

## CHAPTER 1

### INTRODUCTION TO THE WATERSHED ASSESSMENT

#### 1.1 Purpose

The State of California protects the quantity and quality of water for human and ecological uses through water regulation and management. A major focus for State water agencies is the Sacramento-San Joaquin Delta, which supplies 25 million Californians with water. Environmental issues in the Delta of statewide significance include water supply reliability and impairments to water quality. A partnership of state and federal agencies, the CALFED Bay-Delta Program, has worked to resolve these statewide issues in the Delta and San Francisco Bay.

CALFED has supported research to redress impaired water quality, especially impairment arising from mercury in the Delta, and has set the stage for remediating the human sources of mercury loading in its Sacramento River tributaries. Domalgaski (2001) found that the Cache Creek Basin has the highest levels of mercury of all tributary basins to the Sacramento River. Further, from all sites sampled for mercury in the Cache Creek Basin, Domalgaski et al. (2004a,b) found that the second highest concentrations of mercury in Basin water and sediment came from Bear Creek watershed and, more specifically, from Sulphur Creek subwatershed in the area downstream of numerous abandoned mercury mines and natural hot springs with high levels of mercury.

Mercury contamination provided the original impetus for the Bear Creek watershed assessment. However, CALFED and its funding agent, the Department of Water Resources, requested that the watershed assessment have a broader scope of stakeholder concerns about Bear Creek watershed.

The process of Bear Creek watershed assessment consisted of the following eight steps:

- Gather and organize information from stakeholders, technical literature, agency documents, and data sets that describe past and current conditions in the watershed
- Describe stakeholders' goals and stewardship issues for the watershed
- Conduct resource inventories as feasible and identify data gaps
- Prepare a written solicitation to the public for additional goals and issues and for additional information about Bear Creek watershed
- Assess water quality, hydrologic function, soil and site stability, and biological resources
- Identify locations, stewardship practices, and opportunities appropriate for addressing stakeholders' issues in the watershed through analysis areas based on subwatersheds

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- Present a draft version of the assessment for public review and comment
- Incorporate public comments and any new information into the final draft of the Bear Creek watershed assessment.

By assembling existing information, identifying gaps in information, and analyzing subwatersheds, the watershed assessment can be a reference for stakeholders as they address issues of concern.

The Bear Creek watershed assessment combines the format and subject matter for watershed assessments from two sources: the US Environmental Protection Agency (US EPA) (2003); and the two California Watershed Assessment Manuals (Shilling et al. 2005 and draft undated ms.) prepared for the California Resources Agency. The US EPA guidance focuses on water resources while the California Watershed Manuals use a multiple-resource perspective for a range of stakeholder issues.

### **1.2 Goals**

Eight stakeholder goals have guided the assessment process. The following sections discuss each of them.

#### ***Improve Water Quality***

Multiple contaminant chemical elements are impairing or have the potential to further impair water quality in Bear Creek watershed. The principal contaminant of concern is mercury. Most mercury contamination originates from abandoned mercury mine sites. Large quantities of sediment rich in mercury flow into watershed streams, especially during winter storms. The Central Valley Regional Water Quality Control Board (CVRWQCB) has established two total maximum daily load (TMDL) targets for Bear Creek and its tributary Sulphur Creek to recover the beneficial uses of water compromised by mercury contamination. The TMDLs limit amounts of total mercury permissible in Sulphur Creek subwatershed and amounts of methylmercury, the form of mercury that accumulates in aquatic microorganisms, fish, birds, and people, over the entire Bear Creek watershed.

Sediment discharges to watercourses are also occurring from roads, highways, culverts, livestock grazing and contribute to degraded water quality. Excessive sediment in streams is limiting beneficial uses for water such as municipal water supply and quality habitat for fisheries, frogs, turtles, and other aquatic organisms.

New threats to water quality are developing. Recently, law enforcement officers have found illegal marijuana gardens in the watershed where pesticides and fertilizers were used carelessly and are contaminating the soil and water. The extent of contamination in Bear

Creek watershed from illegal marijuana growing is not yet known.

***Restore Hydrologic Function***

A watershed has three primary water-related functions: capturing water, storing it in the soil, and releasing it beneficially for people and the environment (Bedell and Buckhouse 1995, Pellant et al. 2005). Across Bear Creek watershed, people's modifications to uplands and riparian zones over time have altered how and when water flows. Eroding soils resulting from mining, certain range management practices, poorly designed roads, altered stream channels, and floodplain loss have combined to reduce the ability of the watershed to capture, store, and release water. Symptoms of decreased hydrologic function are soil compaction, low vegetative cover, poor soil infiltration, and accelerated flows in streams. A major concern for stakeholders is the resulting drop in the water table in several parts of the watershed.

During its visit to Bear Creek watershed in 2001, the National Riparian Service Team from the Bureau of Land Management and the US Forest Service found low channel width-to-depth ratios on private lands in Bear Valley and Sulphur Creek valley and on the Bureau of Land Management's Bear Creek Ranch. Channel incision, lowered water table, creek channels disconnected from historic floodplains, headcuts, gullies, and sparse riparian vegetation were noted as symptoms of poor hydrologic function. These conditions intensify the erosion power of water during rainstorms and reduce the "sponge" capacity of floodplains to retain water longer in the watershed.

Roads alter water movement across the landscape and below ground. Compacted road surfaces decrease infiltration and increase water runoff. Road cuts on slopes intercept and bring groundwater to the surface. Ditches along roads and culverts divert surface and subsurface water flows and concentrate storm runoff, increasing its velocity and accelerating soil erosion.

***Conserve Topsoil and Stabilize Erosion-prone Areas***

Land instability and soil erosion are one symptom of degraded hydrologic function. Soil supports vegetation, retains moisture, and sustains agricultural production. Rates of soil movement and loss in many parts of the watershed are agricultural production and ecosystem services such as wildlife habitat. Management appropriate to the soil type and desired land use entails careful stewardship to avoid soil loss. For example, improvised OHV trails and poorly designed roads built on steep or unstable slopes can trigger unintended soil loss (Weaver and Hagens 1994).

***Protect and Enhance Biological Diversity***

Scientists, land management agencies, and the public recognize the significant ecological values of Bear Creek watershed. Highlights include: spectacular wildflower fields; alkali wetlands; ultramafic soils and their associated rare plants in seep, riparian, grassland, and mixed chaparral environments; extensive blue oak savannas; and the Bear Creek Botanical Management Area. Professor Ellen Dean at UC-Davis (pers. comm.) and her colleagues have documented 387 native plant species from the BLM Bear Creek Ranch alone, including 25 species found only on ultramafic soils and 18 CNPS Class IV rare species.

Professor Peter Moyle at UC-Davis (pers. comm.) considers Bear Creek a rare aquatic ecosystem, harboring native fishes, yellow-legged frog (*Rana boylei*), western pond turtle (*Clemmys marmorata*), beaver (*Castor canadensis*), and river otter (*Lontra canadensis*). It is a major corridor for neotropical migratory birds (P. Hoffman, pers. comm.) and a wintering area for bald eagles (*Haliaeetus leucocephalus*). Tule elk (*Cervus elaphus nannodes*), once nearly extinct in California but re-introduced to the watershed in the 1920's, are thriving again. Bear Creek is one of six known hot-spots in California for damsel- and dragonflies (K. Biggs, pers. comm.). Three rare insects are known only from the Wilbur Hot Springs area.

***Enhance Recreation***

Recreational opportunities abound in the watershed. Each year thousands of people from around the world visit Wilbur Hot Springs, stay in an historic hotel, and hike on trails in Sulphur Creek subwatershed. An estimated 32,000 people visit the federal public lands in the watershed annually for hiking, hunting, equestrian riding, camping, and nature exploration (calculated from the federal Recreation Management Information System 2008). Limited OHV recreation is available in the Walker Ridge area. Wildflower displays in Bear Valley and scenic vistas from Walker Ridge draw people to the watershed. A current proposal to create the Berryessa-Snow Mountain National Conservation Area would include all federally and state-managed lands within Bear Creek watershed and would give national recognition to the recreation resources and the natural setting of the watershed. Focus on recreation can provide economic opportunities for travel and tourism businesses and options to private landowners for income diversification based on the natural resources of their lands.

***Develop Energy Resources***

The federal government and the State of California intend to develop renewable energy resources to achieve greater national self-sufficiency in energy production and limit carbon emissions to the atmosphere. Private landowners in the watershed have already begun tapping solar and wind power for their own use. Energy generation on public lands and on private lands where the federal government manages subsurface geothermal, oil, and gas

rights in Bear Creek watershed are possible in the future. Bear Creek watershed is unusual because it has the potential to supply energy from five sources: oil, gas, geothermal, solar, and wind. Few other places in California have as many potential energy resources so close together. A proposal to lease federal public lands in the watershed to install wind turbines is now under consideration.

***Maintain Economic Livelihoods and Create Jobs***

Bear Creek watershed is a working landscape producing multiple goods, services, amenities, and values for stakeholders. Stakeholders are interested in knowing what options are possible for deriving or diversifying incomes based on natural resources found in the watershed. New opportunities may keep traditional livelihoods viable.

Activities in the watershed that are generating employment include: livestock and crop production, beekeeping, resort management, revegetation, mine remediation, road and culvert redesign and installation, invasive plant removal, repair of streambanks and headcuts, diverse recreational opportunities, and tourism. Ranching has been the cornerstone economic enterprise for many generations in the watershed. Livestock production creates income, provides food, maintains wildflower fields, promotes conservation programs, and protects these large landscapes from commercial development and residential subdivisions. Two ranches within the watershed have conservation easements, providing outside funding sources for ranching enterprises and land protection on private lands.

Stakeholder issues generate possibilities for employment as issues are addressed to reach watershed goals. Past stewardship projects have already generated employment, through project funding amounting to more than \$1.5 million. This assessment identifies project options and employment opportunities that enhance the landscape quality and natural resources of Bear Creek watershed.

***Reduce the Likelihood and Impacts of Catastrophic Events***

Maintaining basic ecological functions such as hydrologic function, soil fertility, and the natural diversity of the watershed is essential to its continued utility as a working landscape. Catastrophic events, especially in combination, have the potential to alter the watershed and its productivity in ways that will not benefit people. Five categories of catastrophic environmental events known to have occurred in the watershed are under discussion: contaminants and sediments that impair water quality; adverse outcomes from large-scale and intense fires; abnormal floods; extended drought; and climate change. Strengthening the capacity of the watershed to be resilient to catastrophic events works to the advantage of people because flows of goods and services from the watershed are more likely to be sustained in times of environmental and economic change.

### **1.3 Audience**

The audience for this assessment consists of individuals or groups such as property owners, businesses, academic and research institutions, government agencies, advocacy groups, and any other persons who have an interest or “stake” in Bear Creek watershed. One of the challenges for this assessment has been to adequately characterize the issues for as many stakeholders as possible. As might be expected, interests among stakeholders differ for a range of reasons, and stakeholders have diverse expectations, values, economic needs, and professional obligations. Although we have attempted to be inclusive and comprehensive, we recognize that many gaps in our knowledge about stakeholder’s values, interests, and aspirations exist.

The following descriptions outline the general categories of stakeholders and their roles in the watershed.

#### ***Private Individual Landowners***

Some private landowners have lived all or most of their lives in the watershed. Their families may have settled in the region generations ago. From their direct experience and knowledge received from their families, they have a deep understanding of the watershed. Other landowners may have purchased property more recently because they appreciate the lands in the watershed and the opportunities and amenities that these lands afford. In many cases, the household economies of private landowners are based on using and managing natural resources in the watershed. Important concerns for this group are: economic resiliency and diversification; continuity of an independent, rural lifestyle; protection of private property rights; and concern about legal liabilities from trespass and from abandoned mines.

#### ***Private Business Landowners***

These landowners mostly do not reside in Bear Creek watershed. Their businesses continue traditional economic enterprises such as livestock ranching both in and outside the watershed. They have broader interests geographically and do not depend solely on conditions in the watershed for their economic well-being. Net profit is important for retaining their land base in a portfolio of business assets. If the highest and best economic use of their land or available tax and stewardship incentives should change, these landowners might change land uses to maximize their benefits from the land.

#### ***Non-Landowner Employees and Residents***

People whom landowners employ to manage property operations share many of the same skills with private individual landowners. The stakes of these employees in the watershed are not property-based; nonetheless, they are likely to care about environmental conditions in the watershed. Other non-landowning residents in the watershed residents rent homes in

the watershed and commute to jobs outside the watershed.

***Former Residents***

The population of the watershed was once much larger than it is now and included more multi-generation families. Opportunities elsewhere have drawn people away from Bear Creek watershed, but memories and emotional bonds from a sense of place link former residents to the watershed. They care about the places that were their past homes; they also may have key information about past events in the watershed important to understanding watershed conditions. This group also includes Native Americans whose ancestors were residents in the watershed and for whom the watershed is a landscape of cultural heritage.

***Non-Resident Consumptive Resource Users***

Businesses, individuals, and advocacy groups outside the watershed have a stake in extracting non-renewable resources from the watershed, such as minerals, decorative rock, petroleum, and natural gas. Stakeholders in this group may seek easements or leases to acquire belowground minerals and energy reserves. Changes in commodity values in the marketplace and government incentives may spur these stakeholders to extract the natural resources of interest to them.

Some consumptive resource uses are renewable. Non-resident stakeholders use water for domestic use and agriculture, produce food and animal forage, hunt game animals, and forage for traditional food plants are examples. The sustainability of these resources depends on maintaining a healthy and resilient watershed.

***Non-Resident Non-Consumptive Resource Users***

Individuals, corporations, and advocacy groups who promote non-consumptive resource use of Bear Creek watershed include tourism and recreation interests. Their economic and environmental significance can be considerable, particularly for public lands. Some stakeholders may come to the watershed from great distances and are interested in public lands for touring, sports, wildlife and wildflower viewing, and other leisure activities.

***Potentially Responsible Parties for Abandoned Mines***

Historic mining in the watershed has left a legacy of contaminated landscapes and modified hydrologic conditions. Responsible parties for cleaning up mines abandoned before 1980 are the corporations or individuals who created the hazardous waste sites, or their successors. Federal law requires that they must pay to clean up abandoned mine sites. In some cases, these stakeholders may not wish to participate because of the liability to remediate conditions and reclaim land at abandoned mines.

***Agencies Providing Public Works and Protection***

This group consists of agencies in the federal, state, or county government that have responsibilities to provide public services such as transportation infrastructure, law enforcement, and fire protection.

***Agencies Managing Public Lands and Resources***

Federal and State of California agencies that manage public lands and resources in trust for citizens have multiple mandates to produce goods, services, amenities, and other values. Best choices for management are seldom clear-cut, and other watershed stakeholders frequently challenge public land management agencies on their management decisions at public meetings, during hearings, and in court. Appendix A of this assessment summarizes current management plans from land management agencies for public lands in Bear Creek watershed.

***Agencies Regulating Public Resources***

Many resources, such as air, water, soil, and biological diversity, are held in public trust regardless of who owns the surface land rights. Regulation of air and water quality and of populations of threatened or endangered species falls to specific Federal and California state agencies. Appendix B of this assessment describes current planning and regulations of resource agencies that refer to Bear Creek watershed.

***Elected Officials***

Elected officials advocate for their constituents' interests. When stakeholders gain the attention of their elected officials for initiating a political action in regard to the watershed, the elected officials become stakeholders as well.

***Appointed Officials***

Some regulatory agencies have boards of directors appointed by the Governor of California, the California State Senate, and the California State Assembly. These appointed officials have received recognition from political leaders as excellent decision-makers regarding trust resources. They may be active advocates for using State of California funds for projects in Bear Creek watershed.

***Outsiders***

Professional expertise for understanding and managing a watershed frequently comes from outside people. Their knowledge and ability to analyze watershed conditions can facilitate people's understanding of watershed conditions and possibilities for change. These individuals can also work with stakeholders groups to design novel solutions that would likely not have been created without the group interaction. For example, these professionals may be local, state, or federal extension agents; researchers and faculty members of

universities; or specialists employed at profit or not-for-profit consulting firms.

#### **1.4 Issues**

Stakeholders have furnished sixteen issues for Bear Creek watershed assessment that serve to orient management actions for achieving watershed goals. Chapter 6 covers the scope and implications of each stakeholder issue identified thus far in greater detail. The list of issues follows:

- Toxic chemicals
- Sediment delivery to watercourses
- Creek channel alterations
- Creek and tributary headcuts
- Roads, trails, and fire suppression lines
- Fire
- Oak woodlands
- Disturbances to ultramafic soils
- Non-native invasive species
- Low recruitment of native woody riparian plants
- Impacts from certain livestock grazing practices and browsing and gnawing animals
- Growing demand for recreation and tourism
- Potential environmental impacts of energy developments
- Fiscal and policy obstacles for landowners to meet regulatory targets
- Climate change
- Information gaps

Most stakeholder issues relate to more than one watershed goal. Table 1.1 below furnishes a crosswalk between stakeholder issues and watershed goals. In the last column of the table, the listed section numbers correspond to parts of the watershed assessment that relate to a particular issue. The table can guide the reader to the parts of the document of greatest interest.

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Table 1.1 – Crosswalk between watershed goals and stakeholder issues

Stakeholder Issues	Watershed Goals								Relevant Watershed Assessment Sections
	Improve water quality	Restore hydrologic function	Conserve topsoil and stabilize erosion-prone areas	Protect and enhance biological diversity	Enhance recreation	Develop energy resources	Maintain economic livelihoods and create jobs	Reduce likelihood and impacts of catastrophic events	
Toxic chemicals	X		X		X	X	X	X	2.6, 2.7, 3.7, 4.1, 5.1-5.12, 6.1, 7.11-7.13, 8.2, Appendices G & H
Sediment delivery to watercourses	X	X	X			X	X	X	2.7, 2.8, 3.5-3.7, 3.9-3.11, 4.1-4.3, 5.1, 5.4, 6.2, 7.1, 7.3, 7.5, 7.6, 7.8-7.13, 8.2, Appendices G & H
Creek channel alterations	X	X	X	X		X	X		3.4, 3.6, 3.7, 3.11, 4.3, 6.3, 7.1, 7.6, 7.7, 7.10-7.13, 8.2
Creek and tributary headcuts	X	X	X						3.4, 3.6, 3.7, 3.11, 4.3, 6.3, 7.6, 7.10-7.13, 8.2
Roads, trails, and fire suppression lines	X	X	X	X	X	X	X		2.7, 2.9, 2.10, 3.4, 3.6-3.12, 5.4, 6.5, 7.3-7.7, 7.11-7.13, 8.2
Fire	X		X	X				X	2.9, 2.11, 3.2, 3.3-3.6, 3.10, 3.11, 4.1-4.3, 6.6, 6.7, 7.1, 7.3, 7.8-7.11, 7.13, 8.2
Oak woodlands		X	X	X		X	X		2.3, 2.4, 2.7, 2.9, 2.10, 2.11, 2.12, 3.2-3.9, 4.1, 6.7, 7.2, 7.5-7.13
Disturbances to ultramafic soils	X		X	X		X			2.6-2.11, 3.5-3.9, 3.11, 4.1, 4.2, 5.1-5.4, 5.6-5.8, 6.1, 6.8, 7.2-7.4, 7.7, 7.11-7.13
Non-native invasive species		X		X			X		2.4, 2.7, 2.9, 2.10-2.12, 3.4-3.6, 3.8-3.11, 4.1, 4.4, 5.3, 6.9, 7.2, 7.5-7.8, 7.11-7.13, 8.2
Low recruitment of native woody riparian plants		X	X	X					2.7, 2.9, 2.10, 2.12, 3.3-3.6, 3.11, 4.3, 4.4, 5.3, 6.9, 6.11, 7.3, 7.5-7.8, 7.10-7.13, 8.2

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Stakeholder Issues	Watershed Goals								Relevant Watershed Assessment Sections
	Improve water quality	Restore hydrologic function	Conserve topsoil and stabilize erosion-prone areas	Protect and enhance biological diversity	Enhance recreation	Develop energy resources	Maintain economic livelihoods and create jobs	Reduce likelihood and impacts of catastrophic events	
Impacts from animals	X	X	X	X					2.5, 2.7, 2.9-2.11, 3.2, 3.4-3.6, 5.1, 5.4, 6.9-6.11, 7.1, 7.2, 7.5-7.13, 8.2
Growing demand for recreation and tourism	X				X	X	X		2.1, 2.3-2.6, 2.9-2.13, 3.5, 3.8, 3.9, 3.11, 5.6, 6.12, 7.1, 7.2, 7.4, 7.8, 7.11-7.13
Potential impacts of energy developments	X			X	X	X	X		2.3-2.13, 3.2-3.5, 3.8-3.11, 4.1-4.3, 5.4, 6.13, 7.3, 7.4, 7.11
Obstacles for landowners to meet regulatory targets	X		X						2.6, 3.1-3.4, 3.7, 5.1-5.7, 6.14, 7.6, 7.11-7.13
Climate change		X	X	X		X	X	X	2.4, 2.9-2.10, 2.13, 3.3-3.6, 3.9, 4.1, 4.3, 4.4, 6.16, 7.1-7.4, 7.6, 7.7, 7.9-7.13, 8.2
Information gaps	X	X	X	X	X	X			2.7-2.11, 3.3-3.12, 4.1, 4.3, 4.4, 5.2-5.4, 5.6-5.8, 5.10, 5.12, 6.1-6.16, 7.2-7.4, 7.7-7.13, 8.2

### **1.5 Guiding Principles**

In preparing the watershed assessment, we used the following guiding principles to guide the work:

- respect for all stakeholders
- appreciation for the unique places and resources in Bear Creek watershed
- desire to share information
- commitment to make the assessment easy to access, understand, and use
- inclusion of stakeholders in assessment input and review to the extent that they are interested and had time
- continual search for available information about Bear Creek watershed
- the value of science, data, and assessment to inform thinking about the watershed.

### **1.6 Information Sharing and Public Outreach**

In the first phase of the assembling the watershed assessment, the authors informally contacted and visited with stakeholders (including landowners, resource and land management agencies, researchers familiar with the watershed, and resource users), visited remote sites in the watershed, and developed the scope and outline of the watershed assessment. Contractors were engaged to provide new information about the watershed geomorphology in the northern two-thirds of the watershed as well as to analyze the roads and erosion in Sulphur Creek subwatershed. The authors collected and organized data sets covering a wide spectrum of environmental data about the watershed, including geology, soils, hydrology, plants, fish and wildlife, geochemistry, and land uses.

Once an initial set of watershed goals and stakeholder issues were identified, the assessment authors produced an Introduction to the Assessment on December 01, 2008, to present goals and issues and to request additional information from the stakeholders that could expand the scope of the watershed. Public presentations were provided for the BLM California State Office Natural Resources Division staff, the BLM Ukiah Field Office staff, the Colusa County Resource Conservation District (RCD) Board Members and staff, the Northwest California Resource Advisory Council members, and the Cache Creek Forum. Many residents of Colusa County, all watershed landowners including those living outside the county, governmental agencies, non-governmental organizations, and user groups received the introduction in a version emailed, sent by post, or downloaded from the Colusa County RCD website at [www.colusarcd.org](http://www.colusarcd.org).

After an internal review by core stakeholders and by the BLM National Operations science team, the Colusa County RCD posted a revised draft version for full public review on December 10, 2009. Copies again were delivered by download from the RCD's website.

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People were requested to submit new information, goals, and issues as well as detailed comments for improving the assessment during a 45-day comment period. Public meetings at the time of release of the draft version took place at the offices of the Colusa County RCD, the Yolo County RCD, and the BLM Ukiah Field Office.

In February 2010, the final draft of the watershed assessment appeared on the Colusa County RCD website. Public meetings to present the final assessment took place at the Colusa County RCD, Yolo County RCD, and the BLM Ukiah Field Office.

### **1.7 Participants in Preparation and Review**

#### ***Watershed Assessment Authors***

James F. Weigand  
Craig D. Thomsen

#### ***Bureau of Land Management Editorial Review***

David Christy  
Sandra McGinnis

#### ***Bureau of Land Management National Operations Center Science Review***

Karl Ford  
Craig Goodwin  
Don Prichard  
Bill Ypsilantis

#### ***Stakeholder Technical Review***

Residents and landowners in Bear Creek watershed  
Staffs of the BLM Ukiah Field Office and the Mendocino National Forest  
Jack Alderson, USDA Natural Resource Conservation Service  
Dr. Janis Cooke, Central Valley Regional Water Quality Control Board  
Dr. Joseph Furnish, Aquatic Ecologist, US Forest Service, Region 5  
Margie Graham, Department of Water Resources, Northern District  
Dr. Susan Harrison, University of California at Davis  
Stefan Lorenzato, Yolo County Flood Control and Water Conservation District  
Patti Turner, Colusa County RCD

### **1.8 Structure and Content of the Following Chapters**

Chapter 2 describes Bear Creek watershed in terms of its physical setting, key natural resources, and ecosystem functions.

Chapter 3 presents the historic and current information about land uses, the economy, and watershed residents.

Chapter 4 introduces natural disturbances that affect the appearance and function of the watershed: fire, geological hazards, floods, and drought.

Chapter 5 assesses water and air quality, sources and types of pollutants, and impacts to aquatic ecosystems from pollutants.

Chapter 6 takes up stakeholders' issues, discusses the factors that contribute to creating or alleviating issues.

Chapter 7 examines subwatersheds to determine priorities and draws attention to coordinated actions to benefit the watershed and provide job opportunities.

Chapter 8 summarizes watershed assessment findings, discusses the use of best management practices, and makes recommendations to stakeholders for inventories, monitoring, and research to support decision making in watershed management. A separate document accompanying the assessment describes projects that are funded or likely to be funded over the period 2010 to 2014.

Following Chapter 8, appendices provide greater detail on subjects discussed in the preceding chapters. Appendices cover selected watershed resources, the scope of public land management, and the government regulations in place.

A bibliography of references used for this watershed assessment and a glossary of terms are found at the end of the document.