An Educator's Guide to the Tujunga/Pacoima Watershed

produced by

The RIVER PROJECT

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Who We Are

The River Project is a non-profit organization whose mission is to encourage responsible management of our watershed lands and revitalization of our rivers for the social, economic and environmental benefit of our communities. Through outreach, advocacy, scientific research and hands-on educational programs, we provide communities with the tools to reclaim their riverfront lands.

What We Do In This Watershed

In 2005, with funding from the California Bay-Delta Watershed Program, we set out to develop a stakeholder-driven Watershed Management Plan for the Tujunga/Pacoima Watershed with the goals of identifying opportunities to maximize water recharge, optimize water reuse, and improve water quality. In addition, we were looking for other opportunities to benefit the watershed, such as improving wildlife habitat, and increasing park space in underserved communities.

Why We Do It

We developed this Plan in order to facilitate positive change for Los Angeles. Water is one of our most valuable assets. It is apparent that we have room for improvement in how we manage our land and our water. Most of our waterways have been encased in concrete and our land has been covered in asphalt. 98% of our riverside habitat has been lost. In the storms of 04/05, we sent several years' worth of water supply speeding out to the ocean rather than capture it for use. We spend $1 billion a year to import most of our water supply from other regions whose ecosystems are threatened by that loss. More than 20% of the state's energy use goes to importing water to Southern California. Meanwhile, the aquifer beneath the San Fernando Valley that could be meeting as much as 50% of our water needs is dangerously depleted. The water quality in our waterways and beaches is so bad we're under Federal court order to improve it. We have less parks and open space than any other major city in the country. These things are all related, but we're unaccustomed to looking at them that way.

Watersheds are a common-sense, natural framework for better understanding, managing and protecting our rivers, streams, lakes and beaches. Around the world, people are beginning to take a more integrated approach to managing watersheds. To do this in Los Angeles will require a major shift in thinking and that's never easy. But as Einstein said, "the world that we have made as a result of the level of thinking that we have done so far, has created problems we cannot solve at the level of thinking at which we created them... We shall require a substantially new manner of thinking if humankind is to survive."
The benefits we can enjoy from practicing a watershed approach are many. With climate change and population growth, the time is now to begin exploring this new way of thinking about how to manage our resources sustainably. We have reached, if you will, a watershed moment.

About The Tujunga/Pacoima Watershed

The Tujunga/Pacoima Watershed is a special place. Covering over 225 square miles, it has both some of the most densely urban and undisturbed natural lands in Los Angeles. Its habitats range from conifer and hardwood forests, to rare alluvial fan scrub to the common asphalt jungle. Because it also includes dynamic streams and lands atop the San Fernando Valley aquifer, it has the potential – if managed differently – to provide us with a roadmap for a more sustainable future in Los Angeles.

The Tujunga/Pacoima is the largest subwatershed of the upper Los Angeles River Watershed. The 225-square mile area comprises both remote open space of the Angeles National Forest, and the highly urbanized lands of the cities of Los Angeles & San Fernando. The watershed has a very steep slope - the high elevations of the San Gabriel Mountains. (above 7100 ft.) in the upper watershed drop rapidly to the valley floor at an average rate of 41 ft/mile. Dozens of blue line streams feed the three main tributaries – the Big Tujunga, Little Tujunga, and Pacoima Washes. Since the mountains are geologically young and highly dynamic, its waterbodies are a “young” stream system. Big and Little Tujunga Wash come together in the Hansen Dam Reservoir. Below Hansen Dam, Pacoima Wash joins the channelized concrete box Tujunga Wash as it flows to its confluence with the Los Angeles River in Studio City.

Geomorphology

The mountains of the upper watershed are historically prone to episodic fires, common to the chaparral plant communities that dominate the southern slopes, with fire frequency intervals estimated between 20-100 years. A fire history computed for the watershed estimated that 95 percent of the watershed may have burned during the period 1878-1975. In the post-fire scenario, runoff and erosion increase significantly. Additionally, frequent activity along the numerous fault lines within the San Gabriel range can increase the amount of fractured bedrock available for sediment transport by large storms. Prior to the engineering and channelization of the regions rivers and streams, these washes formed a network of as many as five wide, alluvial channels across the eastern valley. What this meant to the history of the Valley in real terms was that nutrient-rich soils were being deposited across the valley, making it ideal for agriculture.

Water

Historically, the Tujunga Wash was a major contributor of groundwater supply. The Valley sits atop the San Fernando Groundwater Basin - a huge aquifer that has become depleted over the years as we have made the valley floor impervious. Rain that used to soak into the ground now runs off of concrete and asphalt and directly into the stormdrains, and our channellized washes and river.

Although Los Angeles averages only 15 inches of annual rainfall, the higher elevations of this watershed receive some of the most concentrated rainfall in the United States. The depleted basin currently provides nearly 15% of local drinking water supplies to Los Angeles. Prior to the channelization of our river systems and the subsequent intense development, roughly 80% of stormwater percolated to groundwater. Current estimates

are that around 8% percolates, the rest being lost to the ocean via the channelized river system carrying contaminants from urbanized land use. Approached from a watershed context, the Tujunga/Pacoima Watershed provides significant opportunities to maximize recharge, optimize reuse, improve water quality, and reduce reliance on imported water.

Habitat

Habitats include alluvial fan scrub, riparian woodland, willow thicket, mulefat scrub, coastal sage scrub, oak woodland and conifer woodland forests. These habitats currently provide critical cover, forage, nesting and breeding sites for many bird, mammal, reptile, amphibian and invertebrate species. The area supports several threatened and endangered species listed for Los Angeles County, including California Condor, spotted owl, Least Bell's Vireo, southern willow flycatcher, American peregrine falcon, arroyo toad, slender-horned spineflower, California red-legged frog, Santa Ana sucker, unarmored threespine stickleback, and arroyo chub.

Communities

The watershed includes the City of San Fernando as well as the communities of Pacoima, Arleta, Sylmar, Sunland, Tujunga, Panorama City, Van Nuys, North Hollywood, Valley Glen, Valley Village & Studio City within the City of Los Angeles. The watershed has a population of nearly 500,000, is roughly 62% Latino with 32% of the population under the age of 17 and 19% living in poverty.

Infrastructure

The watershed contains numerous facilities, including Big Tujunga & Hansen Dams; Pacoima & Tujunga Reservoirs; Hansen & Lopez Flood Control Basins; Tujunga Gallery, Tujunga, Pacoima, Hansen, Branford, Spreading Grounds; numerous small debris basins and sediment retention sites. In addition, four gravel mining operation areas and a power generating station occur within the watershed boundary. Transportation corridors include Interstates 5, 405 & 210, and Highways 170, 101,118 and 14. Metrolink and Amtrak lines and the Metro Rapidway dedicated bus corridor cross the lower watershed. The Metrolink corridor is heavily industrialized.

Open Space

The upper watershed encompasses more than 100 square miles of the Angeles National Forest and a large regional recreation area behind Hansen Dam. The lower watershed is extremely park-poor but includes vacant lots that could support opportunities to provide much-needed open space to economically disadvantaged minority communities that have been adversely impacted by past resource management decisions. Along the easement adjacent to the box channel sections, good opportunities exist for green corridors that could include bike paths, walking areas, small pocket parks and stormwater retention areas. In addition, with some minor modifications to Dam and Spreading Grounds operations, along with utilization of some measure of storage at one of the gravel pits, the possibility exists to remove the concrete armoring of the mainstem channels of Tujunga and Pacoima Washes, thereby restoring natural processes and functions while providing for habitat restoration all along both washes.

A Teachers Guide to the Tujunga/Pacoima Watershed

for grades K - 5

produced by

The RIVER PROJECT

A Teacher's Guide to the Tujunga/Pacoima Watershed

This Guide was created to support the learning of the Tujunga/Pacoima Watershed throughout the grade levels using the watershed as a context for learning specific California State content standards. Each grade has a specific "theme" so that as students move up through each grade level they build on their knowledge of their watershed. Each unit begins with a "Sense of Place" activity that introduces students to the watershed and directs them to see and learn the major features of the watershed – mountains, trees, water, etc. Additional lessons include activities and worksheets that teach the theme using specific content standards information and culminates with a chosen service project that helps the community and the Tujunga/Pacoima Watershed. As the teacher, feel free to add-to or modify the lessons as necessary to meet the needs of your classroom and school.

How To Use This Guide

California State Standards
The suggested set of Content Standards are listed.

Vocabulary
New words are listed.

Materials
A detailed list of what is needed to complete the activities, including worksheets.

Overview
The Overview briefly explains the main idea for each of the activities within the grade-level unit. All activities in a grade level fall under the same topic or theme.

Background Information
Background information related to the theme is provided for the instructor about the Tujunga Watershed.

Preparation
Step-by-step instructions are provided to prepare for the activities.

Activities
Three to five activities are included for each grade-level unit depending on the grade.

Procedure
Step-by-step instructions for conducting the activities.

Service Project
The last activity is designed to lead students in finishing their unit by conducting a service project to benefit their surrounding community (school) and ultimately support the health of the Tujunga watershed.

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What is a Watershed?

California State Standards

Earth Science: 3a, 3b, 3c

Vocabulary

dam, concrete, river, stream, valley, watershed

Materials

- Figure A – *Water Drop's Journey Through the Tujunga Watershed*
- soil
- watering can or cup with holes poked in the bottom
- water
- trash
- Figure B – *My Watershed* – 1 per student
- crayons
- large, blue sequin or blue construction paper cut-out – 1 per student

Optional for Activity 1

- toilet paper tubes – 2 per student
- stapler
- yarn

Optional for Activity 2

- flannel board characters from *Water Drop's Journey Through the Tujunga Watershed*

Overview

In Activity 1 – *A Sense of Place*, students begin to understand what is around them when asked to recall, and later look around from the schoolyard to identify the location of mountains, trees, and more. In Activity 2 – *The Tujunga Watershed*, students first listen to a story about the journey of a water drop through the watershed before observing the journey first-hand with a mini watershed demonstration. Students demonstrate what they have learned by creating a picture of the watershed, adding their school and a "water drop." Finally, in Activity 3 - *Helping the Water of the Tujunga Watershed*, students brainstorm a project that they can do at the school or in the community to help keep water clean.

Background Information

Your school site sits in a watershed. A watershed is the land area that "sheds" water to a common waterbody like a lake, a wash, or a river. It helps provide water by feeding aquifers or directing water into rivers as water moves from higher areas to lower ones. The Los Angeles metropolitan area is made up of several watersheds. These include the Santa Clara watershed in the north, the Ballona Creek/Santa Monica Bay watershed in the west, the San Gabriel in the east, and the Los Angeles River watershed in the middle. The Tujunga is the largest sub-watershed of the Los Angeles River Watershed. The 225-square mile area captures the south and west slopes of the western San Gabriel Mountains and the alluvial plains of the eastern San Fernando Valley.

During the latter half of the 19th century, general land use was transformed from a relatively undisturbed condition to ranching, and then to agriculture. By the 1890's with the arrival of the railroads, the population of the region began to increase and building progressed on the floodplain. A flood control system was first implemented in the 1930s after major floods. The San Fernando Valley experienced a continuous building boom in the latter half of the 20th century with suburbs, commercial centers and industry eventually displacing ranch, farmland, and wild land. This urban expansion completely changed the flow of water, material, and energy across the landscape. With urban expansion came increased water pollution.

Preparation

- Choose an area on the schoolyard that provides students the best view of the San Gabriel Mountains and other natural landmarks.
- Determine the school's physical relationship to the Tujunga and Pacoima Wash.
- Find an area of concrete or asphalt that can get wet and dirty to create the mini watershed.
- Prepare "water drops" using either blue sequins, construction paper, or another material.
- Prepare some ideas for a water quality class project. See Resource section.
- Optional:

  Activity 1 – Have students create homemade binoculars. First, staple two toilet paper tubes together. Punch a hole on either side and attach a length of yarn to create a strap for around the neck. Have students decorate their own binoculars.
  Activity 2 – Create flannel board characters to visually demonstrate Water Drop's Journey Through the Tujunga Watershed.

Activity 1 – A Sense of Place

Procedure

1. Ask the students the following questions and write their responses on the board or chart paper:
   a. What do you think you might see if you stood in the middle of the schoolyard, circled around, and looked through a pair of binoculars?
   b. What do you think you might see if we took all the buildings, cars and streets away?

2. Take students outside to an open area on the schoolyard to look around. Optional: Have students use their homemade binoculars when making observations.

3. Point out to the students:
   a. The San Gabriel Mountains
   b. The direction of the closest waterway: Big Tujunga, Little Tujunga, or Pacoima Washes, or Hansen Dam
   c. Any trees or other visible plant and wildlife
   d. The direction the sun moves from east to west
   e. Any other visible landmarks

4. Direct students to look at various levels or "views" including: the sky; the horizon; top of the trees; buildings; and finally, the ground. Ask the students what they see at each level.

5. Assign students to draw one of the "views" they see.

6. After taking the students back into the classroom, ask them the following questions and compare their responses to those recorded earlier:
   a. What did you observe?
   b. What did you see that surprised you?

7. Invite students to look around outside at home and record what they observe.

Activity 2 - The Tujunga Watershed

Procedure

1. Read Figure A – *Water Drop's Journey Through the Tujunga Watershed* to the students. This can be done as a flannel board story or with drawings. Invite students to respond to the questions asked in the story.

2. Discuss what was read and how it relates to what they observed from the schoolyard and at home. Ask the students:
    a. What are the different parts of Water Drop's journey?
    b. What do you observe when it rains at our school?
    c. Where does the rain go?
    d. What is the weather like when it rains?
    e. What clothes do you wear when it rains?

3. Create a mini model of a watershed to demonstrate what happens when it rains in the mountains.
    a. Find an open space of concrete or asphalt.
    b. Create a mound of soil on top of the concrete or asphalt representing the San Gabriel Mountains near their school.
    c. Using a watering can or cup with holes, slowly pour water onto the top of the mountain to create a rainstorm. Invite students to make the sounds of rain by clicking their tongues, snapping their fingers, or clapping their hands.
    d. Point out how:
        i. The soil erodes away to form ridges and valleys as the water travels over the watershed.
        ii. Some of the water seeps into the soil.
        iii. Some travels as streams that come together as rivers that will eventually lead to the ocean.
        iv. Water pools up and is unable to seep into soil when it hits the concrete – just like rain that hits concrete around their school and community.

4. Add small bits of trash, such as a crumpled gum wrapper to the top of the plastic. Slowly pour water onto the plastic surface. Point out how the water carries the trash across the surface. Explain that water carries all sorts of trash and pollution left on the ground.

5. Using Figure B – *My Watershed*, have students create a picture of the watershed model. Have them do the following to their picture:
    a. Color in the different parts, including: clouds, rain, mountain, river and ocean.
    b. Add their home or school.
    c. Add "Water Drop" somewhere along the route from rain to ocean. This can be a large blue sequin or blue construction paper cut-out in the shape of a raindrop.

Activity 3 - Helping the Water of the Tujunga Watershed

Procedure

1. Review with the students what they observed during the watershed demonstration:
    a. Rain from the sky came down onto the mountains.
    b. Some of the water soaked into the soil. Some formed ridges and flowed down to the concrete or asphalt.
    c. When the rainwater hit the concrete or asphalt it could not get into the soil. Rainwater that does not get into soil cannot provide us with water.
    d. Rainwater that travels over concrete picks up trash and other things left on the ground – making it dirty and unusable for drinking and other needs.

2. Discuss with students how they can help Water Drop by putting their trash in trash cans and not on the ground.

3. Choose a day to do a school trash pick-up or see Resource section for additional ideas.

Figure A

Water Drop's Journey Through the Tujunga Watershed

The children of (name of your school) use clean water in many ways. They use water for drinking, watering plants, brushing their teeth, and so much more!

How do you use water?

Water is very important to our lives and for keeping us healthy. In fact, without water we couldn't live!

One day, the children of (name of your school) wondered, "Where does our water come from?" They decided to check with their friend, Water Drop. Surely, Water Drop could tell them, because Water Drop had made the journey many times. Water Drop was happy to tell them, and began the story up in the sky, in the clouds that gather over the school and mountains.

"Water droplets, high up in the sky where it is cold, gather together and form clouds. These droplets join together to form larger drops that get so heavy, they fall as rain. The rain falls down onto the mountains near our school. The mountains are called the San Gabriel Mountains. When I, and all the other water drops, fall as rain we hit the ground and seep down into the soil. Then, all the water drops either move downward under the soil, or pop out of the ground and join together to form a stream. As a stream we flow down, down, down like a giant slide, making our way to the bottom of the mountains. Here we are captured, either under the ground or behind a dam – a large wall that stops water and forms a large lake. Water stored in either of these places can be used for drinking water.

Sometimes though, we land on the hard ground at the school and surrounding community. Because sidewalks and playgrounds are covered with hard surfaces called concrete and asphalt, we cannot seep into the earth to become water for drinking. Instead, we travel fast across the top of these surfaces. As we move, we gather all the trash that is left on the ground. We flow into streets that carry us from Tujunga and Pacoima Washes into the Los Angeles River – a large stream of water. The Los Angeles River takes us, and all the trash, straight to the ocean. We arrive at the ocean dirty and trashed.

Where have you seen trash on the ground?

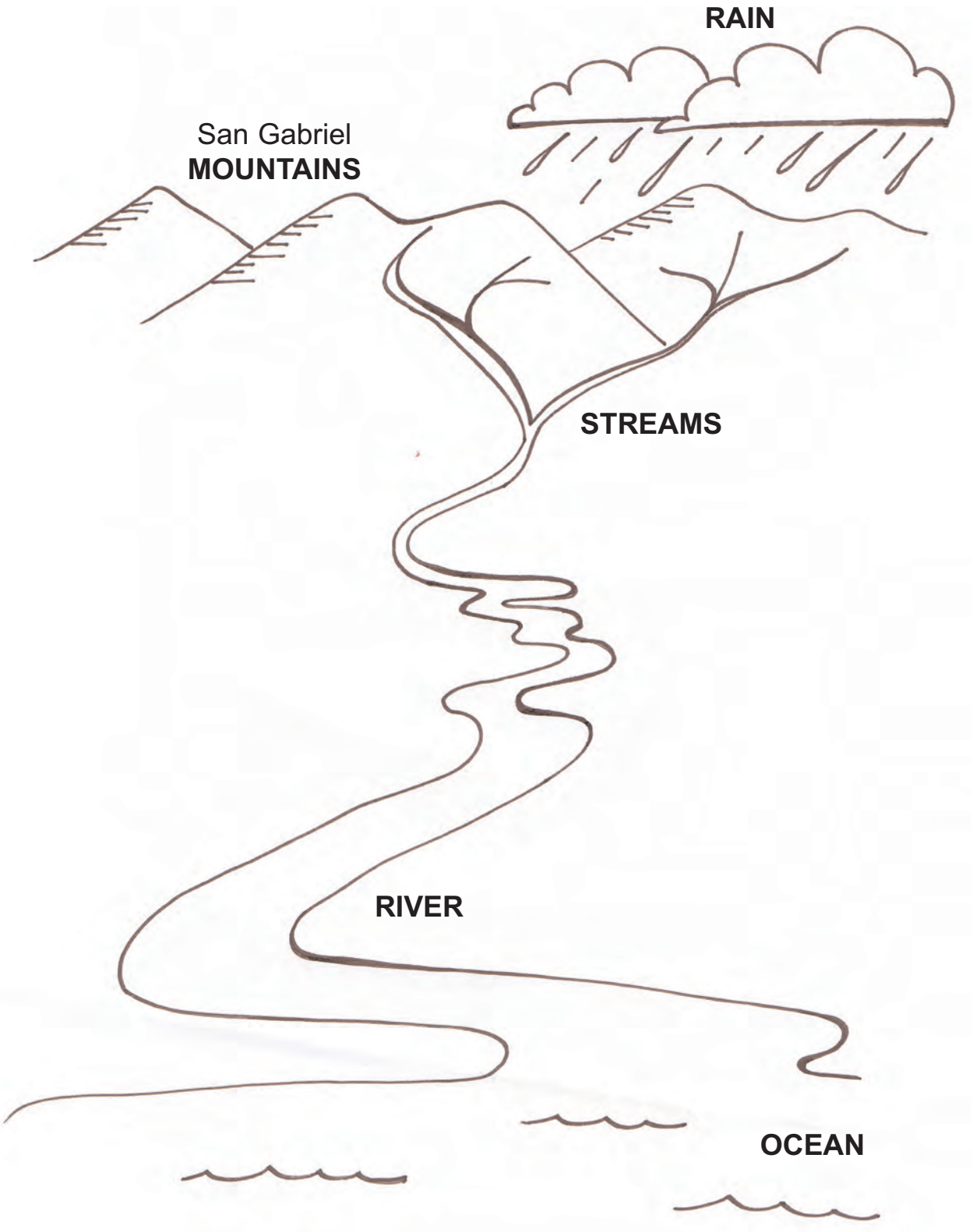
It is important to keep all of us water drops clean so we can be used for drinking and all the other uses you listed!"

So, now the children of (name of your school) knew where their water came from. They were glad to find out about Water Drop's journey and decided to always do what they could to help keep water clean.

Figure B

My Watershed

Name _____ Date _____



GRADE ONE

1

Plants of the Tujunga Watershed

California State Standards

Life Science: 2a, 2b, 2e

Vocabulary

branch, carbon dioxide, native, oxygen, root, trunk

Materials

- paper
- crayons
- Figure C – *Historical Photos of Tujunga Watershed Area*
- Figure D – *A Letter From the Plant Expert*
- mural paper
- glue
- dropped leaves, bark, branches
- Figure E – *Become A Plant Expert* – 1 per student
- Figure F – *The Plant Expert*
- Native chaparral plant leaves – at least 1 per student (see Resources section for types of plants)

Optional for Activity 2

- flannel board characters from *Ask the Plant Expert*
- magnifying glasses – 1 per student or group of students

Overview

In Activity 1 – *A Sense of Place*, students begin to understand what is around them when asked to recall, and later look around from the schoolyard to identify the location of mountains, trees, and more. In Activity 2 – *Plants of the Tujunga Watershed*, students first listen to a story describing what it is like to be a plant before becoming "Plant Experts" and observing first-hand, characteristics of native plant leaves. In Part I, students demonstrate what they have learned as "plant experts" by drawing themselves as a plant, and in Part II, recording their plant feature observations on a worksheet. Finally, Activity 3 – *Helping the Plants of the Tujunga Watershed*, students brainstorm a project that they can do at the school or in the community to help native plants.

Background Information

Your school site, as part of the Tujunga watershed, is within a Mediterranean biome. Biomes are distinguished by their location, climate, soil and plant life. The climate of the Mediterranean biome of Southern California is characterized by hot, dry summers that are followed by cool, rainy winters. It is also characterized by cycles of drought and inundation, commonly referred to as La Nina and El Nino. Early rains begin around November, saturating soils that have baked during long summers, with heaviest rainfall occurring January through March.

Plant life of a Mediterranean biome includes those that survive in these harsh conditions, such as coastal and alluvial fan sage scrub. The most predominant native plant community typical of this biome, and of the Tujunga Watershed overall, is chaparral. Chaparral is characterized by fire-adapted evergreen shrubs that have drought-adapted leaves that are often small, leathery, thick, fuzzy and/or waxy. Chaparral occurs throughout the central section of the watershed up to an elevation of about 1500 m. One of the most dominant chaparral plants is Ceanothus, or more commonly known as California lilac, noted for its early spring blue and white blooms that cover entire hillsides. At least six different species grow within the Tujunga Watershed. Scrub oaks are also common on north-facing slopes and canyon bottoms.

Ascending to higher elevations, major communities include montane and valley riparian, oak woodlands, oak-conifer forests and coniferous forests. Riparian habitats are characterized by willows, cottonwoods, sycamore and alder. Oak woodlands and forests occur in upper Tujunga and Pacoima Canyons. Typical tree species are canyon live oak, and interior live oak. At the highest elevations in the watershed, along the northern ridge and the eastern boundary, coniferous forests predominate with Coulter pine, Jeffrey pine, sugar pine, and white fir.

The lower Tujunga and Pacoima Washes and their storm drain tributaries no longer have native plant communities. Historically, the valley was dominated by perennial grasslands, scattered oak and walnut woodlands, and corridors of riparian habitat. Now, the areas adjacent to the water are concrete and any vegetation nearby is mainly non-native grass or landscaped areas. There are vacant lots and easements that could support green corridors of native plants, helping to restore natural processes and functions while providing for habitat restoration all along both Washes.

Preparation

- Choose an area on the schoolyard that provides students the best view of the San Gabriel Mountains and other natural landmarks.
- Enlarge Figures D and E to poster size so students can read along.
- Cut lengths of mural paper the height of each student.
- Collect dropped leaves, bark and branches for students to glue onto their tree murals.
- Collect native plant leaves that demonstrate a variety of features (fuzzy, sticky, thick, waxy, curved, prickly, small, etc.). See the Resources section for types of native plants and where to locate them.
- Optional:

  Activity 2 – Create flannel board characters to visually demonstrate A Letter From the Plant Expert.

Activity 1 – A Sense of Place

Procedure

1. Ask the students the following questions and write their responses on the board or chart paper:
   a. What do you think you might see if you stood in the middle of the schoolyard, circled around, and looked through a pair of binoculars?
   b. What do you think you might see if we took all the buildings, cars and streets away?

2. Take students outside to an open area on the schoolyard to look around.

3. Point out to the students:
   a. The San Gabriel Mountains
   b. The direction of the closest waterway: Big Tujunga, Little Tujunga, or Pacoima Washes, or Hansen Dam
   c. Any trees or other visible plant and wildlife
   d. The direction the sun moves from east to west
   e. Any other visible landmarks

4. Direct students to sit where they have a view of a tree or other plantlife. Have students describe colors, shapes and other characteristics of the trees and plants that they see. Record responses.

5. Assign students to draw one of the trees/plants they observe.

6. After taking the students back into the classroom, ask them the following questions and compare their responses to those recorded earlier:
    a. What did you observe?
    b. What did you observe that was different than what you expected?
    c. What do you think you might see if we took all the buildings, cars and streets away (only the mountains, soil, trees, plants, river, etc.)?

7. Share with students Figure C – *Historical Photos of the Tujunga Watershed Area*.

8. Invite students to look around outside their home, and record what they observe.

Activity 2 - Plants of the Tujunga Watershed

Procedure

Part I

1. Read along with students an enlarged copy of Figure D – *A Letter From the Plant Expert*. This can be done with a flannel board or drawings.

2. Discuss what was read and how it relates to what they observed from the schoolyard and at home. Illustrate on the board the student answers to the following questions:
    a. What are the different parts of a plant?
    b. What is the job of the roots?
    c. What is the job of the trunk?
    d. What is the job of the branches?
    e. What is the job of the leaves?
    f. What do plants need to live and grow?

3. On sheets of mural paper, have each student lie down on a sheet as you trace the outline of their bodies to create individual life-size images.

4. Have students draw in their face.

5. Have students draw on their image the likeness of a tree. Then, using your drawn illustration or the illustration on Figure D, guide students to label the following:
    a. body/trunk
    b. feet and long legs/roots
    c. arms/branches
    d. fingers and hair/leaves

6. Have students add to the outside of the drawing what they, as the tree, need to live and grow: water, light, soil and air.

7. Provide dropped leaves, bark and branches for students to glue on to their images.

Part II

1. Read Figure E – *Become A Plant Expert* to the students. This can be done with a flannel board or drawings. Invite students to respond to the questions asked in the story.

2. Discuss what was read and how it relates to what they learned about leaves. Illustrate on the board the student answers to the following questions:
    a. Name some features on the leaf of a native plant that would help it to survive in the hot sun.
    b. How do some of these features protect the plant?
    c. Why is important for native plants to have these features?

3. Explain to students that they now get to become a "plant expert." Begin by showing and describing different samples of chaparral plant leaves. Demonstrate how to feel for the texture of the leaf (fuzzy, thick, prickly, etc.), the shape and edges, and how to look closely for signs of insects and animals (eaten holes). Allow the samples to be passed around the class for closer observation.

4. Pass out a new set of chaparral leaves, giving one to each student.

5. Pass out a Figure F – *The Plant Expert* worksheet to each student. If available, pass out magnifying glasses for use. Ask students to observe their leaf and record on their worksheet, the following:
    a. A picture of their leaf – draw the edges, shape and veins.
    b. How the leaf feels – fuzzy, thick, waxy, etc.
    c. Describe why this plant would be able to survive hot summers.

Activity 3 ~ Helping Native Plants of the Tujunga Watershed

Procedure

1. Ask the students:
    a. Why do you think it is important to help native plants to grow?
    b. How do you think growing native plants might help us?

2. Review with the students and explain how native plants of the Tujunga Watershed not only survive hot, dry summers, but also help to save water. By planting natives that don't need a lot of water, we can have the water available for other important uses. This is why planting and caring for native plants at school and in the community helps the Tujunga Watershed.

3. Review with the students what plants need to live and grow.

4. Brainstorm with the student's different ways they can help the plants of the Tujunga Watershed. Ideas include:
    a. Taking care of potted native plants before planting them at the school.
    b. Creating and taking care of a native plant garden at the school or in the community.

5. Choose one of the ideas to carry out. See Resources section for additional ideas.

Figure C

Historical Photos of the Tujunga Watershed Area

Cattle Ranching on the Valley Plain
The San Fernando Valley: America's Suburb 2001

Lankershim-Van Nuys Wheat Harvest 1900 (Canoga-Owensmouth Historical Society)

Olive grove in Sylmar
(West Valley Museum, CSUN Library)

Figure D

A Letter From the Plant Expert

Dear Students:

Ever wonder what it might be like to be a plant? Just ask me – the Plant Expert! You just might learn enough to become a plant expert too.

First of all, imagine yourself as a plant. Your feet would be down in the soil as roots, but instead of walking, your roots are used to hold you tight in the ground. They also send food and water from the soil up your very long legs and into your plant body. These nutrients and water help you to grow.

Your body would be the main stem or trunk of the plant. Like your body, the trunk helps send food and water up and down the plant.

Your arms would be the branches. Branches reach out from the plant and grow leaves. Leaves capture energy from the sun and turn it into food for the plant. Plants also need air to live. Leaves take in carbon dioxide from the air and give off oxygen.

So, as a plant, what do you need to live and grow?

That's right - sun, soil, water, and air!

So there you have it! Now you have a little bit more knowledge about what it is like to be a plant. Now you can be a plant expert too!

Signed,

The Plant Expert

Figure E

Become A Plant Expert

Dear Students:

Remember when you imagined yourself as a plant? You found out that every part of a plant is important to living and growing strong. In fact, sometimes the shape, size and feel of your leaves can help you to survive!

If you are a plant that lives in the mountains near your school and community you are special. You are a native plant – the type of plants that have lived in this area for hundreds of years. This area has mostly hot, sunny days; dry, rocky soil; and hardly any rainfall.

However, your leaves can help. In order to help protect you from the hot sun, and keep you from loosing too much water, your leaves are either:

Small in size. A small leaf has less area for the sun to heat up.

Fuzzy, sticky, waxy, or prickly to the touch. These textures keep water from escaping the leaf.

Thick in size. A thick leaf helps keep water from escaping the leaf and causing it to wilt.

Curved in shape. A curved shape helps the leaf shade itself from the sun.

Now it is time to investigate some native leaves.

What kind of leaf features do they have?

See and draw what your leaf has that helps it to survive. Become a plant expert!

Signed,

The Plant Expert

Figure F

The Plant Expert

Name _____ Date _____

1. Draw a picture of your leaf.

2. How does the leaf feel?_____

_____

3. How does this plant survive hot summers?_____

_____

_____

California State Standards

Earth Science: 3a, 3b, 3c, 3e
Investigation & Experimentation 4c

Vocabulary

mineral, mulch, rock, soil

Materials

- paper
- crayons
- Figure G – *Going On a Rock Hunt* – 1 per student/group
- Figure H – *My Rock Hunt* worksheet – 1 per student
- egg carton – 1 per student
- nail or paperclip – 1 per student or group of students
- Figure I – *What's In Soil* worksheet – 1 per student
- paper bowl – 1 per student group
- soil sample – 1 per student group
- jar with lid – 1 per student group
- dish washer detergent
- water
- watering can or cup with holes punched in the bottom
- bucket of mulch – shredded dry leaves, sticks, etc.

Optional for Activity 2

- magnifying glass – 1 per student/ group
- balance scale

GRADE TWO

Rocks & Soil of the Tujunga Watershed

Overview

In Activity 1 – *A Sense of Place*, students begin to understand what is around them when asked to recall, and later look around from the schoolyard to identify the location of mountains, trees, and more. In Activity 2 – *Rocks and Soil of the Tujunga Watershed*, students read about rocks and soil, before "going on a rock hunt" and observing first-hand the physical properties of rocks. Students demonstrate what they have learned by recording their observations on a worksheet. In Part II, students continue learning about rock minerals by observing and separating out the minerals in soil. Finally, Activity 3 - *Helping the Soil of the Tujunga Watershed*, students watch a demonstration of what happens to rain on concrete, soil and mulch, before brainstorming a project that they can do at school or in their community to help water get into the soil.

Background Information

The soil beneath your school site likely contains rock material that was once part of the San Gabriel Mountains. Millions of years of weathering, earthquakes, and fire, caused rock to break away, wash down out of the mountains, and deposit as gravel and sand onto the alluvial plains of the San Fernando Valley. An alluvial plain is the relatively flat and gently sloping landform found at the base of a mountain range. As mountains erode due to weathering and water flow the sediment from the upper areas are transported to the lower plain.

The upper Tujunga Watershed is within the Southern California Transverse Range Province, which includes the San Gabriel, San Bernardino, Santa Susana, and Santa Monica Mountains. The Transverse Ranges are oriented east-west because of their alignment along the boundary between the North American and Pacific tectonic plates. This is unique to most other mountain ranges in California, which are aligned north-south.

Geologically active, these mountains have experienced rapid, recent, and ongoing uplift. Due to the lack of rainfall, erosion does not keep pace with geologic uplifting causing the mountains to get higher and steeper. This rapid uplift causes streams to move at high velocities, dissect the

mountains and cut steep-sided, narrow, canyons. These rugged, high mountains have the potential to shed enormous amounts of debris. Deposition of boulders, cobbles, gravel, and sand are high along the lower major stream channels. Thick alluvial fan deposits pour out of the major canyons onto lowland alluvial plains immediately adjacent to the mountains.

The lower Tujunga Watershed is now basically stormdrains. There are areas of transition from natural landscape to "urban-scape" in the vicinity of Hansen Dam and in the waterways between the major dams (Pacoima and Big Tujunga) and the lower concrete-lined channels. Historically, the Tujunga and Pacoima Washes were major contributors of groundwater supply. The Valley sits atop the San Fernando Groundwater Basin – a huge aquifer that has become depleted over the years. The native soils atop the aquifer are naturally sandy and highly pervious. Rain that used to soak into the ground now runs off of concrete and asphalt and directly into the stormdrains, and channelized washes.

Preparation

- Choose an area on the schoolyard that provides students the best view of the San Gabriel Mountains and other natural landmarks.
- Gather a variety of rocks.
- Photocopy Figure F – *Going on a Rock Hunt.*
- Photocopy Figure G – *My Rock Hunt* worksheet – 1 per student.
- Photocopy Figure H – *What's In Soil?* worksheet – 1 per student.
- Decide to have students work in groups or individually.
- Gather recycled egg cartons and number each "cup" from 1 to 12 – 1 per student.
- Gather jars with lids – 1 per student group.
- Gather mulch for the demonstration – shredded dried leaves, branches, and sticks work (see Resource section for mulch providers)
- Find an area at school that has soil for the Activity 3 demonstration
- Prepare some ideas for a soil or garden project.

Activity 1 – A Sense of Place

Procedure

1. Ask the students the following questions and write their responses on the board or chart paper:
    a. What do you think you might see if you stood in the middle of the schoolyard, circled around, and looked through a pair of binoculars?
    b. What do you think you might see if we took all the buildings, cars and streets away?

2. Take students outside to an open area on the schoolyard to look around.

3. Point out to the students:
    a. The San Gabriel Mountains
    b. The direction of the closest waterway: Big Tujunga, Little Tujunga, or Pacoima Washes, or Hansen Dam
    c. Any trees or other visible plant and wildlife
    d. Soil and rocks
    e. The direction the sun moves from east to west
    f. Any other visible landmarks

4. Direct students to sit where they can observe an area of soil - under a tree, bush or garden. Have students describe colors, shapes and other characteristics of the soil and rocks that they see.

5. After taking the students back into the classroom, ask them the following questions and compare their responses to those recorded earlier:
    a. What did you observe?
    b. What did you observe that was different than what you expected?
    c. What do you think you might see if we took all the buildings, cars and streets away?

6. Invite students to use look outside at home, and record what they observe.

Activity 2 – Rocks and Soil of the Tujunga Watershed

Procedure

Part 1

1. Have students read Figure F - *Going On A Rock Hunt*.

2. Discuss what was read and how it relates to what they observed from the schoolyard and at home. Ask the students:
    a. Where do rocks come from?
    b. What are rocks made of?
    c. How can you describe a rock?
    d. What mountains did the rocks around your home and school come from?
    e. What causes rocks to break down into smaller rocks and eventually become soil?
    f. What is mulch made from?
    g. Why is mulch good for the soil?

3. Explain to students that they are going on their own "Rock Hunt." Give each student an egg carton. Challenge them to look for, and fill the carton with, 12 different-looking rocks from around their home or the school.

4. Once students have their twelve rocks have them do the following activities, using the egg carton to separate and number the rocks. Have students record their work as they go on their Figure G – *My Rock Hunt* worksheet.

    How My Rock Looks

    Have students:

    a. Choose four rocks from the carton.
    b. Write the number of each rock (number listed in the cup) on their worksheet.
    c. Observe each rock up close, using a magnifier, if possible.
    d. For each rock, circle the colors seen.
    e. For each rock, answer whether it was shiny or not.
    f. For each rock, answer whether it has minerals or not.
    g. Ask the students:
        - Was there a color that was in all your rocks?
        - Were any rocks only one color?

- What color was not in any of the rocks?
- Were any of the rocks shiny?
- Could you see minerals in any of the rocks?

How My Rock Feels

Have students:

a. Choose four other rocks from the carton.
b. Write the number of each rock (number listed in the cup) on their worksheet.
c. Feel each rock with their fingers. Circle the texture.
d. Feel the weight of each rock and determine which one is the heaviest.
e. Feel the weight of each rock and determine which one is the lightest.
f. Feel the weight of every rock in the carton and determine which one is the heaviest and which one is the lightest.
g. Ask the students:
   - How could you tell if the rock was smooth?
   - How could you tell if the rock was rough?
   - What was the lightest rock?
   - What was the heaviest rock?

5. Using each student's last four untested rocks have them test for hardness. Using a nail, paperclip, or other hard item, have students test the hardness of their rocks by scratching the surface.

6. Have students share the results of their observations, creating a class chart (numbers of rocks up one axis, with hard and soft along the bottom axis) showing:
   a. How many rocks are soft enough to scratch
   b. How many rocks are too hard to scratch.

Part II

1. Pass out a bowl of healthy soil to each student or student group.

2. Using Figure H – *What's In Soil?* worksheet, have students observe and answer the following questions:
   a. What are the colors of your soil?
   b. What is the texture of your soil?
   c. What did you find in your soil?

3. Have groups share their findings by using the answers on their worksheet.

4. Allow bowls of soil to sit out and dry overnight.

5. Pour the soil samples into an empty jar:
   a. Add one tablespoon of powder dishwasher detergent.
   b. Add water to fill the jar ¾ths full.
   c. Cap the jar and shake hard to mix the water and soil thoroughly.
   d. Fill the rest of the jar with water and shake again.
   e. Leave the jar undisturbed for 2 days.

6. Explain to students that soil is composed of organic matter (leaves, sticks, etc.), mineral particles and air spaces. Soil minerals come in three types: sand, silt and clay. Have

students observe their jars showing the different minerals of soil:
   a. Sand particles will be at the bottom
   b. Silt particles will be in the middle
   c. Clay particles will be on the top
   d. Any sticks and other organic matter will sit on the clay or float in the water

7. Based on their observation, ask the students:
   a. Which minerals – sand, silt, or clay – are the greatest in their soil.
   b. What colors can they see in the soil?
   c. What is the function of soil?
   d. Why is soil important?

8. Have students draw a picture of their jar with the soil sample on their figure H – *What's In Soil* worksheet. Have them add the following to the picture:
   a. Label the different layers of minerals, including: sand, silt and clay.
   b. Label any organic matter.

Activity 3 - Helping the Soil of the Tujunga Watershed

Procedure

1. Using a watering can, demonstrate:
   a. What happens when rain falls on concrete at school – it hits the concrete, slides off moving down toward the street, and into storm drains that lead to the ocean. When it gets to the ocean it cannot be used for drinking and other fresh water needs.

   b. What happens when it rains on soil at school – it soaks into the ground where the water is captured and held as ground water. Later, it can be pumped, cleaned and used for drinking and other water needs.

   c. What happens when mulch is placed on the dirt – it slows and holds the water, allowing it to seep down into the soil slowly, where the water is captured and held as ground water. Later, it can be pumped, cleaned and used for drinking and other water needs.

2. Review with the students how healthy soil and less concrete is important to the Tujunga Watershed allowing water to seep into the earth and replenish underground stores of water.

3. Brainstorm with the student's different ways they can help the soil of the Tujunga Watershed. Ideas include:
   a. Mulching bare dirt at school.
   b. Keeping and maintaining a compost bin to add to the soil in planters at school.
   c. Removing concrete in an area and creating and maintaining a garden.

4. Choose one of the ideas to carry out. See the Resources section for additional ideas.

Figure G

Going On a Rock Hunt

Have you ever gone on a rock hunt?

Where would you look?

Easy answer. Anywhere on the ground!

The question to ask is, where did the rock come from?

The earth is made of rock. From the tallest mountains to the bottom of the ocean different types of rocks can be found.

Rocks are mostly made up of minerals or broken pieces of smaller rock. They have different shapes, colors, hardness and even brightness. Some are so hard they can't be scratched by a nail. Others are so soft you can write on the sidewalk with them.

The rocks around your school and home used to be part of the San Gabriel Mountains. Weather such as wind, rain and ice, break down larger rocks into smaller rocks. Even tree roots and animals that dig into the ground help to break down large rocks. Smaller rocks are then carried away and down the mountain by streams and rivers. Some make their way to the ocean. Some continue to break down and become part of the soil.

Rocks and soil are an important part of the Tujunga Watershed. They not only help to provide food for plants, but also help to capture and store rainwater. Fresh water that is stored in the ground can be used for drinking and our other water needs.

In order to capture rainwater, soil needs mulch. Mulch – the sticks, bark, and leaves that fall from trees and plants – covers the soil and helps to slow the rain, and absorb it like a sponge. This allows the water to seep into the soil where it is stored below ground. Mulch can be used on the soil around your school to catch the rain and help it to seep into the soil.

Water that gets into the soil where you live helps the Tujunga Watershed.

Figure H

My Rock Hunt

Name _____ Date _____

How My Rock Looks

Rock number:_____ brown black grey white pink

blue red green orange yellow

Is it shiny? yes no

Can you see minerals? yes no

Rock number:_____ brown black grey white pink

blue red green orange yellow

Is it shiny? yes no

Can you see minerals? yes no

Rock number:_____ brown black grey white pink

blue red green orange yellow

Is it shiny? yes no

Can you see minerals? yes no

Rock number:_____ brown black grey white pink

blue red green orange yellow

Is it shiny? yes no

Can you see minerals? yes no

How My Rock Feels

Rock number:_____	rough	smooth	both
Is it the heaviest?	yes	no	
Is it the lightest?	yes	no	

Rock number:_____	rough	smooth	both
Is it the heaviest?	yes	no	
Is it the lightest?	yes	no	

Rock number:_____	rough	smooth	both
Is it the heaviest?	yes	no	
Is it the lightest?	yes	no	

Rock number:_____	rough	smooth	both
Is it the heaviest?	yes	no	
Is it the lightest?	yes	no	

Of all your rocks, which one is the heaviest? Rock number:_____

Of all your rocks, which one is the lightest? Rock number:_____

How Hard or Soft Are Our Rocks?

Class graph

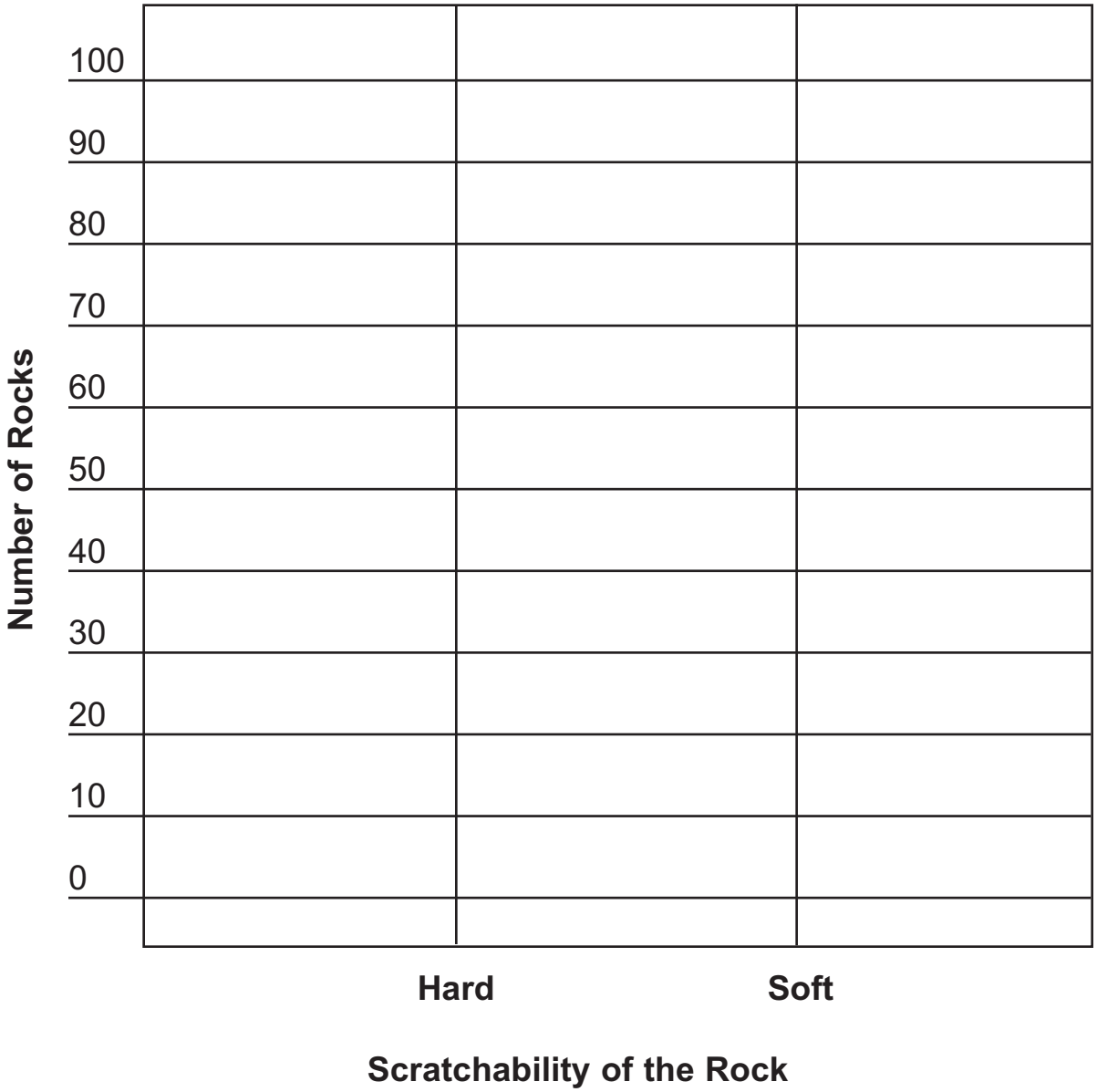


Figure 1

What's In Soil?

Name _____ Date _____

1. What are the colors of your soil?

_____

2. What is the texture of your soil?

☐ Rough and grainy ☐ Crumbly ☐ Smooth and slippery

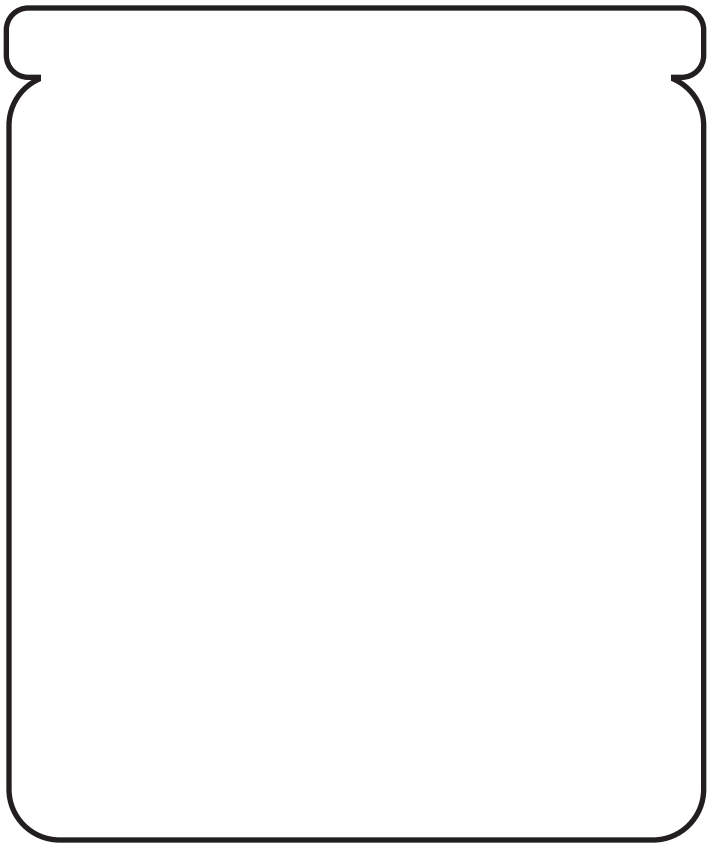
3. What did you find in your soil?

_____

_____

4. Draw a picture of your soil sample inside this jar.

5. Label the sand, silt, clay, and organic matter.



California State Standards

History/Social Science: 3.1-1, 3.1-2

Vocabulary

aquifer, dam, channel, compass rose, groundwater

Materials

- Tujunga Watershed Map (see Resources section) – 1 per student/group
- Figure J – *How Has It Changed?*
- sheet of paper – 1 per student
- Figure K – *Mapping My Watershed* – 1 per student
- 1 2-liter plastic bottle with the top cut off
- modeling clay
- 1 cup each of soil, gravel, 1" size rocks
- watering can or cup with holes in the bottom
- water
- Figure L – *The Water Below My Feet* – 1 per student

GRADE THREE

3

Geography of the Tujunga Watershed

Overview

In Activity 1 – *A Sense of Place*, students begin to understand what is around them when asked to recall, and later look around from the schoolyard to identify the location of mountains, trees, and more. Students read about how major natural features and landforms that created the Tujunga Watershed help with the flow of water, and contribute to stores of groundwater in Activity 2 – *How Has It Changed?*. They study a map of the Tujunga Watershed to see current features and landforms and how it was altered to prevent flooding. For Activity 3 – *What Is Groundwater?* students observe a demonstration of groundwater to understand how water moves through the soil and is stored. Finally, Activity 4 – *Helping the Rainwater that Falls on the Tujunga Watershed*, students observe what happens to rain on concrete-covered soil, to then brainstorm a project that they can do at school to help replenish stores of groundwater.

Background Information

The geography of the Tujunga Watershed encompasses 225-mi^2 in north-central Los Angeles County, and captures the south and west slopes of the western San Gabriel Mountains and the alluvial plains of the eastern San Fernando Valley. Elevations in the upper watershed reach between 5,000 – 7,000 ft above sea level – as much as three times higher than the nearby Santa Monica and Santa Susanna Mountains. These high mountain ranges were created over long periods of time through uplifting caused by tectonic activity along the many earthquake faults present in the upper watershed.

Rainfall in the upper watershed can be in excess of 35 inches a year, whereas the lower watershed averages 13 inches. Steep slopes and heavy rains flow quickly through canyons created by fractures in rock formations, carrying sediment down to the valley floor via numerous streams which join together at the base of the mountains to form the two main waterbodies: the Tujunga and Pacoima Washes. These flow in turn to the Los Angeles River.

During the 19th century, general land use was transformed from a relatively undisturbed condition to ranching and then to agriculture. By the 1890's with the arrival of the railroads, the population of the region began to increase and building progressed on the floodplain – changing the geography. The early 20th century brought the first residential subdivisions, often built within historic streambeds. As development began to displace agriculture, a flood control system was implemented. The San Fernando Valley experienced a continuous building boom after World War II with suburbs, commercial centers and industry eventually displacing what ranch land, farmland, or wild land remained. This urban expansion completely changed the flow of water, material, and energy across the landscape.

Today, the basic geography of the Tujunga Watershed has urban landscapes and processes dominating the lower watershed and natural communities and processes dominating the upper watershed, with the break between upper and lower being Hansen and Pacoima Dams and Interstate 210.

Hansen Dam is at 1,000 feet elevation in the watershed and was completed in 1940 by the Army Corps of Engineers. It was designed and built to control flood flows in the lower urbanized watershed and can hold 74,100 acre-feet of water before spilling. It captures the water, sediment, and other material from the Big and Little Tujunga Washes. Water is not impounded behind Hansen Dam as floods are typically released within 24 hours. Therefore, much of the area behnd the Dam is used for habitat and recreational purposes. Directing water from Hansen Dam is the Tujunga Wash Channel, which extends approximately 9.5 miles from Hansen Dam to connect with the Los Angeles River. The Tujunga Wash flood control channel, built in 1952, is a rectangular, concrete box. The creation of Hansen Dam, and the channelization of the Tujunga Wash are just two examples of how people have used the resources of the local region and modified the physical environment, greatly altering the water's natural flow and function of the watershed.

Another alteration due to urbanization is the ability for water to recharge the groundwater basin. Groundwater exists in geologic formations called aquifers that contain and move "significant" quantities of water. The San Fernando and Sylmar Groundwater Basins lie below the soil layer of the watershed at depths between 20 – 1,000+ feet, where water fills all the space between and within the rocky subsurface. Groundwater makes up about 30% of California's water supply in an average year and about 40% in dry years (Department of Water Resources 2003). Groundwater is a slow-moving and slowly changing part of the hydrologic cycle, only interacting with the surface as surface water percolates down, or as groundwater is pumped up by humans, or as it feeds a surface waterbody.

Percolation and recharge refer to the passive movement of water from the surface to the sub-surface (percolation) in a way that partially or completely refills the aquifer or groundwater basin (recharge). Percolation is inhibited by the construction of impervious surfaces, typical of urban and urbanizing areas. These impervious surfaces encourage water to runoff rather than to penetrate the ground preventing necessary recharge. Over the last 100 years, the changes we've made to the land and Waterbodies in this watershed have left our groundwater basins severely depleted.

Preparation

- Choose an area on the schoolyard that provides students the best view of the San Gabriel Mountains and other natural landmarks.
- Make color copies of the Tujunga Watershed Map located in the Resources section.
- Photocopy Figure J – *How Has It Changed?* – 1 per student.
- Photocopy the Figure K – *Mapping My Watershed* worksheet – 1 per student.
- Decide to have students work in groups or individually.
- Prepare a 2-liter plastic bottle by cutting the top off.
- Gather together the materials needed for the groundwater demonstration and test it out.
- Photocopy the Figure L – *The Water Below My Feet* worksheet – 1 per student.
- Prepare some ideas for a service project.

Activity 1 – A Sense of Place

Procedure

1. Ask the students the following questions and write their responses on the board or chart paper:
    a. What do you think you might see if you stood in the middle of the schoolyard, circled around, and looked through a pair of binoculars?
    b. What do you think you might see if we took all the buildings, cars, and streets away?

2. Take students outside to an open area on the schoolyard to look around.

3. Point out to the students:
    a. The San Gabriel Mountains
    b. The direction of the closest waterway: Big Tujunga, Little Tujunga, or Pacoima Washes, or Hansen Dam
    c. Any trees or other visible plant and wildlife
    d. The direction the sun moves from east to west
    e. Any other visible landmarks

4. Direct students to look at the San Gabriel Mountains. Have them describe what they see – both natural and man-made. Do they see canyons, trees, etc.? Do they see houses, roads, etc.?

5. After taking the students back into the classroom, ask them the following questions and compare their responses to those recorded earlier:
    a. What did you observe?
    b. What did you observe that was different than what you expected?

Activity 2 – How Has It Changed?

Procedure

1. Have students read Figure J – *How Has It Changed?* Review any necessary vocabulary words beforehand.

2. Discuss what was read and how it relates to what they observed from the schoolyard. Ask the students:
    a. What were the mountains like thousands of years ago?
    b. What happens to the rain when it falls on the mountains?
    c. How has the flow of water changed?
    d. How does water help shape the mountains?
    e. What is a dam?
    f. Why were dams built?

3. Pass out a copy of the Tujunga Watershed map to each student group. Point out the following:
    a. Name of the map. Explain that this map shows the land area where water flows in their community.
    b. Compass rose. Explain that this is used to describe direction. East is the direction the sun rises. West is the direction the sun sets. When facing west, north is to the right and south is to the left, and east is behind.

4. As they observe the map, instruct the group to do the following:
    a. Locate the boundary of the Tujunga Watershed.
        i. How can you tell it is the boundary?
    b. Locate the San Gabriel Mountains.
        i. How can you tell they are mountains?
    c. Locate where water flows.
        i. How can you tell it is water?
        ii. Which direction is the water flowing? (You may want to crumble a piece of paper to demonstrate a mountain with ridges, and that water moves from higher to lower places.)
        iii. What are the names of the main waterways coming down from the San Gabriel Mountains?
        iv. Where do these waterways lead?
    d. Locate the major roads/freeways.
        i. How can you tell it is a freeway?
        ii. What is the name of some of the freeways in the Tujunga Watershed?
    e. Locate where our school is situated on the map.
        i. Based on our observations from the schoolyard, where do you think we are on the map? (Show students where the school is located and have them mark it with an X.)
        ii. What is the major waterway closest to our school?
        iii. Which direction (North, South, East or West) is the major waterway to our school?
        iv. Which direction are the San Gabriel Mountains to our school?
        v. Which direction is the closest freeway to our school?
    f. If we were to create a Key for this map, what would it look like?

5. Pass out a piece of paper and Figure K – *Mapping My Watershed* worksheet. Using their copy of the Tujunga Watershed map, have each student create their own map of the watershed.

Activity 3 – What Is Groundwater?

Procedure

1. Ask students to list all the ways they use water and how it is used in their community.

2. Ask students to recall how in the past most of the water we used in the community was from rainwater that seeped into the ground and was pumped out for use. This is known as groundwater.

3. As you perform a groundwater demonstration, discuss the process.
    a. Flatten the modeling clay and place it at the bottom of the container. “This is the clay at the bottom of an aquifer. An aquifer is an area way down in the ground below your feet.”
    b. Add 1 cup of rocks, then gravel, sand, and soil until the container is nearly full. “These are the layers of ground under our feet.”
    c. Using the watering can or plastic cup with holes, pour the water to rain on top of the soil. “Let’s see what happens when it rains on the ground.”
    d. Observe the water as it seeps through each of the layers and stops at the bottom of the aquifer. Explain that the water collected above the clay and in between the rocks is called groundwater. The layer where the water is stored is the aquifer. An aquifer provides groundwater that can be pumped out of the ground. After it is cleaned it can be used for drinking, cooking, bathing and more.

4. Using Figure L – *The Water Below My Feet* worksheet, have students draw a picture and label the layers within the container, including water in the pockets between the rocks. Have students answer the question about how the water from groundwater can be used.

Activity 4 - Helping the Rain Water That Falls on the Tujunga Watershed

Procedure

1. Using the groundwater demonstration container, place a layer of plastic wrap over the top of the soil and seal it well. Explain that the plastic represents all the places where the soil is covered by streets, freeways, sidewalks, playgrounds, etc. Using a watering can, demonstrate what happens when rain falls on concrete at school – it cannot get into the soil to become groundwater. Instead it either flows over concrete into the street or floods.

2. Review with the students how soil is important to the Tujunga Watershed allowing water to seep into the earth and replenish the groundwater.

3. Brainstorm with the student’s different ways they can help the soil of the Tujunga Watershed. Ideas include:
    a. Mulching bare dirt at school.
    b. Removing concrete in an area and creating and maintaining a garden.
    c. Using swales and planted berms to direct water into the ground instead of concrete.

4. Choose one of the ideas to carry out. See Resources section for additional ideas.

Figure J

How Has It Changed?

Looking up at the mountains of our community it looks as if nothing has changed for hundreds of years. The land is steep with deep canyons that make their way down to the valley where we live. Year after year, when it rained in the mountains, the water would hit the earth and seep into the ground or flow down through the canyons carved out by streams. As water moved down the canyons, it broke down larger rocks into pebbles of sandy soil. When it hit the valley this sandy soil would flow out to cover the land.

The type of soil that washed down from the mountains allowed lots of rainwater to seep into the ground. The rainwater moved through layers of dirt and rock where it stayed and was stored. Water from the ground was then pumped out using machines, and then used for drinking, cooking, bathing and more.

Has this changed?

Over time people began covering the land with houses and streets in the areas where the streams would come out of the mountains. In 1938, over 50 years ago, it was raining so hard that the water that came down out of the mountains could not get into the ground, and so it overflowed the streams onto the land. This is called a flood. The flood water washed out homes and businesses that were built next to the streams. People decided that they needed to stop the water and help to control it from flooding.

So, they built dams to help stop the water. A dam is a barrier built across a stream to prevent water from flowing. They also covered the bottom and sides of the streams with concrete to form a channel. A concrete channel is used to direct the water toward the ocean.

People have changed the land and the flow of water in the area – they have changed the "physical environment."

Figure K

Mapping My Watershed

Name _____ Date _____

1. On a separate piece of paper draw your own map of the Tujunga Watershed. Use the Tujunga Watershed map as your guide.

Include the following on your map:

a. Name of the watershed

b. Boundary line

c. San Gabriel Mountains

d. Major waterways

e. Freeway closest to your school

f. Your school

g. Other features, such as your home.

h. Key

i. Compass rose

2. Answer the following questions:

What feature on the map has helped to shape the mountains and the land?

_____

_____

How do people use this land and water?

_____

_____

How have people affected this land?

_____

_____

Figure L

The Water Below My Feet

Name _____ Date_____

1. In the outline of the jar, draw a picture of the different layers of ground. Label the following:

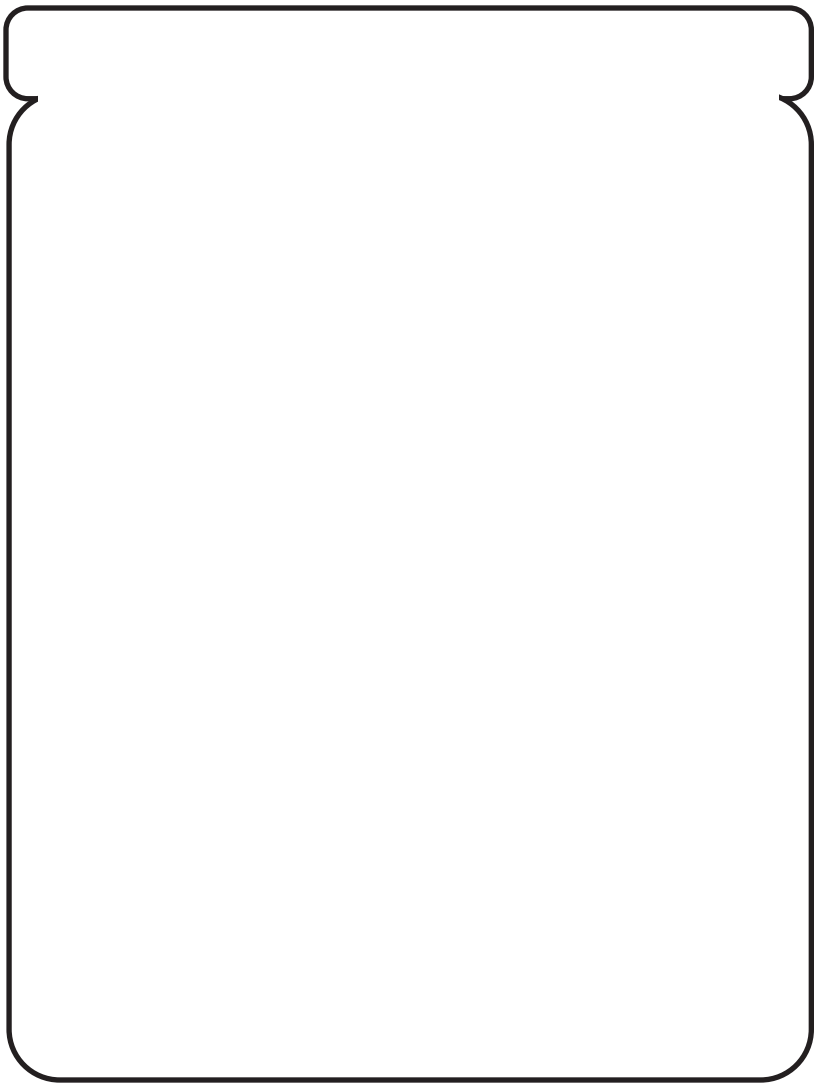
a. Soil

b. Sand

c. Gravel

d. Rock

e. Aquifer



2. Color in the water.

3. What are ways that people can use groundwater?

_____

_____

_____

California State Standards

History-Social Science: 4.1.4, 4.1.5, 4.2.1, 4.4.7

Vocabulary

acorn, irrigation, tannic acid, Tataviam

Materials

- Map of Southern California
- Tujunga Watershed Map (see Resources section) – 1 per student/group
- Figure M – *Mapping My Watershed* – 1 per student
- Figure N – *My Water Use* – 1 per student/group
- Figure O – *The Tujunga Watershed Water Use of the Past*
- Figure P – *Water Use Then and Now* – 1 per student/group

Optional for Activity 2

- acorn flour (See page 50 for sources)
- water
- bowl
- stirring spoon
- electric griddle

GRADE FOUR

4

Cultural History of the Tujunga Watershed

Overview

In Activity 1 – *A Sense of Place*, students begin to understand what is around them when asked to recall, and later look around from the schoolyard to identify the location of mountains, trees, and more. Students study a map of the Tujunga Watershed to learn the major features and landforms of their local area. In Activity 2 – *Water Use Now and Then*, students explore the current uses of water by charting, categorizing and graphing their everyday use. After reading about the use of water throughout the history of the Tujunga Watershed, students compare the uses of water in the past to how it is used today. Finally, Activity 3 - *Helping Conserve and Protect the Water of the Tujunga Watershed*, students imagine what it was like before there were water pipes to carry water, to then brainstorm a project that they can do at school or in their community to help conserve or protect water.

Background Information

There is a rich cultural history of the Tujunga Watershed. Over centuries, people and cultures come and go and with them their practices and perceptions of the physical and biological place around them. Cultures and societies evolve over time, sometimes responding to natural events and constraints, sometimes causing them.

Little remains in the lower watershed that would be familiar to the inhabitants of 200, or even 75 years ago. Certain landmarks such as San Fernando Mission, Andres Pico and Lopez Adobes, and Bolton Hall still persist. The Great Wall of Los Angeles mural at LA Valley College provides a visual timeline of the region's cultural evolution, and reminders of history are still apparent throughout daily life. For example, the names Tujunga and Pacoima originate from the indigenous Tataviam language and mean "old woman place" and "the entrance," respectively. The City of San Fernando takes its name from the mission established there in 1797. Van Nuys is named for the powerful wheat merchant who once owned the land. Many of the street names, such as Sherman Way, Maclay, Chandler, and Lankershim Boulevards are named after people who played pivotal roles in shaping the watershed's future.

Before the influence of missionaries, gold miners, and farmers, the first people to have settled in the San Fernando and Santa Clarita Valleys, around 450 AD, were the Tataviam. Tatviam means 'people facing the sun.' The name comes from the Tataviam practice of building their homes on the sunnier, south facing slopes. They later became known as the Fernandeño, or band of mission Indians because of their role in the construction of the San Fernando Mission.

The Tataviam lived without agriculture or domestic animals. Deer, rabbits, quail, squirrels, birds, lizards, snakes, grasshoppers and caterpillars were hunted and trapped; and acorns, yucca, juniper berries, chia seeds and buckwheat were gathered for sustenance. Rivers and creeks were essential to the Tataviam not only for water, but for the willows and tule reeds that surrounded the riverbanks. These played a crucial role in the construction of shelter and the settlement of their villages. The Tataviam paid meticulous attention to the drainage and flooding patterns of the watershed. They felt a connection to the water and natural resources that many Westerners now do not understand. They relied on the land for survival, yet still worked to conserve their natural resources.

Water continued to play an important role in the cultural history of the area. When the San Fernando Mission was built in 1797, a small irrigation network was developed for the growing of fruit, vegetables, olives and grapes, and to feed livestock. Over the next few decades, the number of Tataviam people dwindled significantly due to disease, changes in their diets and the obliteration of their culture and language. By 1826, Spanish ranchos dominated the area and there were 56,000 longhorn cattle and 1500 horses and ponies in the San Fernando Valley.

By 1834, miners used water to mine gold found in the San Gabriel Mountains. Gold prospectors from Europe, Latin America and China started arriving after gold was discovered in 1842 and used the streams and rivers to mine the gold. By 1845, the mining had ended. Cattle ranching was brought to a sudden end by the disastrous drought of 1863-1864, which resulted in the loss of practically all the cattle and sheep in California. One resident was prompted to observe: "I could have walked across the valley on the bones of sheep and cattle."

By 1880, land use in the valley had shifted once again. Numerous types of agriculture were attempted, each culture bringing with it a different crop, with various results. In the south-east watershed where the water table is closest to the surface, vineyards and fruit orchards flourished. Olives did well in the north valley. Small-scale irrigation was tried with citrus. A single farm a few miles from San Fernando produced vegetables with irrigation. Until 1910, almost all the land south of what is now Roscoe Blvd. was functioning as the largest wheat farm in the world. The wheat was grown without an irrigation system.

In 1913, a small group of powerful men saw the valley as a good way to make a lot of money. They bought most of the farmland intending to break it up into thousands of small lots for homes – each of them with running water – that would attract new residents from all over the country. Up until that time, all the water for crops, and for drinking, bathing, and everything else had come from rivers and creeks and from wells that brought water up from the vast underground reservoir called the San Fernando Groundwater Basin. While there was enough water to go around, the men knew that building hundreds of thousands of homes with running water meant creating a reliable water supply and delivery system. So the men devised a plan to take water from other areas in California and bring it to the area by an aqueduct – a large concrete channel used to bring water from one place to another. Today, this is the main source of our drinking water.

Preparation

- Choose an area on the schoolyard that provides students the best view of the San Gabriel Mountains and other natural landmarks.
- Make color copies of the Tujunga Watershed Map located in the Resources section.
- Obtain a map of southern California that shows the local mountain ranges, rivers, and Pacific ocean.
- Photocopy the Figure M – *Mapping My Watershed* worksheet – 1 per student.
- Find and cut out images from a magazine or other source showing different uses of water including washing dishes, taking a drink, taking a bath, watering plants, swimming, etc.
- Photocopy the Figure N – *Water Use Now* worksheet – 1 per student.
- Photocopy Figure O – *The Tujunga Watershed Water Use of the Past* – 1 per student.
- Photocopy the Figure P – *Water Use Then and Now* worksheet – 1 per student.
- Decide to have students work in groups or individually.
- Decide whether you will be making acorn bread. Gather the materials and practice preparing the bread. See page 50 instructions.
- Prepare some ideas for a water conservation project.

Activity 1 – A Sense of Place

Procedure

Part I

1. Ask the students the following questions and write their responses on the board or chart paper:
    a. What do you think you might see if you stood in the middle of the schoolyard, circled around, and looked through a pair of binoculars?
    b. What do you think you might see if we took all the buildings, cars and streets away?

2. Take students outside to an open area on the schoolyard to look around.

3. Point out to the students:
    a. The San Gabriel Mountains
    b. The direction of the closest waterway: Big Tujunga, Little Tujunga, or Pacoima Washes, or Hansen Dam
    c. Any trees or other visible plant and wildlife
    d. The direction the sun moves from east to west
    e. The direction of north and south
    f. Any other visible landmarks

4. After taking the students back into the classroom, ask them the following questions and compare their responses to those recorded earlier:
    a. What did you observe?
    b. What did you observe that was different than what you expected?

Part II

1. Display a map of southern California. Point out the following:
    a. Name of the map. Explain that this map shows the part of the United States where they live.

b. Compass rose. Explain that this used to describe direction. Explain that this is used to describe direction. East is the direction the sun rises. West is the direction the sun sets. When facing west, north is to the right and south is to the left, and east is behind.

c. Have students point out the main features of southern California, including:
    i. Pacific Ocean and other major water bodies of water
    ii. Mountain ranges including the Santa Monica Mountains and the San Gabriel Mountains
    iii. Major rivers including the Los Angeles River
    iv. San Fernando Valley

2. Ask students, "Why do you think this area was so important to people throughout history, including Native Americans, ranchers and farmers?"
    a. Explain to students the importance of the rich natural resources of the area, which included the ocean, rivers, plants and animals, and healthy soil.

3. Pass out a copy of the Tujunga Watershed map to each student group. Point out the following:
    a. Name of the map. Explain that this map shows the land area where water flows in their community.
    b. Compass rose. What is in the East part of the watershed? What is located in the West, North and South parts of the watershed?

4. As they observe the map, instruct the group to do the following:
    a. Locate the boundary of the Tujunga Watershed.
        i. How can you tell it is the boundary?
    b. Locate the San Gabriel Mountains.
        i. How can you tell they are mountains?
    c. Locate where water flows.
        i. How can you tell it is water?
        ii. Which direction is the water flowing? (You may want to crumble a piece of paper to demonstrate a mountain with ridges, and that water moves from higher to lower places.)
        iii. How does water help to shape the mountains?
        iv. What is the name of the main waterways coming down from the San Gabriel Mountains?
        v. Where do these waterways lead?
    d. Locate the major roads/freeways.
        i. How can you tell it is a freeway?
        ii. What is the name of some of the freeways in the Tujunga Watershed?
    e. Locate where our school is situated on the map.
        i. Based on our observations from the schoolyard, where do you think we are on the map? (Show students where the school is located and have them mark it with an X.)
        ii. What is the major waterway closest to our school?
        iii. Which direction (North, South, East or West) is the major waterway to our school?
        iv. Which direction are the San Gabriel Mountains to our school?
        v. Which direction is the closest freeway to our school?
    f. If we were to create a Key for this map, what would it look like?

5. Pass out a piece of paper and Figure M – *Mapping My Watershed* worksheet. Using their copy of the Tujunga Watershed map, have each student create their own map of the watershed.

Activity 2 – Water Use Now and Then

Procedure

Part I

1. Display images and a list of water-related activities on the board, such as taking a drink, washing dishes, taking a bath, watering plants, and cooking pasta. Ask the students what these actions all have in common. Discuss the variety of uses for water.

2. Distribute the Figure N – *Water Use Now* worksheet. Go over Part I of the worksheet, and how to keep track of their family's water usage by filling in the log. Have students complete the worksheet for homework and bring it to class the next day.

3. Ask students what they learned about completing the *Water Use Now* worksheet. Were they surprised by any additional uses of water?

4. Working in groups, have students review each other's worksheet and compare their results. Have groups take the group's data and place the water uses into the following categories:
    a. Food/Drink
    b. Transportation
    c. Cleaning
    d. Making items
    e. Recreation
    f. Other

5. Using Part II of their *Water Use Now* worksheet, instruct the groups on how to display their data by graphing.

6. After completing their graphs, have groups share their findings with the class.

7. As groups present their findings, create a class graph combining the results of each group. Discuss what the greatest use of water was in their daily lives.

Part II

1. Have students read Figure O – *The Tujunga Watershed Water Use of the Past*.

2. Discuss what was read and how it relates to what they learned about their own water use. Ask the students:
    a. What were similar ways now and then that water was used?
    b. What were different ways now and then that water was used?
    c. How has water played an important role in the history of the watershed?

3. Distribute the Figure P – *Water Use Then & Now* worksheet. Using the reader, have students complete Part I listing the different uses of water that were used throughout history of the area. Have them circle the type of water use.

4. Have students complete Part II of the worksheet by filling in the Venn diagram comparing examples of how water was used differently "now," "then," and what was used "now and then."

Part III (optional)

1. Have students help make a batch of acorn bread using acorn flour. See page 50 for a modern version of the recipe.

Activity 3 ~ Helping Conserve and Protect the Water of the Tujunga Watershed

Procedure

1. Discuss with students how at home and at school it is so easy to turn on a faucet to get water. Have students imagine what it was like before there were water pipes to carry water. Discuss with students:
    a. The difference between getting water now (turn on a faucet) and getting it then (gathering it in a container from a stream or river, or a well).
    b. How water gets to their homes and school (a vast system of underground pipes).
    c. What would be the impact on their lives if there was not enough clean water.

2. Brainstorm with the student's different ways they can help conserve water, or keep the water of the Tujunga Watershed clean. Ideas include:
    a. Creating a litter patrol and recycling program at school.
    b. Creating an awareness campaign with posters and brochures on the importance of conservation and keeping water clean.
    c. Creating an "Eco-classroom" with water conservation behaviors and challenging other classrooms to do the same.

3. Choose one of the ideas to carry out. See the Resources section for additional ideas.

Figure M

Mapping My Watershed

Name _____ Date _____

1. On a separate piece of paper draw your own map of the Tujunga Watershed. Use the Tujunga Watershed map as your guide.

Include the following on your map:

a. Name of the watershed

b. Boundary line

c. San Gabriel Mountains

d. Major waterways

e. Freeway closest to your school

f. Your school

g. Other features, such as your home.

h. Key

i. Compass rose

2. Answer the following questions:

What feature on the map has helped to shape the mountains and the land?

_____

_____

_____

How do people use this land and water?

_____

_____

_____

Figure N

My Water Use

Name _____ Date_____

PART I

Directions

Every time you use water either directly; like getting a drink or washing your hands, or indirectly; like eating dinner with soup made with water, record it on the chart below.

Time of Day	Water Related Activity
(Sample) 6:00pm	Ate soup

PART II

Our Water Use

Group graph

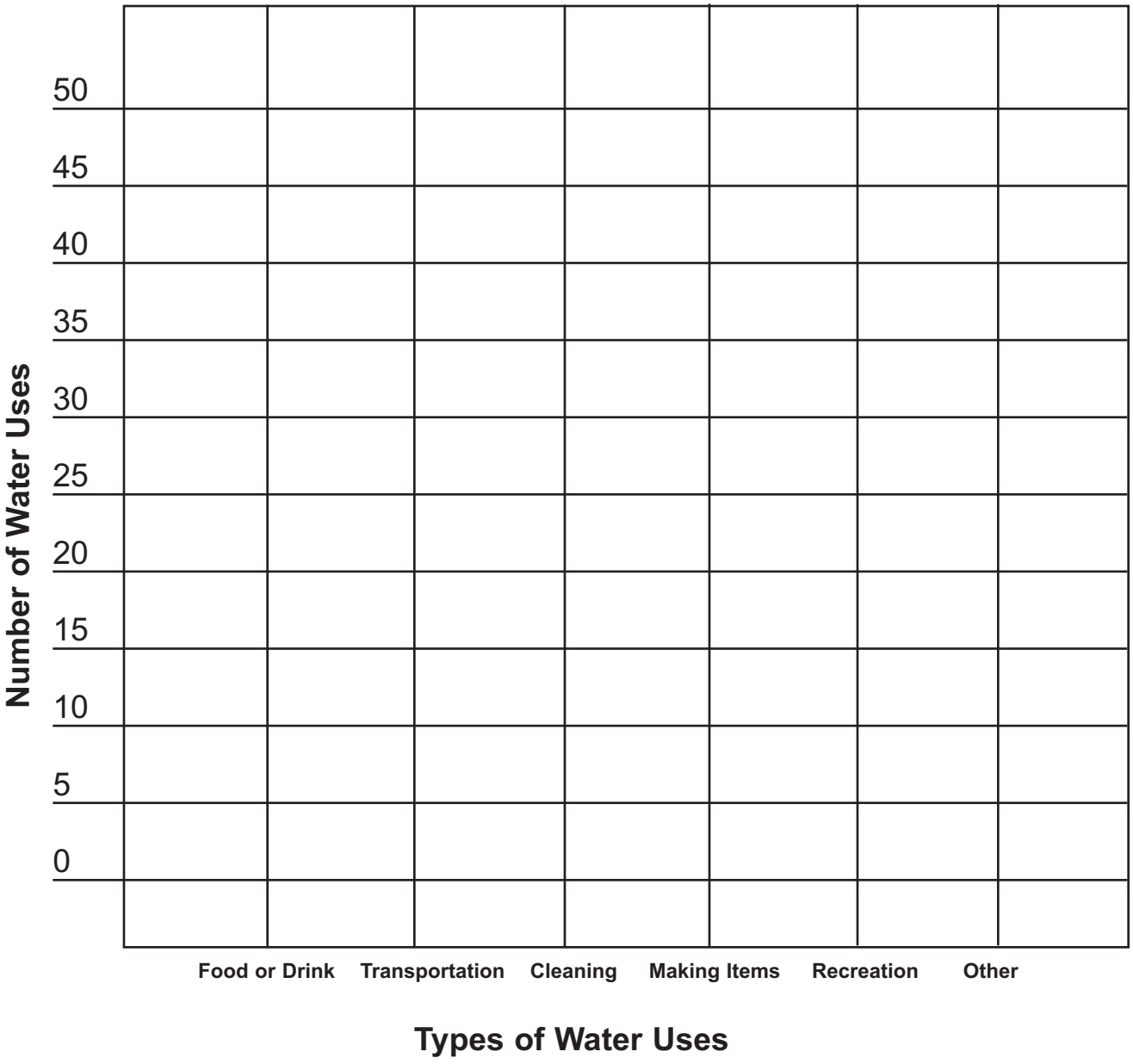


Figure O

The Tujunga Watershed
Water Use of The Past

Flowing down from the San Gabriel Mountains and through the Tujunga Watershed are the rivers. The streams and rivers are as important to us today as they were to the people who lived here hundreds of years ago.

For the Tataviam, the native people that lived in this area around 450 AD, it provided them with the water, plants, and animals that they needed to live. The Tataviam were hunters and gatherers. They did not plant any crops. Everything they needed for food came from the plants and animals in the area and from the rivers.

Water was used for preparing food. One main source of food was from the oak tree. Seeds of the oak tree called acorns were ground down into a flour. Water was poured over the ground acorn repeatedly unto the bitter-tasting tannic acid was washed or leached out. Water was added to the flour to create acorn mush, soup, or bread.

Water was used in providing medicines. For example, leaves of the native buckwheat plant when brewed with water created a tea to relieve headaches and stomach pains.

Trees such as willow and sycamore, and plants such as bulrush and cattails grew in and around the streams and rivers. These trees and plants were used in the building of their homes and other useful home items such as sitting mats and baskets. They were also used to create boats that were made for transportation along the water.

The typical Tataviam home, or Ki'j, was a dome-shaped circle between 12 to 20 feet in diameter. Willow trees branches were cut and placed upright into the ground to form a circle. The tops were then arched toward the center and secured. Cross pieces of willow were then attached before bundles of bulrush or cattails were layered onto the willow frame to form the walls. The hole left in the top allowed for a fire pit in the center of the Ki'j, and was covered with a hide when it rained.

Even the word Tujunga relates to water, as the name comes from a Tataviam legend about an old woman by the river. From the time of the Tataviam, and throughout history, water continued to be a valuable resource to this area.

In 1797, missionaries were drawn to the area because of its fertile soil, and abundant spring water that could be used for irrigation and drinking. When the San Fernando Mission was built, a small irrigation network was developed for the growing of fruit, vegetables, olives, and grapes, and to feed livestock.

San Fernando Mission (Oviatt Library, CSUN)

By 1842, gold prospectors and settlers started arriving after gold was discovered. They used the streams and rivers to mine the gold.

Olive grove in Sylmar
(West Valley Museum, CSUN Library)

Farmers were drawn to the area because of the plentiful underground water supply, warm climate, and fertile soil ideal for growing crops. By the late 1880s, the area had the largest wheat farm in the world and orchards of trees, including olives, and citrus fruits such as oranges and lemons.

In 1913, when a small group of powerful men bought all the farms to develop housing, water from other areas in California was brought to the area by an aqueduct – a large concrete channel used to bring in water from other places. This is the main source of our drinking water today.

Opening of the Los Angeles Aqueduct, 1913
(San Fernando Valley Historical Society)

Figure P

Water Use Then & Now

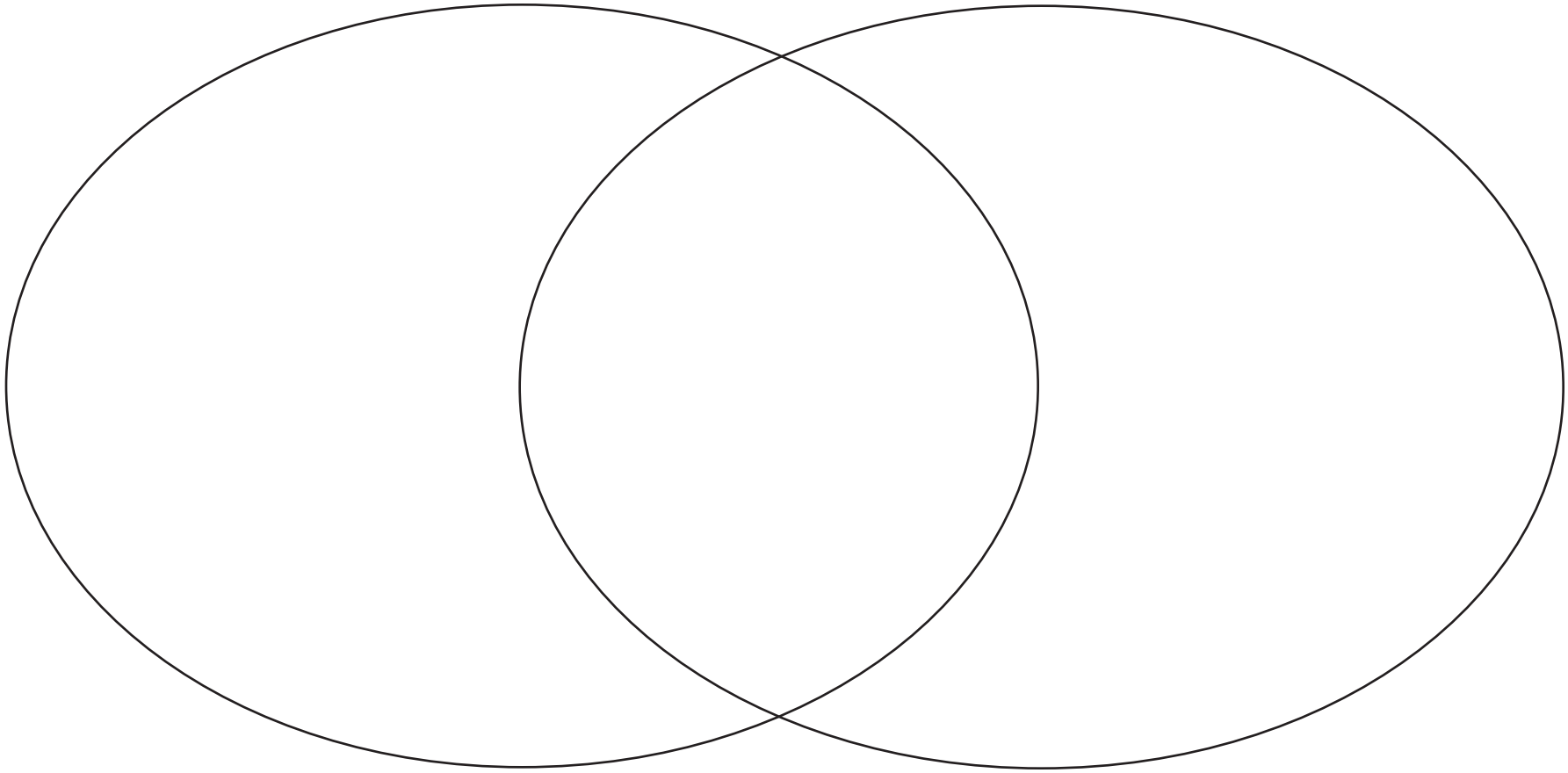
Name _____ Date_____

PART I
Directions
Read through the handout and list all the uses of water described. Circle the type of water use.

Water Related Activity	Type of Water Use		
1.	**Food or Drink**	**Transportation**	**Cleaning**
	Making Items	**Recreation**	**Other**
2.	**Food or Drink**	**Transportation**	**Cleaning**
	Making Items	**Recreation**	**Other**
3.	**Food or Drink**	**Transportation**	**Cleaning**
	Making Items	**Recreation**	**Other**
4.	**Food or Drink**	**Transportation**	**Cleaning**
	Making Items	**Recreation**	**Other**
5.	**Food or Drink**	**Transportation**	**Cleaning**
	Making Items	**Recreation**	**Other**
6.	**Food or Drink**	**Transportation**	**Cleaning**
	Making Items	**Recreation**	**Other**
7.	**Food or Drink**	**Transportation**	**Cleaning**
	Making Items	**Recreation**	**Other**
8.	**Food or Drink**	**Transportation**	**Cleaning**
	Making Items	**Recreation**	**Other**
9.	**Food or Drink**	**Transportation**	**Cleaning**
	Making Items	**Recreation**	**Other**
10.	**Food or Drink**	**Transportation**	**Cleaning**
	Making Items	**Recreation**	**Other**

PART II

Directions
Using examples from your own water use and examples from PART I, create a diagram showing some of the uses of water that are used differently then, now, and those that are the same.



Water Use Now **Water Use Now and Then** **Water Use Then**

Acorn Bread Recipe

Modern version

- 1 cup acorn flour*
- 1 cup flour
- 2 tablespoons baking powder
- ½ teaspoon salt
- 3 tablespoons sugar
- 1 egg, beaten
- 1 cup milk
- 3 tablespoons oil

– Sift together, acorn meal, white flour, baking powder, salt and sugar.
– In separate bowl, mix together egg, milk, and oil.
– Combine dry ingredients and liquid ingredients.
– Stir just enough to moisten dry ingredients.
– Pour into a greased pan and bake at 400 degrees for 30 minutes.

*Look for acorn flour at Asian markets

California State Standards

Earth Science: 3a, b, c, d, e

Vocabulary

atmosphere, condense, evaporate, freshwater, glacier, groundwater, precipitation, sanitary sewer system, storm drain, water cycle, water vapor

Materials

- large trash bag
- Tujunga Watershed Map (see Resources section) – 1 per student/group
- Los Angeles River Watershed Map (see Resources section) – 1 per student
- Figure Q – *Mapping My Watershed* – 1 per student
- Figure R – *The Cycle of Water in Our Community* – 1 per student/group
- poster paper – 1 per group
- markers or colored pencils
- Figure S – *The Source of Water in Our Community* – 1 per student/group
- watering can
- water
- Figure T – *Where Does Water Go?* – 1 per student/group

GRADE FIVE

5

Water of the Tujunga Watershed

Overview

In Activity 1 – *A Sense of Place*, students begin to understand what is around them when asked to recall, and later look around from the schoolyard to identify the location of mountains, trees, and more. Students study a map of the Los Angeles River watershed and the Tujunga Watershed to learn the path water takes in their local area. In Activity 2 – *The Cycle of Water*, students read how water cycles, including the water that flows across the school grounds. Students demonstrate what they have learned by illustrating the cycle. For Activity 3 – *The Source of Water in Our Community*, students learn the source of their drinking water. Through demonstrations of the impact of concrete on the local source of fresh water, students are prepared for Activity 4 – *Where Does Water Go in Our Community?*. Using trash collected on the grounds at school, students read about the impact of trash on the water system and categorize what they found. Finally, Activity 5 - *Helping Conserve and Protect the Water of the Tujunga Watershed*, students use what they have learned, to then brainstorm a project that they can do at school to help conserve and protect water.

Background Information

One of our most valuable assets is our water and waterways. However, most of our waterways have been encased in concrete and much of our land has been covered in asphalt. When it rains, instead of contributing to groundwater supply, most of our water ends up in the ocean. As a result, we spend $1 billion a year to import most of our water supply from other regions whose ecosystems are threatened by that loss. Nearly 20% of the state's energy use goes to importing water to Southern California. Meanwhile, the aquifer beneath the San Fernando Valley that could be supplying as much as 60% of our water needs is dangerously depleted.

The Tujunga is the largest subwatershed of the upper Los Angeles River Watershed. The 225-square mile area comprises both remote open space of the Angeles National Forest, and the highly urbanized lands of the cities of Los Angeles & San Fernando. The watershed has a very steep slope – the high elevations of the San Gabriel Mountains

(above 7100 ft.) in the upper watershed drop rapidly to the valley floor at an average rate of 41 ft/mile. Dozens of streams feed the three main tributaries – the Big Tujunga, Little Tujunga, and Pacoima Washes. Big and Little Tujunga Wash come together in the Hansen Dam Reservoir. Below Hansen Dam, Pacoima Wash joins the channelized Tujunga Wash as it flows to its confluence with the Los Angeles River in Studio City. The Los Angeles River directs water all the way down to Long Beach harbor and deposited into the ocean.

Historically, the Tujunga Wash was a major contributor of groundwater supply. The San Fernando Valley sits atop the San Fernando Groundwater Basin – a huge aquifer that has become depleted over the years as we have made the valley floor impervious. Rain that used to soak into the ground now runs off of concrete and asphalt and directly into stormdrains and our channelized washes and river.

Although Los Angeles averages only 15 inches of annual rainfall, the higher elevations of this watershed receive some of the most concentrated rainfall in the United States. The depleted basin currently provides nearly 15% of local drinking water supplies to Los Angeles. Prior to the channelization of our river systems and the subsequent intense development, roughly 80% of stormwater percolated to groundwater. Current estimates are that around 8% percolates, the rest being lost to the ocean via the channelized river system carrying contaminants from urbanized land use. Approached from a watershed context, the Tujunga Watershed provides significant opportunities to maximize recharge, optimize reuse, improve water quality, and reduce reliance on imported water.

Preparation

- Choose an area on the schoolyard that provides students the best view of the San Gabriel Mountains and other natural landmarks.
- Make color copies of the Los Angeles River Watershed Map located in the Resources section.
- Make color copies of the Tujunga Watershed Map located in the Resources section.
- Photocopy the Figure P – *Mapping My Watershed* worksheet – 1 per student.
- Decide to have students work in groups or individually.
- Photocopy Figure Q – *The Cycle of Water in Our Community* – 1 per student/group.
- Have available markers, colored pencils, or other materials for students to create posters.
- Photocopy Figure R – *The Source of Water in Our Community* – 1 per student/group.
- Locate areas at school to demonstrate water runoff on concrete and soil.
- Photocopy Figure S – *Where Does Water Go?* – 1 per student/group.
- Prepare some ideas for a water conservation or protection project.

Activity 1 – A Sense of Place

Procedure

1. Ask the students the following questions and write their responses on the board or chart paper:
    a. What do you think you might see if you stood in the middle of the schoolyard, circled around, and looked through a pair of binoculars?
    b. What do you think you might see if we took all the buildings, cars and streets away?

2. Take students outside to an open area on the schoolyard to look around.

3. Point out to the students:
    a. The San Gabriel Mountains
    b. The direction of the closest waterway: Big Tujunga, Little Tujunga, or Pacoima Washes, or Hansen Dam
    c. Any trees or other visible plant and wildlife
    d. The direction the sun moves from east to west
    e. The direction of north and south
    f. Any other visible landmarks

4. Before going back into the classroom, using a large trash bag, ask students to gather up any trash that they find on the school grounds. Carry the bag back into the classroom for later use.

5. After taking the students back into the classroom, ask them the following questions and compare their responses to those recorded earlier:
    a. What did you observe?
    b. What did you observe that was different than what you expected?

6. Display a map of Los Angeles/ Los Angeles River watershed. Point out the following:
    a. Name of the map. Explain that this map shows the part of Los Angeles where they live.
    b. Compass rose. Explain that this is used to describe direction. East is the direction the sun rises. West is the direction the sun sets. When facing west, north is to the right and south is to the left, and east is behind.
    c. Have students point out the main features of the map, including:
        i. Pacific Ocean and other major water bodies of water
        ii. Mountain ranges including the Santa Monica Mountains and the San Gabriel Mountains
        iii. Major rivers including the Los Angeles River
        iv. San Fernando Valley and the area where the school is located.

7. Pass out a copy of the Tujunga Watershed map to each student group. Point out the following:
    a. Name of the map. Explain that this map shows a closer view of the land area where water flows in their community.
    b. Compass rose. What is in the East part of the watershed? What is located in the West, North and South parts of the watershed?

8. As they observe the map, instruct the group to do the following:
    a. Locate the boundary of the Tujunga Watershed.
        i. How can you tell it is the boundary?
    b. Locate the San Gabriel Mountains.
        i. How can you tell they are mountains?
    c. Locate where our school is situated on the map.
        i. Based on our observations from the schoolyard, where do you think we are on the map? (Show students where the school is located and have them mark it with an X.)
        ii. What is the major waterway closest to our school?
        iii. Which direction (North, South, East or West) is the major waterway to our school?

iv. Which direction are the San Gabriel Mountains to our school?
v. Which direction is the closest freeway to our school?

9. As they observe the map, show how water cycles through area. Point out:
   a. How rain water that falls in their local mountains, either seeps into the ground, or flows down through the canyon creeks and streams that lead to the washes.
   b. The washes that carry the water down into the San Fernando Valley where it is captured behind Hansen Dam.
   c. The path water takes from the Tujunga and Pacoima Washes to the Los Angeles River.
   d. The path water takes from the Los Angeles River to the ocean.
   e. How water is then evaporated back up into the sky, where clouds eventually form to rain down on the land again.

10. Pass out a sheet of graph paper and Figure Q – *Mapping My Watershed* worksheet. Using their copy of the Tujunga Watershed map, have each student create their own map of the watershed.

Activity 2 – The Cycle of Water

Procedure

1. Review the path water takes in their community when it hits the local San Gabriel Mountains. Review how this process creates a cycle.

2. Distribute Figure R – *The Cycle of Water In Our Community* and have students read and think about the questions asked.

3. Ask students what they learned about the cycle of water. Had they ever thought of the cycle of water through their school? Discuss the questions asked.

4. Working in groups, have students complete a posterboard display creating a picture of the water cycle. Have them:
   a. Draw a picture of how water cycles through the Tujunga Watershed
      Include:
      – San Gabriel Mountains
      – Tujunga Wash
      – Pacoima Wash
      – Los Angeles River
      – Pacific Ocean
   b. Draw arrows to show the direction of the cycle
   c. Label where the following happens to water:
      – Condensation
      – Precipitation
      – Evaporation
   d. Use their own words to describe what is happening at different stages of the cycle.

5. Have groups present their picture.

Activity 3 – The Source of Water in Our Community

Procedure

1. Review the cycle of water in the community.

2. Distribute Figure S – *The Source of Water in Our Community* worksheet and have students read and think about the questions asked.

3. Ask students what they learned about where their drinking water comes from. Discuss the questions asked.

4. Take students outside to the playground. Using a watering can, demonstrate what happens when rain falls on concrete at school – it hits the concrete, slides off moving down toward the street, and into storm drains that lead to the ocean. When it gets to the ocean it cannot be used for drinking and other fresh water needs. Locate areas where they can see how water travels, including any drains, gutters or higher levels that direct water to lower levels.

5. In other areas around the school, have students point out the different places where water flows over concrete and is wasted, and where instead, water can fall on grass, soil and garden surfaces and seep into the ground.

6. As the class walks back to the classroom, using the trash bag from Activity 1, have students pick up more trash from the schoolyard.

Activity 4 – Where Does Water Go in Our Community?

Procedure

1. Review the source of water in their community.

2. Distribute Figure T – *Where Does Water Go?* worksheet and have students read Part I.

3. Ask students what they learned about where water goes. Discuss the questions asked in Part I.

4. Pull out the trash collected from the school grounds, and display it on a table where students can observe what was collected.

5. Working in groups, have students complete Part II of the worksheet by categorizing the trash and answering the questions. Explain the different categories as needed.

6. Have groups present their work.

Activity 5 - Helping Conserve and Protect the Water of the Tujunga Watershed

Procedure

1. Discuss with students:
    a. Their trash findings around the school.
    b. The ideas they had for preventing trash and pollution from harming water.

2. Brainstorm with the student's different ways they can keep water of the Tujunga Watershed clean. Ideas include:
    a. Creating a litter patrol and recycling program at school
    b. Creating an awareness campaign with posters and brochures on the importance of conservation and keeping water clean.
    c. Creating an "Eco-classroom" with recycling behaviors and challenging other classrooms to do the same.
    d. Removing concrete in an area and creating and maintaining a garden.
    e. Using swales and planted berms to direct water into the ground instead of concrete.

3. Choose one of the ideas to carry out.

Figure Q

Mapping My Watershed

Name _____ Date _____

1. On a separate piece of paper or graph paper draw your own map of the Tujunga Watershed. Use the Tujunga Watershed map as your guide.

Include the following on your map:

a. Name of the watershed

b. Boundary line

c. San Gabriel Mountains

d. Major waterways

e. Freeway closest to your school

f. Your school

g. Other features, such as your home.

h. Key

i. Compass rose

2. Answer the following questions:

Where does rainwater go when it rains down in the San Gabriel Mountains?

_____

_____

What is the closest waterway to the school?

_____

Where do the waterways take the water?

_____

_____

What happens to some of the water when it reaches the ocean?

_____

_____

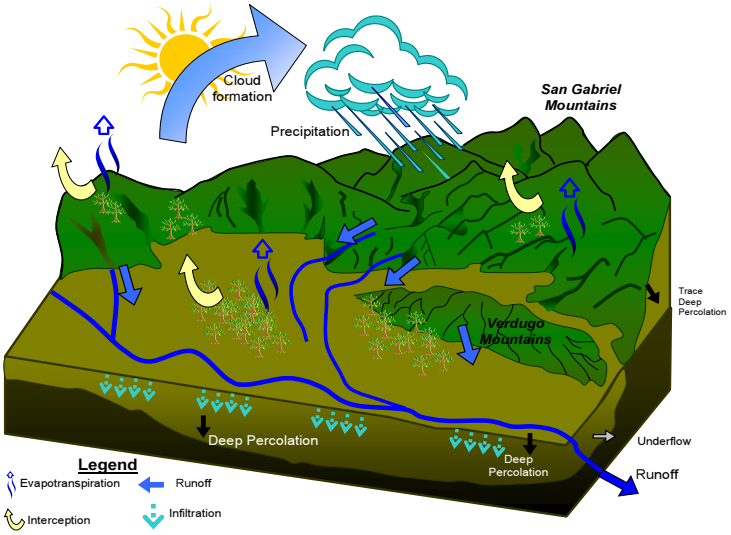
Figure R

The Cycle of Water in Our Community

Name _____ Date_____

Where does water cycle?
Freshwater is an important element of the Tujunga Watershed since most of the Earth's supply of water is salt water and only a fraction of Earth's water is usable fresh water. Even though freshwater is limited, it never runs out because it is constantly moving through the water cycle. Even the water that flows through the schoolyard is an important part of the water cycle.

As part of the larger water cycle, the sun warms salty ocean water, causing water particles to evaporate and enter the air as water vapor, leaving behind the salt. Water from rivers, lakes, plants, and other sources also give off water vapor. High in the atmosphere, clouds are formed by water vapor condensing into tiny liquid drops of water. Finally, droplets of fresh water fall to Earth as rain, hail, sleet, or snow, called precipitation.



When water reaches the Earth, it will either seep into the ground, called percolation,where it is stored as groundwater; or run off the land into moving streams and rivers that go to lakes or the ocean. From there, or if fallen on a hard surface, the water evaporates back into the air – all part of the cycle of water.

1. When it rains at your school, what happens to water that lands on the playground or parking lot?

2. When it is sunny at your school, what happens to water that lands on the playground or parking lot?

3. What happens to water that lands on soil, grass or garden areas?

4. Other than rain, what are other sources of water at your school?

5. At what stage is your school in the water cycle?

Figure 5

The Source of Water in Our Community

Name _____ Date_____

Where Does Fresh Water Come From?
Did you know that rainwater that falls in the Tujunga Watershed used to provide Los Angeles with all of its fresh water needs? Rainwater would flow out of the mountains onto the San Fernando Valley where it would seep down into the ground filling up huge underground layer of rock to become groundwater. Groundwater can be pumped out for drinking, growing plants for food, manufacturing goods, cooking, bathing and more!

This source of fresh water was important because even though most of the earth is covered with water, only one percent of it is usable. Ninety-seven percent of all water on earth is saltwater, and two percent is frozen in the polar ice caps and glaciers. The water that flows down from the San Gabriel Mountains is a needed source of fresh water.

What happened?
Over time, much of the land where you live and go to school has been covered in concrete and asphalt. Concrete and asphalt covered streets, playgrounds, and parking lots prevent water from getting into the ground. The washes and rivers in our community have been lined with concrete to help direct the water. Now, when it rains in our community, instead of seeping into the ground, rainwater flows into a storm drain system that directs the water to the concrete-lined washes and rivers, and carries it straight to the ocean. Once in the ocean, the water is not usable.

If it is not the watershed, what is the main source of fresh water for our community?
In Los Angeles we get our water from four different sources. Fifteen percent of our fresh water comes from groundwater. The rest comes from places throughout California including the Eastern Sierra (Los Angeles Aqueduct), the San Francisco-San Joaquin Bay Delta (California Aqueduct), and the Colorado River (Colorado River Aqueduct). After being cleaned, pipes carry water to our homes and schools.

1. **What happens to the underground stores of water when the land is covered in concrete?**

2. **Where do we get most of our water instead?**

3. **Why do you think it costs a lot of money to bring water to Los Angeles?**

4. **Why is it important to have clean fresh water?**

Figure T

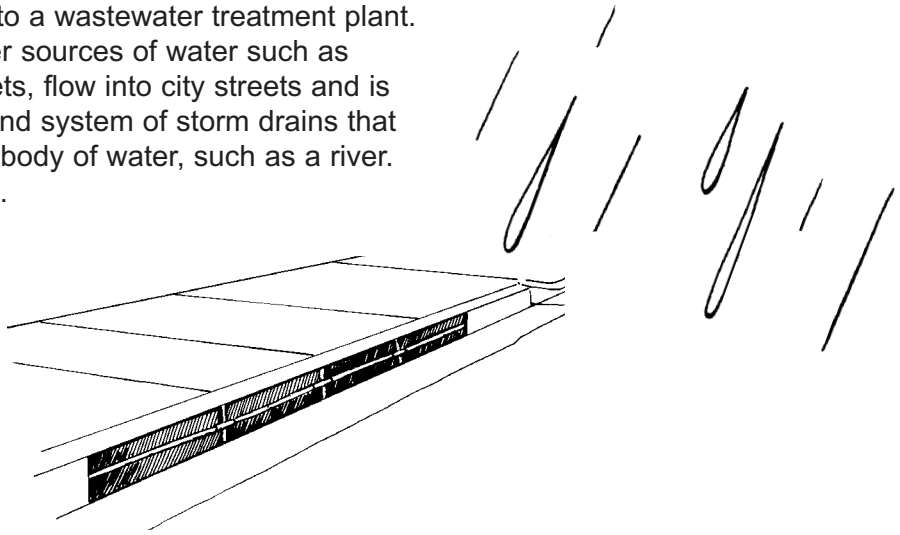
Where Does Water Go?

Name _____ Date_____

Part I

Water in our homes and school that goes down a drain, flows into water pipes. This indoor sanitary sewer system then carries the water to a wastewater treatment plant. Here, the dirty water is treated (or cleaned) before it is sent into rivers or the ocean.

Outdoor water that flows over playgrounds, streets, and other hard surfaces does not go to a wastewater treatment plant. Instead, rainwater and other sources of water such as sprinklers, hoses and faucets, flow into city streets and is carried off by an underground system of storm drains that lead directly to the nearest body of water, such as a river. The water is never cleaned.



When was the last time you saw trash on the ground?

When it rains in the Tujunga Watershed, materials that have been left on the ground including car oil, garden pesticides, pet droppings, and trash are picked up by rainwater. All of these harmful materials get carried by rainwater, as well as water from hoses, sprinklers, and faucets into the storm drain system that leads to our washes, streams and rivers. All these materials are carried to the ocean, polluting the water and harming wildlife.

1. Where does inside water go?

2. Where does outside water go?

3. How do people have an impact on the quality of water in our area?

4. What is left on the ground that can be harmful to water?

5. What about all that trash you collected from the schoolyard? How would it have been harmful if it was left on the ground?

Part II

The Trash At School

1. Use the following chart to list the trash found on the ground at school. Put a check mark under the best way to dispose of it.

Trash item	Can it be recycled?	Can it be reused?	Should it go in a trashcan?

2. Answer the following questions:

How many items could have been recycled? _____

What were some of the items?_____

_____

How many items could have been reused? _____

What were some of the items?_____

_____

How many items should have been put in a trashcan? _____

What of those items could have been replaced with something recyclable?_____

_____

In what way would this trash harm water in our watershed? _____

_____

What ideas do you have for reducing the amount of harmful items that end up on the ground?

_____

_____

_____

_____

Make A Watershed Difference

A Youth Guide to the Tujunga/Pacoima Watershed

produced by

The RIVER PROJECT

Overview

This set of activities and worksheets is designed to help you help your community and more specifically, the Tujunga/Pacoima Watershed.

As a part of this program you will:
- Explore your part of the Tujunga/Pacoima Watershed
- Work with your team to observe and map your community
- Use your own ideas and voice to choose and carry out a project
- Find others in the community to help

The program is broken down into the following sections:

Step 1 – Map Your Watershed
In order to take action in your watershed, you need to know something about it – what it is and where you are located. First you will do a simple activity to understand what a watershed is before looking at maps to find your place in the big picture. By the end of the activity a large map of your area will be created showing the area between your site and the closest waterway.

Step 2 - Explore the Issue
Now that you have a better idea about watersheds, and more specifically the Tujunga/ Pacoima Watershed; and have created a map of your immediate area leading to the closest waterway; it is now time to learn what is going on. Working in groups, each team will be given an information sheet to read and discuss. Then, groups will take what they have learned and create a visual display to share with and teach the other teams.

Step 3 - Identify a Problem
So what is happening in your targeted area? Using the map that you created, a community survey is completed to get a better idea of what is happening in your area. It will require walking the site, making observations, taking pictures, answering questions, and then marking your findings onto the larger map. After reviewing your findings, questions will help you to identify any areas of concern and come up with a project idea.

Step 4 - Take Action
Now the work begins, it is time to take action! Once you break down your project into tasks it is important to set a timeline, look at your resources, set a budget and more. All this is important when working to complete a project.

Step 5 - Looking Back
Once the project is complete it is important to reflect on your project both personally and as a group to understand what you learned. Evaluation questions help you to measure success, see how you worked as a group, how you can improve and to get the most out of your experience.

Resources
A resource section includes a glossary of terms, local organizations related to the watershed, project ideas, and more.

What Do You Need to Begin?

Adult/Group Advisors
Your group should have an adult group advisor. Depending on the age of your group members, the group advisor may play a very active role, or he or she may only offer advice and help when needed.

The group advisor plays a crucial role in facilitating this process, making sure you are meeting your timeline, and offering suggestions and encouraging members to make decisions for themselves. The group advisor should ensure that every member is included in group decisions and project work.

Easy-to-follow instructions are provided for each activity making it easy for an adult/group advisor or even a student facilitator to guide the process.

MAP YOUR WATERSHED

Step 1

Materials

- 2 sheets of paper
- Scotch tape
- Black marker
- Blue marker
- Spray bottle of water
- Los Angeles River Watershed map (see Resource section)
- Tujunga/Pacoima Watershed map (see Resource section)
- Thomas Guide map of your area or other city map
- 1890's Hydrology of the Tujunga Watershed map (see Resource section)
- Current Hydrology of the Lower Tujunga Watershed map (see Resource section)
- Poster or mural paper
- Markers

Overview

In order to take action in your watershed, you need to know something about it – what it is and where you are located. First you will do a simple activity to understand what a watershed is before looking at maps to find your place in the big picture. By the end of the activity, a large map of your area will be created showing the area between your site and the closest waterway.

Procedure

Part I – A Closer Look at Watersheds

1. Crumple a piece of paper into a ball. Open it up to create a "mountain" by pulling up the center of the paper, and taping down the edges of the paper onto another sheet.

2. Using a black marker, trace the ridges of your mountain starting at the tallest peak.

3. Using a blue marker, trace the lowest points between all the ridges. This is where creeks and streams flow.

4. At the points where the streams meet are the rivers. The rivers carry the water to the ocean or another large body of water.

5. Discuss:
   - A watershed is the entire land area around a creek from which all rainwater and runoff ends up in that same creek.
   - The boundaries of a watershed are the natural ridges. On one side of the ridge, water drains into one stream, and on the other side of the ridge, the water drains into another creek. These drainage separates one watershed from another.
   - Look at your mountain, is there more than one watershed?

6. Demonstrate the flow of water from upper areas to lower areas by using a water sprayer to see where the creeks flow. Spray from above, so the water falls like rain. Keep spraying until the water flows in the creeks down each watershed.

Part II – The Los Angeles River Watershed

1. Look at the *Los Angeles River Watershed* map. The Los Angeles River Watershed is the main watershed at the heart of the Los Angeles area. How does this map reflect the model you created?

2. Using the map of the Los Angeles Watershed:
    a. Locate the upper boundaries of the watershed. Follow the mountain ridges all around the upper part of the watershed. These ridges are part of different mountain ranges:
        i. San Gabriel Mountains in the north and east
        ii. Santa Susanna Mountains in the west
        iii. Santa Monica Mountains in the south
    b. Locate the waterways that flow into the Los Angeles River. What are the names of these waterways that are part of the watershed?
    c. Follow the path of the Los Angeles River to the lower point of the watershed. What body of water does the river flow into?

3. The Los Angeles River Watershed is bordered by other watersheds:
    a. Santa Clara River Watershed to the north
    b. San Gabriel River Watershed to the east
    c. Santa Monica Bay Watershed to the west

Part III – The Tujunga/Pacoima Watershed

1. Look at the *Tujunga/Pacoima Watershed* map. The Tujunga/Pacoima Watershed is a sub-watershed of the Los Angeles River Watershed. Find where the Tujunga/Pacoima Watershed fits into the larger Los Angeles River Watershed.

2. Using the map of the Tujunga/Pacoima Watershed
    a. Locate the upper boundaries of the watershed. What mountain range is the watershed a part of?
    b. Locate the upper creeks. What are the names of the creeks that are part of the watershed?
    c. Follow the path of the creeks. What bodies of water do the creeks flow into?
    d. Follow the path of water to the lower point of the watershed. What river does the water flow into?
    e. Identify areas where humans have manipulated the flow of water through the watershed.

3. Look at the map and identify where your school or facility is located. You can do this by finding major streets, freeways or other landmarks. Use a local city map, if necessary, to pinpoint your location on the watershed map.

4. Identify what the closest body of water (wash, river, dam) is to your school or facility. The land from your school or facility to the closest body of water will be the area you will map for water flow, paved and unpaved, planted and non-planted sites, and pollution and trash.

Part IV – Watershed Hydrology

1. Look at the *1890's Hydrology of the Tujunga Watershed* map. The 1890's Hydrology of the Tujunga Watershed shows where water naturally used to flow through the watershed.

2. Using the map of the 1890's Hydrology:
    a. Locate where the current boundary of the watershed is in relation to where water used to flow.
    b. Compare where your facility or school is located to where water used to flow.

3. Look at the *Current Hydrology of the Lower Tujunga Watershed* map. The Current Hydrology of the Lower Tujunga Watershed shows where water currently flows through the watershed.

4. Using both maps of the Hydrology of the Lower Tujunga/Pacoima Watershed:
    a. Identify areas where humans have manipulated the flow of water through the watershed.
    b. What are the differences between the natural boundaries of the watershed and the man-made boundaries?

Part V – Map Your Local Area

1. Using a local city map (Thomas Guide, Google Maps or other) find your location and mark out a square that leads from your site to the closest body of water.

2. Using the city map as your guide, create your own map of the marked out area onto poster or mural paper, making it larger and easier to read.

3. Add details to your map including well-known places such as schools, parks, the grocery store, parking lots, etc.

Materials

- Information sheet: *Thinking About Water*
- Information sheet: *A Concrete Slide to the Ocean*
- Information sheet: *What's Going Down the Drain?*
- 3 poster or dry erase boards – 1 per working group
- Markers – 1 set per group

EXPLORE THE ISSUE

Step 2

Overview

Now that you have a better idea about watersheds, and more specifically the Tujunga/Pacoima Watershed; and have created a map of your immediate area leading to the closest waterway; it is now time to learn what is going on. Working in groups, each team will be given an information sheet to read and discuss. Then, groups will take what they have learned and create a visual display to share with and teach the other teams.

Procedure

1. Divide into three different working groups.

2. Each group takes a different topic to read and discuss. Topics are:
   - *Thinking About Water*
   - *A Concrete Slide to the Ocean*
   - *What's Going Down the Drain?*

3. Each group, after reading and answering the questions through discussion, uses poster or dry erase board and markers to visually illustrate what they have learned.

4. Once the posters are complete, each group presents their poster to the entire group.

Information Sheet

Thinking About Water

If you were to chart every time you used water – directly or indirectly – you would be surprised at how much you need water in your daily life. Think about it. Obvious uses are showering, brushing your teeth, washing your hands or flushing the toilet. Or, making coffee, washing dishes or just drinking water. But what about agricultural and industrial use, such as the water that was used to grow your food or make your car? How much drinkable water do you think we use to water our lawns? We use a lot of water!

All this water use costs us money

The city of Los Angeles alone, with a population of around 4 million people, uses approximately 212 billion gallons of water per year. Without a local supply of water to meet our need, Los Angeles must import 85% of its water from outside the area, spending over $1 billion each year to do this. Add to that the energy costs – more than 20% of the state's total energy use - of moving all that water over such great distances and you can begin to imagine how unsustainable our system is. As the climate begins to change, less water is becoming available from other areas. Working together, we can begin to find more cost-effective, sustainable ways to meet our water needs.

Was it always like this?

Historically, the Tujunga/Pacoima Watershed was a major contributor of groundwater supply. Groundwater is rain water that is allowed to seep into the soil and is stored below the earth's surface in aquifers. The aquifer under the valley is one of the largest in the region, and although it is nearly empty, it provides nearly 15% of our local drinking water supplies to Los Angeles. Before we covered the valley with impervious streets and parking lots, and our river system was lined in concrete, roughly 80% of rainwater percolated to groundwater. Current estimates are that around 8% percolates, the rest is lost in storm drains, polluted and unusable.

What if rainwater was allowed to seep into the ground?

Some estimate that if we captured all the rainwater that fell and allowed it to fill aquifers, it would be enough to meet as much as 50% of the city's water needs every year! Replacing impervious concrete and asphalt with pervious materials, creating parks and rain gardens, planting trees and mulching dry soil are all actions that help rainwater to get into the soil. Water conservation practices, such as using native plants or installing evapotranspiration meters, reduces our need for water. Without the need to import so much water, imagine the money and energy we would save.

Discuss and illustrate the following:

1. How do you use water?
2. Why does our water cost so much money?
3. How does the Tujunga/Pacoima Watershed help our need for water?
4. What are some ideas to help the Tujunga/Pacoima Watershed supply some of our need for water?

Information Sheet

A Concrete Slide to the Ocean

Do you ever notice where water goes when it rains? Following the path water takes shows you that the rain will either hit grass, trees, and dirt – where it seeps down into the ground, or it will hit rooftops, concrete sidewalks and driveways – where it is directed into the street. When it isn't raining, water from sprinklers, washing cars, and hoses also ends up in the street. Water that ends up in the street will be directed by concrete gutters into the concrete storm drain system. This system carries water into concrete-lined washes and rivers and is sent directly to the ocean. In areas with no storm drains and lots of concrete, water has nowhere to go and ends up flooding streets. Water that floods in the street or ends up in the ocean, is unusable.

What about the water that seeps into the ground?
Water that seeps into the ground – groundwater – can become part of our local drinking water supply. Currently, groundwater provides nearly 15% of that supply to Los Angeles. Before we paved over and re-engineered our watershed roughly 80% of rainwater percolated into the aquifer to replenish groundwater supplies. Imagine how much more of our locally available water could be used if we took steps to prevent it from being carried away to the ocean.

What is the quality of the water that runs off concrete and asphalt?
Water that does not seep into the ground becomes "runoff" – water that runs off of concrete and other impervious surfaces and is directed into the storm drain system. As water moves across concrete it picks up trash, oil, gasoline, pesticides, fertilizers, animal waste and detergents from driveways, streets and parking lots, carrying it into the waterways of the Tujunga/Pacoima Watershed. Urban runoff pollutes the water harming fish and wildlife populations, killing native plants and making the river and ocean unsafe.

What if there were more open space, gardens and trees?
Less paved land means more areas where rainwater can be captured and absorbed into the ground. Gardens, parks and other planted areas keep water from flowing into the street. These open spaces also improve quality of life for people and provide natural habitat for birds, animals and plants. Vegetation helps absorb and clean up polluted runoff. Trees planted throughout the watershed not only help to clean the air and provide shade but slow the flow of rain and flood waters. Using trees and plants native to the area will require less water and fertilizers – helping to not only conserve water, but ensure good water quality. Pervious concrete and asphalt can provide stable surfaces that also absorb water. There is a direct relationship between the overall level of pervious surface and watershed health. Finding ways to capture and infiltrate or reuse rain where it falls can improve both water supply and quality.

Discuss and illustrate the following:
1. What happens to water that hits concrete and other impervious surfaces?
2. What happens to water that hits dirt, grass and trees?
3. What is urban runoff?
4. What are some ideas to provide more pervious areas and help direct water into the ground of the Tujunga/Pacoima Watershed?

Information Sheet

What's Going Down the Drain?

It's in the street, on the sidewalk, blown against fences and just about anywhere you look. Trash in the form of plastic bags, fast-food and candy wrappers, cigarette butts and more can be found throughout the Tujunga/Pacoima Watershed. And, this isn't the only "land" pollution. A closer look might show you oil and grease on the street, dog waste on the sidewalk, and pesticides and fertilizers on grass – all toxic when carried by water into our waterways.

How does this affect the Tujunga/Pacoima Watershed?
Good water quality is critical to the health of the Tujunga/Pacoima Watershed. Polluted and trashed waterways affect our ability to utilize water for drinking supplies, lessens the ability of living systems to remove pollutants naturally, and impacts the ability of the water to support wildlife. Water quality monitoring within the watershed indicates that the waterways are polluted with nitrogen, ammonia, copper, bacteria, and trash.

What is the source of this pollution and trash?
A broad range of human activities impact water quality. Pollutants such as nitrogen and ammonia come from human and animal wastes and commercial fertilizers. Bacteria come from human and animal wastes, leaky septic tanks or sewer lines, and from decaying organic trash dumped in the water. Copper and other metals come from a variety of industrial sources and car-related uses. Trash comes from everyday human behaviors that include leaving trash on the ground, illegally dumping unwanted items into the waterways or simply not keeping lids on trash cans.

What if there was less trash and pollution?
Protecting water quality makes good public health sense, good economic sense, and good environmental sense. Keeping trash and other contaminants off the ground and out of the waterways is essential. Finding, educating about, and ideally eliminating the source of continued trash problems such as plastic bags, fast food containers, packaging and cigarette butts is even better. Landscaping with native plants lessens the need for fertilizers and pesticides. These ideas and others along with continued water monitoring will help raise awareness and lessen the impact of pollution and trash to the Tujunga/Pacoima Watershed.

Discuss and illustrate the following:
1. What types of pollution and trash can be found on the ground and in the waterways of the Tujunga/Pacoima Watershed
2. How does pollution and trash affect the water?
3. What are some of the sources of this pollution and trash?
4. What are some ideas to lessen the amount of pollution and trash in the Tujunga/Pacoima Watershed?

Materials

- Maps of the area (these can be photocopied from a Thomas Guide or other city map, or hand-drawn)
- *Community Survey* – 1 per working group
- Clipboard – 1 per working group
- Pencils
- Colored markers – blue, red, and green – 1 per working team
- Notepaper for notes – 1 per working group
- Camera (optional)
- Larger map completed in the *Map Your Watershed* activity
- *Which Project Should We Choose* worksheet

IDENTIFY A PROBLEM

Step 3

Overview

Using the map of your targeted area that you created in the *Map Your Watershed* activity, complete a community survey to get a better idea of what is happening in your area. It will require walking the site, making observations, taking pictures, answering questions, and then marking your findings onto the larger map. After reviewing your findings, answer questions to help you identify any areas of concern and come up with a project idea.

Procedure

Part I - Community Survey

1. Depending on the size of your group, you can either walk the area and complete the survey as one group or divide the area up and work in smaller teams.
    a. If the area is divided up, assign each smaller area a number.

2. Pass out markers/colored pencils, notepaper, maps of the area, and the *Community Survey* worksheet.

3. Read the maps and make sure each group is familiar with their designated area.

4. Go through the *Community Survey* worksheet and make sure each group knows what they will be looking for and how to mark their map and take notes.

5. Set a deadline for when the *Community Survey* must be complete.

6. Once complete have each group share their findings by answering the questions from the survey and showing the map of their area.

7. Gather all the information and add it to the large map of the targeted area.

Part II – Choosing a Project

1. As a group answer the following questions:
    a. Was there anything that you noticed that you haven't noticed before?
    b. On your map, what areas concerned you and why?
    c. For each area of concern:
        - What is the cause of the concern?
        - What is the effect it is having on the watershed?
        - What is an idea for helping with this issue?

2. Based on your answers, or other ideas that you may have had while surveying the area pick 3 project ideas that will help the Tujunga/Pacoima Watershed. Projects can be as simple as a trash campaign or they can be more complex like planting a "rain garden" in an area that normally floods. Some project ideas can be found in the *Resource* section.

3. Use the *Which Project Should We Choose?* worksheet to answer questions about your different project ideas. The worksheet helps you to look at each idea carefully. If you are unable to answer any of the questions, you may need to do some research to find the answer. See below about where to do more research.

4. Once the worksheet is complete, look at the different project ideas. Based on the questions you answered, select the project that is most doable and that will make a difference in your watershed.

5. Give your project a name. This will be helpful for fliers, posters, etc., or when speaking to others about your project.

Researching more about the issue

- Check your local library for more information. Ask the reference librarian for help to find out more about the issue.

- Conduct a computer search for more information. Be specific with what you are looking for to lead you to the right information.

- Check local papers and magazines for information about what is happening in your community. These articles can lead you to who you should be talking to about your issue.

- Find people in the community to talk to. Create a list of questions and conduct an interview.

- Check with local government about any policies that deal with your issue. There may be people working on proposed policies – laws or programs that are addressing your problem. This may lead you to organizations you can work with.

Community Survey

Name(s): Date: Area #

- Use your pencil to take lots of notes. If necessary, place a number on your map to correspond with numbered notes.
- Use colored markers to mark your map showing blue for water flow, green for natural areas, and red for pollution and trash.
- Use a camera to show more details, if necessary.

On Your Map

1. **Show the direction of water flow.**
   a. Does water flow to gutters, storm drains, ditches, culverts, straight into the body of water or does it flood?

   b. If you are looking at a waterway in an urban environment, the streets may direct water to an underground storm drain system. Make note of where there are catch basins in the street (grates in the gutter, at the end of streets).

   c. Make note of where there are sources of water in your area (faucets, hoses, etc.)?

   d. Count how many times you see sprinkler systems watering sidewalks and mark them on your map.

   e. Draw blue arrows to show the direction (north, south, east, west) that water flows.

   Answer the following in your notes:
   - Is there trash or pollution along these areas where water flows?
   - What kind of trash or pollution is it?
   - Where do you think it comes from?
   - Are there areas where water is allowed to soak into the ground?
   - At what point does water empty into the waterway?

2. Show where there is dirt, planted trees, grass and shrubs.

a. Use green to show these areas on your map.

b. Are there areas (parking lots, alleys, empty lots, tree wells, dirt, etc.) that could use pervious surfaces, plants or trees? Make note of these areas.

Answer the following in your notes:

- Is there more concrete/asphalt or planted open area?
- Are the areas of soil hard (you can't you push your finger into it) or soft and full of organic material?
- If you know, what are the types of plants and trees found?
- Of the green areas, are the plants native or water friendly – need little water to survive?

3. Show areas where there is a lot of trash or other pollution left on the ground.

a. Use red to show areas that are heavily littered or have potential pollution issues (heavy industry, fast food outlets, pesticides, paint/paint cleaner, motor oil, etc.)

b. What are the types of trash and pollution found? Make note of what you find.

Answer the following in your notes:

- Where are there potential sources of pollution?
- Where is the most trash found?
- What is the main type of trash found?
- Are there any options for recycling?

Which Project Should We Choose?

Project Idea #1 _____

_____

_____

_____

1. How would this project help my area of the Tujunga/Pacoima Watershed?

2. Are there others working on this problem – agencies, businesses, organizations?

3. What resources (money, skills, time, tools, etc.) are needed to complete this project?

4. Do we have the time necessary to complete the project?

5. How will we evaluate whether our project is having an impact?

Project Idea #2

1. How would this project help my area of the Tujunga/Pacoima Watershed?

2. Are there others working on this problem – agencies, businesses, organizations?

3. What resources (money, skills, time, tools, etc.) are needed to complete this project?

4. Do we have the time necessary to complete the project?

5. How will we evaluate whether our project is having an impact?

Project Idea #3

1. How would this project help my area of the Tujunga/Pacoima Watershed?

2. Are there others working on this problem – agencies, businesses, organizations?

3. What resources (money, skills, time, tools, etc.) are needed to complete this project?

4. Do we have the time necessary to complete the project?

5. How will we evaluate whether our project is having an impact?

Materials

- Sheets of paper cut into fourths or a set of 3 X 5 cards
- Calendar

TAKE ACTION

Step 4

Overview

Now the work begins, it is time to take action! Once you break down your project into tasks it is important to set a timeline, look at your resources, set a budget and more. All this is important when looking to complete a project.

Procedure

Part I – Create Tasks

1. Using different sheets of paper or 3 X 5 cards, list all the steps you can think of to complete your project. Put one task on each card.

2. Group together similar tasks under specific categories, such as: materials, publicity, etc.

3. For each group, put the tasks in order of when they need to be completed and record this on the task worksheet.

4. Assign who is responsible for each task.

Part II – Create a Timeline

1. Choose a completion date for the project.

2. How long will each task take? Work backwards from your completion date to assign when the task has to be started and completed.

3. Use a calendar to help you figure out dates, and mark when tasks need to be completed.

Part III – Use Local Resources

1. Think about all the ways to gather support for your project by telling others.
    - Can you make a presentation about your project?
    - Who can you meet with to share your vision?
    - What can you learn from others?

2. Make a list of all the people who would be interested in knowing about your project, especially those who can help you. Use the list below to generate some ideas and create a list.

Agencies and Elected Officials

What agencies and elected officials in your area have jurisdiction over the issue that you are working on? In what way can you get their support or help with your project? A list of agencies and elected officials that work within the Tujunga/Pacoima Watershed are listed in the Resource section. For example, for information on storm drain system pathways and discharge points you can contact the Los Angeles County Department of Public Works (George Aintablian at 626-458-7959).

Local Experts

What experts in your area can help you with your project? Some may have similar projects in the community or may have strategies that they have used in the past that could be helpful to you. For example, the Theodore Payne Foundation located in Sunland can provide expert advice on native plants and gardens.

Community Groups

What groups in your area can help you attain your goal? A list of local watershed groups are listed in the *Resource* section. Here are other ideas to help you think of your own resources:

- Neighborhood Councils
- Environmental clubs
- Faith youth groups
- Science clubs
- Service organizations
- Boy/Girl Scout troops

Part IV – Follow Your Task List to Complete the Project

Materials

- Evaluation and reflection questions
- Chart or other board to write down responses, if desired

LOOKING BACK

Step 5

Overview

Now that the project is complete it is important to reflect on your project both personally and as a group to understand what you learned. Evaluation questions help you to measure success, see how you worked as a group, how you can improve and to get the most out of your experience.

Procedure

1. As a group, ask yourselves the following questions to evaluate your project:
    - What did you accomplish?
    - Where were some of your greatest successes?
    - What do you think were some of the reasons for your successes?
    - What things were more difficult than you expected?
    - Did your project make a difference? How?

2. As a group, ask yourselves the following questions to reflect on what you have accomplished and what you learned:
    - How did your project affect the community?
    - How would you do things differently if you had the chance?
    - How do you feel about your project?
    - What did you learn?
    - Would you like to get involved in another project like this? Explain why or why not.

3. Celebrate! Be sure to find a way to celebrate what you have accomplished. Looking back you will see that it took a lot of work. Some ideas for celebrating:
    - Have a pizza party or ice cream social
    - Write an article for the local paper sharing what you did and learned
    - Have a picnic along the waterway you are helping
    - Take a hike in the local mountains – the top of the watershed

Elementary Project Ideas

Trash Reduction

- Create a student litter reduction campaign. Students can help to keep trash in trashcans and not left on the ground during lunch time. The campaign could include posters, fliers, and student-assigned "litter patrol" members. Come up with incentives for a clean campus.

- Analyze trash. Have students survey and determine what is the most common trash left on the ground. Have them come up with a plan to reduce its use. For example, if the majority of trash is paper bags, encourage the use of lunch boxes, etc.

- Start a recycling program. Start small by collecting one kind of item - one that is used most often at school and found on the ground. Then, increase the program with additional recyclables. Create measurable, attainable goals for the students to reduce trash each week or month. Generate money for special activities.

- Adopt a stream, river or local park in the watershed. Clean up a portion and help maintain it.

Create and Take Care of Green Space

- Work with the Principal and school facility managers to find areas where concrete can be removed and more trees/grass/gardens can be added that will absorb water and rainfall.

- Landscape an existing area with native trees, shrubs, flowers, and grasses that do not require a lot of water.

- Improve soil quality and permeability at the school by adding mulch on top of bare soil areas. Create a plan for maintaining the mulch and adding more as needed.

Watershed Awareness

- Teach others about the Tujunga Watershed. Design a "watershed awareness" display for other students, parents, and the community. This could include student-made information and pictures that teach the different aspects of the watershed, including where it is located, where water flows, how the watershed has changed throughout history, what can be done to help, etc.

- Have students write a letter to the principal, mayor, and/or city representative to provide ideas about what they have learned, and their ideas for protecting the watershed.

- Find out about a watershed project (e.g., citizen's water quality monitoring project, river or beach clean-up) in the community. Take a field trip to participate, or invite the group to the classroom.

- Design and distribute flyers or brochures about the ways community members can help improve water quality.

Youth Project Ideas

Site Changes

- Identify sites for pocket parks, green streets and alleys, medians, tree wells, pervious gutters and sidewalks, curb cuts, rain gardens, etc.
- Retrofit downspouts to direct water into planters instead of concrete
- Lift up concrete and create a soft median, pocket park or rain garden to capture rainwater
- Plant native plants in an area that is just dirt
- Replant empty tree wells & create curb cuts that allow rainwater to water them
- Landscape an area with native trees, shrubs and flowers to reduce runoff
- Care for older trees
- Plant and care for new trees
- Mulch bare dirt

Pollution and Trash

- Conduct a community clean-up and arrange for hazardous waste dumping
- Find the source of the most trash found and work to eliminate it or suggest an alternative
- Conduct a waterway clean up
- Campaign to use canvas bags at stores instead of plastic
- Get recycle and waste bins distributed throughout the area with regular disposal by the City

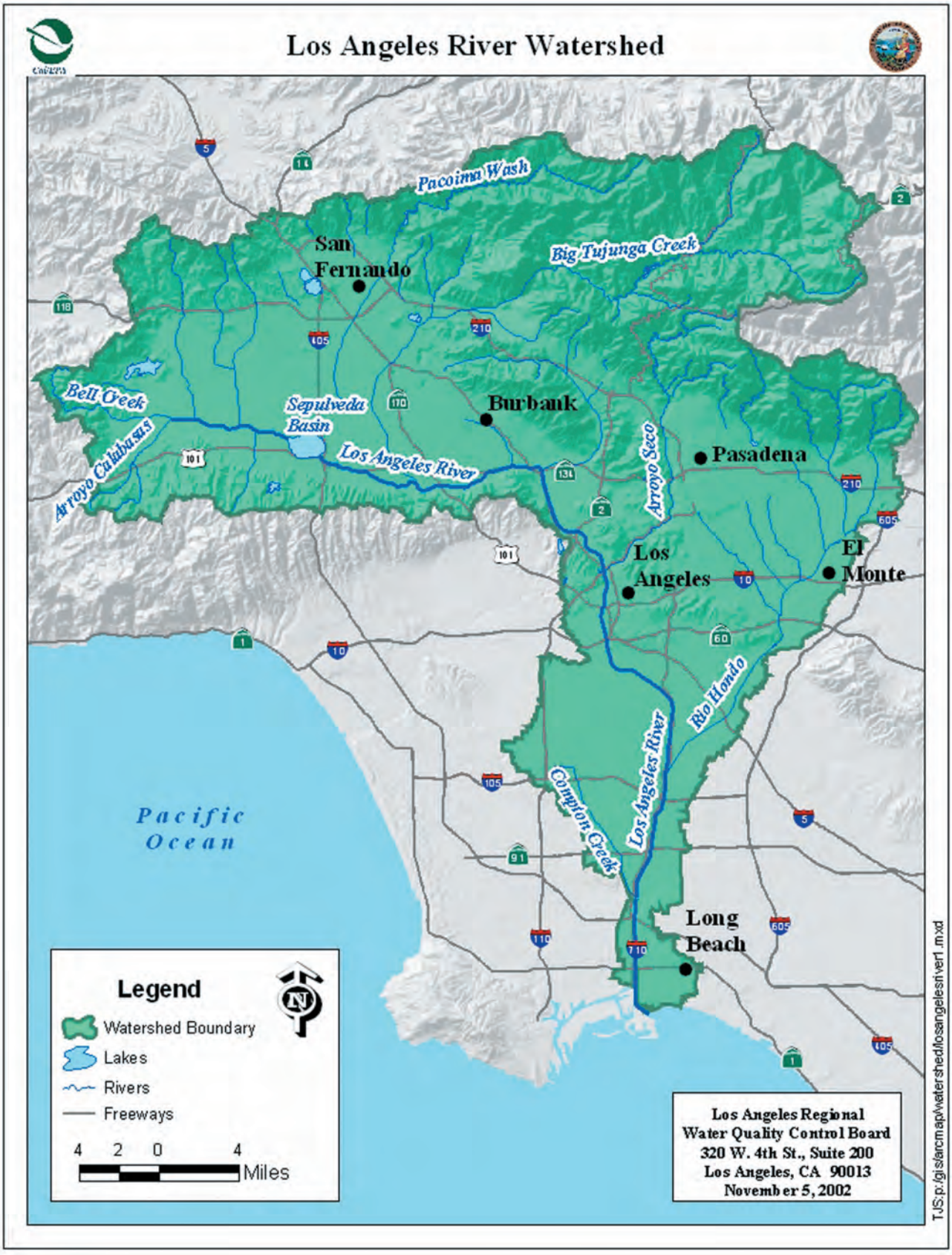
Influence Policy

- Conduct a letter-writing campaign to urge change
- Lobby city council
- Make a presentation to you Neighborhood Council
- Present at hearings on the subject

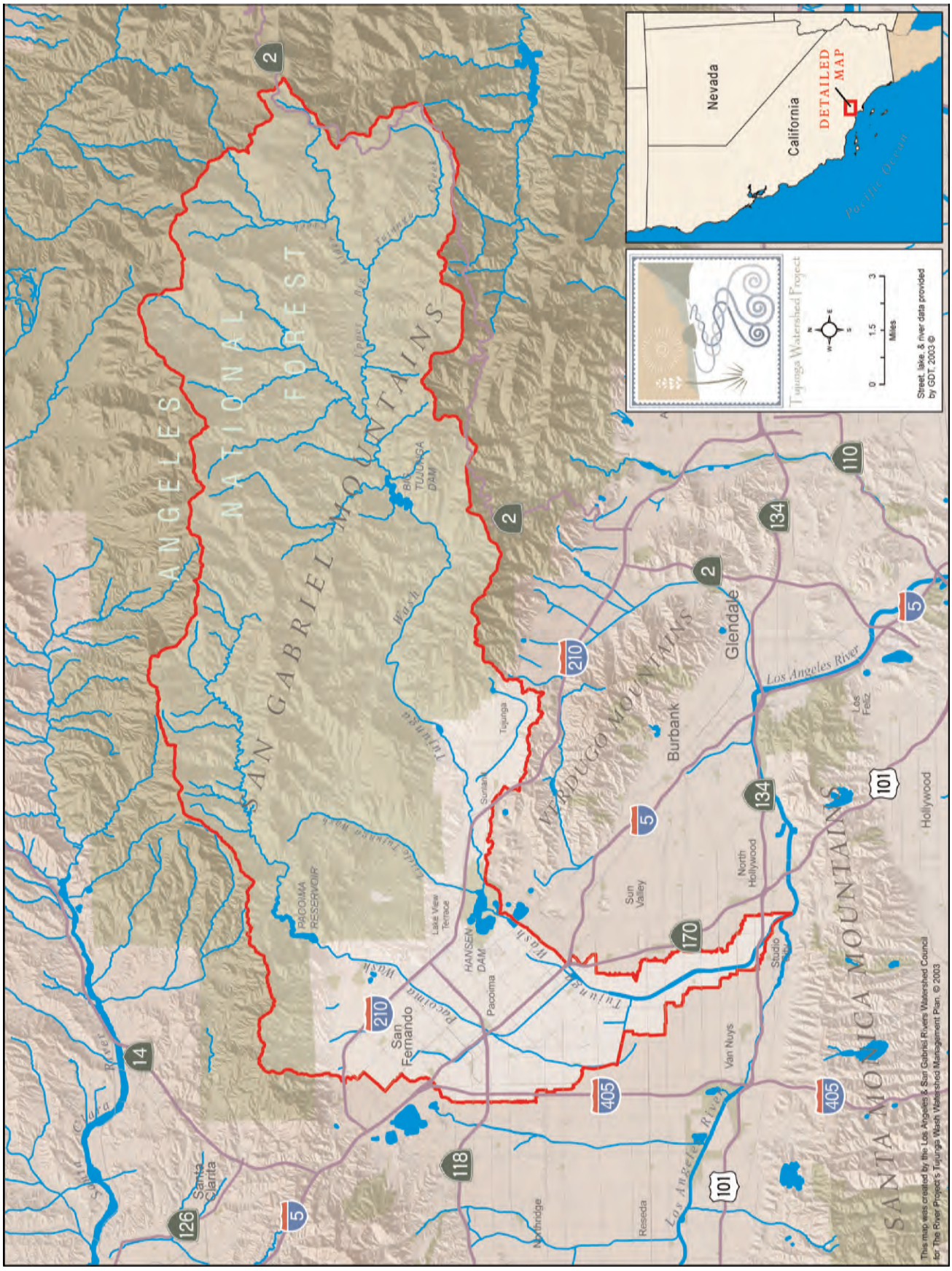
Awareness about the issue

- Organize an awareness campaign with posters and brochures
- Create a play and perform it for others or make a video and post it on YouTube
- Write an article for the local paper
- Create a public service announcement for the local radio station
- Make a brochure and distribute it in your target area

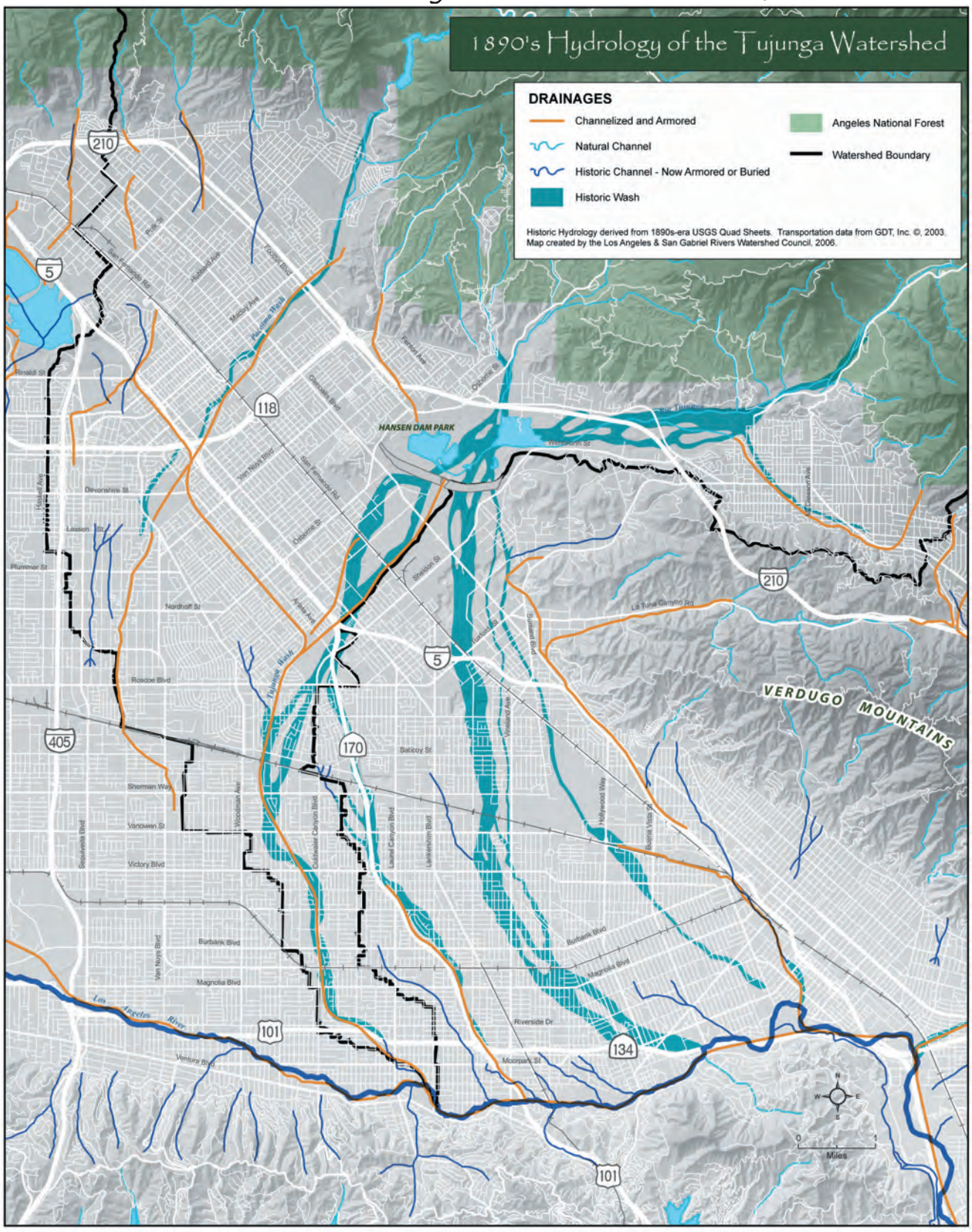
Los Angeles River Watershed Map



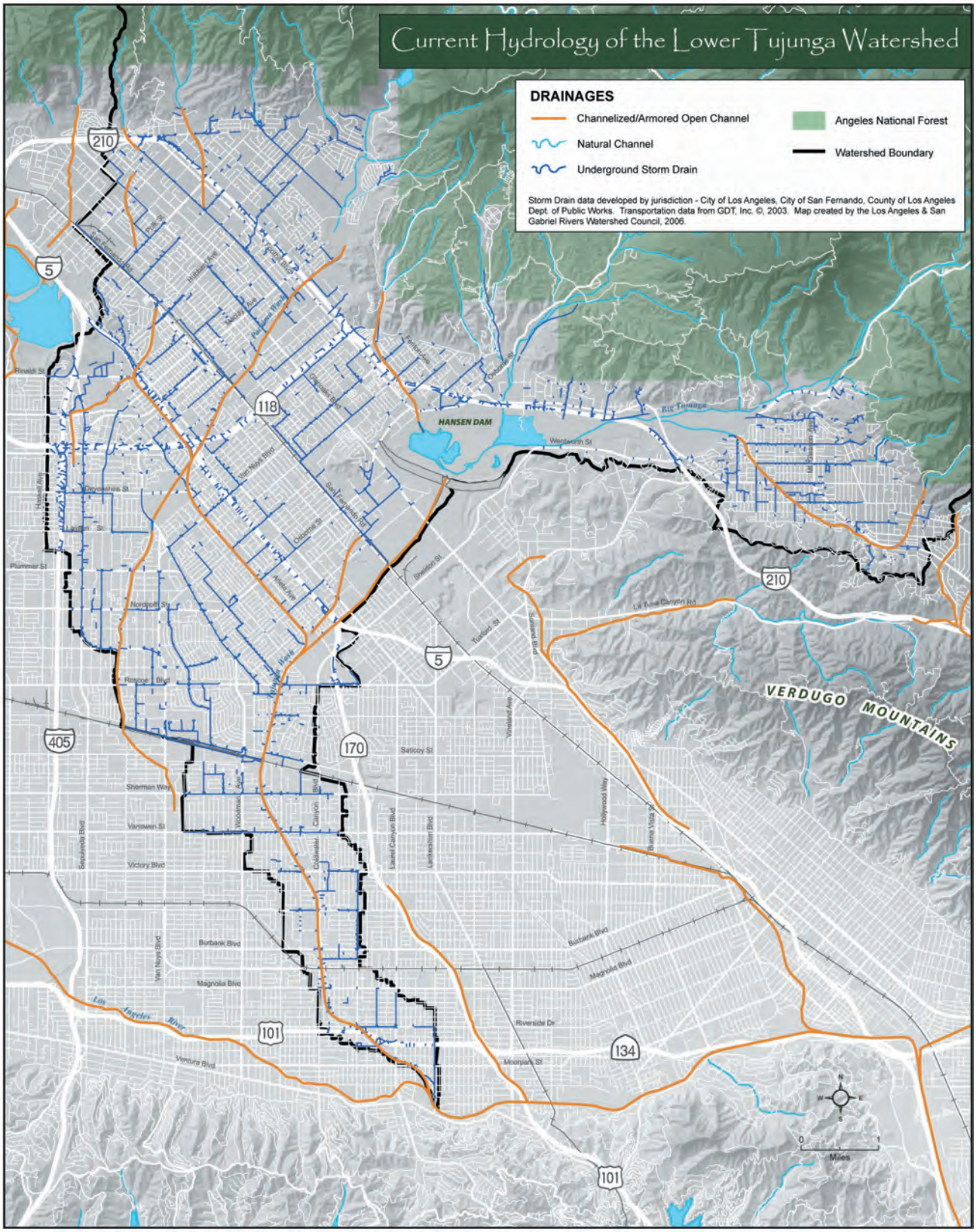
Tujunga Watershed Map



1890's Hydrology of the Tujunga Watershed Map



Current Hydrology of the Lower Tujunga Watershed Map



Local Watershed Groups

Arroyo Seco Foundation
Phone: 626-584-9902
E-Mail: info@arrroyoseco.org
Web Site: www.arroyoseco.org

Ballona Network
Phone: 310-721-3521
E-Mail: Jeanette@SaveBallona.org
Web Site: www.BallonaNetwork.org

Heal The Bay
Phone: 310-581-4188
E-Mail: htb@healthebay.org
Web Site: www.healthebay.org

Los Angeles & San Gabriel Rivers Watershed Council
Phone: 213-229-9945
E-Mail: info@lasgrwc.org
Web Site: www.lasgrwc.org

Sun Valley Watershed Stakeholders
Phone: 818-623-4867
E-Mail: rdrayse@treepeople.org
Web Site: www.sunvalleywatershed.org

The River Project
Phone: 818-980-9660
E-Mail: info@theriverproject.org
Web Site: www.theriverproject.org

Native Plant Nurseries

El Nativo Growers, Inc.
626-969-8449
200 S. Peckham Road
Azusa, CA 91702
Open M-F 7:30am-3:30pm

Las Pilitas Nursery
805-438-5992
www.laspilitas.com
Central Coast:
3232 Las Pilitas Road
Santa Margarita, CA 93453
Open Saturdays
South Coast:
2 Nelson Way
Escondido, CA 92026
Open 6 days

Matilija Nursery
805-523-8604
www.matilijanursery.com
8225 Waters Road
Moorpark, CA 93021
Open Fri & Sat 8:30am-2pm

Rancho Santa Ana Botanic Garden
909-625-8767
www.rsabg.org
1500 N. College Avenue
Claremont, CA 93013

Santa Barbara Botanic Garden
Garden Growers Nursery
805-682-4726
1212 Mission Canyon Road
Santa Barbara, CA 93105
Open 9am-3pm weekdays,
9am-5pm weekends

Theodore Payne Foundation
818-768-1802
www.theodorepayne.org
10459 Tuxford Street
Sun Valley, CA 91352
Open Fri & Sat, 8:30-4:30,
Sunday Noon-4:30

Tree of Life Nursery
949-728-0685
33201 Ortega Highway
San Juan Capistrano, CA 92675
Open Fridays 9am-4pm

Sources of Free Mulch

Tree Trimmers
Many tree trimmers will deliver bulk quantities of mulch for free. Minimum delivery is usually 10 cubic yards. Check the phone book for names and numbers of local companies.

City of Los Angeles, Bureau of Sanitation
Provides free mulch. Just bring your shovel and take as much as you need.

Lake View Terrace
11950 Lopez Canyon Rd.
7am - 5pm, 7 days a week
800-773-2489

Sample of Native Plants in the Tujunga Watershed

TREES	LEAF CHARACTERISTIC
Coast Live Oak (*Quercus agrifolia*)	curved, stiff, prickly, fuzzy underside
Engelmann Oak (*Quercus engelmanni*)	stiff
Canyon Live Oak (*Quercus chrysolepis*)	stiff, prickly
Interior Live Oak (*Quercus wislizenii*)	curved, prickly
Scrub Oak (*Quercus berberidifolia*)	stiff, prickly, thick
California Sycamore (*Plantanus racemosa*)	fuzzy
Mexican Elderberry (*Sambucus mexicana*)	thick, small
SHRUBS	**LEAF CHARACTERISTIC**
Manzanita (Arctostaphyllos)	thick, waxy
Mulefat (Baccharis salicifolia)	sticky
Coyote Brush (Baccharis pilularis)	thick, small
Ceanothus (Ceanothus)	thick, small
Mountain Mahogany (Cercocarpus betuloides)	thick, small, light colored underside
Toyon (Heteromeles arbutifolia)	stiff, prickly, thick
Laurel Sumac (Malosma laurina)	curved, thick, waxy
Lemonade Berry (Rhus integrifolia)	prickly, thick, waxy
Sugar Bush (Rhus ovata)	curved, thick, waxy
California Sagebrush (Artemesia californica)	small, narrow
California Buckwheat (Eriogonum fasciculatum)	small, narrow
Black Sage (Salvia mellifera)	small, thick
White Sage (Salvia apiana)	thick, fuzzy
Purple Sage (Salvia leucophylla)	small, thick
Monkeyflower (Mimulus)	sticky

Native Plant Images

- A wide variety of native plant images and information
  www.theodorepayne.org/gallery/glossary.htm

- Trees only
  www.selectree.calpoly.edu/

- Images and guidelines for native plant gardens
  www.bewaterwise.com/gardensoft/index.aspx

Locations of Native Plants in the Tujunga Watershed

- Hansen Dam Park
  - – Osborne St. / Dronfield Ave. in Lake View Terrace
  - – Wentworth Street from Sheldon in Lake View Terrace

- Little Tujunga Road into the Angeles National Forest

- Tujunga Ponds
  Foothill / Tujunga Wash in Sunland

- Tujunga Wash
  Between the 210 Foothill Freeway and Hansen Dam in Sunland

- Placerita Canyon State Park
  Off the 14 Antelope Valley Freeway at Placerita Canyon Rd

- La Tuna Canyon Road in Sunland

- Foothill areas of Sunland, Tujunga, Lake View Terrace, San Fernando and Sylmar

Glossary

- **acorn** – The nut-like fruit of an oak that contains a single, large seed.
- **aquifer** – An underground zone of earth that contains water.
- **atmosphere** – The gaseous mass surrounding the earth.
- **branch** – A secondary woody stem or limb growing from the trunk or main stem of a tree.
- **carbon dioxide** – A colorless, odorless, gas formed during respiration, combustion, and organic decomposition.
- **catch basin** – The opening in a curb or gutter that catches water and directs it to stormdrains.
- **chaparral** – A dense, shrub-dominated vegetation of fire-adapted, drought-tolerant plants.
- **compass rose** – a star-like drawing of the points of a compass showing north, east, south, and west
- **concrete channel** – Refers to the paved bottom and sides of a river bed.
- **condense** – The conversion of vapor (gas) into water (liquid).
- **creek** – A small stream or tributary to a river.
- **culvert** – A channel that directs water to a drain.
- **dam** – A barrier built across a river or stream to hold water.
- **ditch** – A long, narrow drainage trench.
- **evaporation** – The conversion of water (liquid) into a vapor (gas).
- **evapotranspiration meter** – A meter used to measure evaporation from ground surface and vegetation cover.
- **fertilizer** – Nutrients used by plants for growth.
- **flood** – When water overflows the boundaries of a stream, river or other body of water.
- **freshwater** – Water with less than 0.5 parts per thousand of dissolved salts and usable for human consumption.

- **glacier** – A huge mass of ice and snow that moves slowly over the land.

- **groundwater** – The freshwater that fills the cracks and pores beneath the earth's surface,which supply wells and springs and can be pumped out, cleaned, and used for our water needs.

- **gutter** – A channel for draining off water.

- **impervious** – Not having pores or openings that allow water to pass through.

- **irrigation** - The controlled application of water to cropland and fields to supplement rainfall.

- **land pollution** – The trash dropped on the land, such as gum, food wrappers, cans, paper, and plastic bags. It also includes pet waste and oil dripped from cars.

- **mineral** – Natural compounds formed through geological processes.

- **mulch** – A protective covering of fallen leaves, branches and bark that cover the soil and is in a constant state of decay. It serves to feed the soil, prevent evaporation and erosion and insulates the roots of plants and trees.

- **native species** – An indigenous, as opposed to introduced, species.

- **oxygen** – A colorless, odorless, tasteless gaseous element constituting 21 percent of the atmosphere by volume.

- **percolation** – The movement or flow of water through soil or rocks.

- **pervious** – Having pores or openings that allow water to pass through.

- **pesticides** – Chemicals used to kill pests. Pests may include ants, termites and rats.

- **precipitation** – Water deposited on the earth as hail, mist, fog, rain, sleet, or snow.

- **polluted runoff** – Sometimes referred to as non-point source pollution is caused by rainfall moving over and through the ground picking up pollutants along its journey.

- **river** – A large body of running water moving along defined channels from higher elevations to lower ones.

- **rock** – Relatively hard, naturally formed mineral.

- **root** – The underground portion of a plant that serves as support, draws minerals and water from the surrounding soil, and sometimes stores food.

- **runoff** – Water that flows over the ground because it cannot seep into the soil, evaporate,or transpire through plants. It finds its way into streams and rivers as surface flow, and may pick-up contaminants, such as trash and fertilizer, along the way.

- **sanitary sewer system** – An underground system of pipes that carries waste water from homes and businesses totreatment plants where it iscleaned,solids and pollutants are removed,and the water is discharged into the ocean.

- **soil** – The top layer of Earth's surface that contains rock, minerals and organic material.

- **stormdrain** – Above ground or below ground pipes and channels thattransport stormwater to the ocean for flood control purposes.

- **stream** – A small body of running water moving along natural channels from higher elevations to lower ones.

- **tannic acid** – Astringent, bitter tasting chemical found in acorns.

- **Tataviam** – The native American people that occupied the Tujunga watershed area.

- **trunk** – The main woody stem of a tree.

- **valley** – A broad area of low-lying land situated between hills or mountains and usually having a river or stream flowing along its bottom.

- **water cycle** – The paths water takes through its various states – vapor, liquid, and solid – as it moves throughout the Earth.

- **water vapor** – The gaseous state of any substance that is normally liquid or solid. Specifically the term refers to a form of water in its cycle.

- **watershed** – The land area that directs water to a drainage or river system.