Developing a Citizen Water Quality Monitoring Program for the Arroyo Seco

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In Partnership with North East Trees As Part of the Arroyo Seco Watershed Management Plan & Education Program Funded by the CALFED Bay-Delta Program

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Table of Contents	Page

Executive Summary

This report is intended to be a handbook for the development of a citizen monitoring program in the Arroyo Seco Watershed, the Arroyo Seco Water Quality Monitoring Program (ASWQMP). For more than three years, the Arroyo Seco Foundation and North East Trees along with governmental agencies and community-based groups have been pursuing a restoration program in the Arroyo Seco, part of the Los Angeles River system. This report, funded by CALFED as part of the Arroyo Seco Watershed Management Plan & Education Program (ASWMPEP), outlines the next step in improving the health of the watershed. It reviews the status of current water quality efforts, approaches to establishing a citizen-based program, and the plentiful resources available to build a successful program

The Arroyo Seco, a 46.6 square mile watershed in Los Angeles County, CA, begins in the Angeles National Forest and the San Gabriel Mountains and proceeds through the communities of La Cañada Flintridge, Pasadena, South Pasadena, Altadena and northeast Los Angeles. (See Table 1).

Water quality monitoring is important to protect human and aquatic health in the Arroyo Seco stream, but an effective monitoring program, such as ASWQMP also will serve as a measure of the health of the entire watershed and of the success of efforts to restore the natural functioning of the Arroyo Seco.

As part of the development of this report, we put together a scope for a snapshot assessment of water conditions in the Arroyo Seco, which is contained in Appendix 1: "Arroyo Seco Water Quality Sampling Plan." We are pleased to report that the County of Los Angeles Department of Public Works has agreed to carry out this sampling effort using their staff and to bear the laboratory costs associated with a one-time sampling event for nine sites in the Arroyo Seco.

ASWMPEP has provided considerable momentum for the development of a citizen-based monitoring effort. An important element of that program was the very successful Watershed U, the overview of watershed science presented at the Los Angeles River Center last spring. Following up on that outreach and education program, the Arroyo Seco Foundation has formed the Arroyo Seco Stream Team, a volunteer corps that will serve as the vehicle for the implementation of the monitoring program described herein.

The Need for Water Quality Monitoring in the Arroyo Seco

Water quality monitoring is a key tool to improve the health of the Arroyo Seco watershed. A well-constructed citizen monitoring program can:

- Be used in the planning and evaluation of stream enhancement activities;
- Promote understanding of the overall function of the Arroyo Seco stream;

- Measure upstream-downstream, seasonal, year-to-year, and long-term changes in water quality and watershed conditions;
- Detect point sources and non-point sources of pollution;
- Educate the public about the stream and its riparian corridor; and
- Develop a sense of community stewardship for the Arroyo Seco and its rich aquatic resources.

Seasonal monitoring is essential for an accurate assessment of the water quality of the Arroyo Seco because the ecological life of the watershed varies with the seasons. Changes in weather conditions have a great influence on water quality. Heavy rainstorms in the winter and early spring introduce large amounts of pollutants due to runoff. In the summer, reduced flows and higher temperatures caused by dry weather alter the conditions. Baseline monitoring data (chemical, physical, biological) are necessary to identify vulnerable areas to be targeted for improvement.

The Arroyo Seco Watershed Restoration Feasibility Study (ASWRFS) sets Restoration Goal Number 2 as: ”Better Manage, Optimize, & Conserve Water Resources While Improving Water Quality.” That plan also provides more detailed objectives to achieve that goal. (Appendix 1)

In the section on Water Quality, ASWRFS states “To improve the water quality in the Arroyo Seco watershed, several things are needed. First, accurate, complete and timely data is needed regarding constituents in all surface and ground waters. Capturing these data and completing analyses requires ongoing, steady funding for data collection and planning efforts. Water quality testing should occur at different times, including immediately after the first storm of the season (called the “first flush”), during dry weather, and at other times of the year. On-going clean up efforts must continue as well, especially with regard to trash.”

Water quality in the Arroyo Seco Watershed is degraded in several significant ways. The Hahamongna Basin is a Superfund site due to the presence of volatile organic chemicals and perchlorate. Nitrates past agricultural practices and septic tank systems are a significant factor in some parts of the watershed. Street runoff from throughout the watershed pollutes the Arroyo Seco stream with trash and contaminants, and the Los Angeles Regional Water Quality Control Board has detected un acceptable levels of coliform from animal waste.

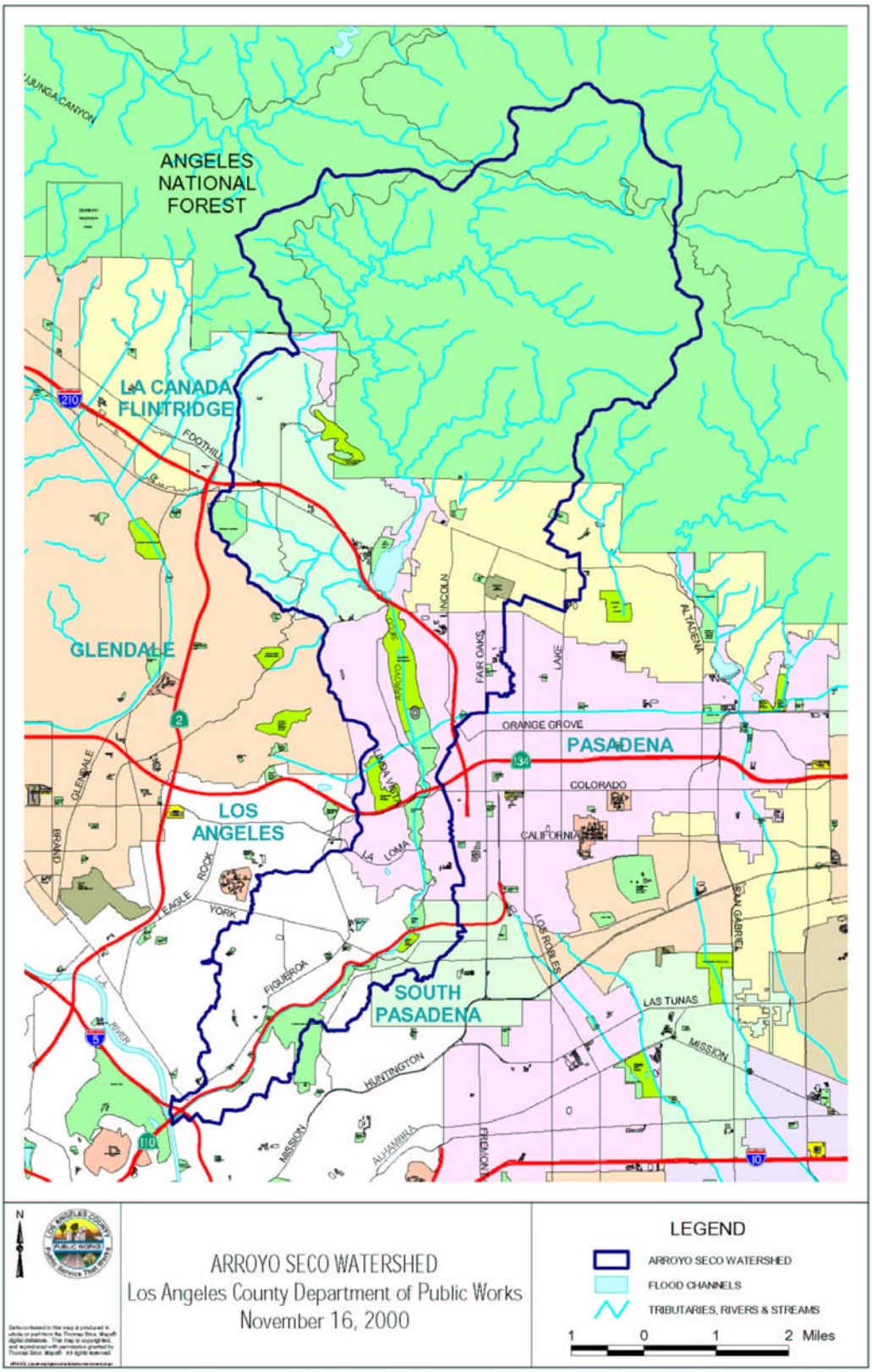

Table 1 - Arroyo Seco Watershed

Summary of Water Quality Work To Date

The Arroyo Seco Watershed Restoration Feasibility Study provides an overview of the water quality regulatory framework as well as a comprehensive review of water quality issues in the Arroyo Seco. It is essential reading and can be found at: (http://www.arroyoseco.org/FinalReport/WaterQuality.pdf)

Water Agency Testing

The US Environmental Protection Agency sets Maximum Contaminate Levels (MCLs) and Maximum Contaminate Level Goals (MCLG), health protective standards for dangerous potential contaminants.

The California Department of Health Services (DHS) regularly tests drinking water supplies and set standards for contaminants in water. The Office Environmental Health Hazards Assessment is charged with developing Public Health Goals (PHGs) for contaminants in California's publicly supplied drinking water.

Local agencies, following EPA guidelines, perform analyses for organic and inorganic chemicals, minerals, metals, bacteria and general physical parameter in their ground water sources (wells) as well as their distribution system (reservoirs and designated sample sites representative of the entire system by pressure zone). Pasadena Water and Power is also required to test regularly for chlorine/chloramines residual, nitrites, ammonia, bacteria, total trihalomethanes and haloacetic acids in local distribution systems. Lead and copper are tested in tap water from selected residences. The Metropolitan Water District of Southern California (MWD), the local supplier of imported water, is responsible for testing of their treated water.

Each year utilities must provide their customers with a report on water quality called a Consumer Confidence Report (CCR), which lists MCL limits and the Public Health Goal (PHG), set by the California Environmental Protection Agency.

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- Pasadena Water and Power Department's most recent report for 2002 is available here: http://www.ci.pasadena.ca.us/waterandpower/pdf/PWP%20Water%20Quality%20Report%202002.pdf
- MWD's most recent report for 2002 is available online at: http://www.mwd.dst.ca.us/mwdh2o/pages/yourwater/ccr02/ccr01.html
- The Los Angeles Department of Water and Power issues a water quality report for the Central and Eastern areas of Los Angeles. Their most recent is available online at: http://www.ladwp.com/ladwp/cms/ladwp001965.jsp

The City of Los Angeles also issues a Drinking Water Public Health Goals Report each year. The report is intended to provide the public and decision makers with specific information regarding drinking water safety so they can consider further purification of

water to move its quality closer to health goals. The most recent report available can be found online at http://www.ladwp.com/ladwp/cms/ladwp000505.jsp.

In addition, the City of Pasadena completed an assessment of the drinking water sources for Pasadena's water system in August 2002. The wells in Pasadena were found to be most vulnerable to contamination from automobile gas stations, repair shops and body shops, underground storage tanks, and military installations. A copy of the complete assessment is available at Pasadena Water and Power, 150 S. Los Robles Ave., Suite 200, Pasadena CA 91101.

In December, 2002, MWD completed its source water assessment of its Colorado River and State Water Project supplies. Colorado River supplies are considered to be most vulnerable to recreation, urban/stormwater runoff, increasing urbanization in the watershed and wastewater. State Water Project supplies are considered to be most vulnerable to urban/stormwater runoff, wildlife, agriculture, recreation and wastewater. A copy of the assessment can be obtained by contacting MWD at (213) 217-6850.

Community Based and School Programs

While water agencies focus on the human health aspects of drinking water, water quality monitoring programs generally focus on the health of the stream or watershed in a broader context testing for benthic invertebrates and various contaminants that might affect the flora and fauna of the stream system.

In the Arroyo Seco there have been a series of sporadic testing efforts. The Southern California Coastal Water Research Project had three teams sample the conditions in the Arroyo Seco on September 11, 2000 as part of a program to characterize the Los Angeles River Watershed. Friends of LA River collected samples in 2001. There have also been several school-based collection efforts. Students at California State University, Franklin High School in Los Angeles, and Sequoyah School in Pasadena have conducted water quality sampling as part of programs to teach students a scientific approach to water quality and to become better stewards of the local environment.

Identified Water Quality Issues

ASWRFS describes the water quality of the Arroyo Seco in Volume 1 on page III-3:

> ***Water Quality Structure***
>
> The water quality of the Arroyo Seco Watershed is directly impacted from the surrounding land use. With nearly half of the watershed (22.3 sq mi. - 48%) in the Angeles National Forest, the upper watershed tends to be relatively free of human-generated pollutants, but with steep slopes and natural cycles of fire, drought, and flooding, the upper watershed can generate fine suspended solids to major debris flows. Wildfires may also affect water quality, due to the loss of vegetative cover, increase in erosion and ash deposits. For a more comprehensive analysis of potential

sources of pollutants, including urban runoff, sedimentation, nitrification and groundwater contamination, please see Appendix G: *Technical Report-Water Quality*.

Moving south in the watershed, horse corrals and golf courses may contribute nutrients (nitrogen, phosphate, ammonia) from manure and fertilizers. Urbanization has resulted in an accumulation of polluted runoff from roads, commercial areas, industry, and residential neighborhoods. Polluted storm water from these land uses can load the system with trash and a mixture of petrochemicals. Of serious potential consequence is the contamination of the Federal Environmental Protection Agency's (EPA) Superfund site at Jet Propulsion Laboratory (JPL). Due to early testing of rockets, missiles and aircraft, the groundwater at the mouth of the Arroyo near JPL is contaminated with volatile organic compounds (VOC). Several wells had been shut down due to the contamination. Also of potential concern is the use of septic systems in the La Cañada Flintridge area. If these systems were maintained and repaired on a regular basis, the Raymond Basin is protected. However, leakage from an old or impaired system could potentially contaminate the groundwater (Figure III-1: *Land Use*).

Unauthorized activities pose many different kinds of threats to water quality in the Arroyo Seco Watershed. These activities include illegal dumping, illegal bodily contact with water, and vehicle abandonment. Some of the camping and picnicking areas lack restrooms, which contributes to the illegal uses of the water. Abandoned vehicles may have leaks of oil, gasoline, or other fluids, and from ongoing rust and oxidation. Recreational uses contribute pollution via water contact with domestic dogs and trash.

Los Angeles Region Water Quality Control Board

The Arroyo Seco is a tributary of the Los Angeles River, which drains most of Los Angeles County and is one of the most highly modified watersheds in the world. About half of the Los Angeles River watershed is developed and 30% is impervious. Most of the river and its tributaries have been lined with concrete to reduce flooding and to protect property. These successful efforts at flood control, however, have resulted in environmental impacts throughout much of the river system. The loss of habitat and water quality degradation have led the Los Angeles Regional Water Quality Control Board (LARWQCB) to add much of the river and many of its tributaries to the state/federal list of impaired waterbodies, the §303(d) list. The Clean Water Act stipulates that waterbodies on the §303(d) list are required to develop total maximum daily loads (TMDLs) to achieve water quality objectives in the receiving waterbody, in this case the Pacific Ocean. The TMDL process requires a process to characterize the problem (impairment) that led to the listing, identify the sources of pollution, establish the target needed to achieve water quality standards, conduct a linkage analysis where sources are linked to ocean impairment, and finally establish waste load and load allocations for each point and nonpoint source in order to reduce the pollution.

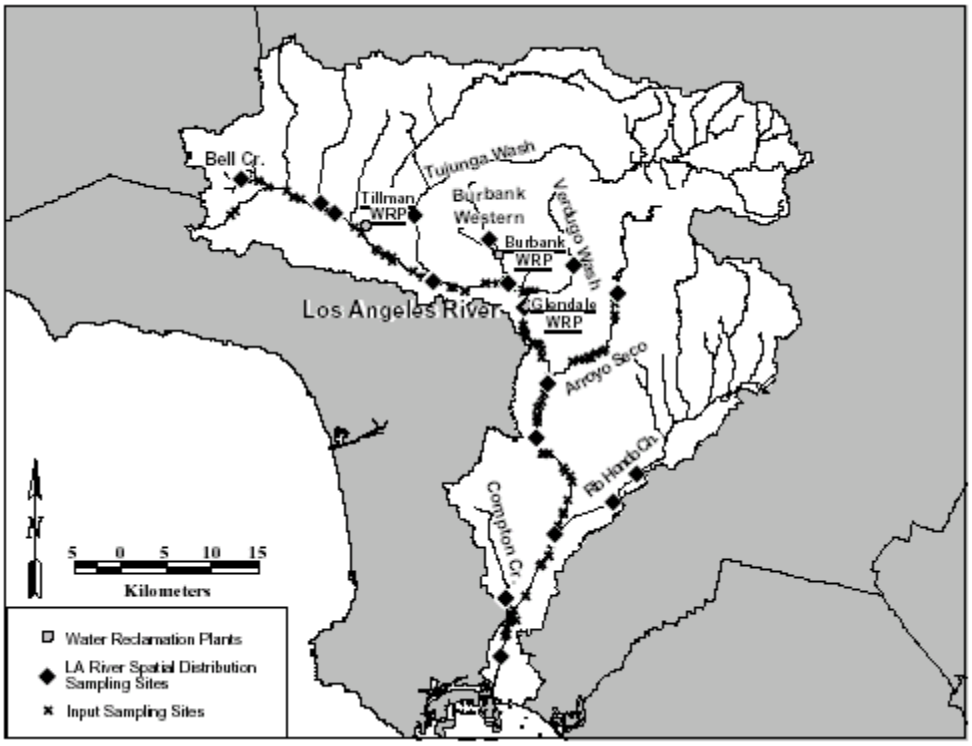


Table 2 - Impaired Streams of Los Angeles River Watershed

Source: Southern California Coastal Water Research Project

The Arroyo Seco is one of the impaired water bodies in the Los Angeles River system. The Los Angeles Regional Water Quality Control Board (LARWQCB) is mandated to develop a total maximum daily load (TMDL) for the Arroyo Seco for each constituent responsible for the impairment.

The Arroyo Seco steam is impaired due to the occurrence of several contaminants. Table 1 contains the characterization of the Arroyo Seco found in the 2002 Clean Water Action Section 303(D) List Of Water Quality Limited Segments approved by the California Water Resources Control Board on February 4, 2003.

Table 3: Arroyo Seco Contaminants

Region	Name	Calwater Watershed	Pollutant/ Stressor	Potential Sources	TMDL Priority	Est. Size Affected	Proposed TMDL Completion
4	**ARROYO SECO REACH 1 (LA RIVER TO WEST HOLLY AVE)**	40515010	Algae	Nonpoint Source	High	5.2 Miles	2002
			High Coliform Count	Nonpoint Source	High	5.2 Miles	2002
4	**ARROYO SECO REACH 2 (Figueroa Street to**	40515010	Algae	Nonpoint Source	High	4.4 Miles	2002

	Riverside Drive)						
			High Coliform Count	Nonpoint Source	High	4.4 Miles	2002
			Trash	Nonpoint Source	Low	4.4 Miles	2002

The JPL Contamination

Jet Propulsion Laboratory (JPL) is a 176-acre site in northwest Pasadena. Situated at the mouth of the Arroyo Seco canyon immediately adjacent to Hahamongna Watershed Park, this area is of great importance for drinking water resources. The Army developed and operated JPL between 1945 and 1957. In 1958, jurisdiction was transferred to the National Aeronautics and Space Administration (NASA). The California Institute of Technology conducts research and development at JPL under a NASA contract in the areas of aeronautics, space technology, and space transportation.

Sources of contamination at the site include approximately 35 seepage pits where liquid and solid wastes were disposed of, a settling chamber in the JPL storm drain system, contaminated soil excavated from part of that system, and an area where waste solvents were dumped into three separate holes. Hazardous substances located at JPL include waste solvents, solid rocket fuel propellants, cooling tower chemicals, sulfuric acid, freon, mercury, and chemical laboratory wastes.

In the 1980s the Pasadena Water & Power Department and Lincoln Avenue Water Company detected significant levels of volatile organic chemicals such as trichloroethylene and carbon tetrachloride in their groundwater sources, which come from the Monk Hill subbasin of the Raymond Basin aquifer. Lincoln Avenue Water Company closed two wells due to volatile organic contaminants in 1987. Pasadena closed four municipal wells between 1989 and 1990. In 1990 Pasadena installed a closed aeration with carbon filter treatment system, funded by JPL, to treat the VOC tainted water to insignificant levels. The Lincoln Avenue Water Company also has installed a treatment system on its wells, which are again operational.

In 1997 elevated levels of percholorate, a rocket fuel accelerant that may have detrimental effects on pregnant women and infants, were detected in local wells. Perchlorate can block iodine from entering the thyroid gland, which will result in a decrease in production of thyroid hormones.

There is currently no state or federal standard for perchlorate. California Department of Health Services has adopted a 4 parts per billion action level (AL) for perchlorate to protect consumers, especially pregnant woman and infants, from its adverse health effects.

When the perchlorate was first detected locally, Pasadena promptly closed four wells to protect consumer health. In 2002 when the California DHS reduced the action level to 4 parts per billion, Pasadena closed an additional five wells due to high concentration of perchlorate. Lincoln Avenue Water Company has also lost wells because of perchlorate.

The groundwater contamination from the JPL has traveled off site and affected local groundwater supplies. JPL estimates that approximately 120,840 people live within 4 miles of the site; an estimated 68,000 people obtain drinking water from municipal wells within 4 miles of the site.

The JPL contamination site was declared a Superfund Site in 1992. JPL and NASA are now finalizing plans to treat and cleanup the remaining contamination.

EPA's website on the JPL contamination (http://yosemite.epa.gov/r9/sfund/overview.nsf/0/78584149433b1be58825660b007ee65a?OpenDocument) states that:

> Off-Site Groundwater: NASA has tested several treatment systems to remove perchlorate from ground water and now in a process to select the most appropriate treatment alternative for City of Pasadena. NASA is helping the City apply for a special permit from the California Department of Health Services to treat and distribute treated water. The permit review process is expected to last until approximately 2004. Ion-Exchange and Biodegradation of perchlorate are two best available technologies available today.

Defining the Key Goals of the Program

Water quality monitoring programs can have a variety of goals. Programs generally focus on one or more of the following purposes

1. The Development of Regulatory Data
2. Evaluation of Restoration Indicators, and
3. Education and Community Involvement

The most successful programs will combine all three of the above goals, as the ASWQMP should do. This requires careful planning and training of volunteers to ensure that observations and data are accurate and useful. It also requires attention to the collection, processing and maintenance of data.

Before Monitoring

The EPA, in it's Volunteer Stream Monitoring: A Methods Manual suggests that before beginning a stream monitoring study, volunteer program officials should develop a design or plan that answers the 10 basic questions.

1. Why is the monitoring taking place?
2. Who will use the monitoring data?
3. How will the data be used?
4. What parameters or conditions will be monitored?
5. How good does the monitoring data need to be?
6. What methods should be used?
7. Where are the monitoring sites?

8. When will monitoring occur?
9. How will monitoring data be managed and presented?
10. How will the program ensure that data are credible?

"A planning committee composed of the program coordinator, key volunteers, scientific advisors, program supporters, and data users should resolve these questions well before the project gets under way," the Manual states. The Manual offers a full treatment of the key considerations that need to be carefully evaluated to answer these questions.

Watershed Survey

The watershed survey is a key preliminary step that can be very rewarding at minimal cost. The survey consists of a comprehensive survey of the geography, land and water uses, potential and actual pollution sources, and history of the stream and its watershed. Much of this work has already been accomplished in the ASWRFS.

Volunteer Stream Monitoring: A Methods Manual outlines two distinct parts of a watershed survey:

- *A onetime background investigation of the stream and its watershed.* (To do this, volunteers research town and county records, maps, photos, news stories, industrial discharge records, and oral histories.)
- *A periodic visual assessment of the stream and its watershed.* (To do this, volunteers walk along the stream and drive through the watershed, noting key features.)

The watershed survey requires little cost or equipment, but its benefits are multiple:

- Screening for pollution problems
- Identifying potential sources of pollution
- Identifying sites for monitoring
- Helping interpret biological and chemical information
- Giving volunteers and local residents a sense of the value of the stream or watershed
- Educating volunteers and the local community about potential pollution sources and the stressors affecting the stream and its watershed
- Providing a blueprint for possible community restoration efforts such as cleanups and tree plantings

Stream Habitat Walk

After the watershed survey, the Stream Habitat Walk is the next step. This is a simple but effective approach for identifying and assessing the elements of a stream's habitat. It consists primarily of visual observation of stream habitat characteristics, wildlife present, and gross

physical attributes. An in-stream macroinvertebrate evaluation can also be performed. This approach requires little in the way of equipment and cost.

The Stream Habitat Walk is valuable as:

- A screening tool to identify severe water quality problems
- A vehicle for learning about stream ecosystems and environmental stewardship

Data from this approach is not likely to be useful for state and local water quality management agencies, but the Stream Habitat Walk's ease of use, adaptability, and low cost make it a powerful tool for public awareness and citizen involvement.

The stream walk component is essential to any monitoring effort interested in identifying and addressing pollution sources. Through the stream walk volunteers precisely locate and document likely sources of pollution and environmental degradation. They map the conditions located in the field to one-meter accuracy using GPS devices so they can be easily relocated, targeted for removal and/or restoration. The stream walk component provides data that can be used to develop watershed scale restoration plans and is crucial to prioritizing restoration efforts, as well as setting funding priorities. Heal The Bay's Malibu Stream Team has trained and certified dozens of volunteers to help conduct Stream Walk surveys. The Malibu Stream Walk Teams have mapped over 15 miles of creeks throughout the Malibu watershed.

Streamside Biosurvey

The next step is a Streamside Biosurvey, which involves more complete sampling and data techniques described in the EPA's Methods Manual available at: http://www.epa.gov/owow/monitoring/volunteer/stream/vms42.html

The biosurvey involves a simple macroinvertebrate sampling approach with two basic components: 1) a biosurvey of aquatic organisms that involves collecting and identifying macroinvertebrates in the field and calculating an index of stream quality, and 2) a *Streamside Biosurvey Habitat Walk.*

The Stream Team Program of the California Water Resources Control Board has produced The California Streamside BioSurvey, an Introduction to Using Aquatic Invertebrates as Water Quality Indicators.

The California Department of Fish & Game Bioassessment Protocol is also an essential document to review.

The Save Our Streams program of the Isaak Walton League has also produced a very useful key to the identification of macroinvertebrates, animals that have no backbone and are visible without magnification. Stream-bottom macroinvertebrates include crayfish, mussels, aquatic snails, aquatic worms, and the larvae of aquatic insects. The key can be found at http://www.people.virginia.edu/%7Esos-iwla/Stream-Study/Key/MacroKeyIntro.HTML.

Water Quality Challenges

Previous studies have shown that the health of the Arroyo Seco watershed is threatened by increased temperatures, sedimentation, flow barriers and reduced flow rates, high rates of erosion and deposition, non-point source pollution, trash, coliforms and algal blooms. The Arroyo Seco Watershed Restoration Program is developing activities and program to address these issues, but more information is needed.

The Los Angeles Regional Quality Control Board has found that algae, trash and coliform are of special concern in the Arroyo Seco Watershed. An effective monitoring program will screen for these and other water quality indicators. Fecal coliform monitoring would indicate contamination from warm-blooded mammals. This group of bacteria should be reduced to a lower level since the Los Angeles Regional Water Quality Control Board has detected high coliform counts. Continued monitoring for coliform organisms in a variety of locations will identify target areas for prioritizing various types of clean up projects.

Data from ASWQMP will be used for regulatory purposes, designing restoration programs and citizen stewardship education.

Field Observations

Field observations give a general view of the conditions and health of the stream and watershed, help to explain unusual water quality results, and may help identify unusual pollution sources. For example, odors can be caused by decaying material or by pollutants. An oily sheen may indicate a source of urban runoff, or illegal dumping of used motor oils or other toxic materials. Field observations should include air and water temperature, site and water odors, presence of oils sheen or litter, characteristics of the stream channel (concretized vs. natural), type of vegetation, wind conditions, and weather observations. These observations provide the context in which the samples were collected.

Surface Flow Rates

Flow rates are critical because the amount of water in the stream affects many of the factors needed to support aquatic and riparian life. Flow data will also be used to estimate the relative contribution of water and pollutants from tributaries, storm drains and other sources. In addition, the relationship of specific parameters to the flow can help indicate whether various flow conditions create pollution problems. Flow is also necessary to calculate the "load" of any pollutant, which is a measure of how much pollution is moving through the system over time rather than just an instantaneous snapshot of conditions. Variations in flow rate may create periodic cycles of disturbance characteristic of natural systems.

The United States Geologic Survey maintains a flow meter in the upper Arroyo Seco. The County of Los Angeles Department of Public Works has a gage just south of Devil's Gate Dam, but there is no measurement system in the urbanized plain of the Arroyo Seco Watershed. This is a major limitation in the current measurement system.

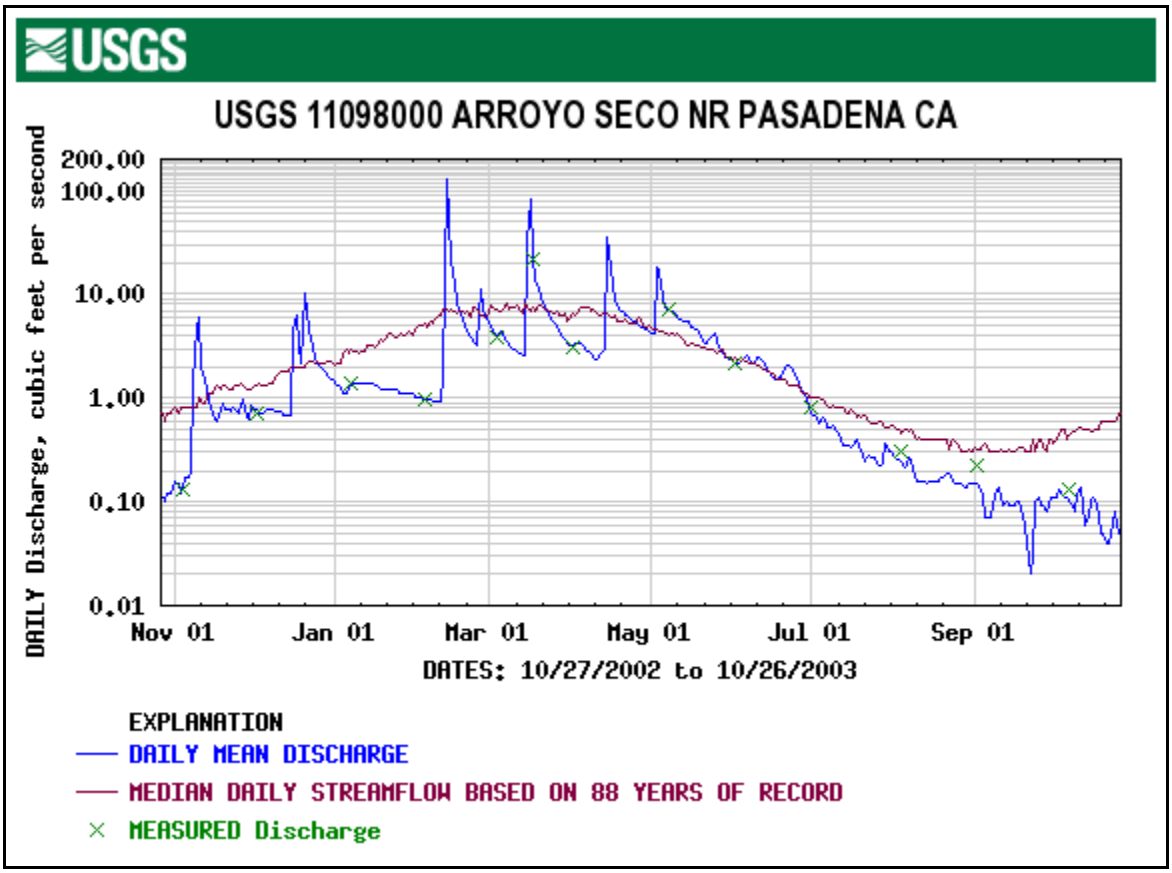


Table 4 - Arroyo Seco Streamflow

Water Temperature

Water temperature plays a critical role in controlling a wide range of factors within the aquatic environment. Certain life stages of aquatic organisms require specific ranges of temperature for growth. For example, optimal water temperatures for steelhead trout are between 13°C (55°F) and 21°C (70°F). Temperature is also used as a correction in pH tests and used to calculate the percent saturation of Dissolved Oxygen from the (ppm) value. In the Arroyo Seco watershed, stream temperatures may fluctuate by as much as 10-12 degrees Fahrenheit each day.

Turbidity

Turbidity measures how clear or murky the water is. Specifically, it is a measure of how much light can pass through the water. Turbid waters limit submerged plant growth and survival of aquatic eggs. Turbidity is also an indirect measure of suspended solids concentrations and may be an indicator of locations where upstream erosion is contributing fine sediment to the stream. Ideally there is no measurable turbidity. Usually a low level of turbidity is found in streams, rivers, and lakes, on the order of 0.5-1.0 NTU. For example, in August 2003 turbidity level of 0.72 NTU was measured in Lake Havasu, 0.67 NTU in lake Castaic, 1.0 NTU in Lake Mathews. Turbidity levels consistently above 20 NTU's may indicate significant problems.

Dissolved Oxygen

Dissolved oxygen (DO) is necessary to support aquatic life. Reduced levels of DO may be caused by an overabundance of algae (which both produces and consumes oxygen) or by pollutant sources that contribute to the biochemical oxygen demand of the water.

The most important measure of dissolved oxygen is the percent saturation, a function of temperature. DO decreases with increased temperature. DO levels that sink to levels as low as 60 or 70% saturation should cause concern about aquatic life. At 50% aquatic life becomes stressed and at levels around 30% or lower aquatic life may die off.

pH

pH is a measure of the acidity of the water. It is a water quality parameter that affects a number of aquatic factors such as ammonia toxicity and heavy metal adsorption rates. Dramatic changes in pH may indicate the presence of significant pollutant sources.

Nitrate

Nitrate is an inorganic compound that occurs under a variety of conditions in the environment, both naturally and synthetically. The primary sources of nitrate in the Arroyo Seco watershed are past agricultural practices, septic systems, and run-off from urban areas where residents use lawn chemicals. The amount contributed by these sources can be reduced with best management practices, or BMP's, which are subtle modifications that are easy to implement and often carry other advantages for landowners and communities.

Ideally nitrate will not be detected in the Arroyo Seco. While the federal standard for nitrate in drinking water is 10 milligrams per liter (10 mg/l or 10 parts per million), even 1 ppm should cause concern. As nitrate levels approach 5 ppm, problems may result. The most common problem is acceleration of algal growth. Nitrates feed algal blooms that can grow to nuisance levels and seriously reduce oxygen. When these blooms die, microbes that deplete dissolved

oxygen supplies and affect aquatic life decompose them. Nitrate does not normally cause health problems unless it is reduced to nitrite. Nitrite can cause a fish blood disease and impair the ability of red blood cells in infants to transport oxygen, causing methemoglobinemia.

Presence and Extent of Algal Cover

The presence and extent of algae is of interest because it sometimes reaches nuisance levels within portions of the Arroyo Seco stream. Algal blooms can cause eutrofication, which is a state of severely low dissolved oxygen levels. Algal coverage data will be used to document the level of the problem and to assess the effectiveness of control measures.

Site Selection

Developing a site selection methodology is key to the success of ASWQMP. Geographic classification approaches and empirical data should guide site selection.

The twenty-two mile course of the Arroyo Seco falls into several distinct geographic zones. The upper watershed above Devil's Gate Dam, which consists of 32 square miles, can be divided into four major zones. The first is the main Arroyo Stream, which is fed by than twenty canyon tributaries. Millard Canyon, a major tributary and water source enters the Arroyo from the east just north of the JPL Bridge. Just south of there, the Altadena Town Drain flows into the center of the Hahamongna Basin. From the west entering the Arroyo just north of Devil's Gate Dam, Flint Canyon Wash drains the streams and storm drains of La Canada, including Hay, Gould and Winery Canyons.

Below Devil's Gate all the way to the Los Angeles River, all Arroyo Seco tributaries have been turned into storm drains and culverts. Major storm drains can be found near the Rose Bowl and at Sycamore Park in Highland Park where the North Branch enters the Arroyo Seco,

A thorough review of pollution records and documents such as the Arroyo Seco Sanitary Survey will provide an initial list of sites for monitoring. Stream conditions and barriers identified by the Stream Walk also will help identify candidate sites for monitoring. These might include horse stables, barriers, dumping sites or other potential sources of pollution. Sites should be targeted to be representative of specific reaches of the stream and conditions and to monitor pollution sources.

For baseline data to characterize the Arroyo Seco and screen for problems, ASWQMP should monitor a number of sites representing a range of conditions in the stream watershed (e.g., an upstream "pristine" area in the mountain watershed, major storm channels, etc.). For specific sites suspected of polluting the stream, monitors should take samples upstream and downstream of the area. As Best Management Practices are developed in the watershed, pre- and post-implementation sampling can yield informative results. Another approach to determine the effectiveness of runoff control measures is to sample two similar small watersheds, one with controls in place and one without controls).

Safety and accessibility (both legal and physical) will be important factors in determining site locations. ASWQMP will need to maintain the same sites over time and identify them clearly in the monitoring program design.

EPA's Methods Manual suggests considering the following questions when selecting sites:

- Are other groups (local, state, federal agencies; other volunteer groups; schools or colleges) already monitoring this site?
- Can you identify the site on a map and on the ground?
- Is the site representative of the watershed?
- Does the site have water in it during the times of year that monitoring will take place?
- Is there safe, convenient access to the site (including adequate parking) and a way to safely sample a flowing section of the stream? Is there access all year long?
- Can you acquire landowner permission?
- Can you perform all the monitoring activities and tests that are planned at this site?
- Is the site far enough downstream of drains or tributaries? Is the site near tributary inflows, dams, bridges, or other structures that may affect the results?
- Have you selected enough sites for the study you want to do?

Data Collecting and Access

It is hard to overemphasize the importance of having established methods of collecting volunteer data, handling and analyzing that data, and presenting results effectively to volunteers, the public, and water resource decision-makers. Without these tools and processes, the data that volunteers and program managers have labored hard to collect are virtually useless, and the program will fail to meet its goals.

Chapter Six of EPA's Methods Manual addresses data management and presentation. That chapter recommends:

> "Members of the program planning committee will need to make many decisions on these issues before the first field data sheet is filled out by the program's first volunteer. In particular, they should consult any potential data users such as state water quality agencies or county planning boards regarding their own data needs. Data users will be particularly concerned about:
>
> - Procedures used to verify and check the raw volunteer data.
> - Databases and software used to manage the data.
> - Analytical procedures used to convert the raw data into findings and conclusions.
> - Reporting formats."

Websites offer tremendous potential for reporting water quality data in a way that will make the information easily accessible on a real-time basis to the public and motivational for monitoring program volunteers. An effective water quality website can provide water monitors with a place to store their water monitoring data, track water monitoring projects and to provide educational

resources need for a water monitoring program. The GREEN – Global Rivers Environmental Education Network website at http://www.green.org is a good illustration of this potential. The Arroyo Seco website at http://www.arroyoseco.org already serves an a handy resource on watershed topics and can be used effectively for online access to water quality monitoring data for ASWQMP.

Developing a Quality Assurance/Quality Control Plan

The accuracy and precision of data will be critical to the success of ASWQMP. The program should establish a detailed methodology of quality assurance and quality control measures to demonstrate the accuracy (how close to the real result the sample is) and precision (how reproducible the results are) of monitoring.

Quality Assurance (QA) is a broad plan for maintaining quality in all aspects of a program. This plan should describe monitoring methodology, proper documentation of all procedures, training of volunteers, study design, data management and analysis, and specific quality control measures. Quality Control (QC) consists of the steps to determine the validity of specific sampling and analytical procedures. Quality assessment is the assessment of the overall precision and accuracy of data, after the analyses have been conducted.

The Arroyo Seco Water Quality Monitoring Program should incorporate the principles of QA/QP detailed on the website of the California Water Resources Control Board at:

http://www.swrcb.ca.gov/swamp/qapp.html

Various Organizational Approaches to Water Quality Monitoring

Water quality monitoring is conducted in a variety of ways. Sometimes professionals who work for water or resource agencies or consulting firms conduct the surveys and sampling. This method is too expensive to be practical for ongoing monitoring of the Arroyo Seco.

Volunteers, properly trained and motivated, can produce high quality results that are useful for regulatory and restoration purposes, while involving concerned citizens as stewards of their watershed. The Malibu Creek Watershed Stream Team Pilot Project subtitled their manual, "Shattering the Myths of Volunteer Monitoring." The report provides a detailed analysis of the reduced costs and broad benefits of volunteer monitoring. Their program is a Southern California model of the excellent work volunteer monitors can perform, and there are many more across the county. They summarize some of their findings:

> "Heal the Bay believes that LARWQCB, the State Water Resources Control Board, counties, cities and public agencies mandated to conduct water chemistry monitoring and identify pollution sources should financially support volunteer monitoring efforts modeled after the Stream Team. These programs are cost effective and provide high quality data that fulfills these mandates. In addition, volunteer monitoring has the added benefit of community outreach and public education. Over 500 people have been educated about the issues concerning the future water quality and ecological health of the

Malibu Creek Watershed. These volunteers witness first hand the affects of impervious surfaces, nutrient loading, sediment loading and urban runoff on stream ecology. Volunteers, who attend Stream Team trainings, leave with the knowledge of what they can do to protect this precious resource. Heal the Bay has witnessed our volunteers take ownership of the Malibu Creek Watershed and truly become stewards of the environment."

Training Considerations

Educational outreach about water quality issues within Arroyo Seco schools would enlighten our young citizen about the natural environment of the Arroyo Seco. Teachers could include a short unit in the science curriculum on protecting and enhancing the quality of our local natural resource, the Arroyo Seco. High school service and science clubs could be a resource for active volunteers in the monitoring program.

Community based organizations involved in the Arroyo restoration program such as the Arroyo Seco Foundation, North East Trees, Highland Park Heritage Trust, the Pasadena Sierra Club and Audubon Society groups, make up a rich of pool of volunteers for a citizen monitoring program. Through Watershed U and other outreach activities, hundreds of local activists have demonstrated their interest in restoring and protecting the Arroyo. A citizen monitoring program offers a rewarding and educational way to participate in Arroyo enhancement efforts.

Other local watershed groups, such as the Tujunga Wash, Rio Hondo, Friends of the Los Angeles River and San Gabriel River also have plans to develop citizen water quality monitoring programs. It would be good to work with these groups to consolidate the planning, training and even the sampling activities to reduce cost and improve the quality of local watershed monitoring programs.

Training Resources Available

A wide variety of training materials are available online and for purchase. A complete list of such resources can be found in the appendices.

- Handbooks
- Web Resources
- Arroyo Seco Sanitary Survey
- Arroyo Seco Watershed Restoration Feasibility Study
- The Malibu Creek Watershed Stream Team Pilot Project
- EPA Resources
- Regional Board Resources

Organizations that have established effective monitoring programs, such as Heal the Bay's Stream Team, can provide the best trainers for the Arroyo Seco program. They are experienced

in the practical realities of establishing and maintaining a monitoring program. Heal the Bay's Stream Team has already trained more than 5,000 volunteers to participate in monitoring efforts.

Conclusion

Development of the Arroyo Seco Water Quality Monitoring Program is the next step in restoring the Arroyo Seco Watershed. An effective volunteer-based program will provide important technical data for restoration planning and expand citizen stewardship of the Arroyo Seco. A variety of funding sources are available from local, state and federal sources, such as the Los Angeles Regional Water Quality Control Board and various bond issues for water quality improvements.

The information and resources found in this report and its appendices can provide the tools for a successful Arroyo Seco Water Quality Monitoring Program.

Appendices

Appendix 1: Arroyo Seco Water Quality Sampling Plan

I. Introduction

The Arroyo Seco Foundation and North East Trees are developing the Arroyo Seco Watershed Management Plan in cooperation with the Los Angeles County Department of Public Works (DPW) and the Council of Arroyo Seco Agencies.

The Arroyo Seco is a major tributary to the Los Angeles River in eastern Los Angeles County. The watershed encompasses 47 square miles that includes La Canada in the west across the foothills of the San Gabriel Mountains to Millard Canyon in Altadena to the east, and then south through Pasadena, South Pasadena and Northeast Los Angeles. The major tributaries of the Arroyo Seco are Flint Canyon Wash and Millard Canyon as well as several storm channels in the urbanized section of the watershed. The Arroyo Seco Watershed Management Plan (Plan) will develop recommendations to integrate water quality, hydrologic function, habitat and land use issues.

Purpose of Sampling Program

The purpose of implementing a sampling program is to provide a "snapshot" of dry weather water quality in the watershed to support preparation of the watershed management plan. The table below lists the current 303(d) Listings of impairments to the Arroyo Seco and its tributaries (2002 CWA Section 303(d) List of Water Quality Limited Segment).

Table 1: Arroyo Seco Contaminants

Region	Name	Calwater Watershed	Pollutant/ Stressor	Potential Sources	TMDL Priority	Est. Size Affected	Proposed TMDL Completion
4	**ARROYO SECO REACH 1 (LA RIVER TO WEST HOLLY AVE)**	40515010	Algae	Nonpoint Source	High	5.2 Miles	2002
			High Coliform Count	Nonpoint Source	High	5.2 Miles	2002
4	**ARROYO SECO REACH 2 (Figueroa Street to Riverside Drive)**	40515010	Algae	Nonpoint Source	High	4.4 Miles	2002
			High Coliform Count	Nonpoint Source	High	4.4 Miles	2002
			Trash	Nonpoint Source	Low	4.4 Miles	2002

Dry weather sampling is proposed since it is the more common annual condition and introduces less risk to those conducting the sampling. It is anticipated that the conclusions from this sampling event will not result in the isolation of specific land use areas as a source. Instead, general land use patterns from each subwatershed will be summarized as part of the final Plan.

The sampling data will be used to propose a future course of action and monitoring for the watershed.

III. Constituents for Sampling

The following parameters and water constituents have been proposed for analysis during the event.

CONSTITUENTS					
Nutrients		**Metals**		**Physical Parameters**	
	Ammonia-Nitrogen	10	Aluminum, Total	20	Air temperature
	Nitrate-Nitrogen	11	Aluminum, Dissolved	21	Water temperature
	Nitrite-Nitrogen	12	Cadmium, Total	22	pH
	Phospate	13	Cadmium, Dissolved	23	Hardness
Bacteria		14	Copper, Total	24	Chloride
	Total Coliform	15	Copper, Dissolved	25	Dissolved Oxygen
	Fecal Coliform	16	Lead, Total	26	Chemical O Demand (COD)
	E. Coli	17	Lead, Dissolved	27	TSS
	Enterococcus	18	Zinc, Total	28	TDS
	Streptococcus	19	Zinc, Dissolved	29	Turbidity
				30	Conductivity
				31	Flow
				32	Algae (presence)
				33	Trash (photographs)

IV. Overview of Sampling Event

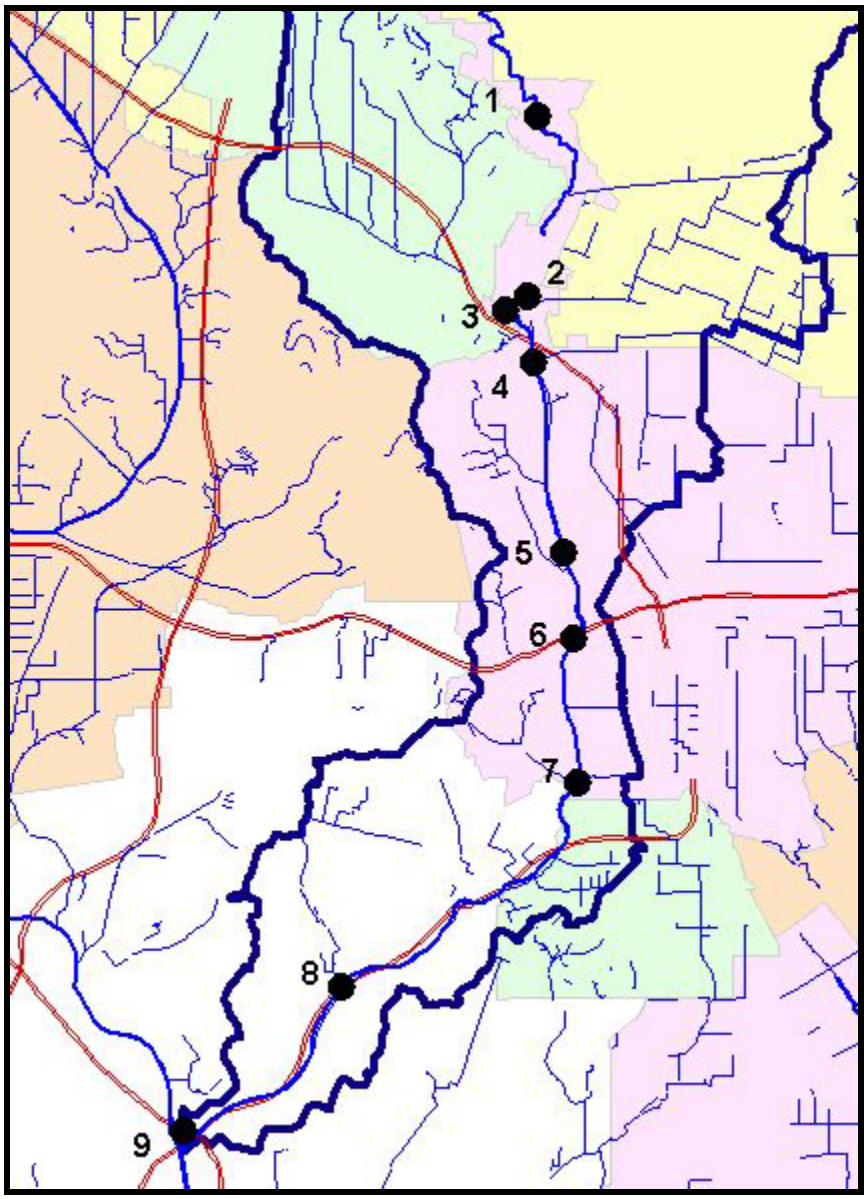
We request that DPW carry out the sampling effort using in-house staff and bear the laboratory costs associated with a one-time sampling event for nine sites. DPW currently samples in the Los Angeles River Watershed and can utilize sampling procedures as stated the Quality Assurance/Quality Control Plan from the *Los Angeles County 2001-2002 Storm Water Quality Monitoring Report*, August 15, 2002. Because the sampling locations are easily accessible and within an 11-mile stretch of the Arroyo Seco, sampling can be completed in less than a day.

V. Proposed Sampling Locations

There are nine proposed sites. The first site is in the Upper Arroyo Seco just upstream of the City of Pasadena diversion facility. This site will serve as a "reference site" for comparing natural and urban watershed influences. Samples will be taken at two sites in the Hahamongna, one outlet of the West Altadena Drainage System, the other at the oulet of Flint Canyon Channel where it enters the Arroyo just west of Devil's Gate Dam. Sampling will also occur at Project 560, the Seco Street Drain, and the Arroyo Seco Channel under the Colorado Street Bridge. Further south, Annandale Canyon (Project 562) and The Arroyo Seco North Branch (Project 5202) will be sampled. The last sampling site is the Arroyo Seco Channel just upstream from its confluence with the Los Angeles River.

Below are the locations per Thomas Bros. (2003). Samples need to be collected just before the

tributary flow joins Arroyo Seco flow. All sites are accessible via public trails or the channel invert.



PROPOSED SAMPLING SITE LOCATIONS		
No.	**Thomas Bros.**	**Location**
1	535 F3	Upper Arroyo Seco u/s of Pasadena's diversion dam.
2	535 E6	West Altadena Drainage System
3	535 E6	Flint Canyon Channel
4	505 E7	Project 560 – Montana Street
5	565 F3	Seco Street Drain
6	565 F5	Arroyo Seco Channel at Colorado Street Bridge
7	565 F7	Project 562 – Annandale Canyon
8	565 B4	Project 5202 - Sycamore Grove Park
9	594 J7	Arroyo Seco at Confluence with LA River

Appendix 2: ASWRFS Water Quality Goals

Restoration Goal 2 - Better Manage, Optimize, & Conserve Water Resources While Improving Water Quality			
2.1	Improve quality of surface water for aquatic habitat and human contact.	2.1.1	Implement BMPs to mitigate water quality pollutants flowing into the Arroyo Seco.
		2.1.2	Develop source protection measures.
		2.1.3	Reduce non-point sources of pollution.
		2.1.4	Develop ongoing water quality monitoring programs and public education of water quality issues.
		2.1.5	Monitor and clean out pollutants that accumulate in non-structural BMPs.
		2.1.6	Evaluate existing point-sources of pollution for monitoring compliance on a regular basis.
2.2	Restore the quality and quantity of water recharge to the Raymond Aquifer.	2.2.1	Increase permeability of developed land uses through implementation of BMPs such as redirecting runoff into bioswales, removing unneeded concrete and asphalt.
		2.2.2	Manage groundwater to prevent future overdraft.
		2.2.3	Mitigate water quality pollutants percolating into the groundwater.
		2.2.4	Test the feasibility of recharging the groundwater basin with surface flows in the channel through Hahamongna Basin. Requires a detailed monitoring program and cooperation by groundwater users.
		2.2.5	Develop detailed water budget to assess current inputs and outputs of rainfall, imported water and groundwater for the hydrologic cycle of the watershed. One purpose includes assessing the potential overdraft of groundwater.
		2.2.6	Promote program that encourages all property owners to take responsibility for retaining 50% of the “first flush” of storm water or similar benchmark onsite.
2.3	Develop groundwater management strategy for optimum use of local water resources.	2.3.1	Expand conjunctive use of groundwater basin for enhanced storage during wet periods for use during dry periods.
		2.3.2	Preserve foothill open space to protect percolation into the groundwater basin and to prevent aggravated runoff.

2.4	Reduce dependence on imported water.	2.4.1	Increase groundwater percolation through BMPs.
		2.4.2	Promote comprehensive conservation programs and best management practices throughout the watershed to reduce water consumption.
		2.4.3	Develop upper hillside watershed reforestation and revegetation programs to improve local retention.
2.5	Reinstate sediment transport.	2.5.1	Control erosion & manage sedimentation in restored streams (e.g., bank regrading and revegetation, channel grade control structures, riprap), and under bridges & freeway overpasses.
		2.5.2	Implement BMPs for construction and existing land uses to reduce and manage sedimentation from human disturbance.
		2.5.3	Conduct a detailed hydraulic and geomorphic investigation of channel conditions with respect to erosion potential.
		2.5.4	Establish a maintenance and management program to either trap the sediment in areas where it can be easily processed or to promote its passage through Devil's Gate reservoir and dam downstream.
		2.5.5	Develop re-vegetation programs and BMPs where appropriate to reduce erosion.

Appendix 3: What to Monitor

CONSTITUENTS					
Nutrients		**Metals**		**Physical Parameters**	
1	Ammonia-Nitrogen	10	Aluminum, Total	20	Air temperature
2	Nitrate-Nitrogen	11	Aluminum, Dissolved	21	Water temperature
3	Nitrite-Nitrogen	12	Cadmium, Total	22	pH
4	Phospate	13	Cadmium, Dissolved	23	Hardness
Bacteria		14	Copper, Total	24	Chloride
5	Total Coliform	15	Copper, Dissolved	25	Dissolved Oxygen
6	Fecal Coliform	16	Lead, Total	26	Chemical O Demand (COD)
7	E. Coli	17	Lead, Dissolved	27	TSS
8	Enterococcus	18	Zinc, Total	28	TDS
9	Streptococcus	19	Zinc, Dissolved	29	Turbidity
				30	Conductivity
				31	Flow
				32	Algae (presence)
				33	Trash (photographs)

Appendix 4: Books and Handbooks Available on Water Quality Monitoring

Books Available from River Network

http://www.rivernetwork.org/marketplace/category.cfm?Category=25

Testing the Waters: Chemical and Physical Vital Signs of a River
Price: $25.00

Product #: LW100
by Geoff Dates
This comprehensive resource describes how to design and carry out a river study using benthic macroinvertebrates. It provides background information about macroinvertebrates and the role they play in the river ecosystem, four options for monitoring them, the detailed procedures for each option and how to interpret and present your results. Also included are the following keys: A Dichotomous Key to the Freshwater Macroinvertebrate Fauna of New England, A Simple Picture Key to Freshwater Macroinvertebrates, and dichotomous keys to the Stonefly, Mayfly and Caddisfly families.
200 pgs. Partners $20, Others $25.

Testing the Waters: Chemical and Physical Vital Signs of a River
Price: $15.00

Product #: ISBN0-7872-3492-3
by Sharon Behar
Do you have questions about what, when, where and how to monitor your river for water quality? This manual, designed to meet the needs of high school teachers and community groups, covers nine water quality indicators, information you need design your study and deal with the data once you've carried it out, and how to use the information to take action. Each indicator chapter (physical survey, temperature, turbidity, dissolved oxygen, pH, alkalinity, phosphate, nitrate and conductivity) is clearly written with background information, procedures for measuring them and great activities for teaching the information to students.
211 pgs. Partner $16. Others $20.

Program Organizing Guide
Price: $10.00

Product #: POG100
By Sharon Behar and Geoff Dates
This guide addresses the organizational issues frequently encountered by a group starting a monitoring program. The manual leads you through an eleven-step process to help organize effective and sustainable programs. It can be used to initiate a new program or to assess the progress of an existing one.
1995, 24 pages. Partners $8. Others $10.

River Monitoring Study Design Workbook
Price: $10.00

Product #: SDW100
by Geoff Dates
A study design is crucial to creating a monitoring program that has a focus and creates information that can be used. It will help produce a study design that is tailored to the needs, issues and resources of your community. It systematically guides you through the decision-making process of determining the purposes of your monitoring program; selecting appropriate water quality indicators, methods and sites; deciding who to involve; setting a schedule; and setting up a quality assurance program.
1995, 39 pgs. Partner $8. Others $10.

The Clean Water Act: An Owner's Manual

Price: $25.00

Product #: ISBN 1-930407-02-5
By Don Elder, Gayle Killam and Paul Koberstein

Here is a comprehensive manual for people who want to clean up their rivers, streams and watersheds. This down-to-earth, information-packed book explains crucial sections of the Clean Water Act, points out how to get involved in regulatory decisions, and tells the stories of others who've done so. Packed with references, web sites and other resources, this manual turns legalese and scientific terminology into language you can use.
1999, 157 pgs. Partners $20. Others $25

Books Available from Streamkeepers

http://www.streamkeeper.org/tools/catalog.htm

Streamkeeper's Field Guide: Watershed Inventory and Stream Monitoring Methods

By Thomas B. Murdoch and Martha Cheo with Kate O'Laughlin. Illustrated by Thomas B. Whittemore with Gary Larson, Dave Horsey, Steve Greenberg, Chris Britt, Brian Basset, Ken Alexander and Tom Toles. The Adopt-A-Stream Foundation, 1996, 1999, Field tested by teachers and community leaders, *The Streamkeeper's Field Guide* provides comprehensive and entertaining training in watershed inventorying and stream monitoring techniques. Includes protocols for monitoring physical, chemical and biological parameters, reproducible data sheets for collecting information, steps on how to create Quality Assurance and Quality Control plans based upon EPA guidelines, directions to construct monitoring equipment, as well as inspiring tales of real Streamkeepers who have successfully taken action to protect their streams. 300 pages, 8-1/2"x11" with hundreds of illustrations, tables and graphs, softcover. **$29.95**

Adopting A Stream: A Northwest Handbook

By Steve Yates. Illustrated by Sandra Noel. The Adopt-A-Stream Foundation, 1988, 1991. A stream ecology primer. Easy to read, fully illustrated. Introduces readers to streams in temperate climates and provides directions on how community and school groups can help protect and restore nearby streams. 126 pages, 8-1/2"x11" softcover. **$14.95**

Using Technology to Conduct Contaminant Source Inventories: A Primer for Small Communities

The Applying Community Technology Today (ACTT) project identified and tested technologies that can be useful to small communities interested in minimizing drinking water threats. A *Primer* identifying technologies and lessons learned from the ACTT project is now available.

The *Primer* allows other communities and public water suppliers to select and preview the effectiveness of technologies that have proved useful for conducting a CSI. For example, technologies such as Geographic Information Systems (GIS) and Global Positioning Systems (GPS) allow communities to accurately obtain, manage, and update data that help identify potential contaminant sources within a source water protection area. This information can then be used to develop a plan to protect a community's drinking water supplies. Available at:
http://www.groundwater.org/ProgEvent/ACTT.htm

Field Manual for Water Quality Monitoring : An Environmental Education Program for Schools
Mark K. Mitchell, William B. Stapp, Kevin Bixby (Editor)

This field manual details nine chemical/physical water quality tests and methods for biological monitoring, showing how to perform tests and calculate results, and explains methods for assessment of toxins using a bioassay, studying benthic macroinvertebrates, and coordinating educational activities with land use practices. Two case studies show how the curriculum has been used regionally and internationally. Material can be used with middle school through graduate students. The manual is used in many national and international programs linked through Global Rivers Environmental Education Network (GREEN). GREEN is a program under the umbrella of Earth Force, a national, nonprofit organization committed to developing environmental stewardship and citizenship. Price: $25.95. Available from
http://www.earthforce.org/catalog/products.cfm?pid=62

Appendix 5: Free Online Manuals

Volunteer Water Quality Monitoring Field Manual
The Schuylkill Center for Environmental Education and the Environmental Alliance for Senior Involvement compiled this very useful Volunteer Water Quality Monitoring Field Manual. http://www.easi.org/Publications/fieldmanual.pdf
Volunteer Stream Monitoring: A Methods Manual
This is US EPA's online manual for citizen monitoring programs. http://www.epa.gov/owow/monitoring/volunteer/stream/
Drinking Water Quality Monitoring Manual - Physical and Chemical Parameters
This manual from the Government of Newfoundland and Labrador provides protocols for a drinking water quality monitoring program. http://www.gov.nf.ca/env/Env/waterres/Surfacewater/DWQ%20Manual/DWQMonitoringManual.asp
Streamkeepers Handbook and Modules
The Streamkeepers Handbook and Modules from the Pacific Streamkeepers Federation in Vancouver is an easy to use resource for getting actively involved in your local stream. It will help you discover and monitor the health of your stream, undertake restoration projects, and includes information about: Streamkeeper Programs, Project Modules for Streams, Watershed Ecology, and Home Tips for Clean Streams. http://www.pskf.ca/publications/handbook.html
Heal the Bay Malibu Stream Team Project
Shattering the Myth of Volunteer Monitoring is a thorough guide to the fine points of water quality monitoring. See also the Malibu Creak Framework for Monitoring, Enhancement and Action. http://www.healthebay.org/streamteam/volmon.pdf

Appendix 6: Effective Data Display

Here are some examples of online sites that provide an interesting or particularly effective approach to reporting obtained from citizen water quality monitoring.

- Global Rivers Environment Education Network (GREEN). Riverbank. Ann Arbor, MI. This site, specially designed for student projects, provides webspace for citizen monitoring groups to display their data. There are many useful examples and tools. http://www.green.org/
- San Francisco Estuary Institute. The San Francisco Bay Area EcoAtlas. Richmond, CA. http://www.ecoatlas.org/
- "Verdugo Wash to the Arroyo Seco" is an interesting example of water quality data online. www.paccd.cc.ca.us/envsci/LAR2.ppt
- Heal The Bay's Malibu Stream Team – Here is the online data on the Stream Team's efforts: http://www.healthebay.org/Streamteam/data/chem/waterchem.html

Appendix 7: Key Contacts

- **Erick Burres**, volunteer monitoring coordinator of the Los Angeles Regional Water Quality Control Board, (213) 576-6788
- **Eileen Takata**, was project director of the Arroyo Seco Watershed Restoration Feasibility Study and also helped put together the Mailibu Creek Stream Team. She now works for Moore Iacafono and Goltsman (MIG) Consulting, (626) 744-9872
- **Mark Abramson**, is Stream Team Coordinator for Heal the Bay, 310-453-0395 x146
- **Nancy Ngugi**, Los Angeles Regional Water Quality Control Board, (213) 576-6600.
- **Inna Babbit**, City of Pasadena Water & Power Department Water Quality Section, (626) 744-4465, communicates Water Quality Information to Pasadena's water customers, including chemistry of Colorado River water, challenges of blending with PWP's well water, supply challenges and regulations about surface water and groundwater.

Appendix 8 – Equipment List

Appendix 9 – Biosurvey Macroinvertebrates Data Sheet

Appendix 10 – Stream Quality Survey Sheets

Appendix 11 – Water Quality Terminology

Appendix 12 - Supply Vendors

Water Quality Monitoring Kits:

LaMotte Company **P.O. Box 329** **Chestertown, Maryland 21620**	Phone: Fax: Web:	800-344-3100 (to place orders or request info); 410-778-3100 (in MD) 410-778-6394 http://www.lamotte.com/
This firm also has available lessons plans for testing equipment. These teaching aids cover topics such as dissolved oxygen, nutrients, soil texture, and a wide variety of others.		

Hydrometers:

La Motte Company **P.O. Box 329** **Chestertown, Maryland 21620**	Phone: Fax: Web:	800-344-3100 (to place orders or request info) 410-778-3100 (in MD) 410-778-6394 http://www.lamotte.com/
LaMotte Company Hydrometer (1.000/1.070), code 3-0011~$28		

Bacteriological Tests for *E. coli* and General coliforms:

Micrology Laboratories, LLC **206 W. Lincoln Ave.** **Goshen, IN 46526-3219**	Phone: Fax: Email: Web:	1-888-EASYGEL 219-533-3370 micrologylabs@juno.com www.micrologylabs.com
ColiScan EasyGel & Pre-treated Petri Dishes (Cat. no. 25001)		
1 ml Droppers (Cat. no. DR001) - needed for sample collection		

Collecting trays - Macroinvertebrate:

Bioquip **17803 LaSalle Avenue**	Phone: Fax:	310-324-0620 310-324-7931

Gardena, CA 90248-3602	Web:	http://www.bioquip.com/
Large Larval Tray (Cat. no. 1426B)		

Forceps - Student Grade:

Nasco Science	Phone:	800-558-9595
Item #: SB 126-28M SB12628M Dissecting Forceps (Fine Points) - Stainless Steel 1-11 1.65/each 12 or more 1.35/each SB29983M Green Water Monitoring Kit 165.00 SB33597M Water Monitoring Kit 28.95		

Bioquip **17803 LaSalle Avenue** **Gardena, CA 90248-3602**	Phone: Fax: Web:	310-324-0620 310-324-7931 http://www.bioquip.com/
Forceps (Cat. no. 4524) -very sharp point, laboratory grade		
Forceps (Cat. no. 4522) -laboratory grade		

Nets:

Wildco (Wildlife Supply Co) **95 Botsford Pl.** **Buffalo, NY 14216**	Phone: Fax: Email: Web:	(800) 799-8301 (800) 799-8115 goto@Wildco.com www.wildco.com
D-frame Aquatic Dip Net (Cat. no. 425-A46) ~$117 Zo Net with handles (Cat. no. 427-B35) ~$111		

The Izaak Walton League	Web:	http://www.iwla.org/merchant2/merchant.mv?Screen=CTGY&Store_Code=ICCS&Category_Code=EQ
SOS Kick Seine Net (Volunteer) (Code: SOSE001) ~$41 SOS Kick Seine Net (Professional) (Code: SOSE002) ~$46 SOS D-frame Net for Muddy-Bottom Stream Sampling (Code: SOSE003) ~$52		

"Rite in the Rain" All Weather Writing Paper:

J.L. Darling Corporation **2614 Pacific Highway**	Phone: Fax:	253-922-5000 253-933-5300

Tacoma, WA 98424-1017	Email: Web:	sales@riteintherain.com www.riteintherain.com

Additional Scientific Supply Companies:

Cole-Parmer Instrument Co. **625 E. Bunker Court** **Vernon Hills, IL 60061-1844**	Phone: Fax: Email: Web:	(800) 323-4340 www.coleparmer.com

Fisher Scientific **711 Forbes Ave.,** **Pittsburgh, PA 15219**	Phone: Fax: Email: Web:	1-800-766-7000 1-800-926-1166 www.fishersci.com
Supplies a wide range of testing and monitoring equipment		

HACH Company **P.O. Box 389** **Loveland, CO 80539**	Phone: Fax: Email: Web:	(800) 525-5940 www.hach.com
HACH COMPANY provides advanced analytical systems and technical support for water quality testing, with solutions for lab, process, and field.		

Hydrolab Corporation **P.O. Box 50116** **Austin, TX 78763**	Phone: Fax: Email: Web:	(512) 255-8841 www.hydrolab.com

GREEN **Earth Force** **1908 Mount Vernon** **Second Floor** **Alexandria, VA 22301**	Phone: Fax: Email: Web:	703-299-9400 703-299-9485 green@earthforce.org www.green.org
GREEN Low-Cost Water Monitoring Kit		

Great as an introduction to ANY water-quality monitoring program. Comes complete with an instruction guide and materials to test 10 water samples., **Catalog #** 5886, **Price:** $29.95 http://www.earthforce.org/catalog/products.cfm?pid=16
GREEN Advanced Water Monitoring Kit Includes dissolved oxygen kit, nitrate test kit, wide range pH kit, turbidity kit, total phosphate kit, armored thermometer and bottles for testing biochemical oxygen demand., **Catalog #** 5884, **Price:** $397.95 http://www.earthforce.org/catalog/products.cfm?pid=25
GREEN Standard Water Monitoring Kit Comes complete with materials to test 100 water samples (44 for coliform bacteria) for pH, dissolved oxygen, biochemical oxygen demand, nitrate, phosphate, turbidity, coliform bacteria and temperature change., **Catalog #** 5848, **Price:** $175.00 http://www.earthforce.org/catalog/products.cfm?pid=18

Appendix 13 – Related Agencies and Organizations

1.	USEPA Surf Your Watershed (website)
	Identify your local watershed organization for past water quality data colleted and posted for the public.
2.	River Network (website)
	Helping People Understand, Protect, and Restore Rivers and Their Watersheds
3.	USEPA Directory of Monitoring Programs (website)
	This directory lists volunteer organizations around the country engaged in monitoring rivers, lakes, estuaries, beaches, wetlands, and ground water as well as surrounding lands
4.	Kentucky Water Watch (website)
	A summary of high-quality web sites that deal directly with the field of volunteer monitoring
5.	Conservation Technology Information Center (website)
	State Watershed Contacts
6.	Rivers Project (website)
	Increasing the Scientific Literacy of High School Students Through Water Study.
7.	USEPA Adopt Your Watershed (website)
	EPA's "Adopt Your Watershed" campaign. Through this effort, EPA challenges citizens and organizations to join together to protect and restore our valuable rivers, streams, wetlands, lakes, ground water, and estuaries. An on-line database cites opportunities to get involved in activities such as monitoring, cleanups, and restoration projects.
8.	Volunteer Stream Monitoring: A Methods Manual (website)
	The guide describes the role of volunteer monitoring in state programs and discusses how managers can best organize, implement, and maintain volunteer programs.
9.	USEPA What is Nonpoint Source Pollution? (website)
	Questions and Answers.
10.	USEPA Index of Watershed Indicators (website)
	The Watershed Atlas provided by the Watershed Information Network gives a general overview (PDF, 597KB) and the national maps and fact sheets for all the indicators and candidate indicators of watershed health.
11.	USGS Water Science Topics for Schools (website)
	Information on many aspects of water, along with pictures, data, maps and an interactive

	center where you can give your opinions and test your water knowledge.
12.	USGS Water Information Sources (website)
	An ever-growing list to continue the search for information about water and also find out how schools around the nation and around the world are putting their own water information on the web.
13.	USGS Water Science Data Library (website)
	Summary data tables about water use in the United States, by state.
14.	American Rivers (website)
	American Rivers is a national non-profit conservation organization dedicated to protecting and restoring America's rivers and to fostering a river stewardship ethic. Toolkits for a variety of river restoration programs can be found at http://www.amrivers.org/aboutrivers/toolkits.htm
15.	Los Angeles Regional Water Quality Control Board (website)
	The Los Angeles Regional Water Quality Control Board (LARWQCB) protects ground and surface water quality in the Los Angeles Region, including the Arroyo Seco. Their Watershed Management Initiative (WMI). is designed to integrate surface and ground water regulatory programs while promoting cooperative, collaborative efforts within a watershed. It is also designed to focus on key issues and use sound science.
16.	Give Water A Hand (website)
	With Give Water A Hand, young people team up with educators, natural resource experts and committed community members to study water issues and take ACTION! Excellent instructions and handbooks are available for free.
17.	LA County Watershed Management
	The County Department of Public Works implements watershed management County-wide to improve the overall quality of life for residents of Los Angeles County.
18.	Center for Watershed Protection
	The Center for Watershed Protection provides local governments, activists, and watershed organizations around the country with the technical tools for protecting streams, lakes and rivers. http://www.cwp.org/index.html and http://www.stormwatercenter.net/
	Vulnerability Analysis: The Watershed Vulnerability Analysis provides guidance on delineating subwatersheds, estimating current and future impervious cover, and identifying factors that would alter the initial classification of individual subwatersheds. This technical release outlines a basic eight-step process for creating a rapid watershed plan for either a large watershed or jurisdiction.
	RSAT: The **Rapid Stream Assessment Technique** (RSAT) was developed by John Galli at Metropolitan Washington Council of Governments to allow watershed managers to perform a simple, rapid reconnaissance-level assessment of stream quality conditions. Read about how the RSAT system works.
19	California Water Resources Control Board's Clean Water Team
	Here's a great site from the California Water Resources Control Board that has lots of

	resources for citizen-based water quality monitoring programs.
20.	City of Santa Barbara Clean Creeks Program
	This is an outstanding municipal program to protect and restore local streams and to turn citizens into watershed stewards.
21.	North East Trees
	North East Trees is a nonprofit environmental organization dedicated to watershed sensitive planning, sustainable design, local construction and long term preservation of green space in Northeast Los Angeles and surrounding communities.
22.	Los Angeles and San Gabriel Rivers Watershed Council
	LASGRWC is an organization of community groups, government agencies, business and academia working cooperatively to solve problems in the watershed. Its mission is: to facilitate a comprehensive, multi-purpose, stakeholder driven consensus process to preserve, restore, and enhance the many beneficial uses, economic, social, environmental and biological, of the Los Angeles River and San Gabriel River watersheds eco-system through education, research, planning, and mediation.
23.	Friends of the Los Angeles River
	Friends of the Los Angeles River is a non-profit organization founded in 1986 to protect and restore the natural and historic heritage of the Los Angeles River and its riparian habitat through inclusive planning, education and wise stewardship.
24.	The River Project
	The River Project organized the Coalition for a State Park at Taylor Yard and led the successful fight to establish the first state park on the Los Angeles River. The group has undertaken a comprehensive study of the Tujunga Wash subwatershed and are actively engaged in the design and development of several river greenway parks in the San Fernando Valley. http://www.theriverproject.org/
25.	Arroyo Seco Foundation
	The Arroyo Seco website has a complete list of Watershed Web Resources found online. It also has general information on the Arroyo Seco and the Watershed Restoration Program as well as the full text of the Arroyo Seco Watershed Restoration Feasibility Study.

Appendix 14: Valuable Resources for Citizen Monitoring Projects

The Volunteer Monitor Newsletter The Volunteer Monitor newsletter facilitates the exchange of ideas, monitoring methods and practical advice among volunteer monitoring groups across the nation. *The Volunteer Monitor* is published twice yearly.
An Evaluation of the Statistical Power of Volunteer Generated Data Compiled by the Upper Merrimack Monitoring Program. It is hoped that the information presented within this report, along with the results presented here will act as a template for other volunteer organizations to strive toward the goal of producing statistically valid data.
Databases and Mapping from EPA Office of Wetlands, Oceans, & Watersheds The EPA has data, lots of it. Especially interesting is their STORET system (short for STOrage and RETrieval), a repository for water quality, biological, and physical data and is used by state environmental agencies, EPA and other federal agencies, universities, private citizens, and many others.
Ecoregional Nutrient Criteria Documents for Lakes and Reservoirs These documents present EPA's nutrient criteria for Lakes and Reservoirs in eight Ecoregions across the country. They contain EPA's recommendations to states and authorized tribes for establishing their water quality standards. These recommended criteria are not laws or regulations - they are guidance that states and tribes may use as a starting point for the criteria for their water quality standards.
EPA's Volunteer Monitoring Program EPA's Office of Water encourages all citizens to learn about their water resources and supports volunteer monitoring because of its many benefits.
GREEN: Global Rivers Environmental Education Network This website can help you make lasting improvements to your watershed by offering an online monitoring database and community action tool. Designed for monitoring groups and interested browsers alike.
Watershed Monitoring Links River Network has searched the Web for information related to watershed monitoring approaches. This link lists some of the best information.
Hudson Basin Data Xchange If you're looking for a way to store and share data online check out this page. This web site allows schools and volunteer groups to exchange stream monitoring data. To insure data quality, your group must be part of Hudson Basin River Watch to submit data. Contact your regional coordinator for the required password.
Index of Biological Integrity: Kispiox Report
Measuring Biological Integrity - DRAFT
Missouri Stream Team

This group tracks and reports on their monitoring data using a web-based tracking system they developed. Visit this site to see how they do it.
National Directory of Volunteer Monitoring Programs This directory lists volunteer organizations around the country engaged in monitoring rivers, lakes, estuaries, beaches, wetlands, and ground water.
National Nutrient Guide Manual for Rivers and Streams The intent of this document is to provide States and Tribes with methods to assess waterbody nutrient impairment and develop ecoregion-specific nutrient criteria. The Rivers and Streams document provides background information on classifying rivers and streams, selecting criteria variables, designing monitoring programs, building a database analyzing nutrient and algal data, deriving regional criteria, and implementing management practices.
Proceedings: Fifth National Volunteer Monitoring Proceedings: Fifth National Volunteer Monitoring Conference: Promoting Watershed Stewardship This page provides links to the proceedings of the Fifth National Volunteer Monitoring Conference.
The Stream Study: Identification Key for Common Stream Bottom Macroinvertebrates The Stream Study presents a catalogue and identification key of common stream bottom macroinvertebrates. It describes the kick-seine method used to determine the water quality by collecting stream-bottom macroinvertebrates from streams with rocky or gravel stream beds. It also provides practice samples to identify macroinvertebrates and determine overall water quality. The Stream Study was developed through the University of Virginia to support the Save Our Streams Program.
Year of Clean Water 2002-2003 Congress, along with a number of the nation's Governors and national organizations have proclaimed 2002 as the Year of Clean Water. On this site you can sign up to participate in National Water Monitoring Day on October 18, 2002 and obtain a test kit.
A Plan for Watershed-Wide Volunteer Monitoring Obviously, monitoring a large watershed can be a mind-boggling scientific, organizing, and political challenge. A coalition of agencies and groups have designed an approach to tackle that challenge in the Merrimack River watershed. This article outlines their approach.
Fighting a Proposed River Reclassification We hope that the lessons learned by River Watch Network through their involvement in an adversarial proceeding will help you present as effectively as possible in support of your position.
Getting Started: Designing a monitoring program Designing a scientifically-credible and realistic watershed monitoring effort involves making choices about the why, what, how, where, when, and who of your monitoring effort. This article explains the steps.
How Citizen Monitoring Data Became a Part of Community Life During the summer, data from the Mad River Watch Program is as important as the daily weather forecast to people who live in the Mad River watershed. Read how Friends of the Mad River made it happen.
Monitoring for Phosphorus - OR - How Come They Don't Tell You This Stuff in the Manual Is there a simple, economical, user-friendly method that is capable of detecting low levels of phosphorus? This article will attempt to boldly go where no manual has gone before and answer that question.
Healthy Waters / Healthy Communities Help stop the threat of environmental contamination to community health by filling out River

Network's national health survey. The survey will help us:

- Demonstrate the extent of the problem;
- Create a database to network communities with one another and to others who can provide help; and
- Develop the right tools to help communities.

This page has information about our Health Assessment project with links to the survey and a powerpoint presentation.

River Network's River Watch Program
A description of the River Watch Program.

River Watch Success Stories and Lessons Learned
River monitoring and protection program success and lessons learned.

So You Want To Work With Schools
This article is written for monitoring programs currently working only with adult volunteers, who would like to expand their program to include schools.

Study Design ~ The Foundation of Credibility
Reprinted from the Volunteer Monitor Newsletter, this article summarizes the Study Design Process.

Success Stories and Lessons Learned
Featured success stories from grassroots groups around the country.

Success Story: Effective Nonregulatory Approaches Attract National Watershed Award
The Tri-State Water Quality Council, based in Sandpoint, Idaho, won an award for using effective nonregulatory approaches to improve water quality. They were recognized for their model programs that include partnerships, nutrient reduction agreements, water monitoring and public education. Read on for more about their efforts.

Testing for E. coli Bacteria
EPA studies have found that the best indicators for fresh water are Escherichia coli (a particular species within the fecal coliform group) and enterococci (another bacterial group; not part of the fecal coliform group). This page describes the method for monitoring E. coli, quality assurance techniques and reporting and using your results.

Thanks to Local Students a portion of the Big Thompson Creek (Colorado) is protected for swimming
Understanding the Clean Water Act, using a scientific approach, and community collaboration were all keys to success for these students who successfully pushed through a classification upgrade for their favorite swimhole in Colorado.

Watershed Health 101
You just can't understand what's going on in your watershed unless you get out into the field and look or take some measurements. That's called monitoring. Then you try to figure out the story of your watershed's health. That's assessment. In this article, I'll briefly describe some of the general approaches to watershed monitoring and assessment.

Appendix 15: Printed Sources

Printed Sources

- The Malibu Creek Watershed: A Framework for Monitoring, Enhancement, and Action, by Mark Abramson, Chris Padick, Eileen Takata Schueman, and Gerald Taylor, August, . 1998. California State Polytechnic University. Pomona, CA.
- The Malibu Creek Watershed: Stream Team Field Guide by Abramson, Mark, Padick, Chris, Takata Schueman, Eileen, and Taylor, Gerald. 1998(August). California State Polytechnic University. Pomona, CA.
- Save Our Streams Volunteer Trainer's Handbook, by Karen Firehock, Izaak Walton League of America. Gaithersburg, MD.
- Riparian Station How-To Manual, Final Report. By Chris Fischer, Michael Rigney, and Elizabeth Elizabeth. September, 1996, San Francisco Estuary Institute. San Francisco, CA.
- Envisioning an Arroyo Seco Watershed Water Quality Monitoring Program by Jonathan Tracey, May, 2002, 22 pages
- Arroyo Seco Watershed Restoration Feasibility Study, North East Trees and the Arroyo Seco Foundation, May, 2002
- Sanitary Study of the Arroyo Seco Watershed, Pasadena Water & Power, 1996
- Save Our Streams Project Packet, Isaak Walton League, 2001

Appendix 16: Acknowledgements

There is a great deal of excellent background and training material for citizen monitoring efforts available. This document has leaned heavily on the experiences, approaches and resources provided by these programs:

1. The Arroyo Seco Watershed Restoration Feasibility Study compiled by North East Trees and the Arroyo Seco Foundation;
2. Heal the Bay's Malibu Creek Stream Team Project
3. The Schuylkill Center for Environmental Education and the Environmental Alliance for Senior Involvement's Volunteer Water Quality Monitoring Field Manual
4. California Water Resources Control Board and the Los Angeles Regional Water Quality Control Board
5. A wide variety of documents from the US Environmental Protection Agency, particularly "*Volunteer Stream Monitoring: A Methods Manual, United States Environmental Protection Agency, Office of Water, #EPA 841-B-97-003, November 1997;*
6. Global Rivers Environmental Education Network
7. The Save our Streams Program of the Izaak Walton League of America
8. River Network
9. Center for Watershed Management http://www.cwp.org/index.html and http://www.stormwatercenter.net/
10. Rio Hondo Water Quality Sampling Program developed by Moore Iacafono and Goltsman (MIG) Consulting

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