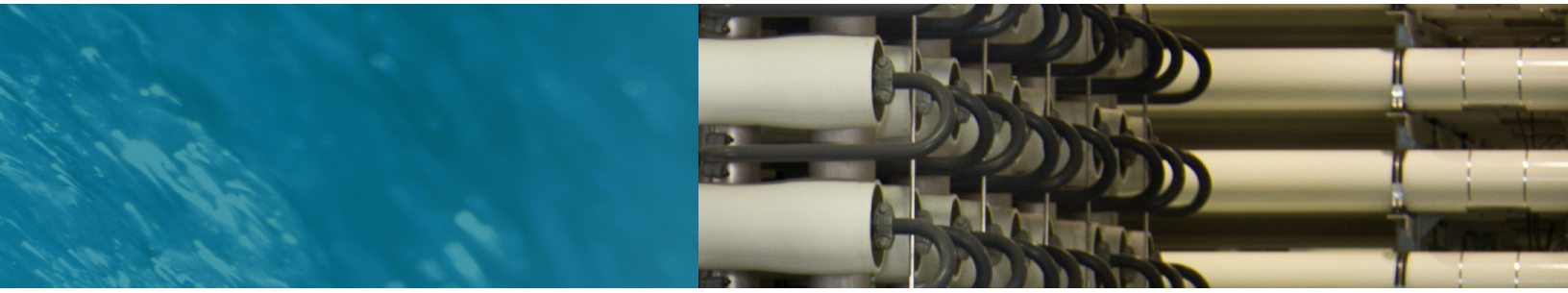
VOLUME 3 - RESOURCE MANAGEMENT STRATEGIES

CHAPTER 15

Drinking Water Treatment and Distribution



Fremont, CA. Assistant General Manager Robert Shaver and District Board President Jim Gunther inspect Alameda County Water District's Newark Desalination Facility. (July 16, 2013)

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Chapter 15. Drinking Water Treatment and Distribution

Providing a reliable supply of safe drinking water is the primary goal of public water systems in California. To achieve this goal, public water systems must develop and maintain adequate water treatment and distribution facilities. In addition, the reliability, quality, and safety of the raw water supply are critical to achieving this goal. In general, public water systems depend greatly on the work of other entities to help protect and maintain the quality of the raw water supply. Many agencies and organizations have a role in protecting water supplies in California. For example, the basin plans developed by the regional water quality control boards recognize the importance of this goal and emphasize protecting water supplies — both groundwater and surface water.

A public water system is defined as a system for the provision of water for human consumption, through pipes or other constructed conveyances, which has 15 or more service connections or regularly serves at least 25 individuals daily at least 60 days of the year (Health and Safety Code Section 116275[h]).

Public water systems are divided into three principle classifications: community water systems (CWS), non-transient non-community (NTNC) water systems, and transient non-community (TNC) water systems. As the name indicates, CWS serve cities, towns, and other residential facilities occupied by year-round users. Examples include everything from apartment complexes served by their own wells to systems serving California's largest cities. NTNC systems are public water systems that are not CWS and provide water to the same non-residential users daily for at least 180 days of the year. Examples include schools, places of employment, and institutions. TNC systems are places that provide water for a population that mostly comes and goes. Examples include campgrounds, parks, ski resorts, rest stops, gas stations, and motels. Table 15-1 shows the number of public water systems in California by class. CWS serve approximately 36.6 million of the estimated 37.7 million people throughout the state, or 97 percent of the state's population. The remaining estimated 1.1 million people in the state (3 percent of the population) receive their drinking water from private wells serving their individual residences or from other sources. Virtually every Californian and visitor to the state will use drinking water from a regulated public water system through their work, while on vacation, or while traveling through the state. Figure 15-1 shows water system class by percentage of total number of public water systems in California.

Under the California Safe Drinking Water Act and Toxic Enforcement Act, the California Department of Public Health (CDPH) or CDPH Drinking Water Program has adopted regulations to ensure high-quality drinking water is provided by public water systems at all times. In developing drinking water regulations and carrying out the public water system regulatory program, CDPH recognizes that healthy individuals and communities cannot exist without safe, reliable water supplies. These actions are necessary not only for drinking water, but also to meet basic sanitary and public safety needs.

Drinking water regulations mandated by the California Safe Drinking Water and Toxic Enforcement Act apply to all public water systems, regardless of ownership. There are two basic water system ownership types — publicly owned and privately owned. Publicly owned systems

Table 15-1 Public Water Systems in California by Class

Public Water System Classification	Number
Community	2,973
Non-transient non-community	1,490
Transient non-community	3,111
Total number of public water systems	7,574

Source: California Department of Public Health records, August 2012. Does not include water systems serving Native American tribes or on tribal lands.

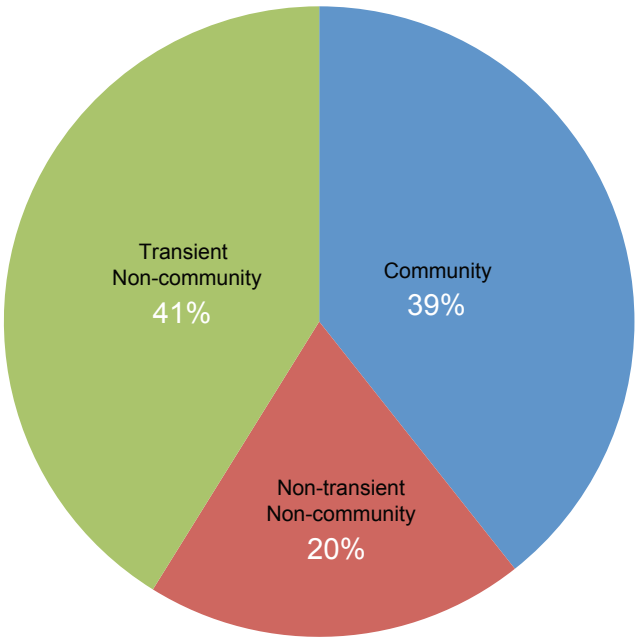
include municipalities, special districts, and federal or State government systems. Privately owned systems include investor-owned utilities, mutual water companies, mobile home parks, and water associations, and may include various commercial enterprises, such as restaurants, hotels, resorts, employee housing, or other similar businesses that have their own water supply. While CDPH regulates all public water systems for all aspects that may affect water quality regardless of ownership, the California Public Utilities Commission (CPUC) regulates privately owned, for-profit systems serving communities for the purposes of establishing appropriate water rates. The CPUC regulates sole proprietorships, partnerships, and corporations that provide water service to the public for profit. Mutually owned systems and homeowners associations are exempt from CPUC oversight if they provide water only to their stockholders or members. In addition, systems serving privately owned mobile home parks are also exempt except that CPUC may conduct an investigation into water rate abuses when they receive complaints from residents. Table 15-2 provides a summary of the type, number, and size of the CPUC-regulated water systems.

At the federal level, the U.S. Environmental Protection Agency (EPA) is responsible for ensuring implementation of the federal Safe Drinking Water Act and related regulations. The State has primacy for the public water system regulatory program in California and works closely with the EPA to implement the program. In addition, local primacy agencies (typically the county environmental health departments) are responsible for regulating many small public water systems (typically those serving fewer than 200 homes) in 32 of the 58 California counties. EPA directly provides regulatory oversight for tribal water systems.

Public water systems rely on groundwater, surface water, or a combination of both as their source of supply. Groundwater wells used for drinking water are constructed in a manner to intercept high-quality groundwater. Therefore, many groundwater wells require little to no treatment. However, some groundwater wells are affected by anthropogenic (human-made) and/or naturally occurring contaminants that require treatment to achieve the high level of quality mandated by State and federal regulations for a safe, reliable water supply. All surface water supplies used for drinking water must receive a high level of treatment to remove pathogens, sediment, and other contaminants before being suitable for consumption. Once the water is treated to drinking water standards, this high level of water quality must be maintained as the water passes through the distribution system to customer taps. Water treatment and distribution issues are discussed in detail later in this chapter. There is an increasing effort aimed at preventing pollution and matching water quality to water use. This is described in this volume in Chapter 17, “Matching Water Quality to Use,” and Chapter 18, “Pollution Prevention.”

The use of bottled water in the United States has been an increasing trend; however, recently that trend appears to have flattened from 2007 through 2011. The Beverage Marketing Corporation and International Bottled Water Association report that U.S. consumption of bottled water was 29.2 gallons per person in 2011 and 29.0 gallons per capita in 2007. In 2005, California ranked Number 1 in the nation for percentage of the bottled water share (23.9 percent) and was ranked Number 3 behind Arizona and Louisiana for per-capita consumption at 51.2 gallons (Donoho 2007). Some of the reasons that individuals choose bottled water include convenience, image, taste, and perceived health benefits. On the other hand, many consumers are becoming aware of the environmental impact associated with the production, transportation, and waste disposal of bottled water, including the contributions to greenhouse gas (GHG) emissions. While tap water and bottled water are regulated differently, both are generally safe. Tap water provided by a public water system yields public health and fire protection among its other advantages to a modern quality of life. Bottled water costs significantly more than tap water for the volume consumed in cooking and drinking.

Figure 15-1 Public Water System Class by Percentage of Systems



Bottled water is regulated by the U.S. Food and Drug Administration under the 1938 Food, Drug, and Cosmetic Act. California regulates bottled and vended water to a much greater degree than provided in the act. The California Sherman Food, Drug, and Cosmetic Law is the basic statute that authorizes such regulation and is implemented by the CDPH Food and Drug Branch.

Drinking Water Treatment in California

Public Health

Water treatment includes processes that treat, blend, or condition the water supply of a public water system for the purpose of meeting primary and secondary drinking water standards. These processes include a wide range of facilities to treat surface water and groundwater. Common surface water treatment facilities include basic chlorine disinfection; sedimentation basins; filtration; and more recent technical advances, such as membrane filtration, ultraviolet light, and ozonation to meet pathogen removal and/or inactivation as well as disinfection requirements while controlling the formation of disinfection byproducts. Common facilities for groundwater sources that require treatment are chemical removal and/or blending facilities. Blending treatment

Table 15-2 Number and Type of CPUC-Regulated Water Agencies

CPUC class	Number of Connections Served	Number of Agencies in Class
A	>10,000	10[a]
B	2,000-10,000	6[a]
C	500-2,000	22
D	<500	85

Source: California Public Utilities Commission Web site, June 2012.

Notes:

[a] Many of the private agencies included in the number shown operate multiple water systems throughout California.

is an acceptable practice for meeting chemical water quality standards and is a process of reducing the contaminant concentration in one water source by blending or dilution with water that has a lower contaminant concentration. Many water systems must also buffer or adjust the pH of the water to ensure that the delivered water is not corrosive in the distribution system and customers' piping. Fluoridation treatment, now commonly practiced in California, may be used to add fluoride to an optimal level that provides dental health benefits.

Widespread treatment of drinking water, especially disinfection, filtration, and fluoridation, was a great public health advancement of the 20th century. The 21st century promises to bring additional advances in water treatment technologies to improve the removal of contaminants, reduce the cost per gallon of treated water, improve water use efficiency (increase water recovery and reduce waste streams), and manage energy consumption. Water recovery — or recycling of water containing treatment process wastes (i.e., filter backwash water, filter rinse water) that would otherwise be disposed — begins with treatment of the recovered or recycled water so it may be blended with raw untreated water at the start of the treatment plant process. This enables a larger percentage of a water supply to be converted to potable water and concentrates the solids generated at the treatment plant. It is important for treatment processes in water-short areas to maximize the amount of a water supply that can be converted to potable water by reducing the amount of water that is discharged as waste.

California public water systems use an estimated 17,983 groundwater wells and surface water supplies to meet the water supply needs of consumers. Some of these sources need treatment to remove or inactivate harmful contaminants or to meet aesthetic quality prior to consumption. These could include minerals, metals, chemicals from industry or agriculture, pathogens, and radiological constituents. Currently, there are an estimated 8,560 water treatment facilities in California. Most of these are disinfection facilities provided at sources, treated water storage tanks, or within the distribution system. The remaining systems provide more extensive treatment summarized in Table 15-3.

Fluoridation

Fluoridation of community drinking water has been practiced in the United States for more than 60 years. It is accepted as a safe and effective public health practice for people of all ages. The

Table 15-3 Treatment Plants on California Public Water System Sources

Type of Contaminant	Approximate Number of Major Treatment Plants
Surface water[a]	699
Nitrate	150[b]
Arsenic	79[b]
Perchlorate	40
Radiological	10[b]
Volatile and synthetic organic chemicals	220[b]
Aesthetic water quality	350

Source: These estimates are based on a survey of California Department of Public Health offices and from California Department of Public Health records.

Notes:

[a] Surface water, defined under the California Surface Water Treatment Rule (California Code of Regulations, Title 22, Section 64651.83) means "all water open to the atmosphere and subject to surface runoff..." and hence would include all lakes, rivers, streams, and other water bodies. Surface water includes all groundwater sources that are deemed to be under the influence of surface water (i.e., springs, shallow wells, wells close to rivers), which must comply with the same level of treatment as surface water.

[b] Includes only chemical removal treatment facilities. Blending facilities are not included.

previous five U.S. Surgeons General have recommended that communities fluoridate their water to prevent tooth decay, the major form of preventable dental disease in America. California's fluoridated drinking water act, Assembly Bill (AB) 733, became law in 1995 and required water systems with 10,000 or more service connections to fluoridate once money from an outside source is provided for both installation and operation and maintenance costs. CDPH is also responsible for identifying funds to purchase and install fluoridation equipment for public water systems.

During fluoridation treatment of public water system supplies, water systems adjust fluoride in drinking water to an optimal level shown to reduce the instances of tooth decay. Optimal fluoridation means that the water treatment facility and distribution system is closely managed to provide a consistent level of fluoride at the appropriate prophylactic level to reduce dental disease. Other water systems, that purchase water from a wholesale provider that fluoridates, provide variable fluoridation at levels up to the optimal level. The level of fluoride in these systems depends on many factors, including time of year, water demand, and the use of sources that may not have fluoridation treatment facilities. Additional information on water systems that provide fluoridated water is available at http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Fluoridation.aspx.

Regulation

Both EPA and CDPH have ongoing programs for improving public health through new or more stringent drinking water regulations. These regulations include monitoring requirements, maximum contaminant levels (MCLs) in the water provided to the customer, multi-barrier

treatment requirements, permitting requirements, public notification, and more. These regulations include specific MCLs for constituents of health concern that are present in drinking water sources. In California, new drinking water standards — the MCLs — are adopted only after development of a Public Health Goal (PHG), which is the level of a contaminant in drinking water below which there is no known or expected risk to health. PHGs are set by the Office of Environmental Health Hazards Assessment, an agency under the California Environmental Protection Agency (Cal/EPA). MCLs take into account not only chemicals' health risks, but also such factors as their detectability and treatability, as well as costs of treatment. The Health and Safety Code requires CDPH to establish a contaminant's MCL at a level as close to its PHG as is technically and economically feasible, placing primary emphasis on the protection of public health.

In some cases, California adopted MCLs in advance of the federal adoption of an MCL. For example, CDPH adopted a perchlorate MCL of 6 micrograms per liter (µg/L) in 2007. This MCL is based primarily on potential adverse effects on the thyroid. In 2008, EPA indicated that it did not intend to adopt an MCL for perchlorate. However, in 2011 EPA reversed its earlier decision and now plans to propose a formal rule for perchlorate (U.S. Environmental Protection Agency 2011). In September 2012, EPA posted a Federal Register notice of a public meeting regarding its intent to regulate perchlorate levels in drinking water through adoption of an MCL and anticipated that a draft rule would be available for public comment in 2013.

CDPH is currently in the regulation process to establish an MCL for chromium-6. On July 1, 2011, Cal/EPA's Office of Environmental Health Hazard Assessment completed the setting of a PHG for chromium-6 at a concentration of 0.02 µg/L, a necessary prerequisite to adopt an MCL. In August 2013, CDPH released a proposed MCL for chromium-6 of 10 µg/L and accepted public comments on this proposed MCL during a 45-day comment period. It is anticipated that in the absence of any major delays, an enforceable MCL will be established in 2014.

In addition, if the adoption of a specific MCL is not practical, EPA and CDPH have adopted specific treatment performance standards that essentially take the place of an MCL. An example of this is in the various rules for surface water treatment that are intended to provide protection against *Giardia* and *Cryptosporidium*, two microbial contaminants found in surface waters where direct testing is impractical, costly, or lacks the level of reliability necessary for setting an MCL.

New Technology

New or innovative treatment technologies are often developed to address new or more stringent drinking water standards, improve the contaminant removal efficiency, reduce treatment plant footprint, reduce energy consumption, or reduce/eliminate waste streams from the treatment process. Innovative environmental technologies hold the promise of being more effective than traditional methods and can address today's far more complex environmental problems. Technologies increasingly used in California as a result of new regulations include:

- Ultraviolet (UV) disinfection treatment to comply with disinfection byproducts under the Stage 2 Disinfection Byproducts Rule and requirements for the treatment of surface waters under the Long Term 2 Enhanced Surface Water Treatment Rule.
- Arsenic removal technologies including adsorptive (disposable) media to increase affordability of small water system compliance with the arsenic MCL.

- Membrane filtration to comply with requirements of the Long Term 1 and Long Term 2 Enhanced Surface Water Treatment Rules.
- Biological treatment in the form of fixed bed, fluidized bed, and membrane bioreactors to treat for perchlorate and now being demonstrated for nitrate and other contaminants.

As a result of both increases in demand and the relative scarcity of new water supplies, many water providers are now shifting toward treating sources formerly considered unsuitable for domestic use. Treatment processes such as reverse osmosis are used to desalt brackish shallow groundwater for potable uses and are discussed in greater detail in Chapter 10, "Desalination (Brackish and Sea Water)" in this volume.

Drinking Water Distribution in California

Treated and/or conditioned water that meets drinking water standards is considered to be "finished water," suitable for distribution to consumers for all potable water uses. Water distribution systems consist of pipes, storage tanks, pumps, and other physical features that deliver water from the source or the water treatment plant to the customer's connection. Even high-quality drinking water is subject to degradation as it moves through the distribution system to the tap. For example, contaminants can enter the distribution system via backflow from a cross-connection, permeation and leaching during water main repair or replacement activities, and contamination via finished water storage facilities. Within the distribution system, water quality may deteriorate as a result of microbial growth and biofilm, nitrification, corrosion, water age, effects of treatment on nutrient availability contributing to microbial growth and biofilm, and sediments and scale within the distribution system (U.S. Environmental Protection Agency 2006).

CDPH has established laws and regulations for the design, construction, operation, and maintenance of distribution systems primarily through the California Waterworks Standards (California Department of Public Health 2008a). Regulations mandate monitoring distribution system water quality for coliform bacteria, chlorine residual, lead, copper, physical water-quality parameters, and disinfection byproducts. California has also adopted cross-connection control and backflow prevention regulations to protect water quality within a water distribution system.

In 2000, a federal advisory committee working to develop more stringent EPA regulations for disinfection byproducts and microbial contamination noted the following factors as part of its key considerations to develop further regulations.

- Finished water storage and distribution systems may have an impact on water quality and may pose risks to public health.
- Cross-connections and backflow in distribution systems represent a significant public health risk.
- Water quality problems can be related to infrastructure problems, and the aging of distribution systems may increase risks of infrastructure problems.
- Distribution systems are highly complex, and there is a significant need for additional information and analysis on the nature and magnitude of risk associated with them.

The maintenance of water quality within the distribution system has received considerable attention in recent years, especially as systems have modified treatment methods. Changes to

the methods and levels of disinfectants can create the potential for reduced control of microbial contaminants that may be present in the distribution system.

Water utilities are also constantly making improvements to their distribution systems, including increasing the reliability of their water supply. One example is the installation of emergency water interties between neighboring water utilities. These interties provide a backup source, with the neighboring water system, in case of an outage resulting from an unforeseen emergency or a potential disaster. The intertie also allows a water utility to shut down a part of its system to do necessary maintenance without interrupting service to customers.

For example, a number of San Francisco Bay Area water systems have constructed emergency interties with neighboring water systems. There is an emergency intertie between the East Bay Municipal Utility District (EBMUD), the City of Hayward, and the San Francisco Public Utilities Commission (SFPUC) to supply treated water among the three water systems and is intended to be used during planned outages, for needed maintenance, and to avoid service interruptions. EBMUD has two small interties, each able to carry 4 million gallons per day, with the City of Hayward which adjoins its service area. SFPUC, the agency in charge of the Hetch Hetchy water used by many Bay Area water districts and residents, has also constructed an intertie with the Santa Clara Valley Water District and has been considering constructing another intertie. These interties may also play a role in the security of the water distribution system by creating a backup source should a terrorist act or disaster disrupt the source of supply from any single water provider.

In other cases, interties can provide untreated water between utilities in an emergency. For example, Contra Costa Water District (CCWD), whose service area is crossed by EBMUD Mokelumne pipeline, has an intertie that can be used to transfer untreated water between EBMUD and CCWD in an emergency.

Interties are one of the strategies for improving water supply reliability and quality, and were recommended by the CALFED August 28, 2000, Record of Decision.

Potential Benefits

Improved water quality can directly improve the health of Californians, thereby improving the state's standard of living and reducing the burden and costs on the state's healthcare system.

Since 1989, a number of rules have been adopted by the EPA and CDPH that are aimed at controlling both microbial pathogens and disinfection byproducts. The first of these rules were the Surface Water Treatment Rule (1989) and the Total Coliform Rule (1989). Both rules are intended to reduce the occurrence of both viral and microbial pathogens in drinking water. As the regulatory community became more aware of the risks posed by organisms such as *Giardia*, *Cryptosporidium*, and certain enteric viruses present in surface water supplies, rules were adopted to address these risks and increase the degree of protection for consumers. These rules included:

- Interim Enhanced Surface Water Treatment Rule (1998).
- Filter Backwash Rule (2001).
- Long Term 1 Enhanced Surface Water Treatment Rule (2002).
- Long Term 2 Enhanced Surface Water Treatment Rule (2005).

Concurrently, rules were adopted to improve the disinfection process while at the same time providing protection against two groups of disinfection byproducts: trihalomethanes (TTHM) and haloacetic acids (HAA5). The following disinfection byproduct rules were adopted:

- Stage 1 Disinfection Byproducts Rule (1998).
- Stage 2 Disinfection Byproducts Rule (2006).

In addition to the surface water rules, EPA adopted the Groundwater Rule (2006) to increase the level of protection primarily from enteric viruses.

The perchlorate MCL and the arsenic MCL reduce the permissible level of these contaminants and result in direct benefits. Perchlorate exposure is a public health concern because it interferes with the thyroid gland's ability to produce hormones. In the very young, hormones are needed for normal prenatal and postnatal growth and development, particularly for normal brain development. Therefore, a reduction in thyroid hormones is a serious concern. In adults, thyroid hormones are needed for normal body metabolism. About 515,000 people in California will avoid exposure to perchlorate at levels above the MCL annually as a direct result of the perchlorate regulation (California Department of Public Health 2007). The arsenic MCL of 10 ug/L will result in an exposure reduction for more than 790,000 people and a theoretical reduction of 57 lung and bladder cancer cases per year in California (California Department of Public Health 2004).

Adequate operation and maintenance of the distribution system network will reduce delivery problems (main or tank ruptures, water outages) and ensure delivery of high-quality water. Operators of drinking water distribution systems in California must be certified at the appropriate level, depending on the size and complexity of the distribution system. This certification requirement helps to ensure a competent level of operation of distribution systems. Similarly for water treatment facilities, proper operation and maintenance is essential for achieving optimum water treatment plant performance.

Water fluoridation ranks as one of 10 great public health achievements of the 20th century according to the U.S. Surgeon General in 2000. Fluoridation of public water supplies targets the group that would benefit the most from its addition, namely infants and children under 12, by decreasing cavities and improving dental health. Studies have shown that fluoridation, at the optimal concentration, reduces the incidence of dental cavities by 50-70 percent. It has also been demonstrated that tooth decay will increase if water fluoridation is discontinued in a community for an extended period. For example, the City of Antigo, Wisconsin, started fluoridating its community water supplies in 1949 and discontinued it in 1960. Five and one-half years later, second graders had more than 200 percent more tooth decay, fourth graders had 70 percent more, and sixth graders had 91 percent more tooth decay than children of the same age in 1960 (California Department of Public Health Community Water Fluoridation Program 2009).

Potential Costs

The cost of providing drinking water in compliance with all drinking water standards is steadily increasing as a result of increasing costs for energy and materials and increasing regulations requiring higher levels of treatment. Water bills reflect the costs of pumping, treating, and delivery of water, as well as the operation and maintenance of the system, water quality testing, and debt repayment. Water treatment costs may include the cost of chemicals, energy, and

operation and maintenance of the treatment facilities. Drinking water treatment costs will vary widely from plant to plant. Many different factors can affect the cost of water treatment, including the choice of which water treatment technology to use.

Table 15-4 summarizes the past and future estimated costs of treated full-service water provided by the Metropolitan Water District of Southern California (MWD), which treats a blend of surface water from the Colorado River and the California Aqueduct. The table shows an increase of approximately 65 percent from 2007 to 2012 in the cost to provide treated water in an area serving a large rate base. The additional cost reflects improvements to the treatment provided, increased cost for chemicals and energy, and reduced availability of new water supplies. The primary cost factors causing the rate increase included increased conservation efforts, the quagga mussel control program, litigation, and the higher cost for State Water Project deliveries. MWD may not capture the true cost of service with these rates and must cover some costs through the use of reserves.

The increase in cost to provide safe drinking water for smaller systems may be significantly greater on a per-capita basis. These systems lack the economy of scale necessary to achieve savings in their day-to-day operations. In addition, most small systems have not set up any asset management plans or capital improvement accounts to fund infrastructure replacement.

Per household costs for compliance with new regulations for small water systems can be more than four-fold higher than those for medium-to-large water systems (U.S. Environmental Protection Agency 2006). Where substantial areas are affected by contamination, such as the nitrate contamination in the Tulare Lake basin and Salinas Valley, the cost to consumers can be significant. According to a recent University of California, Davis study, titled "Addressing Nitrates in California's Drinking Water – Technical Report 7: Alternative Water Supply Options" (Honeycutt et al. 2012), about 2.4 million people receiving groundwater supplies from community water systems and state small water systems are potentially affected by nitrate in the Tulare Lake basin and Salinas Valley study areas. In addition, about 245,490 persons in these areas obtain water from unregulated private water supplies that may also be subject to nitrate contamination. According to the study, the estimated cost per person to provide safe water (water that meets nitrate standards) is estimated to be between $80 and $142 per year. For a typical public water system customer, this cost represents an estimated increase in the monthly water bill from $23 to $42 per month (based on $80 to $142 per year times 3.5 persons per household).

The most prevalent groundwater contaminant is arsenic, a naturally occurring contaminant, affecting an estimated 287 community drinking water system statewide (State Water Resources Control Board 2012). The average annual cost per household to comply with the arsenic MCL is estimated to range from $140 to $1,870 per residence, depending on the size of the water system (California Department of Public Health 2008b). These costs are in addition to current costs for drinking water.

Up to one-third of the operations and maintenance costs for some water utilities are energy related, including energy used for water treatment and pumping. One factor in water-related energy consumption is using new technologies that are more energy intensive than most previous treatment technologies (e.g., UV treatment and high-pressure membranes).

Desalination will play an increasing role in California's water supply, both for brackish groundwater desalination and seawater desalination. Historically, the high cost and energy

Table 15-4 Metropolitan Water District of Southern California Treated Water Rate History

Year	Cost of Treated Water ($/af)	
HISTORICAL AND CURRENT WATER RATES		
1994	412	
1995-1996	426	
1997-2002	431	
	Tier 1[a]	Tier 2[b]
2003	408	489
2004	418	499
2005	443	524
2006	453	549
2007	478	574
2008	508	606
2009	579	695
2010	701	811
2011	744	869
2012	794	920
2013	847	997
2014	890	1,032

Source: Metropolitan Water District of Southern California 2014.

Notes:

af = acre-feet

[a] Tier 1 supply rate – recovers the cost of maintaining a reliable amount of supply.

[b] Tier 2 supply rate – set at Metropolitan Water District cost of developing additional supply and to encourage efficient use of local resources.

requirements of desalination have confined its use to places where energy is inexpensive and fresh water is scarce. Recent advances in technology, especially improvements in membranes, are making desalination a realistic water supply option. The cost of desalinating sea water is now competitive with other alternatives in some locations and for some high-valued uses. However, although process costs have been reduced as a result of the newer membranes that allow for lower energy consumption, the total costs of desalination, including the costs of planning, permitting, and waste salt brine concentrate management, remain relatively high, both in absolute terms and in comparison with the costs of other alternatives (National Resource Council 2008). Since development of other traditional sources of supply is limited and may require substantial capital investment, such as new storage or canal systems, the expanded development of brackish water and seawater desalination may become more cost competitive.

The condition of infrastructure is a growing concern in California and throughout the country. In the *2013 Report Card for America's Infrastructure*, the American Society of Civil Engineers gave drinking water infrastructure across the country a D (American Society of Civil Engineers 2013). The EPA conducted a Drinking Water Infrastructure Needs Survey and Assessment in 1995, 1999, 2003, 2007, and 2011. The 2011 survey (U.S. Environmental Protection Agency 2012) shows a total investment need of $384.2 billion over the next 20 years nationwide. It identified a total investment need of $44.5 billion for California. This is more than 11 percent of the national need. The majority of the California need was for transmission and distribution systems (60 percent or $26.7 billion). The second highest need category was for treatment (19 percent or $8.4 billion), followed by water storage (14 percent or $6.4 billion), and water source (5.6 percent or $2.5 billion). (All amounts are in January 2011 dollars.) This does not include the infrastructure needs of tribal water systems that are regulated directly by the EPA. (See the following link for information about these systems: http://water.epa.gov/grants_funding/dwsrf/upload/epa816r13006.pdf.) California's investment needs may not include all cost associated with changes in the Colorado River water resources, recent or evolving drought issues, or changes to groundwater basins.

Funding for drinking water projects on tribal lands is provided by the federal government as part of the Drinking Water Infrastructure Grants: Tribal Set-aside Program, which was established by the federal Safe Drinking Water Act reauthorization of 1996. The program allows the EPA to award federal grants for infrastructure improvements for public drinking water systems that serve tribes.

Major Implementation Issues

Based on a review of issues discussed within the water supply industry and regulatory agencies, the following topics represent some of the most significant challenges for public water suppliers and the regulatory agencies today.

Deteriorating Infrastructure

With the aging of the nation's infrastructure and the growing investment needed to replace deteriorated facilities, the water industry has a significant challenge to sustain and advance its achievements in protecting public health and the environment (Grumbles 2007). During the last several decades, the public investment has been toward expanding and upgrading service levels, such as providing higher levels of treatment.

New solutions are needed for critical drinking water investments over the next two decades. Many utilities are moving to the concept of asset management to better manage and maintain their water facilities and infrastructure (Cromwell et al. 2007) for greater operational efficiency and effective use of limited funds. However, addressing the replacement of deteriorating infrastructure will add to the cost of water.

Asset management alone will not fix the basic problem. Particularly in smaller systems, inadequate funding for capital improvement plans for infrastructure replacement has created a serious problem. From the post-war period of the late 1940s and into the early 1980s, a proliferation of small community water systems occurred in rural areas, some far from the nearest city. In the past, such systems could often fund major maintenance and needed infrastructure

replacement with informal assessments from the rate payers. However, the magnitude of the current infrastructure needs makes it very difficult to finance without creating an inordinate burden on rate payers.

CDPH has funding "set-asides" from the Safe Drinking Water State Revolving Fund (SDWSRF) program for technical assistance to small water system operators and managers to develop technical, managerial, and financial capacity. Additional funding would allow the expansion of this program into more detailed areas of asset management and rate setting.

Source Water Protection

There is an increasing need to protect source water quality as the first critical barrier in the multiple barrier approach to provide safe drinking water. A key issue is the increasing difficulty of protecting source water quality as the state population increases, which results in increased wastewater discharge and urban runoff into surface water supplies. Another major issue is that some drinking water contaminants (organic carbon, nutrients, and pathogens such as *Giardia* and *Cryptosporidium*) are not currently regulated by the regional water quality control boards in basin plans. Thus, there are generally no requirements for dischargers to control these contaminants.

Inadequate Financial Assistance to Address Both Water Treatment and Infrastructure Issues of Public Water Systems

The four major funding programs for California public water systems are SDWSRF, Proposition 50, Proposition 84, and the American Recovery and Reinvestment Act of 2009 (ARRA). Combined, these programs have provided more than $1.87 billion to 441 public water systems to solve health risk problems and Safe Drinking Water Act violations, resulting in an overall risk reduction for consumers. However, this funding has not been adequate to address all of California's identified needs. The combined project priority list for these funding programs includes more than 4,000 projects, many of which have been on the list since its inception in 1997 and have not received funding. The estimated value of unfunded need on the combined project priority list exceeds $12 billion is shown in Table 15-5.

The CDPH Drinking Water Program administers multiple funding programs to assist water systems to achieve and maintain compliance with safe drinking water standards. These programs use federal funds and State funds to address the highest priorities of the total infrastructure need.

Safe Drinking Water State Revolving Fund

The largest funding program CDPH administers is the SDWSRF . The EPA provides SDWSRF funds to states in the form of annual capitalization grants. States, in turn, provide low interest rate loans and other assistance to public water systems for infrastructure improvements. In order to receive a federal SDWSRF Capitalization Grant, states must have statutory authority for the program and must provide a State match equal to 20 percent of each annual capitalization grant. Pursuant to State statutes (Health and Safety Code, Division 104, Part 12, Chapter 4.5 commencing with Section 116760, Safe Drinking Water State Revolving Fund Law of 1997), CDPH is authorized to receive the federal capitalization grants and administer the SDWSRF program in California. California's SDWSRF program began in 1998 and issued its first loans in

Table 15-5 California Department of Public Health Summary of Funded and Unfunded Projects

	Funded Projects		Unfunded Projects
Funding Source	**Number of Systems**	**Funded Amount (million $)**	**Unfunded Need (million $)**
SDWSRF	224	1,351	11,700[a]
ARRA	51	150	
Proposition 50	78	295	366
Proposition 84	88	81	174
TOTAL	441	1,877	12,240

Source: California Department of Public Health 2012.

Notes:

[a] American Recovery and Reinvestment Act (ARRA) used the Safe Drinking Water State Revolving Fund (SDWSRF) project priority list for funding.

1999. California's current share of the national SDWSRF is 9.35 percent (Table 15-6), the highest allocation of all states.

Total SDWSRF funding provided to public water systems in executed loans and grants to date is more than $1.3 billion. Approximately 80 percent of these funds are distributed by CDPH as subsidized interest rate loans to public water systems serving disadvantaged communities (DACs). The remainder is distributed in the form of grants to DACs. Water systems determined to serve a DAC receive a zero percent interest rate loan and may receive grant funding. DACs are communities with a median household income (MHI) less than or equal to 80 percent of the statewide MHI and may receive grant funding up to 80 percent of the project costs based on affordability criteria. Severely DACs are communities with a MHI less than or equal to 60 percent of the statewide MHI and may receive grant funding up to 100 percent of the project costs based on affordability criteria.

The majority of the SDWSRF funding is subsidized, low-interest rate and zero-interest rate loans that typically have a 20-year repayment term. All loans are secured; however, the security varies and is most often provided by user water rates, charges, and/or surcharges. As the outstanding loans are repaid, they generate a steady repayment stream that currently exceeds $40 million per year. In accordance with State and federal SDWSRF laws, the funds from the repayment stream are added to the SDWSRF fund and can be utilized in the same manner.

SDWSRF Funding Priority

In accordance with federal requirements and State law, CDPH establishes the priority for SDWSRF funding based on the risk to public health. Each pre-application submitted for funding is evaluated and, if eligible for funding, is assigned a category, based on the problem to be addressed. Highest categories are problems associated with bacteriological pathogens, followed by nitrate, and then other chemicals that exceed primary (health-based) drinking water standards.

Table 15-6 California Safe Drinking Water State Revolving Fund: Capitalization Grants from the U.S. Environmental Protection Agency

Fiscal Year	DWSRF Grant (million $)	Percent of National DWSRF Funds
1997	75.68	—
1998	77.11	10.83% (FY1998-2001)
1999	80.82	—
2000	83.99	—
2001	84.34	—
2002	82.46	10.24% (FY2002-2005)
2003	81.97	—
2004	85.03	—
2005	84.85	—
2006	67.10	8.15% (FY2006-2009)
2007	67.10	—
2008	66.4	—
2009 SDWSRF	66.4	8.15%
2009 ARRA[a]	159.0	8.15%
2010	137.32	9.35% (FY2010-2013)

Source: U.S. Environmental Protection Agency's Drinking Water Needs Survey 2009 and the Federal Register. See http://water.epa.gov/grants_funding/dwsrf/allotments/ for more information on Drinking Water State Revolving Fund (DWSRF) state allotments.

Notes:

[a] In 2009, California Department of Public Health also received funding under the American Recovery and Reinvestment Act (ARRA) that essentially followed Safe Drinking Water State Revolving Fund (SDWSRF) funding rules.

After the appropriate funding category is determined, CDPH further prioritizes projects based on bonus points. Bonus points are used to rank projects within a category. The addition of bonus points will not move a project from one category to another. To the extent feasible, when a group of systems is invited to complete the application process for SDWSRF funding, all the systems within that category seeking funding that year are invited to apply. Bonus points are assigned based on affordability, consolidation, type of water system, and population.

CDPH factors in affordability by comparing the MHI of the community served by the proposed project to the statewide MHI level. Communities that are below the statewide average MHI level receive additional ranking consideration. This gives poorer communities a higher ranking within a category than communities with higher income levels.

For purposes of ranking projects within a category, any project that includes consolidation of separate existing water systems will receive additional ranking points. Consolidation ranking points support projects that will provide reliability, efficiency, and economy of scale that can be achieved with larger water systems while discouraging the proliferation of numerous separate small systems that have inherent inefficiencies and limitations.

The type of water system is considered in the prioritization process because there is a relatively higher health risk associated with persons who drink the same water each day over a period of time, known as accumulated exposure. Thus, community and NTNC water systems are ranked above TNC systems within a category and with the same bonus ranking points.

All projects within a category that have the same number of ranking points and are the same type of system are ranked in ascending order based on the population served by the water system. Smaller populations are ranked above higher populations.

CDPH combines all these factors to develop a Project Priority List (PPL) each year. CDPH then invites projects for funding from the PPL. Recently, Congress has required states to commit 20 percent of the SDWSRF funds to "green projects," such as water or energy efficiency, green infrastructure, or other environmentally innovative activities. CDPH has awarded a portion of the funding to install water meters in DACs.

American Recovery and Reinvestment Act

The American Recovery and Reinvestment Act was signed by President Obama on February 17, 2009. ARRA allocated $2 billion nationally for safe drinking water infrastructure improvements. California's share of these funds is $159 million and is administered by CDPH through its existing SDWSRF program. The ARRA funds were a one-time opportunity and did not require State matching funds.

CDPH issued funding agreements totaling $149 million to 51 projects statewide. These 51 projects are distributed among 47 community drinking water systems. The funds were committed to drinking water infrastructure projects identified as "ready to proceed." All funding agreements were issued by December 2009, and all projects were under construction by February 2010. The ARRA-funded projects are in different stages of construction, and all must be completed by June 30, 2013.

Proposition 50

Proposition 50, the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 (California Water Code [CWC] Section 79500, et seq.) was passed in the November 2002 general election. CDPH is responsible for portions of the act that deal with water security, safe drinking water, and treatment technology. This approved bond measure allocated $485 million to CDPH to address drinking water quality issues. Proposition 50 authorizes up to 5 percent of the funding for CDPH to administer the funding programs listed below. In addition, 3.5 percent must be allocated for bond costs. Under Proposition 50, CDPH is also responsible for multiple funding programs described below.

Chapter 3, Water Security

CWC Section 79520 provides $50 million to CDPH to protect State, local, and regional drinking water systems from terrorist attacks or deliberate acts of destruction or degradation. These funds may be used for

- Monitoring and early warning systems.
- Fencing.
- Protective structures.
- Contamination treatment facilities.
- Emergency interconnection.
- Communications systems.
- Other projects designed to:
  - Prevent damage to water treatment, distribution, and supply facilities.
  - Prevent disruption of drinking water deliveries.
  - Protect drinking water supplies from intentional contamination.

CDPH developed criteria that prioritized Chapter 3 funding to water systems to construct emergency interties with adjacent water systems. Emergency intertie connections ensure there is an alternate connection to a water system if there is a disruption in water supplies during emergencies, such as natural catastrophes or terrorist attacks. This provides additional assurance of continuous water supplies to the largest populations.

Chapter 4, Safe Drinking Water

CWC Section 79530 provides funding to CDPH for grants for public water system infrastructure improvements and related actions to achieve safe drinking water standards.

Section 79350(a) (Chapter 4a) provides $70 million for grants to small community water systems (less than or equal to 1,000 service connections or less than or equal to 3,300 persons) to upgrade monitoring, treatment, or distribution infrastructure. It also provides grants for community water quality monitoring equipment, drinking water source protection, and treatment facilities necessary to meet disinfection byproduct drinking water standards. CDPH developed criteria that prioritized Chapter 4a funding to water systems based on public health risk, using the SDWSRF categories as well as other criteria specific to the funding section. In addition, the criteria give priority to DACs within each category.

Section 79350(b) (Chapter 4b) provides $260 million for grants to Southern California water agencies to assist in meeting California's commitment to reduce Colorado River water use to 4.4 million acre-feet per year. CDPH developed criteria that prioritized Chapter 4b funding to water systems in accordance with the bond language. Projects are assigned points based on three ranking criteria, and a cumulative score is determined for each project. The projects are then ranked by that score from lowest to highest. Criterion 1 ranks projects by Proposition 50/ AB 1747 categories and by water system population (from highest to lowest) within a category. Criterion 2 ranks projects by reduction of the annual volume of Colorado River water demand. Criterion 3 ranks projects by the cost per volume of the reduced demand.

Proposition 84

Proposition 84, the Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Act of 2006 (Public Resources Code Section 75001, et seq.) was passed in the November 2006 general election. This approved bond measure allocated $300 million to CDPH to address drinking water and other water quality issues in California. Proposition 84 authorizes up to 5 percent of the funding for CDPH to administer the funding programs. In addition, 3.5 percent must be allocated for bond costs. Within Proposition 84, CDPH is responsible for multiple funding programs listed below.

- Section 75021 provides $10 million for grants and direct expenditures for emergency and urgent actions to ensure safe drinking water supplies. CDPH developed criteria to determine the eligibility of emergency grant projects. All requests that meet the eligibility criteria are funded until the funds are exhausted. Factors that CDPH considers include:
  - Type of contaminant(s).
  - Degree of contamination.
  - Whether the health hazard is acute (immediate) or chronic (long-term).
  - Length of time to which consumers have been or will be exposed.
  - Any actual or suspected illnesses.
  - Any actions taken by the local health officer or the local director of environmental health department.
  - Other funds to resolve the public health threat or emergency.
  - Duration and extent of a water outage due to an emergency.
  - Duration and extent of loss of power due to an emergency.
- Section 75022 provides $180 million in grants for small community drinking water system infrastructure improvements for chemical and nitrate contaminants and related actions to meet safe drinking water standards. Pursuant to the 2011-2012 Budget Act, $7.5 million is allocated to projects in the cities of Santa Ana and Maywood.

  CDPH developed criteria that prioritize eligible projects in accordance with the bond language and subsequent legislation. Projects were scored by points based on:
  - Regulatory status of the principal contaminant to be addressed.
  - Health risk associated with the principal contaminant to be addressed.
  - Number of contaminants in the project's drinking water supply that exceed a primary drinking water standard.
  - Median household income of the applicant water system.
  - Project includes consolidation.
  - Project is part of a regional project.
- Section 75025 provides $60 million for immediate projects needed to protect public health by preventing or reducing the contamination of groundwater that serves as a major source of drinking water for a community. Pursuant to Senate Bill X2 1, $2 million of the funding is allocated to the State Water Resources Control Board to develop pilot projects in the Tulare Lake basin and the Salinas Valley that focus on nitrate contamination.

CDPH developed criteria that prioritize eligible projects in accordance with the bond language and subsequent legislation. Projects were scored by points that are based on:

- The regulatory status of the principal contaminant to be addressed.
- The health risk associated with the principal contaminant to be addressed.
- The number of contaminants in the project's drinking water supply that exceed a primary drinking water standard.
- The median household income of the applicant water system.
- Whether the project includes consolidation.
- Whether the proposed project is part of a regional project.

Regionalization/Consolidation

One way to improve the economy of scale, which results in the potential for many benefits including lower costs, is to increase regionalization of water supply systems. This can be achieved by physical interconnections between water systems or managerial coordination among utilities. CDPH has established a requirement for evaluating consolidation as part of every project funded under the available financial assistance programs. To address deteriorating infrastructure successfully for the hundreds of smaller public water systems, regionalization and consolidation may be necessary on a larger scale. It is not cost-effective for a small system to replace aging and deteriorated sources, treatment plants, and distribution systems fully. However, with a larger rate base to spread costs across, the economies of scale improve for consolidated systems. Managerial consolidation of water districts, even where the boundaries are not contiguous, can provide great savings to the consumers by sharing the costs of oversight and management of the systems, thus freeing up funds for system upgrades. Box 15-1 describes a regional consolidation project in the planning stages.

Disadvantaged Communities/Environmental Justice

There has been heightened interest in environmental justice issues as a result of nitrate contamination problems in public water systems, particularly those in agricultural areas such as the Central Valley and Salinas Valley. The governor also set State policy when he signed AB 685 in 2012 that added CWC Section 106.3, which declares that the established policy of the State recognizes every human being as having the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes. All relevant State agencies, including the California Department of Water Resources, State Water Resources Control Board, and CDPH, are required to consider this State policy when revising, adopting, or establishing policies, regulations, and grant criteria when those policies, regulations, and criteria are pertinent to the uses of water described in this section.

One of the challenges for water systems that serve DACs is finding a solution to funding new operation and maintenance costs associated with a new treatment plant needed owing to groundwater contamination or in order to meet stricter water quality regulations. CDPH through its three major funding programs provides grant funding and/or zero-percent interest loans for the construction of a new treatment plant that serves a DAC. However, State funding is not available for annual operation and maintenance costs. For many small DACs, this is a substantial financial burden because treatment plants generally are expensive to operate and maintain. If the

Box 15-1 Rosamond Community Services District Regional Consolidation Project

The Rosamond Community Services District (CSD) Regional Consolidation Project is currently in the feasibility and planning stage to solve water quality problems of nine small water systems (one high school, four mutual water companies, one apartment complex, and three mobile home parks) in the Rosamond area. Eight systems have arsenic maximum contamination levels (MCL) violations and one system has a uranium MCL violation. Funding for this regional consolidation project will be through a combination of Safe Drinking Water State Revolving Fund and Proposition 84 funding.

The ultimate plan will physically consolidate eight water systems with Rosamond CSD by using a combination of pipelines, storage tanks, and booster pumps. By consolidating the small water systems with Rosamond CSD, the customers of these small systems will receive water that meets drinking water quality standards and avoid installing treatment equipment which is very expensive to operate and maintain and may be unaffordable.

One mutual water company, which is farther away from Rosamond CSD and is currently under a court-ordered receivership with Rosamond CSD being the court appointed receiver, may need to install arsenic removal treatment equipment depending upon its affordability. This project will explore managerial consolidation of this mutual water company with the Rosamond CSD in an effort to improve the economy of scale for this project and to improve operational reliability of any treatment installed.

It is anticipated that Rosamond CSD will request construction funding for the project following completion of the feasibility and planning studies.

new operation and maintenance costs are inadequately funded, the water system runs the risk of improperly operating its treatment plant and delivering unsafe drinking water to its customers.

As part of the California Water Plan Update 2013 process, the California Department of Water Resources updated a 2005 report titled *Californians without Safe Water*. The updated report, titled *Californians without Safe Water and Sanitation*, is available online as a stand-alone file (California Department of Water Resources 2014) and also can be found in Volume 4, *Reference Guide*. The report continues the dialogue regarding Californians without safe drinking water and includes a number of recommendations to continue the progress toward ensuring that all Californians have safe drinking water.

Impact of Climate Change

Climate change projections include warmer air temperatures, diminishing snowpack, precipitation extremes and storm intensity, prolonged droughts, and sea level rise. These anticipated changes could affect water quality in regions that are already experiencing difficulty meeting current water demands.

Earlier snowmelt and more intense episodes of precipitation with increased flood peaks may lead to more erosion, resulting in increased turbidity and concentrated pulses of pollutants in source waters. Increased flooding may lead to sewage overflows, resulting in higher pathogen loading in source waters. These potential changes could result in challenges for surface water treatment plants and may require additional monitoring to quantify changes in source water quality and to meet post-treatment drinking water standards.

Increased water temperatures and reduced reservoir levels may result in more prevalent eutrophic conditions, increasing the frequency and duration of algal blooms. Higher water temperatures can also accelerate some biological and chemical processes, such as increasing growth of algae and microorganisms, depletion of dissolved oxygen, and various impacts on water treatment processes. Higher sea levels as a result of climate change could affect coastal groundwater basins by making protection of groundwater from seawater intrusion more difficult.

Adaptation

Increasing demand on limited available and valuable water resources will compound any climate change impact. The continued growth in the state will continue to stress the availability of the freshwater resources needed for domestic, agricultural, and industrial uses. Coastal water providers have begun evaluating and employing desalination of sea water as an additional drinking water supply. Desalinated sea water, although more expensive to develop owing to the high energy requirements and planning and permitting costs, has been identified as a reliable drought-proof supply.

Regionalization of water supply systems as an adaptation strategy will also help counter the effects of climate change by adding operational flexibility during periods of drought or flooding. Investments in drinking water facilities and conveyance systems will add efficiency and lead to enhanced sustainability in the future. Adaptation to climate change involving the provision of adequate drinking water will likely require specific regional strategies, described in this chapter, which focus on conservation, sustainability, and operational flexibility.

Mitigation

Demand for drinking water treatment and distribution will continue to increase as climate change has major impacts on water quality and availability of the freshwater resources used for drinking water. Adverse impacts on climate change related to increasing GHG emissions could result from energy uses in (1) drinking water treatment and distribution systems; (2) bottled water production, including related transportation and waste disposal; and (3) treatment of new sources of drinking water from low-quality groundwater and recycled wastewater. Nonetheless, improving water and energy efficiency from management strategies described in this chapter could have benefits that reduce energy uses and GHG emissions as part of climate change mitigation, including:

- Promoting opportunities to use more tap water and less bottled water to reduce related energy and GHG emissions.
- Conducting audits for water and energy efficiency in drinking water treatment and distribution systems.
- Providing operational efficiency and improving aging infrastructure to control water losses for water and energy saving.
- Developing programs and applying new technologies to reduce energy use in both water treatment plants and for new sources of drinking water, such as low-quality groundwater and recycled wastewater.
- Developing energy efficiency standards for drinking water treatment and distribution systems.

- Coordinating with water-use efficiency programs and using best management practices to save water and energy, such as utility leak detection, water conservation, and water efficiency pricing and incentives for installing water efficient appliances and landscaping.

Water Use Efficiency

The efficient use of water is regarded as a viable complement, and in some instances a substitute, to investments in long-term water supplies and infrastructure. Water use efficiency is a concept to maximize the use of water or minimize its waste. Water use efficiency will continue to be a key element of addressing reduced water availability and is regarded as a major step to take before turning to more costly water sources such as desalinated seawater. Water efficiency programs and practices may include utility leak detection, water conservation programs, water efficiency pricing and incentives for installing water efficient appliances and landscaping, as well as improvements in water recovery as part of water treatment plants (e.g., recycling water used in treatment plant processes for backwash).

An important aspect of strongly encouraging water conservation is the ability of the water utility to establish an escalating metered rate based on the volume of water used. This promotes full cost recovery, conservation, or efficiency pricing. Since 1992, California law has required urban water suppliers (those serving more than 3,000 connections or delivering more than 3,000 acre-feet of water per year) to install a water meter on new connections. More recently, AB 2572 established the requirement for retrofitting water meters on pre-existing connections and charging customers for water based on the actual volume of water used. Neither of these laws addresses smaller water systems that do not meet the definition of an urban water supplier.

Many larger water agencies have already taken advantage of conservation programs to reduce the need for new water supplies. The Los Angeles Department of Water and Power has shown success in conservation where water use today is the same as it was 40 years ago, despite a population increase of nearly 1 million people (City of Los Angeles Department of Water and Power 2010). Obtaining additional conservation increases will be more difficult and may result in higher costs to achieve.

To address water losses or unaccounted water, water utilities conduct audits to identify water main leaks, unmetered water use for parks and recreation consumption, water theft, and inaccurate meters. Deteriorated and aging infrastructure contributes to significant water leakage and a high rate of water main breaks and can play an important role in water losses. Nationally, there has been reported water losses by utilities of between 10 percent to nearly 50 percent of the water produced. Due to the continued aging of distribution infrastructures that are at or near the end of their useful life, water losses due to water main leaks can be expected to remain a significant and potentially increasing barrier to California's efforts to conserve water. Both the SDWSRF program and the ARRA funds administered by CDPH provide funding to drinking water systems for water meter installation. Water meters are an important tool to measure water losses in the distribution system.

Maintaining a Trained Workforce

California requires operators of water treatment plants and distribution systems to receive certification to perform these duties. This certification is designed to ensure that operators have

adequate knowledge, experience, and training to operate these facilities properly. Due to the increased complexity of water system facilities, the importance of properly trained and certified operators is increasing.

Sustaining a trained workforce to maintain an adequate level of qualified oversight at water treatment plants and operation of distribution systems has been identified as an important issue. This is, in part, due to the increased number of people from the large Baby Boom generation beginning to leave the workforce. CDPH data indicate that the average age of operators certified in California is about 50, and the average age of Grade 5 treatment plant operators (the highest treatment certification available) is greater than 55 (Jordan 2006). Many water utilities will lose 30 to 50 percent of their current workforce within the next 5 to 7 years, which will result in an unprecedented knowledge drain. A knowledge retention strategy is necessary to ensure long-term success.

Knowledge retention, broadly termed *succession planning*, is the process of identifying and preparing suitable employees through mentoring, training, and job rotation to replace key staff, such as treatment or utility managers, within an organization as current managers retire. Succession planning will become more important in the near future to ensure the transfer of knowledge as less-experienced staff moves into higher decision-making positions. This issue applies to both the public and the private water sectors, as well as to the government agencies that regulate the water industry.

In November 2006, CDPH introduced the Expense Reimbursement Grant Program (ERG) for small water system operators using an EPA grant. The ERG provided funding for small water system operators to receive reimbursement for training to become certified operators or to maintain and advance their operator certification levels. This program provided training reimbursement for operators until all funding was expended in early 2011.

Treatment Technologies for Small Water Systems

Providing safe and affordable drinking water is still a significant challenge for small water systems. Economies of scale typically become more limited for the small system size categories, resulting in per-household costs for compliance with new regulations that can be more than four times higher than those for medium-to-large water systems (U.S. Environmental Protection Agency 2006). There have been advances in the effective use of point-of-use (POU) and point-of-entry (POE) technologies for certain contaminants under controlled circumstances for some small drinking water systems (Cadmus Group 2006). POU devices are those that treat water at the location where it is consumed, such as at the tap or a drinking fountain. POE devices are those that treat all of the water entering a home or building, not just water that is consumed. POE technologies treat all water that a consumer comes in contact with, such as bathing and hand washing, while a POU device provides treated water at one tap intended for drinking and cooking and is usually installed in the kitchen. The California Safe Drinking Water and Toxic Enforcement Act allows the consideration and approval of POE for compliance with drinking water standards where it can be demonstrated that centralized treatment at the wellhead or surface water intake is not economically feasible. The California Safe Drinking Water and Toxic Enforcement Act also allows the consideration of POU devices as per the above and provided they also demonstrate that the use of POE devices is either not economically feasible or POE devices would not be as protective of public health as POU devices. Specifically, only systems serving fewer than 200 connections may be eligible to use POU or POE devices; and they must

first demonstrate that (1) the installation of centralized treatment is not immediately economically feasible, (2) usage of the POE or POU device is allowed under the federal Safe Drinking Water Act for the specific contaminant, and (3) the water system has submitted a pre-application for funding to correct the violation for the contaminant that the POE or POU device is proposed to treat.

New treatment technologies that are cost-effective and do not require extensive operator attention are often needed to address chemical contaminants that affect small water systems. Proposition 50 provided funding to demonstrate some of these technologies. As new technologies are proposed to treat water to drinking water standards, CDPH must review and approve these technologies and use staff dedicated to reviewing these technical aspects of drinking water treatment.

Treatment Residuals Disposal

In many areas, treatment options for contaminants are limited owing to residual disposal issues. For example, the disposal of brine from ion exchange and reverse osmosis treatment has been identified as a potential source of salinity in groundwater. California, and especially the central San Joaquin Valley, is experiencing increased salts in the groundwater. As the salinity of local groundwater sources increases, more water customers use water softeners to improve the quality at their tap. This, in turn, results in a higher discharge of salts to the wastewater treatment plants, which increases the salinity of wastewater and exacerbates the problem. The Central Valley Regional Water Quality Control Board completed a study in May 2006 on salinity in groundwater in the Central Valley, which introduced the concept of a long-term salinity management program for the Central Valley and for California (Central Valley Regional Water Quality Control Board 2006). Additional information is available in Chapter 19, "Salt and Salinity Management."

Disposal of residuals, such as backwash water or spent media, poses additional costs for water treatment, especially those that may be classified as a hazardous or radioactive waste due to the concentration and leaching characteristics of the contaminant. Selection of treatment alternatives, especially for arsenic, must consider disposal issues. The spent treatment plant media must be evaluated under the California Waste Extraction Test (WET) for classification before determining appropriate disposal options owing to the potential for the arsenic to leach from the media in a landfill environment. The California WET classification is more stringent than federal leaching tests. The City of Glendale water system conducted a study that evaluated treatment alternatives for removal of chromium-6 that included disposal of treatment residuals. (See Box 15-2 for additional information.)

Security of Drinking Water Facilities

Water system facilities are vulnerable to security breaches, acts of terrorism, and natural disasters (all-hazards). Water system personnel and the general public have developed a greater awareness of the vulnerability of California's critical infrastructure and key resources because of the events of September 11, 2001; Hurricane Katrina in 2005; and many other disasters and incidents since then. The enhancement of security and of emergency response and recovery capabilities is crucial to maintain a reliable and adequate supply and delivery of safe, clean, and wholesome drinking water. Just as crucial are forming, developing, and exercising relationships with partners and stakeholders.

Box 15-2 City of Glendale Chromium-6 Treatment Residuals Disposal Study

The City of Glendale completed a study comparing the treatment residuals waste produced by two treatment processes for removing chromium-6: a weak-based anion exchange (WBA) process and a reduction/coagulation process that removes chromium-6 through filtration (RCF).

The main waste in the WBA treatment process is spent ion exchange resin. Based on results of the federal Toxicity Characterization Leaching Procedure (TCLP) and the California Waste Extraction Test (WET), the waste resin is classified as a California-regulated nonRCRA waste (hazardous waste regulated by the State of California, other than hazardous waste within the state that is federally regulated per the Resource Conservation and Recovery Act) and requires special handling and disposal. Additional waste characterization is needed due to the detectable quantities of uranium and thorium in Glendale's source water. While these contaminants are in the source water at concentrations below the maximum contamination levels (MCL), they are removed in the treatment process and concentrated in the resin. Testing was also conducted to determine whether the waste resin would be classified as a Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) or a Low-level Radioactive Waste (LLRW). Findings indicated that waste resin would not be classified as TENORM as long as the waste resin could be taken out of service prior to reaching uranium concentrations of 0.05 percent by weight, where it would require even more expensive disposal and handling as a LLRW.

The wastes from the RCF process are mostly settled solids after thickening and dewatering. The solids from the RCF process are classified as California-regulated nonRCRA waste and they are not classified as either a TENORM or a LLRW since the RCF process does not remove or concentrate appreciable quantities of uranium.

The disposal of treatment waste streams in California adds a major cost component to the cost of treating drinking water. Rather than disposal at a local landfill or other approved land disposal option, spent resin or solids must receive special handling and be sent to special disposal facilities that accept hazardous and/or radioactive materials.

Under the U.S. Public Health Security and Bioterrorism Preparedness and Response Act of 2002, drinking water utilities serving more than 3,300 people are required to conduct vulnerability assessments and develop/update their emergency response plans to address these vulnerabilities. All of California's water utilities in this category have prepared these documents. These documents and their implementation are an important element in building and maintaining the ability to respond to security breaches and other catastrophes and to recover from them.

The accomplishments by the water industry, the wastewater industry, and regulatory agencies to protect California's water and wastewater facilities from all-hazards include:

- Emergency Water Quality Sample Kit (EWQSK) developed by CDPH and based on the EPA Response Protocol Toolbox. These sample kits provide water systems with a resource to sample drinking water quickly for an unknown contaminant during a credible event.
- Partnerships between water agencies and the regulatory community were established to address emergency response and recovery, including the California Water/Wastewater Agency Response Network (CalWARN), Laboratory Response Network (LRN), and the California Mutual Aid Laboratory Network (CAMAL Net). CalWARN systems facilitate a utilities-helping-utilities approach by providing assistance during a crisis. By establishing mutual aid agreements before a crisis occurs, CalWARN participants pave the way for member utilities within and outside of their respective regions to send valuable aid in a quick and efficient manner. CalWARN participants can access specialized resources to assess and assist water

and wastewater systems until such time as the system can develop a permanent operating solution.

- Water Infrastructure Security Enhancement (WISE) Guidelines, drafted for the Physical Security of Water/Wastewater Utilities by national water and wastewater organizations, provide recommendations for the management, operation, construction, and retrofit of water and wastewater treatment plants and distribution/collection systems to enhance physical security. The WISE Guidelines are at http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Security.aspx.
- Coordination among partners and stakeholders and developing those relationships are critical to a successful response and recovery, and to improving situational and operational awareness. The water and wastewater communities and respective regulatory organizations have formed many groups to accomplish this critical network that meet periodically and communicate regularly. These groups include:
  - InfraGard, created and sponsored by the Federal Bureau of Investigation as a public/private information sharing and analysis collaborative. It was established because the majority of critical infrastructures and key resources are owned and operated by private entities.
  - Local Terrorism Early Warning Groups (TEWG), which meet to exchange information and discuss local and national issues.
  - Water Information Sharing and Analysis Center (Water ISAC), a Department of Homeland Security-recognized center, which provides water and wastewater information sharing and analysis.
- Recognizing that communication during a crisis can make or break a successful response, the CDPH used the Centers for Disease Control and Prevention Crisis and Emergency Risk Communication (CERC) Toolkit and modified it specifically for the water and wastewater community. CDPH has conducted numerous CERC training classes detailing the toolkit and espousing the virtues of being prepared to address risk communication during a crisis.
- A successful response and recovery is also strongly dependent upon exercising the policies, procedures, processes, and partnerships. To that goal, the regulatory communities are providing training to the water and wastewater communities on designing and conducting tabletop exercises. Tabletop exercises are a low cost, low stress process by which partners can work together on scenarios and discover any gaps or gains. This is further strengthened by the nationwide acceptance, training, and use of the Department of Homeland Security, Homeland Security Exercise and Evaluation Program (HSEEP), which provides a nationwide framework for exercises and improvement.
- Numerous tools have been created to help water and wastewater utilities be better prepared for crises and emergencies. These include:
  - Water Health and Economic Analysis Tool (WHEAT) is a consequence analysis tool designed to assist drinking water and wastewater utility owners and operators in quantifying human health and economic consequences for a variety of scenarios that pose a significant risk to the water sector.
  - Vulnerability Self-Assessment Tool (VSAT) is a risk assessment software tool for water, wastewater, and combined utilities to assist drinking water and wastewater owners and operators to conduct security threats and natural hazards risk assessment as well as updating utility emergency response plans.

- FedFUNDS is a new interactive Web site created to help water and wastewater utilities navigate through the maze of Federal Disaster Funding. (See http://water.epa.gov/infrastructure/watersecurity/funding/fedfunds/index.cfm.)

Existing and Emerging Contaminants

New contaminants in drinking water are often discovered and then regulated because of increased pollution, improved analytical abilities, and/or a better understanding of health effects. Media attention to a particular contaminant has also resulted in a legislative response to address or speed up the regulatory process. Examples include hexavalent chromium, pharmaceuticals, and personal care products. In addition, the health effects of many known contaminants are re-evaluated and re-regulated as new information becomes available. For many emerging contaminants, such as pharmaceuticals and personal care products, there may not yet be a full understanding of the health risks they cause in drinking water and available treatment technologies to remove them from drinking water. For such contaminants, the pollution prevention and matching water quality to water use resource management strategies will help address water quality concerns while additional information is gathered. For pharmaceuticals and personal care products, control of discharge to the environment is the best initial approach via source control programs and reduction through wastewater treatment, rather than relying on drinking water treatment.

Emerging contaminants may be created by treatment itself, for instance, when water utilities implement new methods or processes for disinfecting water that may create new disinfection byproducts. For some contaminants, treatment options may be available, but they may be relatively expensive.

Recommendations

Because of the importance of drinking water, there is strong interest from many groups to promote improvements to drinking water treatment and distribution facilities, operation, and management. These groups include:

- Water system managers and operators.
- Local governmental agencies — city, county, planning.
- Regulatory agencies such as CDPH, local primacy agencies (county), and the EPA.
- Environmental and community stakeholders.

Based on the major issues outlined in this chapter, the following additional actions are needed to ensure there is adequate protection of public health through the maintenance of infrastructure, advancements in water treatment, and developing and maintaining relationships among the groups that advocate safe drinking water:

1. The Legislature should take necessary steps to maintain a sustainable source of funding of water supply, water treatment, and infrastructure projects to ensure a safe and reliable supply of drinking water for individuals and communities and to provide State matching funds for the federal SDWSRF.

2. Additional funding should be provided to CDPH to provide increased technical assistance to small water systems related to asset management and rate setting.

3. The Legislature should take steps to require publicly owned water systems to establish water rate structures at a level necessary to provide safe water, replace critical infrastructure, and repay financing for treatment and distribution system improvements necessary to meet drinking water standards.

4. State government should support enactment of a federal water infrastructure trust fund act that would provide a reliable source of federal assistance to construct and repair water treatment plants.

5. Additional programs should be developed to encourage regionalization and consolidation of public water systems. Regionalization and consolidation are useful both in achieving compliance with water quality standards and in providing an adequate economy of scale for operating and maintaining existing facilities as well as planning for future needs.

6. State government should continue to develop funding for small water systems and DACs to assist in complying with drinking water standards.

7. State government should continue to encourage conservation and develop additional incentives, such as expanded rebate programs, to allow water systems to reduce the waste of limited water resources.

8. Public water systems that provide flat rate water service should strongly consider changing to a metered water rate structure to discourage waste. In addition, water systems that have water meters for some customers, but not on all service connections, should strongly consider providing water meters for all customers.

9. State government should consider providing incentives that would encourage water systems to adopt rate structures that encourage conservation and discourage the waste of water.

10. The Legislature should establish a requirement for all public water systems, whether in urban or other areas of the state, to install a meter on each service connection and charge a metered rate for actual volume of water used.

11. California's regulatory agencies, such as the State Water Resources Control Board and CDPH, should maintain internship programs for college students to continue the interest of the next generation in water and environmental regulatory agencies.

12. State government should support research and development of new and innovative treatment technologies by providing funding for demonstration pilot projects. Additional program funding is also needed by CDPH to address the review and acceptance of these new treatment technologies adequately.

13. Water systems should fully evaluate residual disposal issues when planning new water treatment facilities due to increased costs and other issues associated with disposing treatment residual wastes.

14. All public water systems should be encouraged to join the California Water/Wastewater Agency Response Network. This program will provide mutual aid and assistance more quickly than the normal resource requests submitted through the Standardized Emergency Management System.

15. The control of pharmaceuticals and personal care products in the environment should be addressed initially via source control programs and reduction through wastewater treatment.

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