California
Department of Water Resources

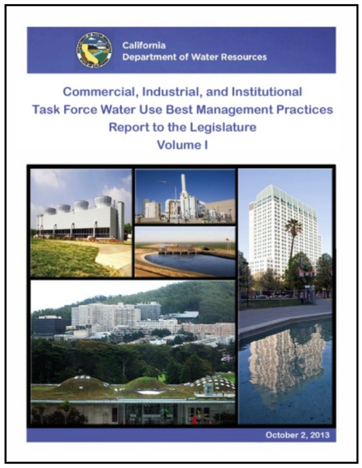
Commercial, Industrial, and Institutional Task Force Water Use Best Management Practices Report to the Legislature Volume I: A Summary

October 21, 2013

This report to the Legislature pursuant to Section 10608.43 of the California Water Code is displayed in two volumes for the reader's convenience.

Navigating Through this Report

Targeted to the general public, the legislature, and other policy makers and managers

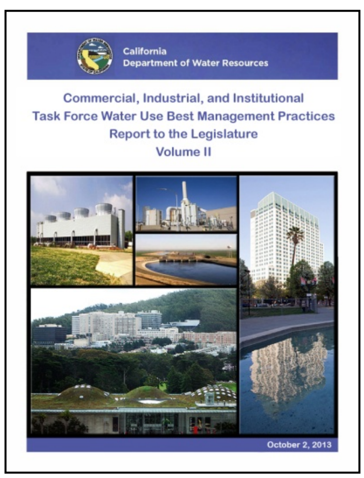


Volume I: A Summary

Sections:

1. Introduction
2. Report Organization
3. Current Water Use and Demand in the Urban Sector
4. Recommended Action Summary
5. Sections 5 - 10, Summary of Volume II

Targeted to those implementing best management practices



Volume II: Technical Information

Sections 1 – 4 (same as Volume I)

Sections:

5. Water Use Metrics
6. Technical and Financial Feasibility of Implementing the BMPs
7. Commercial, Industrial, and Institutional Sector BMPs
8. Standards and Codes
9. Public Infrastructure Needs for Recycled Water
10. Evaluation of Institutional and Economic Barriers to Municipal Recycled Water

Appendices A through F

State of California
The Natural Resources Agency
Department of Water Resources
Division of Statewide Integrated Water Management
Water Use and Efficiency Branch

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A report to the Legislature pursuant to Section 10608.43 of the California Water Code

October 21, 2013

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Copies of this report are available from:

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This report is also available on the Water Use and Efficiency website at:
http://www.water.ca.gov/wateruseefficiency/sb7/committees/urban/u1/

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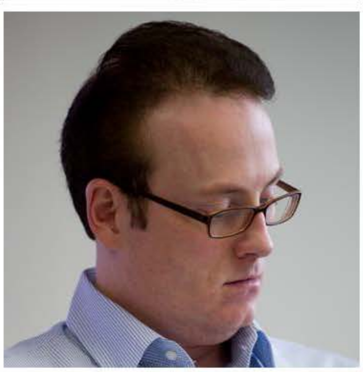


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List of Abbreviations and Acronyms

ACWA	Association of California Water Agencies
af	acre feet
af/yr	acre-feet per year
ANSI	American National Standards Institute
APN	Assessor's Parcel Number
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
B/C	Benefit/cost analyses
BAT	best available technology
BCC	best classification code
BMPs	best management practices
CBSC	California Building Standards Commission
CC	cycles of concentration
ccf	hundred cubic feet
CDCR	California Department of Corrections and Rehabilitation
CDPH	California Department of Public Health
CEC	California Energy Commission
CEE	Consortium for Energy Efficiency
CEQA	California Environmental Quality Act
CIP	clean in place
CII	commercial, industrial and institutional
CIWQS	California Integrated Water Quality System
CLCA	California Landscape Contractors Association
COP	clean out of place
CPUC	California Public Utilities Commission
CUWA	California Urban Water Agencies
CUWCC	California Urban Water Conservation Council
CWC	California Water Code
DE	diatomaceous earth
DI	deionization
DOF	Department of Finance
DWR	Department of Water Resources (State of California)
DX	direct expansion
EBMUD	East Bay Municipal Utility District
EO	executive order
EPAct	Federal Energy Policy Act
ET	evaporation-transpiration
FEMP	Federal Energy Management Program

GAMA	groundwater ambient monitoring and assessment
GBI	Green Globes' Green Build Initiative
GDP	gross domestic product
gpcd	gallons per capita per day
gpm	gallons per minute
gpv	gallons per vehicle
HCD	Department of Housing and Community Development (California)
HEUs	High-efficiency urinals
HVAC	Heating, ventilating, and air conditioning
IAPMO	International Association of Plumbing and Mechanical Officials
ICA	International Carwash Association
ICC	International Code Council
IPC	International Plumbing Code
IRR	Internal Rate of Return
IRWMP	Integrated regional water management plan
IWIP	Illinois Water Inventory Program
kWh	Kilowatt-hour
LEED	Leadership in Energy and Environmental Design
maf	million acre feet
mcf	thousand cubic feet
MEF	modified energy factor
Mgd	million gallons per day
M&I	municipal and industrial
MAWA	maximum applied water allowance
MMWD	Marin Municipal Water District
MS4	small municipal separate storm sewer system permits
MWELO	Model Water Efficient Landscape Ordinance
NAICS	North American Industrial Classification System
NEPA	National Environmental Policy Act
NF	nanofiltration
NGOs	Non-governmental Organizations
NPDES	National Pollutant Discharge Elimination System
NPV	net present value
NSF	National Sanitation Federation
OPL	on-premise laundries
PBMP	Potential Best Management Practice
PCB	Printed circuit board
PG&E	Pacific Gas & Electric Company
psi	pounds per square inch
PRSV	Pre-rinse spray valve
PWSS	Public Water System Statistics Survey
RO	reverse osmosis
ROI	return on investment
RWQCB	Regional Water Quality Control Board (California)

SB	Senate Bill
SIC	standard industrial classification
SWRCB	State Water Resources Control Board (California)
TDS	total dissolved solids
TWDB	Texas Water Development Board
UPC	Uniform Plumbing Code
USEPA	U.S. Environmental Protection Agency
USGS	U. S. Geological Survey
UV	ultraviolet
UWMP	urban water management plan
WF	water factor
WPU	Water Plan Update
WRDA	Water Resources Development Act

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1.0 Introduction

This report, *Commercial, Industrial, and Institutional Task Force Water Use Best Management Practices Report to the Legislature*, identifies specific best management practices (BMPs) and actions to support the commercial, industrial, and institutional (CII) sector's efforts to improve water use efficiency and support California's water supply sustainability. It is intended to provide the CII sectors with information on water-saving technologies and applicable BMPs.

This report is intended for use as a resource for:

- Existing and new businesses, facilities, and institutions.
- Developers, consultants, and designers.
- Water service providers.
- Planning agencies.
- Policy makers.

Since technology and practices change over time, the information in this report is intended and recommended to be updated periodically.

This report provides the CII sector with the ability to capture the multiple benefits of reduced costs for water, energy, wastewater, and onsite water and wastewater treatment facilities. Water efficient landscape BMPs are also included because outdoor water use may represent a significant percentage of CII water use.

Recommendations include BMPs, actions for implementation, metrics, and the use of alternate water sources for certain applications.

"Fortunately, there are numerous cost-effective strategies that can be applied to achieve significant water savings in the CII sector. Estimates indicate that this potential ranges between 710,000 and 1.3 million acre-feet per year."

(Quote from Making Every Drop Work: Increasing Water Efficiency in California's Commercial, Industrial, and Institutional (CII) Sectors 2009 NRDC. Efficiency estimate based on 2003 Pacific Institute analysis in Waste Not, Want Not: The Potential for Urban Water Conservation in California.)

1.1 Background and History

The CII sector is fundamental to California's economy and structure. It employs residents, provides goods and services, and maintains the state's position as a center for technology and innovation. Though California's economy has grown, the water used in the state has remained generally consistent (see Figure 1.1). Increasing water use efficiency is critical to growing and protecting the state's economy and to reduce pressures on California's water resources and environmental health.

Growing population, climate change, and the need to protect and grow California's economy, while protecting and restoring our fish and wildlife habitats, make it essential that the state manage its water resources as efficiently as possible.

The California Department of Finance (DOF) estimates that California's population will continue to grow from 37 million people (2010 census), surpassing 40 million by 2020 and 50 million in 2050. The 2009 California Water Plan Update (Update 2009) addressed the variability of population, water demand patterns, environmental patterns, climate, and other factors that affect water use and supply. Incorporating consideration of uncertainty, risk, and sustainability, Update 2009 estimates that in 2050, urban sector water use will be between 1.5 and 10 million acre-feet per higher than the 2009 annual use.

To address increasing demands on the State's water supply, Governor Schwarzenegger issued an executive order in February of 2008 that called for a 20 percent reduction of per capita water use in the urban sector by 2020. In November 2009, Senate Bill (SB) X7-7 (Steinberg) made that order a state law by amending the California Water Code (CWC). This report meets one of the requirements of this law.

SB X7-7 recognizes that:

- Reduced water use through conservation achieves significant energy and environmental benefits and can help protect water quality, improve stream flows, and reduce greenhouse gas emissions.

- Diverse regional water supply portfolios will increase water supply reliability and reduce dependence on the Sacramento - San Joaquin Delta.

- The success of state and local water conservation programs to increase efficiency of water use is best determined on the basis of measurable outcomes related to water use or efficiency.

Future increases in air temperature, shifts in precipitation patterns, and rising sea level could affect California's water supply by changing how much water is available, when it is available, and how it is used (DWR Climate Change Effects, Update 2009).

SB X7-7 contains specific actions requiring water conservation, measurement, and reporting activities for urban and agricultural water suppliers. One of the SB X7-7 actions directs the Department of Water Resources (DWR), in coordination with the California Urban Water Conservation Council (CUWCC) to "convene a Task Force consisting of academic experts, urban retail water suppliers, environmental organizations, commercial, industrial, and institutional water users to develop alternative best management practices for the commercial, industrial, and institutional water users" (CWC 10608.43).

The CII Task Force was also directed to assess the potential statewide water use efficiency improvements in CII sectors that would result from implementation of the alternative BMPs. The CII Task Force, in conjunction with DWR, was ordered to submit a report to the Legislature by April 1, 2012.

The CUWCC played a key role in the CII Task Force formation and implementation. The CUWCC is a non-governmental organization created in

1991 by urban water agencies and environmental groups. The CUWCC was created to “increase efficient water use statewide through partnerships among urban water agencies, public interest organizations, and private entities.” The CUWCC's goal is to integrate urban water conservation BMPs into the planning and management of California's water resources. It has adopted water use BMPs that its 389 member agencies have agreed to implement.

1.2 Scope of the Commercial, Industrial, and Institutional Task Force

The scope of the CII Task Force is defined by statute §10608.43 as outlined below. It was tasked with:

- Developing alternative BMPs for CII businesses and an assessment of the potential statewide water use efficiency improvement in the CII sectors that would result from implementation of these BMPs.
- Conducting a review of multiple sectors within CII businesses and recommended water use efficiency standards for CII businesses among the various water use sectors.
- Developing appropriate metrics for evaluating CII water use.
- Evaluating water demands for manufacturing processes, goods, and cooling.
- Evaluating public infrastructure necessary for delivery of recycled water to the CII sectors.
- Assessing the institutional and economic barriers to increased recycled water use within the CII sectors.
- Identifying of the technical feasibility and cost and benefit of the BMPs to achieve more efficient water use statewide in the CII sectors that is consistent with the public interest and reflects past investments in water use efficiency.

1.3 CII Task Force Members, Meetings, and Report

DWR and the CUWCC project management team assembled the CII Task Force to develop BMPs, metrics, recommendations, and this report to the legislature. The Task Force consisted of key CII leaders with strong expertise in water-related issues, representing "academic experts, urban retail water suppliers, environmental organizations, commercial water users, industrial water users, and institutional water users," as specified in the CWC §10608.43. CII Task Force members were invited to participate or were recommended. Participation was voluntary and, in several cases, a member or alternate served only once because of scheduling conflicts.

At the CII Task Forces initial meeting in March 2011, subcommittees were formed to review, assess, and develop new BMPs, as necessary. The subcommittees included:

- Food and Beverages - Trudi Hughes/California League of Food Processors, chair
- High Tech - Mike Mielke/Silicon Valley Leadership Group, chair
- Commercial Landscape - Mike Pimentel/Rain Bird, chair
- Metrics – Jeremy Jungreis/US Marine Corp Reserve, chair
- Petroleum Refining and Chemicals – Ken Letwin/British Petroleum, chair
- Water Recycling – Dave Smith/WateReuse, chair

Subcommittees were comprised of CII Task Force members and non-member subject matter experts with interest and expertise in the subcommittee topic. Subcommittees met regularly to implement the BMP mission and prepare relevant portions of the Task Force Report. Subcommittee actions and status were reported at each CII Task Force meeting.

Agendas were posted ten days prior to meetings on the CUWCC's CII Task Force and on the DWR's Water Use Efficiency websites.[1] Meetings of the CII Task Force were open to the public and were subject to the Bagley Keene 2004 Open Meeting Act. The public and other interested parties were given an opportunity to comment throughout the process.

The Task Force members provided technical information, reviewed technical material and documents, and provided comments, data, and supporting

[1] http://www.cuwcc.org/2column.aspx?id=16620 and www.wateruseefficiency/sb7

information to the DWR and CUWCC project management team, which prepared this report as stipulated under the CWC §10608.43. The recommendations in this report reflect a consensus of the Task Force members.

The CUWCC and their contractors, under the direction of DWR, drafted the initial documents for the first draft of this report. DWR then assembled and edited the first and subsequent drafts.

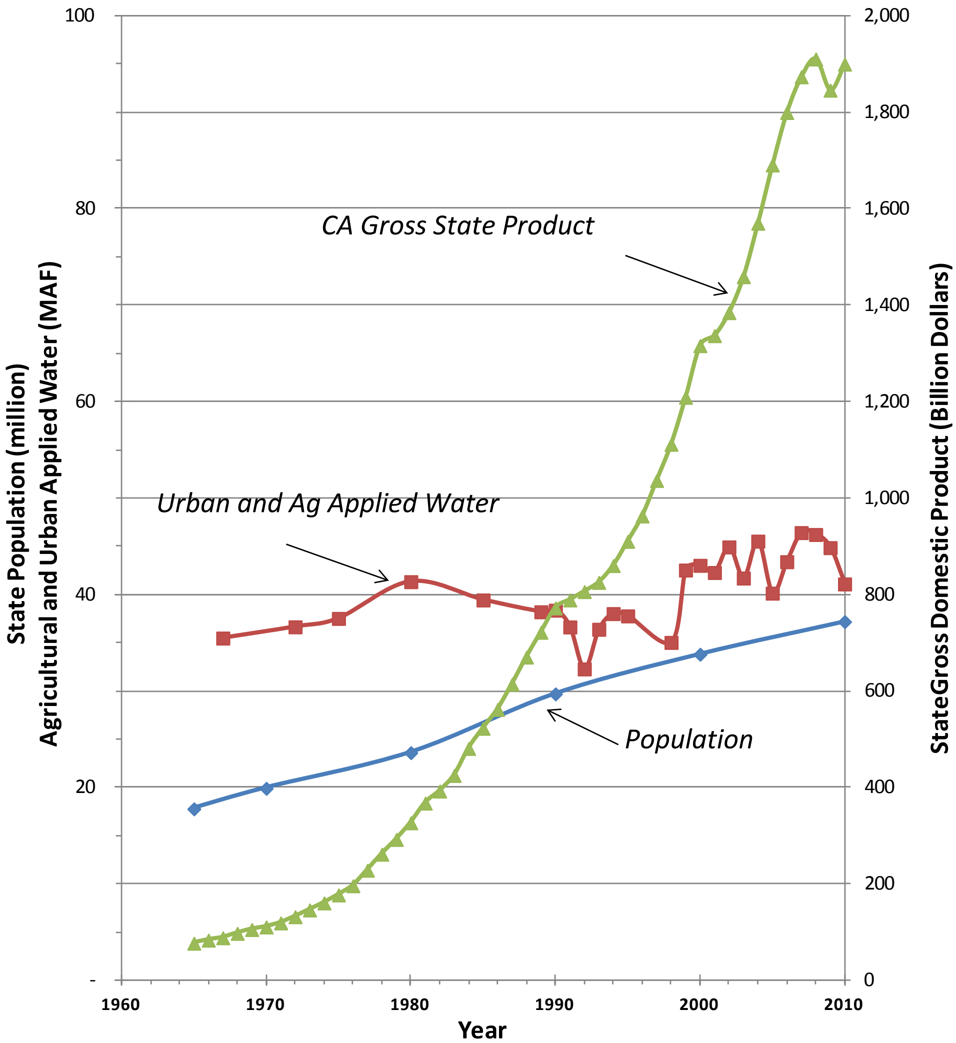

Figure 1.1 California Population, Gross Domestic Product (GDP) and Water Use Comparison.

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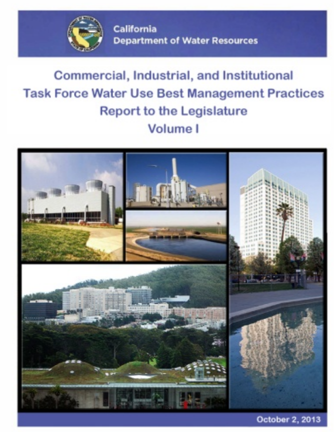
2.0 Report Organization

This report is organized on multiple levels to support its use for diverse purposes. It provides a general overview for those interested in the commercial, industrial, and institutional (CII) best management practices (BMPs) concepts, as well as detail for those implementing them. Recommendations also include the use of alternate water sources for certain applications, and many of the BMPs can be applied to other business types not specifically addressed herein.

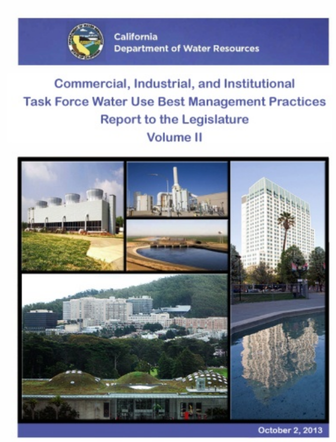


This report includes the following:

- **Executive Summary** – Report highlights.
- **Volume I: A Summary** – This volume contains summary of the in-depth information provided in Volume II. The targeted audience for Volume I is the general public, the legislature, and other policy makers and managers.
- **Volume II: Recommendations, BMPs, and Technical Background –** This volume contains the fully-developed, technical report prepared by the CII Task Force team and the full recommendations of the CII Task Force. Volume II also includes the report appendices, which contain supplemental information, the glossary, case studies, and references. This volume is targeted to those who would implement the BMPs and are interested in a more technical discussion.

For the reader's convenience, this report is displayed in two volumes. Volume I provides a summary of the material presented in greater detail in Volume II, which includes the Appendices and Case Studies.

Both Volumes I and II are prepared as stand-alone documents; however, references and appendices are only included in Volume II. Each volume contains the same sections, but the technical sections are only briefly summarized in Volume I.



The introductory sections are the first four sections of each volume. They are the same in both volumes except for references, and provide information critical to any reader of this report. The introductory sections include:

1.0 Introduction
2.0 Report Organization
3.0 Current Water Use and Demand in the Urban Sector
4.0 Recommendation Summary

The technical sections (Sections 5.0 through 10.0) follow the introductory sections in both volumes. However, the level of detail in the technical sections differs between the two volumes. In Volume I, each section is a brief summary of the more detailed information contained in Volume II. The technical sections are:

5.0 Water Use Metrics and Data Collection
6.0 Technical and Financial Feasibility of Implementing the BMPs
7.0 Commercial, Industrial, and Institutional Sector BMPs
8.0 Standards and Codes for Water Use Efficiency
9.0 Public Infrastructure Needs for Recycled Water
10.0 Evaluation of Institutional and Economic Barriers to Municipal Recycled Water Use

The BMPs are the highlight and focus of the CII Task Force Report. They are presented in three locations:

- **Volume I** – A brief overview of how the BMPs were developed and what BMPs are included
- **Volume II** – A fully developed, detailed discussion of each BMP, including relevant information for implementation.
- **Appendix A** – A BMP list and description only, without background information.

A glossary of terms is included in Appendix B. Selected case studies describing water savings efforts currently being implemented in California are in Appendix C. These, and each of the other appendices, are located in Volume II.

3.0 Current Water Use and Demand in the Urban Sector

California's water demands have begun to reach and, in some circumstances, exceed the available water supply. Although the State has a vast supply of water resources, competing demands from agricultural, residential, commercial, industrial, and institutional (CII) users, and the environment, are placing a strain on that supply. Yet water is vital in California, as this state is the 8th largest economy in the world and the most populous state in the nation, with 37 million residents according to the 2010 census.

DWR estimates that the CII sector accounts for approximately 30%, or roughly 2.6 million acre-feet (maf), of total urban water use in California (Update 2009).

The 2009 California Water Plan Update (Update 2009) estimated that the annual average water demand is 33.2 million acre feet (maf) for the agricultural sector and 8.8 maf for the urban sector based on the average uses during the 1998 to 2005 time period (Update 2009). Long-term variability (1967 to 2010) in these annual demands is shown in Figure 1.1. These estimates do not include additional state developed water that is allocated, mitigated, legislated, designated, or otherwise used to support the environment.

The Update 2009 estimated that the CII sectors use approximately 30 percent, or roughly 2.6 maf[2], of total urban water use. Figure 3.1 shows how CII water use relates to California's overall water use, excluding environmental use, as well as the proportion of the three components of CII water use measured by the Update 2009 – industrial, commercial and institutional, and large landscape (golf courses, parks, etc.).

Reductions in CII water use would contribute to the urban sector meeting its 2020 targets. Water conservation and efficiency benefits the CII sector by reducing costs as well as physical, regulatory, and reputational water-related risks.

The CII sector obtains water from numerous sources, including:

- Delivered water from external suppliers, including both surface and groundwater supplies.
- Self-supplied water, primarily groundwater.
- Municipal recycled water, supplied from an external supplier.

In addition, the CII sector frequently internally reuses its process water to maximize water supply benefits. This internal reuse has not been quantified because such practices may involve proprietary information.

[2] This number does not include self – supply, but does include recycled water.

Seawater, or saline water, is an additional source of water supply available to some coastal CII facilities providing an estimated 14.5 maf primarily to the mining and steam electric power plants sectors (USGS 2009). Saline water use is not included in the Update 2009, as illustrated in Figure 3.1. Figure 3.2 shows the total estimated CII annual water sources and use, considering both saline and freshwater use.

Reductions in CII water use would contribute to the urban sector meeting its 2020 targets. Conservation and efficiency benefits the CII sector by reducing costs as well as physical, regulatory, and reputational water-related risks.

Within the CII Task Force Report, BMPs are generally considered applicable to any CII water sources, with the exception of municipal recycled water. Because of the uniqueness of municipal recycled water relative to the ranges of water quality and its dependence on the local supplier, as well as infrastructure and process issues, recycled water is addressed separately in Chapters 9.0 and 10.0 of this report.

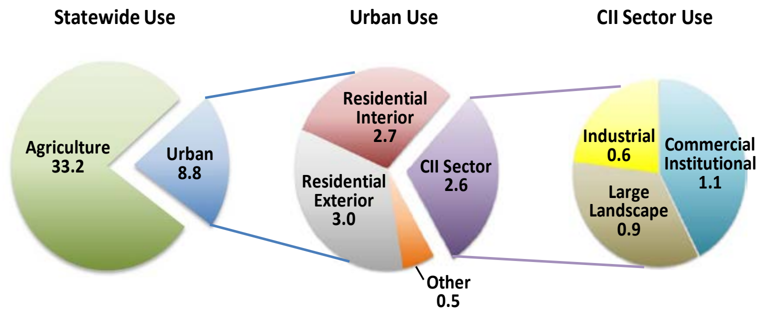


Figure 3.1 Volumetric breakdown of California Non-Environmental Developed Water Use

Note: Based on 1998-2005 CWP averages. Volumes shown are in millions of acre-feet per year.

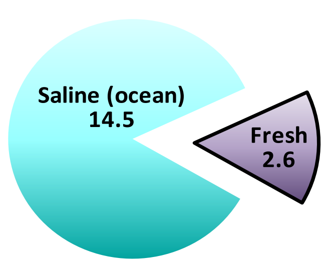


Figure 3.2 Sources of CII Water in California

4.0 Task Force Recommended Actions Summary

This report explores a range of issues associated with water use and efficiency opportunities within the CII sector and recommendations including:

- Best Management Practices (BMPs)
- Best Available Technology (BAT)
- Recommendations for actions
- Metrics for evaluating water use
- Recycled water and alternative supplies

> The "Task Force Recommended Actions Summary" section of this report provides direction on how noted tasks can be accomplished, plus a list of potential recommended legislative actions and next steps.

The recommendations found in this report provides direction, procedures or actions to formalize and assure implementation, verify and report on implementation, and adopt changes as practices and technologies improve. Recommendations also include next steps and a list of potential legislative actions.

The Task Force, furthermore, recommended that throughout the BMP implementation process, participation by the state legislature, state agencies, industry groups, CII businesses, water service providers, wastewater agencies, environmental groups, and other stakeholders should be included.

While stakeholders in the implementation process have been identified, their continued support and specific roles must be confirmed. An assessment of the resources needed for implementation must be completed and sources of additional support, both financial and technical, must be defined. The implementation process should include state legislation, regulations, and stakeholder buy-in. Also, a mechanism for verification of progress will need to be defined, implemented, and monitored.

Throughout the implementation process it is important to remember that each CII site is unique and needs to be treated as such. Accordingly, the approaches to implementing BMPs, determining metrics, the technical feasibility, and cost-effectiveness need to consider that uniqueness. Finally, water use comparisons between various business sectors or between individual customers may not be helpful in determining metrics and selecting benchmarks, and are best applied within an individual business or customer due to unique site-specific characteristics.

The following sections; metrics, the technical and financial feasibility of implementation, BMPs and recycled water summarizes actions that can be implemented. Specific BMPs and recommendations for metrics and recycled water can also be found in the corresponding sections of Volumes I and II.

4.1 Metrics and Measuring Progress

The purpose of this section is to provide a conceptual understanding and approach to establish appropriate metrics for evaluating water use, efficiency, and productivity in the CII sectors, and to identify the savings potential from implementation of the CII BMPs in California. The usefulness and feasibility of metrics are tied to the availability and reliability of data. This section summarizes objectives and introduces the need for consistent and reliable water use data collection, reporting, and monitoring. Volume I, Section 5.0 Metrics summarizes Volume II Section 5.0 and includes recommendations, while Volume II contains the full discussion and recommendations.

The applicability and feasibility of metrics are tied to the availability, consistency, and reliability of data collection, reporting, and performance monitoring.

It should be noted, however, that water use metrics require further evaluation, especially for the industrial sector.

The objectives identified for water use metrics and data collection include:

Metrics:

- Providing a framework for understanding water use metrics and their applications.
- Discussing who uses metrics and why.
- Presenting criteria for selecting appropriate metrics.
- Providing examples of metrics in use and potential new metrics.
- Providing recommendations to improve the use of metrics that will encourage water use efficiency and demonstrate the effectiveness of BMP implementation.

Data Collection and Reporting:

- Providing context perspectives to address CII water use data collection and reporting at the water service provider and state level.
- Providing recommendations to evaluate options for data collection and reporting across end use, water service provider, subsector, state, and sector levels.

4.2 Technical, Financial Feasibility and Potential Water Use Efficiency Improvements for BMPs and Audits

The Legislature called upon the CII Task Force to develop “an assessment of the potential statewide water use efficiency improvement in the commercial, industrial, and institutional sectors that would result from implementation of these best management practices” (CWC Section 10608.43). A statewide assessment was challenging, as described in this section, but examples of water savings accomplished in specific applications are presented in this section along with an approach based on penetration rate for a BMP.

Finally, water audits have been found to be effective in assisting managers of CII entities to identify areas of inefficient water use within facilities and appropriate BMPs to reduce water use. A discussion of audits concludes this section.

This section is more completely summarized in Section 6.0 of Volume I with a more detailed description in Section 6.0 of Volume II and begins with CII Task Force recommendations.

Recommendations

The CII Task Force has the following recommendations based on the background information provided in Section 6.0 of Volume I and II.

- CII entities should perform water audits to identify opportunities for implementation of BMPs.
- Following audits, CII entities should evaluate the technical and financial feasibility of BMPs to determine whether to implement BMPs.
- Water and energy service providers should incorporate water audits into their efficiency programs, consider financial incentives for BMP implementation, and provide other technical assistance as appropriate.
- Organizations representing businesses and industry, water service providers, CUWCC, and DWR should educate CII businesses on the BMPs and approaches to doing audits and performing a cost-effectiveness analysis.
- All new water users should consider implementing the recommended BMPs at the time of installation or construction.
- When replacing equipment, CII business should evaluate the equipment and the maintenance and operational practices needed to achieve an industry standard of water use efficiency for the new equipment being purchased.

4.3 Best Management Practices

A wide range of BMPs have been developed that focus on technical advancements and improved management practices that will increase the efficiency of water use in the CII sectors. A detailed discussion on specific BMPs that could be implemented for the various CII sectors and their financial feasibility and potential water efficiency improvements are described in Volume I, Sections 6.0 and 7.0 and Volume II, Sections 6.0 and 7.0 and Appendix A.

Implementation of the BMPs could be facilitated by all stakeholders doing the following:

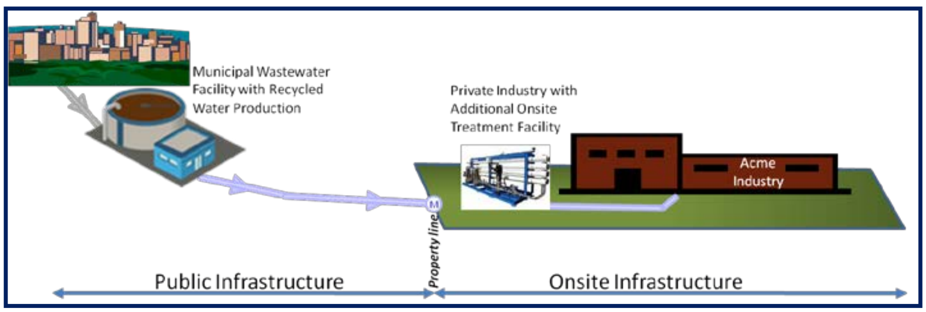
- Endorse and adopt a formal process and commit to ongoing support for CII water conservation measures to address issues identified in this report.
- Share and promote the importance of BMP implementation with CII businesses and the general public.
- Conduct state-wide BMP workshops in coordination with industry organizations to implement the recommendations of this report;
- Provide technical and financial assistance and advice to those implementing the BMPs.
- Develop a mechanism for reporting progress that could include:
    - Periodic reports to the Legislature through DWR or other designated entities
    - Inclusion of progress reports in CUWCC reports to the State Water Resources Control Board (SWRCB)
    - Inclusion of progress reports in urban water service supplier Urban Water Management Plans (UWMPs)
- Develop local, sector specific, and state wide approaches to track the success and effectiveness of BMP implementation efforts and water savings results.
- Develop a mechanism to update the CII BMPs as practices and technologies improve.
- Identify assurance mechanisms that recommendations of this report are addressed.

It is recommended that an advisory group or committee be formed to further analyze and make recommendations regarding the development, use, and capture of pertinent metrics and BMPs.

Water service providers (and energy utilities) should incorporate audits into their efficiency programs, consider financial incentives for BMP implementation, and provide other technical assistance as appropriate.

Financial Feasibility and Potential Water Use Savings for BMPs:

- CII businesses should perform audits to identify opportunities for implementing BMPs. Following audits, they should calculate the cost-effectiveness of various measures, factors such as:
    - Projected water and wastewater cost savings over time
    - Energy savings and changes in operation and maintenance costs including changes in water, wastewater, energy, waste disposal, pre-treatment, chemical, and labor costs
    - Implementation cost
    - Potential incentives available
    - Water supply reliability benefits
- Water service providers (and energy utilities) should incorporate audits into their efficiency programs, consider financial incentives for BMP implementation, and provide other technical assistance as appropriate.



The CUWCC should continue to update their BMPs for water service providers' CII conservation programs and technologies to incorporate the CII BMPs, audits, and cost-effectiveness assessments. All new water users should also consider and re-evaluate implementation of recommended BMPs at the time of equipment installation or construction improvements.

4.4 Recycled Water and Alternative Supplies

Key issues in the CII Task Force Report address how non-potable water sources can be obtained and incorporated into CII applications. These issues are considered in Sections 7.0 (alternate water supplies and specific BMPs), Section 9.0 (infrastructure limitations for obtaining municipal recycled water), and Section 10.0 (barriers and solutions for CII use of municipal recycled water). Overall these recommendations include legislative, financial, regulatory, and operational mechanisms for increasing non-potable water use in CII applications.

The following actions should be taken to encourage more aggressive use of recycled water and alternative water supplies by CII water users:

- Improve regulatory and statutory requirements to overcome barriers to potable and non-potable recycled water use in a manner that is protective of public health and water quality.

- Encourage the California Building Standards Commission (CBSC) to consider national and international codes and to:
    - Periodically update and expand the plumbing code.
    - Address alternative water supplies.
- Encourage financial and technical assistance to increase recycled and alternative water use.

Overall these recommendations include legislative, financial, regulatory, and operational mechanisms for increasing non-potable water use in CII applications.

The California Energy Commission (CEC) should consider allowing offsets for the use of recycled water at power plants. Under an offset program, where it is not feasible to use recycled water at a power plant, a power plant operator would be allowed to provide funding to expand recycled water at another location.

4.5 Legislative Opportunities

Opportunities for state legislation in assisting in implementation of the CII Task Force BMPs and recommendations include:

- Provide the state with a mechanism and the authority for collecting detailed water use data in the private and public agency sectors for the purpose of tracking the progress of statewide CII sector water use and implementation of the CII BMPs and recommendations of this report. This information can be reported back to the legislature and used to assist DWR in quantifying urban water use for the California Water Plan Update.

- Provide support and state funding for the implementation of recommendations in this report, including those water conservation programs and recycled water projects with benefits to the state and overcoming financial barriers toward expanded use of recycled water.

- Improve statutory requirements where appropriate to overcome barriers to potable and non-potable recycled water use in a manner that is protective of public health and water quality.

- Promote updates to the plumbing code that encourage alternative water supplies and implementation of cost-effective BMPs.

Some of the opportunities for State legislation in assisting implementation of the CII Task Force BMPs and other recommendations include: providing additional funding to implement the recommendations of this report, providing authority to collect water use data, and improving statutory requirements to overcome barriers to recycled water.

4.6 Next Steps

To help assure that the work of the CII Task Force benefits the State of California, CII water users, water service providers, wastewater agencies, energy utilities, climate action plans, the environment, CII stakeholders, and others, DWR and CUWCC should:

- Commit to ongoing support for CII water conservation measures.
- Identify a mechanism to ensure that these critical issues are being addressed going forward.
- Develop a mechanism for reporting on progress that could include:
    - Periodic reports to the Legislature through DWR or other designated entities.
    - Inclusion of progress reports in CUWCC reports to the SWRCB.
    - Inclusion of progress reports in urban water supplier UWMPs.
- Ensure a process to address these issues is in place and is initiated by the end of 2014.

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5.0 Water Use Metrics and Data Collection

5.1 Introduction and Overview

This section summarizes the more technical Volume II Section 5, Water Use Metrics and Data Collection. The purpose of this section is to establish a path toward developing appropriate metrics for evaluating water use, efficiency, and productivity in the CII sectors and to demonstrate the potential future success of implementing the CII BMPs throughout California. The utility and feasibility of metrics are tied to the availability, consistency, and reliability of data collection, reporting, and monitoring.

> The Task Force agreed upon the recommendations summarized in this section for the development and use of metrics to evaluate water use and on an approach to improve data collection and reporting in California.

Volume I, Section 5.0 of the report provides:

- A framework to understand water use metrics and their application.
- Criteria for selecting appropriate metrics.
- Recommendations for next steps to improve the use of metrics that encourage efficient water use and demonstrate the effectiveness of BMP implementation.
- Examples of metrics in use and metrics that may be used.
- Recommendations for CII water use data collection and reporting at the customer, sector, utility, and state level.

Proper accounting (inventory, tracking, and measurement) of water use is needed to ensure sufficient water is available to meet the needs of California’s economy, society, and environment. It also provides a means to ensure compliance with laws governing water allocation. Agreement on how and why we account for water is needed to achieve our common goals.

The intent in identifying and developing appropriate water use metrics is to effectively monitor and evaluate water use and water use efficiency and productivity in the CII sectors. There must be an established set of commonly accepted definitions and a terminology related to water use and measurement before there can be a useful discussion of metrics issues.

The most fundamental metric to plan and evaluate water use is the total volume of water used over time. Water suppliers and state agencies often track these volumes aggregated into several major sectors. Even though this metric is valuable, some measure of the efficiency and productivity of water use may provide better guidance in evaluating water use efficiency. Another common water-use metric, gallons per capita per day (GPCD), is required by SB X7-7 for setting and meeting urban water service provider targets. However, GPCD may not be informative about trends within many of the CII sectors.

5.2 Recommendations

The CII Task Force agreed upon the following recommendations on the development and use of metrics to evaluate water use, and on an approach to improve data collection and reporting in California.

The recommendations presented below are identical to those given in Volume II and stem from the information or conclusions found later in this section or Section 5.0, Water Use Metrics and Data Collection in Volume II of this report.

> The recommendations presented here are identical to those in Volume II and the information or conclusions summarized in this section.

This section does not currently recommend any single metric for use in all CII sectors. Furthermore the CII Task Force cautions against setting regulatory minimum standards for water use efficiency metrics that would be applicable to specific CII establishments, sectors, or subsectors. Even within subsectors, it would be difficult to set uniform standards across CII establishments (defined as individual CII water user sites) because of the variability in the types of products made or services provided and the many confounding factors in how water is used.

5.2.1 Metrics Recommendations

Recommendation 5-1: CII establishments should use metrics to improve and track their water use efficiency over time. Where norms or ranges are available, establishments should compare their metrics to those norms.

Recommendation 5-2: CII associations, water service providers, and the CUWCC, among others, should provide tools, guidance, and training to their constituents and customers on BMPs and the establishment and use of metrics-based benchmarking to demonstrate improved water use efficiency over time.

> The CII Task Force found there are limited centralized data concerning how much water is used in the CII sectors. Moreover, the data that exist are tracked inconsistently at the local level.

Recommendation 5-3: Organizations such as the U.S. Environmental Protection Agency or CUWCC should develop software for voluntary and anonymous water use reporting and trending using an approach similar to Energy Star's Portfolio Manager. This data can then be used to develop norms for CII water use.

Recommendation 5-4: Manufacturers of equipment and products, CII associations, CII establishments, utilities, and the state should set efficiency standards for certain water use devices and equipment similar to existing device standards for commercial pre-rinse spray valves and clothes washers.

Recommendation 5-5: The CUWCC, water service providers, energy utilities, and CII associations should collect and compile data on market penetration levels for installation of particular devices or practices for which industry or regulatory water use efficiency standards exist.

Recommendation 5-6: DWR should continue to develop appropriate efficiency or productivity metrics for the CII sector to determine and monitor subsector water use at the statewide level and progress toward improving water use efficiency over time.

"Full-spectrum" is a water use classification term denoting the complete range of water uses and users, such that a classification system will have utility across different water planning or management functions at various levels of government and water service providers.

5.2.2 Data Collection and Reporting Recommendations

Recommendations 5-7 and 5-8 are intended to make improvements in data collection.

Recommendation 5-7: DWR should work with the Association of California Water Agencies (ACWA), CUWCC, California Urban Water Agencies (CUWA), California Public Utilities Commission (CPUC), California Water Association (CWA), and American Water Works Association (AWWA) to develop a full-spectrum, water-centric standardized classification system of customer categories. This classification system should include consistent use of North American Industry Classification System (NAICS) codes and assessors' parcel numbers (APNs).

Recommendation 5-8: DWR, in consultation with a stakeholder advisory committee and through a public process, should develop a system and implementation plan for water production, delivery, and use data collection for classification and for reporting and tracking at the user, water service provider, state, and federal levels. One or more of the following options should be considered:

- **Option 5-8.1:** DWR should develop a water-centric water use and user classification system.
- **Option 5-8.2:** Water service providers should classify water users using a common classification system and transition their customer databases to incorporate this system.
- **Option 5-8.3:** Water service providers should consider recording and maintaining key data fields, such as assessor's parcel numbers, for customers. This would enable the linking of water usage data with information from other sources for purposes of metrics, water demand analysis, and demand projections.

"Water-centric" is a water use classification term meaning being designed around and central to water uses and users, in contrast to characterizing economic activity, water billing functions, or other factors.

- **Option 5-8.4:** Water service providers and self-supplied water users meeting defined criteria should be required to report water use to the state.

- **Option 5-8.5:** Water service providers, CUWCC, and water users should expand on landscape irrigation water use categorizations that recognize and promote BMPs for separate metering, especially for larger and mixed use sites.

5.3 Water Use Metrics

5.3.1 Metrics Terminology and Definitions

Common definitions are important to understanding water use metrics. This report adopts the following AWWA guidance report definition of "metric":

> *"Metric" means a unit of measure (or a parameter being measured) that can be used to assess the rate of water use during a given period of time and at a given level of data aggregation, such as system-wide, sector-wide, customer, or end-use level. Another term for a metric is "performance indicator."*

A metric may also include an additional factor that correlates to the benefits obtained from water use in the CII sectors, such as employment, quantities of manufactured output, or square foot of land or building space.

> A metric may include an additional factor that correlates to the benefits obtained from that water use in the CII sectors, such as employment, quantities of manufactured output, or square foot of land or building space.

It is essential to also have a shared understanding of the terms "metric," "benchmark," and "target." These terms often are used interchangeably, but the different connotations of the words may lead to confusion if not clarified. An important distinction is that benchmarks and targets are not metrics in themselves or definitions of a metric; they are numerical values assigned to or derived from metrics. A "benchmark" is a numerical value of a metric that denotes a specific level of performance, or a current or beginning (baseline) value of a metric. A "target" is a benchmark that is expected at a future time. Benchmarks and targets may be used to set water use efficiency goals and measure progress over time. The CII Task Force encourages the use of benchmarks or targets to track progress in water use efficiency or productivity on both the statewide and local levels.

5.3.2 Calculation and Terminology

Metrics can take many forms, from simple to complex. The simplest water use metric is calculated as follows:

$$Basic\ quotient = \frac{Volume}{Time}\ \left(e.g.\frac{gallons}{day}\right)$$

The basic quotient may stand alone to show trends in total water use. However, to assess the efficiency or productivity of water use, we must apply a scaling factor to the equation. The scaling factor may take several different forms such as general population (per capita), employees, economic output, or square feet of building space.

The scaling factor may take several different forms such as general population (per capita), employees, economic output or square feet of building space.

The most common use of the scaling factor is to relate the basic quotient so that comparisons may be made relative to the chosen scaling factor. The scaling factor becomes the denominator of a water-use efficiency or productivity metric equation as shown below:

$$WUE\ Metric = \frac{Basic\ quotient}{Scaling\ factor} = \frac{\frac{Volume}{Time}}{SF}, \left(e.g. \frac{\frac{gallons}{day}}{capita}\right)$$

With the use of the scaling factor, the basic water use metric is normalized to allow comparisons of entities of different sizes or scales, or comparisons of a common entity, such as population or production that is changing in scale over time.

It is important to recognize that inconsistent definitions and factors unrelated to the purpose of a metric can lead to data inaccuracies.

5.3.3 Contexts and Selecting Water Use Metrics

Whether a metric is appropriate depends on the context of its use. One may consider the metric from a geographic or end-use profiling perspective. Geographic perspectives include looking at water use data at the level of an application or process, user, utility, region, state, or nation. End-use profiling looks at water use by process or application, user, sector, subsector, or cross-sector perspective. The relationship of these perspectives is illustrated in Figure 5.1.

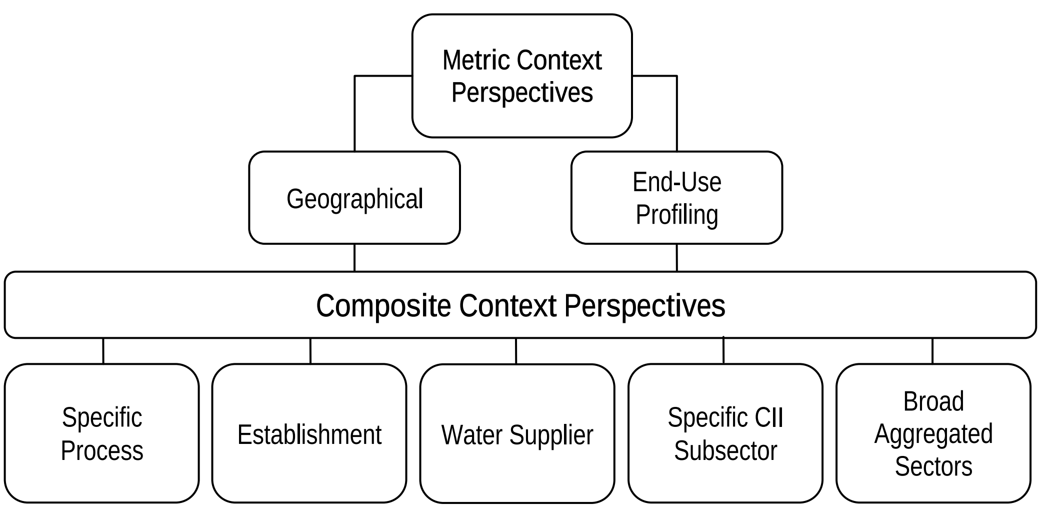

Figure 5.1 Metric Context Perspectives

Many water-use metrics are in use, as shown in Appendix A. However, most have very narrow intended uses. In Volume II of this report, metrics are applied to specific BMPs or technologies. Water supply planners and policy-makers may use water-use metrics to make broad assessments of how trends in efficiency may affect future water demands or to look at the effectiveness of water use efficiency and management programs. For CII uses, the most commonly suggested and analyzed metrics are:

- GPCD
- Gallons per employee per day or year
- Gallons per square foot of building area per day
- Gallons per day per dollar of economic value added
- Gallons per product or service

5.4 Data Collection and Reporting

Water resources management relies on data illustrating water use, the purposes of the use, and where and how efficiently it is used. The data may be used by water users, water agencies, land-use planning agencies, economists, nongovernmental organizations, and others for:

- Planning and designing water supply, treatment, and delivery facilities.
- Developing programs to use water more effectively and reduce waste.
- Managing water to reduce environmental impact.
- Developing funding sources to manage water supply, water quality and associated infrastructure.
- Developing policies, regulations, and laws to govern the wise use of water.

Water supply planners and policy-makers may use these metrics to make broad assessments of how trends in efficiency may affect future water demands or to look at the effectiveness of water use efficiency and management programs.

5.4.1 Existing Water Data Collection by Water Suppliers

Virtually every study of water use has cited the lack of available detailed water use data in the state. Most water service providers collect customer data to provide adequate water service, collect revenue, meet state laws, and comply with local ordinances. Many water service providers categorize data by residential (single family and multifamily), CII, large landscape, and agriculture uses. Others use more sophisticated classification systems. The water use data reported to DWR and CUWCC indicate that water service providers use inconsistent definitions of water use sectors when aggregating data.

5.4.2 Existing Statewide Water Data Reporting

The principal organizations collecting water use data in the state are DWR, Department of Public Health (CDPH), SWRCB, PUC, and CUWCC. At the federal level, water supply and use data are collected and reported by the U.S. Geological Survey (USGS) and the U.S. Bureau of Reclamation (USBR), which collects municipal and industrial (M&I) data.

Currently, insufficient resources and time prevent conducting a thorough analysis of these and other metrics to determine if they are appropriate for CII sectors and subsectors. However, Volume II includes a limited analysis of some metrics.

While statutory and regulatory requirements for reporting water use or diversions for storage and use exist, these requirements leave significant gaps that either are unreported or are not reported in sufficient granularity for adequate analysis.

The major issues and limitations for data collection by DWR's Public Water System Statistics Survey (PWSS), CDPH's annual reporting system, and CUWCC's reporting system include the lack of uniform definitions for water demand and supply categories; different population estimation techniques by user groups attempting to account for the variance between census and service area boundaries; differences in how multi-family and large landscape data are compiled; lack of a uniform definition for unaccounted water loss; inconsistent distinctions between CII water use; and, a lack of self-supplied and reported water data. The newer methodologies for population and demand calculations, derived from SB X7-7 GPCD calculations and the water loss methodology adopted by AWWA and CUWCC in 2009, are good first steps in providing some universal definitions. However, more such effort is needed if demand data is to be tracked more accurately.

The major issues and limitations for data collection by SWRCB is that this data cannot be correlated to total water supply, delivery by water service providers service area, or deliveries to water users.

5.4.3 Data Reporting in Other States

A few other states have reporting on self-supplied water. They also have more detailed and consistent reporting of customer water use data. States with good examples of statewide reporting systems include Kansas, Texas, and Illinois. In Illinois, for example, the locations and amounts of water withdrawn from surface water and groundwater sources, as well as significant amounts of water purchased from other sources are inventoried every year for a variety of water-using facilities, including commercial and industrial facilities. Commercial-industrial data is published only in combination with township or regional totals and is kept confidential unless it is authorized to be released by the water using authority.

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6.0 Technical, Financial Feasibility and Potential Water Use Efficiency Improvements for Best Management Practices and Audits

Technical and financial feasibility are two key criteria used in making investment decisions, whether by CII entities or water service providers. The Legislature recognized this and called upon the CII Task Force Report to include "[i]dentification of technical feasibility and cost of the best management practices to achieve more efficient water use statewide in the commercial, industrial, and institutional sectors that is consistent with the public interest and reflects past investments in water use efficiency" (CWC Section 10608.43(e)). The general framework for these two criteria is presented in this section. Analytical procedures for conducting cost analyses are provided for use when making a decision to implement any particular BMP.

The Legislature also called upon the CII Task Force to develop "an assessment of the potential statewide water use efficiency improvement in the commercial, industrial, and institutional sectors that would result from implementation of these best management practices" (CWC Section 10608.43). A statewide assessment was challenging, as described in this section, but examples of water savings accomplished in specific applications are presented in this section along with an approach based on penetration rate for a BMP.

Finally, water audits have been found to be effective in assisting managers of CII entities to identify areas of inefficient water use within facilities and appropriate BMPs to reduce water use. A discussion of audits concludes this section.

This section begins with CII Task Force recommendations related to this section.

6.1 Recommendations

The CII Task Force has the following recommendations based on the background information provided in this section and Volume II.

Recommendation 6-1: CII entities should perform water audits to identify opportunities for implementation of BMPs.

Recommendation 6-2: Following audits, CII entities should evaluate the technical and financial feasibility of BMPs to determine whether to implement BMPs.

Recommendation 6-3: Water and energy service providers should incorporate water audits into their efficiency programs, consider financial incentives for BMP implementation, and provide other technical assistance as appropriate.

Recommendation 6-4: Organizations representing business and industry, water service providers, the CUWCC, other interested parties, and DWR should educate CII water users or entities on the BMPs and approaches to doing audits and performing a cost-effectiveness analysis.

Change to a waterless process

There are many examples of replacing water using equipment with equipment that does not use water.

Recommendation 6-5: All new CII water users should consider implementing the recommended BMPs at the time of installation or construction.

Recommendation 6-6: When replacing equipment, CII entities should evaluate the equipment and the maintenance and operational practices needed to achieve an industry standard of water use efficiency for the new equipment being purchased.

6.2 Technical Feasibility of Implementing the BMPs

All of the BMPs in this document are technically feasible and will be cost-effective in certain situations; the appropriateness of using any single BMP must be assessed for each site by the site operator or owner.

The legislation stated that the final report should contain "identification of technical feasibility and cost-effectiveness of the best management practices to achieve more efficient water use statewide in the commercial, industrial and institutional section…" Because each use site is unique, cost-effectiveness and the feasibility of using BMPs must be determined on a case by case basis for each site.

Therefore, when developing and implementing the best BMPs, three guiding principles were deemed to be important.

1. **One size does not fit all** – For any given CII sector, subsector, or entity, there may be a dozen potential BMPs. Not all will be applicable. In many cases establishing one BMP could mean that another will not be applicable due to "saving the same water."

2. **Every facility is unique -** Analysis of potential payback is unique to each facility and situation. Facilities, even in the same CII sector, vary in their process, equipment selection, and design. This means that what may work at one vegetable processing plant may not be applicable at another; what works in one research laboratory or hotel may not be applicable in another.

3. **The BMPs in this document should be used only as a guide -** The intent of this report is to provide compendium of BMPs that are possible measures that CII entities can adopt for their specific situation.

6.3 Cost Analyses

SB X7-7 calls for the CII Task Force to address "cost of the best management practices to achieve more efficient water use statewide in the commercial, industrial, and institutional sectors that is consistent with the public interest and reflects past investments in water use efficiency." This can be addressed in three dimensions. The first is the stand-alone costs of implementing the BMPs. To the extent that data are available, these costs are presented in the discussion of the BMPs in Section 7.0 of Volume II. The second is the cost-effectiveness analysis of implementing BMPs from the perspective of the water user or water service provider. The third is the economic analysis of implementing BMPs from the perspective of regional or state public policy makers to address the public interest. The latter two dimensions involve computational methodologies that provide the basis for deciding whether to implement BMPs. The computational methodologies will be presented and followed by discussion of analysis approaches depending on perspective within Volume II. Volume I provides a brief summary of each cost analysis approach.

Because each use site is unique, the costs of the BMPs and the cost-effectiveness and the feasibility of using BMPs must be determined on a case by case basis. While all of the BMPs in this document are technically feasible and are cost-effective in certain situations, the appropriateness of using any one BMP must be assessed for each site. The CII water user will need to conduct a site audit to determine which BMP(s) would be technically feasible for them. This would be followed by a cost/benefit analysis to determine if implementing the BMP(s) would be cost-effective.

6.3.1 Computational Methodologies

Conducting cost analyses for determining whether or not to implement BMPs involves some basic methodologies. In general, the methodologies allow comparison of benefits to the short- and long-term costs of implementing a BMP.

Benefits can take various forms:

1. Avoided costs from purchasing less water or from delaying development of alternative water supplies.

2. Added productivity from a more reliable water supply or environmental benefits from reduced water withdrawals.

The common computational methodologies are summarized below.

6.3.1.1 Calculating the Unit Cost of Water

For many types of cost analyses, it is helpful to compare costs based on unit costs, that is, the dollars per unit volume of water. When evaluating the benefits of water savings, the cost of heating water for certain purposes and the cost of wastewater disposal may also be important. Calculations can become complicated because water, wastewater, and energy are measured in various units, so conversion factors must be on hand.

6.3.1.2 Payback Period

The payback period is the time required for an investment in efficiency to pay for itself. The simple payback is calculated by dividing the total costs (including installation, capital, permitting, and operation and replacement equipment costs) by the annual benefits, giving a simple payback in terms of years. Though a two-year payback is generally considered to be extremely cost-effective, many firms may choose a 3-4 year payback period.

6.3.1.3 Return on Investment (ROI)

Another metric, which is similar to payback, is the ROI, or the percent of payback the BMP produces per year. In the case of a one-year payback, the ROI is 100%. If the payback is in 1.6 years, the ROI is equal to ($100%/1.6) or 62.6% a year.

6.3.1.4 Internal Rate of Return (IRR)

The IRR provides an indication of the efficiency or profitability of an investment. It is defined as the effective annual interest rate at which an investment accrues income. Based on an assumed investment and expected cash flow, the internal rate of return is the equivalent interest rate at which an investment would yield identical net profits. The IRR can be compared to the interest rate on borrowed funds or the rate of return that is possible from other investments. If IRR is higher than the company’s or agency's cost of capital, expected rate of return, or discount rate, then the investment is deemed to be worthwhile.[3]

While the IRR is useful for determining whether a single project is worth investing in, it cannot be used to compare mutually exclusive projects. The IRR can only be used under certain conditions. With a complex series of cash flows that change signs more than once, there is more than one mathematically feasible solution. In other words, the information from an IRR is not always meaningful.

6.3.1.5 Net Present Value (NPV)

The NPV is among the most common financial metrics used in capital budgeting. It is based on the concept of present value, which is the conversion of future cash

[3] Note that the model calculates the IRR based on the undiscounted net cash flows. Therefore the resulting rate of return should be compared to the agency’s undiscounted rate of return.

transactions into equivalent values in the present taking into consideration the time value of money. NPV is the sum of the present values of all costs and benefits over a time period and reports their value at the beginning of the project. The NPV analysis has advantages over payback period and ROI methods in that is takes into consideration the time value of money, the useful life of the item being purchased or built, the sometimes complex variations in annual costs and benefits over time, and residual effects at the end of the useful life, such as disposal costs for a device. NPV is more useful for long-term investments.

6.3.2 Financial and Economic Analyses

Aside from technical feasibility, financial feasibility is probably the most prominent test of whether implementing a BMP makes business sense. Financial analyses are often viewed from different perspectives, including those of the utility and the customer. The focus of a financial analysis is on cash flow with the goal of remaining at least financially whole if not achieving greater monetary benefits than costs from implementing a BMP. In water resources economics, financial analyses are distinguished from economic analyses, which are viewed from the perspective of the community or society as a whole. An economic analysis looks beyond the perspective of any particular entity and incorporates benefits and costs that may not be realized when doing an analysis from the perspective of a single customer or water service provider

6.3.2.1 Overall Cost-Effectiveness Approach

To determine whether a BMP is cost-effective, the customer will need to assess the financial costs and benefits of implementing the BMP. This section describes an analysis looking at the true cost of water to a business or industry, examining the costs of implementing the BMP, and focusing on the balance of costs to benefits to reduce associated water costs. The true cost of water considers all costs to the customer associated with its use and disposal as it flows through the system.

A sample of applicable costs, benefits, and factors typically included in a financial analysis includes:

- Capital costs of installing the BMP (if it includes equipment)
- Changes in operation and maintenance costs including changes in water, wastewater, energy, waste disposal, pre-treatment, chemical, and labor costs
- Expected usable life of the measure
- Reduced risk factors

6.3.2.2 Factors Affecting Cost Considerations

There are long-term trends that should be considered when evaluating a BMP. Some can be quantified on a cost basis to incorporate directly into the cost analysis directly and others are nonmonetary benefits or factors that must be weighed along with the cost analysis.

Increased Water Rates

Water shortages and development of costly water supplies will result in increased water rates. Implementing water use efficiency measures will reduce the demand on the local water supply and the need to develop costly future water supplies, which may reduce the long-term costs of water to the business. Large water users are likely to feel the greatest impacts of increased water rates. Predicting water rates is not an exact science since water agencies have many factors influencing rates, such as supply, conservation pricing, operational costs, capital costs, bonds, and employee salaries and benefits. In addition, water is priced differently throughout the state because water sources, infrastructure, and reliability vary.

Replacement of Outdated Equipment

As improved technology becomes available, CII entities may decide to upgrade their water-using equipment, fixtures, and machines when they reach the end of their useful life as a cost-effective measure. Older equipment by design will typically use more water, energy, chemical, and wastewater than newly designed equipment.

Geographical Variability

Water, wastewater, and energy costs are continually increasing, have significant variations across the State and are increasingly becoming a larger component of a business' bottom line. How water is used at a specific location, variations in plant design for similar types of facilities, and past conservation efforts all further affect the cost-effectiveness calculations for any given BMP.

Consideration of Risk Factors by Businesses

When making a decision to invest in water use efficiency, businesses may also consider other risk factors and benefits that are less quantifiable, such as potential future mandates, reliability of water supply, or reputational risks and benefits. This may also apply when deciding to upgrade to more water and energy efficient equipment when making a business decision to replace outdated equipment. Assessment of these risks will require close communication and cooperation between the business community and its local water supplier.

- **Reliability of Water Supply -** A CII entity may want to consider the reliability of the local water supply in the region or community, the possible impacts of disruptions in the water supply, or a lack of adequate supply would have on the operations and the long term profitability of the CII entity.

- **Reputational Risks and Benefits -** A CII entity that has a large presence in local, national, or global communities will generally strive to maintain a positive reputation and good relations. CII entities that have taken this approach can include water use efficiency as a priority in demonstrating their environmental stewardship.

6.4 Potential Water Savings by Implementation of the BMPs

Many CII facilities in California are already practicing up-to-date water efficiency techniques. Others have a real opportunity to further reduce water use economically. The selection and implementation of these BMPs are determined by local economics and design. Facilities have real opportunity to reduce water use further in an economic manner that is feasible to the individual business. The state does not currently have the data necessary to establish the baseline of use in each CII sector. That is addressed in Section 5.0,Water Use Metrics and Data Collection, of this report.

A number of factors are involved in assessing the potential statewide water use efficiency improvement in the CII sectors that would result from BMP implementation:

- Savings potential from application of an individual BMP.

- Existing penetration levels of a BMP, that is, the degree of current use of a BMP.

- The penetration potential of a BMP, the maximum potential applications of a BMP where it would be cost-effective.

- The total water use in particular CII sectors or subsectors or in particular common CII processes where a BMP would be used, to assess water use efficiency improvement.

Volume II contains numerous examples of water savings on a case by case basis. However, in most cases, the information needed to estimate statewide savings must await the development of the baselines and metrics recommended in this report. In any case, the BMPs in Volume II describe many ways to reduce freshwater use and can be summarized into the following five categories:

- Water Loss Control - Adjust equipment, fix leaks and make repairs to existing equipment and processes so that it operates more efficiently.

- Water Efficiency Retrofits - Modify equipment or install or add water saving devices and controls, automated systems, or equipment to existing water using equipment and processes.
- Water Efficiency Replacements - Replace older inefficient water using equipment and fixtures with water saving types of equipment. This is one of the most recognized ways to reduce water use.
- Alternative Water Sources/Water Reuse/Recycle – There is significant potential for use of recycled municipal wastewater, onsite recycling, and reuse of water and use of alternative non-potable supplies.
- Non-Water Using Technology/Change to a waterless process - There are many examples of replacing water using equipment with equipment that does not use water.

6.5 Conducting an Audit

This BMP report provides CII water users with information they can use to reduce water, energy and wastewater use and help reduce bills, while recognizing that it is up to the entity to evaluate specific circumstances. The facility can either conduct the audit or hire a professional consultant. Many facilities managers have found that they can begin the process (Figure 6.1) by simply looking at water and wastewater use and utility bills, and comparing their use to similar facilities that their company may operate.

The audit looks at the current water use and types of water using equipment in the facility. The audit then asks seven important questions:

1. How much water is the facility using?
2. Where in the facility is the water being used?
3. When is the water being used?
4. How and for what is it being used?
5. Who controls its use?
6. Why is water needed here?
7. Are there other ways to do the same work that reduces or does not use water?

Once these seven questions have been answered, the facility manager can evaluate ways for each individual operation to reduce use. The first step is to calibrate equipment and repair malfunctions and leaks. Generally, the facility may reduce use by employing one of these five measures:

1. Adjust existing equipment to use less water.
2. Modify existing equipment or install a water saving device.
3. Replace existing equipment with more efficient models or types.
4. Reuse and recycle water where possible.
5. Choose equipment or methods that eliminate water use.

One potential method of reducing potable and freshwater use, for example, is to use recycled water if it is available from a public utility. The use of recycled water may require dual plumbing. Economic incentives and reduced rates for the use of recycled water are available from some water suppliers.

Another way to reduce potable and freshwater use is to examine how water may be reused within a facility. This reuse can span from industry process water to the capture of rainwater or using air conditioning condensate for irrigation or in a cooling tower. The following decision table can help the facility manager or engineer identify all water uses, the water quality needed for that operation, and the water streams from their operation to see if they may be candidates for reuse.

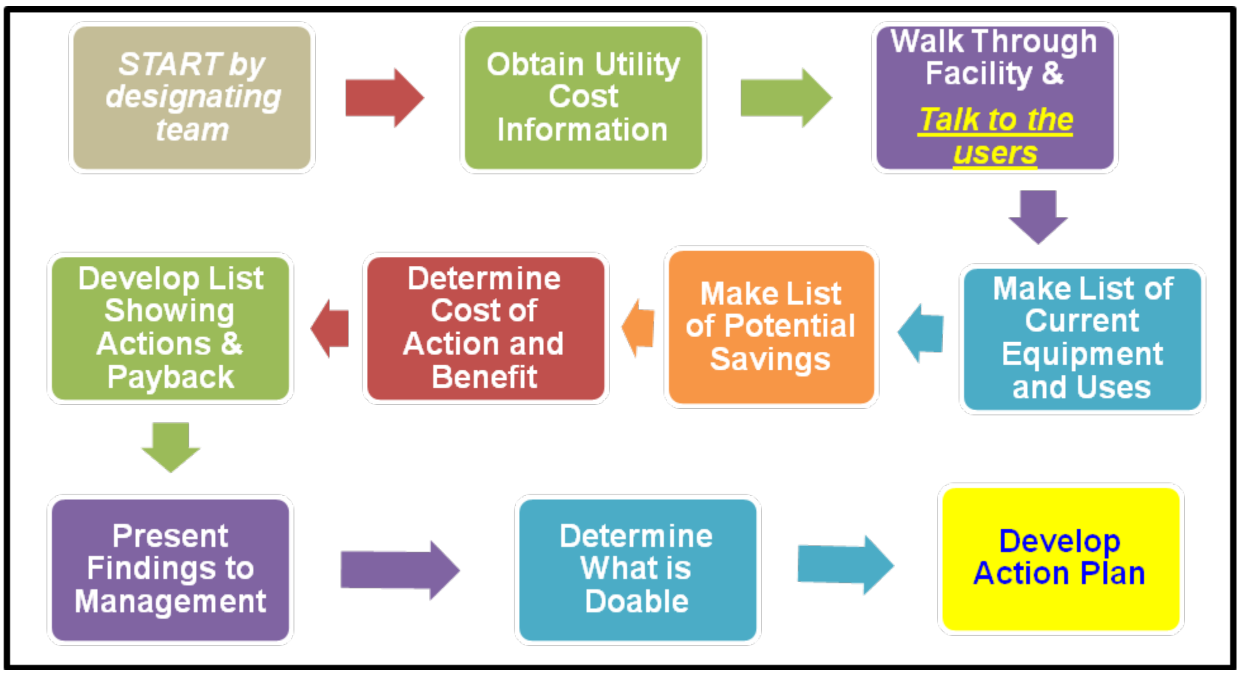

Figure 6.1 The Audit Process

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7.0 Commercial, Industrial, and Institutional Sectors and Best Management Practices

This report is generally intended to help businesses be more water efficient by providing information on water-saving technologies and best management practices (BMPs) applicable in the commercial, industrial, and institutional (CII) sectors. The information in this section is intended for use as a resource for:

- Existing and new businesses
- Developers, consultants, and designers
- Water service providers
- Planning agencies

Note, the BMPs discussed in this report are not the same BMPs that are reported to the CUWCC.

Since technology and practices change over time, the information in this section is intended and recommended to be updated periodically.

This section of the Volume I provides the CII sector with valuable BMP information to capture the multiple benefits of reduced costs for water, energy, wastewater, and onsite water and wastewater treatment facilities. This section also summarizes BMPs for specific water uses within the typical CII sectors. These range from commercial food service and laundries, to carwashes and offices. Information is organized to be useful for those who are intending to implement or to assist in BMP implementation and for those concerned with the overall potential for water use efficiency and conservation.

Included is information on landscape water use efficiency practices, since outdoor water use is an important issue and may represent a significant percentage of use for any given CII entity. Recommendations include the use of alternate water sources for certain applications, and many of the BMPs can be applied to other CII entity types not specifically addressed herein.

This section of the report, Volume I, also contains summaries for each CII entity type, technology, and BMP, and refers the reader to the section in Volume II that contains an in-depth description of the hardware and processes associated with water-use efficiency improvements for various types of CII entities, along with a series of proven example case studies. The information provided includes references on where to find additional technical data and recommendations to address water use metrics, water savings potential, economic payback, and consideration of business risk factors.

The Best Management Practices are divided into three distinct sections:

1. Section 7.1 contains BMPs related to common CII sectors.
2. Section 7.2 contains BMPs related to specific industrial sectors, which the CII Task Force determined were responsible for a significant amount of water use in California.
3. Section 7.3 contains BMPs related to common water uses found among many CII sites.

The BMPs included in this report have been implemented and demonstrated to be technically feasible.

The sources for the information about CII BMPs found in Volume II include: the US EPA WaterSense® program, the CUWCC's potential BMP research projects, the Federal Energy Management Program (FEMP), and the Consortium on Energy Efficiency (CEE). Also included is research performed by academia, CII Associations, and other industrial sources using statistically and scientifically defensible methods. A wide number of sources were considered and are cited in association with the BMPs to which they relate. When available, general information about the size of the CII sector and its associated water uses is included with the BMPs. Many CII factors affect water use and thus water use efficiency potential including the size, type, and location of the CII entity, the relative market impacts of the general economy, and for some uses, weather. There are also differences in the price of water and relative ease of use or reuse of treated effluent or alternative water resources (rainfall, stormwater, and onsite reuse of water), which are covered in greater detail in Volume II.

The level of detail varies for each CII sector discussion and BMPs, depending upon the availability of reliable information and system complexity. Each discussion presents water use efficiency BMPs for both equipment and processes. Where information is available and applicable, equipment retrofit and replacement BMPs are addressed separately; improvements in maintenance or management practices and design options are identified; and, water use efficiency standards (e.g., regulatory requirements, Energy Star®) that can be applied to the equipment being used are addressed. Additional detail can be found in Volume II Section 7 and Appendix A.

7.1 Commercial and Institutional Sectors

This section summarizes BMPs for specific water uses within the typical CII sectors. These range from commercial food service and laundries to carwashes and offices. Information is organized to be useful for those who are intending to implement or to assist in BMP implementation and for those concerned with the overall potential for water use efficiency and conservation.

7.1.1 Commercial Food Service

Scullery operations (dish washing and work area cleaning) and certain food preparation and service equipment are major water consumers in the commercial food service industry. This section summarizes water savings BMPs applicable to commercial food service operations and equipment. Formulas are provided in Volume II for calculating payback for retrofit and replacement options.

BMP recommendations include:

- Scraping waste into the garbage before washing.
- Use of pressurized pre-rinse spray valves (PRSVs) to rinse before dishwashing.
- Turning off valves when not in use.
- Running only full loads in dishwashers.
- Inspection and maintenance of equipment to ensure proper operations.
- Using mops, sponges, and squeegees to manually clean facilities.
- Replacing older equipment with water-efficient equipment (e.g., replace conventional garbage grinders with Energy Star®-qualified equipment or garbage pulpers), non-pressurized valves with low-flow pressurized valves, and oversized equipment with equipment sized to meet the operational needs.
- Retrofitting equipment and facilities to include reuse/recirculation systems and valve shutoff controls to prevent flowing water when equipment is not in use.
- Operator training and education to run only full loads and to program automatic controls for maximum water efficiency, along with equipment inspection and maintenance.

7.1.2 Fabric Cleaning and Washing Equipment

Equipment used in commercial laundry operations depends upon the type of laundry facility, the total quantity and type of laundry to be cleaned, and the cleaning frequency needed. More detail about the BMPs below can be found in the corresponding section of Volume II.

This section summarizes recommended water savings BMPs applicable to fabric cleaning and washing operations and equipment such as:

- Running only full loads
- Separating laundry based on soiling
- On-going service and maintenance
- Using detergents specifically for high-efficiency washers
- Setting machines to maintain the manufacturer-rated water factor
- Back-flushing any filters only when necessary

- Retrofitting existing washer extractors and coin- or card- operated machines with ozone systems or water reuse/recycling systems
- Replacing inefficient equipment with Energy Star®-qualified washers and replacing washer extractors with tunnel washers or machines with built-in water reuse systems that are easily programmable

Formulas are provided in Volume II Sections 6.0 and 7.0 for calculating Payback for retrofit and replacement options.

7.1.3 Hospitality: Lodging - Hotels and Motels

Each activity within a hotel or motel has its own special need for water. Smaller facilities have guest-room water demands similar to those of the larger properties, but do not usually have heavily irrigated landscapes. Water saving BMPs for pools are described in Section 7.3 in both Volumes I and II. More detail about the BMPs below can be found in the corresponding section of Volume II.

Overall, restrooms and domestic functions account for about 33 percent of water used at lodging facilities, cooling and heating systems account for about 11 percent (with cooling towers and boilers as the primary systems accounting for this use), on-premise laundries account for about 15 percent, kitchen operations account for about 16 percent, and landscaping accounts for the remainder (about 23 percent) of water use at lodging facilities.

Some recommended BMPs for these common uses include:

- Using only single and low flow showerhead showers
- Substituting showers for bathtubs
- Using low-volume bathtubs if bathtubs are used
- Encouraging guest practices to reduce laundry loads
- Using recycled water in toilets and urinals if possible (refer to Section 9.0, Public Infrastructure Needs for Recycled Water)
- Arranging equipment for easy use such as a mop and squeegee system or floor-cleaning machine
- Installing drains close to areas where liquid discharges are expected
- Installing automatic shutoff valves on all hoses and water-using equipment
- Preventing the unofficial use of fire protection water supply lines

7.1.4 Medical and Laboratory Equipment and Processes

Hospitals, dental offices, laboratories, aquariums, and research facilities are found in most large communities. All of these facilities have water uses such as restrooms, landscape, and often cooling towers and boilers that are common to many types of facilities and are discussed in other sections. These CII sectors also have water using equipment and operations not commonly found in other facilities. This section summarizes the types of equipment or operations specific to this CII sector including: sterilizers; vacuum systems; fume hoods; instrument, glassware, cage, rack, and bottle washers; vivariums and aquariums; and, photographic and X-ray equipment. More detail about the BMPs below can be found in the corresponding section of Volume II.

Some recommended BMPs for these specific operations and equipment include:

- Replacement of older equipment with water-efficient equipment/ processes
- Retrofitting process equipment to reuse/recirculate water
- Where water is used for cooling, retrofitting single-pass equipment cooling systems with recirculation systems, air-cooled, or chilled water cooled systems
- Where applicable use non-potable water equipment/processes or wastewater can be recycled for potable reuse or it can be reused for another non-potable application
- Proper operation and maintenance can help save water

Additional water savings can be achieved during cleaning processes by:

- Running only full loads in washers or adjusting water used based on load size
- Using efficient cleaning detergents
- Manually cleaning vivariums
- Using higher pressure values within low flow rates for wash down
- Setting the minimum number of rinse cycles necessary
- Operating washer-disinfectors only when needed

Water savings for flushing animal watering systems can also be achieved by minimizing the number of flushing cycles, reusing wastewater for another purpose, or by replacement with a recirculation system. For aquariums, good filtration systems substantially reduce water use. In large aquariums, backwash from larger filters can be captured, treated, and filtered to recover as much water as possible.

Traditional film processing is extremely water-intensive; however, modern 35-mm film processing equipment uses only a few ounces of water to develop a roll of film. Water is sometimes also used for equipment cooling in old X-ray equipment. Water savings for image processing and development can be achieved by replacement of older systems with digital technology, since it eliminates the need for film development, and use of dry printing processes similar to laser printing. Water savings for old X-ray machines can be achieved by retrofitting with special “WaterSaver” recirculation equipment.

7.1.5 Office Buildings

Office buildings may combine residential apartments, hotels, retail stores, and office space into a mixed-use structure. Each end use has its own special needs for water. Refer to sections describing typical sectors, specific industries, and common practices for discussion on appropriate water saving BMPs. The primary water using processes include restrooms, floor cleaning, and kitchens if one is present. More detail about the BMPs below can be found in the corresponding section of Volume II.

Some of the common office building recommended BMPs include:

- Installing high-efficiency plumbing fixtures and fittings
- Installing automatic shutoff valves on all hoses and water-using equipment
- Using recycled water in toilets and urinals; minimizing the use for water where allowable and available
- Using gauges/metering devices to determine when to backwash, change filters, and set recharge cycles

7.1.6 Prisons and Correctional Facilities

Prisons are much like small cities. They have living, eating, medical, laundry, manufacturing, boilers and cooling towers, and industrial operations. Water savings BMPs for typical and common water uses can be found in report sections appropriate to that sector.

In addition to those BMPs identified under the sections addressing specific and common types of CII water use, one recommended BMP unique to prisons is the use of flush valves that limit the number of flushes that can occur in a given amount of time, thus eliminating excessive flushing. A number of California prisons have used these valves, saving substantial volumes of water.

7.1.7 Retail, Grocery Stores and Food Markets

Grocery stores and food markets typically use water for a variety of operations: spraying fresh vegetables with cold water, ice machines, deli operations, food preparation and restaurant service, restrooms, photo processing, floor cleaning, and cooling refrigeration equipment with cooling towers and evaporative condensers. Ice is often used in vegetable displays to maintain product freshness and to enhance aesthetic appeal. In the general retail sector, water use is directed more at sanitary applications (restrooms and cleaning), and, in most cases, landscaping. Preparation of food for sale and the resulting scullery operations in some grocery stores are also areas that use large amounts of water. Common processes and practices (e.g., restrooms, plumbing, and water treatment) used by many CII entities are described in Section 7.3, and water uses in food service and preparation are described in Section 7.1.1.

Multi-tenant commercial structures, such as mixed-use strip malls that are also occupied by photo labs and medical activities, such as dentists, physicians, and clinics include some water uses specific to these businesses. Section 7.1.4 Medical and Laboratory Equipment and Processes describe water saving BMPs for the medical and laboratory equipment and processes. Additionally, use of self-contained "mini labs" that require no plumbing or washing for onsite photo processing can contribute to water savings. More detail about the BMPs below can be found in the corresponding section of Volume II.

Other recommended BMPs that could be used at retail, grocery stores, and food markets include:

- Installing automatic shutoff valves on all hoses and water-using equipment
- Using recycled water in toilets and urinals where appropriate
- Minimizing the use for water treatment using gauges/metering devices to determining when to backwash, change filters, and set recharge cycles
- Conspicuously marking fire-protection plumbing so no connections will be made other than those for fire protection, and installing flow-detection meters on fire services to reveal unauthorized water flows

7.1.8 Schools and Educational Facilities

Schools, colleges, universities, and vocational institutions use water in many ways, including some that are similar to the lodging, food service, laundry, and office buildings sectors. Common processes and practices (e.g., restrooms, plumbing, and water treatment) used by many CII entities are described in Section 7.3. Where film imaging is required, used self-contained "mini-lab" developing units that require no special plumbing or washing to develop the film can help save water.

Restrooms and domestic uses account for about 44 percent, cooling and heating (mostly in cooling towers and boilers) account for about 12 percent, landscaping and irrigation account for about 31 percent, and kitchen and other uses account for about 13 percent of total water consumption in the typical

7.1.9 Vehicle Washing

This section addresses vehicle washing. It includes commercial carwashes open to the public; fleet operations, including car, truck, and bus washes; and washes for trucks and light vehicles that leave industrial sites and enter the public thoroughfare. This section only addresses washing equipment associated with cleaning the exterior of vehicles, however, a discussion on 'reclaim' (reused process water) is also provided. Water uses and BMPs associated with domestic uses, landscaping, and co-located CII entities can be found in corresponding sections of Volumes I and II.

Onsite capture and re-use of water in vehicle washes is referred to as reclaim water. Use of reclaim water can achieve water savings; however, feasibility is limited in some types of vehicle washes. The use of municipal recycled water in carwashes, on the other hand, is limited by pathogens and spotting on cars because of salts.

> A 2006 Potential Best Management Practice Report by the CUWCC indicated that a statewide requirement for reclaim (water reuse) systems in all new conveyor and in-bay automatic vehicle wash systems has a potential for water savings totaling 22,877 acre-feet per year (af/yr) by 2020.

Self-service vehicle washes are typically coin-operated with customer operated spray wands and brushes. The customer controls water use by how long they use low-pressure or high-pressure settings, as well as through selection of a spray wand or brush. Self-service car washes use the least water; however, reclaim systems may be limited because of contamination and mixed chemicals in the wash and rinse water. Further water savings can be achieved by incentive-based pricing structures.

"In-bay automatics" and conveyor washes have a wash bay in which the customer stays in the vehicle. In-bay automatics that use brushes or cloth use less water than frictionless or "touch-free" vehicle washes.

More detail about the recommended BMPs below can be found in the corresponding section of Volume II.

Recommended BMPs for "In-bay automatics" and conveyor washes include:

- Adjusting nozzle size, number, alignment, and flow rates.
- The timing of flows.
- Using laser sensors.
- Reject water from the RO, spot-free rinsing unit may be reused to save water; however, as with self-service washes, reclaim may be limited because of mixed chemicals and pollutants.
- If towel drying services are included, replacing older flow-through sinks or top loading washing machines with front loading machines for towel washing can also save 40 percent or more of water consumed by this process.

The type of equipment used to wash trucks, buses, utility vehicles, and heavy equipment is similar to those described above, except larger in scale. Due to differences in vehicle size and shape, hand held wands are prevalent in truck washes. In 'drive through tunnels", the speed of the vehicle driving under the arch influences the amount of water used. As a result, they use more water per vehicle than a typical carwash. However, in industrial uses and for large vehicles, the controlled access to such facilities allows for more innovative treatment for reclaim, and closed-loop systems can approach 100 percent nonpotable water use. Other water savings practices would be similar to those described above.

7.2 Industrial Sectors

This section summarizes BMPs for a subset of industrial sectors in California that CII Task Force members identified as being significant water users, and therefore, worthy of attention in order to identify water savings opportunities. Each of these sections was developed by the Working Group or Subcommittees of the CII Task Force. Much of the focus in these sections is on processes that control the use of water within a facility; therefore, it is important to note that actual water savings potential in the field will be affected by the size of an industry and by the type of processes used.

Geographic location in the state will also affect the water use efficiency potential due to wide variations in evapotranspiration, temperature, and rainfall levels throughout the state. This variability, as it applies to specific BMPs, is explained within each section of Volume II, along with the general water user information and gross potential for water savings. The importance of the industrial sector to California is illustrated in Figure 7.1.

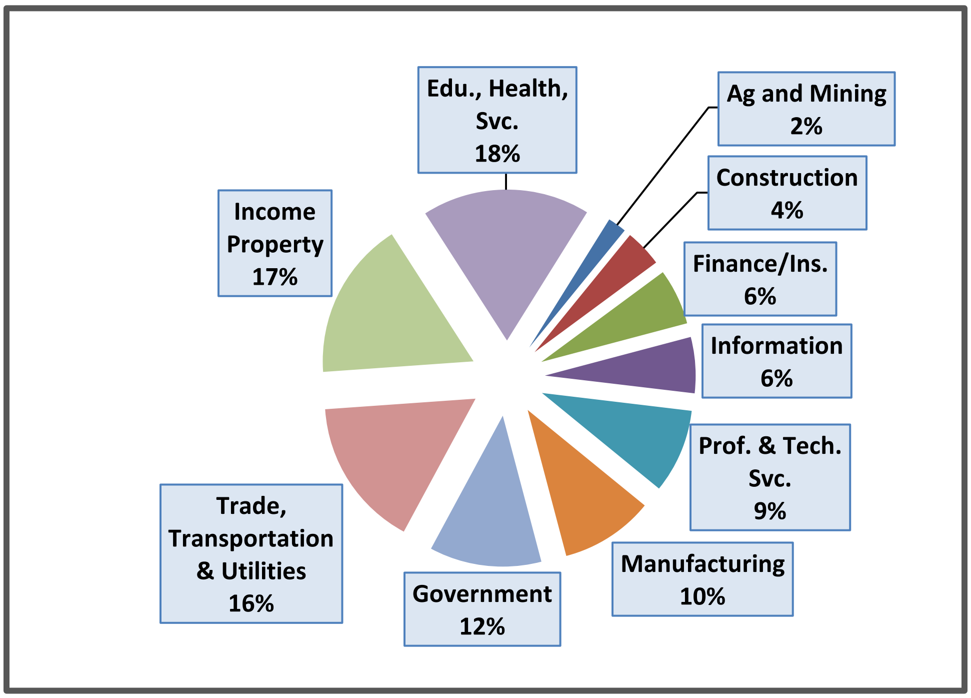

Figure 7.1 California's Gross Domestic Output in 2005

The manufacturing sector employed 1.2 million Californians in 2009 and produced over $443 billion in total shipments based on the U.S. Census of Manufacturers. Figures 7.29, 7.30, and 7.31 of Volume II summarize employment and shipments by each of the major sectors. Value added, approximately the difference between raw materials and shipment, represents the "worth" added by the manufacturing process. Value added in 2009 was $225 billion while workers earned over $63.6 billion, which averages to a little over $53,000 annually for each worker.

7.2.1 BMPs for Industrial Operations

Although the processes are generally the same in any given specific type of industry, the configuration or layout of the actual facility and the design of equipment, which is often proprietary, will affect the feasibility of potential BMPs; for any given industry, there may be a dozen potential BMPs and not all will be applicable. The industries selected for discussion are described in much greater detail in Volume II, Section 7.2.

Industrial water is used in eight basic ways: cooling and boilers, cogeneration and energy recovery, processes, in-plant conveyance, cleaning, environmental controls, sanitation, and irrigation of landscapes. Industry can often use water unsuitable for other uses, which contributes to potable water savings. For example, saline water from coastal areas is often used for cooling, and recycled water and water from onsite sources can often be beneficially reused in industrial operations. Table 7.1 lists some of the potential common water uses in industrial facilities, with reference to the section in this report that addresses water saving BMPs for those uses.

Table 7.1 Industrial Water Use Described in Other Sections

Type of Use	Section Describing BMP for Use
Restroom facilities and plumbing	7.3.6 General Building Sanitary and Safety Applications Section, 9.0 Public Infrastructure Needs for Recycled Water
Cooling and heating Systems	7.3.3 Thermodynamic Processes
On-premise laundries	7.1.2 Fabric Cleaning and Washing Equipment
Floor cleaning	7.1.1.4 Commercial Food Service, Washing and Sanitation
Kitchen operations	7.1.1 Commercial Food Service
Ice machines	7.1.1.5 Commercial Food Service, Commercial Ice Machines; 7.1.3 Hospitality: Lodging - Hotels and Motels
Pools and other water features	7.3.7 Pools, Fountains, and Spas
Landscaping	7.3.5 Commercial Landscape, 7.3.7.5 Pools, Spas, and Fountains, Filtration
Water treatment: filtration and other processes	7.3.8 Water Treatment
Vehicle washing	7.1.9 Vehicle Washing
Medical and laboratory: pumps, sterilization, and air scrubbing processes	7.1.4 Medical and Laboratory Equipment and Processes
Water use accounting, leak detection and management	7.3.2 Building Meters, Submeters, and Management Systems

7.2.2 Industry-Specific Information

When examining industrial use, the potential available water sources will impact overall costs. Industry can often use water unsuitable for other uses. Saline water from coastal areas is often used for cooling, and recycled water and water from onsite sources can often be beneficially reused.

To better understand the breadth of water use in industry, this section describes seven industrial sectors selected to highlight the different types of water use.

The seven industrial sectors described in this report are:

1. The aerospace industry, including making of engine components, metal finishing, and plastic extrusion and molding.
2. Plating, Printed Circuit Boards, and Metal Finishing.
3. Food processing and beverage industries, including fruit and vegetable processing, wine making, and poultry processing.
4. The High-Tech Industry.
5. The petroleum refining and petrochemical industries.
6. Pharmaceuticals, including drug production and the emerging biotechnology industries.
7. Power plants.

7.2.2.1 Aerospace and Metal Finishing Industries in California

The aerospace industry includes a variety of industrial operations associated with the production and maintenance of aircraft, missiles, space vehicles, and the equipment and services that serve that sector. Because of the industry’s diversity, almost every conceivable type of water use occurs at some place in this sector. Refer to Table7.1 for references to applicable sections describing BMPs for common water uses and BMPs for typical CII sectors’ water uses. Metal finishing is the principal water using operation in aircraft production and is discussed in the next section, Section 7.2.2.2 Plating, Printed Circuit Board, and Metal Finishing.

Some recommended BMPs include:

- Reuse/recirculation in processes and cooling systems.
- Substitution of dry processes for rinsing processes (e.g., dry paint removal and application, dry air scrubbing) where possible, use of high pressure water.
- Controls to apply only as much water when needed.

In all cases where water is using in casting and molding processes, other methods are available that do not use water and replacement with these processes can save water.

For milling and cutting operations recommended BMPs include:

- Substitution of other chemicals for water.
- Using techniques that do not require water or brine quenching and air cooled systems.
- If a water-based air-scrubber must be used to clean contaminants from air, it should be a recirculating-type.
- Controls should be incorporated to provide only the amount of water needed.
- Use alternative water sources, where feasible.

7.2.2.2 Plating, Printed Circuit Boards, and Metal Finishing

Cleaning metal, metal plating and surface finishing, coating plastic parts with metal, and the processing of circuit and wire boards all use similar techniques to clean and plate surfaces. All processes begin with cleaning to prepare the parts, followed by the process. Water saving methods for equipment and plant cleaning, cooling towers, boilers, domestic uses, and irrigation are discussed in their respective sections (refer to Table 7.1).

Recommended BMPs in plating, printed circuit boards, and metal finishing operations include:

- Dragout and evaporative control.
- Water recovery and reuse to reduce system water losses.
- Chemical concentration control, multiple tank and counter current rinsing.
- Pretreatment of makeup water to improve water efficiency.
- Mechanical mixing, agitation, air blowing, and use of air scrubbers to substitute for water using processes.
- Water recovery and reuse.
- Metering, flow control, and data acquisition.
- Selecting of water efficient cleaning methods, rectifiers, and cooling processes.

7.2.2.3 Food Processing and Beverage Manufacturing

This subsection focuses on water used in the commercial and industrial processing of food and beverages; it does not address water used in agricultural production or water used in the commercial food service. Water uses that are common to multiple industry sectors are discussed in other sections of this report (refer to Table 7.1 for section references for water saving BMPs for common uses and processes used in the food and beverage manufacturing industry).

These BMPs are generally used and proven in industry, but they may not be applicable to every site. Recycling water within the plant, use of alternate sources for non-food processing areas, and reuse of process wastewater for irrigation can contribute to water savings. However, when evaluating BMPs, regulations governing the food processing industry must be considered and may limit water reuse options or use of alternative water sources.

Cleaning and sanitizing produce provide the most significant opportunities for water savings in many food and beverage processing facilities.

In produce preparation recommended BMPs include:

- Sorting before cleaning.
- Using mechanical conveyance systems or optimizing conveyance flume design, dry/mechanical cleaning methods.
- Spraying instead of emersion for cleaning, water reuse, and non-water or dry methods for initial processes (e.g., peeling, blanching).
- Reuse of pump seal water for non-potable uses.
- BMPs identified in Section 7.1.4 Medical and Laboratory Equipment and Processes can help save potable water.

The meat, pork, poultry, and seafood industries all involve water use for the cleaning and processing of the carcasses, cleaning and sanitizing equipment, boiler operations, and cooling and refrigeration. Refer to Table 7.1 for cross-references to the sections describing water saving BMPs for these processes.

Recommended BMPs include:

- Moving from wet cleaning methods to dry cleaning methods.
- Hand cleaning equipment and areas.
- Using drip and waste catch systems to contain waste.
- Most product preservation for storage and transport requires heating and cooling processes. Refer to Table 7.1, heating and cooling processes water savings BMPs for these processes.

- Using filtration and membrane processes instead of thermal processes for concentrating foods and juices.
- Efficient washing of filled containers can also save water.
- Use of high pressure sprays instead of emersion.
- Actuating sprayers only when containers are passing by.
- Using dry lubrication conveyance systems.

7.2.2.4 The High-Tech Industry in California

Much of the water use in high-tech is for human use and cooling. Human use is not addressed in this section. The most water-intensive, non-human use activities in this industry are fabrication processes in semiconductor manufacturing and the cooling of enterprise-scale data centers. Much of the water used in fabrication is ultrapure water (UPW), which requires about 1.25 to 2 gallons of city water to produce one gallon of UPW.

The BMPs described in this section are applicable to both manufacturing facilities and research laboratories for the high tech industry. All are currently being successfully employed at various facilities. However, their economic viability depends on specific facility design, cost of utilities, and other related factors; what works at one facility may not necessarily work or be economically practical at another, similar facility. Opportunities for reducing water use in the plating areas are discussed in Section 7.2.2.2 Plating, Printed Circuit Board, and Metal Finishing, and BMPs to reduce water use for heating and cooling (e.g., enterprise-scale data centers, and fabrication equipment and facilities) are addressed in Section 7.3.3 Thermodynamics of Volumes I and II.

Recommended BMPs include:

- Treating water only to the required level and by recovering part of the fresh water processed through the UPW system.
- Controlling rinse water use by precision application.
- Reuse, and optimization of rinse cycles.
- Using dry cleaning methods may also be possible.
- Separation of waste disposal lines increases the feasibility of reuse and chemical management of rinse and process baths to reduce the need for dumping and refilling.

7.2.2.5 The Petroleum Refining and Chemical Industries in California

This section explores the potential for water efficiency in the petroleum refining and chemical industries in California. Both industries have much in common, although the chemical industry is more diverse. For the purposes of this report, the pharmaceutical industry is discussed in its own section. For BMPs regarding water uses common to many CII entities, such as employee sanitation, cooling towers, irrigation, and others, refer to Table 7.1.

Water is used petroleum refining to cool and condense oil fractions, provide steam to heat fluids, for use in reactions and air pollution control, to wash crude and remove salts, for fire and safety, and for equipment testing and maintenance. Because 75 to 90 percent of all water used in a refinery is for heating and cooling, water savings can be achieved by implementing BMPs identified in Section 7.3.3 Thermodynamic Processes.

In addition to water used in cooling and heating, water use for cleaning of vessels and equipment, inclusion in the product, and sanitary water use by employees can represent large uses in a facility. For water saving BMPs, refer to Table 7.1 for the appropriate similar process.

7.2.2.6 The Pharmaceutical and Biotech Industries

The pharmaceutical/biotech industry produces a wide variety of products. California's pharmaceutical/biotech industry is the largest in the nation. Major water uses in the pharmaceutical/biotech industry include heating and cooling systems, UPW treatment systems and uses, water as a product ingredient, fermentation, autoclaves and sterilizers, air scrubbers, vacuum/pump seals, humidification, and landscape irrigation. For water uses common to many CII entities, such as employee sanitation, cooling towers, irrigation, and others, refer to Table 7.1.

Many cleaning operations used in the pharmaceutical/biotech industry are similar to the processes used in food processing, chemical manufacturing, and medical/laboratory cleaning. Refer to those sections in this report describing these sectors.

Similar to the petroleum and chemical industries recommended BMPs can achieve water savings by using:

- Water efficient RO equipment.
- Non-potable water for irrigation of landscapes, cooling tower makeup, and similar uses.

In biological fermentation processes, water savings can be achieved by:

- Using smaller bioreactors with liners that reduce the need for thorough cleaning required by conventional larger reactors in the production of antibiotics and similar products.
- Incorporating automatic shut-off valves to make sure water does not flow when equipment is not operating and installation of other water efficient plumbing fixtures throughout the facility can also help save water.

- Using alternative onsite sources of water, however, feasibility will depend on the actual process(es), equipment, and availability of an alternative water source.

7.2.2.7 Power Plants

Within the electric power subsector, most of the water use is associated with power generation, which is the focus of discussion in this section. The power generation processes has the greatest effects on water use, although the cooling technology also affects water use. For example, solar steam-driven thermal power plants can be as water-intensive as some coal- and natural gas- fueled, steam-driven thermoelectric power plants. The total water use in the thermoelectric power plant sector accounted for nearly 28 percent of the total statewide water withdrawals (fresh water and saline water combined); however, over 99 percent of this sector's water was saline (USGS 2009).

Water is mainly used in power plants for two purposes: heating water to produce steam in the boiler and for cooling. The cooling system uses far more water than the steam cycle. Refer to Section 7.3.3 Thermodynamic Process describes potential water savings BMPs for heating and cooling equipment.

> The SWRCB encourages the use of recycled water for cooling water in lieu of marine, estuarine, or fresh water and SWRCB Resolution No. 2010-0020 "Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling" and the California Energy Commission (CEC) promotes the use of recycled water for cooling water as part of the permitting process.

Recommended BMPs include:

- Using municipal recycled water for power plant cooling.
- Adaptation of innovative water recovery, use, reuse, and recycling measures.
- Using alternate on-site and other water sources.
- Implementation of advanced cooling technologies.
- Adoption of energy efficiency measures.
- Using less water-intensive renewable energy sources, such as solar photovoltaic, wind, and others.

Minimizing withdrawal and consumptive use of fresh water in thermoelectric power sector is important to the State's water use efficiency goals. Integrated energy and water policy is needed to ensure citing of future power plants do not adversely impact water resources.

7.3 Common Devices, Processes, and Practices Applicable across the CII Sectors

> Common Practices are those practices or BMPs that are common to a variety of CII entities. Some common practices or BMPs applicable to CII entities would be; landscaping, metering, using non-potable water, and the thermodynamic processes of cooling and heating.

This section summarizes water saving BMPs for Common Practices across various types of CII entities so that businesses have one place to go for information on water use BMPs, as well as other commonly used techniques in the CII sector, such as heating and cooling (thermodynamic processes), water treatment, and use of alternative water sources. Additional detail can be found in Volume II, Section 7.3.

7.3.1 Alternate Onsite Sources of Non-Potable Water

The use of an alternate onsite source of water is a water saving BMP. Alternate onsite sources are different from recycled water. As the word onsite implies, these are water sources that are generated on the premise where they will be used. By contrast, under Title 22, recycled water is treated municipal wastewater effluent provided by a municipal wastewater authority for reuse for non-potable purposes. Recycled water is discussed extensively in Volume II Section 9.0 Public Infrastructure Needs for Recycled Water and summarized in Volume I, Section 9.0.

> To provide clear direction to local jurisdictions for the oversight of these types of system, ensure protection of public health, and advance the ability to reuse water, the CII Task Force is recommending that the CBSC adopt updates to the plumbing code based on The International Association of Plumbing and Mechanical Officials (IAPMO) 2010 Green Plumbing Code supplement and the NSF 350 standard. Volume II describes regulatory conditions and standards in more detail.

Onsite water can be captured from various sources, including:

- Rainwater and stormwater
- Graywater
- Foundation seepage
- Cooling system condensate or blowdown
- Other non-potable process water

Water treatment should be designed to treat the poorest water quality collected from multiple sources to the minimum water quality level necessary for the end use. A “backup” connection to a potable or recycled water source will allow the facility to maximize its use of the alternate onsite water source while having a water source when onsite sources are low.

7.3.2 Building Meters, Submeters, and Management Systems

Metering is a key water saving BMP for the CII sector in order to identify how much water is being used and the efficiencies that may be achieved. Tracking total property water use, as well as specific uses with the building(s), allows for facility management efforts essential in managing water consumption, costs, and maintaining systems and processes on the property.

> The CII Task Force recommends CII water users install source meters and sub-meters for proper measurement and tracking of water use at an installation.

Effective metering and submetering requires consideration of what to meter and submeter, correct installation and maintenance of meters, and tracking water use and integrating it into a water management plan. Details for consideration are presented in Volume II.

7.3.3 Thermodynamic Processes

Thermodynamics is the term physicists use to describe energy transfers that can be strictly related to heat and work. This section discusses potential BMPs related to heating and cooling systems including: water cooled systems, cooling towers, and boiler systems. Although there are common approaches, what works best on each site needs to be evaluated by a person with expertise in these processes. See Volume II, Section 7.3 for more detail.

7.3.3.1 Cooling Systems

Cooling systems remove “unwanted” energy in the form of heat. There are five basic types of cooling systems that rely on water: single-pass cooling, once-through cooling on natural bodies of water, cooling reservoirs, evaporative cooling, and cooling towers. Water savings can be achieved by energy conservation, which reduces the heat load to a cooling system. However, discussion of the technology and technical feasibility of energy efficiency measures and their cost is beyond the scope of this document.

Recommended BMPs include:

- Proper operations, maintenance, tracking, and operator training programs.
- Using non-water-based equipment and alternative cooling processes.
- Eliminating single-pass cooling by connection to a chilled water or cooling tower loop, or by use of a standalone recirculating refrigeration system.
- Retrofitting to include proper instrumentation.
- Efficient tower design.
- Efficient operation of evaporative cooling systems where blowdown (discharge of used water) occurs.
- Using alternate sources of water air such as conditioning condensate reuse.

Through water quality instrumentation, treatment, proper system design, and proper operation and management, water use efficiencies of these thermodynamic processes may be greatly improved.

Entities with cooling towers are strongly encouraged to consult reputable cooling tower treatment experts to maximize water use efficiency. Volume II, Section 7.3.3.1 contains equations to estimate water use for single-pass cooling and cooling towers.

7.3.3.2 Heating Systems: Boilers

The focus of this section is steam-producing boilers; other heating systems are not addressed because their water use is not substantial. Similar to cooling systems, energy efficiency is the first BMP for consideration with boilers; any reduction in energy use will reduce water use. Maximizing condensate return, steam trap maintenance, and proper insulation of pipes can all contribute to water savings.

Recommended BMPs include:

- Replacing older systems with energy and water efficient equipment, appliances, and fixtures that use hot water.
- Fixing leaks and reducing other losses.
- Reducing water use by controlling cycles of concentration.
- Retrofitting for condensate return; and, energy efficiency and water efficiency with blowdown and sampler cooling tempering water.
- Metering, measurement, and process control are also critical to good boiler operations and management.

Formulas provided in Volume II, Section 7.3.3.1 Heating Systems: Boilers can be used to determine facility-specific water use for steam boiler systems.

7.3.4 Cleaning Industrial Vessels, Pipes and Equipment

Proper cleaning and sanitation represent a critical practice for CII entities. This section discusses water saving practices commonly used in cleaning processes; it excludes water used to meet Environmental, Health, and Safety requirements of local, state, and federal laws. For food and pharmaceutical facilities, the U.S. Food and Drug Administration, U.S. Department of Agriculture, and state and local health agencies all have regulations overseeing these processes. Other local, state, and federal laws may also govern cleaning processes for environmental, health, and safety purposes. BMPs addressed in this section must be considered in light of these requirements.

Types of Cleaning Practices

Clean in place (cleaning of pipes, tanks, processing vessels and transport tanks and trucks without taking them apart)

Clean out of place (removing and cleaning and sanitizing parts)

Can/bottle/package cleaning

Crate and pallet washing

Equipment and floor cleaning

Some common BMP approaches for these systems include:

- Ensuring a good system design that avoids accumulation of product and fosters the recovery, reuse, and recirculation of water.
- Worker and operator training; use of hoses and spray equipment, physical removal of waste materials, timing of cleaning cycles, and the way in which cleaning equipment is used are all controlled by the employees responsible for the operation.

For detailed information and BMPs specific to clean in place, clean out of place, bottle/can/container cleaning, crate/pallet cleaning, and equipment and floor cleaning see Volume II, Section 7.3.4.

7.3.5 Commercial Landscape

Commercial landscapes use a significant amount of water in the CII sector. Reported CII landscape water use represents nine to ten percent of urban water use and 25 percent[4] of total CII water use. However, landscape water use can range from zero to 100 percent at individual CII sites. This section addresses landscape water saving BMPs and makes recommendations for CII water users.

The landscape BMPs discussed in this report are all technically feasible. However, the cost-effectiveness of implementing a particular BMP may vary considerably from site to site, and, in some cases may be impractical.

All of the recommended BMPs discussed should at least be considered for implementation, including:

- Using alternative water supplies including storm water capture and reuse.
- Artificial turf and alternative turf types.
- In-line drip (also called subsurface) irrigation.
- Site review prior to design, inspections during landscape installation followed up with audits.
- Record keeping and communication plans.
- Properly managing following a landscape conversion to low water use, climate-appropriate plants and efficient irrigation.

Based on landscape water use data[5] in the CII sector, potential annual average landscape water savings of approximately 78,475 af/y could be achieved in California.

Additional information and studies cited can be found in Volume II, Section 7.3.5.

> The Task Force included landscape BMPs that recognizes the design and operating standards developed by DWR in the model landscape ordinance required by AB 1881 (Model Water Efficient Landscape Ordinance (MWELO) found in the California Code of Regulations, Title 23, Division 2, Chapter 2.7, which became effective in January 2010) and encourages their application to existing landscapes.

7.3.6 General Building Sanitary and Safety Applications

A number of devices are common to all of the CII sectors associated with building sanitary and safety applications. These include toilet fixtures, urinal fixtures, shower fixtures, and faucets. Domestic water uses by sanitary fixtures account for 45 percent of total water use within a facility (Figure 7.2). Depending upon the type of facility and its occupancy, restroom and other sanitary uses, such as laundries, can provide significant opportunities to reduce water use. Use

[4] (data source-East Bay Municipal Utility District and City of San Diego Water Department)

[5] CII landscape use = Total urban use x 35% (CII use) x 25% (CII landscape use) data source City of San Diego Water Department studies

of hands-free, sensor-activated valves on fixtures actually increases water use compared to conventional, manually-activated valves. As such, these provide no water-efficiency benefits, but do provide health and sanitation benefits.

All of the practices, products, and technologies summarized in this report section have been in existence for an extended period of time and found to be technically feasible. In each case, however, economic feasibility must be evaluated within the context of the physical condition and demands of the specific property or building being considered for high-efficiency sanitary fixtures and fixture fittings.

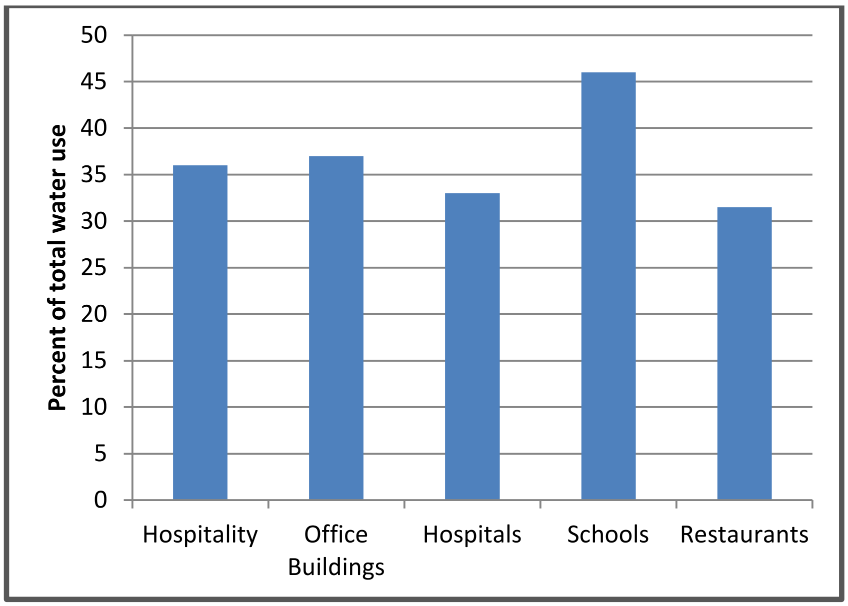

Figure 7.2 Percentage of Water Used for Domestic Purposes

Created from analyzing data in: New Mexico Office of the State Engineer, Water Conservation Guide for Commercial, Institutional, and Industrial Water Users, July 1999 (original source: City of San Jose Environmental Services Department); Dziegielewski, et. al., Commercial and Institutional End Uses of Water, 2000; East Bay Municipal Utility District, WaterSmart Guidebook: A Water Use Efficiency Plan Review Guide for New Businesses, 2008; American Water Works Association, Helping Businesses Manage Water Use, A Guide for Water Utilities.

Recommended BMPs include:

- Using voluntary water use efficiency standards equipment (e.g., WaterSense), for toilet fixtures, urinals, showerheads, and faucets.
- Updating efficiency standards and plumbing code changes, including legislation and administrative updates (e.g., CalGreen).
- Training users to report leaks and problems.
- Providing information and signage on water conservation considerations.
- Ensuring building plumbing is within fixture design pressure.

- Utilizing system inspections and proper maintenance techniques.

For more detail see Volume II, Section 7.3.6.

7.3.7 Pools, Fountains, and Spas

Pools, spas, and ornamental fountains with recirculating filtration and disinfection equipment can be found at homes, schools, gymnasiums, hotels, apartments, public parks, water parks, hydrotherapy pools, and businesses. Although some "fill and dump" type systems (dumped and refilled ever day or two) still exist, they are being eliminated, so this report concentrates on pools, fountains, and other facilities equipped with recirculation systems. Commercially operated pools, ranging from apartment pools to public community pools, must comply with the operational requirements of the health codes. In California, pools used by the public must have specific turnover rates (water replacement).

Evaporation, backwash, control of water quality, and cleaning and vacuuming of pools are all common and necessary elements associated with pools and fountains. In addition to evaporation, leaks, poor chemical and equipment maintenance, drag- and splash-out, use of inefficient cleaning processes, and other wasteful practices all result in preventable water loss.

Other recommended BMPs include:

- Regular inspection of equipment.
- Checking for leaks, installing and reading water supply meters to detect leaks.
- Providing proper guidance on the operation of the equipment and maintenance of the pool and equipment.
- Controlling splash-out and drag-out.
- Providing shade and wind breaks.
- Using properly installed gutters and grates.
- Using a vacuum system not tied into the filter system, thereby extending the time between filter backwashing.

7.3.8 Water Treatment

Water treatment is used in many commercial operations, including food services, laundries, laboratories, pharmacies, car washes, and food service establishments. Industrial water treatment technologies are commonplace but often require technologies not found in commercial settings. Treatment systems provide the ability to use water that would be discharged as wastewater. This water is reusable either directly in the facility where it was generated or used by municipal water recycling. The type of treatment depends on the application and the required water purity for the intended use. Treatment techniques and levels range from simple cartridge filters and water softeners to the production of ultrapure water for medical, laboratory, and microelectronics operations. The following summarizes the major technologies used to treat water in the CII sectors.

- One of the most common processes is filtration. Refer to Volume II, Section 7.3.7.5, for BMPs and details on filtration systems.
- The reuse of water onsite often depends on the removal of sediment and precipitates produced by a process or operation. The two most commonly used processes are coagulation - sedimentation (addition of a chemical that causes particles to “clump” together then settle out) and filter presses and filter belts. These water treatment processes are important BMPs, themselves, and recommended for use in conjunction with onsite water recovery and reuse.
- Using demand-based softener regeneration instead of relying on timers or schedules, and by using water meters that actuate recharge with a predetermined amount of water based on the water chemistry of the source water can achieve water savings.
- In cation and anion processes (also known as strong acid/base resins), water savings can be achieved by resin bed instrumentation to ensure that recharge is done only when a preset percent of the bed's resin has been exhausted.
- In distillation processes, water savings can be achieved by eliminating once-through cooling; maximizing product water recovery as a percent of total water input to 75 percent or better; and, by installing automatic controls to cease processing when the receiving reservoir is full.

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8.0 Standards and Codes for Water Use Efficiency

Plumbing and building standards and codes play an important role in governing the installation and use of water efficient products. This section summarizes the more detailed discussion of standards and codes in Volume II, Section 8.

8.1 What are standards?

Webster's defines a standard as: "...something set up as a rule for measuring or as a model to be followed..." In the vast world of water-efficient products, standards (or "rules for measuring") are necessary to establish standard dimensional requirements and the minimum performance level for all manufacturers to meet with their products. Compliance with established standards, however, is voluntary. That is, until such time as an ANSI[6] consensus standard is adopted into law by regulation (e.g., building codes) or legislation (e.g., the National Energy Policy Act – EPAct), the standards have no force of law.

Once adopted, however, new products from new manufacturers entering the U.S. marketplace, or new product models introduced by existing manufacturers, must be measured against the relevant standards and meet specified minimum requirements in order to be sold in the marketplace.

The California Energy Commission (CEC) is currently planning to amend the Appliance Efficiency Regulations in 2013. This effort is addressing water using appliances such as commercial dishwashers and clothes washers, irrigation controls, and continuous hot water recirculation pumps.

Typical water use efficiency categories within many of the national green building programs (guidelines and standards) include:

- Plumbing fixtures and fixture fittings.
- Residential appliances (clothes washers, dishwashers.
- Water treatment equipment (softeners, filtering systems).
- Landscape & landscape irrigation.
- Pools, fountains, and spas.
- Cooling towers.
- Decorative and recreational water features.

[6] American National Standards Institute

- Water reuse & alternate sources of water (graywater, rainwater and stormwater, cooling condensate and cooling tower blowdown, foundation drain water).
- Specialty processes, appliances and equipment (food service, medical, laboratories, laundries, others).
- Metering & submetering.
- Once-through cooling.
- Vegetated green roofs.
- Building water pressure.

8.2 What are codes?

Codes are promulgated by code authorities and adopted by jurisdictions to protect the health and safety of the citizens. It is important to note that, whereas the national standards approved by ANSI are voluntary consensus-based standards, the codes (which may or may not adopt the national standards by reference) are mandatory within the jurisdiction that adopts them.

Like the standards process, the codes process is complex. There once were five different plumbing code development organizations in the U.S., but mergers have reduced this number to only two. The IAPMO produce the Uniform Plumbing Code (UPC) and the International Code Council (ICC) produces the International Plumbing Code (IPC). These code-authoring organizations have a 3-year development cycle to update their respective model codes. California, through its CBSC and the Department of Housing and Community Development (HCD)[7], uses the UPC as the model plumbing code for the state and makes modifications to that model code to address California-specific interests.

The plumbing codes themselves have no legal status until adopted by jurisdictions such as cities, counties, and states. Where adopted, the codes become as local ordinances and laws. All jurisdictions can amend the model code before and after adoption, and some do this to better suit local conditions. Each of the two plumbing codes contains more than 400 pages of complex requirements; few jurisdictions, however, have the ability to review and analyze every single provision before adopting the code as law.

[7] http://www.hcd.ca.gov/

9.0 Public Infrastructure Needs for Recycled Water

Commercial, industrial, and institutional (CII) water users may contribute to better management of the state's water by replacing potable or fresh water with recycled water or by using less water following the BMPs cited in other sections of this report. This section focuses on CII use of recycled water, as defined in the adjacent text box, obtained from a municipal recycled water supplier. One of the fundamental challenges to increasing CII use of recycled municipal water is infrastructure limitations. For this report, the term "infrastructure" includes both "public infrastructure", facilities serving the community, and "onsite infrastructure", located on customer sites, as shown in Figure 9.1.

"Recycled water" is defined in the Water Code (see glossary) as wastewater treated to a quality suitable for beneficial use. The Water Code definition neither designates the source of the wastewater nor indicates a certain level of treatment. In the context of this section, the discussion of recycled water is focused on treated wastewater of municipal origin and will usually be referred to as "municipal recycled water." It is distinguished from onsite reuse, which is an internal iterative or cascading use of wastewater through multiple cycles or processes and is discussed in other sections of this report. Municipal wastewater is considered to be community wastewater containing a domestic wastewater component.

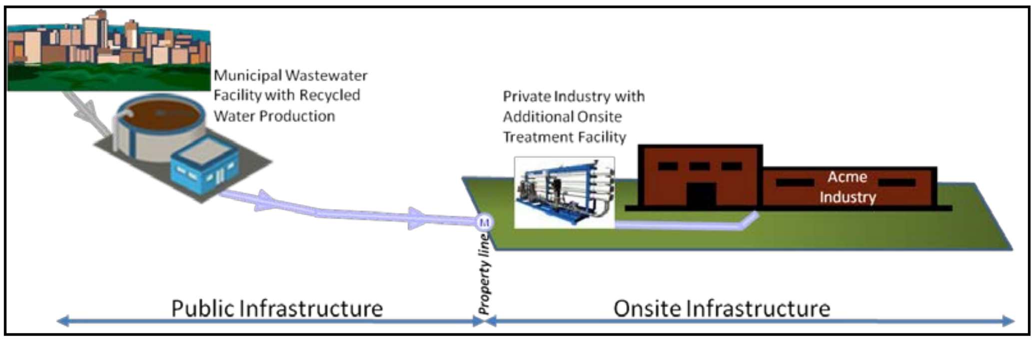

Figure 9.1 Public and Onsite Recycled Water Infrastructure

Public infrastructure is defined as community-based wastewater collection, treatment, and distribution system. Onsite infrastructure is defined as customer-owned pipelines or supplemental treatment systems dedicated to treating water used at a commercial or industrial facility.

9.1 Municipal Recycled Water in California

Municipal recycled water is used extensively in California to meet municipal, environmental, commercial, industrial, and institutional water supply needs. Municipal recycled water projects are almost exclusively implemented on the local or regional level and involve multiple agencies working cooperatively to address wastewater and recycled water supply issues. Because of the link between wastewater and water supply quality, quantity, and reliability, as well as jurisdictional issues and distribution systems, implementing projects can involve extensive interagency collaboration.

Currently, municipal recycled water is used to meet the water needs of the CII sector through non-potable systems and augmentation of groundwater aquifers used for potable water supply. Non-potable municipal recycled water is delivered from the recycled water treatment facility to water users via dedicated water pipeline systems and is typically used by the CII sector for manufacturing processes or landscape irrigation. Eighty-one percent of municipal recycled water use in California is for non-potable purposes and is delivered in these "dual distribution" systems. Municipal recycled water used for groundwater recharge or direct injection for a seawater intrusion barrier is indirectly available for potable reuse, including by CII sectors.

Types of uses for municipal recycled water in California in 2009 are shown in Figure 9.2. The categories of CII use are commercial, industrial, golf course irrigation, landscape irrigation, and geothermal energy production. A few minor CII uses, such as toilet flushing and dust control, are in the "Other" category. These uses total about 34 percent of total municipal recycled water use in California and almost nine percent of the total 2.6 maf CII water use (see Figure 3.2). Though institutional uses were not categorized separately, 10,200 af of the total municipal recycled water uses was reported by prisons, colleges, and military bases were for golf course, landscape, and agricultural irrigation.

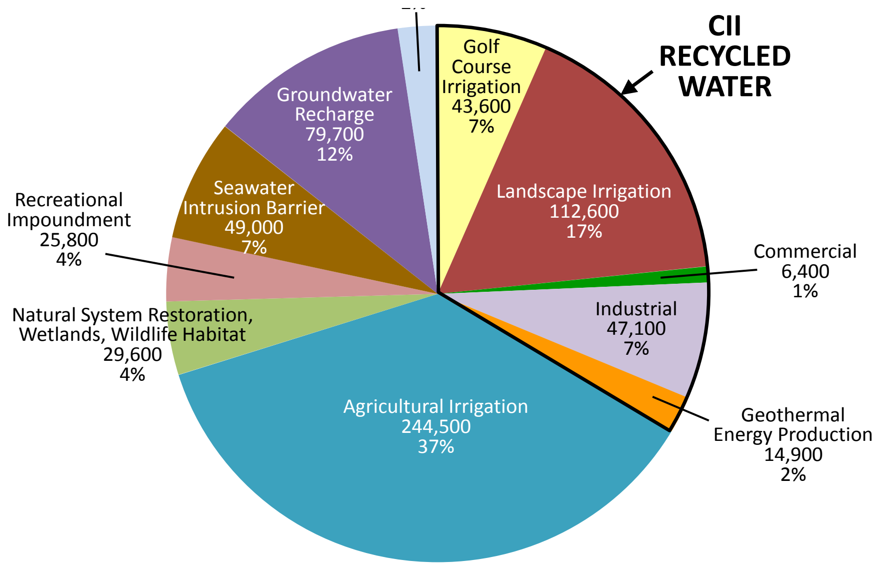

Figure 9.2 Recycled Water Beneficial Use Distribution in 2009.

2009 Municipal Recycled Wastewater Survey, showing beneficial use categories, volume of water in acre-feet beneficially used in 2009, and the overall percentage of the category based on the annual amount of water beneficially used.

9.1.4 Title 22 Levels of Treatment

The California Department of Public Health (CDPH) prescribes the levels of treatment required for municipal recycled water to protect public health. In general, the levels of treatment are based on levels of human exposure and types of exposure that provide pathways to infection. The required levels of treatment are specified in Title 22 of the California Code of Regulations (Division 4, Chapter 3, §60301 et seq.).

A key component of incorporating municipal recycled water into CII applications is aligning potential uses to the availability of various levels of treated municipal recycled water. Volume II includes a summary (Table 9.2) of CII applications that are allowed for the different levels of municipal recycled water treatment specified in Title 22. Water treated to a higher level can be used for potable reuse projects.

9.1.5 Regulatory Agencies and their Roles in Statewide Recycling

The current framework for regulating municipal recycled water has been in place since the 1970s. Primary authority for overseeing municipal recycled water is divided between the SWRCB, including the nine RWQCBs, and CDPH. A memorandum of agreement between the SWRCB and CDPH documents this arrangement and clarifies the roles of the agencies.

Four other state agencies are directly involved with California municipal recycled water issues and implement various sections of state law: DWR, California Public Utilities Commission, California Department of Housing and Community Development, and California Building Standards Commission. Statutes governing municipal recycled water are within the Water, Health, and Safety, and Public Utilities codes and regulations and in various subdivisions (titles) of the California Code of Regulations (CCR). See Volume II, Table 9.3, for a summary of state and local agency roles and responsibilities relative to municipal recycled water.

9.2 Municipal Recycled Water Infrastructure

The infrastructure for use of municipal recycled water begins with the wastewater collection system and ends with the plumbing on the recycled water user's site. Infrastructure for potable reuse is similar to that for non-potable reuse except that additional treatment may be included and groundwater percolation or injection facilities are included. Potable reuse projects can be less costly per unit of water served.

Municipal wastewater recycling projects are generally infrastructure-intensive to construct and operate, requiring capital investment, project siting, construction, maintenance, and other significant challenges for the builder and operator of the project. Key project-specific variables affecting infrastructure requirements for future water recycling projects in California include source control, proper treatment consistent with the use, separate distribution and storage, and cross-connection control.

Existing CII water users must retrofit their sites to meet CDPH requirements before receiving recycled water. In new developments where municipal recycled water delivery is planned, sites can be designed from the beginning with separated potable and recycled water plumbing.

Onsite infrastructure modifications incur expenses for both users and suppliers of municipal recycled water. Onsite design includes use of purple pipes and appurtenances, overspray prevention, and separate potable water and recycled water systems with appropriate backflow prevention to avoid cross-connections. Other onsite issues may include the need for changes in on-site treatment process and other operating criteria to accommodate the differences in water quality.

Prior to implementing onsite use of municipal recycled water, a user is required to:

- Conduct cross-connection testing
- Submit use site plans for review and approval by CDPH or the local county health department

9.3 Municipal Recycled Water CII Applications

CII businesses are successfully integrating municipal recycled water into many aspects of their process, as indicated in Table 9.1. Three key areas affecting the ability of CII businesses to integrate municipal recycled water into its water supply are:

- **Water Quality** – Impacts many aspects of CII recycled water use. For example, high concentrations of some dissolved minerals can affect how many times water can be cycled through the cooling towers and the concentration of the discharge. These concentrations affect both the plant operation and waste disposal – both of which are costly to power plant operation. See Volume II for additional discussion of water quality issues.

- **Supply Issues** – These include public and onsite infrastructure, pricing, and supply interruptions and back up requirements.

- **Alternate Distribution System Options** – Alternate solutions to a dedicated municipal recycled water distribution system includes satellite treatment plants and potable system distribution.

Table 9.1 CII Sector Municipal Recycled Water Applications

CII SECTOR	CII TASK FORCE REPORT SECTION	APPLICATION[1] Cooling Tower Make up	Indoor (Dual) Plumbing	Landscape Irrigation	Process Water	Boiler Feed	Other	CASE STUDIES[2]
Commercial and Institutional Sector Uses								
Office Buildings	7A5	○	○	○				Irvine Ranch Water District supplies recycled water tomany dual plumbed to office buildings
Prisons	7A6			○			●	Prisons in California use recycled water for agricultural and landscape irrigation.
Schools and Educational Facilities	7A8	○	○	●				UC San Diego, San Jose State University, and some schools within IRWD
Vehicle Washing	7A9						○	Marin Municipal Water District
Industrial Sector Uses								
Microelectronics	7B2c						○	South Bay Water Recycling provides recycled water to several high-tech industries for cooling server centers.
Petroleum refining and chemicals	7B2d	●				●		BP Carson
Pharmaceutical	7B2e	○				○		none identified at this time
Power Plants	7B2f	●						Metcalf Energy Center (South Bay Water Recycling), Walnut Energy Center (Turlock) Several proposed solar projects have not begun construction or operation.

NOTES:

1. Filled circles are common applications of municipal recycled water. Open circles are less common applications, but are approved. Small dots are applications which currently have limited application.
2. Case studies cited here are not the only locations where CII municipal recycled water is being used for the application, but they are merely cited here as examples.

Refer to Volume II, Table 9.2 for a summary of municipal recycled water applications, approved under Title 22 of the California Code of Regulations (Division 4, Chapter 3, §60301 et seq.) based on required treatment levels.

Indirect potable reuse projects can generally be built on a larger scale realizing greater increases in recycled water use in a shorter time frame compared to non-potable reuse projects. Current projects include groundwater recharge through percolation and direct injection. With additional research and approvals by CDPH, future projects may include reservoir augmentation or augmentation of raw water supplies. Direct delivery to potable water systems will also be considered under the provisions of SB 918. These projects may be the best approach to meeting the statewide recycled water goals.

9.4 Public Infrastructure Needs for Increasing CII Municipal Recycled Water Use

Despite the gains in California's use of municipal recycled water since the early 1990s, the State is not on target to attain the projected 2030 recycled water use potential of 2.5 maf (an additional two maf above 2009, from the SWRCB Recycled Water Policy). If the current pace of adding recycled water use continues, the state will only be recycling about 1.1 maf by 2030. Strong focus and direction are needed to make better progress to achieving a goal of at least two maf by 2030. The slow pace of infrastructure expansion is a major challenge to meeting the projections.

> Maintaining local and regional control of municipal recycled water works well. However, the State of California sees an overall benefit to expanding municipal recycled water use because doing so supports the overall objective of water supply reliability and sustainability.

The remainder of this section addresses the requirement established for the CII Task Force was in CWC Section 10608.43(c): to evaluate "public infrastructure necessary for delivery of recycled water to the commercial, industrial, and institutional sectors." Barriers and solutions to increasing municipal recycled water use are included in Section 10, with a focus on overcoming infrastructure barrier in Section 10.1.

9.4.1 Municipal Recycled Water Implementation

Municipal recycled water is produced and distributed on a local level, allowing suppliers to maintain control of their systems and meet the needs of their customers. It also enables water service providers with water source challenges to increase local supplies and reduce dependency on imported water.

The success of a local municipal recycled water project depends on good planning and local interagency cooperation. It enables alternatives to be evaluated and to develop an approach to address customer and water supply needs. It also considers both onsite and offsite infrastructure costs. Solutions to this obstacle are discussed in Sections 10.1.1 and 10.1.3. The CII Task Force encourages local planning efforts using good planning practices to maximize the potential implementation of municipal recycled water use. Recommendations to accomplish this goal are identified below.

9.4.2 Justification for Additional Municipal Recycled Water Funding

Infrastructure is a fundamental requirement for water recycling to support water resource supply demands. Local water and wastewater agencies are postponing or shelving planned projects because of fiscal challenges. If additional projects are not implemented, increased municipal recycled water use may not occur.

Augmenting statewide municipal recycled water funding, even in light of current statewide budget issues is expected by the CII Task Force to provide long-term benefit to the state for the following reasons:

- Using existing water supplies efficiently can buffer against continued population growth and recurring periods of drought.
- Establishing and fully utilizing municipal recycled water supplies reduce dependence on imported water.
- Developing local water resources will provide the communities with increased self reliance in the face of potential global warming impacts to the state's water system.
- Using municipal recycled water may reduce greenhouse gas emissions because less energy is needed to treat and reuse water than to convey fresh water long distances.

9.4.3 Known Issues

Three infrastructure needs were identified:

- **Local Delivery Infrastructure -** Some municipal recycled water service providers have been able to construct recycled water facilities. However, expanding customer bases and delivering municipal recycled water have been problematic. Additional funding would support installation of additional conveyance and could also be used to support appropriate onsite infrastructure improvements.
- **Brine Disposal Needs -** This continues to be a significant obstacle to expanding municipal recycled water development, particularly in inland communities. As an example; Southern California has successfully developed portions of the Santa Ana Regional Interceptor, a brine export line. Expansion of infrastructure to dispose of brine would provide opportunities for additional municipal recycled water supply.
- **Expanded Potable Reuse -**Expansion of potable reuse infrastructure will avoid the costs associated with dual distribution of recycled water and user retrofits. At the same time, it may provide reliable drought proof supplies to allow local economic expansion.

9.4.4 Recycled Water Recommendations for Public Infrastructure

The state should work with stakeholders to develop a Statewide Recycled Water Master Plan and the most appropriate approach to statewide investment in additional recycled water projects. The state, working with stakeholders when developing the Statewide Recycled Water Master Plan should include:

1. Develop a Statewide Recycled Water Master Plan. Working with local and regional stakeholders, review the recently completed 2009 Municipal Recycled Water Survey and identify customer bases and geographical areas where the greatest additional benefit can be realized by increasing municipal recycled water use. Working with the stakeholders, identify specific projects and actions that can be implemented to realize the statewide municipal recycled water use potential of at least two maf of municipal recycled water use by 2030. Evaluate whether the current approach to funding municipal recycled water projects (state grant and low-interest loan funding through DWR and SWRCB) is the most cost-effective approach to implementing the master plan.
2. Provide additional funding to existing municipal recycled water agencies with excess treatment capacity; to expand existing infrastructure, or provide grants for onsite infrastructure improvements with the goal of adding customers for municipal recycled water.
3. Provide additional funding to brine management projects that would expand the use of municipal recycled water.

9.5 Funding/Cost

While identifying specific infrastructure necessary for delivering municipal recycled water to CII sectors is not possible, the overall costs of this infrastructure may be estimated based on historic data and experience. The Recycled Water Task Force (RWTF) estimated in 2003 the state-wide capital investment between $9.2 and $11 billion (in 2003 dollars) was needed to increase all municipal recycling from 0.5 to 2.0 maf (1.5 maf increase) by 2030. The high cost of municipal recycled water projects may be reduced through regulatory streamlining, which is discussed in Section 10. The RWTF recommended increasing state and federal funding assistance to the local and regional agencies implementing and operating the water recycling projects. This recommendation has been implemented through grants and loans administered both by the SWRCB and the DWR and through Title XVI federal funding.

Costs of water recycling projects have a wide range. San Diego area costs reported in 2010 for potable and non-potable reuse projects provide an indication of costs typically encountered, including annual capital and operating costs. Proposed potable projects include estimated costs associated conveyance systems necessary to reach the ground or surface water recharge or blending sites, but do not account for wastewater benefits. Ranges of recycled water costs are estimated to be:

- Existing non-potable projects (4): $1,300 - $1,700 per af
- Proposed non-potable projects (5): $1,000 - $2,400 per af
- Proposed indirect potable projects (2): $1,400 - $1,800 per af

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10.0 Evaluation of Institutional and Economic Barriers to Municipal Recycled Water Use

Increasing the amount of municipal recycled water used in California augments the state's water supply resources and provides environmental benefits. As noted in Section 9.0, water recycling in California has achieved some level of success, but continued barriers hinder additional expansion. This Section builds upon the background information provided in Section 9.0 and identifies existing barriers and proposes solutions to increasing CII municipal recycled water use in California, in accordance with CWC Section 10608.43(d).

The CII Task Force developed a list of 10 barriers to integrating municipal recycled water into CII applications. To develop the list, the CII Task Force evaluated obstacles and recommendations of the Recycled Water Task Force (DWR, 2003), and reviewed and assessed the current level of implementation of the recommendations. The CII Task Force also evaluated obstacles not addressed by the RWTF, drawing upon professional experience and knowledge. Finally, the CII Task Force qualitatively ranked the barriers based on their potential to limit increasing local and regional recycled water use and identified possible solutions.

The CII Task Force's ranking of the institutional and economic barriers to increasing the CII use of municipal recycled water reflects a range of different factors related to CII businesses, municipal recycled water producers and distributors, and State policymakers and regulators. The barriers, listed below, are ranked according to how much they are limiting statewide use of municipal recycled water (with number one being the largest barrier).

1. Infrastructure Cost and Feasibility
2. Regulatory Impediments
3. Awareness and Education of Recycled Water Quality
4. Public/Customer Acceptance
5. Cost for CII Users
6. Source Water Quality
7. Recycled Water Supply Reliability
8. Terminology Used in Describing Process
9. Data for Tracking Use
10. Institutional Coordination Among Agencies

Table 10.1 is a summary of the barriers to increasing municipal recycled water use by CII businesses and corresponding solutions. It also includes a listing of suggested key actions and implementers for each barrier and solution. Volume II provides additional discussion for the solutions and key actions with selected examples for solutions.

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Table 10.1 Barriers and Possible Solutions to Increased CII Municipal Recycled Water Use.

BARRIER	VOLUME II SECTION	SOLUTION	KEY ACTIONS	IMPLEMENTORS
Infrastructure Cost And Feasibility	10.1.1	Conduct Local and Regional Water Recycling Planning by Analyzing Appropriate Options	• Evaluate trade-offs for potable reuse versus dedicated parallel distribution systems (purple pipe)	Water service providers and wastewater agencies
	10.1.2	Seek or Provide Funding Sources to Facilitate Local Projects	• Identify onsite and offsite infrastructure funding • Identify recycled water unit pricing • Identify possible financial incentives	Local, regional, and state agencies
	10.1.3	Include Evaluation of Onsite Retrofit and Other Modifications When Assessing Municipal Recycled Water Feasibility	• Consider onsite retrofit costs during recycled water feasibility studies • Consider developing strategies to financially support onsite retrofit, or onsite facility or process modification	Water service providers and wastewater agencies, CII water users
	10.1.4	Fund Development of Indirect and Direct Potable Reuse Regulations	• Consider onsite retrofit costs during recycled water feasibility studies	Legislature
	10.1.5	Provide Greater State Funding for Municipal Recycled Water Projects Commensurate With Benefit to State	• Consider state and federal funding subsidies • Consider state and federal low-interest loans	Legislature
	10.1.6	Provide incentives for installation of customer-side (onsite) infrastructure	• Consider providing technical and financial assistance • Support rate structures and utility subsidies	Water supply agencies and CPUC
Regulatory Impediments	10.2.1	Revise water recycling statutes	• Consider re-codifying laws to consolidate and simplify recycled water statutes into a single “water recycling” code section • Consider amending statutes to provide simplified and consistently implemented permitting • Suggest CDHP regulate the use of “advanced treated” recycled water to be used for potable reuse and RWQCBs regulate other uses of recycled water • Consider updating statutes to address constituents of emerging concern	SWRCB, CDPH, and Legislature

BARRIER	VOLUME II SECTION	SOLUTION	KEY ACTIONS	IMPLEMENTORS
Regulatory Impediments (continued)	Section 10.2.2	Provide consistent implementation of the SWRCB's recycled water policy and revise policy as appropriate	• Develop specific CEC monitoring requirements and salt and nutrient management plans guidelines • Evaluate recommendations and propose changes to the SWRCB's Recycled Water Policy (adopted in 2009) and incorporate recommendations into the groundwater recharge criteria being developed by CDPH • The State Board should work with stakeholders to prepare a guidance document comparing MS4 and NPDES permits to evaluate permitting opportunities and appropriate approaches	RWQCBs, SWRCB, Stakeholders, CDPH, CEC Expert Panel, and other potential monitoring entities (USGS)
	10.2.3	Implement consistent use site oversight throughout the state	• Develop and implement consistent oversight recommendations • Prepare oversight guidance and training • Consider oversight delegation	CDPH, RWQCBs, County health departments, and recycled water purveyors
	10.2.4	Revise water recycling regulations and California Plumbing Code	• Change Titles 17 and 22 to eliminate unnecessary restrictions and inconsistencies and to align with the California Plumbing Code	CDPH, DWR, California Building Standards Commission
	10.2.5	Support the Ocean Plan update addressing brine disposal from municipal recycled water and groundwater facilities	• Work with the SWRCB to modify the Ocean Plan in a way that recognizes the importance of advanced treatment in achieving the State's water recycling goals and identifies appropriate and protective approaches to ocean brine disposal	SWRCB, USEPA, and potential ocean brine dischargers
Awareness and Education of Municipal Recycled Water Quality	10.3.1	Educate potential municipal recycled water users and suppliers	• Expand outreach to CII businesses, with focus on technical information, case studies, the types of municipal recycled water locally available, and the solutions presented in this report	DWR, WateReuse California, recycled water users, trade groups, ACWA, and environmental advocacy groups
	10.3.2	Create and Promote Information on Use of Municipal Recycled Water in CII	• Create and disseminate information on recycling opportunities in various CII settings	WateReuse California, trade associations, water agencies, DWR

BARRIER	VOLUME II SECTION	SOLUTION	KEY ACTIONS	IMPLEMENTORS
Public/Customer Acceptance	Section 10.4.1	Educate and promote municipal recycled water	• Conduct a state-wide information campaign to offer authoritative views from recognized experts including SWRCB, DWR, CDPH, and independent research groups, such as the Pacific Institute and environmental NGOs • Develop a "tool kit" for agencies involved in producing or marketing municipal recycled water	DWR, WateReuse California, ACWA, and industry groups
	10.4.2	Implement community value-based decision-making model for project planning	• Develop and incorporate community value-based decision-making practices into recycled water project planning	Water service providers
Cost for CII Users	10.5.1	Base recycled water pricing on total cost of use and provide incentives	• Consider various pricing strategies to help make recycled water feasible for CII businesses	Retail water service providers
Source Water Quality	10.6.1	Provide water quality suitable for intended use	• Facilitate linking water quality to CII needs by assessing a range of options including onsite or supplemental treatment.	Water service providers, CII businesses, WateReuse California, industry trade associations
Recycled Water Supply Reliability	10.7.1	Consider increased recycled water system reliability features and backup water supply	• Assess the required reliability of recycled water system reliability for the given end-user needs and evaluate the need for additional system redundancy	Water service providers and users
Terminology Used in Describing the Process	10.8.1	Establish terminology	• Establish universal terminology that is transparent, comprehensible, and consistent with State statutes and regulations • Establish a forum of water agencies, regulators and interested parties • "Determine if changing the definition of "waste" in Section 13050(d) of the Water Code and other sections of statute is needed to address a perception that recycled water is being regulated as a waste rather than as a valuable resource."	WateReuse California, water service providers and users, SWRCB, CDPH, DWR, AWCA
	10.8.2	Use new terminology	• Communicate this consistent, clear terminology to water industry professionals and seek its widespread use	SWRCB, CDPH, DWR, WateReuse California, and

				ACWA
Data for Tracking Use	10.9.1	Create Unified Recycled Water Use and Compliance Reporting System	• Develop consistent reporting requirements and a web-based reporting system that meets regulatory compliance needs of regional water quality control boards and data gathering needs of water supply planners	SWRCB, CDPH, WateReuse California, and DWR

BARRIER	**VOLUME II SECTION**	**SOLUTION**	**KEY ACTIONS**	**IMPLEMENTORS**
Institutional Coordination Between Agencies	10.10.1	Review Duplication of Service Regulations	• Determine if laws and regulations need to be revised relative to duplication of service	WateReuse California, DWR, ACWA, and CPUC
	10.10.2	Provide Agency Partnering Case Studies	• Develop case studies where partnering between water service providers, waste water and other utilities has been effective in providing recycled water to CII businesses	WateReuse California, DWR

Glossary

Activated Carbon: An activated carbon filter is used for the removal of dissolved organics and color and odor- causing compounds. Generally high-molecular-weight, non-polar compounds are adsorbed more effectively than low-molecular-weight, polar compounds.

Aggregate-level metric: A metric that does not apply to a specific set of conditions, such as system-wide or sector-wide measures.

Alternative turf: See Synthetic turf.

Alternative water source: Any non-potable water source used for irrigation purposes.

Artificial turf: See Synthetic turf.

As-built documentation: Set of reproducible drawings that show significant changes in the work made during construction and that are usually based on drawings marked up in the field and other data furnished by the contractor (MWELO, Section 491).

Back flow prevention device: A safety device used to prevent pollution or contamination of the water supply due to the reverse flow of water from the irrigation system (MWELO, Section 491).

Benchmark: (1) A particular (numerical) value of a metric that denotes a specific level of performance; (2) A current value or beginning value of a metric.

BMP: Best management practices**;** recommended methods or practices designed to increase irrigation efficiency and uniformity thereby reducing water consumption and runoff, protecting water quality.

Chemical of emerging concern: Constituents that may occur in wastewater and may be resistant to some treatment processes. These constituents include: personal care products, pharmaceuticals including antibiotics and antimicrobials; industrial, agricultural, and household chemicals; natural hormones; food additives (e.g., phytoestrogens, caffeine, sweeteners); transformation products; inorganic constituents (e.g., boron, chlorate, gadolinium); and nanomaterials. Research is ongoing in the scientific community to assess the impacts of chemicals of emerging concern on flora and fauna exposed to wastewater. The term is often used interchangeably with ”constituents of emerging concern” or ”compounds of emerging concern.” It is also frequently abbreviated CECs.

Commercial water user: A water user that provides or distributes a product or service. (See CWC §10608.12(d)).

Confounding-factors: Factors affecting the numeric value of a metric that are not related to the purpose of a metric.

Conservation Index (CI): Nomenclature denoting conservation metric.

CII: Commercial, institutional, and industrial customers. Examples of commercial users include customers who provide or distribute a product or service, such as hotels, restaurants, office buildings, commercial businesses, or other places of commerce; institutional customers include schools, courts, churches, hospitals, and government institutions regardless of ownership; industrial customers are those who primarily manufacture or process materials as defined by NAICS.

Definitional noise: The inaccuracies in both the numerator and denominator of a metric as a result of different, specific or general, definitions used for collecting data.

De-ionization: Ion exchange onto synthetic resins or activated alumina is considered for the removal of mineral ions or hardness in the water. De-ionized water is used in the spot-free rinse by some professional car wash operators.

Direct potable reuse: The planned introduction of highly treated recycled water either directly into a potable water supply distribution system downstream of any water treatment plant or into a raw water supply immediately upstream of a water treatment plant. (Paraphrase of Water Code §13561(b)).

Direct reuse: The use of recycled water that has been transported from a wastewater treatment plant to a reuse site without passing through a natural body of either surface water or ground water.

Economic Efficiency: An efficiency measure that incorporates the concept of value, such as including a monetary or resource factor.

Efficiency: The ratio of output to input or vice versa. Water use metrics and benchmarks are inextricably linked to the concepts of “water conservation” and “water-use efficiency.” Therefore, it is also helpful to define these concepts in the context of evaluating water use. The term “efficiency” derives from engineering practice where it is typically used to describe technical efficiency, or the ratio of output to input.

Enterprise: A legal entity operating as a business, government, or other organization which may have one or more places of operation or activity.

Establishment: A specific water use site (e.g., land parcel or building) at which there may be one or more end-uses of water.

Evapotranspiration: A combination of water transpired from vegetation and evaporated from the soil and plant surfaces (ASABE, 1998).

Existing landscape: For the purposes of this BMP, an established landscape associated with a CII site.

Filtration: The process by which suspended solids are removed from the water in order to better utilize the water in a greater number of processes. Granular media filters such as sand, glass and olivine are all in use. Bag or sack filters, made of woven material such as cloth or paper, are also in use.

Flocculation: The process by which anionic and cationic materials in the reclaim water are removed through use of polymers and/or metal salts. The chemical interactions result in the coagulation and sedimentation of suspended solids smaller than 5 microns. Flocculation can be used to effectively remove turbidity, color and total suspended solids. It is dependent on the proper selection of flocculent, precise control of the dosage and proper design of the hardware.

Graywater: Untreated wastewater that has not been contaminated by any toilet discharge, has not been affected by infectious, contaminated, or unhealthy bodily wastes, and does not present a threat from contamination by unhealthful processing, manufacturing, or operating wastes. Graywater includes wastewater from bathtubs, showers, bathroom washbasins, clothes washing machines, and laundry tubs, but does not include wastewater from kitchen sinks or dishwashers. (Water Code §14876)

Groundwater recharge: The infiltration or injection of water into a groundwater aquifer.

Hardscape: Any durable material pervious and non-pervious (MWELO, Section 491).

Hydro-zones: Portion of the landscaped area having plants with similar water needs. A hydro-zone may be irrigated or non-irrigated (MWELO, Section 491).

Incidental Water User: Water that is used by industry for purposes not related to producing a product, product content, or research and development. This includes incidental cooling, air conditioning, heating, landscape irrigation, sanitation, bathrooms, cleaning, food preparation, kitchens, or other water uses not related to the manufacturing of a product or research and development (23 CCR §596.1a(6).

Indirect potable reuse: The planned incorporation of recycled water into a raw water supply, such as in potable water storage reservoirs or a groundwater aquifer, resulting in mixing and assimilation, thus providing an environmental buffer. (Metcalf & Eddy/AECOM textbook, consistent with definition of "indirect potable reuse for groundwater recharge" in Water Code §13561(c)). Note that as "surface water augmentation" has been defined in the Water Code, it has been distinguished from direct potable reuse and would be a form of indirect potable reuse.

Indirect reuse: The use of recycled water indirectly after it has passed through a natural body of water after discharge from a wastewater treatment plant.

Industrial Water User: (1) A water user that is primarily a manufacturer or processor of materials as defined by the North American Industry Classification System (NAICS) code sectors 31 to 33, inclusive, or an entity that is a water user primarily engaged in research and development (CWC §10608.12(h)). (2) A water user that is primarily manufacturer or processor of materials.

Inline irrigation: See Subsurface irrigation.

Institutional Water User: A water user dedicated to public service. This type of user includes, among other users, higher education institutions, schools, courts, churches, hospitals, government facilities, and non-profit research institutions. (CWC§10608.12 (i)).

Irrigation scheduling: Determining when to irrigate and how much water to apply based on measurements or estimates of soil moisture or crop water used by a plant (NRCS, 1997).

Irrigation system design: Drawings and associated documents detailing irrigation system layout and component installation and maintenance requirements (IA, 2010).

Landscape budget: A volume of water allocated to the entire landscape area for some period of time. This allowance is established by the water service provider for the purpose of ensuring adequate supply of water resources (IA, 2010).

Maximum Applied Water Allowance (MAWA): The upper limit of annual applied water for the established landscaped area as specified in MWELO Section 492.4 (MWELO, Section 491).

Metric: A unit of measure (or a parameter being measured) that can be used to assess the rate of water use during a given period of time and at a given level of data aggregation (e.g., system-wide, sector-wide, customer level, or end-use level). Another term for a *metric* is *performance indicator*.

Metric value: A numerical value either (1) calculated from the mathematical formula for any given metric or (2) assigned to a given metric. A metric is not a benchmark or target.

Microclimate: Climate of a small, specific area that may contrast with the climate of the overall landscape area due to factors such as wind, sun exposure, plant density, or proximity to reflective surfaces (MWELO, 491).

Mulch: Any organic material, such as leaves, bark, straw, and compost; or inorganic mineral material, such as rocks, gravel, and decomposed granite left loose and applied to the soil surface for the beneficial purposes of reducing evaporation, suppressing weeds, moderating soil temperature, and preventing soil erosion (MWELO, 491).

MWELO: The Model Water Efficient Landscape Ordinance of the Department of Water Resources California Code of Regulations.

North American Industry Classification System (NAICS): The North American Industry Classification System (NAICS) is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy. NAICS is based on a production-oriented concept, meaning that it groups establishments into industries according to similarity in the processes used to produce goods or services.

NAICS codes: The North American Industry Classification System (NAICS) is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy. NAICS is based on a production-oriented concept, meaning that it groups establishments into industries according to similarity in the processes used to produce goods or services.

New construction landscape: For the purposes of this BMP, a new building with a landscape or other new landscape associated with a CII site.

New landscape: See the above entry for “New construction landscape.”

Ozonation: The process of treating reclaimed water with ozone to remove odor-producing hydrocarbons. Ozone is a powerful oxidizing agent and effective as a disinfectant. In water, ozone is a powerful bleaching agent, acting more rapidly than chlorine, hydrogen peroxide, or sulphur dioxide. Ozone has an additional advantage over chlorine since it does not leave undesirable odors nor produce trihalomethanes - both potential byproducts of chlorine use. One common means of producing ozone for injection in reclaim water is corona discharge. Another method is to produce ozone using UV light.

Oxidation: Oxidation in simple chemical terms is the loss of electrons. The purpose of oxidation in water treatment is to convert undesirable chemicals to a form that is neither harmful, nor as objectionable as the original form. In the professional car wash reclaim system, oxidation is used to treat for odor, color, or organisms such as bacteria and algae. Common oxidants include chlorine, ozone, and oxygen or air.

Performance indicator: The same meaning as “metric.”

Permeable: Any surface or material that allows the passage of water through the material and into the underlying soil (MWELO, 491).

Planned reuse: The deliberate direct or indirect use of recycled water without relinquishing control over the water during its delivery.

Process water: (1) water used for producing a product or product content or water used for research and development, including, but not limited to, continuous manufacturing processes, water used for testing and maintaining equipment used in producing a product or product content, and water used in combined heat and power facilities used in producing a product or product content. Process water does not mean incidental water uses not related to the production of a product or product content, including, but not limited to, water used for restrooms, landscaping, air conditioning, heating, kitchens, and laundry. (CWC§10608.12 (l)) (2) water used by industrial water users for producing a product or product content, or water used for research and development. Process water includes, but is not limited to, the continuous manufacturing processes; water used for testing, cleaning, and maintaining equipment. Water used to cool machinery or buildings used in the manufacturing process or necessary to maintain product quality or chemical characteristics for product manufacturing or control rooms, data centers, laboratories, clean rooms, and other industrial facility units that are integral to the manufacturing or research and development process shall be considered process water. Water used in the manufacturing process that is necessary for complying with local, state, and federal health and safety laws, and is not incidental water, shall be considered process water. Process water does not include incidental, commercial, or institutional water uses (23 CCR 596.1a(11).

Productivity: A measure of the efficiency of production. The ratio of production output to what is required to produce it (inputs), total output per one unit of a total input.

Rainwater harvesting: Rainwater collection and distribution systems used as an alternative water source for irrigation (AWE, 2010).

Reclaimed water: Same meaning as "recycled water." (Water Code §26)

Recycled water: Water [that], as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur and is therefore considered a valuable resource. (Water Code §13050(n))

Rehabilitated landscape: Any re-landscaping project that requires a permit, plan check, or design review, meets the requirements of MWELO Section 490.1, and the modified landscape area is equal to or greater than 2,500 square feet, is 50% of the total landscape area, and the modifications are completed within one year (MWELO, Section 491).

Reverse Osmosis: Osmosis is defined in terms of water in an ideal state as the transport from a reservoir of pure water through a semipermeable membrane to a reservoir of water containing dissolved solutes. Reverse osmosis (RO) occurs when pressure is increased on the side of the membrane containing the solutes above the osmotic pressure of the solution. In this case water flows from the osmotic side of the membrane to the pure water side.

Scaling variable: Variable that can be used to standardize or characterize per unit rates of water use. Also called "scaling factor."

Separation: The first stage in a reclaim operation. Separation uses a settling tank, usually divided into at least three compartments, to allow grit to settle and to separate grease and oils from the water prior to reclaim in the professional car wash or discharge to the sanitary sewer. The tank will typically be located in-ground with the sections designed for gravity sedimentation, grease and oil separation, and with the third section of the tank for final clarification and discharge to reuse in the professional car wash or to the sanitary sewer system. Usually at this point, particles of up a range of 50 to 100 microns in size are removed, depending upon the size of the settling tank and resultant residence time of the water. A cyclonic separator may also be used to increase the total amount of suspended solids removed from the water.

Standard Industrial Classification (SIC): A classification system for commercial, industrial, and institutional activities that classifies establishments by their primary type of activity and organizes industries in an increasing level of detail ranging from general economic sectors (e.g., manufacturing, services) to specific industry segments (e.g., commercial sports, laundry businesses). This system organizes industries by their output. SIC was replaced by the North American Industry Classification System (NAICS) in 1997.

Soil management: Utilizing a soil analysis report that includes soil properties such as soil type and infiltration rate when designing and scheduling irrigation systems.

Subsurface irrigation: Application of water below the soil surface through emitters, with discharge rates generally in the same range as drip irrigation. This method of water application is different from and not to be confused with sub-irrigation, where the root zone is irrigated by water table control (ASABE, 1998).

Surface water augmentation: The planned placement of recycled water into a surface water reservoir used as a source of domestic drinking water supply (Water Code §13561(d)) or into any surface water when discharged for the purpose of aquatic habitat enhancement.

Synthetic turf: A product manufactured to look like natural turfgrass; a permeable ground cover made from synthetic fibers.

Target: A benchmark that indicates a state of achievement expected at some time in the future.

Turf: A ground cover surface of mowed grass (MWELO, Section 491).

Ultrafiltration: The process of using a membrane to filter out dissolved solids as well as the finest of suspended solids. Unlike reverse osmosis, ultrafiltration is not dependent on overcoming osmotic pressure differential, and can be accomplished at low pressure differences of 5 - 100 psi. The primary mechanism is selective sieving through pores.

UM: A water use metric acronym expressed as “usage ratios” or “usage rates.” The “ratio” metric designates the quotient obtained by dividing the volume of water sold over a specified period of time (day, month, season or year) by a scaling factor (e.g., number of accounts, population served, or number of employees). Additional letters, superscripts, and subscripts can be added to the UM acronym to designate user sector and the scaling variable being used.

Unplanned reuse: Unplanned reuse of treated wastewater effluent after disposal. Also called “incidental reuse.”

Warm season turf: Grasses that grow vigorously in warm summer months and then generally enter some state of dormancy in winter, thereby having alower water need compared to cool season turf. Examples of warm season grasses include Bermuda, Zoysia, and Buffalo grasses.

Water audit: Also known as an irrigation survey, a water audit is an in-depth evaluation of the performance of an irrigation system that includes, but is not limited to: inspection, system tune-up, system test with distribution uniformity or emission uniformity, reporting overspray or runoff that causes overland flow, and preparation of an irrigation schedule (MWELO, Section 491).

Water budget: Volume of irrigation water required to maintain a functional, healthy landscape with the minimum amount of water. A water budget is established through a method of water-efficiency standards for landscapes by providing the water necessary to meet the ET of the landscaped area.

Water conservation: A reduction in water use, water loss, or waste.

Water-efficient landscape: A landscape that minimizes water requirements and consumption through proper design, installation, and management (AWE, 2010).

Water reclamation: (1) Same meaning as definition 1 for "water recycling." (2) The treatment of water of impaired quality, including brackish water and seawater, to produce a water of suitable quality for the intended use.

Water recycling: (1) The process of treating wastewater for beneficial use, storing, and distributing recycled water, and the actual use of recycled water. (2) The reuse of water through the same series of processes, pipes, or vessels more than once by one user, wherein the effluent from one use is captured and redirected back into the same use or directed to another use within the same facility of the user.

Water reuse: (1) The use of treated wastewater for a beneficial purpose, such as agricultural irrigation and industrial cooling. (2) The additional use of previously used water.

Water use efficiency: The relation of water-related tasks accomplished with an amount of water. For example, the ratio of water input to output of a product.

Water Use Metadata: The multitude of agents that may produce or have the capability of producing an effect on whether a metric is appropriate can be termed water metric "metadata", for they are data about the metric.

Water use productivity: The relation of specific or general product, outputs, or economic activity to amount of water associated with those products, outputs, or activities.

Winterization: The process of removing water from the irrigation system before the onset of freezing temperatures (IA, 2010).