater agencies have not considered changing rate structure due to the drought



SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTE: Overall sample size: 115.

Patterns

We used statistical methods to examine the financial impacts of reduced influent flows to wastewater plants, changes in influent and effluent water quality, and operational and infrastructural challenges during the drought. We also evaluated how financial impacts may have differed according to an agency’s rate structure.

- **Reduction in influent flows to wastewater treatment plants:** Wastewater agencies that reported reduced influent flows to wastewater treatment plants during the drought were more likely to experience reduced revenues (p-value = 0.015). These agencies were also more likely to experience reductions or no changes in wastewater treatment costs (p-value = 0.004). Reduction in influent flows did not have statistically significant relationships with other financial impacts such as collection costs, operations and maintenance costs, and capital costs. We analyzed whether or not the magnitude of reduction in influent flows relates to financial impacts. Our analysis suggests a weak relationship between the magnitude of influent reduction and treatment costs. Agencies with lower magnitude of influent reduction (less than 10%) were slightly more likely to report increase in wastewater treatment costs (p-value = 0.095). Influent volume is only one factor in determining treatment costs. For some agencies, lower volumes of influent during the drought may have required less treatment than during non-drought conditions.
- **Changes in influent water quality:** Wastewater agencies that reported changes in influent quality to wastewater treatment plants during the drought were more likely to report increases in wastewater treatment costs (p-value = 0.003). There were no other statistically significant relationships between changes in influent water quality and financial impacts.
- **Changes in effluent water quality:** Wastewater agencies that reported changing effluent quality during the drought were more likely to report reductions in revenues (p-value = 0.012). There were no other statistically significant relationships between changes in effluent water quality and financial impacts.

- **Operations and infrastructural challenges:** Many of the operational and infrastructural challenges that resulted from declining influent flows and changing influent quality during the drought also had financial ramifications for wastewater agencies. Agencies reporting reduced revenues during the drought were also more likely to report odor problems (p-value = 0.061), corrosion of collection infrastructure (p-value = 0.089), and issues in the treatment process (p-value = 0.029). Agencies reporting increasing collection costs during the drought were more likely to report odor problems (p-value = 0.005) and corrosion of collection infrastructure (p-value = 0.018). Agencies reporting increasing treatment costs during the drought were more likely to report odor problems (p-value = 0.066) and issues in the treatment process (p-value = 0.023). Agencies reporting increasing other operations and maintenance costs during the drought were also more likely to report odor problems (p-value = 0.017) and issues in the treatment process (p-value = 0.009). Agencies reporting increasing capital costs during the drought were more likely to report odor problems (p-value = 0.004), corrosion of collection infrastructure (p-value = 0.016), and increasing solids deposition (p-value = 0.006).
- **Rate structure:** Wastewater agencies with a flat rate structure were more likely to experience no change in wastewater revenues during the drought. Alternatively, wastewater agencies with at least some portion of revenues derived from volumetric or variable rate structures were more likely to report reduced revenues during the drought (p-value = 0.001).

Changes Motivated by Drought

Managers were also provided an opportunity to describe and explain the motivation for any other significant change to their wastewater operations or capital plans that they anticipated as a result of experiences during the latest drought (Q 3.5). The survey collected 50 write-in responses. Most of the responses describe anticipated changes, and few provided specific motivations for changes. Responses can be categorized within several trends:

Increasing capacity for wastewater recycling:

- Building new water recycling projects
- Expanding existing water recycling systems (storage, production, and distribution)
- Fast-tracking existing plans to expand water recycling systems
- Investigating options for encouraging on-site recycling
- Upgrading recycling process to improve final water quality

Changing operations and maintenance:

- Increasing frequency of service line cleaning and/or purchasing new equipment to better manage solids in conveyance and treatment systems
- Anticipating higher costs for treatment due to increased power consumption, chemical usage, and more frequent replacement of infrastructure as a result of changes in influent characteristics
- Improving operational efficiency to create fiscal buffer for hard times

Modifying system plans and designs:

- Increasing the ability to handle higher strength influent in the treatment process
- Reframing plans to expand treatment abilities based on pollutant concentrations instead of inflow volume
- Improving collection system to reduce long-term maintenance costs for root-intrusion
- Considering more efficient treatment train components to accommodate higher strength influent
- Evaluating climate change impacts on operations and infrastructure, in light of extreme dry and extreme wet conditions
- Reconsidering future plans for recycled water projects as a result of reduction in influent flows

- Considering transition from regional treatment model to a distributed treatment model

Using rates to increase fiscal stability:

- Increasing rates over time to meet current and future funding needs
- Adjust water rates to maintain fiscal stability when water use declines

Monitoring for changing influent and effluent characteristics:

- Increasing monitoring of source water, influent, and effluent water quality
- Developing improved understanding of potential negative impacts of decreasing influent volumes on wastewater operation and infrastructure

Challenges and Opportunities Ahead

The fourth section of the survey collected information on future challenges and opportunities faced by wastewater agencies as a result of changing water use and demand patterns, climate conditions, and water quality regulations.

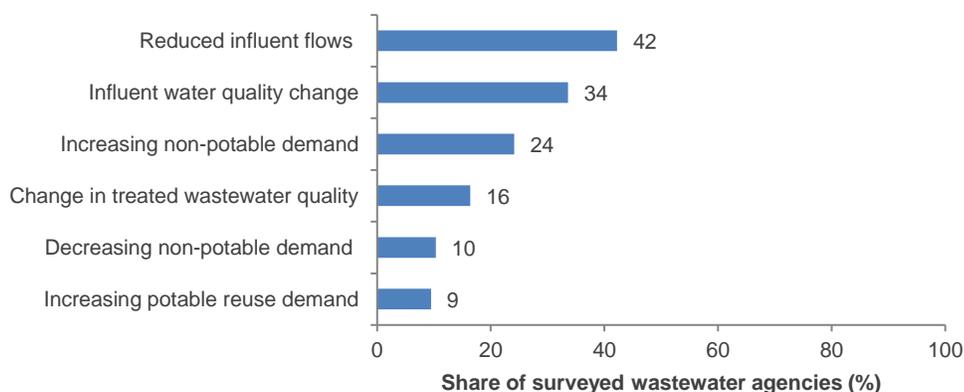
Persistence of Trends Experienced during the Drought

Managers were asked to characterize any trends observed in their wastewater operations or infrastructure that have persisted beyond the end of the drought (Q 4.1). Respondents could select up to six trends representing potential changes in influent and effluent characteristics and changes in demands for recycled water. These were the same trends provided in Question 3.1.

Forty-two percent of respondents indicated that they continued to experience reduced influent flows to wastewater treatment plants following the end of the 2012-16 drought (Figure A15). Over one-third reported persistence in influent water quality changes. Nearly one-quarter reported increasing demand for non-potable recycled water supply. To a lesser extent, respondents reported decreasing demand for non-potable water supplies and increasing demand for potable recycled water supplies.

FIGURE A15

Many wastewater agencies continued to experience changes in influent characteristics after the end of drought



SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTE: Overall sample size: 116.

Future Investments in Wastewater Treatment and Recycled Water Infrastructure

The survey asked managers to describe plans for developing or expanding non-potable recycled water supplies, urban stormwater capture and treatment, potable recycled water supply investments, and investments in wastewater treatment to meet existing or expected regulatory requirements.

Respondents who indicated an increase in demand for non-potable recycled water supplies following the end of drought (Q 4.1) were asked about any constraints encountered in meeting demands (Q 4.1.D.1) and any plans to expand water recycling infrastructure (Q 4.1.D.2). Respondents could select from eight multiple choice options, including the option to indicate that their constraint was not listed or no constraints were encountered:

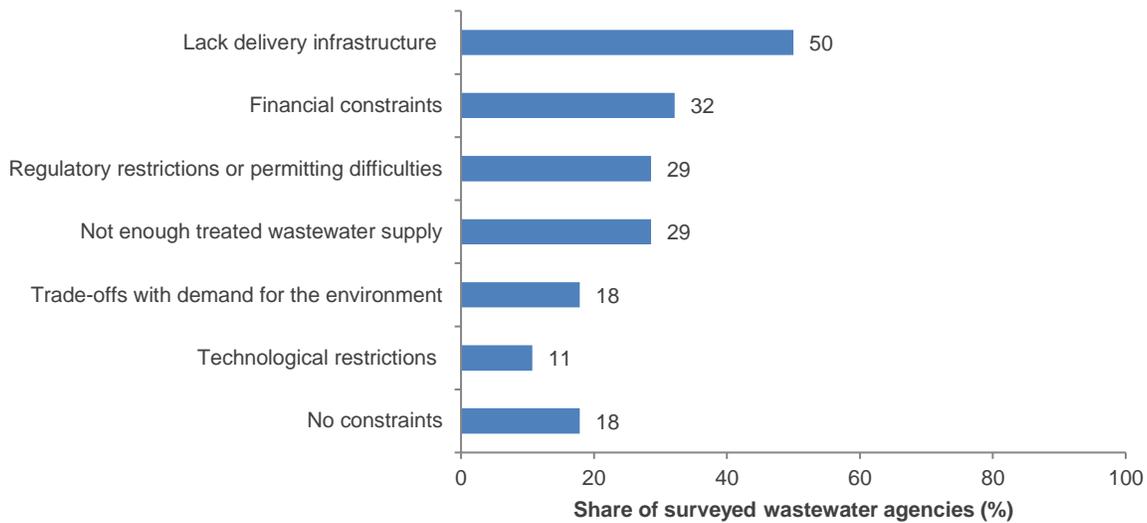
1. No constraints
2. Not enough treated wastewater supply to meet demand
3. Technological restrictions on expanding recycled water supply
4. Regulatory restrictions or permitting difficulties
5. Lacked the infrastructure to deliver the recycled water
6. Tradeoffs with demand for stream or river flows
7. Financial constraints
8. Other

Responses were wide ranging, though half of the respondents indicated that the lack of infrastructure to deliver recycled water was a constraint on fully meeting increased demands for non-potable recycled water after the drought (Figure A16). Around one-third of respondents cited financial constraints as a barrier. Just over one-quarter of respondents reported that regulatory challenges limited the ability to meet increased demands. Over one-quarter indicated that they did not have enough treated wastewater supply to meet the increased demands. Just under one-fifth of respondents encountered no constraints.

Nearly 90 percent of respondents who continued to see an increase in demand for non-potable recycled water after the drought indicated that they are considering new treatment or distribution systems to more fully meet demands (Q 4.1.D.2; Figure A17).

FIGURE A16

Constraints to meeting demand for non-potable recycled water were far ranging

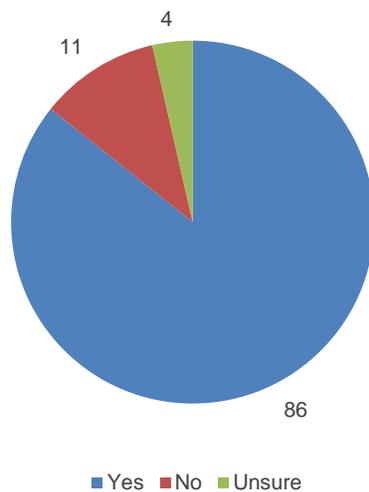


SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTES: Overall sample size: 28. Limited to respondents who continued to see an increase in demand for non-potable recycled water after the drought.

FIGURE A17

Most wastewater agencies with increased non-potable demands after the drought are considering new investments



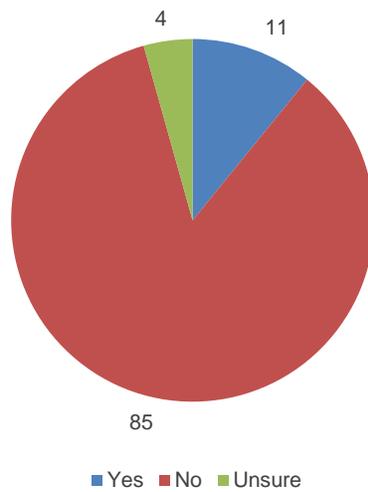
SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTES: Overall sample size: 28. Limited to respondents who continued to see an increase in demand for non-potable recycled water after the drought.

The survey asked wastewater managers whether or not they had existing plans for investments in capturing and treating urban stormwater runoff. Of respondents who did not already indicate stormwater as one of their sources of influent, the vast majority (85%) do not have existing plans to invest in urban stormwater treatment (Q 4.2, Figure A18).

FIGURE A18

New investments in urban stormwater runoff treatment are not likely among wastewater agencies



SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTES: Overall sample size: 92. Limited to respondents who do not already have dry and/or wet stormwater runoff as a source of influent to wastewater treatment plants via Q 1.2.

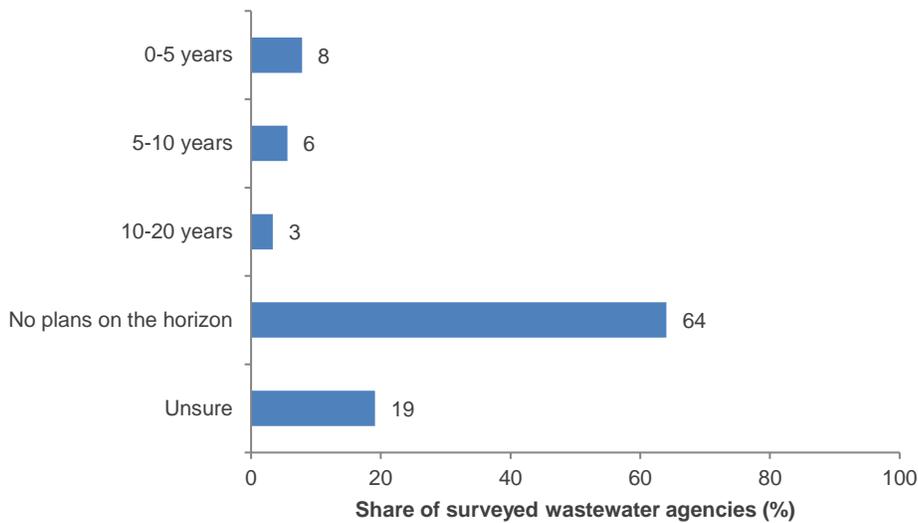
The survey also asked managers who do not already consider stormwater as a source of influent to elaborate on a potential timeline for an urban stormwater runoff capture program. Respondents were provided five options for describing potential timelines for plans: 0–5 years, 5–10 years, 10–20 years, no plans to develop urban runoff capture program, and unsure.

Nearly two-thirds responded that they had no plans on the horizon (Q 4.3; Figure A19). About one-fifth of respondents were unsure of any timelines for implementing a stormwater runoff capture program. Of respondents that indicated they had a timeline for urban runoff capture programs, most expected to have programs within five years. A small number of respondents indicated that they were 10 to 20 years away from having a stormwater runoff capture program.

Several respondents mentioned in write-in responses that they had no plans for capturing runoff because there was not sufficient rainfall in their service areas to justify the investment or their organization did not have the specific mission or authority to capture stormwater (Q 4.3.1). Some respondents also mentioned the need for coordination between neighboring wastewater agencies, flood control districts, municipal stormwater organizations, and water suppliers.

FIGURE A19

Most wastewater agencies don't plan on treating stormwater if they don't already



SOURCE: PPIC California Wastewater Agency Survey 2017.

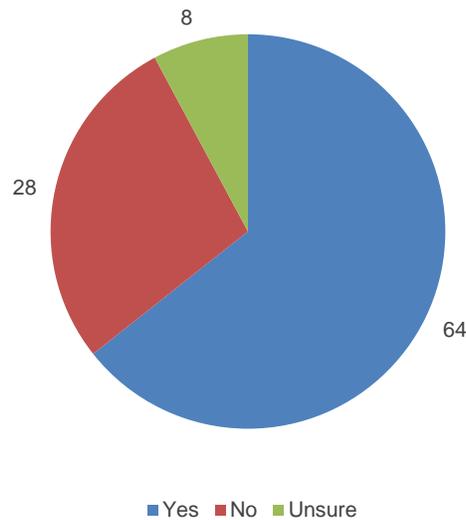
NOTE: Overall sample size: 89. Limited to respondents who do not already have dry and/or wet stormwater runoff as a source of influent to wastewater treatment plants via Q 1.2.

Wastewater managers were asked whether or not they are planning on or currently making investments in order to meet existing or expected regulatory requirements for treating wastewater (Q 4.5). Nearly two-thirds of respondents indicated that they had plans to make investments in their treatment systems to keep up with regulatory requirements for treated wastewater (Figure A20). Over one-quarter of respondents indicated that they did not have immediate plans to upgrade treatment infrastructure in response to regulatory requirements. A small portion of the respondents (8%) were unsure about future investments in treatment infrastructure as they relate to water quality regulations.

Respondents were asked to elaborate on plans to upgrade treatment infrastructure in response to existing or expected regulatory requirements (Q 4.5.1). Several respondents described recently completed or in-progress treatment upgrades to meet discharge permit requirements. Some respondents described the need to re-evaluate upgrade alternatives upon the renewal of their wastewater discharge permits.

FIGURE A20

Most wastewater agencies plan to make investments in treatment systems to meet regulatory requirements



SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTE: Overall response rate: 115.

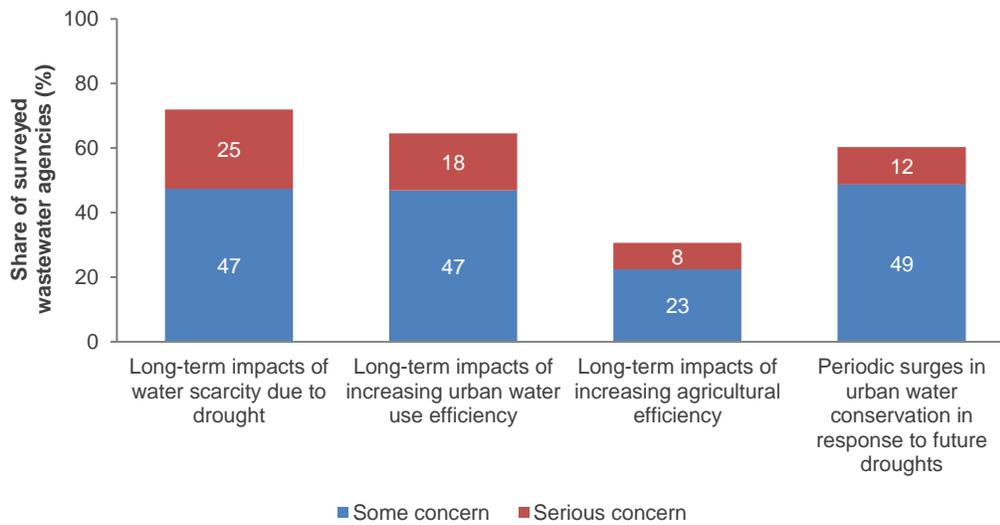
Concerns about the Future

Wastewater managers were asked about concerns related to future drought, changing policies, and climate change. Respondents were asked to rate their concern about water scarcity, increasing water use efficiency, and periodic surges in urban water conservation (Q 4.6; Figure A21). A majority of respondents expressed at least some concern about the long-term impacts of water scarcity, long-term impacts of increasing urban water use efficiency, and periodic surges in urban water conservation. Some respondents reported serious concern. One-quarter of respondents were seriously concerned about water scarcity, nearly one-fifth were seriously concerned about the long-term impacts of increasing urban water use efficiency.

Respondents were also provided an opportunity to elaborate on these concerns (Q 4.6.1). Wastewater agencies commented on how recycled water improves their ability to withstand future long-term water scarcity. Other agencies are concerned about future statewide urban water conservation policies that result in reduced flows and higher strength wastewater influent. Agencies also mentioned the impact of agricultural efficiency on their ability to provide recycled water. In the context of growing demand for recycled water, some agencies suggested that increasing agricultural efficiency could result in an opportunity to meet recycled water demands for other types of water users. Other agencies suggested that increased agricultural efficiency would result in overall reduction in demand for recycled water.

FIGURE A21

Most wastewater agencies are concerned about water scarcity, urban efficiency, and conservation



SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTES: The number of responses varies for each question. N = 114 for long-term impacts of water scarcity due to drought. N = 113 for long-term impacts of increasing urban water use efficiency. N = 111 for long-term impacts of increasing agricultural efficiency. N = 111 for periodic surges in urban water conservation in response to future droughts. Ten respondents were concerned about other categories not listed as response options. In each category, a small number of respondents were unsure about their concerns.

Respondents were asked to describe their concern about specific aspects of their wastewater collection, treatment, and recycling systems with respect to higher temperatures and more frequent dry and wet periods due to a changing climate (Q 4.7). Nearly two-thirds of respondents were concerned about the impacts of a changing climate on sewer planning and operations and treatment plant design and operations (Figure A22). Nearly half of respondents were concerned about the impact of climate change on their ability to comply with treated wastewater quality standards. Over one-third of respondents were concerned about the impact of climate change on the ability of receiving waters to accommodate treated wastewater and the ability to meet recycled water demands. Some agencies reported serious concerns. Around one-tenth of respondents reported serious concerns related to climate change in each category. Write-in respondents offered more specific examples of how climate change poses challenges to their systems (Q 4.7.1). For example, rising sea levels might impair discharge facilities during storm events. Other respondents were concerned about concentrated and localized flooding that might increase as a result of a changing climate.

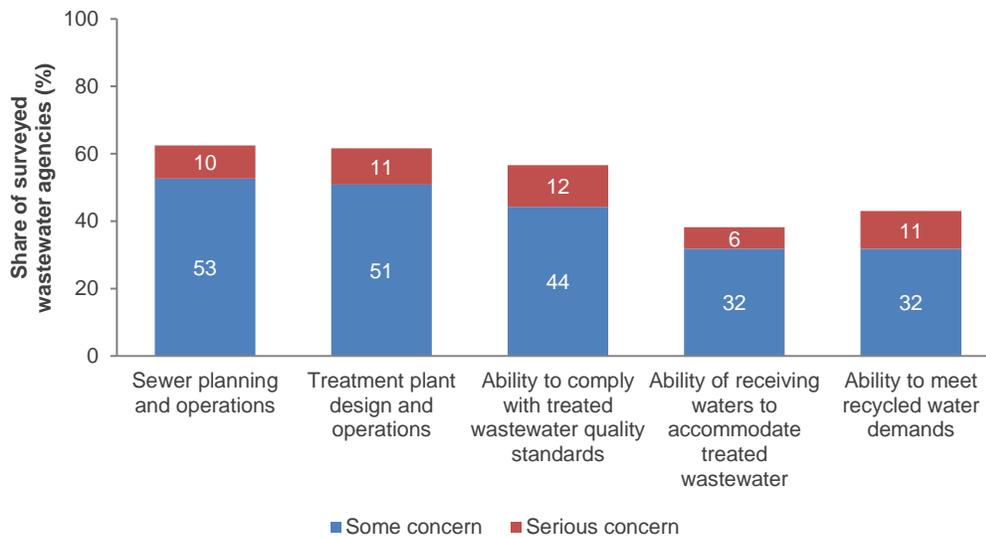
Patterns

We used statistical methods to examine how concerns about the future are related to additional services provided by wastewater agencies and geography:

- **Water service providers:** Wastewater agencies that also perform retail or wholesale water service functions were more likely to report concerns about future water scarcity issues (p-value = 0.028).
- **Coastal versus inland wastewater agencies:** Coastal discharging wastewater agencies were more likely than inland wastewater agencies to report at least some concern about the ability of receiving waters to accommodate treated wastewater (p-value = 0.002†).

FIGURE A22

Most wastewater agencies are concerned about the impact of a changing climate



SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTES: The number of responses varies for each question. N = 112 for sewer planning and operations. N = 112 for treatment plant design and operations. N = 113 for ability to comply with treated wastewater quality standards. N = 110 for ability of receiving waters to accommodate treated wastewater. N = 107 for ability to meet recycled water demands. Seven respondents were concerned about other categories not listed as response options. In each category, a small number of respondents were unsure about their concerns.

Coordination between Wastewater Managers and Water Suppliers

Managers were asked to complete the following sentence: “Given the challenges related to climate change and population growth, the coordination between our community’s water supply agencies and wastewater agencies needs to _____” (Q 4.8). Respondent answers reflect their attitudes towards the need for increased cooperation between wastewater and water supply agencies that service the same customers. Overall, about two-thirds of respondents indicated that some increase in coordination between wastewater and water suppliers was important for facing the challenges of climate change and population growth (Figure A23).

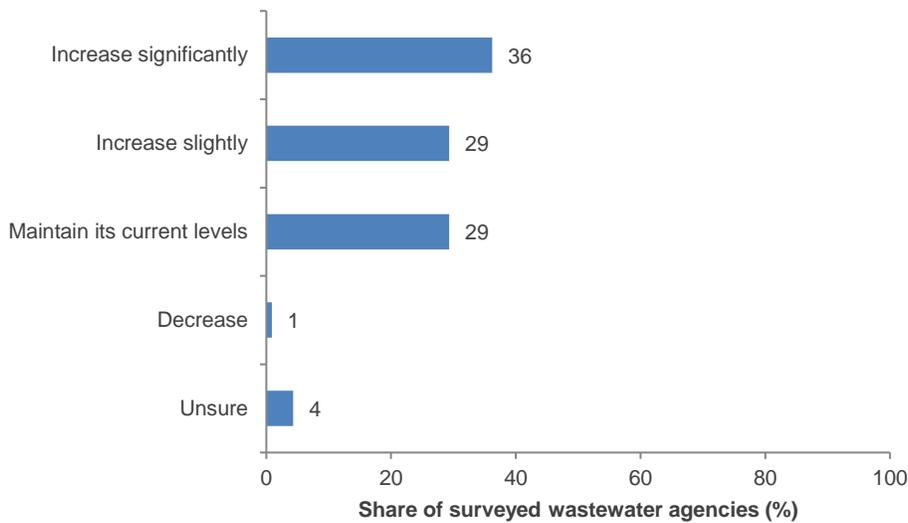
Over half of respondents supporting increased coordination indicated that coordination should increase significantly. Nearly one-third of all respondents indicated that coordination levels should not change. A small number of respondents indicated that coordination should decrease or were unsure about the need for coordination with water suppliers.

Patterns

We used statistical methods to determine if the preference for increased coordination between wastewater and water supply agencies differed based on whether or not the wastewater agency also provided water supply services. There was no statistical relationship detected. Wastewater agencies that provide water service and those that do not were equally supportive of increase coordination between wastewater and water supply organizations.

FIGURE A23

The majority of wastewater agencies prefer to increase coordination with water suppliers



SOURCE: PPIC California Wastewater Agency Survey 2017.

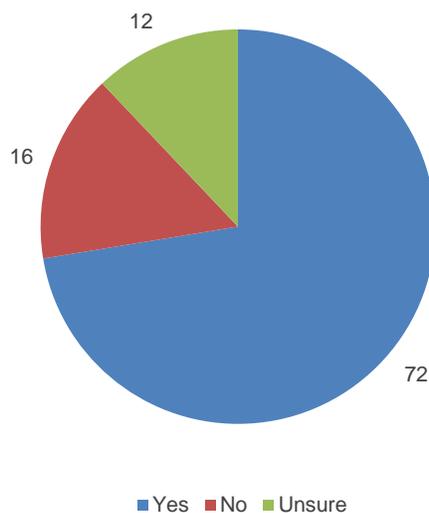
NOTE: Overall sample size: 116.

Wastewater System Technologies and Climate Change

Respondents were asked to indicate whether or not their current wastewater treatment technology is capable of handling the pressures associated with climate change (Q 4.9). Nearly three-quarters of respondents indicated that their wastewater technology was capable of overcoming future challenges posed by climate change (Figure A24). Just over one-quarter of respondents were not confident in their current technology or were unsure.

FIGURE A24

Wastewater agencies are confident in their wastewater technologies in the face of changing climate



SOURCE: PPIC California Wastewater Agency Survey 2017.

NOTE: Overall sample size: 116.

Respondents were also provided the means to elaborate on their answers through a write-in question (Q 4.9.1). Respondents who were confident in their technologies described recent upgrades in their systems that increase their confidence in overcoming future challenges. More than one agency described confidence in upgrades, but concern about the cost of future upgrades in response to climate change. Another agency was concerned that changes to their discharge permit might pose challenges in a future with more extreme weather events.

The 16 percent of respondents who indicated that they were not confident in their current wastewater system technologies in the face of climate change provided several rationales for their response. For example, some respondents mentioned that aspects of their wastewater systems are not currently conducive to wastewater recycling, either because of low influent quality or low influent volume. One agency was concerned about rising total dissolved solids (TDS) levels and their current inability to lower TDS through treatment. Another agency was concerned about large wet weather events on inflows to wastewater treatment plants.

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Public Policy Institute of California
500 Washington Street, Suite 600
San Francisco, CA 94111
T: 415.291.440
F: 415.291.4401
PPIC.ORG/WATER

PPIC Sacramento Center
Senator Office Building
1121 L Street, Suite 801
Sacramento, CA 95814
T: 916.440.1120
F: 916.440.1121