ARROYO SECO WATERSHED RESTORATION FEASIBILITY STUDY

VOLUME I
PROJECT REPORT

May 31, 2002

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ACKNOWLEDGMENTS

Watershed restoration begins when a vision is set into motion. North East Trees and the Arroyo Seco Foundation began this project with a vision to restore the Arroyo Seco watershed. Along with consultants, partner agencies, and the community, the project team pressed forward towards determining the relative feasibility of watershed restoration. We are now in the beginning stages of witnessing the removal of the concrete channel. Key partnerships have been built over the course of laying the foundation for watershed restoration. It is these key partners we wish to acknowledge.

Two state agencies made this project possible. The vision of the California State Coastal Conservancy enabled North East Trees to move forward on this project. We wish to thank the Coastal Conservancy for their courage to fund such an ambitious project. Project manager Chris Kroll has been one of the project's most active supporters from its inception in early 2000. The Santa Monica Mountains Conservancy/Mountains Recreation and Conservation Authority actively participated on the project team in addition to providing funding for the early phases of this planning effort. Many thanks to Kathleen Bullard, Director of the Los Angeles River Center & Gardens and to Cara McLane for their invaluable participation as key project team members. Additional support was provided by the US Army Corps of Engineers, which contributed in-kind support to this study.

Anne Dove of the National Park Service's Rivers, Trails, and Conservation Assistance Program (RTCA) has been an invaluable project team member from the beginning, providing technical assistance on many facets of the project. Her expertise has helped the project team to develop a more sensitive and successful stakeholder process. We appreciate the assistance from this very effective National Park Service program.

Several Federal, State, County and city agencies were key participants on the Agency Technical Review Committee (ATRC). First, we wish to acknowledge the Los Angeles County Department of Public Works (LACDPW), Watershed Management Division (WMD) for their outstanding contributions of staff time and data, and for their unfailing support for the project. Thanks to WMD head Rod Kubomoto for his leadership and support; Vik Bapna, Los Angeles River Watershed Manager; and his capable and enthusiastic staff including Mickey Chaudhuri, Maria Lopez, Frank Wu and Dan Sharp. Michael Bohlander, formerly with LACDPW's Water Resources Division, developed a hydrologic model of the watershed which was of great use to the project team and consultants.

At the Federal level, the US Army Corps of Engineers' planners, Dan Young and Brian Whelan, were unfailing in their support of exploring the restoration of the Arroyo Seco. From the US Forest Service, Angeles National Forest, Bernice Bigelow, Vik Andresen and Bill Brown all participated in our stakeholder meetings. They also shared valuable Geographic Information Systems (GIS) mapping data with the project team. Peter Robles from NASA's Jet Propulsion Laboratory (JPL) shared information on the Superfund clean-up efforts in the Hahamongna Basin area.

From the State of California, Scott Harris of California Department of Fish and Game brought biological expertise to the project, providing valuable comments on our habitat restoration technical studies. California Department of Transportation, Environmental Planning Division graciously loaned us Architectural Historian Diane Kane who brought unbounded enthusiasm and creative partnering opportunities. From Metropolitan Water District of Southern California, Bob Joe provided planning insights and expertise in understanding the US Army Corps of Engineers' processes and planning insights.

Three cities were actively involved in our ATRC meetings. From the City of Los Angeles, Department of Recreation and Parks, Teresa Proscewicz demonstrated outstanding support for the project. We thank Ms. Proscewicz for her assistance and vision throughout the process. Also from the City of Los Angeles, Department of Public Works, Bureau of Sanitation, Stormwater Program, Morad Sedrak and Peter Tonthat have been committed and conscientious throughout these early phases. From the City of South Pasadena, Veronica Dolleschel, Community Services Director and Cesar Vega ensured that our efforts were relayed to the City, and that our efforts be complimentary.

The City of Pasadena has been a key collaborator from the beginning of this project. Bob Baderian, formerly from Public Works and Transportation, and currently with the City Manager's Office has been a consistent supporter of this project. Gary Takara from the Water and Power Department provided the project team with excellent information on water resources issues. Rosa Laveaga from the Parks and Natural Resources division has been closely involved in the City's own Arroyo Seco Master Plan project, but always found time to lend assistance to the project team during critical early stages of the project. The Rose Bowl Operating Company has opened their doors to our project team for discussion on decisions that will ultimately benefit multiple parties.

The project team consisted of several talented consultants. Arthur Golding, architect and urban designer, provided vision and critical insight from the inception of the project. From Montgomery Watson Harza engineers, Michael Drennan brought his watershed vision to the team. The engineering talents of Chip Paulson came from the Denver, Colorado office. Chip did not even flinch when Matt Stoecker, fisheries ecologist from Santa Barbara, California suggested taking down major barriers to fish passage in the

future. Verna Jigour, conservation ecologist from Santa Clara, California provided valuable insight, not only for habitat restoration, but also for the overall planning process. Her multi-faceted talents were truly appreciated on this complex project. Dan Cooper from the National Audubon Society brought expertise and local knowledge of native fauna. Martin Kammerer, independent geomorphologist, provided insights into the issues of sediment management, and into what is truly possible with watershed restoration.

Ellen Mackey from the Metropolitan Water District, on loan to the Los Angeles and San Gabriel Rivers Watershed Council (Watershed Council) mapped vegetation along the Arroyo. We also wish to thank the Watershed Council as an organization, particularly Rick Harter, for their continual support for the project. FORMA systems of Irvine provided expertise in GIS mapping and analysis, rectifying our data to make it usable. ESRI in Redlands, California granted us ArcView GIS software and training to assist in the development of this project.

The project team would also like to thank the participants of our Biology Summit series, in addition to the team members listed above, who included Rosa Laveaga and John Cox from the City of Pasadena and Marcus Renner from Occidental College. We are also grateful to the non-profit organization Lighthawk for the opportunity to fly members of the project team for an eagle-eye view of the tremendous beauty of the watershed.

The enthusiasm and dedication of project team members has made this project possible. Lynne Dwyer, former Executive Director of North East Trees and project manager, established the groundwork for the success of this project. Her passion, vision, creativity and leadership brought the project to the attention of regional, State and Federal leadership. Scott Wilson, President of North East Trees is a tireless supporter of the project and its team members. Lynnette Kampe, Interim Executive Director, has been a tremendous advocate for the project. To move the project forward, North East Trees has recently welcomed the arrival of Claire Robinson , the new Executive Director. North East Trees is blessed with truly dedicated and talented staff who have helped in countless ways throughout the project including contributing to this report. Many thanks to Chuck Arnold, Adan Arreola, Nishith Dhandha, Lisa Duardo, Sarah Easley, Jessica Hall and Gabby Mendevil for their patience, support and amazing talents. Achva Stein, formerly with the University of Southern California and now a professor at North Carolina State University, was instrumental in the early, formative stages of this project.

In December 2001, this project was awarded the Annual Carla Bard Advocacy Award, presented by Public Officials for Water and Environmental Reform (POWER), at the California Water Policy Conference in Los Angeles. We wish to thank the POWER Committee for their acknowledgment and support of this project. We would also like to extend a special thank you to David Czamanske of the Sierra Club for his belief in the importance of this project.

Finally, members of the community, stakeholders in the watershed, have participated in our community and stakeholder meetings, providing invaluable insight and support for the project. Representatives of numerous local agencies and community-based organizations have participated in public meetings and workshops, including but not limited to:

-Arroyo Arts Collective
-California Cycleways
-California Native Plant Society

-City of La Cañada Flintridge
-City of Los Angeles, Environmental Affairs
-Friends of the San Gabriel River
-Hahamongna Watchdog Group
-Highland Park Heritage Trust
-Inland Valley Land Trust
-La Cañada Flintridge Trails Council
-LA County Bike Coalition
-Los Angeles & San Gabriel Rivers Watershed Council
-National Audubon Society
-Pasadena Beautiful
-Rose Bowl Riders
-San Gabriel and Lower Los Angeles Rivers and Mts. Conservancy (RMC)
-Save Open Space in the Arroyo Seco Parklands
-Sierra Club
-Trust for Public Land
-Urban & Environmental Policy Institute, Occidental College
-The Wildlands Conservancy

The last group we wish to acknowledge is the public officials who have participated in and/or supported this project. These include the offices of US Congressman Xavier Beccera, US Congressman Adam Schiff, California State Senator Richard Polanco, California State Assemblyman Robert Pacheco, California State Assemblywoman Carol Lui, Los Angeles County Supervisor Gloria Molina, Los Angeles County Supervisor Michael Antonovich, Los Angeles City Councilman Edward Reyes and former Los Angeles City Councilman Mike Hernandez.

We believe that restoration efforts will ultimately benefit the communities in this region, and we encourage others to participate in the planning processes that affect them. There will be many opportunities for on-going participation in watershed planning thanks to additional funding which has been awarded to the project in 2002 from Proposition 13/State Water Resources Control Board, and CALFED Bay-Delta Watershed Program. This funding will enable the project to continue to move forward, putting in place the pieces that will ultimately lead towards restoration of the Arroyo Seco watershed.

Sincerely

Eileen Takata
North East Trees

Tim Brick
Arroyo Seco Foundation

I. INTRODUCTION

The purpose of the *Arroyo Seco Watershed Restoration Feasibility Study* (*ASWRFS*), a cooperative project of North East Trees and the Arroyo Seco Foundation, is to develop an environmentally-sensitive and sustainable plan to manage and restore the Arroyo Seco watershed. An interdisciplinary team of landscape architects, planners, engineers and biologists has been mobilized to contribute to this project, utilizing an ecosystem-based approach to planning and design for the watershed. The study is intended to integrate issues of flood management, stream naturalization, water resources, habitat rehabilitation, and educational and community recreational opportunities. The outcome of this project is a series of recommended projects and programs for implementation.

A. PROJECT DESCRIPTION

The Arroyo Seco is one of southern California's greatest natural treasures. The Arroyo Seco watershed represents an outstanding opportunity for the region to demonstrate a collaborative, multi-purpose approach to the management of vital natural resources. The 46.6 square mile Arroyo Seco watershed is tributary to the Los Angeles River and spans five 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. We are pleased that the study has the support of the California Coastal Conservancy, the Santa Monica Mountains Conservancy, the Los Angeles County Department of Public Works, the National Park Service, the cities of Pasadena, South Pasadena and Los Angeles and a variety of other agencies with management and regulatory responsibility for the Arroyo Seco watershed.

This report summarizes the work of both Phase I and Phase II of the *ASWRFS*. In Phase I, the project team surveyed and catalogued the extensive documentation that already exists about the watershed, identified gaps

in the analysis and technical studies, defined goals and objectives for watershed management and developed substantial support for our project from local agencies, stakeholders and the public at large. In Phase II, technical studies of hydrology/stream restoration, water resources, water quality, habitat restoration and recreation/open space were conducted by consultants and team members. Recommendations from these technical studies were integrated with project team recommendations. Two matrices, including the "Framework for Restoration Projects: Watershed Restoration Goals, Guidelines, and Action Items," and the "Recommendations for Projects and Studies," summarize the synthesis of recommendations. These can be found in Section IV: *Restoring the Watershed: Feasibility and Planning Recommendations*.

As a result of this study, it has become clear that the work of watershed restoration is a long-term and costly series of efforts. In addition to numerous implementation projects, several areas of further investigation will be needed beyond the completion of this Feasibility Study. Next steps include securing funding for additional planning, engineering, technical studies and implementation of projects and programs. To support these future efforts, North East Trees has applied for and received two grants to be awarded in Fall 2002, from Proposition 13 and CALFED Bay-Delta Watershed Program funding. In addition, North East Trees and the Arroyo Seco Foundation are encouraging agencies to pursue grant funding to begin implementation of restoration projects.

B. WATERSHED DESCRIPTION

The Arroyo Seco Watershed is located in northeast Los Angeles, between the San Gabriel Mountains and the Los Angeles River (Figure I-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 (Figure I-2: *Arroyo Seco Watershed*, Figure I-3: *Topographic Relief*). Two of Los Angeles County's five Supervisorial Districts can be found in the watershed, as well as three U.S. Congressional Districts (Figure I-4a: *Elected Official Boundaries 1*). For the State of California, the Arroyo Seco watershed intersects three Senate Districts and four Assembly Districts (Figure I-4b: *Elected Official Boundaries 2*).

A distinctive history and culture links the communities of the Arroyo. The southern tip of the watershed was a camp location of the first Spanish exploration, and the historic *zanjas*, or irrigation ditches, were located just across from the confluence. As one of the earliest settled parts of the Los Angeles region, the Arroyo Seco contains many cultural and historic attractions, as well as several historic districts. The Arroyo area is known worldwide for its concentration of historic Arts and Crafts resources and many original Craftsman structures. Historic Route 66 runs through the watershed; historically, travelers to Los Angeles entered through the Arroyo's gateway of sycamores.

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 Arroyo Seco stream runs in a deeply incised canyon that begins in the San Gabriel Mountains and drains into the Los Angeles River near downtown Los Angeles. Below Devil's Gate Dam, most of the stream has been channelized. Prior to channelization, stands of alder, willow, and sycamore lined a perennial, trout-filled stream. Most stream and riparian habitats are located above the dam. 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. Chaparral, which covers much of the land mass in the adjacent Angeles National Forest, has encroached significantly within the

Prepared by: Mountains Recreation and Conservation Authority (MRCA).
Source: Los Angeles County Department of Public Works

FIGURE 1- 1: LOCATION MAP

Arroyo Seco Watershed Restoration Feasibility Study

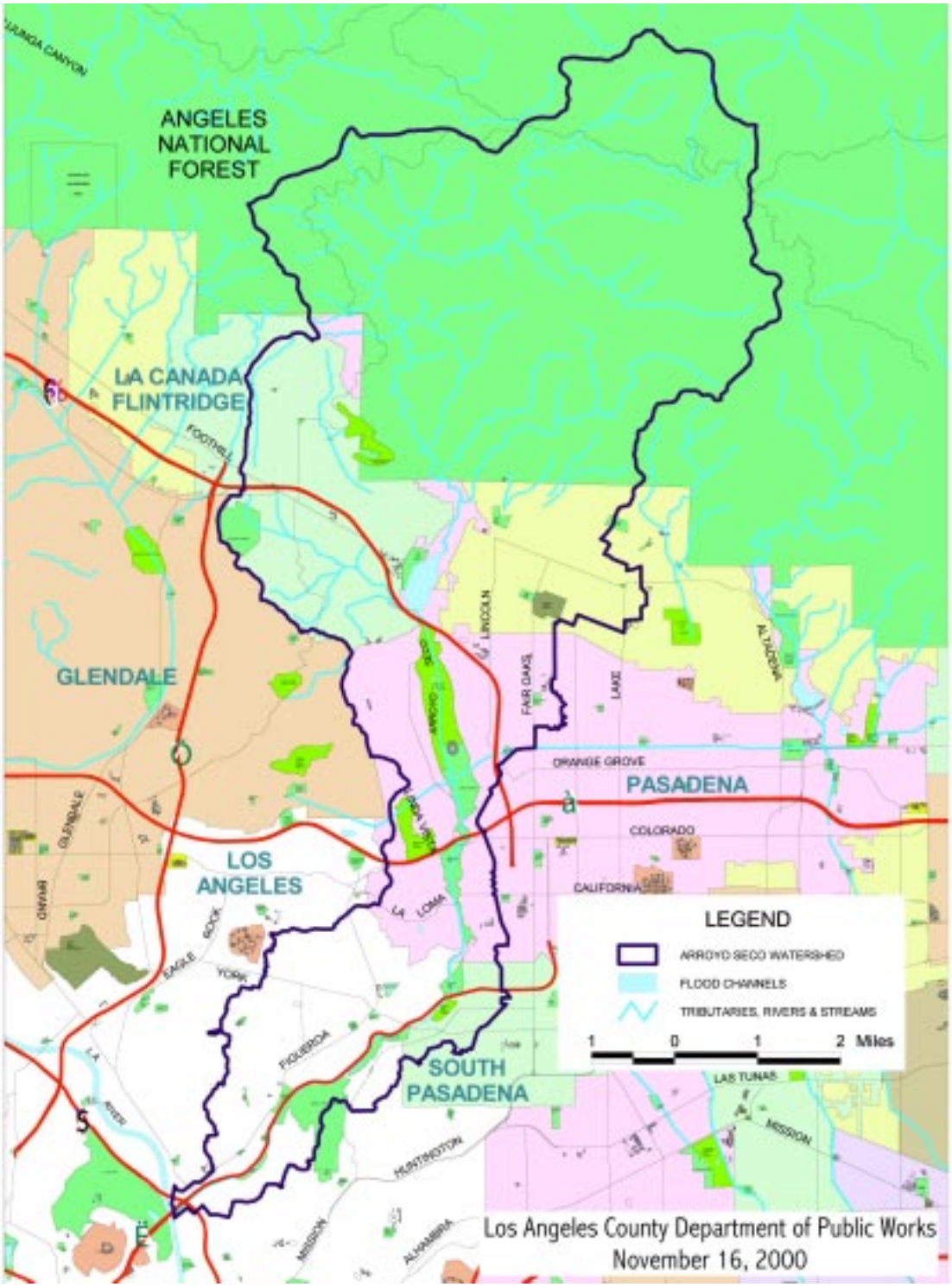


FIGURE 1-2: ARROYO SECO WATERSHED

Arroyo Seco Watershed Restoration Feasibility Study

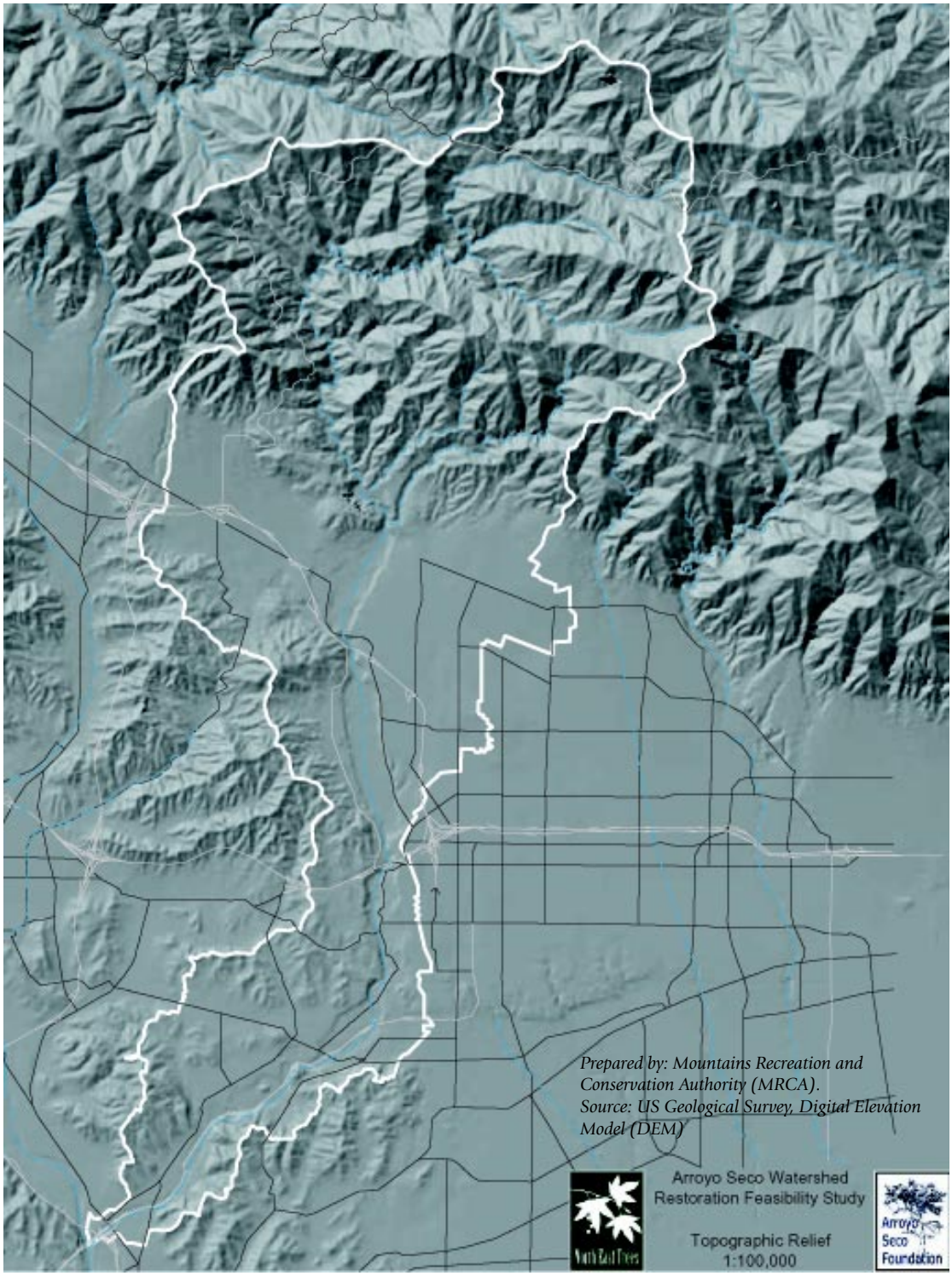
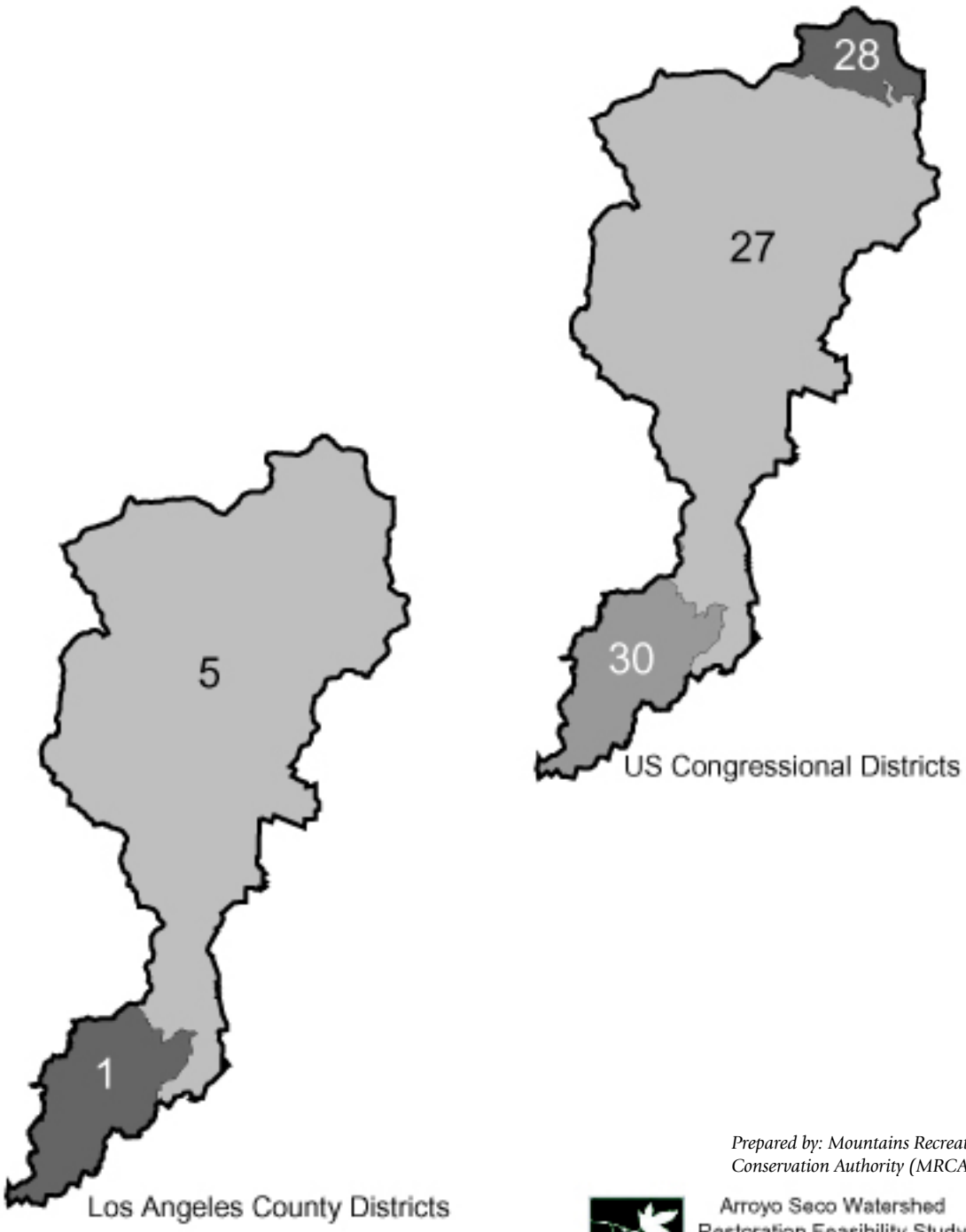


FIGURE 1-3: TOPOGRAPHIC RELIEF

Arroyo Seco Watershed Restoration Feasibility Study



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Arroyo Seco Watershed Restoration Feasibility Study

Elected Official Boundaries
1:200,000

FIGURE 1-4A: ELECTED OFFICIAL BOUNDARIES 1

Arroyo Seco Watershed Restoration Feasibility Study

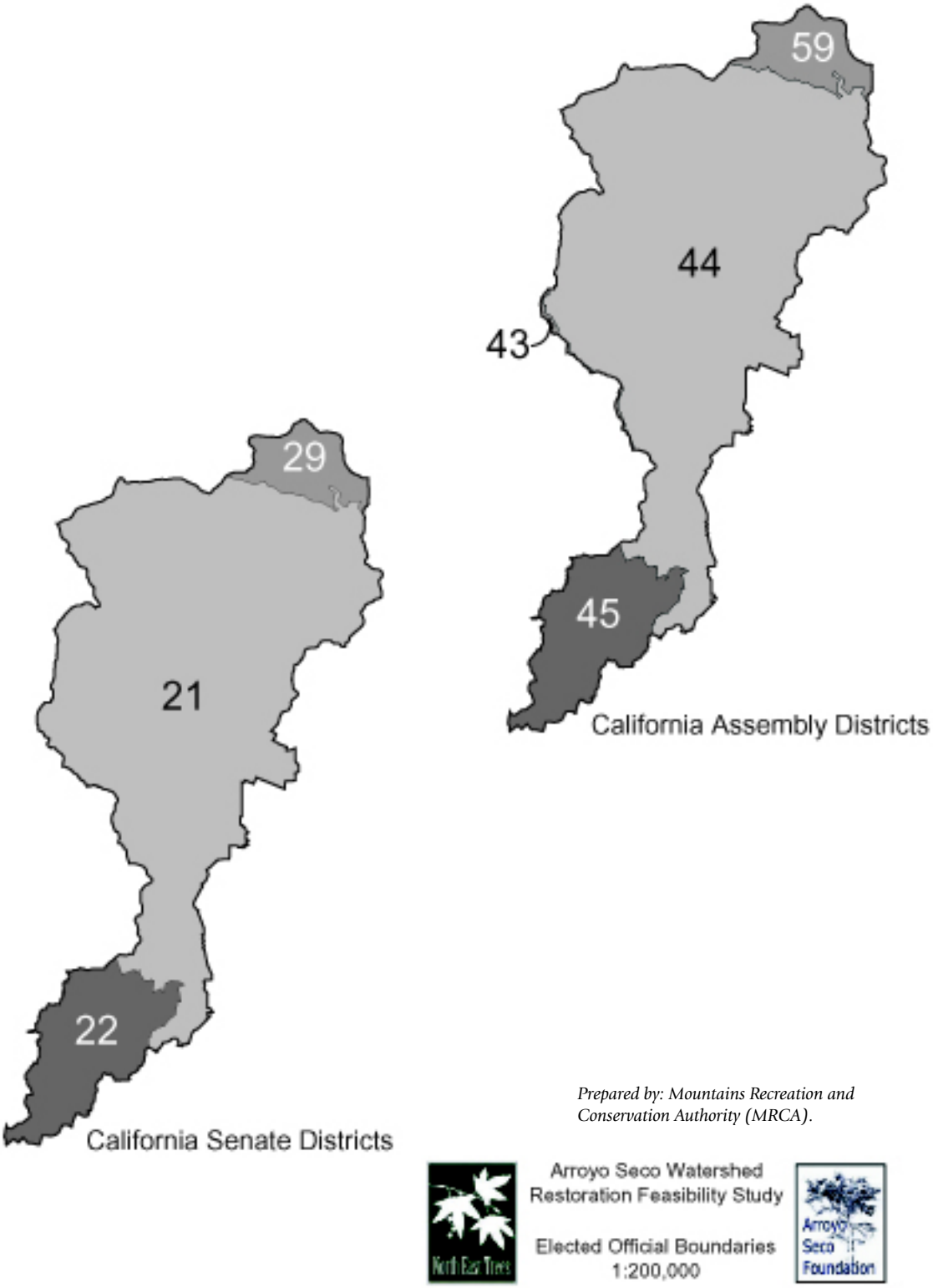


FIGURE 1-4B: ELECTED OFFICIAL BOUNDARIES 2

Arroyo Seco Watershed Restoration Feasibility Study

Arroyo Seco watershed. The remaining lush riparian habitat, which now comprises only 15 percent of the total land mass within the watershed.

Approximately half of the Arroyo Seco's 22-mile length is contained within the Angeles National Forest. The Arroyo's upper watershed drains 32 square miles of steep, mountainous terrain. The San Gabriel Mountains are among the most erodible mountains in the world, releasing large amounts of sediment into the Arroyo every year. The vegetation of the upper watershed is characterized by Bigcone Spruce-Canyon Oak Forest, Southern Sycamore-Alder Riparian Woodlands, and Southern Mixed Chaparral. Above the dam, the arroyo travels through one of the last ecologically significant Alluvial Sage Scrub habitats in southern California. In the mountains, the Arroyo Seco stream is stocked with rainbow trout. Wild trout has also been observed. The watershed supports the Raymond Basin Aquifer, a 40-square mile groundwater basin that provides half of the local water supply for the City of Pasadena and other local communities and sustains a water flow in the Arroyo through most of the year.

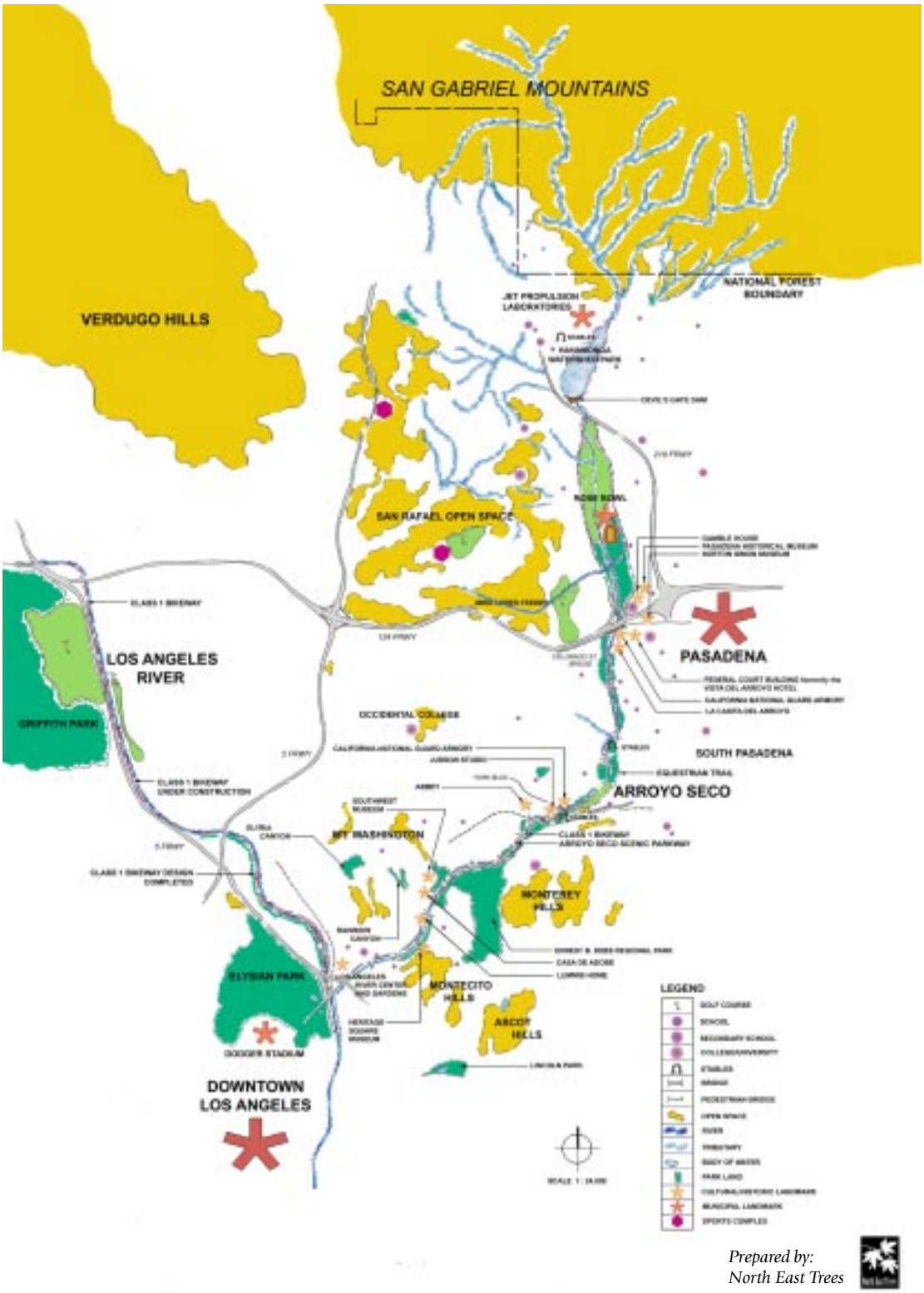
Devil's Gate Dam and the National Aeronautics and Space Administration's (NASA) Jet Propulsion Laboratory (JPL) are located at the point where the arroyo emerges from Angeles National Forest. The stream is mostly channelized from the dam to the confluence with the Los Angeles River, a distance of eleven miles. Near the confluence, the Arroyo is flanked by Mount Washington and the Montecito Hills, which still support Southern California Black Walnut Woodlands.

Significant park and natural areas line the arroyo from Angles National Forest in the upper watershed to Elysian Park at the southern tip, across from the confluence with the Los Angeles River (Figure I-5: *Arroyo Seco Cultural & Open Space Map*, Figure I-6: *Points of Interest*). Parks in the watershed are operated by the Cities of Los Angeles, South Pasadena, and Pasadena, the Santa Monica Mountains Conservancy, and the US 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.

Below the dam, the Arroyo Seco becomes a channelized urban stream, bordered by parks, golf courses, parking lots, residential areas, the Rose Bowl, limited industrial areas, and the Arroyo Seco Parkway, also known as the Pasadena Freeway. The arroyo passes through a variety of neighborhoods with a great mix of income, race, and ethnicity. Many of these neighborhoods have traditionally been under-served by parks and other public amenities.

A sample of demographic information from the 1990 census shows the diversity of the watershed's residents. Median home values range from $150,000 - $500,000. Racially, some areas have over 75% Caucasian population, others a roughly 50/50 mix of Hispanic and Caucasian. A high concentration of Black population occurs in the northeast portion of the watershed while the Asian population is under 10% for the entire watershed. A quarter of the population is listed as Other for various areas of the watershed. No age group dominates any part of the watershed. Half of the residential areas have less than 3% of homes renter-occupied; the other half has up to 40% renter-occupied.

A combination of factors makes the Arroyo Seco a strong potential stream restoration project in southern California. These factors include:



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North East Trees

FIGURE 1-5: ARROYO SECO CULTURAL & OPEN SPACE MAP

Arroyo Seco Watershed Restoration Feasibility Study

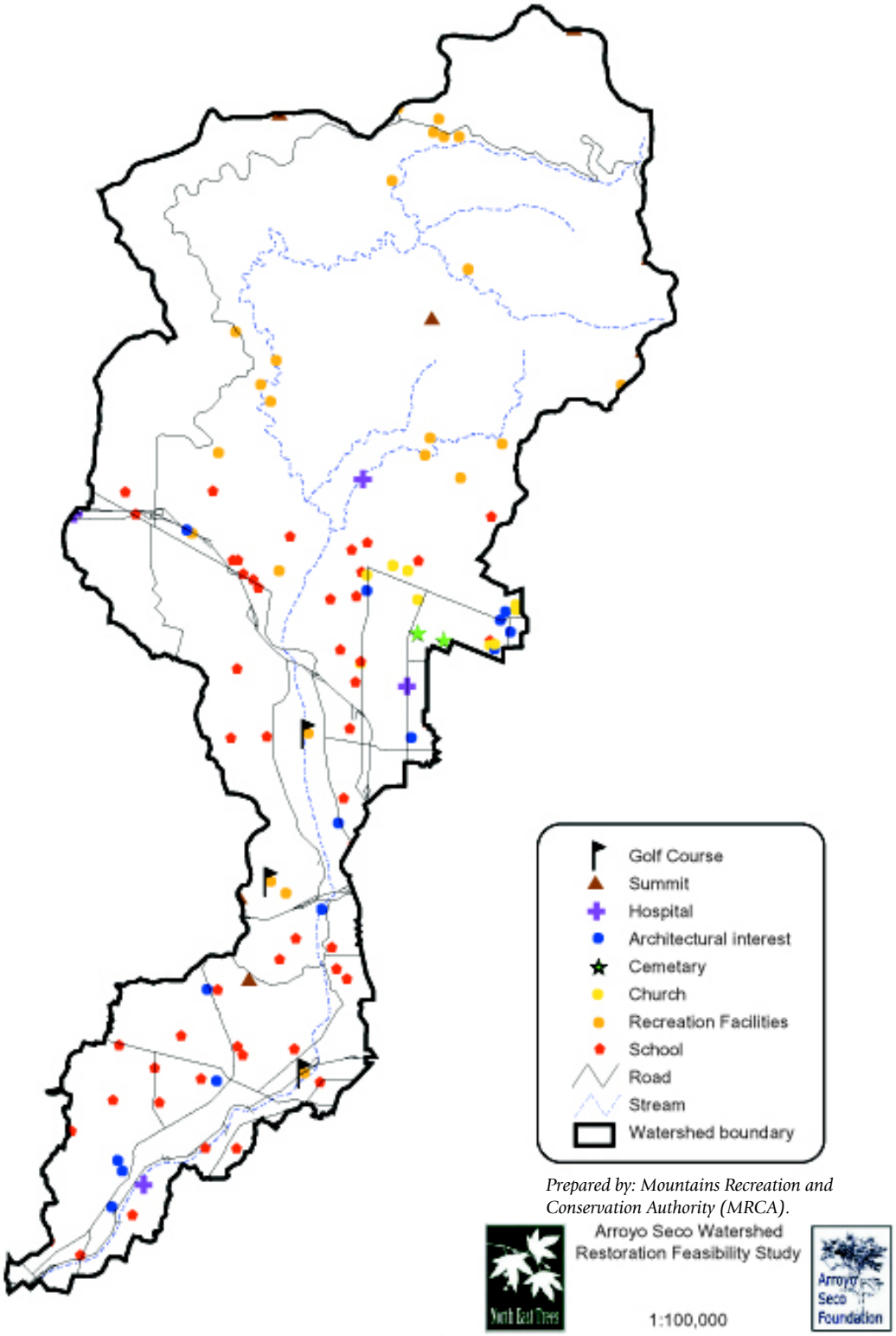


FIGURE 1-6: POINTS OF INTEREST

Arroyo Seco Watershed Restoration Feasibility Study

- The spectacular natural character of the Arroyo Seco with parks and open space along most of its course;
- Public ownership of adjacent land;
- Successful demonstration projects;
- The potential for southern steelhead/rainbow trout and arroyo southwestern toad habitat;
- Substantial community and political support to naturalize the Arroyo Seco;
- US Army Corps of Engineers preparation of a Reconnaissance Study for the watershed;
- 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 along the Arroyo.

Flood management in the Arroyo Seco has changed dramatically in recent years. The rehabilitation of Devil's Gate Dam, completed by the Los Angeles County Department of Public Works (LACDPW) in 1998, has necessitated a new look at flood and stream management issues in the entire Arroyo Seco. A recent LACDPW study (*Compilation of Arroyo Seco Hydrologic and Hydraulic Data Available in Late 1999*) indicates that the concrete channel that divides the Arroyo is under-capacity in portions of the Arroyo. In addition, the channel is aging and has serious maintenance issues that need to be addressed. An example of this occurred in 1983 when the channel failed during a flood event. The costs and regulatory challenges of replacing the existing concrete channel would be enormous. With broad community support for a more naturalized stream and the creation of the Watershed Management Division as part of the LACDPW, there is great potential for a new, collaborative, more holistic approach to stream and watershed restoration.

C. RESTORATION VISION, GOALS AND GUIDELINES

The project goals and guidelines were developed to address the key issues affecting the watershed within the scope of this project. Based on input from various stakeholder and community groups and a one-day intensive workshop with members of the project team, the original list of goals and objectives were revised and refined (Appendix A: *Phase I Goals & Objectives*). These were also generated within the context of several assumptions and guidelines (Appendix B: *Assumptions & Guidelines*). The following are being used to guide the development of the technical studies and will later be used to provide the framework for planning and design recommendations. It is recognized that some of the goals and objectives may conflict with one another. However, these potential conflicts will be addressed in the next phase of the process as well as in the generation of planning and design recommendations.

1. VISION

Early in the process of developing this study, the project team identified a vision statement for the project:

> *To develop a Watershed Plan for the Arroyo Seco that integrates issues of flood management, stream naturalization, water resources, habitat rehabilitation, and educational and community recreational opportunities.*

2. GOALS AND GUIDELINES

The following text represents a summary of watershed restoration goals and guidelines. These were adapted from the goals and objectives that were developed during Phase I of this study. In Section IV of this report, "Restoring The Watershed: Feasibility and Planning Recommendations," there is an explanation of how these goals and guidelines can be used. In addition, guidelines are broken down further into action items that can be adapted by agencies and stakeholders.

Restoration Goal 1: Restore the natural hydrological functioning of the watershed

1.1 Restore the Arroyo Seco stream and tributaries through widening and lengthening of streams.
1.2 Create floodplain system allowing for periodic overflow while providing the required level of public safety and flood hazard mitigation.
1.3 Reduce volume and velocity of storm water runoff.

Restoration Goal 2: Better Manage, Optimize, & Conserve Water Resources While Improving Water Quality

2.1 Improve quality of surface water for aquatic habitat and human contact.
2.2 Restore the quality and quantity of water recharge to the Raymond Aquifer.
2.3 Develop groundwater management strategy for optimum use of local water resources.
2.4 Reduce dependence on imported water.
2.5 Reinstate sediment transport.

Restoration Goal 3: Restore, Protect and Augment Habitat Quality, Quantity and Connectivity

3.1 Restore and protect missing linkages of fragmented habitat.
3.2 Integrate fire management into native vegetation zones.
3.3 Restore, protect and augment terrestrial species habitat in existing open space of foothills and floodplains.
3.4 Enhance and strengthen the urban interface zone.
3.6 Restore aquatic species habitat.

Restoration Goal 4: Improve Recreational Opportunities and Enhance Open Space

4.1 Improve connectivity and public access from the Angeles National Forest to the coastal shore.
4.2 Protect and interpret natural, community, cultural and historic resources.
4.3 Integrate natural resources management with recreational needs.
4.4 Protect existing open space while augmenting open space network.
4.5 Improve visual quality of the landscape.
4.6 Mediate conflicts between recreation and conservation and opposing recreational users.

D. RELATED PLANNING STUDIES

There are currently several major planning studies, either ongoing or recently completed, that will have substantial impact on the potential outcome of recommendations from the Arroyo Seco Watershed Restoration Feasibility Study. Coordination between these efforts and the project are recommended for maximum benefit and future success of watershed restoration and management measures. Some of these studies were identified during Phase I of this study (Table 1-1: *Related Studies* and Figure I-7: *Capital Projects*).

TABLE 1- 1: RELATED STUDIES

Study	Agency	Due	Description
Arroyo Seco Master Plan & EIR	City of Pasadena	8/31/02	Master Plan for Hahamongna, Central and Lower Arroyo. Public review period for Master Plan and Environmental Impact Report (EIR) to end July 1, 2002.
Arroyo Seco Watershed Reconnaissance Study	US Army Corps of Engineers	2002	Study to determine is there is federal interest in the watershed for potential flood management and ecosystem restoration.
Angeles Forest Master Plan	US Forest Service	2002	Major updates currently being written for the Land and Mangement Resource Plan (Forest Plan) for the four southern California Forests, including the Angeles NF. Draft Environmental Impact Statement (EIS) due in September 2002.
Arroyo Seco Corridor Management Plan	California Department of Transportation	2002	Comprehensive master plan to restore the historic character of the Arroyo Seco Parkway
Watershed Overview	LA Co Dept. of Public Works/ US Army Corps of Engineers	3/15/01	Major mapping study and survey of the LA and SG River watersheds including the Arroyo Seco.
Arroyo Seco/LA River Confluence Park Plan	Mountains Recreation & Conservation Authority	2001	Park Plan for the confluence region just north of downtown Los Angeles
Watershed Hydrology Study	LA Co Dept. of Public Works	3/1/01	Watershed hydrology model of the Arroyo Seco
Arroyo Southwestern Toad Critical Habitat Designation	US Fish & Wildlife Service	2/7/01	A six mile stretch of the Arroyo Seco extending from Hahamongna/Devil's Gate reservoir for seven miles to Long Canyon has now been formally designated as critical habitat for the endangered arroyo southwestern toad.

E. PROJECT PROCESS

The ASWRFS process occurred in two phases. In Phase I, the project team established an ongoing stakeholder information exchange process with agencies and the community, inventoried existing data, and underwent an initial planning investigation. The summary of Phase I is presented in this section. Phase II involved the generation of technical studies and the development of recommendations synthesized from them. The following two chapters merges the findings from the technical studies and puts it into the context of historical landscape structure and function (Section II: *The Arroyo Seco Watershed: An Historic Overview*), and current conditions of the watershed including land use (See Section III: *Current Conditions and Function in the Arroyo Seco Watershed*). Finally, an approach to restoration and recommendations are presented in two matrices, the *Framework for Restoration Projects: Watershed Restoration Goals, Guidelines & Action Items*, and *Recommendations for Projects and Programs* (Section IV: *Restoring the Watershed: Feasibility and Planning Recommendations)*.

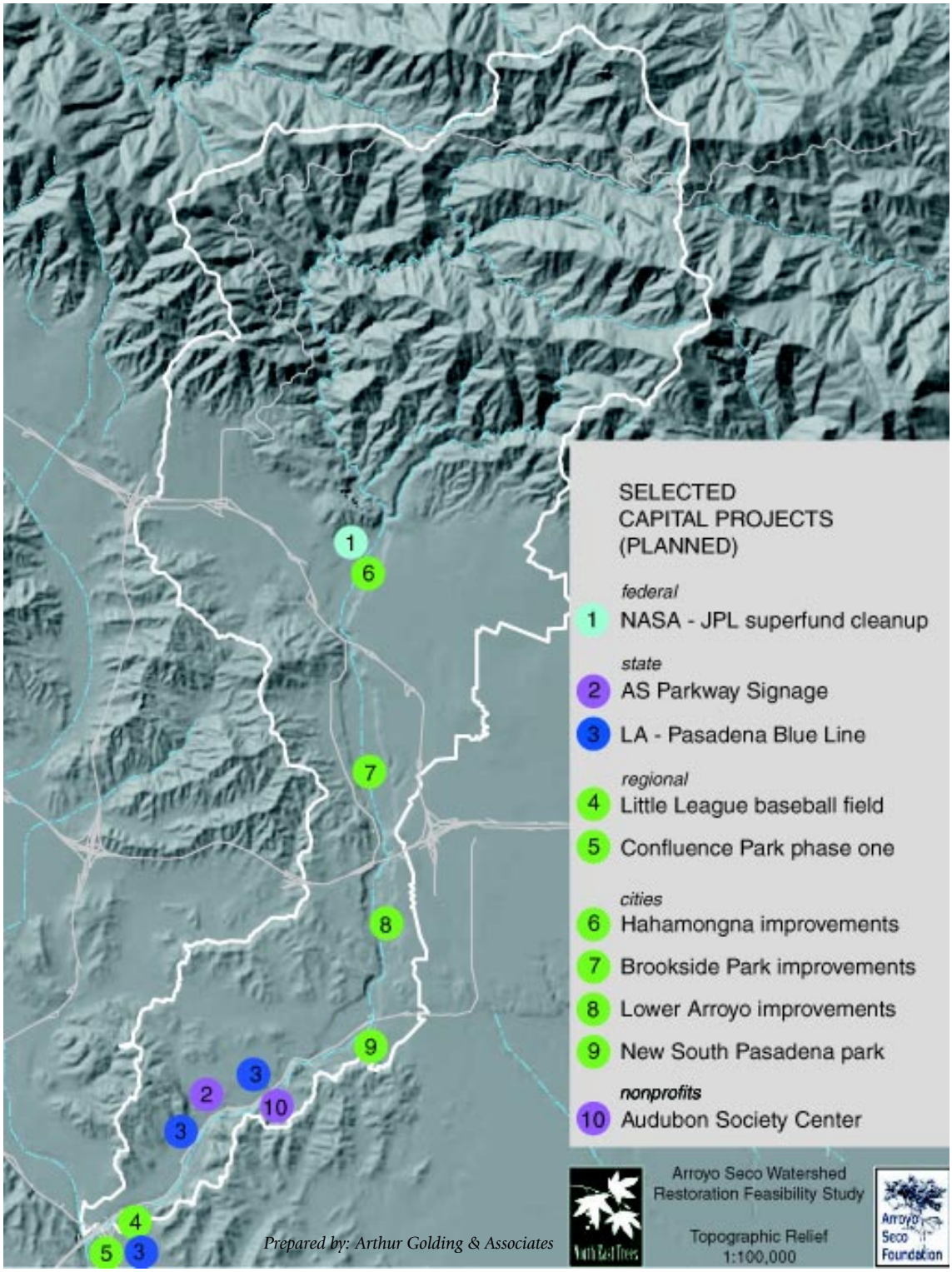


FIGURE 1-7: CAPITAL PROJECTS

Arroyo Seco Watershed Restoration Feasibility Study

1. PUBLIC PROCESS

Acknowledging that it is important for stakeholders and the community to be involved with planning efforts, the project team developed a multiple-tiered outreach process that encouraged members of agencies, community-based groups and members of the general public to participate in the planning process.

a. Agency Coordination

The Agency Technical Review Committee (ATRC) is a working group of representatives of senior staff from agencies having a direct managerial responsibility in the Arroyo Seco watershed (Table 1-2: *Participating Agencies & Representatives*). Formed as a part of the ASWRFS project planning team, the ATRC met monthly for 9 months, then quarterly thereafter. Along with the project team, ATRC members provided strategic and technical guidance and reviewed the scope, process, schedule, work plan, and products prepared by the planning team. Committee members provided drafts of documents in progress for review by their agencies' staff. Committee members served as liaisons between this project and their agencies, assisted in obtaining information and coordinated provision of in-kind services from their agencies.

The ATRC process has also facilitated exchange of information among agencies. Discussion of funding opportunities for additional studies and for implementation of

TABLE 1-2: PARTICIPATING AGENCIES & REPRESENTATIVES

Agency, Level	Representative(s)
Federal	
National Park Service Rivers & Trails Conservation Assistance Program	Anne Dove
US Forest Service Angeles National Forest	Bernice Bigelow
US Army Corps of Engineers	Dan Young, Brian Whelan
State	
California Coastal Conservancy	Chris Kroll
California Department of Fish and Game, Scott Harris	
California Department of Transportation, Environmental Planning Division	Diane Kane
Santa Monica Mountains Conservancy	Kathleen Bullard, Cara McLane
Regional	
Metropolitan Water District of Southern California	Bob Joe
Mountains Recreation & Conservation Authority	Kathleen Bullard, Cara McLane
Los Angeles County	
Department of Public Works, Water Resources Division	Michael Bohlander
Department of Public Works, Watershed Management Division	Vik Bapna, Maria Lopez, Frank Wu, Mickey Chaudhuri, Dan Sharp
City	
Los Angeles Department of Recreation and Parks	Teresa Proscewicz
Los Angeles Department of Public Works, Bureau of Sanitation, Stormwater Program	Morad Sedrak Peter Tonthat
Pasadena Public Works and Transportation/City Manager's Office	Bob Baderian
Pasadena Water and Power Department	Gary Takara
South Pasadena	Veronica Dolleschel, Cesar Vega

projects has led to expressions of interest by several agencies in pursuing joint funding or using one agency's project as a match for a grant application by another.

Several agencies, including the Forest Service, LA County Department of Public Works, City of Pasadena and City of Los Angeles, have provided information and documentation to the project. Individual agency meetings have been held with City of Los Angeles Department of Recreation and Parks, Los Angeles County Department of Public Works Watershed Management and Water Resources Divisions, and others. Los Angeles County Department of Public Works has made a substantial commitment of in-kind services, including hydrologic modeling, and several other agencies have provided in-kind services or data.

b. Stakeholder and Community Process

An important component of the planning process has been the integration of input from a variety of stakeholders and members of the community. This input was gathered through a series of participatory meetings/workshops, which are continuing into the next phase of the project (Appendix C: *Public Participation*). Several objectives have driven the format of these meetings:

- To make people aware of this study,
- To keep stakeholders and community members informed of the project process,
- To bring interested parties together into one forum to express concerns, raise issues, and provide input to project,
- To build a common vision for the Arroyo Seco watershed,
- To empower communities to provide direction for the future of their watershed,
- To create a study that will provide opportunities to develop on-the-ground projects, and
- To promote stakeholders and community acceptance/ownership of the study's recommendations.

i. Stakeholder Meetings

During both phases of the project, three stakeholder meetings were held on November 16, 2000, January 18, 2001 and March 15, 2001. A fourth joint stakeholder/community meeting was held on May 24, 2001. Stakeholder groups were identified from existing North East Trees and Arroyo Seco Foundation outreach mailing lists, through identification of active non-profit groups in the watershed area (Appendix C: *Public Participation*), elected officials, and the City of Pasadena's list of Master Plan participants. Meeting notices were sent to approximately 150 organizations and agencies for the first meeting then increasing to 230 invitations for the second and third meetings. Approximately 30 people attended each of the meetings.

Based on a review of the mailing list, it appears that nearly half of the individuals on the mailing list had representatives of their organizations attend either the ATRC or stakeholder meetings. However, to ensure adequate input from stakeholders, the project team pursued individual meetings with key stakeholders, including some that have not attended any of the meetings. Additionally, other key groups that have not been represented at the meetings have been contacted directly to assess the effectiveness of the outreach strategy and to encourage their future participation.

The purpose of the first meeting was to introduce the stakeholders to the project and to obtain attendees' input on key issues and concerns regarding the watershed (Appendix C: *Public Participation*). The second meeting, which coincided with the analysis phase of

the project, was focused on updating the participants on the project status, and on obtaining input to the opportunities and constraints modeling. In small groups, participants mapped sites that were special "hidden treasures" or resources in the watershed and then identified potential threats or challenges to these resources. The information from these two meetings was integrated into the project goals, objectives, and suitability maps. The third meeting, which included participants from both the stakeholder and community forums, provided an opportunity for participants to hear the findings and recommendations of the project.

ii. Community Meetings

Two community meetings were held during the project process, with a third meeting integrating both the community and stakeholder groups. The meetings were held on December 3 and 5, 2000 and March 22, 2001. One of the meetings was sited in the upper watershed in the City of Pasadena at the Rose Bowl Aquatic Center, and the second meeting was held in the lower watershed, in the Cypress Park community of the City of Los Angeles at the Los Angeles River Center & Gardens. These first two meetings, which had the same agenda, were scheduled for different evenings in Pasadena and Los Angeles, to maximize the ability of people to attend. Approximately 1400 postcards were mailed to individuals on the North East Trees and Arroyo Seco Foundation mailing lists. In addition, bilingual (Spanish and English) flyers were posted at local community centers, churches and libraries. Approximately 35-50 people attended each meeting. A brief article appeared in the *Pasadena Weekly* following these meetings.

The purpose of the first set of community meetings was similar to that of the first stakeholder meeting, which was to introduce the communities to the project and to obtain attendees' input on key issues and concerns regarding the watershed (Appendix C: *Public Participation*). The input from these meetings was integrated into the project goals, objectives and the suitability maps. A second community meeting provided an opportunity to present the findings of the Phase I report and to obtain feedback.

c. Outreach and Media

Throughout Phases I & II of the project, opportunities surfaced for the project team to present the project to stakeholder groups, agencies, and elected officials. On several occasions, one-on-one meetings and special tours were held with elected officials and their staff. Through these personal contacts, decision-makers within the watershed were provided with background information, while providing support for the project. PowerPoint slide shows were created for "road shows." One of the most recent versions is available on the Arroyo Seco Foundation's website, www.arroyoseco.org. Presentations to regional stakeholders were given to the Los Angeles & San Gabriel Rivers Watershed Council, the San Gabriel River Master Plan Steering Committee meeting sponsored by Los Angeles County Department of Public Works, the Los Angeles County Best Management Practices (BMP) Task Force and the Los Angeles Chapter of the American Planning Association. Agency presentations were given to the Santa Monica Mountains Conservancy Board and Rose Bowl Operating Company Golf Course Committee among others.

A few key events have propelled the project into the watershed spotlight statewide. Most notably, at an October 5, 2001 Media Event on top of Devil's Gate Dam, the State of California's Secretary of the Resources Agency, Mary Nichols, announced that the ASWRFS was included as a one of "ten exemplary watershed protection projects" by the Joint Task Force on California Watershed Management. Many state and local officials were present at this event. This Task Force was created through AB2117, the Wayne Watershed

"Arroyo Seco – another microcosm of the future. ***If you want to see the first chunk of concrete fly, then camp out here, because of all the waterways in the basin, the Arroyo in on the fastest track to full-scale watershed management. Why the Arroyo? It has significant green space and less dense development along its banks – in other words, the prerequisites for sound water management that will take a long time to put into place on the L.A. River. A comprehensive study will begin by identifying the best sites for wetlands, stream naturalization, diversion basins, etc. and for a series of demonstration projects. It's brought to you by North East Trees with the Arroyo Seco Foundation, with funds from the SMMC and the California Coastal Conservancy, a major funder of watershed projects on the river." Jenny Price, LA Weekly, August 10-16, 2001, page 35.***

Bill. Through an interview process, the Task Force evaluated watershed projects around the state and made recommendations for future programs through agencies that support these cooperative watershed planning projects. The results are in a report released in Spring 2002 (see http://resources.ca.gov/watershedtaskforce/ for information on Joint Task Force). In addition, hundreds of participants have seen presentations of the project at meetings of the California Biodiversity Council, the California ReLeaf Conference, and the California Association of Resource Conservation Districts.

In the press, the project has received support. The Pasadena Star-News published an article early in the project process on March 26, 2000, titled "Project to Study Entire Arroyo Seco." The same newspaper printed another article in May 2001 describing the watershed project. In the August 10-16, 2001 edition of the LA Weekly, the cover story, "Paradise Reclaimed: A Field Guide to the L.A. River," by Jennifer Price included a piece on the Arroyo Seco watershed. Lighthawk, a non-profit organization, took members of the project team and a Los Angeles Times journalist on a flight above the Arroyo Seco watershed in August of 2001. The result was an article in the Los Angeles Times on September 8, 2001 describing the flight by Lighthawk and the Arroyo Seco project. Lighthawk provides free flights for members of the press, elected officials and the environmental community through donated airplanes provided by volunteer pilots.

2. DATA COLLECTION

The data collection process was divided into three types: documents, geographic information system (GIS) map layers, and contact database. The process of data collection and the results are described below for each type.

a. Potential Contacts

The contacts database compilation began with contacting known interested parties many of whom were previously documented in North East Trees' and the Arroyo Seco Foundation's existing mailing lists. Many of these contacts recommended additional people that would be interested in the study. At each stakeholder and public meeting, participants recommended additional stakeholders and community members that would be interested in the study. Each contact was added to an address database. The current mailing lists of North East Trees and Arroyo Seco Foundation were also added to the address database.

b. Documents

Document data collection consisted of searching library databases, Internet databases and search engines, and drawing on the project team's prior experience and knowledge of resources, together with resources made available by professional colleagues. The team also solicited input from Los Angeles County Public Works and all other agencies that are advising the study (Agency Technical Review Committee). Recent, ongoing, and planned studies and/or master plans that lie within the Arroyo Seco Watershed have also been identified by the project team.

More than 800 references have been compiled in a searchable database available online at www.arroyoseco.org. From this comprehensive list of sources, the team has identified the critical resources for habitat, recreation, flood management, and water resources. Many of these references are specific to the Arroyo Seco, while other references are of more general interest. The Critical Resource Bibliography database was developed using several descriptive criteria (Table I-3: *Critical Resource Bibliography*). The technical studies and planning process was based in part on analysis of these critical resources.

TABLE 1-3: CRITICAL RESOURCE BIBLIOGRAPHY	
Field	**Description**
Title	Title of Resource
Topic	Topics = Cultural, Historical, Parks, Flood, Trees & Plants, Stream Restoration, Recreation
Type	Type = book, article, report, web site, graphic, map
Author	Author of document
Date	Date of Publication
ISBN#	International Standard Book Number
Location/Source	Location of Resource (e.g.: UC Berkeley)
Dewey	Library classification number
Publisher/Agency	Publisher of document or agency sponsoring report
Keywords	Suggested keywords are found on spreadsheet
Pages	Number of pages in document
Entered By	Initials of the Project Team member that entered document
Date Entered	Date of entry on spreadsheet
Abstract	Brief description of the document
Notes	This is a memo field containing any relevant comments about the content of the document or its possible usefulness for ASWRFS.

c. Geographic Information Systems (GIS) Data

Obtaining digital data needed for geographic information systems (GIS) mapping and analysis is a key component of any planning effort today. The process of collecting GIS map layers began with an inventory of data previously collected by the project team. Immediately available were GIS layers from the Mountains Recreation and Conservation Authority (MRCA) and Environmental Systems Research Institute (ESRI). Next, the team conducted a search of USGS information on the Internet, and downloaded critical map layers. The final method of obtaining data was to request data from reviewing agencies (Agency Technical Review Committee). Significant map layers were obtained from the United States Forest Service (USFS)/Angeles National Forest, including a wealth of habitat information. LACDPW shared digital orthographic photographs and valuable GIS layers relating to drainage, storm sewers, and soils. A digital aerial photograph of the watershed, dated July 2000, was purchased from Eagle Aerial. In a manner similar to the bibliography process, the available GIS data was first compiled into a comprehensive list, and critical map layers were identified (Table 4: *Critical Map Layers*).

A variety of printed maps were also obtained for the study. The printed maps include: United States Geological Survey (USGS) topographic maps, USGS geology maps and historic vegetation maps. The City of Los Angeles provided numerous maps of the Northeast Los Angeles area, parks maps, and storm drain maps. The City of Pasadena, among other things, provided maps of the Hahamongna Master Plan, the Central Arroyo Master Plan, and the Lower Arroyo Master Plan, in addition to a recent vegetation survey of the Arroyo.

d. Data Gap Analysis

The available hardcopy data used at the time of the preliminary mapping and analysis was limited. Land use data from SCAG, geology maps from USGS, USGS topographic

TABLE 1-4: CRITICAL MAP LAYERS (GIS)	
Subject	**Source**
Land Use	Mountains Recreation & Conservation Authority (MRCA)
Topo lines - 10' CI	MRCA
Roads – local	MRCA
Roads – Arterials	MRCA
Roads – Freeways	MRCA
Parks	MRCA
Rivers, Streams - Mtn. washes included	MRCA
Streams - Minor	MRCA
Reservoirs & Lakes	MRCA
Digital Elevation Model- 30m	USGS
Digital Ortho Photographs	Los Angeles County Department of Public Works (LACDPW)
CAD base, rectified to Digital Ortho Photographs	LACDPW
Watershed Management Areas	LACDPW
Collection Points for LA River WMA	LACDPW
County-maintained Storm Drains	LACDPW
Dams	LACDPW
Spreading Grounds	LACDPW
Soils	LACDPW
Aerial photo of watershed – 7/2/00	Eagle Aerial
Vegetation Communities	United States Forest Service (USFS)
ANF Boundary	USFS
Soil Types	USFS
Fire locations - polygons. Goes outside ANF boundary	USFS
Stickleback Fish habitat, 100' buffer	USFS
Plant Sightings – points	USFS
Power Lines - above ground	USFS
Wildlife Sightings – points	USFS
Precipitation (annual)	Teale
Census Tracts w/ associated demographic information: Tract - The census tract identification number. Area - Area of county in square miles based on Albers Equal Area Projection. Pop1990 - The population of the county in 1990 based on the US Census. Pop1997 - The population of the county in 1997 estimated by Claritas. Total population and households Population by race and ethnicity Population by age Population by marital status Composition of households Housing unit information	Environmental Systems Research Institute, Inc. (ESRI)
Congressional Districts	ESRI
Buildings -Geographic Names Information System - points	ESRI
Cemeteries - GNIS - points	ESRI
Churches - GNIS - points	ESRI
Golf courses - GNIS - points	ESRI
Hospitals - GNIS - points	ESRI
Locales - GNIS - points- shopping ctrs, other stuff	ESRI
Subdivisions - GNIS - points	ESRI
Schools - GNIS - points	ESRI
Mountain summits - GNIS - points	ESRI
Large Area Landmarks	ESRI
Parks – National	ESRI
National Transportation Atlas Railroads	ESRI
Recreation Areas	ESRI
Retail Centers	ESRI

maps, and aerial photographs were readily available. As shown on the Initial Resource Analysis Diagrams, much of the needed information still needed to be collected (Appendix D: *Spatial Analysis Process and Initial Resource Analysis*, Table 5: Data Gap Analysis). In the final analyses, not all data layers were be used per the diagrams. The diagrams served as a framework, and final analyses occurred with all available data.

3. PHASE I INITIAL PLANNING INVESTIGATION

The initial planning investigation consisted of developing an analysis methodology or process, identifying sources of information to facilitate the analysis, conducting a gap analysis to determine what information was not available, and generating preliminary spatial analyses through mapping. The planning approach conducted by the team was based on ecological principles and systems. By standardizing source spatial information, identifying the criteria or factors that are important in the context of the project's four issue areas, and combining diverse sources of information to reveal new patterns, the project team generated five suitability, or probability models from which planning recommendations were generated (Appendix D: *Spatial Analysis Process and Initial Resource Analysis*).

The *ASWRFS* has been undertaken from the perspective that watersheds function as geographic and ecological units. This approach is also based on the supposition that natural and human landscapes can be described using a similar, ecosystem-based approach. This strategy derives primarily from the field of ecology, which has been gradually integrated over the past few decades into various fields within the broader discipline of environmental design. Rather than focusing on the disparities and duality of natural and human-made landscapes, the project team's approach to this study derives from an assumption that the Arroyo Seco watershed comprises one large, integrated system in which all components, to some varying degree, are interrelated. It is also recognized that the watershed is not an isolated entity but one that is linked to other landscape units. In order to understand the watershed, the project team's approach to this study is based on describing the watershed in terms of its physical structure or form; the processes, functions or flows that take place within and beyond the watershed boundary; and the dynamics which affect the change of watershed through time.

In the book *Design for Human Ecosystems* (1985), the late John Tillman Lyle outlines a design process in which natural systems can co-exist with human systems. The principles of ecosystematic design provide the basis for this project. Through an ecosystem-based design process, it is the intent of the project to shape the structure of the watershed's landscape to guide watershed processes toward a trajectory of change through time which will balance the needs of the floral, faunal and human inhabitants and their environments. An ecosystem can be described as the interacting assemblage of living things in a given space and their nonliving environment (Forman and Godron 1986, Lyle 1985). Though this may imply that an ecosystem is a unit that is closed or discrete in its boundaries, it is important to keep in mind that ecosystems are open systems. They do not stand alone. The understanding of the connections between adjoining and overlapping ecosystems and dynamics between them are critical to understanding any ecosystem. It is also important to understand that humans and their activities are an integral part of most living ecosystems. The Arroyo Seco Watershed ecosystem interacts with the Los Angeles River, the San Gabriel Mountains, the San Rafael Hills, and the San Gabriel River watershed.

TABLE 1-5: DATA GAP ANALYSIS

Information/Data Need	Currently Available	Data Gap and/or Action Plan
Flood Management and Stream Naturalization Feasibility		
Localized Flood Potential: Existing & Alternative Model Scenarios	From Water Budget Model	
County Flood Zones/FEMA flood Insurance Maps	No	Unavailable for the Arroyo Seco
Locations of County-Identified Inadequate Channel Capacity	Yes	
Gaging Stations/Other Flow Rate Stations	Yes	
Locations/Estimated Amounts of Sediments Trapped Behind Dams	No	Should be available from LACDPW
Land Ownership/Parcel Data	No	Should be available from LACDPW
Montgomery Watson Harza Additional Data	Yes	Technical Report
Water Resources Assessment		
Subwatersheds	Yes	
Water Recharge Zones	Yes	
Artesian		
Source Locations	No	Need to research data availability from local sources
Slopes	Yes	
NRCS Soil Types	Yes	
Vegetation Types	Available for Angeles NF, Debs Park; being developed by City of Pasadena	South Pasadena, Alta Dena, and Los Angeles need further investigation
Land Use and/or Cover	Yes	
Stream Channel Locations/Capacity	Yes	Need additional data from LACDPW
Storm Drain Locations/Capacity	Yes	Need additional data from LACDPW
Seasonal Wind Patterns	No	Need further investigation
Roads	Yes	
Vegetation/Landcover	Yes	
Zoning/GP/USFS Designations	No	Should be available from local cities
Land Use	Yes	
Land Ownership	Yes	
Subwatersheds	Yes	
Blue Line Drainages	Yes	
Storm Drain System	Yes	
Documented Locations of Urban Water Quality Problems	No	Possibly available from the LA Regional Water Quality Control Board
Habitat Restoration Feasibility Model		
Land Ownership/Parcel Data	No	Should be available from LACDPW
Slopes	Yes	
Soils	Yes	
Transportation Opportunities/Constraints	From Open Space Process Model	
Land Use	Yes	
Vegetation/Landcover	Yes	
CNDDB Occurrences	Yes	
Subwatersheds	Yes	
Blue Line Drainages	Yes	
Water Management Infrastructure	Yes	
Recreation and Open Space Feasibility		
Zoning	No	Should be available from local cities
Digital Orthophotos	Yes	
Land Use	Yes	
Land Owership/Parcel Data	No	Should be available from LACDPW
Transportation Plans	No	Should be available from local cities/SCAG?
Road/Railway	Yes	
Existing Trails	Yes	
Watershed Management Infrastructure	Yes	
Blue Line Drainages	Yes	
Subwatersheds	Yes	
Zip Codes	Yes	

Central to this process are four criteria upon which success of a planning process is measured: capacities for complexity, predictability, defensibility, and communicability. Ecosystems are complex. The ability to use and synthesize a great deal of information from various disciplines is required to analyze and plan for them. The ability to estimate the potential effects of design alternatives is critical in the ecosystematic design process. A clear and logically correct framework of objective observations that will support the final recommendations are also important. Integral to this process is the participatory inclusion of people who are affected by the final recommendations. Lastly, a successful ecosystematic design process is communicated in a clear, often graphic way that is understood by the general public.

Three organizational concepts guide the structure of ecosystematic design. The first concept is *scale*. The Arroyo Seco watershed comprises a workable scale, because it can easily be traversed in one day; it is not so large that it cannot be easily inventoried. Next is *design process*, the pattern of thought applicable to the ecosystem scale. Lyle divides the *design process* into three stages: the stage of romance, the stage of precision, and the stage of generalization. These are discussed further below. Finally, *order* "binds ecosystems together and makes them work" (Lyle 1985). To understand order, we need to understand the structural, functional and locational elements of an ecosystem.

The stages of the ecosystematic design process can be described in many ways. In the context of this project, the team is utilizing a three stage process (Lyle 1985). In the first phase, the *stage of romance*, members of the project team spent time together and spent time experiencing the site. Together, members of the team hiked, walked, drove and photographed the watershed. Also important in this early stage, were the discussions, debates and charettes to solidify a common vision, goals and objectives.

Moving from this *stage of romance* to the *stage of precision*, members of the planning team began mapping and developed suitability models. Suitability models are analytical maps showing relative suitability (high, medium, low) of a particular human activity or natural system. In our case, the project vision calls for an integration of flood management, stream naturalization, water resources, habitat rehabilitation, and educational and community recreational opportunities. It is in this stage, through mapping and modeling that the planning team begins to comprehend the structural, functional, and locational elements of the watershed. See Appendix D: *Spatial Analysis Process* for detailed Phase I mapping of flood management, habitat restoration, recreation, water quality and water recharge suitability.

In Phase II, during the *stage of generalization*, the team will synthesize the information from the first two stages to develop a set of recommendations for watershed management and restoration, with demonstration project sites identified. Section IV: *Restoring the Watershed: Feasibility and Planning Recommendations* synthesizes the recommendations of the project team and consultants.

4. PHASE II RESEARCH AND RECOMMENDATIONS DEVELOPMENT

In Phase II, five technical studies were developed for this project. The technical studies include Water Resources by Tim Brick; Habitat Restoration in the Arroyo Seco Watershed by Verna Jigour Associates; Water Quality by the Mountains and Recreation Conservation Authority; Hydrology, Hydraulics, and Geomorphology Engineering Information &

Studies by Montgomery, Watson, Harza; and Recreation & Open Space by the Mountains Recreation and Conservation Authority. These technical studies are found in the Appendices to this report.

The information from these reports are summarized within the historic and current context of the landscape in Sections II: The Arroyo Seco Watershed: An Historic Overview, and Section III: Current Conditions and Function in the Arroyo Seco Watershed. The historic context looks at physical elements of the watershed such as geology, hydrology and habitat, in terms of their structure and function. Serving as a baseline for restoration, we gain an understanding of what was once the landscape of this region. However, human disturbance to that landscape has resulted in current conditions of the watershed, summarized in Section III. In this section, alterations to physical elements of the watershed are discussed as a result of land use changes. In addition, there is a review of current land use issues. Restoration needs are determined in Section III, setting the stage for recommendations in Section IV.

The final recommendations were developed from the technical study findings and project team goals. This information is encapsulated in Section IV, Table IV-1: *Restoring the Watershed: Feasibility and Planning Recommendations*. The question of whether or not restoration is feasible is discussed at the beginning of this chapter. Then a restoration vision for the major components of the watershed is described. In other words, this is how the project team envisions the Arroyo Seco and other elements in physical and functional terms.

Recommendation goals and restoration guidelines are provided in Section IV, in the matrix Framework for Restoration Projects: Watershed Restoration Goals, Guidelines & Action Items. The purpose of this information is to give agencies a framework within which to develop project priorities. Action items within this table can be applied to projects or programs watershed-wide. Over 80 specific restoration projects and programs can be found in the final matrix, Recommendations for Projects and Programs. The projects are organized by subwatershed, subregions or city. With this format, a city or regional agency can select potential implementation projects that are appropriate for their jurisdiction. As a part of this table, general planning criteria are included to assist agencies in prioritizing projects that meet their mission, schedule and budget. The first planning criteria indicates which restoration goals the specific project will fulfill if implemented, such as improving water quality or enhancing recreational opportunities. In addition, estimates are given for number of years to complete each project. And finally, an estimated project costs are given for general planning purposes.

It is with these planning tools that the project can move to the next phases including planning and implementation. With anticipated funding from Proposition 13 and CALFED, the project team will move forward towards planning and implementation of the recommendations generated from this study. It is the intention of the project team to collaborate with partner agencies and stakeholders to ensure key restoration projects are funded and implemented in the next phases of the Arroyo Seco Watershed Restoration Feasibility Study.

II. THE ARROYO SECO WATERSHED: AN HISTORIC OVERVIEW

The Arroyo Seco watershed, in its current state, is the result of thousands of years of landscape evolution. This landscape can be described in terms of its structure and function, which through their interactions, result in change through time.

In order to understand the potential for restoring the Arroyo Seco watershed, it is important to understand the historic context which has resulted in the condition of the watershed today. In this section, an historic overview is provided describing the Arroyo Seco watershed in terms of its:

- *Landscape Structure*, the spatial arrangements and relationships between distinctive landscape elements (Forman, 1986), which includes factors such as climate, geology, soils, hydrology (including surface and groundwater), habitat (including vegetation), and cultural settlement patterns (including jurisdictional boundaries and land use);

- *Landscape Function*, the interaction of energy and materials between landscape elements (Forman, 1986), including flows of water, sediment, fire, energy, wildlife, as well as human systems such as transportation and recreation use; and

- *Landscape Change,* the evolution of structure and function over time which is the result of the feedback dynamics between landscape structure and function resulting in change through time (Forman, 1986). To illustrate the dynamics of change, descriptions and models are provided that characterize conditions of the watershed in the time prior to European settlement, the mission/rancho period, the agricultural period and finally, the more recent period of sub/urbanization.

In general, the trend of human influence on the landscape of the Arroyo Seco watershed has been to attempt to stabilize what are inherently dynamic systems. This information provides the background context for understanding how the watershed has evolved, in order that informed recommendations can be made to direct the future trajectory of change though time in a manner that sustains the watershed's key functions.

A. LANDSCAPE STRUCTURE

The Arroyo Seco watershed ranges from the San Gabriel Mountains in the north to the Los Angeles River in the south. It is comprised of diorite, monzonite and gneiss mountains, sandstone and shale foothills, and flatland floodplains. The mountainous upland zone receives higher amounts of rainfall than the foothills and lowlands, and stream flows in these uppermost reaches tends to be seasonal in response to this rain. In the foothill collection zones, seasonal rainfall runoff is collected and stored; springs and streams take on a perennial quality in these areas. In the lowlands, the main stream channel of the Arroyo Seco conveys collected drainage to the Los Angeles River.

The mountains can be found exclusively in the northern portion of the watershed; foothills form a ring around the north, east, and west of the main stream. To the south is the Los Angeles River and the sandstone hills at the eastern edge of the Santa Monica Mountains.

1. GEOLOGIC STRUCTURE AND TOPOGRAPHY

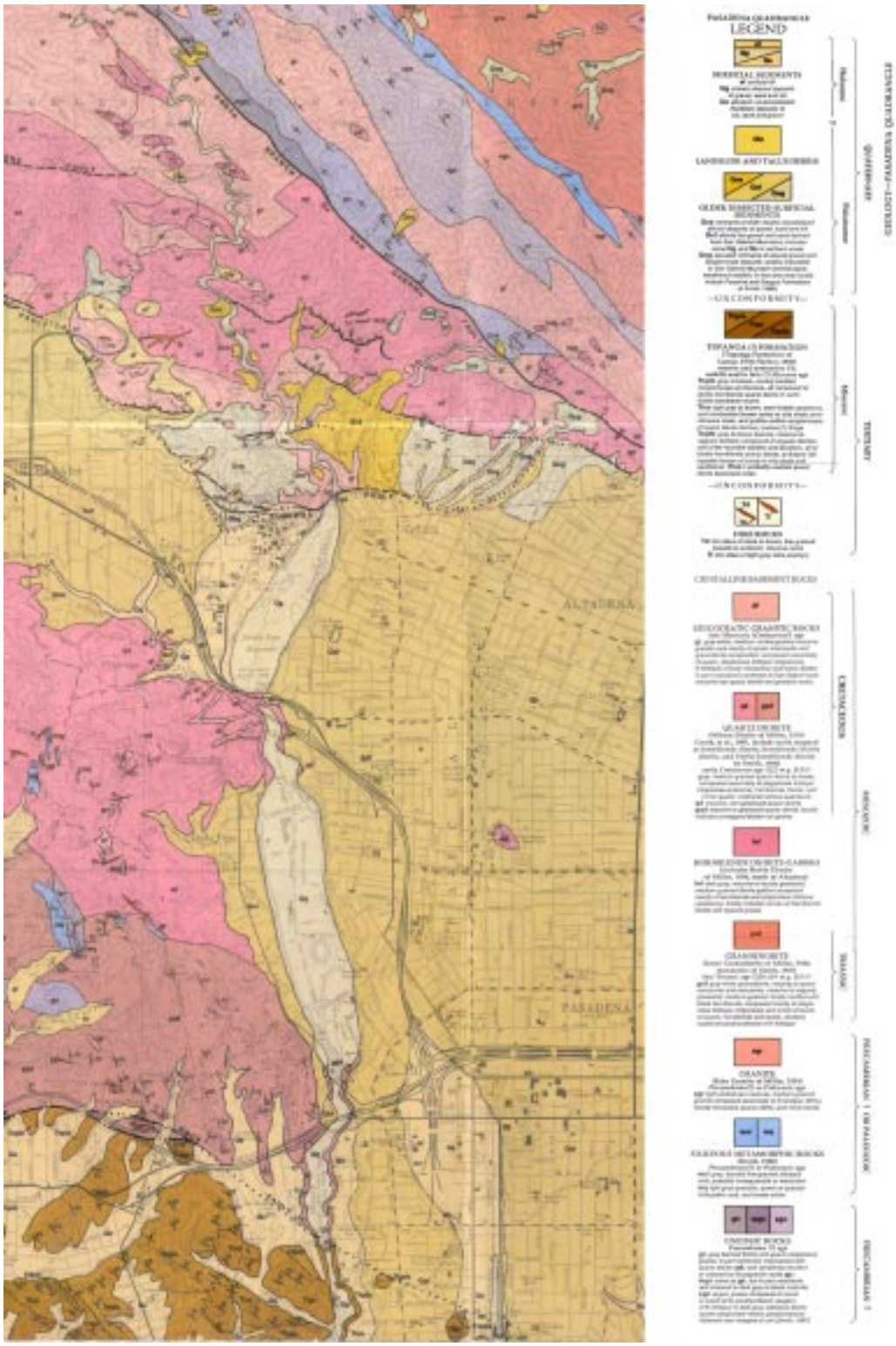
Geology divided the Arroyo Seco into three distinct sections with very different hydrologic characteristics: 1) the precipitous upper mountain watershed; 2) the Raymond Basin area including Pasadena and surrounding communities; and 3) the region below the east-west trending Raymond Fault in South Pasadena and northeast Los Angeles.

a. Mountainous Upper Watershed

Eleven of the 22 miles, or half, of the primary Arroyo Seco drainage are located in the mountainous, upper reaches of the watershed. The upper watershed also represents 32 of the approximately 47 square miles of the entire watershed. This is the front range of the Sierra Madre or San Gabriel Mountains, well-known for their harsh conditions. Geologic processes have been forming the rugged San Gabriel Mountains for more than one hundred million years. The San Gabriels stand on a massive block of the earth's crust, in which the Arroyo Seco is found, separated from the surrounding landscape by a network of major faults—the San Andreas Fault on the north, the San Gabriel and Sierra Madre faults on the south, and the Soledad fault on the west. The great block itself is also fractured by numerous subsidiary faults.

The San Gabriel Mountains, the northern portion of the Arroyo Seco, and the San Rafael Hills on the west consist of crystalline bedrock assigned to the Wilson Diorite, Rubio Diorite and unnamed units of quartz monzonite and gneiss (Figure II-1: *Geology*). The bedrock is Cretaceous and Pre-Cretaceous in age. Most of the parent bedrock is igneous, but the rocks are highly fractured and weathered – decomposing rapidly when exposed to the elements.

The upper watershed is rugged and erosion-prone with a network of more than 20 deeply incised V-shaped canyons. The San Gabriel Mountains are relatively steep, with 67 percent of the landscape at slopes of over 60 percent . Elevation in the upper watershed ranges from 990 feet at the base of Devil's Gate Dam to 1160 feet immediately north of NASA's Jet



Source: Dibblee, 1989

FIGURE II- 1: GEOLOGY

Arroyo Seco Watershed Restoration Feasibility Study

Propulsion Laboratory, with the highest point in the watershed, Strawberry Peak, at an elevation of 6,164 feet.

b. Lower Arroyo

The lower half of the watershed is distinctively different from the upper watershed. Below the Jet Propulsion Laboratory (JPL), the Arroyo Seco is eleven miles long extending from the base of the San Gabriel Mountains to the Los Angeles River. Near JPL, the Arroyo Seco emerges into the alluvial plain of the San Gabriel Valley. Most of this plain, which includes Altadena and Pasadena, drains easterly to the Rio Hondo and the San Gabriel River. This stretch of the Arroyo lies between the La Cañada Alluvial Fan on the west and the Altadena Alluvial Fan on the east. The fans are underlain by older alluvium. The alluvium is Pleistocene to Holocene in age. In these lower reaches of the Arroyo Seco, the underlying material is younger and older alluvium and stream channel deposits. At Devil's Gate Dam, the bedrock material is highly-weathered, fractured diorite gneiss. In general, surface weathering rates are large and these surfaces are the primary source of the sand and silt being washed out of the canyon during rainfall events.

In the Pasadena portion, the Arroyo has cut three major geologic basins: the Hahamongna/ Devil's Gate basin (1.5 miles long) at the foot of the mountains, the Pasadena Central Arroyo (2.5 miles long), which includes Brookside Park and the Rose Bowl, and Pasadena's Lower Arroyo (1.5 miles long), which extends from the Colorado Street Bridge to the City of South Pasadena boundary just south of the Raymond Fault. Historically, portions of the Arroyo are the result of natural confinement resulting from outcrops of hard, crystalline bedrock on both sides of the valley. Below the Raymond Fault, the Arroyo Seco reaches a broad alluvial wash lined by the Monterey Hills, Montecito Heights, Mount Washington and the Verdugo Hills.

In La Cañada Flintridge, the northwest corner of the watershed, several canyons including Hay Canyon, Gould Canyon and Winery Canyon flow into the Arroyo Seco by way of Flint Wash, which is a major tributary to the Arroyo Seco. Flint Wash begins near the Descanso Gardens area and runs along the toe of the San Rafael Hills in the Flintridge area, carrying all the flow from these canyons as well as street runoff into Hahamongna where it enters just west and north of Devil's Gate Dam.

2. SOILS

Shallow, coarse textured soils occur extensively throughout the upper watershed. These are recently formed soils that exhibit little profile development. The substratum typically occurs within 20 inches of the surface and may range from very soft, weathered material to hard, but highly fractured rock. In the Raymond Basin area this material often consists of alluvium that transmits water readily and allows it to percolate into the groundwater basin.

3. HYDROLOGY

Flowing water and rich soil conditions endowed the Arroyo Seco communities with a rich natural heritage. In La Cañada, streams flowed out of the mountain canyons and across the foothills and flatlands into what is now Flint Wash, which enters the Arroyo Seco just to the north and west of Devil's Gate. While most of Pasadena tilts away from the Arroyo Seco towards the Rio Hondo, hundreds of years ago abundant springs and streams lined the western part and the southern rim of that city. Below the Raymond Dike, which lines the southern boundary of Pasadena, more springs bubbled from the ground on the Arroyo ridges as the main Arroyo stream flowed for five more miles to the Los Angeles River.

Highland Park and Garvanza were so rich in springs that pioneers thought it sat on a "sea" of underground water.

The original inhabitants of the Arroyo Seco, the Tongva, called the Arroyo "Hahamongna", which means "Flowing Water, Fruitful Valley."

i. Climate

In order to understand the hydrologic patterns of the watershed, it is important to first understand the climate of the region and the general resulting precipitation patterns. In general, the climate of the region within which the Arroyo Seco is found can be described as Mediterranean-type. This climate type is characterized by long, hot, dry summers and cooler, wet winters. This pattern is an important factor in the hydrology and habitat structure of the watershed. Ninety-five percent (95%) of the precipitation occurs from November to April with seventy-five percent (75%) occurring from December to March. In the higher elevations, some of this precipitation is manifested as snow. Precipitation increases with altitude. The average annual precipitation is twenty inches (20") in the lower elevations and up to thirty inches (30") in the higher elevations. Most years, however, deviate substantially from these averages as many seasons of drought and flood occur. Climatic records show dramatic cyclic variations with little predictability.

ii. Surface Hydrology

The watershed is comprised of two major components – the upper watershed above Devil's Gate Dam and lower watershed below the dam (Figure II-2: *Arroyo Seco Drainage Area*). The drainage area above the dam is 31.9 square miles; the drainage area above the confluence of the Arroyo Seco and the Los Angeles River is 47.4 square miles. Historically natural springs and surface flows dotted the Arroyo Seco.

The Arroyo Seco currently has 20 main tributaries. Upstream of Devil's Gate Dam the main Arroyo Seco tributaries (listed from upstream to downstream) include Colby Canyon, Little Bear Canyon, Bear Canyon, Long Canyon, Dark Canyon, Brown Canyon, Pine Canyon, Falls Canyon, Fern Canyon, El Prieto Canyon, and Millard Canyon. Just north of Devil's Gate gorge, Ivey Springs on the west and Thibbet Springs on the east bubbled to the surface. The presence of a continual stream flow in the upper watershed even during the driest years reveals a significant contribution of groundwater (spring) supplies to the Arroyo Seco stream where these subsurface flows intersect with the surface.

At the bottom of the Devil's Gate gorge on the east side of the Arroyo, fifteen to twenty feet above the stream bed, were Flutter Wheel Springs, a series of springs that extended for several hundred feet. Two and a half miles further south at the entrance of another gorge that begins just south of Brookside Park and proceeds to the Colorado Street Bridge, Sheep Corral Springs gushed out of the gravel of the Arroyo bed. A bog or cienega existed at San Rafael Springs or Johnson's Spring located on the west bank of the Arroyo, nearly opposite the foot of California Street.

Just opposite the foot of West Columbia Street, San Rafael Creek enters the Arroyo. This creek formed the principle drainage of the lower San Rafael area. In San Rafael canyon there was located a small waterfall, Puddingston Falls, which formed a pot hole at their foot.

The Raymond Fault created a tremendously rich area hydrologically. Springs and streams flowed all along the base of the fault from Highland Park through Pasadena, South Pasadena and San Marino. On the west side of Raymond Hill on the rim of the Arroyo in South Pasadena were Garfias Springs. Other springs flowed on the east side of the hill and along its base. Further south were springs at Casa de Adobe near Avenue 54 and extensive wetlands

FIGURE II-2: ARROYO SECO DRAINAGE AREA

Arroyo Seco Watershed Restoration Feasibility Study

near the confluence with the Los Angeles River. At the Raymond Fault, the Arroyo Seco stream enters a hill-lined canyon (5.5 miles) with a wide alluvial wash .

The Highland Park area was particularly rich in a hydrologic sense. A major tributary of the Arroyo Seco, called the North Branch, flowed for six miles through northeast Los Angeles from the Annandale area of the San Rafael Hills near Poppy Peak. The stream flowed along Figueroa Street to Branch Street and then Aldama Street flowing into the Arroyo Seco at Sycamore Grove Park. The North Branch was fed by a series of healthy springs including Springvale and Glen Rock Springs. There were also numerous springs in the area about York Boulevard and Figueroa Boulevard and along Sycamore Grove Park (Appendix E: *Water Resources Technical Report*, Figure II-3: *Arroyo Seco Historic Springs*).

iii. Groundwater

Beneath the surface of the Arroyo Seco watershed lies a complicated groundwater system. In the Arroyo Seco watershed, the majority of the groundwater historically infiltrated at the base of the San Gabriel mountains. While the stream bed of the Arroyo Seco often appeared dry, there was generally subsurface flow, which generally moved away from the mountains, towards the alluvial plain and the Los Angeles River.
The most prominent component of this system is the Raymond Basin, a forty square mile aquifer which results from the alluvial deposits originating in the San Gabriel Mountains. This Raymond Basin is located north of the Raymond Fault. Below the Raymond Fault in South Pasadena and northeast Los Angeles, a limited underground flow moves toward the Los Angeles River.

Historically, points of contact between the water table of the groundwater aquifer and the ground surface resulted in surface springs and flows. Geologic conditions determined where subsurface flows were forced towards the surface.

An interesting characteristic of the groundwater system below the Arroyo Seco is that it overlaps adjacent surface watersheds including the Verdugo Wash watershed to the west, and the Rio Hondo watershed to the east. As a result, some surface flows in the Arroyo Seco watershed eventually percolate into aquifers that underlie other surface watersheds. Likewise, many tributaries of Verdugo Wash and the Rio Hondo feed the Raymond Basin (Appendix E: *Water Resources Technical Report*, Figure II-4: *Arroyo Seco Groundwater Basins*).

The Raymond Basin is a groundwater aquifer that underlies the cities of Pasadena, Sierra Madre, Arcadia, Altadena, San Marino, and La Cañada Flintridge and is bound by the San Gabriel Mountains to the north, the San Rafael Hills to the west and the Raymond Fault on the south and the east. The basin slopes to the south, with elevations from 1,500 feet above sea level at the toe of the San Gabriel Mountains to 500 to 700 feet at the Raymond Fault. The Arroyo Seco, Eaton Canyon and the foothills of the San Gabriel Mountains feed the Raymond Basin. Those groundwaters are stored in thick alluvial deposits of fan origin that were laid down on an irregular bedrock topography. The Raymond Basin then is like a bowl of sand and gravel or alluvial material that has washed down from the mountains and is filled with water. The bowl tilts to the southeast where there is some overflow into the Main San Gabriel Basin. Groundwater levels on the north side of Raymond Fault are 200 to 300 feet higher than on the south side of the fault.

The Raymond Basin is divided into three subareas. The northwest portion of the basin, the Monk Hill subarea, includes La Cañada Flintridge, Altadena and northwest Pasadena down to Monk Hill just north of Washington Boulevard. The main basin is the Pasadena Area,

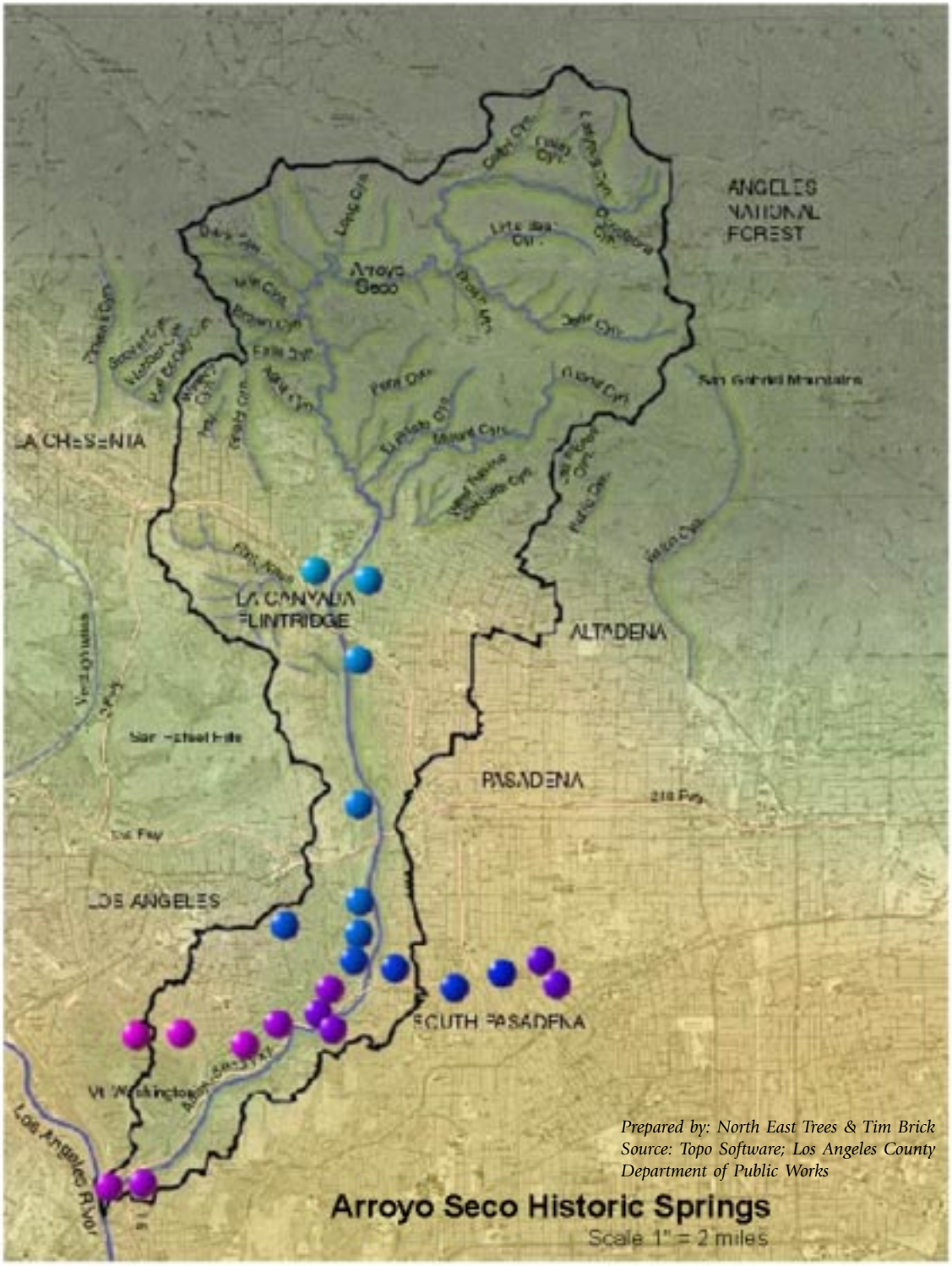
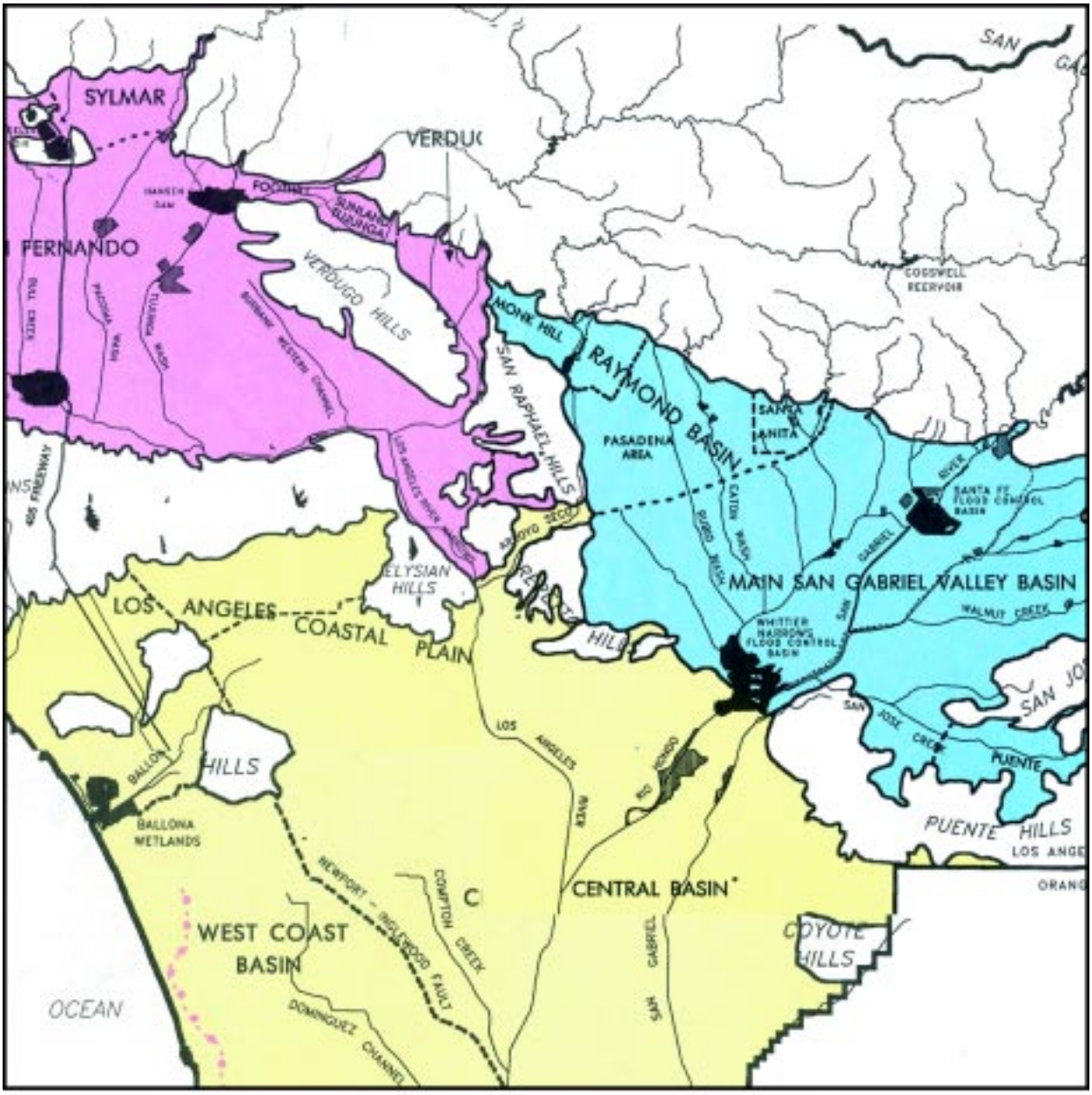


FIGURE II-3: ARROYO SECO HISTORIC SPRINGS

Arroyo Seco Watershed Restoration Feasibility Study



Los Angeles Region Groundwater Basins
adapted from the California Regional Water Quality Control Board

FIGURE II-3: ARROYO SECO GROUNDWATER BASINS

Arroyo Seco Watershed Restoration Feasibility Study

found under Pasadena. The Sierra Madre subarea makes up the northeastern corner of the basin.

Recharge to the groundwater of the Raymond Basin results from the percolation of stream flows originating in the mountains to the north, deep penetration of rain falling on the alluvial surfaces and returns from delivered water used for irrigation or discharged to cesspools. The basin is fed by the Arroyo Seco including Millard Canyon from the east and Flint Canyon from the west, Las Flores Canyon, Rubio Canyon, and Eaton Canyon. Spreading grounds in the basin are located in the Arroyo Seco, Eaton Wash, Sierra Madre and Santa Anita Canyon.

4. HABITAT/VEGETATION

The development and evolution of habitat in the Arroyo Seco watershed is in part due to the dynamics between the geology, topography, climate and hydrology of the area. Historically, the watershed supported a 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 (USFS 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 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.

These plant communities respond to site conditions such as slope, solar aspect, water conditions, and soil. In many regards, plant communities that are native to particular micro environments facilitate the transfer of nutrients and water. Coniferous forests and oak and walnut woodlands slow and filter rainfall runoff. Water adheres to both the leaves on the trees and the leaf duff on the ground. In some cases, such as chaparral and perennial bunchgrasses, the deep root system provides a pathway for rainfall to infiltrate, thus promoting groundwater replenishment (Appendix F: *Habitat Restoration in the Arroyo Seco Watershed*).

B. LANDSCAPE FUNCTIONS

While factors such as geology, topography, hydrology and habitat shape the structure of the watershed, the flows of energy and material define landscape function. Fierce rainstorms and raging forest fires periodically attack the steep erosion-prone slopes in this relatively small upper watershed (32 square miles) to create the conditions for substantial floods that occasionally roar into the heavily populated communities below.

1. GEOMORPHOLOGY & FLOWS OF SEDIMENT

The Arroyo Seco can be divided into two broad segments from a geomorphological perspective, the upstream segment in the San Gabriel Mountains (upstream from the JPL bridge) and the downstream segment (downstream from the JPL bridge).

The upper portion of the watershed is a steep, confined mountain stream that transports the high natural sediment load fairly quickly downstream. It is often said that the San Gabriel Mountains. are among the fastest growing in California. As uplift occurred, the forces of gravity combine with precipitation to cause rapid erosion. Runoff in the upper watershed deeply incised into the underlying crystalline basement rocks (diorite, granodiorite and gneiss) that were covered in chaparral and pines. The majority of sediment supplied to the Arroyo Seco comes from erosion processes in the upper, mountainous portions of the watershed. The extremely steep slopes, periodic removal of vegetation by wildfires, and infrequent intense rainfall resulted in high and extremely variable sediment inputs to the stream. With periodic flushing of the drainages, scouring of the accumulated sediments would carve deep canyons.

As the sediment-laden runoff would reach the opening of the Arroyo canyon into the floodplain, the water velocity would slow, depositing sediment into the alluvial plains and valleys. The area of the watershed downstream from JPL is an alluvial fan system. Alluvial fans are generally depositional environments, where sediment loads are deposited as the stream transitions from a higher gradient, confined reach to a lower gradient, less confined stream channel. As a result, under unmanaged conditions, the stream channel in the lower segment would have been active, either braiding or meandering across its valley, and characterized by channel shifting during high flows. Occasionally, as large storms would create high rates of runoff from the mountains, the stream would cut through the alluvial deposits to create a series of terraces.

2. FLOWS OF WATER

Based on the climate of the region, the majority of precipitation would occur during the winter months with very little significant rain in the summertime. As such, the majority of surface runoff flow would occur during the winter. This is also indicated by the name assigned to the Arroyo Seco by early European settlers. While the Native Americans in the watershed referred to the canyon and stream as "Hahamongna", which translates to "Flowing Water, Fruitful Valley", European settlers assigned the name Arroyo Seco, which translates from Spanish to English to mean *dry stream*. As moisture-laden air masses would move into the Los Angeles basin, the San Gabriel Mountains would force the air to rise, cool and eventually release the moisture in the form of precipitation. Combined with the landforms and springs created by groundwater pressure, runoff would occur, eventually forming stream channels. Where pervious substrates such as alluvium occurred, the runoff would have percolated into the ground where it would flow in the form of underground "streams" or accumulate in underground basins creating aquifers. The flow of runoff would have been closely affected through a complex series of feedback dynamics to influence slopes, soils, vegetation cover, and wildfire potential.

3. FLOWS OF WILDLIFE

One of the largest predators to occupy the Los Angeles River watershed was the grizzly bear. Other significant predators included the mountain lion, the bobcat, the grey fox and the

coyote. While the grizzly bear has long since been driven out of the Los Angeles area, the mountain lion and bobcat continue to live in the Angeles National Forest. Coyotes occupy not only the Angeles National Forest, but also a number of habitat patches in Mount Washington and the San Rafael Hills. The black bear was introduced into the region, and inhabits more secluded portions of the Angeles National Forest.

Many other species were also supported by the diverse environments of the watershed. Some of these are considered target species for restoration efforts. The coast horned lizard, greater roadrunner, lesser nighthawk, California quail, oak titmouse, cactus wren, and California gnatcatcher . Animal species that inhabited riparian areas include the arroyo toad, southwestern pond turtle and arboreal salamander. The steelhead trout, Pacific lamprey, unarmored threespine stickleback, arroyo chub, Santa Ana sucker, and Santa Ana speckled dace are among the species that lived in the Arroyo Seco stream itself (Appendix F: *Habitat Restoration in the Arroyo Seco Watershed*).

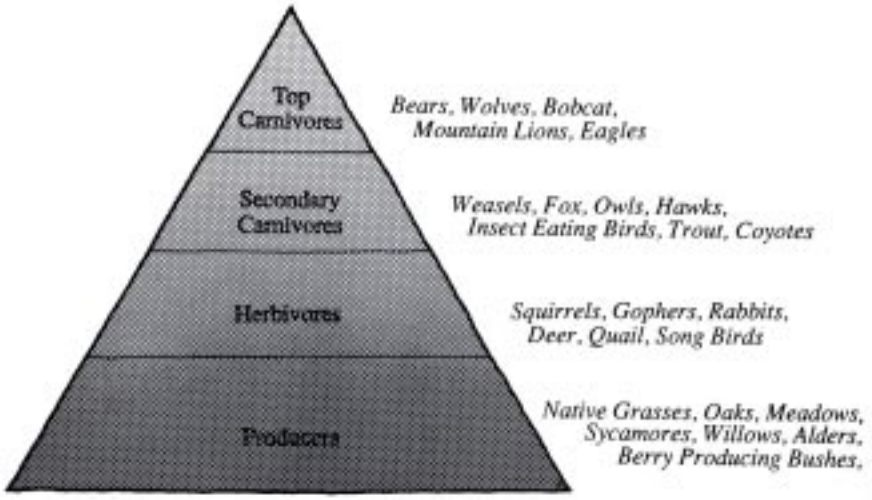
Without impediments to wildlife movement, populations of wildlife were able to disperse from the Arroyo to other adjacent habitat areas and beyond throughout the region. This provided the opportunity to maintain a healthy gene flow between populations. The ability to disperse also provided opportunities for seasonal migration and escape during episodic disturbance such as fire and flood.

4. FLOWS OF ENERGY

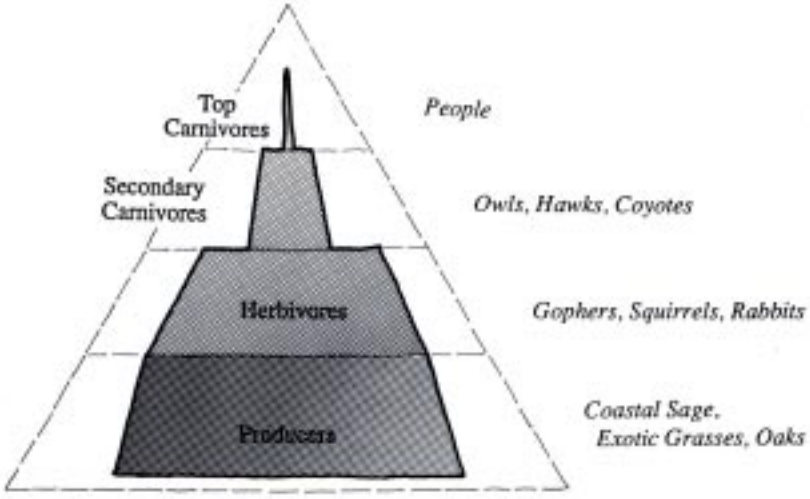
Historically, flows of energy through the ecosystems of the Arroyo Seco watershed traveled through a variety of trophic levels (Figure II-5: *Historic Trophic Structure*). Plants generated energy through photosynthesis which provided forage materials for herbivores such as insects, herpetofauna, birds and small mammals. These organisms were in turn consumed by larger, omnivorous and carnivorous animals. Overall, the trophic structure would have resembled a pyramid where energy was accumulated up the food web with large predators such as bears, mountain lions, bobcats and grey fox representing the top tiers of the system. As energy would move up the trophic structure, there would be a net loss of biomass/energy. Thus, population sizes would decrease up the trophic structure. Decay of biomass would then provided nutrients for plants. With a full-spectrum of species, population dynamics would have fluctuated around a general equilibrium.

5. FLOWS OF FIRE

Fire historically has been one of the key ecological process in the watershed, particularly in the mountainous areas. This is evidenced in fossil records which reveal charred plant material (Byrne, 1978). Evolutionary adaptations to fire are also evident in the physiological and physical characteristic of many chaparral and coastal sage scrub species (Keeley, 1986). The majority of fires would have been ignited by lightning (Burcham, 1974). These occurrences would often coincide with precipitation. As fuel moisture is a significant factor in determining the extent and intensity of wildfires, it can be concluded that fires ignited by summer lightning were probably of low intensity (McCutchen, 1981). In addition, most of the lightning ignitions begin at higher altitudes where the overall fire potential is lower (Keeley, 1981). Also , these small , low-intensity fires created a feedback effect whereby a patchwork of fuel accumulation was created which varies with age. As a new fire progressed through chaparral, its spread was inhibited by the lack of fuel in younger stands of vegetation which had grown after a more recent burn. The result was a fine fire mosaic pattern which creates a fire regime characterized by smaller fires which occurred on a more regular basis



ECOLOGICAL PYRAMID: Past



ECOLOGICAL PYRAMID: Present

Source: California State Polytechnic University, Pomona, 606 Studio, Department of Landscape Architecture, 1988.

FIGURE II-5: HISTORIC TROPHIC STRUCTURE

Arroyo Seco Watershed Restoration Feasibility Study

over time and space (Minnich, 1985). This evidence is reinforced by accounts of early European settlers which show that such a mosaic of open areas and dense shrubland existed (Burcham, 1974). If these are the characteristic which defined the pre-human fire regime of shrub-dominated communities, then it is possible to evaluate how humans have altered this fire regime and the consequences of these changes.

With human influence in the watershed, ignitions became more frequent and during times of year when fire did not necessarily historically occur. Since 1896, there have been at least six major wildfires in the Arroyo Seco watershed (Appendix E: *Water Resources Technical Report*). The largest of these fires occurred in 1959, affecting 10,729 acres. Fire management in the forest has historically been approached through suppression activities, which resulted in an accumulation of fuels (vegetation). Small fires would be contained quickly, and large fires raged uncontrolled over larger areas. These management practices have resulted in the development of more homogeneous stand of vegetation, eliminating the finer fire mosaic. This reduced the natural barriers to larger scaled fires resulting in faster, more widespread fires. These types of fires, which were probably less frequent during pre-European settlement, can reduce the reproductive ability of the vegetation and affect wildlife.

Coastal sage scrub ecosystem health is greatly influenced by the frequency of fire disturbance. Due to the morphology of component species and the type of terrain it typically occupies, coastal sage scrub burns easily. When subjected to multiple burns in a shorter amount of time (such as within a year or two), this vegetation can convert to annual, non-native grasslands. Fire regime, which includes variables such as fire frequency, seasonality, size and intensity, greatly affects coastal sage scrub and chaparral.

Local fires interact with floods to compound their effects. Fierce flames from the altered plant mix bake the soil surface at about 700 degrees and result in impervious soil. Next, heavy rains strike the exposed surface, dislodging soil particles. Water that once infiltrated into the mountains and the groundwater basin flows quickly over the ground surface transporting sediment downstream in significantly larger quantities than in historical conditions. Water that infiltrates during prolonged wet periods reduces the stability of steep slopes and leads to land slides, which now occur more quickly because the roots of native vegetation are no longer stabilizing the soil to the rock beneath. These larger masses of sediment are washed out of the canyons sooner, because flood peaks are occurring more quickly as the run-off process shifts toward more surface runoff. Local geology is such that exposed bedrock decomposes rapidly when exposed to the elements to generate new soil, keeping the destructive processes intact.

Chaparral is the dominant vegetation type in the upper Arroyo Seco watershed. This vegetation type typically burns every 20 to 40 years in the southern California mountains. The US Forest Service (USFS) is responsible for fire suppression and prevention. USFS has determined that since 1878, 61 percent of the watershed has burned twice, 29 percent has burned once, 5 percent has burned 3 or 4 times, and the remaining 5 percent has never burned. Because of the dominance of mature chaparral in the watershed and the history of wildfires, USFS manages the watershed assuming the chance of an extremely large wildfire is very high. As a result, USFS has developed a program of controlled burns to remove high-fuel vegetation. The LACDPW August 1993 report notes that funding and environmental constraints have prevented the USFS from fully implementing the fire prevention program. Recent annual burns of 194 acres in 1997, 81 acres in 1998, and 20 acres in 1999 fall far short of the goal of 3,500 acres per year. Thus the potential for high flood flows and sediment loads to be generated from a burned upper watershed is very high.

C. LANDSCAPE CHANGE THROUGH TIME

The dynamic between structure and function resulted in changes through time through complex, dynamic feedback loops as well as in response to periodic disturbances such as fire and flood. However, the insertion of human induced disturbance has likely drastically redirected the pre-settlement trajectory of change by influencing the structure and function of the landscape. As humans have become an integral part of the landscape, it is important to understand how the insertion of the human variable has affected landscape dynamics. Water was the attraction that brought the first settlers and succeeding generations to the Arroyo Seco. The management of water is also one of the key variables that has driven human history and landscape change in the watershed.

1. PRE-EUROPEAN SETTLEMENT

It is likely that the presence of abundant natural resources attracted Native American settlement in the Arroyo Seco area. This is indicated by the name given to the region between the Los Angeles and San Gabriel Rivers by the Tongva Native Americans (or Gabrielino, meaning "children of Gabriel", as they were named by Spanish settlers after the San Gabriel Mission) , which was Hahamongna meaning "the land of flowing waters, fruitful valley."

These early human inhabitants settled on bluffs overlooking the stream that linked the San Gabriel Mountains to the Los Angeles River. On the banks of Millard Canyon, the Gabrielinos established one major settlement. Further south were three known minor settlements, including: a village on the banks of a brook on the east side of Raymond Hill, another at Los Robles Canyon in Oak Knoll, and a third at Garfias Springs on the banks of the Arroyo. Just west of the confluence of the Arroyo Seco and the Los Angeles River in what is now Elysian Park, the Tongva established another major village, Maungna, on a bluff overlooking the Arroyo Seco.

The combination of substantial runoff from nearby high mountains, large volume of alluvial deposits which absorb the flood flows and a natural underground dike (the Raymond Fault) that forced groundwater to the surface, resulted in perennial springs and artesian wells that were used by the Tongva.

2. THE MISSION & RANCHO ERAS

Settlers entering the region followed the Tongva practice of locating near the Arroyo or near the flowing springs. The San Gabriel Mission, established in 1771, was in part sited to take advantage of water resources. Though the mission was established outside of the Arroyo Seco watershed, the Spaniards still utilized its resources and dubbed the watershed Arroyo Seco or "dry stream", the meaning of which is notably different than that of the Tongva.

A significant source of water for the mission were the springs and artesian wells that were created by conditions around the Raymond Fault. This water was tapped by the padres of the San Gabriel Mission. The Spanish and Mexican settlers of the early 1800's tapped these rising waters for such purposes as operating a mill, a sawmill, and a tannery in addition to domestic uses. The other major settlement, the Pueblo of Los Angeles, staked out an exclusive "pueblo" water rights claim to the Los Angeles River.

Following the establishment of the missions in the late 1700's, the Spanish government began granting lands to veterans of the Spanish army of occupation. Thus, these rancheros,

as they were known, became the first private land owners in California and the Arroyo Seco watershed. These land grants included areas that were outside of the mission and pueblo areas and they often included some of the best valley grazing lands. In the Arroyo Seco watershed, the first grant was given to Jose Maria Verdugo in 1784. The area covered by this grant includes what is known today as the Rancho San Rafael tract. This grant included 36,000 acres and extended from the western edge of the Arroyo Seco north to Devil's Gate, south to the boundary of the Los Angeles pueblo near current day Debs Park, and the east bank of the Los Angeles River towards and including what is now the City of Glendale and portions of Burbank. The lower Arroyo Seco watershed was included within the Pueblo of Los Angeles boundaries. The eastern side of the watershed was included within the San Gabriel Mission boundaries.

In 1819 Joseph Chapman, the first Anglo settler in southern California, found lumber to build the old Plaza church and much of the early pueblo Los Angeles in what he called "Church Canyon," later known as Millard Canyon, a tributary of the Arroyo Seco. Chapman established the first sawmill on the west coast there, indicating the forested nature of the mountains at that time.

In 1822, control of California transferred from Spain to Mexico. One of the results of this transition was the eventual secularization of the missions which was complete by the mid-1830's. This marked the beginning of the rancho period and the disposition of former mission lands as Mexican grants. Some of the ranchos in the watershed included Rancho San Pascual, Rancho La Cañada as well as Rancho San Rafael, which was a remnant of the original Spanish land grant to Verdugo.

Because the natural rainfall was insufficient to maintain agricultural crops on a year-round basis, settlers soon discovered how to tap the springs along the Arroyo that flowed perennially. The first orchards, subdivisions, and settlements were made possible by piping water from the numerous springs along this water table or by pushing horizontal tunnels back into the hills to tap the waters held in the immense bed of gravel that fed the aquifer beneath.

3. THE AGRICULTURAL PERIOD

1846 marked the beginning of the American occupation of California. From this time until California gained statehood in 1850 as part of the United States, many Americans from other parts of the country immigrated to California. As a result of the Gold Rush and the ending of the Civil War, publicity of California as a destination for settlers proliferated. The resulting surge in population eventually led to a policy of subdividing the Mexican land grants which further led to the development of towns and intensification of agriculture and ranching.

In 1863, the Los Angeles Water Company was formed. Prior to development of water conveyance systems by this organization, water was hauled by hand from ditches, known as zanjas, and rivers and streams. The Arroyo provided a major water supply for the growing city of Los Angeles. In 1870 the Buena Vista Reservoir was built in the hills of Elysian Park immediately west of the confluence of the Arroyo Seco and the Los Angeles River. In the 1880's, the reservoir was expanded and other facilities were constructed to tap the river for a rapidly growing population. In 1904 William Mulholland and Los Angeles built the southernmost of this series of diversion facilities, the Narrows Gallery, to maximize the amount of water that could be diverted from the river. A 1,178 foot tunnel was drilled at a depth of 115 feet through the bedrock beneath the Los Angeles River up the Arroyo Seco.

Nine wells were drilled to allow water to percolate into the tunnel where it was then collected and conveyed through the "Zanja Madre", or "Mother Ditch", to downtown Los Angeles. Eventually, Mulholland recognized that the Los Angeles River could not supply adequate volumes of water to support the burgeoning city. The Los Angeles Department of Water and Power abandoned the Narrows Gallery more than fifty years ago after obtaining new sources from the Owens Valley and the Colorado River.

At around the same time as the formation of the Los Angeles Water Company, Benjamin Eaton, who moved to the Rancho San Pasqual a few years before, experimented with growing grapes without irrigation, something that had never been done before in southern California. Eaton's grapes flourished, and soon the regional demand for grapes and wine increased. Realizing the limitations of dry farming, Eaton in 1867 helped Benjamin Wilson and William Griffin, the owners of the ranch, to build "Wilson's Ditch," the first attempt to export water from Devil's Gate in the Arroyo Seco to the mesa lands of their rancho. The water was further conveyed by wooden pipes. This success lead to the eventual immigration of a group of settlers from Indiana in the 1870's. The demands created by these settlers lead to Eaton's development of a water system to serve the colony. This time, using iron pipes, Eaton brought water from Devil's Gate in the Arroyo Seco through three miles of pipe to a 3,000,000-gallon reservoir located a few hundred feet north of the present intersection of Colorado Street and Orange Grove Avenue on the hill that is now home to the Pasadena Historical Museum. From there the pipeline ran south on Orange Grove Avenue to the lower Indiana Colony lands extending into what is now South Pasadena.

The Indiana Colony incorporated the San Gabriel Valley Orange Grove Association, whose main task came to be the development of an adequate water system. When the association sunseted after ten years, three land and water companies assumed responsibilities for developing Pasadena and its water system: 1) the Pasadena Land & Water Company (west of Fair Oaks), the Lake Vineyard Land & Water Company (east of Fair Oaks), and the North Pasadena Land & Water Company (2000 acres of north Pasadena between Lake and the Arroyo). Development of water systems included:

- The first wells into the Raymond Basin just north of the Raymond Dike which were drilled in 1881
- A water wheel , which was constructed in 1883 to bring water to the Linda Vista area west of the Arroyo
- The first major dam for irrigation in the Arroyo Seco, which was constructed in 1887 and consisted of a six foot rock wall and bridge at the present site of the Colorado Street Bridge. Water from the pond behind the dam was pumped to the land above, where groves of oranges and avocados flourished. Portions of the dam still can be seen today by the diversion structure under the bridge.
- A windmill at the base of the present La Loma Bridge, which pumped water up to irrigate the Campbell-Johnstone lands in the San Rafael section of southwest Pasadena.
- A series of tunnels in the Devil's Gate area built in 1891, the largest of which was 4,730 feet.
- A subsurface dam built between 1897 and 1904 at the Devil's Gate to increase percolation of mountain runoff and the flow in the tunnel system

It is apparent that many came to understand the dynamics of watershed management as it related to forest protection. Theodore Lukens, who was mayor of Pasadena in 1894, noted that, "During the summer of 1896, the Watershed from which Pasadena drew its water supply was burned. The next year our supply had so shrunken as to nearly cause a famine.

We were compelled to sink wells and pump in order to live." In 1911 he stated "Pasadena does not need to look elsewhere for water now or in the future, if she will take care of the watershed from which her supply of water now comes."

Renowned engineer J. B. Lippincott had a very different view. Lippincott, who along with Mulholland played a key role in developing Los Angeles' supply of water from the Owens Valley, was hired in 1898 by Pasadena to assess local water resources. He warned city officials that local sources were being rapidly depleted and stressed the need to develop outside sources promptly. As pumping increased to meet the needs of a growing population, groundwater levels continued to fall. By 1908 there were 141 wells in operation in the Pasadena area. In 1914, after consolidating the three land and water companies that had developed Pasadena's early water system into the municipal water department, Pasadena began a spreading program in the Arroyo Seco and along the foothills to replenish the Raymond Basin by percolating storm runoff through the gravel beds. The spreading continued until 1924 when the program was discontinued in the midst of a drought. The spreading was later revived and now is a major factor in replenishing the Raymond Basin.

4. URBAN/SUBURBAN PERIOD

Through the urbanization of the Arroyo Seco, the patterns of expanding growth have lead to the erosion of individual community identity, particularly those communities within the City of Los Angeles boundaries (Garvanza, Highland Park, Montecito Heights, Mt. Washington, Lincoln Heights, etc). This was largely affected by issues of water resource availability to these communities.

Los Angeles grew to be one of the largest cities in the US in size and population largely due to its tight hold on water supplies. In 1899 the Arroyo Seco communities of Highland Park and Garvanza voted to annex to Los Angeles for this reason. Within a few years the community of Arroyo Seco followed. Later, when the river supply proved insufficient, communities such as Eagle Rock were force to annex to LA to obtain the imported supplies from the Owens Valley. Once the Metropolitan Water District was formed in 1928 through a unique partnership led by Pasadena and Los Angeles to bring the Colorado River to Southern California's coastal plain, the pressures of annexation to Los Angeles eased.

By the early 1920's water had become a critical problem for most southern California cities. Pasadena was particularly hard-hit and aggressive in its pursuit of new supplies. The water level in the Raymond Basin was falling 10 feet per year. When the Copelin well was drilled during the drought of 1899, the drillers found water at 154 feet. By 1924 the level had fallen to 190 feet; by 1929 it was at 240 feet. Local pumping was draining the Raymond Basin by 10,000 acre feet each year.

In 1935 Pasadena officials called together all the pumpers in the Raymond Basin in an effort to reduce pumping to a sustainable level, but this effort was not successful. In 1937 Pasadena initiated legal proceedings against Alhambra and other major Raymond Basin water users. The action sought to legally divide or adjudicate water rights in the basin and to end the annual overdraft. *City of Pasadena v. City of Alhambra et al.*, was the first basin wide adjudication of groundwater rights in California and the first to use the California Division of Water Resources to determine water rights.

After an extensive investigation of the "safe yield" of the Raymond Basin, in 1943 most of the 20 parties involved in the action agreed to a stipulation which provided: 1) an admission

that taking water was adverse to the claims of other parties; 2) allocation of the basin's safe yield; 3) declaration and protection of each party's rights; and 4) arrangement for the exchange of pumping rights among parties. On December 23, 1944 Judge Frank Collier signed the judgment adopting the stipulated agreement worked out by the parties. The California Department of Water Resources became the watermaster for the basin, charged with policing the adjudication. In 1949 the California Supreme Court affirmed *Pasadena v. Alhambra*. The decision validated mutual prescription as a basis for resolving groundwater overdraft problems and establishing water rights.

The other major issue relating to water that was affected by human settlement was that of flood. Following torrential floods in 1914 and again in 1916, the Los Angeles County Flood Control District built Devil's Gate Dam in 1920 at the southern end of the flood basin at the mouth of the Arroyo Seco. The 100 foot tall concrete arch dam had a dual purpose of flood protection and water conservation (Appendix E: *Water Resources Technical Report*).

D. CONCLUSION

The natural and cultural histories of the Arroyo Seco watershed are closely intertwined as the landscape shaped human settlement, and the adaptation and management of the land by people altered the environment. However, it can generally be observed that the trajectory of change over time from human management has accelerated in a direction towards managing the watershed for greater stability than occurred in pre-settlement conditions.

By understanding these historic patterns of the structure and function of the watershed and how it has changed over time due to settlement and land management patterns, informed analysis can be conducted that will inform future planning and management decisions that will contribute to the restoration of the watershed. In the next section of this report, a description and analysis of current watershed conditions is presented which is used to inform the determination of watershed restoration feasibility and planning recommendations that follow in Section IV.

III. CURRENT CONDITIONS AND FUNCTION IN THE ARROYO SECO WATERSHED

The Arroyo Seco watershed is a microcosm of southern California's development by humans and the alteration of natural systems. The watershed exhibits natural and cultural variety that changes dramatically from top to bottom. As a way to understand the watershed's current conditions, the following discussion breaks down the conditions into landscape structure, function and change.

A. LANDSCAPE STRUCTURE - HUMAN PRACTICES AND DISTURBANCES

This section provides an overview of the major land use and hydrologic practices that have altered the physical structure of the landscape within the watershed. The previous section provided a baseline of information, a synopsis of the historic landscape structure of geology, hydrology and habitat. This section looks at how humans have altered the physical makeup of the geology, hydrology, and habitat. An overview of major landowners or jurisdictional agencies also provides insight into the management and maintenance of these natural resources over time.

1. GEOLOGY & SOILS

Geologic structure remains the same and processes continue today as in the past. However, with today's developed land use throughout the watershed, geologic processes downstream of the mountains are significantly altered. In the precipitous upper mountain watershed, erosion, or wearing down, of the San Gabriel Mountains continues, as snowmelt and rain attempt to carry the resulting sediments to the Pacific Ocean. Where sediments were once

transported from the mountains to the sea while being deposited along the floodplains, they are now caught up behind crib dams throughout the Angeles National Forest. Hahamongna was once much lower in elevation, and has been created by the backing up of sediments behind Devil's Gate Dam. Today, because these sediments are trapped behind dams, their management is left up to the owners of the dams, including the US Forest Service and Los Angeles County Department of Public Works.

Urban development in the lower watershed has capped soils minimizing natural erosion in some places, and aggravating erosion in other places. Land along the Arroyo has an altered soil structure through the re-engineering of the stream. Construction of bridges, roads, dams and the flood control channel, and many other land uses, involves earth moving. Soils are either graded for cut and fill, excavated or imported, often as poor quality "engineered" soil. Outside of naturally occurring erosion in the mountains, soil erosion potential is high where man-made disturbances occur, such as highway construction.

2. HYDROLOGY

The historic hydrologic cycle has been significantly altered in four primary ways: surface and groundwater alterations for conservation, supply and flood control; surface and groundwater contamination; variation in groundwater levels from impermeable surfaces, pumping and diversions; imported water entering the system due to demands exceeding local supplies. The structure of the watershed's hydrologic system for the first three issues will be covered in this section. Imported water into this system is to be covered in a future phase of this project.

a. Water Supply, Surface and Groundwater Structure

Surface and groundwater water structure can be grouped into five general categories, each transporting water differently. These include natural streams, the built storm drain system, dams and diversions, impermeable or built surfaces and permeable open space. The most dramatic structure alteration within the watershed is of course the containment of the Arroyo Seco stream and tributaries into concrete flood control channels and underground storm drains. This engineered system quickly conveys storm water flows off of impermeable urban lands straight to the Arroyo Seco where it is rushed to the ocean via the Los Angeles River. Devil's Gate Dam and other smaller dams throughout the Angeles National Forest conserve water, detain sediments, and recharge the Raymond Basin aquifer. Finally, permeable surfaces of vegetated open space slow down runoff, and aid in groundwater percolation.

Several water users divert streamflow or springs in South Pasadena and northeast Los Angeles:

-The Arroyo Seco Golf Course in South Pasadena has taken an unmetered diversion from the Arroyo Seco stream since 1955 to irrigate approximately 30 acres.
-The Yosemite Waters Company taps a spring at Avenue 54 for its drinking water supply.
-Near York Avenue and Eagle Rock Boulevard, just over the ridge that defines the Arroyo Seco, Hinkley Schmidt (formely Mckesson/Sparkletts) uses water from the small Eagle Rock basin for its bottled water business.
-Near the confluence at 451 N. San Fernando Road in Los Angeles, the Angelica Healthcare Services Group, a linen supplier, is pumping groundwater.
-The Arroyo Seco enters the Los Angeles River just below Gage F57, which defines the end of the Upper Los Angeles River Area or San Fernando Basin.

The Los Angeles County Department of Public Works (DPW) has jurisdiction over the actual Arroyo Seco channel. DPW, along with the cities of La Cañada Flintridge, Pasadena, South Pasadena and Los Angeles, maintain storm drains throughout the watershed. The US Forest Service manages Brown Mountain Dam, crib structures and streams in the Angeles National Forest (Angeles NF). Crib structures in the Angeles NF, which were constructed to slow floodwaters and collect sediments, are now altering stream functioning as sediments continue to deposit and accumulate upstream.

Most water resource infrastructure is located in Pasadena, although groundwater pumping occurs in Los Angeles. The Arroyo Seco is a major source of water for Pasadena, La Cañada Flintridge, Altadena and other surrounding communities. Surface flow coming from the nountains is diverted into spreading basins in the Hahamongna area, which replenish the Raymond Basin. This diversion dramatically reduces the natural flow available for aquatic habitat.

The Raymond Basin is a "bowl" of alluvium, or gravelly material that has eroded from the San Gabriel Mountains. It underlies the cities of La Cañada Flintridge, Pasadena, Altadena, Sierra Madre, Arcadia and San Marino. This groundwater basin is supplied by water diverted from the Arroyo Seco canyon mouth to spreading basins where the water then percolates into the Raymond Basin Aquifer. There are thirteen settling ponds that are scraped out as needed to remove accumulated sediments. Other major diversion facilities include the Arroyo Seco Headworks, a concrete weir and two settling ponds, a submerged dam and intake structure, a traveling screen and the Behner water treatment plant. A more detailed description of Pasadena's water infrastructure appears as Appendix E: *Water Resources*.

About 150 yards south of Devil's Gate Dam, the Arroyo Seco flood control channel begins. Streamflow from this point all the way to Long Beach travels in a concrete lined channel, with the single exception of the unlined stretch that extends from the Holly Street Bridge to the Colorado Street Bridge. Below the Raymond Fault, the Arroyo Seco corridor is characterized by a narrow stream lined by steep hills. In addition to the concrete-lined stream, there is some subsurface flow but no connection to a definable water basin, as the stream flows to the Los Angeles River at the base of the Elysian Hills near Dodger Stadium.

b. Water Quality Structure

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

Moving south in the watershed, horse corrals and golf courses may contribute nutrients (nitrogen, phosphate, ammonia) from manure and fertilizers. Urbanization has resulted in an accumulation of polluted runoff from roads, commercial areas, industry, and residential neighborhoods. Polluted storm water from these land uses can load the system with trash and a mixture of petrochemicals. Of serious potential consequence is the contamination of the Federal Environmental Protection Agency's (EPA) Superfund site at Jet Propulsion Laboratory (JPL). Due to early testing of rockets, missiles and aircraft, the groundwater at

the mouth of the Arroyo near JPL is contaminated with volatile organic compounds (VOC). Several wells had been shut down due to the contamination. Also of potential concern is the use of septic systems in the La Cañada Flintridge area. If these systems were maintained and repaired on a regular basis, the Raymond Basin is protected. However, leakage from an old or impaired system could potentially contaminate the groundwater (Figure III-1: *Land Use*).

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

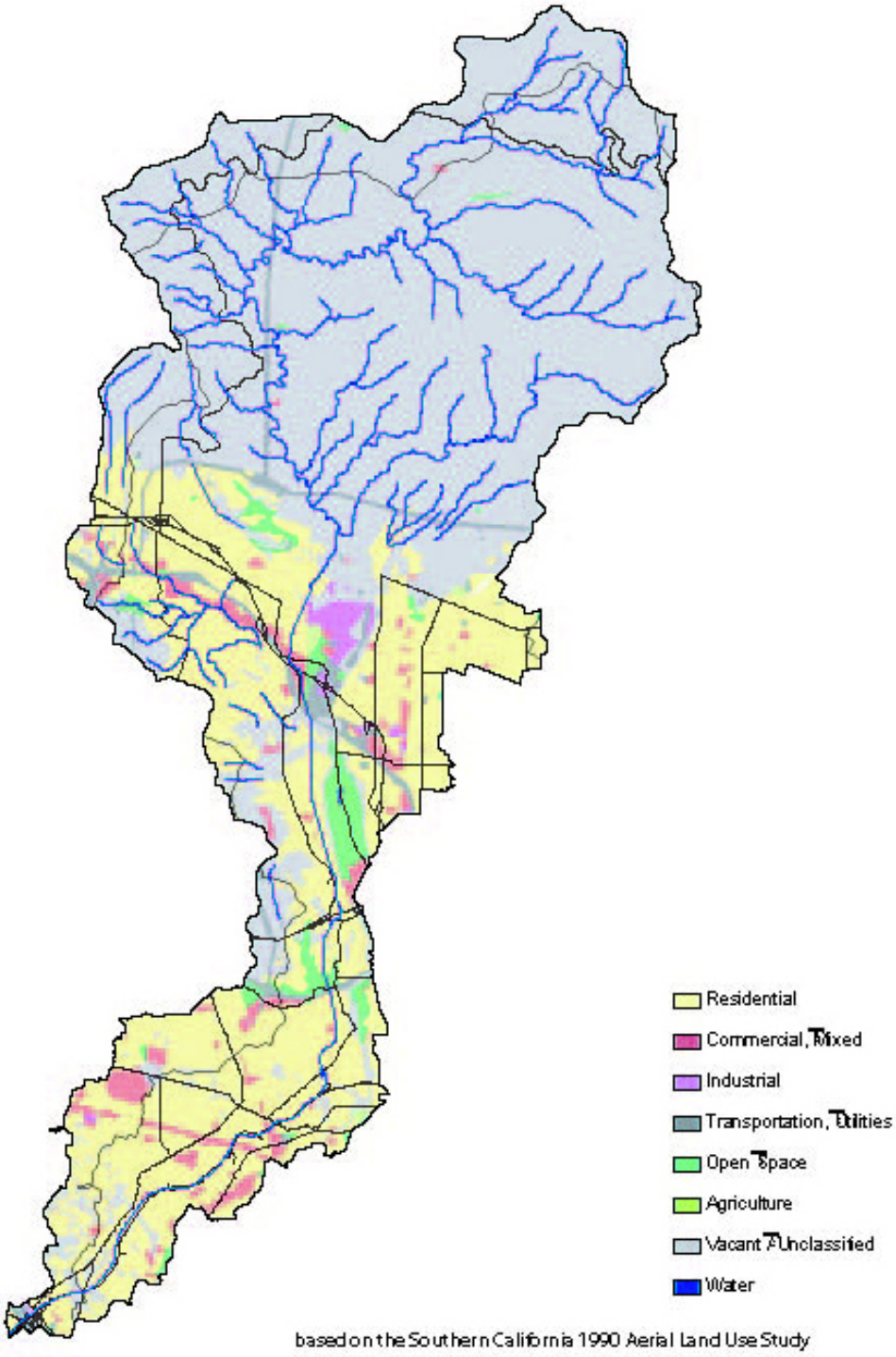
3. HABITAT STRUCTURE

According to project conservation biologist Verna Jigour, "…while the Arroyo Seco watershed retains a relatively high degree of native biological diversity, it may be thought of as teetering on the brink of ecological destruction, evidenced by a high rate of extirpations of historically present wildlife species and significant degradation of many remaining habitats," (Appendix F: *Habitat Restoration in the Arroyo Seco Watershed*).

This is evidenced by the fragmented open spaces of habitat in the Potential Habitat Value map (Figure III-2: *Potential Habitat Value*), shown in red. The uppermost watershed is solid red, indicating vast open space. In the middle, the San Rafael and Verdugo Hills still contain open space habitat, although their connections to the San Gabriels are tentative at best. Lower in the watershed, the mottled look of Mt. Washington, Montecito and Monterey Hills indicate that habitat patches exist, but are so fragmented that their viability of habitat for healthy populations of wildlife is severely limited. The Arroyo Seco is a tentative corridor for wildlife passage, possibly connecting the San Gabriel Mountains to the Elysian Hills to the southwest.

Of foothill habitat, only fragments in the watershed are left today. The Angeles National Forest has the best contiguous mountainous habitat. Before settlement of the foothills, there were lateral habitat connections via tributaries, valleys and ridgelines. These historic passageways have been severed by the development of Los Angeles and vicinity. The Verdugo Hills lay to the northwest of the watershed. The Monterey and Montecito Hills traverse Los Angeles to the southeast towards the Puente-Chino Hills. To the south are the Elysian Hills, the beginning of the Santa Monica Mountains. Currently these hills have little or no connections for they are essentially built out and detached from each other.

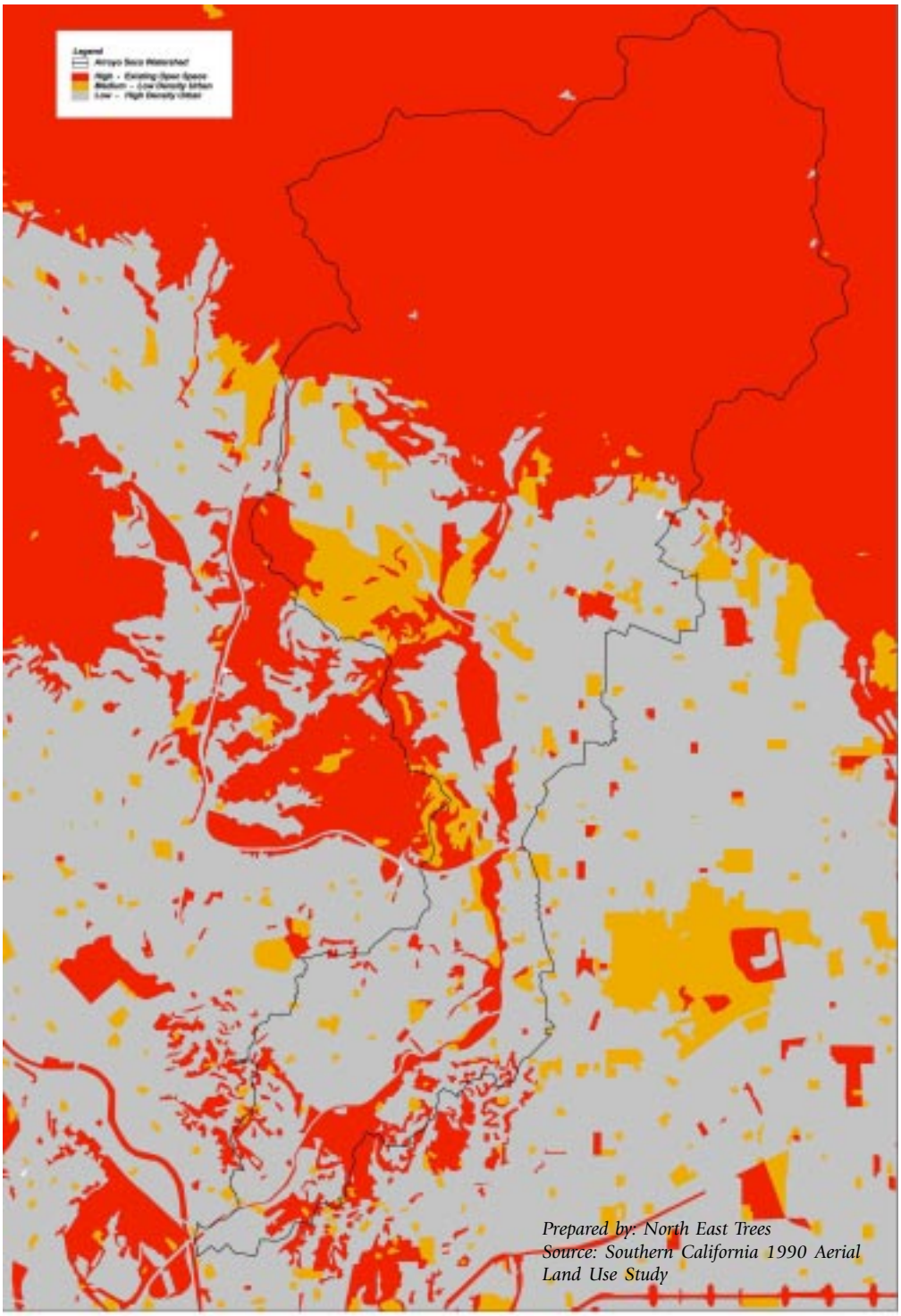
La Cañada Flintridge is sandwiched between open space habitat in the Verdugos and in the San Gabriels. Whether or not a linkage still exists between the Verdugos and the San Gabriels through La Cañada Flintridge is unclear. What is clear is that there is one tentative linkage down Flint Canyon, below the 210 freeway, to just beside Devil's Gate Dam and the bottom of Hahamongna. This fragile linkage must be protected. One stakeholder from La Cañada Flintridge saw her city as a wildlife movement barrier between the two mountain ranges. During a stakeholder workshop, she depicted this sentiment with a black line on a map of the watershed.



Prepared by: Mountains Recreation and Conservation Authority
Source: Los Angeles County Department of Public Works

FIGURE III- 1: LAND USE

Arroyo Seco Watershed Restoration Feasibility Study



Scale 1" = 2 miles

FIGURE III-2: POTENTIAL HABITAT VALUE

Arroyo Seco Watershed Restoration Feasibility Study

Above Devil's Gate Dam, habitat is generally contiguous in Hahamongna and up into the Angeles National Forest. Below the dam however, habitat continuity begins to break down. Brookside Park is developed as a golf course and for Rose Bowl events. With the people, cars, noise and night lighting, Brookside is hardly suitable for wildlife movement except along the extreme edges of the basin. However, in the lower Arroyo of Pasadena, low impact recreation creates an environment more conducive to wildlife habitat. There are coast live oaks and native riparian vegetation that has returned to the BFI Low Flow Wetlands project area. Local residents who take regular walks have a strong attachment to this stretch of the Arroyo.

Current open spaces, if large enough, support more species. However, the majority of open spaces are so fragmented, that their ability to support healthy populations of wildlife are questionable. Debs Park is essentially a habitat island. The California Quail could survive in this park with existing vegetation. But the quail have not been found on this site due to its isolation from other habitat areas. It is tentatively, if at all, linked to other large open spaces. Linking these habitat fragments are the only way to ensure they remain viable as habitat (Appendix F: *Habitat Restoration in the Arroyo Seco Watershed*).

B. LANDSCAPE FUNCTION - EFFECTS ON WATERSHED FUNCTION

Watershed processes continue, despite alterations to the landscape and hydrology over time. Nature has adapted to human disturbances, with varying degrees of functionality. One of the most dramatic alterations involves the shift from a permeable landscape to a virtually impermeable one. Paving over the land and the construction of thousands of structures within the watershed, have dramatically reduced the system's ability to naturally recharge the groundwater. The elimination of foothill and riparian vegetation has had a detrimental effect on our wildlife populations. This section describes the effects of land uses on the natural functioning of geomorphology and sedimentation, hydrology and habitat. A summary of needs occurs at the end of each section.

1. GEOMORPHOLOGY & SEDIMENTATION

Dams play an important role in managing floodwaters in the watershed. They also play a role in groundwater recharge, water quality, and sediment transport. Although relatively undeveloped, the upper watershed still feels the effects of human disturbance. Because of the check dams in the Angeles National Forest which remove sediments from flows, a condition called "hungry waters," occurs. This is when flood waters free of sediments actively scour and erode streambanks. This weakens riparian habitat through erosion, degrading its viability to support native plants. As a result of these dynamics and other human disturbances, silts and sand no longer replenish the beaches of southern California.

Within the watershed, two out of three zones of sedimentation occur. The upper watershed is the zone of erosion, with its recent geologic makeup and steep slopes. The floodplains of the watershed in Pasadena and Los Angeles are the transport and sediment storage zone for sediments and gravels. This is why the Arroyo Seco floodplain valley is filled in with porous alluvium. The third and final zone of deposition for silt and sand lies at the coast in Long Beach, where the Los Angeles River flows into the sea. The entire Arroyo Seco watershed lies within the zones of erosion and transport/storage.

In the valley floodplain, sediments play a diminished role from their pre-settlement condition. Several factors have severely affected sediment flows in the valley. The dams trap most of the sediments that would otherwise have been stored in the floodplains of the Arroyo. Squeezing floodwaters into concrete channels instead of allowing for natural meandering prevents sediments and beneficial nutrients from spreading across the valley floor. Development of permanent structures in the floodplain creates a problem of safety in this zone of natural functioning.

Careful sediment management is extremely critical to maintaining the health of the watershed. To move toward restoration of the hydrologic system, and of land and water resources, reinstating sediment transport where appropriate is recommended. Further studies of the functionality of crib structures and dams are needed to assess their future role with regard to geomorphology, sedimentation and habitat.

2. HYDROLOGY

Urban development has resulted in three major alterations to streams in the watershed: increased water quantity, decreased water quality, and increased velocity. These factors will need to be mitigated and managed for stream restoration. With the majority of the lower developed watershed impermeable, storm water runoff is rushed off the streets and towards the ocean via the storm drain system, of which the Arroyo Seco is the central artery. The many acres of paved roads, sidewalks or parking lots, and residential and commercial buildings, contribute to rapid runoff into the Arroyo Seco and tributaries, whether they be open concrete channels, underground, or natural. Increased volume and velocity of runoff makes the task of stream restoration challenging. Urban areas are covered in pollutants, which rushing water carries off during storm events.

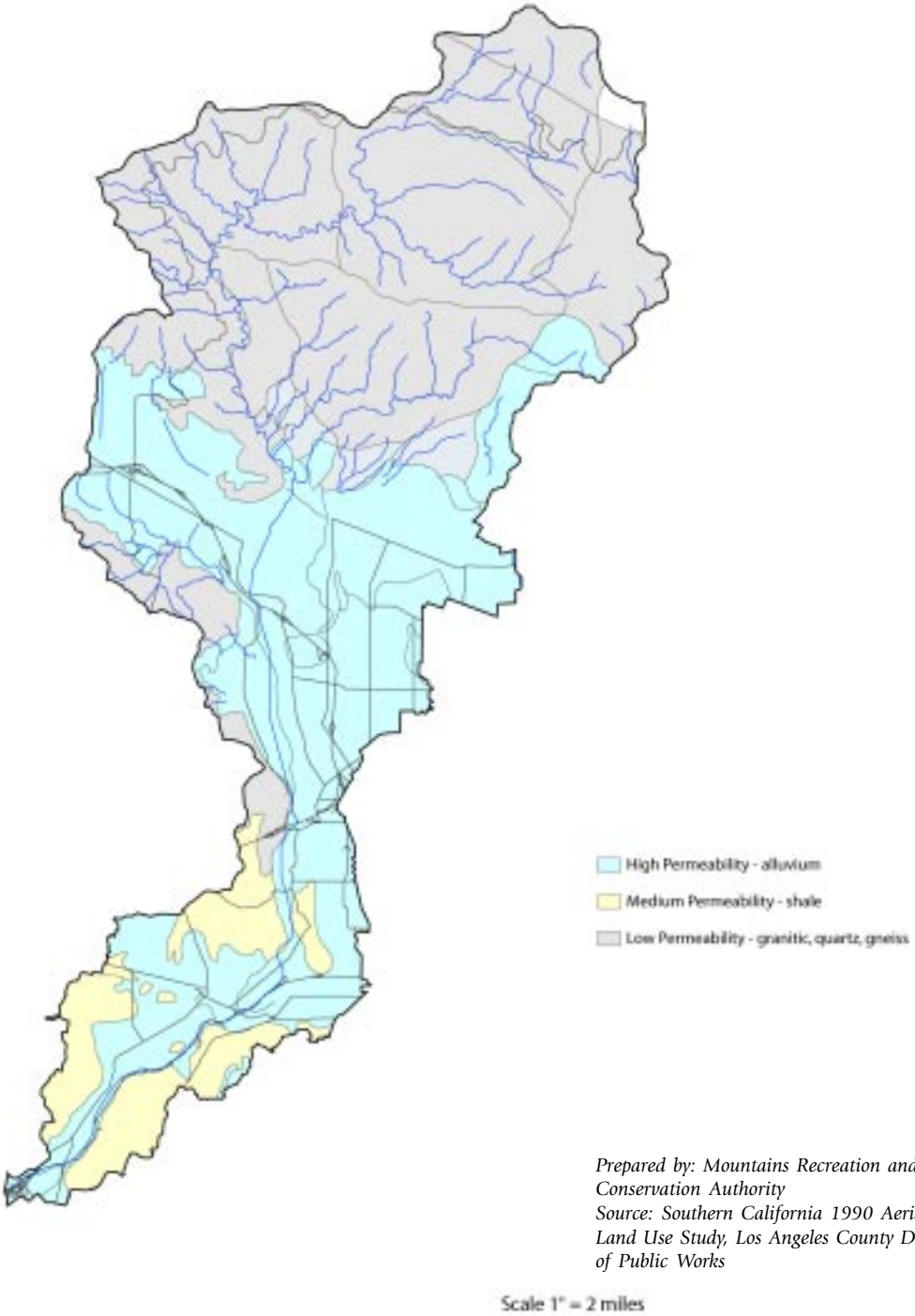
a. Water Supply, Surface and Groundwater Function

Building homes within the floodplain of the Arroyo Seco proved to be a disastrous decision when a number of structures were swept away by floodwaters in the storms of 1914 and 1938. As a result of this storm event, the channel was constructed as a response to flooding. This decision made it "safe" to continue building homes within the floodplain of the stream. Although potential lives were saved, the resultant concrete channel did little to address the multiple problems associated with building in floodplains.

Pouring concrete over porous alluvium or gravel soils eliminated the ability of the groundwater to absorb storm water flows. As a result, the Raymond Basin groundwater aquifer no longer received this beneficial recharge from the porous alluvium underlying the stream corridor (Figure III-3: *Soil Permeability*).

In addition, valuable stream and riparian habitat was destroyed. The lack of sand, gravel and boulders eliminated the habitat for macroinvertebrates (critters at the bottom of the aquatic food chain which fish and other aquatic animals eat), and fish. The elimination of riparian vegetation at the edges of the stream meant hotter temperatures of water due to lack of shade. Riparian vegetation can help reduce runoff velocity and filter pollutants flowing towards a stream.

Reduced groundwater recharge due to impermeable surfaces and stream channelization over alluvial soils has compounded the issue of groundwater overdraft due to surface flow diversion and groundwater pumping. Currently there are at least fifteen users of pumped



Prepared by: Mountains Recreation and Conservation Authority
Source: Southern California 1990 Aerial Land Use Study, Los Angeles County Dept. of Public Works

FIGURE III-3: SOIL PERMEABILITY

Arroyo Seco Watershed Restoration Feasibility Study

groundwater from the Raymond Basin, including several in the City of Pasadena, and other cities throughout the San Gabriel Valley. The aquifer provides 40% of local water supplies, with the remainder coming from imported water sources provided by Metropolitan Water District (Appendix E: *Water Resources*). The City of Pasadena is interested in developing additional groundwater recharge potential for the Raymond Basin aquifer (Appendix H: *Hydrology, Hydraulics and Geomorpholgy-Opportunities and Constraints*).

Restoring the Arroyo Seco stream and tributaries is probably the most challenging, but most rewarding of the watershed restoration tasks. Stream restoration is the key recommendation of this study. The Raymond Basin would benefit from more natural recharge. Removing the concrete channel is a complex issue, and requires that a number of studies and watershed-wide projects take place first. As stated by consulting geomorphologist Martin Kammerer, "...complete restoration is not feasible because substantial portions of the floodplain are urbanized. Final design requires a juggling act between restoration goals and physical constraints," (Appendix I: *Geomorphologic Opinion on Feasibility of Stream Naturalization-The Lower Arroyo Seco*). However, it is also noted that implementing Best Management Practices (BMPs) within urbanized areas of the watershed will definitely contribute towards restoration (Appendix J: *Hydrology, Hydraulics and Geomorphology Engineering Information & Studies*). Ultimately, the entire fabric of our hydrologic system, flood channels, storm drains, dams and diversions, and even the asphalt, concrete and structural caps over permeable soils, must be evaluated for maximum benefit.

b. Water Quality Function

Water quality is degraded in the Arroyo Seco watershed, as in all of southern California. Human settlement and disturbances to natural processes are the main reasons for poor water quality. Both surface and groundwater have serious water quality impairments. Water from the Arroyo is non-potable and it is not safe to come into bodily contact with the water in its current state. Trash, coliform, and algae have been found to be the Arroyo Seco's three main pollutants, according to the state's 303(d) list (Appendix G: *Technical Report-Water Quality*). The Superfund site at Jet Propulsion Laboratory is to undergo a clean-up operation. For the onsite water, JPL intends to put in remedial well(s) onsite, pump the water up, treat it and reinject it into the Raymond Basin, which will require coordination with Raymond Basin administration and their permission (Robles, 2001).

Approximately 45% of the runoff from the Arroyo Seco originates from the urbanized area below Devils Gate Dam (Appendix J: *Hydrology, Hydraulics and Geomorphology Engineering Information & Studies)*. Trash is generated from intense urban use, such as sports events at the Rose Bowl and Brookside Park ongoing recreational use, or in commercial districts throughout the watershed. If trash receptacles become overused, the overflow could be carried into the Arroyo during the next storm event. Coliform bacteria is found in animal and human waste. Many dog walkers are not educated about the negative effects of pet waste left on the ground. Heavy metals from vehicular use can wash into sediments, creating a toxic environment for bottom dwellers.

After each storm event, waste matter left on the ground washes into the Arroyo and eventually into the ocean. Swimmers and surfers become ill, and harmful pollutants damage marine habitat. Algae forms when pollutants high in organic phosphate and nitrates wash into the Arroyo. The sources of these nutrients come from many urban and landscape sources such as turf fertilizers, commercial district pollutants such as from dropped food stuff and trash can dribble. Algal blooms deplete water of needed oxygen, suffocating aquatic life. Heavy metals from vehicular use can wash into sediments, creating a toxic environment for bottom dwellers.

Good water quality allows an aquatic system to support macroinvertebrates, tiny insects visible to the naked eye that support larger aquatic life like fish. The channelized Arroyo Seco currently does not support these insects. Macroinvertebrates are water quality health indicators. Their presence or lack of presence in a stream can gauge the ability of the stream to support aquatic life. Some macroinvertebrates, such as mayflies, are more sensitive than others, and their presence is a good indicator for fish.

Not only is water quality important to macroinvertebrates, but water temperature affects their ability to survive. If riparian vegetation is absent, the temperature of surface waters rises. Surface dwellers are the first to be affected by this temperature change, but middle water dwellers also feel the changes. Macroinvertebrates can tolerate certain ranges of water quality and temperature changes, but extreme alterations to their required environments will kill them, depleting fish and other aquatic life of their staple foods.

With practically the entire stretch of the Arroyo encased in concrete, the likelihood of any aquatic life seemed thin. However, when walking along the cobbled portion of the channel in South Pasadena, fisheries ecologist Matt Stoecker discovered some species of macroinvertebrates inhabiting the spaces between the cobbles (North East Trees, 2001). It seems that even the slight variation in surface allowed for nutrients to be trapped within the cobble joints, allowing for some hardy species of these indicator species to survive.

Improvements to surface water can be made in a relatively short amount of time by retrofitting properties to clean up storm water runoff. Areas of heavy automobile traffic such as parking lots or roadsides are good candidates. Measures to collect trash from runoff will greatly reduce the pollutant-load on the streams. Current infrastructure rushes storm water directly off of roads and buildings, allowing for little or no filtration of pollutants to take place. Implementing Best Management Practices (BMPs) are critical to the improvement of surface water quality in a relatively short time period. Clean-up of contaminated groundwater at JPL is a long-term process. (Appendix G: *Technical Report-Water Quality*).

3. HABITAT FUNCTION

As the region's population grew, demands on natural resources and open space increased. More and more open space was developed for residential neighborhoods, severing habitat corridors that allowed wildlife movement through the foothills. Channelizing the Arroyo Seco meant that it could no longer function as riparian and aquatic habitat. Before dense settlement occurred, the Arroyo Seco and its floodplain most likely served as an aquatic and terrestrial habitat corridor to/from the San Gabriel Mountains to the Santa Monica Mountains and to the Pacific Ocean.

Quality of habitat is an important issue. Without natural processes taking place such as flood and fire disturbance cycles, long-term sustainability of habitat is uncertain. At present, open spaces along and within the urban fringes are not allowed to burn. And by channelizing streams, floodwaters are not allowed to flood and spread. In addition to the lack of disturbance cycles, the presence of exotic invasive plant species prevents native vegetation from surviving.

According to project biologist Verna Jigour, the watershed may be broken down into two basic functional ecological units. These are the upper watershed above Devil's Gate Dam/ 210 Freeway, and the lower watershed (Appendix F: *Habitat Restoration in the Arroyo Seco Watershed*). Devil's Gate Dam blocks most up- and downstream movement of aquatic

species. It also serves as a barrier to terrestrial habitat connectivity in combination with the 210 freeway. Since one focus of the overall feasibility study is to evaluate the feasibility of functional connectivity between the San Gabriel and Santa Monica Mountains, this aquatic and terrestrial habitat connectivity break at Devil's Gate Dam must be acknowledged as a formidable barrier. Another major impediment is the Brown Canyon Debris Dam, which serves as a second major barrier to aquatic habitat connectivity in the watershed.

The upper watershed is a part of a much larger contiguous open space system of habitat throughout the San Gabriel Mountains. With the exception of a couple of highways, much of the mountains are high quality habitat for plant and animal life. The San Gabriel Mountains are clothed with vegetation and habitat types that generally retain much of their historic ecological character. Unfortunately, the project team biologists have found severely degraded understory conditions in riparian corridors up in the watershed. It seems that in the early 1900's, visitors to the canyons and cabin residents brought with them numerous exotic plant favorites. These plants, periwinkle and Algerian ivy to name a few, have now almost completely taken over understory riparian plants, and are making their way up overstory trees. The lack of native plants for native wildlife makes it difficult for them to survive without their needed food and shelter.

Due to the urban-wildland mix at the edge of the Angeles National Forest, fires are put out quickly to prevent loss of homes and lives. The effect is essentially of fire suppression along the urban edges below the San Gabriel Mountains. The prevailing plant communities are largely chaparral and woodlands. These plants are adapted to fire disturbance as part of their life cycles. If they do not burn every few decades, plants become more and more woody, creating a greater fire hazard. This is what is known as fuel-loading. Thus, fires today burn hotter, spread more rapidly and potentially destroy larger areas than pre-development fires once did.

Downstream of Devil's Gate Dam, habitat patches are much smaller and fragmented by urban development and infrastructure. Within the hills of Los Angeles, patches of open space now speckle the landscape. Walnut woodland habitat currently exists in Mount Washington. Although mixed in with exotics from the adjacent homes such as nasturtiums, pine trees or castor bean, good quality habitat for small critters still survives. To or from Mount Washington for example, it is difficult for terrestrial wildlife to cross dense residential neighborhoods, the Arroyo Seco Parkway and the concrete channel to reach Debs Park or other open space areas.

In terms of habitat, the most important step towards a restored watershed is the need to restore and protect missing linkages of fragmented habitat. Without these wildlife movement linkages established, the trend will continue towards extinction of native plant and animal species from this region. At the same time, restoration and protection of existing open space and riparian habitat needs to occur, with new habitat being created where appropriate. With continued creation and restoration of habitat, people and wildlife conflicts will continue to arise. The issue of the urban-wildland interface needs to be addressed without compromising on quality of life for humans and wildlife. This includes serious consideration of the issues related to fire management.

C. CHANGE OVER TIME (CURRENT LAND USE)

Our relationship with the watershed is visible through numerous land use practices with varying impacts to natural functioning both subtle and great. Passive recreational lands

have minimal impacts whereas commercial districts tend to be intensely developed and visited (Figure III-1: *Land Use Map*). In this section an overview of low impact land uses, recreation and open space, will precede a discussion of higher impact land uses in the urbanized portions of the watershed. As part of the discussion on urban land use, local planning efforts will be mentioned.

This project is focused on the eventual restoration of the Arroyo Seco stream and tributaries. Technical restoration is feasible, but political will needs to happen, making the road toward restoration complex. The Arroyo Seco channel is owned and ultimately managed by the federal government but overlapping and adjacent to their jurisdiction, State of California, Los Angeles County and city agencies own land and have overlapping right-of-ways. To create a foundation for successful implementation of watershed-enhancing strategies, a coalition of government agencies is necessary.

1. OPEN SPACE & RECREATION

Open space has many benefits to the public, including increased air quality, a visually pleasing landscape, opportunities for active and passive recreation, and relief from the urban spaces of Los Angeles. A complete network of trails is also beneficial, as it provides a range of recreational uses, access to everyone, alternative methods of transportation, and connections between public open spaces and other trails. It is not difficult to find public open space within the Arroyo Seco watershed, including the Angeles National Forest, numerous city parks, Descanso Gardens, and undeveloped hillsides. However, because most of the public open space is clustered around the Arroyo Seco, many residential neighborhoods are without small neighborhood parks (Appendix K: *Recreation & Open Space Technical Report*).

Many trails exist in the Arroyo Seco watershed, spanning a range from Class I Bikeways to strenuous hiking trails in the Angeles National Forest. The Rim of the Valley Trail Corridor (a project of the Santa Monica Mountains Conservancy) will link the watershed to the San Rafael Hills and adjacent portions of the Angeles National Forest. The watershed's trails vary in their accessibility, ensuring that people of all abilities can participate. While the trail system has many components, additional connections between trails and open spaces are needed.

A high demand exists for recreational use of the natural areas and trails of the Arroyo Seco watershed. With many types of activities available, the watershed has something for everyone. However, recreational activities in the Arroyo must compete for open space, because the amount of natural, open, public land is insufficient. Additional public open space is needed to meet the demands of the public. Of high priority is the need to protect current open spaces. The need exists to maintain existing open space for habitat, recreation and vision quality values. In addition, creating new open space through future land use conversion needs to be examined.

Recreational users in the watershed have a strong interest in the management and future of the area's natural resources. Many have organized activist/stakeholder groups to promote their activities. Activities in the watershed vary widely, ranging from archery to Division I college football. Participants in the ASWRFS' workshops recommended adding new activities including skateboarding, water activities, and enclosed areas for dogs (Appendix C: *Public Participation*). Local conservancies such as the Altadena Foothills Conservancy are working

with the State's Santa Monica Mountains Conservancy to acquire and restore open space parcels for public benefit. Further partnerships through locally-led efforts are needed.

a. Upper Watershed

This mountainous watershed area is primarily managed for recreation, watershed protection and wildlife conservation. It is largely undeveloped and contains few potentially significant sources of contamination and includes 5,000 acres of roadless area with great scenic, recreational and wildlife habitat value. An extensive network of fire roads and trails provides access to the upper watershed for various recreational uses such as hiking, mountain bicycling, horseback riding and off-road vehicle use. The Gabrielino National Recreation Trail follows the Arroyo Seco from the Devil's Gate Dam to the Haramonkgna Cultural Center in Red Box in the Angeles National Forest. The long-distance Pacific Crest Trail is also accessible through the upper watershed. Approximately fourteen miles of the Angeles Crest Highway (CA Highway 2), a major scenic route that crosses the San Gabriel Mountains, are located within the watershed.

Currently the Forest Service is updating the Land and Resource Management Plan (Forest Plan) for the four southern California National Forests. These include the Los Padres National Forest (NF) to the north, the Angeles NF, the San Bernardino NF to the east, and the Cleveland NF to the southeast. Four Forest Plan revisions will be developed for each forest. These four documents will then be folded into a single Environmental Impact Statement (EIS) that will cover the four forests. This draft EIS needs to be completed by June 2002. The main plan components include: 1. Identify desired conditions; 2. Prepare objectives; 3. Prepare standards; 4. Designate of suitable uses; 5. Create a monitoring plan (USFS, 2002).

b. Lower Watershed

The lower half of the watershed is distinctively different from the upper watershed. Below JPL, the Arroyo Seco is highly urbanized, and includes northeast Los Angeles, western Pasadena, western South Pasadena, most of La Cañada Flintridge and Altadena which is part of unincorporated Los Angeles County (Figure III-6: *Arroyo Seco Watershed Aerial Photo-Urban Portion*).

The majority of the developed land is residential, which ranges from low density single family homes to high density multi-family housing tracts. Revitalized commercial districts exist in Pasadena, South Pasadena and Highland Park. The southern tip of the watershed is comprised of portions of the communities of Lincoln Heights and Cypress Park (City of Los Angeles), and is primarily industrial and commercial in nature. Readily accessible open space is largely absent in these densely developed areas, with the exception of neighborhoods along the Arroyo Seco and beneath the San Rafael Hills.

The communities along the Arroyo include some of the oldest neighborhoods in northeast Los Angeles. Today's Lincoln Heights, Cypress Park and Highland Park were some of the earlier neighborhood settlements of the pueblo of Los Angeles. Similarly, some of the earliest portions of Pasadena grew near the Arroyo. Their locations were influenced greatly by their proximity to both the Arroyo Seco and the Los Angeles River. Historic structures and landmarks exist in this portion, listed on the National Historic Register and/or with municipal historic preservation overlay zones (Figure III-1: *Land Use Map*).

i. City of La Cañada Flintridge

The municipality of La Cañada Flintridge forms the northwestern boundary of development in the watershed, and is located in the foothills. Historically, the canyons and washes in this

Prepared by: North East Trees
Source: Eagle Aerial; Los Angeles County Dept. of Public Works

FIGURE III-6: ARROYO SECO WATERSHED AERIAL PHOTO-URBAN PORTION

stretch of the watershed were dotted with oaks and sycamores. Today, the majority of this land has been converted into residential development composed of low density single-family housing tracts. This city considers itself a "gateway for mountain recreation" and hosts several golf courses and equestrian stables. The Angeles Crest Highway (California State Highway 2) leads visitors to trails, campsites, waterfalls and Mount Wilson in the San Gabriels. Descanso Gardens, a 165-acre botanical garden which showcases both exotic and native vegetation, is situated in the southern section of the city. The major source of industry within the city boundaries is NASA's Jet Propulsion Laboratory (JPL), located in the southeastern portion of the city. The runoff and effluent from this site is a major source of potential contamination in the watershed.

ii. Community of Altadena (Los Angeles County)

Covering less than 9 square miles, the unincorporated community of Altadena is adjacent to Pasadena's northern border. This community of approximately 42,000 lies at the foot of the San Gabriel Mountains between Hahamongna Basin and Eaton Canyon. It was created in 1887 by John Woodbury who established the Pasadena Improvement Company for the purpose of developing the subdivision he named Altadena. It's name is derived from Spanish "alta" meaning "upper" and "dena" from Pasadena. Primarily known for its quiet residential neighborhoods, Altadena also has a few small areas of commercial land uses. Undeveloped open space abuts the Angeles National Forest to the north. The Altadena Town Council represents the community at a county level.

iii. City of Pasadena

Pasadena is a medium-sized urban city with approximately 140,000 residents. There are a total of seven council districts, three of which intersect the watershed boundary. This diverse city grew out of the canyons and into the floodplain of the historic Arroyo Seco. The city's residential sections are a composed of low-density and high-density, single and multi-family housing tracts. Three major freeways run adjacent and through the city. A revitalized city center runs through the heart of its Old Town Pasadena District. The city is known for it historic structures that characterize the Arts & Crafts and Art Deco periods. The city is home to several large events, including the annual Rose Parade and Rose Bowl collegiate football game. Important centers of research and key destinations include California Institute of Technology, the Norton Simon Museum, and the Huntington Library, Museum and Gardens in nearby San Marino. The city is a regional economic, cultural and educational center, employing close to 100,000 people with a population of approximately 140,000.

The northern boundary of Pasadena is the point where the Arroyo Seco begins to broaden leaving behind the mountain gorges to the north. With the construction of the Devil's Gate Dam, a large artificial plain was created from sediment and debris trapped behind the dam. The dam is located where the Foothill Freeway (Interstate 210) crosses the Arroyo Seco. The area north of the dam and south of the Jet Propulsion Laboratory is being developed into the Hahamongna Watershed Park by the City of Pasadena. The master plan proposes the construction of recreational interpretive facilities and will encourage both active and passive recreational uses, in addition to habitat conservation.

The Arroyo Seco floodplain reaches its broadest width in Brookside Park located between the historic Colorado Street Bridge and the Devil's Gate Dam to the north, known in Pasadena as the Central Arroyo. The park is the site of the Rose Bowl, Brookside Golf Course, the Aquatic Center and the Fannie Morrison Horticultural Center, future home of Kidspace Museum. In addition to programmed activities, the park is host to thousands of guests monthly, including bicyclists, joggers, and walkers.

The City of Pasadena anticipates increased demands on the carrying capacity of this park. In response, they are preparing a Master Plan for the Arroyo Seco. This includes a broad based community effort to help define the future for the Arroyo running from the top of Hahamongna down to the southern border of Pasadena. It is important for the city to preserve the legacy of the Arroyo while insuring it remains a well managed asset for the community. The Master Plan is intended to address issues related to facilities for passive and active recreation that support the City of Pasadena *Comprehensive General Plan* (1992). The Master Plan supports Policy 9.2 of the General Plan which mandates that the City, "Continue and complete comprehensive planning for, and implementation of, plans for the Arroyo, including restoration of the natural areas of the Lower Arroyo and the Development of the Hahamongna Park Plan," (Sapphos Environmental, 2000).

There are currently four Specific Plans by the City of Pasadena within the watershed. These areas include the Central District, South Fair Oaks Bio-tech Center, West Gateway, and Fair Oaks/Orange Grove *Specific Plans*. A Specific Plan is a document designed to implement the goals and policies of a particular community. These plans will contain detailed development standards, distribution of land uses, infrastructure requirements, and implementation measures for the development of a specific geographic area. Specific plans will be prepared for other areas in Pasadena where development is planned. Coordination with the City of Pasadena Planning Department will be essential in implementing environmental solutions to improve watershed functioning especially as it relates to new development.

Watershed issues include urban density and open space management, re-thinking large event and venue management of trash and other non-point sources of pollution, freeway and street runoff treatment and re-education and awareness of current recreational practices, as well as residential and commercial landscaping practices. Specific Plans for Pasadena's three council districts that overlap the watershed (Council Districts 1, 3, 6) might consider adoption of measures that accommodate for programs and features that will promote the resolution of these aforementioned issues.

iv. City of South Pasadena

South Pasadena is an urban municipality that occupies 3.44 square miles along the east bank of the Arroyo Seco. It is bordered by the Pasadena Freeway between Pasadena and the City of Los Angeles. It is primarily a residential community composed of low-density single family housing with a population of approximately 25,000. Historic character of the city reflects the Craftsman-style detail of the Arts and Crafts movement.

The city includes over 100 acres of parkland within its boundaries, including a golf course and an equestrian facility. Although South Pasadena is a small city in a densely packed urban matrix, it has preserved an open space to population ratio well above the national average. The golf course and the equestrian stables line the current Arroyo Seco channel. Adjacent to the channel for approximately one mile is an equestrian and pedestrian trail. Recreational use of the trails along the Arroyo in this section is a regional attraction not limited to the neighborhoods adjacent to the channel.

Issues to be addressed relate to channel-side recreational carrying capacity, effects of waterway-adjacent equestrian use, pedestrian use, golf course management, and residential management in regard to irrigation and fertilization runoff. Development of guidelines for channel-side recreational use and the implementation of runoff reducing BMPs would have a positive effect on this small reach of the watershed.

v. City of Los Angeles Communities (Highland Park, Mount Washington, Montecito Heights, Lincoln Heights, Cypress Park)

Los Angeles has a population of over 3,000,000 divided into fifteen City Council Districts, and has several other layers of jurisdiction. The Los Angeles portion of the watershed lies in Council District 1, covering roughly 20% of the district area. It is composed of high density urban residential and employment communities. District 1 has a population of 222,165. Communities within the watershed include: Cypress Park, Highland Park, Mount Washington, Lincoln Heights and Montecito Heights.

Council District 1 consists of ethnically diverse, predominantly lower income communities. According to recent census data, the population is primarily Latino at 75.5%; 15.1% Asian; 5.4% White- Non/Hispanic; 2.6% Black/African American; 1.0% Multi-racial; 0.3% American Indian. The communities within the watershed boundary have developed around several natural and man-made topographic features.

On the west side of the Arroyo Seco, the hills of Mount Washington historically guided the course of tributaries and streams that fed into the Arroyo Seco. Today they also define an area of relatively higher income above the floodplain. A similar condition exists on the east side where the boundary of the watershed is formed by the Monterey Hills, which stretch from South Pasadena to the southern extent of Mount Washington. Mount Washington is home to the Southwest Museum and its extensive collection of Native American artifacts. The heart of the Monterey Hills is home to the Ernest E. Debs Regional Park and the communities of Montecito Heights and the Village of Herman.

In this portion of the watershed, the Arroyo Seco floodplain, bounded by these features, is home to the communities of Highland Park, Cypress Park and Lincoln Heights. The Pasadena Freeway, which divides these communities, runs adjacent to the Arroyo Seco and connects downtown to Pasadena. This historic corridor is one of the West's earliest freeways. Currently, this section of the freeway is being dedicated as the Arroyo Seco Historic Parkway with appropriate parkway signage currently being developed by Caltrans.

These communities are also home to several historic landmarks including the Lummis Home, the Judson Studio, Heritage Square Museum and the Abbey. These Arroyo destinations, constructed and preserved since the early 1900's, have defined an architectural and historic legacy for this area. Thus, this section of the watershed and its long-standing communities are defined by the hill systems, freeway and history the surround and bisect them.

Within the City of Los Angeles' *Northeast Los Angeles Community Plan Revision*, which is a component of the City's *General Plan*, there are several special planning documents for certain districts contained in the watershed (City of Los Angeles, 1999). These include a Specific Plan, a Historic Preservation Overlay Zone, three Business Improvement Districts, and a Targeted Neighborhood Initiative zone. These plans are meant to respond to special needs of the residents and businesses in this area. To enhance the sustainability and environmental health of the watershed these plans incorporate the focus area's environmental needs.

In 1993, an ordinance for the *Mount Washington/Glassell Park Specific Plan* became effective. (City of Los Angeles, 1993). This Specific Plan was developed in response to the concern of the community to recent housing structures that were inconsistent to the scale and character of the hillside communities of Mt. Washington and Glassell Park. These hillside residents are interested in preserving the hills and canyons with their native vegetation, as well as

building in a way that is sensitive to the area's identity, culture, history, transportation system, topography and unique character.

In 1994, the City of Los Angeles established the largest historic district (the Highland Park Historic Preservation Overlay Zone) in the city, with over 2,500 contributing structures. Residents and business owners in this zone qualify for assistance when making structural improvements to their properties. However, they must also adhere to certain architectural restrictions in order to maintain historic integrity of the area.

Several of the commercial / industrial / residential communities in this area have business improvement districts (BIDs). They include the Highland Park BID and the Lincoln Heights BID. In Highland Park the business improvement district encompasses Figueroa Street from Avenue 50 to Avenue 61. The Lincoln Heights Industrial Business Park borders the Arroyo Seco's southeastern bank, near its confluence with the Los Angeles River. There is some residential and commercial uses mixed in with industrial buildings, including the historic Lincoln Heights Jail along the Los Angeles River just below the confluence in this area. To fully implement watershed improvement strategies, it will be necessary to obtain the support of the BIDs within the watershed.

In 1997, Highland Park was one of several communities that were selected by the City of Los Angeles on which to focus federal housing funding. The Targeted Neighborhood Initiative district extends from Woodside Drive to Avenue 61 along encompassing a 4-block corridor with Figueroa Street at its center. The $3M of federal funding was earmarked for housing improvements and historic corridor and building restoration. This zone includes Sycamore Grove Park, which is adjacent to the Arroyo Seco channel. One of the focus areas for the current Targeted Neighborhood Initiative includes a portion of Lincoln Heights. As opportunities arise, community development should couple residential and business improvements with open space and watershed needs.

In this section of the watershed, primary issues addressing watershed health revolve around urban runoff: commercial / industrial runoff and runoff associated with residential landscaping. Historically, the majority of this area was a floodplain, the intense development in this area created large expanses of land that are currently impervious to surface infiltration. There is an overwhelming amount of paved surfaces relative to area and number of inhabitants. The amount of green space per inhabitant is well below the national average. Important milestones necessary to reduce the effects of first flush urban runoff include the development of a long-term vision for open space acquisition and development and a community-driven, city-supported watershed education program. Working within area plans to address watershed needs and creating multi-level government coalitions will help phase this vision into a reality.

D. CONCLUSION

This discussion on Current Conditions within the Arroyo Seco watershed provides insight into how land and water uses have altered natural systems. These modifications to natural functioning have resulted in impairments to the flows of sediments, water, habitat, and ultimately, humans. We must make changes on our land through the integration of natural systems thinking. If current practices continue, the potential for infrastructure replacement costs to increase exists. If remaining habitat continues to be taken over by exotics and severed from other remaining patches of open space, wildlife and plant species will continue to disappear from this region. It is clear that our current land and water use patterns cannot continue.

This study focuses on addressing stream restoration, water resources, water quality, habitat restoration, recreation and open space. The report therefore has set the stage for a restoration strategy, first by summarizing the pre-development landscape, then by discussing post-development alterations to the natural systems. In doing so, restoration needs are bought to light. The following section, *Restoring the Watershed: Feasibility and Planning Recommendations*, outlines goals and guidelines for restoration and suggests over 80 specific projects and programs for implementation. What is clear is that broader issues such as transportation and housing, politics, local planning processes and the economy are intricately related to the ability for restoration to take place.

IV. RESTORING THE WATERSHED: FEASIBILITY AND PLANNING RECOMMENDATIONS

The following recommendations represent the heart of this project, the manifestation of the goals and objectives necessary in order to achieve a balanced restoration of the Arroyo Seco watershed. Members of the project team along with the consultants developed these recommendations after conducting the technical studies for each study area. As a result of studies, it has become apparent that restoration of the Arroyo Seco watershed is a complex and long-term process, requiring the cooperation of many agencies and community groups. It is likely that more than one group or agency will need to accept the responsibility of acting as the lead in each particular effort to ensure success. In addition, the recommendations are intricately linked to one another which is reflective of the vision for the +watershed system, where hydrologic and ecological systems are restored and interconnected to human systems of land use and recreational needs.

The proposed strategy for watershed restoration is based on the principles of landscape ecology. As described at the beginning of Section II: *The Arroyo Seco Watershed: An Historic Overview*, the interrelationships between structure, function and change through time provide a model for understanding ecological processes in a comprehensive and meaningful way. Section II built a foundation of pre- and early development watershed conditions, which provided a description of baseline conditions and how they have been changed over time. These conditions inform the restoration planning process by providing a picture of what an ideal restored watershed would be. Section III: *Current Conditions and Function in the Arroyo Seco Watershed* followed, setting the stage for our watershed restoration starting point.

This study seeks to restore the Arroyo Seco watershed to the greatest extent feasible. These restoration planning recommendations create a road map for recovering overall ecosystem function and key processes by: recommending a strategy and phasing for the restoration effort; examining the roles of various parts of the watershed; establishing the needs of habitat, humanity, and a healthy hydrologic system; and identifying potential constraints and conflicts between those needs. We can meet these needs and mediate these conflicts through thoughtful coordination and implementation of restoration projects and programs.

For this study, the road map for restoration is in the form of two matrices which appear as Table IV-A: *Framework For Restoration Projects: Watershed Restoration Goals, Guidelines & Action Items* (Framework), and Table IV-B: *Recommendations For Projects And Studies* (Projects). In brief, the Framework matrix provides goals and guidelines that can be adopted for all ongoing and proposed projects as appropriate. The Projects table identifies potential projects in each area of the watershed. This table also describes projects that can be adopted and further developed by local agencies or organizations working in the watershed.

A. RESTORATION FEASIBILITY & WATERSHED ROLES

The question remains, is restoration of the Arroyo Seco and the watershed feasible? According to the project team, the answer is YES… to a degree. This study acknowledges that complete restoration to historical conditions or functioning is not possible. However, what is possible is restoration of many parts of the watersheds systems, resulting in a better place to live, work and recreate. The first section will examine the different factors related to feasibility of restoration. Following that will be a discussion on the roles of both the Upper and Lower Watershed. Each role, such as "Increasing permeability," will have a short discussion on its feasibility in relationship to restoration of the entire watershed.

1. FEASIBILITY

There are four major aspects to restoration feasibility that must be considered: Technical feasibility, temporal and sequential feasibility, political feasibility and economic feasibility. Technical challenges involved in large-scale restoration may seem daunting. However, according to the project team technical consultants, it is technically feasible to one day remove portions of the concrete channel, while maintaining public safety. There is no question that many restoration projects will require the advice of technical experts, which can become a huge expense. This is necessary. In addition, many other pieces of the restoration puzzle must first fall in to place before portions of the channel can be removed. Sequentially, watershed restoration is a long and complicated process in terms of technical, political and financial challenges. Timing the implementation of projects and long-term planning are also important factors in the success of restoration.

The more difficult aspect of watershed restoration is the need to generate political support. Political will and community support are essential to the implementation of projects. Ecosystem functions take place over multiple political and jurisdictional boundaries. Therefore, restoration projects are collaborative efforts for multiple entities to pursue together. The intent of the study recommendations is to encourage both public agencies and community organizations to work cooperatively together in the pursuit of restoration of common goals. Interest must exist on all levels of public and private participation.

Community-based groups, private citizens, elected officials and multiple agencies must be willing to come to the table to discover mutually beneficial solutions that will meet everyone's needs. Public and agency education and outreach much occur at all levels, at all times. This document can provide a framework from which to begin the dialogue. Organizations such as the proposed Council of Arroyo Seco Agencies (CASA) and Council of Arroyo Seco Organizations (CASO), discussed later in this chapter, may provide a needed forum for the implementation of projects.

The potentially enormous costs of implementing projects may deter agencies and citizens from supporting restoration efforts. However, there is beauty in the potential for one project to blossom into additional funding opportunities. If multiple stakeholders collaborate on a project, the chances of funding increase. Funding sources are more likely to consider projects with multiple stakeholders behind the effort than a single entity. Once seed money is secured, that can be leveraged for additional funds. Momentum will build. In-kind support also adds greatly to the momentum. The Arroyo Seco watershed planning effort has so far attracted three major grants, and several major in-kind agency efforts. Both monetary and in-kind support provide necessary funds for the implementation of restoration activities.

Technical, political and economic realities of watershed restoration feasibility create a complex situation. Where does one start? To better understand what is involved, watershed restoration roles have been broken down in the following section. This text outlines roles for the Upper and Lower Watershed in terms of technical, political, and economic feasibility. Much of this discussion is derived from the findings of the studies found in Volume II: *Technical Appendices* of this report.

2. ROLES OF UPPER WATERSHED

The upper watershed is comprised of the mountains and foothills. The greatest amount of rainfall occurs in this area, which contributes a large portion of the flows through the Arroyo Seco watershed. This area of the watershed is also of particular value from a water resources standpoint. Being largely undeveloped, with native vegetation while providing passive recreation to residents of the watershed and beyond. Due to the limited disturbance of the natural landscape, restoration within the upper watershed is more feasible and less costly. The more altered the land use, the more effort and costly to restore. With one primary landowner, the Angeles National Forest, this is politically the simplest area within which to work.

Tributary streams in the upper watershed, though generally in good condition, are affected by excess siltation due to dams and debris control structures. Exotic invasive plants have colonized these areas particularly the herbaceous understory. Dams also impede the migration of native fish. Additionally, freeways, roads, and private developments impede the migration of terrestrial wildlife while also contributing to erosion problems. Fire management programs that have not been implemented have led to the accumulation of large fire loads. If a large scale fire were to occur, mudslides and major flooding should be expected, contributing to water quality and safety problems downstream. Sensitive habitat would also be destroyed. Finally, spreading basins used to replenish the Raymond Basin are single-purpose.

Restoration efforts in the upper watershed should focus on:

- Restoring natural hydrologic flows. This is the most important aspect of upper watershed restoration since mountain runoff contributes greatly to flows in the Arroyo. Technologically difficult, long-term and rewarding.

- Enhancing habitat, and managing hazards through potential dam removal. This requires careful study of the functions of the crib structures and dams in the Angeles National Forest. Their existence precludes fish passage, therefore serious consideration needs to be given to their benefits and risks. Lowering of dams is another alternative to dam removal that might be beneficial. Technically difficult task with potentially significant rewards.
- Reinstating sediment transport. This is a key component of restoring hydrologic functioning. Requires technical studies and downstream coordination. This is a long-term task.
- Implementing fire management programs. Technically feasible, requiring much public education and coordination, fire management especially at the urban-wildland edge is a key function of the upper watershed. The US Forest Service plays a key role in fire management. Very important to maintaining long-term watershed health. This is a politically difficult task.
- Restoring sensitive habitat areas such as riparian corridors. Of all the tasks mentioned above, this is probably technically and politically the simplest to implement. This should be undertaken immediately. The benefits will be achieved as soon as exotics are removed, and native vegetation starts to move in.

3. ROLES OF LOWER WATERSHED

The lower watershed is predominantly urbanized, and generally residential in character. Due to the intense urbanization of this area, the road to restoration will be a long, challenging and potentially expensive one. However, also due to the thousands of residents in the lower watershed, the potential for increased benefits is great. Benefits of restoration include increased reliance on local water supply, increased water quality resulting in possibility for safe human contact, return of native fish and wildlife species to streams and open spaces, visually pleasing stream corridors, increased recreational opportunities, and increased trail use options and access.

Currently, golf courses and sports fields provide outlets for recreation, although Brookside Golf Course is recognized as a business with fiscal responsibilities. The many roads and trails in the Arroyo provide opportunities for bicyclists, joggers, and walkers, although traffic imposes safety limitations. Trails along the Arroyo Seco channel provide some additional space for recreation. Most wildlife is isolated to patches on steep slopes around Debs Park, Mount Washington and Montecito Heights. Much historic wildlife, such as the roadrunner, has been extirpated, or locally extinct, from the lower watershed altogether.

The lower watershed is comprised of flatlands and hills. Historically, there were many springs in the lower watershed. Historic tributaries have either dried up or been buried in concrete storm drain pipes. This urbanized area contributes a significant amount of runoff, approximately 45% of the runoff in the entire Arroyo Seco watershed. This runoff is also likely to be contaminated by non-point sources of pollution, such as motor vehicles, animal wastes, fertilizers and pesticides.

Restoration efforts in the lower watershed should focus on:

- Naturalizing the Arroyo Seco stream channel. This endeavor is the most challenging and most rewarding of restoration efforts. This should take priority over all else. Efforts that lead towards making this possible should begin immediately, such as storm water retention Best Management Practices

throughout the watershed, and engineering studies of hydrologic and geomorphologic processes.

- Increasing permeability. This can be done anywhere and is technically easy to moderate in terms of implementation. This should be incorporated immediately into any planning, zoning and construction effort., since it will ultimately lead towards the ability of stream naturalization to occur.
- Slowing and filtering runoff. By doing so, velocity and volume of peak runoff is reduced, lessening the loads into the Arroyo Seco. This task requires technical expertise, but is quite doable on a number of land uses such as parking lots and parks.
- Daylighting buried creeks. This task is moderately to very difficult in terms of political feasibility, since much of the land is private. Education is a key component for the success of daylighting creeks. However, this task is potentially greatly rewarding and will do much to allow for the Arroyo Seco to be restored.
- Improving water quality. Implementing upcoming Total Maximum Daily Loads (TMDLs) will become increasingly necessary as the Regional Water Quality Control Board will begin to enforce TMDLs. This requires implementing multiple best management practices (BMPs) along with public education. This effort will have wide support and is technically feasible.
- Enhancing habitat linkages through the creation of new stream corridors. The long-term benefits include the assurance of the existence of native wildlife species, which contributes to the biodiversity of southern California. This will involve technical expertise, education and cooperation by the public.
- Open space protection. The secret to a healthy community is abundance of open space, available for passive recreation, habitat, and aesthetic enjoyment. Land trusts and conservancies have many available tools to assist communities and municipalities in achieving open space protection. This is of high priority. The creation of open space through land use conversion should not be overlooked.
- Native habitat revegetation projects. This may involve education of property owners close to native open space to consider more native plants. Existing open spaces may benefit from native plant restoration and removal of exotic species. This is a very feasible endeavor.
- Development of trails that connect residents across communities to meaningful destinations. This is a critical component to watershed restoration—it draws local and regional citizens to enjoy the beauty and resources of the watershed. Must be a priority. Can be politically tricky, as trail linkages traverse many land owners and jurisdictions.

B. RESTORATION VISION COMPONENTS

Restoring sustainable watershed processes in the Arroyo Seco requires reestablishing the structural elements of the watershed and allowing or managing adaptation of those elements in response to natural and human-induced disturbances and processes.

The US Department of Agriculture defines restoration as the "...reestablishment of the structure and function of ecosystems" (National Research Council, 1992). Ecological restoration is the process of returning an ecosystem as closely as possible to predisturbance conditions and functions. Implicit in this definition is that ecosystems are naturally dynamic. It is therefore not possible to recreate a system exactly. The restoration process reestablishes the general structure, function, and dynamic but self-sustaining behavior of the ecosystem. The project team recognized early in the planning process that there

are serious limitations to full restoration of the watershed. Recovery of ecosystem functions, but not necessarily all structures, to predisturbance conditions is a more realistic goal for the watershed. Within the technical definitions of "restoration" and "rehabilitation", both are realistic goals for components of the watershed.

This section focuses on the vision for each component of watershed restoration. While structure and function may vary throughout the watershed, all components of the watershed are considered to be of value as part of the intrinsic whole. The following structures and functions make up the components of the recommended restoration strategy. The project team has considered each component in broad terms with regards to the desired results. Each component may have multiple lead agencies and organizations that are needed to achieve desired restoration. These components include:

Structures for restoration or rehabilitation:

- The Arroyo Seco stream corridor
- The Raymond Basin
- Arroyo Seco tributaries in both the upper and lower watershed
- Native habitat patches
- Open space
- Trails

Functions to be restored:

- Groundwater recharge
- Storm water runoff detention
- Storm water runoff filtration
- Surface stream flows
- Sediment transport
- Nutrient flows
- Wildlife movement linkages

Multi-objective projects are clearly needed to achieve restoration. It is no longer enough to build a park simply to accommodate recreational needs. If the opportunity exists to develop a park, the opportunity exists to integrate additional functions such as storm water retention and habitat restoration. Agencies must take advantage of every development and improvement opportunity to include as many restoration objectives as possible. For every capital project that has an allocated budget, an opportunity exists to develop alternative designs and plans to achieve as many benefits as efficiently as possible.

A current example of multiple-benefit thinking is the *Sun Valley Watershed Project*. This project is taking place in the eastern part of the San Fernando Valley in an area prone to flooding. Instead of spending millions of dollars on a single-solution storm drain pipe, the Los Angeles County Department of Public Works and TreePeople have brought together a group of stakeholders to create multiple-benefit solutions. The proposed improvements will not only relieve flooding, but will provide additional parks, increased recreational opportunities, additional habitat, job opportunities, and a more attractive place to live. This process involves a vision, technical expertise, and much public outreach and education. It is this kind of effort that needs to take place for the Arroyo Seco to eventually be restored.

1. ARROYO SECO STREAM CORRIDOR NATURALIZATION

Reduction of peak runoff flows can enable the Arroyo Seco to be naturalized for the majority of its length. Reestablishment of sediment transport, stream meanders, and flood plains should be included in this phase of work. Erosion control strategies, such as revegetation and grade control structures, should be considered in order to manage stream velocities. The objective of reestablishing aquatic habitat can be integrated into corridor naturalization. Stepped grade control structures could provide the opportunity for controlling stream velocities while still enabling fish migration.

While naturalization of the Arroyo Seco corridor is the most visible and tangible outcome of this project, flood attenuation and the implementation of effective Best Management Practices for water quality take precedence in terms of rehabilitation phasing. Los Angeles County Department of Public Works emphasizes the need for stream naturalization projects to maintain public safety (Appendix L: *Comments on Draft Technical Report by Los Angeles County Department of Public Works*). These constitute baseline issues upon which stream naturalization depends.

a. The Arroyo Seco Stream Corridor

Restoration of the Arroyo Seco stream corridor itself will be the most visible indication of the success of restoration efforts. Physically, the concrete channel will be torn out where feasible, allowing the stream to spread out. Terracing along the banks can accommodate different types of trails, separating equestrian riders from bicyclists. Riparian habitat, with arroyo willow and other native species would flourish in this restored riparian habitat, securing the banks against erosion and scour during flood events. Storm flows will once again meander and braid across the floodplain, forming habitat rich sand bars. With the widened flows, gravel and silts will once again be transported and deposited.

Based on physical constraints, this restoration scenario is not possible along the entire stretch of the Arroyo Seco. Land use such as the Arroyo Seco Parkway or housing communities in Highland Park may preclude the concrete from being removed along those stretches. However, segments of concrete that are on low-access, low-use, public lands can potentially be removed. These areas include some or all of the "Lower Arroyo" in Pasadena and the "Island" in South Pasadena. It will be technically feasible to implement these projects due to current minimal land uses, with available floodplain to increase the carrying capacity of the restored stream.

b. Arroyo Seco Tributaries in both the Upper and Lower Watershed

A healthy system not only includes the Arroyo Seco as the main stem, but functioning tributaries as well. A restored system will include daylighted creeks in La Cañada Flintridge, Pasadena and Los Angeles, flowing towards the Arroyo Seco. Conveying not only water, the tributaries will also convey wildlife through its vegetated corridors, thereby contributing to the protection of biodiversity in the region.

In Highland Park, the project team envisions historic North Branch flowing once again, emerging in places unexpected. The stream might run alongside a residential street, at the bottom of a schoolyard or surface in Sycamore Grove Park. In Pasadena, running water may one day parallel beautiful tree-lined streets as in Altadena. These streets can attract birds and other small wildlife with its' daylighted storm drains and urban forestry. In La Cañada Flintridge, several daylighted tributaries into Flint Canyon Wash may

eventually serve as habitat movement linkages from the San Gabriel Mountains to the Verdugo Hills.

c. Flood Attenuation

Naturalization of the Arroyo Seco stream corridor depends upon reduction of peak flows in the stream channel during severe storm events. Flood attenuation projects will detain and infiltrate runoff flows in "wetlands" or landscaped bioswales. When implemented using biofiltration techniques, flood attenuation projects will also enhance water quality, provide open space and habitat, and supplement local groundwater supplies.

Recharging local groundwater not only provides more local water for human consumption, it also enhances natural stream flows, thus creating a more habitat area for aquatic species, and a more visually pleasing environment for recreation. In addition, local communities can be less dependent on imported water resources. Spreading basins and other strategies for infiltration can be accompanied with habitat restoration and flood attenuation projects.

The project team recommends pursuing flood attenuation projects on a subwatershed level. The subwatershed approach to flood attenuation provides a natural hydrologic unit from which to work. This approach also affords the opportunity to restore historic stream tributaries. The largest, most urbanized subwatersheds contribute greatly to runoff and should be prioritized in a phased approach to implementation.

d. Storm water runoff detention & filtration

In the near future, storm water runoff will be seen as a valuable resource. This will be accomplished through a shift in thinking about capturing and filtering storm water as the responsibility of everyone. Through appropriate retrofits of every kind of landscape, beneficial changes will occur. The end result will be in less dependence on the built storm drain system and more reliance on an infrastructure of projects that works with, not against natural systems.

No longer will we see the construction of single-purpose detention basins or dams. Instead, multipurpose projects such as wetlands or landscaped bioswales will be built all over southern California. These projects, also known as Best Management Practices (BMPs) will accomplish multiple purposes. Over time, these projects can collectively recharge the groundwater basin, improve water quality by filtering out pollutants, reduce velocity of storm flows into the Arroyo, create habitat and provide visual respite.

For example, seasonal wetlands can simply be a low spot that collects runoff and filters it through a variety of plants and appropriate soil structure. These will be dotted throughout the landscape in open spaces, parks and even in private backyards. Plants in these wetlands can "comb" out trash, making debris collection easy. With native plants, native wildlife will utilize these wetlands. These wetlands improve the visual landscape, providing an oasis of native plants for visitors to experience.

Bioswales are an easy adoption to implement in many urban situations. Instead of allowing storm water to run off a parking lot, bioswales can capture and filter polluted runoff. Property owners can take advantage of opportunities to reconfigure their lot to accommodate a more realistic number of cars (instead of building lots to accommodate Christmas season-only loads). In doing so, retrofitted lots will contain planted strips in

between facing rows of cars, or along the edges of the property. These bioswales can serve multiple purposes through enhancement of the visual quality of the lot, reduction of the urban heat island effect, and the capture of storm water runoff.

e. Surface stream flows

Surface flows will one day function more like a natural undeveloped system, although they will not mimic streams of these predisturbance systems. Water quality, quantity, temperature, and seasonal flows will all be improved in the rehabilitated system. Floodplains will be restored along certain stretches of the Arroyo, allowing for storm water runoff to expand and breathe. Historic creeks buried within storm pipes will be daylighted, giving surface flows air to breathe. These changes will allow for a healthier system of surface flows, contributing to overall watershed quality and health.

In the rehabilitated system, clean mountain runoff will flow through the watershed, gradually percolating into the ground instead of being diverted directly to the Raymond groundwater basin. This clean water will dilute polluted runoff from the urban areas of the lower watershed. However, the urban runoff will be greatly improved through measures that improve water quality.

f. Sediment transport

With the restoration of the Arroyo Seco, sediments will once again be transported downstream. In areas with a restored floodplain, deposition of sediments will occur. Through a multi-pronged approach to sediment management, sand and gravel will once again make its way from the San Gabriel Mountains, down the Arroyo and on to the Los Angeles River. With sediment transport reinstated, impediments to movement of aquatic species may be removed. Fish passage to high quality spawning grounds in the upper reaches of the watershed will one day occur.

2. WATER QUALITY

Water quality projects will meet TMDL objectives. All municipalities in the watershed will work towards reduction of trash, excess nutrients, coliform bacteria, heavy metals and other water pollutants. Cleansed water can then be used to safely support wildlife, provide opportunities for human contact, and to enhance existing water supplies. Water Quality projects can be pursued primarily through the implementation of BMPs. These BMPs will fulfill multiple objectives and will become easy to implement.

3. NATIVE HABITAT

Habitat connectivity, quality and quantity will all be greatly improved in the future, decreasing the threat of continued extirpations or extinctions in the region. In areas where native habitat exists, open space will be protected in perpetuity. Exotic plant species will be removed and native vegetation communities such as alluvial fan sage scrub, stands of sycamore-alder, walnut woodlands, oak woodlands, and native bunchgrasses will reestablish. With the establishment of native habitat, native wildlife will continue to flourish. Along with native habitat, responsible fire management will be a part of the public consciousness.

The naturalized Arroyo Seco stream one day will serve as the primary habitat linkage from the San Gabriel Mountains to the Santa Monica Mountains. For regional viability of biodiversity, restoration of this linkage will be critical. If restored, this linkage will become a part of a larger regional network of open space, including the San Gabriel

Mountains to the Santa Susana/Simi Hills and to the San Bernardino Mountains. With these regional linkages in place, greater habitat connectivity can exist from southern California, north up the coast and the Sierras, and south in to Mexico.

4. RECREATION

The Arroyo Seco watershed will continue to be a haven for a variety of recreationalists. Trails will connect locally and regionally, creating scenic loops, and accommodating multiple modes of use. Equestrian loops may one day encircle the Arroyo, providing outstanding views, and creating security by "patrolling" riders. These equestrian trails will connect to trails in the Angeles National Forest and Griffith Park. With multiple levels of challenge and variety, bicycle trails will pass through scenic areas and connect to the Los Angeles River Bikeway all the way to Long Beach. Along the Arroyo, the famed ArroyoWalk will be in use, connecting pedestrians to the culture and history surrounding the Arroyo. Together, these trails equestrian, bicycle and pedestrian will connect the Arroyo with the Rim-of-the-Valley Trail Corridor encircling the San Fernando Valley.

5. OPEN SPACE

In the restored watershed, open spaces will be easily accessible from all communities in the watershed. Residents will have choices of open spaces and parks for gathering, playing and enjoying nature. Children will have the chance to play in the cleaned waters of the uncovered North Branch stream in Highland Park. There will be adequate soccer and other sports fields through innovative field-sharing programs or creative re-adaptation of land uses, such as industrial lots to soccer fields. Undeveloped open spaces will be protected in perpetuity through a collaboration of government agencies and local land trusts or other community-based organizations.

C. Framework for Restoration Projects: Watershed Restoration Goals, Guidelines & Action Items

The restoration components described in the previous section have been compiled into a single matrix as Table IV-2: *Framework for Restoration Projects: Watershed Restoration Goals, Guidelines & Action Items*. The purpose of this matrix is to provide a framework which agencies and organizations can use to prioritize their own projects. With this matrix, a project can be evaluated for its consistency with watershed restoration goals & guidelines. For example, if an agency is considering implementation of a parking lot Best Management Practices (BMP) project by the Arroyo, that project can be cross-referenced against this matrix for the specific guidelines it fulfills. A parking lot BMP will fulfill Goals 1- Hydrologic Functioning, 2- Water Resources, and 4- Open Space/Visual Quality. It is the hope of the project team that each agency and organization within the region will endorse these Project Goals & Guidelines, and implement projects consistent with this framework. Through cooperative efforts, restoration of our natural resources and enhancement of cultural resources will be achieved over time.

The four Restoration Goals, shown as a shaded heading, describe the overall vision for a restored watershed. These goals describe the general "structure" or physical makeup of the landscape, and "function" or natural or human processes that drive our watershed ecosystem. Project Guidelines, in the left-hand columns, are more detailed describing the structure and function of specific aspects of or locations within the watershed. For example, Project Guideline 1.1 is to restore the Arroyo Seco stream and tributaries, while Project Guideline 3.1 calls for restoration of missing linkages of habitat.

However, it is from the Action Items in the right-hand column that specific projects emerge. These items are detailed enough to provide measurable progress towards restoration, but general enough to be flexible in the execution. These are meant to be implemented throughout the watershed and are not location specific recommendations. Action Items consist of further study and program recommendations. Some of these items are specific topics for further study and analysis before restoration implementation can take place. Additional funding is needed for these studies. Recommended programs ideally begin immediately, because education of the public is crucial to successful implementation of restoration projects as well as overall resource awareness, conservation and protection.

The Project Goals are long-term goals. The assumption is that full attainment of a Project Goal will happen after 30 years, which is beyond the period of this study. However, starting today, partial attainment of these goals is possible through every project or program that is realized. Project Guidelines and Action Items are assumed to take place within the next 30 years. These are the items that the project team hopes every agency and organization in the watershed takes action upon.

TABLE IV-1: FRAMEWORK FOR RESTORATION PROJECTS: WATERSHED RESTORATION GOALS, GUIDELINES & ACTION ITEMS

RESTORATION GOAL 1: RESTORE THE NATURAL HYDROLOGICAL FUNCTIONING OF THE WATERSHED			
1.1	Restore Arroyo Seco stream and tributaries through widening and lengthening of streams.	1.1.1	Remove the concrete lined channel, and replace it with a naturally functioning stream where possible: -Create meanders and braiding in stream -Restore floodplains
		1.1.2	Restore creek tributaries: -Enhance drainage swales -Daylight creek tributaries
		1.1.3	Conduct a detailed hydraulic analysis of the modified channel and floodplain.
		1.1.4	Conduct a detailed geomorphic analysis to determine an appropriate combination of channel sinuosity and channel geometry.
		1.1.5	Formulate program for multi-objective operation and maintenance of restored system that is adaptable by all management agencies.
1.2	Create floodplain system allowing for periodic overflow while providing the required level of public safety and flood hazard mitigation.	1.2.1	Mitigate existing flood hazard conditions.
		1.2.2	Utilize existing open spaces along Arroyo Seco and tributaries for floodplain restoration.
1.3	Reduce volume and velocity of storm water runoff.	1.3.1	Utilize multiple-purpose BMPs and management practices such as reforestation, bioengineering, and/or other non-structural approaches for flood management.
		1.3.2	Implement flood attenuation measures in subwatersheds through increased groundwater percolation and slowing of surface runoff.
		1.3.3	Utilize non-structural, aquatic habitat-friendly grade control measures.
		1.3.4	Utilize neighborhood-based flood detention solutions.
		1.3.5	Restrict hillside development.
		1.3.6	Evaluate the effects of BMPs on volume & velocity of storm water.
RESTORATION GOAL 2: BETTER MANAGE, OPTIMIZE, & CONSERVE WATER RESOURCES WHILE IMPROVING WATER QUALITY			
2.1	Improve quality of surface water for aquatic habitat and human contact.	2.1.1	Implement BMPs to mitigate water quality pollutants flowing into the Arroyo Seco.
		2.1.2	Develop source protection measures.
		2.1.3	Reduce non-point sources of pollution.
		2.1.4	Develop ongoing water quality monitoring programs and public education of water quality issues.
		2.1.5	Monitor and clean out pollutants that accumulate in structural and non-structural BMPs.
		2.1.6	Evaluate existing point-sources of pollution for monitoring compliance on a regular basis.
2.2	Restore the quality and quantity of water recharge to the Raymond Aquifer.	2.2.1	Increase permeability of developed land uses through implementation of BMPs such as redirecting runoff into bioswales, removing unneeded concrete and asphalt.
		2.2.2	Manage groundwater to prevent future overdraft
		2.2.3	Mitigate water quality pollutants percolating into the groundwater.
		2.2.4	Test the feasibility of recharging the ground water basin with surface flows in the channel through Hahamongna Basin. Requires a detailed monitoring program and cooperation by groundwater users.

TABLE IV-1: FRAMEWORK FOR RESTORATION PROJECTS: WATERSHED RESTORATION GOALS, GUIDELINES & ACTION ITEMS (CONT.)

2.3	Develop groundwater management strategy for optimum use of local water resources.	2.3.1	Expand conjunctive use of groundwater basin for enhanced storage during wet periods for use during dry periods.
		2.3.2	Preserve foothill open space to protect percolation into the groundwater basin and to prevent aggravated runoff.
2.4	Reduce dependence on imported water.	2.4.1	Increase ground water percolation through BMPs.
		2.4.2	Expand the reclaimed water infrastructure for irrigation and other non-potable uses.
		2.4.3	Promote comprehensive conservation programs and best management practices throughout the watershed to reduce water consumption.
		2.4.4	Develop upper hillside watershed reforestation and revegetation programs to improve local retention.
2.5	Reinstate sediment transport.	2.5.1	Control erosion & manage sedimentation in restored streams (e.g., bank regrading and revegetation, channel grade control structures, riprap), and under bridges & freeway overpasses.
		2.5.2	Implement BMPs for construction and existing land uses to reduce and manage sedimentation from human disturbance.
		2.5.3	Conduct a detailed hydraulic and geomorphic investigation of channel conditions with respect to erosion potential.
		2.5.4	Establish a maintenance and management program to either trap the sediment in areas where it can be easily processed or to promote its passage through Devil's Gate reservoir and dam downstream.
		2.5.5	Develop re-vegetation programs and BMPs where appropriate to reduce erosion.
RESTORATION GOAL 3: RESTORE, PROTECT AND AUGMENT HABITAT QUALITY, QUANTITY AND CONNECTIVITY			
3.1	Restore and protect missing linkages of fragmented habitat.	3.1.1	Allow Rainbow Trout / Steelhead passage from upper watershed to Glendale Narrows.
		3.1.2	Provide and protect habitat corridors linking the San Gabriels to the Verdugos to the San Rafaels to Mt. Washington to Debs Park to Elysian Hills through smaller linkages between upland and lowland zones, and from habitat patches to waterways need to be established.
		3.1.3	Enhance habitat linkages through the creation of new urban stream corridors.
		3.1.4	Plant linear urban forest streetscapes for urban habitat connectivity.
		3.1.5	Facilitate and monitor terrestrial habitat connectivity from San Gabriel Mountains to Santa Monica Mountains.
		3.1.6	Facilitate and monitor wildlife movement among fragmented habitats of the watershed and the Arroyo Seco.
3.2	Integrate fire management into native vegetation zones.	3.2.1	Implement fire management techniques in urban interface zones.
		3.2.2	Develop fire management strategy, especially in areas that have not experienced burns in over 30 years.
3.3	Restore, protect and augment terrestrial species habitat in existing open space of foothills and floodplains.	3.3.1	Protect and restore habitats, processes and ecological relationships supporting sensitive and endangered species, including arroyo toad, western pond turtle and other focal species.
		3.3.2	Key species to target for restoration include lesser nighthawk, greater roadrunner, California quail, bobcat, and gray fox.

TABLE IV- 1: FRAMEWORK FOR RESTORATION PROJECTS: WATERSHED RESTORATION GOALS, GUIDELINES & ACTION ITEMS (CONT.)

RESTORATION GOAL 4: IMPROVE RECREATIONAL OPPORTUNITIES AND ENHANCE OPEN SPACE			
4.1	Improve connectivity and public access from the Angeles National Forest to the coastal shore.	4.1.1	Improve the network of trails by connecting trails and open spaces with multi-modal trails.
		4.1.2	Provide access for public use of the watershed's rivers and streams.
4.2	Protect and interpret natural, community, cultural and historic resources.	4.2.1	Improve connectivity between parks, open space, cultural and historic resources through trails and land acquisition.
		4.2.2	Develop trails that connect residents across communities to meaningful destinations.
4.3	Integrate natural resources management with recreational needs.	4.3.1	Manage parks and other open spaces, including golf courses, trail connections and native habitat to benefit flood management.
		4.3.2	Provide opportunities for a range of recreational activities.
		4.3.3	Coordinate between agencies and groups to meet community needs for recreation with agency priorities
4.4	Protect existing open space while augmenting open space network.	4.4.1	Inventory existing and potential open spaces for protection, recreation, land use conversion.
		4.4.2	Introduce the concept of long-term acquisition with an open public process.
4.5	Improve visual quality of the landscape.	4.5.1	Expand urban tree-planting programs.
4.6	Mediate conflicts between recreation and conservation and opposing recreational users.	4.6.1	Improve the cooperative spirit among recreational users through an open public process.

D. RECOMMENDATIONS FOR PROJECTS AND PROGRAMS

Through the course of the planning process, the Project Team identified over 78 potential projects, programs, and best management practices. These ranged from a redesign of a golf course to the daylighting of streams watershed-wide. The matrix represents some possible projects, but this list is by no means comprehensive. A matrix was developed to rank the potential benefits of each site for the different specializations represented in the study team: hydrology, water resources & quality, habitat, and recreation. Figure IV-1: *Arroyo Seco Watershed Restoration Plan-Locations of Projects and Programs*, identifies the location of site-specific projects and programs.

This matrix is intended for city, county, regional, state and federal agencies (hereinafter referred to as "agencies") with jurisdictions within the watershed, and for organizations that focus on issues in this region. The first step to using this matrix is for an agency to identify which projects are appropriate to undertake per their jurisdiction. Next, appropriate projects need to be prioritized according its ability to meet an agency's goals and work within a realistic budget and schedule. Often a project will meet an agency's needs, but funding will not be available to implement that desired project. If this is the case, that agency can seek out funding sources, such as Proposition 12, 13 or 40 funds from the state. Assistance on these grant proposals is available from the project team or other entities.

The structure of the matrix is simple. Projects and programs (hereinafter referred to as "projects") occur on each row. They are grouped according to sub regions within the watershed, such as "I. Angeles National Forest" or "VII. Arroyo through Los Angeles." There are a total of eight subregions, generally falling within the Angeles National Forest, foothill communities of La Cañada Flintridge and Altadena, cities of Pasadena, South Pasadena and Los Angeles.

Each project is given a title for ease of communication. These are suggestions only. An organization may see the usefulness in combining several projects into a single effort if

they occur in the same area. Conversely, an organization may see the need to undertake only one aspect of one project. The project description column gives a general overview of the project for clarification. Suggested descriptions stem from the original goals of this project and may not necessarily completely reflect the mission of a particular organization. In the case of potential conflicts between an agency's mission with watershed restoration principles, the Agency Technical Review Committee or other similar entity might provide the forum for discussion on how to arrive at a win-win solution for all involved.

Criteria for the assessment of projects are shown on the right side of this matrix. These include Goals Fulfilled, Years to Complete Project and Estimated Project Cost. These are suggestions and estimates to be used for planning and prioritization purposes only. Several other criteria exist that are not included in this chart. These include public vs. private ownership of a potential project site, community support and involvement, technical feasibility and ease of implementation, political feasibility and "will," and public visibility of the completed project. These and other agency-specific criteria need to be assessed by the lead organization as appropriate.

The five goals listed reflect the original intent of the project team as described in the previous Framework for Restoration Projects: Watershed Restoration Goals, Guidelines and Action Items matrix. Ideally, a project fulfills multiple goals. Using this chart as a guideline, an organization can begin to prioritize projects depending on the number of goals it fulfills, and just as importantly, to the degree to which it can fulfill each goal. A star in one or more columns indicates a high priority project.

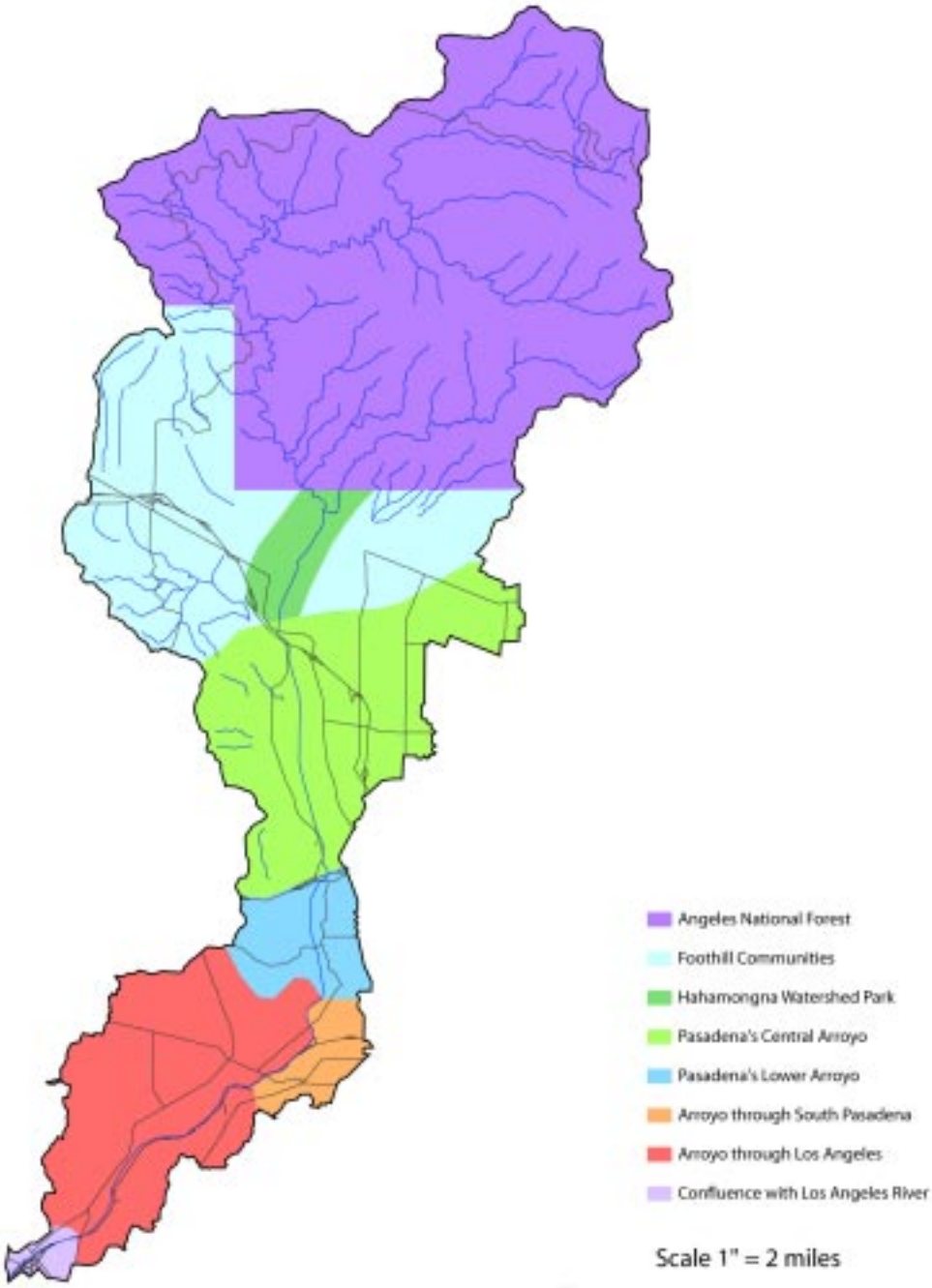
Using the Years to Complete Project estimates, an organization can plan for the integration of a project based on an implementation timeframe. Many of the projects listed are short-term, 1-5 years estimated completion time. The remaining projects are mid-term (5-10 years) or long-term (10+ years). The more difficult projects such as stream restoration need more time and potentially have the greatest rewards. These projects need to begin in the next couple of years if we want to make progress towards restoration. Estimated Project Costs are simply suggestions by the planning team to be used for planning purposes only.

This matrix is to be used as a tool for measuring the success of restoration of the watershed. The more projects and programs completed, the closer this region gets to a healthy watershed. Will the implementation of every project on this list constitute a fully restored watershed? The answer is not clear. What is clear is that the completion of these projects will mean the potential for native fish to return to the Arroyo, the potential for safe human contact with the Arroyo, the potential for the Arroyo to serve as a national model for urban stream restoration, and the potential for the Arroyo to enrich the lives of southern Californians.

Finally, demonstration project focus areas were assessed in the following terms:

- Areas identified through the suitability mapping process,
- Relevance to issues within the watershed,
- Responsiveness to issues peculiar to localized areas of the watershed, i.e. upper or lower watershed, rural or urban conditions, and
- Political jurisdictions, and areas of the watershed with political support for and participation in the watershed planning process.

Potential projects not selected as demonstration projects should still be considered important aspects of the watershed rehabilitation plan.



Prepared by: North East Trees
Source: Los Angeles County Dept. of Public Works

FIGURE IV: ARROYO SECO WATERSHED RESTORATION PLAN-LOCATION OF PROJECTS & PROGRAMS

TABLE IV-2: RECOMMENDATIONS FOR PROJECTS AND STUDIES

PROJECTS, ACTIVITES & STUDIES	PROJECT DESCRIPTION	Goals Fulfilled					Years to Complete Project			Estimated Project Cost			
		★ High Priority Project					*Estimates provided for general project planning purposes only.*						
		Stream / Flood	Habitat Restoration	Water Supply (drinking)	Water Quality	Recreation / Open Space	1 – 5 yrs.	5 – 10 yrs.	10+ yrs.	Less than $500,000	$500,000 - $2,000,000	$2,000,000– $10,000,000	over $10,000,000
I. ANGELES NATIONAL FOREST													
a. Millard Canyon Linkage	Provide trail and wildlife habitat continuity across the Altadena foothills into the Hahamongna area.		●			●	●			●			
b. Fish Barrier Removal Program	Remove or mitigate constructed barriers to fish passage.	●	●						●			●	
c. Exotic Plant Eradication	Remove invasive exotic species that degrade or destroy high value habitat.	●	★				●				●		
d. Exotic Animal Inventory & Reduction	Inventory exotic animal populations, develop a reduction strategy, and implement strategy.	●	★				●				●		
e. Arroyo Toad Habitat	Improve habitat conditions for the Arroyo Southwestern Toad in designated recovery area.		●	●	●		●				●		
f. Brown Mountain Dam	Examine the current conditions, habitat effects and function of the Brown Mountain Debris Dam. Analyze feasibility dam removal and other methods to facilitate fish and sediment passage.	★	★	●			●				●		
g. Haramokngna Tongva Cultural Center	Assist Gabrielino / Tongva leaders with development of an ethno-botanical garden and ceremonial site at Red Box.		●			●	●			●			
h. Water Diversion Fish Passage	Improve fish passage at Pasadena's water diversion facilities by installing an intake screen, flow separator, or other methods.		●				●						
i. Fern Canyon Debris Facility	Assess Fern Canyon Debris Facility with regard to fish passage and habitat effects. Analyze feasibility of removal or mitigation methods.	●	●				●			●			
j. USGS Gauging Station	Assess gauging station and its impacts to aquatic habitat. Analyze feasibility of methods to improve habitat.	●	●				●			●			

TABLE IV-2: RECOMMENDATIONS FOR PROJECTS AND STUDIES (CONT.)

PROJECTS, ACTIVITES & STUDIES	PROJECT DESCRIPTION	Stream / Flood	Habitat Restoration	Water Supply	Water Quality	Recr. / Open Space	1 – 5 yrs.	5 – 10 yrs.	10+ yrs.	<$500k	$500k-2M	$2M-10M	>$10M
k. Trail System Improvements	Complete the trail system through recreational areas of the Angeles National Forest.					★		●			●	●	
l. Trash Reduction	Implement volunteer programs, educate visitors, and modify maintenance methods to reduce the amount of trash / waste left by humans and their pets.		●		★	●	●			●			
II. FOOTHILL COMMUNITIES (LA CAÑADA FLINTRIDGE, ALTADENA)													
a. Flint Canyon Trails & Habitat	Improve trail and habitat connections through Flint Canyon Creek and Devil's Gate Dam. Protect critical habitat link under 210 Freeway.		★			●	●			●			
b. Flint Canyon Creek	Restore and stabilize banks in Flint Canyon Creek to prevent erosion and improve trail conditions.	●	●		●	●	●					●	
c. Millard Canyon Water Diversion Facility	Examine wildlife passage/habitat and water resource conditions of the Millard diversion facility.	●	●	●			●			●			
d. Stream Restoration Planning	Conduct a detailed hydraulic analysis of the modified channel and floodplain and a detailed geomorphic analysis to determine an appropriate combination of channel sinuosity and channel geometry.	●					●			●			
e. Stream Restoration	Remove, replace concrete channel with natural stream and floodplain system. Stream capacity to be 2-year in a low flow channel and 10-year in a main channel. Restored floodplain to convey remainder of a capital flood event. Public safety and protection of structures would still be required. Include sediment management. Monitor changes in configuration over time. Maximize stream meander and construct aesthetically pleasing grade control structures. Integrate with existing natural areas. Raise stream invert to enhance high ground water table.												

TABLE IV-2: RECOMMENDATIONS FOR PROJECTS AND STUDIES (CONT.)

PROJECTS, ACTIVITES & STUDIES	PROJECT DESCRIPTION	Stream / Flood	Habitat Restoration	Water Supply	Water Quality	Recr. / Open Space	1 – 5 yrs.	5 – 10 yrs.	10+ yrs.	<$500k	$500k-2M	$2M-10M	>$10M
f. Trash Reduction	Implement volunteer programs, educate park users, and modify maintenance to reduce the amount of trash/waste generated by humans and their pets. Construct and maintain trash control structures where appropriate.				●	●	●			●			
g. Urban Forestry	Plant trees along streets for enhanced visual quality and habitat.		●			●				●			
III. HAHAMONGNA WATERSHED PARK													
a. Stream Restoration	Develop a naturally functioning riparian system in the Hahamongna basin. Manage diversions to maintain habitat. Increase stream meander.	★	●	★	●	●		●	●				●
b. Percolation and Recharge	Replace proposed recharge basins with recharge in the natural streambed and floodplain. Design low flow channel and construct flow spreaders if necessary to distribute base flows and storm runoff over a wide area. Develop a monitoring and credit program with the Raymond Basin Management Board and regulatory agencies.	●	●	●	●			●	●			●	
c. Sediment Management	Develop management program for sediment control and removal. Perform excavation consistent with the PWA Hahamongna Basin Watershed Plan.	●		●	●		●				●		
d. JPL East Parking Lot	Upgrade critical connecting habitat at the mouth of the Arroyo by relocating JPL's east parking lot.	●	●		●		●					●	
e. Supervision of JPL Contamination Cleanup	Through watchdog efforts, ensure that cleanup is achieved with minimal negative impacts to habitat, water quality and visual quality.	●	●		★	●	On-going until cleanup ends						
f. Alluvial Sage Scrub	Restore, protect, enhance and expand alluvial fan sage scrub habitat at the mouth of the Arroyo and wherever it occurs within the Hahamongna Basin.	●	●	●		●	●	●			●		
g. Permanent Pond Study	Determine potential impacts and benefits of a permanent water pond to: native amphibians and reptiles; exotic plants and animals; sensitive species; flood protection and sediment management			●			●			●			

TABLE IV-2: RECOMMENDATIONS FOR PROJECTS AND STUDIES (CONT.)

PROJECTS, ACTIVITES & STUDIES	PROJECT DESCRIPTION	Stream / Flood	Habitat Restoration	Water Supply	Water Quality	Recr. / Open Space	1 – 5 yrs.	5 – 10 yrs.	10+ yrs.	<$500k	$500k-2M	$2M-10M	>$10M
h. Oak Grove Park Woodlands Understory	Restore appropriate oak woodland understory while accommodating recreational needs.												
i. Devil's Gate Dam Wildlife	Facilitate fish and aquatic species' passage through Devil's Gate Dam. Improve trail and wildlife connections.		★			●		●	●			●	
j. Devil's Gate Dam Management	Investigate alternative Basin configurations or dam operations to improve the ability of the reservoir to reduce Capital Storm outflows.	●		●			●			●			
k. Devil's Gate Dam Release	Conduct a detailed hydraulic and geomorphic investigation of channel conditions with respect to erosion potential due to dam releases.	●			●		●			●			
l. Exotic Species Inventory & Reduction	Inventory exotic plant and animal populations, develop and implement a reduction strategy.	●	★				●				●		
m. Trash Reduction	Implement volunteer programs, educate park users, and modify maintenance to reduce the amount of trash/waste left by humans and their pets.				●	●	●			●			
IV. PASADENA'S CENTRAL ARROYO													
a. Interchange Enhancement	Implement a stream cleanup program to remove concrete slabs and other debris under the 210 Freeway. Implement erosion protection as recommended by hydraulic study. Enhance natural stream function, habitat, and water quality with native vegetation and wetland plants. Provide for periodic sediment removal and study potential for water storage.	●	●	●	●			●				●	●

TABLE IV-2: RECOMMENDATIONS FOR PROJECTS AND STUDIES (CONT.)

PROJECTS, ACTIVITES & STUDIES	PROJECT DESCRIPTION	Stream / Flood	Habitat Restoration	Water Supply	Water Quality	Recr. / Open Space	1 – 5 yrs.	5 – 10 yrs.	10+ yrs.	<$500k	$500k-2M	$2M-10M	>$10M
b. Brookside Golf Course	Plan for anticipated renovations to result in a model of balancing a PGA-level course with increased environmental benefits. Utilize native vegetation; plan for high quality habitat for native bird, fish, and insect species; reduce fertilizer, herbicide, and pesticide needs and use non-toxic alternatives. Develop course layout that will enhance water quality and water resources and be compatible with planned stream restoration projects. Retain course designers with proven experience in balancing course needs with minimal environmental impact.	●	●	●	★	★		●	●			●	●
c. Brookside Stream	Create low-flow natural streambed through Brookside Park with diverted Arroyo water.	●	●			●		●				●	
d. Trail System Improvement	Improve and connect the network of trails, bikeways, and equestrian trails to provide safe access for all.					★	●	●					
e. Trash Reduction	Implement volunteer programs, educate park users, and modify maintenance to reduce the amount of trash/waste generated by humans and their pets. Construct and maintain trash control structures where appropriate.	●			●	●	●			●	●		
f. Equestrian Improvements	Implement and maintain structural and non-structural Best Management Practices to lessen environmental impacts of equestrian trails, while improving or maintaining trail quality.	●			●	●	●			●			
g. Surface Runoff Biofiltration	Use wetlands treatment to reduce contaminants in runoff from paved areas. Provide for periodic re-vegetation due to hazardous waste removal.	●	●	●	●		●	●					
h. Reclaimed Water	Complete connection with Glendale wastewater facility to provide reclaimed water for irrigation.			●	●			●				●	●

TABLE IV-2: RECOMMENDATIONS FOR PROJECTS AND STUDIES (CONT.)

PROJECTS, ACTIVITES & STUDIES	PROJECT DESCRIPTION	Stream / Flood	Habitat Restoration	Water Supply	Water Quality	Recr. / Open Space	1 – 5 yrs.	5 – 10 yrs.	10+ yrs.	<$500k	$500k-2M	$2M-10M	>$10M
j. Parking Lots	Reconfigure parking lots to be compatible with planned stream restoration projects. Re-grade lots to convey stormwater over 10-year discharge. Use permeable paving and shade 30% of pavement within 10 years with vegetation.	●					●	●				●	
k. Parking Structure Study	Conduct a study to determine the negative and positive effects of constructing a parking structure. Structure would carry parking equal to current stream-side parking plus overflow parking.	●				●	●			●			
l. Stream Restoration Planning	Conduct a detailed hydraulic analysis of the modified channel and floodplain and a detailed geomorphic analysis to determine an appropriate combination of channel sinuosity and channel geometry.	●					●			●			
m. Stream Restoration	Remove, replace concrete channel with natural stream and floodplain system. Stream capacity to be 2-year in a low flow channel and 10-year in a main channel. Restored floodplain to convey remainder of a capital flood event. Public safety and protection of structures would still be required. Include sediment management. Monitor changes in configuration over time. Maximize stream meander and construct aesthetically pleasing grade control structures. Integrate with existing natural areas. Raise stream invert to enhance high ground water table.	★	●	●	●				●				●
V. PASADENA'S LOWER ARROYO													
a. Exotic Species Inventory and Reduction	Inventory exotic plant and animal populations, develop and implement a reduction strategy.	●	●				●				●		
b. Trail System Improvement	Improve and connect the network of trails and bikeways to provide access for all.					●	●			●	●		

TABLE IV-2: RECOMMENDATIONS FOR PROJECTS AND STUDIES (CONT.)

PROJECTS, ACTIVITES & STUDIES	PROJECT DESCRIPTION	Stream / Flood	Habitat Restoration	Water Supply	Water Quality	Recr. / Open Space	1 – 5 yrs.	5 – 10 yrs.	10+ yrs.	<$500k	$500k-2M	$2M-10M	>$10M
c. Trash Reduction	Implement volunteer programs, educate park users, and modify maintenance to reduce the amount of trash/waste generated by humans and their pets. Construct and maintain trash control structures where appropriate.				●	●	●			●			
d. Open Space & Flood Impact Study	Inventory all structures at risk of flooding in both current conditions and planned restoration conditions.	●				●	●			●			
e. Laguna Restoration	Create wetlands and restore natural streambed from Johnson Lake to the San Rafael Bridge.	●	●		●			●				●	
f. Stream Restoration	Remove, replace concrete channel with natural stream and floodplain system in the following reaches: Lower Arroyo Park - north; Lower Arroyo Park – south; BFI project to La Loma bridge; La Loma bridge to San Rafael bridge. In Lower Arroyo Park-south, stream capacity to be 50-year. In other areas, create a bi-level stream with 2-year low flow and 10-year main channel. Higher flows to overflow into floodplain. Public safety and protection of structures would still be required. Include sediment management. Maximize stream meander and construct aesthetically pleasing grade control structures. Integrate with existing natural areas. Raise stream invert to enhance high ground water table.	★	●	●	●				●				●
VI. ARROYO THROUGH SOUTH PASADENA													
a. San Pasqual Stables Improvement	Implement and maintain structural and non-structural Best Management Practices to lessen environmental impacts of stables.	●			★	●	●			●	●		
b. Arroyo Nature Park	Remove exotic plants, improve trail access, protect and enhance existing native vegetation and animals.		●			★	Project in Progress (MRCA)						

TABLE IV-2: RECOMMENDATIONS FOR PROJECTS AND STUDIES (CONT.)

PROJECTS, ACTIVITES & STUDIES	PROJECT DESCRIPTION	Stream / Flood	Habitat Restoration	Water Supply	Water Quality	Recr. / Open Space	1 – 5 yrs.	5 – 10 yrs.	10+ yrs.	<$500k	$500k-2M	$2M-10M	>$10M
c. Arroyo Seco Bank Restoration	Restore natural stream bank on west bank land between the 110 and Arroyo Seco in the City of Los Angeles.	●		●	●			●				●	
d. Trash Reduction	Implement volunteer programs, educate park users, and modify maintenance to reduce the amount of trash generated by recreational uses.				●	●	●			●			
e. Stream Restoration Planning	Conduct a detailed hydraulic and geomorphic analysis of the channel and floodplain from Arroyo Seco Parkway to Pasadena Avenue. Determine existing ground water levels and estimate the increase in ground water levels that could be achieved with a naturalized channel. Determine impacts to wildlife habitat.	●	●	●			●			●			
f. Water Quality Evaluation	Evaluate water quality conditions of proposed restorations. Include impact of periodic flooding at stables.												
g. Open Space & Flood Impact Study	Inventory all structures at risk of flooding in both current conditions and planned restoration conditions.												
h. Stream Restoration	Remove the existing concrete channel and create a natural streambed with 50-year capacity. A restored floodplain would convey overflows greater than 50-year. Public safety and protection of structures would still be required.	★	●	●	●				●				●
VII. ARROYO THROUGH LOS ANGELES													
a. Debs Park	Enhance wildlife habitat, habitat restoration, and passive recreational uses throughout the park in accordance with Debs Park Framework Plan. Enhance open space connectivity between Debs Park and Arroyo Seco, especially north of Avenue 52. Focus areas to include: Main entrance, parking lot, pond, Nature Center lease area along Griffin Avenue.		●			●	●				●		
b. Nature Center	Construct a Nature Center in Debs Park, highlighting selected native species.		●			●	Project in Progress (Audubon)						

TABLE IV-2: RECOMMENDATIONS FOR PROJECTS AND STUDIES (CONT.)

PROJECTS, ACTIVITES & STUDIES	PROJECT DESCRIPTION	Stream / Flood	Habitat Restoration	Water Supply	Water Quality	Recr. / Open Space	1 – 5 yrs.	5 – 10 yrs.	10+ yrs.	<$500k	$500k-2M	$2M-10M	>$10M
c. Trail System Improvement	Improve and connect the network of trails and bikeways to provide access for all. Provide connections to Mt. Washington and Montecito Heights. Improve pedestrian route to Bushnell Way Elementary School with grading, native plants, and safety enhancements.		●			★	●			●	●		
d. Cultural Corridor	Create a uniform system of pedestrian improvements to connect Southwest Museum, Casa de Adobe, Lummis Home and Heritage Square. Provide historic interpretation and trails. Utilize signage, native plants, and Best Management Practices as appropriate.		●		●	●	●	●			●		
e. Gold Line Stations (cost estimate is per station)	Improve Gold Line Station sites with native plants, amenities and layout to encourage pedestrian and bike access, and connections to the trail system.		●			★	●			●	●		
f. Pedestrian Bridges	Improve safety, security, and visual quality of pedestrian bridges. Improve connections to trail and bikeway systems.					●		●				●	●
g. Trash Reduction	Implement volunteer programs, educate park users, and modify maintenance to reduce the amount of trash/waste generated by humans and their pets. Construct and maintain trash control structures where appropriate.				●	●	●			●			
h. Exotic Species Inventory and Reduction	Inventory exotic plant and animal populations, develop and implement a reduction strategy. Focus specie include Castor Bean and Pittosporum.	●	●				●				●		
i. Native Plant Collection	Collect cuttings, seeds, and root stock as needed to create a nursery bank for plantings of native bunchgrasses, wildflowers, shrubs, and trees.		●				●			●			
j. Hillside Restoration Study	Test different techniques for hillside restoration. Methods should be analyzed for costs, success rates, environmental impact, and speed.		●		●		●				●		

TABLE IV-2: RECOMMENDATIONS FOR PROJECTS AND STUDIES (CONT.)

PROJECTS, ACTIVITES & STUDIES	PROJECT DESCRIPTION	Stream / Flood	Habitat Restoration	Water Supply	Water Quality	Recr. / Open Space	1 – 5 yrs.	5 – 10 yrs.	10+ yrs.	<$500k	$500k-2M	$2M-5M	>$10M
k. Rainbow Canyon	Remove below ground stormwater pipes and create wetlands, natural streambed, native plantings, and trash reduction measures in lower Rainbow Canyon.	●	●	●	●		●					●	
l. North Branch	Restore natural stream flow and habitat to remnant sections of Arroyo Seco's North Branch. Include trash reduction measures.	★	●	●	●			●				●	
m. Stream Restoration Planning	Conduct a detailed hydraulic and geomorphic analysis of the channel and floodplain. Determine the feasibility of a natural streambed vs. a low-flow stream over a buried flood facility, and possible combinations. Determine existing ground water levels and estimate the increase in ground water levels that would be achieved with a natural streambed. Coordinate recommended designs with the Arroyo Seco Bikeway.	●					●			●			
n. Stream Restoration	Remove the existing concrete channel and create a natural streambed as recommended by restoration planning studies. A restored floodplain in the golf course and open areas would convey overflows as indicated in planning studies. Public safety and protection of structures would still be required. Construct grade control features to reduce channel slope and flow velocity. Include sediment management.	★											
VIII. CONFLUENCE WITH LOS ANGELES RIVER													
a. Confluence Park	Create public open space in the vicinity of the confluence. Provide bikeway connections, pedestrian improvements, and enhance plantings.		●		●	●	Project in Progress (MRCA)						
b. Trash Reduction	Organize and sponsor regular trash removal from the confluence area.	●			●		●			●			
c. Open Space Connection Study	Develop specific routes to connect the east and west banks of the Los Angeles River and existing open space for pedestrian and bicycle access.					★	●			●			

TABLE IV-2: RECOMMENDATIONS FOR PROJECTS AND STUDIES (CONT.)

PROJECTS, ACTIVITES & STUDIES	PROJECT DESCRIPTION	Stream / Flood	Habitat Restoration	Water Supply	Water Quality	Recr. / Open Space	1 – 5 yrs.	5 – 10 yrs.	10+ yrs.	<$500k	$500k-2M	$2M-10M	>$10M
d. Habitat Connection Study between Debs Park-Mt. Washington to Elysian Hills	Develop specific connectivity routes to connect the east and west banks of the Los Angeles River and existing habitat for wildlife.		★								●		
e. Stream Restoration	Restore a natural streambed at the confluence. Lower channel invert and construct a natural streambed with concrete sides. Widen waterway where possible. Use grade control features as needed to reduce channel slope and flow velocity. Alternatively, create naturalized low flow channel over a buried flood facility. Include sediment management. Public safety and protection of structures required.	★								●			●

E. NEXT STEPS

The project team has identified a series of the next steps that will need to be undertaken to carry the restoration of the Arroyo Seco watershed into the future. Some of these steps have already commenced while others will require additional coordination with the responsible entities.

1. US ARMY CORPS OF ENGINEERS RECONNAISSANCE STUDY

In response to a request from the Los Angeles County Department of Public Works (Public Works) in partnership with North East Trees and the Arroyo Seco Foundation, the US Army Corps of Engineers (Corps) is currently undergoing a Reconnaissance Study of the Arroyo Seco watershed. The purpose of this study is to determine if there is a "federal interest" in a particular flood management, watershed, or ecosystem restoration issue. If the Corps finds that there is a federal interest in the watershed as a result of this study and that a watershed plan or project is possible, Congress may authorize funding to enable the Corps undertake a more detailed Feasibility Study. A Feasibility Study must be cost-shared 50%-50% with a local non-federal sponsor. Public Works has agreed to be the lead local sponsor in partnership with additional sponsors such as the cities of the watershed. In working with the local partners, the Corps will develop a technically viable, economically feasible, and environmentally acceptable project to be forwarded to Congress for authorization and funding for capital projects. In the long term, the result of this process would be one or more capital projects in the watershed, of which the Corps would fund a majority of implementation costs which would be cost-shared with local sponsors. In most cases, completed projects would be operated and maintained by a State or local entity.

2. PROPOSITION 13/CALFED GRANTS

In order to continue the Arroyo Seco watershed planning process, North East Trees has been awarded two grants from the State of California. The first is the result of Proposition 13, the Costa-Machado Water Act of 2000. This funding will come from the State Water Resources Control Board, and is being administered by the local Los Angeles Regional Water Quality Control Board. The work generated from this grant will focus on water quality issues, especially with regards to the importance of implementing TMDLs. The second funding source is from the CALFED Bay-Delta Watershed Program and will be used to examine water resource issues and develop public education and outreach about water supply and watershed issues. The work for both of these grants is to begin in the latter half of 2002 and is expected to continue through 2003.

3. ONGOING COORDINATION

To continue the ongoing coordination that has taken place between stakeholder agencies and organizations, the project team is proposing the development of two standing councils. One will be the Council of Arroyo Seco Agencies (CASA) while the other, which will consist of community-based and nonprofit organizations, will be the Council of Arroyo Seco Organizations (CASO). CASA will be a natural outgrowth of the ongoing Agency Technical Review Committee, with the potential to expand agency representation as interests in this watershed expand. There are many efforts underway that address issues affecting the entire Arroyo Seco subregion beyond the watershed study including the designation of the historic Arroyo Seco Parkway as a National Scenic Byway, which is due to occur in June, 2002. There is a need for these new councils to broaden to encompass all of these issues and efforts. The project team will be coordinating the development of these organizations.

4. IMPLEMENTATION OF PROJECTS

Consideration and possible adoption of the project restoration goals are the first steps towards restoration implementation. Once that is done, on-the-ground implementation of projects one-by-one is the next most important step. The following five action items are a summary of earlier text for using the "Recommendations for Projects and Studies" matrix:

1. Identify appropriate projects per an agency's or organization's mission.
2. Prioritize projects according criteria such as the projects ability to meet an agency's goals, budget and scheduling.
3. Seek out funding sources, such as Proposition 12, 13 or 40 funds from the state. Seek local, federal and private funds as well. Form partnerships to strengthen proposal. leverage existing funds or in-kind services.
4. Design and build projects and implement programs.
5. Continue ongoing coordination with other stakeholders to leverage resources, collectively educate the public, and meet individual goals with mutually beneficial projects and programs.

F. CONCLUSIONS

There is no better time to restore the Arroyo Seco stream than right now. Watershed consciousness has permeated agencies and organizations throughout the country. The public is becoming more aware of and concerned about the future of our finite resources. Major changes need to occur with how we manage our natural resources, or we will

continue to separate ourselves from the natural systems upon which our very survival relies. From an unknown source comes this thought, "Whatever his accomplishments, his sophistication, his artistic presentation, man owes his existence to 6" of topsoil & the fact that it rains."

Currently, the State of California has millions of dollars of potential funding for watershed-related projects available through Propositions 12, 13 and 40. CALFED also has monies available for proposals that make the connection between local water supply efforts and the Sacramento Bay-Delta water supply region. Just released is the Joint Task Force on California Watershed Management AB2117 report, "Addressing the Need to Protect California's Watersheds: Working with Local Partnerships," 2002. The Arroyo Seco is one of the ten featured watersheds in that report.

In southern California, several efforts relate directly to the work of the Arroyo Seco Watershed Restoration Feasibility Study. Non-profit groups, including North East Trees and the Arroyo Seco Foundation, and agencies have coordinated to take responsibility for the planning of several subwatersheds of the Los Angeles and San Gabriel Rivers. This regional effort is being coordinated by the Los Angeles and San Gabriel Rivers Watershed Council, who is in their 6th year of existence. With regards to habitat connectivity, the South Coast Missing Linkages Project is currently undergoing large-scale planning of connecting major mountain ranges with each other. This work ties in to the eventual habitat linkage between the San Gabriel and the Santa Monica Mountains, which the project team envisions for the Arroyo Seco. The Rivers and Mountains Conservancy have released their Open Space Plan, which offers planning guidelines that local efforts can adapt.

Locally, there are efforts happening that seeks to bring about awareness, appreciation and positive change for the Arroyo Seco's natural, historic and cultural resources. Current local efforts include the proposed ArroyoFest Event, the Corridor Management Plan/ Scenic Byway and the Pasadena Master Plan EIR. The ArroyoFest event, being planned by Occidental College and a consortium of local agencies and community-based organizations, proposes to close down the Arroyo Seco Parkway to host a bike ride and walk on the historic parkway. Occidental College teamed up with the University of California Los Angeles and the California Institute of Technology to form a joint academic course on issues related to the Arroyo Seco in the Spring Semester 2002. The Corridor Management Plan/Scenic Byway is being proposed by Caltrans, and will take into consideration improvements within the viewshed of the historic Arroyo Seco Parkway. The Pasadena Master Plan EIR is currently under a public review period, and proposes environmental and recreation enhancements for the heavily used Arroyo Seco within the city limits.

Many of us have worked for years to position ourselves for this moment in history—to remove what flood control engineers have created over 60 years ago, the Arroyo Seco concrete flood control channel. It is time to make urban stream restoration a reality, in a place many thought it impossible--the largest metropolitan region in the United States with the most extensively engineered flood control system anywhere in the world--southern California. This is an enormous challenge. This long term process will require further technical analysis, planning, collaboration, education, outreach, and funding.

YES, restoration of the Arroyo Seco IS feasible. Technical experts from both consulting firms and public agencies agree on this point. To what degree is still not clear, but this

question will become clearer as we take definite action towards watershed-wide restoration.

It is the hope of the project team that the recommendations from this report, laid out in a simple matrix format, will be the springboard from which multiple restoration efforts will take place. Each project or program needs a lead agency to take on the responsibility of that aspect of restoration. Each project in important. Every completed project brings us that much closer to a more sustainable future and a more livable environment.

Future generations will experience, as we do, the natural beauty, cultural richness and quality of life that is embodied in the Arroyo Seco watershed. In the words of Theodore Roosevelt, "The nation behaves well if it treats the natural resources as assets which it must turn over to the next generation increased and not impaired in value." Along with the tremendous responsibility that comes with the management of land and water resources, comes a tremendous opportunity. We have been given a chance to fully integrate these life-giving natural systems into our daily lives. By doing so we will have enhanced the beauty and resources of this unique region that is defined by the Arroyo Seco. Ultimately, we will be turning these resources over to future generations for their use and enjoyment for years to come.

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