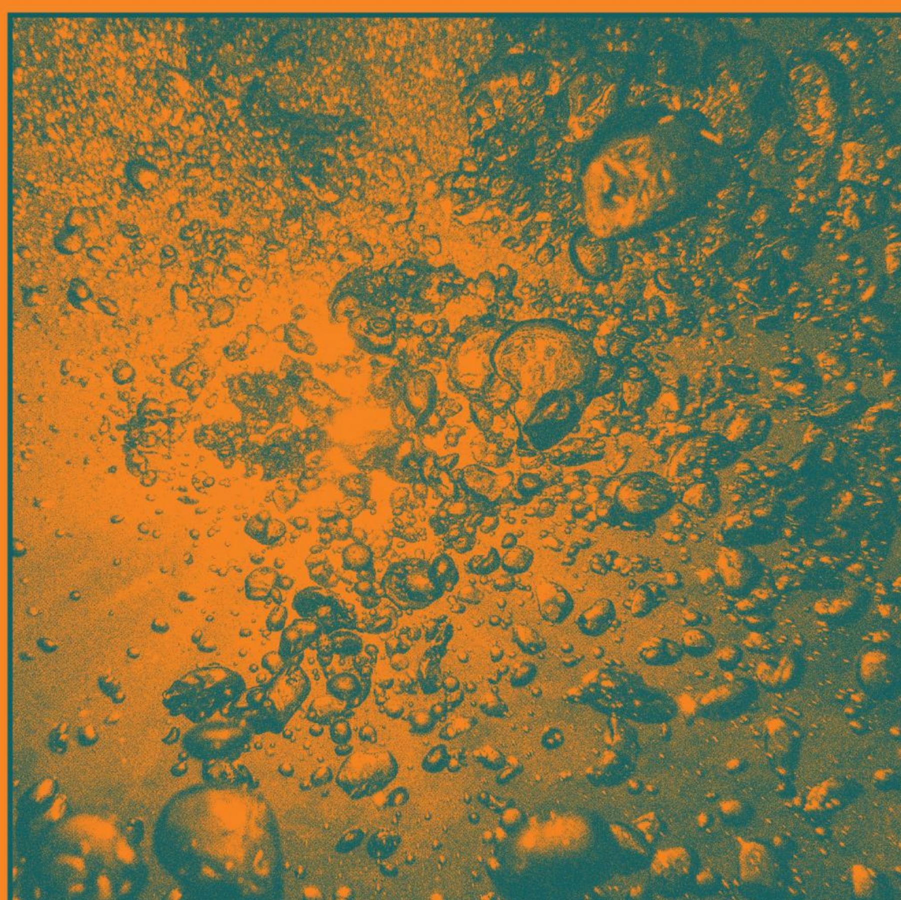
WATER SUPPLY



COLLEGE OF THE CANYONS

WATER SUPPLY

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Table of Contents

INTRODUCTION TO WATER SUPPLY

You're about to understand water demand and water supply more deeply. This understanding is going to change how you look at your water bill, grass in your yard and around town, the food you eat, and all those canals you see while driving around in California.

Understanding the connection between demand and supply is critical to anyone working in the water industry today. Water demand is our need and use of water. Water supply refers to our sources of water.

This textbook has three primary parts.
In Part One, you will learn foundational concepts in water supply, including the water cycle, water management concepts, water rights and stakeholder concepts.

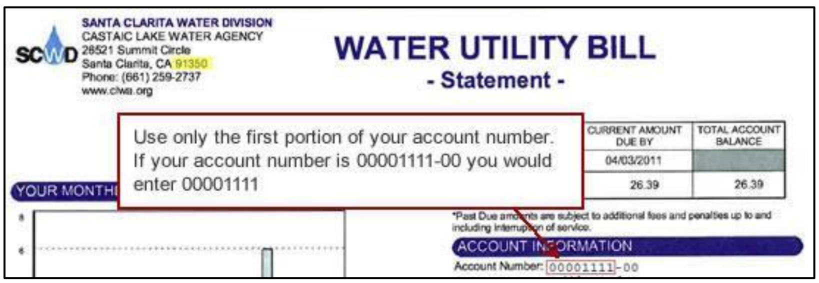

Figure 1: Photo used with permission of Castaic Lake Water Agency

In Part Two, you will apply what you learned in Part One to water development projects and supply side management including the Los Angeles Aqueduct, Central Valley Project, Colorado River Aqueduct and State Water Project. There are voluminous books written on each of these projects, so you will not learn everything about each project here, but rather key details that characterize each project's purpose, stakeholders, development, and future. You will also explore alternative water supplies, including desalination.


Figure 2: Photo by the U.S. Bureau of Reclamation is in the public domain

In Part Three, you will learn about demand management, which includes using legislation and regulatory tools, water rates, and conservation programs to manage water use. Rather than simply understanding demand management as conservation program-based, you will learn that there are powerful ways, sometimes far more useful at times than conservation programs, to decrease demand in the long-term.

Figure 3: Photo used with permission of [Castaic Lake Water Agency]

PART ONE: WATER ALL AROUND US

In Part One of this text, we'll explore the basics of water supply and demand. We'll review the water cycle, explore basic concepts in water management, introduce surface water and groundwater rights, and then introduce the ideas of stakeholders in water projects. Part One is divided into these four sections:

- The Water Cycle
- Water Management Concepts
- Water Rights
- Stakeholder Concepts

For many of you, the Water Cycle will not be a new concept. But now you will need to frame it differently. Rather than considering it as a scientific concept, you'll have to see the interface between science and society and between supply and demand.

Water management concepts will take the water cycle further as you learn how different sources of groundwater and surface water supplies are identified and used both separately and together. There are benefits and drawbacks to each type of source of water.

Water rights are important to all aspects of the water supply. While we can't make you an attorney, you'll understand the basic types of water rights in California by the end of this section.

And, lastly, in Part One, you'll finish with an examination of typical stakeholders in different water issues. Stakeholders aren't just a concept from management theory. They are critical to how we get things done in the water industry. You'll look at a few real-life examples of the consequences of working with (or neglecting) stakeholders in the water industry.

Figure 1.1: Hydraulic mining in the 1880s in Nevada City, California (Hydraulic Gold Mining by Carlton Wakins is in the public domain)

SECTION 1.1 WATER CYCLE

In this section, we'll dive deeper into the water cycle in terms of how it affects water supply.

LEARNING OBJECTIVES

After reading this section, you should be able to:

- identify processes in the water cycle that influence the water supply;
- analyze situations in terms of precipitation, condensation, evaporation and transpiration; and
- evaluate yearly data for evapotranspiration.

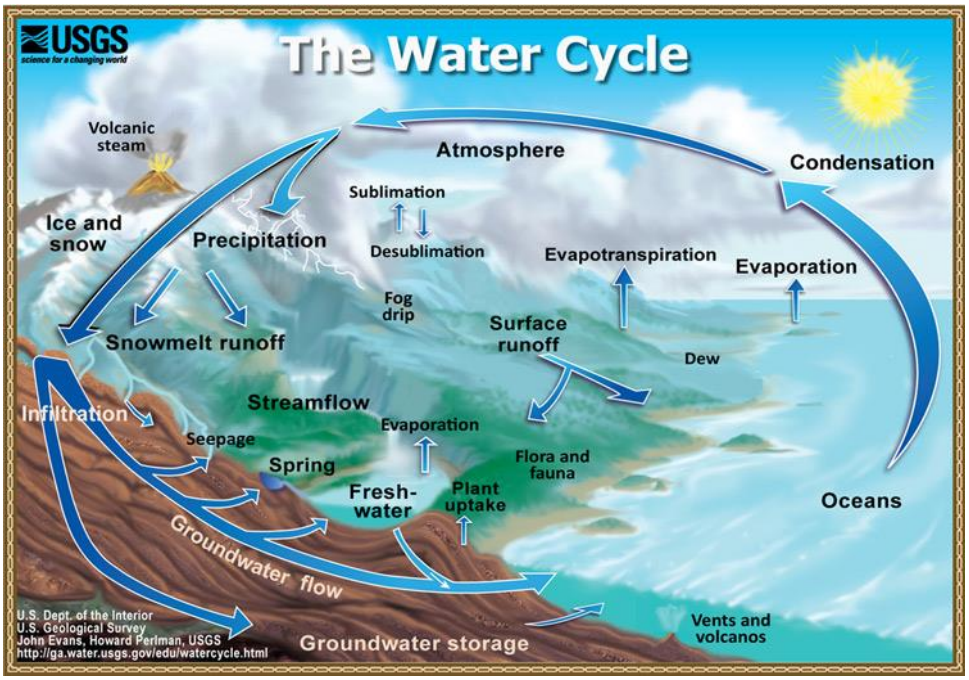

Figure 1.2: [The Water Cycle]() by John Evans and Howard Perlman is in the public domain

You've probably heard on the news the statewide water supply in California described in terms of snowpack and rainfall. These are critical measures of how much water is available for human use. Water managers in California follow both snowpack measurements and rainfall measurements closely. In the diagram above from the United States Geological Survey (USGS), you can see that precipitation is shown as rainfall and snow.

Precipitation also includes something you don't see too often in Southern California: hail and sleet. All forms of water that fall from the sky, including rain, snow, hail and sleet, are forms of **precipitation**. Rainfall can provide much needed water in the ground by the process of **infiltration**, the process by which water seeps into the ground and eventually recharges our **groundwater,** water stored in the ground. Using the diagram above, you can also trace the flow of groundwater in some cases to both rivers, lakes, and even to the ocean.

Above ground, rainfall can also be stored on earth's surface in lakes. Precipitation in California also provides snow for snowpack, which can be our largest area of storage of water in the winter. In fact, it is common for water managers to view the snowpack in the Sierra as a reservoir; it is simply a seasonal reservoir that melts in the spring. Snowmelt runoff from the snowpack can fill streams and lakes. Runoff from rainfall is also captured in streams and lakes and can serve to recharge aquifers through percolation and infiltration.

The diagram also shows the key process of **evaporation**, or the process through which liquid water turns into a gas. Evaporation occurs over bodies of water like the ocean or lakes, but also over the land. If you own a home with a pool, you have probably noticed that if you leave the pool without a cover in the summer, you have to add water more often in the summer than in the winter. This is because the rate of evaporation is higher in the summer than the winter, often dramatically so.

Transpiration is the process through which plants lose water. This may seem like an inconsequential process, but it is the entire process that drives irrigation. In the diagram below you can follow the transpiration process. In Step 1, plants bring in moisture from the soil with their roots. Then, in Step 2, water travels up through the plant. In Step 3, water leaves through their pores or stomates (plural of stomatas) and enters the atmosphere again.

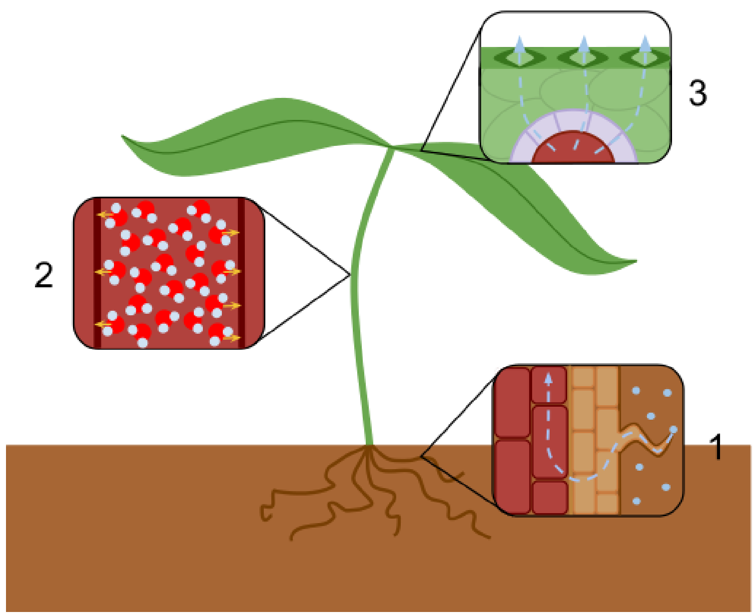

Figure 1.3: [Transpiration Overview](#) by Laurel Jules is licensed under [CC BY-SA 3.0](#)

The combination of water loss from liquid water in the ground evaporating and water in plants losing water is called **evapotranspiration (ET)**. Evapotranspiration is frequently used by scientists as a measurement of the plant water needs. If a location has a high ET, then the plant needs are greater than a location with a low ET.

Most locations in the state of California are close to a weather station that is part of the California Irrigation Management Information System (CIMIS) network. A CIMIS station measures a variety of variables in order to calculate the ET including: temperature, solar radiation, humidity, wind speed, and wind direction. With a complicated formula, the CIMIS station will calculate the ET for a specific geographic location. This information is frequently used to make a **water budget**, an estimate of how much water a location should use, including outdoor watering based on the amount of landscaping, the type of landscaping and the evapotranspiration.

Figure 1.4: CIMIS Station #204 (Photo used with permission of Castaic Lake Water Agency)

The monthly inches of ET data in the table for Santa Clarita reflects the water needs in terms of inches of water that grass would need to receive per month. You can see that the highest needs are in summer, primarily in July and August, with needs decreasing rapidly in September through December. Even though September is typically almost as hot as August, the days are shorter and the sun is less intense so the evapotranspiration is less in September than August. This means the plant needs for irrigation are significantly less.

Table 1.1: CIMIS Station #204 Santa Clarita - 2016 Evapotranspiration Data[1]

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly ET (in)	**1.97**	**4.80**	**4.51**	**5.24**	**5.77**	**7.77**	**8.99**	**8.13**	**6.30**	**4.68**	**3.40**	**2.69**

Knowledge of evapotranspiration has a practical application - in Southern California, many people find they can turn off their irrigation systems for grass in normal years from November through February and that their plants' water needs will be met with rainfall alone.

[1] California Irrigation Management Information System, www.cimis.water.ca.gov, monthly 2016 report for station #204 retrieved on 5/7/17

The opposite process of evaporation is **condensation**, the process through which water as a gas turns into liquid water again. Condensation is the process through which clouds form. This is also the process through which water beads on the outside of a glass of iced tea on a humid day or on a mirror in a steamy bathroom. In terms of the water supply picture, condensation is the key process that can lead to precipitation, so clouds are carefully monitored by scientists.

What makes the water cycle work? In short, gravity and the sun. Notice that there is always groundwater flow and streamflow from a higher altitude to a lower altitude. Gravity drives this flow of water in the water cycle, and is also a key force in most water distribution systems. If you're not using gravity, you're going to need a pump to go from a lower elevation to a higher elevation. Systems are generally designed to avoid pumps if possible and use the force of gravity. The sun drives the water cycle in a different way, by heating the water and causing it to evaporate. It also melts the snowpack in the mountains while gravity causes the water to flow into streams, rivers and lakes.

In Section 1.1, you've learned the basic processes in the water cycle: precipitation, infiltration, evaporation, transpiration, and condensation. Next, you'll see how these processes create surface and groundwater supplies and how these supplies are used for water management.

Try It!
Describe a process at work in each scenario and how the process works:

1. Analyze the effect on the water cycle if California had no precipitation for a year.
2. You hang a wet swimsuit out on the balcony to dry overnight. What process is at work? How is water changing states?
3. Using the CIMIS website (http://www.cimis.water.ca.gov/), register for an account (free). Then under the Data tab, find the nearest CIMIS station to your home create a monthly web report for 12 consecutive months, which should include ET. When should you water the most? When should you water the least?

Key Terms

- **condensation** – the process through which water as a gas turns into liquid water again; opposite of evaporation
- **evaporation** – the process through which liquid water turns into a gas; opposite of condensation
- **evapotranspiration** - The combination of water loss from liquid water in the ground evaporating and water in plants losing water
- **groundwater** – water stored in the ground
- **infiltration** – the process through which water seeps into the ground

- **precipitation** – All forms of water that fall from the sky, including rain, snow, hail and sleet
- **transpiration** – the process through which plants lose water
- **water budget** – an estimate of how much water a location should use, including outdoor watering based on the amount of landscaping, the type of landscaping and the evapotranspiration

SECTION 1.2 WATER MANAGEMENT CONCEPTS

Let's engage in a little thought experiment.

If a zombie apocalypse happened right now and you ran for the hills, you would have to find water to survive. How would you go about doing this? In this section, you'll identify sources of water supply. This section is critical to an understanding of water management, both personally as well as regionally and statewide.

LEARNING OBJECTIVES

After reading this section, you should be able to:

- describe various sources of surface and groundwater supply;
- give examples of water storage; and
- evaluate a situation in terms of conjunctive use.

Now back to the zombie apocalypse. If you had to find water, you would probably:

1. try to find a stream or lake; or/and
2. start digging a well

Notice that you didn't start with the ocean. This is important because most of us intuitively understand the amount of energy it takes to make ocean water drinkable. Although most of the water on earth is in the oceans, bays, and seas, it's not drinkable without expensive treatment. Who would have time for that level of treatment in the zombie apocalypse? And you also didn't start with the ice caps (too far and too many zombies in the way). What you have intuitively chosen is the right solution—surface water and groundwater. And your strategy reveals another challenge for water managers—most of the water on earth is not accessible or easily **potable** (drinkable).

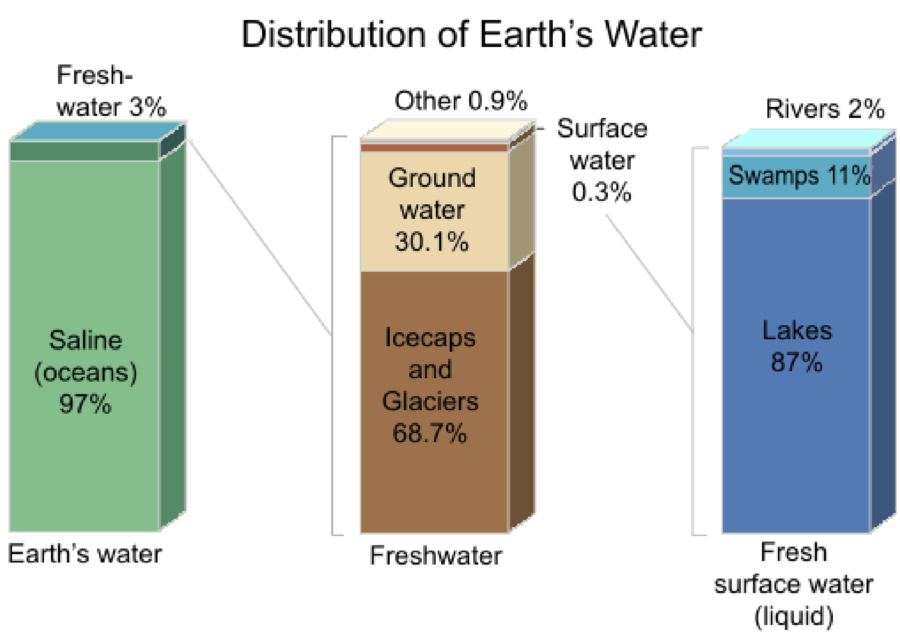

Figure 1.5: [Distribution of Earth's Water]() by the [U.S. Geological Survey]() is in the public domain

Most of the water on earth is in the ocean (97%). For the 3% that remains as fresh water, most of it is trapped in glaciers and ice caps (68.7%). That leaves only groundwater and surface water making up less than 1% of the water on earth. You can see why people refer to water as precious! In fact, 20% of all freshwater on earth is in one enormous lake in Russia, Lake Baikal, which is inaccessible to most of us on earth.

Surface water can be broken into different types, but it is easiest to think of surface water as either bodies of water and flowing water. Surface water can occur as a lake or pond, both bodies of water at low places in the land where water has accumulated. Most lakes have both inflow and outflow. Some lakes lack inflow and/or outflow and they become salty over time (e.g., Great Salt Lake, Dead Sea, Salton Sea). A **reservoir** is a lake that is man-made by making a dam across a river.

Surface water can be flowing water, such as a creek, stream, or river. It can also be water stored in a lake or reservoir. People tend to use the terms creek, stream or river interchangeably. Rivers (or streams or creeks) form when water moves from higher ground to lower ground. You'll remember that in the water cycle, gravity is a driving force—all water flows downhill. When water falls from the sky as rain in the water cycle, it may infiltrate into the ground, but it also may runoff and form creeks and streams. Eventually, many creeks, streams and rivers flow to the ocean.

As a source of water to drink, surface water has both benefits and drawbacks.

Table 1.2: Benefits and Drawbacks of Surface Water

Benefits of Surface Water	Drawbacks of Surface Water
• Easy to access • Lakes and reservoirs can provide flood control in addition to a water supply.	• Water is lost to evaporation. • Lakes and reservoirs may experience a build-up of sediment, especially after fires.[2] • Distribution requires a network of pipes and/or canals.

If surface water isn't the perfect supply, perhaps groundwater is better. In the diagram below, you can see both surface water and groundwater. The **water table** is the line at which soil becomes saturated with water. The soil above the water table is unsaturated and the water below the water table is saturated. Groundwater is stored in **aquifers**, which are areas underground of soil or rock that can hold and transmit water beneath the water table.

[2] County of Santa Barbara, *Santa Barbara Grand Jury Report, Lake Cachuma - Protecting a Valuable Resource, 2014-2015*

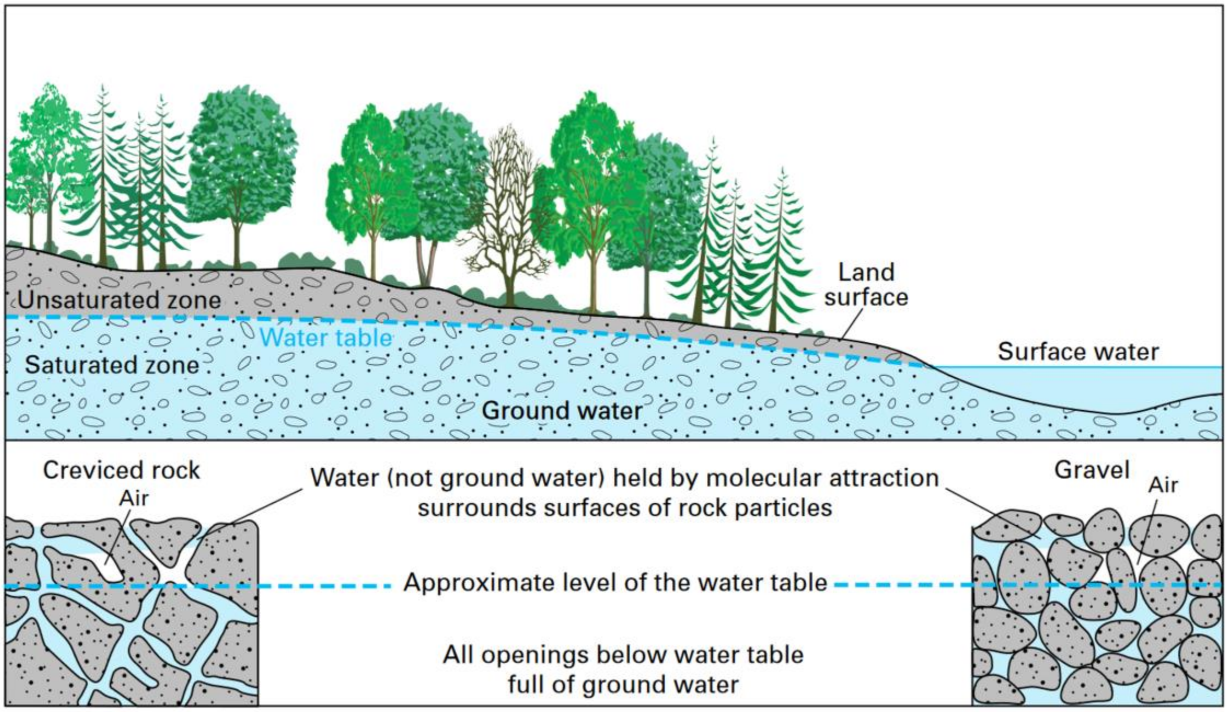

Figure 1.6: [Image]() by [USGS]() is in the public domain

Pin It! Misconception Alert
Frequently, people will describe an aquifer as an underground swimming pool. While this does illustrate the idea that water is stored underground, it is really misleading. A swimming pool contains water entirely without sediment. An aquifer is mostly sediment or rock with water in the pores between grains of rock or sediment.

Sediment and rock varies in terms of how much water it can store. The ability for rock to transmit media is often referred to as **permeability**. Sometimes gravel has large pores and rock has large connected fractures that enable water to move through them. Other times, the pores in gravel and the fractures in rock are impermeable.

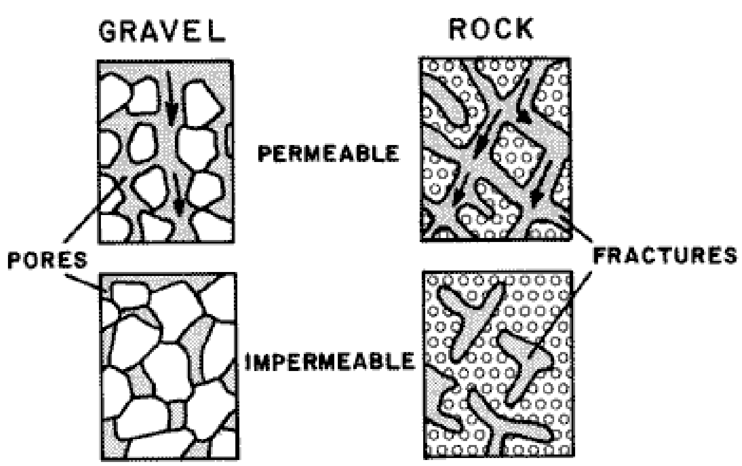

Figure 1.7: Image by [USGS]() is in the public domain

In order to get water from the aquifer to the surface, you need either the water to come up from the ground naturally because of pressure in the layers confining the aquifer or you need to drill a well, which is much more common. In the diagram below, you can see the difference between a deep well and a shallow well. When the water table is at a normal level, both the shallow and deep well can produce water. However, when it is a drought (a dry period) , only the deep well can reach below the water table. The shallow well would end up being dry.

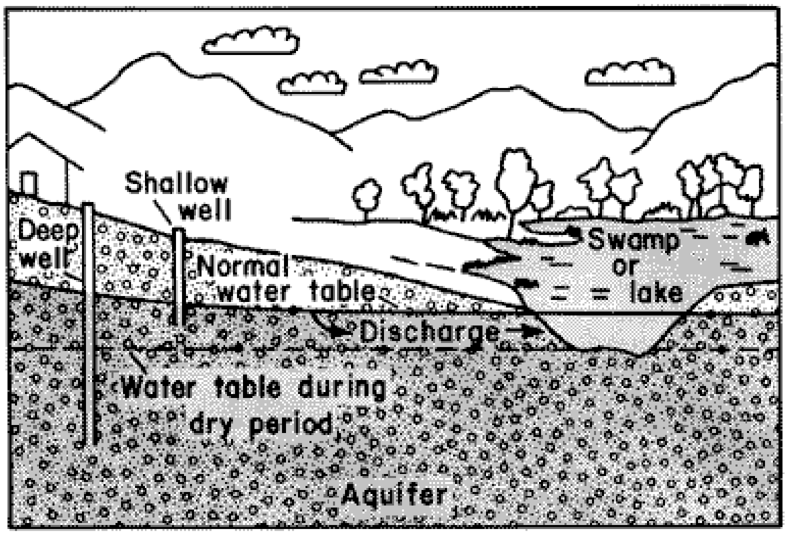

Figure 1.8: Image by USGS is in the public domain

Groundwater as a water supply also has benefits and drawbacks that communities consider when they build their water supply portfolio.

Table 1.3: Groundwater Benefits and Drawbacks

Groundwater Benefits	Groundwater Drawbacks
• Difficult to pollute • Useful in times of drought when surface supplies are low • Generally, cheaper • No need for an expensive network of pipes and canals to transport long distances	• Difficult to clean up • Replenishment is slow • Hard to manage as levels dwindle • Visual inspection is difficult

Some communities use both surface water and groundwater as a supply. In years of heavy snowfall and deep snowpack, there may be abundant surface water available. In this case, surface water would be used for water supply while groundwater supplies could be allowed to replenish naturally through infiltration of rainfall. In addition, surface water could be stored in groundwater basins to aid in replenishment. In the reverse situation, in years of light rainfall and little snowpack, groundwater would be relied on as a primary source because surface water was not a sufficient supply. The practice of alternating water supplies to meet the needs in a community is called **conjunctive use**.

Both surface water and groundwater can provide adequate yearly sources of water, but it is best to have water stored for use in dry years or for emergencies. Water can be stored above ground in reservoirs and below ground in banks. Storing water in reservoirs makes it readily accessible in times of drought or emergencies, such as fires or if part of a distribution system goes out of service. Storing water in the ground can be done in water banks, such as the banks in Kern County.

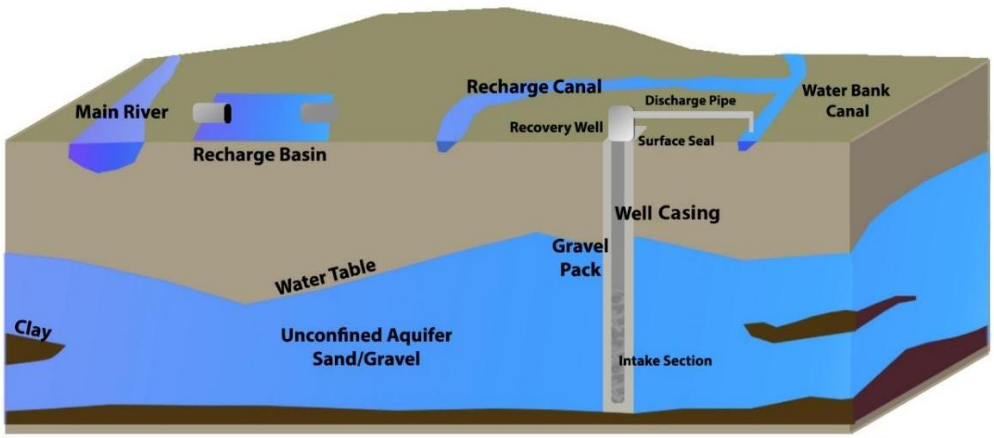

Figure 1.9: Water Bank Diagram by [Natalie Miller](#) is licensed under [CC BY 4.0](#)

In these banks, water is injected or infiltrates directly into an aquifer. It can be retrieved later for a fee during times when groundwater and surface water are not sufficient. Many water districts find that storing water in various water banks can diversify their water supply portfolio, giving them more flexibility in providing water in dry years.

How can you make your water supply more reliable? Think of the last drought. You probably noticed lower levels in surface water at lakes and reservoirs and even in streams. In the photo comparison, you can see the difference in just over a month's time in 2014 in the visible shoreline. In this example, more water has been taken from the reservoir to treatment facilities during the late spring in 2014 with a very visible effect on the appearance of the lake!

Figure 1.10: Images of Castaic Lake (Photo used with permission of [Castaic Lake Water Agency](#))

In California, typically, it is only through a combination of water supplies that you can have a reliable water supply. The best scenario is that you have a water supply that consists of multiple sources of groundwater and surface water. That way, when one source is dry or less reliable due to a drought or unusable due to a water quality issue, you have a backup. The ultimate scenario for water supply reliability also includes a supply of water in storage.

In Santa Clarita, there are multiple sources of water supply for the water retail companies. Sources of supply include relatively shallow groundwater wells into the **alluvium**, as well as deeper groundwater wells into the Saugus formation. While the shallower alluvial wells provide a source of relatively inexpensive supply, they also tend to be more sensitive to droughts. Imported water from the State Water Project makes up roughly 50% of the water supply in a normal year though the amount in this supply relies entirely on the snowpack in the Sierra Nevada Mountains.

During the last drought in Santa Clarita when water deliveries from the State Water Project were at a minimum, groundwater pumping was increased above normal year levels. When deliveries from the State Water Project returned to pre-drought levels in 2017, groundwater wells were pumped less in order to let the well levels recover. This is a classic example of conjunctive use that brings together what you've learned about groundwater and surface water because of the alternation of supplies in order to achieve greater reliability.

Now that you understand the concepts used to manage groundwater and surface water, let's take a look at water rights in California.

Try It!

1. Identify at least three potential sources of water that you could use during the zombie apocalypse.
2. Describe the drawbacks of surface water and groundwater.
3. Many communities in California rely on groundwater and surface water. Explain how conjunctive use might apply.

Key Terms

- **alluvium** – clay, silt, or gravel left from old rivers
- **aquifers** – areas underground of soil or rock that can hold and transmit water
- **conjunctive use** – use of alternating water supplies to meet the water demands
- **permeability** – the ability to transmit water
- **potable** – drinkable water
- **reservoir** – a lake that is man-made by making a dam across a river
- **surface water** – flowing water, such as a creek, stream, or river; also still river stored in a lake or reservoir
- **water table** – the line at which soil becomes saturated with water

SECTION 1.3 WATER RIGHTS

In order to understand the types of water rights that you'll find in California, you'll have to take a bit of a trip back in time, not just in California history, but in British history as well. You will be able to apply what you have learned about surface and groundwater.

LEARNING OBJECTIVES

After reading this section, you should be able to:

- distinguish between surface water and groundwater rights;
- describe types of water rights found in California; and
- analyze a situation involving water rights to determine which rights should prevail.

You probably recall that California was not always a state within the United States. For many years, it was a settlement of the Spanish government, and later, the Mexican government. Settlements of the Spanish and Mexican government have **pueblo rights** to both the surface and groundwater within the settlement limits. These rights are considered to have the highest priority compared to all other right types and cannot be lost.

The City of Los Angeles has exercised pueblo rights several times in its history, illustrating interesting features of pueblo rights:

1. A pueblo water right can increase in quantity as the population increases. As the population of Los Angeles has increased, the pueblo water right to flows of the Los Angeles River as well as to groundwater have increased in terms of quantity;
2. A pueblo water right can be extended to newly annexed areas of the original pueblo, such as when the City of Los Angeles annexed the San Fernando Valley.[3]

You can see how pueblo water rights are extremely encompassing and useful. Shifting continents for a moment, we will explore the idea of riparian rights. In English common law, a **riparian right** (riparian means "streamside") is the right to use surface water because you own property that is adjacent to it. This means that if you bought a home that was adjacent to a stream, you would have the right to use the water from it. You could only use the water that was naturally flowing from the stream, not water from upstream or downstream that you channeled into your land. If you lived one street further away and didn't own any property adjacent to the stream, you would have no riparian rights. Riparian rights are not quantified, so if you owned that house on the stream, you may only use as much water to make reasonable and beneficial use of it.[4]

[3]Arthur L. Littleworth and Eric L Garner. *California Water II*, (Point Arena: Solano Press Books, 2007) p. 80

[4] Ibid., p. 39

Table 1.4: Pueblo vs. Riparian Rights

Pueblo Rights	Riparian Rights
• Exist because of historical affiliation with Spain and Mexico • Can increase in quantity based on population or area annexed	• Exist because of streamside location • Not quantified • Only beneficial and reasonable use (not wasteful)

Now taking what you've learned about pueblo water rights and riparian rights, let's shift back to California to the mid-1800s when gold mining was thriving. An **appropriative right** stems from mining practices in which miners worked on public land using the water to dislodge soil to expose gold. Often, water had to be channeled a distance from its origin to where it was used. This was considered an appropriation of water. Miners literally posted a notice about their diversion of water to stake a claim to that water. Whereas riparian rights are not quantitative, an appropriative right is a specific amount of water for a specific purpose in a specific place. If there is not enough water for all appropriators, the ones with the older appropriations get their water first. [5]

Figure 1.11: Hydraulic mining in the 1880s in Nevada City, California (Hydraulic Gold Mining by Carlton Wakins is in the public domain)

The most famous legal case involving surface water rights is Lux v. Haggin (1886), which established the existence of both riparian rights and appropriative rights and the relationship between the types of rights. In this case, Haggin owned the upstream Kern Valley Land and Water Company, which diverted water for irrigation. Because Haggin did not own land that was adjacent to the water, he was exercising appropriative rights and not riparian rights. Miller-Lux owned downstream land that was adjacent to the Kern River and exercised riparian rights. During a drought, Haggin continued to use upstream water and cattle owned by Miller-Lux died

[5] Ibid., pp. 49-50

due to lack of available water. Miller-Lux sued Haggin. The primary question in this case was whether an upstream appropriator could divert water in a way that hurt a downstream holder of riparian rights. In a surprising outcome, the California Supreme Court ruled that appropriators (Haggin) could have senior rights if the rights were established prior to downstream riparian use.[6]

In Herminghaus v. Southern California Edison (1926), riparian and appropriative rights faced off again. Herminghaus was using riparian rights to irrigate by letting water from the San Joaquin River flood his crops. Southern California Edison wanted to build an upstream power plant using appropriative rights. The California Supreme Court ruled that downstream riparian use had the right to the entire flow of the San Joaquin River for flood irrigation. In other words, the California Supreme Court ruled that the downstream riparian right trumped the appropriative right, which meant Southern California Edison received no water rights.[7]

Currently appropriative rights are governed by a "first in time, first in right" philosophy and regulated by the State Water Resources Control Board. A "first in time, first in right" philosophy means that if you are using the water first, you have seniority in terms of water use. In times of water shortage, you will get your water first. Much like you saw in the previous court cases, you do not need to own the land in order to have an appropriative right to water. However, you do need to use the water in a reasonable and beneficial way with an appropriative right.

While surface water rights have hundreds of years of history, groundwater rights are relatively recent. Currently in California, the Sustainable Groundwater Management Act (SGMA) is driving management of groundwater in a much more deliberate fashion. While SGMA does not change groundwater rights, it will make big changes in how basins are managed. Basins in California have been ranked according to their priority for development of a groundwater management plan into high, medium, and low priority depending on level of overdraft. Basins with high ranking had plans due on January 31, 2020.[8]

SGMA was developed during a drought when people in disadvantaged communities in the San Joaquin Valley had wells going dry and were without drinking water. They had to rely on water deliveries to tanks outside their homes or on bottled water. At the same time, water demand as a result of permanent nut crops had increased substantially over the last twenty years. Governor Brown created SGMA as a way of forcing water agencies, cities and counties to regulate groundwater. Some parts of California will not be significantly changed by SGMA. Other parts, such as the San Joaquin Valley, will undergo significant changes in land use planning, which will most likely include shifting away from permanent nut crops.

Groundwater rights can be overlying or appropriative. Remember your streamside house? It had riparian rights to use water from the stream. You would also own **overlying rights**, the rights to drill a well and pump water to use water on your own land. If your neighbor behind

[6] Ibid., p. 40

[7] Ibid., p. 41

[8] California, California Groundwater, "Sustainable Groundwater Management," http://groundwater.ca.gov/ (accessed 8/6/17)

you wanted to pump water to take the water off of the land, he would be using appropriative rights. **Appropriative rights** in groundwater are similar to rights in surface water. “First in time, first in right” means that groundwater appropriators are evaluated in terms of when they started using the water.

Although groundwater and surface water rights have some of the same names, it is important to note that they are managed as if they are not related. For surface water rights, you can have pueblo water rights if the land was originally a Spanish or a Mexican settlement, riparian rights if you are using the water streamside and appropriative rights if you are using the water away from the source. For groundwater rights, you can have overlying rights or appropriative rights. And you can have **prescriptive rights** to groundwater if you essentially take water without someone’s permission, out in the open for five years! From studying the water cycle, you already understand that surface water and groundwater are related. It would make sense if their rights were connected rather than treated as separate entities.

Water rights are complicated. Sometimes when people or entities do not agree, water rights disputes end in adjudication. Adjudication is a process in which a judge makes a determination about how much water can be used. There is also a “water master” who tracks usage and may have enforcement capability. Most basins in Southern California are adjudicated.

Try It!

1. You own a home and would like to dig a well in the backyard. What type of water rights would be involved?
2. You would like to run a pipe from your neighbor’s creek to your home to engage in flood irrigation. What types of rights are involved? What issues might come up
3. When might you have a surge in water rights disputes?

Key Terms

- **appropriative right** – right to move water from its source; quantities for a specific purpose in a specific location; often called “first in time, first in right” rights
- **overlying rights** – groundwater rights for water underneath land
- **prescriptive rights** - groundwater rights to water in an overdrafted basin when water has been taken for at least five years without the ower objecting
- **pueblo rights** – rights that pueblos and settlements of the Spanish and Mexican government have for surface and groundwater rights; pueblo water rights can increase in quantity as population increases and can extended to newly annexed areas

SECTION 1.4 STAKEHOLDER CONCEPTS

Who are stakeholders in your water supply?

While you might immediately think of your water utility, city or county agencies, you are also a stakeholder in the water supply. You are a resident and you use the water in some fashion (e.g., drinking, cooking, cleaning yourself and clothes, irrigating, and swimming).

How much interest do you have in the water supply? And how much power do you wield in critical discussions about water?

LEARNING OBJECTIVES

After reading this section, you should be able to:

- identify and classify stakeholders; and
- differentiate among stakeholders according to the level of interest and the level of power.

Stakeholders are people with a "stake" in an idea or project. These could be people who are financially related to the idea or project, interested in the environmental impacts, or just plain curious. In many nationwide issues, like the presidential election, health insurance, or gasoline prices, all residents of the United States have a "stake." Some issues are much more regional, such as water supply issues or air pollution issues, in which residents in a smaller geographic area have a stake while some issues, such as health care, are nationwide issues

Stakeholders are typically classified as internal or external. An internal stakeholder is a person within an organization, such as a staff person or board member, while an external stakeholder is outside an organization. For example, suppose that staff was developing a "Cash for Grass" program at a water agency. Who would the stakeholders be? Here is a table of the internal and external stakeholders who have a "stake" in this sort of conservation program.

Table 1.5: Internal and External Stakeholders

Internal Stakeholders	External Stakeholders
• Staff at the water agency • Management at the water agency • Board members at the water agency	• Residents in the area • Landscapers (who install plant material) • Contractors (who install artificial turf) • Landscape designers/architects • Plant nurseries, hardware stores (e.g., Home Depot)

Why is it important to identify stakeholders and categorize them? As you work in the water industry, you will find that reaching out, listening to, and working with stakeholder groups is critical to your success. In the example above, what would happen if staff didn't reach out to contractors who install artificial turf? They might not install artificial turf according to the rules of the program. They might promise your rebate to their customers, but not explain the rules.

Let's take another example from the water industry. Have you ever had someone announce a big change at work without telling you first? How did you feel? Let's say the customer service manager decided to implement a new software program that sent work orders to field representatives. The customer service manager bought the software with her own manager's approval, but chose not to introduce customer service and field staff to the new product. Instead, the customer service manager rolled out the product at a meeting after the software was purchased. How do you think staff felt? They may have had valid concerns about the software, but the entire purchase was presented to them after the fact. The customer service manager should have identified her stakeholders, including internal stakeholders like customer service and field staff, ahead of time.

Stakeholders are people very specifically interested in an idea or concept whether it's artificial turf or work order software. Stakeholders are specific to the locale as well as the concept. For example, the City of Beverly Hills developed a cultural plan, which included an extensive list of stakeholder groups: residents, businesses, chamber of commerce, entertainment industry, faith-based communities, fashion community, financial sector, gay community, homeowners associations, Iranian community, lawyers associations, media, private galleries, restaurants, senior community, service clubs, and the tourist industry, including hotels and visitors.

A stakeholder list for a different issue in the same city would have different stakeholders. Let’s look at what would happen if we look at a different issue, like water supply reliability, and identify internal and external stakeholders in Beverly Hills. Stakeholders who were added to the list are in blue text. Many of the stakeholder groups that were interested in a cultural plan do not appear below because they may not be interested in water supply reliability.

Table 1.6: Internal and External Stakeholders for Water Supply Plan[9]

Internal Stakeholders for Water Supply Plan	External Stakeholders for Water Supply Plan
• City of Beverly Hills staff • City of Beverly Hills management • Beverly Hills City Manager • Beverly Hills City Council • Metropolitan Water District (wholesale supplier of water)	• Residents • Businesses • Chamber of Commerce • Environmental Groups • Homeowners’ Associations (HOAs) • Large Residential Users (A Top 100 List) • Media • Restaurants • Tourism & Hotel Industry • Visitors

[9] City of Beverly Hills, “Beverly Hills Cultural Plan” http://www.lacountyarts.org/UserFiles/File/Grants/Beverly_Hills_Cultural_Plan.pdf p. 12 (5/23/16)

The list is by no means all inclusive, but shows that there are some groups that will be constant in an area because they are powerful (HOAs, tourism & hotel industry, and restaurants) and some groups that are specific to an issue (e.g., Environmental Groups and Top 100 water users). This list is shorter and more focused on where the water is used.

Once you have identified your stakeholders, you can arrange them according to their level of interest and power.

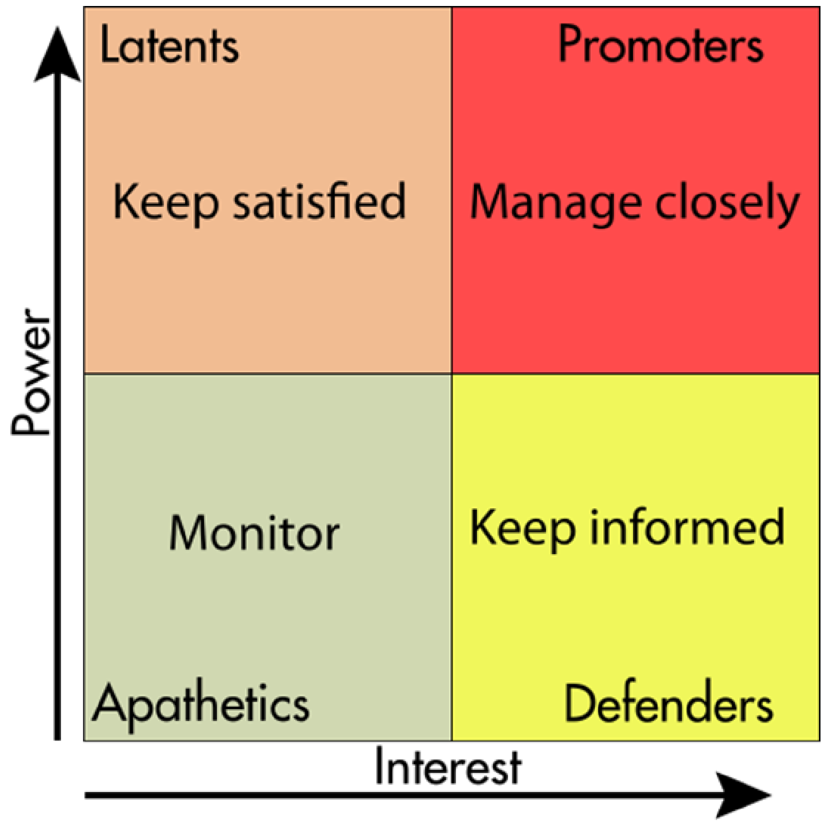

Figure 1.12: Power vs. Interest Chart (Image by Zirguezi is licensed under CC0 1.0)

In terms of water issues, most of the public, most of the time, unfortunately, has a relatively low level of interest and low level of power, which would classify them as Apathetics. But come drought time? You will have a much higher level of interest for most people and they will shift from the Apathetics to the Defenders. They may not have a high level of power, but their interest in water supply reliability is much higher.

Not everyone who is powerful is interested in all issues. For water supply, there are frequently groups that simply do not perceive water supply to be an issue, and choose to focus their energy elsewhere. They would be considered Latents ("latent" means that the interest is lying dormant, but could be expressed with the right circumstances). A Latent stakeholder might become more interested in water supply reliability if he/she were involved in a development that needed water, if there was a drought, or if there were mandatory watering schedules or penalties that affected his/her interests.

One of the most important issues in water supply management in the state of California is the challenge of the Sacramento-San Joaquin Bay Delta. Formed by the confluence of the Sacramento and the San Joaquin Rivers, the Bay Delta, south of Sacramento is the source of continual stakeholder challenges. Who are the stakeholders in the Bay Delta? At first, it seems obvious: there are residents and farmers who live and work in the Delta. While they are the most visible stakeholders, the water supply for much of Southern California flows through the Delta so Central Valley farmers and Southern Californians are also stakeholders (most Southern Californians would be Latents though until a crisis arises). Likewise, Northern Californians are stakeholders, because this is water that is leaving their area. Frequently discussions about the Bay Delta are framed around the strong interest and immense amounts of power that Southern California wields and the high interest, but low amounts of power that the farmers in the Bay Delta hold. We will discuss more about the Bay Delta in the section on the State Water Project.

You've learned about the importance of involving stakeholders and that stakeholders can be classified as internal or external and in terms of power and influence as well as interest. In Part Two of this text, you'll look at four major surface water development projects in terms of stakeholders.

Try It!

1. Identify a water-related issue in your area. Try typing into google "water issues" and the name of the community. Who are the stakeholders? Classify them as internal or external. Classify each stakeholder on a grid in terms of their interest and power.
2. In the water-related issue you chose above, what are ways (other than the drought) to increase the level of interest of stakeholders in the issue?
3. Add the stakeholders in the conservation program rule change scenario to a chart in terms of interest and power. Who has both a lot of interest and a lot of power? Who has neither interest nor power?

Key Terms

- **stakeholders** – people or organizations with a “stake” in an idea or concept

PART TWO: SUPPLY-SIDE MANAGEMENT

In Part Two of this text, we'll explore supply-side management. A supply-side management approach to water concentrates on securing more water supplies through engineering feats. Supply-side management was frequently done by building massive engineering projects to move water hundreds of miles. While they were impressive projects at the time, today, there are more significant regulatory hurdles to building supply-side projects, including environmental regulations. The difficulty of building major infrastructure projects has led to more work being done with exploring alternative supplies and reducing demand.

For a long time, human beings have related to nature as if nature was something to be conquered. In the United States, until the 1960s, the natural environment was viewed as mostly inconsequential to expansion and development. The environmental movement, beginning with the publication of Rachel Carson's *Silent Spring* in 1962 and continuing with the Cuyahoga River catching on fire due to pollution in 1969, began to change the way we viewed nature. Perhaps nature wasn't something to be vanquished as an enemy. Perhaps nature isn't limitless. As you examine four large public works projects in California, it is important to keep the shifting mentality of these times in mind. Each project was a feat to build at the time, and in some cases seen as a battle of man against nature. With current regulatory requirements, these projects would be just about impossible to build today.

In Part Two, we will cover these topics:

- Water Development Projects
    - Los Angeles Aqueduct
    - Colorado Aqueduct
    - Central Valley Project
    - State Water Project
- Alternative Water Sources
    - Recycled water
    - Gray water
    - Storm water
    - Desalination

WATER DEVELOPMENT PROJECTS

The primary challenge in water supply planning in California is usually framed as spatial. Most of the water is in the northern part of the state and most of the people live in the southern part of the state. In other words, the supply does not exist where the demand is. However, there is an additional challenge as well. Much of California receives water during the winter and early spring when the demands are the least, and not during the summer and fall when the demands are the greatest. This creates a temporal (time) challenge because the supply has to be stored until it is needed.

The map below shows the population centers in the Bay Area and Los Angeles Area as well as the volume of storage at various reservoirs throughout California. Notice how storage is concentrated in central and Northern California away from Southern California. This frames many of the water development projects.

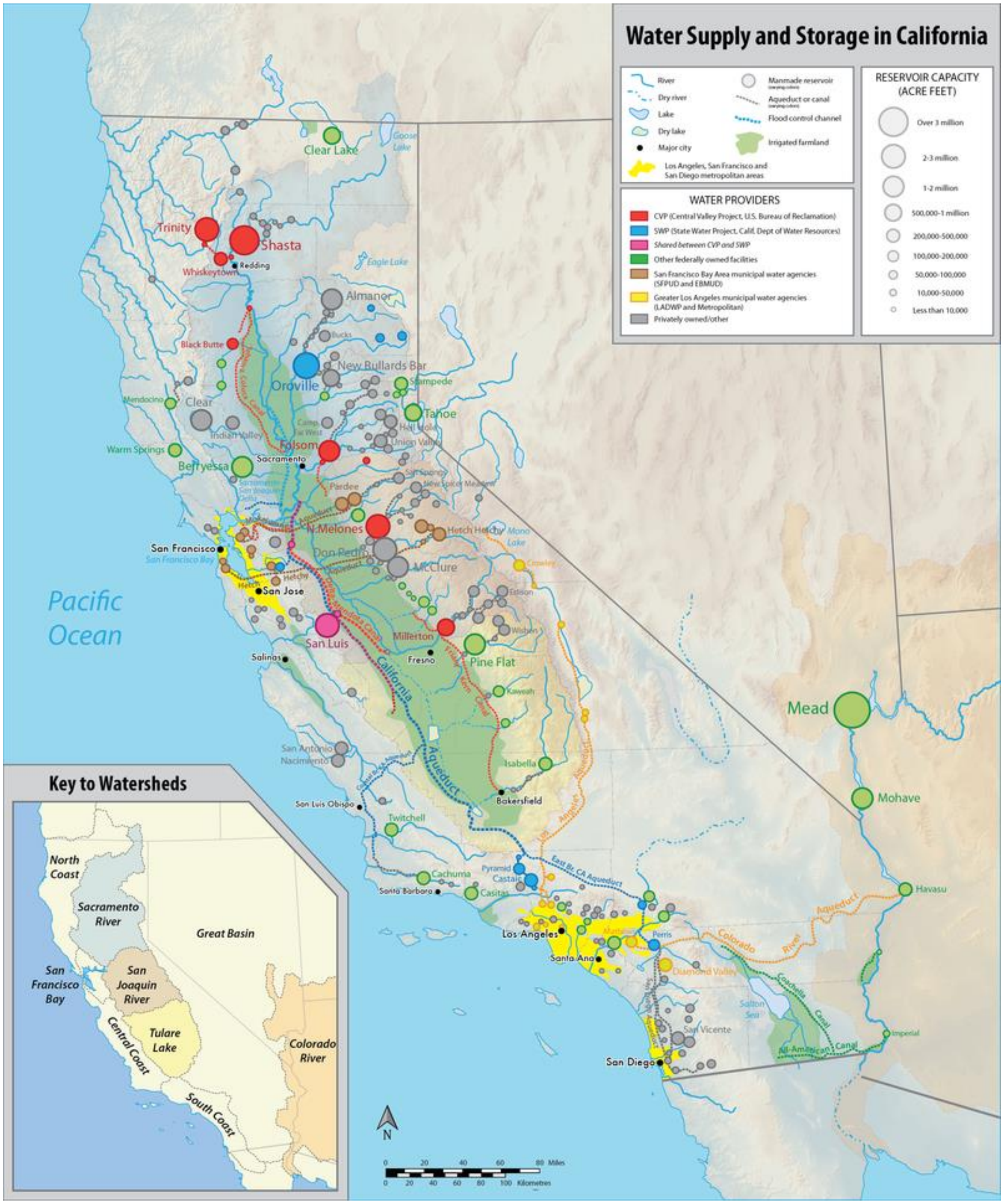

Figure 2.1: [Image](#) by [Shannon1](#) is licensed under [CC BY-SA 4.0](#)

SECTION 2.1 LOS ANGELES AQUEDUCT

LEARNING OBJECTIVES

After reading this section, you should be able to:

- identify driving factors in the construction of the Los Angeles Aqueduct;
- classify stakeholders in the construction of the Los Angeles Aqueduct; and
- evaluate the impacts of Decision 1631.

To understand current day Los Angeles, you need to understand the population explosion in the last two hundred years in the Los Angeles basin. Los Angeles was initially a Spanish pueblo when founded in 1781 and it had a small population. A combination of surface water from the Los Angeles River and groundwater from artesian springs remained sufficient supply for a long time. As you know, Los Angeles was entitled to these supplies of surface water and groundwater because of pueblo water rights.[10] While the supplies were sufficient for the existing population, the introduction of cattle ranching and citrus cultivation in the 1880s coupled with a drought resulted in strained water supplies.[11]

Now, imagine you are the superintendent of this water system within California, which has been reliable under current conditions, but is strained by more and more people.

Table 2.1: California Population from 1850 to 1900

Year	Population
1850	1,610
1860	4,385
1870	5,728
1880	11,183
1890	50,395
1900	102,479

Ack! Look at those population numbers! You're going to run out of water!

In 50 years, the population increased from just over fifteen hundred to over one hundred thousand people. This is the fix William Mulholland found himself in as superintendent of the water system: a burgeoning population and a dwindling water supply.[12] His friend and colleague, former mayor of Los Angeles, Fred Eaton, suggested the Owens River as a potential supply.

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[10] City of Los Angeles, Department of Water and Power, "The City Owns Its Water," https://www.ladwp.com/ladwp/faces/wcnav_externalId/a-w-fact-hist?_adf.ctrl-state=b73kdu4vf_4&_afrLoop=792998873720315 (accessed 5/18/16)

[11] Arthur L. Littleworth and Eric L. Garner, *California Water II* (Point Arena: Solano, 2007) p. 14

[12] City of Los Angeles, Department of Water and Power, "A New Supply," https://www.ladwp.com/ladwp/faces/wcnav_externalId/a-w-fact-hist?_adf.ctrl-state=b73kdu4vf_4&_afrLoop=792998873720315 (accessed 8/6/17)

The Owens River relied on snowmelt from the Sierras. In order to obtain the rights for the water, the land surrounding the river was purchased to obtain water rights. [13]

Figure 2.2: [Photographic portrait of William Mulholland with a surveyor's scope on a tripod](#) by University of Southern California Libraries and California Historical Society is in the public domain

Both Eaton and Mulholland were engineers. They were intrigued by the idea that the water could be conveyed entirely by gravity with a slight slope in the aqueduct from more than 3800 feet above sea level to 1400 feet above sea level. The energy from the water was even enough to generate electricity at a number of power plants that were built along the way. In many ways, their fascination with the engineering aspects of the project may have kept them from fully considering other ethical concerns as they orchestrated purchases of land in the Owens Valley.

Table 2.2: California Population from 1910 to 2010

Year	Population
1910	319,198
1920	576,673
1930	1,238,048
1940	1,504,277
1950	1,970,358
1960	2,479,015
1970	2,811,801
1980	2,968,579
1990	3,485,398
2000	3,694,742
2010	3,792,621

[13] City of Los Angeles, Department of Water and Power, "The Owens Valley is the Only Source," https://www.ladwp.com/ladwp/faces/wcnav_externalId/a-w-fact-hist?_adf.ctrl-state=b73kdu4vf_4&_afrLoop=792998873720315 (accessed 8/6/17)

Eaton and Mulholland certainly seemed to disregard stakeholders in this potential project. For example, the residents of the Owens Valley, including farmers, ranchers and the indigenous Paiute people, were certainly going to be impacted by directing the water to Southern California. These stakeholders, whose lives were dependent on the water, had very little power to mount a protest at the time. And, in fact, they generally were not asked for permission. The purchases of land in the Owens Valley were conducted in ways that seemed underhanded and non-transparent, including agents for the City of Los Angeles representing themselves as from the Bureau of Reclamation.[14] At the point when actual stakeholders in Southern California were brought in to fund and approve the project, the land was already purchased. This is a classic example of stakeholders not being consulted until the project is almost a *fait accompli*.

Even though Mulholland had found enough water for the existing population in Los Angeles, the population continued to grow. By 1923, Mulholland had explored the possibility of bringing water from the Colorado River as well as the second portion of the Los Angeles Aqueduct to Mono Lake. Both projects moved ahead because it was clear that the original Los Angeles Aqueduct was not enough.

And, in the end, even the second addition to the Los Angeles Aqueduct was not enough. The Los Angeles Aqueduct was completed in three parts:

1. Part One: 1913 - Los Angeles voted 10 to 1 to authorize $23 million for the first Los Angeles Aqueduct and it is subsequently built.[15]
2. Part Two: 1940 - Los Angeles votes to extend the Los Angeles Aqueduct to the Mono Lake watershed for $40 million and the extension is built.[16]
3. Part Three: 1963 - Los Angeles begins the construction of the second Los Angeles Aqueduct project[17]

In sum, using only gravity, the Los Angeles Aqueduct encompasses canals from the Mono Lake watershed to Los Angeles stretching over 340 miles in three separate projects.

While the Los Angeles Aqueduct provided a great benefit to the residents in Southern California, it left the Owens Valley a dust bowl, including carcinogenic dusts containing cadmium and nickel. After numerous years of protest and litigation, the State Water Resources Control Board in **Decision 1631** drastically reduced the amount of water that could be removed from the Owens Valley from 90,000 acre-feet per year (AFY) to 16,000 AFY. How did this happen? This decision applied the public trust doctrine in a new way. The public trust doctrine

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[14] City of Los Angeles, Department of Water and Power, "The Last Spike is Driven," https://www.ladwp.com/ladwp/faces/wcnav_externalId/a-w-fact-hist?_adf.ctrl-state=b73kdu4vf_4&_afrLoop=792998873720315 (accessed 8/6/17)

[15] City of Los Angeles, Department of Water and Power, "A Hundred or a Thousand Fold More Important," https://www.ladwp.com/ladwp/faces/wcnav_externalId/a-w-fact-hist?_adf.ctrl-state=b73kdu4vf_4&_afrLoop=792998873720315 (accessed 8/16/17)

[16] City of Los Angeles, Department of Water and Power, "The Mono Basin Project," https://www.ladwp.com/ladwp/faces/wcnav_externalId/a-w-fact-hist?_adf.ctrl-state=b73kdu4vf_4&_afrLoop=792998873720315 (accessed 5/18/16)

[17] City of Los Angeles, Department of Water and Power, "The Mono Basin Project," https://www.ladwp.com/ladwp/faces/wcnav_externalId/a-w-fact-hist?_adf.ctrl-state=b73kdu4vf_4&_afrLoop=792998873720315 (accessed 5/18/16)

addresses rights to things that are owned collectively for public use by the government, such as water and air. This interpretation allowed the water in the Owens Valley to be seen as a public resource and not something that could solely benefit Los Angeles.

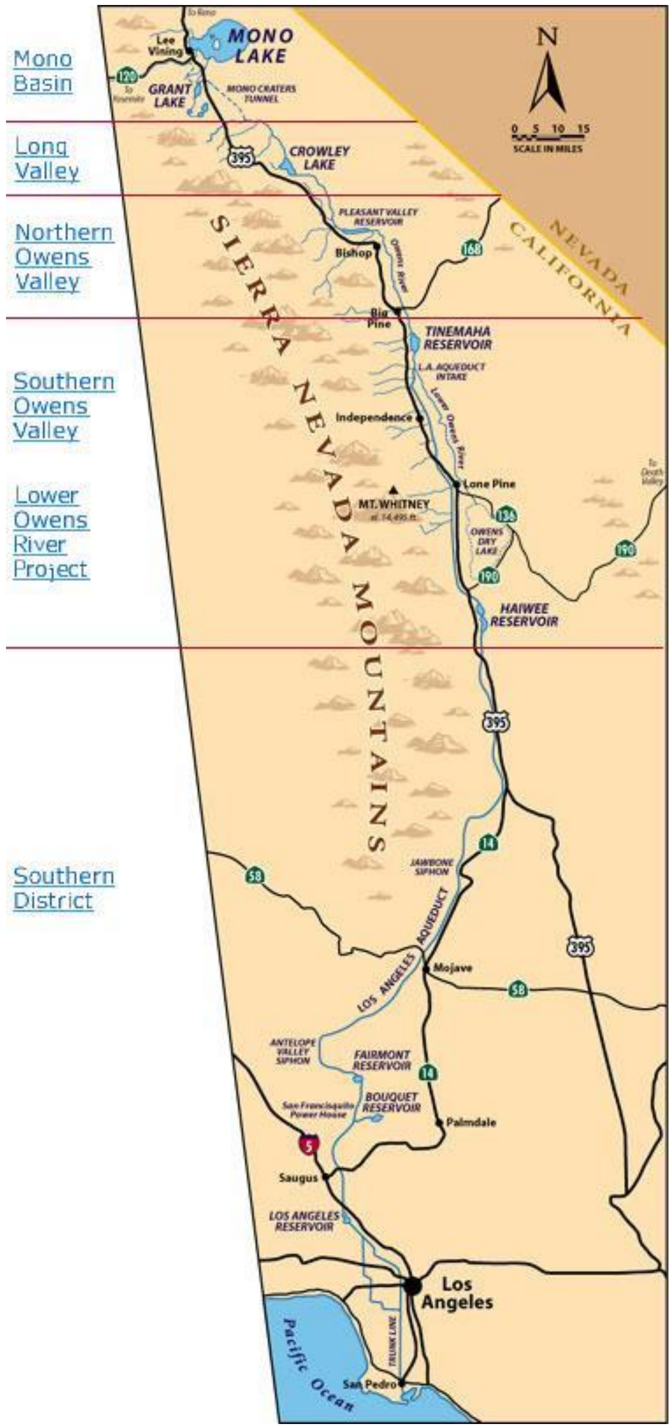

Figure 2.3: Los Angeles Aqueduct used with permission of Los Angeles Department of Water and Power

As a water supply, the Los Angeles Aqueduct provides water that is dependent on local hydrology within Owens Valley. Because of the variability and Decision 1631, Los Angeles has been forced to focus on demand reduction, rely more on alternate sources of water, such as those from Metropolitan Water District of Southern California, and remediation of existing groundwater supplies in the San Fernando Groundwater Basin.

Pin It! Misconception Alert

Many people think that all of the water supply in Los Angeles comes from the Owens Valley. As you saw in this section, only 16,000 AFY currently come through the Los Angeles Aqueduct. The rest of the supply is a matter of other imported water, including the Colorado River, as well as groundwater in the San Fernando Groundwater Basin.

Try It!

1. What were some of the drawbacks in removing water from the Owens Valley?
2. What were the effects of Decision 1631?
3. What stakeholders were not consulted in the development of the Los Angeles Aqueduct?

SECTION 2.2 CENTRAL VALLEY PROJECT

Figure 2.4: [Central Valley Project](#) by [Shannon1](#) is licensed under [CC BY-SA 4.0](#)

California's Central Valley is known as one of the most productive agricultural regions on earth, but it was not always this way. For a long time, the Central Valley was ranching country. And then it was farming country, but was farmed "dry," meaning without supplemental irrigation. It wasn't until the population influx in the 1850s with the gold miners and the development of a pump that there was a drive to make the Central Valley intensively agricultural. [18]

After decades of pumping water for irrigation in the Central Valley and a drought from 1928-1934, the Central Valley Project was conceived as a plan to ensure water supply reliability and protect it from floods. After reading this section, you should be able to:

- identify and critique the purposes of the Central Valley Project; and
- anticipate the future crises for the Central Valley Project.

The Central Valley typifies the challenge of California's water supply. Most of the rainfall occurs in five months, from December to April. There is enough rain to regularly produce flooding in these months. But when the needs of the plants are the greatest for food production (spring and summer), there is little natural rainfall. Pumping supplemental water made the groundwater levels drop significantly in the Central Valley causing subsidence. Diverting river flows for irrigation brought in the salt waters to the Sacramento-San Joaquin Bay Delta, which meant saltier water, sometimes unfit for irrigation, came inland. [19]

The state of California authorized the **California Central Valley Project Act of 1933** to sell bonds to fund the project. However, due to the Great Depression, the bonds didn't sell. The federal government took control of the project with the **Rivers and Harbors Act of 1935** and the project was finally approved in 1935 for construction by the federal Bureau of Reclamation, which eventually took over operation. [20]

The Central Valley Project was authorized with three key elements in its mission: flood control, water for irrigation and power generation. Water quality was added later to the mission as well as recreation and fish and wildlife enhancement.[21]

Although the Central Valley Project is the largest of the federal water reclamation projects and includes reservoirs capable of storing 11 million acre-feet of water, it has a fairly simple structure. Water is stored in Shasta Reservoir and Shasta Dam acts as flood control for the Sacramento River. The Trinity River supplements the Sacramento River. The San Joaquin River supplies areas south of the Delta. [22]

The Central Valley Project shares some facilities including San Luis Reservoir with the State Water Project. The photo below shows Shasta Dam, which is exclusively used by the Central Valley Project.

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[18] Littleworth and Garner, California Water II, p. 21

[19] U.S. Department of the Interior, Bureau of Reclamation, "Central Valley Project Overview," Eric A. Stene, Bureau of Reclamation http://www.usbr.gov/mp/cvp/docs/cvp-overview.pdf (accessed 8/6/17)

[20] Littleworth and Garner, California Water II, p. 22

[21] U.S. Department of the Interior, Bureau of Reclamation, Eric A. Stene. *Central Valley Project Overview*. Bureau of Reclamation http://www.usbr.gov/mp/cvp/docs/cvp-overview.pdf p. 8 (accessed 8/6/17)

[22] Littleworth and Garner, *California Water II*, p 23

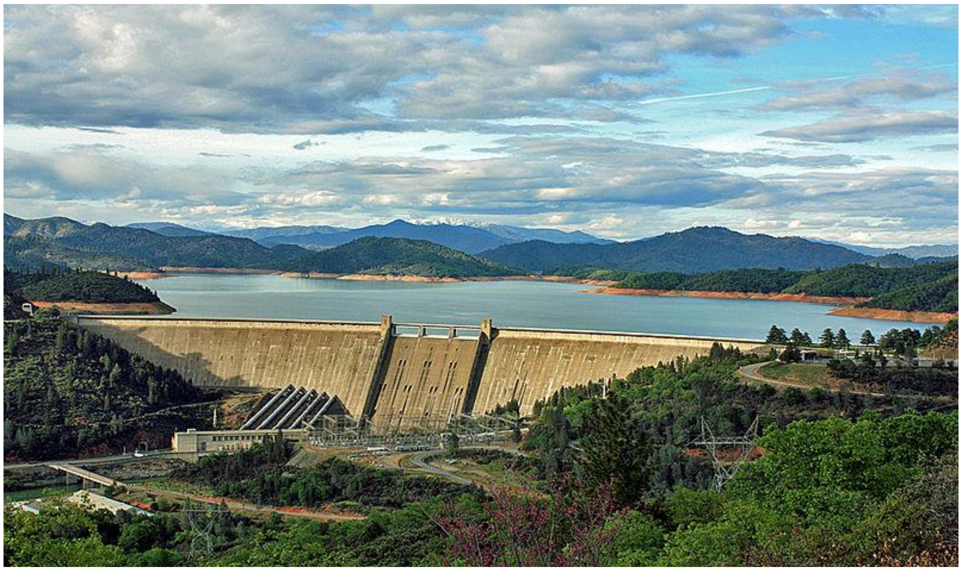

Figure 2.5: [Shasta Dam, California](#) by [Apaliwal](#) is licensed under [CC BY 3.0](#)

Pin It! Misconception Alert
Many people believe that Shasta Lake is part of the State Water Project. As you learned in this section, this is part of the Central Valley Project. The State Water Project has another larger reservoir that stores water in Northern California, Lake Oroville. These reservoirs are typically confused by many people.

The **Central Valley Project Improvement Act in 1992** allocated water for fishery restoration. This is similar to Decision 1631 in that a water development project was re-evaluated with current environmental norms. The allocation for fishery restoration is 800,00 AFY, which is perceived as enormous by some. This was a considerable change in the mission of the Central Valley Project from water supply reliability, irrigation and power generation to fish and wildlife enhancement.[23]

Try It!
1. Compare and contrast the Los Angeles Aqueduct and Central Valley Project.
2. Investigate potential challenges to the Central Valley Project in the future.

Key Terms

- **California Central Valley Project Act of 1933** – authorized by the state of California to sell bonds to fund the Central Valley Project. However, due to the Great Depression, the bonds didn't sell.

[23] U.S. Department of the Interior, Bureau of Reclamation, "Central Valley Project (CVP) Water Quantities for Delivery 2016," http://www.usbr.gov/mp/cvp-water/docs/5-9-16-1-cvp-water-quantities-only.pdf (accessed 5/20/16)

- **Central Valley Project Improvement Act in 1992** – allocated water for fishery restoration in the Central Valley Project
- **Rivers and Harbors Act of 1935** – authorized by the federal government to fund the Central Valley Project in 1935 for construction by the federal Bureau of Reclamation

SECTION 2.3 COLORADO RIVER AQUEDUCT

Metropolitan Water District was formed in 1928 with the explicit purpose of picking up on where the City of Los Angeles left off with the planning for the use of the Colorado River. The Colorado River Aqueduct was funded by voters three years later in 1931, begun in 1933 and completed in 1935. Water first began to flow in 1939. Even though this time frame is relatively short, the Colorado River Aqueduct was the result of a series of lengthy and heated negotiations, which we will now explore. Collectively the agreements that govern the Colorado River are known as **The Law of the River**.

LEARNING OBJECTIVES

After reading this section, you should be able to:

- differentiate among key agreements that are part of The Law of the River; and
- conjecture as to possible sources of future disagreement.

Figure 2.6: [Map of the Colorado River Aqueduct] by [Wikimedia Commons] is licensed under [CC BY-SA 3.0]

The primary tension with all Law of the River negotiations is similar to the tension in California: spatial. The water doesn't exist where the population centers are. But the geography of the Western United States is much more vast than just California. There are seven states considered to be within the Colorado River Basin: Wyoming, Colorado, Utah, New Mexico, Arizona, Nevada, and California. These are all primary stakeholders in the use of the Colorado River. The upper basin states include Wyoming, Colorado, Utah and New Mexico. Upper basin states were especially sparse in population and anticipated that they might need the Colorado River water at some point as their populations increased or industries like natural gas extraction grew, but they didn't have an immediate need for the water. The lower basin states included California, Arizona and Nevada, most of whom had burgeoning populations. The upper basin states were originally concerned that if the lower basin states constructed dams, including Hoover Dam, and began to use the Colorado River that under the doctrine of prior appropriation, the upper basin states would not be able to use the Colorado River's water

The first important agreement in The Law of the River is the **Colorado River Compact of 1922**, which divided the basin in half. Each basin had the right to use 7.5 MAF of water based on an average flow of the Colorado River of 18 million acre-feet per year, plus a small allocation to Mexico. While most states ratified this agreement, it took Arizona 22 years to ratify it, which is a window into the contentiousness. Arizona was greatly concerned about not receiving enough water eventually and of California taking water that Arizona was entitled to.[24]

The second important agreement in The Law of the River was the **Boulder Canyon Project Act of 1928**. Negotiations for this agreement lasted seven years, and including four bills being introduced and a filibuster. In this agreement, the lower basin was apportioned among the states:

- Arizona - 2.8 MAF
- California - 4.4 MAF
- Nevada - 0.3 MAF

The Secretary of the Interior was directed to function as the authority for water use in the lower basin, including the ability to commission studies on feasibility for dams and storage. [25] It is interesting to note how small the apportionment for Nevada is.

As a slightly less important agreement in the Law of the River, the California Seven Party Agreement of 1931 is an agreement for division of water among seven entities. The parties included Palo Verde Irrigation District, Yuma Project, Imperial Irrigation District, Coachella Valley Irrigation District, Metropolitan Water District, and the City and County of San Diego. This agreement temporarily settled longstanding disagreements between agricultural and urban users. [26]

The third important act in The Law of The River is an international treaty. In the **Mexican Water Treaty of 1944**, 1.5 MAF of the Colorado River flow were committed to be received in Mexico. While the amount was agreed upon, the quality of the water remained undetermined. Due to agricultural and urban use, the quality of the Colorado River becomes worse the further south the river flows. A desalting plant for removing salt was eventually built in Yuma, Arizona to increase the quality of the water released to Mexico.

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[24] U.S. Department of the Interior, Bureau of Reclamation, "Law of the River," http://www.usbr.gov/lc/region/g1000/lawofrvr.html (accessed 8/6/17)

[25] U.S. Department of the Interior, Bureau of Reclamation, "Boulder Canyon Project Compact," https://www.usbr.gov/lc/region/pao/pdfiles/bcpact.pdf (accessed 8/6/17)

[26] U.S. Department of the Interior, Bureau of Reclamation, "Law of the River," http://www.usbr.gov/lc/region/g1000/lawofrvr.html (accessed 8/6/17)

In the fourth important agreement in The Law of the River, the **Upper Colorado River Basin Act of 1948**, the upper Colorado River Commission was created and the Upper Basin was apportioned:

- Colorado - 51.75%
- New Mexico - 11.25%
- Utah - 23%
- Wyoming - 14%[27]

During the negotiations, it was noted that the originally agreed upon amount of 18 million acre-feet of normal flow for the Colorado River might be an overestimation and that agreements would be better done by percent rather than flat allocations of water.[28]

The Law of the River is a complicated set of agreements, and the previous pages only covered the major agreements. It should be clear that there will be issues of allocations, water rights, and urban v. agricultural differences for many years to come. Several recent modifications to the Law of the River were made because of droughts. In 2007, interim guidelines for allocating the Colorado River during water shortages through 2026 were signed by the Secretary of the Interior. Water shortages were determined based on the surface elevation of Lake Mead. In 2012, the United States and Mexico signed **Minute 319** that addressed how Mexico's allocation of 1.5 MAF would change in drought conditions also based on the surface elevation of Lake Mead.[29]

Try It!

1. What is the difference between the Upper Colorado Basin Act and the Boulder Canyon Project Act?
2. What is a likely source of disagreement in the future?

Key Terms

- **Boulder Canyon Project Act of 1928** – Apportioned the lower Colorado River basin among three states:
  - Arizona - 2.8 MAF
  - California - 4.4 MAF
  - Nevada - 0.3 MAF
- **Colorado River Compact of 1922** – which divided the basin in half; each basin had the right to use 7.5 MAF of water based on an average flow of the Colorado River of 18 million acre-feet per year, plus a small allocation to Mexico
- **The Law of the River** – collectively the laws and regulations that govern the Colorado River

[27] Ibid

[28] Ibid

[29] U.S. Department of the Interior, Bureau of Reclamation, "Interior Secretary Salazar and Reclamation Commissioner Connor Join U.S. and Mexico Delegations for Historic Colorado River Water Agreement Ceremony," http://www.usbr.gov/lc/region/feature/minute319.html (accessed 8/6/17)

- **Mexican Water Treaty of 1944** – committed 1.5 MAF of the Colorado River flow to Mexico; did not describe quality of water, just quantity
- **Minute 319** – an international agreement between the United States and Mexico regarding the Colorado River that addressed how Mexico's allocation of 1.5 MAF would change in drought conditions also based on the surface elevation of Lake Mead
- **Upper Colorado River Basin Act of 1948** – apportioned the Upper Colorado River Basin by percent:
    - Colorado - 51.75%
    - New Mexico - 11.25%
    - Utah - 23%
    - Wyoming - 14%

SECTION 2.4 STATE WATER PROJECT

The last major water infrastructure project undertaken for water supply in California was the State Water Project (SWP) and it still isn't quite finished! The SWP major features were outlined in 1957 in the California Water Plan and it was funded by the **Burns-Porter Act** in 1960 in $1.75 Billion in general obligation bonds.

LEARNING OBJECTIVES

After reading this section, you should be able to:

- identify the major stakeholder groups and their needs;
- analyze major threats to the Sacramento-San Joaquin Delta in terms of water supply; and
- project future impacts to the State Water Project.

The State Water Project is a massive infrastructure project that involves several major stakeholder groups throughout the state of California, all of which have been stakeholders in other water development projects that you've learned about:

- Northern California communities that wanted flood control protection (as a result of devastating floods on the Feather River in 1955);
- San Joaquin-Sacramento River Delta communities that wanted flood protection, but also access to high quality water for farming;
- San Joaquin farmers who wanted access to water for expansion of agriculture, but also because of groundwater overdraft issues; and
- Southern California residents who wanted water for future growth and for water supply reliability.[30]

The State Water Project brought together these stakeholder groups with a combined mission of providing water supply to the San Joaquin Valley farmers as well as Southern California.
The State Water Contract was among 32 public water agencies all over the state, including some agencies that formed specifically to contract for SWP water supplies. The terms of the contract were 75 years minimum or until the bonds were repaid. The State of California was obligated to make reasonable efforts to complete the project. The Contractors were obligated to pay even if the water supplies were reduced or the project was not complete. As you might guess, these aren't great contract terms (paying for a project that is incomplete or reduced in some way).[31]

The State Water Project had several purposes: flood control (specifically at Lake Oroville), recreation (e.g., Pyramid Lake, Castaic Lake) and water supply (including primary reservoirs at Oroville and San Luis and terminal reservoirs at Pyramid and Castaic Lake, Lake Perris and Lake De Val). Facilities to convey water through the Delta and for additional storage were not completed.

[30] California, Department of Water Resources, "History of California State Water Project," http://www.water.ca.gov/swp/history.cfm (accessed 8/6/17)

[31] California, "California State Water Project Overview," http://www.water.ca.gov/swp/ (accessed 8/6/17)

The Delta

The Sacramento-San Joaquin Delta (sometimes referred to only as “the Bay-Delta" or “the Delta”) is one of the most interesting places in California to study in terms of stakeholders, science and water supply.

In terms of stakeholders, the Delta is home to historic towns and family farms. Many farms are under sea level with manmade levees their only protection. The Delta is also fully used for recreation - boating, fishing, sightseeing, bird watching (and duck hunting). There are also millions of stakeholders south of the Delta that rely on the water supply that passes through the Delta. So combine various stakeholders with a location that is literally described as the “heart” of the water supply and you can see how there might be inherent conflicts.

Figure 2.7: Image of the [Sacramento-San Joaquin Bay-Delta]() by the [U.S. Geological Survey]() is in the public domain

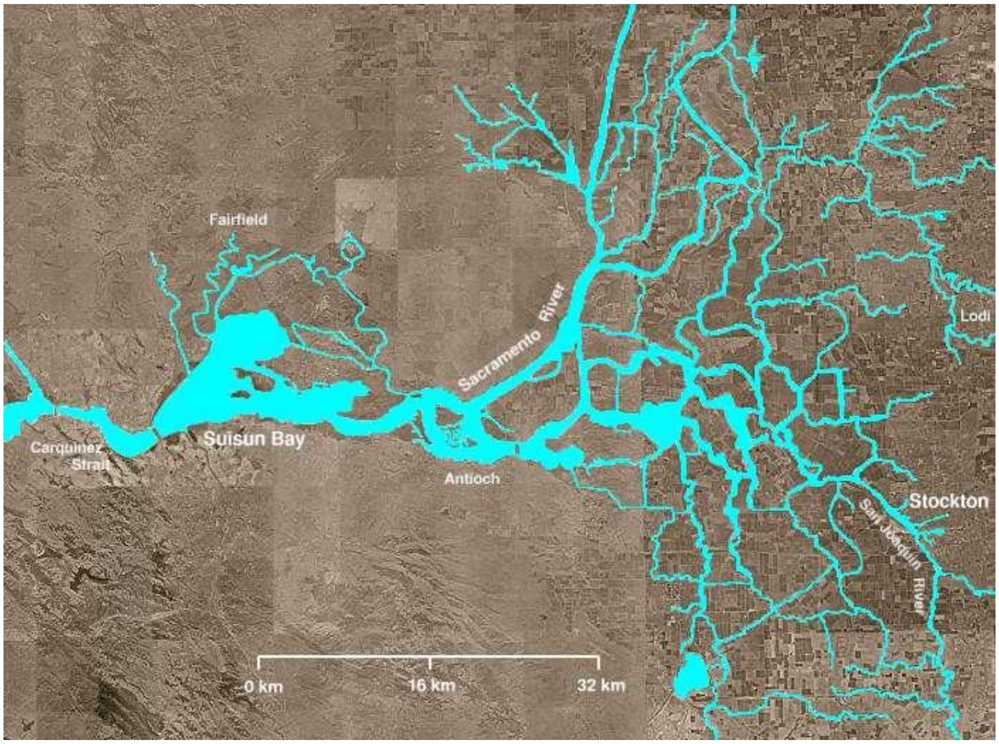

Figure 2.8: [Sacramento Delta]() by [Matthew Trump]() is licensed under [CC BY-SA 3.0]()

The Delta has been altered by farmers over the past 150 years and it has also been altered by the operation of the State Water Project and Central Valley Project. It is currently threatened by three primary issues:

Seismic - A large earthquake could break down the manmade levee system, allowing seawater into the Delta, and essentially making the water supply undrinkable for anyone south of the Delta.

Subsidence - Land within the Delta is made of peat soil, which is excellent for farming, but compacts and subsides over time, leading to levees sinking and needing to be repaired and strengthened.

Sea Level Rise - Sea level rise also threatens the Delta as there is often only a few feet between the top of the water and the top of the levee.[32]

The most likely path forward is a tunnel or tunnels under the Delta. two twin tunnels under the Delta. This is known as the California Water Fix (formerly known as the Bay Delta Conservation Plan).

Try It!

1. Identify three purposes of the State Water Project.
2. Write a letter advocating a plan to fix the Delta.

[32] Bay Delta Conservation Plan, “About the Problem,” http://baydeltaconservationplan.com/AboutTheDelta/AbouttheProblem.aspx (accessed 8/6/17)

Key Terms

- **Burns-Porter Act** – Funded the State Water Project in 1.75 billion in general obligation bonds in 1960

This table summarizes the four major infrastructure projects covered.

Table 2.3: Four Major Infrastructure Projects

Part of Project	Los Angeles Aqueduct	Central Valley Project	Colorado River Aqueduct	State Water Project
Purpose	Water supply reliability	Flood control Water for irrigation Power	Water supply	Water supply Flood control Irrigation for farms
Stakeholders	Southern California residents Owens Valley ranchers, farmers, Paiute tribe	San Joaquin Valley farmers	Wyoming, Colorado, Utah, New Mexico, Nevada, Arizona, California	Southern California residents San Joaquin Valley farmers Northern California communities with flood protection needs
Legislation	n/a	California Central Valley Project Act of 1933 Rivers and Harbors Act of 1935 Central Valley Project Improvement Act in 1992	All under The Law of The River: Colorado River compact of 1922 Boulder Canyon Project Act of 1948 Mexican Water Treaty of 1944 Upper Colorado River Basin Act of 1948 Minute 319	California Water Plan Burns-Porter Act
Major Features	Owens Lake Mono Lake	Lake Shasta San Luis Reservoir	Lake Powell Lake Mead	Lake Oroville San Luis Reservoir

SECTION 2.5 ALTERNATIVE WATER SUPPLIES

Alternative Water Supplies are supplies other than groundwater and surface water. Frequently, they are "reused" supplies, meaning they were potable water supplies that were captured for use individually or system wide after being used once.

Here are a few quick definitions to begin:

Table 2.6: Types of Water Supplies

Term	Definition
Recycled Water	Heavily treated wastewater that is used for irrigation, groundwater replenishment and as a subsurface barrier against seawater intrusion; typically in California, recycled water is used for irrigation
Gray water	Household wastewater, including water from the washing machine, shower, bathroom sinks, that is captured and reused, but excluding blackwater, which is water from toilets and kitchen sinks; commonly referred to as "lightly used" water
Storm water	Runoff from precipitation (rain or snowmelt) that flows overland; may mobilize pollutants and is better to capture on site to replenish groundwater
Desalinated Water	Ocean or brackish water that has had the salt removed to make it potable; two primary methods are used worldwide, but in the United States, reverse osmosis is most frequently used

After reading this section, you should be able to:

- analyze the water supply portfolio for several geographic locales in terms of the likelihood of adding an alternative water supply
- differentiate among types of alternative supplies and their appropriateness given different situations

Recycled Water

You may hear "recycled water" used in a variety of ways in the United States and abroad. In California, specifically, there is some confusion in terminology. Changes to a variety of codes occurred in 1995 when "recycled water" became the term of choice rather than "reclaimed water." These are essentially the same thing. Regulations for the level of treatment for various uses are in Title 22 of the California Code of Regulations. [33]

What happens to wastewater when it leaves your house? It travels through a series of larger and larger pipes to a wastewater treatment facility. Alternatively, if you live rurally, your wastewater may be held and separated in a septic tank on your own property. Wastewater that has undergone primary treatment has had the solids removed. Wastewater that has undergone

[33] Littleworth and Garner, *California Water II*, p. 276

secondary treatment has had organic materials removed through biological processes. Secondary treated wastewater can be used for groundwater recharge and irrigation. Water that has undergone tertiary treatment has undergone sedimentation, chemical flocculation and filtration. As you might imagine, water that has undergone tertiary treatment has a range of uses, even those involving body contact, such as recreational use in lakes, as well as irrigation.

Recycled water has only system-wide applications in that individual homes are not creating and using recycled water. You may be familiar with recycled water for irrigation of golf courses, medians, but it also can be used for groundwater recharge, including to act as a seawater intrusion barrier. Orange County Water District treats recycled water in a three step process of microfiltration, reverse osmosis and ultraviolet treatment. The treated water is then injected into the groundwater basin. The water serves as a barrier against the intrusion of ocean water into the aquifer. [34]

Recycled water seems like an important source to add to a water supply portfolio. After all, what community in California wouldn't want a reliable source of water for irrigation of landscapes? And what coastal community wouldn't want water to inject into the ground as a barrier of seawater intrusion. Overall, recycled water can decrease the demand for potable water by providing an addition to a water supply portfolio. But recycled water is expensive. Next to desalination, it is one of the most expensive options out there (think of the treatment costs!). Like many aspects of infrastructure, recycled water is politically appealing to residents, but the added costs are not.

Gray water

Certainly the water that you drink, wash your clothes in and use to bathe needs to be potable. But what about the water that you flush your toilets with? What about the water that you irrigate with? The premise of gray water use is that not all water that we use on a daily basis needs to be potable. Keeping this in mind, you then have to consider what can be reused in your indoor water use.

Wastewater from toilets and wastewater from the kitchen sink both contain bacteria from feces or meats. But wastewater from a washing machine can be reused without many concerns, assuming diapers are not washed or clothes are not highly soiled, greasy or contaminated.

The easiest gray water system to construct is called “Laundry to Landscape.” Wastewater from the washing machine is directed to a drip irrigation system outside the house. Water isn’t stored in any fashion - when you run a load of clothes in the wash, you are irrigating with the wastewater directly afterwards. You can see that you would need to time your laundry - washing everything on Sunday would lead to too much water for irrigation. Doing a load of wash every other day might be enough water for irrigation in the summer.

What do you need in order to have a simple Laundry to Landscape system?

[34] Orange County Water District, Groundwater Replenishment System http://www.ocwd.com/gwrs/ (accessed 4/8/16)

- Your washing machine should be located close to an exterior wall in order to run a pipe to the outside of the house;
- Your house should be slightly above the area that you are irrigating so you can use gravity to direct the water to the drip system and the plants without a pump (though pumps that remove water from washing machines can be powerful enough to move water some distance);
- You need to have plants that can be irrigated with drip irrigation (shrubs or trees); and
- You need to install a diverter valve at the washing machine that would allow especially dirty loads of laundry to drain toward the sewer or septic tank and not into your irrigation system.

Figure 2.9: Photo of a diverter valve by Stephanie Anagnoson is licensed under [CC BY 4.0]

There are more complicated gray water systems that involve storing gray water in tanks and using pumps and filters, but most gray water practitioners agree that simple is best.

City or county code may dictate how gray water can be used on your property. In California, typically using gray water for an irrigation system with drip irrigation is encouraged. Other uses are not.

Here are some best practices in residential gray water systems:
- Don’t store gray water.
- Minimize body contact with gray water.
- Allow gray water to infiltrate the soil with drip irrigation, not pool on the surface.
- Simple is better. Avoid pumps and filters.
- Install a diverter valve.
- Match needs of plants.

Please note that these are best practices, but not necessarily rules and regulations. Rules and regulations vary by city and county.

In a recent study of gray water systems in the Bay Area, it was noted that the most common problem in gray water systems was clogs, but this wasn't much of a surprise because most people reported performing no maintenance on the system. Plants were generally just as healthy as with a standard irrigation system and some were overwatered and some were under watered. Overall, people saw an average reduction in water use of 26%. There was at least one unintended consequence - with an abundance of water to irrigate, some people planted more plants and their irrigated area increased in size. [35]

There are a number of institutional hurdles to expanding gray water use. The primary hurdle is one related to the construction of homes: homes are plumbed with intermingled gray water and blackwater. This means that the wastewater from the entire home is treated as blackwater and sent to the sewer or septic tank. Additionally, if you check the city, county and state code related to graywater, they are frequently contradictory. California code, Title 24, Part 6, Chapter 16 a, Part 1 establishes minimum requirements for gray water regulations. Additionally, AB 849 (Gatto) prohibits local jurisdictions from banning gray water. However, a city or county may impose additional regulations so that it becomes too complicated to establish gray water in the home. Furthermore, as you can imagine, setting up a gray water system relies on a knowledge base of basic plumbing and wastewater. It is probably not an overstatement to say that most customers try not to think about this.

Pin It! Misconception Alert!
Many people use "gray water" to refer to all sorts of alternative supplies, including recycled water and stormwater. This is simply incorrect, but a common misuse of language. Gray water must be water from indoor use that can be reused, typically for irrigation. It is not wastewater or stormwater.

Stormwater

Picture the last rain storm that you remember in Southern California. Was there gentle rain for a long time? Or was there a short burst of rainfall? When there is an entire day (or even just an afternoon) of gentle rain, the rain is usually able to infiltrate into the ground, and eventually recharge the aquifers beneath the surface. But much of the rainfall that we receive in California is in bursts with heavy downpours and then days, weeks, and even years of nothing. This type of heavy rain results in a lot of run off. Stormwater is runoff that can be captured.

Stormwater becomes a problem when it encounters a lot of impervious surfaces, such as asphalt and concrete. These surfaces may hold visible pollutants (e.g., trash, dog poop) and invisible residues (e.g., pesticides, herbicides). When stormwater encounters impervious surfaces and pollutants, it turns can drain pollutants into storm drains and eventually the ocean.

[35] Laura Allen, "Greywater in the Real World: A Study of 83 Greywater Systems" (presentation made at Water Smart Innovations, Las Vegas, Nevada, October 2013). https://www.watersmartinnovations.com/documents/sessions/2013/2013-W-1335.pdf

What slows down stormwater? Vegetation and pervious surfaces. These sorts of textured surfaces allow water to infiltrate the soil. Parkways, the area in between the sidewalk and the street, can slow water from running off properties and into the street. Planter beds near downspouts can let water percolate rather than run into the street. Plants, whether shrubs, or groundcover, or even trees, can slow water down on slopes and hillsides.

What about rain barrels? Aren't they a good way to capture stormwater? Rain barrels are typically used on a residential site to capture water that comes off the roof through the rain gutters. In many parts of the country, rain barrels work well because the water needs of the plant correspond to the times when there are heavy rains. In much of California, the rainfall occurs in the cooler times of the year when the plant water needs are minimal. This means that water in a rain barrel must be stored for lengthy periods of time. And this is where we run into issues with creating the perfect habitat to breed mosquitoes - it’s still water available for irrigation, but it may be there for more than 4-7 days, which is all mosquitoes need to breed.

There are other (and better) ways to capture rainfall. On a small scale keeping vegetation on hillsides and parkways, directing downspouts to planter beds, and keeping lots of green plants will decrease stormwater run-off. On a larger scale, stormwater can be captured within a neighborhood. Several neighborhoods within Los Angeles are tackling this. Elmer Avenue in Los Angeles has a stormwater capture area as well as bioswales in te yards to slow run off. Much of the City of Fresno has largescale basins to catch stormwater. Catch basins with soft bottoms allow water to percolate into the groundwater rather than re-enter the stormwater system and get flushed into the ocean. [36]

Desalination

You may hear desalination or “desal” frequently touted as the solution to all water supply problems. You may wonder why there are not more desalination plants around if it is such the perfect solution. Good question—read on.

There are two primary methods of desalination: thermal and membrane. In thermal desalination, water is heated in a boiling chamber, it then condenses in a dome, and collects in a chamber leaving all the salt behind. In membrane desalination, seawater is screened, filtered, and pushed through a reverse osmosis membrane under high pressure, and then the distilled water is treated to drinking water standards. These methodologies aren’t that complicated, but they do tend to use large amounts of energy, leading to a high cost.

For both methods of desalination, there are similar hurdles:

- Seawater intake - Seawater needs to be removed from the ocean very carefully so as not to hurt plant and animal life. Typically, a speed slower than the ocean current is best.

[36] Amy Quinton, “Stormwater Capture: California’s Untapped Supply,” Capital Public Radio http://www.capradio.org/articles/2015/06/23/stormwater-capture-californias-untapped-supply/ (accessed 5/18/16)

- Power consumption – Typically, the reverse osmosis process uses the most energy, which contributes to the highest costs
- Brine - While brine can be returned to the ocean, most plants and animals thrive in a small range of salinities. There may be environmental consequences associated with creating areas of higher than normal salinity.

Santa Barbara, California, provides an interesting case study in desalination work. As a result of the drought in the 1980s, the City of Santa Barbara along with Montecito and Goleta constructed a desalination facility with a capacity of 7,500 acre feet per year (AFY) with expansion to 10,000 AFY. Construction costs of $34 million were shared based on proportions of water provided for the City of Santa Barbara of 3,181 AFY, Montecito of 1,250 AFY and Goleta of 3,069 AFY.[37]

By the time the desalination facility was built, the drought had ended and a period of heavy rainfall had begun. The plant operated for March, April, May and June of 1992 during and after a time of heavy rainfall. Then the desalination plant was put on standby. After it was paid off over 5 years, Goleta and Montecito decided not to renew the contract and subtracted desalination from their water supply portfolio.[38]

Santa Barbara has recently decided to re-activate the desalination plant as the sole funder of this enterprise. The facility will produce 3,125 acre-feet per year or roughly 30% of Santa Barbara's water supply in a year. In terms of hurdles, the intake is 2,500 feet off shore with openings of 1 millimeter and takes in water at a rate of 0.5 feet per second, which is slower than the existing current. Additionally, the power consumption for reverse osmosis has decreased by 40% since the facility was designed. [39] The brine has twice the salinity of seawater and will be discharged at an outfall shared with the wastewater treatment facility. A study was recently completed with Scripps Institute of Oceanography, which suggested the city can comply with discharge requirements. [40]

It probably goes without saying, but let's say it anyway: desalination is more appropriate for coastal communities, such as Santa Barbara, San Diego or Santa Cruz. For an inland community to fund desalination, the inland community would also be evaluating an expensive pipeline to transport water or negotiating a water exchange with a coastal community in order to avoid building the pipeline. Proximity to the source is everything in desalination.

[37] City of Santa Barbara, Public Works, “Desalination,” http://www.santabarbaraca.gov/gov/depts/pw/resources/system/sources/desalination.asp (accessed 5/15/17)

[38] Ibid, (accessed 5/15/17)

[39] City of Santa Barbara, "Desalination Facility Update " http://www.santabarbaraca.gov/civicax/filebank/blobdload.aspx?BlobID=170771 (accessed 5/15/17)

[40] Ibid, (accessed 5/15/17)

Table 2.7: Alternative Water Supply Descriptions

Alternative Supply	What is it?	What are the benefits?	What are the drawbacks?	System-wide Opportunities?
Desalinated water	Potable water that was ocean or brackish water that has the salt removed to make it potable	A drought-proof supply	Generally, the most expensive source of supply. Disposal of the brine can be problematic. High energy use.	Yes
Gray water	Non-potable household wastewater, including water from the washing machine, shower, bathroom sinks, that is held and reused; excludes blackwater, which is water from toilets and kitchen sinks	Cost-effective method for residential irrigation	Supply and demand must be balanced. Easy to end up with too much supply Water can contain pathogens.	No
Recycled water	Non-potable water that is treated wastewater that is used for irrigation, groundwater replenishment and as a barrier against seawater intrusion	Non-potable use of water; can recharge groundwater	Expensive; requires separate plumbing system of purple pipes	Yes
Stormwater	Non-potable water that is runoff from precipitation (rain or snowmelt) that flows overland; may mobilize pollutants	Can recharge groundwater	Must be captured, retained and allowed to percolate	Yes

Try It!

1. A coastal community in Southern California is considering diversifying their water supply with an alternative water supply. Which type of water supply is considered "drought-proof"? Why?
2. An inland community is looking for an alternative supply to use for recharge. Which type of supply (ies) make sense to use for recharge? Why?

Key Terms

- **desalinated water** – Potable water that was ocean or brackish water that has the salt removed to make it potable; considered a drought-proof supply
- **gray water** – Non-potable household wastewater, including water from the washing machine, shower, bathroom sinks, that is held and reused; excludes blackwater, which is water from toilets and kitchen sinks
- **recycled** – Non-potable water that is treated wastewater that is used for irrigation, groundwater replenishment and as a barrier against seawater intrusion
- **stormwater** – Non-potable water that is runoff from precipitation (rain or snowmelt) that flows overland; may mobilize pollutants

PART THREE: DEMAND-SIDE MANAGEMENT

In Part Three, you will shift from supply-side to demand-side management. When we manage the water demand, which is to say the water “need” or water “consumption” you tend to lessen the need for supply-side management. That is to say, if you can get people to need less water, you do not need to go out and find more water for them to use. In Part Three, we will cover:

- regulations that affect conservation in California
- water loss
- water rates
- indoor water use and conservation
- outside water use and conservation
- CII water use and conservation
- social marketing campaigns

Everything listed above addresses ways of decreasing demand for water, whether it is a regulation that mandates watering schedules, an aggressive leak detection program run by a water district, or higher water rates for higher consumption or toilet rebates.

There are many ways to control demand of water. One of the most effective ways is with regulation. This frequently isn’t what people want to hear, but between statewide legislation, statewide mandates from the State Water Resources Control Board and California Building Code requirements, demand was substantially regulated during the drought in California and continues to be regulated.

LEARNING OBJECTIVES

In this section, you will:

- analyze potential outcomes of the requirements of SBX7-7 and SGMA
- identify the prohibited measures by the State Water Resources Control Board
- interpret requirements of building codes in California for water conservation

SECTION 3.1 REGULATIONS

SBX7-7

For many years, urban water agencies conducted water conservation programs as public outreach. They often set goals of fairly minimal savings over long periods of time—in other words, goals that were easy to achieve. Rebates were intended to help people save water, but also make them feel good and appreciate the water agency at the same time. Meanwhile, water agencies often had their own revenues in mind. They did not want people to be wasteful with water, but they also calculated a certain demand in order to set rates. They did not want too much conservation without planning for a reduction in revenue.

Senate Bill X7-7 changed everything. In 2009, Governor Schwarzenegger signed into law SBX7-7, the Water Conservation Act of 2009, which required retail water suppliers to determine their baseline per capita water use and reduce water use by 20% of their baseline by 2020.[41]

What happens if a retail water supplier misses its target? Compliance with SBX7-7 determines eligibility for state water grants and loans. Failure to meet the target establishes a violation of law for administrative or judicial proceedings. This means a supplier wouldn't be eligible for many grants and loans that suppliers rely on to fund infrastructure, and could have legal actions taken against it.

At the same time that SBx7-7 became the law of the land, the drought and statewide messaging on conservation took over. Most, if not all, urban water agencies will make their goal. Many agencies expect that the new governor will increase the goal from 20% to higher.

State Water Resources Control Board Mandatory Measures

While SBX7-7 set a long-term goal of 20% by 2020, in July of 2014, mandatory measures from the State Water Resources Control Board (SWRCB) were enacted to combat the severity of the drought. The table on the next page walks you through the executive and regulatory decisions about the drought. You can see that the drought progressed and changes were made incrementally rather than all at one time.

Table 3.1: Mandatory Measures

Date	Measure
January 2014	Governor Brown declared a drought state of emergency.[42]
April 2014	Governor Brown signed an Executive Order (April 2014 Proclamation), which asked for reductions of 20% by all Californians with an emphasis on outdoor conservation. The order prohibited HOAs from punishing homeowners who limit their watering,[43]
July 2014	State Water Resource Control Board (SWRCB) asked for mandatory reductions with an emphasis on outdoor reductions.[44]
March 2015	SWRCB adopted an expanded mandatory emergency conservation regulation, which prohibited: • non-recirculating fountains

[41] California, Department of Water Resources, "SB X7-7," http://www.water.ca.gov/wateruseefficiency/sb7/ (accessed 6/11/17)

[42] California, Office of Edmund G. Brown, Junior, "Governor Brown Declares Drought State of Emergency," https://www.gov.ca.gov/news.php?id=18368 (accessed 5/18/17)

[43] California, Office of Edmund G. Brown, Junior, "Governor Brown Issues Executive Order to Redouble State Drought Actions," https://www.gov.ca.gov/news.php?id=18496 (accessed 6/18/17)

[44] California, State Water Resources Control Board, "State Water Board Approves Emergency Regulation To Ensure Agencies and Residences Increase Water Conservation," http://www.swrcb.ca.gov/press_room/press_releases/2014/pr071514.pdf (accessed 6/18/17)

Date	Measure
	• hosing sidewalks and driveways to clean • washing a car without a shut-off nozzle • run-off from over-irrigating Water suppliers are tasked with enforcement and ordered to report data monthly to the SWRCB.[45]
April 2015	Governor Brown directed the SWRCB to implement mandatory water reductions in urban areas to reduce urban use overall by 25% compared to 2013. Instructions to the SWRCB included considering relative per capita water usage of each supplier's service area and requiring areas with higher use to cut consumption more.[46]
May 2015	SWRCB adopted an emergency conservation regulation with residential gallons per capita per day (R-GPCD targets).
January 2016	Mandatory measures are extended through October 2016 with adjustments to R-GPCD possible for suppliers for climate and growth.
May 2016	Prohibited measures described above become permanent. Water suppliers are allowed to "self-certify" their conservation targets by analyzing their water demand (average of 2013 and 2014) and their water supply and using a target for any shortfall. [47]

So while SBX7-7 concentrated on long-term conservation goals compared to a baseline of total water production, the SWRCB mandatory measures concentrated on short-term conservation goals, particularly in the residential sector and particularly outdoors.

The goals (or targets) were widely criticized for not being fair. This is usually referred to as having "equity issues." While the SWRCB separated out commercial, industrial and institutional water use and concentrated strictly on a residential water reduction, it tended to penalize the water suppliers with higher per capita consumption with larger goals. Water suppliers with higher per capita consumption tended to be inland areas with higher water demand—meaning it was simply hotter inland and the plant water needs were much greater.

[45] California, State Water Resources Control Board, "State Water Board Expands and Extends Emergency Water Conservation Regulation," http://www.swrcb.ca.gov/press_room/press_releases/2015/pr031715_renewed_emergency_wtr_regs.pdf (accessed 7/8/17)

[46] California, Office of Edmund G. Brown, Junior, "Governor Brown Directs First Ever Statewide Mandatory Water Reductions," https://www.gov.ca.gov/news.php?id=18910 (accessed 7/8/17)

[47] California, State Water Resources Control Board, "State Water Resources Control Board Resolution 2015-0032," http://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2015/rs2015_0032.pdf (accessed 7/8/17)

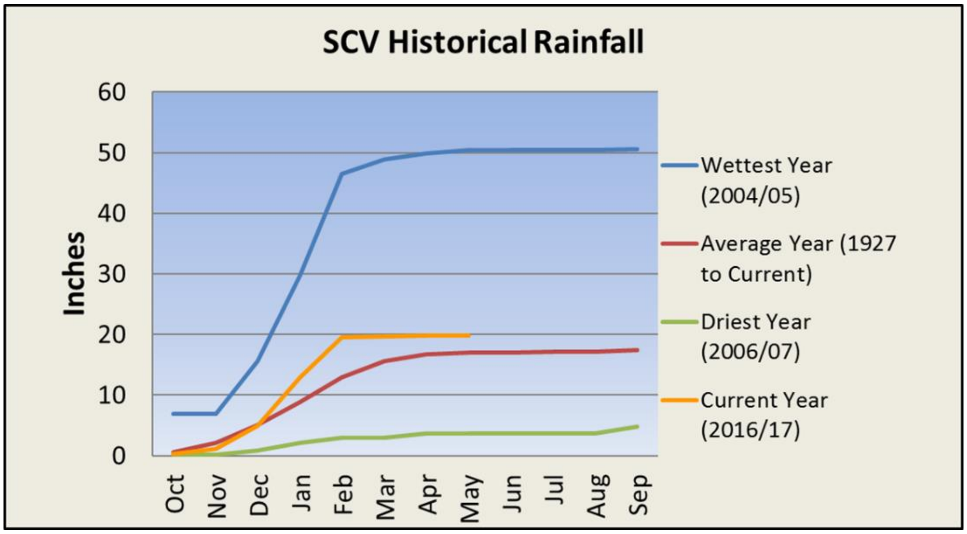

Figure 3.1: Used with permission of Castaic Lake Water Agency

And then the winter of 2017 was wet. In Northern California, it was unbelievably wet breaking records[48]. In Southern California, it was slightly wetter than average. In the Santa Clarita Valley, while it "felt" like a break from the drought, you can see that Water Year 16/17 (October 2016 – September 2017) was only slightly wetter than average with around 20 inches of rain for the entire year.

Is the drought over? Certainly if you rely on imported water from the State Water Project, there was plenty of water in 2017 imported from Northern California. But most Southern California communities that used groundwater still found their groundwater supplies below average and remained below average for years. For some parts of Southern California, including Ventura and Santa Barbara Counties, the drought was definitely not over. Looking at the graph above, would you say the drought was over in the Santa Clarita Valley?

As of this writing, the State Water Resources Control Board is implementing new targets by service area to include an indoor component, a landscape component, a water loss requirement and separate measures for commercial, industrial and institutional users. [49]

Sustainable Groundwater Management Act

The Sustainable Groundwater Management Act (SGMA) will also be responsible for reducing demand, primarily in the agricultural sector. Over the past thirty years, much of the Central Valley has changed land use types. While row crops (called “Field, Truck Crops” below) were typically favored and considered non-permanent, there has been a significant shift to permanent crops, including almonds and pistachios. The table below of crop type change over time in the Madera Subbasin is typical of what has occurred throughout the Central Valley.

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[48] "Janburied: Snow Breaks Records in Sierra Nevada," https://weather.com/news/weather/news/record-january-snow-sierra-mammoth-mountain-california (retrieved 7/8/17)

[49] California, Department of Water Resources. "Making Water Conservation a California Watery of Life," http://www.water.ca.gov/wateruseefficiency/conservation/docs/20170407_EO_B-37-16_Final_Report.pdf (retrieved 7/8/17)

Table 3.2: Crops and Acreage in the Madera Subbasin

Crop Type	1989 Acres	2015 Acres
Citrus and Subtropical	6,071	4,512
Corn	5,266	6,963
Grain and Hay Crops	5,548	9,118
Grapes	69,562	67,489
Idle	32,783	4,198
Field, Truck Crops	27,480	12,943
Almonds	21,797	75,006
Pistachios	14,169	27,189
Walnuts	1,180	1,157
Pasture and Alfalfa	30,069	7,581
Total	213,924	216,158

Although irrigation equipment has grown more efficient, the actual plant needs of the crops have increased substantially by replacing row crops with permanent crops. The total acreage that is irrigated hasn't necessarily changed, but much of the idle land has gone into permanent production, and the amount of almonds has almost quadrupled.

Building Codes

What type of regulations govern the building of a home? In terms of water use, how does a developer decide what type of toilet to use? Or aerators to install? Or landscaping to put in? These sorts of choices are governed by layers of codes, including city, county, state, and federal. In most instances, when there are overlapping standards, the most stringent apply.

Table 3.3: Cal Green Building Code (2016 with 2019 supplement) [50]

Indoors	Water Use
Toilets	1.28 gallons per flush
Showerheads	1.8 gallons per minute at 80 psi
Bathroom faucets	1.2 gallons at 60 psi
Kitchen faucets	1.8 gallons at 60 psi
Outdoor	n/a
Controllers	All controllers shall be weather-based or soil-moisture-based and shall have a rain shut off

All of the indoor devices listed above have a specific flow or flush rate. This is the rate from the manufacturer and may not be the rate in real life. Toilets, for example, leak over time, and may use more than 1.28 gallons per flush. Similarly, faucets have a rating at 60 pounds per square inch, but it is entirely possible to have more pressure inside a house, and use more water because of it.

Building codes are very useful in driving long-term demand downwards, primarily inside the home. In California; if there was a change to the code that forbid turf grass from being installed in new homes, demand could be driven down further outside rather than simply relying on controllers.

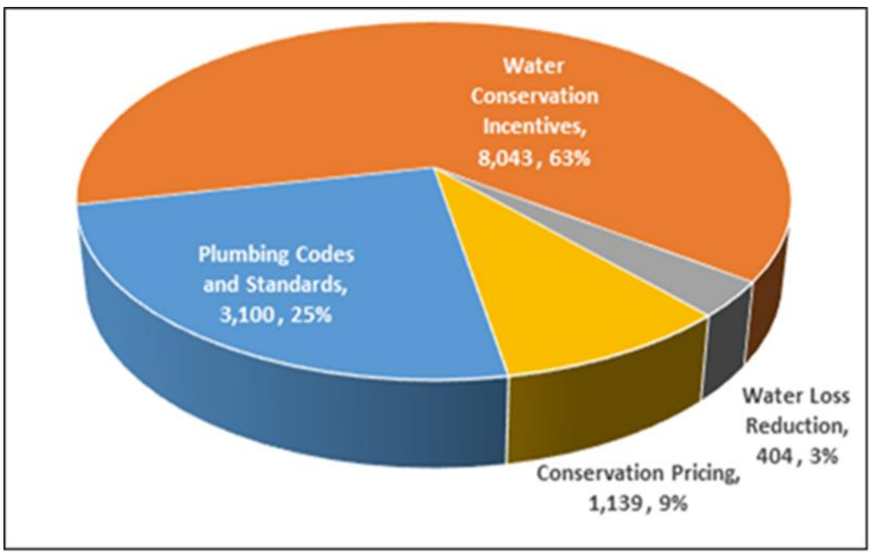

Figure 3.3: Image used with permission of [Castaic Lake Water Agency]

The graph above shows the savings in 2020 in the Santa Clarita Valley as a result of various measures, including incentives (rebates), plumbing code and standards, pricing and water loss

[50] California, Department of General Services, "2016 CalGreen Residential Mandatory Measures," https://codes.iccsafe.org/public/public/chapter/content/2057/?chapter_name=CHAPTER+4+-+RESIDENTIAL+MANDATORY+MEASURES(accessed 7/8/17)

reduction. Note that 9% of the savings are from conservation pricing and 25% of the savings are from plumbing codes and standards. These are powerful ways to drive demand down

Try It!

Conduct a quick inventory of a bathroom at home. What can you tell about the flow rate of these devices?

- Toilets: _____ gallons per flush
- Showerheads: _____ gallons per minute at 80 psi
- Bathroom faucets: _____ gallons at 60 psi

1. Which type of regulation (SBX7-7, SWRCB restrictions, or Building Code) do you think will result in the most savings over time?
2. Which measure prohibited by the SWRCB would be the most difficult for customers to prevent?

SECTION 3.2 WATER LOSS

If you were asked to picture water loss, you would probably think of a leak. Water is definitely lost through leaks. In this section, you will learn about types of leaks, but there are other ways systems lose water as well. As a general rule, you can estimate the amount of loss in a system by subtracting total consumption from total production.

LEARNING OBJECTIVES

After reading this section, you will

- differentiate among real losses;
- differentiate among apparent losses; and
- prioritize leak fixing.

Real losses include leaking pipes, joints, fittings; leaks from reservoirs and tanks; reservoir overflows, improperly open drains and system blow-offs. Real losses are typically used (in terms of a percent of total production) to show how efficient a water retailer is in managing its assets. You can think of real losses as three primary types:

Reported leaks - These are the most dramatic leaks that end up in the local newspaper. These have high flow rates, but a relatively short run time because they are reported. They can be disruptive to staff (Stop everything and fix this!) as well as the customer (Why don't I have any water?)

Unreported leaks - These are hidden underground. They may have low to moderate flow rates, and often very long run times. How would a utility find these leaks? They would need an active leak detection program of some sort or the leak would need to increase in flow to become noticed on the surface.

Background leakage - All systems have weeps and seeps. The flow rates are generally too small to be detected and not cost-effective to be fixed (until the leak escalates). [51]

Keep in mind that as much as customers like to have water under relatively high pressure delivered to their homes, and high pressure is necessary to make it up to the top of hills in your service area, high pressure systems are much more likely to leak than lower pressure systems.

Leaks are wasted water and money, but there are other consequences too. Wet areas may be liabilities for a water supplier and create a slippery surface or even a sink hole where people may get hurt.

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[51] Julian Thornton, Reinhard Sturm, and George Kunkel. *Water Loss Control*, Second Edition. (New York: McGraw Hill, 2008) pp. 20-21

Figure 3.4: Photo used with permission of Laura Miller Ginsberg (taken April 4, 2016)

Pin It! Misconception Alert
Many people think of real losses as the only type of losses. But there are losses that occur in all sorts of ways, which you'll learn about below. Imagine what has to happen from the meter read to the actual delivery of the bill. Inaccuracies can be introduced in any number of ways.

Real losses are not the only source of leaks; they are just the most obvious ones. Water can be lost because of under-recording customer meters or theft. These are considered **apparent losses**. With an apparent loss, water may not be actually lost from the system. You can think of apparent losses as stemming from these sources:

1. Customer metering inaccuracies - It is considered a best practice for all connections to be metered (though in some communities this is certainly not the case). Metering allows customers to make a connection between volume of water used and cost of water. It also provides information for water resource planners in terms of consumption trends. As meters age, they slow down. Without a meter replacement program, a water utility could easily be under billing based on customer metering inaccuracies.
2. Customer billing system errors and data handling errors - Think of the process to get information from the customer meter to the customer water bill - there are a number of steps, including the actual read of the meter and transfer of information into customer information system to billing. At any point in data transfer, an error can occur, but data errors can also be introduced in analysis if estimates are used or accounts are closed or not transferred between customers.
3. Unauthorized consumption - You would be surprised how much water is stolen! Yes, intentionally stolen! This could be an illegal opening of a fire hydrant, illegal connection or tampering with a meter. Some customers will reactivate their own

service connection after the service connection has been terminated for non-payment.[52]

As you can see, there are a half dozen ways a water utility can lose water. The biggest reason for recovering water lost through real and apparent losses is revenue. This is literally money that is lost, whether it is by a medium-sized leak underground, a broken main above ground, theft, or meter reading errors. Other than weeps and seeps, all of these losses can be fixed, and usually cost-effectively.

Try It!

1. W If a water agency tracks the difference between consumption (the sum of all meter reads) and production (the sum of all water pumped from the ground or imported), would the difference between consumption and production be real or apparent losses?
2. What is the relationship between pressure and leaks?
3. What might be an argument to implement a leak detection program?

Key Terms

- **Apparent losses** – losses from customer metering inaccuracies, customer billing system errors and inaccuracies, and unauthorized consumption (theft)
- **Background leakage** – weeps and seeps that have small flow rates and are not cost-effective to fix
- **Real losses** – leaking pipes, joints, fittings; leaks from reservoirs and tanks; reservoir overflows and improperly open drains and system blow offs
- **Reported leaks** – leaks that are reported with high flow rates, but short run times
- **Unreported leaks** – leaks that are most likely hidden underground with moderate flow rates and long run times

[52] Julian Thornton, Reinhard Sturm, and George Kunkel. *Water Loss Control*, Second Edition. (New York: McGraw Hill, 2008) pp. 25-29

SECTION 3.3 WATER RATES

Retail water suppliers generally include both a fixed and variable (volumetric) charge on a water bill. The fixed charge is the same for each month regardless of the water consumption because it is based on the size of the pipe coming in and the costs that remain the same for the water agency; the variable rate is volumetric and based on consumption (water use).

LEARNING OBJECTIVES

In this section, you will

- differentiate among types of water rates; and
- classify rates according to whether they encourage conservation.

You can look at the ways that water suppliers can organize a volumetric rate structure:

Table 3.4: Organization of a Volumetric Rate Structure

Type of Rate	Description	Benefits	Drawbacks
Uniform Rate	a constant unit price for all volumetric water sales	Simple and perceived as equitable; easy to implement (not a lot of math!); some revenue stability	Not much of a conservation signal
Declining Block Rates	the unit price for each block of water use is charged at a lower unit rate than the previous block	High-water users benefit from lower rates than in other structures	Perceptions of inequity, does not encourage conservation; complicated to design
Increasing Block Rates	the unit price for each block of water use is charged at a higher unit rate than the previous block	Encourages conservation	Perceptions of inequity; complicated to design
Seasonal Rates	the unit price varies by time period (generally a higher price during peak demand months)	Encourages conservation	Complicated to design and administer

The common wisdom is to encourage conservation, you need to make people aware of how much water they use, and increase the price as they use more. In this way, customers get a price signal to be conscious of their water use and are intentional about their water use and conserving.

You can see in the chart above, two rate types (uniform and declining block rates) do not encourage conservation. They actually could encourage an increase in demand. Why do these rate types exist? A uniform rate exists for one reason: equity (or perceptions of equity). A uniform rate treats the smallest customer and the largest customer exactly the same with the same volumetric rate. A declining block rate exists when the agency wants to increase water use, presumably by commercial and industrial users who would benefit.

Why not increase rates across the board to increase conservation? Rates are considered governed by **Proposition 218** and have to go through a public process that ties the rates to actual costs from the water retailer. In general, Proposition 218 is intended to make sure that additional taxes are brought to the public for a vote. In short, a water retailer cannot charge more than proportional costs of the water per parcel served. This means that the water retailer can't charge high fees just because it wants to decrease consumption overall. [53]

In the case of Capistrano Taxpayers Association v. City of San Juan Capistrano, the trial court decided that the City of San Juan Capistrano had not provided enough justification for their costs for the higher tiers. This has been interpreted by some as making tiered rates illegal, but this isn't really the case. Rate calculations need to be able to be justified by the cost of service. If it is costing a significant amount more to purchase an additional source of expensive supply because of high water users, these costs can be passed on to the high water users. But you can't simply charge high water users more because you want to decrease their consumption.

Pin It! Misconception Alert
Many people disregard the fixed charge on their bills and focus on the volumetric charges. While the volumetric charges are a measure of how much water is used, they may not actually be the bulk of the cost. Much of the cost may be in the fixed charge. There is just very little you can do about the fixed charge.

Try It!

1. Check out your water bill. How are you billed? Is there a fixed and volumetric rate? What type of rate is the volumetric rate?
2. What types of rates will encourage conservation? Why?

Key Terms

- **Declining block rates** – the unit price for each block of water is charged at a lower unit rate than the previous block
- **Increasing block rates** – the unit price for each block for water use is charged at a higher unit rate than the previous block

[53] California, Legislative Analyst's Office, "Understanding Prop 218," http://www.lao.ca.gov/1996/120196_prop_218/understanding_prop218_1296.html (accessed 5/25/16)

- **Proposition 218** – the legislation that governs the public process for rate setting. In general, Proposition 218 is intended to make sure that additional taxes are brought to the public for a vote.
- **Seasonal rates** – the unit price varies by time period, generally with a higher price during peak demand months
- **Uniform rates** – a constant unit price for all volumetric water sales

SECTION 3.4 INDOOR WATER USE

When you start to talk to people about conservation, they generally want to discuss ways of reducing their indoor water consumption, particularly bathing less. This is a problem - most of the water in the residential sector in California is used outside! And, frankly, no one in conservation wants to decrease basic hygiene of the general public. Still, indoor water use and conservation is not a bad place to start because it is a place people are very familiar with.

LEARNING OBJECTIVES

In this section, you will

- analyze indoor water consumption; and
- audit and track your own indoor water use.

In the graph below, based on data from residential homes, you can see that toilets are the biggest users of water in the home, followed by showers and faucets, and then clothes washers. Surprisingly, 14% of all water metered to the home is also lost to leaks. That puts an interesting spin letting a leaky faucet drip. It's using only a little less water than your faucets!

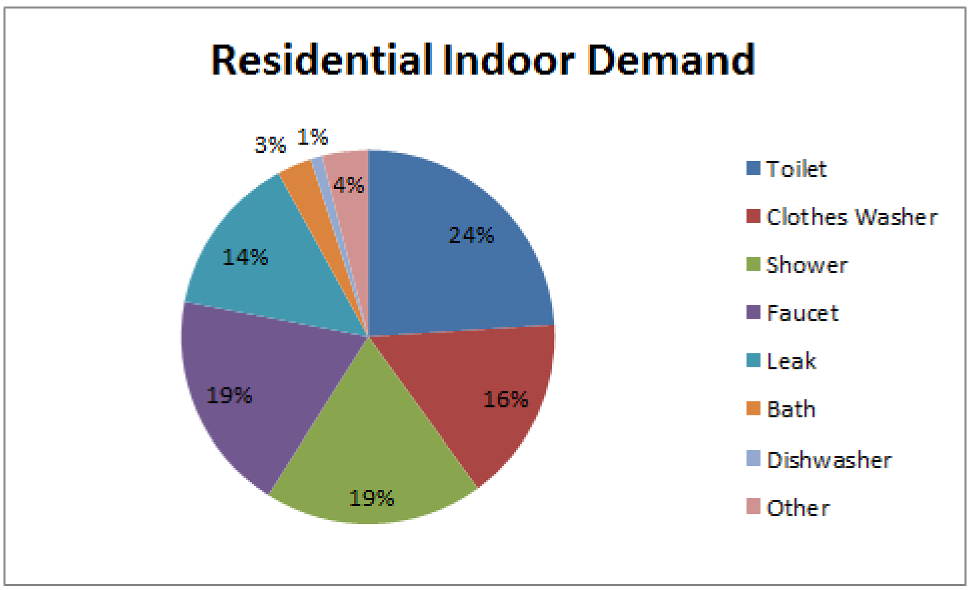

Figure 3.5: [Residential Indoor Demand](#) by the [EPA](#) is in the public domain

Let's return to our inventory of your bathroom fixtures. What did you discover when you inventoried your bathroom?

- Toilets: _____ gallons per flush
- Showerheads: _____ gallons per minute at 80 psi
- Bathroom faucets: _____ gallons at 60 psi

Toilets

How many gallons does your toilet use?

Sometimes it is difficult to tell how many gallons per flush a toilet has by observation. But if you remove the tank lid, often the number of gallons per flush is stamped somewhere on the inside of the tank at the top. In some toilets, you can also find the gallons per flush on the flat surface behind the seat lid. And, of course, in a store, the gallons per flush is written on the box. If you are browsing in a store, a toilet with the WaterSense label guarantees that the product is 1.28 gallons per flush. [54]

Figure 3.6: [Image](#) by the EPA is in the public domain

In the United States (as of 2017), you can purchase 1.6 gallon per flush toilets in most states, which is the federal standard, but in California, you can only purchase 1.28 gallon per flush toilets. This is 20% less water used per flush. (1.28 compared to 1.6). Yuck! you may say. That's not enough water. Actually, it's plenty. Some of us remember the early 1990s, which was the time "low-flush" (a.k.a. low-flow) toilets came on the market in California. These were the first toilets that used 1.6 gallons per flush. Unfortunately, most of them were not re-engineered from the 3.5 gallon per flush toilets of the previous generation. A 1.6 gallon per flush toilet was pretty much a 3.5 gallon per flush toilet with less water. And these did not work well. Water agencies up and down the state of California had to deal with angry customers who felt that the water agency rebate had "recommended" a toilet with poor performance. No one wants a repeat of this. The current 1.28 gallon and 1.6 gallon per flush toilets work well. To check the performance rating of your toilet, see map-testing.com for an entire database of toilet rankings.

Toilet-Related Conservation

Toilet rebates are a "classic" conservation program and a favorite of many in conservation. Why? The toilet stays in place for a long time. The savings are essentially "hard-wired" into the home. In this type of rebate program, a customer buys an approved product from a list, and the water agency gives a check or a credit on the bill after the purchase of the toilet. In order to receive the credit or check, the customer must present the receipt and purchase from the list. The approved list is important. It is a best practice to only rebate fixtures that are more efficient than what is standard in the market. Otherwise, you are essentially rebating for people to replace something with a fixture they would have purchased anyway. So if a high-efficiency toilet (1.28 gallons per flush) is on the market, customers shouldn't be rebated for purchasing it because you are not incentivizing an increase in efficiency. They should be rebated for purchasing an ultra-high-efficiency toilet (1.0 gallon per flush or less).

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[54] U.S. Environmental Protection Agency, WaterSense, "Toilets," http://www3.epa.gov/watersense/products/toilets.html (accessed 7/8/17)

Sometimes retail water suppliers will run a one-day toilet giveaway program. In this conservation program, people come to a central location, such as a big park, and pick up a new toilet after providing a driver's license for identification purposes and a water bill (with a matching name). They are allowed to take the toilet back home, but they must return two weeks later to drop off the old toilet to the park (in a giant dumpster) or they will be charged for the new toilet on their bill. This guarantees (almost!) that the new toilet is installed at the home in the service area. This is one model for success, but involves a lot of coordination and disposal of old toilets.

Pin It! Misconception Alert
You have probably heard, "If it's yellow, let it mellow. If it's brown, flush it down." Do not do this. Please keep flushing your toilets. This is advice from the 1980s when toilets used 3.5 gallons per flush or more. It wasn't bad advice then (though still sort of gross), but it's terrible advice now. Upgrade your old toilet with a 1.28 gallon per flush toilet and keep flushing. We don't want to keep waste in our homes, and if you have kids, it's a hard-to-break habit if they learn not to flush. Keep flushing!

Showerheads

It may be hard to tell how many gallons per minute a showerhead uses just by looking at it. Many showerheads are labeled with this information, but calcium and magnesium in hard water build up to obscure the numbers. In the United States, you can buy showerheads with up to a 2.5 gallons per minute rating, but in California, the only showerhead you can buy is 2.0 gallons per minute or less. To earn a WaterSense label, a showerhead would also need to use 2.0 gallons per minute or less.

Figure 3.7: [Shower Better image](#) by the [EPA](#) is in the public domain

Shower-Related Conservation

Many water agencies have giveaway programs with showerheads. One of the challenges with a giveaway program is that the water agency typically does not know that the product is installed properly (or installed at all). So the water agency may "count" on the savings from purchasing and distributing showerheads, but not necessarily receive the savings as a decrease in overall consumption.

Additionally, and equally problematic to conservation program design, showers are seen as "sacred" by many people. It's their "me" time and they do not want you to mess with their shower, including affecting the quality with a sub-par showerhead and length of shower.[55]

Washing Machines

A traditional style washing machine uses 40-50 gallons per load of laundry. That's a lot! A high-efficiency washing machine uses about half of that (20-25 gallons). That's a significant savings. But, of course, high-efficiency washing machines cost more - typically $200 more than a traditional machine (as of 2016). A high-efficiency machine typically soaks the clothes longer to remove stains and dirt rather than using a central agitator. The loads of wash may take longer in a high-efficiency machine.

Washing-Machine-related Conservation

Many water agencies operate washing machine rebates, which offer a rebate of $100-300 to make the purchase more cost-effective for consumers. Washing machines rebates have mostly replaced toilet rebates in popularity in California. While it's possible that a customer may receive the rebate and move out of the water agency's service area, it's also equally possible that a customer may move in with a high-efficiency machine already.

Figure 3.8: [Image of sink faucet](#) by the [EPA](#) is in the public domain

Faucets

A standard faucet purchased in the United States uses 2.2 gallons per minute. A WaterSense-approved faucet will use 1.5 gallons per minute. Aerators can be added to standard faucets to inject air into the water flow and make the flow seem fuller with less water.[56]

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[55] U.S. Environmental Protection Agency," Showerheads" http://www3.epa.gov/watersense/products/showerheads.html (accessed 5/26/16)

[56] U.S. Environmental Protection Agency, WaterSense, "Bathroom Sink Faucets," http://www3.epa.gov/watersense/products/bathroom_sink_faucets.html (accessed 5/26/16)

Faucet-related Conservation

Aerators are typically available at water agencies for free and are given away at events. As with showerheads, aerators are difficult to track and impossible to make sure they are installed properly. They can also present problems in giveaway programs in that customers may need a male or female threaded aerator, but take one of each to hedge their bets.

Audits

Do you remember the table where you quantified your measurements of indoor fixtures? An "audit" is really an extension of that exercise. You make a list of all the water-using fixtures in the house, quantify their use, decide on a number of times per day, and come up with a total. Completing the table below will help you audit your own home.

Try It!
Complete the table below to audit your own home (indoor water use).

- In what category is the most water used per day?
- What could you do to save the most water in your home?

Bathrooms	Amount of Water Used per Use	Times Used per Day	Total Water Used per Day by Device
Toilet #1	______ gallons per flush		
Toilet #2	______ gallons per flush		
Toilet #3	______ gallons per flush		
Showerhead #1	______ gallons per minute		
Showerhead #2	______ gallons per minute		
Showerhead #3	______ gallons per minute		
Bathroom faucet #1	______ gallons per minute		
Bathroom faucet #2	______ gallons per minute		
Bathroom faucet #3	______ gallons per minute		
Kitchen			
Kitchen faucet	______ gallons per minute		
Dishwasher	______ gallons per use		
Other Water Using Devices			
Total Water Used Per Day			________________

SECTION 3.5 OUTDOOR WATER USE

How much water is used outdoors? Most estimates for outdoor water use in the United States suggest that it is more than 50% of all water used for residential use.[57] In general, the hotter the locale, the more water is used for landscaping.

LEARNING OBJECTIVES

In this section, you will:

- identify the benefits and needs of landscape;
- differentiate among types of irrigation;
- classify plants according to their watering needs; and
- design a landscape with best practices in mind.

Why don't we get rid of all the landscape, cover the ground with cement, and save all that water? Landscape serves a variety of purposes, and is considered a beneficial use of water. After all, plants make oxygen, and we love oxygen. Plants also lower the air temperature. An entirely paved landscape would be a hot one - check out the center of a parking lot in the summer. And soil acts as a giant sponge, absorbing and filtering water, which eventually allows for aquifers to replenish. So, keeping landscape is a given, and acknowledging that live plants in the landscapes need water is important. However, choosing a waterwise landscape and giving it just the water it needs is essential.

Couldn't all of our irrigation problems be solved if we saved the rainwater that falls from the sky? Doesn't that just go to waste if it runs into the ocean? We do save it in both surface reservoirs and in groundwater aquifers. Water isn't wasted if it infiltrates. And even when it runs into the ocean, it is still part of the water cycle.

Sometimes, rain barrels are presented as the perfect solution to irrigating landscape. However, rain barrels bring with them a host (no pun intended) of other problems, including providing the perfect breeding ground for mosquitoes. We are poised on having a worldwide explosion of babies with microcephaly, caused by the Zika virus, which is spread by mosquitoes.

Additionally, mosquitoes spread the West Nile Virus, and a number of locations in Southern California, including Santa Clarita, are "hot spots" for the disease. It is almost impossible to mosquito-proof a rain barrel—mosquitoes will enter that smallest opening to lay eggs in water. This makes rain barrels perfect for breeding mosquitoes, and not for saving water.

Setting mosquitoes aside, why wouldn't rain barrels help save water? In Southern California, most of the rainfall occurs when the plant water needs are the least. Rain barrels may be a good solution in places like Arizona and New Mexico, which get summer monsoonal storms when the water needs for plants are the greatest. In California, our storm season generally lasts from November through February when the plant water needs are the least.

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[57] U.S. Environmental Protection Agency, WaterSense, "Outdoor Water Use in the United States," https://www3.epa.gov/watersense/pubs/outdoor.html (accessed 5/22/16)

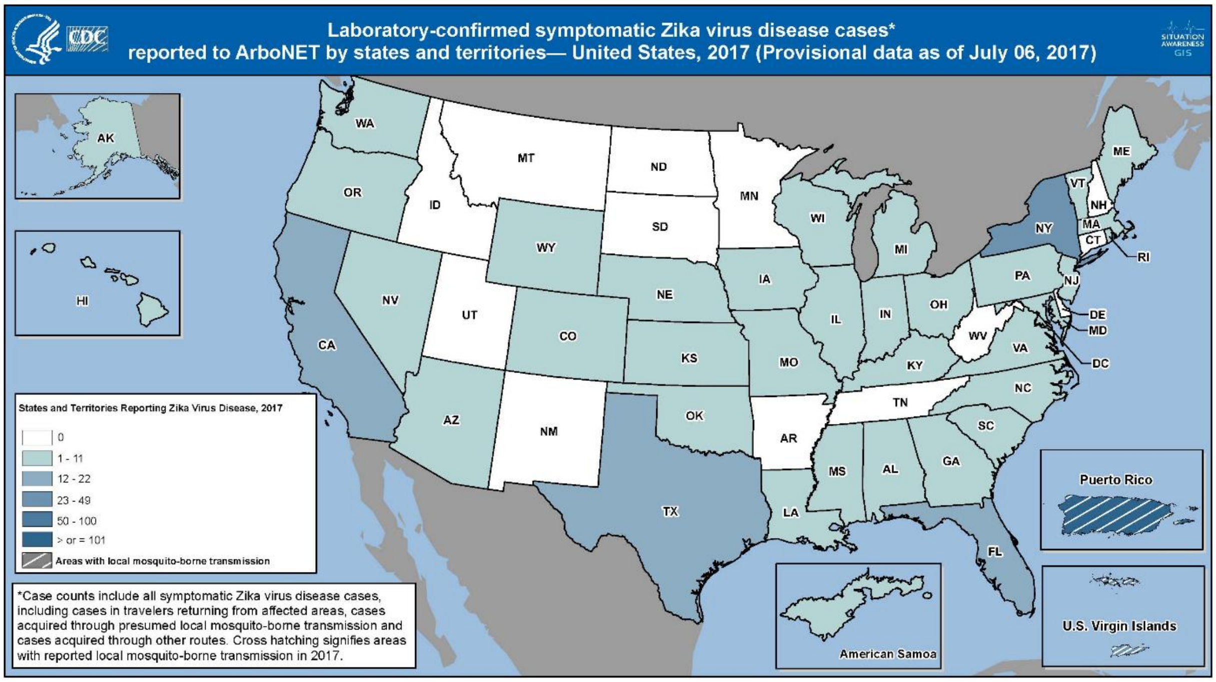

Figure 3.9: [US Map of Zika Virus Cases](#) by the [CDC](#) is in the public domain

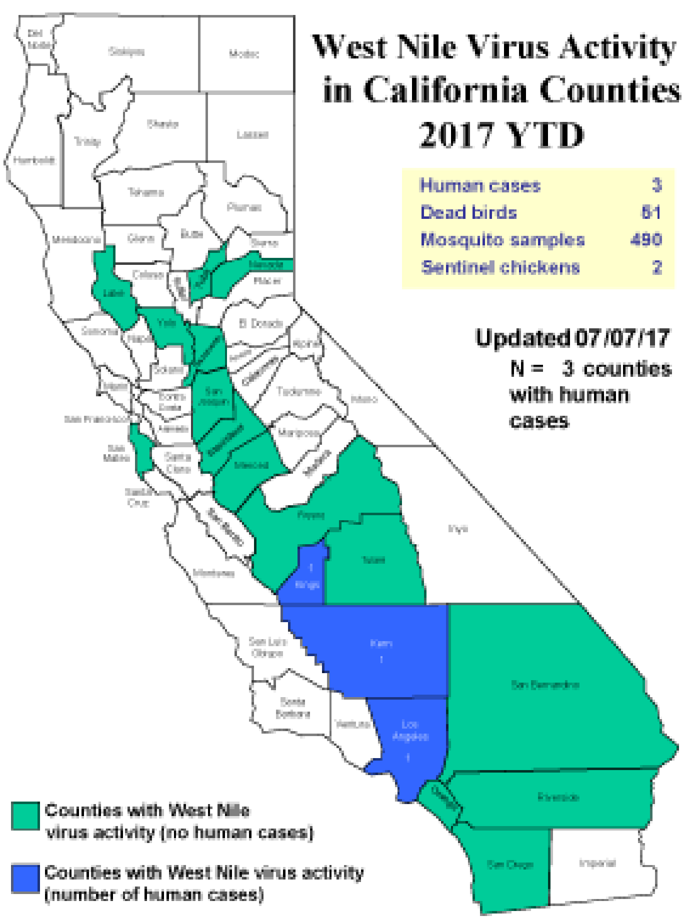

Figure 3.10: [West Nile Virus Activity map](#) by the [California Department of Public Health](#) is in the public domain

Best Practices in Landscapes

It is a much better idea to look beyond rain barrels and beyond eliminating landscape entirely to principles that would help landscape use water more efficiently. These are practices that are a compromise between what is called “all or nothing” thinking. You will hear a lot of this sort of thinking as you hear people talk about their landscape. This is the sort of thinking that says, “If I can’t have my grass in the front and backyard, then I’m going to pave over everything” or “If I can only water twice a week, I’m just going to give up and let everything die.” In the next part, you will learn a few of the principles that landscape professionals use to create and maintain drought-tolerant landscapes. There is a middle ground between paving everything and having no landscape and having turf grass everywhere.

Maintain the irrigation system - This means conducting a regular review of the system while it is running to look for common problems (overspray, clogged nozzles, blocked heads). Much like we learned in the section on alternative water supplies, including gray water, frequently maintenance is a hurdle that homeowners do not want to overcome. If something needs maintenance, such as a gray water system or an irrigation system, it may simply be avoided and neglected. There is water-saving potential in conducting maintenance.

Mulch the exposed soil - Any surface that is not covered by a plant (or a six inch space around a plant) should be covered with three to five inches of mulch. Mulch has a ton of benefits including keeping the soil temperature more moderate (warmer in the winter and cooler in the summer), preventing weeds from sprouting in soil and decreasing the evaporation. Mulch does need to be raked periodically and re-applied year to year, but it makes a great improvement in the aesthetics and health of a planted surface.

Hydrozone - The highest water use plants used in California landscapes are types of turf, including cool season turf, which has slender blades of darker green color, and warm season turf, which has wider blades of medium-green color. You can see in the table below how the water needs, measured in evapotranspiration in inches per day, vary tremendously among types of turf grasses. Typically, when someone admires a lawn, the lawn is Kentucky blue grass or another cool season turf grass. There are low water using options, such as Buffalo grass, which can easily use half as much water. But grass overall is still a very water thirsty plant.

Table 3.5: Types of Turf Grass and Water Needs

Relative Ranking	ET in inches/day	Cool Season	Warm Season
Very low	< 0.24		Buffalo grass
Low	0.24-0.28		Bermuda grass Zoysia grass
Medium	0.28-0.33	Red fescue St. Augustine	
High	0.33-0.39	Perrential Rye grass Kikuyu grass	
Very high	> 0.39	Annual bluegrass Kentucky blue grass Annual rye grass	

Hydrozoning or separating your plants by their water needs, helps you water the right amount in each zone. In the table below, you can see how you might group plants according to their high, moderate, low and very low water needs. Each plant is compared to a cool season turf grass of 4-7 inches tall that is not stressed. This is the plant with the highest water need. Trees and shrubs should be in their own zone. Anything drought-tolerant typically has a low water need and should be in a separate zone. And anything with a very low water need typically does not need irrigation. Note that a plant with moderate water needs only needs 40-60% of the water of a cool season turf grass. That means that typically anything other than turf grass will need half as much water - this is truly astounding.

Table 3.6: Types of Plants and Water Needs

Water Needs	Percent of Reference ET	Types of Plants
High	70-90% ET	Most turf grasses
Moderate	40-60% ET	Most trees and shrubs
Low	10-30% ET	Drought-tolerant plants, like salvia (sages)
Very Low	<10% ET	Cacti

Irrigate deeply and water infrequently - Daily watering isn't necessary for most plants, including turf grass, even during the summer. Irrigation depends on a number of factors, including:

- Soil type - Both clay and sandy soil in your yard mean you must irrigate in short bursts and allow water to sink in in between bursts. This is typically called **cycle and soak** because you allow the controller to cycle on once and then let the water soak in before cycling on again.
- Depth of roots - If you water grass multiple times a day, you train the grass to have short roots, which mean the roots cannot reach other available water deeper in the soil. Try to water less frequently to encourage deeper roots to grow.

- Seasonal variation - Plants have greater water needs in the summer than the spring, fall or winter. This is intuitive, but many people water the same amount of time all year round.
- Types of plant material - Would you water your lawn and a cactus the same amount? Of course not. But many people water everything in their yard the same amount, which usually results in over-irrigation of most non-grass plants. This is why separating your yard into hydrozones is so important.
- Irrigation system type - Spray heads put out water much faster than rotating heads or than drip irrigation - you need to understand this when you program your system. Spray heads and rotating heads can be high-efficiency, meaning they apply water at a slower rate. Spray and rotating nozzles are appropriate for grass, but drip irrigation is a more appropriate choice for shrubs and trees. The table below summarizes the four major types of irrigation, including their water pattern, ideal use, and precipitation (precip) rate, which is the amount of water that the irrigation type puts out.

Table 3.7: Four Major Types of Irrigation

Irrigation Type	Water Pattern	Ideal for	Precip Rate	How to irrigate well with it?
Spray	fan	turf grass	Faster than soil can absorb	Cycle and soak
Rotating	stream	turf grass	Faster than soil can absorb	Cycle and soak
Bubbler	gush	trees with wells	Faster than soil can absorb	One run time to fill the wells
Drip	drip	shrubs and trees	Same rate soil can absorb	One long run time (45 minutes +)

Irrigation Controllers

In California, any new homes will come with a weather-based or soil-moisture-based irrigation controller. This means that some of the guess work will be taken out of irrigation decisions. Typically people have no idea how much to water and end up over-irrigating everything. Irrigation controllers can be programmed by the days to water, the time of days to water (called the start time), the length of time to water (called the run time). A weather-based irrigation controller or a soil-moisture based irrigation controller needs to be guided on what days to water and what times to start, but can determine how long to water based on weather or on soil moisture.

When do you think you might see savings from using a weather-based irrigation controller? Typically, people set their controller at the summer levels for irrigation and keep the controller at that level all year. This means they are watering both more frequently than needed and longer than needed for most of the year. The savings when upgrading to a weather-based irrigation controller come in the spring, fall and winter, when the person was over-irrigating.

Grass and Artificial Turf

When is grass appropriate? Are people playing on the surface? If so, grass is the perfect plant - no other plant will take being trampled and literally bounce back. If kids or adults are using the grass to play on, keep it. It's the right plant in the right place at the right time. But the way grass is used in many communities is as a default plant. Grass is easy and inexpensive to install and has been installed in all sorts of places that are hard to irrigate without run-off, like parkways, hills and slopes or medians.

What about artificial turf? While artificial turf does not change the landscape aesthetic in a community, it has both benefits and drawbacks, which are detailed in the table below.

Table 3.8: Benefits and Drawbacks of Artificial Turf

Benefits of Artificial Turf	Drawbacks of Artificial Turf
• It's green. • It saves water. • No mowing is necessary. • No fertilizers are necessary • Costs incurred are most likely one time charges (until time for replacement in around 10 years).	• It can become hot in the sun (and contribute to a heat island effect on your property). • Many installers recommend hosing down artificial turf for dust control and to clean pet waste. • It can photodegrade in the sun (10 year lifespan). • It will smell of pet waste if not cleaned effectively. • Typically, artificial turf is $10-15 a square foot.

There are other types of outdoor water use, but they are negligible in the greater scheme of things when compared to landscaping. For example, leaks may occur outdoors in the irrigation system. Water can also be used for cleaning hardscape (pavement, sidewalks, driveways), washing vehicles, filling fountains and swimming pools.

Try It!

1. Propose a strategy for landscaping an area that you see frequently, such as your home, a local park, or your school. This could be your front or backyard, a common area, or an area at work. Consider the types of plants that you might install, an arrangement for them, the irrigation system you should use, and what obstacles you might encounter along the way. Identify the best practices you have used.
2. A friend wants to install artificial turf in his front and backyard. Give an overview of the benefits and drawbacks of artificial turf.

Key Terms

- **Cycle and soak** – irrigating in short bursts and allow water to sink in in between bursts
- **Hydrozoning** - separating your plants by their water needs, which helps you water the right amount in each zone

SECTION 3.6 CII WATER USE

What do a car mechanic and an aerospace engineer have in common? They both work in the Commercial, Industrial and Institutional (CII) section, which is very diverse in terms of water use. Using water for cleaning as a car mechanic or water for manufacture of aerospace parts are very different uses. As we study CII customers, you'll be able to bring together what you've learned about indoor and outdoor conservation and apply it to the workplace.

LEARNING OBJECTIVES

In this section, you will:

- classify customers according to type;
- identify challenges in the CII sector; and
- analyze consumption history of CII customers.

For CII customers considering conservation, financial incentives are typically a useful conservation tool as well as providing information on the return on investment (ROI). One particular challenge in the CII sector is that a master meter typically provides water for both indoor and outdoor use. Sometimes an entire strip mall of diverse businesses (e.g., nail salon, microlender, lawn mower repair) will be behind the same meter. This makes it very difficult to account for individual commercial water use and to offer appropriate rebates and incentives. With the challenges in the CII sector understood, we will spend some time looking at each type of business within the CII sector.

Commercial, Industrial and Institutional Customers

Within the commercial, industrial and institutional (CII) sector, water use varies by type of customer. The EPA provides this bar graph of typical water use within different types of commercial and institutional organizations:

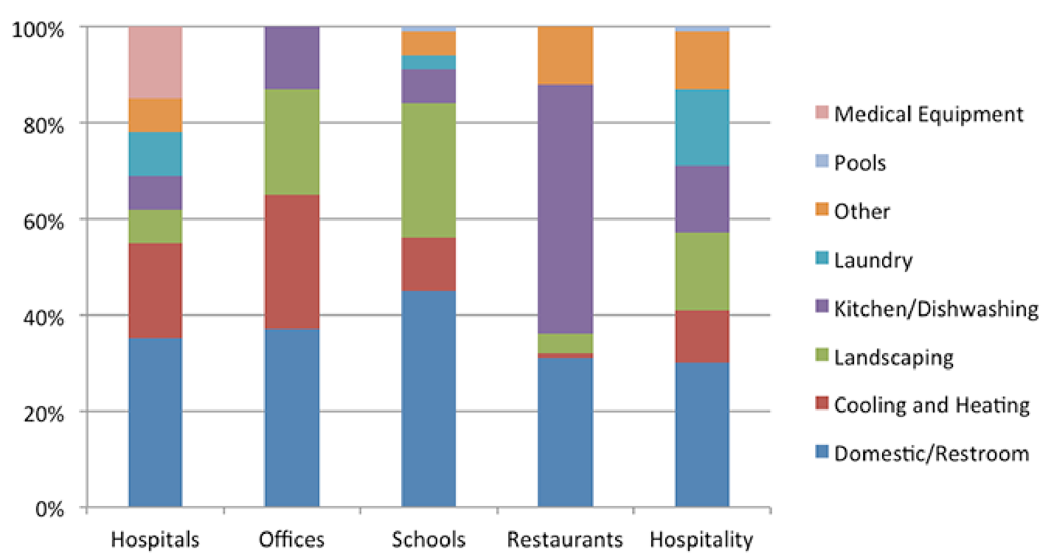

Figure 3.11: End Uses of Water in Various Types of Commercial and Institutional Facilities by the EPA is in the public domain

There are a few key observations you can make, most of which are intuitive:

- Most customers have a sizable proportion of domestic or restroom water use. This suggests that a program that rebates toilets, urinals, and aerators might be useful to many types of customers.
- Schools, offices and hospitality (hotels) use a significant amount of water for landscaping. This suggests that a rebate program for smart irrigation controllers, sprinkler nozzles, landscape audits or checkups or for turf grass removal might be useful.
- Some types of customers, such as hospitals or offices, have sizable amounts of water used for heating and cooling (including cooling towers, which can recirculate water).
- Kitchens and hotels (hospitality) use a significant amount of water in the kitchen.

Commercial Customers

Restaurant water use is typically about 50% used in the kitchen, primarily for dishwashing. This suggests that a dishwasher rebate for a water-efficient dishwasher might be in order. And, of course, there is typically a third of the total water used for restrooms, which suggests a toilet and urinal rebate program might be well received and needed.

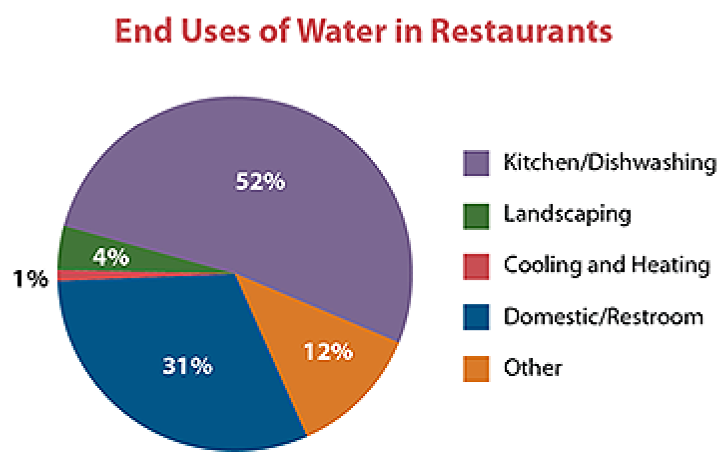

Figure 3.12: [End Uses of Water in Restaurants](#) by the [EPA](#) is in the public domain

Restaurants have other uses of water in the kitchen, including woks and dipper wells, both of which may have continuous flows of water. The next time you are in an Asian restaurant, if the restaurant has an open kitchen, check out the wok. Many restaurants have a continuous flow of water in a faucet behind the wok to use while cooking and to cool the wok. Similarly dipper wells in ice cream parlors may also have a continuous flow of water to keep the ice cream scoop clean. For kitchen clean-up, pre-rinse spray valves, which are used to pre-clean dishes before going in the dishwasher, can also be upgraded to less gallons per minute, and are a common rebate program.

The EPA features a case study in conservation in a restaurant, Uncommon Grounds, in Chicago, Illinois. The restaurant conducted three stages of upgrades:

1. Aerators on prep sinks, more efficient pre-rinse spray valves and water only served on request;
2. Dishwasher and ice machine upgrades to ENERGY STAR qualified models; and

3. Rooftop garden with a drip irrigation system that uses a rainwater collection system.

This case study illustrates that there are a wealth of possibilities for upgrades, but that for restaurants focusing on the kitchen first often makes the most sense. [58]

Hotels are another common customer type in the commercial sector. Their water use often encompasses a restaurant, but also restrooms, landscape, and laundry uses.

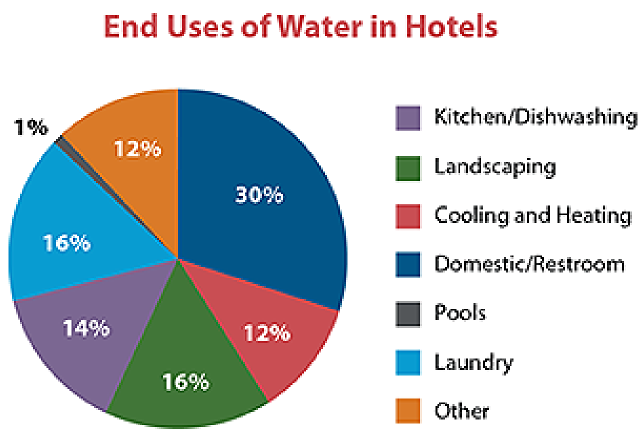

Figure 3.13: [End Uses of Water in Hotels](#) by the [EPA](#) is in the public domain

Hotels may have more flexibility for implementing changes for water conservation if they are small and privately-owned or if they have sustainability as part of their mission, such as Kimpton Hotels. Small behavioral changes may be successful for hotels, such as instituting linens/towels re-use options for customers, particularly if customers have to "opt-in" for fresh daily towels or linens.

The EPA has a case study in water conservation in a hotel in a Holiday Inn in San Antonio Texas. The water utility spent $100,000 in a retrofit of guest bathrooms upgrading as shown below:

Table 3.9: Efficiency Comparison of Hotel Before and After Bathroom Upgrade

Fixture	Original Efficiency	Retrofit Efficient	Number of Units
Toilets	3.5 gpf	1.1 gpf	297
Toilets	5.0 gpf	1.1 gpf	100
Aerators	2.2 gpf	1.5 gpm	397
Showerheads	2.5 gpm	1.75 gpm	397

The hotel achieved an average of 35% savings per upgraded room and $68,000 in water and sewer costs per year.[59]

[58] Ibid, accessed 8/20/17

[59] Putting Water Sense to Work, Case Study: Hotel Installs Water Efficient Sanitary Fixtures. https://www.epa.gov/sites/production/files/2017-01/documents/ws-commercial-casestudy-holiday-inn-sanantonio.pdf accessed 8/20/17

Industrial Customers

The Mid-Continent Ecology Division Laboratory (MED) of the Environmental Protection Agency (EPA) can also be studied as a case study for water conservation. Located in Duluth, Minnesota, the MED is 50 labs, administrative offices, a library and 7 constant temperature rooms. As with many scientific laboratories, there was a good deal of water used for cooling of scientific instruments. In particular, single pass cooling occurred not only in the cooling system for the building but for many elements of the research equipment. Because the facility is adjacent to Lake Superior, the facility was able to use water from the lake for cooling rather than potable water, which reduced its total potable use by 90 percent. Additionally, the water can be returned to Lake Superior after it is used to cool the building or equipment.

This use of lakewater for cooling is innovative. In California, lakes are much more sporadically occurring than in Minnesota and this would be more of a challenge both in finding a lake to use and in not having detrimental environmental effects. Also, aquatic species tend to like water within a temperature range so any water that is returned to the lake would need to be similar in temperature to the lake water. [60]

Institutional Customers

Although decreasing water use by 90% in the case of the MED or 35% for the Holiday Inn seems extreme, the types of processes and analyses that occurred at the MED are the sorts of processes that would need to occur are typical of ways to save with other industrial customers as well as institutional customers. Institutional customers are typically schools and universities, hospitals, houses of worship, and city and county agencies. These are typically the sorts of customers who may have many people visiting their facilities for a short period of time. They may also have a variety of different types of use in one building, such as a church that also has a school during the weekdays and group counseling or AA meetings during weekday evenings.

Stanford University is useful as a case study because of the wide ranging uses of the facility ranging from scientific research to residential housing. At Stanford University, conservation staff met with each department to attempt to quantify water use and potential reductions. Important to this effort was the involvement of stakeholders in the process, which include professors and research staff, but also building and grounds staff who understand how the buildings function, particularly the cooling systems. [61]

In the end, a variety of conservation measures were chosen from removal of unnecessary turf grass and installation of weather-based irrigation controllers as outdoor measures to upgrading most bathrooms on campus and replacing one-pass sterilizing equipment, to real-time metering to provide feedback on water use, and especially on leaks.[62]

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[60] Mid-Contintent Ecology Division, https://www.epa.gov/greeningepa/mid-continent-ecology-division-laboratory retrieved 8/20/17

[61] Stanford University, Sustainability and Energy Management, "Water Efficiency," http://lbre.stanford.edu/sem/Water_Efficiency (accessed 5/26/16)

[62] Stanford University, Stanford University Water Efficiency Fact Sheet http://lbre.stanford.edu/sem/sites/all/lbre-shared/files/sem/files/shared/sem_WE_Program.pdf (accessed 5/26/16)

In the same vein as Stanford University, a case study from the EPA found a wide range of possible upgrades for a hospital in Olympia, Washington, to decrease water use. These water conservation measures concentrated on:

- Upgrading sterilizer equipment
- Recovering condensate from the sterilizer for re-use (non-potable use); and
- Upgrading water-using equipment with non-water using equipment.

This process resulted in a savings of 5.9 million gallons once the retrofits were completed and a cost savings of $140,000 per year. So while it may seem like the CII sector is technical, case studies such as this one illustrate that by identifying the high-water using appliances and equipment and researching upgrades, there is a significant potential for water savings.[63]

Try It!

1. Where is most water used in a restaurant? Where is most water used in a school?
2. College of the Canyons is considered an "institutional customer." Where might the greatest water savings lie?

[63] Putting WaterSense to Work: Hospital Installs Water Efficient Laboratory and Medical Equipment. https://www.epa.gov/sites/production/files/2017-01/documents/ws-commercial-casestudy-provst-peter-hospital.pdf accessed 8/20/17

SECTION 3.7 SOCIAL MARKETING CAMPAIGNS

How do you get people to change? It's a good question and one with which numerous governmental agencies struggle, particularly those in the health and healthcare fields, where there are the most social marketing campaigns of any field.

As you have seen, there are major water infrastructure projects that can be relied on to a certain extent to bring water to the thirsty parts of California. But how can you decrease the amount of water that is needed in the first place? This is called managing demand. You've learned a variety of tools from regulation to restrict water use or limit waste, to building codes that require more efficient devices to water loss detection to conservation programs. Decreasing demand is both an art and a science. One additional way to reduce demand is to engage in a social marketing campaign with residents.

LEARNING OBJECTIVES

In this section, you will:

- differentiate between awareness campaigns and social marketing campaigns;
- identify behaviors that most water utilities target; and
- design a social marketing campaign.

Typically, public outreach campaigns in the water industry have focused on awareness. That is to say the campaign wants you to be aware of the importance of water or the amount of water that you use. In the Santa Clarita Valley, a campaign in 2010 focused on residents knowing their "water number," the amount of water that they used in one day. This campaign relied on the jarring realization that the amount of water that people used was much more than they expected.

Figure 3.14: What's Your Water Number? (Image used with permission of [Castaic Lake Water Agency](#))

An awareness campaign might also focus on a rebate program by promoting toilet or washing machine rebates. The goal of an **awareness campaign** is to make more people aware of something, but it isn't necessarily to make people change their behavior. There isn't a clear call to action.

Figure 3.15: Images used with permission of Castaic Lake Water Agency

In the image above, the viewer is made aware that funds are still available for a Cash for Grass Program (called Lawn Replacement). This ad assumes that most people do not know that there is still money available, and is attempting to raise awareness of this. In Southern California, water agencies, such as Castaic Lake Water Agency, frequently have challenges with messaging that contradicts the messaging from Metropolitan Water District of Southern California, which is a much larger wholesale agency. In this case, Castaic Lake Water Agency has funds available for a cash for grass program, while Metropolitan Water District has run out of funds. Customers who do not know who their water wholesaler was were confused about the availability of funds.

Success or failure of the campaign could be measured in a change of awareness in rebates with a phone or email survey of a representative sample of residents. Awareness of the rebate could be measured before the campaign launches to establish a baseline (e.g., 20% of residents surveyed in the Santa Clarita Valley are aware there are funds available for the Lawn Replacement Program) and then a follow-up phone survey after the campaign runs for 3-12 months to see if there is any increase in awareness (e.g., 3 months later, 30% of residents surveyed in the Santa Clarita Valley are aware there are funds available for the Lawn Replacement Program).

Another awareness campaign that you may have seen is a drought awareness campaign. Most water agencies had to launch some sort of drought awareness campaign that combined with efforts from the State of California to make people aware of the severity of the drought. San Diego County Water Authority has an effective ad to make people aware of state-mandated conservation. Using a modified image from the Drought Monitor of the state of California, the campaign make some suggestions for conservation, but is mostly focused on awareness of the drought and restrictions in place.

Figure 3.16: Image used with permission of San Diego County Water Authority)

A similar awareness campaign from the Family of Water Suppliers in Santa Clarita, including Castaic Lake Water Agency, focuses slightly differently on a common misconception: when it rains, the drought is over. This awareness campaign reminds people that just because it rains, the drought is not over.

Figure 3.17: Image used with permission of San Diego County Water Authority)

A social marketing campaign differs from an awareness campaign significantly. A **social marketing campaign** is a campaign that tries to change behavior. By presenting images that motivate people to do the "right" thing (or that poke fun of people doing the "wrong" thing), public agencies can gently move people to better practices that are good for the residents and good for the public agency. However, most of the time, you can't just tell people to do the right thing. It generally doesn't work. People have too much going on in their lives to listen, unless you make it extremely relevant. You need to have a campaign that refines your message.

These are the sorts of questions that are used in campaign planning:

- Who are we targeting?
- What is our message?
- What partnerships will help with our message?
- What are the barriers to being understood (or listened to)?

During the last drought, many water agencies in California had to tackle how to let people know it was okay to let their lawn get less water and go dormant (yellow). Because green lawns are one way that people tend to rate their status (i.e., I have a green lawn, so I must be financially secure), this is a particularly challenging task. San Diego County Water Authority has a social marketing campaign that tackles this in a unique way.

Figure 3.18: Image used with permission of [San Diego County Water Authority]

In the image from San Diego County Water Authority, the Authority has chosen to reframe brown grass as "tan" grass, most likely hoping that this will make it seem more appealing. This is a variation of "Brown is the new green," a phrase made popular by Governor Brown in the same drought, but working with language that may be more appealing (i.e., tan rather than brown).

Castaic Lake Water Agency has a similar goal of reducing water use for turf grass, but has taken a different tactic by focusing on the appealing aspects of replacing a lawn (more color, more fun, more time):

Figure 3.19: Images used with permission of [Castaic Lake Water Agency]

Many social marketing campaigns have concentrated on the behavior that was prohibited initially during the drought in California, including stopping irrigation run-off, but also refraining from watering sidewalks or washing cars without shut-off nozzles, or using even non-recirculating fountains. While raising awareness of the drought is important, these were all behaviors that were targeted by many water companies in social marketing efforts to behavior change.

Try It!

1. Do a quick scan through a newspaper or click through a few websites starting with an online newspaper. Give an example of an awareness campaign and an example of a social marketing campaign. Examples do not need to be from the water industry.
2. Design a social marketing campaign and present your results. Answer these questions:
    a. Who are you trying to target?
    b. What is the message?
    c. What are the hurdles?

Key Terms

- **awareness campaign** – a campaign to make more people aware of something, but it isn’t necessarily to make people change their behavior
- **social marketing campaign** – a campaign that tries to change behavior

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