



# GRAB-AND-GO WATER ACTIVITIES

for Orange County K-12 students



## WHAT'S INCLUDED

- ✓ Activity Background
- ✓ Learning Objectives
- ✓ Activity Procedure
- ✓ List of Materials
- ✓ Advanced Resources
- ✓ Engineering Design Process Worksheet
- ✓ Natural and Human Social Systems Venn Diagram
- ✓ Key Terms and Definitions
- ✓ Water Distribution Handout
- ✓ Additional Resources

## Orange County Water Supply

Students engage in the steps of the engineering design process—Ask, Research, Imagine, Plan, Create, Test, Improve, Share—as they investigate and develop solutions to a real-world problem, and discover the challenges Orange County water providers face in delivering a safe, clean, and reliable water supply. Using commonly available materials, students design and build a marble run that effectively demonstrates how our water supply is delivered via a gravity-fed system of aqueducts and pipelines from Northern California to Orange County. Through evaluation of their model, students will modify their system and repeat the process to measure the effectiveness of their water delivery system. Students will be able to explain their process and the reasoning behind it to their peers or families.

## Activity Background

From hydration to hygiene, water is essential for life. Water is a renewable natural resource, meaning that nature can replenish it, but just because it's renewable does not mean it's unlimited. Here in Orange County, we live in a semi-arid climate, meaning "somewhat dry." Rain primarily falls in Northern California, but the majority of the state's population lives in Southern California.

As such, nearly half of Orange County's total water supply is imported from hundreds of miles away through aqueducts, pumping plants, reservoirs, pipelines, and treatment plants. Our imported water supply sources include the Colorado River - traveling nearly 242 miles through the Colorado River Aqueduct - and snowmelt from the Sierra Nevada Mountains through the State Water Project - the largest state built water delivery system in the nation consisting of more than 700 miles of canals and pipelines. The rest comes from a large underground aquifer, recycled wastewater, and several small groundwater basins.

As our population grows, the demand for water also increases. Water industry professionals continuously study and develop new local water supplies such as advanced water treatment, recycled water projects, and saltwater desalination to ensure that we have enough water long into our future.



## Learning Objectives

**Through this activity, students should be able to:**

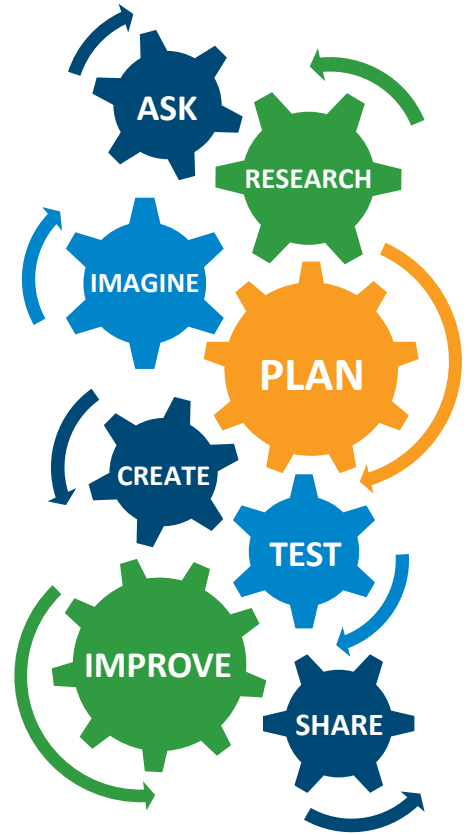
- ◆ Engage in exploration and evaluation to solve a problem
- ◆ Understand the process for water distribution
- ◆ Identify California and Orange County drinking water sources
- ◆ Practice the steps of the engineering design process as they design, build, and test a water delivery system
- ◆ In a written summary or spoken presentation, describe the materials used and explain the challenges faced in delivering water

# Building the Water System

Allow enough time to prepare and gather available materials. Using the engineering design process, brainstorm different ways to use the materials to build the marble run. The student’s model can be built on any scale as long as their water delivery system includes a representation of the following elements: pipelines and/or aqueducts, reservoir(s), groundwater basin, and a water treatment plant. The challenge is for students to use the design-test-redesign approach to determine how best to deliver water from Point A (Sierra Nevada Mountains or Colorado River) to Point B (their home or school). Be sure to discuss each design, making observations and asking guiding questions to help students connect, reflect, and communicate their design to their peers or families. **Note:** *Much of California’s water distribution system is gravity-fed. Discuss this concept with students as they work to design, build, and test their models.*

## PROCEDURE:

- ◆ Make sure each student has the attached engineering design worksheet to complete the assignment.
- ◆ Prepare and gather available materials needed to build a water distribution system (marble run). If using a plastic bottle as a funnel, cut the empty bottle about 4 inches below the mouth.
- ◆ Additional cutting may be required to make a hole in the bottom of the paper plates, bowls, or plastic cups big enough for a marble to fit through. **Tip:** Paper plates can also be cut in a spiral pattern to make pipelines. **Caution:** *Adult supervision is required when handling sharp objects.*
- ◆ Have students label their materials to make sure all required elements are included in their design—pipelines and/or aqueducts, reservoir(s), groundwater basin, and a water treatment plant. **Tip:** Paper towel rolls can be used as the foundation or as pipelines, plates can be cut into pipelines or used as a reservoir, funnels can be used as catchment basins. *See image on Page 02 as reference.*
- ◆ Once students have completed their model, have them describe their process. Place the marble or small ball representing water at the start of their system, and watch as they test how effective their system is for delivering water.



## LIST OF MATERIALS

- ✓ Paper plates and bowls
- ✓ Funnels or plastic bottles cut in half
- ✓ Paper towel and/or toilet paper cardboard tubes
- ✓ Rubber bands
- ✓ Scissors
- ✓ Tape or glue
- ✓ Plastic cups, food cans, or jars
- ✓ Colored pens and/or pencils
- ✓ Paper
- ✓ Marble, small ball, or candy

**Note:** *Materials can be anything readily available to you. There are many ways to build a marble run. There’s no right or wrong answer! Just remember to use the design-test-redesign approach.*



# OC Water Supply Marble Run

Engineering Design Process Worksheet

NAME: \_\_\_\_\_

DATE: \_\_\_\_\_

## ASK

What is the problem? What are your constraints?  
What do you hope to accomplish?

## RESEARCH

Use books, technology, or human resources to research what process or solutions already exist.

## IMAGINE

What are the possible solutions? Brainstorm ideas.  
Then, choose your best idea.

## PLAN AND CREATE

Draw your design, gather your materials, and build your first model.

## TEST

Test your model. Make notes on what materials you used, what worked and what didn't, and why.

## IMPROVE

What could work better? How can you improve your model? Redesign your model, and test it again.



# OC Water Supply Marble Run

Natural Systems and Human Social Systems

NAME: \_\_\_\_\_

DATE: \_\_\_\_\_

**System:** When different parts or components connect to form a whole. Example: Pedals, handle bars, and wheels are different parts or components that connect to form a bicycle.

**Natural Systems:** Systems that occur in nature without any human influence like weather, rivers, or trees.

**Human Social Systems:** Systems that are created by humans like schools, freeways, parks, and government.

## STEP 1

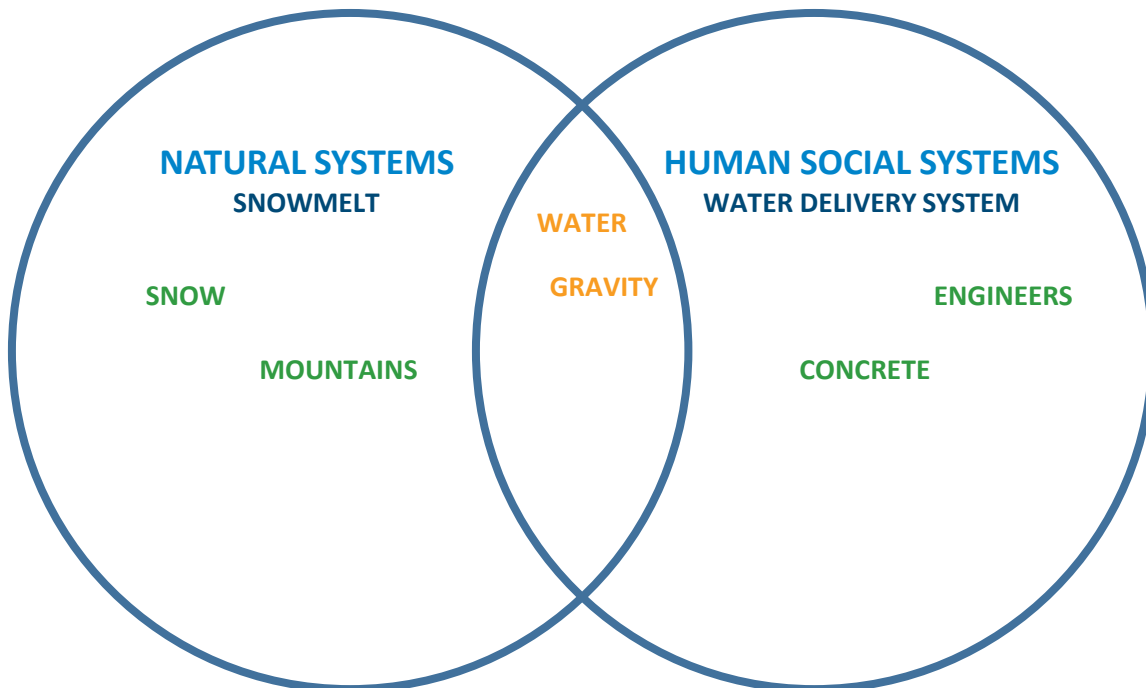
Explore your home and neighborhood, and observe examples of natural systems and human social systems. Where do you find water? How is the water used? Are there different sources of water?

## STEP 2

Snowmelt is a natural system. In the spring, snowpack on the Sierra Nevada Mountain Range slowly melts recharging streams, lakes, rivers, and reservoirs, providing much of our freshwater supply. What natural components help supply water to your home or neighborhood? Write your list in the natural systems circle below.

## STEP 3

A water delivery system is a human social system. It is a man-made system built to collect, transport, treat, store, and deliver water to cities, farms, and towns. What components do you think make up a water delivery system? Write your list in the human social systems circle below.



## STEP 4

In the center of the two circles, make a list of connections between the natural systems and the human social systems. Think about the components used to construct a water delivery system and what natural elements are a part of the water delivery process.

How have human activities caused changes to natural systems in your home or neighborhood?  
Are there ways that you can help save water at home or in your neighborhood?



# OC Water Supply Marble Run

## Key Terms and Definitions



- 01** **Aqueduct:** A man-made channel built to transport water to cities or farms for drinking, irrigation, or hydroelectricity (using water for electricity).
- 02** **Aquifer:** Bodies of permeable rock (allows water to pass through it) that can hold water underground.
- 03** **Groundwater Basin:** Water that is found underground. Much of Orange County's water supply comes from a large groundwater basin located in Northern Orange County.
- 04** **Natural Resource:** Materials or substances that are found in nature and can be used by people, like air, plants, animals, soil, and water.
- 05** **Pipeline:** A line of connected pipes that carries water (and other liquids or gases) from one place to another.
- 06** **Recycled Water:** Wastewater that has been treated to remove matter and contaminants. Recycled water is used for irrigation, to make products in factories, cool towers, and replenish groundwater supply.
- 07** **Reliability:** Someone or something to be trusted or relied upon. You can trust that Orange County's water is clean and safe, and there is plenty of it.
- 08** **Saltwater Desalination:** The process of removing salt and other minerals from water for consumption or irrigation purposes.
- 09** **Semi-Arid Climate:** "Somewhat dry." Here in Southern California we have warm, dry summers and mild, wet winters.
- 10** **Water Delivery System:** A system built to collect, transport, treat, store, and deliver water to your home and neighborhood. This water can be used for drinking, firefighting, irrigation, and more.
- 11** **Water Treatment Plant:** A facility that treats water through the process of removing particles and matter so that it is safe to drink or use.



# WATER DISTRIBUTION



**1. Aqueduct**— Two-thirds of the water used in Southern California flows in through man-made canals and pipelines called aqueducts. Sometimes the aqueducts go through or over mountains. The rest of the water used in Southern California comes from local groundwater, rivers, and lakes.

**2. Pumping Plant**— Water in all aqueducts but the Los Angeles Aqueduct must be pumped along the way. Pumping plants lift the water over mountains. In between pumping plants, water travels downstream until it comes to another place it must be helped over. It takes a lot of energy to pump water into Southern California.



**5. Pipelines**—The treated water flows through underground pipelines to homes and businesses. As soon as we turn on a tap or nozzle, water flows out for us to use.

**3. Reservoir**—Along the way and at the end of the aqueduct, water is stored in reservoirs. The reservoirs hold the water until it is needed by homes, businesses, and farms. Many reservoirs form lakes that are used for fishing and boating.



**4. Filtration Plant**—Some water used on farms comes straight from reservoirs. But water for homes and businesses is treated to make it clean and safe for people. Dirt is filtered out. Chlorine or other chemicals, such as chloramines, is added to kill germs and keep it safe.

# Orange County Water Supply Sources



## Imported Water

The Municipal Water District of Orange County purchases high-quality water from the Colorado River and the Sacramento-San Joaquin Bay Delta through the Metropolitan Water District of Southern California.



## Groundwater

The northern portion of the county lies above a large aquifer known as the Orange County Basin. This water source provides a significant portion of water for the Orange County cities north of Newport Beach and Irvine. To the south lies the San Juan Basin, which is small and salty compared to the Orange County Basin. This water must be desalinated (have the salt removed) prior to its use as drinking water.



## Recycled Water

In Orange County, wastewater is treated and used for irrigation, toilet flushing, industrial processes, cooling towers, and groundwater replenishment.



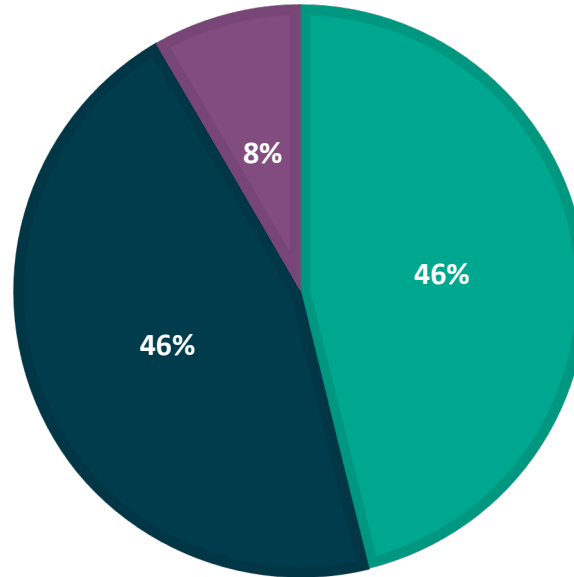
## Water Treatment

Water from lakes and streams contains microorganisms and contaminants that must be removed before it can be used for drinking water.



## Wastewater Treatment

Contaminants must be removed from wastewater/sewage so that it can be returned to the water cycle with minimum impact on the environment, or directly reused.

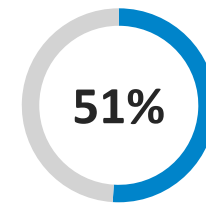


## OC Water Sources

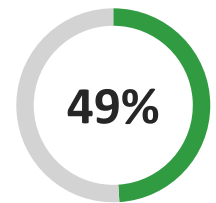
Approximately 50% of the water used in Orange County comes from imported water supplies. The rest comes from a vast underground aquifer, recycled wastewater, and several small groundwater basins.



**Did you know? Nearly half of all the water used in Orange County is used to water landscaping.**



**Indoor**



**Outdoor**



# Orange County Imported Water Supplies



## State Water Project

The State Water Project (SWP) is a water storage and delivery system of reservoirs, aqueducts, power plants, and pumping plants that begins near Sacramento and extends more than 700 miles through the state. The SWP supplies water to more than 27 million people and 750,000 acres of farmland across California.

<https://www.mwdoc.com/StateWaterProject>



## Colorado River Aqueduct

The Colorado River Aqueduct (CRA) is a 242-mile aqueduct that begins at Parker Dam, straddling the border between California and Arizona, and terminates at Lake Mathews in Riverside County. The CRA is capable of moving more than 1 billion gallons of water each day and provides water for 19 million California residents.

<http://www.mwdoc.com/ColoradoRiverAqueduct>



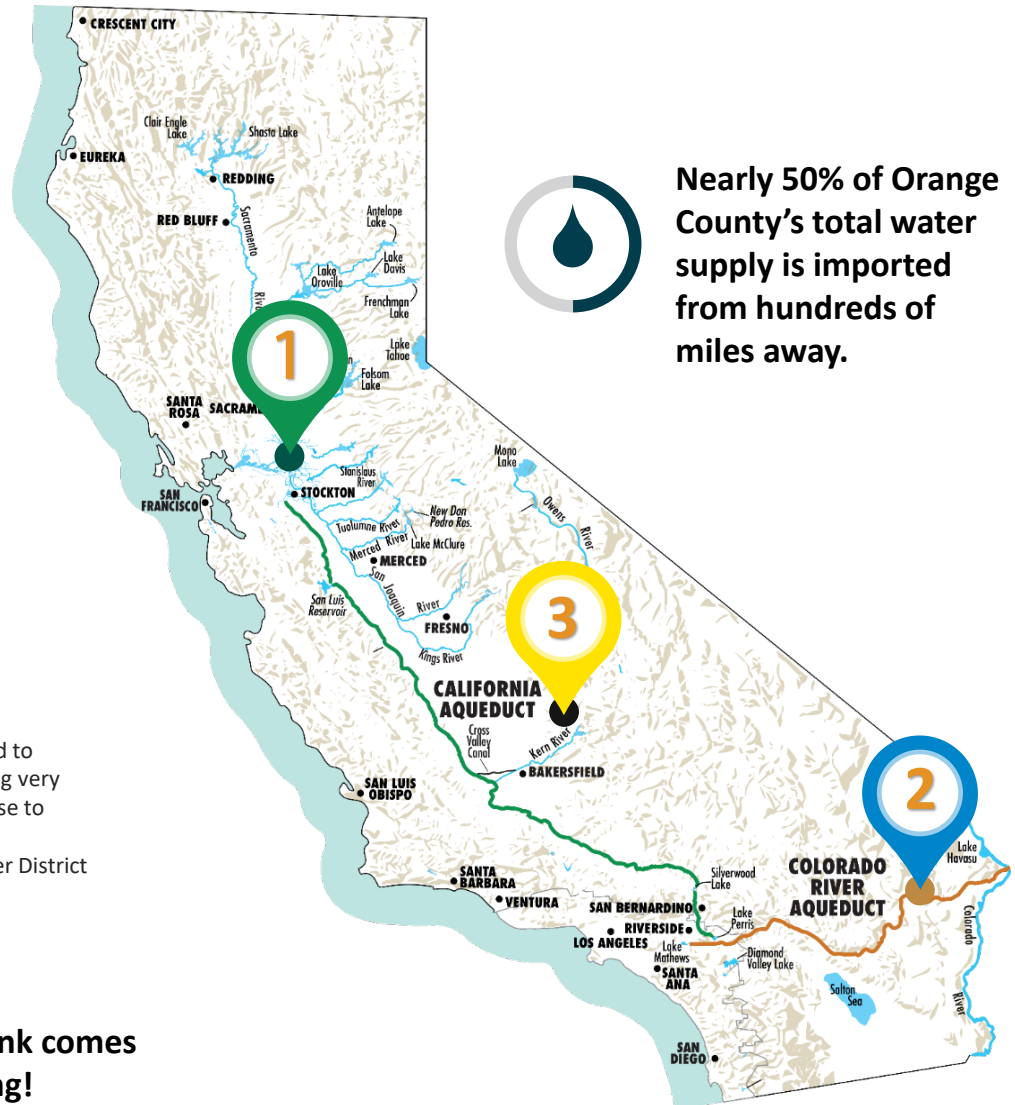
## Strand Ranch Water Bank

The Strand Ranch Water Bank is a water storage project created to increase the amount of water available to Orange County during very dry years. Water banking is an important tool water agencies use to create and manage additional water supplies. Strand Ranch is a mutually beneficial partnership between the Irvine Ranch Water District and central California water agencies.

<https://www.irwd.com/services/water-banking>



**Did you know? Some of the water you drink comes from rain that falls as far away as Wyoming!**



# Orange County Groundwater, Water and Wastewater Treatment



## Groundwater Projects

1. Orange County Groundwater Basin  
<https://www.ocwd.com/what-we-do/groundwater-management/>
2. San Juan Valley Groundwater Basin  
<https://sjbauthority.com/about/map.html>



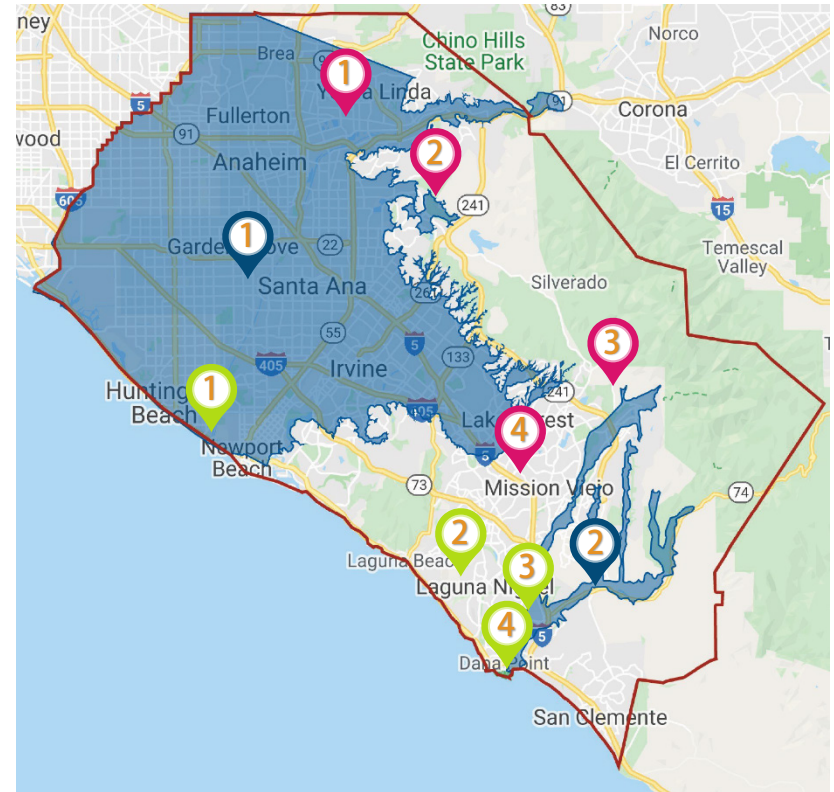
## Water Treatment Projects

1. Robert B. Diemer Treatment Plant  
<http://www.mwdh2o.com/AboutYourWater/Water-Quality/robert-b-diemer>
2. Lenain Water Treatment Plant  
<https://www.anaheim.net/5137/Lenain-Water-Treatment-Plant>
3. Water Treatment Facility  
<https://www.tcwd.ca.gov/about-us/facility-types>
4. Baker Water Treatment Plant  
<https://www.irwd.com/construction/baker-water-treatment-plant>



## Wastewater Treatment Projects

1. Treatment Plant 2  
<https://www.ocsd.com/Home/ShowDocument?id=29045>
2. Coastal Treatment Plant  
<https://www.socwa.com/infrastructure/coastal-treatment-plant/>
3. 3A Water Reclamation Plant  
<https://smwd.com/310/Wastewater>
4. JB Latham Treatment Plant  
<https://www.socwa.com/infrastructure/jb-latham-treatment-plant/>



**100% of Orange County wastewater is treated before reuse or discharge into the ocean.**



**100% of Orange County water flowing from your tap is safe to drink.**

# Orange County Recycled Water Projects



## Recycled Water Projects

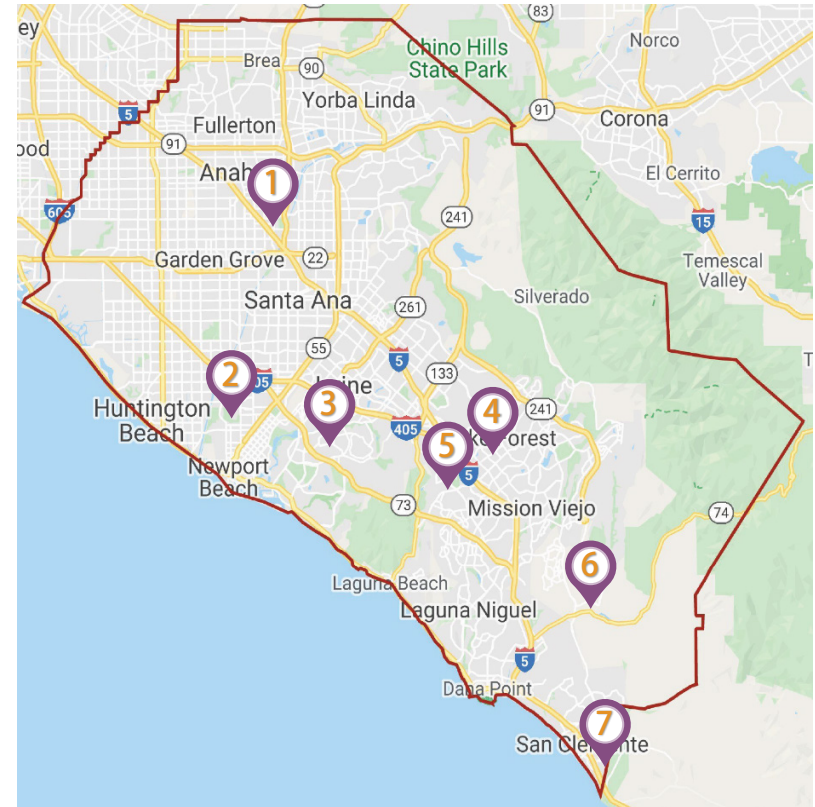
1. Anaheim Water Recycling Demonstration Facility  
<https://www.anaheim.net/734/Water-Sustainability-Campus>
2. Groundwater Replenishment System  
<https://www.ocwd.com/gwrs/about-gwrs/>
3. Michelson Water Recycling Plant  
<https://www.irwd.com/construction/michelson-water-recycling-plant>
4. Los Alisos Water Recycling Plant  
<https://www.irwd.com/construction/los-alisos-recycled-water-plant>
5. El Toro Water District Water Recycling Plant  
<https://etwd.com/water-recycling-plant/>
6. Chiquita Water Reclamation Plant  
<https://www.smwd.com/309/Recycled-Water>
7. San Clemente Water Reclamation Plant  
<https://www.san-clemente.org/departments-services/utility-services>



**Recycled water contains beneficial nutrients that act as fertilizer for plants.**

## What is Recycled Water?

Recycled water is highly treated wastewater that has been filtered to remove impurities and disinfected at a water recycling plant. The wastewater used in recycling comes from domestic sewage, industrial wastewater, and stormwater runoff. Recycled water is also known as reclaimed water, effluent water, treated effluent water, and treated sewage water. While recycled water can't be used for drinking, it can be used to water plants, make products in factories, and replenish groundwater supplies.



**95% of water that enters a home goes down the drain daily.**



**Did you know? Humans have reused wastewater for irrigation for over 5,000 years!**