ARROYO SECO WATERSHED MANAGEMENT AND RESTORATION PLAN

FINAL REPORT

03-01-06

Prepared For:

California State Water Resources Control Board
1001 I Street
Sacramento, CA 95812

Prepared By:

North East Trees
570 W. Avenue 26, Suite 200
Los Angeles, CA 90019

With Assistance From:

GreenInfo Network
3578 Eastham Drive, Suite C
Culver City, CA 90232

GEOSYNTEC CONSULTANTS
6601 Center Drive West Suite 500
Los Angeles, California 90045

Verna Jigour Associates
3318 Granada Avenue
Santa Clara, CA 95051

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Funding for this project has been provided in full or in part through a contract with the State Water Resources Control Board (SWRCB) pursuant to the Costa-Machado Water Act of 2000 (Proposition 13) and any amendments thereto for the implementation of California's Nonpoint Source Pollution Control Program. The contents of this document do not necessarily reflect the views and policies of the SWRCB, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

1 Introduction

The purpose of the Arroyo Seco Watershed Management and Restoration Plan (WMRP) project is to develop a plan to manage and restore water quality and habitat in the Arroyo Seco watershed. The study is intended to build upon the work completed during the Arroyo Seco Watershed Restoration Feasibility Study (ASWRFS), published in 2002. The ASWRFS reviewed many essential elements of restoring the Arroyo Seco, including hydrology, water quality, water resources, habitat, and recreation/open space, and listed broad projects that could improve these elements in the watershed.

The WMRP focuses on two key elements covered by the ASWRFS, water quality and habitat, and aspires to enhance the previous recommendations by subjecting them to in-depth technical analysis and presenting more detailed project descriptions. Like the ASWRFS, the outcome of this effort will be a series of recommended projects. But, by describing the contributions these projects will make to water quality and habitat improvement, and by clearly prioritizing them along several dimensions, the WRMP will provide a clear roadmap to any government agency or organization looking to improve water quality and habitat in the Arroyo Seco.

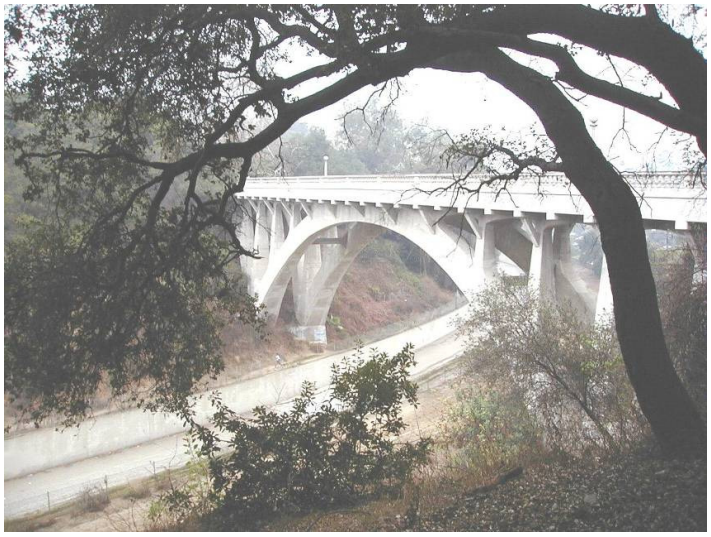
1.1 Executive Summary

The Arroyo Seco is one of southern California's greatest natural treasures, surrounded by large expanses of open space and running through a water-carved canyon on its way from the San Gabriel Mountains to its confluence with the Los Angeles River . The watershed covers 46.6 square miles and spans six jurisdictions, including, from north to south, the Angeles National Forest, the unincorporated community of Altadena, the City of La Cañada Flintridge, the City of Pasadena, the City of South Pasadena, and the City of Los Angeles. Representatives from all of these jurisdictions, and from others with interests throughout the watershed such as the U.S. Army Corps of Engineers and the County of Los Angeles Department of Public Works, participated in the development and review of this plan.

As will be discussed in later sections of this Plan, the Arroyo Seco watershed has two separate identities. One identity is a wild, cobble-strewn stream, with dense stands of white alder, sycamore and willow towering overhead and forested hillsides rising up from the canyon bottom. Aside from several dams and diversion structures, this is how the Arroyo exists from its origins high in the San Gabriel Mountains to where it emerges from the mountains just north of the Jet Propulsion Laboratory[1] in northern Pasadena. It is easy in these places to envision what the Arroyo was like 100 years ago.

[1] The Jet Propulsion Laboratory lies in La Cañada Flintridge; the boundary of Pasadena and La Cañada Flintridge falls between JPL and the Hahamongna basin.

Figure 1-1. San Pasqual Bridge (Arroyo Seco Foundation)



The other identity is that of an open concrete channel surrounded by dense development. Fragments of native habitat persist along the concrete channel, but even these fragments have been tailored to development's needs and uses. This Arroyo is found virtually everywhere south of Devil's Gate Dam. Here, one must look to historic photographs, or to the visions of local artists, for some depiction of what the Arroyo once was.

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The funding for this study does not allow NET to develop a comprehensive plan for the entire watershed. Since this Plan focuses on improving water quality and restoring habitat, and since the gravest threats to these two objectives lie south of the San Gabriel Mountains, it is in this area that we will focus our planning efforts.

The WMRP is comprised of two distinct but tightly linked sets of analyses. One set focuses on improving water quality, while the other focuses on restoring native habitat. The habitat restoration portion involved the identification of key indicator species for the Arroyo's varied habitats, and the identification of key projects required to protect or enhance the status of these indicator species' populations. The water quality analyses involved the assessment of Arroyo Seco water quality, the identification of key sources of nonpoint source pollution, and the identification of Best Management Practices (BMPs) to mitigate these pollution sources. Both of these studies made use of extensive existing information, including the full results of the Arroyo Seco Watershed Restoration Feasibility Study, hydrology information from the County of Los Angeles Department of Public Works, water quality information from the City of Los Angles and several other key sources, and many other studies and documents.

The WMRP results suggest that there are many opportunities to improve both water and habitat quality throughout the watershed. Unlike many of the Los

Angeles' area's other urban watersheds, a significant portion of the land adjoining the Arroyo Seco Channel is protected open space, making the installation of BMPs and the restoration of habitat quite possible. The key outcome of the WMRP is the list of recommendations contained in Section 6 of this document. It is our hope that these recommendations can serve as the seed for future projects to be initiated by government agencies and other organizations throughout the watershed, for they are already supported by technical analysis and presented in a watershed-wide context.

However, watershed restoration remains a long-term and expensive process. Many questions remain unanswered as a result of this study, and will require more work in the future. At the end of this document, we have listed a number of initiatives that must be undertaken in the future. These include:

- The development of an Arroyo-wide water quality sampling program to confirm or identify the location of key sources of nonpoint pollution, and to understand the differences in wet versus dry season water quality in the watershed;

- The integration of our water quality and habitat recommendations into a broader framework that also includes the consideration of recreational open space, transportation, flood control, water supply and zoning issues; and

- The assessment of the overall feasibility of restoring the Arroyo Seco to a natural state.

1.2 Document Organization

This document is divided into three rough sections: background information, analysis, and recommendations.

Background information is contained in the Chapters 2-4. Chapter 2, Background, provides an overview of the watershed, reviews the 2002 Arroyo Seco Watershed Restoration Feasibility Study, and presents the context for this project, the Arroyo Seco Watershed Management & Restoration Plan. Chapter 3, Project Process, discusses the overall execution of the planning effort, including stakeholder involvement and adoption. Chapter 4, Existing Conditions, presents detailed information on existing water and habitat quality in the Arroyo Seco watershed.

An overview of the analysis performed to go from our existing understanding of the watershed to new recommendations is contained in Chapter 5. This section contains some detail about the separate water quality and habitat restoration analyses; more detail on these steps is contained in the Appendices to this plan.

Finally, Chapter 6 (Recommendations) and Chapter 7 (Next Steps) present the recommendations on how the plan can be used to further Arroyo Seco restoration. These chapters discuss specific project recommendations, watershed-wide programs that if adopted would contribute to watershed restoration, and proposed next steps for NET and other organizations working towards restoring the Arroyo Seco.

1.3 Objectives

The goal of this project is to develop a watershed management and restoration plan with recommendations that, when implemented in future phases, will achieve the following objectives:

1. Improve water quality for beneficial uses, including protecting public health, and
2. Restore habitat for terrestrial and aquatic species.

The Arroyo Seco Watershed Restoration Feasibility Study (ASWRFS) laid the groundwork for this current planning effort by evaluating the restoration of the Arroyo Seco stream channel as a natural stream in terms of the following study areas:

1. Water Quality and the History of Water Resources,
2. Habitat,
3. Hydrology, Hydraulics, and Geomorphology, and
4. Recreation and Open Space.

This project, the Arroyo Seco Watershed Management and Restoration Plan, therefore covers only a subset of the range of issues associated with restoring the Arroyo Seco. It is intended to build upon the results of the ASWRFS in the areas of habitat restoration and water quality improvement, leaving progress in the other areas to future planning efforts undertaken by other agencies. The work to be performed for this project consisted of the following activities:

1. Stakeholder Process,
2. Water Quality Technical Study,
3 Habitat Restoration Technical Study, and
4. Development of a Watershed Restoration and Management Plan.

1.4 Definitions

A number of key concepts and phrases are repeated throughout this document. Given their technical origins, they may be unfamiliar to many people, so we have provided brief definitions below.

Beneficial Uses. Beneficial uses is a regulatory term that refers to how a particular body of water is classified for regulatory purposes. Each body of water in an area is assigned, by a state agency, a set of beneficial uses that the body of water should support. Examples include municipal and domestic water supply, water contact and non-contact recreation, and warm and cold freshwater habitat. The regulatory agency then uses these beneficial uses to identify any sources of pollution that impair them, and proposes measures to eliminate these impairments (see TMDLs below). For every waterway in the state, the list of beneficial uses and impairments to them is used to develop and prioritize regulations to restore the beneficial uses. For more information on this process, see Sections 2.3 and 4.1 of this document.

Best Management Practices (or BMP). Best Management Practices, or BMPs, are initiatives undertaken to reduce or eliminate pollution entering our waterways. They are called Best Management Practices because they employ the "best" practices or technologies for reducing these pollutants, as recognized by the general stormwater management community. BMPs are often grouped into two categories: nonstructural and structural BMPs. ***Nonstructural*** BMPs are changes in behavior or operating procedures to reduce pollution, and include such things as educational programs aimed at homeowners to street sweeping programs in areas of cities to reduce trash on streets. ***Structural*** BMPs are structures that are constructed to remove pollutants from water. They can be as simple as special gardens designed to absorb rainfall, or as complex as large engineered treatment systems capable of removing toxic chemicals.

Daylighting. Daylighting refers to the practice of converting a storm drain back into a natural creek that is therefore open to "daylight." When storm drains were installed to reduce flooding, they were often placed in the same locations as existing creeks and streams since these were the natural flow paths for water in that area. The storm drain carried the flow of the former creek, but in a closed pipe. Daylighting a storm drain restores the natural character and processes of the former creek or stream.

Fluvial geomorphology. Fluvial geomorphology is the study of how river systems interact with the geologic features they flow through. Particular aspects include the study of sediment transport by rivers and streams, the location, configuration, and geometry of stream channels and how they change under different conditions, and how man-made developments will affect natural stream channel conditions.

Imperviousness / Impermeability. Imperviousness refers to surfaces that are covered with materials that prevent rainwater from soaking into the ground. In a natural setting, most rainwater soaks into the ground before it enters rivers and streams during light to moderate rainfall. Once development occurs, much natural soil is covered by hard surfaces such as parking lots, driveways, and rooftops. These surfaces convey virtually all of the rainfall that falls on them into waterways. This water in turn carries trash, debris and other pollutants that have collected on these hard surfaces. One goal of watershed restoration is to reduce the imperviousness of urban areas. This reduces the amount of pollution entering waterways, and often reduces the volume of water that drainage systems must be designed to carry.

Non-point source pollution. Non-point source pollution is water-borne pollution such as trash, metals, and bacteria that does not originate from a single source or location, but is instead generated by the dispersed activities that occur throughout an urban area. Non-point source pollution includes trash that is deposited on streets, metals that wear off of car brake pads, and bacteria from pet waste. This non-point source pollution is then carried into waterways by rainfall, car washing, over-irrigation, and other events that cause water to flow over impervious surfaces. Because there is no one responsible party for non-point source pollution, it is very difficult to regulate and reduce. In urban areas, non-point source pollution is the vast majority of pollution entering our waterways during storm events.

Point source pollution. Point source pollution is pollution such as trash, metals, and bacteria that are generated by a specific source or location within a watershed. Factories, junk yards, and wastewater treatment plants are examples of point sources of pollution. Today, point sources are heavily regulated and monitored, and are not the largest sources of wet-weather waterway pollution.

Riparian. Riparian refers to the transition zone along bodies of water between the aquatic zone in the water body and the dry or terrestrial zone above it. Riparian areas often have specialized flora and fauna that are adapted to periodic flooding and wet conditions. These areas are very rich in natural resources, and often remain green and vital well after terrestrial areas have dried out in the Southern California summer. However, natural riparian zones are very rare and under threat, as they are destroyed whenever rivers are channelized and by new development along bodies of water.

Runoff. Runoff refers to the water generated during storms (or other sources such as over-irrigation or car washing) that does not drain into the ground but instead “runs off” over streets and parking lots, into storm drains, and eventually into local waterways and the ocean. Runoff is increased when natural surfaces are covered by paving, rooftops, and other hard surfaces. Runoff is the primary source of non-point source pollution, so increases in runoff caused by development can lead to more pollution in our waterways.

Total Maximum Daily Load (TMDL). A Total Maximum Daily Load or TMDL is a limit set by a regulatory agency such as the U.S. Environmental Protection Agency or the State (of CA) Water Resources Control Board that states the maximum amount of a particular pollutant that can enter a waterway without impacting the beneficial uses of the respective water body. As an example, a nutrient TMDL for the Los Angeles River limits the amounts of nitrates, nitrites, and ammonia that can enter the LA River on any given day. TMDLs are the regulatory mechanism targeting non-point source pollution. TMDLs are discussed in more detail in Sections 2.3 and 4.1 of this document.

1.5 Acknowledgements

Writing a watershed plan is a difficult task. Restoring a watershed is even harder. Fortunately, the Arroyo Seco is much loved, and many people and organizations were willing to lend their time, energy, and passion to protecting and restoring it. Collectively, they will ensure that the overall goal of restoring the Arroyo Seco becomes a reality.

The California State Water Resources Control Board (SWRCB) and the Los Angeles Regional Water Quality Control Board (RWQCB) made this project possible. The SWRCB funded this effort. Macaria Flores, the Project Representative for the RWQCB, provided invaluable technical assistance and administrative oversight from beginning to end. Along the way, other RWQCB staff members such as Shirley Birosik and Rod Collins contributed their technical expertise to sections of the plan.

While many Arroyo government and community stakeholders participated in this planning effort, several stood out for their deep and long-term assistance with the project. Dan Sharp, Watershed Manager of the Arroyo Seco for the County of Los Angeles Department of Public Works, was a tireless leader of the Council of Arroyo Seco Agencies (CASA), and contributed technical information and detailed reviews at many points during this project. Tim Brick and Jeff Chapman of the Arroyo Seco Foundation continually contributed “on the ground” knowledge of the Arroyo, gleaned from many years as Arroyo advocates and residents, and also helped to carry the Council of Arroyo Seco Organizations (CASO) from being an idea on paper to a vital forum for community collaboration.

All of the Arroyo cities contributed ideas to this plan at various stages, but two were active collaborators throughout. The City of Pasadena, through representatives Rosa Laveaga and John Cox, was an invaluable source of ideas and technical information regarding the Pasadena portions of the watershed. The City of Los Angeles, via Lupe Vela of the Los Angeles River Ad-Hoc Committee and Jill Sourial in the Los Angeles City Council Office of Ed Reyes, provided support and guidance on specific projects in the lower part of the watershed. Representatives from the City of Pasadena’s Department of Public Works, and the City of Los Angeles’ Department of Recreation and Parks and Watershed Protection Division were frequent contributors through participation in CASA.

Early in the project, several local experts graciously volunteered their time and expertise to review preliminary habitat restoration methodologies and proposals. Dan Cooper, formerly Director of Bird Conservation for Audubon California, and Mickey Long, Natural Areas Administrator for the County of Los Angeles Department of Parks and Recreation, both contributed their unparalleled knowledge about the birds of the Arroyo Seco. Camm Swift of Entrix

Environmental Consultants (Los Angeles County Museum of Natural History Emeritus) spent a day in the field surveying the lower elevation tributaries of the Arroyo for their current and possible future suitability for native fish.

NET benefited from the talents of several consulting partners on this project. GreenInfo Network's team of Aubrey Dugger and Amanda Kochanek created all of the maps in this study, and in doing so helped us visualize the watershed in new ways. GeoSyntec Consultants engineers Ken Susilo and Brandon Steets assisted NET in evaluating various BMP technologies for use in the Arroyo Seco, and in developing the approach to prioritize BMP projects. Last, Verna Jigour, principal of Verna Jigour Associates, brought her extensive knowledge about Southern California flora and fauna to bear on the habitat restoration part of this plan.

A large number of past and present NET staff members contributed to this project over its two year duration. Larry Smith, the Executive Director of North East Trees, has provided overall guidance at every stage of the project. Eileen Takata conceived of the project and applied for the grant funding that made it possible. Scott Wilson, President of North East Trees, was a tireless contributor to all public forums associated with the project. Claire Robinson and Lynnette Kampe, former Executive Directors of North East Trees, provided the early leadership required to get the project off the ground. Jessica Hall brought a wealth of information and passion about the Arroyo's historic streams to bear on both the water quality and habitat restoration components of the plan, and spent numerous hours poring over aerial photos to identify potential BMP project sites. Sonja Nicholson did the same for habitat restoration projects. Many thanks as well to Adan Arreola, Nishith Dhanda, Tom Dwyer, Nidia Garcia, Holly Harper, Jennifer Rodriguez, Pieter Severynen, Joy Simon, Aaron Thomas for their support and assistance during the project.

Finally, many different stakeholders in the watershed participated in CASO meetings during which elements of this plan were presented and discussed. Nicole Possert, of the Highland Park Heritage Trust, and Anne Dove, of the National Park Service's Rivers, Trails and Conservation Assistance Program (along with Tim Brick and Dan Sharp) were instrumental in launching CASO in early 2004. CASO participants over the past two years have included (but are not limited to):

- Altadena Foothills Conservancy
- Arroyo Seco Gardens
- Arroyo Seco Journal
- Arroyo Seco Neighborhood Council
- Audubon Center at Debs Park
- California Cycleways
- Equestrian Trails, Inc.
- Foothill Bicycle Initiative

- Franklin High School Transportation Academy
- Friends of Debs Park
- Friends of Echo Park
- Friends of the Los Angeles River
- Goodwill Industries
- Heritage Square Museum
- Highland Park Heritage Trust
- Historic Highland Park Neighborhood Council
- Kidspace Children's Museum
- La Cañada Trails Council
- Latino Urban Forum
- National Parks Rivers, Trails, and Conservation Assistance Program
- Northeast Democrats
- Occidental College, Urban and Environmental Policy Institute
- Pasadena Arts Council
- Pasadena Audubon Society
- Pasadena Museum of Natural History
- Pasadena Roving Archers
- Rock Rose Gallery
- Sequoya School
- Sierra Club
- Trust for Public Land
- West Pasadena Residents Association

It is this group of committed, passionate individuals and organizations who will help realize the goal of restoring the Arroyo Seco. We thank them for all of their assistance on this project.

Sincerely,

North East Trees

2 Background

2.1 Watershed Description

2.1.1 Geographic Location

The Arroyo Seco Watershed is located in central Los Angeles County, between the San Gabriel Mountains and the Los Angeles River (Figure 2-1: Location Map). Lying partially within the watershed are the Angeles National Forest and the cities of Los Angeles, South Pasadena, Pasadena and La Cañada Flintridge, as well as the unincorporated area of Altadena (see Figure 2-2: Arroyo Seco Watershed Topography).

2.1.2 Political Boundaries

Three U.S. Congressional Districts intersect the Arroyo Seco Watershed. For the State of California, the Arroyo Seco watershed intersects four Senate Districts and three Assembly Districts. Two of Los Angeles County's five Supervisorial Districts intersect the watershed. The following people held these positions as of December 2005:

- LA County First Supervisorial District: Gloria Molina
- LA County Fifth Supervisorial District: Michael D. Antonovich
- US Congressional District 26: David Dreier
- US Congressional District 29: Adam Schiff
- US Congressional District 31: Xavier Becerra
- CA Senate District 21: Jack Scott
- CA Senate District 22: Gilbert Cedillo
- CA Senate District 24: Gloria Romero
- CA Senate District 29: Bob Margett
- CA Assembly District 43: Dario Frommer
- CA Assembly District 44: Carol Liu
- CA Assembly District 45: Jackie Goldberg

2.1.3 Physical Characteristics

The Arroyo Seco has long been important to its human inhabitants; Native American communities were found throughout the watershed, and later the City of Los Angeles was founded where the Arroyo Seco meets the Los Angeles River (NET et al, 2002). Despite this human habitation, the Arroyo itself remained relatively unchanged until the early 20th century, when the risks of floods coupled with burgeoning population of the surrounding communities resulted in it being dammed and channelized. These changes had a profound effect on the natural character of the Arroyo, fragmenting open space, disrupting habitat, changing the natural hydrological system of the river, and via these

changes and the associated urbanization of the watershed severely reducing the quality of the Arroyo's waters.

Figure 2- 1: Arroyo Seco Watershed Location

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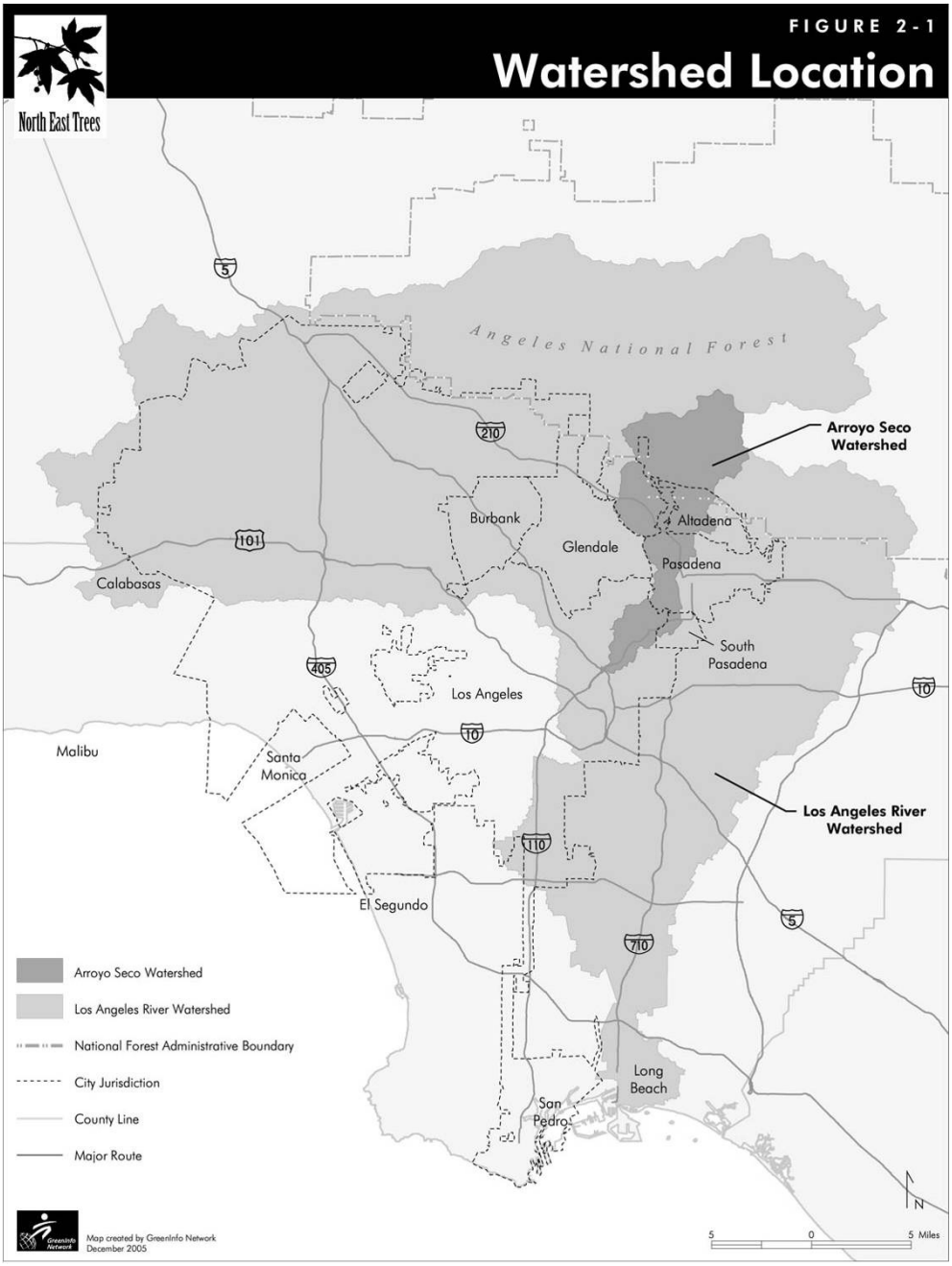

Figure 2-2: Arroyo Seco Geography & Topography

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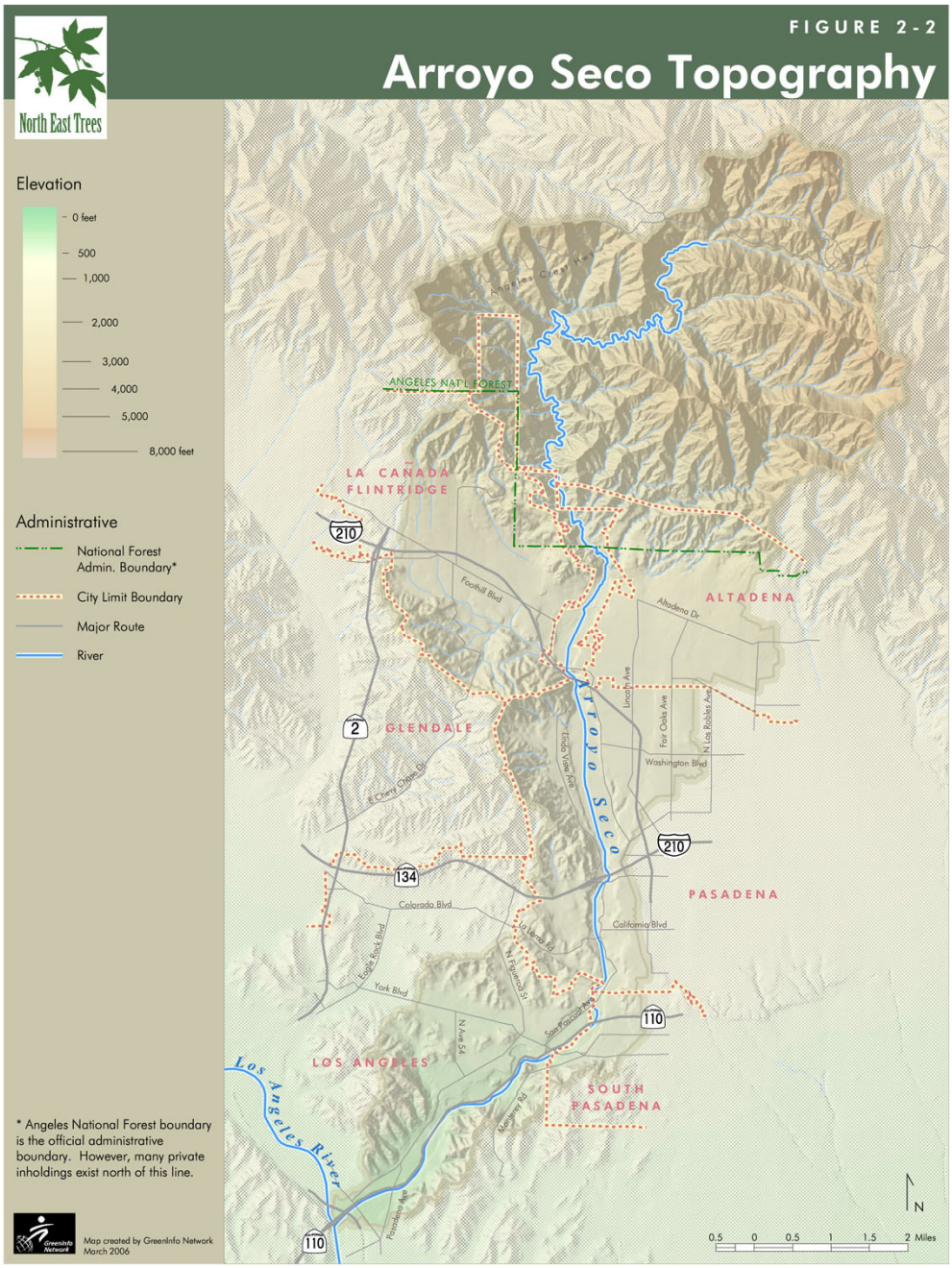

The Arroyo Seco Watershed is a sub-watershed of the Los Angeles River watershed, which is a coastal watershed partly within the coastal zone. The watershed drains 47 square miles, approximately two-thirds of which are in the San Gabriel Mountains within the Angeles National Forest. The stream runs 22 miles in a deeply incised canyon, beginning under Strawberry Peak in the San Gabriel Mountains and draining into the Los Angeles River near downtown Los Angeles. Roughly half of this length is contained within the boundaries of the Angeles National Forest.

Several major obstacles impede the Arroyo's flow between its headwaters and the Confluence. The two key ones are the Brown Mountain Debris Dam, located seven miles below the Arroyo headwaters, and Devil's Gate Dam, a large flood control facility bisecting the Arroyo five miles downstream of Brown Mountain Dam at the southern end of Pasadena's Hahamongna Watershed Park. Below Devil's Gate Dam, most of the stream has been channelized to increase its capacity to carry floodwaters during winter storms.

Over its 22-mile course, the Arroyo drops from an elevation of nearly 6,100 at its headwaters on Strawberry Peak to 320 feet at its confluence with the Los Angeles River. This drop over such a short distance, coupled with heavy rainfalls caused by Pacific storms slamming up against the San Gabriel Mountains, has produced catastrophic floods in the past. Normally flowing at less than ten cubic feet per second, the peak streamflow measured at the USGS gauging station north of Hahamongna was 8,620 cfs in 1938; streamflow has exceeded 2,000 cfs at least fourteen times since 1914 (USGS, 2005). At the Confluence, peak flows were not measured but could have been at least double these values. In 1914 Arroyo flooding took 43 lives and destroyed 10 bridges and 30 homes (Brick, 1997). Shortly thereafter, in 1920, Devil's Gate Dam was dedicated as the first flood control dam constructed by the County of Los Angeles Flood Control District.

Figure 2- 3. Arroyo Seco Upper Watershed (Arroyo Seco Foundation)

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Aside from the Brown Mountain Dam, the character of the upper watershed remains relatively natural. The vegetation of the upper watershed is characterized by Bigcone Spruce-Canyon Oak Forest, Southern Sycamore-

Alder Riparian Woodlands, and Southern Mixed Chaparral. The forest in this area is rich with wildlife, including black bears, mountain lions, California spotted owls, and numerous smaller birds, reptiles and amphibians, while the stream itself supports rainbow trout. In this area, the Arroyo and some major tributaries such as Millard Canyon generally flow year-round, fed by numerous small springs and groundwater discharge. This condition allows fish, reptiles and amphibians dependent on aquatic habitat to thrive in the upper Arroyo Seco. Above the Devil's Gate Dam, the Arroyo travels through one of the last ecologically significant Alluvial Fan Sage Scrub habitats in southern California.

After Devil's Gate Dam, however, the Arroyo's natural character is lost to urbanization. Prior to channelization, stands of alder, willow, and sycamore lined a perennial, trout-filled stream. The removal of riparian vegetation has significantly impacted wildlife and plant diversity. Urban development and exotic plant species have all but replaced the once lush vegetation below the dam. The remaining lush riparian habitat now comprises only 15 percent of the total land mass within the watershed, and far less than this proportion in the urbanized area south of Devil's Gate. Remnants of the Southern California Black Walnut and Coast Live Oak Woodlands still cling to the hillsides, but many of their associated wildlife species have been locally extirpated due to habitat fragmentation and predation by nonnative predators.

Surface waters of the Arroyo Seco are contaminated by urban runoff, as are most of the lower-elevation watersheds passing through urban areas in Southern California. The Arroyo is listed on California's Clean Water Act 303(d) list of impaired waterways for three contaminants: nutrients/algae, high coliform counts, and trash (California, 2002). The high coliform and trash are direct results of nonpoint source pollution running into the Arroyo via storm drains from urbanized portions of the watershed. Algae is a result of the lower watershed's overall degraded condition, a product of elevated nutrients, high water temperatures, a lack of canopy or any other shade over the water, and a lack of organisms to feed on it. As a key tributary to the Los Angeles River, the Arroyo will also be affected by any water quality regulations limiting pollutant inputs into the LA River, even if not specifically listed for them.

Despite these water quality limitations in the southern watershed, the Arroyo north of Devil's Gate Dam remains an important contributor to the local water supply. Water infiltrating from the Arroyo Seco north of South Pasadena infiltrates to the Raymond Basin Aquifer, a 40-square mile groundwater basin that currently provides 40% of the water supply for the City of Pasadena and other local communities and sustains a water flow in the Arroyo through most of the year. In recent years, this supply has been contaminated by organic compounds and perchlorate leaking from old disposal sites at the Jet Propulsion Laboratory, on the northwest edge of the Hahamongna Basin. However, NASA is in the process of cleaning up the groundwater in the area.

The name “Arroyo Seco” means “dry stream”, which suggests that in the past the lower Arroyo was dry during certain times of the year. Prior to widespread development in the watershed, the lower Arroyo Seco south of Devil’s Gate Dam was fed by numerous springs and small creeks coming out of the surrounding hills. However, this discharge combined with the highly permeable soils of the Arroyo floodplain was often not enough to sustain the Arroyo’s flow year-round. In many dry summers, the Arroyo dried up in stretches, only to reappear above the surface where geologic conditions forced groundwater to the surface.

2.1.4 Open Space

Significant park and natural areas line the Arroyo from Angeles National Forest in the upper watershed to Elysian Park at the southern tip across from the confluence with the Los Angeles River (Figure 2-4: Arroyo Seco Open Space Map). Parks in the watershed are operated by the cities of Los Angeles, South Pasadena, and Pasadena, the Santa Monica Mountains Conservancy, and the USDA Forest Service. Numerous hiking, biking, and equestrian trails converge in the Arroyo and lead to the Angeles National Forest, which is one of the nation’s most heavily used national forests. Ongoing regional bikeway planning efforts will eventually link the San Fernando Valley and the Arroyo Seco to the Pacific Ocean via new bikeways along the Los Angeles River.
A combination of factors makes the Arroyo Seco a strong potential stream restoration project in southern California. These factors include:

- The spectacular natural character of the Arroyo Seco with parks and open space along most of its course;
- Public ownership of adjacent land;
- Substantial community and political support to naturalize the Arroyo Seco;
- US Army Corps of Engineers preparation of an Arroyo Seco Watershed Management Plan;
- The evolving attitude about flood and watershed management among the public agencies responsible for managing the area; and
- The presence of historic structures and strong cultural institutions.

Figure 2- 4: Arroyo Seco Open Space

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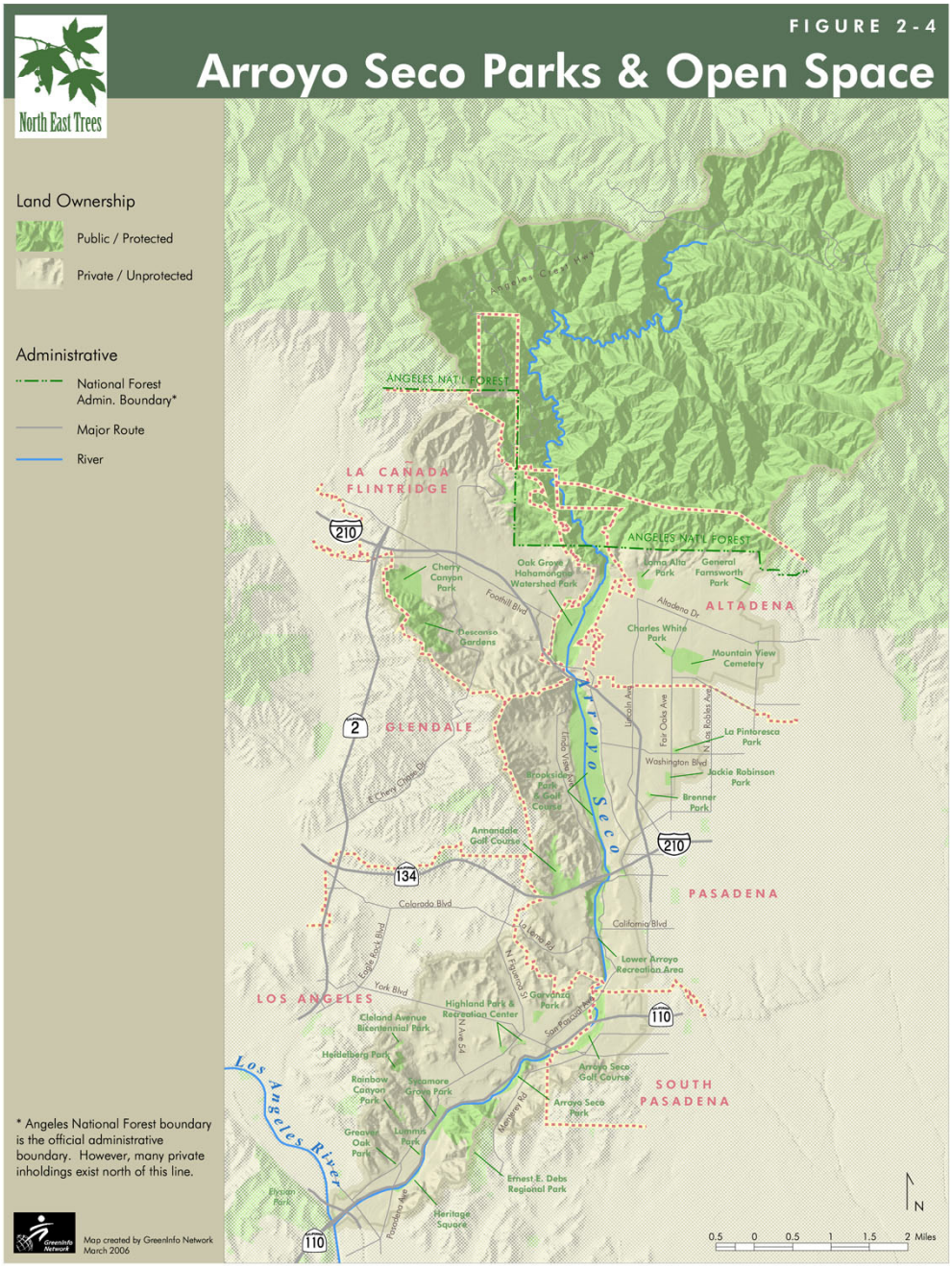

2.2 Overview of the 2002 Arroyo Seco Watershed Restoration Feasibility Study

In early 2000, a group of community stakeholders led by North East Trees and the Arroyo Seco Foundation conceived of the Arroyo Seco Watershed Restoration Feasibility Study (ASWRFS) to begin considering opportunities to restore the Arroyo Seco watershed. With a grant from the California Coastal Conservancy, the two organizations began the complex process of answering a relatively simple question: to what extent could the Arroyo Seco watershed be restored to its natural condition?

Over the next two years NET and the ASF engaged many stakeholders and technical consultants in crafting an answer to this question, culminating in the publication of the ASWRFS in early 2002. The project looked at watershed restoration from a number of perspectives, summarized in the projects goals:

1. Restore the natural hydrological functioning of the watershed;
2. Better manage, optimize, and conserve water resources while improving water quality;
3. Restore, protect and augment habitat quality, quantity and connectivity; and
4. Improve recreational opportunities and enhance open space.

NET and ASF along with their consulting teams performed a variety of technical studies to determine the feasibility of these goals. In the end, the team's conclusion was that progress could be made towards all four of the goals. In some cases, the team identified specific projects that would make progress towards achieving the goals. However, many issues associated with the complexity of restoring a highly urbanized watershed remained unanswered and required future study. The proposed projects, along with recommendations for future study, were the key outcomes of the ASWRFS.

The entire ASWRFS is available on CD-ROM from North East Trees (info@northeasttrees.org), or on the website of the Arroyo Seco Foundation, www.arroyoseco.org.

2.3 Arroyo Seco Watershed Management and Restoration Plan - Project Context

Restoring habitat and securing more open space in Southern California have long been at the top of planning agendas. The ASWRFS delved deeply into habitat restoration, identifying a specific methodology for identifying appropriate projects, and proposing many discrete habitat restoration projects.

Over the time period covered by the ASWRFS project, improving water quality in particular rose to prominence not just in the Arroyo Seco but throughout California. This was due to the beginnings of a process to ensure that the waters of the State were brought into full compliance with the Federal Clean Water Act (CWA).

Historically, only discrete sources of pollution such as oil refineries and wastewater treatment plants were regulated. More diffuse but much larger sources of pollution result when rainfall or other sources of surface water wash trash and other pollutants into storm drains and ultimately to the ocean. This group of sources, often referred to as nonpoint source pollution, would have to be dealt with if the State's waterways were to meet water quality objectives.

The Federal Clean Water Act Section 303 Subpart (d) requires that all states identify those waterways that do not meet water quality objectives through the regulation of point source discharges alone. In addition, each state must prepare a list, listing the waterway, the pollutants for which the water quality standard cannot be met, and a relative priority for resolving the particular waterway / pollutant issue. This list is commonly referred to as the 303(d) list.

This process has been performed in California, and the Arroyo Seco has been listed for three different contaminants: nutrients/algae, high coliform counts, and trash, with priorities of high, high, and low respectively. The source for all three is listed as "nonpoint source."

The CWA also proposes a mechanism for bringing these listed waterways into compliance: the Total Maximum Daily Load, or TMDL. Under TMDLs, all sources of pollution in a waterway, whether they are point or nonpoint sources, are allocated a portion of the waterways "allowable" pollution load; any contributions above and beyond this would require treatment before discharge. This is a very difficult task, as the volumes of water generated during winter storms are far larger than even Los Angeles' largest treatment plants can handle.

The long-term result of TMDLs will be that cities and other agencies responsible for sections of impaired watersheds will have to treat nonpoint source pollution. This can be done in many ways, including installing small treatment devices at individual buildings, reducing runoff by converting paved areas to gardens and open space, and educating the public about how to reduce contaminated runoff emanating from their own yards and small businesses. These and many more approaches are collectively called stormwater Best Management Practices, or BMPs. All BMPs, however, are not created equal. They often work best under particular site conditions, and for specific contaminants. Therefore, it is critical to match BMPs to local watershed conditions.

The Arroyo Seco Watershed Management and Restoration Plan was initiated to propose just such a mix of projects for the Arroyo Seco. By identifying what the

water quality issues in the Arroyo are and what can be done about them, and how these potential projects could relate to the overall goal of restoring the natural character of the Arroyo Seco, NET could put in place a plan to benefit not just water quality but the other elements of restoration discussed in the ASWRFS.

3 Project Process

3.1 Relationship to Other Plans

The Arroyo Seco Watershed Management and Restoration Plan is a standalone document, but builds on past planning work and will contribute to future planning related to the Arroyo Seco.

The Arroyo Seco Watershed Restoration Feasibility Study (ASWRFS), described in Section 2.1, served as the starting point for the analysis described in this document. The habitat restoration methodology proposed in the ASWRFS, which relies on the identification of focal species as the basis for habitat restoration planning, was adopted wholly here. The set of indicator species proposed in the ASWRFS served as the starting point for this project.

The process used to identify water quality improvement projects used here differs significantly from that employed in the ASWRFS; it makes use of new analytical tools, and also focuses on recent developments in the water quality regulatory environment. However, all projects associated with water quality described in the ASWRFS were reviewed and prioritized as part of this new project.

Separate from this watershed-wide planning effort, the City of Pasadena has approved three separate master plans that govern Pasadena parks along the Arroyo Seco: The Lower Arroyo Master Plan, the Central Arroyo Master Plan, and the Hahamongna Watershed Park Master Plan. These plans were adopted by the city between 2003 and 2005. The plans attempt to balance many different objectives, including habitat restoration, recreational access, water supply, and others. NET reviewed the Arroyo Seco Master Plans as part of this study, and incorporated project elements when they were consistent with the objectives of the ASWMRP.

As this Plan was being created, several new planning efforts involving the Arroyo Seco were getting underway. First, the County of Los Angeles was preparing an Integrated Regional Water Management Plan (IRWMP) in order to compete for state grant funding under Proposition 50. The IRWMP covers a much broader area, and thus the Arroyo Seco is only one of several watersheds covered in the plan. However, draft project recommendations from this effort were submitted to the IRWMP planning committee.

The most significant new planning effort related to the Arroyo is the U.S. Army Corps of Engineers' and County of Los Angeles Department of Public Works' Arroyo Seco Watershed Management Plan. This project will take a comprehensive look at the feasibility of restoring the Arroyo Seco to a more natural state, and will in particular examine flood control and fluvial geomorphology conditions. This study could in turn lead to significant federal funding for major flood management and environmental restoration projects in

the future. NET is collaborating closely with the leaders of this effort to ensure that the findings of the ASWMRP are factored into this analysis.

3.2 Stakeholder Involvement

Throughout the development of this plan, stakeholders were involved in contributing to and reviewing materials via two primary stakeholders groups, the Council of Arroyo Seco Agencies (CASA), representing government agencies with an interest in the Arroyo Seco, and the Council of Arroyo Seco Organizations (CASO), a forum for nonprofit, neighborhood, and other citizen-based groups representing various issues in the Arroyo Seco Watershed.

CASA was launched as the technical advisory committee for the ASWRFS, and continues to meet every two months. Active participants include representatives from the U.S. Army Corps of Engineers, the County of Los Angeles Department of Public Works, the cities of Pasadena, La Cañada Flintridge, South Pasadena, and Los Angeles, various public utilities throughout the watershed, and North East Trees and the Arroyo Seco Foundation. CASA has received and reviewed interim deliverables of the this project, and will be involved in the review of the draft and final WMRP. A list of the member agencies that have participated in the review of various stages of this project, along with a list of previous meeting dates, is included in Appendix 1.

CASO was proposed as part of the ASWRFS, but was only launched in early 2004. It has since met quarterly, drawing members from a wide range of organizations throughout the Arroyo Seco. Appendix 1 also lists organizations that have participated in CASO meetings since 2004. This list demonstrates that CASO not only reflects the geographic diversity of the Arroyo watershed, but also the diversity of community interests and needs. CASO members include environmental, environmental justice, transportation, cultural, arts, historic preservation, community development, and other types of community organizations working throughout the watershed. NET has presented interim updates regarding this project to CASO at various times. CASO organizations will be invited to review and comment on the draft and final WMRP.

3.3 Adoption Process

The adoption process for this plan is multifaceted, involving approvals from three different classes of organizations. It is important to note that the adoption process for this plan involves influence – as a non-governmental organization, NET can only request, but not require, relevant government agencies to approve the plan.

First, NET will bring the final plan before the Council of Arroyo Seco Agencies (CASA) for review and comment. NET will modify the plan to address as many CASA comments as possible. CASA representatives can then recommend that

the plan be adopted by their parent agencies, since CASA itself has no designated approval authority.

If necessary, NET will present the plan to relevant government bodies of the Arroyo Seco cities, with the goal of getting a formal resolution of adoption for the plan. This might require resolutions by city councils, which could prove to be challenging and time-consuming. Accordingly, NET will also pursue securing approval from city agencies responsible for water quality, such as the City of Los Angeles' Bureau of Sanitation Watershed Protection Division.

Last, this plan must be adopted by the Los Angeles Regional Water Quality Control Board. NET will address all comments required to secure this approval by February 28, 2005.

3.4 Implementation

Implementation of this plan will require substantial funding, and will likely take many years. Individual projects associated with removing the concrete channel and other major flood control structures could each cost tens of millions of dollars. Furthermore, the more far-reaching proposals in this plan will require significant changes in local city ordinances, priorities, and standard designs for public works infrastructure that are likely to require years of continued effort to put in place.

NET has developed this plan with these challenges in mind. Wherever possible, recommendations have been made as standalone, location-specific projects so that individual groups or government agencies working in specific areas of the watershed can carry them forward. All recommendations are also grouped by city, suggesting a clear path forward for cities willing to move ahead on their own. North East Trees has already begun submitting proposals to secure funding for some projects, and is already working to help other organizations and agencies do the same.

Perhaps the most important factors in implementing this plan are to continue to increase public awareness of the need to restore watersheds, and to ensure that watershed restoration remains on the agendas of elected officials throughout the Arroyo into the future. NET, in partnership with the many other community organizations working towards a restored Arroyo Seco, will continue our outreach and education efforts with the goal of building a strong long-term constituency supporting Arroyo Seco restoration.

4 Existing Conditions

The Arroyo Seco today is a far different watershed than it was 100 years ago. Then, the population throughout the watershed likely did not exceed 15,000 people (Los Angeles Almanac, 2005). Grizzly bears roamed the upper watershed, and southern steelhead migrated upstream from the Pacific Ocean to the Arroyo foothills. President Theodore Roosevelt, in a visit to the Arroyo region in 1911, stated that "this Arroyo would make one of the greatest parks in the world" (Lin et al, 2002).

Today, the population in the Arroyo Seco region is nearly 170,000 (U.S. Census Bureau, 2000). Nearly every portion of the lower Arroyo Seco is heavily developed, and some of the Los Angeles region's densest neighborhoods can be found in the southern Arroyo Seco in the City of Los Angeles. The Arroyo has been channelized, dammed, and obstructed at multiple locations; even in the Angeles National Forest, where the watershed conditions are still natural, several major dams and diversions impede the Arroyo's progress south. The West's first freeway, the Arroyo Seco Parkway, was built in the Arroyo Seco floodplain directly adjacent to the channel and is still a critical transportation link between the San Gabriel Valley and downtown Los Angeles.

All of these changes have had profound effects on the Arroyo's natural ecosystem. Natural stream conditions are nearly nonexistent south of the Devil's Gate Dam. Natural habitats have been fragmented or destroyed, and many creatures native to the Arroyo can no longer be found in the watershed. The destruction of the aquatic ecosystem, coupled with urban pollution from neighboring areas and increased runoff due to the replacement of natural areas with concrete, asphalt, and manmade structures have led to a serious decline in water quality.

4.1 Water Quality

Water quality in the Arroyo Seco is heavily impacted by the urban areas that surround it. Trash, bacteria, metals, and various chemicals all find their way into the Arroyo Seco via storm drains that pass through Arroyo neighborhoods. In addition, the non-natural condition of the Arroyo itself generates pollution: without the complex biological processes that occur in a river with a natural bottom filled with animals and plants, algae and other indicators of poor natural function prevail in the Arroyo during certain times of the year.

In 1972, Congress passed the Federal Water Pollution Control Act, more commonly known as the Clean Water Act (CWA). Among many other things, this law sets limits on point sources of pollution in each watershed. Point sources typically are facilities that emit pollutants into rivers and waterways, such as oil refineries, chemical plants, or wastewater treatment plants.

In many cases, though, these limits alone are not enough to bring water quality to levels that protect human and ecosystem health. This is particularly true in heavily urbanized areas where the majority of pollution doesn't come from point sources, but instead from nonpoint sources described above. The CWA has a way of dealing with these sources, too. Although the CWA doesn't specify limits on nonpoint sources of pollution, it **requires** that each state identify what water bodies within its boundaries cannot comply with water quality limits for specific contaminants strictly by regulating point sources alone. These areas are listed by each state on a list called the CWA Section 303(d) list, commonly called the 303(d) list. Once these combinations of waterways and contaminants are identified, then each state must develop limits on how much pollution is allowed to enter the waterway from nonpoint sources. The limit for this nonpoint source pollution combined with the output of all point sources is called a Total Maximum Daily Load, or TMDL.

One way to characterize Arroyo Seco water quality is to refer to the 303(d) list. The Arroyo Seco appears on the State of California 303(d) list for several contaminants. They are coliform bacteria, nutrients / algae, and trash. Trash and other debris enters the Arroyo from the many storm drains that carry storm runoff from surrounding neighborhoods. Nutrients, which cause the growth of algae in the Arroyo Seco, come from fertilizer and other chemicals that are washed from people's lawns and from agricultural areas. Finally, bacteria come from human and animal wastes, leaky septic tanks or sewer lines, and from the decay of organic trash deposited in the water.

Figure 4-1. Storm Drain With Algae and Trash (NET)

Another way to assess current water quality in the Arroyo Seco is to compare water quality data collected in the field to relevant water quality objectives. Over the past 30 years, many different agencies and organizations have collected water quality data in the Arroyo Seco. NET was able to identify nearly 2,000 different sample results (representing 80 discrete sampling events) collected by seven different

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agencies in the Arroyo Seco since 1976. All told, over 200 different water quality parameters were tested for across the 2,000 different samples. Table 3 in Appendix 2 is a summary of the dataset that NET assembled for this project.

Although 74 different parameters have been detected in Arroyo Seco water over the past 30 years[2], a large proportion of them showed up at very low levels that weren't of concern. However, twelve different parameters exceeded relevant water quality objectives (as described in Appendix 2) at least one time over the period, indicating a possible water quality problem. Table 4.1 presents a summary of these twelve pollutants.

Table 4.1. Results of Comparisons to Water Quality Objectives

Parameter	# Samples	Average Concentration	Water Quality Objective	Source[3]	# Samples Over WQ Objective	% of Samples Over WQ Objective
Enterococcus	46	21,500	104	Basin Plan	42	91
Fecal Coliform	18	46,100	400	Basin Plan	14	78
E.coli	38	9,600	235	Basin Plan	29	76
Total Coliform	57	102,400	10,000	Basin Plan	40	70
Diazinon	6	0.00059	0.00008	CA DF&G	2	33
Copper – Total	16	0.0178	0.022 (D) 0.017 (W)	LAR TMDL	4	25
Aluminum	6	1.75	1	Basin Plan	1	17
Lead	19	0.0103	0.011 (D) 0.062 (W)	LAR TMDL	2	11
Cyanide	9	0.004	0.0052	CTR	1	11
Zinc – Total	17	0.0783	0.16 (W)	LAR TMDL	1	6
Nitrite	19	0.209	1	Basin Plan	1	5
Chloride	20	88.7	150	Basin Plan	1	5

NOTE: Units of MPN / 100mL for bacteria, all other units mg/L
CA DF&G – California Department of Fish and Game
LAR TMDL – Los Angeles River Total Maximum Daily Load

One other sampling program warrants discussion here. In 2003, the County of Los Angeles Department of Public Works initiated a monitoring program to assess the biological integrity of the benthic macroinvertebrate communities in

[2] Some parameters are not truly "detected" but are included in this number. For example, parameters such as pH and conductivity are inherent characteristics of water and thus are always detected at some level.
[3] Sources for the water quality objectives used here are contained in Appendix 2.

receiving waters throughout Los Angeles County (Los Angeles County, 2005). Two of the locations surveyed during this study were in the Arroyo Seco, one upstream of the spreading grounds located in Hahamongna Watershed Park (Site #6) and the other in the soft-bottomed section of the Arroyo Seco underneath the 134 Freeway overpass (Site #7). Surveys were conducted twice, in October of 2003 and 2004. Site #6 was dry both times, and thus was not surveyed.

While many detailed statistics were generated, they were "rolled up" into an overall regionally specific Index of Biological Integrity (IBI). Then, all of the sites were assigned based on the IBI into one of five categories: Very Good, Good, Fair, Poor or Very Poor. Overall, results were obtained for 16 locations throughout Los Angeles County, and were distributed as follows:

- Very Good: 0
- Good: 1
- Fair: 1
- Poor: 3
- Very Poor: 11

In both surveys, the Arroyo location at Site #7 rated in the lowest category, Very Poor. However, of the 11 locations in the Very Poor category, the Arroyo Seco was tied for the highest scores with a location in the Los Angeles River adjacent to the confluence with the Arroyo Seco.

This limited data suggests that the Arroyo Seco harbors a relatively impaired macroinvertebrate community. The data alone do not suggest whether this is due to habitat impairment, poor water quality, or both.

The following observations can be made based on these results:

1. Indicator bacteria counts are the most significant water quality impairment in the Arroyo Seco. Average concentrations of the key indicators for fresh water systems, fecal coliform and e.coli, both exceeded water quality objectives in over 75% of samples collected. And, average concentrations across all samples collected for fecal coliform and e.coli were 115 and 40 times the relevant water quality standards.

2. Concentrations of metals occasionally exceed regulatory limits, but are marginally above those limits when exceedences occur.

3. Several other analytes occasionally show concentrations above appropriate limits, but are not as significant as bacterial or metals exceedences.

4. Limited biological assessment suggest that the Arroyo Seco macroinvertebrate community is very poor. Future sampling is needed to determine the source of this impairment.

4.2 Habitat Quality

Historically, the Arroyo Seco watershed supported a diverse mosaic of vegetation. In the steep, upper mountainous reaches of the watershed, the majority of land was covered by shrub dominated chaparral with substantial patches of mixed hardwood/conifer woodlands/forests and corridors of riparian vegetation in the drainages (Stephenson et al,1999). Further down the watershed, the foothill areas were dominated by a matrix of fire-adapted, shrub-dominated communities, such as coastal sage scrub and chaparral, which likely were found almost exclusively on south-facing slopes which receive the most direct sunlight. On shadier slopes and canyon floors, patches of oak and walnut woodlands thrived while the wet drainage areas sustained corridors of riparian vegetation. In some foothill areas, springs flowed abundantly, resulting in marshes and lagunas. Where the Arroyo exited the canyon into the floodplain, alluvial fan sage scrub probably dominated the terraces created through periodic inundation from flooding. Grasslands composed of perennial bunchgrasses, annual grasses and herbs most likely occupied large areas of the valley lowlands.

This rich vegetation supported a diverse population of wildlife. Grizzly bears and mountain lions roamed throughout the watershed. Many types of native fish flourished in the low elevation and mountain streams, including southern steelhead, which migrated from the Pacific Ocean up the Los Angeles River to spawning grounds in the Arroyo Seco foothills and mountains. Many types of smaller wildlife flourished in different ecological niches. Arroyo toads lived in the floodplain area and nearby uplands along the braided stream channels. California gnatcatchers thrived in coastal sage scrub in the southern watershed. For more information about the diverse species found in the watershed, please refer to the Arroyo Seco Watershed Restoration Feasibility Study, Volume II, Appendix F.

These natural conditions were modified as humans began settling in the Arroyo Seco watershed. The first known settlers of the watershed included the Tongva (Gabrielino) Native Americans, who built several settlements along the Arroyo Seco from the San Gabriel Mountains to present day Elysian Park, overlooking the confluence of the Arroyo Seco and the Los Angeles River. The Native Americans were followed by the Spaniards in the 1770s, Mexicans in early 1800s, and finally settlers from the eastern United States in the late 1800s. More detailed information about the human settlement of the Arroyo Seco can be found in the Arroyo Seco Watershed Restoration Feasibility Study, Volume I, Section II, Chapter C.

By the early 1900s, much of the lower watershed had been modified by human development. Former villages such as Pasadena and Los Angeles began expanding into towns and small cities. Lowland areas were heavily used for

agriculture and grazing. Water was diverted for drinking and irrigation, lowering the water table and drying up many natural springs.

Perhaps the most significant changes in the Arroyo ecosystem were enacted to control the periodic winter floods. In 1920, Devil's Gate Dam was constructed, and between 1934 and 1947 most of the Arroyo Seco below Devil's Gate Dam was lined with concrete. These last developments protected Arroyo residents from floods, but at a high cost: a once-rich aquatic ecosystem was destroyed.

Figure 4-2. Construction of the Arroyo Seco Flood Control Channel (Arroyo Seco Foundation)

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Today, while the river itself has been channelized, significant portions of the Arroyo Seco floodplain south of Devil's Gate exist in a natural state in that they are not developed. Pasadena's Hahamongna Watershed Park and Lower Arroyo Park protect substantial areas of open space adjacent to the Arroyo Seco, as do a number of parks in the Los Angeles and South Pasadena reaches of the river. However, even these protected areas are not as they once were. Native vegetation has been reduced and fragmented, and exotic plants and trees are predominant. Less surface water is available to both plants and animals due to groundwater extraction and the channelization of natural streams. And, roads and other manmade structures cut off wildlife corridors, separating attractive natural areas in the south from wildlife in the north that might inhabit them.

The list of species formerly found in the Arroyo Seco that have been extirpated (made locally extinct) is long. It includes the grizzly bear, all native fish including the southern steelhead, and many smaller animals such as the arroyo toad,

California gnatcatcher, and the coast horned lizard (NET et al, 2002). Despite these losses, many native species still inhabit the watershed, both in the natural northern portions and the urbanized southern stretch. In the forested north, many large and/or rare species remain. Mountain lions, California spotted owls and rainbow trout (of uncertain origin) are still found in the foothills and mountains. In the south, smaller animals including many native birds still frequent areas where native habitat remains, and others such as coyotes, crows and ravens have all flourished at the interfaces between natural lands and urban communities.

5 Restoration Analysis

NET used the results and recommendations of the ASWRFS as a starting point throughout this project. The increased focus on two components, water quality and habitat restoration, required that additional technical analysis be performed; the level of analysis in the ASWRFS was not sufficient to prioritize and potentially monitor the impact of projects proposed in these two areas. As a result, many of the projects proposed at the end of this document were proposed in the ASWRFS. Numerous new projects were also identified, especially with respect to water quality improvement. The entire list of proposed projects, both new and old, is presented in priority order and at a level of detail that should make them easier to implement in the future.

The following sections present short summaries of the analyses performed in the water quality and habitat restoration areas to come up with the concrete, prioritized and technically valid recommendations needed for this plan.

5.1 Water Quality

North East Trees began its analysis of water quality for this project by collecting and analyzing all existing water quality. In total, NET collected nearly 2,000 discrete sample results representing nearly 80 sampling events and over 200 different parameters, collected over the past 30 years by seven different agencies. Appendix 2 provides a profile of this large dataset.

5.1.1 Identifying Problem Pollutants

NET then analyzed this dataset to try to understand what if any water quality problems exist in the Arroyo Seco. This was a challenge for a couple of reasons. First, the data was collected over many years, from many different locations, and during both wet and dry times of the year. Over the 30 years that data has been collected in the Arroyo Seco, water quality standards have changed dramatically, with the most stringent standards in place today. As a result, we compared all of the data to today's standards, rather than those that might have been in place when it was collected.

Through this analysis we found that 12 different contaminants exceeded the water quality objectives in place today. In some cases, only one or two individual samples exceeded the relevant limits. In others, the limits were exceeded over 50% of the time, and by large multiples. These are summarized in Table 4.1 in the previous section. This table is sorted from highest to lowest, as measured by the percent of the time that a particular contaminant was found to exceed the associated water quality objective.

These results seem to indicate that bacterial contamination is the most significant water quality problem in the Arroyo Seco. The two most important bacteria indicators for fresh water, e.coli and fecal coliform, both exceeded the relevant limits as specified in the Los Angeles Regional Water Quality Control Board's Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties (California, 2002) over 70% of the time. Furthermore, individual results were sometimes as much as 50 – 1,000 times greater than the water quality standards.

Several metals also exceeded the relevant limits, including copper, lead, and zinc, for which new standards were recently released for the Arroyo Seco as part of the Los Angeles River Metals TMDL (released in 2005). Aluminum also exceeded its limit specified in the Basin Plan.

Diazinon, a potent pesticide previously available for residential use, exceeded limits set by the California Department of Fish and Game on two occasions in 2002 and 2003. This pesticide was outlawed for consumer use in 2004, however, so it is unlikely to be a major concern in future years. Another unusual result was the detection of cyanide above a limit set by the California Toxics Rule, measured as part of sampling done by the County of Los Angeles Department of Public Works in November of 2002. Cyanide can make its way into stormwater via atmospheric fallout, agricultural runoff, and various industrial processes. The significant of this result is unclear, since it was only detected in one out of nine samples.

Last, nitrite and chloride also exceeded standards set in the Basin Plan during one out of 19 and 20 sampling events, respectively. Because these parameters are not of significance unless occurring at elevated levels over a long period of time, these results are not judged to represent a significant water quality problem.

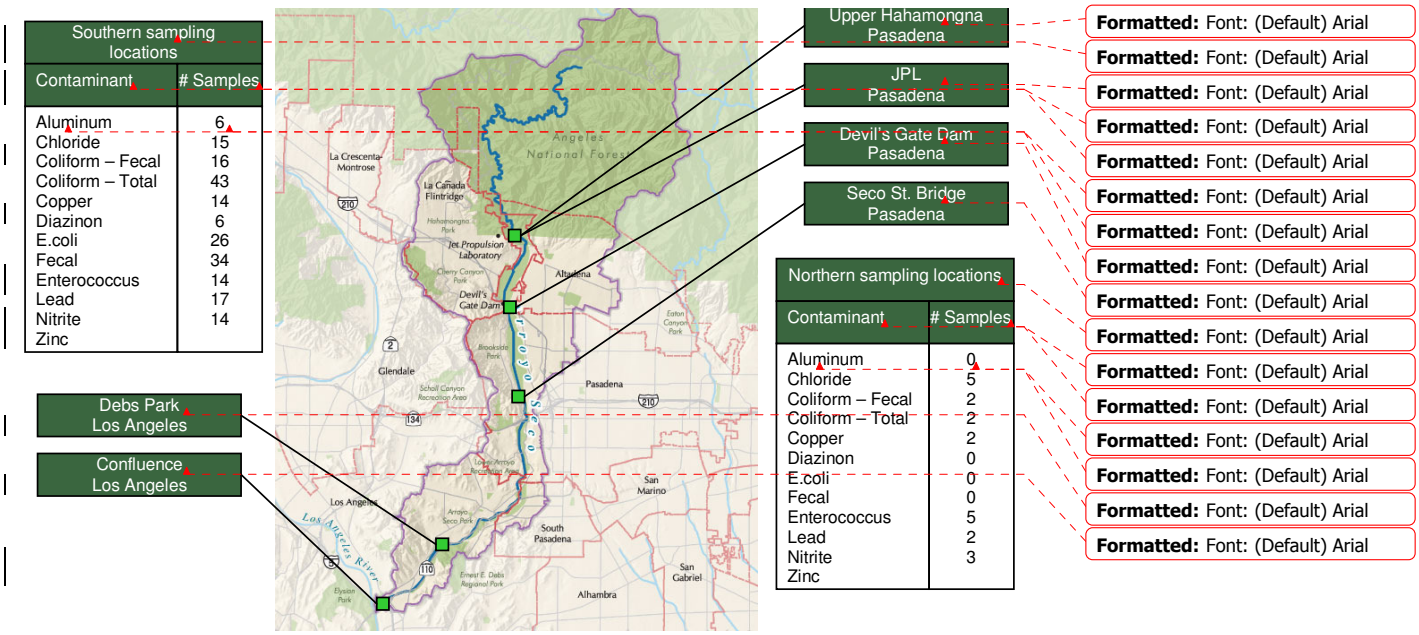
The water quality sampling program proposed in the Recommendations portion of this document (Section 6) would provide additional information on all of these pollutants and their distribution and sources throughout the watershed.

5.1.2 Identifying the Sources of Pollution

Next, NET set out to identify the sources of the pollutants discussed above. All of the constituents that exceeded water quality objectives are commonly found in nonpoint source runoff from urban areas. Therefore, the higher levels most likely come from general areas in the watershed rather than from particular facilities. Because NET did not have any funding under this project to complete water quality sampling, we were unable to identify any locations using field testing. Instead, we attempted to do this by mapping the data in our existing database against specific locations in the Arroyo Seco.

Figure 5.1 shows the results of this effort. It shows the number of samples available for the key pollutants at each of the different sampling locations in the

Figure 5- 1: Samples Collected by Location



watershed. This map shows that the samples were highly concentrated in the lower watershed. Given the locations of the data, we were not able to identify specific pollution-producing areas, nor were we able to even tell whether it was coming from the south or the north of the watershed – we simply had too few sample results in the northern two-thirds of the watershed to make this determination.

The only conclusion that the data allowed us to draw with respect to location was that there is a problem in the Arroyo Seco as it enters the Los Angeles River. In hindsight, this was not surprising. Most water quality sampling in the Arroyo Seco has been done to assess the Arroyo's contribution to problems in the Los Angeles River, not to characterize the Arroyo Seco itself. One key recommendation from this project, to be discussed later in this plan, is to launch a water quality sampling program to do just this by spreading sampling locations at strategic points throughout the watershed.

This result presented a major obstacle: we would be unable to identify specific sites for projects to reduce pollution without better information about where pollution is coming from. Based on consultations with experts in the U.S. Environmental Protection Agency (Fleming, 2004), the Los Angeles RWQCB (Collins, 2004), and the Southern California Coastal Waters Research Project

(Stein, 2004), we decided to use simple water quality modeling to get around this obstacle.

5.1.3 Water Quality Modeling

NET selected a simple water quality model called PLOAD to use in prioritizing areas of the Arroyo Seco for implementing Best Management Practices. PLOAD is a model that allows the user to calculate nonpoint source pollutant loads on an annual (and therefore average) basis. It was developed by the consulting firm CH2M Hill for the US Environmental Protection Agency (EPA, 2001). The model is based on the assumption that particular land uses are correlated with the pollution they generate. As an example, a heavily industrial neighborhood is predicted to generate more pollution than a low density residential neighborhood. The user supplies five pieces of input, which are:

- A map of the watershed, subdivided into smaller areas that drain to common points in the river system. For instance, all land that drains to the Arroyo through one storm drain would be subdivided into one area. The Arroyo Seco watershed was divided into 71 different sub-watersheds, based on the breakdowns used in the County of Los Angeles Department of Public Works' (LACDPW, 2000) flood control model for the Arroyo Seco (See Appendix 3, Figure 1).

- Estimates of the land use composition for each of the smaller areas. These estimates were based on data obtained from the Southern California Association of Governments (Southern California Association of Governments, 2000) (See Appendix 3, Figure 2).

- Estimates of percent imperviousness (i.e., the percent of each area of land that is covered by hard surfaces and thus doesn't let water sink in) for different land use types, estimated from figures from the County of Los Angeles Department of Public Works (See Appendix 3, Figure 3; LACDPW 2000).

- Estimates of the concentration of a particular pollutant that is generated by a particular land use type during rainfall, called event mean concentrations (EMC). This information is available in the County of Los Angeles Department of Public Works' 1994 – 2000 Integrated Receiving Waters Impacts Report (LACDPW, 2000; See Appendix 3, Table 1).

- Average rainfall estimate for the watershed. NET used an estimate of 20" for the lower watershed, taken from the ASWRFS (NET & ASF, 2002).

Using these estimates for each pollutant, PLOAD can be used to calculate the average concentration and average pounds of pollutant runoff.

Because PLOAD is a relatively simple model, we did not set out to estimate exact concentrations throughout the watershed. This can only be done using a complex model that takes into account dry weather and wet weather conditions and allows for changing conditions throughout the year. Rather, we hoped to use PLOAD as a tool to identify those portions of the Arroyo Seco that were most likely to contribute pollution given land use patterns and topography.

Once we ran the model for all of the pollutants for which we had data (metals, bacteria, and nutrients), we then classified the 71 sub-watersheds into three categories: high priority, medium priority, and low priority. High priority watersheds were those that demonstrated model results higher than water quality objectives for all three main classes of pollutants (bacteria, metals, and nutrients), medium priority were those that produced high results for either metals or bacteria but not both, and low priority were the remainder.

This calculation resulted in the classification of eight high priority sub-watersheds, three medium priority sub-watersheds, and sixty low-priority sub-watersheds (predominantly those in Angeles National Forest and other undeveloped areas). These sub-watersheds are shown in Figure 5-2. Because the eleven high- and medium-priority sub-watersheds were projected to generate over 50% of the pollution emanating from the Arroyo Seco, our BMP analysis will concentrate on improving water quality in these areas.

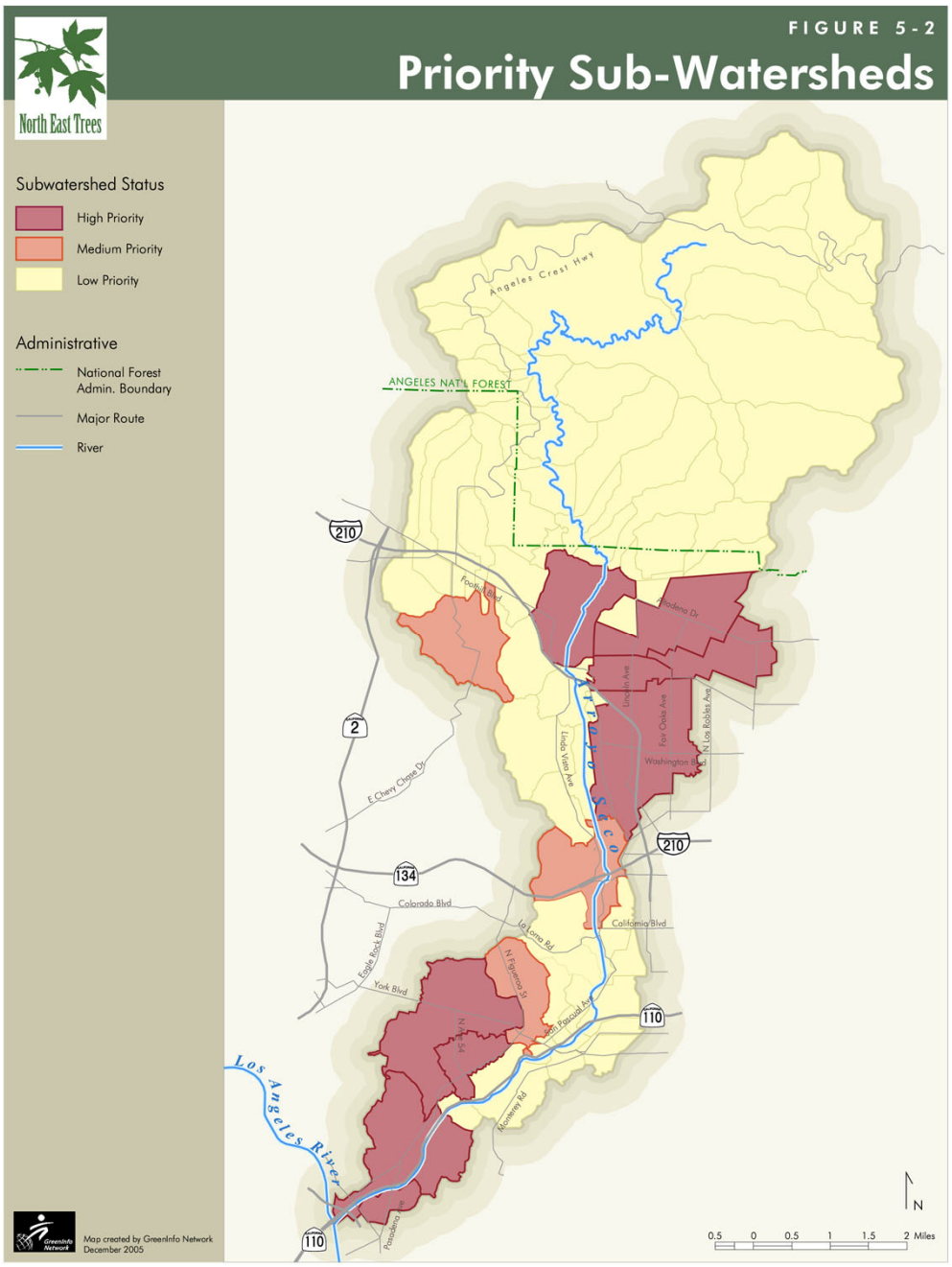
5.1.4 BMP Selection

The next step of NET's analysis was to identify sites where Best Management Practices (BMPs) could be implemented to improve water quality. BMPs are projects or programs that can be employed to reduce contaminated runoff. There are two main categories of BMPs. They are often used together, for they complement one another. They are:

- ***Structural BMPs*** are BMPs constructed at a particular site to reduce contaminated runoff. Structural BMPs come in many different designs. Some employ the same cleaning processes found in natural ecosystems. An example of this type is called a vegetative swale. Vegetative swales are channels lined with low vegetation such as grasses that slow the flow of stormwater and filter it through plant material and soil. Vegetated swales are often found along roads and treat runoff washed from the roads during storms. Other BMPs are highly technical in nature. The same technologies employed in wastewater treatment plants are often used in BMPs to treat stormwater. These types of BMPs are employed where the runoff is heavily polluted, or where there isn't sufficient space to employ more natural treatment types. Structural BMPs can be employed in a wide range of locations, from an individual residential lot to the largest municipal storm drains.

- ***Nonstructural BMPs*** are BMPs that do not involve the construction of some device at a particular place. They are typically intended to reduce polluted stormwater either by reducing pollution at the source or by reducing the amount of water that runs off from a particular area or region.

Figure 5- 2: Priority Sub-Watersheds in the Arroyo Seco



An example of the first type would be increased municipal street sweeping before rain events, which would clean up trash and other waste on streets before it runs off into the storm drain system. An example of the second type would be a public education initiative to encourage people to turn off irrigation systems during the rainy season.

As mentioned in Section 2.3, BMPs must be tailored to particular site conditions, and to particular pollutants. Based on the analyses described previously, bacteria and metals are the two largest water pollution issues in the Arroyo Seco. These two pollutants are fairly difficult to deal with, for they are not easily filtered from stormwater.

Bacteria also pose unique challenges. One is that even natural waterways can contribute bacteria levels higher than water quality standards during the wet season. Another is that bacteria tend to grow in storm drain systems themselves; discharging cleaned-up water into a dirty storm drain might lead to it being re-contaminated before it reaches the Arroyo Seco. Therefore, systems designed to treat bacteria must be close to the river itself in order to have the most benefit.

North East Trees and their consultants GeoSyntec reviewed many different technologies for use in the Arroyo Seco. Appendix 4 presents this analysis in detail, and shows many examples of each type of BMP. Four in particular showed the greatest promise in that they use natural processes (and therefore are compatible with publicly-used open space in most cases) and can deal with both metals and bacteria pollution. These were:

- ***Onsite retention and reuse***. One of the best ways to control runoff is to eliminate it at the source. One way of doing this is to store water onsite, and then reuse it for irrigation or other purposes. Individual homeowners can do this by connecting their gutters to specially designed “rain barrels,” while larger facilities can do the same using underground cisterns. In both cases, the stored runoff never reaches the storm drain system, but is either used by plants onsite or evaporates.

- ***Bioretention, or “rain gardens***.” Bioretention is a BMP that involves the use of specially designed gardens or vegetation areas to store and treat rainfall. Bioretention areas look on the surface like depressed gardens, with specially selected plants that can withstand being submerged for short periods of time. When it rains, rainfall is diverted to these sunken areas, where it ponds and slowly infiltrates over following hours or days. In the process, pollutants are removed by the soils and the plants planted in the garden area.

- ***Infiltration trenches and galleries***. Infiltration trenches and galleries are engineered devices designed to take rainfall and convey it into the ground,

where it will eventually filter down to groundwater. Along the way, pollutants are removed and broken down by bacteria, plant root systems, and other natural processes in the soil. These systems can be used to treat large volumes of water, as they can be built underground beneath surface areas intended for other uses such as parking lots and playing fields.

- ***Subsurface flow wetlands***. Natural wetlands have a high capacity to reduce stormwater pollution. Plants, bacteria, and other organisms and natural processes break the pollution down into less- or nontoxic forms. Engineered wetlands (i.e., manmade wetlands designed to perform like natural ones) have been shown to be very effective in treating polluted urban runoff. However, the recent increase in West Nile Virus has heightened concerns about wetlands in our communities. Therefore, engineers have designed systems that use the same processes as wetlands, but keep all water below the ground surface. These are called ***subsurface flow wetlands***. They are particularly effective when soil conditions do not allow for infiltration trenches, such as when large amounts of clay (which does not drain) are present.

Figure 5- 3. Example of a Rain Garden

These four BMPs are all described in Appendix 4.

5.1.5 BMP Assignment

The final step of the process was to determine what sites are most suitable for BMPs in the Arroyo Seco watershed, and at those sites what BMPs should be employed.

After looking at many different locations in the Arroyo Seco, it became apparent that attractive BMP sites fell into two categories. The first category were ***regional BMP sites***. Regional BMP sites met certain conditions. They were:

a) In a location near the Arroyo Seco itself, so that treated water doesn't get re-contaminated in the storm drain system;
b) Adjacent to a storm drain, so that flow from the storm drain can be removed and treated before it flows into the Arroyo Seco; and

c) In an area where site land use is compatible with installing a large BMP, which after careful consideration we concluded to mean it must be either under public ownership or protected open space.

Regional BMP sites are the most critical ones, for they offer the greatest opportunity to clean urban runoff. Larger systems could be installed on them, and their locations along storm drains allowed for the treatment of runoff from an area much larger than the site itself. However, given the density of the Arroyo Seco area, there are relatively few of these locations. Examples of regional BMP sites include large public parklands and schools with extensive playing field complexes.

The second group of BMP sites is the group of ***localized BMP sites***. These sites are those where space exists to install BMPs to treat runoff from only that individual site. In theory, every piece of land is a potential localized BMP site; as mentioned above, every individual homeowner could install rain barrels to reduce runoff from his/her property. However, certain sites stood out as the most critical ones. These were sites that were a) large and b) highly impervious, meaning that they were almost entirely covered by hard surfaces where water would not sink into the ground. The larger and more impermeable the site, the more important it would be as a localized BMP site. Examples of high-priority sites would include large shopping centers and school complexes. NET used aerial photos to identify all such areas in the high and medium priority sub-watersheds.

The choice of what type of BMP to employ at a site involves many factors. Such considerations include whether the soil on site allows for water to infiltrate (clay soils, for example, do not permit infiltration), whether the land is under public or private ownership, whether the site is open to the public or not, the cost of ongoing maintenance, how much land is available to install the BMP on, and other factors.

NET's water quality consultants, GeoSyntec Consultants, developed a prioritization approach that weights all of these factors and calculates an overall score for each BMP / site combination. Examples of this template are shown in Appendix 4, Tables 12 and 13. The result is a prioritized list, from highest score to lowest, of BMPs at specific sites throughout the watershed. The highest-ranked BMPs are those that will remove the greatest amount of pollutants and have the lowest barriers to implementation. Because they are already located in the high-priority sub-watersheds (i.e., those calculated to generate the most polluted urban runoff), these projects are the most important projects for improving water quality in the Arroyo Seco.

Figure 5-4 displays a map showing the priority of BMP sites throughout the Arroyo Seco. More detailed descriptions of the BMP projects are provided in the Recommendations section later in this document.

Figure 5-4. BMP Priority Projects

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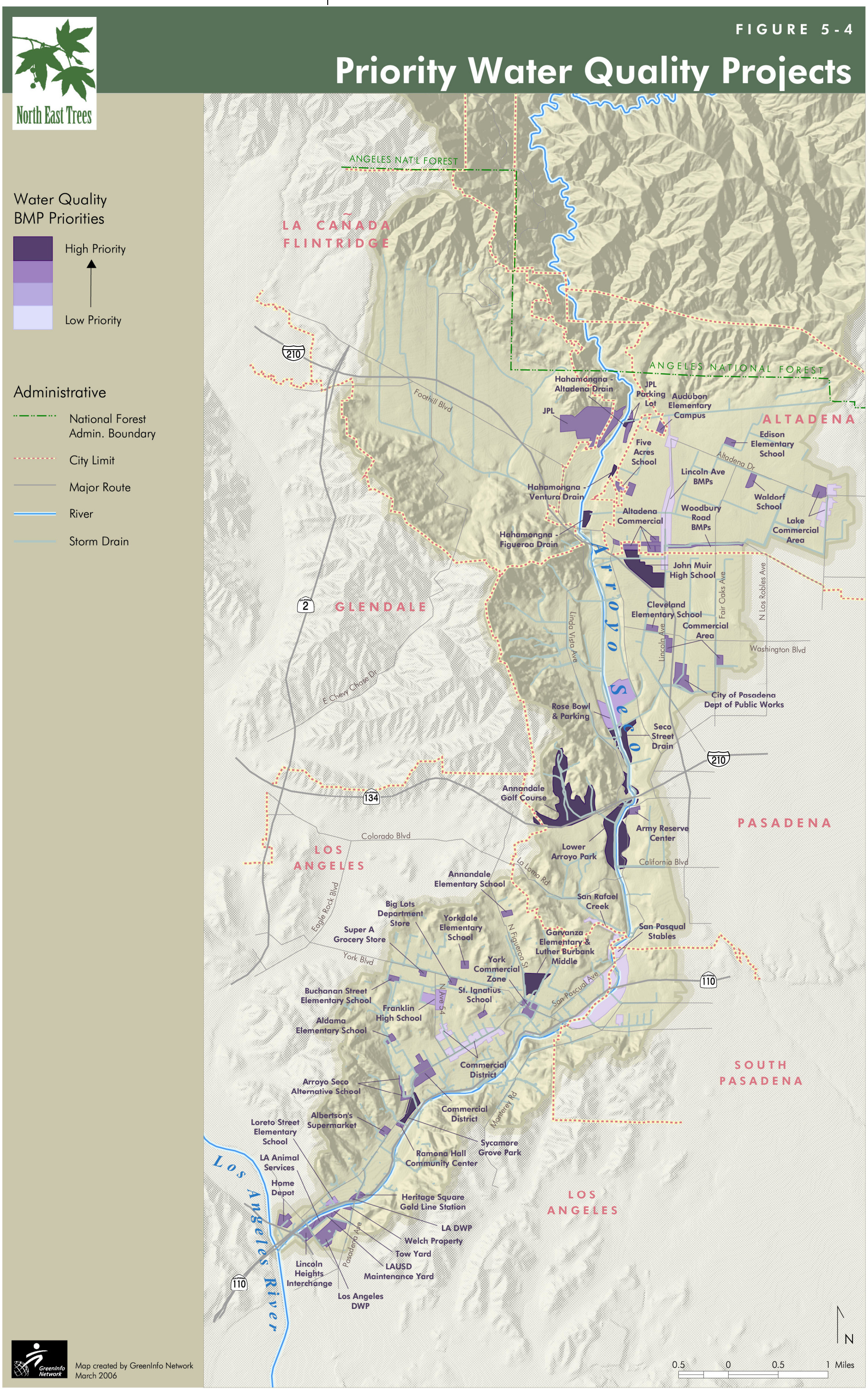

5.2 Habitat Restoration

Although natural habitat still exists in the Arroyo Seco, sometimes in surprisingly urban locations, the overall extent of natural habitat is a small fraction of the original. Today, approximately 170,000 people call the Arroyo watershed home (U.S. Census Bureau, 2002); restoring the Arroyo to truly original conditions is not feasible given this level of human habitation. However, protecting existing habitat, expanding current habitat areas into neighboring areas, establishing protected linkages between islands of habitat, and ultimately restoring the Arroyo Seco stream itself to a natural state are all feasible within the constraints created by human development.

NET conducted a habitat restoration analysis to identify ways in which habitat could be restored throughout the watershed. This analysis is described in the following sections.

5.2.1 Focal Species Analysis

Habitat restoration efforts are often based on restoring a habitat *type*, which in general means replanting the vegetation formerly found in the area, taking into account the relative prevalence and spatial diversity found in undisturbed habitat. This can lead, over the long term, to the return and stability of native wildlife species found in that habitat.

In many circumstances, though, restoring habitat type is not enough. Rather, the restoration of habitat, distinct from habitat type, is what is required. The distinction here, as explained by esteemed restoration ecologist Michael Morrison in his book *Wildlife Restoration: Techniques for Habitat Analysis and Animal Monitoring (2002)*, is that habitat type in general refers only to the particular plant community, whereas habitat incorporates those plants *and* any other elements or factors necessary for the survival of animal species. An example would be the restoration of oak woodland habitat by planting the relevant plant and tree species. Without focusing on providing the cavities found in dead or dying trees in mature oak woodland habitat at the same time, many of the bird species depending on cavities for nesting in mature oak woodlands would not appear unless these cavities were somehow provided.

As a result, NET in consultation with our consulting restoration ecologist, Verna Jigour, decided to adopt a focal species restoration model rather than simply restoring the various Arroyo habitat types. In order to achieve habitat restoration we must have one or more wildlife species in mind. We needed to understand how that species relates to its environment – how it responds to physical processes and how it accesses resources. So we select focal species whose habitat needs we can begin to home in on. It makes sense to select focal species that serve as indicators of some kind. They could be indicators of

physical conditions, such as water quality. Ideally they will serve as physical environment indicators and also serve as stand-ins or representatives for other wildlife species with similar habitat needs. Assuming we learn as much as we can about the habitat needs of species x, with this focal species strategy we stand a better chance of achieving habitat restoration for at least one native wildlife species than if we just began planting native plants.

5.2.2 Focal Species Selection

The ASWRFS identified 17 different focal species, representing all of the major habitats of the Arroyo Seco. For the purposes of this study, this number was too unwieldy (and too expensive) to proceed with habitat planning for all. As a result, NET and Verna Jigour identified the top habitats of the Arroyo, and selected focal species that served as the best indicators for these habitats. These species, and their associated habitats, are shown in Table 5-1 below.

Table 5-1

Habitat	Indicator Species
Scrub (incl. coastal sage scrub and chaparral)	Spotted towhee
Oak and walnut woodlands	Oak titmouse
Riverine	Arroyo chub
Riparian	Yellow warbler
General habitat connectivity	California quail

These species were selected over other options for two primary reasons. First, they allow progress within the Arroyo Seco itself to be measured. As an example, the southern steelhead was suggested as a Flagship / Umbrella species in the ASWRFS. However, unless habitat suitable for steelhead passage up the entire length of the Los Angeles River is restored, thereby allowing steelhead to return to the Arroyo from the ocean, biologists would be unable to measure whether riverine restoration in the Arroyo Seco is providing suitable habitat. Second, by meeting the needs of these species, most if not all of the others are covered. Using the arroyo chub as an example, the restoration of suitable arroyo chub habitat throughout the Arroyo would produce the conditions necessary for steelhead to migrate to the upper watershed. Table 5-2 shows all of the ASWRFS indicator species, and how they link to the five species used in this plan.

Figure 5- 5. Spotted Towhee (Mike Yip, Vancouver Island Birds)

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Table 5-2. Linkage Between ASWRFS and ASWRMP Focal Species

WMRP Indicator Species	ASWRFS Indicator Species	Additional habitat requirements not met by WMRP indicator species	Rationale for selection / exclusion of ASWRFS species from WMRP
Arroyo chub	Southern steelhead	Connection to (and naturalization of) access to the Pacific Ocean via the Los Angeles River	No way to measure restoration progress along sections of river, or unless significant LA River restoration completed
	Unarmored threespine stickleback	None	Habitat needs covered by Arroyo chub; not as resilient as chub; federal endangered status makes reintroduction more difficult
Yellow warbler	Yellow warbler	None	None
Oak titmouse	Oak titmouse	None	None
	Arboreal salamander	Requires connectivity to riparian areas	Very difficult to monitor; little known about range / status in Arroyo Seco
California quail	California quail	None	None
	Bobcat	May require larger expanses of connected habitat, although have been observed in areas overlapping current quail habitat	Given large territories, more difficult to monitor than quail
Spotted towhee	Cactus wren	Coastal / alluvial fan sage scrub with mature native cacti	Likely habitat of very limited extent in Arroyo Seco watershed
	Greater roadrunner	Large expanses of dry scrub habitat with few / no trees	Same as cactus wren
	California gnatcatcher	Large expanses of high-quality coastal sage scrub habitat	Requires large area of contiguous habitat, therefore problematic as an indicator in fragmented, urbanized areas
	Coast horned lizard	Requires measures to control replacement of native ants by non-native Argentine ants	Only valid for limited sections of coastal sage and alluvial fan sage scrub
	Lesser nighthawk	Large expanses of alluvial fan sage scrub in particular	Possible extent of alluvial fan sage scrub very limited in Arroyo Seco; not useful as an indicator in other habitats
	Plummer's Mariposa lily	Found in chaparral and alluvial fan sage scrub; only blooms in wet years.	Very difficult to monitor
No direct connection with WMRP species	Arroyo toad	Requires fluctuating hydrological and geological conditions found along natural stream courses	Later stage indicator of habitat health (i.e., after much restoration completed); Arroyo Seco recently removed from critical habitat designation for Arroyo toad.
	Southwestern pond turtle	Pools in perennial, slow-moving streams; only likely in upper watershed tributaries	Focus of this plan is lower watershed

	Grasshopper sparrow	Grassland habitat, interspersed with coastal sage scrub	Limited opportunities for restoration given dense urban development in historical extents in southern watershed.

5.2.3 Ecological Reference Site Surveys

The next step of the focal species approach is to identify the characteristics of healthy habitat for each of the indicator species. While much of this information can be secured via research, it is helpful to augment this with field surveys of existing habitat.

Verna Jigour performed reference site surveys for four of the five indicator species. A survey for quail was not performed, as the habitat needs of this species are more general than those of the other four, and were already well documented.

The results of this analysis are habitat models for each of the indicator species. These models are the "target" for restoration design – they indicate the conditions necessary to support stable populations of the indicator and other related species.

Table 8-3 displays the reference site locations of the four indicator species. The detailed habitat models generated using both the field surveys and literature reviews are provided in Appendix 5.

Table 5-3. Indicator Species Reference Sites

Indicator Species	Reference Site
Arroyo chub	Haines Canyon Creek, Big Tujunga Wash Mitigation Bank
Oak titmouse	Western Hahamongna Watershed Park (Pasadena) & Cherry Canyon Park (La Cañada Flintridge)
Spotted towhee	Audubon Center at Debs Park
Yellow warbler	Riparian forest above Hansen Dam in Tujunga Wash, Glendale Narrows section of the Los Angeles River

5.2.4 Species-Specific Priorities

Next, NET and Verna Jigour developed species-specific restoration priorities. These priorities were based on two assessments: what types of activities are needed to protect or restore a species' habitat in the Arroyo, and the relative state of the species' populations in the Arroyo. For instance, the oak titmouse is relatively common in the northern watershed where fair to good oak woodland habitat exists. Therefore, the key priorities for the oak titmouse are to monitor and protect existing populations, while focusing on expanding the species' range back into historic habitat to the south. The arroyo chub, on the other hand, is currently extirpated (i.e., locally extinct) from the Arroyo Seco watershed. As a result, the key priority for the chub is to identify a limited number of sites where reintroduction might be possible, and attempting to reintroduce the chub in order to establish a viable local population in a limited area.

The following Table 5-4 presents the priorities for each of the five indicator species.

Table 5-4. Species-Specific Restoration Priorities (1 = highest priority)

Species	Priority Rank	Initiative Description
Arroyo chub	1	Restore soft-bottom sections of low elevation tributaries
	2	Restore soft-bottom sections of low elevation main channel
	3	Restore soft-bottom sections of transitional gradient channel
	4	Restore hard-bottom sections of low elevation tributaries, adjacent to restoration areas
	5	Restore hard-bottom sections of low elevation main channel, adjacent to other restoration areas
Yellow warbler	1	Protect and improve existing breeding habitat
	2	Improve non-breeding habitat, with the goal of restoring breeding populations
	3	Restore habitat adjacent to existing habitat areas
	4	Restore habitat in nonadjacent areas where components of suitable habitat exist (canopy trees in riparian zone, etc)
Oak titmouse	1	Protect and improve existing breeding habitat
	2	Improve existing non-breeding habitat
	3	Improve condition and management of existing oak / walnut woodlands without observed populations
	4	Work to ensure that native tree species are considered for planting on all public / private lands in suitable hillside zones
Spotted towhee	1	Restore stands of native scrub vegetation suitable for towhees in areas of open space in the lower watershed
	2	Expand areas of scrub habitat in lower watershed adjacent to existing core habitat areas
California quail	1	Improve existing quail habitat
	2	Protect and improve bottlenecks between core habitat areas and adjacent potential habitat areas
	3	Restore reconnected adjacent habitat areas to conditions suitable for quail

5.2.5 Project Identification

Two types of projects were identified as part of the habitat restoration analysis. Most projects were location-specific opportunities to improve or protect habitat for one or more of the indicator species. An example of such a project would be the restoration of arroyo chub habitat in a stream. Other projects were identified that apply throughout the watershed. These include such initiatives as the launch of monitoring programs for the indicator species. Different steps were taken to develop these projects, as described below.

Site-Specific Projects

Initially, project sites were identified species by species. NET and Verna Jigour reviewed aerial photos and existing information about habitat condition throughout the watershed and performed field surveys to identify all areas in which each species might be found assuming future restoration efforts. Using this set of sites as a starting point, the species-specific priorities listed above were then used to assign a priority to each site. Finally, the priorities were summed up across the five species. This process assigns heavier weights to projects benefiting multiple species, with the highest-scoring projects being those that are high-priority for most or all of the indicator species.

Prioritized projects sites for each species independently are shown in Appendix 5 in Figures 1-5. The overall habitat restoration priorities, summed across all five of the species, are shown in Figure 5-6.

Watershed-Wide Projects

A number of projects were identified that didn't apply to a specific location. These include overall projects that will support future restoration efforts, such as wildlife monitoring programs, and others that might involve actual restoration efforts but over widely dispersed areas. An example of this type of project would be to develop specifications for backyard habitat, intended to be used as guidelines for landscaping on private property.

NET and Verna Jigour kept a running list of such ideas over the course of this analysis. Once the site-specific project process was complete, we evaluated these watershed-wide projects on two dimensions. First, would the proposed project score highly if the species priorities were applied to it? An example would be the backyard habitat project listed above; it could be important to several species if instituted across the watershed. Second, is the proposed project an enabler of the site-specific projects (such as wildlife monitoring and reporting)? If the answer to either question was yes, then the project was included on our list. The final list is discussed in the recommendations section below.

Figure 5- 6. Overall Habitat Priorities

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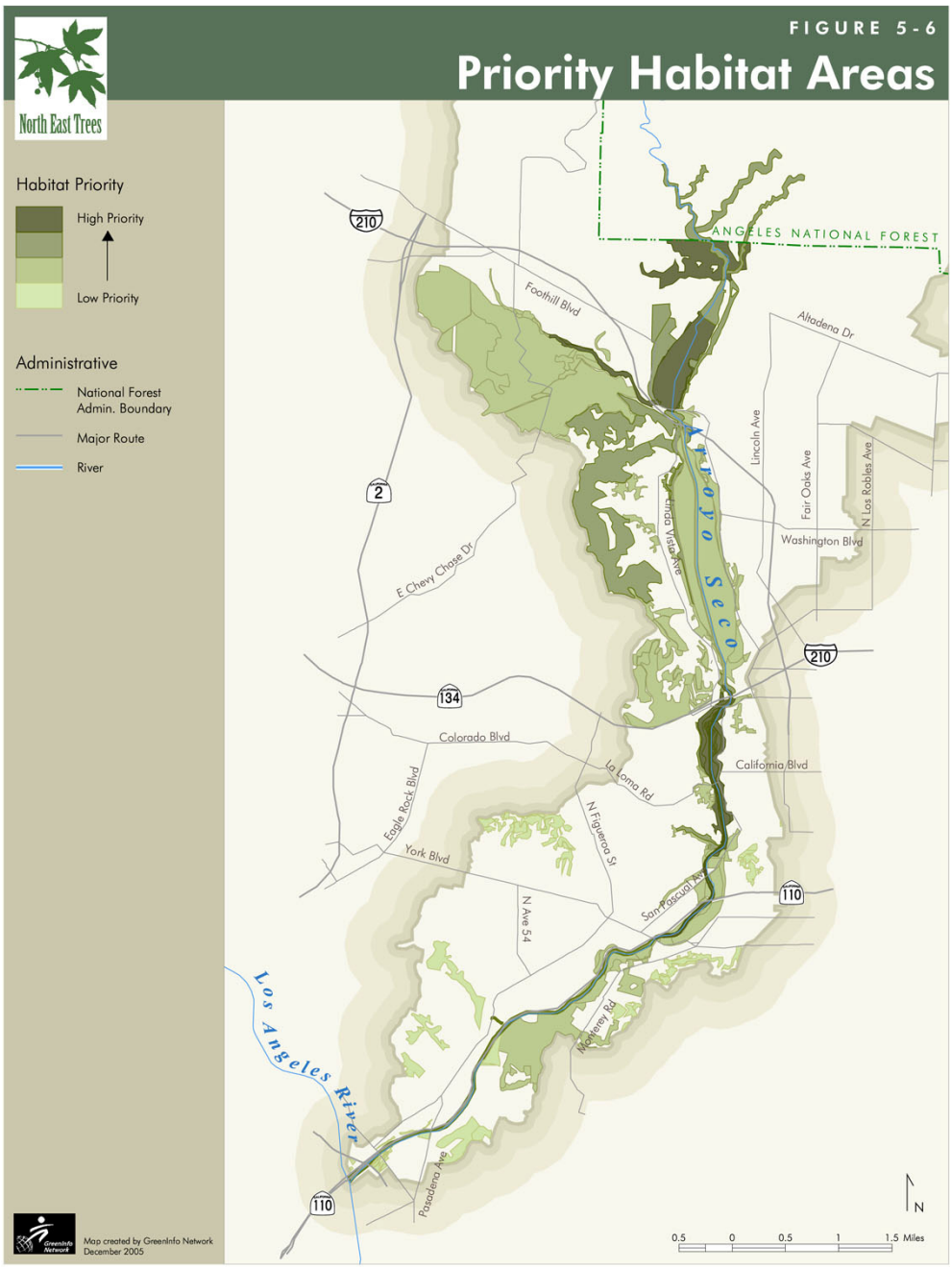

5.3 Combined Projects

The Water Quality and Habitat Restoration analyses produced separate lists of water quality and habitat restoration projects, sorted in priority order. In many instances, project locations overlapped, meaning that both habitat and water quality projects could be combined at one location.

These combined projects are very important; with so little “real estate” to work with in the Arroyo, any opportunity to achieve multiple benefits at the same site is worth more than either individual project implemented in isolation. Therefore, these joint projects are described in a separate section of this document.

A desired outcome of this plan is to identify and describe the highest priority projects within each separate jurisdiction in the watershed such that those cities or groups focused in them will have a ready supply of project ideas to work with. To address this goal, the last step of the technical analysis process was to describe and list the highest priority multi-benefit projects for each region of the watershed. It is these projects that offer the most “bang for the buck” for each of the cities with an interest in the Arroyo Seco.

These projects, hereafter described as “High Priority Site-Specific Projects”, are listed separately at the outset of the recommendations section.

6 Recommendations

There are a huge number of options available to improve water quality and restore habitat in the Arroyo Seco watershed. North East Trees along with its consultants completed the technical work described in previous sections in order to identify what options would have the most impact, and how other factors such as cost, existing land uses, and technical feasibility would enhance or detract from these high-impact projects. It is important to note that additional analysis might be necessary to implement the recommended projects. In particular, entities considering projects that modify existing hydrologic conditions must assess flood protection impacts as part of the detailed design process.

This section describes the outcomes of this process. The following projects would result in significant improvements in water and habitat quality if implemented. We have organized them into several categories, depending on how they would be implemented and on their scope. The categories are as follows:

High Priority Site-Specific Projects. These projects are the most important ones proposed in this plan. In most cases, they are projects that would produce both habitat and water quality improvements, although a few focusing on one or the other are also included because their potential impacts are so great. An example of a project is the naturalization of stream channels that would provide aquatic habitat and also allow for the infiltration of stormwater.

Watershed-wide projects. These projects are ones not tied to a specific location in the watershed. Because they are distributed in their implementation, they would also produce benefits throughout the Arroyo Seco. Examples include wildlife monitoring programs for indicator species, and educational programs and workshops to encourage the use of native plants in backyard landscaping.

Single-Benefit Site-Specific Projects. Single benefit projects are smaller, site-specific projects that improve either water or habitat quality but not both. Such projects can be implemented at almost any property in the Arroyo. Accordingly, only those that offer the largest benefit are specifically called out in this plan.

Given the urbanized nature of the watershed, full “restoration” to pre-settlement conditions is not feasible. The projects proposed in this plan, however, will restore habitat and water quality to the greatest degree possible given reasonable existing constraints. Every effort has been made to “push” the boundaries of what is possible. Figures 6-1 and 6-2 display the areas of the Arroyo Seco watershed that would be improved under the site-specific recommendations presented in this plan. Figure 6-1 displays the areas of the watershed from which runoff would run through a BMP, while Figure 6-2 displays the quality of habitat restored under the plan’s projects. Areas where restoration

or water quality improvement are indicated should not be interpreted as fully restored, but rather restored based on the goals, objectives, and priorities described previously in this plan.

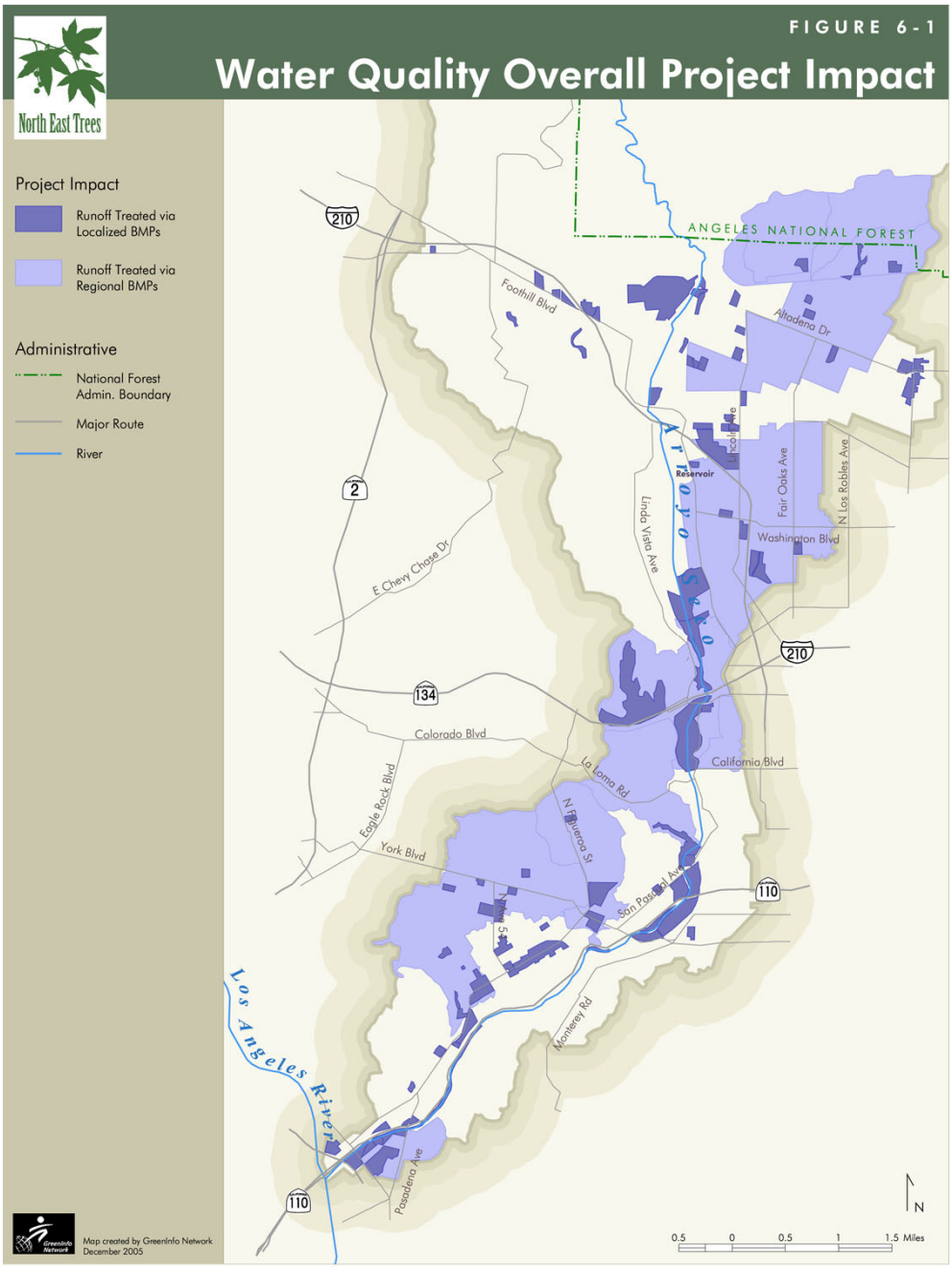
FIGURE 6-1
Water Quality Overall Project Impact
North East Trees
Project Impact
Runoff Treated via Localized BMPs
Runoff Treated via Regional BMPs
Administrative
National Forest Admin. Boundary
Major Route
River
ANGELES NATIONAL FOREST
Foothill Blvd
Altadena Dr
Arroyo Seco
Reservoir
Fair Oaks Ave
N Los Robles Ave
Washington Blvd
Linda Vista Ave
E Chevy Chase Dr
Colorado Blvd
California Blvd
La Loma Rd
Eagle Rock Blvd
York Blvd
N Figueroa St
San Pascual Ave
Monterey Rd
Los Angeles River
Pasadena Ave
210
2
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110
N
0.5 0 0.5 1 1.5 Miles
Map created by GreenInfo Network December 2005

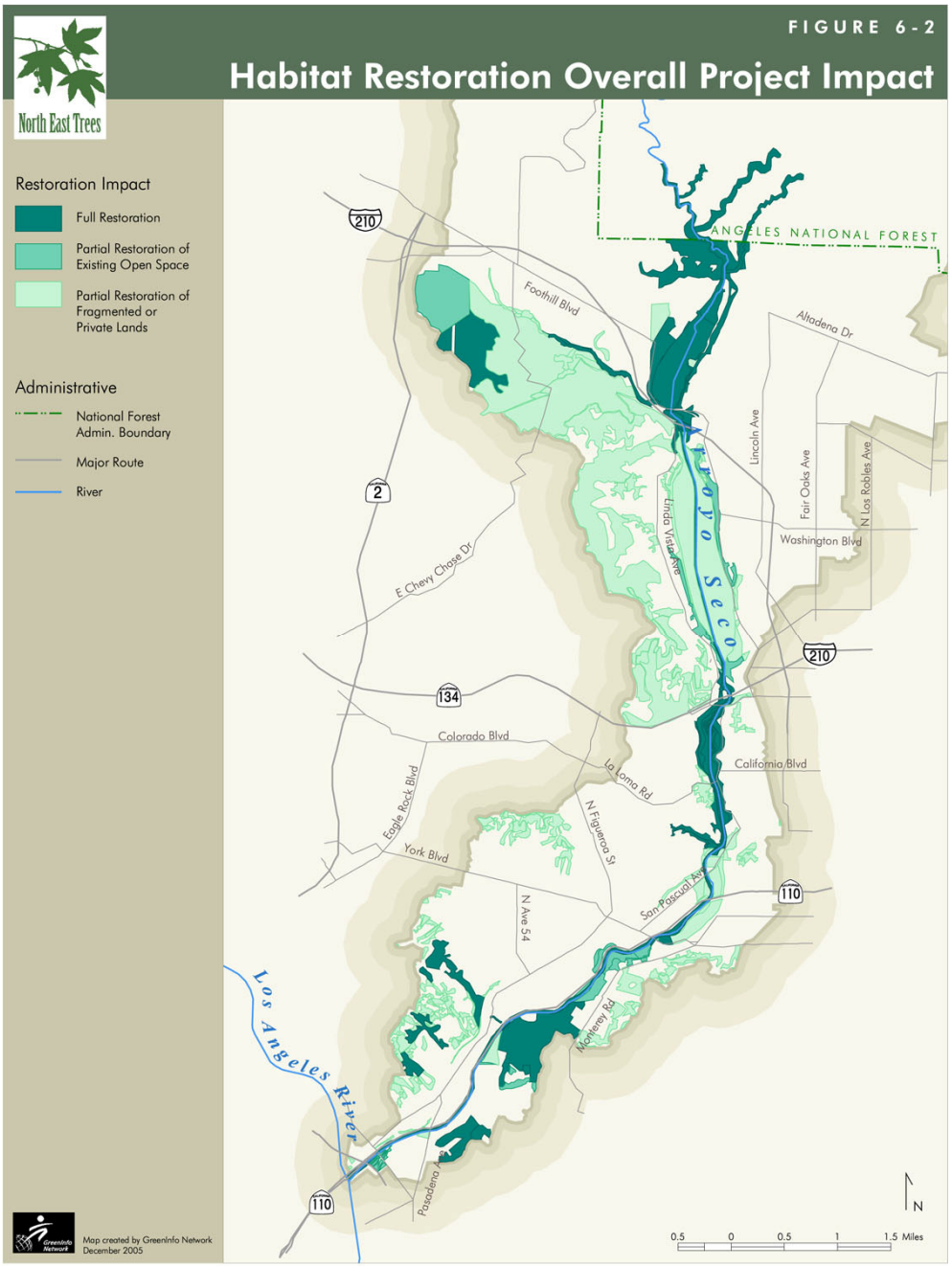
FIGURE 6-2
Habitat Restoration Overall Project Impact
North East Trees
Restoration Impact
Full Restoration
Partial Restoration of Existing Open Space
Partial Restoration of Fragmented or Private Lands
Administrative
National Forest Admin. Boundary
Major Route
River
ANGELES NATIONAL FOREST
Foothill Blvd
Altadena Dr
Lincoln Ave
Fair Oaks Ave
N Los Robles Ave
Washington Blvd
Linda Vista Ave
Arroyo Seco
E Chevy Chase Dr
Colorado Blvd
California Blvd
La Loma Rd
Eagle Rock Blvd
York Blvd
N Figueroa St
San Pascual Ave
N Ave 54
Monterey Rd
Los Angeles River
Pasadena Ave
210
2
134
110
N
0.5 0 0.5 1 1.5 Miles
Map created by GreenInfo Network December 2005

6.1 Arroyo Seco Naturalization

WW-1 Arroyo Seco Stream Restoration. The long-term goal of this plan can be summarized in one statement: the re-establishment of the Arroyo Seco as a natural river and set of tributaries that runs unobstructed from the San Gabriel Mountains down to the confluence with the Los Angeles River. This will require major engineering and scientific effort, for it will require among other things:

- the removal of major flood control dams and channels;
- the reduction of impermeable surfaces throughout developed areas of the watershed wherever they are found, and/or the installation of on-site stormwater retention devices;
- the construction of dispersed treatment areas and systems throughout the watershed;
- the restoration of natural ecosystems through re-vegetation and wildlife monitoring / reintroduction in developed areas where possible.

Figure 6-3. Arroyo Seco Above JPL (Arroyo Seco Foundation)

Achieving this goal would result in the reestablishment of species formerly found in the watershed such as the steelhead trout. In addition, it would dramatically increase infiltration and natural biological processes in the aquatic system, thereby improving water quality.

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However, this goal, if ever fully accomplished, will occur over decades and will require continuous investment of millions of dollars over that time. Full restoration will occur as the implementation of individual projects over many years. For this to be successful, the projects must be manageable in scope and

prioritized so that earlier projects will achieve the most impact. The following sections present these projects, in priority order, starting with a list by city of site-specific projects that will have the greatest impact on achieving the overall goal of restoring the Arroyo Seco to a natural state.

6.2 High Priority Site-Specific Projects

Outside of restoring the Arroyo Seco as a natural stream, the highest priority projects in this plan are listed below. As described previously, most offer significant benefits for both water quality and habitat. A few are focused on only one dimension, but are important enough to stand on their own in this section. All of these projects are displayed in Figure 6-4.

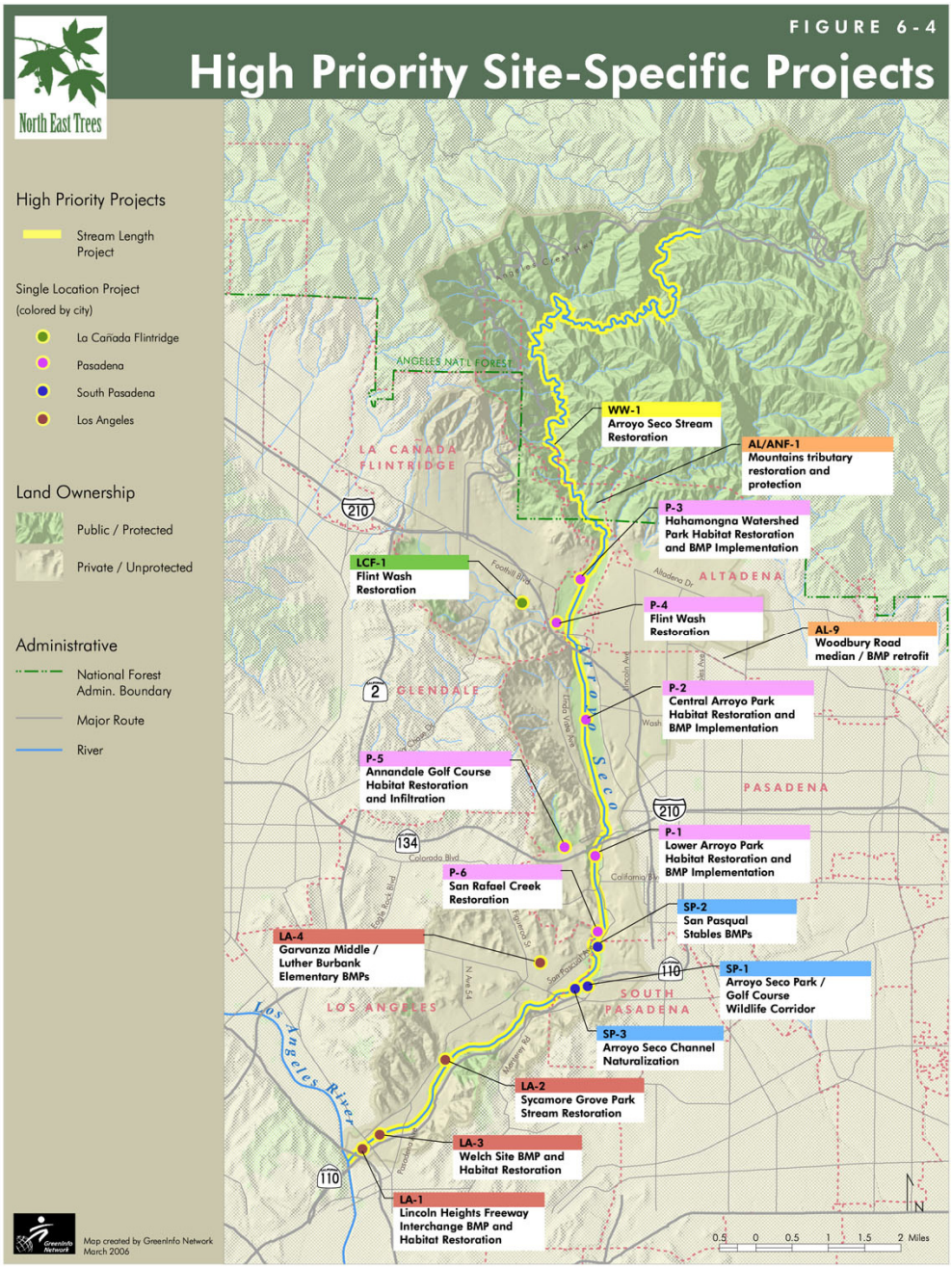
FIGURE 6-4
High Priority Site-Specific Projects
North East Trees
High Priority Projects
Stream Length Project
Single Location Project (colored by city)
La Cañada Flintridge
Pasadena
South Pasadena
Los Angeles
Land Ownership
Public / Protected
Private / Unprotected
Administrative
National Forest Admin. Boundary
Major Route
River
ANGELES NATL FOREST
LA CAÑADA FLINTRIDGE
GLENDALE
ALTADENA
PASADENA
SOUTH PASADENA
LOS ANGELES
Arroyo Seco
Los Angeles River
WW-1 Arroyo Seco Stream Restoration
AL/ANF-1 Mountains tributary restoration and protection
P-3 Hahamongna Watershed Park Habitat Restoration and BMP Implementation
LCF-1 Flint Wash Restoration
P-4 Flint Wash Restoration
AL-9 Woodbury Road median / BMP retrofit
P-2 Central Arroyo Park Habitat Restoration and BMP Implementation
P-5 Annandale Golf Course Habitat Restoration and Infiltration
P-1 Lower Arroyo Park Habitat Restoration and BMP Implementation
P-6 San Rafael Creek Restoration
SP-2 San Pasqual Stables BMPs
LA-4 Garvanza Middle / Luther Burbank Elementary BMPs
SP-1 Arroyo Seco Park / Golf Course Wildlife Corridor
SP-3 Arroyo Seco Channel Naturalization
LA-2 Sycamore Grove Park Stream Restoration
LA-3 Welch Site BMP and Habitat Restoration
LA-1 Lincoln Heights Freeway Interchange BMP and Habitat Restoration
Map created by GreenInfo Network March 2006
0.5 0 0.5 1 1.5 2 Miles

Altadena

AL-7 / ANF-1 Upper Arroyo Seco Stream Protection and Restoration.

Within a mile north of the Arroyo Seco's emergence from the San Gabriel Mountains, a number of critical tributaries join the Arroyo, functioning as conduits of both water and wildlife from the higher country beyond. Moving northeast from the JPL Bridge, these streams are Millard, El Prieto, Fern, and the main channel of the Arroyo itself.

In one sense, these streams have been heavily impacted for a century. Over that time, various small dams, culverts, diversions and weirs have been constructed to supply water to the Lincoln Avenue Water Company (serving Altadena) and the City of Pasadena, as well as to enable road and trail crossings. These structures all impede the movement of fish and other aquatic creatures up and down these streams.

However, high quality terrestrial habitat still exists, and is under threat of development. Much of this land falls north of the administrative boundary of the Angeles National Forest, but is in fact privately owned (known as "in-holdings"). There are no limits on how this land is developed, and many parcels lie very near the streams and contain high quality riparian and hillside habitat, particularly in Millard Canyon. Protecting the key parcels that preserve the integrity of these north/south passages is critical.

Key project elements are the following:

a. Work with local land trusts and conservation groups such as the Altadena Foothills Conservancy to identify and prioritize all critical parcels under private ownership (see also Project WW-6).
b. Initiate efforts to protect these parcels, either through the development of conservation easements or via outright acquisition.
c. Work with the City of Pasadena, the Lincoln Avenue Water Company, and the Angeles National Forest to develop plans for the removal or modification of structures that impede stream passage.
d. With local nonprofits and citizen groups, develop a plan to monitor the movement of terrestrial and aquatic fauna through these low elevation tributary links with the Arroyo Seco.

AL-9 Woodbury Road BMP

Woodbury Road is one of the larger surface streets in Altadena, extending from Altadena's southwest corner near Devil's Gate Dam east along Altadena's southern border with Pasadena. Many roadways in the Arroyo were predicted to contribute significant runoff to the Arroyo, but for most

this runoff would be treated via BMPs located at storm drain outlets given the limited space along the roadways.

Woodbury Road presents a unique opportunity; not only is it a significant source of runoff, but for most of its length there is a wide, paved median strip between the east- and west-bound directions. This median, if converted into planted bioretention areas, could be used to treat all of the runoff from the road itself, plus some for adjacent lots. A major County of Los Angeles Department of Public Works storm drain also runs under the median for much of its length; BMPs in the median could be employed to treat dry-weather flows from this drain, which empties directly into the Arroyo Seco south of Devils Gate Dam.

Key project elements include:

a. Secure engineering drawings for the Woodbury storm drain, and determine feasibility of installing bioretention areas adjacent to / on top of the storm drain.
b. Investigate feasibility of treating dry weather flows through drain with median BMPs.
c. Calculate runoff generated by Woodbury Road, and specify BMP area / volume needed to treat runoff.
d. If area needed from #3 is < available area, specify additional BMPs to treat runoff from adjacent areas with large impervious surfaces.
e. Develop detailed design for entire BMP project, and construct contingent upon securing funding.

Pasadena

P-1 Lower Arroyo Park Habitat Restoration and BMP Implementation. This project is critical for several reasons. Lower Arroyo Park (LAP) presently contains some of the best remaining native habitat in the Arroyo Seco south of Devil's Gate Dam. With additional work, LAP could be a haven for all five of the indicator species addressed in this plan. It is also the location where removal of the Arroyo's concrete lining and the restoration of a natural stream channel are most feasible. Finally, the ample open space, coupled with possible Arroyo naturalization, offer the opportunity to infiltrate large volumes of urban runoff generated upstream.

Some work associated with this project is already being completed as part of the implementation of the City of Pasadena's Lower Arroyo Master Plan (Pasadena, 2005). Elements include the restoration of aquatic and riparian woodland habitat in the soft-bottom section of the Arroyo Seco under the Colorado Street Bridge, and habitat restoration proposed as part of the upcoming Westside Multi-Use Trail Project. However, there are additional project elements not under way that are critical to the

improvement of water quality and the protection of the five indicator species in the Arroyo. The key elements are listed below.

a. Removal of Arroyo concrete lining, or expansion and modification of low flow wetlands, to increase infiltration of Arroyo flow.
b. Restoration of aquatic habitat where possible, and the potential reintroduction of the Arroyo chub and other low-elevation native fish.
c. Protection and restoration of riparian vegetation.
d. Restoration of coastal sage scrub and oak woodland habitat along adjacent hillsides and floodplains, with a focus on connecting isolated islands of existing native vegetation and minimizing human impacts on healthy habitat areas.

P-2 Central Arroyo Park Habitat Restoration and BMP Implementation. The Central Arroyo Park provides a critical linkage between the more natural areas contained in Lower Arroyo Park to the south and Hahamongna Watershed Park to the north. Central Arroyo Park is highly developed; it contains among other structures the Rose Bowl, Brookside Golf Course, associated parking areas, and other related buildings and structures. Because of this, the restoration and protection of the remaining natural habitat that exists on the steep hillsides surrounding it is critical to maintaining habitat connectivity between these two other areas.

In addition, several critical storm drains carrying the urban runoff from large sections of western Pasadena terminate in Central Arroyo Park. Best Management Practices that would infiltrate and treat this water before it enters the Arroyo Seco would improve water quality throughout the watershed and are compatible with existing and future land uses as proposed in Pasadena's Central Arroyo Master Plan (Pasadena, 2005). Specific project elements include the following.

a. Install an infiltration gallery at the end of the Seco Street Storm Drain prior to its discharge to the Arroyo Seco.
b. Protect and restore hillsides for use as a wildlife corridor, and protect and improve the existing oak woodland habitat. Focus should be placed on hillsides along the western edge of the park, as these offer the best connectivity with larger areas to the north and south.
c. Naturalize the main Arroyo Seco stream channel through Brookside Golf Course, and eventually connect it with a restored Arroyo Seco in Lower Arroyo Park.
d. Work with Brookside Golf Course managers to use native plants in out-of-bounds and hazard areas around the course, and to plant native trees throughout the course when appropriate.

P-3 Hahamongna Watershed Park Habitat Restoration and BMP Implementation. Hahamongna Watershed Park is the most important

current habitat area in the urbanized portion of the Arroyo Seco watershed. It most likely hosts breeding populations of all four bird indicator species, and could also host arroyo chub with limited work in the lower sections of Flint Wash. Several rare plant communities are also found in the HWP, including remnant areas of alluvial fan sage scrub.

Pasadena's Hahamongna Watershed Park Master Plan (Pasadena, 2005) proposes many projects that would improve this habitat. However, we propose that these habitat restoration projects use the particular needs of the indicator species from this plan as restoration guidelines, rather than the more general restoration of associated plant communities as proposed in the Master Plan. In addition, the Hahamongna Watershed Park Master Plan maintains and expands existing infrastructure used for water supply and flood control. This could prevent the restoration of high quality aquatic habitat, and also could result in the removal of southern willow scrub habitat at the south end of the Park. It is the belief of this plan's authors that the rarity of these habitat types, coupled with the Park's capacity to protect this habitat and its associated wildlife, may outweigh some of the uses proposed in the HWP Master Plan. Further analysis is required to identify whether changes in the existing infrastructure plans as proposed in the HWP Master Plan can be made to preserve existing functions while also allowing for a greater level of habitat restoration.

Several large storm drains also discharge directly into the Hahamongna Basin. The two largest (excepting Flint Wash, which will be discussed as an individual project) run under Figueroa Drive and Altadena Drive and discharge into the east side of Hahamongna. The Altadena Drain was shown to have high levels of bacteria contamination during a sampling event conducted by the County of Los Angeles Department of Public Works in September 2004. Infiltration galleries designed to infiltrate and treat this water could be installed in ways compatible with existing and future land uses in the park.

Specific project elements include:

a. Installation of an infiltration gallery for the Altadena Storm Drain prior to its discharge into the Arroyo Seco (known by the City of Pasadena as Altadena Storm Drain #1, P-175).
b. Installation of an infiltration gallery for the Figueroa Storm Drain (known by the City of Pasadena as the West Altadena Storm Drain) prior to its discharge into the Arroyo Seco.
c. Installation of an infiltration gallery for the storm drain running along Ventura Street prior to its discharge into the Arroyo Seco.
d. The protection and/or restoration of:
    i. Oak woodlands, using oak titmouse species requirements as restoration goals.

ii. Riparian habitat, using the needs of yellow warblers as restoration goals.
iii. Scrub habitat, using the needs of both spotted towhees and California quail as restoration goals.

P-4 **Flint Wash Restoration.** Flint Wash / Canyon is a sub-watershed of the Arroyo Seco that drains approximately 5.5 square miles of La Cañada Flintridge and far western Pasadena. The last ¾ of a mile of Flint Wash before its entry into Hahamongna Watershed Park is unlined, making it one of the largest stretches of natural low-elevation stream in the Arroyo Seco Watershed.

Flint Wash is one of the few near-natural wildlife corridors around the imposing obstacle of Devil's Gate Dam; animals moving up the Wash can move between Hahamongna, the San Rafael Hills, and the hillsides of Central Arroyo Park. It is a critical habitat link between the San Gabriel Mountains and the rest of the lower Arroyo Seco watershed. Flint Wash is also critically important because it is perhaps the only location in the Arroyo Seco where native fish could be reintroduced without the expensive removal of concrete channel lining. It is the best opportunity for demonstrating that native fish can once again live in the Arroyo Seco

Figure 6-5. Flint Wash Near Oak Grove Drive

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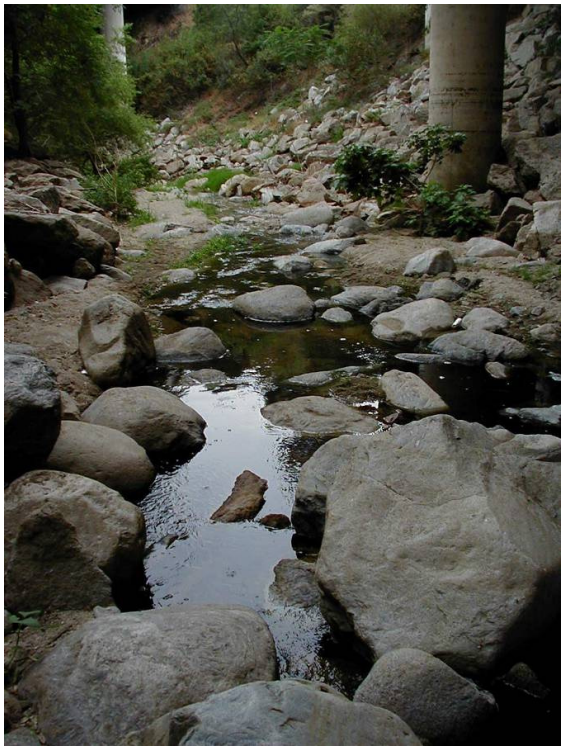

watershed. However, the channel, although unlined, has been heavily modified and disturbed from its natural profile and location. To make the channel more amenable to native wildlife, it is necessary to perform an analysis of the existing stream course to identify measures to restore and stabilize the stream channel.

Core project elements include:

a. The removal of invasive exotic plants and the restoration of riparian habitat.
b. The removal of fish barriers and the restoration and improvement of stream channel geometry.
c. The establishment of a wildlife corridor through Flint Wash, over Highland Drive / Linda Vista Avenue, and down into Central Arroyo Park, involving
    i. Securing easements along hillside adjacent to Highland Drive / Linda Vista Avenue.
    ii. Improve signage along Highland / Linda Vista.
    iii. Replace fencing with passable alternatives between 210 Freeway and Highland / Linda Vista.
d. The reintroduction of native fish into Flint Wash, starting with arroyo chub.

P-5 **Annandale Golf Course Habitat Restoration and Infiltration**. The Annandale Golf Course is a private golf course located in southwestern Pasadena near the border with Glendale. The course sits in the lower end of the San Rafael Hills.

Annandale and its surrounding residences are important for both water quality and habitat reasons. All runoff from the course and surrounding residences is routed through a large storm drain south underneath the 134 Freeway, where it eventually is discharged to the open channel of San Rafael Creek (see Project P-6 below). Given the nature of golf course operations, it is likely that this runoff contains higher-than-normal levels of nutrients (from fertilizers), herbicides, and pesticides. Infiltrating more of this runoff onsite would not only reduce potential pollutants, but would also reduce the flows to San Rafael Creek, thereby making the removal of its concrete lining more feasible from a flood control perspective.

Annandale also sits at the southernmost intersection of the San Rafael Hills and the Arroyo Seco. Because the golf course is open space and the surrounding residential lots are large, it is likely that wildlife passes between the Arroyo and the San Rafael Hills through this area. However, much of the existing landscaping consists of nonnative plants. Using a greater mix of native plants and trees in the golf course's landscaping would make the area more conducive to the passage and presence of

California quail, oak titmouse, spotted towhees, and the other animal species that require similar conditions.

Project Elements:

a) Work with Annandale Golf Course to use native plants in out-of-bounds and hazard areas around the course, and to plant native trees throughout the course when appropriate.
b) Work with Annandale Golf Course to reduce runoff from golf course and surrounding residences

P-6 **San Rafael Creek Restoration**. San Rafael Creek is a tributary of the Arroyo Seco that runs in a canyon just south of La Loma and Laguna Roads in southwestern Pasadena. A creek runs along the canyon bottom for approximately one mile, broken up in the middle by the dam that forms Johnson Lake. Towards the eastern end of the creek, storm drains from Laguna Drive and from the Annandale Golf Course area further north discharge into San Rafael Creek. As a result, the last few hundred feet of the creek are lined with concrete to prevent scouring of the channel during heavy winter rains.

Figure 6-6. Outlet of San Rafael Creek

San Rafael Creek is one of the few remaining relatively natural tributaries of the Arroyo Seco, and as such is worth protecting. However, for most of its length it runs through private property. As a result, the creek bed is from time to time threatened by expansion of the hillside residences that lie above. In order to prevent future encroachment and increased degradation of the stream, it is important that property owners along the creek and the City of Pasadena work together to protect this valuable natural asset.

In combination with Project P-5 above, it may be possible to reduce storm flows enough to warrant removing the concrete lining at the bottom of San Rafael Creek,

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and to restore the confluence of San Rafael Creek and the Arroyo Seco to a natural state. This would add valuable riparian habitat, and would be a strong addition to the natural character of Lower Arroyo Park.

Project Elements:

a) Develop a working group of residents and the City of Pasadena with the goal of identifying ways to protect and restore San Rafael Creek while also respecting private property rights.
b) Restore riparian habitat and remove exotic invasive species from the San Rafael Creek drainage.
c) In combination with Project P-5, remove the concrete lining at the bottom of San Rafael Creek.
d) Restore the natural confluence of San Rafael Creek and the Arroyo Seco.
e) Develop trails and interpretive materials focusing on stream hydrology and habitat where San Rafael Creek and the Arroyo Seco meet in Lower Arroyo Park.

La Cañada Flintridge

LCF-1 Flint Wash Restoration. While a small portion of lower Flint Wash falls in Pasadena (see Project P-4 above), the vast majority of the Wash itself and its watershed falls in La Cañada Flintridge. The lower ¾ of a mile of Flint Wash is a natural, unlined channel with intermittent bank modifications. Approximately 2,000 feet of this length falls in La Cañada Flintridge, with the balance falling in Pasadena. Unlike in Pasadena, where Flint Wash falls on public property, most of the unlined portion in La Cañada Flintridge is on private property, complicating restoration efforts.

Figure 6- 7. Flint Wash in La Cañada Flintridge

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The rest of Flint Wash is a series of lined channels draining over five square miles of La Cañada Flintridge. All of the channels fall on County of Los Angeles Flood Control

District easements. In this section of the Wash, there are opportunities to naturalize the channel. In both the unlined and lined portions, the opportunities are similar to those presented in the Pasadena discussion, namely to restore aquatic habitat where possible, and to restore and protect riparian habitat, oak woodland habitat, and habitat connectivity. However, given the private property constraints, the means of doing so are different. The key project elements are:

Unlined (lower) Flint Wash

a. The development and/or acquisition of easements or property rights to Flint Wash and immediate stream banks and hillsides.
b. The removal of invasive exotic plants and the restoration of riparian habitat.
c. The removal of fish barriers and the restoration and improvement of stream channel geometry.
d. The reintroduction of native fish into Flint Wash, starting with arroyo chub.

Lined (upper) Flint Wash

e. Work with the Corps of Engineers to examine the feasibility of removing lined sections of upper Flint Wash.
f. Secure funding, develop plans and secure necessary access for restoring sections where channel removal is possible.
g. Conduct restoration efforts as described above in any newly unlined sections.

South Pasadena

SP-1 Arroyo Seco Park / Golf Course Habitat Corridor. South Pasadena's Arroyo Seco Park, and the Golf Course immediately to the south, is a critical bottleneck between Pasadena's Lower Arroyo Park and the more natural parklands in the City of Los Angeles between the South Pasadena city line and Ernest E. Debs Regional Park. Although protected as open space, Arroyo Seco Park contains ballfields, courts, parking areas, and the golf course, all of which are not conducive to the movement of small animals such as California quail up and down the Arroyo Seco.

In Arroyo Seco Park itself, the best remaining habitat exists on the hillsides on the eastern edge of the park; it is critical to protect, restore and possibly expand the habitat that exists here so that smaller animals have shelter in which to move and hide. In addition, a small stream created via a diversion of the Arroyo Seco runs parallel to the Arroyo between San Pasqual Avenue and Stoney Drive. This small stream could be restored and connected with the one described below that flows through Arroyo Seco Golf Course.

Within the Arroyo Seco Golf Course, there are two restoration opportunities. First, hazard and out-of-bounds areas could be replanted with native vegetation to provide forage and shelter for small animals moving through the area. Second, a stream fed by diverted Arroyo Seco water runs throughout the course. This stream could be restored to a more natural state, and given the water quality (relatively high), protected nature, and shallow gradient, could be a possible site for the introduction of arroyo chub.

Finally, these areas all lie adjacent to other more natural habitat parcels in the cities of Los Angeles and Pasadena. Improving connectivity to these specific areas would increase the park's function as a wildlife corridor. The following are key project elements.

a. Restore, protect, and possibly expand natural habitat along hillside east of stables, ball fields, and golf course.
b. Restore and naturalize stream diversion N of Stoney Drive.
c. Plant native gardens / planting areas in hazard / out-of-bounds areas to improve GC habitat value.
d. Naturalize diversion channel through golf course, and connect to stream N of Stoney Drive.
e. Examine the long-term possibility of introducing arroyo chub to a restored golf course diversion channel.
f. Establish habitat connectivity with habitat parcels in surrounding cities, including with the "Island" parcel, located between the Arroyo Seco channel and the Arroyo Seco Parkway in Los Angeles across from the golf course.

SP-2 San Pasqual Stables BMPs. San Pasqual Stables is a large equestrian facility operated by a private operator under a lease with the City of South Pasadena. It occupies the parcel of land between the southern end of Pasadena's Lower Arroyo Park and the northern boundary of South Pasadena's Arroyo Seco Park on the east bank of the Arroyo Seco. It is critical bottleneck in the Arroyo Seco wildlife corridor, and could be improved as mentioned above in project SP-1.

In addition, given the intensive equestrian use on the facility and its function as an access point for horses and riders to the trail along the Arroyo Seco, it is likely a source of bacteria from horse manure washed into the channel. The core project element, in addition to the habitat restoration mentioned above, is the addition of BMPs directly adjacent to the channel walls that prevent any runoff from entering the channel from either the trail or the facility, and treat any runoff through natural means before it enters the Arroyo Seco.

a. Install natural stormwater best management practices along the Arroyo Seco channel wall, with the goal of eliminating and treating any runoff from the facility or equestrian trail before it enters the Arroyo Seco.

SP-3 Arroyo Seco Channel Naturalization. Between the York Street Bridge to the south and the Arroyo Seco Parkway Bridge to the north, the Arroyo Seco channel as currently constructed is much wider than elsewhere and has open space on either side. As a result, this section is a prime candidate for full or partial naturalization involving the removal of the channels fully armored bottom. At a minimum, it may be feasible in this stretch to construct a reach with conditions similar to those existing in the Glendale Narrows area of the Los Angeles River, where willows and other riparian vegetation grow out of the cobble-strewn soft-bottomed channel between armored banks. Combined with a connection to a restored stream through Arroyo Seco Golf Course, this section could host most of the Arroyo Seco indicator species, including the Arroyo chub.

a. Study feasibility of a full or partial naturalization of the Arroyo Seco channel between York Street and the 110 Freeway.
b. Remove channel or channel bottom depending on outcome, and restore natural stream conditions and vegetation.
c. Engineer mechanism to bring end of Arroyo Seco Golf Course diversion down to the same elevation as the Arroyo Seco.
d. Explore and implement the reintroduction of arroyo chub to this stream reach.

Los Angeles

LA-1 Lincoln Heights Freeway Interchange Restoration and BMP (Interstate 5 / 110 Interchange). The far southern end of the Arroyo Seco watershed contains the most industry and the densest development. There is little natural habitat, and water quality is heavily impacted by the dense urban land uses.

There is a significant opportunity to improve on both of these factors on the property where Interstate 5 and the Pasadena Freeway meet. There is approximately six acres of open space (some underneath elevated freeway ramps) at this location, presently closed off to public access and not used. Today, the vegetation on site is predominantly exotic invasive plants, with some limited native plants as well. With some restoration, this site could provide one piece of a future corridor between the large expanse of Ernest E. Debs Park to the north and Elysian Park to the south.

In addition, a storm drain draining a highly impervious area of industrial and commercial enterprises passes directly through the site along Avenue

26. There is ample space to install a natural BMP such as an infiltration gallery or a subsurface flow treatment wetland that would be compatible with the habitat restoration activities.

a. Restore riparian and coastal sage scrub habitat throughout the site where possible.
b. Install an infiltration gallery or subsurface flow wetland for the Avenue 26 storm drain.
c. Create a minipark with public access on the site.

LA-2 Sycamore Grove Park Stream Restoration. Prior to the channelization of the Arroyo Seco and the installation of subsurface storm drains throughout the Arroyo Seco watershed, a large tributary of the Arroyo Seco called the North Branch flowed through Mt. Washington and Highland Park and merged with the Arroyo Seco at the present day location of Sycamore Grove Park. This tributary is now buried within one of the largest and most contaminated storm drains in the entire watershed.

Although this area is densely developed and populated, there are several opportunities at the terminal end of this drain to naturalize it or install best management practices. The daylighting of the drain through Sycamore Grove Park and the restoration of the former stream would add to the environment of the Park. In addition, a natural stream bed would infiltrate dry weather and low volumes of wet weather runoff. The storm drain also runs under the nearby Arroyo Seco Alternative School, another opportunity to install a subsurface BMP. Finally, adjacent to the school the drain runs underneath a vacant storm drain easement – yet another opportunity to install a subsurface BMP to treat runoff prior to discharge to the Arroyo Seco.

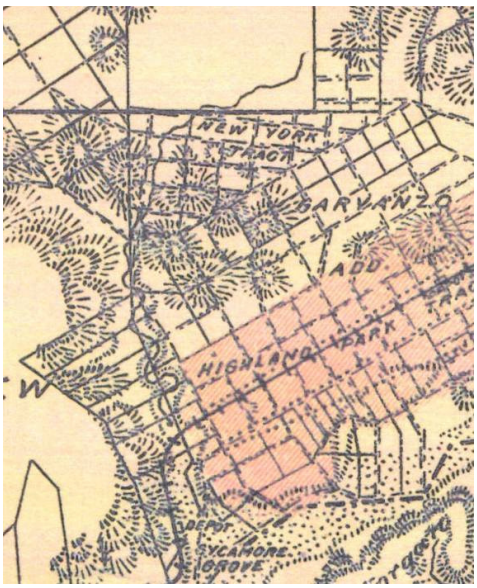

Figure 6-8. Historical topographic map showing the North Branch of the Arroyo Seco.

a. Naturalize the North Branch Storm Drain and restore former stream through Sycamore Grove Park.
b. Install subsurface structural best management practices under the Arroyo Seco Alternative School.
c. Daylight the storm drain, or

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install BMPs, in the vacant storm drain easement north of the Arroyo Seco Alternative School.

LA-3 The Welch Site BMP and Habitat Restoration. The Welch Site is a three acre parcel of private property along Pasadena Avenue and adjacent to the Arroyo Seco channel. It is currently vacant and unused. The project opportunity at this site is very similar to that described in project LA-1: install BMPs to treat runoff from an industrial / commercial area of the Arroyo Seco, restore habitat, and create a parkland in a densely packed urban neighborhood.

The Welch Site sits at the terminal end of a storm drain running along Pasadena Avenue that drains approximately 100 acres of industrial, commercial, and residential properties. Based on the land uses, it is likely that this runoff is heavily contaminated with various types of urban pollutants including bacteria and metals. The installation of either an infiltration gallery or a subsurface flow wetland would treat this runoff before it enters the Arroyo Seco channel.

The Welch Site is also ideally located to be another link in the wildlife corridor that could link Ernest E. Debs Park and Elysian Park via the Confluence. Restoration with native plants would provide both forage and cover for resident and transient animals alike.

Finally, the Welch Site sits in the midst of a park-poor area of the Lincoln Heights neighborhood. All of the previously described proposals are consistent with use as a park as well.

Several major complications must be addressed before this project can move forward. First, the property is currently under private ownership, and previous acquisition efforts have not been successful. Second, prior uses of the property have resulted in subsurface contamination that must be cleaned up before any of the aforementioned uses can be considered. This could be a lengthy and expensive process, but there are numerous brownfield cleanup funding mechanisms that might be employed.

Key project elements include:

a) Acquisition of the property by a public agency.
b) Investigation and cleanup of subsurface soil and groundwater contamination.
c) Install of an Infiltration gallery or subsurface flow wetland for the Pasadena Avenue storm drain.
d) Conversion of the property to public open space with areas of coastal sage scrub and riparian habitat.

LA-4 Garvanza Park / Garvanza Elementary / Luther Burbank Middle Schools BMP Implementation. Garvanza Park plus the sites of the two schools, both part of the Los Angeles Unified School District, sit atop two major storm drains that drain nearly 400 acres of high density residential and commercial development in Los Angeles. These drains run along the west side of campus under Figueroa and the east side under Avenue 63. Our analysis predicts that these drains contribute significant amounts of polluted urban runoff to the Arroyo Seco. The schools themselves occupy 25 acres of land, most covered by impermeable asphalt, concrete, and buildings. Given the large expanses of parking lots and ballfields, there are significant opportunities to install BMPs that treat both onsite and upstream runoff without disrupting existing uses (outside of construction).

a) Install infiltration galleries under Garvanza Park ballfields and open space at the northeast corner of the complex, and under parking / blacktop area at southeast corner; treat discharge from Avenue 63 storm drain.
b) Install infiltration galleries under parking lots at southwest edge of campus to treat discharge from Figueroa storm drain.
c) If these regional BMPs prove to be infeasible, install bioretention areas and cisterns to retain runoff from onsite rooftops and parking lots.

6.3 Watershed-Wide Projects

WW-2 Launch "Arroyo Backyard" program.

The Arroyo Backyard program is proposed to involve homeowners in the preservation and protection of the overall Arroyo Seco watershed. There are many ways that homeowners can do this, but this proposal focuses on three of them: reducing runoff from residential lots, reducing the sources of contamination originating from residences, and increasing the habitat value of residential landscaping.

NET hopes that the different cities and public utilities in the Arroyo Seco will also contribute to this effort by offering rebates, other financial incentives, or in-kind assistance to homeowners opting to implement these recommendations. Even without this support, the proposal could still be effective if implemented with strong outreach and a publicity / education campaign, modeled after programs such as the Metropolitan Water District's "Be Water Wise" program.

Runoff reduction efforts will focus on installing solutions that store, collect and reuse runoff (called direct solutions) and on those that encourage lower outside water use overall (indirect solutions). Direct runoff reduction can be achieved through the installation of rain barrels or cisterns, rain

gardens, and more permeable paving solutions, while indirect components can include reducing over-irrigation, upgrading landscaping with low-water plants, and reducing excessive car washing. Some municipalities prohibit the collection and storage of rainwater, so implementing these solutions may hinge upon advocating for change in these locales. In addition, this program will offer guidance to homeowners on how to deal with vector control issues associated with the long-term storage and reuse of rainwater.

Source control measures are primarily educational in nature. Programs should be designed to heighten the awareness of various residential practices that impact water quality. Reducing the over-use of chemical and biological fertilizers, herbicides and pesticides, cleaning up after pets on private and public property, and properly disposing of household chemical wastes would all be part of this program.

Finally, incentives and workshops could be offered to encourage property owners and in particular garden hobbyists to not only plant low-water native plants, but more specifically focus on those plants appropriate to their particular setting. Hillside homeowners will be encourage to properly care for oaks and black walnut trees, and to plant decorative plants that would normally be found in oak and black walnut woodland understories. Residents living in the lower, flatter portions of the watershed will instead be encouraged to choose from those plants commonly found in coastal sage scrub habitat.

Project elements:

a. Develop simple plans, educational materials, and workshops to show homeowners how to install rain barrels, cisterns and rain gardens, and what the more watershed-friendly options are for hardscape areas of their properties.
b. Create materials and programs that show how household water use practices can generate excess runoff and therefore pollution. Explain simple ways to reduce this runoff without compromising cleaning efforts and lawn / garden health.
c. Prepare materials and information that describe the impacts household gardening, cleaning and storage practices have on water quality, and provide simple examples of how to reduce these impacts. Also, continue to emphasize the importance of cleaning up pet wastes from a watershed protection perspective.
d. Prepare simple neighborhood-specific plant palettes for distribution to local residents, gardening clubs, and landscapers. Encourage local nurseries to carry and identify plants on these lists.
e. Develop an outreach campaign, educational materials, and workshop series to promote awareness of initiatives a-d.

f. Work with Arroyo governments and public utility agencies to offer homeowner incentives, rebates, or other rewards to encourage the adoption of the proposed programs.

WW-3 Citizen Wildlife Monitoring Program.

While the general ranges of the five indicator species proposed in this plan are well known, their specific ranges in the Arroyo Seco, and in particular south of Devil's Gate Dam, are primarily anecdotal. Coordinating a citizen's monitoring program would have several benefits. First, it would generate information critical to monitoring the effectiveness of the measures proposed in this plan. Second, it would provide a concrete way to involve wildlife-related citizens groups in restoring the Arroyo. Finally, the program could be a compelling way to teach children about the ecology of the Arroyo Seco watershed, and what they can do to improve it.

Figure 6-9. Yellow Warbler (Helene Provencher, TrekNature)

Project elements would include:

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a. Developing a set of standards for use in recording observation information.
b. Preparing educational materials that describe the indicator species, their habits, possible locations, and tips on how to observe and find them.
c. Launching the program through outreach to nonprofit groups, environmental education facilities, and Arroyo schools.
d. Setting up a web-based database through which observations can be entered and updated results can be viewed.

WW-4 Local Government Ordinances and Policies.

City policies and ordinances can play a large role in either promoting or discouraging programs designed at improving watershed health. North East Trees investigated what other cities around the country are doing to promote watershed health and found many alternatives, most not being

employed in the Arroyo Seco Watershed. Portland, Oregon, for instance, charges property owners a "stormwater utility fee" on their sewer and water bills to pay for stormwater programs and provide an incentive to take measure to reduce runoff. The City of Austin, Texas specifies watershed protection zones where permeability must be maintained at certain levels.

Another key inhibitor for implementing water quality improvement projects in the Los Angeles area is the lack of standard, approved construction designs for best management practices needed to deal with urban stormwater runoff. Because there are no existing standard plans, proposals to install such systems on public property must undergo expensive and time-consuming approvals for every project initiated. These delays and costs significantly reduce the time and funding allotted to actually constructing and designing these projects. A systematic, high-level effort by all cities in the watershed would be much more efficient and effective over the long run than the case-by-case process now required.

A number of these initiatives should be considered in Los Angeles, particularly in light of large ongoing watershed-related projects such as the Los Angeles River Revitalization Plan and the recently launched $3 million Army Corps of Engineers study to restore the Arroyo Seco. Options include:

a. The implementation of a runoff fee, with offsets for citizens who take action to reduce runoff.
b. The specification of buffer zones along all rivers and tributaries that restricts the type of development that can occur.
c. The creation of "permeability" zones around sensitive watershed areas that have more stringent restrictions on onsite water retention for new development and redevelopment.
d. The development of standard plans for the many pieces of infrastructure that could be employed on public lands to reduce and treat urban runoff before its discharge to waterways. Such items could include standard plans for infiltration basins and trenches, cisterns, permeable paving, dry wells, and other structural BMP solutions.

WW-5 Increase street sweeping / density of trash cans / signage in densely developed areas of Arroyo to reduce waste in storm drains.

The frequency of street sweeping varies throughout the watershed, from daily in some high-use areas to as infrequently as one time per month. And, the policies differ by city. Increased street sweeping along with higher density of trash barrels and Arroyo-specific signage, standardized

throughout the watershed in areas of high use could reduce nonpoint pollution at the source.

a. Secure street sweeping schedules and trash barrel placement information from Arroyo Seco cities.
b. Using geographic information system (GIS) software, overlay schedules and barrel locations with water quality maps in this plan, identifying major streets in high priority areas with low street sweeping frequency or low barrel density.
c. Approach city about increasing sweeping and/or barrels.
d. Develop an Arroyo-wide signage and drain stenciling program focused on improving Arroyo Seco (in addition to ocean) water quality.

WW-6 Work with nonprofit land trusts and local, county and state governments to identify and acquire key parcels for habitat and watershed restoration.

There are a number of parcels of land spread throughout the watershed that are important to either improving water quality or restoring habitat and are also under private ownership. Some might be vacant parcels that could be used for important BMP projects. Others might present obstacles to wildlife movement if developed in a way different than present use. Many of these parcels could be protected through conservation easements without disrupting current uses (example: hillside parcels that cannot be developed. A smaller number might only be protected through outright acquisition.

Another set of parcels are important for a different reason: although they lie north of the administrative boundary of the Angeles National Forest and appear on most maps to be protected lands, they are private property and therefore subject to development. These parcels are important because, if developed, they could become barriers to wildlife movement or reduce water quality where there were no such challenges before.

A number of organizations interested in protecting open space have already developed plans that propose protection for various parcels throughout the Arroyo. The first phase of any inventory and prioritization of Arroyo open space parcels should start by consolidating these pre-existing lists. Some of these organizations and planning efforts consist of the following:

- **Altadena Foothills Conservancy** (www.altadenafoothills.org). The Altadena Foothills Conservancy is a land trust focusing on preserving the foothills that provide a buffer between the Angeles National Forest and the developed areas of Altadena. The AFC has identified many parcels that would contribute to the protection

of the stream corridors mentioned in project AL-7. The AFC's conservation plan, available on the website, highlights many of these opportunities.

- **Santa Monica Mountains Conservancy** (http://smmc.ca.gov). The Santa Monica Mountains Conservancy (SMMC) is a California state agency that works to protect and preserve the open space and trails of the Santa Monica Mountains.San Fernando Valley and neighboring areas (including most of the Arroyo Seco watershed). The SMMC workplan identifies many parcels as acquisition targets important to components of this plan, including:

    - Arroyo Seco / Los Angeles River Confluence;
    - Welch Property;
    - Ridgetops and hillsides in Eagle Rock;
    - Mt. Washington parcels;
    - Millard Canyon parcels;
    - San Rafael Hills parcels.

- **Trust for Public Lands** (www.tpl.org). TPL is a nationwide nonprofit that works to acquire or otherwise protect open space and parks. TPL has an active Los Angeles office that has partnered with government agencies to protect parcels throughout the Arroyo Seco / Los Angeles River areas. TPL has a number of ongoing programs, including the Los Angeles Parks for People initiative, that are actively working to identify and acquire urban parcels throughout the Los Angeles area, including in the Arroyo Seco watershed.

There are several ways to protect these properties. One would be to work with private owners and land trusts to secure conservation easements. Another would be to approach other landowners for outright sale. Still another would be to begin assembling a pool of funds that could be used to bid on important properties that come up for sale through natural market turnover. All will require significant collaboration between nonprofit organizations, private landowners, and government agencies who might be able to provide funding or manage protected lands.

a. Generate short list of key properties benefiting from further protection.
b. Review list with city governments and land trusts, and identify measures that could be taken to protect properties.
c. For conservation easement opportunities, conduct outreach to landowners to gauge interest.
d. With partners, write grants or raise funds to secure protected status or outright ownership.

WW-7 Reduce the impacts of domesticated animal and livestock wastes on Arroyo Seco water quality.

Given the large expanses of open space with well-developed trails along the Arroyo Seco, it is a haven for dog walkers and equestrians. Both of these uses, however, have potential water quality impacts. Pet wastes left uncollected can be washed directly into the Arroyo channel given the proximity of walking trails to the channel banks. The wastes of horses and other livestock can also impact water quality if incorrectly stored or disposed of.

The Arroyo Seco watershed also has a long and vibrant history of equestrian use. Today, the Arroyo Seco offers one of the most extensive trail networks and some of the best and least expensive stable facilities in the San Gabriel Valley and greater Los Angeles Region. Equestrian groups are often some of the strongest advocates for improving trail connectivity and conditions, and for keeping as much space as possible in a natural condition.

There is a potential downside to the density of equestrian use in the Arroyo watershed. The wastes of horses and other livestock can, if stored and disposed of improperly, lead to the contamination of stormwater with pathogens such as bacteria and viruses (2005, County of San Diego and 2004, Los Angeles Regional Water Quality Control Board). The Arroyo Seco has several large equestrian facilities along its banks (at San Pasqual Stables in South Pasadena and Rose Bowl Riders stables in Pasadena). And, many residents of Altadena take advantage of looser restrictions on livestock ownership as compared to neighboring areas and keep horses and other livestock in backyard enclosures.

To reduce the impacts of animal wastes on Arroyo water quality, a number of programs should be pursued throughout the watershed, including:

a. Implement the latest Best Management Practices specific to livestock facilities at stables in the Arroyo Seco; employ natural BMPs such as bioretention areas wherever possible.
b. Enforce all pet waste ordinances (or put them in place if they don't exist) on public lands throughout the watershed.
c. Make waste bags and waste disposal containers readily available in all public parks.
d. Develop educational materials and an outreach program specific to locales and user groups likely to generate domesticated animal wastes, including but not limited to:
    i. Dog walkers;
    ii. Equestrians;

iii. Residents of Altadena who keep backyard livestock.

e. Launch volunteer "Clean Teams", targeting specific user groups, to clean up equestrian waste hot spots along Arroyo trails prior to the rainy season and periodically during it.

WW-8 Implement "Green Streets" concept throughout the watershed.

Roadways must be a critical part of any watershed-side BMP strategy: not only are they major sources of runoff themselves, but via the public right-of-way that exists on either side of a street (sidewalk and parkway areas), they offer large stretches of space in which to install BMPs. Many other cities, such as Portland, OR and Seattle, WA have built BMPs into the design of new streets. Parkways are turned into bioretention areas, curbs are cut and street runoff is channeled into these parkway treatment areas, and innovative materials are used in streets and sidewalks to make them more permeable.

North East Trees is in the process of completing a project employing these approaches in a residential neighborhood along the Los Angeles River. This project will demonstrate that such techniques are equally valid in meeting water quality limits in Southern California, and can at the same time enhance the natural beauty of urban neighborhoods.

This project, called the Green Streets / Streetend Biofiltration Project, employs two simple technologies to reduce urban runoff from urban neighborhoods. The first is the installation of engineered bioretention areas and redesigned sidewalks between the edge of the street and the private property line. These "stormwater gardens" can treat the runoff from residential lots before it enters the street and storm drains. The second is the installation of an infiltration trench *underneath* an existing small public park. This unit will treat all of the runoff not captured in the stormwater gardens, including that from the street itself. This portion of the project demonstrates that water quality improvements can be secured while preserving all existing uses of public parks and other areas of public open space such as schoolyards and utility rights-of-way.

These solutions could be employed at many of the street-based projects recommended in Section 6.4, including projects LA-13, LA-29, LA-30, P-13, AL-3, AL-5 and AL-8. However, they are also applicable along ANY street with sufficient parkway space or adjacent open areas. Such approaches should be considered whenever any public agency, through its regular maintenance program, must reconstruct whole or portions of existing streets, or as parts of any new development project.

Figure 6-10. Conceptual Drawing of a Completed Green Street

Key project elements include:

a. Produce and distribute conceptual and detailed design materials describing project options to the public works departments of all Arroyo cities and the County of Los Angeles.
b. Produce outreach materials, and present the Green Streets concept at neighborhood forums and meetings throughout the watershed.
c. Identify pilot projects in each Arroyo city and write grant proposals to secure the necessary funding.

6.4 Single Benefit Site-Specific Projects

While the previously listed projects often propose both water quality and habitat improvements, the following projects offer water quality or habitat benefits, but not both. Within each dimension, however, some of the following projects may be as important as the corresponding parts of the projects listed above. The following tables list the water quality and habitat improvement projects, sorted in order of priority (an additional table contained in Appendix 6 shows these same projects sorted by city). For reference purposes, the relevant pieces of the larger projects described above are shown.

Table 6-1. Site-Specific Habitat Restoration Projects, Ranked by Priority

Project #	Name	Description	Location	Size (acres)	AC	OT	YW	CQ	ST	Overall Score
P-3	Hahamongna Watershed Park	See comments under project P-3 in Section 9.2 above.	Pasadena, between JPL Bridge and Devil's Gate Dam	410+	3	3	3	3	3	15
P-1	Lower Arroyo Park	See comments under project P-1 in Section 9.2 above.	Pasadena, between 134 Freeway and city boundary with Los Angeles	240+	2	3	3	3	3	14
P-4 / LCF-1	Flint Wash Restoration	See comments under project P-4 in Section 9.2 above.	Pasadena / La Cañada Flintridge, NW of Devil's Gate Dam	30+	3	3	2	3	3	14
P-2	Central Arroyo Park	See comments under project P-2 in Section 9.2 above.	Pasadena, between Devil's Gate Dam and 134 Freeway	450+	1	3	2	3	3	12
AL-7 / ANF-1	Upper Arroyo Seco Aquatic Restoration	Remove or develop passages around barriers in Arroyo Seco and streams through Millard, Fern, and El Prieto Canyons.	Angeles National Forest north of JPL	130+	3		3	3	3	12
P-6	San Rafael Creek Restoration	See comments under project P-6 in Section 9.2 above.	South end of Pasadena Lower Arroyo Park	13			3	3	3	9
LCF-2	San Rafael Hills Open Space Preservation	Protect undeveloped parcels through conservation easement or acquisition, and protect connectivity through canyons	La Cañada Flintridge, Pasadena	1,500+	3	3		3		9
SP-3	Arroyo Seco Channel Naturalization	See comments under project SP-3 in Section 9.2 above.	South Pasadena, Arroyo Seco Channel between Pasadena Avenue and Arroyo Seco Parkway	10+	1		2	2	3	8
SP-1	Arroyo Seco Park / Golf Course Habitat Study	See comments under project SP-1 in Section 9.2 above.	SE Bank of Arroyo Seco through South Pasadena	200+			2	2	3	7
LCF-3	Cherry Canyon Park & Descanso Gardens	Monitor movement of wildlife through protected open space.	La Cañada Flintridge	300+		3			3	6

LA-5	Arroyo Seco Park Habitat Restoration and Connectivity	Protect N/S habitat migration corridor through the area ○ Identify ownership of all parcels, secure easements if possible to protect a viable wildlife corridor. ○ Focus on area between Avenue 60 (S) and York ▪ Restore understory / scrub habitat where possible ▪ Protect and improve management of mature riparian trees for habitat value ▪ Acquire land on and around Santa Fe Hill, and restore oak / black walnut woodland habitat	Los Angeles, along SE bank of Arroyo Seco between York Blvd and Via Marisol	60+			1	2	3	6
LA-6	"The Island" Restoration	Restore scrub and riparian habitat, and establish connectivity with South Pasadena Woodland and Wildlife Park	Los Angeles, across from Arroyo Seco Golf Course	5			1	1	3	5
LA-7	Ernest E. Debs Regional Park Restoration	▪ Continue to support ongoing restoration efforts ▪ Develop monitoring programs with Audubon for all terrestrial indicator species ▪ Identify and protect corridors between Arroyo Seco Debs and other hillside areas of open space to the east ▪ Identify ownership of and protect corridors between Debs and Montecito Heights hillsides, including Flat Top Hill, to the south	Los Angeles	200+		2			3	5

P-5	Annandale Golf Course Habitat Improvement	See comments under project P-5 in Section 9.2 above.	Pasadena, north of 134 Freeway (and areas adjacent to Golf Course property)	200+		3			2	5
LA-8	Mt. Washington Open Space Restoration	▪ Protect native hillside trees ▪ Restore understory vegetation ▪ Monitor and track density and breeding presence of spotted towhees, and presence / absence of oak titmice	Kite Hill, Mt, Washington Canyon, Rainbow Canyon areas in Mt. Washington area of Los Angeles	40+		1			3	4
LA-34	Eagle Rock Hillsides	Restore and protect hillside woodland habitat and existing scrub vegetation	Los Angeles, east of Occidental College	83		1			3	4
SP-3	Arroyo Seco Channel Naturalization	See comments under project SP-3 in Section 9.2 above.	South Pasadena, Arroyo Seco Channel between Pasadena Avenue and Arroyo Seco Parkway		1		2	2	3	8
LA-31	Confluence Open Space	Secure any private open space, and restore coastal sage scrub and riparian habitat where possible	Los Angeles, south of Avenue 26	5.5					3	3
LA-32	Flat Top	Restore and protect hillside woodland habitat and existing scrub vegetation	Los Angeles, SE of Griffin Ave.	11					3	3
LA-33	Montecito Heights Hillsides	Restore and protect hillside woodland habitat and existing scrub vegetation	Los Angeles, SE of Griffin Ave.	43					3	3
LA-1	Lincoln Heights Freeway Interchange Restoration	See comments under project LA-1 in Section 9.2 above.	Los Angeles, at Interstate 5 & Arroyo Seco Parkway interchange	10+					2	2
LA-2	Sycamore Grove Park Stream Restoration	See comments under project LA-2 in Section 9.2 above.	Los Angeles, in Sycamore Grove Park and Arroyo Seco Alternative School grounds	18+					2	2

LA-3	Welch Site Habitat Restoration	See comments under project LA-3 in Section 9.2 above.	Los Angeles, where Pasadena Avenue crosses the Arroyo Seco	3					2	2

Table 6-2: Site-Specific Best Management Practices, Ranked By Priority

Project #	Name	BMP Type	Description	Location	Total Score
LA-2	Sycamore Grove Park	Storm drain daylighting	See comments under project LA-2 in Section 6.2 above.	Los Angeles, Figueroa Street and Pasadena Avenue	4.6
P-2	Central Arroyo Park – Seco Street Drain	Infiltration gallery	See comments under project P-2 in Section 6.2 above.	Pasadena, Seco Street at Arroyo Seco	4.5
P-3	Hahamongna Watershed Park – Altadena Drain	Altadena Drain Infiltration	See comments under project P-3 in Section 6.2 above.	Pasadena / Altadena, east side of Hahamongna at Altadena Drive	4.40
P-3	Hahamongna Watershed Park – Figueroa Drive	Figueroa Drain Infiltration	See comments under project P-3 in Section 6.2 above.	Pasadena / Altadena, east side of Hahamongna at Figueroa Drive	4.40
P-7	John Muir High School	Infiltration gallery	Install infiltration gallery to infiltrate runoff from site and contents of storm drain running along W. Montana Street	Pasadena, intersection of Lincoln and Cañada Avenues	4.4
P-1	Lower Arroyo Park	Channel naturalization	See comments under project P-1 in Section 6.2 above.	Arroyo Seco channel between Colorado Street Bridge and South Pasadena border	4.35
P-5	Annandale Golf Course	Infiltration gallery	See comments under project P-5 in Section 6.2 above.	Pasadena	4.25
LA-4	Garvanza Elementary School	Infiltration gallery	See comments under project LA-4 in Section 6.2 above.	Los Angeles, Figueroa and Meridian Streets	4.2
P-8	Army Reserve Center	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Pasadena, Arroyo Blvd and Colorado Blvd	3.8
P-11	Pasadena DPW HQ	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns	Pasadena, Mountain St. at 210 Freeway	3.78

			with on-site reuse mechanism (backup)		
LA-1	Lincoln Heights Freeway Interchange BMP	Infiltration gallery or subsurface flow wetland	See comments under project LA-1 in Section 6.2 above.	Los Angeles, interchange of Interstate 5 and Arroyo Seco Parkway	3.75
LA-3	Welch Site BMP	Infiltration gallery or subsurface flow wetland	See comments under project LA-3 in Section 6.2 above.	Los Angeles, Pasadena Ave. and Arroyo Seco	3.75
AL-9	Woodbury Road BMP	Bioretention areas	Replace concrete median with planted bioretention areas.	Altadena, along Woodbury between Marengo and Lincoln	3.68
AL-2	Edison Elementary School	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup) **Note:** This school is on Pasadena Unified School District's closure list. Any redevelopment / reuse should take into account water quality impacts.	Altadena, Glenrose Ave and Palm St	3.68
AL-4	Waldorf School	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Altadena, E. Altadena Drive at Highview Ave.	3.68
LA-17	Aldama Elementary School	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Los Angeles, Figueroa & Poppy Peak	3.68
LA-18	Annandale Elementary School	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Los Angeles, Figueroa & Pasadena Ave	3.68
LA-19	Arroyo Seco Alternative School	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Los Angeles, York & Avenue 56	3.68
LA-21	Buchanan Street Elementary School	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Los Angeles, Avenue 26 & Artesian	3.68
LA-24	Yorkdale Elementary School	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Los Angeles, San Fernando Rd & I-5	3.68
P-9	Cleveland Elementary School	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns	Pasadena, Palisade St and Lincoln Ave	3.68

			with on-site reuse mechanism (backup)		
AL-6	Five Acres School	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Altadena, Windsor Ave and Mountain View St	3.68
AL-1	Audubon Elementary Campus	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup) **Note:** This school is on Pasadena Unified School District's closure list. Any redevelopment / reuse should take into account water quality impacts.	Altadena, W. Altadena Drive and Casitas Avenue	3.63
LCF-3	Jet Propulsion Laboratory	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	La Cañada Flintridge, at northern end of Hahamongna Watershed Park	3.63
LA-10	LA DWP Substation - Pasadena Ave @ Arroyo Seco	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Los Angeles, Pasadena Ave. at Arroyo Seco	3.63
LA-11	Heritage Square Gold Line Station	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Los Angeles, Lincoln Heights	3.63
LA-12	Los Angeles Animal Services North Central Shelter	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Los Angeles, York & Avenue 53	3.63
LA-13	Super A Grocery Store (Highland Park)	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Los Angeles, Along Figueroa in Highland Park	3.63
LA-15	Ramona Hall Community Center	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Los Angeles, Figueroa & Avenue 45	3.63
LA-16	Albertson's Supermarket	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Los Angeles, Avenue 50 & Salient Dr	3.63
LA-20	Big Lots Department Store	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Los Angeles, Buchanan & Avenue 50	3.63
LA-22	LA DWP Maintenance	Bioretention areas	Depending on soil infiltration rates, install	Los Angeles, Monte Vista &	3.63

	Yard - Lincoln Heights	or cisterns	bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Avenue 61	
LA-23	St. Ignacius School	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Los Angeles, Meridian & Avenue 57	3.63
LA-25	Home Depot	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Los Angeles, Lacy St & Avenue 33	3.63
LA-26	LA USD District Office (Lincoln Heights)	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Los Angeles, Arroyo Seco Ave & Marmion Way	3.63
LA-28	Tow Yard	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Los Angeles, Arroyo Seco Channel and Avenue 34	3.63
LA-29	Commercial District	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Los Angeles, Figueroa and Avenue 50	3.63
LA-30	York Commercial Zone	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Los Angeles, York and Figueroa	3.63
P-10	JPL Parking Area	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Pasadena, north end of Hahamongna Watershed Park on east floodplain of Arroyo Seco	3.63
P-13	Pasadena Commercial Areas	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Pasadena, along Washington Blvd.	3.63
SP-2	San Pasqual Stables	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	South Pasadena, on east bank of Arroyo Seco at Pasadena city boundary	3.63
AL-5	Altadena Commercial Areas	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	West Altadena south of Figueroa Drive	3.63
LA-9	Franklin High School	Subsurface flow wetland	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Los Angeles, Pasadena Ave. at Arroyo Seco	3.53

LA-27	Loreto Street Elementary School	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Los Angeles, Pasadena Ave. at Arroyo Seco	3.53
P-12	Rose Bowl & Parking Areas	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Pasadena, Central Arroyo Park	3.50
AL-3	Lake Commercial District (Altadena)	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Altadena, Lake Avenue north of Alameda St.	3.23
AL-8	Lincoln Avenue	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Altadena, Lincoln Avenue between Woodbury Rd. and West Loma Alta Drive.	3.23
LA-14	Figueroa Commercial District - Highland Park	Bioretention areas or cisterns	Depending on soil infiltration rates, install bioretention areas (preferable) or cisterns with on-site reuse mechanism (backup)	Los Angeles, S. of Sycamore Grove Park	3.18
P-6	San Rafael Creek	Channel naturalization	See comments under project P-6 in Section 6.2 above.	Pasadena, Laguna Road and Arroyo Seco	

FIGURE 6-11

Project Priorities - Southern

North East Trees

Water Quality BMP Priorities

High Priority

Low Priority

Habitat Priorities

High Priority

Low Priority

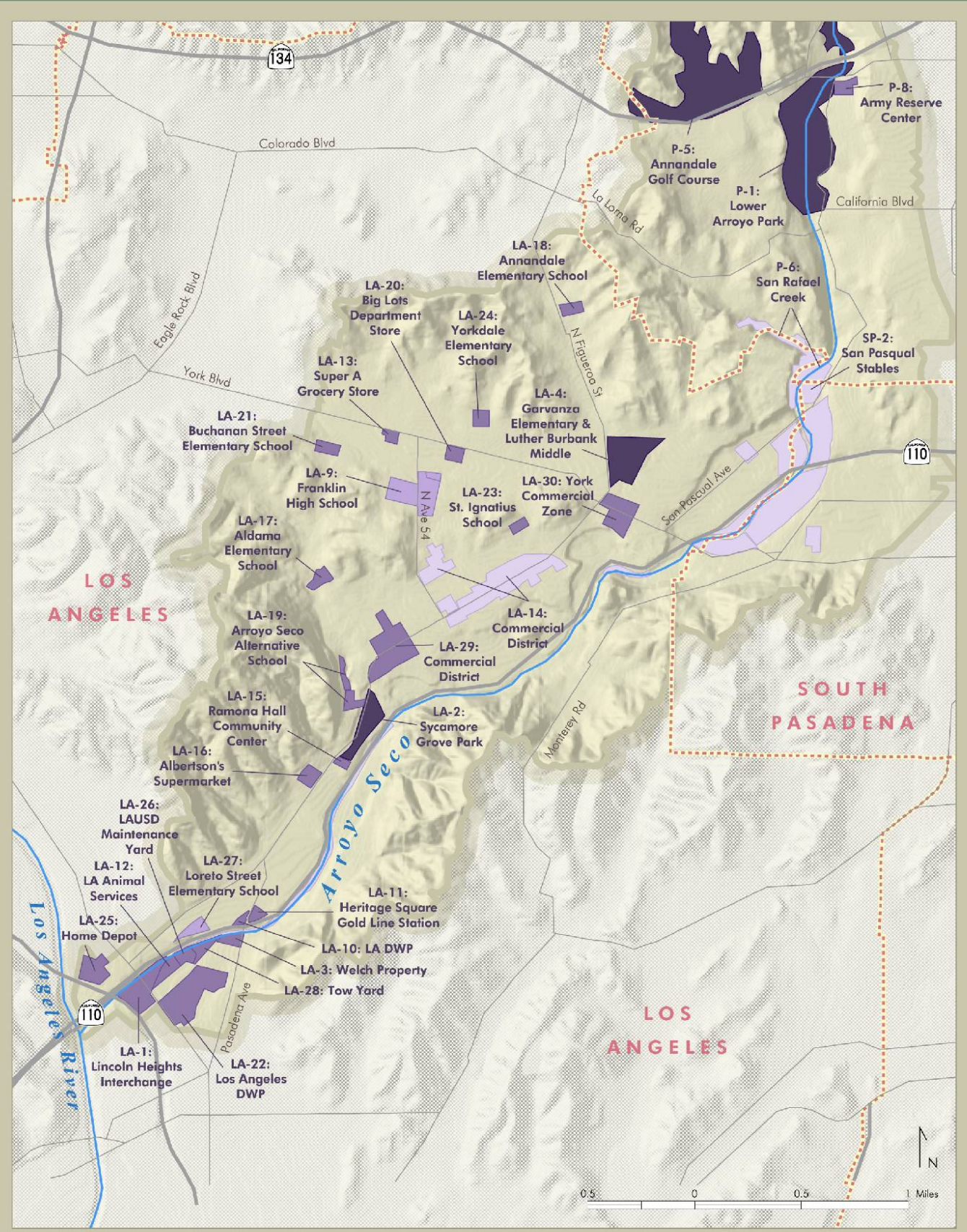
Administrative

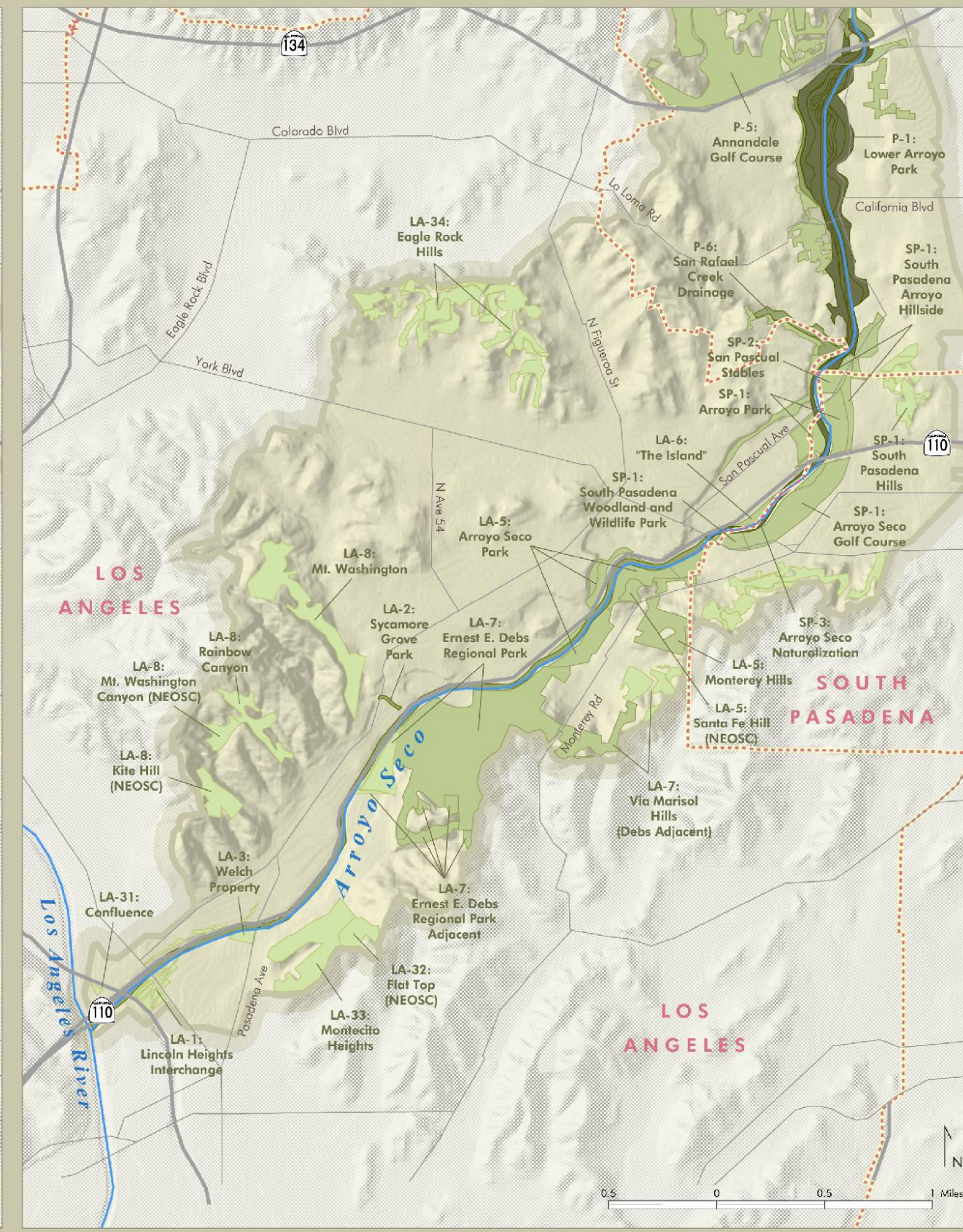
National Forest Admin. Boundary

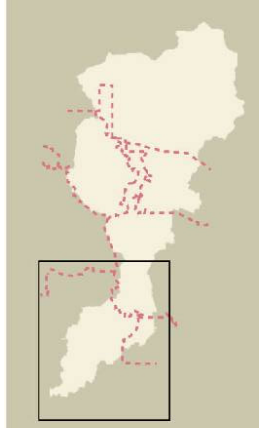
City Limit Boundary

Major Route

River







Map created by GreenInfo Network March 2006

FIGURE 6-12

Project Priorities - Central

North East Trees

Water Quality BMP Priorities

High Priority

Low Priority

Habitat Priorities

High Priority

Low Priority

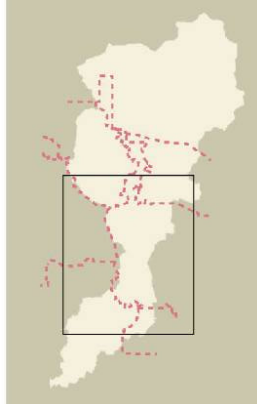
Administrative

National Forest Admin. Boundary

City Limit Boundary

Major Route

River



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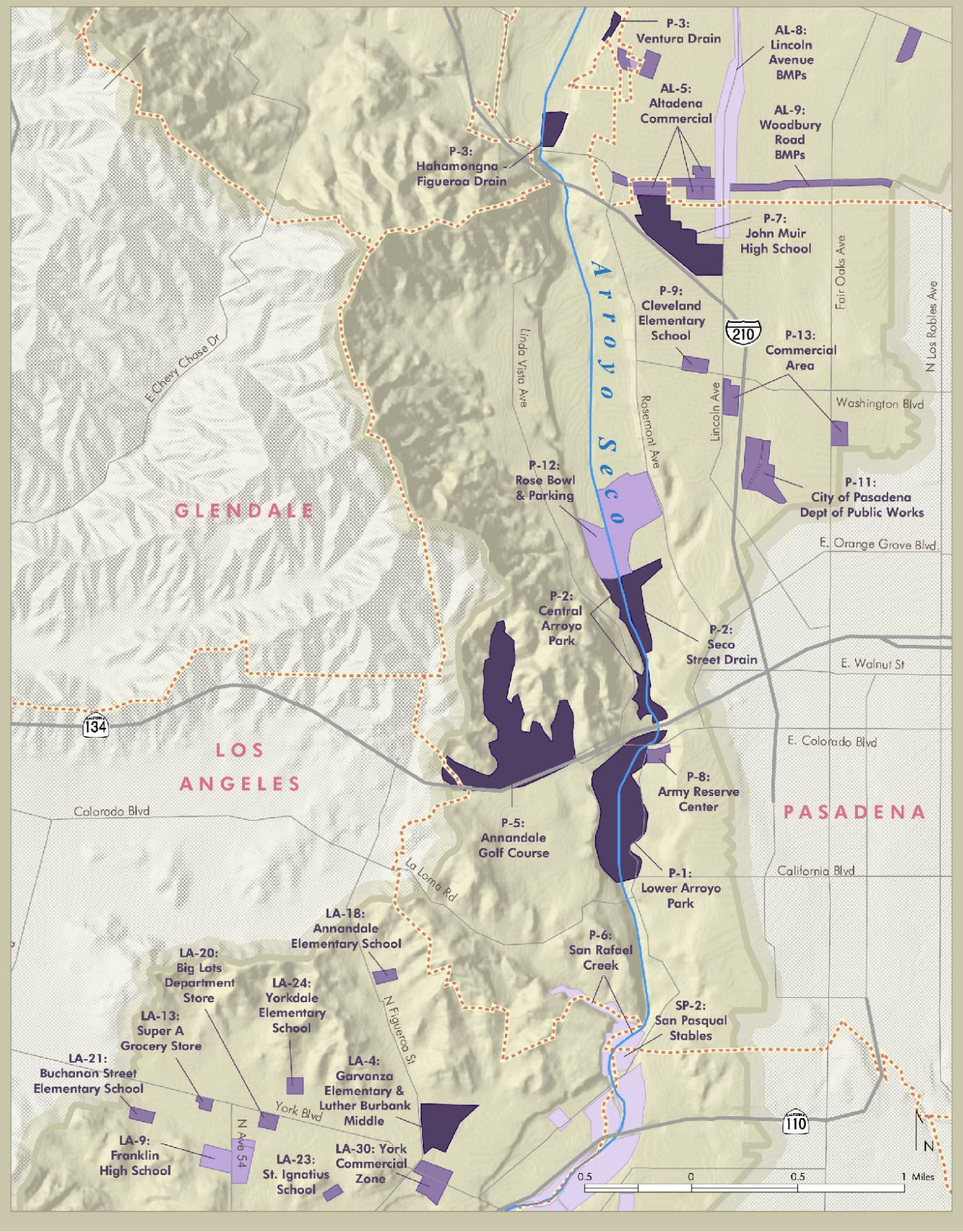


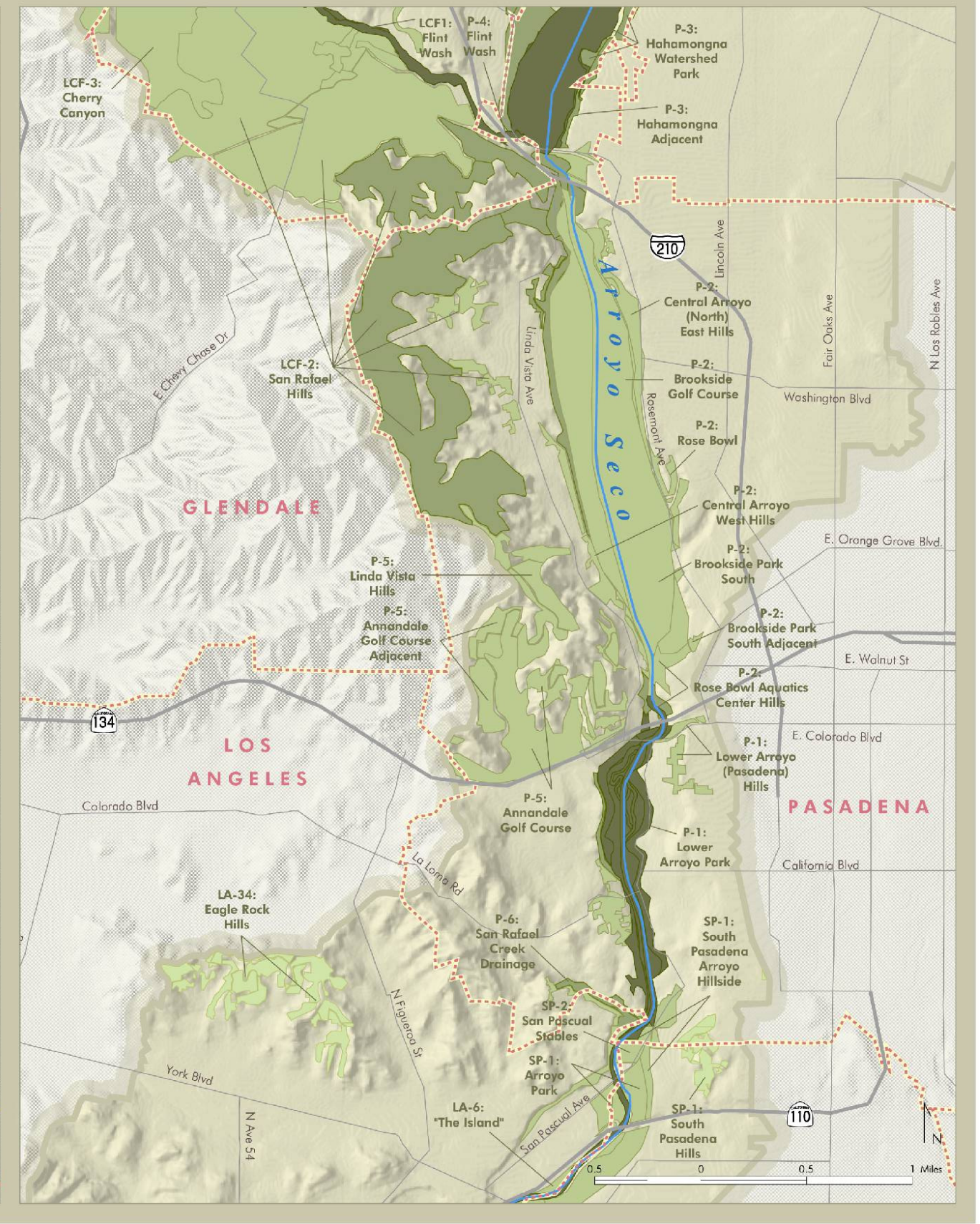


FIGURE 6-13

Project Priorities - Northern

North East Trees

Water Quality BMP Priorities

High Priority

Low Priority

Habitat Priorities

High Priority

Low Priority

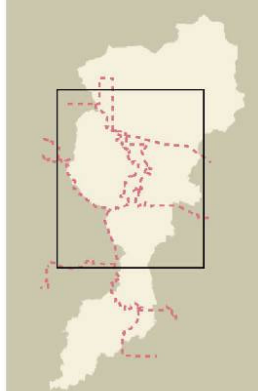
Administrative

National Forest Admin. Boundary

City Limit Boundary

Major Route

River



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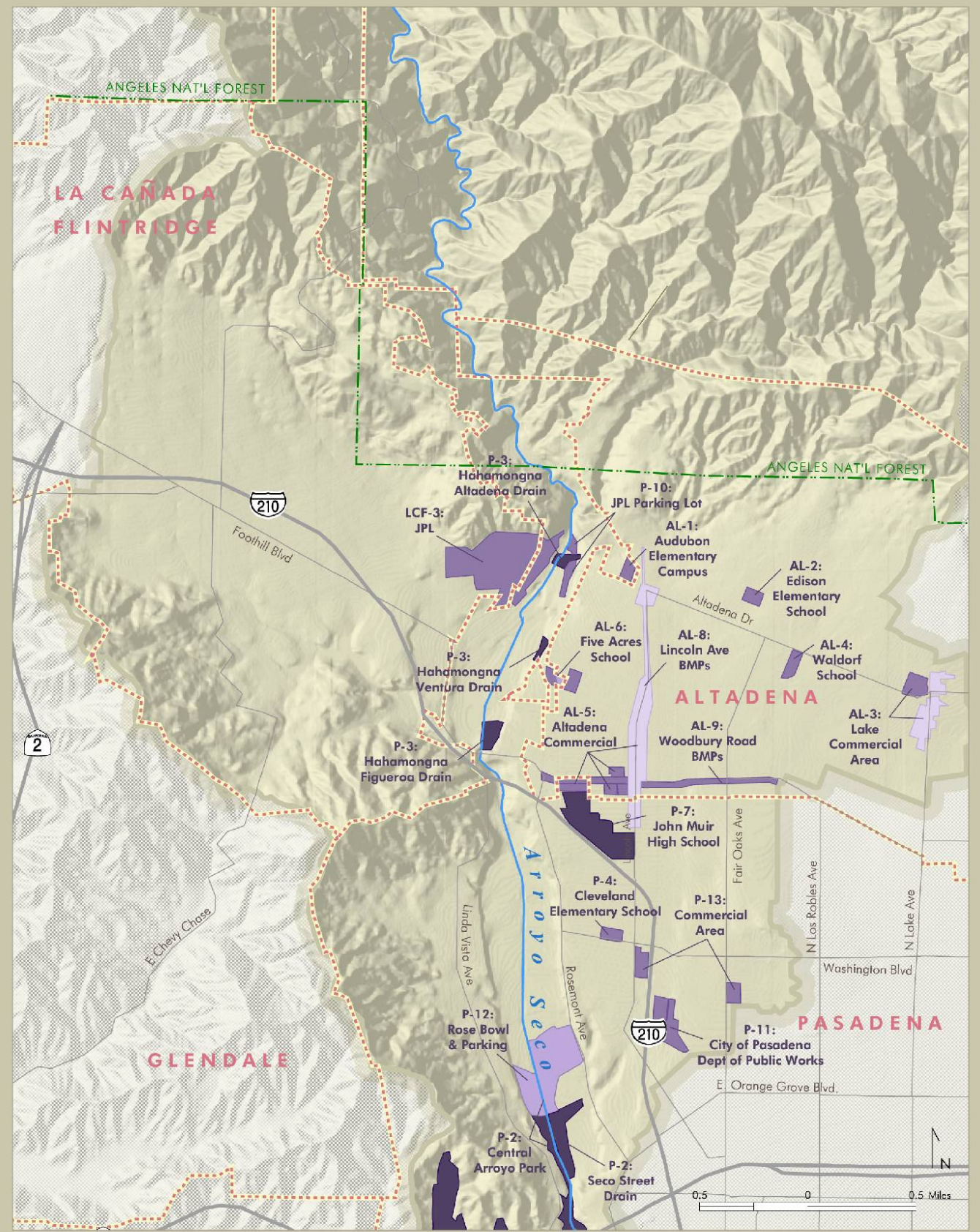

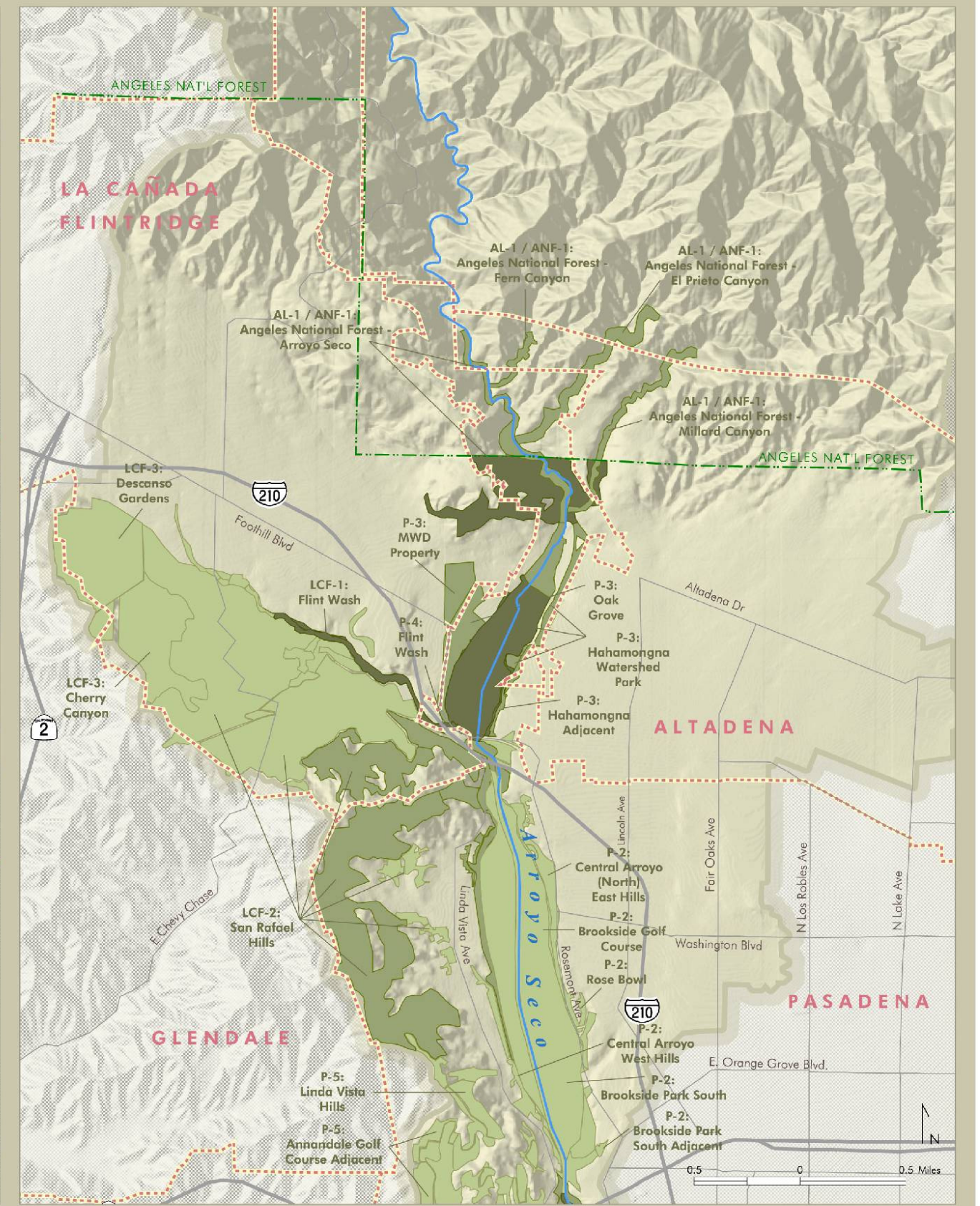

6.5 Water Quality Monitoring Recommendations

As mentioned in Section 5.1.2, existing water quality testing efforts in the Arroyo are inadequate to characterize the sources of urban runoff throughout the watershed. Ongoing efforts are mainly intended to determine the Arroyo's contribution to the Los Angeles River, rather than to characterize the Arroyo itself. Many of the water quality-related proposals in this Plan are based on general knowledge about the sources and characteristics of urban runoff, coupled with modeling specific to the Arroyo Seco.

A strengthened Arroyo Seco water quality testing program is critical to both confirm the proposals in this Plan, and to establish a baseline for determining any improvements in water quality once projects begin to be installed.

NET's proposal for an Arroyo Seco water quality testing program is divided into two main components: a baseline sampling program, and an ongoing sampling program. The baseline program is intended to generate a comprehensive picture of water quality in the Arroyo Seco ***today***. The ongoing program will start once BMPs begin to be used in the watershed, and will is designed to measure the impact of projects ***in the future***.

6.5.1 Baseline Sampling Program

There are three objectives of the baseline water quality sampling program:

1) To generate a complete annual snapshot of Arroyo Seco water quality;
2) To confirm the locations of key sources of nonpoint pollution in watershed; and
3) To identify wet vs. dry season trends.

This could be completed through four sampling events. Two would be dry season sampling events at a number of locations throughout the Arroyo, and two would be wet seasons events at the same locations. The wet season events should capture the "first flush" (the first storm of a given season) and another "representative" storm.

6.5.2 Ongoing sampling program

The objective of the ongoing sampling program is to assess changes in water quality due to the implementation of the projects in this plan. This program is designed to be done each year after the baseline period. The number and timing of sampling events is the same as that in the baseline period. However, the number and locations of samples *within* an event are different. During the two

dry season sampling events, samples will be collected at specific locations determined during the baseline program that contributed dry season contaminants, and also at in-channel sampling locations. During the two wet season sampling events, sampling would focus only on those areas where BMPs are installed; the scope would expand as the number of BMPs installed throughout the watershed increases.

6.5.3 Sampling parameters

The list of sampling analyses is based on NET's analysis of existing Arroyo Seco water quality data. During the baseline period, all of the following parameters would be analyzed. This list would then be adjusted to reflect the presence or absence of contaminants after baseline sampling is completed.

General Parameters
- Alkalinity
- Hardness
- Specific Conductance
- Turbidity
- NH3-N, Nitrate-N, and Nitrite-N

Conventional Parameters
- Oil and Grease
- pH
- Dissolved Oxygen

Indicator Bacteria
- E. coli
- Fecal coliform

Metals
- Copper
- Lead
- Zinc
- Cadmium

Other Parameters
- Cyanide
- Diazinon
- Toxicity (to assess causes of low macroinvertebrate diversity / counts identified in LA County bioassessment study (LA County, 2005)). Actual analysis to be determined during development of sampling program.

6.5.4 Sampling Locations

Sampling locations are divided into three groups: in-channel locations designed to determine how concentrations change at the various city and administrative boundaries in the watershed, priority tributary locations where major storm drains and streams enter the Arroyo Seco, and secondary tributary locations for storm drains and streams of lesser significance. They are as follows, and are shown in Figure 6-14.

In-Channel Sampling Locations

1. In-channel at confluence with Los Angeles River
7. In-channel at Los Angeles / South Pasadena border
9. In-channel at Los Angeles / South Pasadena / Pasadena border
12. In-channel in soft-bottom section under Colorado Bridge
15. In-channel in soft-bottom section near outlet of Devil's Gate Dam
19. In-stream north of Jet Propulsion Laboratory Bridge

Priority Tributary Sampling Locations

2. Avenue 26 storm drain
4. Sycamore Grove Park storm drain, aka North Branch Arroyo Seco (known as Project 5202 by the County of Los Angeles Department of Public Works)
10. San Raphael Creek outlet (known as Project 562 by the County of Los Angeles Department of Public Works)
13. Seco Street storm drain
14. Montana Street storm drain (known as Project 560 by the County of Los Angeles Department of Public Works)
16. Figueroa Drive storm drain, also known as the West Altadena Drainage System.
17. Flint Canyon outlet
18. Altadena (along Loma Alta Drive) storm drain system

Secondary Tributary Sampling Locations

3. Pasadena Avenue storm drain
5. Avenue 52 storm drain
6. Marmion Way storm drain
8. Outlet of Arroyo Seco Golf Course diversion
11. Outlet of Lower Arroyo Park low flow diversion

Figure 6-14. Proposed Water Quality Testing Locations

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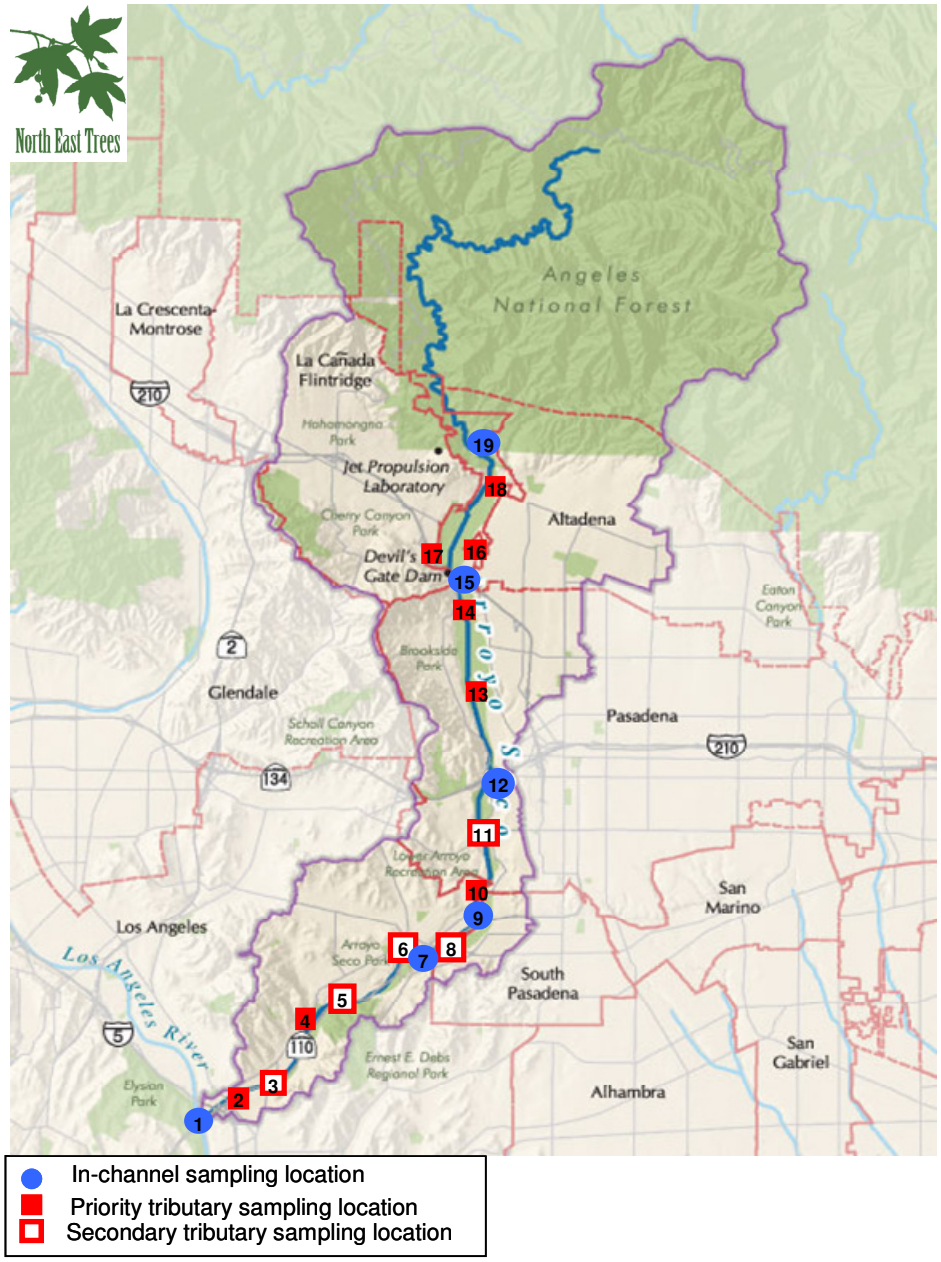

6.5.5 Other Recommendations

Today, there is only one stream gauge in the Arroyo Seco, and it is located in the Angeles National Forest above Devil's Gate Dam. This location means that there is no solid estimate of flow rates at the Arroyo's confluence with the Los Angeles River. This is a major gap, both for water quality planning purposes and for broader efforts aimed at restoring the Arroyo Seco. Therefore, another recommendation of this plan is that a gauging station be constructed at the Confluence.

In addition, today there is no central repository for water quality information in the Arroyo Seco. NET recommends that a website be established where concerned citizens can access general water quality information and the results of all sampling performed to date in the Arroyo Seco.

7 NEXT STEPS

The NET project team has identified a number of next steps that are either already in process or will follow the completion of this plan.

7.1 US Army Corps of Engineers Feasibility Study.

In October of 2005, after several years of intense planning, the US Army Corps of Engineers (Corps), in partnership with the County of Los Angeles Department of Public Works, launched the Arroyo Seco Watershed Feasibility Study. This $2.7 million study, to be funded 50% by the Corps and 50% by local sponsors (led by the County of Los Angeles Department of Public Works), is designed to explore opportunities to restore the Arroyo Seco.

The Corps will bring significant expertise to the project, and will be able to tackle many of the complex flood control and fluvial geomorphology questions that previous efforts have left unanswered. The outcome of the study will be a short list of five to six significant projects which will then be eligible for federal funding. These projects are likely to be the best hope of removing portions of the concrete flood control channel, and reducing the obstacles to the upstream and downstream migrations of fish and wildlife.

Progress on the feasibility study is limited by Congressional funding allocations to the Corps. In order to ensure the timely completion of this study, it is imperative that all groups working to restore the Arroyo Seco work to generate the political support needed to speed this critical project through to completion.

7.2 City of Los Angeles Proposition O

In November 2004, the citizens of the city of Los Angeles approved Proposition O, a $500 million bond measure intended to pay for water quality improvement projects over the next ten years. Under Proposition O, community groups and government agencies can submit project proposals to a Citizen Oversight Advisory Committee, which will then recommend projects to the Mayor and City Council for approval. Selected projects will then be implemented by relevant entities within the City of Los Angeles.

One of NET's key goals in developing this plan was to identify projects for submission to funding programs such as Proposition O. We hope that city agencies and other nonprofit groups will adopt projects mentioned in this plan and develop the materials necessary to submit them for Proposition O funding.

NET itself has already prepared a Proposition O submission based on this plan (for project LA-1, Lincoln Heights Interchange Restoration and BMP Project), and intends to do so for more projects, resources permitting.

7.3 Other State, Federal, and Private Grant Opportunities

There are many grant programs to fund habitat restoration and water quality improvement projects. As is the case with Proposition O, NET expects that this plan will help government agencies and other nonprofits to produce more competitive proposals for these funding sources.

Although they are too numerous to list comprehensively here, some of the most important funding sources available for projects in this plan include the following:

State of California

1. Proposition 40 (http://www.swrcb.ca.gov/funding/prop40.html)
    a. Non-Point Source Pollution Control Program
    b. Urban Storm Water Program
    c. Integrated Watershed Management Program
2. Proposition 50 (http://www.swrcb.ca.gov/funding/prop50.html)
    a. Coastal Non-Point Source Pollution Control Program
    b. Integrated Regional Water Management Program
3. Federal Clean Water Act Section 319 (h) Nonpoint Source Implementation Program (http://www.swrcb.ca.gov/funding/319h.html)

7.4 Outreach and Coordination

NET conducted outreach for this planning effort through two main groups, the Council of Arroyo Seco Agences (CASA) and the Council of Arroyo Seco Organizations (CASO). Both groups will continue to meet on a regular basis to discuss opportunities to enhance the communities and natural areas of the Arroyo Seco watershed.

CASA, facilitated by the County of Los Angeles Department of Public Works, meets every other month on the second Thursday of the month (Jan / Mar / May / Jul / Sep / Nov) at LA County DPW headquarters in Alhambra. For more information about these meetings, please contact Dan Sharp (dsharp@ladpw.org).

CASO holds quarterly meetings at locations throughout the Arroyo Seco watershed. These meetings are forums for community groups to share information about Arroyo-related projects, and also to discuss and plan CASO-sponsored projects that cross across multiple jurisdictions. All information about CASO can be found on the website of the Arroyo Seco Foundation, www.arroyoseco.org.

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(for additional references, see detailed bibliographies in each Appendix section)

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